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FINAL REPORT

An Evaluation of the Four Licensed and Operating Nuclear Power Plant Sites in Michigan for Co-Location of a Low-Level Radioactive Waste Isolation Facility

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EXECUTIVE SUMMARY

The "Low Level Radioactive Waste Authority Act," Act 204, Public Acts (PA) of 1987, established the Michigan Low-Level Radioactive Waste Authority. The primary function of the Authority is to safely manage low-level radioactive waste within the state of Michigan and to ensure the safety of Michigan's citizens and the protection of its environment.

Among its many other responsibilities, the Authority is charged with the duty of reporting to the governor and the state legislature on the feasibility and desirability of co-location of a low-level radioactive waste disposal site at or adjacent to one of Michigan's licensed and operating nuclear power plants. To facilitate its evaluation, the Authority chose to use the draft siting objectives and criteria found in the February 15, 1988 Draft Siting Criteria report. The 9 objectives and 31 criteria are the result of recommendations from individuals appointed by the Authority to serve on the Siting Criteria Advisory Committee (SCAC). The objectives and criteria were drafted to ensure the public health and safety and the protection of the state's environment.

To aid in the determination of the suitability of the power plant sites and the adjacent areas for the location of this type of disposal facility, the Authority also consulted the federal performance objectives and technical criteria established in the Code of Federal Regulations (CFR) Title 10 Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste." The 4 specific objectives are found in Subpart C (Sections 61.40-61.44) "Performance Objectives," while the 10 criteria are found in Subpart D (Section 61.50) "Technical Requirements for Land Disposal Facilities."

Using the Draft Siting Objectives and Criteria of February 15, 1988 and the federal performance standards and criteria, Environmental Resources Management, Inc. (ERM) evaluated the four existing nuclear power plant sites for their potential as a low-level radioactive waste disposal site.

The four power plants are located on shoreline property along the Great Lakes. The Consumers Power Company owns and operates two of the facilities, the Big Rock Point facility near Charlevoix in northern Michigan and the Palisades plant north of Benton Harbor/St. Joseph. Another facility located to the south of the Benton Harbor/St. Joseph area is the D. C. Cook facility which is owned and operated by the Indiana and Michigan Power Company. The fourth facility is the Enrico Fermi II facility. This facility is owned and operated by the Detroit Edison Company and is located south of Detroit near Monroe, Michigan.

Information on the four sites was reviewed at the Radiological Health Division of the Michigan Department of Public Health. Final Safety Analysis Reports, Safety Evaluation Reports, and Final Environmental Statements among other documents were made available to ERM to aid in the evaluation process. In addition, individuals at the Michigan Department of Natural Resources provided information particular to each site.

Some of the criteria developed by the Authority are exclusionary, meaning that any disposal site must meet or exceed the criterion for it to be considered acceptable. The remainder are favorability criteria, meaning that a site meeting or exceeding the requirements would be given a preference. When evaluating the sites for a favorability criterion, a system was used to rank the sites relative to one another on a scale of 1 = best to 4 = worst. For some of the criteria, adequate information was not available to allow any determination. These were labeled inconclusive.

A summary of these findings is shown in Tables ES-1, ES-2, and ES-3. Detailed information about each of the sites relative to the siting objectives, siting criteria, and the federal performance objectives and criteria, can be found in Section 3.0 of this report.

Given the goals of the Michigan Low-Level Radioactive Waste Authority and the information reviewed in this study, it is our professional opinion that a low-level radioactive waste facility cannot be safely located at or adjacent to any of the four nuclear power plant sites in Michigan. The primary reasons that support this opinion are the proximity of the sites to wetlands, the high permeability of the soils in each area, and the difficulty of predicting the long-term stability of surface topography for a Great Lakes shoreline location. These locations offer little or no natural protection to prevent release of radioactive waste materials to the environment. The satisfaction of long-term performance goals at any of the four sites can not be ensured in that none of the sites can be considered environmentally isolated and thereby capable of complete containment of all radioactive waste materials.

Although it may be possible to design and construct a facility at or adjacent to one of the power plant sites that would be capable of withstanding the forces associated with a shoreline environment, specifically those of wind-driven flooding and seiches, the uncertainty of the stability of a near-shore environment for the 500 year life of the facility is such that siting a waste facility is not recommended at the plant site locations themselves. Other areas adjacent to or near the plant sites may be more suitable for locating a facility of this type.

A complete discussion of the conclusions of this study can be found in Section Four of this report.

TABLE ES-1
Summary Table of Michigan Criteria

EXCLUSIONARY CRITERIA

I-A	Incorporated within city.....
I-B	Assured 3000 ft Isolation distance.....
II-A	1 mile or less from fault.....
II-B	Earthquake of VIII or more (mM).....
II-C	500 year floodplain.....
II-D	Intense geologic processes.....
III-A	Water table level.....
III-B	Soil thickness.....
III-C	Radionuclide travel time.....
III-D	Water travel time.....
III-E	Sole source aquifer.....
III-F	Ground water discharge.....
III-G	Ponding and drainage capability.....
III-H	Distance from Great Lakes (not applicable).....
VII-A	Wetlands areas.....
VII-B	Environmental areas and high risk areas.....
IX-A	Comply with federal laws.....

Big Rock Point	D.C. Cook	Palisades	Fermi II
PASS	PASS	PASS	PASS
PASS	PASS	PASS	INC.
PASS	PASS	PASS	PASS
PASS	PASS	PASS	PASS
PASS	PASS	PASS	FAIL
FAIL	FAIL	FAIL	FAIL
FAIL	PASS	PASS	FAIL
INC.	FAIL	FAIL	FAIL
INC.	FAIL	FAIL	INC.
INC.	FAIL	FAIL	INC.
PASS	PASS	PASS	PASS
PASS	PASS	PASS	PASS
FAIL	PASS	PASS	FAIL
FAIL	FAIL	FAIL	FAIL
PASS	FAIL	PASS	FAIL
.	.	.	.

Total number failed or inconclusive

7 6 5 10

FAVORABILITY CRITERIA

I-C	Population growth.....
III-I	Simple hydrogeology.....
III-J	Overlying aquifers.....
III-K	Public water supply.....
IV-A	Transportation Accidents.....
IV-B	Exposure from accidents.....
V-A	Meteorology.....
VI-A	Natural resources.....
VII-C	Wildlife conservation areas.....
VII-D	Visual intrusion.....
VII-E	Prime farmland removal.....
VIII-A	Approved development.....
VIII-B	Disruption of economy.....
VIII-C	Preference to communities that want facility.....

Big Rock Point	D.C. Cook	Palisades	Fermi II
1 (A)	2 (A)	3 (A)	4 (A)
4 (NA)	2 (A)	1 (A)	3 (A)
2 (NA)	3 (NA)	4 (NA)	1 (NA)
(A)	(A)	(A)	(A)
4 (A)	2 (A)	1 (A)	3 (A)
1 (A)	3 (A)	2 (A)	4 (A)
(A)	(A)	(A)	(A)
2 (A)	3 (A)	4 (A)	1 (A)
INC.	INC.	INC.	INC.
4 (A)	3 (A)	2 (A)	1 (A)
2 (A)	3 (A)	4 (A)	1 (A)
3 (NA)	2 (A)	1 (A)	4 (NA)
2 (A)	3 (A)	4 (A)	1 (A)
.	.	.	.

Total number of not acceptable or inconclusive

4 2 2 4

LEGEND

INC.=inconclusive Ranking 1=Best 4=Worst .NA=Not Acceptable
 * = criterion not used for evaluation A=Acceptable



TABLE ES-2
Summary Table of Federal Criteria

	Big Rock Point	D.C. Cook	Palisades	Fermi II
I Capable of being characterized, modeled, etc.....	PASS	PASS	PASS	PASS
II Population growth.....	PASS	PASS	PASS	FAIL
III Natural resources.....	PASS	PASS	PASS	PASS
IV Well drained; ponding and flood-free.....	FAIL	FAIL	FAIL	FAIL
V Minimized upstream drainage.....	PASS	PASS	PASS	PASS
VI Depth to water table.....	FAIL	PASS	PASS	FAIL
VII Ground water discharge.....	PASS	PASS	PASS	PASS
VIII Tectonic processes.....	PASS	PASS	PASS	PASS
IX Surface geologic processes.....	FAIL	FAIL	FAIL	FAIL
X Nearby facilities or activities.....	INC.	INC.	INC.	INC.
Total number failed or inconclusive	4	3	3	5

LEGEND
INC. = Inconclusive

TABLE ES-3
Summary Table of Michigan
and Federal Objectives

MICHIGAN OBJECTIVES

- I **Avoid population centers and human conflicts.....**
- II **Avoid areas subject to geologic/flood hazard.....**
- III **Protect surface and ground water quality.....**
- IV **Minimize transportation problems.....**
- V **Protect air quality.....**
- VI **Avoid resource development conflicts.....**
- VII **Avoid conflicts with land use.....**
- VIII **Avoid conflict with social and economic goals**
 of community.....
- IX **Comply with federal laws.....**

Big Rock Point	D.C. Cook	Palisades	Ferri II
3 of 3	3 of 3	3 of 3	1 of 3
3 of 4	3 of 4	3 of 4	2 of 4
4 of 11	7 of 11	7 of 11	5 of 11
2 of 2	2 of 2	2 of 2	2 of 2
1 of 1	1 of 1	1 of 1	1 of 1
1 of 1	1 of 1	1 of 1	1 of 1
3 of 5	2 of 5	3 of 5	2 of 5
1 of 2*	2 of 2*	2 of 2*	1 of 2*

Numbers denote satisfied criteria of total number of criteria for objective

FEDERAL OBJECTIVES

- I **Assure protection of population.....**
- II **Assure protection of individuals from intrusion.....**
- III **Assure protection of individuals**
 during operation.....
- IV **Assure stability of site after closure.....**

Big Rock Point	D.C. Cook	Palisades	Ferri II
✓	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓
FAIL	FAIL	FAIL	FAIL

LEGEND

- ✓ = passes due to engineering of facility
- * = criterion not used for evaluation

SECTION ONE

Introduction

1.1 Background Information

The Federal Low-Level Radioactive Waste Policy Act (Public Law 99-240) gave each state the responsibility to safely manage the low-level radioactive waste generated within its borders. On December 30, 1982, the Michigan Legislature passed, and Governor Milliken signed into law, Act 460 of 1982, allowing Michigan to enter into the Midwest Interstate Low-Level Radioactive Waste Compact Commission (Midwest Compact). The Midwest Compact includes the states of Michigan, Ohio, Indiana, Wisconsin, Missouri, Minnesota and Iowa. It was formed to help establish a low-level radioactive waste disposal facility within its boundaries for the use of all Midwest Compact members.

After extensive study and review, the Midwest Compact selected the State of Michigan to be the first state responsible for selecting, constructing and operating a facility for Midwest Compact member states. In December 1987, the Michigan Legislature enacted Act 204 of 1987 which created the Michigan Low-Level Radioactive Waste Authority (the Authority). The Authority's primary objective is to safely manage low-level radioactive waste within the state.

Among its many responsibilities, the Authority is charged with developing siting criteria for a low-level radioactive waste disposal facility. To aid the Authority in developing the criteria, a Siting Criteria Advisory Committee (SCAC) was formed to recommend to the Authority specific siting objectives and criteria that protect the health and safety of Michigan's citizens and protect the quality of Michigan's environment. Based on these recommendations, the Authority developed a draft report on siting criteria dated February 15, 1988. This report consists of 9 siting objectives and 31 siting criteria. All proposed sites are to be evaluated against these state objectives and criteria to determine the suitability of the sites in providing an adequate natural protection barrier. Federal performance standards and siting criteria must also be met. A copy of the February 15, 1988 Draft Siting Criteria report is included in this report as Appendix C. The Draft Siting Criteria report also includes the sections of Title 10 Part 61 CFR which contain the federal performance objectives and siting criteria.

The Michigan Low-Level Radioactive Waste Authority, in preparation for a report to the Governor and Legislature required by Section 21 of Act 204, Public Acts of 1987, requested assistance in evaluating the suitability of locating a low-level radioactive waste disposal facility at or adjacent to an

existing nuclear power plant site. Environmental Resources Management, Inc. (ERM) proposed to evaluate the suitability of sites on March 21, 1988 and was awarded the contract on March 25, 1988. Work was performed and completed as outlined in the Management Consultant Services Contract dated March 25, 1988.

1.2 Statement of the Problem

The Michigan Low-Level Radioactive Waste Authority was seeking consultant assistance for a report it must submit to the governor and state legislature on the feasibility and desirability of locating a low-level radioactive waste disposal facility at or adjacent to one of the four existing licensed and operating nuclear power plants. Each of the plant sites required evaluation and review to determine the satisfaction of the federal performance objectives and criteria and the Michigan draft siting criteria and objectives dated February 15, 1988. In addition, professional recommendations and opinions were solicited regarding the suitability of such a facility being located at a nuclear power plant site.

The primary objective of the draft siting criteria is to protect the health and safety of Michigan's citizens and to protect the quality of Michigan's environment. Generally speaking, a site for a low-level radioactive waste disposal facility should have natural features such that waste breaching any of the engineered barriers would be naturally isolated and contained at the site.

1.3 Scope of Work

In order to evaluate each site for its conformance with the federal siting criteria listed in Subpart D, "Technical Requirements for Land Disposal Facilities" (Section 61.50), and the 31 criteria proposed by the Michigan Low-Level Radioactive Waste Authority in its publication of February 15, 1988 entitled Draft Siting Criteria, ERM was asked to review the information that was available at the Radiological Health Division of the Michigan Department of Public Health (MDPH) in Lansing. MDPH has Final Safety Analysis Reports (FSARs), Safety Evaluation Reports, and Final Environmental Statements on file for each of the power plants developed and published as part of the Nuclear Regulatory Commission's (NRC) requirements for licensing. Because Big Rock Point was licensed prior to many of the NRC requirements, Big Rock Point did not have a Final Safety Analysis Report (FSAR) or a Final Environmental Statement published and on file at the Michigan Department of Public Health.

In addition to the information at the Michigan Department of Public Health, ERM took advantage of several other information resources. Other documents that were consulted to obtain additional general geologic,

hydrologic, physical, geographic, and institutional (demographic, cultural, etc.) information for the areas included the Michigan Hydrogeologic Atlas, the Regional Management Plan of the Midwest Compact, USGS Topographic maps and other published and unpublished information and documents. A complete bibliography of information used to prepare this report can be found in Section Five of this report.

Finally, for information that was not available in the Final Safety Analysis Reports (FSARs), ERM contacted the Michigan Department of Natural Resources (MDNR). Information pertaining to Act 203 of 1979 and Act 245 of 1970 concerning wetlands status and environmental and high risk areas specific to each of the sites was evaluated from the MDNR information and can be found in Appendix B of this report.

Since the Big Rock Point plant was licensed for operation in 1963, prior to the development of federal standards requiring extensive environmental impact documentation, no detailed information was available at the Public Health Department for that facility. For this reason, Consumers Power Company, owner and operator of the facility, was contacted and agreed to make available a copy of pertinent portions of a draft Updated Final Safety Analysis Report for ERM's use and review. Because of the draft nature of the document provided, strict reliance upon the information obtained from the Big Rock Point plant is not recommended.

All of the information mentioned above was reviewed for each site and evaluated against the 31 state and 10 federal siting criteria. The siting criteria were divided into two groups, exclusionary and favorability.

Exclusionary criteria are those criteria that must be met or exceeded as outlined in either federal or state law. Those sites that met or exceeded the exclusionary criteria were labeled as **PASS**. Any site in which the information indicated that the site did not meet or exceed the criteria was labeled **FAIL**. In either case, reasons for the labeling were noted on worksheets and are summarized in Section Three of this report.

Favorability criteria were ranked relative to each other, with 1 being the relative best and 4 being the relative worst case. When applicable, the rankings were labeled as being **ACCEPTABLE** when the site met or exceeded the overall goal of the criteria or **NOT ACCEPTABLE** if the site did not meet the overall goal of the criteria.

Sufficient information was not always available to adequately determine whether a particular site passed or failed a certain criterion. In such instances, an **INCONCLUSIVE** was noted. Copies of the worksheets used for this study are included in this report as Appendix A.

PASS or **FAIL** indicates the evaluation of the site as reported in the published Final Safety Analysis Reports and the other data sources mentioned above. It is possible that a change in the reported information or status about a site could result in a change in this evaluation.

It was not the intent of the Authority, nor ERM, to provide a comprehensive environmental evaluation of each of the sites. The evaluations of the plant sites were based only on information listed in Section Five and Appendix B of this report.

SECTION TWO

General Information

2.1 General Plant Information

The primary task of this project was to evaluate the four licensed and operating nuclear power plants on the question of whether a low-level radioactive waste isolation facility could be co-located at or adjacent to the plants according to the federal siting criteria listed in Subpart D of 10 CFR 61 (subsection 61.50) and the 31 Draft Siting Criteria dated February 15, 1988. The four licensed and operating plants that were reviewed and evaluated are:

- Big Rock Point Nuclear Power Plant, Hayes Township, Charlevoix County, operated by Consumers Power Company.
- Donald C. Cook Nuclear Power Plant, Lake Township, Berrien County, operated by Indiana and Michigan Electric Company.
- Palisades Nuclear Power Plant, Covert Township, Van Buren County, operated by Consumers Power Company.
- Enrico Fermi Atomic Power Plant, Unit II, Frenchtown Township, Monroe County, operated by Detroit Edison.

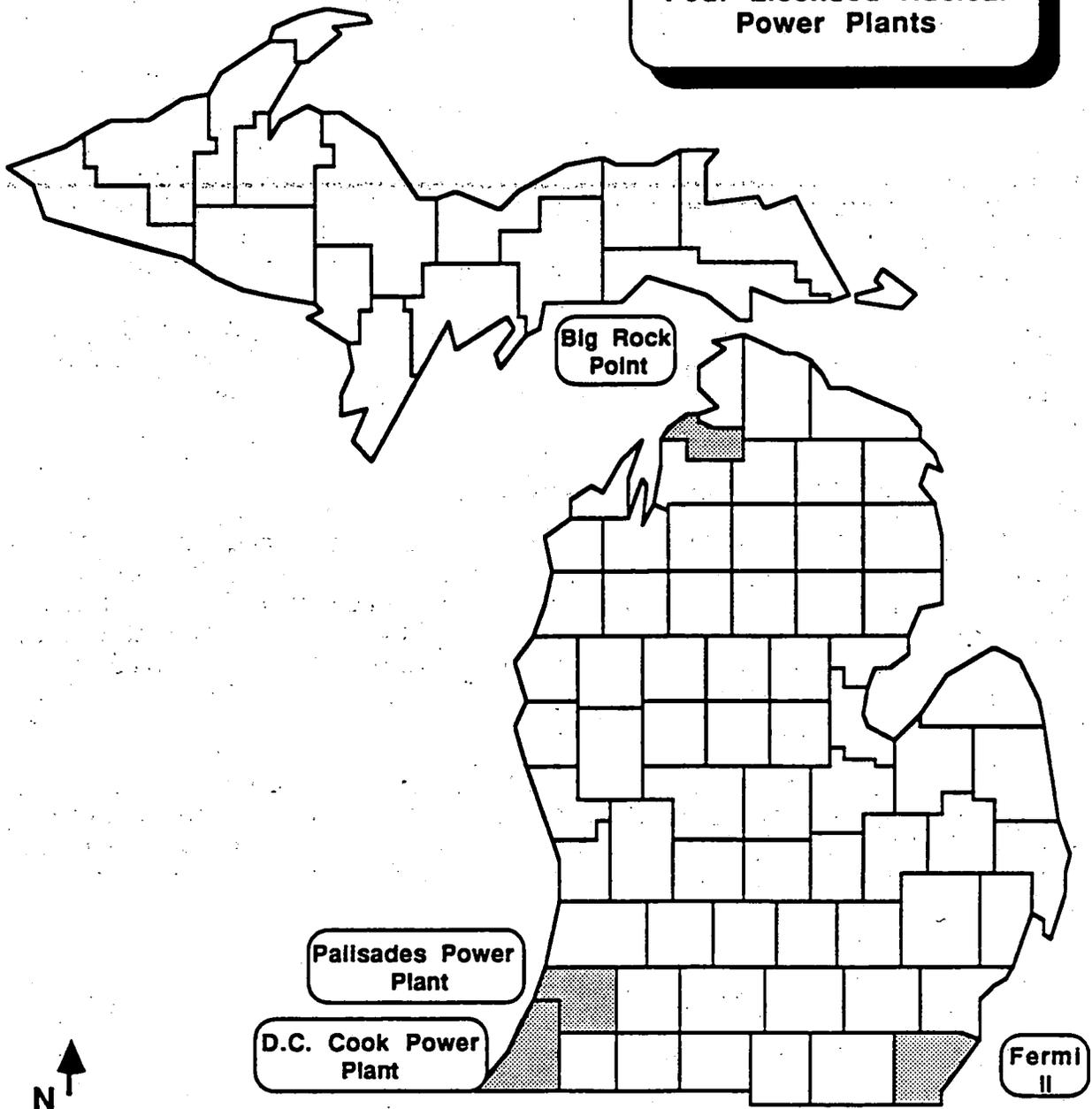
At the time of this report, all four sites were operating and licensed for producing commercial power. Figure 2-1 shows the general location of the four licensed power plants.

Big Rock Point Nuclear Power Plant

The Big Rock Point Nuclear Power Plant site is located between the towns of Charlevoix and Petoskey on the northern shore of Michigan's lower peninsula. Big Rock received a provisional operating license on August 30, 1962 and began commercial operations on March 29, 1963. A full-term operating license was granted to Consumers Power Company on May 1, 1964 and in May, 1964, the plant increased its power from 157 to 240 MWt (Megawatts thermal). The plant currently runs at 69 MWe (Megawatts electric).

FIGURE 2-1

**General Location Map
of the
Four Licensed Nuclear
Power Plants**



The plant's operating license is valid through midnight on May 31, 2000. Currently, no plans for decommissioning of the facility have been developed. Plant officials report that application for an extension of the license is likely.

A full scale Final Safety Analysis Report (FSAR) was not required at the time of licensing. The FSAR's typically contain information about the general area and about the site. The FSAR's were used as a primary source of information for review and evaluation of the sites.

Since an FSAR was not available for this plant, the plant's owner, Consumers Power Company, was contacted and information about the plant site and the general setting was obtained via phone conversation. Big Rock Point is currently preparing a safety analysis report for the plant and surrounding area for the Nuclear Regulatory Commission. A copy of the relevant portions of this report was made available to ERM by Big Rock Point personnel.

Other sources of information about the site pertaining to wetlands, high risk areas, floodplains and environmental areas were obtained from the Michigan Department of Natural Resources, Land and Water Management Division.

Donald C. Cook Nuclear Power Plant

The Donald C. Cook Nuclear Power Plant is located approximately 11 miles south of Benton Harbor, Michigan, along the eastern shoreline of Lake Michigan. The plant is operated by the Indiana and Michigan Electric Company and consists of two units. The two units received operating licenses in the early seventies and began operation in August 1975 and July 1978 respectively. Unit One is capable of producing 1020 MWe of power while Unit Two produces 1060 MWe.

The FSARs for the two units were available at the Michigan Department of Public Health. Other sources of information about the site pertaining to wetlands, high risk areas, floodplains and environmental areas were obtained from the Michigan Department of Natural Resources, Land and Water Management Division.

Palisades Nuclear Power Plant

The Palisades Nuclear Power Plant is located approximately 4 1/2 miles south of South Haven, Michigan, along the eastern shoreline of Lake Michigan. Palisades is operated by Consumers Power Company and received a provisional operating license in March, 1971 and began commercial operation on December 31, 1971. In 1974, the plant's cooling system was modified to include a closed-loop cooling system that incorporated a cooling tower, rather than the original once-through cooling system. The plant is

capable of producing 770 MWe of power with one reactor unit. The 1973 FSAR was on file at the Department of Public Health in Lansing, Michigan and was used to evaluate the site. Other sources of information about the site pertaining to wetlands, high risk areas, floodplains and environmental areas were obtained from the Michigan Department of Natural Resources, Land and Water Management Division.

Enrico Fermi Atomic Power Plant

The Enrico Fermi Atomic Power Plant, Unit II is located approximately 5.5 miles northeast of Monroe, Michigan, along the northwestern shore of Lake Erie. Fermi II is operated by the Detroit Edison Company. The plant applied for an operating license in the mid-seventies and was scheduled to begin commercial operations in January of this year. Commercial operations have begun but the plant is currently off-line for refueling and will begin gradual reoperations in the near future. The plant has yet to come on-line to its full power capacity of 1100 MWe. Unit I was decommissioned in 1972.

The 1987 FSAR was on file at the Department of Public Health and was used as a primary source of information about the site and the area. Other sources of information about the site pertaining to wetlands, high risk areas, floodplains and environmental areas were obtained from the Michigan Department of Natural Resources, Land and Water Management Division.

SECTION THREE

Site Evaluation

3.1 Criteria

Act 204, Public Acts of 1987, requires the Low-Level Radioactive Waste Authority to develop siting criteria for the location of a low-level radioactive waste site. The criteria used for this study included those developed by the Authority and outlined in the February 15, 1988 report entitled "Draft Siting Criteria." These draft criteria were formulated based on recommendations from the Siting Criteria Advisory Committee (SCAC). The SCAC consists of five members appointed by the Authority.

In addition, the ten federal criteria under Subpart D of 10CFR61, entitled "Technical Requirements for Land Disposal Facilities" (Section 61.50), were used to evaluate the suitability of each site.

The Siting Criteria are formulated based on the primary goal of ensuring the health and safety of Michigan's citizens and protecting the environment. A secondary goal was established to ensure that the areas selected as a result of the application of the criteria can be licensed in compliance with federal and state regulations. A third goal was to avoid conflict with established societal and community values.

The criteria are formulated assuming no engineered containment. Based on the siting criteria, the potential site selected is to serve as a natural means of isolation for the waste.

The Low-Level Radioactive Waste Authority organized the 31 state criteria into the following nine objectives.

- I. Avoid population centers and conflicts with human activities.
- II. Avoid areas subject to geologic and flood hazards.
- III. Protect surface water and ground water quality.
- IV. Minimize transportation hazards.
- V. Protect air quality.
- VI. Avoid resource development conflicts.
- VII. Avoid conflict with special or protected land use.
- VIII. Avoid conflict with community social and economic goals.
- IX. Comply with federal laws.

Within each of the objectives, several specific criteria are given. These criteria are divided into two basic types: those that reflect a legislative

mandate and those that reflect desirable qualities in the selected waste site. In addition, the four federal performance objectives were used. They are as follows:

- I. Assure protection of the general population from releases of radioactivity.
- II. Assure protection of individuals from inadvertent intrusion.
- III. Assure protection of individuals during operations.
- IV. Assure stability of the site after closure.

Appendix C of this report contains the Low Level Radioactive Waste Authority's Draft Siting Criteria of February 15, 1988, and the Federal Siting Criteria found in Subpart D of 10 CFR 61.

The remainder of this section will discuss the individual state and federal criteria and evaluate each of the plant sites.

Criterion I-A *Exclude areas within incorporated city limits as established on January 1, 1988*

Big Rock Point Pass

The Big Rock Point Nuclear Power Plant is not incorporated into a city. It is located within Hayes Township, Charlevoix County.

D.C. Cook Pass

The D.C. Cook Nuclear Power Plant is not incorporated into a city. It is located within Lake Township, Berrien County.

Palisades Pass

The Palisades Nuclear Power Plant is not incorporated into a city. It is located within Covert Township, Van Buren County.

Fermi II Pass

The Fermi II Nuclear Power Plant is not incorporated into a city. It is located within Frenchtown Township, Monroe County.

Criterion I-B *Exclude areas not sufficiently large to assure that an isolation distance of 3,000 feet or more from the disposal unit and adjacent property lines is available.*

In all cases, sufficient land at the plant site was not available to assure the 3,000 foot isolation distance requirement could be met. The purchase of additional property would be necessary. The site would consist of state owned land in any case.

Big Rock Point Pass

According to plant personnel, there is approximately 2,700 feet of property surrounding the unit. The unit currently owns a total of approximately 800 acres. Additional property could potentially be purchased from surrounding land owners in an effort to meet this criteria.

D.C. Cook Pass

According to the FSAR (Final Safety Analysis Report), the property comprises 650 acres. The property boundaries do not allow a 3,000 foot isolation distance to be maintained. As with Big Rock, the potential for purchasing additional property from surrounding landowners exists.

Palisades Pass

According to the FSAR, the property comprises 487 acres. Site boundaries for this plant do not allow for the mandatory 3,000 foot boundary around a disposal site. Van Buren State Park is located along the northern property boundary and I-96 borders the eastern edge of the property making expansion of the existing property difficult.

Fermi II Inconclusive

The information contained in the FSAR was incomplete. Site maps of the property did not include a scale for measuring the property. It is known that this is one of the largest sites, comprising 1,120 acres.

Criterion I-C *Seek areas where projected population growth and future developments are not likely to affect the ability of the disposal facility to meet the performance objectives of 10CFR61 Subpart C (10 CFR 61.50 (a) (3)) and are not likely to significantly interfere with an environmental monitoring program.*

This criterion is a favorability criterion. The sites are ranked relative to one another and it is noted whether each site is still considered to be acceptable. It is beyond the scope of this study to attempt to provide precise population trends, given the element of time that the site is expected to be in operation and secured. Demographic information was obtained for each site and used to rank the areas relative to one another with 1=best and 4=worst.

Based on information on regional population density found in FSARs, all of the sites appeared to have similar population growth trends. Given that growth near these sites would be about the same, ranking of the sites was based primarily upon proximity to existing population centers.

Big Rock Point 1 (Acceptable)

The northern shore of Michigan's Lower Peninsula has relatively fewer residents within a 25 mile radius than the other three sites.

D.C. Cook 2 (Acceptable)

Both D.C. Cook and Palisades are located within relatively moderate population areas.

Palisades 3 (Acceptable)

Both Palisades and D.C. Cook are located within relatively moderate population areas.

Fermi II 4 (Not Acceptable)

The Fermi II site is located proximate to the most densely populated area of all of the sites, with downtown Detroit and Toledo both within 30 miles.

Criterion II-A Exclude areas located one mile or less from a fault where tectonic movement has occurred within the last 10,000 years.

Big Rock Point Pass

Information in the Draft copy of the Updated FSAR indicates that no major faults are known to exist in the area.

D.C. Cook Pass

According to the FSAR for this plant, there are no known faults within one mile of the plant site.

Palisades Pass

According to the FSAR for this plant, there are no known faults within one mile of the plant site.

Fermi II Pass

According to the FSAR for this plant, there are no known faults within one mile of the plant site.

Criterion II-B *Exclude areas of significant earthquake intensity, defined as a zone with a modified Mercalli index of VIII or greater.*

Information was not found within the FSARs which delineated zones of earthquake intensity for the various sites based on the modified Mercalli index. Sites were passed given the fact that earthquake epicenters were not located within a reasonable proximity of the sites.

Big Rock Point Pass

The draft updated FSAR reports that the closest epicenter of an earthquake with a significant modified Mercalli index was approximately 62 miles from the plant site and had an intensity of V (mM).

D.C. Cook Pass

The FSAR for the D.C. Cook Plant indicates that the two closest epicenters of the highest modified Mercalli index were within 75 miles of the plant site, each with an intensity of VI (mM) (1883 and 1947).

Palisades Pass

The FSAR for the Palisades Plant indicates that the closest epicenter of an earthquake of a significant modified Mercalli index occurred in 1883 within 50 miles of the site. The intensity of this earthquake was VI (mM).

Fermi II Pass

The nearest epicenter reported in the FSAR occurred within 100 miles of the plant with a modified Mercalli Index intensity of VIII (1937).

Criterion II-C *Exclude areas within the 500 year floodplain, including areas designated under 245 PA 1929 (Sections 323.1 to 323.13 of the Michigan Compiled Laws).*

This criterion was developed to protect the site from flood damage during the expected life of the site. In general, the low-level radioactive waste site is to be located 10 miles or more from the Great Lakes and their interconnecting waterways. An exception to this criterion was granted to the four licensed and operating power plant sites.

Because the power plants are located along the Great Lakes, a 500 year flood plain, *per se*, is not applicable at these sites. This is due to the fact that they are not located within any of the proximate river flood plains. Instead, a 500 year maximum lake level was used in the evaluation of these sites. Information about the 500 year maximum lake level was obtained from the MDNR-Floodplain Control Unit in Lansing, Michigan. Copies of MDNR correspondence can be found in Appendix B. Wave action and wave flooding would also play an important part in the siting of a waste site at these locations.

Big Rock Point Pass

The Big Rock Point Draft FSAR reports that the elevation of the site ranges from 594 to 592.5 feet above Mean Sea Level (MSL). The MDNR-Floodplain Control Unit reports that the 500 year maximum Lake Michigan water level at this site is expected to be approximately 584.2 ft. MSL (583.0 International Great Lakes Data point (IGLD)). The highest recorded lake level was reported to be 584 ft. MSL.

D.C. Cook Pass

According to the MDNR-Floodplain Control Unit, the 500 year maximum Lake Michigan water level for this site is 584.8 MSL (583.3 IGLD). The surface elevation at this site is estimated to be 610 ft. MSL at the plant site. Topography of the site is quite variable.

Palisades Pass

According to the MDNR-Floodplain Control Unit, the 500 year maximum Lake Michigan water level for this site is 584.8 MSL (583.3 IGLD). The surface elevation at this site is approximately 600 ft. MSL.

Fermi II Fail

According to the MDNR-Floodplain Control Unit, the 500 year maximum Lake Erie water level for this site is 578.6 MSL (577.1 IGLD). The surface elevation at this site is approximately 575 ft. MSL.

Criterion II-D Exclude areas where geological processes such as mass wasting, erosion, slumping, landsliding, or weathering precludes meeting the performance objectives in 10 CFR 61 Subpart C or precludes defensible modeling and prediction of the long term impact of such occurrences.

The life of the low-level radioactive waste site is expected to be over 500 years. Because of this length of time and because the level of the Great Lakes is in a state of fluctuation, all shoreline sites, such as the four nuclear power plant sites, fail to satisfy this criterion. Associated with the everchanging lake levels are the ongoing processes of erosion, landsliding, weathering and mass wasting. The dynamic nature of the Great Lakes ecosystem is such that predictions of future lake levels and activities are not practicable.

Big Rock Point Fail

This site failed because of the possibility of wave erosion at this site given the 500 year life of the site.

D.C. Cook Fail

This site failed because of the possibility of wave erosion at this site given the 500 year life of the site.

Palisades Fail

This site failed because of the possibility of wave erosion at this site given the 500 year life of the site.

Fermi II Fail

This site failed because of the possibility of wave erosion at this site given the 500 year life of the site.

Criterion III-A *Exclude areas where the water table associated with geologic deposits or formations is not sufficiently low to prevent the intrusion of ground water into the bottommost portions of the leak detection system of the disposal unit.*

Assuming an above ground facility, relatively high ground water levels at a low-level radioactive waste site can be tolerated. The sites were evaluated based upon this assumption. Twenty feet was used as the pass/fail criterion (see also III-B). Given the fact that the waste repository will be constructed near the surface, perhaps completely buried within the ground, it is likely that these evaluations would differ remarkably. In the case of a near surface facility, 40 feet might not be a sufficient depth for ground water.

Big Rock Point *Fail*

The ground water level at the site is approximately 10 feet below the surface of the site.

D.C. Cook *Pass*

According to the FSAR, ground water levels appear to be between 40-80 feet below the surface of the site in the underlying unconsolidated sand deposit.

Palisades *Pass*

Ground water levels at the Palisades Plant are approximately 20 feet below the surface of the site. Unconsolidated sand underlies the site and is the principal water bearing aquifer along the lake shore.

Fermi II *Fail*

Ground water levels appear to be very high in the area due to the presence of swamps on site. A piezometric water level of between 570-580 MSL was noted in the FSAR (surface elevation is approximately 575).

Criterion III-B Exclude areas where there is not 6 or more meters of soil with a maximum hydraulic conductivity of 1.0 times 10^{-6} to the minus 6 centimeters per second at all points below and lateral to the bottommost portions of the leak detection system of the disposal unit.

Detailed site information about the subsurface soils at these sites was for the most part unavailable in the information obtained at the Michigan Department of Public Health. Generally speaking, sites adjacent to the Great Lakes have near surface soils that grade from clay to coarse sand, indicative of near-shore geologic environments.

Detailed site specific information may enhance or change these conclusions.

Big Rock Point Inconclusive

No site specific information, such as permeability tests, was available in the Draft FSAR. It is stated that the area is well-drained and that the underlying soil is of questionable uniformity. Clay is the predominate subsurface soil at the site, interbedded with lenses of artesian sand zones.

D.C. Cook Fail

The D.C. Cook site is located on sand dunes that predominate the southeastern shoreline of Lake Michigan. It is unlikely that 20 feet of 10^{-6} cm/sec soil can be found at this site.

Palisades Fail

The Palisades site is located on sand dunes that predominate the southeastern shoreline of Lake Michigan. It is unlikely that 20 feet of 10^{-6} cm/sec soil can be found at this site.

Fermi II Fail

The Updated FSAR states that the subsurface soils vary from clay to coarse sand. It is unlikely that 20 feet of 10^{-6} cm/sec soil can be found at this site.

Criterion III-C *Exclude areas where the travel time of radionuclides along any 100 foot flow path from the water table at the edge of the disposal unit is less than approximately 100 years.*

Site specific information about the subsurface hydrogeology is typically not incorporated into the FSAR's that were reviewed during the evaluation of the sites. D.C. Cook and Palisades both fail this criterion because the sites are located on sand dunes. Because of the relatively high permeability of the sand dunes, little or no natural protection is available to the ground water.

Detailed site specific information may enhance or change these conclusions.

Big Rock Point *Inconclusive*

No site specific permeability information was found for this site.

D.C. Cook *Fail*

The site is located on a sand dune area which allows rapid movement of ground water.

Palisades *Fail*

The site is located on a sand dune area which allows rapid movement of ground water.

Fermi II *Inconclusive*

No site specific permeability information was found for this site.

Criterion III-D *Exclude areas where the ground water travel time from the water table at the edge of the disposal unit to an aquifer is less than 500 years.*

Site specific information about the subsurface hydrogeology is typically not incorporated into the FSAR's that were reviewed during the evaluation of the sites. D.C. Cook and Palisades both fail this criterion because the sites are located on sand dunes, offering little or no protection to the ground water and rapid movement of ground water to the natural discharge point, Lake Michigan.

Detailed site specific information may enhance or change these conclusions.

Big Rock Point *Inconclusive*

No site specific permeability information was found for this site.

D.C. Cook *Fail*

The site is located on a sand dune area which allows rapid movement of ground water.

Palisades *Fail*

The site is located on a sand dune area which allows rapid movement of ground water.

Fermi II *Inconclusive*

No site specific permeability information was found for this site.

Criterion III-E *Exclude areas located over a sole source aquifer.*

As of the time of this study, no sole source aquifers have been designated in Michigan by the US Environmental Protection Agency. The EPA defines a sole source aquifer as an aquifer that is the sole or principle drinking water source for an area, which, if contaminated, could create a significant hazard to the public health.

Big Rock Point Pass

D.C. Cook Pass

Pallsades Pass

Fermi II Pass

Criterion III-F *Exclude areas located where the hydrogeology beneath the site discharges ground water to the land surface within 3,000 feet (915 m) of the boundaries of the disposal unit.*

Ground water at three of the four sites discharges directly into Lake Michigan. Ground water at Fermi II discharges into Lake Erie. Any of the standing water on each of the sites is more likely due to the existence of perched ground water, than to direct water table ground water discharge. Perched ground water occurs when an impermeable layer of material is located within a permeable layer. The impermeable layer serves as a trap for any incident precipitation. This results in ponding, if near or at the surface, or submerged "perched ground water," if well below the surface.

With the 3,000 foot buffer isolation distance from the Lake to the disposal unit, the ground water discharge criterion will be met by all of the sites.

Big Rock Point Pass

D.C. Cook Pass

Palisades Pass

Fermi II Pass

Criterion III-G *Exclude areas not free of ponding or incapable of being drained in a manner that insures the integrity of the disposal unit.*

Big Rock Point Fail

Cedar Swamp surrounds the site. Wetlands are noted within a 3,000 foot radius of the power plant. These wetlands are more likely due to the presence of perched ground water than to direct water table ground water discharge. The area appears incapable of being drained.

D.C. Cook Pass

Some swampy areas are noted within the lowlands of the general area. There are wetlands noted within the 3,000 foot isolation boundary. These wetlands are more likely due to the presence of perched ground water than to direct water table ground water discharge. The area appears to be capable of being drained.

Palisades Pass

Some swampy areas are noted in the area. There are wetlands noted within the 3,000 foot isolation boundary. These wetlands are more likely due to the presence of perched ground water than to direct water table ground water discharge. The area appears to be capable of being drained.

Fermi II Fail

The area is generally surrounded by swampy lowlands. These wetlands are more likely due to the presence of perched ground water than to direct water table ground water discharge. The area appears incapable of being drained.

Criterion III-H Exclude areas located within 10 miles of Lake Michigan, Lake Superior, Lake Huron, Lake Erie, Saint Mary's River, Detroit River, St. Clair River or Lake St. Clair. This criterion shall not apply to a site that is located at or adjacent to a nuclear power generating facility.

Big Rock Point Meets exception

D.C. Cook Meets exception

Palisades Meets exception

Fermi II Meets exception

Criterion III-I *Seek areas with simple hydrogeologic systems that can be characterized, modeled, analyzed and monitored.*

This criterion is difficult to measure because of the lack of detailed site-specific information about the sites. Given the geologic setting of the sites and the general information provided within the FSAR's, most of the sites could be mathematically modeled with a high degree of confidence.

Big Rock Point 4 *(Not Acceptable)*

The presence of artesian sand lenses (thin sand layers that contain ground water under pressure) would make modeling of this site difficult unless the location and extent of each of the sand lenses were known.

D.C. Cook 2 *(Acceptable)*

The FSAR states that the hydrogeologic system is simple.

Palisades 1 *(Acceptable)*

The FSAR states that the hydrogeologic system is simple.

Fermi II 3 *(Acceptable)*

The FSAR states that the hydrogeologic system is simple.

Criterion III-J *Seek areas that do not overlie aquifers.*

All of the sites that were evaluated overlie an aquifer.

Big Rock Point 2 *(Not Acceptable)*

This site overlies a limestone aquifer.

D.C. Cook 3 *(Not Acceptable)*

This site overlies a sand aquifer.

Palisades 4 *(Not Acceptable)*

This site overlies a sand aquifer.

Fermi II 1 *(Not Acceptable)*

This site overlies a limestone aquifer.

Criterion III-K *Seek areas which do not include public water supply wells, well fields, high capacity production wells, and abandoned wells.*

According to the FSARs, no public water supply wells, high capacity production wells or abandoned wells were located on any of the four sites. The sites were not ranked relative to one another based on the assumption that this information is complete and correct.

Big Rock Point *(Acceptable)*

D.C. Cook *(Acceptable)*

Palisades *(Acceptable)*

Fermi II *(Acceptable)*

Criterion IV-A *Seek areas which minimize the risk of transportation accidents.*

This criterion was developed to address the consequences of transportation accidents. Accident probability varies with the type of route traveled, time of year, traffic densities, and type of road. Interstate freeways are the safest of the different highway types. Based primarily on the type of highway used to access the site and the relative traffic densities, the four sites were ranked relative to one another with 1 = best and 4 = worst.

Big Rock Point 4 *(Acceptable)*

The highway closest to the Big Rock Point site is US 31. It is a two-lane limited access United States Highway. Of the four sites, this site is considered worst primarily because of the increased risk of accident due to the highway type.

D.C. Cook 2 *(Acceptable)*

Interstate Highway 94 runs directly through the D. C. Cook site. This multi-lane freeway is considered to be the safest type of highway. The final ranking was based on the implied traffic densities for the area, because of the nearness to the industrial area of Benton Harbor/St Joseph.

Palisades 1 *(Acceptable)*

Interstate Highway 196 and US Highway 31 run together at this point on the eastern boundary of the Palisades site. These highways are multi-lane freeways at this location, and thus offer the safest type of highway travel. Based on the assumption that the traffic densities are somewhat less in this region than those further south along the lakeshore, this site was ranked as the best for minimizing conventional traffic accidents.

Fermi II 3 *(Acceptable)*

Interstate Highway 75, a multi-lane freeway runs adjacent to the Fermi II site. Although this highway is considered to be of the safest type, due to the traffic densities on the highway and its nearness to two major metropolitan areas, Detroit and Toledo, the site was ranked on the lower end. Assumed traffic densities were believed to be much higher for this area than for the two sites on the southwestern shore of Michigan.

Criterion IV-B *Seek areas which minimize the risks of exposures to radiation associated with transportation incidents.*

Transportation routes which avoid areas of high population serve to minimize risks of exposure to radioactive materials during routine transport or in transportation accidents, however negligible those exposures might be. Based primarily on regional populations and secondarily on available transportation routes, the four sites were ranked relative to one another for population exposure minimization, with 1 = best and 4 = worst.

Big Rock Point 1 *(Acceptable)*

The population density in this region is well below the values for the three remaining sites.

D.C. Cook 3 *(Acceptable)*

Population density in this region was considered to be somewhat greater than for the area surrounding the Palisades plant due to the proximity of Benton Harbor/St. Joseph and the Chicago area as well.

Palisades 2 *(Acceptable)*

This area was considered to have the second lowest population density of the four power plant site areas. In addition, Interstate 196 is a less highly traveled highway than Interstate 94.

Fermi II 4 *(Acceptable)*

The population density figures for this area were assumed to be much higher due to the nearness of Detroit and Toledo, Ohio.

Criterion V-A *Seek areas with simple meteorological systems that can be characterized, modeled, analyzed, and monitored.*

Meteorological systems are monitored at each of the nuclear power plant sites as required by the Nuclear Regulatory Commission. Modeling of weather systems requires long histories of detailed information about the specific site. With these monitoring systems already in place, modeling weather patterns would be relatively easy. The sites were not ranked relative to one another based on the assumptions that the meteorological conditions would be similar at each location and that modeling would be equally facilitated by the reasons stated above.

Big Rock Point *(Acceptable)*

D.C. Cook *(Acceptable)*

Palisades *(Acceptable)*

Fermi II *(Acceptable)*

Criterion VI-A *Seek areas where natural resources do not exist on or significantly near to the candidate site that, if exploited, would result in failure to meet the performance objectives in Subpart C of 10 CFR 61.*

In developing the siting criteria, the Low-Level Radioactive Waste Authority defined natural resources as those minable resources, which if mined, might lead to a breach of containment at the facility. Future exploitations were not taken into account when making the following determinations...

Big Rock Point 2 (Acceptable)

There is limestone mining in the area surrounding the site. However, it does not occur near the site. Mining could easily continue outside the boundaries of the site with no impairment of productivity.

D.C. Cook 3 (Acceptable)

This area is known to provide silica sand to industry. The siting of a disposal facility on the site would likely not result in any adverse impacts on silica sand availability.

Palisades 4 (Acceptable)

This area is known to provide silica sand to industry. The siting of a disposal facility on the site would likely not result in any adverse impacts on silica sand availability.

Fermi II 1 (Acceptable)

According to information obtained from the Updated FSAR, there is a very low potential for hydrocarbon or subsurface gas production in the area.

Criterion VII-A Exclude areas with wetlands as defined in the Goemaere-Anderson Wetland Protection Act, Act 203 of the Public Acts of 1979, being sections 281.701 to 281.722 of the Michigan Compiled Laws.

Big Rock Point Fail

According to information provided by the Michigan Department of Natural Resources, there are small wetland areas within the site boundaries and larger, more significant areas directly surrounding the site. These wetlands are more likely due to the presence of perched ground water, than to the direct discharge of water table ground water.

D.C. Cook Fail

According to information provided by the Michigan Department of Natural Resources, wetland areas are found on the site, within the 3,000 foot isolation boundary. These wetlands are more likely due to the presence of perched ground water, than to the direct discharge of water table ground water.

Palisades Fail

According to information provided by the Michigan Department of Natural Resources, wetland areas are found on the site, within the 3,000 foot isolation boundary. These wetlands are more likely due to the presence of perched ground water, than to the direct discharge of water table ground water.

Fermi II Fail

The entire Fermi II site is located within an active swamp with the north and south areas of the site dominated by large permanent lagoons. According to the Michigan Department of Natural Resources, wetlands areas are found on the site, within the 3,000 foot isolation boundary. These wetlands are more likely due to the presence of perched ground water, than to the direct discharge of water table ground water.

Criterion VII-B *Exclude areas with environmental areas or high risk areas as defined in the Shorelands Protection and Management Act of 1970, Act No. 245 of the Public Acts of 1970, being sections 281.631 to 281.644 of the Michigan Compiled Laws.*

Big Rock Point Pass

According to the Michigan Department of Natural Resources, no environmental areas or high risk areas are located on or nearby the site.

D.C. Cook Fail

The information provided by the Michigan Department of Natural Resources indicates that a high risk erosion area is located on the power plant site. The shoreline is receding at a rate such that a 70/95 foot setback is recommended by the MDNR (note: this is based on an expected life span of only 30 years so designated for the power plant). No environmental areas were noted in the local region.

Palisades Pass

According to the Michigan Department of Natural Resources, no environmental areas or high risk areas are located on the site. However, high risk erosion areas are noted proximate to the site.

Fermi II Fail

According to the Michigan Department of Natural Resources, the site does have environmental areas within one mile. However, no high risk areas are located at or nearby the site.

Criterion VII-C *Seek areas which have not been designated pursuant to Michigan Statute for Wildlife Conservation and Management, for public recreation, or for protection of wilderness, wild, or natural values.*

Because a power plant has already been located on each of the sites, it could be assumed that the areas are not wildlife conservation areas. However, the location of a nuclear power plant on any site does not necessarily preclude the use of the area for wildlife conservation. No readily available information dealt with this subject, thus enabling only an inconclusive note to be attached to this criterion for each site.

A further investigation of the surrounding areas may result in the discovery of proximate wildlife conservation areas.

Big Rock Point *Inconclusive*

D.C. Cook *Inconclusive*

Palisades *Inconclusive*

Fermi II *Inconclusive*

Criterion VII-D *Seek sites which do not cause visual intrusion on designated scenic highways so designated as of January 1, 1988.*

Big Rock Point 4 (Acceptable)

There is a state scenic highway that travels along the Lake Michigan coast directly adjacent to the power plant site. Since a power plant has already been located upon the site, it is assumed that no additional visual intrusion would be caused by siting a waste disposal facility on the same site.

D.C. Cook 3 (Acceptable)

Several scenic routes are located in this area of the state. Since a power plant has already been located upon the site, it is assumed that no additional visual intrusion would be caused by siting a waste disposal facility on the same site.

Palisades 2 (Acceptable)

Several scenic routes are located in this area of the state. Since a power plant has already been located upon the site, it is assumed that no additional visual intrusion would be caused by siting a waste disposal facility on the same site.

Fermi II 1 (Acceptable)

Since a power plant has already been located upon the site, it is assumed that no additional visual intrusion would be caused by siting a waste disposal facility on the same site.

Criterion VII-E *Seek sites which will not require that prime farmland be removed from agricultural production.*

Big Rock Point 2 (Acceptable)

The surrounding area is not well known for its prime farmland. It is primarily considered a resort area. The siting of a nuclear power plant on the land has already designated the area for a non-farming use.

D.C. Cook 3 (Acceptable)

The surrounding area is considered relatively good farmland. However, the siting of a nuclear power plant on the land has already designated the area for a non-farming use.

Palisades 4 (Acceptable)

The surrounding area is considered relatively good farmland. However, the siting of a nuclear power plant on the land has already designated the area for a non-farming use.

Fermi II 1 (Acceptable)

The surrounding area is highly urbanized. The siting of a nuclear power plant on the land has already designated the area for a non-farming use.

Criterion VIII-A *Seek areas which are not included in formally proposed approved development plans as of January 1, 1988.*

The information available at the Michigan Department of Public Health included no information regarding existing development plans for any of the sites. Accordingly, the Planning Commissions for each county were consulted for information regarding proposed development plans for the areas.

Big Rock Point 3 *(Not Acceptable)*

According to a representative of the Big Rock Point plant, a major housing development is in the planning stages for a plot of land proximate to the facility site, however, it has not yet been approved by any authority. According to the Charlevoix and Emmet County Planning Commissions, two major development plans have been proposed for sites within five miles of the facility. One plan has received preliminary zoning approval, while it is uncertain as to whether the other proposed plan has yet been approved.

D.C. Cook 2 *(Acceptable)*

No development plans were noted in the FSAR. In addition, the Berrien County Planning Commission reported that no major development plans had been proposed for the area immediately surrounding the facility as of January 1, 1988. A large hotel complex development within 10 miles of the facility has been proposed but is not yet approved.

Palisades 1 *(Acceptable)*

No development plans were noted in the FSAR. The Van Buren County Planning Commission, as well as the Covert Township Planning Commission was unaware of any major development plans for the area immediately surrounding the facility.

Fermi II 4 *(Not Acceptable)*

No development plans were noted in the FSAR. However, the Monroe County Planning Commission's "Preliminary Draft Overall Economic Development Plan" showed that several major development plans within 5 miles of the plant site had been proposed as of January 1, 1988. The report provided no information as to whether any of these plans had been approved.

Criterion VIII-B *Seek areas which do not require the removal from production of prime farmland that would disrupt the economic base of the community.*

The siting of a nuclear power plant on the land has already designated the land for a non-farming use. It is assumed that the economy of each area has stabilized from this initial designation and would not be affected by the siting of a waste disposal facility on the site. This same information is valid for each of the four sites.

Big Rock Point 2 (Acceptable)

D.C. Cook 3 (Acceptable)

Palisades 4 (Acceptable)

Fermi II 1 (Acceptable)

Criterion VIII-C *If all other criteria are met, give preferences to areas near communities desiring the facility.*

This criterion was not considered applicable to the study; therefore, it was not evaluated.

Criterion IX-A Exclude areas where siting will be inconsistent with the requirements of the following federal laws:

- (i) Atomic Energy Act of 1954, chapter 1073, 68 Stat. 919.
- (ii) Federal Water Pollution Control Act, chapter 758, 62 Stat. 1155.
- (iii) Coastal Zone Management Act of 1972, Public Law 89-454 16 USC 1451 to 1454b, 1455 to 1459, 1461 to 1463, 1464.
- (iv) Endangered Species Act of 1973, Public Law 93-205, 87 Stat. 884.
- (v) Wild and Scenic Rivers Act, Public Law 90-542, 16 USC 1271 to 1287.
- (vi) Wilderness Act, Public Law 88-577, 16 USC 1131 to 1136.
- (vii) National Wildlife Refuge System Administration Act of 1960, Public Law 89-669, 16 USC 668dd, 668ee.
- (viii) Chapter 5993, 49 Stat. 666, 16 USC 461 to 467.
- (ix) The National Historic Preservation act, Public Law 89-665 16 USC 470 to 470a, 470b, 470c to 470w-6.

The research necessary to determine the compliance of each site with this number of federal laws is beyond the scope of the current project.

Federal Criterion I *The disposal site shall be capable of being characterized, modeled, analyzed, and monitored.*

It is assumed that each of the sites is capable of being characterized, modeled, analyzed, and monitored based on the fact that nuclear power plants have already been sited in each location.

Big Rock Point Pass

D.C. Cook Pass

Palisades Pass

Fermi II Pass

Federal Criterion II *The disposal site shall be selected so that projected population growth and future developments are not likely to affect the ability of the disposal facility to meet the performance objectives in 10CFR61 Subpart C.*

It is beyond the scope of this study to attempt to provide precise population trends, given the element of time the facility is expected to be in operation and secured. The following determinations were based primarily on proximity to areas of high population density.

Big Rock Point Pass

The northern shore of Michigan's Lower Peninsula has relatively fewer residents within a 25 mile radius than the other three sites.

D.C. Cook Pass

Both D. C. Cook and Palisades are located within relatively moderate population areas.

Palisades Pass

Both Palisades and D. C. Cook are located within relatively moderate population areas.

Fermi II Fail

The Fermi II site is located in a very high population density area, being within 30 miles of both downtown Detroit and Toledo.

Federal Criterion III *Areas must be avoided having known Natural Resources, which if exploited, would result in a failure to meet Subpart C of 10CFR61 Performance Objectives.*

Natural Resources are considered, for the purpose of this study, to be minable resources. Future exploitations were not taken into account when making the following determinations.

Big Rock Point Pass

There is limestone mining in the area surrounding the site. However, it does not occur near the site. Mining could easily continue outside the boundaries of the site with no impairment of productivity.

D.C. Cook Pass

This area is known to provide silica sand to the industry. The siting of a disposal facility on the site would likely not result in any adverse impacts on silica sand availability.

Palisades Pass

This area is known to provide silica sand to the industry. The siting of a disposal facility on the site would likely not result in any adverse impacts on silica sand availability.

Fermi II Pass

According to information from the Updated FSAR, there is a very low potential for hydrocarbon or subsurface gas production in the area.

Federal Criterion IV *The disposal site must be generally well drained and free of areas of flooding or frequent ponding. Waste disposal shall not take place in a 100 year flood plain, coastal high-hazard area, or wetlands.*

A 500 year maximum lake level was used as a reference point for evaluating flood potential. This was done because none of the four sites is located within a proximate river flood plain. This information, as well as that on wetlands and high-hazard coastal areas was obtained from the Michigan Department of Natural Resources Land and Water Management Division.

Big Rock Point Fail

Cedar swamp surrounds the site, therefore, ponding frequently occurs. Wetlands were noted within a 3,000 foot radius of the power plant. No high-hazard coastal areas are present near the site. Finally, the 500 year maximum lake level at this site is expected to be approximately 584 ft Mean Sea Level (MSL), while the average elevation of the site is 594 ft MSL.

D.C. Cook Fail

Wetlands areas were noted within the 3,000 ft isolation boundary. In addition, the area is noted to be a high risk erosion area. Ponding does occur on the site but the area appears capable of being drained. Finally, the 500 year maximum lake level at this site is expected to be approximately 584.8 ft Mean Sea Level (MSL), while the average elevation of the site is 610 ft MSL.

Palisades Fail

Wetlands are found within the 3,000 ft isolation distance. However, there are no high risk areas noted within the proximate area. Ponding does occur on the site but the area appears capable of being drained. Finally, the 500 year maximum lake level at this site is expected to be approximately 584.8 ft Mean Sea Level (MSL), while the average elevation of the site is 600 ft MSL.

Fermi II Fail

Wetlands are found on the site and ponding frequently occurs in the area's swampy lowlands. Coastal high-hazard areas are not present. Finally, the 500 year maximum lake level at this site is expected to be approximately 578.6 ft Mean Sea Level (MSL), while the average elevation of the site is 575 ft MSL.

Federal Criterion V *Upstream drainage areas must be minimized to decrease the amount of runoff which could erode or inundate waste disposal units.*

None of the four sites are located within any proximate river flood plains thus negating the risks associated with flooding rivers, such as runoff and erosion.

Big Rock Point Pass

D.C. Cook Pass

Palisades Pass

Fermi II Pass

Federal Criterion VI *The disposal site must provide sufficient depth to the water table that ground water intrusion, perennial or otherwise, into the waste will not occur.*

Assuming an above ground facility, relatively high ground water levels at a low-level radioactive waste disposal site can be tolerated. The sites were evaluated based upon this assumption. Twenty feet was used as the pass/fail criterion (also see III-B). Given the fact that the waste repository will be constructed near the surface, perhaps completely buried within the ground, it is likely that these evaluations would differ markedly. In the case of a near surface facility, 40 feet might not be a sufficient depth for ground water.

Big Rock Point Fail

The ground water level at the site is approximately 10 feet below the surface of the site.

D.C. Cook Pass

According to the FSAR, ground water levels appear to be between 40-80 feet below the surface of the site in the underlying unconsolidated sand deposit.

Palisades Pass

Ground water levels at the Palisades Plant are approximately 20 feet below the surface of the site. Unconsolidated sand underlies the site and is the principal water bearing aquifer along the lake shore.

Fermi II Fail

Ground water levels appear to be very high in the area due to the presence of swamps on site. A piezometric water level of between 570-580 MSL was noted in the FSAR (surface elevation is approximately 575).

Federal Criterion VII *The hydrogeological unit used for disposal shall not discharge ground water to the surface within the disposal site.*

Ground water at three of the four sites discharges directly into Lake Michigan. Ground water at Fermi II discharges into Lake Erie. Any of the standing water on each of the sites is more likely due to the existence of perched ground water, than to direct water table ground water discharge. Perched ground water occurs when an impermeable layer of material is located within a permeable layer. The impermeable layer serves as a trap for any incident precipitation. This results in ponding or submerged "perched ground water."

With the 3,000 foot buffer isolation distance from the Lake to the disposal unit, the ground water discharge criterion will be met by all of the sites.

Big Rock Point Pass

D.C. Cook Pass

Palisades Pass

Fermi II Pass

Federal Criterion VIII Areas must be avoided where tectonic processes such as faulting, folding, seismic activity, or vulcanism may occur with such frequency and extent to significantly affect the ability of the disposal facility to meet Subpart C of 10CFR61 performance objectives.

Big Rock Point Pass

Information in the draft FSAR indicates that no major faults are known to exist in the area. In addition, the draft FSAR reports that the nearest epicenter with a significant modified Mercalli index was approximately 62 miles from the plant site and had an intensity of V (mM).

D.C. Cook Pass

According to the FSAR, there are no known faults within one mile of the site. In addition, the FSAR indicates that the two closest epicenters of the highest modified Mercalli index were within 75 miles of the plant site, each with an intensity of VI (mM).

Palisades Pass

According to the FSAR, there are no known faults within one mile of the site. In addition, the FSAR indicates that the closest epicenter of a significant modified Mercalli index was within 50 miles of the plant site, with an intensity of VI (mM).

Fermi II Pass

According to the FSAR, there are no known faults within one mile of the site. In addition, the FSAR indicates that the closest epicenter of a significant modified Mercalli index was within 100 miles of the plant site, with an intensity of VIII (mM).

Federal Criterion IX *Areas must be avoided where surface geologic processes such as mass wasting, erosion, slumping, landsliding, or weathering occur with such frequency or extent to significantly affect the ability of the facility to meet the performance objectives of 10CFR61 Subpart C.*

The life of a low-level radioactive waste site is expected to be over 500 years. Because of this length of time and because the level of the Great Lakes is in a state of fluctuation, all shoreline sites, such as the four nuclear power plant sites, fail to satisfy this criterion. Associated with the everchanging lake levels are the ongoing processes of erosion, landsliding, weathering and mass wasting. The dynamic nature of the Great Lakes ecosystem is such that predictions of future lake levels and activities are not practicable

Big Rock Point Fail

This site failed because of the possibility of wave erosion at this site given the 500 year life of the site.

D.C. Cook Fail

This site failed because of the possibility of wave erosion at this site given the 500 year life of the site.

Palisades Fail

This site failed because of the possibility of wave erosion at this site given the 500 year life of the site.

Fermi II Fail

This site failed because of the possibility of wave erosion at this site given the 500 year life of the site.

Federal Criterion X *The disposal site must not be located where nearby facilities or activities could adversely impact the ability of the site to meet Subpart C of 10CFR61 performance objectives.*

It is beyond the scope of this study to determine all the possible activities that might impact adversely upon the siting of a low-level radioactive waste facility in any of the four sites being investigated.

Big Rock Point *Inconclusive*

D.C. Cook *Inconclusive*

Palisades *Inconclusive*

Fermi II *Inconclusive*

3.2 Objectives

The Low-Level Radioactive Waste Authority established nine Performance Objectives in their development of draft siting criteria. After evaluating the four nuclear power plant sites for their satisfaction of Michigan's siting criteria, the findings were used to determine the extent to which each of these 9 objectives was satisfied. Protecting the air quality, minimizing transportation problems, and avoiding resource development conflicts were objectives shown to be easily accomplished by each site. However, the remaining objectives were satisfied to a lesser degree at the four power plant sites. Protecting surface and ground water quality presented the greatest obstacle to any of these sites in meeting the established objectives.

The Fermi II site showed the least number of satisfied criteria and thus achieved fewer of the Michigan performance objectives. The Big Rock Point Plant also showed similar problems, although they were not as extensive as those of the Fermi II Plant. Both Palisades and D. C. Cook failed to satisfy all the criteria, thus making the achievement of all performance objectives difficult.

The four Federal Performance Objectives were evaluated as well to determine the relative achievement of the objectives for each of the four sites. The objective of greatest concern is the stability of the site after closure. Due to the proximity of the sites to the Great Lakes, and the occurrence of intense geologic processes in these areas, it cannot be adequately assured that the sites would remain stable over the life of the facility. The remaining three objectives can be achieved through the engineering of the facility and are less controlled by the environment in which the facility is constructed.

SECTION FOUR

Conclusions

This study found that none of the four nuclear power plants in Michigan are suitable sites for co-location of a low-level radioactive waste isolation facility. Based on the available information listed in Section Five of this report, the nuclear power plant sites and immediately adjacent areas did not meet several key exclusionary criteria. These criteria include those in which areas of intense geologic processes such as mass wasting, erosion and the like must be excluded, areas with high values of soil permeability must be excluded, areas exhibiting poor drainage and ponding must be excluded, and areas designated as wetlands must be excluded.

Although some specific detailed information about the sites was unavailable, the information that did exist was enough for a proper initial evaluation as requested by the Authority.

The goal of the siting criteria is to select a site with outstanding natural barriers in the event of a leak or spill breaching one of the many engineered barriers of the actual facility and disposal process.

Relying only on the available information that was reviewed, a low-level radioactive waste disposal facility would not meet the goals of the Siting Criteria Advisory Committee, Act 204 of 1987, the Authority's and the NRC's siting objectives and criteria and the overall goals of the NRC's performance objectives. All of the sites are located near either populated or popular seasonal resort areas of the State and are located adjacent to one of the Great Lakes. These sites do not offer suitable natural protection from an inadvertent spill or undetected leak of the anticipated waste mixture.

Finally, the shoreline setting of each of the nuclear power plants does not offer the safety and security of alternative non-shore sites. Wind-driven flooding and seiches will undoubtedly play an important role in the integrity and longevity of the site and facility throughout its life.

SECTION FIVE

Bibliography

Big Rock Point Nuclear Power Plant

Big Rock Point Plant, Updated FHSR; draft Chapter 2, undated.

Environmental Qualifications and Safety-Related Electrical Equipment, Big Rock Point Nuclear Plant; Consumers Power, October 31, 1980.

Integrated Plant Safety Assessment, A Systematic Evaluation Program for Big Rock Point Plant; US Nuclear Regulatory Commission, September 1983.

Operating License with Technical Specifications; continually amended.

D.C. Cook Nuclear Power Plant

D.C. Cook Final Safety Analysis Report for Units 1 and 2: Unit 1, 1974; Unit 2, 1977.

D.C. Cook Nuclear Power Plant Technical Specifications, ongoing updates.

Enrico Fermi II Nuclear Power Plant

Fermi 2 Nuclear Power Plant Technical Specifications, ongoing updates.

Final Environmental Statement Related to the Operation of Fermi Atomic Power Plant Unit #2; U.S. Nuclear Regulatory Commission, August 1981.

Safety Evaluation Report Related to the Operation of Fermi Atomic Power Plant; U.S. Nuclear Regulatory Commission, July 1981.

Updated Final Safety Analysis Report for Fermi 2; April 1987.

Preliminary Draft Overall Economic Development Plan; May 1988.

Palisades Nuclear Power Plant

Environmental Qualification of Safety-Related Electrical Equipment, Palisades Nuclear Plant; Consumers Power, September 1981.

Palisades Nuclear Power Plant (cont.)

Environmental Report of the Operating License Stage, Palisades Plant;
October 1970.

Final Environmental Statement Related to Operation of the Palisades
Nuclear Generating Plant; US Nuclear Regulatory Commission, February
1978.

Final Safety Analysis Report, Volumes 1, 2, and 3; December 15, 1973.

Integrated Plant Safety Assessment - A Systematic Evaluation Program for
Palisades Nuclear Plant; US Nuclear Regulatory Commission, April 1982.

Operating License with Technical Specifications; continually amended.

Palisades Plant Full Term Operating License Application, Volumes 1 and 2;
January 22, 1974.

Palisades Plant Facility Description and Safety Analysis Report: General
Information, Volume 1.

Palisades Nuclear Power Plant Radiological Emergency Preparedness
Exercise - 1985; Emergency Management Division, Department of State
Police, State of Michigan; August 1985.

General

Ostrow, J.L., et al; Maine Yankee Atomic Power Station, In-situ
Decommissioning/Low Level Waste Management Topical Report; Ebasco,
January 1987.

Regional Management Plan, Volumes 1-12; Midwest Interstate Low Level
Radioactive Waste Commission, St. Paul, Minnesota, August, 1986.

Hydrogeologic Atlas of Michigan, Department of Geology, Western Michigan
University; Kalamazoo, MI, 1981.

Appendix A

Worksheets

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
	FEDERAL	Protection of the general population from releases of radioactivity			Within 5 miles of Charlevoix (population = 3300); within 15 miles of Petoskey (population = 6000); total population reported to be 59,000 within 30 mile radius
	FEDERAL	Protection of individuals from inadvertent intrusion	X		Power plant maintains intrusion protection
	FEDERAL	Protection of individuals during operations	X		Emergency preparedness and procedures in place for power plant
	FEDERAL	Stability of the disposal site after closure		X	
I-A	Prime EX	Exclude areas within incorporated city limits as established on 1/1/88	X		Plant reports that it is not incorporated in any city; located in Hayes Township
I-B	Prime EX	Exclude areas not large enough to assure isolation distance of 3,000 or more ft. from the disposal unit		X	Approximately 2700 feet from unit to property boundary
I-C	Favorable	Seek areas where population growth is not expected to affect the performance of the unit	1		Three county area has an estimated growth rate of 20-30% over a ten year period (Ranking 1=Best; 4=Worst)
II-A	Prime EX	Exclude areas located 1 mile or less from a fault where tectonic movement has occurred in the last 10,000 years	X		According to draft UFSAR, no major faulting recognized in local area
II-B	Prime EX	Exclude areas of earthquakes with intensities of a modified Mercalli index of VIII or greater	X		Keewenaw Peninsula in 1906 VIII; Houghton in 1905 V; Indiana, MI in 1883 VI; closest was 100km from plant site and was V (modified Mercalli)

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
II-C	Prime EX	Exclude areas within the 500 year flood plain	X		Probable maximum flood = 598.8 ft MSL. Probable maximum wave = 586.8 ft MSL. Highest recorded lake level = 584 MSL. According to MDNR, 500 year maximum Lake level 583.0 IGLD or 584.2 MSL; site=592.8 MSL
II-D	Prime EX	Exclude areas of intense geologic processes such as mass wasting, erosion, slumping, landsliding, or weathering		X	Wave erosion may be a problem: no solution features (HLA Report)
III-A	Prime EX	Exclude areas where the water table is not sufficiently low to prevent the intrusion of ground water - Ground Water must not be within the bottom of the unit - Leak detection system above the water table		X	Ground water level = 583.6 MSL design; Site elevation=592.8 MSL; soil is noted to be well drained; artesian sand lenses noted in clay till
III-B	Prime EX	Exclude areas where there is not 6 meters (20 feet) of soil with $1.0 \times 10E-6$ cm/sec below the leak detection system			Inconclusive; soil is noted to be well drained and porous; specific permeability test not available
III-C	Prime EX	Exclude areas where radionuclide travel time is less than 100 years along a 100 foot flowpath			Inconclusive; specific permeability test not available
III-D	Prime EX	Exclude areas where the travel time from the water table at the edge of the disposal unit to an aquifer is less than 500 years			Inconclusive; specific permeability test not available
III-E	Prime EX	Exclude areas located over a sole source aquifer	X		No sole source aquifers present in Michigan (4/1/88)

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
III-F	Prime EX	Exclude areas where ground water is discharged within 3000 feet of the unit	X		Ground water discharges into Lake Michigan; 3000 foot isolation distance from disposal unit to lake
III-G	Prime EX	Exclude areas not free of ponding or incapable of being drained in a manner to ensure integrity		X	Cedar Swamp surrounds site; water stands in some areas
III-H	Prime EX **	Exclude areas located within 10 miles of the Great Lakes and the St. Mary's river, Detroit River, St Clair River, Lake St. Clair (not applied if located at or adjacent to a nuclear power plant)	X		Meets exception
III-I	Favorable	Seek areas with simple hydrogeology (modeled and monitored)		X	Artesian sand lenses in clay soil make modelling difficult
III-J	Favorable	Seek areas that do not overlie aquifers		X	Site overlies limestone (dolomite) aquifer
III-K	Favorable	Seek areas which do not include public water supply wells, well fields, high capacity production wells and abandoned wells	X		Charleviox has off-shore intake; wells greater than 5 miles from site
IV-A	Favorable	Seek areas which minimize transportation accidents	4		Regional population and available transportation routes used to rank four power plant sites(Ranking 1=Best; 4=Worst); US 31 (20 miles)
IV-B	Favorable	Seek areas which minimize exposures to radiation associated with transportation accidents	1		Regional population and available transportation routes used to rank four power plant sites (Ranking 1=Best; 4=Worst)
V-A	Favorable	Seek areas with simple meteorological systems that can be modeled and monitored	X		Systems monitored on-site at plant

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
VI-A	Favorable	Seek areas where natural resources do not exist on or significantly near the site	X		Limestone mining in area; several state and local parks within 10 miles of site
VII-A	Prime EX	Exclude areas with wetlands as defined by Act No. 203		X	According to MDNR, wetlands noted within 3000 feet of site
VII-B	Prime EX	Exclude areas with environmental areas (EA) or high risk areas as defined in the shorelands protection act - Act 245	X		No EA's or high risk areas (MDNR)
VII-C	Favorable	Seek areas which are not wildlife conservation areas			Inconclusive; power plant already located on site
VII-D	Favorable	Seek sites that do not cause visual intrusion on designated scenic highways (1/1/88)	X		Power plant already located on site
VII-E	Favorable	Seek sites that will not remove prime farmland	X		Power plant siting has already designated land for non-farming use.
VIII-A	Favorable	Seek areas which are not included in formally proposed approved development plans as of 1/1/88	X		Major development planned for old Cement Plant, 11 miles away (not approved)
VIII-B	Favorable	Seek areas which do not require removal of prime farmland that would disrupt a community's economy	X		See VII-E
VIII-C	Favorable	Give preference to communities that want the unit			

Type of Criteria	Criteria
<p>Prime EX</p>	<p>Comply with federal laws:</p> <p>Atomic Energy Act of 1954, Chapter 1073, 68 Stat. 919 Federal Water Pollution Control Act, Chapter 7587, 62 Stat. 1155 Coastal Zone Management Act of 1972, Public Law 89-454, 16 USC 1451 to 1454b, 1455 to 1459, 1461 to 1463, 1464 Endangered Species Act of 1973, Public Law 93-205, 87 Stat. 884 Wild and Scenic Rivers Act Public Law 90-542, 16 U.S.C. 1271 to 1287 Wilderness Act Public Law 88-577, 16 U.S.C. 1131 to 1136 National Wildlife Refuge System Administration Act of 1960 Public Law 89-669, 16 USC 668dd, 668ee Chapter 593, 49 Stat. 666, 16 U.S.C. 461 to 467 The National Historic Preservation Act, Public Law 89-665, 16 U.S.C. 470 to 470a, 470b, 470c to 470w-6</p>
	<p>Other Laws Referenced:</p> <p>Act No. 204 of Public Acts of 1987 10 CFR 61 subpart C - (performance objectives) Act No. 245 of Public Acts of 1929 (sections 323.1 to 323.13 of MCL) - floodway designation 49 CFR Parts 100-179 Act No 203 of Public Acts of 1979 (sections 281.701-281.722 MCL) - wetlands Act 245 of Public Acts of 1970 (sections 281.631-281.644 MCL) - shorelines and high risk areas</p>

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
	FEDERAL	Protection of the general population from releases of radioactivity			Within 11 miles of Benton Harbor/ St. Joseph (~27,000); total population of approximately 4.6 million within 60 mile radius; summer resort area
	FEDERAL	Protection of individuals from inadvertent intrusion	X		Power plant maintains intrusion protection
	FEDERAL	Protection of individuals during operations	X		Emergency preparedness and procedures in place for power plant
	FEDERAL	Stability of the disposal site after closure		X	Shoreline erosion imminent
I-A	Prime EX	Exclude areas within incorporated city limits as established on 1/1/88	X		According to the FSAR, plant is not incorporated into a city; located in Lake Township
I-B	Prime EX	Exclude areas not large enough to assure isolation distance of 3,000 or more ft. from the disposal unit		X	Site comprises 650 acres; site boundaries do not allow sufficient property to assure isolation distance
I-C	Favorable	Seek areas where population growth is not expected to affect the performance of the unit	2		Projected moderate growth rate for area within 60 mile radius of site; Chicago, IL is within 58 miles of site (Ranking 1=Best; 4=Worst)
II-A	Prime EX	Exclude areas located 1 mile or less from a fault where tectonic movement has occurred in the last 10,000 years	X		According to FSAR; no faults within 1 mile of site
II-B	Prime EX	Exclude areas of earthquakes with intensities of a modified Mercalli index of VIII or greater	X		2 epicenters within 75 miles of site with maximum intensity of VI modified Mercalli (1883 & 1947)

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
II-C	Prime EX	Exclude areas within the 500 year flood plain	X		According to MDNR, 500 year maximum Lake Michigan water level - 583.3 IGLD or 584.8 MSL; surface elevation = 610 feet
II-D	Prime EX	Exclude areas of intense geologic processes such as mass wasting, erosion, slumping, landsliding, or weathering		X	According to MDNR, site is in a high erosion potential area; near shoreline; sand dune ecology; swampy areas in eastern portion of site
III-A	Prime EX	Exclude areas where the water table is not sufficiently low to prevent the intrusion of ground water - Ground Water must not be within the bottom of the unit - Leak detection system above the water table	X		Static water table elevations in 19 test borings ranged from 582 to 609 feet above MSL; water table 40-80 feet below grade
III-B	Prime EX	Exclude areas where there is not 6 meters (20 feet) of soil with $1.0 \times 10E-6$ cm/sec below the leak detection system		X	On sand dunes; permeability = 1-2 feet per day
III-C	Prime EX	Exclude areas where radionuclide travel time is less than 100 years along a 100 foot flowpath		X	Sand loose to moderate at surface - compacting with depth (25-35 ft. thick); site permeability indicates an average permeability 1-2 ft/day; gradient=0.5 to 4 %
III-D	Prime EX	Exclude areas where the travel time from the water table at the edge of the disposal unit to an aquifer is less than 500 years		X	Sand underlies site
III-E	Prime EX	Exclude areas located over a sole source aquifer	X		None in Michigan (4-1-88)
III-F	Prime EX	Exclude areas where ground water is discharged within 3000 feet of the unit	X		Ground water discharges to Lake Michigan; 3000 foot isolation distance from lake to disposal unit

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
III-G	Prime EX	Exclude areas not free of ponding or incapable of being drained in a manner to ensure integrity	X		Some shallow ponds on eastern portion of site; some swampy areas exist; ponds reflect ground water table in dunes
III-H	Prime EX	Exclude areas located within 10 miles of the Great Lakes and the St. Mary's river, Detroit River, St Clair River, Lake St. Clair (not applied if located at or adjacent to a nuclear power plant)	X		Meets exception
III-I	Favorable	Seek areas with simple hydrogeology (modeled and monitored)	X		FSAR states relative simplicity of area hydrogeology
III-J	Favorable	Seek areas that do not overlie aquifers		X	Overlies sand aquifer
III-K	Favorable	Seek areas which do not include public water supply wells, well fields, high capacity production wells and abandoned wells	X		Private wells directly surrounding area; municipalities in area utilize Lake Michigan water as potable source
IV-A	Favorable	Seek areas which minimize transportation accidents	2		Regional population and available transportation routes used to rank four power plant sites (Ranking 1=Best; 4=Worst); I-94 runs through property
IV-B	Favorable	Seek areas which minimize exposures to radiation associated with transportation accidents	3		Regional population and available transportation routes used to rank four power plant sites (Ranking 1=Best; 4=Worst)
V-A	Favorable	Seek areas with simple meteorological systems that can be modeled and monitored	X		Systems monitored on-site at plant
VI-A	Favorable	Seek areas where natural resources do not exist on or significantly near the site	X		Area known to provide silica sand to industry

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
VII-A	Prime EX	Exclude areas with wetlands as defined by Act No. 203		X	According to MDNR, wetlands noted within 3,000 foot isolation distance radius
VII-B	Prime EX	Exclude areas with environmental areas (EA) or high risk areas as defined in the shorelands protection act - Act 245		X	According to MDNR, area does not have EA's within 1 mile of site; high risk areas noted (MDNR); 70/95 foot setback recommended (MDNR)
VII-C	Favorable	Seek areas which are not wildlife conservation areas			Inconclusive; power plant already located on site
VII-D	Favorable	Seek sites that do not cause visual intrusion on designated scenic highways (1/1/88)	X		Power plant already located on site
VII-E	Favorable	Seek sites that will not remove prime farmland	X		60% of surrounding land is used for farming; however, plant siting has already designated land for non-farming use
VIII-A	Favorable	Seek areas which are not included in formally proposed approved development plans as of 1/1/88	X		None noted in FSAR
VIII-B	Favorable	Seek areas which do not require removal of prime farmland that would disrupt a community's economy	X		See VII-E
VIII-C	Favorable	Give preference to communities that want the unit			

MI #	Type of Criteria	Criteria
IX	Prime EX	<p>Comply with federal laws:</p> <p>Atomic Energy Act of 1954, Chapter 1073, 68 Stat. 919 Federal Water Pollution Control Act, Chapter 7587, 62 Stat. 1155 Coastal Zone Management Act of 1972, Public Law 89-454, 16 USC 1451 to 1454b, 1455 to 1459, 1461 to 1463, 1464 Endangered Species Act of 1973, Public Law 93-205, 87 Stat. 884 Wild and Scenic Rivers Act Public Law 90-542, 16 U.S.C. 1271 to 1287 Wilderness Act Public Law 88-577, 16 U.S.C. 1131 to 1136 National Wildlife Refuge System Administration Act of 1960 Public Law 89-669, 16 USC 668dd, 668ee Chapter 593, 49 Stat. 666, 16 U.S.C. 461 to 467 The National Historic Preservation Act, Public Law 89-665, 16 U.S.C. 470 to 470a, 470b, 470c to 470w-6</p>
		<p>Other Laws Referenced:</p> <p>Act No. 204 of Public Acts of 1987 10 CFR 61 subpart C - (performance objectives) Act No. 245 of Public Acts of 1929 (sections 323.1 to 323.13 of MCL) - floodway designation 49 CFR Parts 100-179 Act No 203 of Public Acts of 1979 (sections 281.701-281.722 MCL) - wetlands Act 245 of Public Acts of 1970 (sections 281.631-281.644 MCL) - shorelines and high risk areas</p>

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
	FEDERAL	Protection of the general population from releases of radioactivity			Within 16 miles of Benton Harbor/St. Joseph (population ≈27,000); 4.5 miles from South Haven; total population reported to be near 2 million within 50 mile radius of site; summer resort area (50% population increase)
	FEDERAL	Protection of individuals from inadvertent intrusion	X		Power plant maintains intrusion protection
	FEDERAL	Protection of individuals during operations	X		Emergency preparedness and procedures in place for power plant
	FEDERAL	Stability of the disposal site after closure		X	Shoreline erosion imminent
I-A	Prime EX	Exclude areas within incorporated city limits as established on 1/1/88	X		According to the FSAR, plant is not incorporated into a city; located in Covert Township
I-B	Prime EX	Exclude areas not large enough to assure isolation distance of 3,000 or more ft. from the disposal unit		X	Site comprises of 487 acres; site boundaries do not allow sufficient property to assure isolation distance
I-C	Favorable	Seek areas where population growth is not expected to affect the performance of the unit		3	Estimated 25% increase in population within 25yrs.; South Bend, Indiana and Kalamazoo/Portage within 50 miles (1970 census values 125K and 85K respectively); 50% summer pop. increase; (Ranking 1=Best; 4=Worst)
II-A	Prime EX	Exclude areas located 1 mile or less from a fault where tectonic movement has occurred in the last 10,000 years	X		No faults within 100 miles of site as reported in the FSAR

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
II-B	Prime EX	Exclude areas of earthquakes with intensities of a modified Mercalli index of VIII or greater	X		One epicenter within 50 miles of site (1883) of an intensity of VI modified Mercalli; one within 100 miles (1947) VI modified Mercalli
II-C	Prime EX	Exclude areas within the 500 year flood plain	X		According to FSAR, 597.1 ft. MSL for maximum wave flood; 594.67 ft MSL for maximum flood level; according to MDNR, 500 year maximum Lake Michigan water level - 583.3 IGLD or 584.8 MSL; surface elev. = 600 ft MSL
II-D	Prime EX	Exclude areas of intense geologic processes such as mass wasting, erosion, slumping, landsliding, or weathering		X	Sand dunes present; near shoreline; according to MDNR erosion potential exists
III-A	Prime EX	Exclude areas where the water table is not sufficiently low to prevent the intrusion of ground water - Ground Water must not be within the bottom of the unit - Leak detection system above the water table	X		Ground water apparently high; water level = 581' MSL; surface elevation = 600 ft; no confined aquifer found within area (1966)
III-B	Prime EX	Exclude areas where there is not 6 meters (20 feet) of soil with $1.0 \times 10E-6$ cm/sec below the leak detection system		X	Sand dunes over sandy clay (top of sandy clay is 560-565 MSL)
III-C	Prime EX	Exclude areas where radionuclide travel time is less than 100 years along a 100 foot flowpath		X	High permeability (30-1720 ft/yr); gradient=13 feet per mile)
III-D	Prime EX	Exclude areas where the travel time from the water table at the edge of the disposal unit to an aquifer is less than 500 years		X	Sand underlies the site

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
III-E	Prime EX	Exclude areas located over a sole source aquifer	X		None in Michigan (4-1-88)
III-F	Prime EX	Exclude areas where ground water is discharged within 3000 feet of the unit	X		Ground water discharges to Lake Michigan; 3000 foot isolation distance from lake to disposal unit
III-G	Prime EX	Exclude areas not free of ponding or incapable of being drained in a manner to ensure integrity	X		High ground water; swampy lowlands in area; site can be drained.
III-H	Prime EX	Exclude areas located within 10 miles of the Great Lakes and the St. Mary's river, Detroit River, St Clair River, Lake St. Clair (not applied if located at or adjacent to a nuclear power plant	X		Meets exception
III-I	Favorable	Seek areas with simple hydrogeology (modeled and monitored)	X		Appears geology is simple; no detailed reports found
III-J	Favorable	Seek areas that do not overlie aquifers		X	Overlies sand aquifer
III-K	Favorable	Seek areas which do not include public water supply wells, well fields, high capacity production wells and abandoned wells	X		Private wells located within 1 mile of site; no identified public wells according to FSAR;
IV-A	Favorable	Seek areas which minimize transportation accidents	1		Regional population and available transportation routes used to rank four power plant sites (Ranking 1=Best; 4=Worst); US-31 and I-196 border the site
IV-B	Favorable	Seek areas which minimize exposures to radiation associated with transportation accidents	2		Regional population and available routes used to rank four power plant sites (Ranking 1=Best; 4=Worst)

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
V-A	Favorable	Seek areas with simple meteorological systems that can be modeled and monitored	X		Systems monitored on-site at plant site
VI-A	Favorable	Seek areas where natural resources do not exist on or significantly near the site	X		Area known to provide silica sand to industry; State Park adjacent
VII-A	Prime EX	Exclude areas with wetlands as defined by Act No. 203		X	According to MDNR, wetlands noted within 3,000 foot isolation distance radius
VII-B	Prime EX	Exclude areas with environmental areas (EA) or high risk areas as defined in the shorelands protection act - Act 245	X		No EA's reported by MDNR; plant site is not a high risk area, but high risk areas are noted close to the site (MDNR)
VII-C	Favorable	Seek areas which are not wildlife conservation areas			Inconclusive; power plant already located on site
VII-D	Favorable	Seek sites that do not cause visual intrusion on designated scenic highways (1/1/88)	X		Power plant already located on site
VII-E	Favorable	Seek sites that will not remove prime farmland	X		Plant siting has already desinated land for non-farming use
VIII-A	Favorable	Seek areas which are not included in formally proposed approved development plans as of 1/1/88	X		None noted in FSAR
VIII-B	Favorable	Seek areas which do not require removal of prime farmland that would disrupt a community's economy	X		See VII-E

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
VIII-C	Favorable	Give preference to communities that want the unit			
IX	Prime EX	<p>Comply with federal laws:</p> <p>Atomic Energy Act of 1954, Chapter 1073, 68 Stat. 919</p> <p>Federal Water Pollution Control Act, Chapter 7587, 62 Stat. 1155</p> <p>Coastal Zone Management Act of 1972, Public Law 89-454, 16 USC 1451 to 1454b, 1455 to 1459, 1461 to 1463, 1464</p> <p>Endangered Species Act of 1973, Public Law 93-205, 87 Stat. 884</p> <p>Wild and Scenic Rivers Act Public Law 90-542, 16 U.S.C. 1271 to 1287</p> <p>Wilderness Act Public Law 88-577, 16 U.S.C. 1131 to 1136</p> <p>National Wildlife Refuge System Administration Act of 1960 Public Law 89-669, 16 USC 668dd, 668ee Chapter 593, 49 Stat. 666, 16 U.S.C. 461 to 467</p> <p>The National Historic Preservation Act, Public Law 89-665, 16 U.S.C. 470 to 470a, 470b, 470c to 470w-6</p>			
		<p>Other Laws Referenced:</p> <p>Act No. 204 of Public Acts of 1987</p> <p>10 CFR 61 subpart C - (performance objectives)</p> <p>Act No. 245 of Public Acts of 1929 (sections 323.1 to 323.13 of MCL) - floodway designation</p> <p>49 CFR Parts 100-179</p> <p>Act No 203 of Public Acts of 1979 (sections 281.701-281.722 MCL) - wetlands</p> <p>Act 245 of Public Acts of 1970 (sections 281.631-281.644 MCL) - shorelines and high risk areas</p>			

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
	FEDERAL	Protection of the general population from releases of radioactivity			Within 5.5 miles of Monroe, MI (~23,500); total population reported to be approximately 5.4 million within a 50 mile radius; seasonal recreation area
	FEDERAL	Protection of individuals from inadvertent intrusion	X		Power plant maintains intrusion protection
	FEDERAL	Protection of individuals during operations	X		Emergency preparedness and procedures in place for power plant
	FEDERAL	Stability of the disposal site after closure		X	Located within an active marsh; and on a shoreline
I-A	Prime EX	Exclude areas within incorporated city limits as established on 1/1/88	X		According to the FSAR, plant is not incorporated into a city; located in Frenchtown Township
I-B	Prime EX	Exclude areas not large enough to assure isolation distance of 3,000 or more ft. from the disposal unit			Inconclusive, site comprised of 1120 acres of land; exact site boundaries not provided in FSAR
I-C	Favorable	Seek areas where population growth is not expected to affect the performance of the unit	4		FSAR estimates 10% increase in population per decade for the area within 50 mile radius of site; downtown Detroit within 27 miles; downtown Toledo within 25 miles (Ranking 1=Best; 4=Worst)
II-A	Prime EX	Exclude areas located 1 mile or less from a fault where tectonic movement has occurred in the last 10,000 years	X		According to FSAR, no faults within 1 mile; 1 fault noted within 50 miles of site
II-B	Prime EX	Exclude areas of earthquakes with intensities of a modified Mercalli index of VIII or greater	X		No earthquakes have occurred with an intensity of VI or greater within 50 mile radius; one epicenter within 100 miles of site (1937) of intensity VIII (modified Mercalli)

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
II-C	Prime EX	Exclude areas within the 500 year flood plain		X	According to MDNR, 500 year maximum Lake Erie water level - 577.1 IGLD or 578.6 MSL; surface elevation ≈ 575 ft
II-D	Prime EX	Exclude areas of intense geologic processes such as mass wasting, erosion, slumping, landsliding, or weathering		X	Near shoreline; located within an active swamp; area noted for sink holes
III-A	Prime EX	Exclude areas where the water table is not sufficiently low to prevent the intrusion of ground water - Ground Water must not be within the bottom of the unit - Leak detection system above the water table		X	Ground water level is high; piezometric water level is 570-580 feet (Lake Erie water level is 572)
III-B	Prime EX	Exclude areas where there is not 6 meters (20 feet) of soil with $1.0 \times 10E-6$ cm/sec below the leak detection system		X	Soil cover ranges from 2-9 meters
III-C	Prime EX	Exclude areas where radionuclide travel time is less than 100 years along a 100 foot flowpath			Inconclusive; drift deposits in area range from impervious till to coarse deposits of gravel and boulders; no reported permeability tests found in FSAR
III-D	Prime EX	Exclude areas where the travel time from the water table at the edge of the disposal unit to an aquifer is less than 500 years			Inconclusive; no reported permeability tests found in FSAR
III-E	Prime EX	Exclude areas located over a sole source aquifer	X		No sole source aquifers present in Michigan (4/1/88)

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
III-F	Prime EX	Exclude areas where ground water is discharged within 3000 feet of the unit	X		Ground water discharges into Lake Erie; 3000 foot isolation distance from disposal unit to lake
III-G	Prime EX	Exclude areas not free of ponding or incapable of being drained in a manner to ensure integrity		X	North and south area of site are dominated by large lagoons; swampy low lying areas present on site; located within the Lake Erie drainage basin; area considered primary marshland
III-H	Prime EX	Exclude areas located within 10 miles of the Great Lakes and the St. Mary's river, Detroit River, St Clair River, Lake St. Clair (not applied if located at or adjacent to a nuclear power plant)	X		Meets exception
III-I	Favorable	Seek areas with simple hydrogeology (modeled and monitored)	X		FSAR states that hydrogeology is simple
III-J	Favorable	Seek areas that do not overlies aquifers		X	Overlies dolomite aquifer; used for water supply in the general area
III-K	Favorable	Seek areas which do not include public water supply wells, well fields, high capacity production wells and abandoned wells	X		According to FSAR, a total of ~4300 wells (both private and municipal) located within 10 mi. of site (none noted within 5 miles of site); Monroe, Flat Rock, Detroit, Toledo use Lake Erie water as potable source
IV-A	Favorable	Seek areas which minimize transportation accidents	3		Regional population and available transportation routes used to rank four power plant sites (Ranking 1=best; 4=worst); I-75 and US Route 24/25
IV-B	Favorable	Seek areas which minimize exposures to radiation associated with transportation accidents	4		Regional population and available transportation routes used to rank four power plant sites (Ranking 1=best; 4=worst)

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
V-A	Favorable	Seek areas with simple meteorological systems that can be modeled and monitored	X		Systems monitored on-site at plant
VI-A	Favorable	Seek areas where natural resources do not exist on or significantly near the site	X		Several state and local parks and beaches within 10 mi. of site; according to FSAR, low potential for hydrocarbon or subsurface gas production
VII-A	Prime EX	Exclude areas with wetlands as defined by Act No. 203		X	Located within a swamp area; according to MDNR, wetlands noted within 3,000 3,000 foot isolation distance radius
VII-B	Prime EX	Exclude areas with environmental areas (EA) or high risk areas as defined in the shorelands protection act - Act 245		X	According to MDNR, area does have EA's within 1 mile of site; no high risk areas noted (MDNR)
VII-C	Favorable	Seek areas which are not wildlife conservation areas			Inconclusive; power plant already located on site
VII-D	Favorable	Seek sites that do not cause visual intrusion on designated scenic highways (1/1/88)	X		Power plant already located on site
VII-E	Favorable	Seek sites that will not remove prime farmland	X		55% of land within 10 mi. of plant is farmland; however, power plant siting has already designated land for non-farming use.
VIII-A	Favorable	Seek areas which are not included in formally proposed approved development plans as of 1/1/88	X		None noted in FSAR

MI #	Type of Criteria	Criteria	OK	Fails	Reasons:
VIII-B	Favorable	Seek areas which do not require removal of prime farmland that would disrupt a community's economy	X		See VII-E
VIII-C	Favorable	Give preference to communities that want the unit			
IX	Prime EX	<p>Comply with federal laws:</p> <p>Atomic Energy Act of 1954, Chapter 1073, 68 Stat. 919 Federal Water Pollution Control Act, Chapter 7587, 62 Stat. 1155 Coastal Zone Management Act of 1972, Public Law 89-454, 16 USC 1451 to 1454b, 1455 to 1459, 1461 to 1463, 1464 Endangered Species Act of 1973, Public Law 93-205, 87 Stat. 884 Wild and Scenic Rivers Act Public Law 90-542, 16 U.S.C. 1271 to 1287 Wilderness Act Public Law 88-577, 16 U.S.C. 1131 to 1136 National Wildlife Refuge System Administration Act of 1960 Public Law 89-669, 16 USC 668dd, 668ee Chapter 593, 49 Stat. 666, 16 U.S.C. 461 to 467 The National Historic Preservation Act, Public Law 89-665, 16 U.S.C. 470 to 470a, 470b, 470c to 470w-6</p>			
		<p>Other Laws Referenced:</p> <p>Act No. 204 of Public Acts of 1987 10 CFR 61 subpart C - (performance objectives) Act No. 245 of Public Acts of 1929 (sections 323.1 to 323.13 of MCL) - floodway designation 49 CFR Parts 100-179 Act No 203 of Public Acts of 1979 (sections 281.701-281.722 MCL) - wetlands Act 245 of Public Acts of 1970 (sections 281.631-281.644 MCL) - shorelines and high risk areas</p>			

Appendix B

Michigan Department of Natural Resources
Correspondence

Floodplain Control Unit Letter

STATE OF MICHIGAN



JAMES J. BLANCHARD, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING
BOX 30028
LANSING, MI 48909

GORDON E. GUYER, Director

April 4, 1988

URAL RESOURCES COMMISSION
THOMAS J. ANDERSON
ARLENE J. FLUHARTY
ERRY KAMMER
STEWART MYERS
AVID D. OLSON
AYMOND POUPORE

Mr. John Voytek
Low Level Radioactive Waste Authority

Re: Service No. 8803 168
Floodplain Information

Dear Mr. Voytek:

The following are the 100-year and 500-year floodplain elevations in the vicinity of the four power plants. The elevation datums used were: International Great Lakes Datum of 1955 (IGLD) and Mean Sea Level Datum of 1929 (MSL).

Cook Power Plant

Watercourse: Lake Michigan
Section 6, T6S, R19W
Baroda Township
Berrien County

100-Year
500-Year

582.7 IGLD, 584.2 MSL
583.3 IGLD, 584.8 MSL

Big Rock Power Plant

Watercourse: Lake Michigan
Section 8, T34N, R7W
Hayes Township
Charlevoix County

100-Year
500-Year

582.4 IGLD, 583.6 MSL
583.0 IGLD, 584.2 MSL

Palisades Power Plant

Watercourse: Lake Michigan
Section 5, T2S, R17W
Covert Township
Van Buren County

100-Year
500-Year

582.6 IGLD, 584.0 MSL
583.2 IGLD, 584.6 MSL

John Voytek
April 4, 1988
Page Two

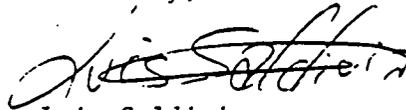
Enrico Fermi Power Plant

Watercourse: Lake Erie
Section 21, T6S, R10E
Frenchtown Township
Monroe County

100-Year: 576.4 IGLD, 577.9 MSL
500-Year: 577.1 IGLD, 578.6 MSL

If we can be of further assistance, please feel free to contact us by mail or telephone.

Sincerely,



Luis Saldivia
Floodplain Control Unit
Land and Water Management Division
517-335-3188

LS:cjr

Wetland Location Maps

Palisades Site

Scale 1:24 000

Contour Interval 10 feet

The Palisades Nuclear Power Plant is immediately enclosed within the box on the left hand side of the map.

Designated Wetlands areas within the 3000 foot isolation distance are circled and shaded. Wetlands areas outside the 3000 foot isolation distance are merely circled.

Big Rock Point Site

Scale 1:25 000

Contour Interval 5 feet

The Big Rock Point Nuclear Power Plant is enclosed immediately within the box on the top middle of the map.

The designated Wetlands areas within the 3000 foot isolation distance are circled and shaded.

R10R

Scale 1:25,000
Contour Interval 5 feet

640 12' 30"

641

642

643

10'

644

1790000

L A K E M I C H I G A N

APPROXIMATE MEAN LAKE ELEVATION 177.0

Big Rock Point

Big Rock Powerplant

PUBLIC ACCTG
BOAT NAME

NORTHERN

Burgess

THIRTYONE

BAY

SHORE

31

12

R8W
R7W

13

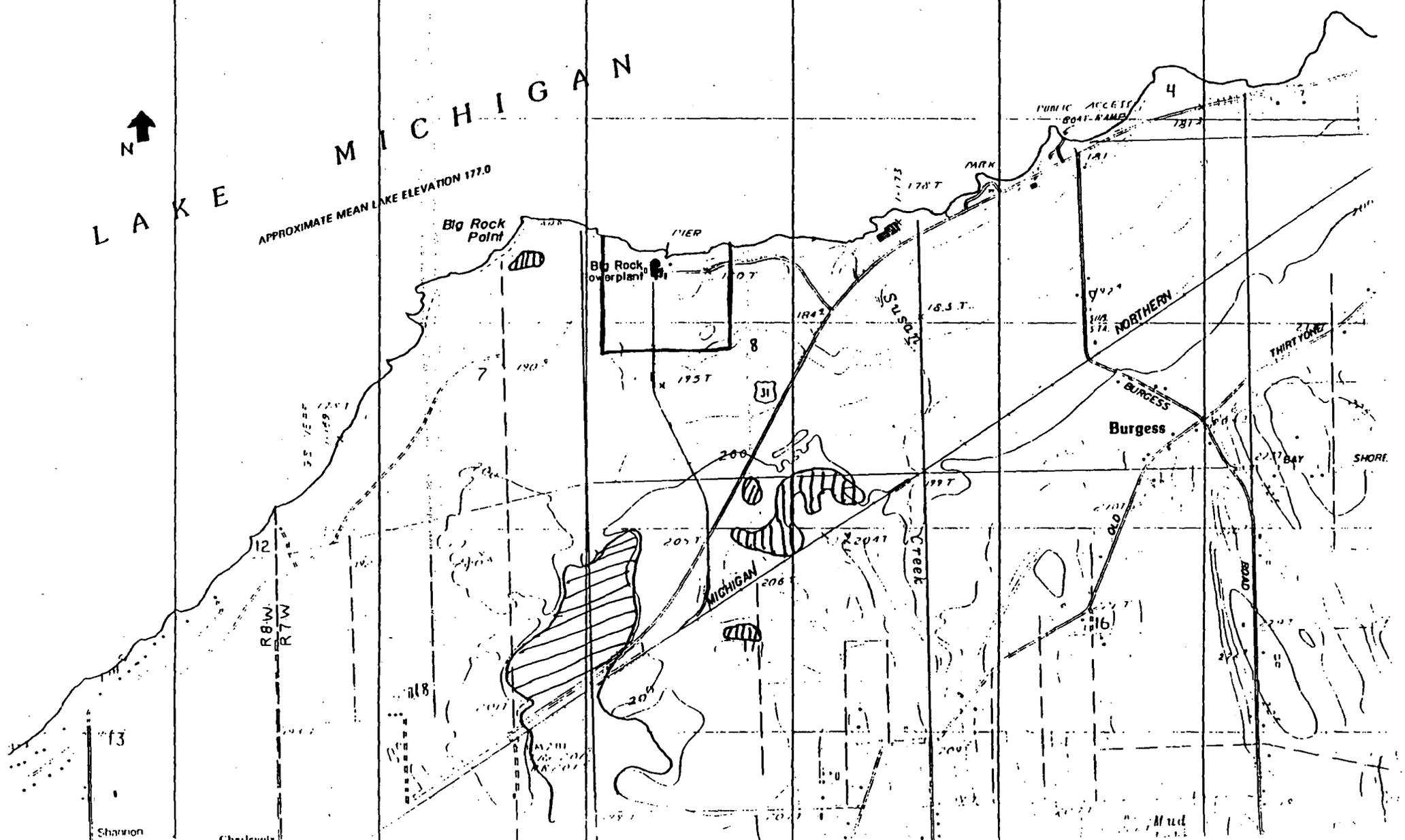
Shannon Field

Charlevoix Co.

Creek

ROAD

Mud



Fermi Unit II Site

Scale 1:24 000
Contour Interval 5 feet

The Fermi Nuclear Power Plant is immediately enclosed within the box on the right hand side of the page.

The designated Wetlands areas within the 3000 foot isolation distance are circled and shaded. The wetlands area outside the isolation distance are merely circled.

D. C. Cook Site

Scale 1: 24 000

Contour Interval 10 feet

The D. C. Cook Nuclear Power Plant is immediately located within the boxed area on the left hand side of the page.

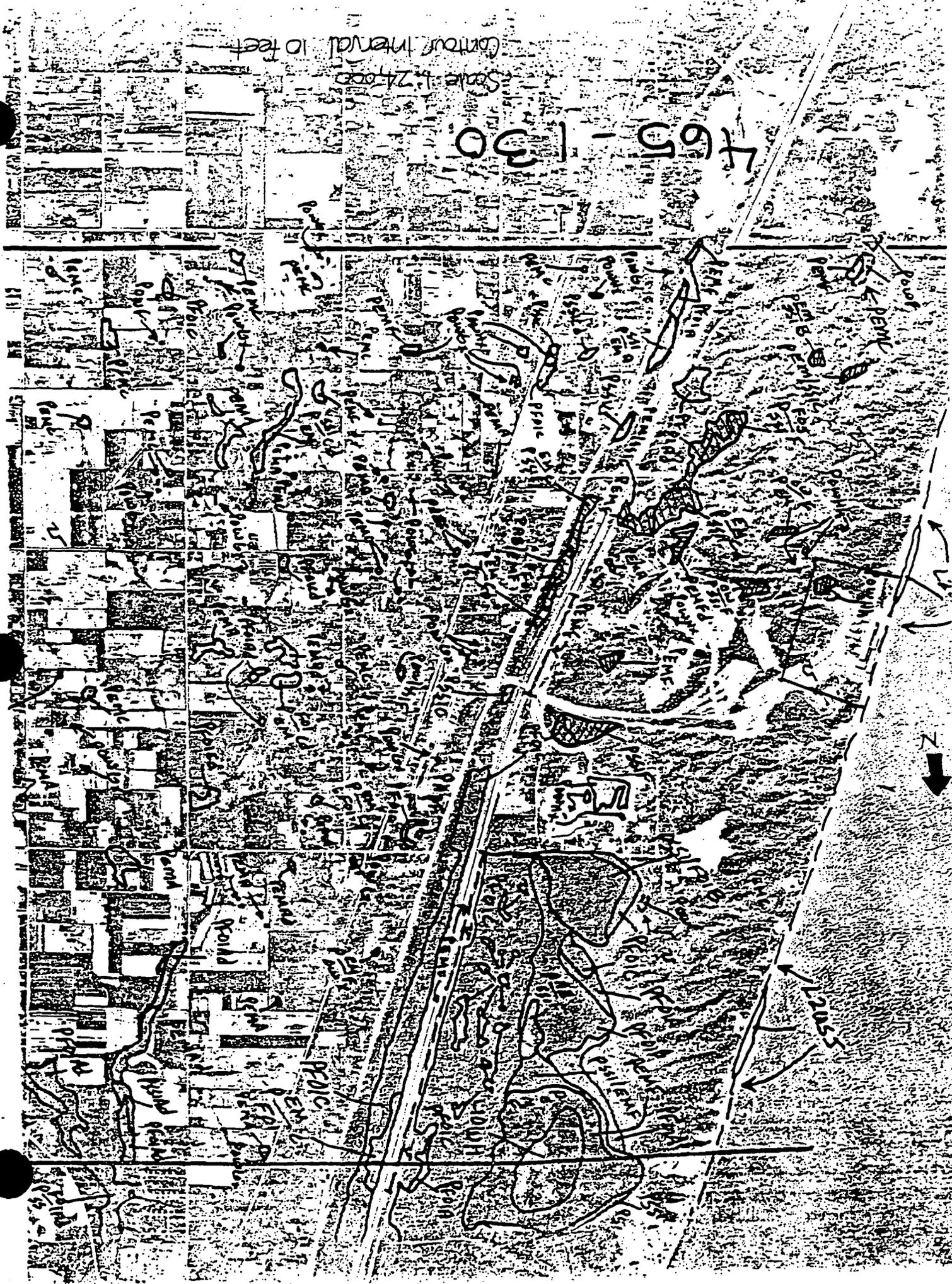
Designated Wetlands areas within the 3000 foot isolation distance are circled and shaded. Wetlands outside the isolation distance are merely circled.

465-130

Scale 1:24,000

Contour Interval 10 feet

Bridge



Environmental Area Map

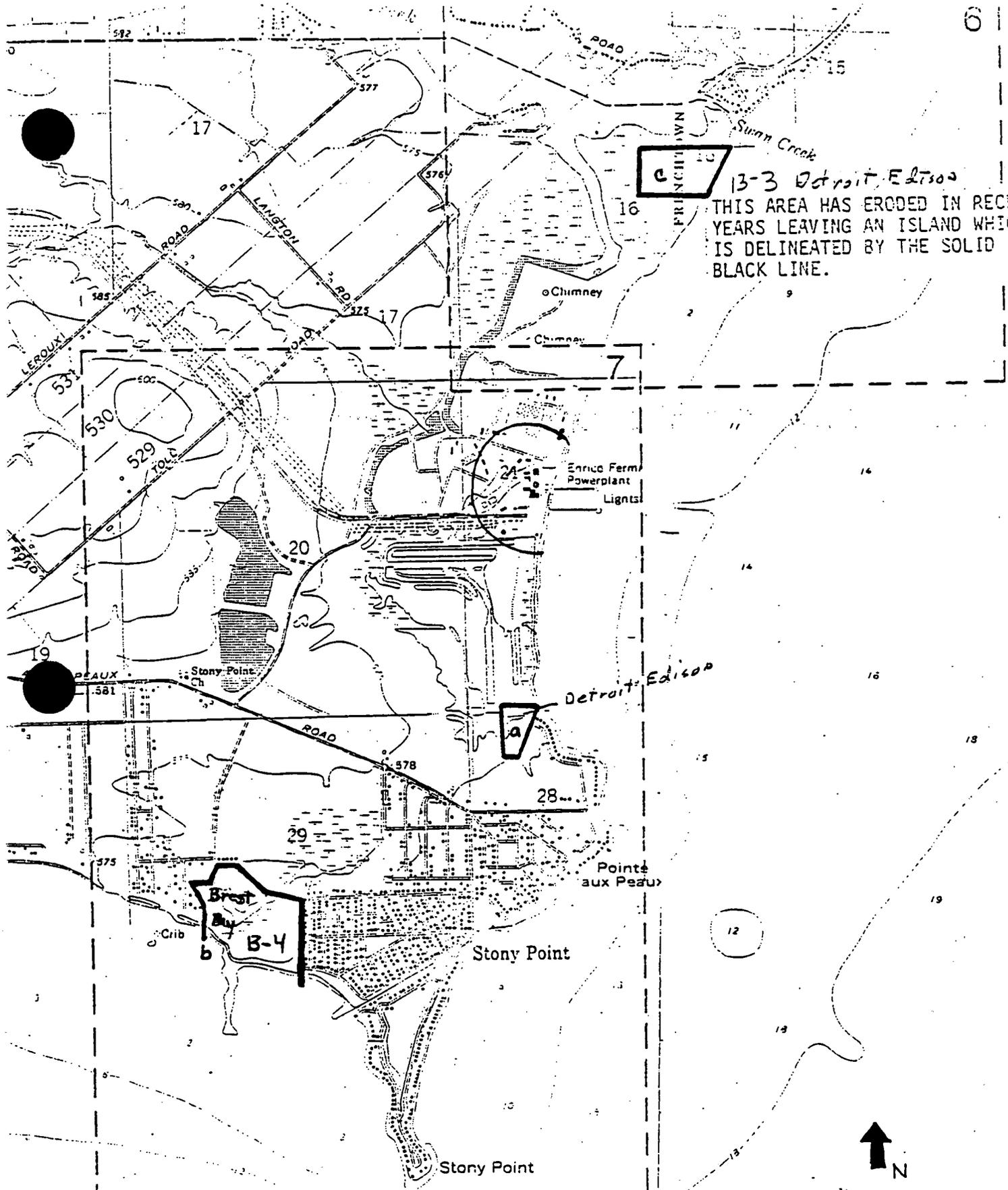
Fermi Unit II Site

Scale 1:24 000

Contour Interval 5 feet

The Fermi Nuclear Power Plant is immediately enclosed within the semi-circle.

The three areas enclosed in black boxes are considered Environmental Areas by the Michigan Department of Natural Resources. The box labeled "a" is within the 3000 foot isolation distance, while the boxes labeled "b" and "c" are within one mile of the site.



13-3 Detroit Edison
 THIS AREA HAS ERODED IN RECENT YEARS LEAVING AN ISLAND WHICH IS DELINEATED BY THE SOLID BLACK LINE.

Scale
 1:24,000
 Contour Interval
 5 feet

Appendix C

Draft Siting Criteria
(February 15, 1988)

Low-Level Radioactive Waste
Isolation Facility
For
Midwest Interstate Compact

Draft Siting Criteria

February 15, 1988

Michigan Low-Level Radioactive Waste Authority



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PROPOSED SITE SELECTION CRITERIA FOR A LOW-LEVEL RADIOACTIVE WASTE ISOLATION FACILITY

MICHIGAN LOW-LEVEL RADIOACTIVE WASTE AUTHORITY

INTRODUCTION

The Federal Low-Level Radioactive Waste Policy Act (Public Law 99-240) gave each state the responsibility to safely manage the low-level radioactive waste generated within its borders. In December, 1982, the Legislature passed and Governor Milliken signed into law Act 460 of 1982 an act for entering into the Midwest Interstate Low-Level Radioactive Waste Compact, where Michigan indicated its willingness to join with other midwestern states in a regional compact to meet these responsibilities. This Compact was approved by the United States Congress in December 1985 (Omnibus Compact Act of 1985). In July, 1987, the Midwest Compact selected Michigan as the State responsible for constructing a facility to isolate low-level radioactive waste generated in member states. In December, 1987, Michigan enacted legislation creating the Michigan Low-Level Radioactive Waste Authority to safely manage Michigan's waste (204 PA 1987) and creating a regulatory framework in the Department of Public Health to ensure the safety of Michigan's citizens and the protection of its environment.

Among other responsibilities, the Authority is directed to develop final criteria for siting a low level radioactive waste isolation facility in Michigan by March 15, 1988. To assist the Authority in carrying out its responsibilities, the Act required the establishment of a Siting Criteria Advisory Committee. Members of the Committee "...shall by education and experience be knowledgeable in a technical specialty related to the siting of a low-level radioactive waste disposal site." The Authority's charge to the Siting Criteria Advisory Committee was:

...to assist the Authority in its goal of assuring the protection of the health of Michigan's citizens and the quality of Michigan's environment in the process of selecting a low-level radioactive waste isolation facility site.

The Committee shall employ its expertise to:

- (a) Recommend to the Authority proposed siting criteria.
- (b) Review existing and proposed federal and state laws and rules pertaining to siting criteria.
- (c) Review all of the technical information available to the Committee and make recommendations regarding siting criteria.
- (d) Attend any public hearing that may be scheduled by the Authority that pertains to proposed siting criteria.

- (e) Assist the Authority in drafting responses to the comments of the Department or any person regarding the final siting criteria adopted by the Authority.
- (f) At the request of the Authority, provide scientific and technical review of site selection activities.
- (g) Fulfill its responsibilities in accordance with target dates established by the Authority.

The Committee was convened on January 6, 1988, and has met on the following dates: January 6, 12, 15, 16, and 28, and February 9, 1988. Each meeting was open to the public and public involvement and participation were encouraged. Meeting minute summaries are available at the Michigan Low-Level Radioactive Waste Authority, Suite 574, Hollister Building, Lansing, Michigan. Copies of the materials used by the Siting Criteria Advisory Committee and related information are available at the twelve public libraries listed in Appendix A. These materials may also be examined at the office of the Authority.

The criteria developed by the Committee provide the basis for this draft version of final siting criteria proposed by the Authority as the standards by which areas of the state are to be judged for suitability as a location for a low-level radioactive waste isolation facility. Proposed criteria are based on Federal Regulatory Guidelines and Michigan statute. Most of the proposed criteria are the same as those in Federal Regulation or State statute. In some instances, the proposed criteria are more restrictive than legislation or regulatory guidelines. In other instances, the Committee and the Authority have interpreted guidelines which were unclear in such a manner as to provide proposed criteria which are most protective of citizen health and the environment. In two instances, the Committee recommends and the Authority concurs, that criteria specified in 204 PA 1987 should be changed in order to provide more protection to citizen health and safety and the environment. Recommended changes affect criteria III. D(Section 11(2)(E) of 204 PA 1987) and III. F(Section 10(h) of 204 PA 1987). Reasons for suggesting changes are discussed in the text accompanying each criterion.

The proposed criteria can be divided into two categories: 1) Primary criteria, or criteria that exclude an area from further consideration; and 2) Secondary criteria, or criteria that distinguish the relative suitability of those areas not excluded from further consideration. The primary criteria will be applied statewide and areas of the state which fail to meet each primary criterion will be excluded from consideration. The remaining areas will be evaluated using the secondary criteria. Areas selected as candidate sites are scheduled to be announced in June, 1988.

During the period from February 15, 1988, to March 15, 1988, the Authority solicits comments and questions from all interested parties. The Authority will consider public comments and the Siting Criteria Advisory Committee responses to those comments and additional recommendations in its preparation of Final Siting Criteria.

The Authority strongly encourages all those interested in issues pertaining to the management of low-level radioactive waste to participate in the discussion of these siting criteria.

PUBLIC PARTICIPATION PROCESS

The Authority is seeking opportunities for the public to participate in the discussion of the draft siting criteria and has arranged a series of information meetings with opportunity for public comment. In addition, the Authority has scheduled a public hearing. These public participation opportunities are as follows:

<u>DATE</u>	<u>TIME</u>	<u>LOCATION</u>	<u>FORMAT</u>
February 15, 1988	7:00 PM	Room G, Clarion Hotel & Conference Center 6820 South Cedar, Lansing, Michigan	Information meeting with opportunity for public comment
February 23, 1988	7:00 PM	Community Room Old Kent Bank Main Office Main St. Gaylord, Michigan	Information meeting with opportunity for public comment
March 8, 1988	7:00 PM	Stryker Room Room 2020 Second Floor Fetzer Center Western Michigan Univ. Kalamazoo, Michigan	Information meeting with opportunity for public comment
March 9, 1988	7:00 PM	Ball Room 3 Novi Hilton 21111 Haggerty Road Novi, Michigan	Information meeting with opportunity for public comment
March 10, 1988	7:00 PM	Delta Charter Township 7710 W. Saginaw Highway Lansing, Michigan	Public Hearing

PROPOSED SITE SELECTION CRITERIA

GOALS

The Siting Criteria Advisory Committee formulated its recommendations based on the primary goal of ensuring the health and safety of Michigan's citizens and protecting the environment. The secondary goal of the committee was to ensure that the areas selected as a result of the application of the recommended criteria can be licensed in compliance with federal and state regulations. The third goal of the committee was to avoid conflict with established societal and community values.

Although any low-level radioactive waste isolated in Michigan will be in proper containers and enclosed in a containment structure, in evaluating the criteria necessary to assure that a disposal site will be as safe as possible, the committee did not assume that artificial structures at the site would permanently isolate the waste from the environment. The intention of the Committee was to develop criteria to guide the selection of a site, the geologic, hydrogeologic, and geographic characteristics of which will ensure that long-term performance goals are met. Protection provided by careful operational procedures, site and facility design measures, and continuous environmental monitoring will be additional to protection provided by the site itself.

OBJECTIVES

The Siting Criteria Advisory Committee, in consultation with the Authority, identified eleven objectives to be met by the siting criteria:

- I. Avoid population centers and conflicts with human activities.
- II. Avoid areas subject to geologic and flood hazards.
- III. Protect surface water and groundwater quality.
- IV. Minimize transportation hazards.
- V. Protect air quality.
- VI. Avoid resource development conflicts.
- VII. Avoid conflict with special or protected land use including areas.
- VIII. Protect environmentally sensitive areas.
- IX. Protect cultural and heritage values.
- X. Avoid conflict with community social and economic goals.
- XI. Comply with Federal Laws.

After considering the recommendations of the Committee, the Authority combined objectives VII, VIII, and IX, into one objective,

--Avoid conflict with areas of special or protected land use, including environmentally sensitive areas--.

Although the Authority fully agrees with the objectives discussed by the Committee, the suggested criteria under the Committee's Objectives VIII and IX were so vague as to give little practical guidance in facility site selection. In addition, the Michigan Legislature, in mandating siting criteria pertaining to these values in section 11(3)(e) of 1987 PA 204, seems to have encompassed what the Committee intended. The Authority believes that its responsibility to comply with State and federal laws and regulations, specifically those referenced in PA 204 of 1987 will result in the full protection of these values.

Nevertheless, the Authority encourages those with special interests and expertise in these areas to closely review the criteria associated with this objective and to suggest more specific guidance if that seems necessary or advisable.

In addition, the Authority has reworded Objective IX (SCAC Objective XI) so that it is proposed as,

--Comply with Federal laws which protect environmentally sensitive areas and protect cultural and heritage values--.

CRITERIA

OBJECTIVE I. - AVOID POPULATION CENTERS AND CONFLICTS WITH HUMAN ACTIVITIES

A. Criterion - Exclude areas within incorporated city limits as established on January 1, 1988.

By eliminating heavily populated areas from consideration, the risk that the operation of a low-level radioactive waste disposal facility might interfere with human activities is minimized. Any risk that a large population might be exposed to radiation due to a release of radionuclides from a waste disposal facility or a low-level radioactive waste transportation accident is also reduced.

B. Criterion - Exclude areas not sufficiently large to assure that an isolation distance of 3,000 feet or more from the disposal unit and adjacent property lines is available.

[Section 10(d) of 204 PA 1987 reads, "The Authority shall establish final siting criteria that at a minimum excludes a candidate site that is any of the following:....(d) Not sufficiently large to assure that an isolation distance of 3,000 feet or more from the disposal unit and adjacent property lines is available."]

The specific 3,000 foot isolation distance, is mandated by the legislation (Section 10 (d) of 204 PA 1987) presumably to assure that releases of radionuclides will not reach the disposal site boundary and to minimize impact on local populations. One important effect of the 3,000 foot buffer zone is a reduction in the impact of the facility on surrounding populations and protection of private property values since the total area of the site will be on the order of 2 square miles. This offers opportunities for land use that will be compatible with local interests, and given the long term control, such space has the potential of being a resource of considerable value to local communities.

Had the Legislature not chosen this buffer zone for several beneficial purposes, the committee would have recommended a distance, which in combination with other criteria, would be sufficient to isolate radionuclides within the site for several hundred years. The isolation distance required by the Legislature will be more than sufficient for this purpose.

C. Criterion - Seek areas where projected population growth and future developments are not likely to affect the ability of the disposal facility to meet the performance objectives of 10 CFR 61 Subpart C (10 CFR 61.50 (a)(3)) and are not likely to significantly interfere with an environmental monitoring program.

[Section 11(3)(d) of 204 PA 1987 reads, "In designating 3 candidate sites, the Authority shall give preference to sites that are all of the following: (d) Located where projected population growth and future developments within the municipality and county where the candidate site is located are not likely to affect the ability of the disposal site to meet the performance objectives in subpart C of 10 CFR part 61 or could not significantly interfere with an environmental monitoring program."]

The performance objectives of 10 CFR 61 subpart C are summarized by the general requirement of 10 CFR 61.40 which states, "....land disposal facilities must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposure to humans are within the limits established in the performance

objectives in section 61.41 through 61.44." These performance objectives are as follows:

1. Protection of the general population from releases of radioactivity.
2. Protection of individuals from inadvertent intrusion.
3. Protection of individuals during operations.
4. Stability of the disposal site after closure.

(See Appendix B for subparts C and D of 10 CFR 61)

The Committee believes that the location of the disposal site in areas with low population density and distant from populated centers will minimize the number of people that could be exposed to radiation from accidents. This also enhances compliance with the performance objective of protection of the general population from releases of radioactivity.

OBJECTIVE II. - AVOID AREAS SUBJECT TO GEOLOGIC AND FLOOD HAZARDS

- A. Criterion - Exclude areas located one mile or less from a fault where tectonic movement has occurred within the last 10,000 years.**

[Section 10(c) of 204 PA 1987 reads, "The Authority shall establish final siting criteria that at a minimum excludes a candidate site that is any of the following: (c) Located 1 mile or less from fault where tectonic movement has occurred within the 10,000 years preceding the effective of this act."]

Tectonic movement is the movement of the earth's crust along faults. An isolation facility should not be located in an area where movement could breach its integrity or change the geologic structure of the site. Such a breach of integrity could result in a release of radionuclides by water (rain, snow melt or groundwater) flowing through the damaged area and transporting radionuclides off the isolation facility site. A change in the geologic structure of the site could reduce the ability to predict groundwater movement and therefore radionuclide migration and reduce the effectiveness of an environmental monitoring system. In the judgement of the committee, tectonic movement is unlikely in Michigan, but the committee believes this potential should be addressed by the siting criteria.

- B. Criterion - Exclude areas of significant earthquake intensity, defined as zone with a modified Mercalli index of VIII or greater.**

Although there is no specific statutory reference, areas of significant earthquake intensity should be excluded because of the potential for damage to the waste isolation facility or change in the geologic structure of the site. Such damage or change could result in a release of radionuclide by water (rain, snow melt or groundwater) flowing through the damaged area and transporting radionuclides off the isolation facility site. A change in the geologic structure of the site could reduce the ability to predict groundwater and thereby radionuclide migration and reduce the effectiveness of an established environmental monitoring system. The modified Mercalli intensity scale follows:

Modified Mercalli Intensity Scale*

Intensity		Characteristic Effects
I	Instrumental	Detected only by seismographs
II	Feeble	Noticed only by sensitive people
III	Slight	Like the vibrations due to a passing heavy truck; felt by people at rest, especially on upper floors.
IV	Moderate	Felt by people while walking; objects rock, including standing vehicles.
V	Rather Strong	Felt generally; most sleepers are awakened
VI	Strong	Trees sway; suspended objects swing; loose objects overturn and fall
VII	Very Strong	General alarm; walls crack; plaster falls
VIII	Destructive	Masonry cracks; chimneys fall; poorly constructed buildings damaged; water well levels may change
IX	Ruinous	Some houses collapse where ground begins to crack; pipes break open
X	Disastrous	Ground cracks badly; many buildings destroyed and railway lines bent; landslides on steep slopes
XI	Very Disastrous	Few buildings remain standing; bridges destroyed; all services (railways, pipes, and cables) out of action; great landslides and floods
XII	Catastrophic	Total destruction; objects thrown into air; ground rises and falls in waves.

The Committee believes that earthquakes of less intensity than VIII will not breach the integrity of a disposal facility. Although earthquakes of this intensity have not occurred within Michigan's recorded history, the Committee believes this potential should be addressed by the siting criteria.

* Wood, H.O. and Neumann, F., 1931, Modified Mercalli intensity scale of 1931: Seismological Society of America Bulletin, v. 5 no. 5, p. 979-987.

C. Criterion - Exclude areas within the 500 year flood plain, including areas designated under 245 PA 1929 (Sections 323.1 to 323.13 of the Michigan Compiled Laws).

[Section 10(a) of 204 PA 1987 reads, "The Authority shall establish final siting criteria that at a minimum excludes a candidate site that is any of the following:

(a) Located in a 500 year flood plain.

(g) A floodway designated under Act No. 245 of the Public Acts of 1929, being sections 323.1 to 323.13 of the Michigan Compiled Laws."]

Excluding such areas minimizes the potential of flooding a waste isolation facility. Flood waters could come into contact with waste during facility operations or through a breach in the containment structure after a facility has closed and transport radionuclides off the facility site. Although most other host states and the Nuclear Regulatory Commission require exclusion of areas within the 100 year flood plain, the Committee believes that the added margin of safety gained from excluding areas within the 500 year flood plain is warranted. By definition, a 500 year flood is caused by a storm that is likely to occur only once in a 500 year time period. Similarly, a 100 year flood is caused by a storm that is likely to occur only once in a 100 year time period.

D. Criterion - Exclude areas where geological processes such as mass wasting, erosion, slumping, landsliding or weathering precludes meeting the performance objectives in 10 CFR 61 Subpart C or precludes defensible modeling and prediction of the long term impact of such occurrences.

[Section 11(3)(i) reads, "In designating 3 candidate sites, the Authority shall give preference to sites that are all of the following: (i) Located where geologic processes such as mass wasting, erosion, slumping, landsliding, or weathering do not occur to the extent and with such frequency that the ability of the disposal site to meet the performance objectives in subpart C, 10 CFR 61.41 to 61.44 is significantly affected or may preclude defensible modeling and prediction of the long-term impact of such occurrences."]

The performance objectives of 10 CFR 61 Subpart C are summarized by the general requirement of 10 CFR 61.40 which states, "land disposal facilities must be sited, designed, operated, closed and controlled after closure so that reasonable assurance exists that exposure to humans are within limits established in the performance objectives in Sections 61.41 and 61.44." (See Criterion I.C.)

The geologic processes described could damage the facility or change the geologic structure of the site and result in a release of radionuclides by water (rain, snow melt or groundwater) flowing through the damaged area. Such a flow could transport radionuclides off the disposal site. A change in the geologic structure of the site could eliminate the ability to model and predict groundwater movement and reduce the effectiveness of an established environmental monitoring system.

OBJECTIVE III. - PROTECT SURFACE AND GROUNDWATER QUALITY

- A. Criterion - Exclude areas where the water table associated with geologic deposits or formations is not sufficiently low to prevent the intrusion of groundwater into the bottommost portions of the leak detection system of the disposal unit.**

[Section 11(2)(d) of 204 PA 1987 reads, "In designating 3 candidate sites, the Authority shall exclude any site that is not all of the following: (d) Located where the unconfined water table which is not the potentiometric surface, is sufficiently low to prevent the intrusion of groundwater into the disposal unit, except as outlined under 10 CFR 61.50 (a)(7)."]

[Section (a)(7) of CFR 61.50 reads, "The disposal site must provide sufficient depth to the water table that groundwater intrusion, perennial or otherwise, into the waste will not occur.....In no case will waste disposal be permitted in the zone of fluctuation of the water table."]

Criterion A is essentially the same as that written in 11(2)(d) of 204 PA 1987 and CFR 61.50 (a)(7). It requires that near-surface disposal of low-level radioactive waste will be in the unsaturated soil and that the leak detection system at the bottom of the disposal unit be above the water table. For purposes of operationalizing this criterion, the top of the saturated zone is defined to be the water table, and any water below the water table is defined to be groundwater.

The intent of criterion A is to restrict groundwater intrusion into the isolation facility. The occurrence of perched water tables, as well as seasonal and long term fluctuations of the water table, both prior and subsequent to waste disposal, must be considered.

B. Criterion - Exclude areas where there is not 6 or more meters of soil with a maximum hydraulic conductivity of 1.0 times 10 to the minus 6 centimeters per second at all points below and lateral to the bottommost portions of the leak detection system of the disposal unit.

[Section 11(2)(c) of 204 PA 1987 reads, "In designating 3 candidate sites, the Authority shall exclude any site that is not all of the following: (c) Located where there is 6 or more meters of soil with a maximum permeability of 1.0 times 10 to the minus 6 centimeters per second at all points below and lateral to the bottommost portions of the leak detection system of the disposal unit or an area that provides equivalent environmental protection to the public, health, safety, and welfare, and the environment."]

Criterion B is essentially the same as that written in section 11(2)(c) of 204 PA 1987, except that it sets limits to how thin the soil can be. The committee accepts the fact that certain soils less than 20 feet thick may appear to provide equivalent or greater environmental protection. However, we feel it is important to limit how thin the soil can be because of our concerns that it may become breached by either natural or human activities, or that it may contain subtle heterogeneities (dissimilar soils) and discontinuities (breaks in soils) that could potentially allow for the rapid transport of radionuclides. We also feel that it is important to maintain at least twenty feet of separation distance between the leak detection system and an aquifer that might underlie the disposal unit. The Committee assumes that as used in the statute "permeability" means "hydraulic conductivity."

The intent of criteria B is to minimize the lateral and/or downward migration of radionuclides through the soil should leakage occur at the disposal unit. It would also facilitate cleanup operations should any leakage occur.

C. Criterion - Exclude areas where the travel time of radionuclides along any 100 foot flow path from the water table at the edge of the disposal unit is less than approximately 100 years.

[Section 11(2)(b) of 204 PA 1987 reads, "In designating 3 candidate sites, the Authority shall exclude any site that is not all of the following: (b) Located where the groundwater travel time along any 100 foot flow path from the edge of the disposal unit is greater than approximately 100 years."]

Criterion C is the same as that of section 11(2) (b) of 204 PA 1987. It effectively requires that with a hydraulic gradient of 0.5, which is near to the upper limit of gradients observed in Michigan, at least 100 feet of soil with a hydraulic conductivity of 4.85 times 10 to the minus seven directly underlie the disposal unit.

In the case of hydraulic gradients less than 0.5, the soil may be thinner than this, yet it still must meet the requirements stated in criterion B .

The intent of criterion C is to minimize the lateral and/or downward migration of radionuclides through the groundwater should leakage occur at the disposal unit, and would apply mainly in areas where the hydraulic gradient in the soil is relatively large. This criterion also effectively guards against the potential upward intrusion into the disposal unit of groundwater associated with confined aquifer that may underlie the disposal site.

D. Criterion - Exclude areas where the groundwater travel time from the water table at the edge of the disposal unit to an aquifer is less than 500 years.

[Section 11(2)(e) of 204 PA 1987 reads, "In designating 3 candidate sites, the Authority shall exclude any site that is not all of the following: (e) Located in an area that is not above an aquifer that is the primary source of water for a municipality or county or for persons residing or doing business in the municipality or county where the candidate site is located."]

Criterion D is more restrictive than Section 11(2)(e) of 204 PA 1987 because it eliminates weaknesses inherent in the language of section 11(2)(e). It avoids problems associated with artificial political boundaries and extends protection to aquifers that are not currently being used as a primary source of water. The committee defines an aquifer as a geologic deposit or formation that may be a significant source of drinking water.

The intent of criterion D is to protect aquifers from contamination by radionuclides should leakage occur at the disposal unit. Protection is afforded by requiring a groundwater travel time to an aquifer that is equal or greater than the effective life span of the disposal unit. As an added safety factor, criterion B requires that at least 20 feet (6 m) of soil occur between the disposal unit and an aquifer.

E. Criterion - Exclude areas located over a sole source aquifer.

[Section 10(b) of 204 PA 1987 reads, "The Authority shall establish final siting criteria that at a minimum excludes a candidate site that is any of the following: (b) Located over a sole source aquifer."]

Section 1424(e) of the Safe Water Drinking Act of 1974 authorizes the Environmental Protection Agency Administrator to determine that an aquifer is the sole or principal source of drinking water for an area.

The intent of Criterion E is to exclude the possibility of radionuclides entering an aquifer that is designated the sole source or principal source of drinking water as defined by Environmental Protection Agency. Currently, no sole source aquifers have been defined within the State of Michigan.

- F. Criterion - Exclude areas located where the hydrogeology beneath the site discharges groundwater to the land surface within 3,000 feet (915 m) of the boundaries of the disposal unit.**

[Section 10(h) of 204 PA 1987 reads, "The Authority shall establish final siting criteria that at a minimum excludes a candidate site that is any of the following: (h) Located where the hydrogeology beneath the site discharges groundwater to the land surface within 3,000 feet of the boundaries of the candidate site."]

Criterion F is somewhat different than that stated in Section 10(h) of PA 204 of 1987. It excludes a candidate site where the hydrogeology beneath the site discharges groundwater to the land surface within 3000 feet from the boundary of the "disposal unit", rather than 3000 feet from the boundaries of the "candidate site."

The committee believes that the specified 3,000 foot buffer zone is mandated by section 10(h) of PA 204 of 1987 presumably to assure that any release of radionuclides will not reach the disposal site boundary, and to encourage long flow paths from the disposal site to the point of groundwater discharge in order to increase the amount of time for decay of released radionuclides, increase the hydrodynamic dispersion within the soil, and increase the likelihood of retardation of reactive radionuclides. In effect, Section 10(h) of PA 204 of 1987 excludes the consideration of areas that contain groundwater discharge features such as springs, seeps, swamps, or bogs within 6,000 feet of the disposal unit.

It is the opinion of the committee however, that a 3,000 foot isolation distance beyond the 3,000 foot buffer zone that is required by section 10(d) of PA 204 of 1987 provides more than adequate protection to the public and effectively compromises the selection of candidate sites that are demonstrably more safe and suitable. With this in mind, we believe an exclusion distance 3,000 feet from the boundary of the disposal unit would be more beneficial and ultimately offer better protection should leakage occur.

- G. Criterion - Exclude areas not free of ponding or incapable of being drained in a manner that ensures the integrity of the disposal unit.**

[Section 11(2)(f) of 204 PA 1987 reads, "In designating 3 candidate sites, the Authority shall exclude any site that is not of the following: (f) free of ponding or incapable of being drained in a manner that ensures the integrity of the disposal unit."]

The intent of criterion G is to prevent runoff from eroding or inundating the disposal unit. This criterion is also useful for excluding areas where the water table is very near to or level with the ground surface.

H. Criterion - Exclude areas located within 10 miles of Lake Michigan, Lake Superior, Lake Huron, Lake Erie, Saint Mary's River, Detroit River, St. Clair River or Lake St. Clair. This criterion shall not apply to a site that is located at or adjacent to a nuclear power generating facility.

[Section 10(i) of 204 PA 1987 reads: "The Authority shall establish final siting criteria that at a minimum excludes a candidate site that is any of the following: (a) Located within 10 miles of Lake Michigan, Lake Superior, Lake Huron, Lake Erie, Saint Mary's River, Detroit River, St. Clair River or Lake St. Clair. This criterion shall not apply to a site that is located at or adjacent to a nuclear power generating facility."]

This criterion is legislatively mandated (Section 10(i) of 204 PA 1987) to reflect the considerable concern in Michigan for protection of the Great Lakes and its connecting waters. The 10 mile exclusion distance in combination with the other criteria, in particular Criterion III A, B, C, and D will be more than adequate to limit the migration of any released radionuclides to the Great Lakes system for thousands of years if they should leak from the disposal facility. The 10-mile distance encompasses protection of other cultural, economic, scenic, aesthetic, and heritage values, many of which are heightened near the shores of these fresh water bodies. The committee believes that both sets of considerations need to be provided and is supportive of the Legislature's determination.

The exception for nuclear plant sites may appear inconsistent; however, when viewed in the context of the other criteria (especially III A, B, C and D above) and other important values, which have already been weighed in the siting of the nuclear plants, the consideration allows flexibility in siting and is therefore justified. The committee believes this particular exception should be considered only if such a site is clearly demonstrated to be one of the best after application of all the other criteria.

I. Criterion - Seek areas with simple hydrologic systems that can be characterized, modeled, analyzed and monitored.

[Section 11(3)(b) reads, " In designating 3 candidate sites, the Authority shall give preference sites that are all of the following: (b) Able to be characterized, modeled, analyzed, and monitored."]

10 CFR 61.50 (a)(2) Reads, "The disposal site shall be capable of being characterized, modeled analyzed, and monitored."

The intent of Criterion I is to make the geology and hydrology of the site simple. For example, NUREG-0902 advises that "the hydrogeological units used for disposal should not have continuous permeable or impermeable anomalies such as faults or fracture features, sand lenses, weathered horizons, or karstic features that provide preferential pathways.... to groundwater flow. This criterion also implies that natural processes affecting the disposal site should be occurring at a consistent and definable rate such that the modeling of the site will represent both present and anticipatable site conditions after closure. Finally, since monitoring programs can sample only a small fraction of the surface area or subsurface volume of the disposal site, site characteristics must be such that the number of monitoring points can adequately describe the extent to which radionuclides have migrated from the waste disposal units."

J. Criterion - Seek areas that do not overlie aquifers.

The intent of Criterion J is to minimize the possibility of an aquifer being contaminated by radionuclides derived from the disposal unit. The committee recognizes that throughout Michigan there are geologic deposits or formations that yield varying amounts of drinking water and that it may be impossible to find a suitable site for the disposal unit which is not underlain by one of these deposits or formations. We believe however, that Criterion J, together with Criterion B through F, and I provide adequate protection of the groundwater and insure the integrity of these deposits and formations.

K. Criterion - Seek areas which do not include public water supply wells, well fields, high capacity production wells, and abandoned wells.

The intent of Criterion K is to avoid siting the disposal unit where public water supply wells, well fields and high capacity production will affect the groundwater movement in the surrounding area. It also avoids siting in areas where abandon wells may result in preferential pathways for the migration of radionuclides.

OBJECTIVE IV. - MINIMIZE TRANSPORTATION HAZARDS

A. Criterion - Seek areas which minimize the risk of transportation accidents.

This criterion addresses the conventional consequences of transportation accidents, while Criterion IV. B addresses the risk of radiation exposure due to transportation of wastes.

The conventional hazards of a transportation accident outweigh the radiological hazards of an accident. Accident probability varies with the route traveled. The Michigan Department of Transportation has statistical data on the number of accidents on Michigan's highways.

The accident rate varies considerably (by a ratio of as much as 3 to 1) as a function of the design standards of the highway system. Freeways are the safest highways, and areas with good access to the freeway network would be preferred to areas which would require the transport of radioactive waste over roads with lower design standards and a higher probability of accidents. Since the severity of accidents involving trucks is greater than that for accidents involving only automobiles, public safety concerns argue for encouraging as much travel on freeways as can reasonably be achieved.

The committee believes that minimizing accidents is an appropriate consideration in siting a facility.

B. Criterion - Seek areas which minimize the risks of exposures to radiation associated with transportation accidents.

Available information indicates that there is negligible risk of exposure to radiation associated with accidents involving transportation of low-level radioactive wastes. The Committee believes that transportation routes which avoid areas of high density population will serve to minimize the risk of exposure.

If an accident should result in a breach in the container carrying radioactive waste, there is a radiological risk to humans who come into contact with the shipment before the waste material is re-packaged. This risk is greatest where the population density is highest and the probability of contact is incurred. Transportation of commercial low-level radioactive waste is regulated under Department of Transportation Hazardous Materials Regulations (49 CFR Parts 100-179).

OBJECTIVE V. - PROTECT AIR QUALITY

A. Criterion - Seek areas with simple meteorological systems that can be characterized, modeled, analyzed, and monitored.

The meteorological system refers to the near surface atmospheric characteristics over an area. A waste isolation facility with a simple meteorological system is easier to assess, monitor and model. A simple system provides a greater level of confidence that the model accurately predicts the characteristics of the meteorological system.

OBJECTIVE VI. - AVOID RESOURCE DEVELOPMENT CONFLICTS

A. Criterion - Seek areas where natural resources do not exist on or significantly near to the candidate site that, if exploited, would result in failure to meet the performance objectives in Subpart C of 10 CFR 61.

[Section 11(3)(c) of 204 PA 1987 reads, "In designating 3 candidate sites, the Authority shall give preference to sites that are all of the following: (c) Located where natural resources do not exist on or significantly near to the candidate site that, if exploited, would result in failure to meet the performance objectives in subpart C of 10 CFR part 61."]

Natural resources include metallic or industrial mineral deposits, coal deposits and hydrocarbon deposits. According to Nuclear Regulatory Commission guidelines, areas should be avoided if they contain natural resources in sufficient quantity and quality that future exploitation could affect waste isolation.

OBJECTIVE VII. - AVOID CONFLICT WITH AREAS OF SPECIAL OR PROTECTED LAND USE INCLUDING ENVIRONMENTALLY SENSITIVE AREAS

A. Criterion - Exclude areas with wetlands as defined in the Goemaere-Anderson wetland protection act, Act No. 203 of the Public Acts of 1979, being sections 281.701 to 281.722 of the Michigan Compiled Law

[Section 10(e) of 204 PA 1987 reads, "The Authority shall establish final siting criteria that at a minimum excludes a candidate site that is any of the following: (e) Has wetlands within the boundaries of the candidate site as defined in the Goemaere-Anderson wetland protection act, Act No. 203 of the Public Acts of 1979, being sections 281.701 to 281.722 of the Michigan Compiled Laws."]

The purpose of the Goemaere-Anderson Wetland Protection Act is to protect and conserve the fragile wetland ecosystems that are vital habitats for fish, birds, and

other wildlife. A low-level radioactive waste facility should not be sited in an area that would disrupt wetlands conservation.

- B. Criterion - Exclude areas with environmental areas or high risk areas as defined in the shorelands protection and management act of 1970, Act No. 245 of the Public Acts of 1970, being sections 281.631 to 281.644 of the Michigan Compiled Laws.**

[Section 10(f) of 204 PA 1987 reads, "The Authority shall establish final siting criteria that at a minimum excludes a candidate site that is any of the following: (f) An environmental area or high risk area as defined in the shorelands protection and management act of 1970, Act No. 245 of the Public Acts of 1970, being sections 281.631 to 281.644 of the Michigan Compiled Laws.

The purpose of the Shorelands Protection Act is to protect and conserve the fragile shoreland ecosystems that are a valuable national resource. This criterion would exclude from consideration those areas identified in the Shorelands Protection Act.

- C. Criterion - Seek areas which have not been designated pursuant to Michigan Statute for wildlife conservation and management, for public recreation, or for protection of wilderness, wild, or natural values.**
- D. Criterion - Seek sites which do not cause visual intrusion on designated scenic highways so designated as of January 1, 1988.**
- E. Criterion - Seek sites which will not require that prime farmland be removed from agricultural production.**

OBJECTIVE VIII. - AVOID CONFLICT WITH COMMUNITY SOCIAL AND ECONOMIC GOALS

- A. Criterion - Seek areas which are not included in formally proposed or approved development plans as of January 1, 1988**
- B. Criterion - Seek areas which do not require the removal from production of prime farmland that would disrupt the economic base of the community.**
- C. Criterion - If all other criteria are met, give preference to areas near communities desiring the facility.**

[Criteria I.A, I.B, I.C, and VI.A are also directly relevant to the achievement of this objective]

OBJECTIVE IX. - COMPLY WITH FEDERAL LAWS WHICH PROTECT ENVIRONMENTALLY SENSITIVE AREAS AND WHICH PROTECT CULTURAL AND HERITAGE VALUES

A. Criterion - Exclude areas where siting will be inconsistent with the requirements of the following federal laws:

- (i) Atomic energy act of 1954, chapter 1073, 68 Stat. 919.**
- (ii) Federal water pollution control act, chapter 758, 62 Stat. 1155.**
- (iii) Coastal zone management act of 1972, Public Law 89-454, 16 U.S.C. 1451 to 1454b, 1455 to 1459, 1461 to 1463, 1464.**
- (iv) Endangered species act of 1973, Public Law 93-205, 87 Stat. 884.**
- (v) Wild and scenic rivers act, Public Law 90-542, 16 U.S.C. 1271 to 1287.**
- (vi) Wilderness act, Public Law 88-577, 16 U.S.C. 1131 to 1136.**
- (vii) National wildlife refuge system administration act of 1960, Public Law 89-669, 16 U.S.C. 668dd, 668ee.**
- (viii) Chapter 593, 49 Stat. 666, 16 U.S.C. 461 to 467.**
- (ix) The national historic preservation act, Public Law 89-665, 16 U.S.C. 470 to 470a, 470b, 470c to 470w-6.]**

[Section 11(3) of 204 PA 1987 reads, "In designating 3 candidate sites, the Authority shall give preference to sites that are all of the following: (e) Consistent with the requirements of federal laws, including all of the following:

- (i) Atomic energy act of 1954, chapter 1073, 68 Stat. 919.
- (ii) Federal water pollution control act, chapter 758, 62 Stat. 1155.
- (iii) Coastal zone management act of 1972, Public Law 89-454, 16 U.S.C. 1451 to 1454b, 1455 to 1459, 1461 to 1463, 1464.
- (iv) Endangered species act of 1973, Public Law 93-205, 87 Stat. 884.
- (v) Wild and scenic rivers act, Public Law 90-542, 16 U.S.C. 1271 to 1287.
- (vi) Wilderness act, Public Law 88-577, 16 U.S.C. 1131 to 1136.
- (vii) National wildlife refuge system administration act of 1966, Public Law 89-669, 16 U.S.C. 668dd, 668ee.
- (viii) Chapter 593, 49 Stat. 666, 16 U.S.C. 461 to 467.
- (ix) The national historic preservation act, Public Law 89-665, 16 U.S.C. 470 to 470a, 470b, 470c to 470w-6."]

APPENDIX A - PUBLIC LIBRARY REPOSITORIES

APPENDIX B - SUBPARTS C AND D OF 10 CFR 61

PART 61 • LICENSING REQUIREMENTS FOR LAND DISPOSAL OF RADIOACTIVE WASTE

necessary maintenance and repairs at the disposal site until the license is transferred by the Commission in accordance with § 61.30. Responsibility for the disposal site must be maintained by the licensee for 5 years. A shorter or longer time period for post-closure observation and maintenance may be established and approved as part of the site closure plan, based on site-specific conditions.

§ 61.30 Transfer of license.

(a) Following closure and the period of post-closure observation and maintenance, the licensee may apply for an amendment to transfer the license to the disposal site owner. The license shall be transferred when the Commission finds:

(1) That the closure of the disposal site has been made in conformance with the licensee's disposal site closure plan, as amended and approved as part of the license;

(2) That reasonable assurance has been provided by the licensee that the performance objectives of Subpart C of this part are met;

(3) That any funds and necessary records for care will be transferred to the disposal site owner;

(4) That the post-closure monitoring program is operational for implementation by the disposal site owner; and

(5) That the Federal or State government agency which will assume responsibility for institutional control of the disposal site is prepared to assume responsibility and ensure that the institutional requirements found necessary under § 61.23(g) will be met.

(b) [Reserved]

§ 61.31 Termination of license.

(a) Following any period of institutional control needed to meet the requirements found necessary under § 61.23, the licensee may apply for an amendment to terminate the license.

(b) This application must be filed, and will be reviewed, in accordance with the provision of § 61.20 and of this section.

(c) A license is terminated only when the Commission finds:

(1) That the institutional control requirements found necessary under § 61.23(g) have been met; and

(2) That any additional requirements resulting from new information developed during the institutional control period have been met, and that permanent monuments or markers warning against intrusion have been installed.

Subpart C—Performance Objectives

§ 61.40 General requirement.

Land disposal facilities must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposures to humans are within the limits established in the performance objectives in §§ 61.41 through 61.44.

§ 61.41 Protection of the general population from releases of radioactivity.

Concentrations of radioactive material which may be released to the general environment in ground water, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.

§ 61.42 Protection of individuals from inadvertent intrusion.

Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.

§ 61.43 Protection of individuals during operations.

Operations at the land disposal facility must be conducted in compliance with the standards for radiation protection set out in Part 20 of this chapter, except for releases of radioactivity in effluents from the land disposal facility, which shall be governed by § 61.41 of this part. Every reasonable effort shall be made to maintain radiation exposures as low as is reasonably achievable.

§ 61.44 Stability of the disposal site after closure.

The disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate to the extent practicable the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care are required.

Subpart D—Technical Requirements for Land Disposal Facilities

§ 61.50 Disposal site suitability requirements for land disposal.

(a) Disposal site suitability for near-surface disposal.

(1) The purpose of this section is to specify the minimum characteristics a disposal site must have to be acceptable for use as a near-surface disposal facility. The primary emphasis in disposal site suitability is given to isolation of wastes, a matter having long-term impacts, and to disposal site features that ensure that the long-term performance objectives of Subpart C of this part are met, as opposed to short-term convenience or benefits.

(2) The disposal site shall be capable of being characterized, modeled, analyzed and monitored.

(3) Within the region or state where the facility is to be located, a disposal site should be selected so that projected population growth and future developments are not likely to affect the ability of the disposal facility to meet the performance objectives of Subpart C of this part.

(4) Areas must be avoided having known natural resources which, if exploited, would result in failure to meet the performance objectives of Subpart C of this part.

(5) The disposal site must be generally well drained and free of areas of flooding or frequent ponding. Waste disposal shall not take place in a 100-year flood plain, coastal high-hazard area or wetland, as defined in Executive Order 11988, "Floodplain Management Guidelines."

(6) Upstream drainage areas must be minimized to decrease the amount of runoff which could erode or inundate waste disposal units.

(7) The disposal site must provide sufficient depth to the water table that ground water intrusion, perennial or otherwise, into the waste will not occur. The Commission will consider an exception to this requirement to allow disposal below the water table if it can be conclusively shown that disposal site characteristics will result in molecular diffusion being the predominant means of radionuclide movement and the rate of movement will result in the performance objectives of Subpart C of this part being met. In no case will waste disposal be permitted in the zone of fluctuation of the water table.

(8) The hydrogeologic unit used for disposal shall not discharge ground water to the surface within the disposal site.

PART 61 • LICENSING REQUIREMENTS FOR LAND DISPOSAL OF RADIOACTIVE WASTE

(9) Areas must be avoided where tectonic processes such as faulting, folding, seismic activity, or vulcanism may occur with such frequency and extent to significantly affect the ability of the disposal site to meet the performance objectives of Subpart C of this part, or may preclude defensible modeling and prediction of long-term impacts.

(10) Areas must be avoided where surface geologic processes such as mass wasting, erosion, slumping, landsliding, or weathering occur with such frequency and extent to significantly affect the ability of the disposal site to meet the performance objectives of Subpart C of this part, or may preclude defensible modeling and prediction of long-term impacts.

(11) The disposal site must not be located where nearby facilities or activities could adversely impact the ability of the site to meet the performance objectives of Subpart C of this part or significantly mask the environmental monitoring program.

(b) Disposal site suitability requirements for land disposal other than near-surface (reserved).

§ 61.51 Disposal site design for land disposal.

(a) Disposal site design for near-surface disposal.

(1) Site design features must be directed toward long-term isolation and avoidance of the need for continuing active maintenance after site closure.

(2) The disposal site design and operation must be compatible with the disposal site closure and stabilization plan and lead to disposal site closure that provides reasonable assurance that the performance objectives of Subpart C of this part will be met.

(3) The disposal site must be designed to complement and improve, where appropriate, the ability of the disposal site's natural characteristics to assure that the performance objectives of Subpart C of this part will be met.

(4) Covers must be designed to minimize to the extent practicable water infiltration, to direct percolating or surface water away from the disposed waste, and to resist degradation by surface geologic processes and biotic activity.

(5) Surface features must direct surface water drainage away from disposal units at velocities and gradients which will not result in erosion that will require ongoing active maintenance in the future.

(6) The disposal site must be designed to minimize to the extent practicable the contact of water with waste during storage, the contact of standing water

with waste during disposal, and the contact of percolating or standing water with wastes after disposal.

(b) Disposal site design for other than near-surface disposal (reserved).

§ 61.52 Land disposal facility operation and disposal site closure.

(a) Near-surface disposal facility operation and disposal site closure.

(1) Wastes designated as Class A pursuant to § 61.53, must be segregated from other wastes by placing in disposal units which are sufficiently separated from disposal units for the other waste classes so that any interaction between Class A wastes and other wastes will not result in the failure to meet the performance objectives in Subpart C of this Part. This segregation is not necessary for Class A wastes if they meet the stability requirements in § 61.56(b) of this part.

(2) Wastes designated as Class C pursuant to § 61.55, must be disposed of so that the top of the waste is a minimum of 5 meters below the top surface of the cover or must be disposed of with intruder barriers that are designed to protect against an inadvertent intrusion for a least 800 years.

(3) All wastes shall be disposed of in accordance with the requirements of paragraphs (a)(4) through (11) of this section.

(4) Wastes must be emplaced in a manner that maintains the package integrity during emplacement, minimizes the void spaces between packages, and permits the void spaces to be filled.

(5) Void spaces between waste packages must be filled with earth or other material to reduce future subsidence within the fill.

(6) Waste must be placed and covered in a manner that limits the radiation dose rate at the surface of the cover to levels that at a minimum will permit the licensee to comply with all provisions of § 20.103 of this chapter at the time the license is transferred pursuant to § 61.30 of this part.

(7) The boundaries and locations of each disposal unit (e.g., trenches) must be accurately located and mapped by means of a land survey. Near-surface disposal units must be marked in such a way that the boundaries of each unit can be easily defined. Three permanent survey marker control points, referenced to United States Geological Survey (USGS) or National Geodetic Survey (NGS) survey control stations, must be established on the site to facilitate surveys. The USGS or NGS control stations must provide horizontal and vertical controls as checked against USGSD or NGS record files.

(8) A buffer zone of land must be maintained between any buried waste and the disposal site boundary and beneath the disposed waste. The buffer zone shall be of adequate dimensions to carry out environmental monitoring activities specified in § 61.53(d) of this part and take mitigative measures if needed.

(9) Closure and stabilization measures as set forth in the approved site closure plan must be carried out as each disposal unit (e.g., each trench) is filled and covered.

(10) Active waste disposal operations must not have an adverse effect on completed closure and stabilization measures.

(11) Only wastes containing or contaminated with radioactive materials shall be disposed of at the disposal site.

(b) Facility operation and disposal site closure for land disposal facilities other than near-surface (reserved).

§ 61.53 Environmental monitoring.

(a) At the time a license application is submitted, the applicant shall have conducted a preoperational monitoring program to provide basic environmental data on the disposal site characteristics. The applicant shall obtain information about the ecology, meteorology, climate, hydrology, geology, geochemistry, and seismology of the disposal site. For those characteristics that are subject to seasonal variation, data must cover at least a twelve month period.

(b) The licensee must have plans for taking corrective measures if migration of radionuclides would indicate that the performance objectives of Subpart C may not be met.

(c) During the land disposal facility site construction and operation, the licensee shall maintain a monitoring program. Measurements and observations must be made and recorded to provide data to evaluate the potential health and environmental impacts during both the construction and the operation of the facility and to enable the evaluation of long-term effects and the need for mitigative measures. The monitoring system must be capable of providing early warning of releases of radionuclides from the disposal site before they leave the site boundary.

(d) After the disposal site is closed, the licensee responsible for post-operational surveillance of the disposal site shall maintain a monitoring system based on the operating history and the closure and stabilization of the disposal site. The monitoring system must be capable of providing early warning of releases of radionuclides from the

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disposal site before they leave the site boundary.

§ 61.54 Alternative requirements for design and operations.

The Commission may, upon request or on its own initiative, authorize provisions other than those set forth in §§ 61.51 through 61.53 for the segregation and disposal of waste and for the design and operation of a land disposal facility on a specific basis, if it finds reasonable assurance of compliance with the performance objectives of Subpart C of this part.

§ 61.55 Waste classification.

(a) Classification of waste for near surface disposal.

(1) *Considerations.* Determination of the classification of radioactive waste involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides (and their shorter-lived precursors) whose potential hazard will persist long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective. These precautions delay the time when long-lived radionuclides could cause exposures. In addition, the magnitude of the potential dose is limited by the concentration and availability of the radionuclide at the time of exposure. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective.

(2) *Classes of waste.* (i) Class A waste is waste that is usually segregated from other waste classes at the disposal site. The physical form and characteristics of Class A waste must meet the minimum requirements set forth in § 61.56(a). If Class A waste also meets the stability requirements set forth in § 61.56(b), it is not necessary to segregate the waste for disposal.

(ii) Class B waste is waste that must meet more rigorous requirements on waste form to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements set forth in § 61.56.

(iii) Class C waste is waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements set forth in § 61.56.

(iv) Waste that is not generally acceptable for near-surface disposal is waste for which waste form and disposal methods must be different, and in general more stringent, than those specified for Class C waste. In the absence of specific requirements in this part, proposals for disposal of this waste may be submitted to the Commission for approval, pursuant to § 61.58 of this part.

(3) Classification determined by long-lived radionuclides. If radioactive waste contains only radionuclides listed in Table 1, classification shall be determined as follows:

(i) If the concentration does not exceed 0.1 times the value in Table 1, the waste is Class A.

(ii) If the concentration exceeds 0.1 times the value in Table 1 but does not exceed the value in Table 1, the waste is Class C.

(iii) If the concentration exceeds the value in Table 1, the waste is not generally acceptable for near-surface disposal.

(iv) For wastes containing mixtures of radionuclides listed in Table 1, the total concentration shall be determined by the sum of fractions rule described in paragraph (a)(7) of this section.

TABLE 1

Radionuclide	Concentration limits per cubic meter
C-14	6
C-14 in activated metal	60
H-3 in activated metal	270
H-3 in activated metal	0.2
Ti-62	3
I-129	0.06
Alpha emitting transuranic nuclides with half-life greater than ten years	1,000
Pu-239	2,000
Am-241	20,000

¹Units are micrograms per gram.

(4) Classification determined by short-lived radionuclides. If radioactive waste does not contain any of the radionuclides listed in Table 1, classification shall be determined based on the concentrations shown in Table 2. However, as specified in paragraph (a)(6) of this section, if radioactive waste does not contain any nuclides listed in either Table 1 or 2, it is Class A.

(i) If the concentration does not exceed the value in Column 1, the waste is Class A.

(ii) If the concentration exceeds the value in Column 1, but does not exceed the value in Column 2, the waste is Class B.

(iii) If the concentration exceeds the value in Column 2, but does not exceed the value in Column 3, the waste is Class C.

(iv) If the concentration exceeds the value in Column 3, the waste is not generally acceptable for near-surface disposal.

(v) For wastes containing mixtures of the nuclides listed in Table 2, the total concentration shall be determined by the sum of fractions rule described in paragraph (a)(7) of this section.

TABLE 2

Radionuclide	Concentration limits per cubic meter		
	Col. 1	Col. 2	Col. 3
Total of all nuclides with less than 5 year half life	700	15	15
H-3	40	15	15
Co-60	700	15	15
Mo-93	35	70	700
Mo-93 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Ce-137	1	44	4600

¹There are no limits established for three radionuclides of Class B or C wastes. Practical considerations such as the effects of natural radon and internal heat generation on transportation, handling, and disposal limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other nuclides in Table 2 determine the waste to be Class C independent of these nuclides.

(5) Classification determined by both long- and short-lived radionuclides. If radioactive waste contains a mixture of radionuclides, some of which are listed in Table 1, and some of which are listed in Table 2, classification shall be determined as follows:

(i) If the concentration of a nuclide listed in Table 1 does not exceed 0.1 times the value listed in Table 1, the class shall be that determined by the concentration of nuclides listed in Table 2.

(ii) If the concentration of a nuclide listed in Table 1 exceeds 0.1 times the value listed in Table 1 but does not exceed the value in Table 1, the waste shall be Class C, provided the concentration of nuclides listed in Table 2 does not exceed the value shown in Column 3 of Table 2.

(6) Classification of wastes with radionuclides other than those listed in Tables 1 and 2. If radioactive waste does not contain any nuclides listed in either Table 1 or 2, it is Class A.

(7) The sum of the fractions rule for mixtures of radionuclides. For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each nuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0 if the waste class is to be determined by that column. Example: A waste contains Sr-90 in a

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concentration of 50 Ci/m^3 and Cs-137 in a concentration of 22 Ci/m^3 . Since the concentrations both exceed the values in Column 1, Table 2, they must be compared to Column 2 values. For Sr-90 fraction $50/150 = 0.33$; for Cs-137 fraction, $22/44 = 0.5$; the sum of the fractions = 0.83 . Since the sum is less than 1.0, the waste is Class B.

(8) *Determination of concentrations in wastes.* The concentration of a radionuclide may be determined by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements. The concentration of a radionuclide may be averaged over the volume of the waste, or weight of the waste if the units are expressed as nanocuries per gram.

§ 61.56 Waste characteristics.

(a) The following requirements are minimum requirements for all classes of waste and are intended to facilitate handling at the disposal site and provide protection of health and safety of personnel at the disposal site.

(1) Waste must not be packaged for disposal in cardboard or fiberboard boxes.

(2) Liquid waste must be solidified or packaged in sufficient absorbent material to absorb twice the volume of the liquid.

(3) Solid waste containing liquid shall contain as little free standing and noncorrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume.

(4) Waste must not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.

(5) Waste must not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste. This does not apply to radioactive gaseous waste packaged in accordance with paragraph (a)(7) of this section.

(6) Waste must not be pyrophoric. Pyrophoric materials contained in waste shall be treated, prepared, and packaged to be nonflammable.

(7) Waste in a gaseous form must be packaged at a pressure that does not exceed 1.5 atmospheres at 20°C . Total activity must not exceed 100 curies per container.

(8) Waste containing hazardous, biological, pathogenic, or infectious material must be treated to reduce to the

maximum extent practicable the potential hazard from the non-radiological materials.

(b) The requirements in this section are intended to provide stability of the waste. Stability is intended to ensure that the waste does not structurally degrade and affect overall stability of the site through slumping, collapse, or other failure of the disposal unit and thereby lead to water infiltration. Stability is also a factor in limiting exposure to an inadvertent intruder, since it provides a recognizable and nondispersible waste.

(1) Waste must have structural stability. A structurally stable waste form will generally maintain its physical dimensions and its form, under the expected disposal conditions such as weight of overburden and compaction equipment, the presence of moisture, and microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.

(2) Notwithstanding the provisions in §§ 61.56(a) (2) and (3), liquid wastes, or wastes containing liquid, must be converted into a form that contains as little free standing and noncorrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume of the waste when the waste is in a disposal container designed to ensure stability, or 0.5% of the volume of the waste for waste processed to a stable form.

(3) Void spaces within the waste and between the waste and its package must be reduced to the extent practicable.

§ 61.57 Labeling.

Each package of waste must be clearly labeled to identify whether it is Class A waste, Class B waste, or class C waste in accordance with § 61.55.

§ 61.58 Alternative requirements for waste classification and characterization.

The Commission may, upon request or on its own initiative, authorize other provisions for the classification and characteristics of waste on a specific basis, if, after evaluation, of the specific characteristics of the waste, disposal site, and method of disposal, it finds reasonable assurance of compliance with the performance objectives in Subpart C of this part.

§ 61.59 Institutional requirements.

(a) *Land ownership.* Disposal of radioactive waste received from other persons may be permitted only on land

owned in fee by the Federal or a State government.

(b) *Institutional control.* The land owner or custodial agency shall carry out an institutional control program to physically control access to the disposal site following transfer of control of the disposal site from the disposal site operator. The institutional control program must also include, but not be limited to, carrying out an environmental monitoring program at the disposal site, periodic surveillance, minor custodial care, and other requirements as determined by the Commission; and administration of funds to cover the costs for these activities. The period of institutional controls will be determined by the Commission, but institutional controls may not be relied upon for more than 100 years following transfer of control of the disposal site to the owner.

Subpart E—Financial Assurances

§ 61.61 Applicant qualifications and assurances.

Each applicant shall show that it either possesses the necessary funds or has reasonable assurance of obtaining the necessary funds, or by a combination of the two, to cover the estimated costs of conducting all licensed activities over the planned operating life of the project, including costs of construction and disposal.

§ 61.62 Funding for disposal site closure and stabilization.

(a) The applicant shall provide assurance that sufficient funds will be available to carry out disposal site closure and stabilization, including: (1) Decontamination or dismantlement of land disposal facility structures; and (2) closure and stabilization of the disposal site so that following transfer of the disposal site to the site owner, the need for ongoing active maintenance is eliminated to the extent practicable and only minor custodial care, surveillance, and monitoring are required. These assurances shall be based on Commission-approved cost estimates reflecting the Commission-approved plan for disposal site closure and stabilization. The applicant's cost estimates must take into account total capital costs that would be incurred if an independent contractor were hired to perform the closure and stabilization work.

(b) In order to avoid unnecessary duplication and expense, the Commission will accept financial sureties that have been consolidated with earmarked financial or surety arrangements established to meet