YANKEE ATOMIC ELECTRIC COMPANY

Telephone (508) 779-6711
TWX 710-380-7619

YANKEE

580 Main Street, Bolton, Massachusetts 01740-1398

December 20, 1993
BYR 93-086

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Attention: Dr. Thomas E. Murley, Director
Office of Nuclear Reactor Regulation

References:
(a) License No. DPR-3 (Docket No. 50-29)
(b) Letter, J. Thayer, Yankee Atomic Electric Company (YAEC) to T. Murley, U.S. Nuclear Regulatory Commission (NRC), dated December 21, 1993
(c) Letter, A. Kadak, YAEC to T. Murley, NRC, dated February 27, 1992

Dear Dr. Murley:

Subject: ENVIRONMENTAL REPORT FOR THE DECOMMISSIONING OF YANKEE NUCLEAR POWER STATION

Pursuant to 10 CFR 51.53(b) of the Commission's Rules and Regulations, Yankee Atomic Electric Company (YAEC) hereby submits the Supplement to Applicant's Environmental Report - Post Operating License Stage. This report is being submitted simultaneously with the Decommissioning Plan (Reference (b)) for the Yankee Nuclear Power Station (YNPS).

By letter dated February 27, 1992 (Reference (c)), YAEC notified the U.S. Nuclear Regulatory Commission (NRC) of the company's decision to cease power operations permanently at YNPS. Consistent with that decision, YAEC has submitted the Decommissioning Plan for YNPS in accordance with 10 CFR 50.82, which requires that a decommissioning plan be submitted to the NRC within two years of permanent cessation of power operations (Reference (b)). In addition, 10 CFR 51.53(b) requires that a supplement to the Environmental Report for the post-operating stage be submitted with the Decommissioning Plan.

As discussed in the enclosed Environmental Report, YAEC evaluated the three decommissioning alternatives described in NUREG-0586, Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities. The alternatives are immediate dismantlement, storage followed by dismantlement, and entombment. Based on this evaluation, in part, YAEC determined that the most appropriate alternative for YNPS is to defer final decontamination and dismantlement activities dependent upon the availability of a low level radioactive waste disposal facility. The Environmental Report as required by 10 CFR 51.53(b) demonstrates that the decommissioning of the YNPS will have no significant environmental impacts.

In accordance with 10 CFR 51.55(a), forty-one (41) copies of the Environmental Report are included with this letter. Additional copies are available from YAEC for distribution to other parties or organizations at a later date, if so instructed by the NRC. Should you have any questions regarding this submittal, please forward the questions to Ms. Jane Grant for resolution.

Sincerely,

YANKEE ATOMIC ELECTRIC COMPANY

J. K. Thayer
Vice President and Manager of Operations

Attachments

c: USNRC Region I
R. Dudley, NRC, NRR
M. Fairtile, NRC, NRR

COMMONWEALTH OF MASSACHUSETTS)
)ss
WORCESTER COUNTY)

Then personally appeared before me, J. K. Thayer, who, being duly sworn, did state that he is a Vice President and Manager of Operations of Yankee Atomic Electric Company, that he is duly authorized to execute and file the foregoing document in the name and on behalf of Yankee Atomic Electric Company and that the statements therein are true to the best of his knowledge and belief.

Kathryn Gates Notary Public
My Commission Expires January 24, 1997

YANKEE NUCLEAR POWER STATION

SUPPLEMENT TO APPLICANT'S ENVIRONMENTAL REPORT

POST OPERATING LICENSE STAGE

DECOMMISSIONING ENVIRONMENTAL REPORT

YANKEE ATOMIC ELECTRIC COMPANY

DECEMBER, 1993

DECOMMISSIONING ENVIRONMENTAL REPORT

TABLE OF CONTENTS

DECOMMISSIONING ENVIRONMENTAL REPORT

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

DECOMMISSIONING ENVIRONMENTAL REPORT

TABLE OF CONTENTS

DECOMMISSIONING ENVIRONMENTAL REPORT

LIST OF TABLES

DECOMMISSIONING ENVIRONMENTAL REPORT

LIST OF FIGURES

DECOMMISSIONING ENVIRONMENTAL REPORT

ABREVIATIONS, TERMS AND UNITS

ALARA	As Low As is Reasonably Achievable
BOD_5	Biological oxygen demand
CFR	Code of Federal Regulations
Ci	Curie: unit of radioactivity = 3.7E10 disintegrations/second
μCi	0.000001 Ci = 37,000 disintegrations/second
pCi	0.000000000001 Ci = 0.037 disintegrations/second
CRP	Component Removal Project
DF	Decontamination Factor
DECON	Immediate Decontamination and Dismantlement Option
DLI	Massachusetts Department of Labor and Industries
DOT	Department of Transportation
ENTOMB	Encasement in Concrete with Future Dismantlement Option
EPA	Environmental Protection Agency
FCC	Federal Communications Commission
GEIS	Generic Environmental Impact Statement
HEPA	High Efficiency Particulate Air [filter]
ICRP	International Commission on Radiological Protection
LLW	Low Level Waste
MM	Modified Mercalli scale
MDEP	Massachusetts Department of Environmental Protection
MWe	Megawatts Electric
MWt	Megawatts Thermal
NCPR	National Council on Radiation Protection and Measurement
NEP	New England Power Company
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
NRC	[or USNRC] United States Nuclear Regulatory Commission
ODCM	Off-Site Dose Calculation Manual
OSHA	Occupational Safety and Health Administration
PAG	Protective Action Guides
PCB	Polychlorinated Biphenyls
PCP	Process Control Program
PWR	Pressurized Water Reactor
Person-rem	Collective Radiation Dose to a Population
mrem	0.001 Rem (unit of dose equivalent)
mR	0.001 Roentgen: unit of radiation exposure
μR	0.000001 Roentgen
REMP	Radiological Environmental Monitoring Program
RWP	Radiation Work Permit
SAFSTOR	Delayed Decontamination and Dismantlement Option

ABREVIATIONS, TERMS AND UNITS

TLD	Thermoluminescent Dosimeter
YAEC	Yankee Atomic Electric Company
YAEL	Yankee Atomic Environmental Lab
YNPS	Yankee Nuclear Power Station

DECOMMISSIONING ENVIRONMENTAL REPORT

1.0 OVERVIEW

The following sections provide an overview of the Decommissioning Environmental Report for Yankee Nuclear Power Station (YNPS), including an introduction to the facility, the purpose and regulatory basis for this report, Yankee Atomic Electric Company's (YAEC, Yankee) choice of decommissioning alternative for YNPS, final release criteria for the site, and the summary and conclusions of the assessment of the environmental impact of decommissioning YNPS.

1.1 INTRODUCTION

YNPS is located on the east bank of the Deerfield River in Rowe, Massachusetts. YNPS achieved initial criticality in 1960, began commercial operations in 1961, and operated through 1991 with an average capacity factor of about 74 percent. The nuclear steam supply system is a four loop pressurized water reactor (PWR) designed by Westinghouse Electric Corporation. The original thermal power design limit of 485 MWt was upgraded in 1963 to 600 MWt. The turbine generator, also designed by Westinghouse, was rated to produce 185 MWe.

YNPS is located on a 2000 acre site which straddles the Deerfield River in the towns of Rowe and Monroe, Massachusetts. About 10 acres have been developed for plant use.

For economic reasons, commercial operation ceased in February 1992, after about 31 years of operation. Defueling was completed on February 14, 1992. Subsequently, a Possession Only License was issued by the Nuclear Regulatory Commission (NRC) on August 5, 1992.

Since then, Yankee has proceeded with plant closure activities, preparations for safe storage, and "activities prior to decommissioning plan approval" [References 1-1 and 1-2]. These activities included decontamination, disposal of radioactive components and hazardous materials, lay-up of plant equipment and facility modifications to improve plant operations during the safe storage period. YNPS will continue these activities in accordance with applicable regulatory requirements and Yankee's commitment to maintain the facility in a safe and economical manner.

1.2 PURPOSE

As a part of the license amendment for construction period recapture, the NRC issued and published in the Federal Register an "Environmental Assessment [for] Yankee Nuclear Power Station" [Reference 1-3]. The conclusion of the report was that continued operation of YNPS to the year 2000 posed no significant impact on the environment.

The purpose of this "Decommissioning Environmental Report" is to revise the previous environmental assessment to present an evaluation of the environmental impacts resulting from the decommissioning of YNPS, including safe storage, dismantlement and decontamination activities. The Environmental Report addresses all actual or potential environmental impacts associated with the proposed decommissioning activities and is responsive to 10 CFR 51.53(b). The level of detail in the Environmental Report is proportional to the significance of the associated impact.

1.3 REGULATORY BASIS

Decommissioning of nuclear facilities is a regulated process whereby the radioactive materials contained in equipment, structures and portions of the facility are reduced to residual levels, and NRC licenses are terminated. The voluntary termination of an operating license requires NRC approval as specified in 10 CFR 50.82. Pursuant to 10 CFR 50.82, Yankee has prepared a Decommissioning Plan for YNPS [Reference 1-4].

This Environmental Report has been prepared in accordance with 10 CFR 51.53(b) and guidance provided in the NRC's Final Generic Environmental Impact Statement (GEIS), NUREG-0586 [Reference 1-5]. The Environmental Report is being submitted simultaneously with the Decommissioning Plan.

1.4 YNPS DECOMMISSIONING ALTERNATIVE

Yankee has evaluated the three decommissioning alternatives described in the generic environmental impact statement on decommissioning of nuclear facilities, NUREG-0586 (Reference 1-5): DECON, SAFSTOR, and ENTOMB. The most appropriate alternative for decommissioning YNPS is to defer dismantlement until a low level radioactive waste disposal facility is available to receive low level radioactive waste from decommissioning. A disposal facility is not expected to be available to YNPS until 2000. This results in a decommissioning duration in excess of the approximately six year period associated with the DECON alternative in the generic environmental impact statement. Therefore, the YNPS decommissioning alternative is most similar to the SAFSTOR alternative with a relatively short period before final dismantlement and license termination. A more detailed discussion and justification is provided in Section 7.

1.5 FINAL RELEASE CRITERIA

The release of the site, facilities and materials remaining on site will be based on application of criteria for surface contamination, soil and water concentrations, and exposure rate.

1.5.1 Site Release Criteria

The NRC is in the process of developing a rule for decommissioned site release criteria. A final rule is not expected before the end of 1994.

The NRC provided YAEC with release criteria that will be applied to sites encompassed by the Site Decommissioning Management Plan [Reference 1-6]. Yankee has evaluated these criteria with respect to YAEC comments presented as a participant in the rulemaking on radiological criteria for decommissioning NRC-licensed facilities. Yankee participated as a member of the NUMARC Ad Hoc Advisory Committee on Residual Radioactivity and as a panelist at the NRC Workshop held in Boston, Massachusetts on March 12, 1993.

Based on the review of the Site Decommissioning Management Plan release criteria and the development of a position for the participatory rulemaking [Reference 1-7], YAEC will use the following release criteria for the decommissioning of YNPS:

- Surface contamination must not exceed the values presented in Table 1 of Regulatory Guide 1.86 [Reference 1-8] for average, maximum and removable contamination.

- Direct exposure from gamma emitting radionuclides (e.g., cobalt-60, cesium-137, europium-152), created as a result of reactor operation and located in concrete, components and structures, must not exceed 5 μR/hr above natural background measured 1 meter from the surface.

- Total effective dose equivalent from residual contamination in the components, structures, soil and water must be maintained below 30 mrem/yr. The dose determination is based on the methods described in NUREG/CR-5512 [Reference 1-9].

- Migration of contamination into the ground water and potential airborne contamination of streams must not exceed the Environmental Protection Agency regulation 40 CFR Part 141, National Primary Drinking Water Standards.

The selection of the surface contamination, direct exposure, and water quality limits is consistent with those presented by the NRC in Reference 1-5. The total effective dose equivalent is based on the International Commission on Radiological Protection (ICRP) and National Council on Radiation Protection and Measurement (NCRP) recommendation of 100 mrem/yr dose to members of the public from all sources of man made radiation with the exception of radon and medical exposure. A conservative value of 30 mrem/yr was chosen to ensure that the total dose from residual site radioactivity and other man made sources would not exceed the ICRP and NCRP value.

A total effective dose equivalent of less than 30 mrem/yr is consistent with the variability of background gamma radiation levels in New England (30 - 40 mrem/yr from site to site). No health effects have ever been observed at this level of background variability.

An optimization process, based on ALARA, will be used to reduce the levels of radioactivity on the site commensurate with the minimization of total risk. Based on the NRC Issues Paper supporting the rulemaking, the ALARA analysis will take into account the following:

- Radiation doses and environmental impacts from the decommissioning process and from the residual radiation remaining on the site after completion of decommissioning, and

- All of the costs and other risks associated with decontamination and decommissioning the site.

An additional screening level of 10 mrem/yr will be established below which further optimization analyses are not necessary. This level is well below background variability, and below the level where expenditure of additional efforts will likely result in a net reduction in risk.

It is unlikely that YNPS decommissioning and final survey activities will be completed prior to completion of the scheduled rulemaking. Yankee will continue to monitor and participate in the rulemaking activities. Changes will be made to the final release criteria, if appropriate, after the final rule is issued. However, until such time, the final release criteria above will be used as the basis for detailed decommissioning planning.

1.5.2 Material Release Criteria

All materials leaving the Radiation Control Area and the YNPS site will be surveyed to ensure that radioactive materials are not inadvertently discharged from the facility. In accordance with the current program, all potentially radioactive or contaminated items removed from the Radiation Control Area or the YNPS site will be surveyed [References 1-10 and 1-11]. The following survey methods will be used:

- Materials and Equipment - Direct frisking with a portable Geiger-Mueller or a gas flow proportional detector.
- Smear Samples - Analysis with a Geiger-Mueller or a gas flow proportional detector.
- Bulk Liquids or Soil -Analysis with high resolution gamma spectrometry system to the environmental lower limit of detection.

Materials will be released if no discernable plant-related activity is detected within the capability of the survey methods presented above.

1.6 SUMMARY AND CONCLUSIONS

The decommissioning of YNPS will result in generally positive environmental effects, in that:

- Local traffic will be reduced (fewer employees, contractors and materials shipments than are required to support an operating nuclear power plant).
- Radiological sources that create the potential for radiation exposure to site workers and the public will be eliminated.
- Noise levels in the vicinity of the facility will be reduced.
- The thermal impact on the Deerfield River from facility operations will be eliminated.
- The site will be returned to unrestricted use.

The decommissioning of YNPS will be accomplished with no significant adverse environmental impacts in that:

- No site specific factors pertaining to YNPS would alter the conclusions of the GEIS.
- Radiation dose to the public will be minimal.

- Radiation dose to decommissioning workers will be a small fraction of the operating experience.

- Decommissioning is not an imminent health or safety problem and will generally have a positive environmental impact.

As discussed in Section 4.4, the non-radiological environmental impacts from the YNPS decommissioning are temporary and are not significant. The largest occupational risk associated with decommissioning YNPS is related to the risk of industrial accidents. The primary environmental effects are short term, small increases in noise levels and dust in the immediate vicinity of the site, and truck traffic to and from the site for hauling equipment and waste. No significant socioeconomic impacts or impacts to local culture, terrestrial or aquatic resources have been identified.

The total radiation exposure impact for the proposed Decommissioning Plan is approximately 744 person-rem, much less than the 1,115 person-rem exposure estimate of the GEIS for a PWR. Section 4.1 describes the occupational radiation exposure in more detail.

Radiation exposure to off-site individuals for expected conditions, or from postulated accidents, is very low with respect to the GEIS, the Environmental Protection Agency's Protective Action Guides and federal regulations. Doses due to the release of radionuclides in effluents will be negligible in comparison to allowable limits. Section 4.2 describes the off-site radiation exposure in more detail.

Finally, no significant impacts are expected from the disposal/burial of YNPS low level radioactive waste. The total volume of YNPS low level waste has been conservatively estimated at 15,732 cubic feet for the Component Removal Project and 89,033 cubic feet for safe storage and the final dismantlement. The actual volume is expected to be much less, since these estimates assume all contaminated systems, the reactor vessel, and the reactor vessel internals will be sent to a disposal facility. Many of these systems and components will be decontaminated and will not need to be sent to a disposal facility. In addition, Yankee will further reduce the volume of waste by utilizing volume reduction techniques.

Given the low level of contamination and the small volume of the YNPS waste (compared to the GEIS reference PWR after 30 years of operation), it should be possible to dispose of such waste off-site in a prompt manner. If for any reason some portion of these waste needs to be stored temporarily on-site, adequate space exists. No significant environmental impacts are anticipated from temporary on-site storage.

REFERENCES

1-1 Letters, Activities Prior to Decommissioning Plan Approval:
- S. Weiss, USNRC, to J. Thayer, YAEC, July 15, 1993
- R. Mellor, YAEC, to M. Fairtile, USNRC, June 24, 1993
- J. Thayer, YAEC, to M. Fairtile, USNRC, June 17, 1993
- J. Thayer, YAEC, to M. Fairtile, USNRC, April 23, 1993
- T. Murley, USNRC, to A. Kadak, YAEC, March 29, 1993

1-2 Staff Requirements Memorandum, S. Chilk, USNRC to W. Parler and J. Taylor, USNRC, January 14, 1993.

1-3 Letter, M. Fairtile, NRC, to G. Papanic, YAEC, dated June 2, 1988.

1-4 YNPS Decommissioning Plan.

1-5 NUREG-0586, Final Generic Environmental Impact Statement On Decommissioning Of Nuclear Facilities, GEIS, August 1988.

1-6 NYR 93-028, Site Release Criteria For Decommissioned Nuclear Plants, S. Weiss (USNRC) to A. Kadak (YAEC), February 25, 1993.

1-7 FYC 93-017, "Rulemaking Issues Paper on Radiological Criteria for Decommissioning of NRC-licensed Facilities", D. Edwards, YAEC, to S. Chilk, USNRC, June 28, 1993.

1-8 Regulatory Guide 1.86, Termination of Operating Licenses For Nuclear Reactors, June 1974.

1-9 NUREG/CR-5512, Residual Radioactive Contamination From Decommissioning, September 1992.

1-10 NRC IE Circular No. 81-07, Control of Radioactively Contaminated Material, May 14, 1981.

1-11 NRC IE Information Notice No. 85-92, Surveys of Wastes Before Disposal From Nuclear Reactor Facilities, December 2, 1985.

2.0 DECOMMISSIONING ACTIVITIES AND PLANNING

This section presents a summary description of the decommissioning activities as well as a schedule for the implementation of safe storage and final dismantlement activities at YNPS. The information presented in this section reflects initial planning of decommissioning activities. Yankee will complete more detailed planning prior to initiating each decommissioning activity, including engineering design, ALARA planning, and cost, schedule and resource refinement.

The YNPS decommissioning plan is comprised of four phases: "activities prior to decommissioning plan approval" [References 2-1 and 2-2], safe storage, plant dismantlement, and site restoration. This section presents a description of each.

2.1 ACTIVITIES PRIOR TO DECOMMISSIONING PLAN APPROVAL

Following the decision to permanently cease power operations at YNPS, Yankee began activities associated with plant closure. In March 1992, Yankee proposed to the NRC a change to modify the plant full power operating license to a Possession Only License status. The change removed YNPS' authority to load fuel into the reactor and to operate the reactor. The Possession Only License amendment was issued in August 1992 [Reference 2-3].

Other NRC regulations and programs were reviewed to assess their applicability to the permanently defueled condition. This process included detailed engineering and licensing studies unique to the permanently defueled condition. Where appropriate, relief was requested from regulations determined to be no longer applicable.

Plant systems, structures and components were evaluated to identify those needed to support plant operations (e.g., Spent Fuel Pit cooling). The systems, structures and components not required to support plant operation were evaluated for inclusion in the plant lay-up program based on their potential future use during plant decommissioning or their salvage value.

A Component Removal Project was initiated to remove and dispose of the steam generators, pressurizer and reactor vessel internals before June 1994. These components will have been removed from the site, with the exception of certain materials from the reactor vessel internals which will be stored in the Spent Fuel Pit.

Other, limited component removal activities will occur, consistent with appropriate rules and regulations, and the availability of radioactive materials processing or disposal options.

2.2 SAFE STORAGE

The safe storage period includes activities associated with establishing and maintaining the facility in a safe condition following approval of the decommissioning plan. The goal of the safe storage period is to prevent inadvertent exposure to radiation and to prevent spread of contamination. Most of the activities required to establish the safe storage condition will be completed before Decommissioning Plan approval.

During the safe storage period, plant operations will include those needed to monitor the radiological status of the facility, to maintain systems in a dormant condition, and to support operation of the spent fuel storage facility. The Radiation Protection Program implemented during the safe storage period is intended to support routine clean-up and decontamination operations. The radiation protection staff will be augmented with other plant personnel who will perform full-time on-site monitoring. The objective of the monitoring is to control access within the facility, preventing inadvertent exposure to radiation or the spread of contamination.

Yankee will maintain the systems, structures and components required to support decommissioning and spent fuel storage in accordance with the Facility Possession Only License and administrative and implementing procedures. The maintenance program in effect during the safe storage period consists of corrective maintenance, preventive maintenance, and surveillances. Yankee will continue preventative maintenance practices for systems and components required by technical specifications. Preventative maintenance will continue for other systems at a level commensurate with their functional requirements.

The Decommissioning Plan assumes, for planning purposes, storage of fuel in the Spent Fuel Pit until 1996, after which it will be transferred to an on-site dry storage facility. Spent fuel is projected to remain in storage until 2018. The likelihood of storing fuel on-site during and after decommissioning significantly impacts both the decommissioning process and cost. A spent fuel management strategy is outlined in Section 4.3.7 and is detailed in the Decommissioning Plan.

Yankee will continue to seek potential low level radioactive waste disposal sites for YNPS decommissioning waste during the safe storage period. If a site is identified that can support the decommissioning waste, Yankee will proceed with earlier dismantlement. Limited access to low level radioactive waste disposal facilities may also occur. Yankee intends to use these opportunities to remove components and structures, consistent with the Decommissioning Plan.

2.3 PLANT DISMANTLEMENT

Before the start of decontamination and dismantlement activities, the Yankee decommissioning organization will be mobilized. During the first several months the following activities will occur:

- Initiation of detailed project planning,
- Preparation of engineering specifications and procedures,
- Procurement of special equipment needed to support decommissioning,
- Negotiation of service contracts required for decommissioning activities, and
- Reactivation and return to service of systems required for decommissioning.

The engineering and preparation phase is followed by plant dismantlement activities. Contaminated systems will be removed, packaged, and either shipped to an off-site processing facility or shipped directly to a low level radioactive waste disposal facility. Decontamination of plant structures will be completed concurrently with the equipment and system removal process. Structural decontamination will include a variety of techniques ranging from high pressure water washing to selective removal of concrete to allow release of the structures. Contaminated structural material will be packaged and either shipped to a processing facility for decontamination or shipped directly to a low level radioactive waste disposal facility.

Following the removal of the contaminated systems, structures and components, a comprehensive final radiation survey will be conducted. The survey will verify that radioactivity has been reduced to sufficiently low levels allowing unrestricted release of the site. Successful completion of the final survey will be demonstrated through a verification survey completed by an NRC selected, independent contractor.

2.4 SITE RESTORATION

Site restoration activities will be initiated following termination of the YNPS possession only license by the NRC. Activities associated with the Vapor Container will include removal of internal structures, disassembly of the Vapor Container shell, and demolition of the Reactor Support Structure. All building foundations will be back-filled with concrete rubble and structural fill. The site areas will be graded and landscaped as necessary.

2.5 SCHEDULE FOR DECOMMISSIONING ACTIVITIES

Figure 2-1 is a schedule of the major decommissioning tasks. This schedule is used as the top-level view of the project milestones and detailed schedules. The decommissioning schedule assumes for planning purposes that a low level radioactive waste facility will be available for YNPS decommissioning waste in 2000 and that fuel will be transferred to a dry cask storage facility in 1996.

Based on these assumptions, the following is a summary of the YNPS decommissioning project schedule:

- Detailed site radiological characterization of the plant systems, structures, components, soil and groundwater will be completed to support dismantlement activities.

- NRC approval of the Decommissioning Plan is expected before January 1, 1995. Following approval, the facility will be maintained in a safe storage condition until the year 2000.

- A dry cask spent fuel storage facility will be constructed in 1995 and loaded with fuel in 1996. Spent fuel will be transferred to the Department of Energy beginning in 1998. The final spent fuel assembly will be removed from the site in 2018.

- Detailed engineering and planning for plant decontamination and dismantlement activities will begin in 1999. Actual dismantlement and decontamination activities are scheduled to begin in July 2000 and continue through January 2002. Site restoration will be completed by December 2002.

Yankee will continue to seek potential low level radioactive waste disposal sites for YNPS decommissioning waste during the safe storage period. If a site is identified that can support the decommissioning waste, Yankee will proceed with earlier dismantlement. Limited access to low level radioactive waste disposal facilities may also occur. Yankee intends to use these opportunities to remove components and structures, consistent with the Decommissioning Plan.

2.6 DECOMMISSIONING WORK FORCE

The individual tasks making up the decommissioning effort have been delineated using methods presented in the AIF/NESP-009 study report, "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives" [Reference 2-4] and the U.S. DOE "Decommissioning Handbook" [Reference 2-5]. These references utilize a unit cost factor method for estimating decommissioning activity costs, which include labor requirements.

The planning phase of the actual dismantling and decommissioning activities integrates individual labor requirements to dictate the size of the decommissioning work force. Throughout the project, dismantling the systems, structures and components in the Radiation Control Area is the critical path activity. The balance of the dismantling activities are scheduled to coincide with periods of reduced Radiation Control Area efforts as a means of workload leveling.

The planning phase occurs over a several month period and the actual dismantling and decommissioning activities at the site are planned for a 19 month period. The workforce will consist of a combination of YAEC and contractor personnel, with YAEC acting as the general contractor. The human resource level may range as high as 200 people.

However, if a site is identified that can support the decommissioning waste, Yankee will proceed with earlier dismantlement. In that case, the planning and actual dismantling and decommissioning activities at the site will occur earlier, over a longer period of time and involve fewer personnel on site at any given time.

REFERENCES

2-1 Letters, Activities Prior to Decommissioning Plan Approval:

- S. Weiss, USNRC, to J. Thayer, YAEC, July 15, 1993
- R. Mellor, YAEC, to M. Fairtile, USNRC, June 24, 1993
- J. Thayer, YAEC, to M. Fairtile, USNRC, June 17, 1993
- J. Thayer, YAEC, to M. Fairtile, USNRC, April 23, 1993
- T. Murley, USNRC, to A. Kadak, YAEC, March 29, 1993

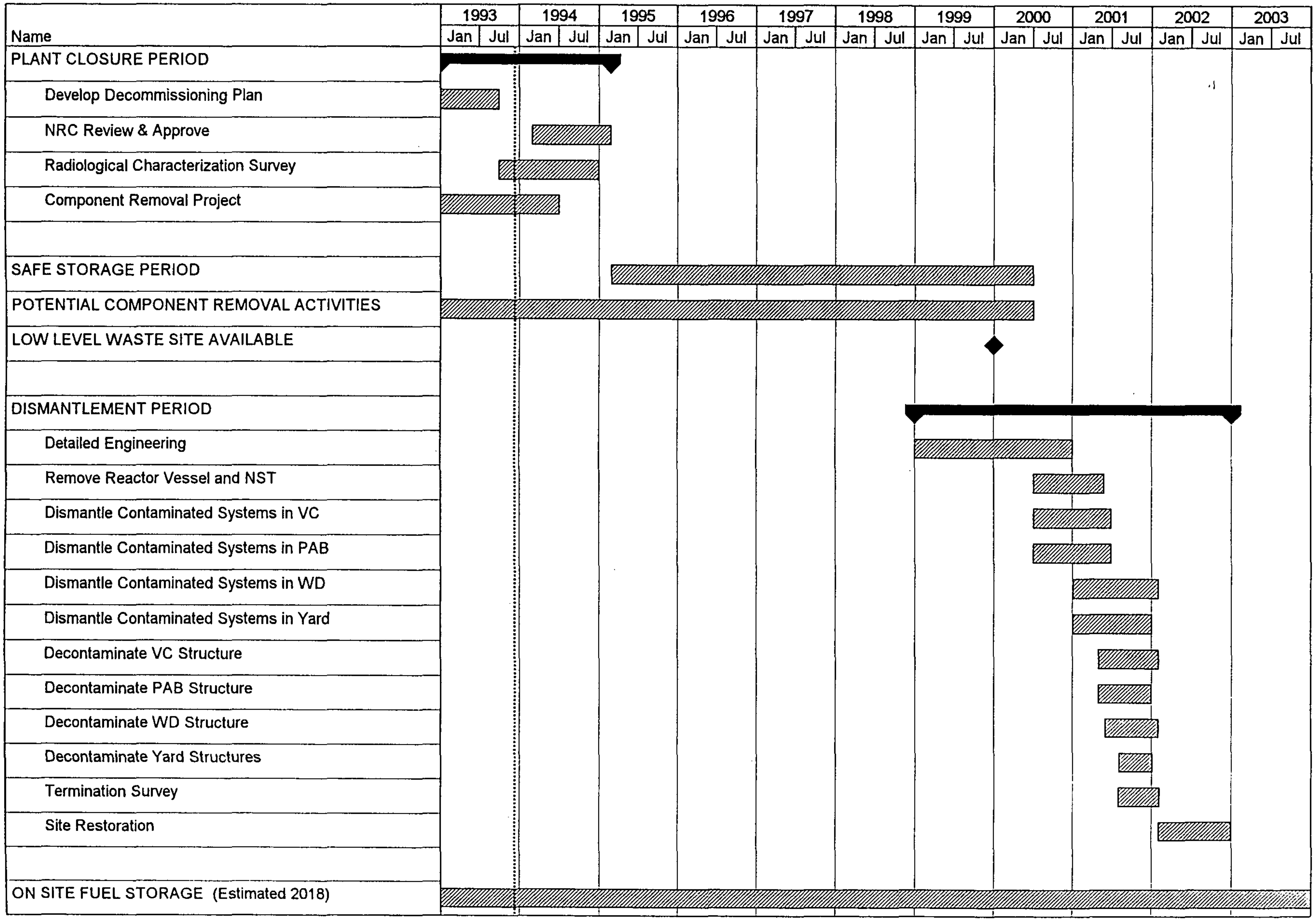
2-2 Staff Requirements Memorandum, S. Chilk, USNRC to W. Parler and J. Taylor, USNRC, January 14, 1993.

2-3 Letter, M. Fairtile, USNRC, to J. Grant, YAEC, dated August 5, 1992.

2-4 W. Manion and T. LaGuardia, "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives", AIF/NESP-009, November 1976.

2-5 W. Manion and T. LaGuardia, "Decommissioning Handbook", U.S. Department of Energy, DOE/EV/10128-1, November, 1980.

FIGURE 2-1
DECOMMISSIONING SCHEDULE



3.0 ENVIRONMENTAL INTERFACES

The following sections characterize the external environment interfacing with Yankee Nuclear Power Station (YNPS). It also includes descriptions of trends and changes to these features observed over the term of the operating license. Topics include geography, demography, terrestrial and aquatic ecology, meteorology, hydrology and geology. These factors form the basis for assessing the potential environmental impact of the decommissioning of YNPS.

3.1 GEOGRAPHY AND DEMOGRAPHY

The data presented in this section describe the terrain immediately surrounding the facility in terms of its human occupancy and uses.

3.1.1 Site Location and Description

The YNPS site consists of about 2,000 acres on both sides of the Deerfield River in the Towns of Rowe and Monroe, in Franklin County, Commonwealth of Massachusetts. Figure 3.1-1 shows the boundary of the site and plant exclusion area.

All of the land in the exclusion area is owned by YAEC or the New England Power Company (NEP), except for a small parcel situated across the river and southwest of the plant, which is owned by the Deerfield Specialty Paper Company. All of the area within the exclusion boundary is under the control of YAEC.

Two public secondary roads traverse the exclusion area. The closest is across the river from the plant and is approximately 1,500 feet away at its closest point. This road runs north-south along the river between Monroe, Massachusetts and Readsboro, Vermont. The second road, which connects the main access to the plant, is approximately 2,500 feet away at its nearest point and runs between Monroe and Rowe, Massachusetts, south of the plant. There are no rail lines which traverse or are adjacent to the site.

Most of the site area is wooded with very steep gradients on both sides of the Deerfield River. Features of the site include the Yankee Nuclear Power Station, the Sherman hydroelectric plant, the transmission lines running throughout the site, the Sherman Reservoir and Dam, and the Yankee Atomic Visitors Center. In addition, there is one residential structure within the site's boundaries. This residence is located approximately 1,500 feet northwest of the plant along the western shore of the Deerfield River in Monroe. It is owned by NEP and provides housing for an NEP employee.

3.1.2 **Population Distribution**

3.1.2.1 Existing Population

The population within 10 miles of the plant is estimated to be 23,100 [References 3-1, 3-2 and 3-3] and includes 17 municipalities in two states (Figure 3.1-2). Table 3.1-1 shows the total population of each town with borders within 10 miles of the plant, while Table 3.1-2 lists the population distribution by sector [References 3-4, 3-5 and 3-6].

The area is rural, with North Adams being the most populous municipality (16,797), with almost 85 percent of its population within 10 miles of the plant. The population of North Adams has decreased since 1980, which has been the primary reason for the overall population decline of the 10-mile area compared to the 1980 census.

The nearest population center of 25,000 people or more is Pittsfield, Massachusetts, located about 21 miles southwest of the plant at its closest point. Pittsfield has remained the nearest population center since the plant began operations in 1960.

3.1.2.2 Projected Population

The projected population distribution [References 3-7 and 3-8] within 10 miles of the plant for the years 2000, 2010, and 2020 is presented in Tables 3.1-3, 3.1-4 and 3.1-5.

Very little change in the total population is projected for the 10-mile area. Projections for the individual municipalities vary; some show a growth in population while others a decline. In general, however, the 10-mile population is expected to remain virtually unchanged. The year 2000 population is projected to increase only a little more than one percent over the 1990 population. By the year 2020, the 10-mile population is projected to increase to 24,731, which is a total 30-year increase of about seven percent over the existing population.

Based on the population projections, the nearest population center will remain Pittsfield, Massachusetts in all future years.

3.1.3 Uses of Adjacent Lands and Waters

3.1.3.1 Land Use within 5 Miles

Figure 3.1-3 shows the general land uses identified within 5 miles of the plant. The 5-mile area is generally wooded. Some farming exists, but this use is limited. Commercial land uses consist of small centers in the various towns. These commercial uses generally include small retail businesses, which are mixed with a small cluster of medium density residential development. Aside from these residential developments, homes are sparsely scattered throughout the area.

- Major Bodies of Water

  The primary body of water in the vicinity of the plant is the Deerfield River which runs north to south adjacent to the plant. There are also several branches of the Deerfield River and brooks which flow into it at various points. Northernmost at the plant's 5-mile radius is the Harriman Reservoir in Whitingham, Vermont, which has a surface area of about 2,100 acres. From the Harriman Dam, the river flows through Whitingham and Readsboro and back through Whitingham into the Sherman Reservoir. The Sherman Reservoir covers an area of about 262 acres. Flowing from the Sherman Dam, adjacent to the plant, the Deerfield River continues southward forming the Monroe-Rowe town boundary and then the Florida/Rowe town boundary in Massachusetts. The Fife Brook Dam holds the Bear Swamp Lower Reservoir at this point. In Florida, the river turns southeastward and flows through Charlemont, Massachusetts.

  Other major bodies of water within 5 miles include Sadawga Pond (184 acres), Shippee Pond (25 acres), North Pond (17 acres), and Clara Lake (12 acres) in Whitingham, and Howe Pond (42 acres) in Readsboro, Vermont. Within Massachusetts, the Bear Swamp Upper Reservoir (128 acres) and Pelham Lake (89 acres) are both located in Rowe. Figure 3.1-3 shows the specific location of these water bodies.

- Commercial Areas/Industry

  There are no exclusively commercial areas within 5 miles of the plant. The only commercial activity can be found in the local population centers, which generally consist of small retail businesses mixed with personal residences.

  There is no large industrial activity within 5 miles of the plant. The only industry in the area is YNPS and NEP's hydroelectric stations. NEP has five powerhouses within 5 miles of the plant. There are three stations as part of NEP's Deerfield River Project. They are the Harriman, Sherman and No. 5 stations. In addition, the Bear Swamp and Fife Brook stations are part of NEP's Bear Swamp Pumped Storage Project. The locations of these powerhouses are shown in Figure 3.1-3. The Deerfield Specialty Paper Company located in Monroe is no longer in operation.

- Schools

There are two schools within 5 miles of the plant (refer to Figure 3.1-3). The Rowe Elementary School, located about 2.5 miles southeast on Pond Road in Rowe, Massachusetts, had 126 students enrolled during the 1992-1993 school year [Reference 3-10]. The Readsboro Central School, located off Route 100 in the center of Readsboro, Vermont, had 99 students in kindergarten to 8th grade, and 13 preschool children during the 1992-1993 school year [Reference 3-11].

- Farms

Farming appears to be on the decline in the area within 5 miles of the plant. This observation is based on a survey of the area which indicated that a number of farm fields are not currently being worked [Reference 3-5]. Figure 3.1-3 shows the locations where fields and/or livestock were identified during a survey of the 5-mile area. In addition to the field survey, each town was contacted to obtain an official listing of farms within the town [Reference 3-12]. The symbols denoting these farms have been boxed in Figure 3.1-3 to distinguish them from the remaining fields identified during the survey.

Based on the information obtained from each municipality, there are nine farms within 5 miles of the plant, with additional ones located just beyond 5 miles. Seven of the farms are in Massachusetts. There are four farms in Rowe, which are all family farms. In Monroe, there are two commercial farms and one family farm. The other two farms within 5 miles are in Vermont, one in Whitingham, and the other in Readsboro. The owners of both farms have retired. The primary use of the farms is for dairy, haying, beef cattle, and maple sugaring.

In addition to the information collected from the municipalities, a survey conducted by Yankee documented the nearest garden and milk animal locations within each sector [Reference 3-13]. These locations may include farms, or simply private gardens or dairying locations. Table 3.1-6 lists these locations by sector.

- Public Lands/Conservation Areas

  The several public lands/conservation areas within 5 miles of the plant offer a variety of recreational opportunities, including fishing, hunting, boating, swimming, picnicking, and hiking. These include the Monroe State Forest, located in Monroe, Florida, and Rowe; Pelham Lake Park in Rowe; Howe Pond State Forest and Readsboro Municipal Forest in Readsboro; and the Atherton Meadows Wildlife Area in Whitingham. In addition, much of the land owned by NEP is maintained for passive recreational use. Figure 3.1-3 shows the public lands listed above, as well as the locations of recreational activities found within 5 miles of the plant.

- Historic Areas

  There are no historic resources which are listed in the National Register of Historic Places within 5 miles of the plant [References 3-14 and 3-15]. However, just beyond 5 miles, southwest of YNPS, is the Hoosac Tunnel, which was designated a National Register property in 1973 (Figure 3.1-3). The closest site considered to have local historic significance is the Brigham Young birthplace monument located in Whitingham, Vermont, approximately 5 miles northeast of YNPS. The western shoreline of the Deerfield River from the Harriman Dam south to the Harriman Powerhouse is considered to be a potential area of archaeologic sensitivity [Reference 3-9], but there is no known archeological significance to the YNPS site.

- Highways

  There are no state or federal highways which traverse the YNPS 5-mile area. Route 2 passes about 5.5 miles from the plant at its nearest point. Nearest to the plant is Monroe Hill Road, a secondary road, which provides access from the south. Access from the western side of the Deerfield River is provided via River Road which runs north-south along the western edge of the river. In Vermont, the primary travel route is Route 100, which runs east-west through Whitingham and Readsboro. All other roadways are local secondary streets.

- Railroads/Airways

  The nearest rail line to the plant runs about 4.5 miles southsouthwest of the plant at its nearest point [Reference 3-16].

There are no airports within 5 miles of the plant. The nearest airport facility is Harriman and West Airport in North Adams. Activity from the surrounding airports includes primarily small private aircraft. At the Harriman and West Airport there may be up to 25 takeoffs and landings per day [Reference 3-17].

There are two federal aviation airways within 5 miles of the plant. Airway V2-14 is used for aircraft flying below 18,000 feet. The center of this airway passes about 2.5 miles south of the plant. Airway J16-94, which passes further south is used by aircraft at 18,000 feet or above. Both federal airways have a width of about 8 nautical miles [Reference 3-18].

3.1.3.2 Water Supplies

Water supplies within the Deerfield River Drainage Basin (Figure 3.4-1), including the entire area within 5 miles of the plant, generally consist of private wells. The only communal source of water within 5 miles is Phelps Brook, servicing 40 connections in the center of the Town of Monroe [Reference 3-19].

Beyond 5 miles, downstream, there are two small water supply wells servicing local private developments: the Deerfield River Club and Heath Stage Apartments, both in Charlemont [Reference 3-20]. Still further downstream, the closest public water supply wells, Stillwater Springs, are in the town of Deerfield between 20 and 25 miles south of the plant [Reference 3-21]. Stillwater Springs has a safe yield of about 120,000 gallons per day (gpd). This well field is immediately adjacent to the Deerfield River. The South Deerfield Well Field off Route 116 has been closed since 1984 due to contamination from agricultural uses nearby.

The Quabbin Reservoir, which serves the Greater Boston area, is 35 to 40 miles southeast of the plant.

3.2 ECOLOGY

The data presented in this section describes ecological conditions immediately surrounding the facility and the corresponding occupancy by species other than humans. The data reflects a detailed study conducted around the YNPS site in 1989 in conjunction with an investigation of the potential for extending the operating license at YNPS. YNPS operated at full power during the period of this study. Although the license extension program was not completed, the ecological study remains useful and valid for this environmental report.

3.2.1 Water Quality

Water quality sampling was conducted at four stations on Sherman Reservoir (Figure 3.2-1) to supplement historical data. Stations were located in the Deerfield River downstream of YNPS (Station 1), in Sherman Reservoir near the intake of YNPS (Station 2), in the center of the impoundment (Station 3), and near the north end of the impoundment (Station 4). No unexpected or unusual data was discovered in this sampling program. This information can be related to other biological surveys taken concurrently with the water quality program.

3.2.1.1 Physical Parameters

The physical parameters reviewed included depth, temperature, conductivity, apparent color and true color (Table 3.2-1). Depths ranged from an average of 4 meters within the Deerfield River downstream of YNPS to nearly 20 meters adjacent to the YNPS intake. Temperature profiles at each station reflected the general seasonal pattern of cooler temperatures in the spring and fall and higher summer values during the warmer periods in Sherman Reservoir. Temperatures within Sherman Reservoir and below the Sherman hydroelectric dam within the Deerfield River at the surface and bottom, ranged from approximately 43-60°F in the spring to 53-71°F in the summer.

Conductivity readings are consistently greater near the bottom than at the surface and parallel each other closely. The Deerfield River station, however, revealed surface and bottom readings that were very similar, probably because depths were no greater than 6 meters and because of less stratification due to discharge from hydroelectric generation.

At all stations, apparent and true color readings were nearly identical. Color in water results from the presence of several constituents such as naturally occurring metallic ions, humus and peat material, plankton and weeds. As expected, the highest readings were recorded in early August and late fall for both parameters.

3.2.1.2 Chemical Parameters

Dissolved oxygen concentrations were essentially homogeneous throughout the water column on all sampling dates at all stations, indicating low productivity and little biochemical oxygen demand. The 5-day biological oxygen demand (BOD_5) was relatively constant throughout the year, declining only from August through October (Table 3.2-1). BOD_5 concentrations were always well below observed dissolved oxygen concentrations and never at levels that would suggest potential threats to biota resulting from depressed dissolved oxygen concentrations.

Generally, pH was lower at all stations in spring than in the fall with a gradual increase occurring during the latter part of the sampling program. Depressed pH observations in waterbodies in the Northeast are not uncommon and often are the result of acidic snowmelt [Reference 3-22].

Several nutrient and mineral parameters were measured during the water quality survey. These parameters were taken at the surface at Stations 1, 2 and 3. Bacterial action on organic materials produces nitrogenous compounds in water bodies. Ammonia was present in relatively constant concentrations during the year, with the highest values observed during May at 0.05 mg/l declining during the year to 0.02 mg/l. Concentrations of nitrate in April/May of 0.43 mg/l declined to 0.16 mg/l by November. Nitrite concentrations of 0.005 mg/l in May declined to 0.001-0.002 mg/l for the remainder of the year. Total Kjeldahl nitrogen was greatest during July at 0.38 mg/l, declining in the fall to 0.14-0.30 mg/l.

Total phosphorus generally had concentrations ranging from 0.006-0.008 mg/l from April through July. In August, values fell to 0.001 mg/l then increased to 0.10 mg/l by November. Phosphorus concentrations indicate that Sherman Reservoir is oligotrophic or unproductive [Reference 3-24]. The ratio of nitrogen to phosphorus (N:P) can be used to indicate which nutrient may be limiting to plant growth or primary productivity. Ratios greater than 15:1 indicate that phosphorus is the nutrient limiting primary productivity [Reference 3-23]. In Sherman Reservoir, the ratio was always greater than 15.

Sulfate is typically found in fresh waters in concentrations of 5-30 mg/l [Reference 3-24]. Sulfate concentrations in Sherman Reservoir were within or below this range. The highest value occurred in April (10-13 mg/l). Elevated spring concentrations of sulfate resulting from acid snowmelt is common in the Northeast. The slightly elevated concentration is further supported by relatively low pH values observed during the spring.

The chloride concentrations ranged from 3.8 - 6.4 mg/l throughout the year. Higher concentrations were observed in the first half of the year than were observed in the latter half at Stations 1, 2 and 3. Chloride concentrations were always below the average concentration of 8.3 mg/l reported for natural fresh waters [Reference 3-24].

3.2.1.3 Particulates

Turbidity and Secchi disk readings paralleled each other over the duration of the sampling program (Table 3.2-1). Elevated in the spring due to runoff, low turbidity values recorded at all stations from July through September (less than 1 NTU) were reflected in the greater Secchi disk readings during the same period (ranging from 3 to 5 meters).

Concentrations of total solids were greatest at all stations in July and fell to their lowest in November. Fall concentrations were similar to spring levels. Slightly elevated levels observed in April and October are likely attributable to turnover events in the water column.

Chlorophyll a pigments are found in all of the groups of algae found in fresh water [Reference 3-24] and provide a good estimate of the standing crop of phytoplantkton at a given time. In the spring, values ranged from near zero to 1.99 mg/l and were 0.6-1.2 mg/l for the remainder of the year.

3.2.2 Characterization of Biological Communities

3.2.2.1 Phytoplankton

The phytoplankton community in the vicinity of YNPS was assessed through biweekly sampling and enumeration. Phytoplankton were identified to the lowest possible taxonomic level and reported in numbers of cells per liter. In addition, a larger portion of each sample was scanned and all species present were reported. In order to facilitate comparison with historical phytoplankton data, all phytoplankton taxa with a cell or colony diameter greater than 76 mm were reported. These taxa are referred to herein as net phytoplankton.

Chlorophyll a results from lake stations generally indicated that the phytoplankton community biomass reached an annual maximum in May and June and varied around a lower level through the rest of the April through November sampling season. The initial pulse in chlorophyll a seems to be largely attributable to reduced grazing by seasonally depressed zooplankton populations in the spring coupled with an influx of nutrients from spring runoff and spring overturn. Once this pool of nutrients has been partially depleted through the establishment of a defined thermocline, and zooplankton populations build to a level where grazing becomes a significant loss mechanism, phytoplankton populations decline. Overall, chlorophyll a concentrations suggest that the system is exhibiting productivity typical of an oligotrophic water body [Reference 3-24]. Over 150 species of phytoplankton were identified during the course of the 1989 study. Data from the river station were very similar to data from the reservoir stations. A summary of the groupings and results by sampling date and stations are presented in Table 3.2-2.

Blue-green algae were numerically the most abundant of the major groups. The patchiness of algal blooms, particularly blue-greens, has been well documented [Reference 3-25], and may provide an explanation for the discrepancies among stations in the spring. By late June and early July, blue-green numbers declined at all three stations. However, by mid-August, blue-green algae once again became numerically dominant at all of the sampling stations and remained so throughout the sampling season.

Abundances of other algal taxa over the course of the sampling season do not follow as clear a pattern. Mean cell numbers per unit volume were nearly equal for green algal species, dinoflagellates, diatoms, and golden-brown algal species when data for the entire sampling season were combined. On individual sampling dates, among sampling locations, elevated numbers of particular taxa relative to others is evident; however, numbers never exceeded those reported for blue-green species for the same period.

On nearly every sampling date at every station, blue-green species comprised well over 90 percent of the numbers of cells counted, but, because of the small size of the individual cells of most species of blue-greens, this figure is probably a gross overestimation of the relative importance of this taxon to the phytoplankton community. When blue-greens exhibited exceptionally high numbers of cells, abundance of blue-greens if expressed as a biomass per unit volume of water would not exceed the abundance of green algae, diatoms, or golden-brown algae taxa, species of algae several orders of magnitude larger than the blue-green species. A more appropriate conclusion would be that no one algal taxon dominates the community for the entire year, but rather that there is a succession from diatoms, greens and golden-browns to blue-greens as the season progresses.

The total number of phytoplankton species reported over the course of the growing season was fairly consistent spatially. The seasonal phytoplankton succession in Sherman Reservoir is fairly typical of what would be expected in a northern temperate lake [Reference 3-24]. The phytoplankton community of Sherman Reservoir and the

Deerfield River downstream generally reflects what could be expected from a similarly sized impoundment in the Northeast with similar water quality characteristics.

3.2.2.2 Zooplankton

Zooplankton at all three stations sampled were dominated by three major groups: Cladocera, Rotifera and Copepoda (Figure 3.2-2). Generally, zooplankton in and just below Sherman Reservoir had two peak periods. The first occurred in spring and was dominated by copepods at Stations 1 and 2, and by cladocerans at Station 3. A second smaller peak which occurred in late summer - early fall was also dominated by copepods at Stations 1 and 2 and by cladocerans at Station 3. Rotifers had a similar pattern at the three stations but occurred later in the season, whereas the first peak occurred at the three stations in July with a second in October. The three stations, however, differed somewhat in when each of the three groups was dominant during the 1989 sampling program.

A temporally-limited investigation of the zooplankton communities of several oligotrophic lakes (Eastern Grand Lake, Tomah Lake and Floods Pond) in Maine was conducted in 1975 [Reference 3-27] using sampling techniques similar to those used in the Yankee plant studies. The lakes in Maine were selected because they are representative of conditions found in Sherman Reservoir. Copepods were an order of magnitude more abundant in Eastern Grand Lake in August than at any time in Sherman Reservoir. Both abundances and distribution among families of cladocerans were similar between the two water bodies. Rotifers, an important component of the zooplankton in Sherman Reservoir, were notably absent from Eastern Grand Lake. Although abundances and types of cladocerans were similar at Sherman Reservoir and Tomah Lake in late summer, both copepods and rotifers were an order of magnitude more abundant at Tomah Lake. Floods Pond was only examined in March and exhibited the typically low early spring abundances that were also noted in Sherman Reservoir.

3.2.2.3 Ichthyoplankton

Ichthyoplankton within Sherman Reservoir and the Deerfield River below Sherman Dam were sparse (Table 3.2-3), being comprised of only two taxa, sunfish (Lepomis species) and yellow perch (Perca Flavescens). Ichthyoplankton in the open waters of small lakes in northeastern North America usually are limited to a small number of species, and are typically dominated first by yellow perch and later in the season by one or more species of Lepomis [References 3-28, 3-39 and 3-30]. In these respects, Sherman Reservoir and just below it in the Deerfield River were typical for the region.

Yellow perch larvae occurred in Sherman Reservoir (Stations 2 and 3) from early May through late June with greatest abundances occurring in late May through late June. This correlates with published observations that yellow perch spawn from late April to early May in water temperatures of 44 to 54°F (6.5 to 12°C) [Reference 3-36]. Sunfish larvae occurred from mid-July through mid-August, corresponding to the later spawning period of this genus compared to yellow perch [Reference 3-26].

3.2.2.4 Benthos

Temporal and spatial differences were evident between the soft-bottom fauna of Sherman Reservoir (Stations 2, 3, and 4) and an area downstream of Sherman Dam (Station 1). Station 1 was examined during May, July and September 1989, to characterize benthic communities.

Total abundance (monthly mean over stations) did not vary substantially among months. Lowest mean abundance was observed in May and the highest occurred in September. During each sampling period, more than 90 percent of the total abundance (see Figure 3.2-3) was attributable to:

chironomid larvae	37 to 55 percent
oligochaetes	16 to 32 percent
molluscs	20 to 34 percent

During 1989, 26 distinct chironomid genera or species were collected, 10 of which were present during all sampling periods. Only two taxa of molluscs were identified. The gastropod Valvata species and the two groups of unidentified immature tubificids, as well as Aulodilus Pluriseta, consistently accounted for more than 80 percent of the oligochaetes, although six genera were identified.

These dominant groups account for 35 of the 58 distinct taxa occurring. Most (17) of the other taxa were present in May, only 10 in July, and 7 in September. Ceratopogonidae and Sialis species were the only nondominant taxa present during all 3 months, although 6 other taxa occurred in 2 months. These less abundant groups included Ephemeroptera (2 genera), Trichoptera (4 genera), Plecoptera (1 genus), Isopoda (1 family), Amphipoda (1 genus), Odonata (1 genus), Megaloptera (1 genus), Coleoptera (6 genera), Hirudinea, Hydracarina, and Nematoda.

The stations studied in Sherman Reservoir and below Sherman Dam are subjected to different hydraulic conditions, as well as being at varying depths. The benthic fauna tends to reflect these differences. Stations 2 and 3, located within the pond proper, are the deepest stations. They each host a fauna that is typical of lacustrine (lake) conditions - a modest number of taxa (each had a total of 23) comprised almost entirely (all but three of the taxa at each) of oligochaetes, chironomids, and bivalves. Other taxa contributed <2 percent of the total abundance at either of these stations.

The dominant groups, oligochaetes, chironomids and molluscs, comprised 92 percent of the abundance and 60 percent of the 49 taxa occurring at Station 4. During only one sampling period, in May, 36 taxa occurred. Coleoptera was represented by more taxa (96) than other nondominant groups. The greater variety of taxa at Station 4 than at other stations may be related to the greater water flow and moderate depth at the head of Sherman Reservoir.

3.2.2.5 Adult and Juvenile Fish

Gill net catches of juvenile and adult fish were generally the largest from Stations 3 and 4 (Table 3.2-4). Catches from Station 1 (approximately 3 meters deep and located downstream from the Sherman Dam hydro-electric power station) were small and of limited diversity. White sucker (Catostomus commersoni) was the most abundant species at Station 1, accompanied by brown bullhead (Ictalurus nebulosus), chain pickerel (Esox niger), smallmouth bass (Micropterus dolomieui), and yellow perch (Perca flavescens). Single specimens of American eel (Anguilla rostrata) and rock bass (Ambloplites rupestris) were also collected at Station 1. The habitat at Station 1 was more riverine than at the other stations, and this probably accounts in part for the absence at Station 1 of several species found at the other stations.

Catches of most species were greatest at Station 4, with the exception of American eel, longnose suckers, rainbow smelt, and rock bass. Catches of yellow perch were greatest in April and May with specimens caught during each month of sampling. A similar pattern of abundance was noted for white suckers. Golden shiners were quite numerous in May and June catches, but were relatively scarce during the other months. Catches of fallfish were greatest in May but were relatively uniform among the other sampling dates. Chain pickerel and pumpkinseed (Lepomis gibbosus) were three to four times more numerous in the catches from Station 4 as compared to Station 3.

3.2.3 Terrestrial Ecology

3.2.3.1 Flora

The ecosystem surrounding YNPS is predominantly forest. Along the eastern shore of the Deerfield River and within a 1-mile radius of the plant, the forest is primarily that of a hardwood community of high density. Trees are typically 40-60 feet tall with an 80-100 percent crown closure. To the west of the Deerfield River, the forest is of mixed hardwoods and softwoods with hardwoods predominating. These are of high density, with individual species being 40-60 feet tall with an 80-100 percent crown closure. South of YNPS, forests are predominately hardwoods, 20-40 feet in height with greater than an 80 percent crown closure. Additionally, there are areas of abandoned fields reverting to natural habitat, now comprised of woody vegetation and grasses with a tree crown cover of less than 30 percent.

Slopes within the vicinity are relatively steep with stony soils, rising within a mile of the plant to an elevation approximately 1,000 feet above Sherman Reservoir. As a result, few wetlands occur within the area. The exceptions to this are the numerous intermittent runoff streams and the abundant spring-fed streams which, throughout the year, descend through the hills to the Deerfield River below. Small spring-fed wet pockets can be found throughout the hills where terrain permits.

Water resources within the vicinity include the Deerfield River system, the main stream and its tributaries, as well as the numerous spring-fed streams. Flow is controlled through numerous hydroelectric facilities. Discharges from these are based upon runoff from the seasonal snow melt and storms, as well as through a need for power.

Residences within one mile of the facility are limited to those within the town of Monroe. Traversing the site from south to east is a power line, managed by NEP, maintaining a diverse community of low lying vegetation.

3.2.3.2 Fauna

The habitat surrounding YNPS contains a diverse assemblage of wildlife species. Birds and mammals within the region are representative of species found within the transitional zone between the mountainous regions of Vermont and Massachusetts and the lower elevations along the Connecticut River. Within a mile of the plant, the steepness of the terrain has maintained the forest resources following early cutting. However, recent logging operations on YAEC property has again opened this area. As a result of the maturation of the forests, wildlife populations within the region have expanded for some species while causing a decline in others.

The white tail deer population, at low numbers during the turn of the century due to extensive deforestation within the region throughout the 1800's, has returned during recent years due to regrowth of critical habitat and through management by state agencies. The black bear population has shown a slow but gradual increase within the region west of the Connecticut River, while that of the turkey has expanded significantly over the last decade.

Nongame species are found throughout the region within their preferred habitat. Of particular interest is a pair of bald eagles which have returned to the plant vicinity for a number of years. Arriving in mid-winter, the eagles frequent the Sherman Reservoir area to feed, remaining until spring, at which time they leave to nest.

3.3 METEOROLOGY

The data presented in this section were collected primarily by the YNPS on-site meteorological monitoring system and by cooperative weather observers located in Readsboro, Vermont [Reference 3-31] (approximately 2 miles north of YNPS) and Hoosac Tunnel, Massachusetts [Reference 3-32] (approximately 4 miles southwest of YNPS).

3.3.1 Regional Climate

YNPS is located at the bottom of the Deerfield River valley in the hilly and forested Berkshire region of western Massachusetts. The ground elevation at the site is approximately 1,120 feet above mean sea level. The hills on either side of the river valley rise to elevations over 1,900 feet above mean sea level within one mile of the site. This steep-slope characteristic of the river valley extends from 12 miles north of the site to 8 miles south-southeast of the site. The river course is erratic along this 20-mile stretch but generally bends southward. The valley hillsides are densely wooded.

Massachusetts lies in the prevailing westerlies, a belt of generally eastward-moving air located in the middle latitudes. Extensive air masses originating in higher and lower latitudes move through the region, interacting to produce storm systems. A large number of these storm systems pass over or near Massachusetts, relative to other parts of the United States [Reference 3-32].

Three major air mass types affect the State: cold, dry, subarctic air from Canada; warm, moist air from the Gulf of Mexico; and cool, damp air from the North Atlantic Ocean. The site is influenced more by the first two air mass types than it is by the third due to the site's inland location and the fact that winds are usually from the west. The nearby Atlantic Ocean, while serving as a modifying influence, does not dominate the climate of the site [Reference 3-32].

Climatic characteristics of Massachusetts include frequent changes in the weather, large ranges in daily and annual temperatures, great differences between the same seasons in different years, and equable distribution of precipitation throughout the year. The procession of contrasting air masses and the relative frequent passage of storm systems bring about a roughly twice-weekly alternation from fair to cloudy or stormy conditions, attended often by abrupt changes in temperature, moisture, sunshine, wind direction, and wind speed. This sequence can be interrupted by periods during which the weather patterns continue the same for several days, infrequently for several weeks [Reference 3-32].

3.3.2 Temperature

The annual average temperature at the YNPS site is approximately 44°F. Monthly mean daily maximum and minimum temperatures (the arithmetic mean of all the maximum and minimum temperatures recorded on separate days during each month) in the vicinity of the YNPS site are listed in Table 3.3-1.

Temperatures during the warmest month of the year, July, average approximately 67°F with a typical diurnal range of around 25°F. Hot days with maximum recorded temperatures of 90°F or higher generally average 4 per year at Readsboro and Hoosac Tunnel. Temperatures during the coldest month of the year, January, average approximately 19°F with a typical diurnal range of around 20°F. Cold days with minimum recorded temperatures of 0°F or below generally average 21 per year at Readsboro and 14 per year at Hoosac Tunnel.

Record extreme temperatures recorded in the vicinity of the YNPS site are as follows:

	YNPS	Readsboro	Hoosac Tunnel
Record Highest (°F)	90.6	98	97
Record Lowest (°F)	-21.5	-25	-21
Period of Record	1977-1992	1951-1992	1951-1972*

* The Hoosac Tunnel recording station was discontinued in 1972.

3.3.3 Wind

Wind speed and direction joint frequency distributions for data measured at two elevations (35 feet and 199 feet above ground level) at the YNPS site are provided in Tables 3.3-2 and 3.3-3 for the period 1988-1992. The relatively high frequencies of southwest and north-northeast winds at the upper level are the result of "channel flows" up and down the Deerfield River valley. Additionally, the frequent occurrences of low wind speeds and easterly through south-easterly wind directions at the lower level are indicative of nighttime drainage flows down the eastern walls of the river valley.

3.3.4 Precipitation

Storm systems are the primary year-round moisture producers, with bands and patches of thunderstorms and showers making up the difference during the summer when storm system activity ebbs. Yearly precipitation totals average approximately 45-49 inches which is, on average, distributed relatively evenly throughout the year. Precipitation totals of 0.10 inches or more are recorded on an average of 90 days per year [References 3-31 and 3-32].

Monthly mean precipitation totals in the vicinity of the YNPS site are listed in Table 3.3-4. Maximum short-term precipitation totals recorded at Readsboro and Hoosac Tunnel are as follows:

	Readsboro	Hoosac Tunnel
Greatest Monthly Precipitation (in)	13.64	13.61
Greatest Daily Precipitation (in)	4.11	3.35
Period of Record	1951-1980	1951-1972

Snowfall totals average approximately 100 inches a year. Monthly mean and maximum monthly snowfall totals in the vicinity of the YNPS site are listed in Table 3.3-5. The greatest snow depth recorded at Hoosac Tunnel (1951-1972) was 48.0 inches.

3.3.5 Severe Weather

Thunderstorms occur an average of 28 days per year in the site region. Based on the annual number of thunderstorm days, the calculated annual flash density of ground lightning strikes is four flashes per square kilometer. On average, hail storms occur about two days annually, and freezing rain occurs approximately 12 days per year [Reference 3-33].

According to the National Severe Storms Forecast Center, 112 tornadoes were recorded within 50 nautical miles of the YNPS site from 1950 through 1992. Over 85 percent of these tornados occurred during the months of May, June, July and August. According to these data, the YNPS site is located in a region that experiences an average of 2.5 tornados per year per 10,000 square miles.

Occasionally in the summer or fall, a storm of tropical origin, up to the severity of a hurricane, affects the region. Given the distance from the Atlantic coast, the full force of a hurricane is diminished before reaching the site. In general, hurricanes and their accompanying large rainfalls are usually the catalyst for flooding events in the region. Significant floods on the Deerfield River resulting from hurricanes occurred in September 1938, August 1955 and September 1960. Hurricanes are tracked by the National Weather Service which provides estimated storm path and arrival times such that adequate preparations can be made before the hurricane reaches New England.

3.4 HYDROLOGY

The data presented in this section describes physical characteristics of the ground and surface waters within the area immediately surrounding the facility.

3.4.1 Surface Waters

The plant site is located on the east bank of the Deerfield River adjacent to Sherman Dam and Sherman Reservoir, which serves as the source of cooling water for the plant.

The Deerfield River, a tributary of the Connecticut River, has a total drainage area of 664 square miles. The drainage area extends from southern Vermont into the northwestern corner of Massachusetts. The upper Deerfield River basin has fairly steep slopes and is characterized by a dendritic drainage pattern.

The plant is located in the central portion of the Deerfield River basin (Figure 3.4-1). The drainage area upstream of the plant is 236 square miles. The Deerfield River is highly developed for hydroelectric generation. River flow at the plant is highly regulated by two large upstream reservoirs, Somerset and Harriman.

The U.S. Geological Survey maintains two gaging stations downstream from the plant on the Deerfield River. The gage near Rowe is located approximately 5 miles downstream from the plant. The gage at Charlemont is located approximately 17 miles downstream from the plant. Flow data for the two gages are listed in Table 3.4-1. The flood of record on the Deerfield River was the September 1938 hurricane-induced flood. Maximum flow measured at the Charlemont gage during this flood was 56,300 cubic feet per second.

The average annual rainfall in the upper Deerfield River basin is between 40 and 50 inches.

The plant's once-through Service Water System will use an average of 0.4 million gallons per day of water from Sherman Reservoir for cooling during decommissioning. This is less than one percent of operational uses. Limitations on the flow as well as the temperature increase of the circulating water will continue to be regulated by the National Pollutant Discharge Elimination System (NPDES) permit.

3.4.2 Ground Water

The plant uses a bedrock well for potable water supply. This well is located about 200 feet south of plant structures. This well is 437 feet deep and has a yield of 13 gpm. Another bedrock well serves the Visitors Center, which is located about one-half mile southwest of the plant. This well has a yield of about 8 gpm.

There are no major bedrock aquifers within the upper portion of the Deerfield River basin. Bedrock in the region is not a substantial source of groundwater, supporting only low-yield, domestic wells. The glacial till, which generally overlies the bedrock at the site, also is not a substantial source of groundwater in the region. Some localized pockets of river alluvium provide moderate amounts of groundwater. The extent of these alluvium deposits is quite limited.

The direction of flow of the groundwater under the plant site is from the recharge areas on the slopes surrounding the plant toward the adjacent Deerfield River. Natural subsurface conditions along the steep sections of the Deerfield River valley result in a number of springs which discharge ground water to the ground surface. These may flow seasonally or, like Sherman Spring near the base of Sherman Dam, continually from the river banks. There are no private groundwater wells in the immediate vicinity of the site.

No adverse impacts on groundwater are anticipated from decommissioning activities. The groundwater system under the plant area is effectively separated from any potential contact with private wells. The down-gradient direction of groundwater flow is from the surrounding steep slopes to the south, southeast, southwest, and west toward the Deerfield River. In these directions, some 220 acres of land is owned as part of the site. To the north, the Deerfield River represents a formidable limit for groundwater flow.

3.5 GEOLOGY

The data presented in this section describes physical characteristics of the earth surrounding, and under, the facility.

3.5.1 Regional Geology

New England's bedrock geology is complex [Reference 3-34]. Bedrock age ranges from a hundred million to over a billion years.

The youngest deposits are glacial soils, 10 to 12 thousand years old. Glacial erosion of the bedrock and deposition of glacial soils shape much of the region's surface topography.

New England bedrock is mostly a mosaic of metamorphic and igneous rocks. The metamorphic rocks are the oldest, having been modified by high temperatures and pressures during deep burial in the earth. Large and small igneous bodies intruded into these during periods of active tectonism. These were molten intrusions, most of which occurred at depths of 5 km to 25 km. Most volcanic and sedimentary rock in the region are now metamorphosed. The Connecticut Valley contains the most significant sedimentary rocks, mostly sandstones, interbedded with basaltic flows.

3.5.2 Regional Tectonics

The region's bedrock records a history of collisions and rifting apart of continents, the creation and erosion of land masses and mountain systems, as well as the opening and closing of vast ocean areas. Ancient episodes of orogeny (mountain building) are recorded as folds, faults, and metamorphic features. Table 3.5-1 is a geologic time chart showing names of geologic ages and periods designated based on world-wide geologic events. Key events in New England history are also listed in this table.

The Grenville orogeny (Table 3.5-1) is the oldest distinguishable geologic event affecting regional bedrock, 1,100 million years (my) ago. Affected rock is seen at the surface in uplifts of the Adirondacks, the Green Mountains and the Berkshires, and in deeply buried rock under the rest of New England. Following the Grenville, the Avalonian (900 my), the Penobscot (500 my), the Taconic (450 my) and the Acadian (350 my) orogenies occurred. Each of these affected portions of the region's bedrock. Detailed descriptions of their effects are outlined by Weston Geophysical [Reference 3-35]. Each orogeny helped consolidate blocks of bedrock with common boundaries marked by basement fault zones. Some of these faults have been remobilized through time, but none have moved for the past 200 million years, and none now have seismic activity associated with them.

In addition to these orogenic events, a Late Paleozoic compressional event, the Allegheny disturbance, reactivated or created new tectonic structures in several basement blocks. Geologists attribute this disturbance to a closing of the Atlantic Ocean and resultant continental collisions about 260 million years ago. Subsequently, about 200 million years ago, the Atlantic began to reopen, rifting apart North America from Africa. This was the last significant tectonic event experienced by New England.

3.5.3 Tectonic Province

In areas such as the northeast United States, where seismic activity is relatively infrequent, seismic events do not cause motion along faults which have any expression at the ground surface. That is, seismic events do not cause surface faulting to occur. Thus, determination of a value for seismic design of a nuclear facility begins with a description of tectonic provinces in the region of the plant. A tectonic province is defined in 10 CFR 100, Appendix A, as:

> "...a region of the North American continent characterized by a relative consistency of the geologic structural features contained therein."

Design basis for a plant is the largest historic earthquake for the site's tectonic province unless the largest earthquake in an adjacent province, moved to the province boundary closest to the plant site, results in a larger postulated ground motion at the plant.

Systematic Evaluation Program studies done for YNPS [Reference 3-35] defined regional tectonic provinces. The plant resides in the Western New England Fold Belt province. The province borders the Adirondack Uplift province to the west, and the Valley and Ridge province and the New York Recess to the southwest and south. To the east it borders the Southeast New England Platform, and to the northeast, the Merrimack Synclinorium.

The Western New England Fold Belt province contains four subprovinces, each a northerly trending belt extending from the Massachusetts-Connecticut border northward across the United States-Canadian border. They are in order from west to east: the Middlebury Synclinorium occurring along the eastern border of New York; the Berkshire-Green Mountain Anticlinorium, subprovince for the Yankee plant; the Connecticut Valley Synclinorium; and the Bronson Hill Anticlinorium.

The Western New England Fold Belt formed during the Taconic orogeny and was later affected by the Acadian and Allegheny orogenies (Table 3.5-1). During Triassic to Middle Cretaceous time, the Connecticut rift basin developed nearby. Related volcanic and plutonic activity occurred in the eastern portion of the province. No post-Allegheny fracture deformation is apparent in the province except for widely-spaced normal faults of Mesozoic age in the Bronson Hill Anticlinorium. A network of thrust faults in the aseismic western part of the province is related to submarine gravity sliding during the Taconic orogeny. A recent study defined two other thrusts, the Whitcomb Summit and the Bristol Thrust [Reference 3-36], which are described as ancient structures related to Silurian or older continental collision. This antiquity of the site province's tectonic structures supports a historic record of very low seismic activity.

Only two historic seismic events had a size greater than Intensity V (Modified Mercalli [MM] scale). The first occurred on January 30, 1952 in Burlington, Vermont. Its felt area was extremely small for an event of its size. Cracks in frozen ground, pavement, and basement walls most likely resulted in assignment of the event to a Intensity VI. The second Intensity VI event was spatially related to the Middle Cretaceous Megantic Complex, a large, cylindrical mafic intrusive near Woburn, Quebec. It occurred June 15, 1973. Near this epicenter are several faults related to the intrusive and a fault of regional scale and large displacement, the Northern Border fault of the Boundary Mountain Anticlinorium. These two events occurred 125 miles and 210 miles from the site, respectively. Their circumstances, location and character are in keeping with a regional trend of low seismic frequency and intensity.

3.5.4 Maximum Earthquake at the Site

Due to the rarity and low intensity of historic earthquakes in the plant site's tectonic province, an estimate of maximum earthquake potential was made assuming that the largest historical events in adjacent tectonic provinces were to occur at the closest point to the boundary of the site province. Weston Geophysical [Reference 3-35] concludes that an Intensity VI (MM) event is an appropriately conservative estimate of the Safe Shutdown Earthquake for YNPS. Corresponding ground acceleration for such an intensity is from 0.06g to 0.07g. Further study (Weston Geophysical, 1980) showed that a value of 0.10g was appropriate based on 10 CFR 100, Appendix A.

Seismic design values for the plant were reviewed by Yankee [References 3-37, 3-38 and 3-39]. Based on this data, a peak ground acceleration of 0.19g was chosen for all new installations at the plant. The NRC [Reference 3-40] concluded that the return time for the design basis earthquake for YNPS is between 10,000 and 100,000 years. Support for this conclusion is provided in a study by EPRI [Reference 3-41].

3.5.5 Site Geology

The Yankee plant site is situated on the eastern edge of the Deerfield River Valley. Plant structures are founded mostly on dense Wisconsinan-aged glacial till. This till ranges from 0 to 140 feet thick across the site. Bedrock under the till is part of the lower Cambrian Hoosac formation (Figure 3.5-1) and consists of quartz-albite-biotite gneiss and a rusty gneiss in adjacent areas. Underlying these are a garnet schist and a layered gneiss with some dolomitic marble. These latter units belong to the lower Cambrian or older Cavendish formation. A south-plunging anticline, the axis of which occurs just west of the site, defines local bedrock structure (Figure 3.5-2).

The site lies at an elevation of about 1,120 feet above sea level. Slopes of the Deerfield River Valley range up to about 35 degrees with occasional bedrock cliffs.

Foundations for major plant structures are in very dense glacial till. The till is, in fact, so dense that blasting was required to reach final footing elevations during construction. Scattered deposits of late glacial sand, gravel, and outwash along the river alluvium overlie the till. All of these loose soils were removed from the site prior to construction.

Site area bedrock is hard, internally welded metamorphic rock, not subject to significant deterioration. Bedrock fracturing is not a prominent structural feature. Bedrock outcrops exhibit either no joints or minor discontinuous joint surfaces. Geologic mapping identified five small faults near the site. All of these are very minor features [Reference 3-35]. These faults are all single surfaces without associated fracturing, gouge or brecciation. Four of the five could not be traced along strike direction. Fracture pattern analysis for 74 joints or joint sets and the faults in the site vicinity showed no anomalous trends for fractures. These studies also suggest the absence of any through-going zones of post-metamorphic faulting or shear. All evidence from site geologic studies supports the conclusions of regional studies, which indicate the site is one of pronounced seismic stability.

REFERENCES

3-1 1990 U.S. Census, P.L. 94-171 Counts for Massachusetts, Vermont, New Hampshire, Bureau of the Census, Department of Commerce.

3-2 Massachusetts Populations - 1980, ... 1989, 1990, 1995 - State, HSAs, Counties, Cities/Towns by Sex and 5-Year Age Groups, Bureau of Health Statistics, Research and Evaluation, Massachusetts Department of Public Health.

3-3 Population and Housing Estimates - 1987, Public Health Statistics, Vermont Department of Health: Population estimate as of July 1, 1987; Vacation/seasonal units, 1987.

3-4 United States Geological Survey Topographic Maps - Ashfield, Heath, North Adams, Plainfield, Rowe, Williamstown, Wilmington, and Windsor Quadrangles.

3-5 Limited field surveys conducted on September 27, October 12, and October 23, 1989.

3-6 Listings of new construction by the towns of Heath, Charlemont, Rowe, and Monroe for 1987, 1988, and 1989.

3-7 MISER - Massachusetts 1986 Population Estimates and Population Projections.

3-8 Vermont Population Projections - 1985 to 2000, Vermont Department of Health and State Planning Office, 1983.

3-9 Deerfield River Project, Deerfield River, Vermont and Massachusetts - Information for the Initial Stage of Consultation FERC Project No. 2323, Volumes I and II, New England Power Company, March 1988.

3-10 Personal communication with Rowe Elementary School administrative personnel, July 26, 1993.

3-11 Personal communication with Readsboro Central School administrative personnel, July 26, 1993.

3-12 Personal communication with Town Clerk or Assessor's Office personnel in Rowe, Monroe, Charlemont, Heath, Readsboro, and Whitingham, November 2, 1989.

3-13 YAEC, 1993 Land Use Census Results, Technical Memorandum, September 30, 1993.

3-14 State Register of Historic Places/1988, Massachusetts Historical Commission.

3-15 National Register Survey Books, Bennington County and Windham County listings, Vermont Division of Historic Preservation.

3-16 Personal/letter communication with Director of Safety and Training, Guilford Transportation Industries, Inc., October 30, 1989 and November 14, 1989.

3-17 Personal communication with Harriman and West Airport personnel, October 18, 1989.

3-18 Personal communication with Public Affairs Department, Federal Aviation Administration - Bedford Flight Standards District Office, October 20, 1989.

3-19 Personal communication with Monroe officials, November 9, 1989.

3-20 Personal communication with Charlemont officials, September 19, 1989.

3-21 Water supply maps at Department of Environmental Protection, Western Division, Springfield, Massachusetts.

3-22 A. Ruby, P. Godfrey, and O. Zajicek, "The Massachusetts Acid Rain Monitoring Project, Phase II," Water Resources Research Center, University of Massachusetts, Amherst, Massachusetts, 1988.

3-23 S. Levine and D. Schindler, "Phosphorus, Nitrogen, and Carbon Dynamics of Experimental Lake 303 During Recovery From Eutrophication," Can. J. Fish. Aquat. Sci., 46:2-10, 1989.

3-24 R. Wetzel, "Limnology," 2nd Edition, Saunders College Publishing, 1983.

3-25 H. Bold and M. Wynne, "Introduction to the Algae," Prentice-Hall, 1978.

3-26 W. Scott and E. Crossman, "Freshwater Fishes of Canada," Bull. Fish. Res. Bd. Can. 184, 1973.

3-27 D. Cowing and M. Scott, "Limnological Data Report for the Maine Department of Environmental Protection," U.S. Geological Survey Cooperative Lake Studies Project, 1976.

3-28 D. Faber, "Limnetic Larval Fish in Northern Wisconsin Lakes," J. Fish. Res. Bd. Can., 24(5):927-937, 1967.

3-29 J. Amundrud, D. Faber, and A. Keast, 1974, Seasonal Succession of Free-Swimming Perciform Larvae in Lake Opinicon, Ontario, J. Fish. Res. Bd. Can., 31(10):1661-1665.

3-30 R. Gregory and P. Powles, "Chronology, Distribution, and Sizes of Larval Fish Sampled by Light Traps in Macrophytic Chemung Lake," Can. J. Zool., 63(11):2569-2577, 1985.

3-31 Vermont; Climatography of the United States No. 20; National Oceanic and Atmospheric Administration; National Environmental Satellite, Data, and Information Service; National Climatic Data Center, Asheville, North Carolina, 1985.

3-32 Climate of Massachusetts; Climatography of the United States No. 60; National Oceanic and Atmospheric Administration; National Environmental Satellites, Data, and Information Service; National Climatic Data Center, Asheville, North Carolina, June 1982.

3-33 D. Crutchfield (USNRC) letter to J. Kay (YAEC), Yankee Rowe - SEP Topic II-2.A, LS05-80-12-038, December 17, 1980.

3-34 E. Zen (Editor), R. Goldsmith, N. Ratcliffe, P. Robinson, and R. Stanley (Compilers), Bedrock Geologic Map of New England, United States Geological Survey, Scale 1:250,000, Three Sheets, 1983.

3-35 Weston Geophysical, "Geology and Seismology Yankee Rowe Nuclear Power Plant", prepared for YAEC, Docket No. 50-29 (February 23, 1979).

3-36 R. Stanley and N. Hatch Jr., "The Pre-Silurian Geology of the Rowe-Hawley Zone USGS Professional Paper 1366A, 39 pages," 1988.

3-37 "Seismic Response Spectra for the Yankee Nuclear Power Station, Rowe, Massachusetts," Report No. YAEC-1263, 1981.

3-38 "Supplemental Seismic Probabilistic Study," Report No. YAEC-1331, 1982.

3-39 "Yankee Plant Seismic Hazard Analysis," Report No. YAEC-1477, 1985.

3-40 "Seismic Hazard Analysis - Application of Methodology, Results and Sensitivity Studies," Lawrence Livermore National Laboratory, NRC NUREG/CR-1582," 1981.

3-41 EPRI, "Seismic Hazard Methodology for the Central and Eastern United States," NP-4726, 1986.

3-42 Vermont; Climatography of the United States No. 81; National Oceanic and Atmospheric Administration; National Environmental Satellite, Data, and Information Service; National Climatic Data Center, Asheville, North Carolina, January 1992.

TABLE 3.1-1

Permanent Population Estimates for Municipalities within 10 Miles of the Yankee Nuclear Power Station

	1980 Census	1990 Census
Massachusetts:		
Adams*	10,381	9,445
Clarksburg	1,871	1,745
Florida	730	732
North Adams	18,063	16,797
Savoy	644	634
Buckland	1,864	1,928
Charlemont	1,149	1,249
Colrain	1,552	1,757
Hawley	280	317
Heath	482	716
Monroe	179	115
Rowe	336	378
Vermont:		
Halifax	488	588
Whitingham	1,043	1,177
Wilmington	1,808	1,968
Readsboro	638	762
Stamford	773	773

* No residents within 10 miles

Source: 1990 U.S. Census of Population Counts [Reference 3-1]

TABLE 3.1-2

Population within 10 Miles of the Yankee Nuclear Power Station

Existing*

Sector	Distance to Plant 0-1	1-2	2-3	3-4	4-5	5-10	TOTAL
N	0	5	20	22	15	154	216
NNE	0	0	13	34	143	820	1,010
NE	0	10	10	13	114	713	860
ENE	0	9	7	7	39	348	410
E	0	9	23	51	29	251	363
ESE	0	2	25	19	55	415	516
SE	0	12	65	0	17	386	480
SSE	0	30	71	0	30	668	799
S	0	18	19	16	19	222	294
SSW	0	0	0	4	0	122	126
SW	19	0	0	0	27	204	250
WSW	15	8	0	0	2	8,554	8,579
W	3	17	21	13	7	7,772	7,833
WNW	0	14	3	14	32	486	549
NW	0	37	43	20	12	203	315
NNW	1	6	38	269	26	160	500
TOTAL	38	177	358	482	567	21,478	23,100

* Based on the 1990 U.S. Census of Population Counts [Reference 3-1].

TABLE 3.1-3

Projected 10-Mile Population for the Year 2000

2000*

Sector	Distance to Plant 0-1	1-2	2-3	3-4	4-5	5-10	TOTAL
N	0	5	20	23	15	172	235
NNE	0	0	13	33	138	900	1,084
NE	0	10	10	13	110	696	839
ENE	0	9	9	7	38	337	400
E	0	11	29	63	36	295	434
ESE	0	2	31	24	69	506	632
SE	0	15	81	0	21	482	599
SSE	0	37	88	0	38	821	984
S	0	22	24	20	24	267	357
SSW	0	0	0	4	0	126	130
SW	19	0	0	0	28	209	256
WSW	15	8	0	0	2	8,296	8,321
W	3	16	21	12	7	7,582	7,641
WNW	0	14	3	15	33	578	643
NW	0	38	45	21	12	233	349
NNW	1	6	39	282	27	168	523
TOTAL	38	193	413	517	598	21,668	23,427

* Based on data obtained from Massachusetts and Vermont planning agencies [References 3-7 and 3-8].

TABLE 3.1-4

Projected 10-Mile Population for the Year 2010

2010*

Sector	Distance to Plant 0-1	1-2	2-3	3-4	4-5	5-10	TOTAL
N	0	6	21	25	16	184	252
NNE	0	0	13	34	143	954	1,144
NE	0	10	10	13	114	728	875
ENE	0	10	11	8	39	355	423
E	0	14	35	80	46	348	523
ESE	0	3	38	31	87	613	772
SE	0	19	101	0	26	601	747
SSE	0	46	109	0	46	1,008	1,209
S	0	27	30	24	29	325	435
SSW	0	0	0	5	0	130	135
SW	20	0	0	0	28	216	264
WSW	15	8	0	0	2	8,068	8,093
W	4	16	20	12	7	7,399	7,458
WNW	0	14	3	16	36	616	685
NW	0	42	49	23	13	250	377
NNW	1	7	43	305	30	183	569
TOTAL	40	222	483	576	662	21,978	23,961

* Based on data obtained from Massachusetts and Vermont planning agencies [References 3-7 and 3-8].

TABLE 3.1-5

Projected 10-Mile Population for the Year 2020

2020*

Sector	Distance to Plant 0-1	1-2	2-3	3-4	4-5	5-10	TOTAL
N	0	6	22	26	17	198	269
NNE	0	0	14	35	149	1,007	1,205
NE	0	11	11	14	119	762	917
ENE	0	12	14	8	41	373	448
E	0	17	44	101	57	414	633
ESE	0	3	47	38	110	746	944
SE	0	24	125	0	32	749	930
SSE	0	57	135	0	57	1,237	1,486
S	0	34	37	30	36	394	531
SSW	0	0	0	7	0	135	142
SW	21	0	0	0	29	226	276
WSW	14	8	0	0	2	7,879	7,903
W	4	15	19	12	6	7,247	7,303
WNW	0	14	3	18	39	652	726
NW	0	46	53	25	14	267	405
NNW	1	7	46	330	32	197	613
TOTAL	40	254	570	644	740	22,483	24,731

* Based on data obtained from Massachusetts and Vermont planning agencies [References 3-7 and 3-8].

TABLE 3.1-6

1993 Land Use Census
Nearest Residence, Garden, and Milk Animal Locations
within 5 Miles

Sector	Nearest Residence (miles)	Nearest Garden (miles)	Nearest Milk Animal (miles) *
N	3.0	2.2	3.8
NNE	2.75	2.9	-
NE	1.9	1.9	-
ENE	1.9	3.6	5.2
E	1.9	1.9	-
ESE	2.0	2.2	4.9
SE	1.4	1.4	2.0
SSE	1.3	2.9	-
S	1.4	1.8	-
SSW	-	-	-
SW	0.8	4.8	-
WSW	0.8	0.8	-
W	1.2	1.7	4.3
WNW	1.2	1.2	4.2
NW	0.3	2.8	-
NNW	1.8	2.4	-

Source: 1993 Land Use Census Results Memorandum [Reference 3-13].

* Where cows or goats that were known not to be milked were identified, the location was documented but was not included as a "nearest milk animal" location in this table.

\- None identified within 5 miles.

TABLE 3.2-1

Monthly Values for Water Quality Parameters
In the Vicinity of YNPS, April-November 1989
(Sheet 1 of 5)

Parameter	Units	Station	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Temperature (a,d)										
Surface	°F	1	46.1	58.3	58.1	63.2	66.3	70.6	60.4	53.8
		2	47.4	59.5	60.1	71.1	68.8	72.3	62.9	55.2
		3	46.7	59.9	62.3	70.6	69.2	69.9	61.4	54.0
		4	43.0	58.4	62.0	71.2	67.5	69.1	59.7	54.1
Bottom	°F	1	45.8	55.3	58.0	62.8	66.0	70.1	59.6	53.4
		2	39.9	58.3	57.9	62.8	58.4	59.9	54.1	50.2
		3	39.4	46.5	48.7	53.7	58.3	60.2	53.2	50.4
		4	38.8	49.6	48.7	53.1	58.8	59.7	53.2	48.7
Conductivity (a,d)										
Surface	μS at 25°C	1	51	54	52	51	46	45	42	49
		2	48	52	52	51	46	46	42	45
		3	56	51	52	59	46	46	43	47
		4	50	52	50	54	47	46	44	48
Bottom	μS at 25°C	1	54	56	56	54	48	48	44	53
		2	65	62	65	54	58	56	56	57
		3	71	60	62	64	55	55	51	55
		4	62	58	60	58	52	52	48	56

TABLE 3.2-1
(Sheet 2 of 5)

Parameter	Units	Station	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Apparent Color (a,d)	Standard Color Units	1	20	20	23	23	28	25	28	30
		2	20	20	20	23	28	25	28	30
		3	20	18	23	23	28	25	28	30
		4	20	18	23	23	28	25	28	30
True Color (a,d)	Standard Color Units	1	20	18	20	23	25	25	28	30
		2	20	18	20	23	25	25	28	30
		3	20	18	20	23	25	25	28	30
		4	20	18	20	23	25	25	28	30
Color pH (a,d)	pH units	1	5.6	5.9	5.8	6.1	5.6	6.0	6.3	6.6
		2	5.6	5.8	5.8	6.2	5.6	6.1	6.4	6.4
		3	5.6	5.8	5.7	6.2	5.6	6.1	6.3	6.4
		4	5.6	5.8	5.7	6.2	5.6	6.1	6.3	6.2
Dissolved Oxygen (a,d)										
Surface	mg/l	1	11.4	9.6	9.7	8.7	8.0	7.4	8.4	9.5
		2	11.0	9.4	9.3	8.7	8.4	7.4	8.6	9.7
		3	11.1	9.6	9.4	8.4	8.2	7.6	8.7	9.7
		4	11.2	10.0	9.4	8.2	7.8	7.4	8.8	9.7
Bottom	mg/l	1	11.4	9.4	9.6	8.6	7.8	7.2	8.5	9.5
		2	11.7	9.9	9.8	8.6	7.2	6.9	8.5	8.7
		3	11.8	8.0	9.5	8.7	7.2	7.2	8.8	9.9
		4	11.8	10.6	9.6	9.0	7.4	7.0	8.5	10.0

TABLE 3.2-1
(Sheet 3 of 5)

Parameter	Units	Station	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Biological Oxygen Demand (b,d)	mg/l	1	1	1	2	2	<1	<1	<1	1
		2	2	1	2	1	<1	<1	1	2
		3	1	1	2	2	<1	<1	<1	1
Field pH (a,d)	pH units	1	5.7	6.2	6.1	6.0	6.0	6.0	7.0	7.6
		2	5.9	6.3	6.1	6.1	6.1	6.0	6.8	7.6
		3	5.9	6.2	6.1	6.0	6.1	6.0	6.9	7.6
		4	6.1	6.3	6.0	6.0	6.1	6.1	6.9	7.6
Alkalinity (b,d)	mg/l	1	2	2	4	2	2	8	12	8
		2	2	2	3	2	2	8	9	8
		3	2	2	2	2	2	8	9	10
Total Hardness (b,d)	mg/l	1	11	11	11	11	12	11	11	9
		2	11	12	11	12	11	11	11	9
		3	11	11	11	11	11	11	11	10
Ammonia (b,d)	mg/l	1	.02	.05	.04	.05	.03	.03	.04	.03
		2	.04	.05	.04	.04	.04	.03	.05	.02
		3	.02	.04	.03	.04	.02	.03	.04	.02
Nitrate (b,d)	mg/l	1	.42	.43	.31	.25	.17	.19	.15	.16
		2	.42	.37	.31	.26	.17	.19	.15	.16
		3	.42	.38	.31	.26	.17	.19	.15	.16

TABLE 3.2-1
(Sheet 4 of 5)

Parameter	Units	Station	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Nitrite (b,d)	mg/l	1	<.001	.005	.001	.002	<.001	.002	.003	.002
		2	<.001	.005	.001	.002	<.001	.002	.002	.002
		3	<.001	.002	.002	.002	<.001	.003	.002	<.001
Kjeldahl Nitrogen (b,d)	mg/l	1	.33	.12	.38	.38	.24	.18	.21	.24
		2	.24	.12	.36	.38	.23	.20	.24	.30
		3	.26	.17	.27	.38	.20	.14	.27	.27
Total Phosphorus (b,d)	mg/l	1	.008	.008	.006	.008	.001	.003	.008	.010
		2	.008	.007	.008	.008	.001	.003	.008	.010
		3	.008	.007	.007	.008	.001	.003	.010	.010
Sulfate (b,d)	mg/l	1	11	3	4	3	<1	<1	<1	<1
		2	13	2	7	3	<1	<1	<1	<1
		3	10	9	1	2	<1	<1	<1	<1
Chloride (b,d)	mg/l	1	6.0	5.8	5.8	6.4	4.1	5.6	4.5	4.2
		2	5.1	5.6	4.4	6.0	3.9	5.8	4.5	4.1
		3	5.1	5.7	5.6	6.0	3.8	5.6	4.5	4.0
Turbidity (a,d)	NTU	1	1.2	2.2	1.5	1.1	0.7	0.8	0.8	1.8
		2	1.2	2.0	1.9	0.7	0.6	0.8	1.1	1.9
		3	1.2	1.9	1.2	0.6	0.6	0.6	1.0	1.9
		4	1.3	1.7	1.2	0.7	0.5	0.7	0.9	1.9

TABLE 3.2-1
(Sheet 5 of 5)

Parameter	Units	Station	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Secchi Disk	m	1	3.5	3.5	4.0	4.1	4.5	4.0	2.5	3.0
(a,d)		2	2.5	3.0	4.0	3.6	3.4	3.5	2.9	2.5
		3	3.0	3.3	4.0	3.6	3.5	4.0	3.0	2.5
		4	2.8	3.5	3.5	3.9	3.8	4.3	3.0	2.5
Total Solids	mg/l	1	31	27	39	46	35	38	40	14
(b,d)		2	32	30	42	48	37	33	36	19
		3	31	30	43	45	38	39	40	14
Suspended Solids	mg/l	1	2.0	1.2	2.0	0.8	0.8	1.0	1.2	1.5
(b,d)		2	2.4	1.2	0.8	0.7	0.7	1.3	1.3	1.4
		3	1.9	1.6	1.2	0.4	1.1	1.4	1.4	1.3
Chlorophyll a	mg/l	1	.43	.43	.89	1.55	.82	.95	1.18	1.19
(a,c)		2	.52	1.22	1.20	1.08	1.00	.96	1.04	1.12
		3	.19	1.99	1.44	1.14	1.46	.85	.95	1.14

---

a - Mean of two sampling dates per month, except for November (one date only).
b - Sampled once per month.
c - Mean of two replicates per sampling date at each station.
d - No replicate analysis.
NTU - Nephelometric Turbidity Units.

TABLE 3.2-2

Abundance (Thousands of Cells/Liter) of Major Taxonomic Groups of Phytoplankton by Station and Monthly Average in the Vicinity of YNPS, April-November 1989

Station	Group[a]	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Mean *
1	Golden-Browns	94	798	110	153	92	115	68	12	192
	Greens	18	257	194	39	73	60	97	96	104
	Blue-Greens	946	364	244	29601	9400	19276	24096	13022	10773
	Diatoms	66	356	31	18	130	111	181	877	175
	Euglenoids	0	0	0	0	0	0	0	24	1
	Dinoflagellates	0	68	6	0	0	0	0	0	10
2	Golden-Browns	131	338	140	202	560	326	108	48	244
	Greens	50	35	49	83	213	47	162	237	101
	Blue-Breens	76	60	327	1084	13222	9391	21932	23235	7695
	Diatoms	50	85	43	26	56	85	273	404	110
	Euglenoids	6	0	0	0	0	0	0	24	2
	Dinoflagellates	25	6	6	0	0	6	0	0	6
3	Golden-Browns	452	442	145	99	690	140	74	0	272
	Greens	190	43	90	13	112	82	56	93	84
	Blue-Greens	541	8985	127	670	8655	5576	18424	25564	7435
	Diatoms	303	55	36	6	56	171	499	359	175
	Euglenoids	0	0	0	0	12	0	0	0	1
	Dinoflagellates	6	6	18	0	6	19	0	0	7

[a] Golden-Browns = Chrysophyceae
Greens = Chlorophyta (including desmids)
Blue-Greens = Cyanophyta
Diatoms = Baccilariophyceae
Euglenoids = Euglenophyceae
Dinoflagellates = Dinophyceae

* Mean is the average of all samples, rather than the average of the monthly averages.

TABLE 3.2-3

Abundance (number/100 m^3) of Ichthyoplankton at Stations 1 (Deerfield River), 2 and 3 (Sherman Reservoir), 1989[a]

Station	Species	May 10	May 22	Jun 14	Jun 26	Jul 12	Jul 25	Aug 16
1	Lepomis	0	0	0	0	0	1.9	0
2	Lepomis	0	0	0	0	0	0.9	0
3	Lepomis	0	0	0	0	3.5	2.9	1.4
2	Perca Flavescens	0	32.1	0	0.9	0	0	0
3	Perca Flavescens	0.7	51.5	15.3	1.6	0	0	0

[a] Data presented only for dates when larvae occurred. The following dates were also sampled, but no larvae were found: April 12 and 24, August 29, September 13 and 26, October 11 and 25, and November 15.

TABLE 3.2-4

Total Catch of Fish by Species and Station Summed Over all Sampling Dates, April-November 1989, in the Vicinity of YNPS[1]

Family	Species	Station 1	2	3	4	Total	%
Anguillidae	American Eel	1	0	0	0	1	<1%
Osmeridae	Rainbow Smelt	0	4	18	6	28	1%
Esocidae	Chain Pickerel	2	4	3	17	26	1%
Cyprinidae	Golden Shiner	0	21	41	202	264	13%
	Fallfish	0	15	60	94	169	8%
Catostomidae	White Sucker	38	67	155	179	439	22%
	Longnose Sucker	0	1	16	9	26	1%
Ictaluridae	Brown Bullhead	4	1	30	68	103	5%
Centrarchidae	Rock Bass	1	2	4	0	7	<1%
	Pumpkinseed	0	2	1	13	16	1%
	Smallmouth Bass	4	6	4	8	22	1%
Percidae	Yellow Perch	6	44	330	549	929	46%
	TOTAL	56	167	662	1,145	2,030	

[1] Total of 70 overnight gill net samples (surface and bottom nets at a station counted as separate samples).

TABLE 3.3-1

Monthly Mean Daily Maximum and Minimum Temperatures
(Values in °F)

Month	YNPS	Readsboro	Hoosac Tunnel
Daily Maximum			
Jan	28.0	29.0	29.5
Feb	31.9	31.5	32.9
Mar	40.6	40.5	40.3
Apr	51.5	53.1	54.2
May	65.0	66.2	66.8
Jun	71.0	74.5	76.2
Jul	76.2	79.8	80.5
Aug	74.0	77.5	78.1
Sep	66.3	69.6	71.3
Oct	56.0	58.7	61.2
Nov	45.1	45.8	45.8
Dec	33.2	33.0	32.8
Year	53.2	54.9	55.8
Daily Minimum			
Jan	12.5	7.8	9.7
Feb	15.0	8.7	11.4
Mar	23.3	19.8	21.4
Apr	34.2	31.0	32.6
May	44.6	41.2	41.5
Jun	51.2	49.9	50.9
Jul	56.7	54.6	55.6
Aug	56.0	52.9	53.1
Sep	48.1	45.4	46.7
Oct	38.2	35.1	36.8
Nov	30.8	27.9	28.5
Dec	18.8	15.1	16.8
Year	35.8	32.5	33.8
Period of Record	1977-1992	1961-1990	1951-1972
Reference	On-Site Program	[3-42]	[3-32]

TABLE 3.3-2

YNPS 35-Foot
Wind Speed and Direction Joint Frequency Distributions
1988-1992

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
C-3	570	1010	1351	1672	2941	3952	2556	1741	1284	942	763	385	283	221	169	297	0	20137
(1)	1.33	2.36	3.16	3.91	6.88	9.25	5.98	4.07	3.00	2.20	1.78	.90	.66	.52	.40	.69	.00	47.11
(2)	1.33	2.36	3.16	3.91	6.88	9.25	5.98	4.07	3.00	2.20	1.78	.90	.66	.52	.40	.69	.00	47.11
4-7	1468	1363	975	727	761	374	455	773	1230	2046	2570	1176	773	565	625	783	0	16664
(1)	3.43	3.19	2.28	1.70	1.78	.87	1.06	1.81	2.88	4.79	6.01	2.75	1.81	1.32	1.46	1.83	.00	38.98
(2)	3.43	3.19	2.28	1.70	1.78	.87	1.06	1.81	2.88	4.79	6.01	2.75	1.81	1.32	1.46	1.83	.00	38.98
8-12	1137	952	263	35	4	2	2	13	96	483	1159	481	179	137	188	308	0	5439
(1)	2.66	2.23	.62	.08	.01	.00	.00	.03	.22	1.13	2.71	1.13	.42	.32	.44	.72	.00	12.72
(2)	2.66	2.23	.62	.08	.01	.00	.00	.03	.22	1.13	2.71	1.13	.42	.32	.44	.72	.00	12.72
13-18	141	195	12	1	0	0	0	0	1	12	116	9	1	1	0	7	0	496
(1)	.33	.46	.03	.00	.00	.00	.00	.00	.00	.03	.27	.02	.00	.00	.00	.02	.00	1.16
(2)	.33	.46	.03	.00	.00	.00	.00	.00	.00	.03	.27	.02	.00	.00	.00	.02	.00	1.16
19-24	2	5	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	10
(1)	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02
(2)	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02
GT 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
ALL SPEEDS	3318	3525	2602	2435	3706	4328	3013	2527	2611	3483	4610	2051	1236	924	982	1395	0	42746
(1)	7.76	8.25	6.09	5.70	8.67	10.12	7.05	5.91	6.11	8.15	10.78	4.80	2.89	2.16	2.30	3.26	.00	100.00
(2)	7.76	8.25	6.09	5.70	8.67	10.12	7.05	5.91	6.11	8.15	10.78	4.80	2.89	2.16	2.30	3.26	.00	100.00

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD

C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

TABLE 3.3-3

YNPS 199-Foot
Wind Speed and Direction Joint Frequency Distributions
1988-1992

WIND DIRECTION FROM

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	VRBL	TOTAL
CALM	9	13	7	3	7	5	1	4	4	4	10	2	5	2	3	4	0	83
(1)	.02	.03	.02	.01	.02	.01	.00	.01	.01	.01	.02	.00	.01	.00	.01	.01	.00	.20
(2)	.02	.03	.02	.01	.02	.01	.00	.01	.01	.01	.02	.00	.01	.00	.01	.01	.00	.20
C-3	1864	3814	1714	774	557	509	501	500	670	886	1082	696	474	334	402	570	0	15347
(1)	4.45	9.11	4.10	1.85	1.33	1.22	1.20	1.19	1.60	2.12	2.59	1.66	1.13	.80	.96	1.36	.00	36.67
(2)	4.45	9.11	4.10	1.85	1.33	1.22	1.20	1.19	1.60	2.12	2.59	1.66	1.13	.80	.96	1.36	.00	36.67
4-7	1726	3172	852	263	183	212	340	612	1073	1592	2197	1258	804	512	540	662	0	15998
(1)	4.12	7.58	2.04	.63	.44	.51	.81	1.46	2.56	3.80	5.25	3.01	1.92	1.22	1.29	1.58	.00	38.23
(2)	4.12	7.58	2.04	.63	.44	.51	.81	1.46	2.56	3.80	5.25	3.01	1.92	1.22	1.29	1.58	.00	38.23
8-12	1397	1260	134	23	14	16	51	98	280	846	1469	1378	643	261	299	456	0	8625
(1)	3.34	3.01	.32	.05	.03	.04	.12	.23	.67	2.02	3.51	3.29	1.54	.62	.71	1.09	.00	20.61
(2)	3.34	3.01	.32	.05	.03	.04	.12	.23	.67	2.02	3.51	3.29	1.54	.62	.71	1.09	.00	20.61
13-18	354	353	5	0	0	0	0	0	9	85	399	356	41	11	22	49	0	1684
(1)	.85	.84	.01	.00	.00	.00	.00	.00	.02	.20	.95	.85	.10	.03	.05	.12	.00	4.02
(2)	.85	.84	.01	.00	.00	.00	.00	.00	.02	.20	.95	.85	.10	.03	.05	.12	.00	4.02
19-24	9	21	1	0	0	0	0	0	0	2	58	18	0	0	0	1	0	110
(1)	.02	.05	.00	.00	.00	.00	.00	.00	.00	.00	.14	.04	.00	.00	.00	.00	.00	.26
(2)	.02	.05	.00	.00	.00	.00	.00	.00	.00	.00	.14	.04	.00	.00	.00	.00	.00	.26
GT 24	0	1	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	5
(1)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.01
(2)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.01
ALL SPEEDS	5359	8634	2713	1063	761	742	893	1214	2036	3415	5219	3708	1967	1120	1266	1742	0	41852
(1)	12.80	20.63	6.48	2.54	1.82	1.77	2.13	2.90	4.86	8.16	12.47	8.86	4.70	2.68	3.02	4.16	.00	100.00
(2)	12.80	20.63	6.48	2.54	1.82	1.77	2.13	2.90	4.86	8.16	12.47	8.86	4.70	2.68	3.02	4.16	.00	100.00

(1)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PAGE
(2)=PERCENT OF ALL GOOD OBSERVATIONS FOR THIS PERIOD

C= CALM (WIND SPEED LESS THAN OR EQUAL TO .95 MPH)

TABLE 3.3-4

Monthly Mean Precipitation Totals
(inches of water)

Month	Readsboro	Hoosac Tunnel
Jan	3.49	2.94
Feb	3.43	3.20
Mar	3.86	3.62
Apr	4.32	4.03
May	4.59	3.95
Jun	4.54	3.78
Jul	4.08	3.67
Aug	4.29	3.83
Sep	3.79	3.82
Oct	3.80	3.46
Nov	4.61	4.56
Dec	4.28	4.08
Year	49.08	44.94
Period of Record	1961-1990	1951-1972
Reference	[3-42]	[3-32]

TABLE 3.3-5

Monthly Mean and Maximum Monthly Snowfall Totals
(inches of snow)

Month	Readsboro	Hoosac Tunnel
Monthly Mean		
Jan	23.3	20.8
Feb	23.4	25.7
Mar	19.4	18.6
Apr	5.7	3.9
May	0.2	0.1
Jun	0.0	0.0
Jul	0.0	0.0
Aug	0.0	0.0
Sep	0.0	0.0
Oct	0.0	0.0
Nov	6.4	5.3
Dec	20.4	21.3
Yearly Mean	98.8	95.7
Maximum Monthly		
Jan	44.6	40.1
Feb	48.9	46.6
Mar	45.2	46.0
Apr	21.0	14.5
May	2.5	0.8
Jun	0.0	0.0
Jul	0.0	0.0
Aug	0.0	0.0
Sep	0.0	0.0
Oct	0.5	0.0
Nov	29.4	19.6
Dec	53.5	54.9
Peak Month	53.5	54.9
Period of Record	1951-1980	1951-1972
Reference	[3-31]	[3-32]

TABLE 3.4-1

Deerfield River Flow Data

Location	Drainage Area (square miles)	Period of Record	Average Flow (cfs)	7-Day, 10-Year Low Flow (cfs)
USGS Gage near Rowe	254	1974-1987	738	85
USGS Gage at Charlemont	362	1914-1987	900	69

TABLE 3.5-1

Geologic Time Scale with Key Events in New England Geologic History

Age	Period	MYBP *	Epoch	New England Events
Cenozoic	Tertiary	2	Pleistocene	Four Glaciations
		5	Pliocene	
		24	Miocene	
		37	Oligocene	
		58	Eocene	
		66	Paleocene	
Mesozoic	Cretaceous	98	Late	White Mountain Plutons
		120	Middle	||
		144	Early	|| Final Atlantic Opening
	Jurassic	163	Late	||
		187	Middle	||
		208	Early	||
	Triassic	230	Late	|| Rift Basins Form
		240	Middle	|| Local Dike Swarms
		245	Early	|| Final Breakup of Pangea Begins
Paleozoic	Permian	258	Late	|| Allegheny Disturbance
		286	Early	Regional Uplift
	Carboniferous	320	Pennsylvanian	Boston Basin Forms/Acadian Orogeny
		360	Mississippian	
	Devonian	374	Late	
		387	Middle	Adirondack Faulting
		408	Early	Avalonian Orogeny
	Silurian	421	Late	
		438	Early	
	Ordovician	458	Late	Taconic Orogeny/Continental Collision
		478	Middle	Proto-Atlantic Closes/Penobscot Orogeny
		505	Early	
	Cambrian	523	Late	
		540	Middle	
		570	Early	
Pre-Cambrian	Proterozoic	900	Late	Avalonian Orogeny
		1600	Middle	Grenville Orogeny/Proto-Atlantic Opens
		2500	Early	Origin of Oldest New England Bedrock
	Archean	3000	Late	
		3400	Middle	
		3800+	Early	

* MYBP = Millions of Years Before Present

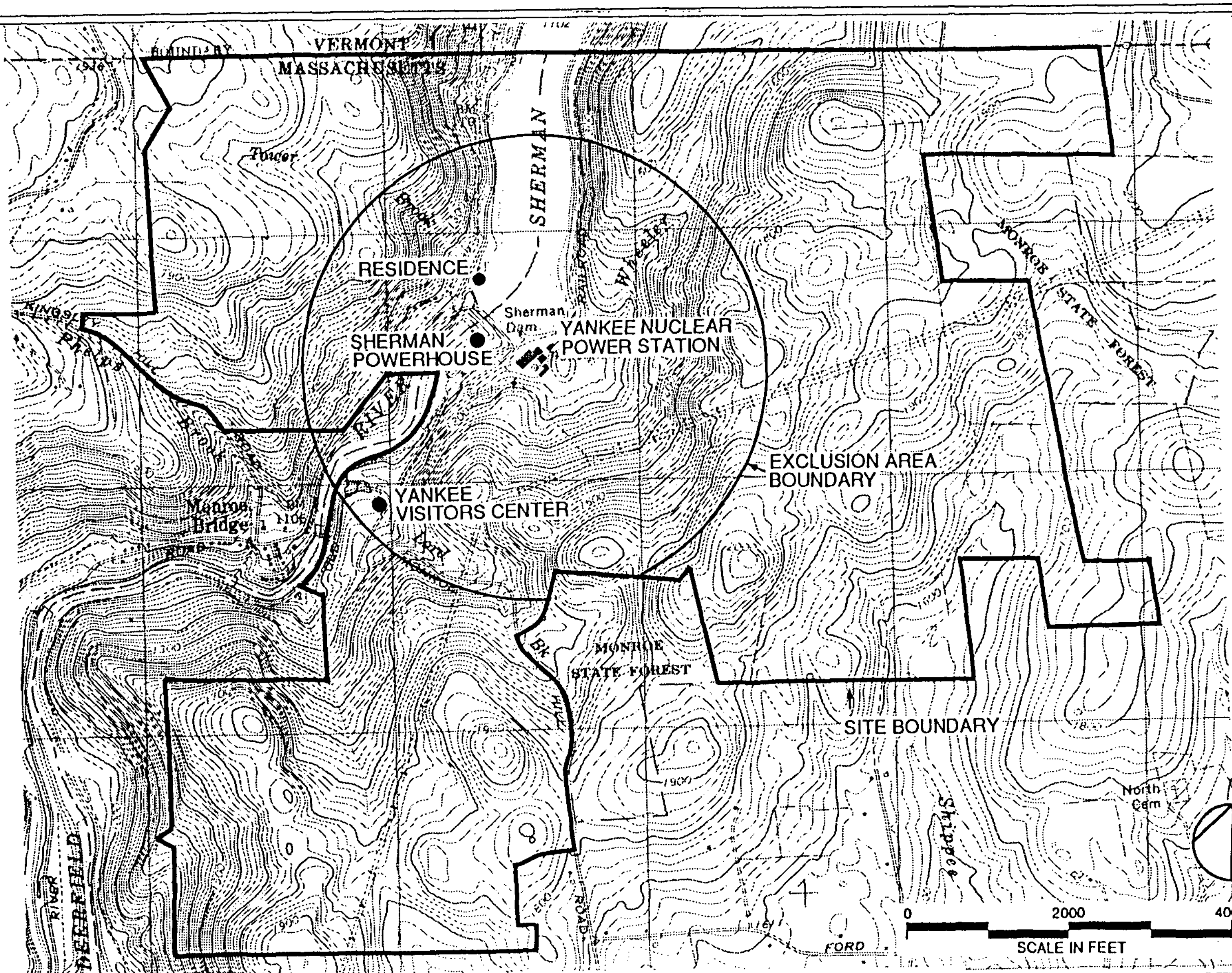


FIGURE 3.1-1

YANKEE NUCLEAR POWER STATION

SITE BOUNDARY AND PLANT EXCLUSION AREA

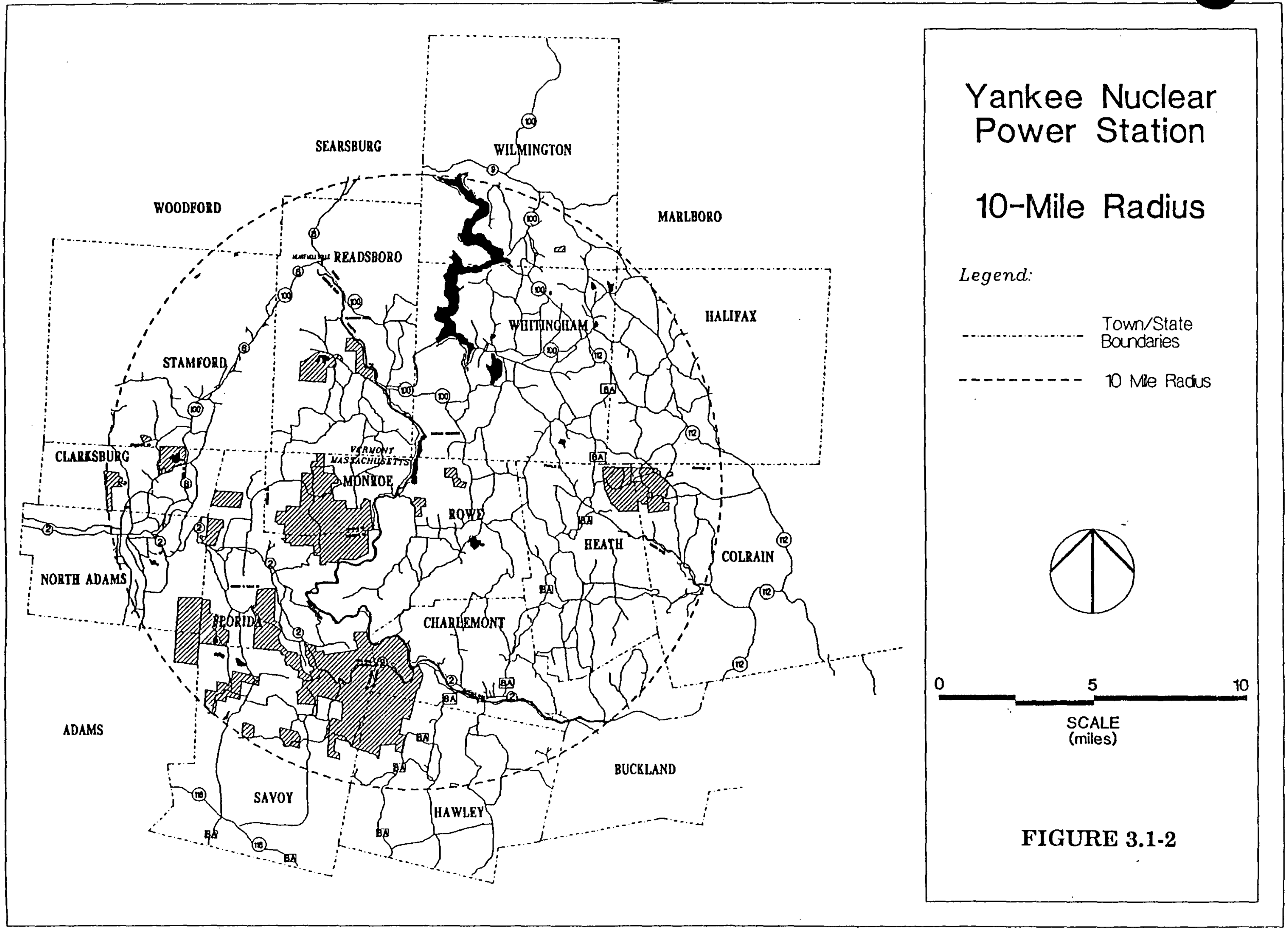
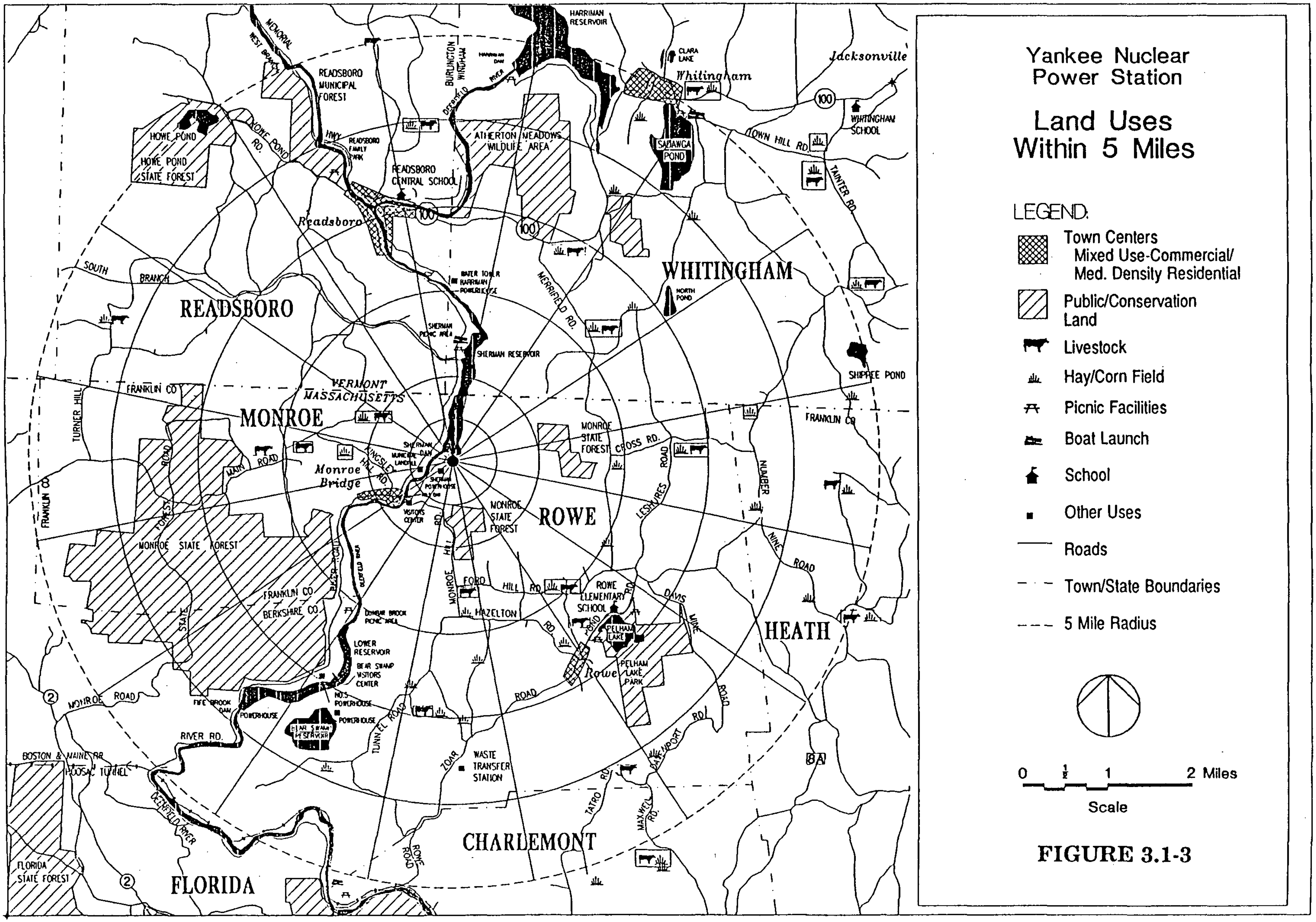

Yankee Nuclear Power Station
10-Mile Radius
Legend:
Town/State Boundaries
10 Mile Radius
0
5
10
SCALE (miles)
SEARSBURG
WILMINGTON
WOODFORD
MARLBORO
READSBORO
HALIFAX
WHITINGHAM
STAMFORD
CLARKSBURG
VERMONT
MASSACHUSETTS
MONROE
ROWE
HEATH
COLRAIN
NORTH ADAMS
FLORIDA
CHARLEMONT
ADAMS
BUCKLAND
SAVOY
HAWLEY

FIGURE 3.1-2



Yankee Nuclear Power Station

Land Uses Within 5 Miles

FIGURE 3.1-3

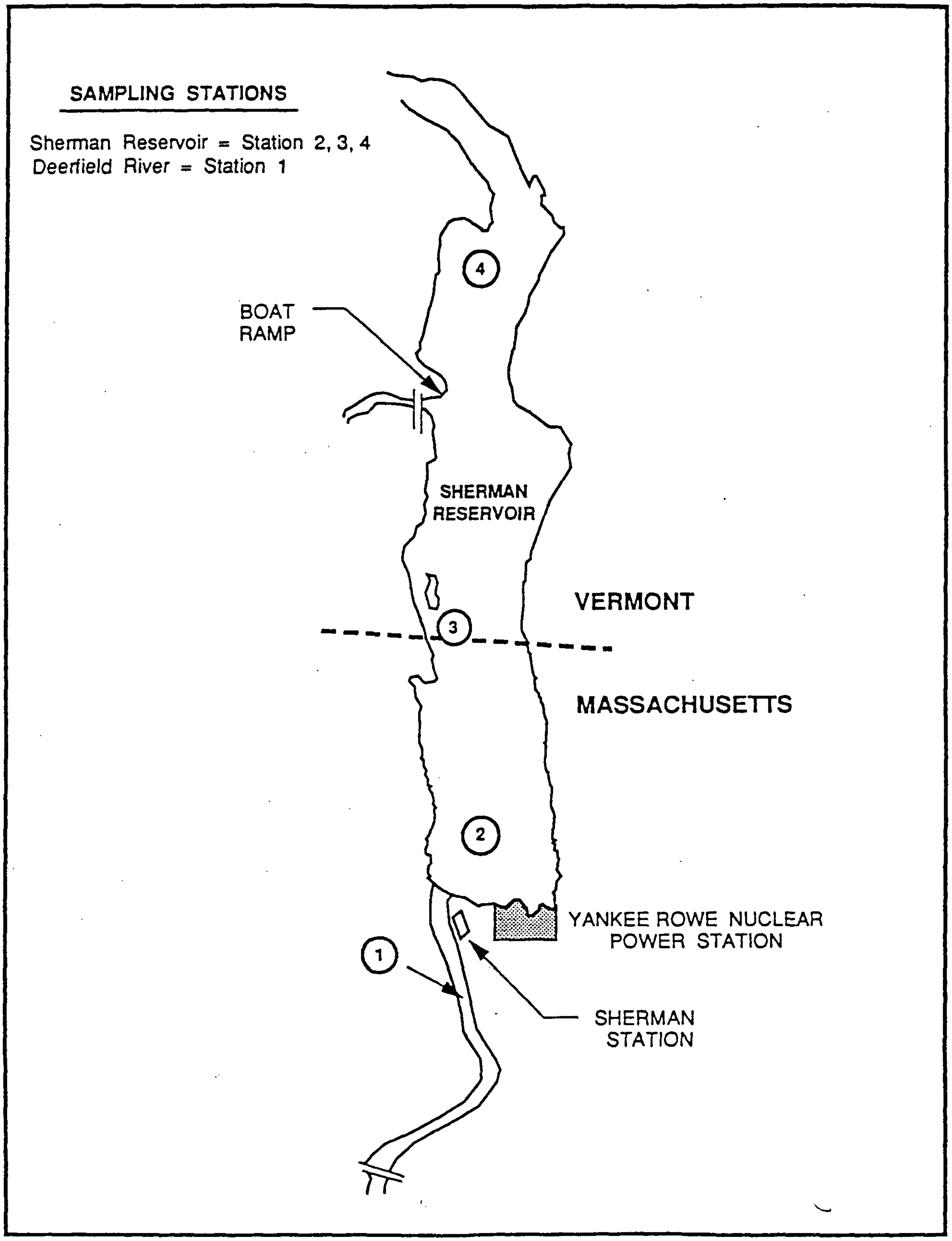


Figure 3.2-1 Water Quality Sampling Locations

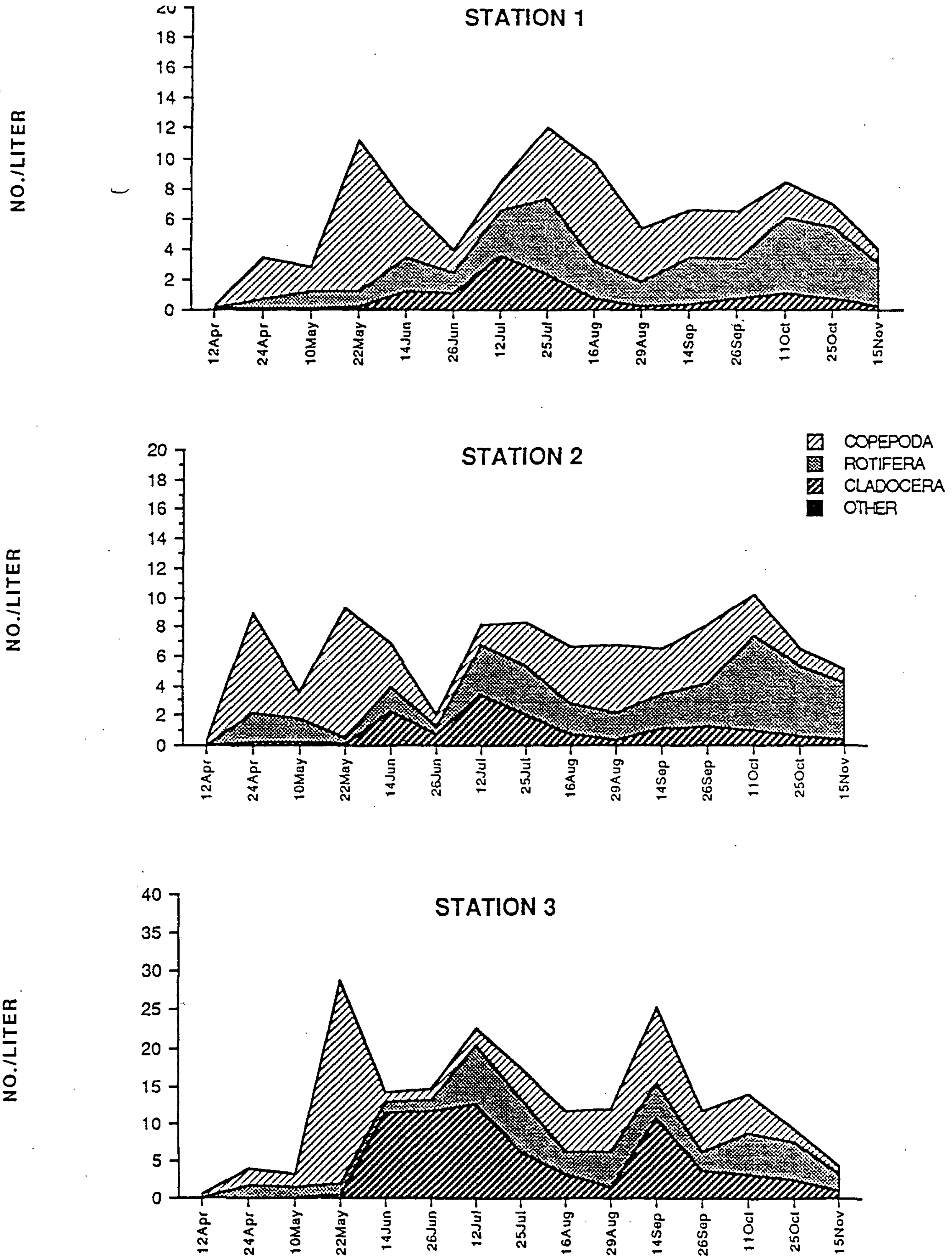


FIGURE 3.2-2 ABUNDANCE OF MAJOR TAXONOMIC GROUPS OF ZOOPLANKTON

Abundance (no./liter) of major taxonomic groups of zooplankton by station and date in the vicinity of Yankee Rowe NPS, April-November 1989.

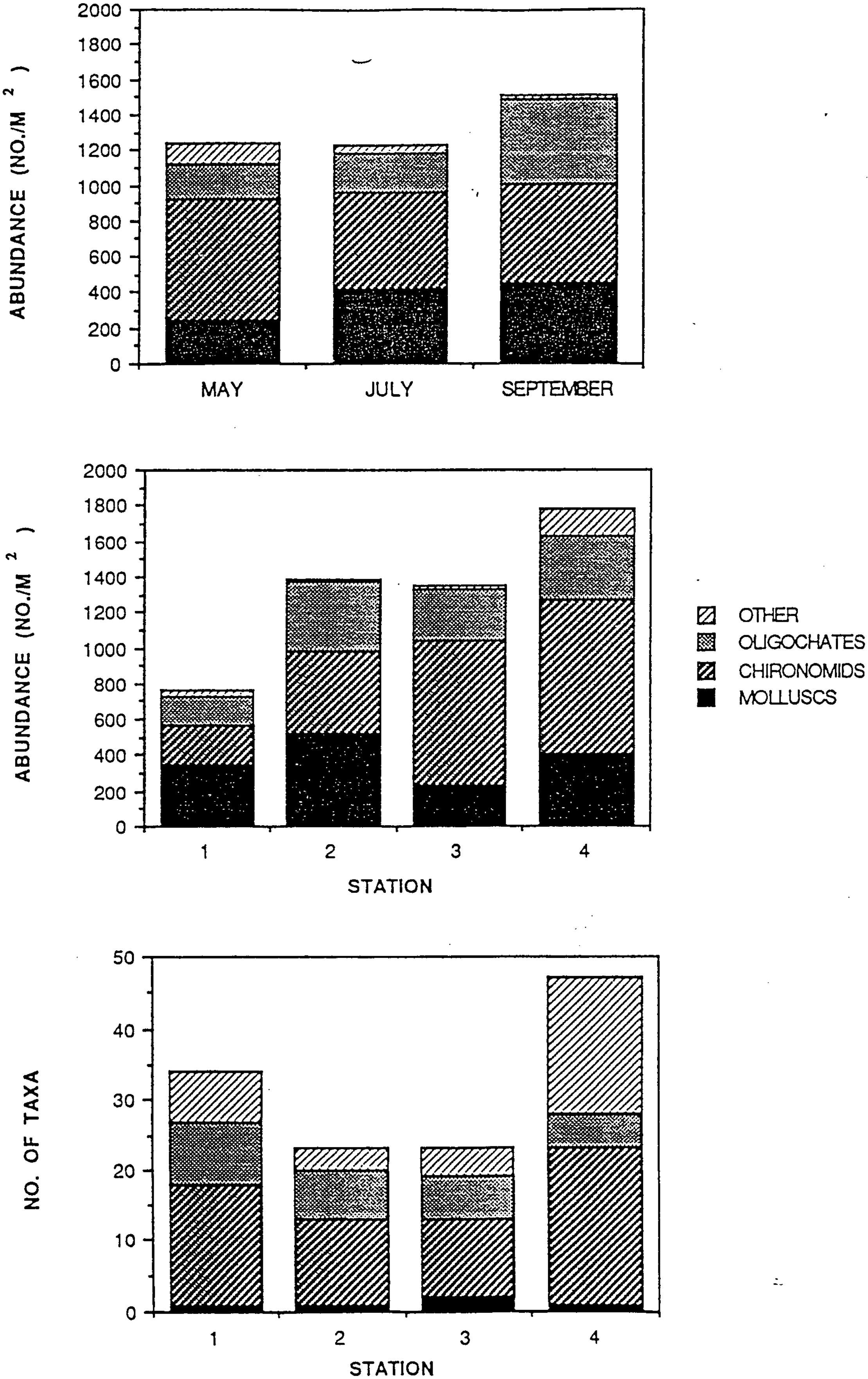
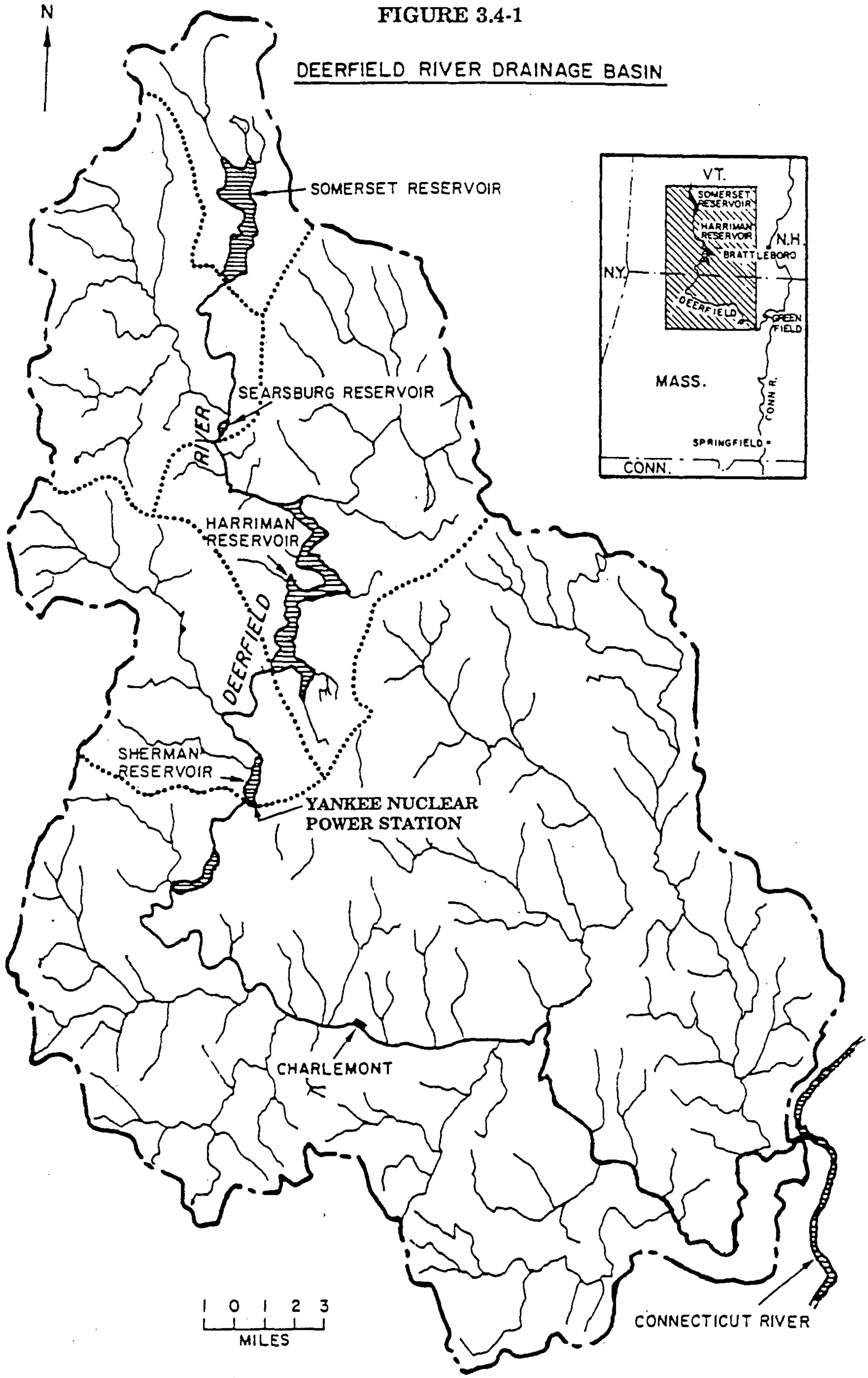


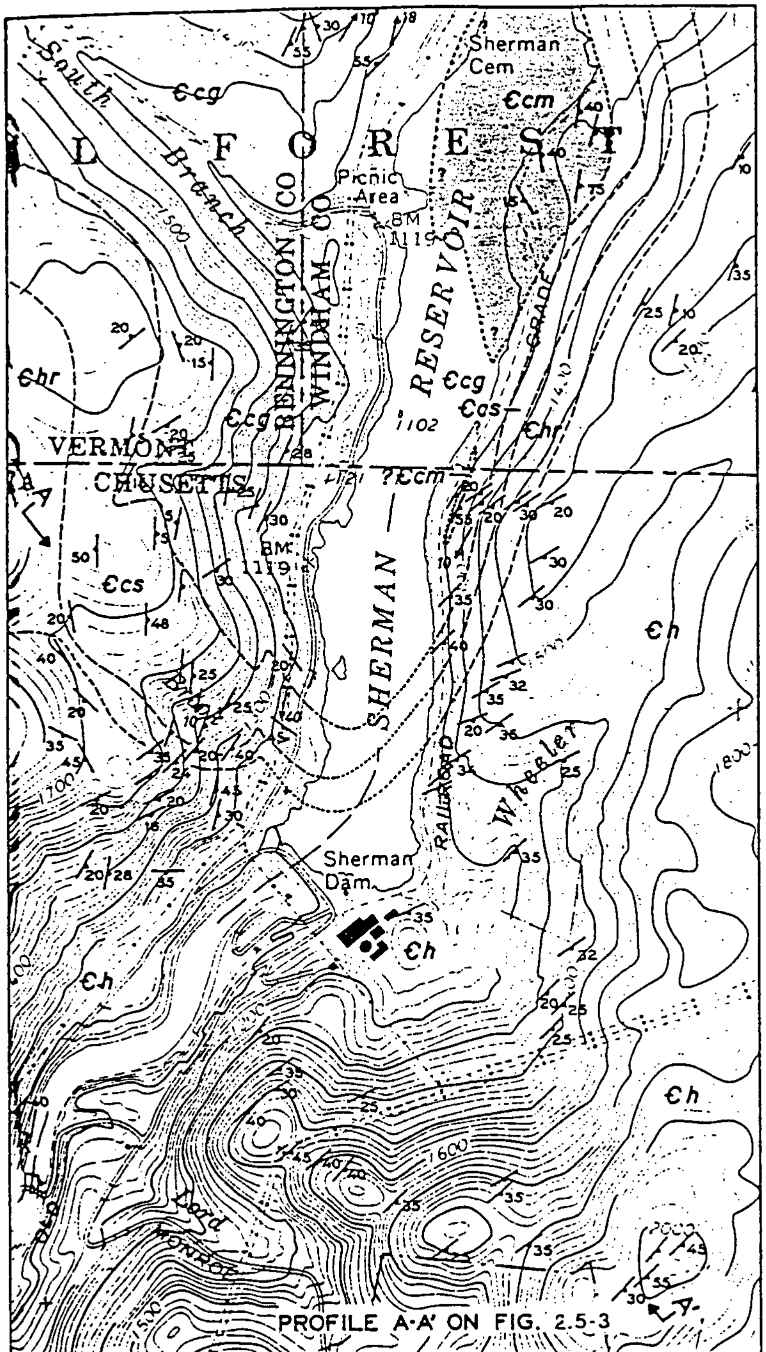
FIGURE 3.2-3 CUMULATIVE ABUNDANCE OF BENTHIC FAUNA

Cumulative abundance (no/m^2) of benthic fauna by major faunal group by month and by station, and cumulative number of benthic taxa by major faunal group by station.

FIGURE 3.4-1

DEERFIELD RIVER DRAINAGE BASIN





HOOSAC FORMATION - LOWER CAMBRIAN

Ꞓh	WELL-BEDDED ALBITE GNEISS
Ꞓhr	RUSTY-WEATHERING GNEISS

CAVENDISH FORMATION - LOWER CAMBRIAN (?)

Ꞓcs	GARNETIFEROUS SCHIST
Ꞓcg	EVENLY-LAYERED GNEISS
Ꞓcm	DOLOMITIC MARBLE

35	FOLIATION - STRIKE AND DIP
10	PLUNGE OF FOLD AXES

FIGURE 3.5-1

BEDROCK GEOLOGY - SITE LOCALE

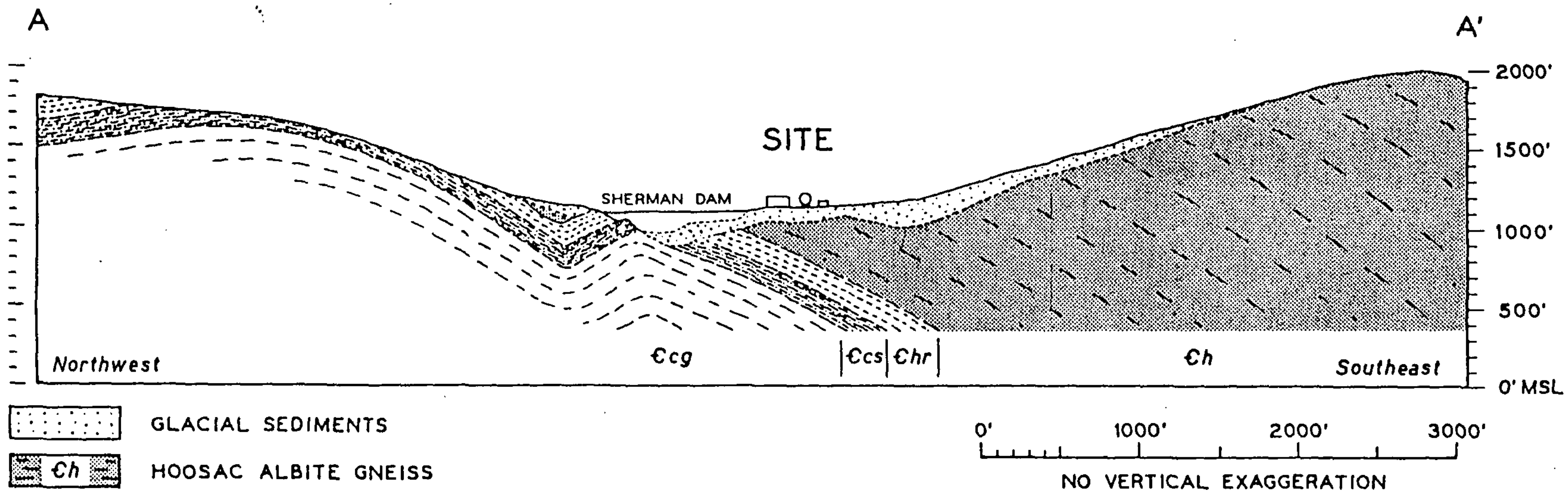


FIGURE 3.5-2

GEOLOGIC PROFILE - SITE LOCALE

4.0 ENVIRONMENTAL EFFECTS OF DECOMMISSIONING

The following sections present an environmental impact assessment of the decommissioning of YNPS. The assessment concludes that the environment will not be adversely affected.

This assessment was performed under conditions as described in the Decommissioning Plan. Radiological and non-radiological effects for both on-site and off-site environments during the decommissioning period are assessed against the following criteria:

- Environmental control and monitoring systems and programs meet applicable regulatory criteria and show evidence of effectiveness through the conclusion of the licensed period.
- The rate of discharge or generation of non-radiological and radiological effluents, solid wastes and occupational exposures are projected to remain well within the bounds of applicable regulatory criteria and permits.
- Off-site exposures that result from plant effluents are projected to remain well within the bounds of the 10 CFR 50, Appendix I guidelines for design criteria.
- Off-site exposures that result from waste transportation are projected to remain well within the bounds of the NRC's "Final Generic Environmental Impact Statement On Decommissioning Of Nuclear Facilities," NUREG-0586 [Reference 4-1].

This chapter is divided into four sections. In Section 4.1, occupational radiation exposure assessments are described along with the radiation protection programs to control and minimize occupational radiation exposures. Section 4.2 presents the assessment of off-site radiation exposures attributable to waste transportation and effluent effects. Section 4.3 describes radioactive waste management, including low level waste disposal projections, methods for minimizing them, and Yankee's plans for fuel handling. Section 4.4 describes the non-radiological environmental effects of decommissioning, including noise, fugitive dust, potential industrial safety concerns, water effluents, and hazardous and non-hazardous wastes.

4.1 OCCUPATIONAL RADIATION EXPOSURE

For purposes of assessing occupational radiation exposure, the Decommissioning Plan is analyzed in four phases, characterized by varying levels of decommissioning activities. They are:

- Component Removal Project (CRP) - Since YNPS was prematurely shut down, there will be a period of two to three years between the date of the permanent shutdown, February 26, 1992, and the date of the approval of the Decommissioning Plan. During that time, limited component removal activities will proceed provided they meet certain rigorous criteria [References 4-2 and 4-3].

- Safe Storage - The safe storage phase will be a period of relative dormancy, awaiting access to a low level waste repository.

  Yankee will continue to seek potential low level radioactive waste disposal sites for YNPS decommissioning waste during the safe storage period. If a site is identified that can support the decommissioning waste, Yankee will proceed with earlier dismantlement. Limited access to low level radioactive waste disposal facilities may also occur. Yankee intends to use these opportunities to remove components and structures, consistent with the Decommissioning Plan.

  Fuel transfer activities planned during the safe storage period are treated separately for purposes of calculating occupational radiation exposure. For planning purposes, fuel transfer to dry cask storage is projected for the 1996 time frame.

- Dismantlement - The dismantling effort will be approximately a two-year period of intense decontamination and dismantling activities, projected to begin in July 2000. The dismantling effort will end with a final survey conducted by an independent contractor, selected by the NRC, and will result in the release of the site for unrestricted use and termination of the current NRC license.

- Site Restoration - The last period is site restoration, lasting approximately one year and occurring after the site is released for unrestricted use. During the site restoration period, the site will acquire its final physical state.

For purposes of directly comparing the YNPS occupational radiation exposures to those described in the GEIS [Reference 4-1], the first three of these four phases are included in this assessment. The fourth is characterized by negligible dose accumulation.

4.1.1 Estimated Occupational Radiation Exposure

The total cumulative occupational radiation exposure for the entire decommissioning effort is estimated to be 737 person-rem total, including:

160 person-rem for the Component Removal Project,
502 person-rem for the final dismantlement activities,
41 person-rem for the fuel transfer activities, and
34 person-rem for the transportation of low level waste.

The 737 person-rem total occupational radiation exposure estimate will be used for planning purposes. Actual doses should be further reduced through implementation of aggressive ALARA practices. Individual worker exposures will continue to be well below regulatory limits.

Estimates of occupational radiation exposure were developed from predicted radiation zone work hour requirements and corresponding radiation exposure rates, based on the decommissioning schedule described in Section 2.5. Calculations were based on the following:

- Occupational radiation exposure estimates reflect the labor necessary for decontamination, removal, packaging and shipping activities, as well as all occupational radiation exposures in support of these activities.

- The exposure hours are based on time spent in the radiation field with the appropriate adjustment for work difficulty.

- Area dose rates from the radiological scoping surveys were used to project CRP and dismantlement personnel exposures.

- Safe storage period occupational radiation exposure is not included. Occupational radiation exposure would be about 48 person-rem for a safe storage period between 1994 and 2000. This value is based on actual YNPS exposure data from the first quarter of 1993 with an annual adjustment for the decay of cobalt-60.

- Fuel transfer personnel exposure is based on an exposure of one person-rem per cask loaded. This rate is based on industry experience in transferring fuel from a wet to dry storage facility. The total exposure also includes decontamination of the Spent Fuel Pit.

4.1.1.1 Component Removal Project

Activities prior to Decommissioning Plan approval at YNPS primarily involve the removal and disposal of the four steam generators, the pressurizer and certain reactor vessel internals. These activities comprise the Component Removal Project.

Due to the timing of these activities, they are comparable to the corresponding activities of the DECON decommissioning alternative as described in the GEIS. The GEIS has characterized the occupational exposure associated with DECON as equivalent to that experienced during normal refueling and maintenance outages. At YNPS, the average exposure during recent outage years was 280 person-rem, with a maximum exposure of 474 person-rem reported in 1982. The total dose for the component removal activities during 1993 and 1994 is estimated to be 160 person-rem.

4.1.1.2 Final Dismantling and Site Restoration

In order to bound the occupational radiation exposures associated with final dismantlement, dose rates are conservatively assumed to occur at 1994 levels, maximizing the total estimated dose. Based on this conservative assumption of complete dismantlement in 1994, the total occupational radiation exposure would be 502 person-rem. Site restoration doses are negligible.

Deferring final dismantlement (beyond 1994) would affect overall occupational radiation exposures in two ways. Additional occupational radiation exposures associated with routine operational activities during a safe storage period would be incurred during the delay. However, reductions in final dismantlement radiation exposures would occur, corresponding to the decay rate of cobalt-60.

Yankee will continue to seek potential low level radioactive waste disposal sites for YNPS decommissioning waste during the safe storage period. If a site is identified that can support the decommissioning waste, Yankee will proceed with earlier dismantlement. Limited access to low level radioactive waste disposal facilities may also occur. Yankee intends to use these opportunities to remove components and structures, consistent with the Decommissioning Plan.

For planning purposes, the final dismantling and site restoration phases are expected to begin by the year 2000, last for 19 months and include the vast majority of the actual dismantling activities as described in the Decommissioning Plan.

4.1.1.3 Fuel Transfer

Fuel transfer occupational radiation exposures amount to 41 person-rem. Activities include the 1996 transfer of fuel from a wet storage facility, the Spent Fuel Pit, to a dry storage facility, and include decontamination of the Spent Fuel Pit upon the removal of fuel.

4.1.1.4 Transportation

Transforation occupational radiation exposures amount to 34 person-rem and are described in more detail in section 4.2.3.

4.1.2 Occupational Radiation Exposure Comparison to GEIS

The estimated occupational radiation exposure of 737 person-rem is much less than the 1,115 person-rem estimate of the GEIS for the reference PWR.

An annual exposure rate, defined as the maximum possible exposure of 737 person-rem averaged over the expected period of 10 years from the start of the Component Removal Project to the end of the dismantling period, is 74 person-rem per year. For comparison, the average annual occupational exposure for YNPS from 1962 through 1990 (about 30 years) was approximately 197 person-rem per year. 74 person-rem per year also compares very favorably with the average annual occupational exposure of 460 person-rem (1973 through 1990) for the reference PWR, as described in the GEIS.

The occupational radiation exposure from the Component Removal Project is 160 person-rem incurred in one year and represents the highest expected annual rate of exposure during the entire decommissioning plan. This is less than the 279 person-rem per year estimate of the GEIS.

4.1.3 Radiation Protection Program

In accordance with 10 CFR 20 and Yankee's Possession Only License, YNPS has a comprehensive Radiation Protection Program. The primary objective of the program is to protect workers, visitors and the public from radiological hazards, including those that could develop during decommissioning.

YAEC and its contractors will provide sufficient facilities, qualified staff and equipment to perform the decommissioning in a radiologically safe manner. Yankee is committed to strict compliance with regulatory requirements, radiation exposure limits and limits regarding release of radioactive materials. YNPS intends to implement the recent revisions to 10 CFR 20 regulations no later than January 1, 1994.

Every reasonable effort will be made to maintain radiation exposures and releases of radioactive materials in effluents to unrestricted areas As Low As is Reasonable Achievable (ALARA). Radiation dose control is accomplished by controlling sources of radiation, controlling access to areas containing radioactive materials, measuring radiation exposures of workers, establishing exposure limits for workers and maintenance of an ALARA program. Specific elements of dose control include the following:

- ALARA Program
- External dosimetry
- Administrative dose control
- Radiation Work Permits (RWP)
- Area Definitions and Postings
- Respiratory protection program
- Internal dose control and monitoring

The inhalation of air contaminated with dusts, mists, fumes, gases, vapors and radionuclides will also be maintained ALARA. The primary means of achieving this goal will be to prevent or mitigate the hazardous condition at the source. Every reasonable effort will be made to achieve this objective by using engineering controls, including process modification, containment and ventilation techniques.

4.1.3.1 As Low As is Reasonably Achievable (ALARA) Program

The purpose of this program is to maintain occupational radiation exposures "As Low As is Reasonably Achievable". The ALARA philosophy will be incorporated into all decommissioning activities and will continue to have full management support. Yankee will establish specific ALARA goals and objectives for decommissioning. The ALARA program will incorporate current technology and sound radiation protection practices to maintain exposure to ionizing radiation ALARA.

Occupational radiation exposure will be minimized, monitored and controlled in accordance with existing YNPS procedures, including the established ALARA Program. This program incorporates ALARA into all the significant design and planning aspects of work involving occupational radiation exposure. Specific elements of this ALARA Program include:

- Training of radiation workers in how proper work practices can help maintain their exposures ALARA.

- The use of shielding, such as water, concrete, lead or steel to minimize exposure.
- The use of remotely operated equipment to minimize exposure.
- The use of "mock-ups" to simulate actual working conditions and constraints in order to provide additional training to radiation workers and to verify equipment and operator performance prior to entrance to radiation areas.
- Projection of anticipated dose accumulation and tracking of actual accumulation in order to detect and investigate potentially significant discrepancies.
- The use of contamination control enclosures to minimize the spread of contamination and the use of respiratory protection equipment to minimize total radiation exposure.
- The avoidance of higher radiation fields when personnel presence is unnecessary.
- Oversight by an ALARA review committee comprised of Radiation Protection specialists and senior plant management.
- Other reasonable means which will minimize personnel exposure and enable the timely completion of the required tasks.

4.1.3.2 Respiratory Protection Program

The primary objectives of the Respiratory Protection Program are personnel safety and limiting the inhalation of airborne radioactive materials wherever practicable. When engineered controls are not practicable, other controls such as increased surveillance, limitations of working times or use of respiratory protection equipment may be appropriate. The program includes the following elements:

- A written policy statement and standard operating procedures.
- Guidance on proper selection of equipment, based on the hazard.
- Proper training and instruction to users.
- Proper fitting, use, cleaning, storage, inspection, quality assurance and maintenance of equipment.
- Appropriate surveillance of work conditions.

- Regular inspection and evaluation to determine continued program effectiveness.
- An adequate medical surveillance program for respirator users.
- Use of only Bureau of Mines/NIOSH - certified or NRC authorized equipment.
- Maintenance of a bioassay program.

4.1.3.3. Radioactive Material Controls

Radioactive material controls prevent inadvertent release of radioactive materials to uncontrolled areas, ensure personnel are not unknowingly exposed to radiation from lost or misplaced radioactive material and minimize the amount of radioactive waste material generated during the decommissioning. Radioactive material is defined as material activated or contaminated by the operation or decommissioning of YNPS and licensed material procured and used to support the operation or decommissioning of YNPS (i.e., calibration sources, check sources and radiography sources). Specific radioactive material controls are in place which provide for the following:

- Receipt and storage of radioactive material
- Identification of radioactive material
- Control of movement of radioactive material
- Accountability and inventory of radioactive sources
- Release of materials for unrestricted use
- Control of materials entering radiologically controlled areas
- Preparation of radioactive materials for shipment
- Radioactive liquid and gaseous release

4.1.3.4 Contamination Control

Contamination controls employ a variety of engineered methods, including permanently installed and portable HEPA ventilation systems, structural and localized containment/enclosures, strippable paint, decontamination of areas and components, and protective clothing. Various methods of contamination controls are considered during job planning and work package review.

4.2 OFF-SITE RADIATION EXPOSURE

This section describes the nature and magnitude of potential exposures to the public from radioactive effluents or radioactive waste being transported.

4.2.1 Exposure Limits

As a condition of its license (Technical Specification 6.7.5.a), YNPS maintains a Radioactive Effluent Controls Program that conforms with 10 CFR 50.36a requirements for the release of radioactive materials to the environment, and for maintaining off-site doses from radioactive effluents as low as is reasonably achievable.

The Radioactive Effluent Controls Program is contained in the YNPS Off-Site Dose Calculation Manual (ODCM) and is implemented by operating procedures. The ODCM sets dose limits due to effluents based on 10 CFR 50, Appendix I. These dose limits include:

Limits on Liquid Effluents

Dose to total body from all pathways	3.0 mrem/year
Dose to any organ from all pathways	10.0 mrem/year

Limits on Gaseous Effluents

Dose to any organ from all pathways	15.0 mrem/year

Liquid releases are also restricted such that the concentration at the point of discharge to unrestricted areas are limited to the Maximum Permissible Concentration limits of 10 CFR 20, Appendix B. These dose and release limitations ensure compliance with the EPA public dose standard in 40 CFR 190, of 25 mrem/year.

During the decommissioning and dismantlement activities, releases will be controlled to maintain off-site exposures to within the plant effluent dose limits, including the effluent and dose limits to members of the public contained in the new 10 CFR 20.1001 through 20.2401. It is expected that the actual releases and resultant doses will be small fractions of those experienced during normal plant operations.

4.2.2 Conservative Exposure Estimates

The maximum potential exposures due to decommissioning YNPS were calculated to be:

Liquid Effluents

Dose to total body from all pathways	0.0026 mrem/year
Dose to any organ from all pathways	0.0027 mrem/year

Gaseous Effluents

Dose to total body from all pathways	0.00008 mrem/year
Dose to any organ from all pathways	0.00064 mrem/year

The bases for these calculations are described in more detail below.

4.2.2.1 Waste Inventories

The magnitude of off-site radiation exposure during decommissioning is related to the inventory of radioactive material in plant systems and the natural decay time of the radionuclides (e.g., the time between plant shutdown, October 1, 1991, and the time when dismantlement and decontamination activities actually take place).

The assessment of potential off-site radiation exposures assumes that decontamination and dismantlement activities all take place in 1994, with no further credit given for radioactive decay. This results in a conservative estimate of the potential off-site radiation exposure from decommissioning.

Between October 1991 and January 1994, the radioactive inventory normally present during operations has undergone substantial decay for the short-lived radionuclides. The principle radionuclides remaining in the reactor system after the decay of the short-lived species, outside of the activation products in the vessel walls, typically have half-lives of a few years.

The Component Removal Project will remove and dispose of the steam generators, the pressurizer, and portions of the reactor internal components. These components contain over 290,000 Curies of activation products and contamination. The balance of plant that will be dismantled in the year 2000 time frame includes approximately 5200 Curies of activity. Of this, 4700 Curies are associated with activation products in the reactor vessel. Approximately 41 Curies are associated with Dry Active Waste from the decommissioning work activities. The remaining 460 Curies reside in the balance of building contamination and general plant systems inventory. Analyses of the contamination indicates that three radionuclides account for more than 96 percent of the activity remaining in plant systems as of January 1994. These radionuclides and their relative fractions are indicated on Table 4.2-2.

In addition to the radionuclides identified as making up the balance of system component contamination, the remaining tritium in plant water has also been estimated. Based on measurements, the inventory remaining approximately two years after shutdown is estimated to be 4.6 Curies. For purposes of bounding the maximum potential exposure due to decommissioning, tritium is assumed to be released without credit for further decay.

4.2.2.2 Liquid Release Pathway

During decommissioning activities, some of the contaminated materials will be dissolved or suspended in water through processes such as cutting pipes and metal, decontamination and rinsing of components removed from the primary auxiliary systems, and the decontamination of building surfaces. During the initial phase of system decontamination and dismantlement, waste water will be collected in one of the waste collection tanks (Primary Building Sump Tank, Gravity Drain Tank, or one of the waste holdup tanks) and processed through the existing liquid radioactive waste evaporator. Distillate from the evaporator will then be collected in either of the two test tanks.

After the evaporator is taken out of service as part of the decommissioning, portable filter/demineralizer units will be utilized to process waste water. All liquid radioactive waste will be processed in accordance with an approved Process Control Program (PCP) and applicable Technical Specifications.

The discharge point for plant liquid waste will be the same during decommissioning as it has been during plant operations. From the Test Tanks, the distilled waste water is sampled and analyzed for radionuclide content. Once the content is certified to be below specified limits, the water is discharged on a batch basis to the Circulating Water Discharge Structure on the edge of Sherman Reservoir, adjacent to the Sherman Dam Hydroelectric Plant water intake.

During liquid batch discharges, the effluent stream can be diluted by use of up to three 2500 gpm service water pumps, or if dilution requirements allow it, an auxiliary service water pump (approximately 300 gpm) is also available. The discharge rate from the test tanks can be varied to ensure that the diluted effluent at the point of discharge meets the concentration limits contained in the ODCM. The discharge flow rate from the test tanks normally averages about 25 gpm. The Deerfield River flow at Sherman Dam has a 10 year minimum monthly average flow of 366 ft^3/sec (164,300 gpm).

4.2.2.3 Airborne Release Pathway

Airborne radioactive waste processing is limited to radioactive particulate emissions during decontamination and dismantlement activities. Exhaust air is filtered through a high efficiency filter assembly before discharging to the primary vent stack. Instrumentation channels monitor gas released and operating procedures ensure that airborne releases are monitored and maintained within the limits of the ODCM.

The exposure pathways for airborne releases during the decontamination and dismantlement of the plant will be the same as during power operations. Building ventilation of areas that contain contaminated systems are routed through high efficiency particulate air (HEPA) filters to the 151-foot tall plant stack located next to the Vapor Container. This release point qualifies as a mixed mode release point in accordance with Regulatory Guide 1.111. Portable HEPA filters using temporary exhaust ducts and containment hoods may also be used when dismantlement of components could give rise to local airborne contamination. The decontamination credit provided by HEPA filters for the purpose of filtering exhaust air prior to release to the environment is 99 percent.

4.2.2.4 Liquid Pathway Exposures

Liquid pathway exposure assessments were performed in accordance with the models and parameters in the Yankee ODCM. The dose models are taken from Regulatory Guide 1.109. The bases for these calculations include the following considerations:

- The exposure pathways include fishing, direct exposure, milk and meat via animal ingestion of Deerfield River water, and vegetable ingestion via crop irrigation using river water. An aquatic invertebrate pathway in the Deerfield River has not been found to exist. Similarly, the Deerfield River is not used as a source of potable water within 50 miles of the plant.

- The location chosen for evaluation is just below the Sherman Hydroelectric Station, providing a conservative measure of impact, since no additional dilution is credited.

- The source term released into liquid discharges is conservatively taken to be generated from incorporation of 1 percent of the waste inventory Curie content of contaminated systems and structures into plant process water before treatment and cleanup.

- The liquid radioactive waste evaporator provides a decontamination factor (DF) of 10,000 for the radionuclide species remaining, except for tritium for which the evaporator provides no improvement (DF equals 1).

In comparison to previous calculated potential liquid pathway exposures due to plant power operations, the decommissioning doses are very small. During the last nine years of operating history, the maximum potential individual organ dose averaged 0.21 mrem/year, or 0.12 mrem/year to the whole body, larger by a factor of at least 40 than the estimates for the period during dismantlement of the plant systems.

4.2.2.5 Airborne Pathway Exposures

Airborne pathway exposure assessments were also performed in accordance with the models and parameters in the Yankee ODCM. The dose models are taken from Regulatory Guide 1.109. The bases for these calculations include the following considerations:

- Airborne exposure pathways are assumed to include inhalation, external irradiation, and ingestion of milk and food grown on land containing airborne deposited material.

- Meteorological dispersion calculations were performed for all site boundary locations, nearest residents, vegetable gardens, and milk animals in each of the sixteen principle compass directions. A five-year meteorological history for the Yankee plant was used along with modeling taken from Regulatory Guide 1.111 in order to determine the maximum potential impact. All airborne pathway exposures were then calculated assuming they were present at the point of maximum potential impact.

In comparison to previous gaseous pathway exposures due to plant operations, the decommissioning gaseous doses are very small. During the past nine years of operating history, the average maximum potential organ dose has been calculated to be 0.59 mrem/year, larger by a factor of over 900 than the estimates for the period during dismantlement of the plant systems.

4.2.2.6 Reporting Requirements

Radioactive Effluent Release Reports are submitted to the NRC each year. The report must contain summarized results of the quantities of radioactive liquid and gaseous effluents and solid waste released, consistent with the objectives outlined in the ODCM and PCP, and in conformance with 10 CFR 50.36a and Section IV.B.1 of Appendix I to 10 CFR 50.

4.2.3 Transportation

Radiation exposures due to transportation of radioactive waste include both occupational and off-site radiation exposures. The occupational radiation exposures (Section 4.1) are estimated to be 34 person-rem to truck and rail workers. The cumulative radiation exposures to onlookers and the general public are estimated to be less than 7 person-rem. See Table 4.2-1.

Assessments for radiation doses from transport of radioactive material are based on the method given in NUREG/CR-0130 [Reference 4-4], which was used in the review of PWR decommissioning costs and technology in WASH-1238 [Reference 4-5]. Consistent with WASH-1238, the bases for these assessments include the following:

- Shipments will be in accordance with Department of Transportation (DOT) regulations, 49 CFR 173.393, that set the following limits:
  - 1000 mrem/hour at 3 feet from the external surface of the package, provided the package is transported in a closed vehicle,
  - 200 mrem/hour at the external surface of the vehicle,
  - 10 mrem/hour at any point 6 feet from the vehicle, and
  - 2 mrem/hour at any normally occupied position in the vehicle.
- Two truck drivers, during a 1000-mile trip from YNPS to a disposal facility, would spend no more than 24 hours inside the cab and 1 hour outside the cab at an average distance of about 6 feet from the truck.
- Normal truck servicing enroute would require that two garage personnel spend no more than 10 minutes each about 6 feet from a shipment.

- Normal train servicing enroute would require that two train brakemen would spend no more than 10 minutes each about 3 feet from a shipment during each of 10 stops.

- The onlooker dose from all shipments is calculated on the basis that 10 people spend an average of 3 minutes each at a distance of about 6 feet from a shipment.

- The cumulative dose to the general public from all shipments is based on an average 0.012 mrem/kilometer (0.0193 mrem/mile) [Reference 4-5].

The types of shipments, packaging and limits on shipment inventories are bounded by DOT regulations for both truck and railroad shipments. Approximately 41 shipments (39 truck and 2 railroad) will have been made for the Component Removal Project. Approximately 227 truck shipments will be required to complete the decommissioning. The assessment of off-site exposures due to these shipments is based on a trucking distance of 1000 miles to a disposal facility. This distance is twice the 500 miles assumed in the GEIS. However, the total number of shipments (268) is much less than the 1363 shipments evaluated for the GEIS reference PWR DECON case. Also, all the shipments will be below, and most of them substantially below, the dose limits assumed above. Consequently, the total off-site exposures due to transportation of radioactive wastes from YNPS are bounded by the GEIS (see Table 4.2-1).

4.2.4 Conclusions

Off-site radiation exposures due to liquid or airborne releases resulting from decommissioning are very small. The dose commitments are much less than those associated with past plant operations, and well within all regulatory and license limits which require that the dose impact be kept as low as is reasonably achievable.

All operations as part of the decommissioning of the plant will be conducted such that the total effective dose equivalent to members of the public will not exceed the limits contained in 10 CFR 20.1301. The actual doses due to decommissioning activities are expected to represent only small fractions of the 10 CFR 20 limits.

The calculated dose impacts for the decommissioning activities of the Yankee plant are consistent with the conclusions reached in the GEIS [Reference 4-1] that off-site exposures from these activities are very small.

4.3 RADIOACTIVE WASTE MANAGEMENT

YNPS decommissioning requires handling of a large volume of radioactive material to reduce residual radioactivity to a level permitting release of the site for unrestricted use and termination of the license. Materials that are not decontaminated and released will be processed as radioactive waste.

Yankee will continue to ensure appropriate processing, packaging and monitoring of solid, liquid and gaseous wastes during decommissioning by implementing the Radiation Protection procedures, the Process Control Program, the Radioactive Effluent Controls Program, and the Radiological Environmental Monitoring Program (Section 6). These programs will be maintained in compliance with Technical Specification requirements to meet federal and state regulations, disposal site requirements, and any other applicable requirements. The YNPS radioactive waste management program is implemented through the Radiation Protection Program (Section 4.1.3). Implementing procedures will be used to control the classification, treatment, packaging and shipment of radioactive material.

4.3.1 Low Level Waste (LLW) Volume Projections

The radioactive waste management program will be used to control radioactive waste handling during decommissioning. The largest volume of low level radioactive waste will be residue generated during the decontamination and dismantlement of systems, components, concrete and structures. Additional waste generated during the support of decontamination activities will include:

- Contaminated water,
- Used disposable protective clothing,
- Expended abrasive and absorbent materials, and
- Contamination control materials (e.g., strippable coatings, plastic enclosures, expended filters)

Radioactive waste volume projections are based on data obtained from a 1993 radiological scoping survey and detailed plant system and commodity reviews.

Packaging, shipping and volume reduction factors were derived and the total radioactive waste volume projections for burial at an authorized low level radioactive disposal facility are as follows:

	Estimated Volume
Component Removal Project:	15,732 ft^3
Safe Storage and Dismantlement:	89,033 ft^3

Significant additional waste volume reduction can be achieved by using off-site radioactive materials processing. Process decontamination could reduce YNPS burial volumes by about 50%. Processing alternatives will be evaluated during decommissioning to determine the most effective processing options for radioactive materials.

4.3.2 Characterizing Radioactive Wastes

The Decommissioning Plan provides a comprehensive program for identifying and characterizing radioactive waste as a first step toward determining methods for disposal. Radiological surveys and measurements of specific radionuclides will determine the extent of contamination or activation. Based on these results, optimum methods for decontamination, packaging, processing and release or disposal of materials will be identified.

4.3.3 Solid Radioactive Waste Processing Methods

Solid radioactive material may not be released, except to another licensee. However, various methods may be applied to reduce the amount of material to be processed, then to reduce the volumes of those materials and, finally, to package and dispose of them at a licensed disposal facility. Following are descriptions of the methods to be utilized for processing plant systems, structures and components as radioactive waste.

It is important to note that a very large percentage of the volume of material on-site is not radioactive. Of that percentage, however, many materials are either attached to radioactive materials or have removable radioactive materials bonded to them (such as paint). When detached from the radioactive materials, they may be surveyed and released.

4.3.3.1 Radioactive Waste Volume Minimization

Minimizing the additional contamination of materials during decommissioning is still the first principle of minimizing waste volume, as it was during normal operation. While some new materials such as protective clothing will necessarily become contaminated during decommissioning, the following techniques will continue to be applied to minimize the impact:

- All radiation workers receive radiation worker training which identifies work practices to prevent unnecessary contamination of areas and equipment and to safely recycle existing materials.
- Policies and procedures are in place to minimize unnecessary packaging, tools, chemicals and equipment from entering radiologically controlled areas.

4.3.3.2 Decontamination

Various decontamination and dismantlement methods may be applied to separate the radioactive parts of a component from those which are not (or are less) radioactive. For example, a block of metal which has contamination embedded only in its paint could be separated from the paint. The removed paint would continue to be treated as radioactive material, but the base metal could then be re-evaluated and, if found to meet release criteria, be released as scrap or salvage material.

On-site decontamination of systems and components will be limited to activities needed to maintain personnel exposure as low as is reasonably achievable, to expedite equipment removal, and to control the spread of contamination. Selective chemical decontamination may be used in localized high contamination areas to reduce radiation dose rates. However, large scale chemical decontamination of contaminated systems is not planned.

Application of strippable coatings and hand wiping will be the preferred methods for fixing or removing loose surface contamination. If other methods are utilized, airborne contamination control and waste processing systems will be used to control and monitor any releases of contamination.

Contaminated and activated concrete and roofing materials will be removed and sent to a low level radioactive waste disposal facility. Removal of contaminated concrete should be performed using a method which controls the removal depth to minimize the waste volumes produced. Vacuum removal of the dust and debris with High Efficiency

Particulate Air (HEPA) filtration of the effluent gas should be used to minimize the need for additional respiratory protection control measures.

Where practical, contaminated systems and components will be sent to a materials reclamation facility (see Section 4.3.3.6). Where not practical, or for items that have too high a specific activity for off-site volume reduction, shipment will be for direct disposal at a licensed disposal facility. Wastes that cannot be processed in a disposal facility (greater than Class C per 10 CFR Part 61), will be packaged for on-site storage and shipped to an appropriate disposal facility, once it becomes available.

4.3.3.3 Compaction

Waste material which can be compressed to reduce voids may be volume reduced using compactors. Radioactive waste materials may be volume reduced on-site using the existing YNPS compactor, or a mobile compactor (or "super-compactor") may be brought to the site, or the materials may be shipped to another licensed facility to be compacted. Compactors may serve a dual function as packaging equipment.

4.3.3.4 Dismantlement

In addition to normal disassembly of components, dismantlement methods can be used to separate the radioactive parts of a component from those which are not (or are less) radioactive. Dismantlement methods can be divided into two basic types, mechanical and thermal. Mechanical methods machine the surfaces of the material that is being cut. The methods typically are capable of cutting remotely without generating significant airborne contamination. Thermal methods melt or vaporize the surfaces of material being cut. Although faster than mechanical methods, thermal methods generate airborne contamination when used in air. However, airborne contamination can be prevented when the method is used underwater in conjunction with appropriate air filtration systems above the water surface.

4.3.3.5 On-Site Solid Waste Packaging

Radioactive waste packaging at YNPS will be performed in areas that minimize radiation exposure to personnel, control the spread of contamination, and are adequate for packaging activities.

Waste packages will meet the requirements for transportation and disposal for each decommissioning waste material. Examples of waste containers that may be used are drums, boxes, cask liners, high integrity containers, sea-land containers, shielded casks, and other specialty containers. Waste container selection will be determined by the size, weight, classification and activity level of the material to be packaged. Selection of the appropriate packaging is the responsibility of the Radwaste Supervisor. In all cases, packaging selected will comply with requirements specified by 49 CFR, 10 CFR 71, and the disposal facility's site specific criteria.

Spent resins, filter media and other wetted wastes requiring stabilization will be processed in accordance with the Process Control Program (PCP). Whenever possible, stabilization will be completed inside the disposal package or liner to minimize handling prior to disposal.

4.3.3.6 Off-Site Shipments of Radioactive Materials for Further Processing

Cost benefit analyses will determine if it is efficient to process certain radioactive materials at an off-site facility specializing in the treatment of radioactive materials. Methods described below are examples of volume reduction processes that may be employed.

- Flammable materials could be transferred to a licensed incinerator facility for burning. This may include such materials as paper, certain plastics, lubricating oils and solvents. When required by regulations, EPA characteristic tests (or other analyses) will be performed to verify acceptability of a material for incineration.

- Low specific activity metals may be transferred to suitably licensed facilities for either melting and consolidation or decontamination and release. A variety of decontamination options exist, including abrasives, chemicals and ultrasonic cleaning.

- Volume reduction by compacting or super-compacting.

Waste packages sent to off-site facilities will primarily be sea-land containers, selected to meet the requirements of transportation and receipt at the off-site processing facility. Only radioactive materials that are acceptable according to the licenses of the receiving facility will be transported to that off-site processing facility.

Radioactive material control and accountability procedures to accurately track material originating from YNPS during receipt, processing and packaging for disposal will be developed and implemented. Only off-site processing facilities which provide adequate radioactive material control and accountability procedures will be selected to perform decontamination, volume reduction or waste processing services.

4.3.4 Comparisons with GEIS and Industry Projections

The total volume of LLW generated due to the component removal and decommissioning efforts at YNPS is estimated to be 2,967 m^3. The GEIS estimates the burial volume for LLW and rubble for a reference PWR to be 18,340 m^3 [Reference 4-1]. In comparison with the GEIS value, the YNPS estimate is significantly less, and in comparison with other nuclear facilities [Reference 4-6]:

	MWe	LLW (m^3)
Saxton	3	508
Shippingport	72	6,056
YNPS	**185**	**2,967**
Dresden Unit 1	200	7,537
Fort St. Vrain	330	4,076
Shoreham	820	2,246
Rancho Seco	918	5,651
Three Mile Island Unit 2	926	7,419
Diablo Canyon Unit 1	1,131	10,184
Diablo Canyon Unit 2	1,156	9,955

4.3.5 Liquid Radioactive Waste Processing Methods

Contaminated water will be generated during YNPS decommissioning as a result of draining, decontamination and cutting processes. The contaminated liquids will be processed either in the liquid waste evaporator or in a temporary facility (e.g. ion exchange and filtration system, solidification system). All liquid radioactive waste will be processed in accordance with an approved PCP, the ODCM, applicable Technical Specifications and plant procedures.

The Process Control Program presents the administrative and technical controls for the liquid radioactive waste solidification system to assure that solidified waste meets shipment and disposal facility requirements. Liquid waste processing is monitored to assure safe operation, storage, drumming and disposal of waste to approved waste disposal sites. Liquids released from the site are monitored and controlled to ensure all releases of radioactivity to the environment are as low as is reasonably achievable. The Process Control Program is maintained in accordance with Technical Specification 6.12.

Technical Specification 6.7.5 establishes two programs affecting radioactive liquids processing: Radioactive Effluent Controls Program, Radiological Environmental Monitoring Program. The Radioactive Effluent Controls Program conforms with

10 CFR 50.36a requirements to control radioactive effluents and to maintain dose to members of the public from radioactive effluents as low as is reasonably achievable. This program is presented in the ODCM (Reference 3.3-5) and implemented through several plant procedures. This program complies with the requirements of Technical Specifications 6.7.5 and 6.13.1.

The ODCM contains methodologies and parameters used in the following:

- Calculation of off-site doses resulting from radioactive gaseous and liquid effluents,
- Calculation of gaseous and liquid effluent monitoring alarm and trip setpoints, and
- Conduct of the Radiological Environmental Monitoring Program (See Section 6.0).

The ODCM forms the basis of plant procedures which document the off-site doses due to plant operation. The off-site dose calculations demonstrate compliance with the numerical guides for design controls of 10 CFR Part 50, Appendix I. Plant procedures implement the ODCM requirements.

4.3.6 Gaseous Radioactive Waste Processing Methods

Plant gaseous effluent filtration and monitoring systems will be operated and be maintained according to the Off-Site Dose Calculation Manual. Gaseous effluent from building exhaust fans is monitored and reported using installed plant equipment and established procedures. The building exhaust fans produce filter materials which may then be processed as solid radioactive waste.

The permanently installed fan system will remain in operation until late in the decommissioning process, when the buildings it serves have been decontaminated to the point where they may be adequately serviced by mobile units.

Mobile in-line HEPA filtration type units will provide ventilation to localized areas, cleaning the air at approximately 99% efficiency. Their byproduct is filters which may then be treated as solid waste.

Supplemental effluent air monitoring in the form of air samples for areas or operations will be performed on an ad hoc basis, as required by the ongoing decommissioning activities. Monitoring capabilities will include beta and gamma radiation measurement of samples.

4.3.7 Uranium Fuel Cycle

There are 533 fuel assemblies stored in double tier racks in the Spent Fuel Pit. These fuel assemblies were discharged from the reactor between 1972 and 1992. There are also several failed fuel pins that must be consolidated before they are moved from the Spent Fuel Pit. The Spent Fuel Pit also contains high level waste in the form of canisters containing portions of the reactor vessel internals (i.e., core baffle and lower core support plate). The canisters have the same external dimensions as fuel assemblies. Several miscellaneous low level radioactive items also are stored in the Spent Fuel Pit (e.g. neutron sources, filter cartridges, material from previous fuel reconstitution activities).

Yankee is currently seeking accelerated acceptance of YNPS's spent fuel by the Department of Energy in accordance with the current fuel disposal contract. The Department of Energy has not yet determined whether priority will be accorded shutdown reactors, or if priority is granted, under what specific circumstances it might be granted. A rulemaking is scheduled that will include the issue of priority for prematurely shutdown plants. YAEC will participate in the rulemaking process. However, it appears that priority for shutdown plants may not be supported by the majority of participants in this process.

It is unlikely that the Department of Energy will accept all YNPS spent fuel before the beginning of the dismantlement period in 2000. Although the Department of Energy may start taking fuel as early as 1998, for planning purposes, fuel shipments will not be considered completed until 2018. This projection is based on the Department of Energy's Acceptance Priority Ranking, Annual Capacity Report, and an extrapolation beyond the 10 year Department of Energy outlook. The YNPS Decommissioning Plan assumes storage of fuel in the Spent Fuel Pit until 1996, at which time it will be transferred to an on-site dry storage facility. For planning purposes, spent fuel is projected to remain in the dry storage facility until 2018.

The likelihood of storing fuel on-site during and after decommissioning significantly impacts both the decommissioning process and cost. The following spent fuel management strategy was implemented:

- Continue operation of the Spent Fuel Pit and implement any safe, but economically attractive improvements.

- Urge the Department of Energy to accelerate acceptance of YNPS spent fuel or to accept financial responsibility for on-site spent fuel storage.

- Continue evaluations of wet and dry storage options to reflect Yankee and industry developments.

- Initiate preliminary design activities for a dry storage facility.

Yankee evaluated the option to store fuel in the Spent Fuel Pit during a portion of the dismantlement phase of decommissioning. The purpose of the evaluation was to identify safety considerations and limitations on decommissioning activities associated with operating the Spent Fuel Pit concurrent with dismantlement activities. Operation of the Spent Fuel Pit during the dismantlement phase would allow YAEC additional time to pursue early transfer of spent fuel to the Department of Energy without incurring a significant investment associated with a dry cask facility. This option also allows additional time for the development of a multi-purpose canister system that is compatible with YNPS design features.

4.4 NON-RADIOLOGICAL EFFECTS

This section addresses the non-radiological factors which impact the environment, including concerns for the industrial safety of workers, noise levels generated by dismantling activities, water utilization, and the disposal of both hazardous and non-hazardous waste products.

4.4.1 Industrial Safety

The largest occupational risk associated with decommissioning YNPS is the risk of industrial accidents. This section provides an overview of the Yankee Occupational Safety Program as provided in the Yankee Safety Manual and applicable plant procedures.

4.4.1.1 Management Policy Statement

YAEC and its management are committed to the safe decommissioning of YNPS. The primary objective of the Occupational Safety Program is to protect workers and visitors from industrial hazards that have the potential of developing during decommissioning. YAEC and its contractors will provide sufficient qualified staff, facilities and equipment to perform decommissioning in a safe and effective manner. Yankee is committed to compliance with federal and state requirements and to the guidance provided through industry standards and practices.

4.4.1.2 Yankee Occupational Safety Program

The existing Occupational Safety Program provides the basis for controlling safety during decommissioning activities. The purpose of the health and safety organization is to ensure that standards of safety are maintained through effective implementation of the Occupational Safety Program. The effective implementation of the Occupational Safety Program is the responsibility of all decommissioning personnel.

The Yankee Occupational Safety Program was developed to establish and maintain a safe work place for Yankee workers, contractors and visitors. The program provides guidelines and procedures to be used to reduce industrial hazards and risks.

The Yankee Safety Manual provides guidelines and requirements which will be incorporated into the detailed decommissioning planning process. The following areas are discussed in the manual:

- Working in Potentially Hazardous Atmospheres
- Personnel Protection and Equipment
- Walking and Working Surfaces
- Electrical Safety
- Welding, Cutting and Brazing
- Hazardous Substances and Materials
- Hand and Portable Powered Tools and Equipment

Additional safety guidelines and instructions may be included in plant procedures which receive a Health and Safety Organization review during the approval process. The Health and Safety Organization will review Decommissioning Work Packages prior to commencement of work activities.

Safety training is conducted as part of the general employee training process and during routine safety meetings. The safety meetings focus on current safety issues and events as well as providing a forum for workers to ask questions and provide feedback.

4.4.2 Noise

As described in Section 3.2.3, Terrestrial Ecology, the YNPS site is bordered on the north and west by Sherman Reservoir. Beyond this and to the south and east of the plant, the area is dominated by forest of mature hardwoods, with mixed stands of hardwoods and softwoods interspersed. The terrain is likewise relatively steep with hills rising some 900 feet above the plant. The nearest residential population is located approximately one mile to the southwest in the town of Monroe.

Few noises are produced at the plant which are audible beyond a quarter of a mile. During operation, the only noise routinely detected outside the security fence resulted from exercising the evacuation alarm, small arms reports from security force training, and broadcasts over the paging system. The large expanse of land controlled by YNPS, however, provides a suitable buffer for noise produced at the plant. Noise levels within the vicinity of the plant, therefore, were characterized as ambient outside of the industrial area boundary.

Decommissioning activities will add minimally to the ambient noise of the surrounding environment beyond the security fence. Activity, in general, will be intermittent and temporary. During the summer, noise generated on-site will be attenuated by the mature forests surrounding the plant. To the north and west of the plant, generated noise can carry over Sherman Reservoir before being attenuated by forest. During the late fall and winter, the absence of foliage enables some additional transmission of noise generated at the plant.

A review of the wildlife species that occur within the vicinity of YNPS revealed an assemblage not unlike that found within similar habitat within the region. These consist of song birds, birds of prey, small mammals such as beaver, fox, and raccoon, and larger mammals such as white tail deer and the black bear. All have been observed by plant personnel on a frequent basis within the vicinity of the plant during operation, indicating that impacts to the surrounding environment as a result of noise generated at YNPS have been negligible. Because decommissioning activities are expected to add minimally to ambient noise beyond the industrial area boundary, noise will have a negligible effect on the environment and vicinity.

4.4.3 Fugitive Dust

The YNPS site consists of stabilized soils with vegetative cover or paved surfaces, as well as buildings either of concrete or steel construction. During various demolition and dismantling operations, particularly the site restoration activities, fugitive dust will be generated. Disturbances to the site will involve the controlled removal of buildings, piping and related components, and excavation of soils to remove components such as underground utilities.

Reasonably available control measures will be utilized to minimize the quantities of fugitive dust. The installed ventilation system, supplemented by localized HEPA filtration units, will monitor and filter particulate emissions from dismantling activities inside buildings. Excavation of soils will include the use of wet suppression or chemical stabilization (surfactants or foaming agents), as required to minimize the generation of fugitive dust.

The controlled dismantlement and packaging of site components and structures will preclude fugitive dust from becoming an ambient air quality concern during the decommissioning process.

4.4.4 Water Utilization

During the decommissioning period, operation of certain plant systems will continue to require water use and discharge. All discharges will be controlled under the National Pollutant Discharge Elimination System (NPDES) permit. The permit is issued jointly by the U.S. Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MDEP).

4.4.4.1 Sources

YNPS uses Sherman Reservoir, an impoundment of the Deerfield River (Figure 3.1-1), as the source of water for the plant's two major cooling water systems, the Circulating Water System and the Service Water System (Figure 4.4-1). Water is drawn from the reservoir through a 10 foot diameter pipe, located about 200 feet offshore at a depth of 70 feet. The water, used mostly for non-contact cooling, is discharged to the environment via three outfalls, two to Sherman Reservoir (Outfalls 001 and 010) and one to the Deerfield River via an unnamed tributary (Outfall 002). These outfalls, other plant water uses, and storm water runoff are described below.

4.4.4.2 Discharges

- Outfall 001

  The Circulating Water System provided cooling water for the main condenser. Water from the Circulating Water System discharges to Sherman Reservoir by way of the surface discharge structure, located on the shoreline adjacent to Sherman Dam. The Circulating Water System has a maximum capacity of about 225M gpd. This system will not be required for cooling during decommissioning.

- Outfall 010

  The Service Water System provides cooling water to various heat exchangers and pumps located in the plant. The Service Water System has a maximum capacity of about 5.4M gpd. During decommissioning, however, a flow of about 0.4M gpd to Outfall 010 will be typical. The largest discharge is the primary effluent, which includes cooling water from various heat exchangers, test tank effluent containing evaporator distillate, and moat water containing rain or melted snow.

  Outfall 010 discharges to Sherman Reservoir via the Circulating Water System (Outfall 001) surface discharge structure. The combined heat rejection rate for

Outfalls 010 and 001 during decommissioning will be less than one percent of the operational rate. The resultant thermal plume will be reduced accordingly.

- Outfall 002

The Service Water System also provides water to the Water Treatment Plant, for processing into demineralized water, and for cooling the Main Transformer. During decommissioning, the Water Treatment Plant will no longer operate. Instead, a portable demineralizer unit will be used about twice per year. The flow rate for the portable unit when operating will be 75-100 gpm. Otherwise, when the portable unit is not operating, flow through the Water Treatment Plant from miscellaneous heat exchangers will average 14 gpm. The main transformer maximum flow is 400 gpm, but 0-50 gpm will be typical during decommissioning.

Other water sources discharged to Outfall 002 include Secondary Floor Drains, service water from small heat exchangers, and blow-down water from the station auxiliary boiler. The maximum flow is 100 gpm, with an average of 20 gpm likely during decommissioning. The heat rejection rate from these sources during decommissioning will be much less than the operational rate.

Outfall 002 discharges into the "unnamed tributary", which flows to the Deerfield River downstream of the Sherman Dam. The maximum flow is 0.9M gpd, although 0.1M gpd or less will be typical during decommissioning.

- Outfalls 003 & 004

There are two, independent storm water discharges, one on the northeast side of the plant and the other on the southwest side. The northeast side (Outfall 003) discharges into Sherman Reservoir, near Outfall 001. The southwest side (Outfall 004), which also includes routine groundwater infiltration, discharges into the Deerfield River downstream of Sherman Dam adjacent to Outfall 002. Each outfall is part of a network of storm drains connected to parking areas and associated facility, employee and administrative buildings. Neither network is directly connected to any plant operation nor are there raw material storage areas within the network. One drain in the northeast network is connected to an oil storage area but is locked closed and controlled by procedures under the Spill Prevention Control and Countermeasure Plan.

- Miscellaneous Outfalls

  The Service Water System also yields water to a sump in the intake Screenwell House. The sump collects pump leakage from the Service Water System (and Circulating Water System, if operating), in-leakage during high reservoir conditions, and rain water. The sump is actuated by a high-level float and discharges to Sherman Reservoir. The average discharge flow during plant operation was 250 - 300 gpd but is 30 gpd or less now because a smaller service water pump was installed after the plant shut down.

  Lastly, the Service Water System supplies water to the intake Screenwell House traveling screens. The traveling screens collect solid materials (e.g., sticks and leaves) that might otherwise enter the Circulating Water System and Service Water System. The materials collected on the screens are washed off with Service Water that in turn discharges to Sherman Reservoir. The collected solid materials are disposed of according to the NPDES permit. During high river flow, the traveling screens operate daily for about one hour. During normal river flow, the traveling screens operate as needed for about one hour. The maximum flow during traveling screen operation is 250 gpm.

4.4.4.3 Effluent Limits and Effect

The Sherman Reservoir and the Deerfield River in the vicinity of the Yankee plant are Class B, cold water fishery waters as defined by the Massachusetts Surface Water Quality Standards [Reference 4-7]. As such, "these waters are designated as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary recreation." The waters are suitable for "irrigation and other agricultural uses and for compatible industrial cooling and process uses." The waters have "consistently good aesthetic value" and can be designated as "suitable as a source of public water supply with appropriate treatment."

As a cold water fishery, these waters have a maximum monthly mean temperature that "generally does exceed 68°F (20°C) and, when other ecological factors are favorable (such as habit), are capable of supporting a year-round population of cold water stenothermal aquatic life such as trout (salmonidae)."

Additionally, the Sherman Reservoir and Deerfield River are protected for their present uses by an anti-degradation provision in the water quality standards [Reference 4-7]. "In all cases existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected."

The potential environmental effects of the Circulating Water System during plant operation included those of the thermal plume created by the heated water discharged to the pond, impingement of fish at the cooling water intake screens, and entrainment of organisms (phytoplankton and zooplankton) as the cooling water passed through the condenser. These effects were assessed by Yankee [References 4-8 and 4-9], the MDEP - Division of Water Pollution Control [Reference 4-10], and the MDEP - Division of Fisheries and Wildlife [References 4-11 and 4-12].

Results of these assessments were used to support Yankee's application for a NPDES Permit and for a variance under Section 316 (a) and (b) of the Clean Water Act. The EPA and the MDEP jointly issued a discharge permit in 1974, which has been modified and reissued several times since including the Section 316 (a) and (b) variance. The permit was most recently reissued in 1988 [Reference 4-13] and requires that various physical and chemical parameters be controlled and monitored. The EPA and MDEP based their decision to issue the permit on the following conclusions:

- The as-built design of the cooling water intake and discharge structures reflect the best technology available for minimizing: (a) fish impingement on the intake screens and (b) entrainment of organisms in the cooling water passing through the condenser. Also, the location and physical characteristics of the thermal plume are such that it should not interfere with the normal migratory pathways of the indigenous population of organisms inhabiting the reservoir.

- The plant has operated since 1960 without any observable impact to fish due to thermal effects. Therefore, the existing thermal limits should continue to ensure the protection and propagation of a balanced indigenous community of fish, wildlife, and other organisms living within the reservoir and adjacent waters.

- Accordingly, the combination of the as-built design of the Circulating Water System and thermal limits imposed by the NPDES permit assure satisfaction of: (a) the technology requirements of the Clean Water Act, including the best available technology economically achievable requirements for toxic pollutants and the best conventional pollution control technology requirements for conventional pollutants, and (b) the Massachusetts Water Quality Standards.

The basis for the EPA/MDEP decision will remain valid throughout decommissioning because the associated activities, including discharges, will be less than during plant operation. The environmental effect, accordingly, will as a minimum remain stable given the controlled Deerfield River and the fixed design of the Circulating Water System. Yankee will continue to monitor the effects of the Circulating Water System under the provision of the NPDES permit. In addition, the EPA and MDEP will periodically re-evaluate their conclusions, since the NPDES permit requires renewal every five years.

4.4.5 Hazardous Waste

YAEC is required by the OSHA Hazard Communication Standard (29 CFR 1910.1200) to provide information to its employees and contractors concerning the hazardous substances to which they may be exposed. Plant procedures and worker training meet these requirements.

4.4.5.1 Hazardous Waste Management

The Yankee Non-Radioactive Waste Management Program was established to ensure compliance with all the federal and state hazardous waste regulatory requirements. Non-radioactive hazardous wastes from the YNPS are transported only by authorized and licensed transporters and shipped only to authorized and licensed facilities.

The program is implemented through procedures which provide direction for the handling, temporary storage, and preparation for shipment of non-radioactive hazardous waste. Routine preventive and emergency response procedures have been developed for precluding and containing hazardous material incidents.

Areas which contained non-radioactive hazardous materials will be evaluated by appropriate sampling and analytical protocols. If needed, remedial actions will meet all federal, state and local environmental quality requirements.

4.4.5.2 Transformer Oil Containing PCBs

PCBs are present in the oil in three Station Service Transformers. Each transformer contains approximately 370 gallons of oil. The transformers will be removed from service and sent to an authorized and licensed contractor for removal, processing and disposal of the oil.

4.4.5.3 Above Ground Fuel Oil Storage Tanks

There are six above ground oil storage tanks at YNPS. The Fuel Oil Storage Tank has a capacity of 30,450 gallons and supplies oil to the auxiliary boilers and the Emergency Diesel Generator Day Tanks. Three Emergency Diesel Generator Day Tanks have a capacity of 275 gallons each. The Diesel Fuel Oil Overflow Tank, which collects any overflow from the Emergency Diesel Generator Day Tanks, has a capacity of 250 gallons. The Diesel Powered Fire Pump tank has a capacity of 275 gallons. These tanks may remain in service through the safe storage period and into the dismantlement phase. When no longer required, the tanks will be emptied, cleaned, and disposed of by an authorized and licensed contractor

4.4.5.4 Underground Oil Storage Tanks

Two underground fuel oil storage tanks are located at the YNPS. One supplied fuel oil to the Safe Shutdown System Emergency Diesel Generator and the other supplied the Security Diesel Generator. Both tanks are no longer in service and have been emptied.

An Underground Waste Oil Tank was used to store uncontaminated waste oil prior to shipment to a licensed disposal facility. The tank has been removed from service, emptied and cleaned. Uncontaminated waste oil is and will continue to be stored in drums in the Lube Oil Storage Room until disposal.

These tanks will be excavated, removed and disposed of by a licensed contractor.

4.4.5.5 Asbestos Containing Materials

The original plant insulation contains 6% to 8% asbestos with a calcium silicate binder. Asbestos insulating material has been identified on many plant systems and in most areas and buildings. Whenever maintenance activities were conducted that required insulation removal, asbestos insulating material was replaced with a non-asbestos material and labeled accordingly. Most of the systems originally covered with asbestos insulating material now have portions which are covered with non-asbestos insulating material. Minor quantities of non-insulation asbestos containing materials, in the form of gaskets and packing, remain present in numerous systems at the plant.

Asbestos containing material will be removed by licensed personnel prior to the start of dismantlement activities. Insulating material will be considered to be asbestos containing material unless marked "NON-ASBESTOS". All asbestos containing materials will be removed and processed in accordance with plant procedures, which assure compliance with federal and state regulations.

Radiologically contaminated asbestos containing material and non-asbestos insulating material will be disposed of as low-level radioactive waste.

4.4.5.6 Mercury

Mercury contained in instruments and switches will be removed and collected prior to final disposal of the equipment. The mercury will be reclaimed or processed by an authorized and licensed contractor.

4.4.5.7 Lead Based Paints

Lead based paints were used at YNPS to coat many steel components, some concrete structures, and underground carbon steel piping. During the operating life of the plant, some of the lead based paints have been covered with several coats of non-lead based paint. In other cases, non-lead based painted surfaces were coated or touched up with a lead based paint. Controls of the lead based paint identification and removal process will be implemented to ensure proper handling of lead materials. Steel components coated with lead based paint will be sent to a reprocessing facility. The lead based paints on non-recyclable components will be removed, processed, and disposed of by an authorized and licensed contractor.

4.4.6 Non-Hazardous Waste

The final dismantlement of YNPS will require the disposal of system and building wastes. These wastes will include materials that were never radiologically contaminated, have been decontaminated to meet release criteria, or do not contain asbestos or other hazardous materials. Non-radioactive non-hazardous wastes are expected to include:

- System piping and components (pumps, valves, tanks, non-asbestos insulation, heat exchangers and supports),
- Duct-work and associated equipment (ducts, fans, filters and supports),
- Electrical systems and equipment (cables and trays, conduit, motor control centers, generators, motors, and panels), and
- Buildings and structures (concrete, structural steel, roofing materials, siding, doors, and windows).

Such materials will be processed in accordance with the rules and regulations governing the disposal of non-radioactive, non-hazardous wastes.

REFERENCES

4-1 NUREG-0586, "Final Generic Environmental Impact Statement On Decommissioning Of Nuclear Facilities," USNRC, August 1988.

4-2 Letters, Activities Prior to Decommissioning Plan Approval:
- S. Weiss, USNRC, to J. Thayer, YAEC, July 15, 1993
- R. Mellor, YAEC, to M. Fairtile, USNRC, June 24, 1993
- J. Thayer, YAEC, to M. Fairtile, USNRC, June 17, 1993
- J. Thayer, YAEC, to M. Fairtile, USNRC, April 23, 1993
- T. Murley, USNRC, to A. Kadak, YAEC, March 29, 1993

4-3 Staff Requirements Memorandum (SRM), S. Chilk, USNRC to W. Parler and J. Taylor, USNRC, January 14, 1993.

4-4 NUREG/CR-0130, "Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station," 1978, through Addendum 4, 1988.

4-5 WASH-1238, "Environmental Survey of Transportation of Radioactive Materials to and From Nuclear Power Plants," Directorate of Regulatory Standards, 1972.

4-6 Department of Energy, DOE/RW0006 Rev. 8, "Integrated Data Base for 1992: Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics", chapter 7.

4-7 "Surface Quality Standards," Massachusetts Department of Environmental Protection - Division of Water Pollution Control, 314 CMR 4.00, 1990.

4-8 "Biological and Thermal Conditions of the Deerfield River," YAEC-1069, 1974.

4-9 "Environmental Data for Harriman Reservoir, Sherman Reservoir, and the Deerfield River," report by Aquatec, Inc., prepared for YAEC, 1974.

4-10 "Ecological Survey of Sherman Reservoir and Adjacent Waters," January-December 1975," report by Aquatec, Inc., prepared for YAEC, 1975.

4-11 "Study of the Effect of Heated Discharge on the Ecology of the Deerfield River," House No. 5369, Massachusetts Division of Water Pollution Control, 1974.

4-12 "Bear Swamp Pumped Storage Hydroelectric Project Fishery Study," Report by J. Forst and W. Este to Massachusetts Division of Fisheries and Wildlife, 1977.

4-13 National Pollutant Discharge Elimination Permit No. MA0004367, U.S. Environmental Protection Agency, Massachusetts Division of Water Pollution Control, 1988.

TABLE 4.1-1

RADIATION EXPOSURE PROJECTIONS

ACTIVITY	EXPOSURE (person-rem)	
Component Removal Project		
Asbestos Abatement	73	
Steam Generators & Pressurizer	62	
Reactor Vessel Internals	25	
subtotal:		160
Fuel Transfer		41
Dismantlement		
Reactor Vessel	48	
Main Coolant System	50	
Other Systems in the Vapor Container	84	
Balance of Plant Systems	98	
Asbestos Abatement	90	
Structures	50	
Miscellaneous (e.g. packaging, inspections)	82	
subtotal:		502
Transportation		41
Plant Effluents		<1
TOTAL RADIATION EXPOSURE PROJECTION:		744

Notes: Conservatively assumes all activities occur in 1994, thereby maximizing projections.

Transportation exposure projections are based on maximum allowable dose rates, rather than expected dose rates, thereby maximizing projections.

TABLE 4.2-1

TRANSPORTATION EXPOSURE COMPARISON

	YNPS		REFERENCE PWR	
	CRP	DP *	DECON	SAFSTOR
LLW Shipments				
Number By Trucks	39	227	1363	139
Distance (miles)	1000	1000	500	500
Number By Rail	2	0	28	0
Distance (miles)	1000	1000	1500	1500
Off-site Exposure (person-rem)				
Onlookers	<1	1	7	1
General Public	<1	4	14	2
Total:	2	5	21	3
Occupational Exposure (person-rem)				
Truck Drivers	5	26	95	10
Garage Personnel	<1	<1	4	<1
Train Personnel	<1	0	3	2
Total:	7	27	102	13

Reference: PWR data from NUREG/CR-0130, "Decommissioning the Reference PWR", Section 11.

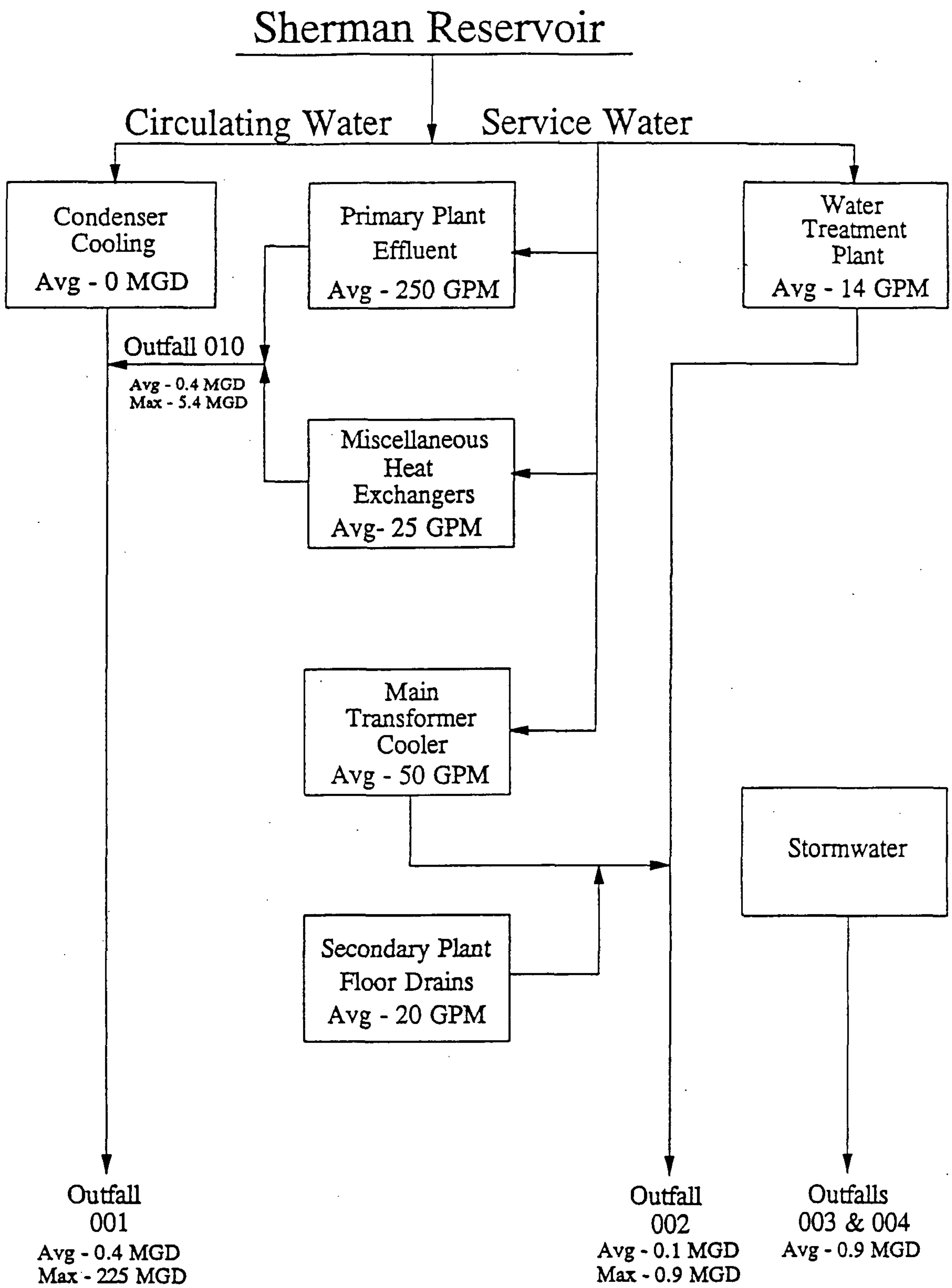
Notes:

* YNPS Decommissioning Plan
* Conservatively based on maximum allowable dose rates, rather than actual expected rates.
* Conservatively based on 1994 dose rates.

TABLE 4.2-2

Principle Radionuclide Distribution
for Plant Systems and Structures
as of January 1994

Nuclide	Half Life	Relative Fraction	
Fe-55	2.70 yr	0.772	
Co-60	5.27 yr	0.113	
Ni-63	100 yr	0.076	
	total:	0.961	(96.1%)



YNPS Water Use
Figure 4.4-1

5.0 ENVIRONMENTAL IMPACT OF ACCIDENTS

The Decommissioning Plan includes an accident analysis that assesses the impact of decommissioning on both occupational and public health and safety [Reference 5-1]. A structured and comprehensive process was used to identify and evaluate events that could occur during the period from approval of the Decommissioning Plan through completion of the final radiation surveys. The accident analysis considers decommissioning, fuel storage and external events and includes all phases of decommissioning activities: decontamination, dismantlement, packaging, storage and radioactive material handling.

5.1 SUMMARY OF RESULTS

The risk of accidents resulting in a significant radiological release during decommissioning activities is much less than that during plant operations. Yankee evaluated all of the Final Safety Analysis Report Section 400 safety analyses for applicability to a permanently defueled condition [Reference 5-2]. The only design basis event still applicable was the Spent Fuel Pit fuel handling accident. The remaining events which could impact the health and safety of workers or the public are related to the release of airborne radioactive materials during decommissioning activities.

The accident analysis assesses all decommissioning and fuel storage events which could impact the health and safety of workers or the public. The consequences of the events considered in this analysis have been conservatively estimated and result in bounding estimates for all decommissioning activities.

Using conservative assumptions, the accident analyses conclude that:

- The consequences of events are much less than the lower limits of the Environmental Protection Agency (EPA) Protective Action Guides (PAGs), as described in Section 5.2, and therefore, any potential impact to the public health and safety would be minimal.

- The evaluation of events that could affect occupational health and safety indicated that implementation of proper planning, the Radiation Protection Program and the Occupational Safety Program will effectively minimize the potential occurrence of these events and their potential impact on the workers.

5.1.1 Exposure Limits

Under an operating license, radiological releases resulting from the postulated design basis accidents were evaluated against dose reference values from 10 CFR 100. The 10 CFR 100 reference values limit dose to an individual at the Exclusion Area Boundary.

With the approval of the NRC [Reference 5-3], and agreement by the Commonwealth of Massachusetts [Reference 5-4] and the State of Vermont [Reference 5-4], Yankee discontinued off-site emergency response activities based on the absence of accidents at a level of severity where the off-site dose could exceed those specified in the EPA PAGs. Off-site protective actions are not warranted if the off-site dose following a postulated accident is less than the EPA PAGs. The EPA PAGs are limiting values based on the sum of external and internal exposures during a radiological event [Reference 5-5].

Releases resulting from accidents postulated in the decommissioning accident analysis are evaluated against the lower, more conservative values specified in the EPA PAGs. This ensures that the current Defueled Emergency Plan is adequate for decommissioning. Use of the EPA PAGs as an administrative limit also ensures that potential off-site doses are significantly less than the 10 CFR 100 reference values.

5.1.2 Assumptions

The following assumptions have been incorporated into the analyses:

- Special Nuclear Material used as reactor fuel will not be moved into the Reactor Vessel. This a condition of the YNPS Possession Only License.

- The Component Removal Project has been completed, having removed the four steam generators, the pressurizer, and portions of the reactor internals.

- The airborne pathway is the dominant release pathway. Activities that could release radioactive liquids will be designed to contain releases within the liquid waste processing system or supplemental barriers.

- Airborne releases occur at ground level with a conservative dispersion factor of 2.84E-04 sec/m^3 [Reference 5-6].

- There are no credible common cause mechanisms that could result in the simultaneous release of radioactivity from multiple activities that would exceed the equivalent release of the radioactive contents of the single, bounding container or component that results in the highest off-site dose.

- Direct failures and consequences of initiating events were considered in the consequence analysis. Separate, coincident, random failures were not considered.

- Mechanical interactions between systems during radioactive material handling activities will be precluded by safe load paths; protective zones around systems, structures and components; and single handling criteria for higher contamination items.

- The consequences of fire and explosions could impact several activities simultaneously.

- Vapor Container pressure retention capability is not necessary. However, the capability to expeditiously isolate the Vapor Container from the environment will be retained. Isolation is the closure of all penetrations and openings to restrict transport of airborne radioactivity from the Vapor Container to the environment.

5.2 EVENTS AFFECTING PUBLIC HEALTH AND SAFETY

Radiological and non-radiological events, both on-site and off-site, were analyzed for potential impact on public health and safety. Following are summary descriptions of the events analyzed and the results of the assessments. More detailed descriptions of the decommissioning safety analyses [Reference 5-1] are provided in the Decommissioning Plan [Reference 5-8].

5.2.1 Radiological Events (On-site)

Radiological events affecting the health and safety of the public are those events that could potentially result in a release of radioactive material exceeding the EPA PAGs. The following events were identified as having the potential to exceed the EPA PAGs and were then analyzed to determine whether they actually could result in a release of radioactive material exceeding the EPA PAGs:

- Any event which could result in the release of large quantities of contamination from the surfaces of systems, structures or components during each of the following decommissioning activities:

    - materials handling
    - decontamination
    - dismantlement
    - packaging
    - storage

- Any event which could result in the loss of major support systems or their dependent systems, including:

  - off-site power
  - cooling water
  - compressed air

- Fire and explosion events, including their simultaneous affect on plant systems, structures and components.

- External events, natural and man made, including the following:

  - earthquakes
  - forest fires
  - aircraft impact
  - external flooding
  - lightning strikes
  - tornadoes and extreme winds
  - on-site transportation accidents

- Spent fuel storage events, including:

  - fuel handling event
  - loss of spent fuel cooling capability
  - interactions with decommissioning activities

In all cases, analyses indicate no on-site radiological events would result in off-site exposures which exceed the EPA PAGs, nor affect the health and safety of the public.

5.2.2 Radiological Events (Off-site)

Off-site events related to decommissioning activities are limited to those associated with the packaging and shipment of radioactive materials.

The packaging and shipment of radioactive wastes will be done in accordance with all applicable NRC and Department of Transportation requirements. A comprehensive radioactive waste management program on site assures compliance with these requirements, verified through the Decommissioning Quality Assurance Plan. Compliance with these regulations ensures that both the probability of occurrence and the consequences of an off-site event do not significantly affect the public health and safety.

The EPA PAGs are not designed to address transportation accidents. However, the GEIS [Reference 5-7] describes risk assessment in terms of regulatory compliance and total shipment-miles for decommissioning. Since the total shipment-miles for transportation of radioactive waste from decommissioning of YNPS is significantly less than those assumed by the GEIS, the risk to the health and safety of the public from the decommissioning of YNPS is bounded and determined to be acceptable by the GEIS.

5.2.3 Non-Radiological Events

There are no non-radiological decommissioning events that could significantly impact public health and safety.

There are no chemicals stored on-site which, after release, could threaten public health and safety. Hazardous materials handling will be controlled through the Non-Radioactive Hazardous Materials and the Chemical Control Programs. Flammable gases stored on-site include combustible gases used for cutting and welding and liquid propane gas used for operation of forklift trucks. Safe storage and use of these gases and any other flammable materials is controlled through the Fire Protection Program.

The programs described above are implemented through procedures that control material identification, inventory, handling, storage, use and disposal, minimizing the probability of on-site non-radiological events. In addition, procedures present mitigative measures that would be implemented if an event occurred.

Implementation of these programs ensures that the probability of occurrence and consequence of on-site non-radiological events do not significantly affect the public health and safety.

5.3 EVENTS AFFECTING OCCUPATIONAL HEALTH AND SAFETY

Radiological and non-radiological events were analyzed for potential impact on occupational health and safety. Following are summary descriptions of the assessments. More detailed descriptions of the safety analyses [Reference 5-1] are provided in the Decommissioning Plan [Reference 5-8].

5.3.1 Radiological Events

Radiological events could occur which result in increased exposure of decommissioning workers to radiation. However, the occurrence of these events are minimized or the consequences are mitigated through the implementation of the Radiation Protection Program and the Defueled Emergency Plan.

The Radiation Protection Program is applied to all activities performed on site involving radiation or radioactive materials. A primary objective of the Radiation Protection Program is to protect workers and visitors to the site from radiological hazards that have the potential to develop during decommissioning. The program requires YNPS and its contractors to provide sufficient qualified staff, facilities and equipment to perform decommissioning in a radiologically safe manner.

Activities conducted during decommissioning that have the potential for exposure of personnel to either radiation or radioactive materials will be managed by qualified individuals who will implement program requirements in accordance with established procedures. Radiological hazards will be monitored and evaluated on a routine basis to maintain radiation exposures and the release of radioactive materials to unrestricted areas as low as is reasonably achievable (ALARA). Radiation protection training will be provided to all occupationally exposed individuals to ensure that they understand and accept the responsibility to follow procedures and to maintain their individual radiation dose ALARA.

Project management will ensure that work specifications, designs, and work packages involving potential radiation exposure or handling of radioactive materials incorporate effective radiological controls. Task planning will include consideration of potential adverse events. The objective of this planning is to ensure that protective measures and contingency plans are developed to address the potential occurrence of these events and to minimize their impact on the health and safety of the workers as well as the public.

The Defueled Emergency Plan retains an on-site emergency response capability. This capability includes removal of personnel from all affected areas, including site evacuation, if necessary. The plan is implemented by Control Room personnel.

Implementation of these programs ensures that potential radiological events affecting occupational health and safety will be sufficiently minimized and mitigated to not warrant further consideration in this analysis.

5.3.2 Non-Radiological Events

Decommissioning YNPS will require some different work activities than were typically conducted during normal plant operations. Effective implementation of the Occupational Safety Program for decommissioning activities will ensure worker safety (See Section 4.4.1). The goal of the Occupational Safety Program is to provide a hazard-free environment for employees. The program incorporates safety into every phase of decommissioning from early design through implementation. Implementation of the Occupational Safety Program will ensure that industrial safety hazards are eliminated to the maximum extent possible.

REFERENCES

5-1 Decommissioning Safety Analysis.

5-2 Letter, BYR 92-057, Request for Exemption From Annual and Biennial Emergency Preparedness Exercise in 1992, S. Schultz, YAEC, to M. Fairtile, USNRC, May 22, 1992.

5-3 Letter, NYR 92-178, Exemption From The Emergency Preparedness Rule 10 CFR 50.54(q) and Approval of The Defueled Emergency Plan At The Yankee Nuclear Power Station (TAC No. M83991), M. Fairtile, USNRC, to J. Grant, YAEC, October 30, 1992.

5-4 Letter of Agreement Between YAEC and the Commonwealth of Massachusetts and State of Vermont, October 2, 1992.

5-5 EPA 400-R-92-001, Manual of Protective Action Guides and Protective Actions for Nuclear Incidents, US Environmental Protection Agency, October 1991.

5-6 YRC-182, Yankee Rowe Accident Atmospheric Diffusion Factors, January 5, 1982.

5-7 NUREG-0586, Final Generic Environmental Impact Statement On Decommissioning Of Nuclear Facilities, August 1988.

5-8 YNPS Decommissioning Plan.

6.0 FACILITY RADIOLOGICAL STATUS AND MONITORING

Three programs define the radiological status and monitor the environs of the facility to determine the environmental impact attributable to decommissioning activities. One, the Radiological Environmental Monitoring Program, has been in progress since before the original startup of the facility. The Radiological Scoping Survey program and the Site Characterization Survey program are specific to the Decommissioning Plan. This section describes those programs.

6.1 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

The facility license requires a Radiological Environmental Monitoring Program (REMP). The purpose of the program is to monitor the radiation and radionuclides in the environs of the plant. The program includes the following elements:

- Monitoring, sampling, analysis and reporting of radiation and radionuclides in the environment in accordance with the methodology and parameters presented in the ODCM.

- Maintenance of a land use census to ensure that changes in the use of areas at and beyond the site boundary are identified and that modifications to the monitoring program are made if required.

- Participation in an inter-laboratory comparison program to ensure that independent checks on the precision and accuracy of the measurements of radioactive materials in environmental sample matrices are performed as part of the Quality Assurance Program for environmental monitoring.

The facility license further requires an annual report to the USNRC of the results, interpretation, and analysis of trends from the REMP.

Historically, the program has consisted of three phases. The first was the pre-operational phase, which was designed to assess background levels of both natural and man-made radionuclides in the plant environment. It was started in 1958, approximately two years prior to the initial plant startup. On the day of startup, the pre-operational program was replaced by the operational program. This phase continued to February 26, 1992, when the plant was permanently shut down. Since then, the post-operational REMP has been in effect.

The post-operational REMP is designed to verify the effectiveness of environmental safeguards inherent in plant design and in the design of the plant decommissioning program. It also verifies the impact, if any, on the environment from decommissioning activities. The objectives of the post-operational REMP are:

- To assure the public and those personnel responsible for protecting the public health and safety that radiation levels and radioactivity concentrations in the environment resulting from plant decommissioning activities meet applicable regulatory requirements.

- To make possible the prompt recognition of any significant increase in environmental radiation or radioactivity levels and to identify the cause of the change, whether it be from plant decommissioning activities, effluents from other nuclear facilities, fallout from atmospheric nuclear weapons tests, seasonal changes in natural background, or other sources.

As with the operational REMP, the post-operational REMP is based in part on guidance given in USNRC Regulatory Guides [References 6-1, 6-2, 6-3 and 6-4], NUREGs [References 6-5 and 6-6], and the USNRC Branch Technical Position on environmental monitoring [Reference 6-7].

The early post-operational REMP has essentially been a continuation of the operational program, with no significant changes being made to the program as a result of the plant shutdown. However, as decommissioning progresses, modifications are expected to be made to the REMP. Changes will be based on an assessment of the potential source term and release pathways, as well as the accumulated knowledge of the plant environs and land use, and will be reviewed in accordance with 10 CFR 50.59 and the requirements of the license (Technical Specification 6.1.3.1).

6.1.1 Summary of Results

Since the Radiological Environmental Monitoring Program began in 1958, over 23,000 environmental samples have been collected. Approximately 1,000 samples per year have been collected in recent years. These results are documented each year in a report to the USNRC entitled "Annual Radiological Environmental Operating Report".

TLDs have been used to continuously measure direct radiation from plant sources and natural background. In recent years, five TLDs at each of forty locations near YNPS, have been collected and processed on a quarterly basis. These monitors demonstrate a large variation in background radiation as a function of time and location. For example, in 1992, quarterly background radiation levels varied from 4.5 to 8.8 μR/hr (39 to 77 mR/yr) at off-site locations. There was no significant difference in data between near-site and far-site locations.

In situ gamma spectroscopy measurements were taken in the vicinity of YNPS in the years 1981, 1984 and 1987. Soil core samples were also taken at many locations along with the in situ measurements. Cesium-137 concentrations in the soil core segments from seven locations surveyed in 1987 varied from 20 to 1150 pCi/kg (wet). Several naturally occurring radionuclides also were detected in these samples: thorium-232, uranium-238 and potassium-40. Direct radiation measurements were also taken coincident with the in situ gamma spectroscopy measurements. Exposure rates varied from 8.9 to 11.0 μR/hr (78 to 96 mR/yr) at the seven locations surveyed in 1987.

Naturally-occurring radionuclides and fallout from atmospheric nuclear weapons testing have been the predominant radionuclides detected in the environs surrounding YNPS. The predominant radionuclides in this category are:

- Potassium-40 - This naturally occurring radionuclide is found in all biological media; including milk, fish and vegetation.

- Thorium-232 - This naturally occurring radionuclide is found in soil and sediment.

- Cesium-137 - This radionuclide resulted from nuclear weapons testing fallout and is detected in milk, vegetation, soil and sediment.

- Strontium-90 - This radionuclide resulted from nuclear weapons testing fallout and is detected in milk.

A small number of samples, from the immediate vicinity of the plant, are found to have very low levels of radioactivity which are attributed to YNPS. Two media have been monitored closely through the Radiological Environmental Monitoring Program:

- Cobalt-60 in Sherman Reservoir sediment near the plant discharge:
  In addition to cesium-137, most of which can be attributed to nuclear weapons testing fallout, cobalt-60 has been detected in the sediment near the plant discharge structure in Sherman Reservoir. The cobalt-60 was deposited during controlled plant discharges through a licensed and monitored discharge point.

- Detection of tritium in Sherman Spring: Sherman Spring is located on site property below the Sherman Dam. In 1965, tritium was detected in Sherman Spring. The source of tritium is believed to be migration from a leak in the Ion Exchange Pit which occurred in 1964. The tritium concentration has decreased exponentially since its discovery. At the present time, the tritium concentration is significantly below the Environmental Protection Agency community drinking water standards.

In no cases do the levels of radionuclides attributed to the plant exceed, or even approach, the most restrictive federal regulatory limits or plant license limits. In all cases, the possible radiological impact from radionuclides attributed to the plant is extremely small when compared to exposures from the natural background radiation.

6.1.2 Monitoring Network

The REMP compares measured radiation levels and levels of radioactivity in samples from the area possibly influenced by the plant to levels found in areas not influenced by the plant. The first group of locations are called Zone I or Indicator locations, and the second are called Zone II or Control locations. The distinction between the two zones, as well as the rationale for choosing specific locations, is based on one or more of several factors, such as site meteorological history, meteorological dispersion calculations, relative direction from the plant, river flow, and distance. Analysis of survey data from the two zones aids in determining if there is a significant difference between the two areas. It can also help in differentiating between radioactivity or radiation due to plant decommissioning activities, and that due to other fluctuations in the environment, such as atmospheric nuclear weapons test fallout or seasonal variations in the natural background.

Four categories of pathways are monitored by the REMP. They are direct radiation, airborne, waterborne, and ingestion. The details of the required program are described in the ODCM. Listed there, by pathway or sample media type, are the required number of sample locations, sample frequency and analysis type.

6.1.3 Direct Radiation Measurements

Environmental Thermoluminescent Dosimeters (TLDs) are located at many locations surrounding the plant, the actual number of which is specified in the ODCM. Their purpose is to continually monitor the ambient direct radiation levels and to allow the determination of an integrated gamma exposure.

6.1.4 Air Sampling

Air sampling pumps operate continuously at several Zone I and one Zone 2 locations, with a dry gas meter measuring the total amount of air sampled in a given interval.

6.1.5 Water Sampling

Samples of river water, ground water and shoreline sediment are collected for the waterborne pathway. For river water samples, a composite water sampler is located downstream (Zone I) from the plant. Aliquots are collected automatically at least every two hours and are composited at the sampling site. Grab samples of river water are collected upstream (Zone II) from the plant. Grab samples of ground water are collected from two Zone I locations in the immediate area of the plant.

Shoreline sediment samples are collected from both a Zone I and a Zone II location. A coring device is used to collect multiple sediment cores, which are separated at the laboratory into 5 cm layers. Each layer is analyzed separately to provide information on the depth distribution of any detected radionuclides.

6.1.6 Ingestion Pathway Sampling

Milk is sampled from two locations in Zone I and one in Zone II. The milk-sampling locations are reassessed annually as part of the Land Use Census. The chosen locations are those having the highest relative likelihood of showing radionuclides in the milk pathway.

Samples of locally grown food crops and/or broad leaf vegetation are collected from two locations in Zone I and one location in Zone II. As with the milk-sampling locations, the food product sampling locations are reassessed annually as part of the Land Use Census. The choice of locations is based upon the relative likelihood of detecting radioactivity at that location.

Recreationally important species of fish are collected by gill net from two locations. The Zone I location is near the plant discharge, and the Zone II location is upstream of the plant.

6.1.7 Laboratory Analysis

Environmental samples are collected by members of the plant Radiation Protection/ Chemistry Department. All samples, including TLDs, are sent to the Yankee Atomic Environmental Laboratory (YAEL) in Westborough, Massachusetts for further chemistry and analytical work. The YAEL maintains an extensive intra-laboratory quality control program to assure the validity and reliability of the data. This program includes: instrument calibrations and control checks, process control checks comprised of known activity concentrations, blind duplicates, and blank samples. The process control checks comprise approximately ten to fifteen percent of the laboratory sample throughput. The records of the quality control program are reviewed by the responsible cognizant individual, and corrective measures are taken whenever applicable. A separate, but similar, program is carried out for environmental TLDs.

To further verify the accuracy and precision of the laboratory analyses via an independent outside third party, YAEL participates in the U.S. Environmental Protection Agency's Environmental Radioactivity Laboratory Intercomparison Studies program for those available species and matrices routinely analyzed by the laboratory. When the results of the cross-check analysis fall outside of the control limit, an investigation is made to determine the cause of the problem, and corrective measures are taken, as appropriate. YAEL also participates in independent third party performance testing for environmental TLDs through the University of Michigan.

A blind duplicate program is also conducted in which paired samples from several nuclear plants, including YNPS, are prepared from homogenous media and sent to the laboratory for analysis. The results from this blind duplicate program are used to check for precision in laboratory analyses.

6.1.8 Land Use Census

To ensure that the Radiological Environmental Monitoring Program continues to include those locations whose environmental samples are most likely, on a relative basis, to show any environmental radioactivity attributable to plant emissions, a Land Use Census is conducted annually. As part of the census, the locations of the nearest milk animal, the nearest residence, and the nearest garden of greater than 500 square feet producing fresh leafy vegetables in each of the sixteen meteorological sectors within a distance of five miles from the plant are determined. The recent long-term meteorological history of the plant site and the identified census locations are used in dosimetric analyses to determine the optimal sampling locations.

6.1.9 Reporting Requirements

An Environmental Radiological Monitoring Report for the previous calendar year is submitted to the USNRC prior to May 1 of each year. The report must contain summarized results of the program, interpretations and analyses of trends, comparisons with controls and previous results, an assessment of the observed impacts of plant activities on the environment, maps, a table of sampling locations, Land Use Census results, and results of the Inter-laboratory Comparison Program. If a radionuclide concentration in an environmental sampling medium exceeds the reporting levels found in the ODCM, a written report is submitted to the Director of the USNRC Regional Office within 30 days from the receipt of the laboratory analysis.

6.2 RADIOLOGICAL SCOPING SURVEY

NUREG/CR-5849 [Reference 6-8] presents guidance for implementing radiological surveys during the decommissioning of nuclear facilities. One of the surveys identified in this document is a scoping survey, which provides "the basis for initial estimates of the level of effort required for decommissioning and for planning the characterization survey." Yankee completed a scoping survey to provide the basis for the Decommissioning Plan. A more detailed description of the Radiological Scoping Survey is included in the Decommissioning Plan.

Yankee's scoping survey consisted of measurements and samples of the plant systems, structures and components and of the soil and groundwater beneath the plant site and surrounding areas. The objective of the scoping survey was to provide a preliminary assessment of site conditions and to classify the site into radiologically affected and unaffected areas. The objective was achieved by developing a survey method that, when combined with analytical methods, achieved the following goals:

- Identification of plant areas affected and not affected by radiological contamination and activation,
- Identification of radionuclide contaminants located on site,
- Determination of the distribution of radionuclides in contaminated and activated materials, and
- Determination of the general extent of radiological contamination and activation - both in terms of activity and volume.

The scoping survey sample location selection process identified both biased and unbiased locations. Biased sampling locations were areas of suspected contamination that were identified using information obtained from plant records and employee interviews. A grid system was established for systematically identifying unbiased sampling locations in areas known to be contaminated and in areas of potential contamination.

6.2.1 Summary of Scoping Survey

Surveys completed on or inside the facility buildings consisted of the following:

- area and contact dose measurements of contaminated and uncontaminated systems, structures and components,
- samples of plant piping, and
- samples of paint and concrete.

Surveys completed outside of the facility buildings consisted of the following:

- samples of soil and groundwater from test wells,
- samples of asphalt and near-surface soil, and
- surface gamma spectroscopy.

Samples collected during the scoping survey were evaluated by the Yankee Atomic Environmental Laboratory and the Yankee Plant Chemistry and Radiation Protection Laboratories. Instrumentation used in the field and laboratory were calibrated against sources and standards traceable to the National Institute of Standards and Technology (NIST). A chain of custody process was established to ensure sample process integrity.

6.2.2 Scoping Survey Results: Systems, Structures and Components

A list of potentially contaminated systems was developed and a survey package developed for each system evaluated. The survey packages included drawings, system descriptions, and lists of piping and components. Uncontaminated systems were surveyed to verify their radiological status. The results of these surveys include:

- Area survey maps for all areas of the plant. Each map presents general area dose rates and average removable surface contamination levels.
- Representative radionuclide distributions, including variability between plant systems, comparisons with previous data, and a specific Main Coolant System distribution.
- Representative measurements of the ratio of fixed to removable activity from internal surfaces.

- Direct external measurements of radiation and contamination levels.

- Direct internal radiation measurements in piping samples for comparison with corresponding external measurements, to support the calculation of internal contamination levels from external dose rates.

- Measurements of contamination depth in structural materials at representative locations.

Neutron activation of the Reactor Vessel and adjacent components were estimated analytically. Further analyses and samples will be obtained during decommissioning to determine the extent of activation the Reactor Vessel and adjacent components.

An estimate of the YNPS systems, structures and components activity inventory is presented in Table 6.2-1. The inventory is based on 1994 curie content and includes all materials except the 533 spent fuel assemblies and the greater than 10 CFR Part 61 Class C Reactor Vessel internal components stored in the Spent Fuel Pit.

6.2.3 Scoping Survey Results: Soil and Groundwater

Soil and asphalt covered areas were analyzed to estimate the extent and distribution of contamination that occurred from plant operation. Groundwater samples were analyzed to determine if contamination was transported into the groundwater.

Surveys were conducted inside and outside the Radiation Control Area. Soil samples were collected in both surface and subsurface locations. Groundwater samples were collected from on-site observation wells. All of the samples were evaluated for gamma emitting radionuclides. The groundwater samples were also analyzed for beta activity and tritium concentrations. The detection capabilities used for the analyses were based on the environmental lower limits of detection presented in the ODCM. Soil was also evaluated using in situ gamma spectroscopy and pressurized ion chamber measurements.

A grid system was established for systematically identifying unbiased sampling locations. This system used a 10 and 20 meter grid spacing for areas inside and outside of the Radiation Control Area, respectively. Biased sampling locations were added in areas of potential contamination.

6.2.3.1 Surface Soil and Asphalt Sampling

Near-surface samples of soil and asphalt were collected from 79 locations on and around the YNPS site as a part of the radiological scoping survey. Most locations were based on a sample grid, but several were biased (i.e., collected in areas of suspected contamination).

Cesium-137 was detected in many soil and asphalt samples. Cesium-137 is a fission product produced from atmospheric testing of nuclear weapons and the operation of a reactor. Cesium-137 was distributed in soils throughout the region as a result of atmospheric testing of nuclear weapons. Environmental concentrations differ widely due to the varying affinity of different soil types for cesium. Off-site control samples collected up to 22 km from the site were collected as part of this scoping survey and the REMP. Cesium-137 was detected in all but one of the control samples. With the exception of the one location described below, the cesium-137 concentrations from the scoping survey results are consistent with those detected in the control samples.

Analysis of samples from a roped off storage area behind the Potentially Contaminated Area Storage Building Number 1 indicated low levels of cobalt-58, silver-108m, and cesium-137 in addition to cobalt-60. This is the only location in which cobalt-58 and silver-108m were detected. The non-occupational exposure limit of 100 mrem/yr (10 CFR Part 20) is not exceeded in this area, based on direct ground plane exposure from the measured radioactivity. Additional sampling will be completed in this area to determine the extent of the contamination as a part of the characterization program.

Cobalt-60 was detected in several soil and asphalt samples. Cobalt-60 is an activation product produced from neutron irradiation of corrosion products in the Reactor Vessel during operation and is contained in the contamination layers on YNPS systems, structures and components. Analyses of the soil and asphalt samples indicated the following number of locations with cobalt-60 detected:

Inside Radiation Control Area	5 of 20 (25%)
Outside Radiation Control Area	4 of 51 (8%)

All of the locations outside the Radiation Control Area with detectable cobalt-60 were inside the Owner Controlled Area fence.

6.2.3.2 Soil Boring and Test Pits

Subsurface samples were collected from four soil borings and four test pits. Test pits were dug in the location where subsurface conditions made soil boring impractical. The soil boring samples were collected using a continuous large diameter split spoon, sampling from ground level to about 10 feet below the groundwater table. The test pit samples were collected using a backhoe.

The 0.3 ft (diameter) core bore sample from the north side of the Spent Fuel Pit Building indicated the only detectable cobalt-60 result. Five samples had detectable levels of cesium-137, all within a range expected from nuclear weapons test fallout. The cobalt-60 and cesium-137 results were all near the lower limit of detection for the measurement system.

6.2.3.3 Soil from Construction Excavations

Contaminated soil from two recent construction excavations is currently stored on site. These projects were the installation of the new Safety Injection Tank during May and June 1990 and the installation of the new Spent Fuel Building security wall during September and October 1992.

The construction for the new Safety Injection Tank resulted in approximately 200 cubic yards of contaminated dirt being excavated and removed. Forty-seven samples were obtained and analyzed for gamma emitting radionuclides. Nine of the samples indicated low levels of cobalt-60. Using conservative assumptions, the total quantity of cobalt-60 in the 200 cubic yards of soil is approximately 44 μCi.

The construction for the Spent Fuel Building security wall resulted in approximately 67 cubic yards of contaminated dirt being excavated and removed. Twenty four samples were obtained and analyzed for gamma emitting radionuclides. Using conservative assumptions, the total quantity of manganese-54, cobalt-60, cesium-134, and cesium-137 in the 67 cubic yards is approximately 228 μCi.

6.2.3.4 Groundwater Samples from Observation Wells

Groundwater samples were collected from 12 observation wells. Ten of the observation wells were installed as a part of the radiological scoping program. Two previously existing observation wells were reactivated.

The ten new observation wells were installed using 2.5 inch PVC screens and piping in previously drilled 5-inch diameter holes. Each well extends at least 10 feet below the groundwater table as measured at the time of installation. Filter sand was installed around the PVC screened portion of the wells and a clay seal was installed above each filter to enhance well operation and prevent leakage from the surface. All installation work was subject to continuous engineering inspection. Each observation well was developed by pumping water from the well before sampling.

Groundwater samples were analyzed for beta and gamma emitting radionuclides. With the exception of naturally-occurring K-40 and radon daughters, no gamma emitting radionuclides were detected in any of the samples.

Beta measurements were higher than typically found in routine REMP samples collected from established potable water wells, Sherman Spring, or surface water. It was noted, however, that most of the samples had visible solids suspended in the water due to the nature of the site soils. Following filtration of the original 12 samples, beta concentrations in the water were reduced in some samples by a factor of up to 14, and in some not at all. Gamma spectroscopy analyses done on both the original water samples and the filtered solids for these samples showed no detectable plant-related radioactivity. Based on these results and visual inspection of the water samples, the beta radioactivity is from naturally-occurring radionuclides in the water and in the suspended solids.

Tritium was detected in groundwater samples from three related wells. Two of the wells are near the Spent Fuel Pit Building and one down-gradient well is near the Administration Building. The tritium concentrations were 3,000 - 8,000 pCi/kg, which is well within the Environmental Protection Agency limit for tritium in community water systems of 20,000 pCi/kg (40 CFR 141.16).

6.2.3.5 In Situ Gamma Spectroscopy and Pressurized Ion Chamber Measurements

In situ gamma spectroscopy analysis was performed to evaluate large soil surface areas with a single measurement (or in high background areas, with two measurements). This method identified gamma emitting radionuclides at or near the surface and estimated the terrestrial exposure rate from gamma emitting radionuclides. Pressurized ion chamber measurements were used to verify the sum of the calculated dose rates from the detected radionuclides.

In situ gamma spectroscopy and pressurized ion chamber exposure rate measurements were performed at 110 on-site locations. The location selection was based on the grid system. The middle of each grid square was selected as the survey point unless a physical structure precluded access.

Naturally occurring radionuclides were found to be uniformly distributed in the surface layers of soil. Fission and activation products had a profile of decreasing activity with depth. The following summarizes the results for cobalt-60, the most prevalent man-made radionuclide detected:

<u>Outside Radiation Control Area</u>

Number of locations Co-60 detected	7 of 40 (18%)
Range of Results	35 - 90 pCi/kg
Average Minimum Detectable Concentration	51 pCi/kg

<u>Inside Radiation Control Area</u>

Number of locations Co-60 detected	26 of 70 (37%)
Range of Results	99 - 3,900 pCi/kg
Average Minimum Detectable Concentration	154 pCi/kg

The cobalt-60 concentrations for the areas outside the Radiation Control Area are near the minimum detectable concentration. All locations with detectable cobalt-60 were within the Owner Controlled Area fence. Cesium-137 was also detected inside and outside of the Radiation Control Area. With the exception of three locations inside the Radiation Control Area, the cesium-137 results are similar to those measured in the off-site control samples described in 6.2.3.1. Trace concentrations of several other gamma emitting radionuclides were also identified inside the Radiation Control Area: Fe-59 (1 location), Mn-54 (1 location) and Ag-110m (1 location).

For areas outside the Radiation Control Area (and inside the Owner Controlled Area), the terrestrial exposure rates, measured in mR/yr, varied as follows:

	Natural	Man-made*	Ratio
Average	41	0.1	.002
Maximum	67	0.4	.006
Minimum	18	0.0	.000

For areas inside the Radiation Control Area, the terrestrial exposure rates, measured in mR/yr, varied as follows:

	Natural	Man-made*	Ratio
Average	31	0.7	.020
Maximum	43	10.8	.260
Minimum	18	0.0	.000

* The terrestrial exposure rate contribution of radionuclides, including plant-related radionuclides and those from atmospheric nuclear weapons testing fallout.

6.3 SITE CHARACTERIZATION SURVEY

Site characterization is the next phase in the radiological survey process. The purpose of the site characterization surveys is to define more precisely the extent and magnitude of the contamination on site. Site characterization surveys will be used to supplement the scoping survey data in areas where data are missing or where the data indicate contamination levels are at or near the release criteria. The level of effort is related to the data needs for the item or area being surveyed. Items or areas that are highly contaminated require less data than items or areas that are near the release criteria to make decisions regarding their radiological status. Scoping and characterization data will be used to plan and complete decommissioning activities.

6.3.1 Program Description

The site characterization survey will collect additional radiological data and samples in areas to facilitate decommissioning planning. The following items will be considered in the site characterization survey for systems, structures, and components:

- Measure the activity and contamination levels associated with inaccessible plant areas before removal activities.
- Perform additional testing on contaminated concrete to improve estimates of contamination levels and depth of contamination.
- Perform a detailed radiological survey of the Reactor Vessel after completion of the Component Removal Project.
- Determine the extent of contamination of non-radiological plant systems, structures, and components.
- Determine the extent of activated structures and components external to the Reactor Vessel.

The following items will be considered in the site characterization survey for soil and groundwater:

- Perform additional surface and subsurface soil sampling as well as in situ measurements to determine the lateral and vertical extent of contamination identified during the radiological scoping surveys. The sampling may include areas identified with significant soil contamination as well as soil under buildings to the extent practicable.

- Establish the expected cesium-137 background concentration for the plant site. This determination may include analysis of additional off-site samples of varying soil types.

- Develop a computer model to define the groundwater regime for the site. Additional wells may be installed to provide the database needed to perform the modelling calculations.

6.3.2 Implementation Schedule

Site characterization surveys were initiated in 1993. The surveys of YNPS systems, structures, and components will be completed to support detailed planning activities associated with their decontamination and dismantlement. The surveys for soil and groundwater will be completed to support detailed planning activities associated with preparation of the site for the final radiation survey.

REFERENCES

6-1 USNRC Regulatory Guide 4.1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," Revision 1, April 1975.

6-2 USNRC Regulatory Guide 4.8, "Environmental Technical Specifications for Nuclear Power Plants," December 1975.

6-3 USNRC Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment," Revision 1, February 1979.

6-4 USNRC Regulatory Guide 4.13, "Performance Testing and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications," Revision 1, July 1977.

6-5 NUREG-0475, "Radiological Environmental Monitoring by USNRC Licensees for Routine Operations of Nuclear Facilities," October 1978.

6-6 NUREG-0472, "Standard Radiological Effluent Controls for Pressurized Water Reactors," Revision 3.

6-7 USNRC Branch Technical Position, "An Acceptable Radiological Environmental Monitoring Program," Revision 1, November 1979.

6-8 NUREG/CR-5849 (Draft), "Manual For Conducting Radiological Surveys in Support of License Termination", June 1992.

TABLE 6.2-1

FACILITY/COMPONENT RADIONUCLIDE INVENTORY

Material / Source	Activity (Ci)*
Contaminated System Components	175
Contaminated Concrete	0.43
Contaminated Steel	0.03
Miscellaneous Tools, Equipment, Duct, Conduit	39
Miscellaneous Drums and Solidified Waste	41
Reactor Vessel	4700
Neutron Shield Tank	180
Instrument Calibration Sources	32
Water in the Spent Fuel Pit and Ion Exchange Pit	4.8
ROUNDED TOTAL	5172

NOTE: Does not include activity in 533 fuel assemblies stored on site, nor the greater than class C reactor internal material stored on site.

* Curie content as of 1994.

7.0 ALTERNATIVE SELECTION AND JUSTIFICATION

Once a nuclear facility has reached the end of its useful life, it must be decommissioned. Several alternatives are possible, although not all may be satisfactory for all nuclear facilities.

7.1 DECOMMISSIONING ALTERNATIVE

Yankee has evaluated the three decommissioning alternatives described in the generic environmental impact statement on decommissioning of nuclear facilities, NUREG-0586 (Reference 7-1): DECON, SAFSTOR, and ENTOMB. The most appropriate alternative for decommissioning YNPS is to defer dismantlement until a low level radioactive waste disposal facility is available to receive low level radioactive waste from decommissioning. A disposal facility is not expected to be available to YNPS until 2000. This results in a decommissioning duration in excess of the approximately six year period associated with the DECON alternative in the generic environmental impact statement. Therefore, the YNPS decommissioning alternative is most similar to the SAFSTOR alternative with a relatively short period before final dismantlement and license termination.

7.2 DECOMMISSIONING ALTERNATIVE JUSTIFICATION

Access to a low level radioactive waste disposal facility is unlikely for the period immediately after NRC approval of the decommissioning plan. Significant dismantlement activities cannot proceed without sustained access to a low level radioactive waste disposal facility. Therefore, the plant must be placed in a safe storage condition until a facility becomes available. Limited dismantlement may be possible during the safe storage period using a combination of low level radioactive waste reclamation facilities, on-site storage, and limited access to waste disposal facilities.

Under the provisions of the Low Level Radioactive Waste Policy Amendments Act of 1985, existing disposal sites are permitted to deny access to waste generated in states that have neither joined a compact with an established disposal site nor established their own sites by January 1, 1993. Existing sites have begun to exercise their right to exclude low level radioactive waste disposal sites from non-compliant states. The Commonwealth of Massachusetts has neither joined a regional compact nor sited its own low level radioactive waste disposal facility. Although Massachusetts continues to develop plans, progress to date indicates that a facility in Massachusetts will not be available to accept YNPS decommissioning waste after June 1994 when the Barnwell, South Carolina Waste Management Facility closes.

YNPS was excluded from all disposal sites after December 1992 with the exception of the Barnwell, South Carolina Waste Management Facility. Barnwell is available to YNPS through June 1994. After that date, the disposal site at Barnwell is not available to YNPS. Although new low level radioactive waste disposal facilities are being planned by several regional compacts, each facility has encountered numerous delays and significant progress appears doubtful. None of the sites appear to be capable of operation by the mid 1990's. In addition, there is a high probability that regional compacts may specifically exclude out-of-compact waste from their facilities.

Massachusetts has not entered into a compact or developed an in-state low level radiological waste disposal facility. In 1993, the Governor filed a bond authorization bill that would allow the Commonwealth to expend funds to site a facility in-state or to use the monies to enter into a compact arrangement with other states. The Commonwealth's Low Level Radioactive Waste Management Board will decide in early 1994 whether to site a facility for its own use or to enter into a compact agreement where a facility would be shared with other states. Compact regulations and legislation have expressly or by implication rejected accepting decommissioning waste, particularly from out-of-compact generators. However, if Massachusetts starts the process in 1994 to either join a compact, form a new compact, or build a disposal facility for its own use, there is a likelihood that a disposal facility under these arrangements will be available in 2000 to accept the YNPS decommissioning waste.

Therefore, Yankee has concluded, for planning purposes, that the option of complete dismantlement in 1995 is not viable. YNPS will be placed in a safe storage condition until the year 2000. Detailed planning and engineering for dismantlement will begin in 1999, with decontamination and dismantlement activities beginning in 2000 and completed by 2002. This proposed schedule is within the 60 year limit (after cessation of operation) in 10 CFR 50.82(b)(1).

Yankee will continue to seek potential low level radioactive waste disposal sites for YNPS decommissioning waste. If a site is identified that can support the decommissioning waste, Yankee will proceed with earlier dismantlement. Limited access to low level radioactive waste facilities may also become available during the safe storage period. Yankee intends to use these opportunities to remove components and structures consistent with the guidance presented in the Decommissioning Plan.

Yankee's choice of the deferred dismantlement is consistent with the GEIS [Reference 7-1]. In that document, the NRC concluded that both DECON and SAFSTOR are reasonable alternatives for decommissioning a pressurized water reactor. Although there are advantages and disadvantages to either option, there is nothing that causes one alternative to be preferred from an environmental impact perspective. The ENTOMB alternative was determined to be less desirable than either the DECON or SAFSTOR alternative. The presence of long lived radioisotopes in nuclear power plants would require implementation of the ENTOMB alternative for a period significantly longer than the 60 year limit.

Earlier YNPS decommissioning studies assumed that DECON was the preferred decommissioning alternative. If a low level radioactive waste disposal site were available, DECON would be the preferred alternative for several reasons:

- The site is remediated as soon as possible after cessation of reactor operations, allowing unrestricted use of the site.
- Experienced plant personnel are more likely to be available, allowing incorporation of detailed operating experience into the decommissioning staff.
- Decommissioning cost is lower, minimizing the cost to the consumer.
- Financial exposure from escalation of low level radioactive waste disposal cost and other decommissioning costs is minimized.

The incentives above form the basis for Yankee pursuing removal of components at the earliest possible time, consistent with our goal of decommissioning YNPS as safely and economically as possible. Yankee intends to take advantage of low level radioactive waste reclamation facilities, on-site storage, and limited access to disposal facilities to pursue timely removal of components, structures, and systems at YNPS. All activities will be reviewed within guidelines described by the Decommissioning Plan to ensure that they meet all regulatory requirements.

REFERENCE

7-1 NUREG-0586, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," U.S. NRC, August 1988.

8.0 ENVIRONMENTAL APPROVALS

Decommissioning of YNPS will require the authorization of several Federal, State (Commonwealth) and local agencies. Some activities, including the decommissioning itself, will require specific authorization. Others may involve permits and approvals already in effect for operation of the facility. Federal, State and local requirements are identified, and the status for each is reviewed below.

8.1 FEDERAL REQUIREMENTS

Decommissioning activities that are subject to Federal regulations, permits, licenses, notification, approvals or acknowledgements include:

- Handling, packaging and shipment of radioactive waste
- Liquid effluents
- Radio communications
- Worker health and safety
- Worker radiation protection
- Handling and removal of asbestos
- Handling and removal of lead paint
- Hazardous waste generation

The majority of these activities fall under the purview of Nuclear Regulatory Commission (NRC) regulations: Title 10 of the Code of Federal Regulation (CFR). Applicable Title 10 regulations are:

- Part 50 - for decommissioning
- Part 20 - for protection against radiation
- Part 51 - for environmental protection
- Part 61 - for disposal of radioactive waste
- Part 71 - (and 49 CFR 171 through 174) for packaging and transportation of radioactive waste.

Decommissioning began with the declaration of the permanent shutdown of the facility on February 26, 1992. The Decommissioning Plan must be submitted to the NRC within two years and requires review and approval by the NRC. Activities prior to Decommissioning Plan approval are governed by existing rules and regulations, as clarified by the NRC [Reference 8-1]. When the Decommissioning Plan is approved, decommissioning will proceed under the conditions established by the Plan.

Worker health and safety protection during decommissioning falls under Occupational Safety and Health Administration (OSHA) regulations. The regulations applicable to worker health and safety during construction are 29 CFR 1910 and 1926. These regulations include requirements for respiratory protection (non-radiological), hearing protection, illumination, scaffold safety, crane and rigging safety.

Environmental Protection Agency (EPA) 40 CFR 141 Safe Drinking Water Standards for radionuclides in drinking water will be met for surface waters located downstream of the liquid effluent release location.

Asbestos and lead paint handling and removal is subject to OSHA regulations 29 CFR 1910 and 1926, and EPA regulations 40 CFR 61, Subpart M. In the Commonwealth of Massachusetts, the Department of Labor and Industries (DLI) administers regulations dealing with asbestos and lead paint handling and removal.

Federal Communications Commission (FCC) licenses are required for radio communications equipment used at YNPS. This would include any radio communications equipment used in the reactor dismantlement and radwaste processing areas.

8.2 STATE (COMMONWEALTH) AND LOCAL REQUIREMENTS

Permits and approvals from or notifications to several State and local agencies are required for safety and environmental protection purposes. Some of these are for specific decommissioning activities, and others are for existing YNPS site facilities and ongoing activities that are necessary to support decommissioning. Decommissioning activities and related site operations that fall under State and local jurisdiction include:

- Air emissions
- Liquid effluents
- Fuel oil storage
- Building permits
- Plant service water wells
- Hazardous waste generation
- Asbestos removal and disposal
- Lead Paint removal and disposal
- Solid waste shipping (radiological)
- Solid waste disposal (non-radiological)

Air emissions from the burning of diesel fuel are regulated by the Department of Environmental Protection, Air Quality Control Division.

Non-radioactive liquid effluents are administered by the Commonwealth of Massachusetts Department of Environmental Protection, Division of Water Pollution Control.

Diesel fuel used during decommissioning is expected to be drawn from existing on-site storage tanks. These are regulated by the State Fire Marshall.

At the local level, building permits may be required from the Town of Rowe, Massachusetts, and temporary field office facilities may be constructed on the plant site to support decommissioning activities. The Town of Rowe, Massachusetts uses the Uniform Building Code for evaluating permit applications.

The site make-up water wells are operated under permits from the Commonwealth of Massachusetts Department of Environmental Protection, Division of Water Supply.

Hazardous waste generation is regulated by the Commonwealth of Massachusetts Department of Environmental Protection, Division of Hazardous Waste. Notification of the generator status and annual reporting are conducted in accordance with Massachusetts regulations.

The Commonwealth of Massachusetts, Department of Labor and Industries (DLI), Division of Industrial Safety regulates the installation, removal and encapsulation of friable asbestos containing materials and lead paint. All non-radiological solid wastes will be handled and disposed of in accordance with state and local rules and regulations.

The Commonwealth of Massachusetts, Department of Public Health, Radiological Control Program, and the Vermont State Health Department, Division of Occupational and Radiological Health, are notified in advance of all placarded shipments of radioactive waste. In addition, the governors of all affected states receive advance notifications in accordance with 10 CFR 71.97, "Advance notification of shipment of nuclear waste."