9.0 ALTERNATIVES TO PROPOSED ACTION

9.1 Background to the Alternatives Analyses

9.1.1 Introduction

This section provides the environmental impact analysis associated with alternatives to the proposed project. As described in Section 1.1, this application seeks an early site permit under 10 CFR 52 for the siting of a new nuclear facility, potentially involving one or more nuclear plants, at the existing GGNS site. At the time of this application, the Applicant's general intention is that a new nuclear facility be a merchant nuclear plant, providing electrical energy to the competitive marketplace. This new marketplace was created by the Energy Policy Act of 1992 and subsequent actions by the Federal Energy Regulatory Commission (FERC) in establishing open transmission requirements for electrical energy providers. A new facility would be expected to provide energy to the grid in a base-loaded manner.

However, there are numerous commercial and regulatory issues that must be addressed and resolved with state and federal agencies to finalize the regulatory status of a new facility. For these reasons, as noted in Section 1.0, the site will be reserved for a facility that may be operated as an unregulated merchant (non-utility) generator or a regulated (utility) generator. The generated power may be sold on the retail and/or wholesale energy market. The numerous factors and issues involved in the final decision on this would not be resolved at the ESP stage but rather would be evaluated and determined in parallel to the finalization of reactor type selection and facility design. Nevertheless, the final regulatory status of a new facility does not impact this analysis of environmental impacts related to alternatives to the proposed project.

Integral to this definition of the proposed project are two important understandings of the likely market environment in which COL decisions would be made and of the benefits now and later of an early site permit. Prior to the specific analyses of alternatives, including the no-action alternative, alternative energy sources, and alternative sites, the following introductory remarks are provided to highlight factors that must be considered in alternative analyses involving a proposal for new generating capacity.

9.1.1.1 The Changing Electrical Power Generation Marketplace

Through the changes brought about by the Energy Policy Act of 1992 and Federal Energy Regulatory Commission (FERC) Order 888 of 1996, the market place no longer follows traditional organizational, power production, transmission and sales patterns that were the norm when the nation's current nuclear fleet were constructed and licensed (Reference 2). As noted by the NRC in NUREG-1555 (ESRP Section 9.2), the deregulation of utilities and open access to power-transmission systems should have significant impact on the analysis of need for power on the competition for cheaper power, and on the service area. Because of deregulation in the bulk sales markets for electricity, the advent of independent power producers, and the increased use of purchases and exchanges of electric power to meet demand, the demand for the power by the ultimate customers within a utility's traditional service area increasingly is not met by a utility's own generating resources (Reference 1).

An important implication of this changing electricity generation marketplace is that, for the merchant nuclear facility, a regulatory structure would not likely be in place to guarantee a return on investment. Apart from compliance with applicable regulations related to safety and environmental impact, the future decision to proceed with the construction of a new nuclear facility (or any new power generation capacity) would only be made if appropriate national policy, energy demand, and marketplace conditions were met and these factors are consistent with the Applicant's business goals at that time. In short, a new facility would be constructed and operated if the market conditions were satisfied such that the project would meet regulations and represent a successful business undertaking. The summary concept is referred hereafter as "market demand."

The approved early site permit, therefore, would allow the Applicant to monitor the marketplace and to decide if conditions, at some time during the life of the permit, would justify the commitment of resources required to proceed with construction and operation of a new nuclear facility.

As discussed in the introduction to these alternative analyses, it is recognized that a new facility may be operated in a regulated status. Should that occur, there would be a regulatory structure in place providing confidence in an established return on investment. The extent and detail of this arrangement can not be determined (or analyzed) at this time. However, the underlying concept of "market demand" would remain applicable and integral to the complex decision-making process regarding the pursuit of new generation construction and operation. Overall market conditions, public policy, energy demand, confidence among lending institutions must be considered in the decision regarding new potential generation. While regulatory status and the potential for retail and/or wholesale power sales add considerable complexity, the underlying concept of "market demand" is a central determinant in the analysis of new generation viability. Regulatory status and the nature of the market type, therefore, do not impact the impact analysis or conclusions provided here.

9.1.1.2 Benefits and Application of 10 CFR 52 in Today's Marketplace

With the approval of 10 CFR 52, the NRC envisioned a number of benefits of an approved early site permit. Accompanying the rule's publishing, the Commission indicated: "Both the (design) certification and the permit make it possible to resolve important licensing issues before a construction permit proceeding. They in effect make possible the banking of designs and sites, thereby making the licensing of a given plant more efficient." The Commission also stated its belief that "... early site permits can usefully serve as vehicles for resolving most site issues before large commitment of resources are made." The Commission indicated its expectation that the rule would have a beneficial effect on the licensing process. "The Commission's intent with this rulemaking is only to have a sensible and stable procedural framework in place for the consideration of future designs, and to make it possible to resolve safety and environmental issues before plants are built, rather than after." [1] (Reference 2)

It is the Applicant's expectation that the successful permitting of the GGNS ESP Site would indeed render the subsequent licensing of a future nuclear facility more efficient. Coupled with the importance of market demand on the decision to build new generation, the improved efficiency expected by the Commission and Applicant is considered a necessary component in maintaining the nuclear option as a viable and competitive alternative.

Several goals must be simultaneously achieved in the decision to proceed with any new generation construction. A project must be cost effective, environmentally sound, and provide value and service to the public while, at the same time, provide the prospect of an appropriate return to shareholders. To respond to the market with new generating capacity, the selected generation method must meet these conditions and must be achievable in on a timeframe that

[1] Federal Register, Vol. 54, No. 73, (April 18, 1989), 15373 and 15378.

would be responsive to the demand. Further, the securing of necessary financial support would dictate efficient licensing and subsequent construction processes such that an acceptable level of financial risk can be achieved, as established by lending institutions.

9.1.1.3 Organization of the Alternative Analyses

As required by Appendix A to Subpart A in 10 CFR 51, the no-action alternative (i.e., denial of the requested permit by the NRC) is discussed in Section 9.1.2.

The assessment of various alternative energy sources is provided in Section 9.2. The assessment of alternate energy sources would normally include consideration of a number of time-sensitive parameters such as energy demand, grid relationships, the potential for purchased power, the schedule for units expected to be retired, and the ability to effectively accomplish a certain amount of conservation. It is recognized that considerable uncertainty is associated with dealing with such factors. However, the concepts discussed above regarding market-driven decisions in concert with reliable current information on the relative environmental impacts of viable base-loaded generation methods, make possible a meaningful and reasonable assessment of a broad range of alternative energy sources.

In that the proposed project involves the possible future construction of a new nuclear facility, this represents a special case in the evaluation of other alternative sites and is, therefore, generally limited to sites with currently licensed, operating nuclear units. The assessment of alternative sites is provided in Section 9.3, along with a discussion of how the GGNS site compares with hypothetical undeveloped (greenfield) and industrial (brownfield) sites.

Consistent with NRC regulations, this application does not provide an assessment of the need for power (10 CFR 52.18). While the record supporting the rulemaking is not clear, it is presumed that the Commission recognized that consideration of need for power would not be appropriate or meaningful at the time of ESP because an ESP application does not involve or imply an intent or commitment to actually build a new nuclear power plant. And, as discussed above, the evolution of the marketplace places special emphasis and consideration on the pre-condition of market demand prior to making a decision to build new electrical generation capacity, nuclear or otherwise. The alternative analyses described herein are in compliance with current regulations and are intended to be responsive to NRC guidance for environmental impact analyses (i.e., NUREG-1555). However, at the same time, the Applicant supports the efforts of the Nuclear Energy Institute in various proposed rulemaking activities related to the need for power, alternative energy sources, and alternate sites (Reference 4).

9.1.2 No-Action Alternative and Potential Outcomes

As required by 10 CFR 51 (Subpart A, Appendix A.4), the alternative of no-action is discussed herein. The term “no-action” is taken here to mean that the NRC (for reasons unspecified) denies the application for an early site permit for the proposed site. The Applicant’s purpose, consistent with the intent of Part 52, is to permit the site for the potential future construction and operation of a new nuclear facility. With the denial of the permit, it follows that the licensing and construction of the new nuclear facility via the Part 52 process referencing an approved ESP is thus precluded. This no-action decision by the NRC then sets up a number of possible outcomes that are discussed below.

By regulation, the need for power is not required to be evaluated at the ESP stage of the Part 52 process. However, for the purposes of this alternatives analysis, it is presumed that there is, indeed, a need for new power generation capacity. From this point, the no-action alternative can take the following general paths.

1. The Applicant may choose not to pursue construction of any new generation capacity at the proposed ESP site, and thus the need for power presumably must be met by other alternative means that involve no new generating capacity. These alternatives would include such approaches as demand-side management, energy conservation, and power purchased from other electricity providers. Given the unique nature of the early site permit, considerable uncertainty is involved in the treatment of a number of time-sensitive factors normally considered in such an assessment. However, with the recognition of factors shaping decisions in the marketplace, along with current information on relative environmental impacts, a reasonable evaluation of alternatives involving no new generation capacity is possible. This evaluation is discussed in Section 9.2.1.
2. The required generating capacity could be provided by the construction of new generating capacity using with other generating alternatives rather than a new nuclear facility. The new capacity may be constructed at the proposed ESP site or at other, non-designated, "greenfield" sites. Assessments of these alternatives are provided in Section 9.2.2, including combinations thereof. It should be noted that the Applicant's purposes in seeking the early site permit is to support possible future construction and operation of a new nuclear facility at the proposed ESP site. This purpose is consistent with the Applicant's overall business, socioeconomic development, and environmental protection strategies (Reference 3).
3. It is also possible that some combination of the above approaches could be taken to provide the equivalent of the generating capacity lost by the NRC's denial of the early site permit. For example, the proposed capacity could be met by a certain amount of new gas turbine capacity, combined with purchased power from outside the Applicant's system. Potential combinations of alternative energy sources are considered in Section 9.2.2.

Since the no-action alternative is the denial of the early site permit, a new nuclear facility would not then be constructed or operated at the proposed ESP site. It, therefore, follows that the environmental impacts described and predicted in this report for the new facility would not occur. However, obviously, while the predicted impacts would not occur at this site if the facility were not built, some of these impacts (or greater impacts) could occur at other sites if new generating capacity is constructed and operated at those other sites to meet the presumed need for power. These impacts are evaluated (i.e., compared with those of the proposed project) in Section 9.2.2.

9.1.3 References

1. U.S. Nuclear Regulatory Commission (USNRC), 1999, Environmental Standard Review Plan (NUREG-1555), Office of Nuclear Reactor Regulation, Washington, DC.
2. U.S. Nuclear Regulatory Commission (USNRC), "Early Site Permits; Stand Design Certifications; and Combine Licenses for Nuclear Power Reactors, Final Rule, Federal Register, Volume 54, Number 73, April 18, 1989, Washington, DC.
3. URL, Entergy Corporation, 2003, "The Environment" and "Greenhouse Gas Reduction Commitment," http://www.entergy.com/corp/environnment/.

9.2 Energy Alternatives

9.2.1 Alternatives Not Requiring New Generating Capacity

As discussed in Section 9.1.2, alternatives to a new nuclear facility include (1) replacing the proposed project's generation capacity without the construction of new generating capacity, or (2) initiating energy conservation measures with a total capacity equivalent to that of the proposed project. Consideration of these alternatives would normally require the evaluation of the opportunity for power purchases from other utilities or power producers, the activation of retired plants, or the delayed retirement of existing plants. Consideration would also be given the potential for and magnitude of conservation measures, such as measures to improve the efficiency of current generators supplying the market in question.

For example, per NRC guidance in NUREG-1555 (Reference 1), such analyses would require the following types of information:

1. Projected regional systems reserve margins for a 6-year period starting with the 1st year of commercial operation of the proposed project.
2. Projected peak loads of the electrical utilities in the area being served, load duration curves, and baseload for the same period.
3. Transmission intertie capability of plants within the relevant region and intertie capability between transmission systems in the relevant regional grid, as well as the applicant's relationship to the various electrical energy generators, transmission, and distribution companies.
4. Listing of plants in the relevant service area scheduled for retirement or that could be reactivated if shutdown, for the same period defined above. This would include the expected plant generating capacity, projected availability factor, environmental impacts, etc. for any plants with the potential for reactivation or extended operation.
5. The potential for energy conservation within the relevant service area.

In general, the above types of information are dependent on the specific time at which the proposed project is expected to come on-line. In the case of the ESP process, that information may not be available at the time of application. Therefore, there would be a considerable uncertainty involved in predicting and applying such information. However, as discussed in more detail in this section, it is possible to use currently published information on relative environmental impacts and to consider the decision-making environment to provide a reasonable and sound assessment of this category of alternative energy sources.

Section 9.2.2 provides a detailed analysis of alternative energy sources that could be considered for replacement generation purposes, i.e., replacing the proposed project. The Section 9.2.2 analysis evaluates the various alternatives, describes the key relative environmental impacts, and identifies those alternatives that are considered competitive and viable in comparison to the proposed project. This analysis (in Section 9.2.1) of energy alternatives not involving new capacity relies, in part, upon results and conclusions provided in Section 9.2.2.

Other important understandings applied in this analysis are the concepts, discussed in Section 9.1.1.2, of market demand and how market considerations act to shape analysis and decisions on purchased power, delayed plant retirements, renewal, and conservation.

9.2.1.1 Power Purchases

The parameter central to consideration of the purchased power alternative would normally be the amount of excess generating capacity (i.e., capacity beyond reserve margin requirements) available for extended periods of time from other sources that could supply the region of interest. Closely related to excess capacity is the time period proposed for the new nuclear facility to come on-line. Given that the specific time itself is likely not known when the ESP application is filed, it is further not likely that sufficiently reliable excess capacity predictions would be available. However, based on the assessment of alternative energy sources in Section 9.2.2, the viable, competitive alternative sources are coal or natural gas. In addition, both of these alternatives are shown in Section 9.2.2 to involve environmental impacts in key evaluation areas to be generally greater than for a new nuclear facility. Further, the types of impacts that support the overall conclusion would not likely change to a significant degree over the lifetime of the ESP permit.

For example, the impact areas of interest for an equivalent coal facility involve its relatively substantial land use commitments, and its adverse combustion product discharges impacting air quality. While not as great, the replacement gas fired plant would also be expected to have greater land use requirements and adverse air quality impacts than the proposed project. Presuming that both coal and gas technologies continue to realize improvements in impact mitigation throughout the duration of the ESP permit, one can assume that the relative magnitude of advantages to the nuclear facility may be reduced. However, it is not conceivable that improvements would be so substantial as to render the coal or gas alternatives as environmentally preferable. Further, such improvements would likely serve to increase coal and gas generation facility capital and production costs as well.

Finally, as discussed in Section 9.1.1.1, the final decision to build a merchant (or utility) nuclear plant must necessarily be made with the pre-condition that market demand warrants new nuclear generating capacity. Given this principal, it is not logical that the permit holder would embark on the necessary financial, engineering, staffing, and public relations steps to construct a new nuclear facility if cost competitive and environmentally acceptable[1] excess electrical energy capacity could be purchased from other sources.

Other sources, in this sense, could also include currently operating nuclear plants. While the proposed project would be environmentally equivalent to such an alternative source (for purchased power), it is logically precluded since the market demand condition for construction of a new nuclear facility would not be fully met if excess nuclear generating capacity was available over the potential lifetime of the proposed project.

Given that purchased power would likely come from coal and gas fired sources, it is concluded (based on the analysis provided in Section 9.2.2) that these alternative energy sources would not be considered environmentally preferable to the proposed project. Further, in view of the role of market demand in making final decisions regarding the construction of a new nuclear plant, it would not be reasonable that cost competitive and environmentally acceptable excess generation capacity through purchased power agreements would be available.

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[1] "Acceptable" in this use means environmentally equivalent or preferable.

9.2.1.2 Plant Reactivation or Extended Service Life

An assessment of potential use of plant reactivations or extended service life requires the identification of plants deactivated (but potentially recoverable) at or near the time when the proposed project is expected to come on line. Likewise, such an assessment would identify plants scheduled for retirement around the same time.[2] As in the case of purchased power, an important variable is obviously the time period when the proposed project is expected to come on line. This information is likely not available at the ESP application phase. Thus, it is difficult to reliably predict the specific plants that should be considered in such an assessment.

However, as discussed above, the plants that would likely replace the proposed project would be coal and natural gas units. These alternative energy sources would involve and thus impose, the relatively greater environmental impacts associated with the dated technology of generating plants near the end of their design life. As discussed above and supported in Section 9.2.2, it can be expected that such energy sources in this category would not represent environmentally preferable alternatives. It is conceivable, that another nuclear plant could also represent a potential alternative source by way of reactivation or license renewal. However, as in the case of purchased power, if additional capacity could economically be made available and meet company, state, and federal environmental goals, then the market demand pre-condition criteria for building the proposed project would not be met.

Therefore, given a real need for the proposed project, reactivation or extended service life are not considered reasonable and/or environmentally preferable alternative energy sources.

9.2.1.3 Conservation (Energy Efficiency)

The assessment of potential capacity offset[3] associated with conservation requires consideration of numerous factors that influence and encourage conservation. This can include the effectiveness of efforts in the region of interest to conserve and promote customer conservation of electrical energy. The role of energy efficiency and the sensitivity of applying efficiency improvement methods to generators in the region of interest would also be considered. The costs of implementing energy efficiency measures must be evaluated against the ability to recover those costs and earn a fair profit. The most thorough analysis would also review regional trends in energy efficiency increases, electricity pricing, economic recessions, and weather variations for their individual and collective impact on load growth.

These factors would be considered, in some form, along with many other variables in an overall assessment of market demand. It is conceivable that conservation measures due to increasing current plant efficiencies and/or energy consumption conservation programs may produce some portion of the required capacity. However, on net, the market demand pre-condition must be met; otherwise, a new facility would not be constructed.

From an environmental impact standpoint, conservation could be considered in combination with other sources. Given the required market demand pre-condition, conservation alone would not be a reasonable alternative to the proposed project. Combinations of the viable alternatives, coal and natural gas, are considered addressed in Section 9.2.2.8. That evaluation concluded

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[2] NUREG-1555 (Section 9.2.1) suggests that the period from the date of application to the 6th year of commercial operation for a project be considered in this assessment.

[3] It is presumed that there is a demand for a project's capacity. Conservation measures are considered as a potential method of offsetting or reducing the need for power.

that such combinations would not result in an environmentally preferable alternative. The ability to offset some portion of required capacity is not expected to have significant impact on that condition. In addition, the market demand pre-condition must always be met before proceeding with construction of the proposed project.

9.2.2 Alternatives Requiring New Generating Capacity

9.2.2.1 Introduction

This section discusses the possible use of alternatives requiring new generating capacity that could reasonably be expected to meet the additional generating capacity expected from a new nuclear facility considered for the ESP site. While the need for power is discussed in this report, for the purposes of this evaluation, it is presumed that there would be a demand for the power at the time a COL application is submitted to the NRC. This section, as a starting point, considers (1) alternatives not yet commercially available, (2) fossil fuels, and (3) alternatives uniquely available within the region to be served by the proposed project.

As discussed above there are numerous factors, which introduce uncertainty into this analysis. During the lifetime of the early site permit, it is expected that technology will continue to improve in its operational and environmental performance. Thus, any qualitative or quantitative analyses of future relative competitiveness or impacts are subject to those uncertainties. However, as in the case of alternatives evaluated in Section 9.2.1, it is believed that sufficient knowledge is available at this time to make reasonable comparisons of the alternatives in the principal areas of cost and environmental impacts to satisfy the intent and requirements of Part 52 regarding an ESP application.

9.2.2.2 Proposed Project

As described in Section 9.1 above, the ESP application's proposed project is to obtain an early site permit that demonstrates the suitability of the proposed ESP site for the construction and operation of a new nuclear power facility. The proposed project is currently intended to be a merchant provider of electric power to the open market and operated in a base-loaded manner. At the time of this application and review, consistent with industry and NRC Staff expectations, the specific type or design of the facility is not known (Reference 6). (See the discussion in Section 9.1.1 regarding the potential for the regulated or unregulated status of a new facility.)

To support this application, as discussed in Section 3.0, a bounding plant parameters envelope (PPE) approach was taken. An early step in this process established, for planning and analysis purposes, an approximate <u>target value</u> for the desired electrical output from the new facility that could be sited at GGNS. As a result, a value of approximately <u>2000 MWe</u> was selected. It should be emphasized that this value is required for the above purposes but does not reflect a future commitment to a specific reactor type or a specific level of generating capacity. Based on many factors, involving commercial, market, policy, and regulatory considerations, the final new facility's capacity may be more or less than the target value of 2000 MWe. However, the PPE approach sets bounding values for key parameters used in this report based on this minimum target electrical output.

The PPE was developed considering a number of reactor designs that were either commercially available at the time of this application or anticipated to be commercially available within the term of the ESP. The reactors chosen for the PPE represent a wide range of nuclear technologies.

Establishment of the target site capacity of 2000 MWe was an initial step in PPE development. Because each reactor type considered in development of the PPE was of a different size, an exact comparison of electrical output ratings and the associated environmental impacts was not possible. For example, for single reactor units, the types considered represented capacities ranging from 160 MWe to 1500 MWe. In order to facilitate comparison between the different plant types in the PPE, the number of units/modules of a specific reactor type was chosen, based on vendors recommended combinations, to approximate 1000 MWe. This resulted in “single-unit plants” with capacities in the range of 1005 MWe to 1500 MWe. Given that the target size of a new facility is on the order of 2000 MWe, the bounding number for each parameter in the PPE was doubled, where appropriate, to determine the overall magnitude of each parameter. In the PPE (Table 3.0-1), the “Composite Value” generally reflects the values corresponding to a plant that is twice the vendor's specified “standard size plant.”[4] Some PPE values were not doubled since having twice the vendor's specified standard size plant does not cause twice the environmental impact. Environmental impacts associated with PPE values are evaluated in this report and used in this alternatives analysis. In like manner, logical multiples of the alternative energy generators were used for impact comparisons since these generators also vary widely in capacity ratings per unit.

The PPE bounding values were “driven” by a multiple of reactor units representing a total generation capacity that was either equivalent to or, in some cases, much greater than 2000 MWe[5]. For example, PPE bounding values for auxiliary boiler sulfur dioxide emissions were associated with sulfur dioxide estimates from a sufficient number of boilers to support two large LWR units. In this case, these two large LWRs are expected to be capable of producing approximately 2400 MWe. The task in this section assesses relative environmental impacts between the proposed project (based on bounding values in the PPE for 2000 MWe or greater) and a combination of alternative energy generators sufficient to achieve approximately 2000 MWe. Thus, this analysis, which compares the impacts based on 2000 MWe or greater for the proposed project, is considered a conservative, reasonable approach.[6] The “permit basis” for the purposes of environmental impact is, thus, not defined by the target capacity of 2000 MWe but rather by the PPE bounding values on which the proposed project’s impacts are based.

9.2.2.3 Use of License Renewal GEIS Analyses

The NRC, per its regulations for implementing the National Environmental Policy Act (10 CFR Part 51), documented its generic impact evaluation of reasonable alternatives related to the license renewal of nuclear power plants in NUREG-1437, Volume 1 (LRGEIS) (Reference 7). As plant specific applications for license renewal are evaluated and approved by the Commission, appropriate supplements are added to Volume 2 of NUREG-1437. While the NRC’s analysis

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[4] For the reactor technologies considered in the PPE, the vendor’s “standard plant” may consist of one (e.g., larger advanced LWR design) to eight individual reactor units (e.g., gas-cooled design).

[5] The largest advanced LWR design considered in the PPE has a capacity rating of 1500 MWe per unit; thus, to meet the target site capacity of 2000 MWe two units are required, resulting in a total site electrical capacity of 3000 MWe.

[6] Given this method, the bounding proposed project’s generating capacity was substantially greater than the target value of 2000 MWe, thus adding conservatism to this alternatives analysis.

was expressly for the purposes of evaluating license renewal, it is believed that a large portion of the data collected and reported in the LRGEIS is applicable and useful in performing this ESP application analysis of alternative energy sources.

The NRC evaluation of the "no-action" alternative in the case of license renewal involves the consideration of the NRC's denial of the requested renewed license. With the denial of the license (and the subsequent shutdown of the subject nuclear plant), reasonable alternatives must be sought (and evaluated) to offset that loss of generating capacity. The NRC, in its evaluation, identifies and evaluates reasonable alternatives in the LRGEIS (and in subsequent plant specific LRGEIS supplements). Some of the alternatives analyzed involve the construction of new facilities fueled by alternative energy sources, considering land use, air quality impacts, water use, etc. There are strong parallels between the license renewal alternative energy analyses and that for an ESP application. Both must identify and discuss the impacts of new construction and essentially long term operation of an alternative energy generator. Information, therefore, provided by (1) the NRC in NUREG-1437 Volume 1 (generic), (2) in plant specific applications for license renewal, and (3) in the NRC's plant specific LRGEIS supplements documenting its review, is useful and applicable to this analysis to the extent that the information pertains to the environmental impacts and costs related to the construction and operation of new, long term generation capacity sufficient to replace that of a new nuclear facility.

Specifically, this alternative energy source analysis relies to a large extent on information provided in one of most recent NRC reviewed and approved license renewal applications, i.e., that of Peach Bottom Atomic Power Station for Units 2 and 3 (PBAPS), published in January 2003 (Reference 8). Not only is this a recent review, but also its total replacement capacity is comparable to the target site capacity of 2000 MWe in this application. In the LRGEIS supplement, the NRC reports the evaluation of replacement coal and gas generating facilities having four plants of 508 MWe (net) capacity each, for a total of 2032 MWe new capacity (Reference 8). Given the comparable replacement capacity and since the NRC evaluated the fossil-fired plants for a 40 year lifetime (i.e., not limited to the term of license renewal), the reported environmental impacts of constructing and operating these fossil-fired plants are useful and appropriate for comparison here (independent of whether the alternatives replace a nuclear plant following denial of its request for license renewal or construction of a new facility under Part 52).

9.2.2.4 Alternative Analysis Method

This alternative energy analysis compares the environmental impacts of a new nuclear facility with the impacts of appropriate, reasonable, alternative energy sources providing equivalent, new capacity.

As discussed in EIA's latest energy forecast summary report, the *Annual Energy Outlook 2003*, published in January 2003 (Reference 5), generation from natural gas, coal, nuclear, and renewable fuels is projected to increase through 2025 to meet growing demand and to offset the projected retirement of existing generating capacity. The EIA predicts that this will result in the construction of new, more efficient natural gas combined-cycle capacity. The natural gas share of electricity generation is projected to increase from 17 percent in 2001 to 29 percent in 2025. The share of coal is projected to decline from 52 percent (2001) to 48 percent (2025) as a more competitive electric industry invests in less capital-intensive and more efficient natural gas generation technologies. However, coal is expected to remain the primary fuel for electricity generation through 2025. Petroleum based fuels are expected to continue to represent a very small share of generation through 2025. Given this picture of predicted electric energy generation, the alternative energy source analysis here focused on competitive gas and coal technologies; however, other sources are considered, as discussed below.

Per the guidance of NUREG-1555, Section 9.2.2, this alternative energy source analysis considered sources that are available to the applicant and have been categorized as either competitive or noncompetitive with the proposed project. The following energy sources were considered in this analysis:

1. Coal
2. Natural gas
3. Oil
4. Wind power
5. Solar power
6. Hydropower
7. Geothermal energy
8. Wood waste
9. Municipal solid waste
10. Other biomass-derived fuels
11. Fuel cells

Possible combinations of these energy sources were also considered.

Based on a review of earlier alternative evaluations, all the above energy alternatives were eliminated from more detailed analysis except for coal and natural gas. Elimination, in general, was due to one or more of the following considerations: high land use impacts, low capacity factors, geographic availability of the resource, high or uncertain fuel costs, lack of overall economic competitiveness, or the unproven nature of the technology. The coal and gas alternatives are considered to be viable, competitive alternatives to the proposed project. Each energy source eliminated is discussed below with a brief explanation as to the basis of elimination.

In that the end product of this analysis is the comparison of impacts of the proposed project with that of the alternatives, remarks regarding proposed project impacts are included in the following sections to facilitate comparison. A summary of this impact analysis, focused on key environmental impact areas, is provided in Table 9.2-1 for the proposed project and alternatives.

9.2.2.5 Coal-Fired Generation

In general, the environmental impacts of constructing a typical coal-fired steam plant are well known because coal, as discussed earlier, is the most prevalent type of central generating technology in the United States. The impacts of constructing a large coal plant at a “greenfield” site can be substantial, particularly if it is sited in a rural area with considerable natural habitat (Reference 7).

The NRC evaluated the construction and operation of four standard coal-fired 509 MWe units, i.e., a total capacity of 2032 MWe (Reference 8). This coal-fired facility capacity is comparable to the proposed project’s target capacity of 2000 MWe and thus, appropriate for this analysis.

9.2.2.5.1 Land Use and Related Impacts to Ecology

Since this alternative would involve new construction, one key environmental impact area is land use. The NRC indicated that this coal-fired facility would require approximately 2680 acres which is considerably larger than that required for the proposed project (approximately 125 acres)[7]. The current GGNS site is approximately 2100 acres (Reference 9). However, a part of the current site is used for GGNS Unit 1 or was dedicated to the partially constructed Unit 2 and cannot be used for a new facility based on rate base related agreements with various states Public Service Commissions. A considerable portion, estimated to be approximately 1000 acres, is in a floodplain and not suitable for a plant or for coal storage. Therefore, if the new coal facility were to be sited at (or near) GGNS, additional land procurement would be required. Given that some of the land was disturbed with the construction of GGNS Unit 1 (and partial construction of Unit 2), it can be assumed that the coal plant construction would impact both disturbed and undisturbed land.

Since large quantities of coal and lime (or limestone) would be delivered via rail line or by river barge, new construction would be required to support the barge and/or the railcar turnaround facilities. Given the substantial land use (relative to the proposed project), the associated impacts related to land clearing, erosion and sedimentation, air quality from construction vehicles, impact to the ecology, etc. would be proportionally much greater for the coal-fired alternative.

The NRC estimated that approximately 22,000 acres would be affected for mining the coal and disposing of the waste to support a coal plant during its operational life (References 7 and 8). Thus, the equivalent land usage requirement for 2000 MWe coal-fired production would be approximately 44,000 acres.[8] Based on NRC estimates, uranium mining and processing required to supply fuel during the operating life of a nuclear facility of 2000 MWe capacity would be approximately 1000 acres.

9.2.2.5.2 Waste Generation and Emissions

The NRC reported that such a plant would consume approximately 6.6 million tons per year of pulverized bituminous coal with an ash content of approximately 11.9 percent. After combustion, this would result in 784,000 tons to be collected and disposed of at the plant site. In addition, approximately 728,000 tons of scrubber sludge would be disposed of at the plant site based on annual lime usage of approximately 246,000 tons. Lime is used in the scrubbing process to control of sulfur dioxide emissions. Waste impacts to groundwater and surface water could extend beyond the operating life of the plant if leachate and runoff from the waste storage area occurs (Reference 8).

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[7] As discussed in Section 4.3, the construction of a project could require up to approximately 400 acres. Approximately 70% of this value involves undisturbed upland forests and fields, or undisturbed wetlands. The remaining 30% was previously disturbed by the construction of GGNS Unit 1. Eventually, disturbed areas not otherwise revegetated or used for permanent structures slowly develop stable communities similar to that which existed prior to construction.

[8] The NRC does not explicitly relate the 22,000 acre value to a 1000 MWe coal plant, but this is inferred. Thus, the land use estimate for a 2000 MWe coal plant would be double that value (Reference 7).

See additional discussion below for considerations of the impacts from wastes, transportation, etc., comparing the coal alternative to the proposed project.

9.2.2.5.3 Air Quality and Human Health

Air quality impacts from a coal-fired plant vary considerably from those of nuclear generation. Typical emission levels from coal plants include sulfur oxides, nitrogen oxides, particulates, carbon monoxide, carbon dioxide, hazardous air pollutants such as mercury and naturally radioactive materials (Reference 8). While the operation of a new nuclear facility does include relatively small quantities of such emissions, typically from auxiliary boilers, the amount of air quality impact for the coal plant is substantially greater. Emissions predicted for the proposed project and other alternatives for SO_X, NO_X, particulates, carbon monoxide and carbon dioxide are addressed in Table 9.2-1.

Title IV of the Clean Air Act (42 USC 7491) was enacted to reduce emission of SO_2 and NO_X, the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. This law provides for the creation, banking, and exchange of allowances for SO_2 emitted. By this provision, it is conceivable that an owner could construct and operate a new coal-fired plant and add no net regional SO_2 emissions, although it might do locally (Reference 8). However, the overall emissions and associated impact to air quality from this alternative would remain much greater than that of a new nuclear facility.

The issue of “global warming” continues to be a pressing policy and regulatory topic that impacts the operations of current fossil-fired plants, as well as considerations in the construction of new fossil-fired facilities. Energy caps and regulated reductions in carbon dioxide emissions are expected in the future but are difficult to predict at this time, particularly due to the questionable status and domestic significance of the Kyoto draft treaty. The EIA projections of generation capacity, in fact, do not include the impact of future policy actions that might be taken to reduce these emissions. EIA predicted an annual 1.5 percent increase in carbon dioxide related emissions (Reference 5). Carbon dioxide emissions represent an additional factor that renders the coal-fired alternative less attractive in terms of environmental impact.

The combustion of coal would result in the exposure of the public to uranium and thorium contained in the coal. The population dose equivalent from the uranium and thorium release and daughter products produced by the decay of these isotopes has been calculated to be significantly higher than that from nuclear power plants. The coal plant alternative introduces worker risks from coal/limestone mining and transportation, and disposal of coal combustion wastes. There are public risks associated with coal/limestone transportation wastes and inhalation of stack emissions. These risks are difficult to quantify. Regulatory agencies set air emission standards and requirements to minimize human health impacts. Absent more quantitative data on impacts, the NRC characterized risks from radioactive doses and inhaling toxins and particulates generated by burning coal as small (Reference 8).

See additional discussion below for considerations of the air quality impacts and human health effects, comparing the coal alternative to the proposed project.

9.2.2.5.4 Cooling System Considerations, Water Use, and Related Impacts to Ecology

The NRC evaluated the coal plant with both open and closed cycle cooling systems. In general, in either case, intake and discharge would be designed to comply with state and federal standards. The closed-cycle system would require slightly more land, but the difference is insignificant relative to the overall land use requirement noted above. The open-cycle system, with a higher intake and discharge flow rate, could have greater potential impacts, e.g., impingement and entrainment of fish and thermal impacts, to the aquatic ecosystem. The closed-cycle system would typically rely on large natural draft cooling towers or mechanical fan-cooled cooling towers. The trade-off in this case would be the evaporation, drift, and other impacts from the cooling tower, including discharge of dissolved solids to the river of cooling tower blowdown (Reference 8). The decreased intake flow rate of the closed-cycle system would have less impact on the aquatic ecosystem (e.g., impingement and entrainment mortalities) and less thermal impact on the receiving water body (Reference 7). Water use impacts depend on the volume of water required and the characteristics of the receiving body (Reference 8).

If sited at (or near) GGNS, the bulk of the coal plant's raw water makeup is assumed to come from the Mississippi River. A new cooling system intake structure on the river would be required, resulting in temporary impact during construction. However, as evaluated for the proposed project (Chapters 4 and 5), neither the construction nor operation of the coal plant's intake would be expected to have no significant impact on surface water, i.e., the Mississippi River. The coal plant's discharge to river would be expected to have impacts comparable to those of the proposed project, i.e., not significant.

If the coal plant were placed on an alternate site, there could be impacts depending on available surface water and groundwater sources. In any case, appropriate permits would govern and limit surface water and groundwater use and impacts. Overall, the impacts would are expected to be small (Reference 8).

9.2.2.5.5 Socioeconomics

The coal plant would require an estimated construction work force of 2500 workers over a 5-year period. Thus, surrounding communities would experience demands for housing and public services. And following the conclusion of construction, the communities would then experience the loss of some portion of these construction jobs. With this workforce, area roads would experience increased traffic loads to and from the construction site (Reference 8). The proposed project expects a construction workforce of 3150 over a comparable five to six year period.

With the slightly smaller construction workforce (2500 vs. 3150), socioeconomic impacts could be expected to be slightly smaller in comparison to the proposed project. However, as was the case in the construction of GGNS Unit 1, these impacts related to the workforce would likely be dispersed over a relatively large geographic area that includes three well-developed population centers, i.e., Vicksburg, Natchez, and Jackson, MS. The respective counties (Warren, Adams, and Hinds) have a total population of about 334,000 (Reference 12). While the commuting workforce would come from counties surrounding the construction site, many would likely originate from these larger population centers due to services available there. Since the construction of GGNS Unit 1, the highway capacity of the main route connecting Vicksburg and the site (U.S. Highway 61) was increased to 4 lanes. Improvements to plant access are planned for Mississippi Highway 18 in 2003. These improvements would tend to mitigate increased traffic loads associated with both the coal plant and the proposed project. Based on an assessment of current highway capacities around the GGNS site and considering reasonable assumptions regarding carpooling and management of shift changes (Section 4.4), there would be little overall difference in impacts between the coal alternative and the proposed project.

Providing some offset to these impacts would be benefits related to construction and operation. In the short term, during construction, some portion of surrounding communities could be expected to find employment in construction jobs at the site. In the long term the tax base would increase for affected communities. Both of these benefits would be proportionally larger for the proposed project. Thus, while the proposed project's workforce is greater than that of the coal plant, the impacts will be short term and mitigated by dispersion over several relatively populous counties and improved transportation routes. Impacts would be offset, to some degree, by proportionally larger employment opportunity and tax base associated with the proposed project.

The proposed project was evaluated to have no significant adverse environmental or human health impacts; therefore, no potential disproportionate impacts to low income and/or minority groups are expected. See the review of environmental justice in Sections 4.4 and 5.8 for additional detail.

9.2.2.5.6 Transportation and Fuel Cycle Impacts of a Project Compared to the Coal Alternative

Table S-3 of 10 CFR 51.51 summarizes environmental impact data associated with the uranium fuel cycle. The PPE approach utilized in this application considers both light-water-cooled (LWR) and gas-cooled reactor technologies. Section 5.7 evaluates the LWR technologies considered in the PPE, demonstrating the applicability of the Table S-3 environmental and human health effects. Section 5.7 also addresses the gas-cooled reactor technologies included in the PPE. The evaluation in Section 5.7 demonstrates that the existing environmental and health effect studies used as a basis for Table S-3 are conservative and appropriate for application to the gas-cooled reactor technologies.

The environmental impacts associated with transporting fresh fuel to and spent fuel and waste from a LWR are summarized in Table S-4 of 10 CFR 51.52. Section 3.8 demonstrates that the LWR technologies being considered in the PPE satisfy the 10 CFR 51.52(a) conditions for use of Table S-4. Thus, the environmental impacts of transportation of fuel and radioactive wastes for LWRs are represented by the values provided in Table S-4. Section 3.8 also evaluated the gas-cooled reactor technologies considered in the PPE. That evaluation showed that the existing environmental and health effects of Table S-4 are conservative and are appropriate to characterize the new gas-cooled reactor technologies.

Both Table S-3 and S-4 compilations are based on reference LWR reactors with a specific electrical (MWe) output. Therefore, the environmental impacts would have to be scaled appropriately to estimate impacts associated with the target site capacity of 2000 MWe of the proposed project. However, in general, given the assessments of the proposed project provided in Section 3.8 and Section 5.7, it can be concluded that the expected impacts associated with the uranium fuel cycle and transportation of nuclear fuels for the proposed project would be consistent with that complied by the NRC in Tables S-3 and S-4. Thus, given the assessments in Section 3.8 and Section 5.7 and in consideration of the above discussion of coal plant waste generation, impacts to air quality, and human health, the coal plant would not expected to be an environmentally preferable alternative.

9.2.2.6 Gas-Fired Generation

The environmental impacts of the natural-gas-fired alternative are examined in this section, considering both the GGNS site and an unnamed alternate site. The analysis assumes a closed-cycle cooling system since the once-through system is considered to have greater overall environmental impacts (for reasons discussed in the preceding analysis of the coal-fired alternative).

The NRC's analysis considered four standard-sized gas-fired units of 508 MWe, representing a total capacity of 2032 MWe net. The plant was assumed to use a combined-cycle technology. It is possible that when the demand for natural gas is high, fuel oil may be used, incurring its relatively higher costs and more emissions than gas. However, this analysis does not quantify that impact. Impacts were determined based on a 40 year operating lifetime for the gas-fired facility (Reference 7).

9.2.2.6.1 Land Use and Related Impacts to Ecology

As reported in Section 2.2.1, the closest natural gas pipeline is 4.75 miles from the GGNS site. Thus, for the case in which the gas plant is built at (or near) the GGNS site, there would be an associated impact related to pipeline construction.

The gas plant would require 110 acres for the power block and support facilities and likely could be sited on land that was previously disturbed in the construction of GGNS Unit 1.[9] Assuming the gas plant uses a closed-cycle cooling system (as discussed below), an additional land area of up to 30 acres is required for cooling towers and support systems, thus bringing the total estimated footprint to 140 acres. If the plant is sited at GGNS, then construction of the gas "branch" pipeline could require approximately 85 acres.[10] If an alternate site were selected, the construction impact would be 640 acres per 15-mile segment of installed gas pipeline (Reference 8). Thus, the total land use commitment (for siting the gas plant at GGNS) would be approximately 225 acres (and larger if additional pipelines are required due to an alternate site selection).

The proposed project is expected to require about 125 acres. Thus, the gas plant's footprint (if sited at GGNS) is somewhat larger than the proposed project's land use (225 acres vs. 125 acres). It can be assumed that the gas plant would, therefore, require a proportionally higher use of land not previously disturbed by the construction of GGNS Unit 1, with associated higher impacts to wildlife habitat, etc. On net, from this perspective, the gas plant would not be considered environmentally preferable to the proposed project.

In addition to the proposed project's use of 125 acres for permanent structures, up to 275 additional acres could be affected (temporarily) during construction of the proposed project. Land used temporarily during construction would be subject to standard mitigation procedures to minimize impact. Appropriate measures would also be taken to restore the land, and long-term impact is not expected. Temporary land use during construction of the gas plant was not available. The estimated total gas plant operational footprint (225 acres) would be larger than that associated with the proposed project. As noted earlier, the gas plant operational footprint could be larger if placed at another site requiring additional gas supply pipeline right-of-way and construction. Without specific data on land temporarily impacted during gas plant construction, further assessment is not possible. However, it can be assumed that with the use of standard mitigation procedures and the temporary nature of these impacts, it is not likely that construction land use and the associated impacts to ecology would make the gas plant environmentally preferable to the proposed project.

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[9] The NRC did not specify land requirements for temporary use during construction (References 7 and 8).

[10] The 85-acre impact is scaled up from the value used in Reference 8 since the connection line to GGNS would be 4.75 miles vs. the 3-mile distance assumed in Reference 8.

Additional land could be required for natural gas wells and collection stations. Based on NRC estimates, this could amount to 7200 acres to support a gas-fired plant of approximately 2000 MWe (Reference 8). Uranium mining and processing could require approximately 2000 acres for the operating life of a nuclear facility of 2000 MWe capacity. Given this consideration and the relatively larger land use related to fuel source (and the related impacts to the ecology), the gas plant alternative would not be environmentally preferable to the proposed project.

9.2.2.6.2 Cooling System Considerations, Water Use and Impact to Ecology

The gas-fired plant is assumed to use a closed-cycle cooling system with the bulk of raw water makeup to come from the Mississippi River (for siting at GGNS). A new cooling system intake structure on the river would be required, resulting in temporary impact during construction. However, as evaluated for the proposed project (Chapters 4 and 5), neither the construction nor operation of the gas plant's intake would be expected to have no significant impact on surface water, i.e., the Mississippi River. The gas plant's discharge to river would be expected to have impacts comparable to those of the proposed project, i.e., not significant.

If the gas plant were placed on an alternate site, there could be other impacts, depending on available surface water and groundwater resources. In any case, appropriate permits would govern and limit surface water and groundwater use and impacts. Overall, the impacts are expected to be small (Reference 8).

9.2.2.6.3 Air Quality and Human Health

Regarding air quality impact, natural gas is a relatively clean burning fuel. The types of emissions would be similar to coal, yet in substantially smaller quantities and subject to the same of type of regulations. The estimated emissions for SO_X, NO_X, CO, CO_2 and particulates for the gas plant are addressed in Table 9.2-1 and are greater than those associated with the proposed project. As with the coal plant, similar concerns regarding impact to global warming apply to the use of gas as a fuel source. The gas plant would contribute significantly to CO_2 emissions, but these impacts are not quantified. As noted earlier, the impact of expected future policy and regulations related to global warming cannot be predicted at this time. But in any case, a new nuclear plant offers a substantially more attractive alternative in the long term in comparison to the gas plant relative to air quality impact. The nuclear alternative will continue to be a principal consideration as electrical energy producers seek effective ways to voluntarily reduce greenhouse gas emissions.[11]

Solid waste generation from the gas plant is expected to be small.

Human health impact, based on NRC estimates, would be related to cancer, emphysema and other risks. However, overall, the impacts to human health from the gas plant alternative are considered small (Reference 8).

9.2.2.6.4 Socioeconomics

Socioeconomic impact would be of a similar nature to that described above for the coal plant alternative except that the estimated gas plant work force is smaller, along with a shorter projected construction period. Peak construction workforce is estimated to be approximately

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[11] According to the EIA, nuclear power plants were responsible for 41 percent of the total voluntary reductions in greenhouse gas emissions reported by U.S. companies in 2001 (Reference 13).

1200 workers (Reference 8). With the smaller construction workforce and shorter construction period, socioeconomic impacts are expected to be smaller in comparison to the larger scale construction effort predicted for the proposed project. However, as discussed above regarding the coal plant alternative, these impacts are expected to be distributed over a relatively large geographic area and two mature population centers. In addition, key transportation routes have been or are being improved which would help mitigate impacts of higher construction traffic loads. Road capacities are considered to be adequate to support the larger construction workforce assumed for the proposed project; thus, on net, the differences regarding transportation impact between the gas plant alternative and the proposed project are not expected to be significant.

These socioeconomic impacts (in general) are short-term, during construction. Providing some degree of offset to these impacts are benefits related to increase job opportunities during construction (short term) and an increased tax base (long term). Thus, while the proposed project's workforce and construction time period are greater than that of the gas plant, the impacts will be short term and mitigated by dispersion over several relatively populous counties and improved transportation routes. Impacts would be offset, to some degree, by proportionally larger employment opportunity and tax base associated with the proposed project.

The proposed project was evaluated to have no significant adverse environmental or human health impacts; therefore, no potential disproportionate impacts to low income and/or minority groups are expected. See the review of environmental justice in Section 4.4 and 5.8 for additional detail.

9.2.2.6.5 Air Quality, Human Health, and Other Fuel Cycle Impacts of a Project Compared to the Gas Alternative

Section 3.8 and Section 5.7 provide assessments of the nuclear fuels transportation and fuel cycle impacts associated with the proposed project. As concluded in Section 9.2.2.5.6, it is expected that impacts related to waste, transportation, and human health would be consistent with that compiled by the NRC in Tables S-3 and S-4 of 10 CFR 51.52. Thus, given the assessments of Section 3.8 and Section 5.7 and considering the above discussion of the impact to air quality and human health for the gas plant, the gas plant would not expected to be an environmentally preferable alternative.

9.2.2.7 Other Alternatives

Other alternative energy sources considered in this analysis are discussed below. The summary remarks include the basis for finding the energy source to be an unacceptable alternative to the proposed project.

9.2.2.7.1 Oil-Fired Generation

As discussed earlier, the EIA *Annual Energy Outlook 2003* noted that oil-fired plants are expected to represent only a small portion of new (electricity) generation through 2025 (Reference 5). This is primarily due to higher and uncertain fuel costs as well as lower efficiencies. Entergy's assessment in support of its application for license renewal for Arkansas Nuclear One (ANO) indicated that oil could be used as a backup to natural gas but indicated several areas of increased air quality impact in comparison to gas (Reference 10). The NRC (in reviewing the ANO application) concluded that, due to cost considerations, the oil-fired plant is not considered a stand-alone fuel when natural gas is available (Reference 11). Oil is, therefore, eliminated as a viable competitive alternative to the proposed project.

9.2.2.7.2 Wind

While wind technology is expected to improve in capacity factor and, of course, is attractive due to the renewable energy source characteristics, low capacity factors for wind generated power along with excessive cost of energy storage devices make this source unacceptable as an alternative to a base-loaded electricity generator (Reference 11). While wind turbines can achieve capacity factors of 30 to 35 percent, such performance falls well short of the 90 to 95 percent required for a baseload plant (Reference 8). Another key consideration is land use. Based on land use estimates, wind farms with sufficient capacity to meet the target site requirement of 2000 MWe would require from 80,000 to 268,000 acres[12], thus representing a large potential land use and ecological impact. In addition, due to the considerably lower capacity factor for wind turbines, the use of MWe to scale up and estimate impacts would tend to greatly underestimate the magnitude of impact from the wind alternative. To produce the same amount of electrical energy (as a project), more then three times the installed wind capacity would be required. Thus, for example, land use and construction related impacts for sufficient effective wind generated energy would be much higher (than from a simple scaling up, using installed MW capacity). The wind energy source is not an acceptable alternative to the proposed project.

9.2.2.7.3 Solar Technologies: Photovoltaic Cells and Solar Thermal Power

In general, solar powered technologies, photovoltaic (PV) cells and solar thermal power do not currently compete with conventional fossil-fueled technologies in grid-connected applications due to higher capital costs per kW of capacity. Like wind, capacity factors also are too low to meet baseload requirements. Land use requirements (and associated construction and ecological impacts) are also much higher for these alternatives in comparison to the proposed project. Equivalent facilities having 2000 MWe capacity are estimated to require 70,000 acres, if powered by PV cells, and 28,000 acres, if powered by solar thermal power (Reference 8). Geographic limitations would also be expected to make solar technologies less competitive since the most promising region in the country for this application is the west. The NRC recognized that some potential for this source exists in the mid-west and south but did not quantify that expectation (Reference 7). Based on these considerations, solar technologies do not represent acceptable alternatives to the proposed project.

9.2.2.7.4 Hydropower

Hydroelectric or hydropower has the ability to produce higher capacity factors (relative to wind and solar). The NRC indicated that capacity factors approaching about 50 percent could be expected (Reference 7), but this cannot meet the baseload requirement. Land use for a large-scale hydropower facility is estimated to be quite large. To meet the 2000 MWe target for the proposed project, a hydropower facility is estimated to require about 2,000,000 acres. The NRC also notes that such facilities are difficult to site as a result of public concern over flooding, destruction of natural habitat, and alteration of natural river courses. Hydropower does not represent an acceptable alternative to the proposed project (Reference 7).

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[12] The range is based on estimated land use rates per MW, reported by the NRC for the Storm Mountain project (West Virginia) and the Altamont Pass facility (CA) (Reference 8).

9.2.2.7.5 Geothermal

Geothermal energy can produce relatively high average capacity factors and can be used for baseload power where this type of energy source is available. However, this energy source is expected to be most appropriate and available in the western United States, Alaska, and Hawaii. Widespread application of geothermal energy is constrained by the geographic availability of the resource and the maturity of the technology (Reference 7). This energy source is not an acceptable alternative to the proposed project.

9.2.2.7.6 Biomass Related Fuels

Wood-burning facilities can provide baseload power with relatively high average capacity factors. Efficiencies are expected to be lower than coal-fired plants. Fuel sources have supply uncertainties and are relatively high-priced. Construction impacts are on the same level as that of coal plants. Fuel storage and processing land use estimates are also quite high (References 7 and 8). For these reasons, similar to the coal-fired facility, the wood-burning energy source is not an acceptable alternative to the proposed project.

Energy production by municipal solid waste (MSW) combustion slowed dramatically in 1990s after rapid growth in the 1980s. Factors cited by the NRC involved tax law changes increasing capital costs, court decisions related to the flow of waste, and environmental regulations impact on initial capital costs (References 7 and 8). Consistent with arguments made by the NRC regarding the relatively small scale of energy production from this source, MSW combustion does not represent an acceptable alternative to the proposed project.

The NRC has evaluated other biomass-derived fuels for the purposes of alternative energy source analysis. These included burning crops, converting crops to a liquid fuel such as ethanol, and gasifying crops (including wood waste). The NRC concluded that none of these technologies had progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant. This conclusion applies to this analysis. The other biomass-derived fuels do not represent an acceptable alternative to the proposed project.

9.2.2.7.7 Fuel Cells

Fuel cell technology offers a number of very attractive characteristics from an environmental impact standpoint in that they work without combustion and the associated environmental impacts. Capital cost competitiveness has not been achieved as yet with current estimates showing fuel cell costs per installed kW to be roughly twice that of a natural gas combined-cycle plant. The NRC concluded that, at the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation (Reference 8). Fuel cells do not represent an acceptable alternative to the proposed project.

9.2.2.8 Combination of Alternatives

Even though individual alternatives might not be sufficient on their own to replace the proposed project target 2000 MWe capacity due to the small size of the resource or lack of cost-effective opportunities, it is conceivable that a mix of alternatives might be cost effective (Reference 11).

For reasons already discussed in Section 9.2.1, alternatives involving purchased power and reactivation or extended service life of generators are not expected to be environmentally preferable (based on relative environmental impacts) and/or reasonable alternatives (due to market demand considerations). Conservation measures could provide a partial offset of the need for power that would be supplied by the proposed project. The remaining portion of the proposed capacity would have to be supplied by one or both of the remaining viable alternatives. The use of some combination of those alternatives is addressed below.

The remaining alternatives that could be considered for possible combinations involve new generating capacity. If the hypothetical mix included coal-fired generation, the environmental impacts associated with construction (land use, ecology) and air quality would remain quite large and are expected to be greater than that of the proposed project. For example, the proposed project's target capacity could be met by the building one 508 MWe coal-fired units along with three 508 MWe natural gas combined-cycle units. Based on Table 9.2-1, this combination coal-gas facility would require approximately 680 acres[13] for permanent structures, or about five times that of the proposed project (about 125 acres). Air quality impact for one 508 MWe coal-fire unit would still compare unfavorably with the nuclear facility due to the large amount of combustion products from coal-fired generation. The impact of the three natural gas units would only add to the overall favorable position of a new nuclear facility. If conservation were available and effective in reducing the total need for power to some degree, any combination of coal and gas generation would still not be expected to be environmentally preferable for the same reasons.

There are other combinations of various sources discussed above. However, poor annual average capacity factors, higher environmental impacts (land use, ecological, air quality), immature technologies, and/or cost-competitiveness are not expected to lead to a viable, competitive alternative which would be either environmentally equivalent or preferable.

9.2.3 Assessment of Alternative Energy Sources and Systems

The preceding alternatives analysis considered the no-action alternative along with other alternatives involving new generating capacity. A wide variety of potential alternative energy sources were considered. The majority of these sources were eliminated due to high land use impacts, low capacity factors, geographic availability of the resource, or the emergent, unproven nature of the technology. Key environmental impact areas were identified, and the viable, competitive alternatives were analyzed to determine if any of the alternatives could be considered environmentally preferable to the proposed project. Table 9.2-1 summarizes the results of this analysis.

Permanent land use for the generating facility (proposed project or otherwise) represents unavoidable environmental impacts. None of the viable, competitive alternatives were identified to provide an appreciable reduction in overall impact. In addition, the proposed project was estimated to require less land use commitment for obtaining the fuel source (by mining or wells, depending on the source). The coal alternative was substantially inferior due to relatively large construction and operational land use requirements.

Ecological impacts can vary depending on whether or not the alternative plants are sited at GGNS or an alternate site. As in the assessment of land use, none of the viable competitive alternatives were found to provide an appreciable reduction in overall impact to the ecology. In addition, these alternatives were expected to have greater impacts to the ecology due to fuel source related land use. No environmentally preferable alternatives were identified.

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[13] This is computed by assuming appropriate portions of the permanent plant foot print land use listed in Table 9.2-1, that is, 25% and 75% for gas and coal, respectively.

Closed-cycle cooling systems were considered for the alternatives (as is intended for the proposed project). In evaluating surface and ground water impact, no environmentally preferable alternatives were identified.

Air quality impacts are largely related to airborne emissions. The proposed project was expected to provide the lowest amount of key contaminants into the atmosphere. The coal alternative, with substantially greater emissions, was considered environmental inferior for this impact area. No environmentally preferable alternatives were identified.

Impacts related to waste generation, transportation, and human health were assessed. No environmentally preferable alternatives were identified.

Socioeconomic impacts related to coal and gas alternatives were considered, relative to that of the proposed project. Construction work force and duration are key parameters. While the proposed project is estimated to have a larger work force and longer construction duration (in comparison to the gas-fired alternative), the associated increased socioeconomic impacts are temporary (during construction) and should be mitigated by the distribution of these impacts over a larger, more populous area and by improved transportation routes. These impacts could be offset to some degree by the opportunity for increased employment during construction. In the long term, surrounding communities could also benefit from a relatively higher tax base. Environmental justice was considered in this analysis. The proposed project has no significant adverse environmental or human health impacts; therefore, no disproportionate impacts to special population groups are expected. No environmentally preferable alternatives were identified.

In regard to historical and archeological resources, the potential for impact is usually related to the need for land. Land use is discussed above. Appropriate evaluations have been completed for the proposed project, concluding that no historical resources are likely to be impacted by the proposed new construction at the GGNS ESP Site. It is expected that any additional potential impacts related to the alternatives considered would be effectively managed. No environmentally preferable alternatives were identified.

This analysis concludes that, for the key environmental impact areas evaluated, there is no alternative energy source identified as environmentally preferable to the proposed project.

9.2.4 References

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9.3 Alternative Sites

9.3.1 Introduction

As discussed earlier in this section on alternatives analyses, the applicant's purpose in making this application is to seek NRC approval for the possible future construction and operation of a new nuclear generation facility at the GGNS ESP Site. The intent is that this new nuclear facility be a merchant nuclear plant, providing electrical energy to the competitive marketplace created by the Energy Policy Act of 1992 and subsequent actions by the FERC, establishing open transmission requirements on electrical energy providers.[1] (See the discussion in Section 9.1.1 regarding the potential for the regulated or unregulated status of a new facility.)

This effort to obtain NRC siting approval is consistent with Entergy's understanding that such actions make nuclear generation a viable alternative, providing the opportunity for a timely and competitive response to anticipated potential future market demands for energy. The future decision, however, to proceed with new nuclear facility construction would only be made if appropriate national policy, energy demand, and marketplace conditions are met, and are consistent with the applicant's business goals.

As required by 10 CFR 52.17(a)(2), this section provides an analysis of alternatives to the proposed GGNS ESP Site for the construction and operation of a new nuclear facility. NEPA mandates that reasonable alternatives to a action be evaluated. Consistent with this requirement, the site selection decision process focused on those alternative sites that are considered to be reasonable with respect to the purpose of this application for an ESP, as described above.

The decision to construct a new nuclear facility in response to market demand presumes that the applicant's internal assessment has concluded that such an enterprise can be undertaken in a cost competitive manner. It, therefore, follows that site selection must be one of the first decisions made in that cost effectiveness evaluation. Inherent in the cost effectiveness evaluation is another presumption that sites already (1) characterized, (2) reviewed and approved by the NRC, (3) having established programs and relationships with state and local agencies, and (4) owned and/or controlled by the applicant, would be the most cost effective choices for considering construction of a new nuclear facility.

Therefore, consistent with NRC guidance in NUREG-1555, this alternative analysis represents a "special case"[2] in which the selection process is limited to sites currently licensed and approved by the NRC for a nuclear generation facility or facilities, and which have been previously found by the NRC to be suitable for construction and operation of a nuclear power plant. That prior NRC review process included an alternative site analysis.

The current fleet of Entergy sites provides significant diversity in geographic location and market access, and each of the sites provides advantages (described later) associated with an already existing nuclear plant. Taken collectively, these sites represent a reasonable set of alternatives for an ESP site and, therefore, comprise an appropriate region of interest (ROI) within which the site evaluation process was conducted.

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[1] For additional discussion on the impacts of the Energy Policy Act and subsequent FERC actions, see Section 9.2.1.

[2] NUREG-1555, Section III(8), (Reference 1).

The process described below was undertaken as part of a broader exploration of business strategies to determine the preferred sites within Entergy's fleet of seven existing licensed nuclear sites most suitable for an ESP application. The overall decision-making process for analyzing the potential sites was derived from EPRI's Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application (Reference 2). Based on this EPRI effort, Entergy developed a site selection guideline document to govern the decision making process (Reference 3).

For reasons discussed above, it is expected that no non-nuclear site would be found to be obviously superior. While not required by NEPA, this report section provides a qualitative analysis that compares the proposed GGNS site to hypothetical (generic) "greenfield" (undeveloped) and "brownfield" (industrial) sites. This analysis demonstrates that such alternative sites are not expected to be found obviously superior to the proposed GGNS site for the stated purpose.

9.3.2 Process for Preferred Site Selection

The process for selection of a preferred site consisted of the following steps.

1. A region of interest was established, and based on that ROI, a set of potential sites was identified that would be considered in the selection process.
2. The initial set of sites was screened, using appropriate criteria, to further refine it to a listing of candidate sites warranting more detailed evaluation.
3. Candidate sites were subjected to more detailed characterization, using appropriate criteria, to arrive at the preferred site (or sites) for an ESP application.

9.3.3 Region of Interest

The region of interest selected for examining potential sites was the set of seven existing Entergy nuclear sites with currently licensed, operating nuclear plants. This included:

- Arkansas Nuclear One (ANO)
- Grand Gulf Nuclear Station (GGNS)
- James A. Fitzpatrick (JAF)
- Indian Point Energy Center (IPEC)
- Pilgrim Nuclear Station (PNS)
- River Bend Nuclear Station (RBS)
- Waterford-3 (W3)

This evaluation was limited to these sites due to multiple advantages characteristic of sites with currently licensed operating nuclear facilities, including considerations such as:

1. NRC review and approval of current site for nuclear plant construction and operation has been completed, including a conclusion regarding no other obviously superior sites.
2. Site infrastructure appropriate specifically for nuclear plant operation is in place.
3. Site characterization data has been collected, and is available and directly applicable in part or whole to the ESP analysis.

4. Site access is readily available.
5. Programs, procedures, and arrangements have been established and are in place with State and local governmental agencies.
6. Company liaisons with local community exist.
7. Operational impact of the existing nuclear plant has been environmentally acceptable.
8. Site records document the presence of any radiological and non-radiological spills and contamination events on site.
9. Sites and related facilities are controlled by Entergy.

These considerations, taken collectively, serve to minimize uncertainty in the licensing process and to improve the likelihood that the selected site (or sites) would meet siting requirements in 10 CFR Part 52, eventually resulting in an approved early site permit. Further, given the advantages of co-locating a new nuclear facility with an existing nuclear plant, it is reasonable to expect that no other sites would be found to be obviously superior.

With the initial condition that all locations have a currently sited nuclear facility, there exists a considerable weight of evidence, at least at the screening stage, that these are logical and appropriate locations to begin the selection process. The process itself then applies more detailed criteria involving established engineering or environmental considerations to allow ranking of these sites, and the possible elimination, if such a conclusion should result.

9.3.4 Initial Screening

The objective of this screening step was to identify any potentially significant impacts on the "apparent" suitability of an existing site, when judged against current standards and conditions. In effect, this step reduced the listing of potential sites from the total available in the ROI, to a smaller sub-set of sites that was the subject of further review. Factors and criteria employed in this screening step were developed expressly for the evaluation of sites with existing nuclear plants and documented in guidelines established for site selection process. These factors included considerations such as seismic siting requirements of 10 CFR 100, demographic status and changes since licensing, emergency planning, transmission capability and access, water availability, and spent fuel storage capability. Consistent with EPRI guidance (Reference 2) and Entergy's guideline (Reference 3), exclusionary and avoidance criteria were considered in this screening process. These are defined as:

- Exclusionary criteria represent requirements that, if not satisfied by site conditions, would preclude an ESP. Such criteria are useful for screening tasks since they provide a basis for making "go/no-go" decisions and are generally based on explicit regulatory and/or plant design requirements.
- Avoidance criteria have the same site screening effect as exclusionary criteria but are more flexible in their application. They are utilized to identify broad areas with more favorable than unfavorable conditions; for example, distance from population centers.

The initial site screening resulted in the reduction of the seven potential sites in the ROI to four candidate sites for further, more detailed characterization and analysis. Two sites in northeast region were selected (Fitzpatrick and Pilgrim), and two sites were selected in the southern region (River Bend and GGNS).

Both the Waterford and ANO sites were screened out from further consideration (at this time) for an initial ESP effort due to certain avoidance criteria or transmission and market constraints. Both site are considered viable for a new nuclear plant but were found to be less suitable than other southern sites. Indian Point was eliminated from further consideration at this time due to population density criteria (greater than 500 persons per square mile).

9.3.5 Preferred Site Selection

The objective of this step was to rank the suitability of the four remaining candidates sites with respect to site criteria established in the Entergy site selection guidelines (Reference 3). Data gathered, analyzed, and documented to support the initial screening step was used in this final step of identifying a preferred site. Information sources included the site licensing basis documentation (i.e., Final Environmental Report, Final Safety Analysis Report, etc.) and other publicly available data. Data gathered and analysis results were organized according to certain prescribed site criteria, grouped in the following categories: (A) health and safety, (B) environmental, (C) socioeconomics, and (D) engineering and cost. Some of the considerations in each category were as follows:

- (A) Health and safety: operational and accident related effects (such as, vibratory ground motion, soil stability, cooling water requirements, flooding, and atmospheric dispersion.
- (B) Environmental: construction and operational impacts to aquatic and terrestrial ecology, such as disruption of habitats and wetlands, thermal discharge impact, and entrainment and impingement effects.
- (C) Socioeconomic: construction and operational impacts in areas such as housing, traffic, education and other public services; land use impacts; and environmental justice.
- (D) Engineering and cost: suitability criteria addressing costs associated with such issues as pumping distance, rail spur construction, barge slip construction, transmission system improvements, and labor rates.

This final step involved a more detailed comparison analysis of the four sites against suitability criteria defined in the Entergy guideline (Reference 3). Suitability criteria represent requirements that affect the relative environmental suitability or cost of developing the site, but do not represent unacceptable environmental stress, significant licensing constraints, or excessive additional cost.

Based on this analysis, the four sites were determined to be suitable for an ESP. Based on the composite suitability results, GGNS and Fitzpatrick were selected as the preferred sites in their respective regions based on relative rankings. The GGNS site received the overall highest ranking in this process, and was selected at the “first-priority” site for development of an ESP application.

9.3.6 Consideration of Sites Other Than Existing Nuclear Sites

An analysis of generic, hypothetical “greenfield” and “brownfield” sites is provided to support the conclusion that such alternatives are not environmentally preferable or obviously superior to the GGNS site, for this purpose.

9.3.6.1 Greenfield Alternative Site Analysis

A “greenfield” site is one that is undeveloped, not having been used previously for any industrial purpose (Reference 3). As such, it is possible that some portion of the greenfield site has been disturbed, for example, for agricultural use. It would, therefore, have no likely history of legacy contamination, no prior NRC review, and limited or no data collected regarding characterization. No specific location for the hypothetical greenfield site was selected; however, a qualitative analysis can be done regardless. Guided by relevant impact areas suggested in the NRC's Table 9.3-2, NUREG-1555 (Reference 1) for alternative site reviews, the following qualitative analysis is provided. Expected impacts associated with siting the new facility at the GGNS site are summarized in Table 10.1-1 (for unavoidable adverse impacts). This table is the primary source for impact information used in the following discussion. For impacts not expected to result in unavoidable adverse impacts, other sections of this report were consulted.

9.3.6.1.1 Land Use

Relative to the proposed site, land use for a new nuclear facility would likely require more land commitment at a greenfield site due to exclusion area requirements. A new nuclear facility takes substantial advantage of the currently existing 2100-acre site with adequate (residence free) area for an exclusion area boundary, which is wholly within the GGNS Unit 1 property boundary.

A new nuclear facility would use the current switchyard. For the greenfield site, additional land would be required to meet this need. It is also likely that additional land would be required, overall, for transmission line corridors to support the greenfield site. It is conceivable that the greenfield site may be located near a well-developed transmission system. However, General Design Criteria 17 (GDC 17) of Appendix A to 10 CFR 50 contains demanding requirements for offsite physical independence and the number of separate transmission lines. This requirement may not be met by a greenfield site simply located near a transmission line or even near a typical industrial site that is not subject to GDC 17. The criteria related to physical independence and the number of separate transmission lines would likely require additional transmission corridors to support most greenfield sites. While it is possible that a new nuclear facility at the GGNS site may require additional transmission line support, it is likely that most greenfield sites, in meeting GDC 17 requirements, would require substantially more transmission line construction and, therefore, have greater related land use impacts.

In addition, depending on the extent to which the greenfield site has been disturbed (from prior non-industrial use), it is possible that its larger land use demands could impact a greater amount of undisturbed land as well.

Based on this expected greater land use demand, the greenfield site alternative would neither be environmentally preferred nor obviously superior.

9.3.6.1.2 Hydrology, Water Quality, And Water Availability

Overall, lasting impacts to the GGNS site from a new nuclear facility to local streams would be minimal. Some sedimentation is expected during construction but would not be expected to change the current characteristics of the streams. Impacts to groundwater from a new nuclear facility are minor and localized; no impact to offsite users is expected. The largest portion of raw water makeup for a new facility is to be drawn from the Mississippi River, and that is only a very small percentage of low river flow.

In general, similar levels of impact could be expected from construction and operation of a new facility at a greenfield site, but the relative impacts would depend on the ground water and surface water availability and layout of streams and topography at that site. In fact, if the greenfield site did not use the Mississippi River, then relative water use impacts could be significantly greater than that associated with a site. Given the overall minimal impact of the proposed project to surface water and ground water, the greenfield site alternative would neither be environmentally preferred nor obviously superior.

9.3.6.1.3 Terrestrial Resources

Approximately 400 acres of land would be impacted by construction of the new facility. About 125 acres of land would be occupied by permanent structures for a new nuclear facility. Approximately two-thirds of this 125 acres of land has been previously disturbed (if sited at GGNS). The remaining land (i.e., about 275 acres) would be revegetated and allowed develop to a natural state. Given the likely increased land use required at a greenfield site related to undisturbed areas and switchyard/transmission needs, a corresponding larger impact to terrestrial resources is expected. It can be assumed that greater land use would likely translate into greater permanent displacement of wildlife and impact to habitats.

Given these disadvantages to the greenfield site, it would not be found environmentally preferred or obviously superior.

9.3.6.1.4 Aquatic Biological Resources

Overall, due to construction and operation, siting of a new facility at the GGNS ESP Site was demonstrated to have no more than minor impact to aquatic biological resources, including consideration of intake impacts, thermal discharge plumes, sedimentation, etc. Depending on the location of the greenfield site, impacts may be equivalent or greater. Therefore, the greenfield alternative may be generally equivalent but not obviously superior.

9.3.6.1.5 Socioeconomics

Regarding impacts to housing, public services, transportation networks, etc., relative assessments of the GGNS site vs. a hypothetical greenfield site are dependent on the specific greenfield site location. However, such socioeconomic impacts from a new nuclear facility on the GGNS ESP Site and surrounding area were evaluated, in general, to be distributed throughout a relatively large area with minor localized impacts to the communities in which the construction or operating workers (and their families) reside. Impacts to principally used transportation routes during commuting periods are expected to be small but within the capacity of the transportation networks. Given the likelihood of selecting a similarly located greenfield site in a relatively remote, non-urban setting, impacts would expected to be roughly equivalent.

The most prominent additional visual features, from an aesthetic perspective, are the natural or mechanical draft cooling towers (and associated plumes). Given that the GGNS site already includes such a tower, the additional towers are not considered to have substantial, additional aesthetic impact. This would not be the case for a greenfield site in which the addition of cooling towers and other structures (such as containment building, transmission lines and towers) would have relatively greater aesthetic impact.

The environmental justice analysis of the GGNS ESP Site identified the presence of minority and low income groups residing in communities surrounding the GGNS site. However, a new facility was evaluated to have no significant adverse environmental impacts and, as such, does not result in a disproportionate impact to the minority and/or low income populations. It is likely that a similar conclusion would be reached regarding a greenfield site depending on the evaluation of environmental impacts specific to that site.

In addition, the existing GGNS facility is already integrated into the socioeconomic, land use, and aesthetic environment of the area. It is reasonable to assume that additional units would be consistent with this baseline. With a greenfield site, depending on its location, the impacts would be new and may have relatively significant impacts on the area. For example, transportation networks in Claiborne County have been substantially improved over the lifetime of GGNS Unit

1 for various reasons. The use of a greenfield site in a similar, somewhat remote, non-urban setting may not have the advantage of these improved roadways, thus resulting in greater transportation related impacts.

Based on the above considerations, it is not likely that the greenfield site alternative would be evaluated as environmentally preferred or obviously superior in any of these socioeconomic related impact areas.

9.3.6.1.6 Summary Evaluation Regarding Superiority of Greenfield Alternative

Given this qualitative analysis in the above potential impact areas, it is concluded that it would be very unlikely that a greenfield site would be found obviously superior to the proposed GGNS ESP Site.

9.3.6.2 Consideration of Brownfield Alternative Site

A “brownfield” field site is one that is or has previously been the location of industrial facilities, either privately or publicly owned. There may be some advantages to considering a brownfield site for an ESP, such as the presence of limited applicable infrastructure and possible proximity of an adequate water supply, electrical transmission facilities, and transportation network access. However, any assessment of the nature and scope of those advantages is not possible without specifying a location for evaluation. However, some general conclusions based on a qualitative assessment are possible, considering likely relative adverse impacts.

The land use requirements of the brownfield site would likely remain greater than that required at the GGNS ESP Site due to the unique 10 CFR 50 requirements for physical independence of offsite electrical supplies (noted above). It is unlikely that an industrial site would already meet this demanding requirement; therefore, additional transmission lines would be required. And with increased land use, a relatively greater impact to terrestrial resources would also be expected. Given this consideration and the above discussion demonstrating that use of the GGNS ESP Site generally has minimal impacts to the environment, it is not likely that a brownfield site would be considered environmentally preferred or found obviously superior.

In addition, given the current or prior industrial use status, a brownfield site can involve legacy contamination and the associated liabilities and costs. Therefore, a complete assessment of a brownfield site must ensure that such contamination, if it exists, does not present cost or schedule impediments that either preclude or hinder the development of a new nuclear facility. Any such cleanup work, once the ESP is issued, must be consistent with the allowed use of the licensed site as provided in 10 CFR 50.10(e)(1). A site redress plan may be required as part of the ESP application, per 10 CFR 52.17(c). Given that no such redress plan (and associated costs) are required for the proposed use of the GGNS ESP Site, the potential presence of legacy contamination at a brownfield site represents an additional potential disadvantage to the brownfield alternative.

On net, without the selection of a specific brownfield site, a more detailed analysis is not possible at this time. However, given the above considerations, it is not likely that a brownfield alternative would be considered environmentally preferred or obviously superior.

9.3.7 References

1. U.S. Nuclear Regulatory Commission (USNRC). 1999. Environmental Standard Review Plan (NUREG-1555), Office of Nuclear Reactor Regulation, Washington, DC.

2. Electric Power Research Institute, Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application, Final Report, August 2001.

3. Entergy Nuclear, Inc., Entergy Nuclear Site Selection Guidelines for an Early Site Permit, August 2001.

9.4 Alternative Plant and Transmission Systems

This section deals with alternatives to the heat dissipation, circulating water and transmission systems for a new facility at the GGNS ESP Site. Section 9.4.1 evaluates alternative heat dissipation systems, Section 9.4.2 alternative circulating water systems and Section 9.4.3 alternative transmission systems.

9.4.1 Heat Dissipation Systems

This section provides discussion of alternatives to the proposed heat dissipation system (described in Section 5.3.3) based on the guidance provided in NUREG-1555 ESRP 9.4.1. Alternatives considered are those generally included in the broad categories of "once through" and "closed cycle" systems. The once through method involves the use of large a quantity of cooling water, withdrawn from a water source and returned to that source (receiving water body) following its circulation through the normal heat sink (i.e., main condenser). Closed cycle cooling systems involve substantially less water usage, since the water performing the cooling is continually recirculated through the normal heat sink (i.e., main condenser) and only makeup water for evaporative losses and blowdown is required. Included in the closed cycle category are the following types of heat dissipation systems/components:

- Mechanical draft wet cooling towers
- Natural draft wet cooling towers
- Wet dry cooling towers
- Dry cooling towers
- Cooling ponds
- Spray canals.

An initial environmental screening of the above alternative designs was done to eliminate those systems that are obviously unsuitable for use in a new facility at the GGNS ESP Site. The screening criteria included onsite land use requirements and terrain conditions, water use requirements, and legislative restrictions that might preclude the use of any of the alternatives (Table 9.4-1). Results of the screening are also shown in Table 9.4-1.

From Table 9.4-1, it can be seen that four of the alternatives are not suitable for the GGNS site. The GGNS site includes approximately 2100 acres of land in rural southwestern Mississippi. Approximately half of this property, i.e., that bordering the Mississippi River and west of the bluffs on the site, is subject to annual flooding. Additionally, approximately 150 acres of the upland area is utilized by the existing GGNS Unit 1 facility. Thus, the site does not have an extremely large amount of land that is usable for construction of a new facility.

Given the size of the site, the layout, and the amount of land required for implementation, the following alternatives are given no further consideration in this section:

- Dry cooling towers
- Cooling ponds
- Spray canals.

A conceptual design for a spray canal heat dissipation system was provided in the Environmental Report (construction stage) and the FER (Reference 1), indicating that the majority of site property in the existing flood plain would be consumed by the system. Due to the permanent destruction of this amount of wetlands habitat, the loss of Hamilton and Gin Lakes and their aquatic habitat, and the significant cost associated with providing flood protection for the canals, this alternative was not considered further. These arguments still hold true for this application.

Based on the screening of Table 9.4-1, the following alternatives were given further consideration as alternatives for use at the GGNS site.

- Mechanical draft cooling towers
- Natural draft cooling towers
- Wet dry cooling towers

Wet dry cooling towers are primarily used in areas where plume abatement is necessary for aesthetics reasons or for considerations of minimizing fogging and icing produced by the tower plume. Wet dry cooling towers use approximately one-third to one-half less water than wet cooling towers (Reference 2). Due to the rural setting of the GGNS site, neither of these advantages/features is significant. Additionally, somewhat more land is required for the wet dry cooling tower due to the additional equipment (fans and cooling coils) required in the tower assembly. This alternative could be utilized at the GGNS site; however, it is not considered to be environmentally preferable to the wet cooling towers proposed for the new facility.

The GGNS Unit 1 facility currently utilizes both a natural draft cooling tower (original plant design) and a mechanical draft “helper” tower recently added for use during the hotter summer months to gain overall plant efficiency and increase electrical generation. The environmental impacts from mechanical draft wet cooling towers and natural draft wet cooling towers are discussed in detail in Section 5.3.3. The primary differences relative to impact between these two types of systems are the potential for fogging, icing, and salt deposition. These impacts are slightly greater for a mechanical draft tower because the plume is lower to the ground. In addition, the mechanical draft tower requires slightly more land area than a natural draft tower. These differences are considered minor, with regards to use of either at the GGNS site. Therefore, they are considered environmentally equivalent, and either could be used for a new facility.

9.4.2 Circulating Water Systems

The circulating water system is an integral part of the heat dissipation system discussed in Section 9.4.1. The circulating water system provides the interface between (1) the normal heat sink main condenser (heat exchanger), where waste heat is discharged from the steam cycle and is removed by the circulating water, and (2) the heat dissipation system (cooling tower(s) in this case), where the heat energy is then dissipated or transferred to the environment.

Essentially, there are two alternative circulating water systems available for the removal of this waste heat: once-through (open loop) and recycle (closed loop) systems. In once-through cooling systems, water is withdrawn from a cooling source, passed through the condenser once, and then returned to the source (receiving water body). In the recycle cooling system, heat picked up from the condenser by the circulating water is dissipated through auxiliary cooling facilities, after which the cooled water is recirculated to the condenser.

As discussed in Section 3.4, the normal heat sink (NHS) for a new facility would be comprised of a closed loop circulating water system, including pumps, water basin, and cooling tower(s). Water from the circulating water system (NHS) would be pumped through the condenser and then to the cooling tower(s) where heat, transferred to the cooling water in the condenser would be dissipated to the atmosphere by evaporation, cooling the water before its return to the condenser. The main condenser for each unit of a new facility would reject heat to the atmosphere at a rate of approximately 10.7×10^9 Btu/hr during normal full-power operation (Table 3.0-1).

NUREG-1555 ESRP 9.4.2 indicates that this section should consider alternatives to the following components of the plant circulating water system:

(1) intake systems

(2) discharge systems

(3) water supply

(4) water treatment.

NUREG-1555 ESRP 9.4.2 also indicates that this section should consider only those alternatives that are applicable at the proposed (GGNS) site and are compatible with the proposed heat dissipation system. Closed loop systems utilizing a cooling pond or a system of cooling/spray canals was discussed in Section 9.4.1 above and were previously evaluated in Reference 1. These were determined, based on required land use, to be not suitable alternatives for the circulating water (heat dissipation) system for the GGNS ESP Site. Heat dissipation with a wet cooling tower relies on evaporation for heat transfer. Therefore, half or more of the water would be lost to the atmosphere and must be replaced. In addition, this evaporation would result in an increase in the level of solids in the circulating water. To control solids, a portion of the recirculated water must be removed, or blown down, and replaced with “clean” water. In addition to the blowdown and evaporative losses, a small percentage of water in the form of droplets (drift) is lost from the cooling tower(s). Water pumped from the Mississippi River (Section 9.4.2.1) intake structure would be used to replace water lost by evaporation, drift and blowdown from the cooling tower(s). Blowdown water is returned to the Mississippi River via an outfall on the river shoreline (Section 5.3.2). The bounding quantity of NHS cooling tower / circulating water system blowdown for a new facility is 39,000 gpm (Table 3.0-1).

<u>Intake Systems</u>

A new facility would have an intake structure to withdraw makeup water from the Mississippi River. GGNS Unit 1 utilizes a series of radial collector wells in the alluvial aquifer to provide makeup water to its cooling tower, and to provide Plant Service Water (PSW) cooling for the plant. A number of investigations have been conducted in regards to the radial collector wells and their capability to provide the necessary makeup and cooling water for GGNS Unit 1. The studies have dealt primarily with the hydrologic setting, aquifer hydraulics, well yields and well conditions. The studies determined that the aquifer supplying the existing PSW wells is capable of meeting system demands through the design life of the existing plant. However, a similar arrangement of collector wells drawing water from the alluvial aquifer for a new facility on the site, with a (maximum) makeup water requirement of 78,000 gpm (Table 3.0-1) to the NHS (85,000 gpm total), could not be supported by the aquifer.

Therefore, makeup water for the heat dissipation system and the circulating water system, would be withdrawn from the Mississippi River via an embayment and intake on the east bank of the river as described in Section 3.4.2.1 (Figure 2.1-1). A conceptual description of the intake design is provided in Section 5.3.1.

Prior to the determination to utilize radial collector wells for service water cooling and plant makeup for GGNS Unit 1, an evaluation of two types of intakes from the river for makeup and service water was done (Reference 1, Section 10.2). One alternative involved direct intake from the river via a “crib” and pipeline in the river channel with gravity feed to an intake structure on the river bank. It was determined that this crib would likely need to be about 2000 ft from the shoreline because of scouring and siltation problems around an intake crib near the shoreline. Locating the crib 2000 ft into the river would create significant construction problems, and may cause navigation hazards. The other alternative considered the construction of a channel directing water to the intake structure on the river shoreline. Both alternatives were determined to have minimal impact to river biota. Based on the analysis provided in Section 5.3.2, neither of the two intake alternatives described in Reference 1 would be environmentally preferable to the proposed embayment and intake structure.

Discharge Systems

As noted above, the circulating water system for a new facility would be a closed loop system, utilizing wet cooling tower(s) for heat dissipation.

GGNS Unit 1 utilizes a cooling tower/circulating water system blowdown discharge to the river located in the existing barge slip. The blowdown discharges to the south bank of the existing barge slip with 54-inch diameter outlet pipe (Reference 1, and Figure 2.3-1).

The thermal effluent from a new facility would be released to the Mississippi River through a new outfall structure located downstream of the existing outfall for GGNS Unit 1. It is proposed that the effluent from GGNS Unit 1 be combined with the effluent from a new facility and released to the river at a location sufficiently away from the new intake structure to avoid recirculation of the effluent through the intake. Construction of the proposed intake and embayment would require rework of the barge slip and the river shoreline around the barge slip. A diffused type outfall on the river shoreline was evaluated in Section 5.3.2 for the discharge, which would create a ribbon-flow discharge configuration to the river. This configuration, as compared to a single point discharge, produces a larger thermal plume in the river, and thus potentially greater (although still minor) environmental impact. A submerged discharge produces a smaller thermal plume than an exposed (above water) discharge, again indicating a potentially greater environmental impact from the diffused outfall type discharge. The environmental impact releasing the combined effluent through the diffused outfall was determined to have minimal impact to aquatic biota in the river (Section 5.3.2).

In the FER for GGNS Unit 1 (Reference 1, Section 10.3), two alternative discharge schemes were evaluated in addition to the existing discharge configuration: a single-port shoreline jet and a single-port offshore jet. Because of the sediment deposition characteristics of the Mississippi River, it was determined that the single-port offshore jet discharge would need to be approximately 2000 ft into the river channel. It was concluded that construction of this pipeline and discharge in the river would cause significant temporary impact to the river biota, and may cause navigation hazards (Reference 1). Therefore, this alternative was not considered further. The single-port shoreline discharge design is similar to the proposed design for the combined discharge for the new facility, except that the discharge was configured with a jet nozzle at the pipe termination point. The environmental impact of this type single-port jet discharge on the shoreline would be similar to the proposed discharge; therefore, it is not considered environmentally preferable.

Water Supply

As noted above, the circulating water system for a new facility would be a closed loop system, utilizing cooling tower(s) for heat dissipation. Cooling towers typically have a storage basin or flume from which water is recirculated by the circulating water system to provide the condenser cooling. As discussed above, there would be a need for continuous makeup water to the closed loop circulating water system. The maximum makeup water flow to the cooling towers in the normal heat sink is 78,000 gpm (Table 3.0-1).

There are two potential sources of water supply on or near the GGNS ESP Site that could be used as a source for makeup water the Mississippi River and wells in the alluvial aquifer. As discussed in Section 9.4.2.1, wells in the alluvial aquifer could not support the large flow requirement for the new facility. Therefore, the Mississippi River would be used for makeup to the circulating water system.

The proposed intake for this makeup water supply is described in Section 5.3.2. Alternatives are discussed in Section 9.4.2.1; no environmentally preferable alternatives are identified.

Water Treatment

Evaporation of water from the cooling towers in the circulating water system leads to an increase in chemical and solids concentrations in the circulating water, which in turn increases the scaling tendencies of the water. The circulating water system would be operated so that the concentration of solids in the circulating water would typically approximate four times the concentration in the makeup water (i.e., four cycles of concentration). The concentration ratio would be sustained through blowdown of the circulating water from the cooling system(s) to the Mississippi River and the addition of makeup water.

Similar to that for GGNS Unit 1, two methods of circulating water system chemistry control are anticipated to be used to prevent biological fouling (e.g., accumulation of algae growth in the cooling tower(s) and the main condenser/heat exchangers). These anticipated methods are the addition of a non-oxidizing biocide and/or a hypochlorite solution. The final choice of methods or combination of methods will be dictated by makeup water conditions, economics and discharge permit requirements.

A non-oxidizing biocide, if used, would be added to achieve a concentration at or below the allowable NPDES (environmental) discharge limits. Discharge of free available chlorine to the river is typically minimized by controlling the addition of hypochlorite solution. This is controlled so that the free available chlorine concentration in the cooling tower blowdown would not exceed NPDES permit limits. Chlorine residuals would be monitored to ensure NPDES permit limits are not exceeded in the discharge. A surfactant-based bio-dispersant may also be added to the circulating water system, as required, to prevent scaling and deposition of iron oxides and suspended solids in the NHS condenser tubes.

Sulfuric acid (or similar additive) may be used to control pH in the system. The circulating water blowdown flow would be controlled to maintain proper circulating water system conductivity and chemical content.

Makeup water withdrawn from the Mississippi River may require pre-treatment before its use in the circulating water system and other systems. Such treatment could include chlorination and removal of suspended solids consisting of sedimentation, flocculation, coagulation, and sludge removal. Waste solids from the pre-treatment process would be either dewatered and transported to an approved onsite or offsite landfill or returned to the river, as allowed by site permits. Any liquid effluents from the pre-treatment process would be in compliance with an approved NPDES permit.

Alternatives to chemical treatment and disposal of chemical wastes to the river were investigated in Reference 1, Section 10.4. Physical size requirements (about 53,000 acres estimated) for an evaporative pond to eliminate discharge of chemical wastes to the river preclude the use of this alternative. Mechanical treatment systems provide some assistance in maintaining main condenser/heat exchanger tubes clean; use of these systems would be evaluated during the final design of the new facility. However, these mechanical cleaning systems are only effective for the condenser/heat exchanger for which they are used, and are not effective “system” water quality control schemes.

The final design and capacity of the circulating water system and the makeup water supply system are not finalized at this point in the licensing process. Because of this, exact methods of water treatment, waste disposal, and the quantities of chemicals required cannot be specified.

9.4.3 Transmission Systems

The power transmission and distribution (T&D) system existing at the time of startup and operation of a new facility at the GGNS ESP Site would be relied upon to distribute the electricity generated, for at least an additional 1311 MWe of generating capacity. There are numerous factors that could give rise to changes, upgrades, etc., to the current T&D system over the life of the ESP permit. When the specific facility design, the expected electrical output, the need for power, and primary market location(s) are established, the adequacy of the existing T&D system to support a new facility can be determined. If, at that time, additional changes to the T&D system were warranted, the associated environmental impacts would be evaluated.

Therefore, analysis of the T&D system, including any related environmental impact and alternative design evaluations are not evaluated for this ESP Application.

9.4.1 References

1. Mississippi Power and Light Company, Grand Gulf Nuclear Station Units 1 and 2 Final Environmental Report (FER), as amended through Amendment No. 8.
2. Technical Development Document for the Final Regulations Addressing Cooling Water Intake Structures for New Facilities (EPA-821-R-01-036), November 2001.
3. NUREG-0777, Final Environmental Statement related to the operation of Grand Gulf Nuclear Station, Units 1 and 2, Docket Nos. 50-416 and 50-417, September 1981.

TABLE 9.2-1

ALTERNATIVE ENERGY SOURCES: COMPARISON OF KEY ENVIRONMENTAL IMPACTS[1]

Environmental Impact Area	Proposed Project[2]	Combined Cycle Natural Gas	Coal
Siting	GGNS or Alternate Site	GGNS or Alternate Site	Alternate Site[3]
Assumed Generating Capacity (MWe)	2000[4]	2032[5]	2032[6]
Land Use - Plant Footprint	Plant would use approx. 125 acres for offices, parking lots, permanent support facilities, power block, and protected area.	Total of 225 acres estimated. 140 acres estimated for power block and support facilities. Additional 85 acres for new gas pipeline (if sited at GGNS). Alternate site could require longer pipeline and additional transmission lines, thus increasing the land use requirement.	Estimated requirement of 2680 acres for plant infrastructure and waste disposal, transmission line, and rail spur.
Land Use - Construction	An additional 275 acres required to support construction laydown areas and temporary construction facilities. Standard mitigation procedures employed for this land, temporarily impacted during construction.	Data not available for additional land use requirement temporarily used during construction.	Data not available for additional land use requirement temporarily used during construction.
Land Use - Fuel Source	Uranium mining and reprocessing requires approx. 3000 acres.	7200 acres required for natural gas wells and collection stations.	44,000 acres estimated for the mining of coal and limestone for 40 yr. plant lifetime.

TABLE 9.2-1 (Continued)

Environmental Impact Area	Proposed Project[2]	Combined Cycle Natural Gas	Coal
Ecology	Impact would be to a combination of undisturbed and previously undisturbed land. Overall permanent impact is small. Cooling tower drift impact would be minimal. Additional ecological impact is expected due to land use related to uranium mining and reprocessing.	Current GGNS site has adequate land with possible impact to some combination of disturbed and undisturbed land. Impact is roughly comparable to that of the proposed project. New pipeline would impact undisturbed land. Overall impact at alternate site depends on ecology at alternate site. Cooling tower drift minimal. Additional ecological impact will occur due to land use related to gas wells and collection stations; expected to be proportionally higher than that related to uranium mining and reprocessing.	Impact relatively large due to high construction land requirement. Impact depends on location and ecology of the site, surface water body used for intake and discharge, and transmission line route. Additional ecological impact will occur due to land use related to mining of coal and limestone. Substantially greater impacts expected, relative to that required for uranium mining and reprocessing.
Water Use and Quality Surface Water and Groundwater	Bulk of new water use would come from Mississippi River intake; considered small fraction of river flow. No significant impact to resource. One additional groundwater well anticipated during construction and to remain during operations. No significant impact to area groundwater resource.	Closed-cycle cooling involves cooling tower blowdown discharge containing dissolved solids (regulated by state). Impact would depend on water volume required and characteristics of receiving body. Appropriate state and/or permitting authority would regulate intake and discharge.	Closed-cycle cooling involves cooling tower blowdown discharge containing dissolved solids (regulated by state). Impact would depend on water volume required and characteristics of receiving body. Appropriate state and/or permitting authority would regulate intake and discharge.

TABLE 9.2-1 (Continued)

Environmental Impact Area	Proposed Project[2]	Combined Cycle Natural Gas	Coal
Air Quality	Emissions from auxiliary boilers and standby diesel generators[7]	Products and residues of combustion	Products and residues of combustion[8]
Sulfur oxides	60 tons/yr.	120 tons/yr.	13,340 tons/yr.
Nitrous oxides	50 tons/yr.	460 tons/yr.	12,800 tons/yr.
Particulates	20 tons/yr.	70 tons/yr.[9]	390 tons/yr.
Carbon monoxide	10 tons/yr.	610 tons/yr.	1650 tons/yr.
Carbon dioxide	Not available for auxiliary boilers or standby diesel generators	Not quantified in LRGEIS; however, expected to be substantially greater than that associated with proposed project.	Not quantified in LRGEIS; however, expected to be substantially greater than that associated with proposed project.
Waste	Solid non-radioactive waste includes typical office trash, aluminum cans, glass, paper etc.; disposed of off-site meeting federal, state, local regulations. Impacts related to waste (and transportation of wastes) are consistent with 10 CFR 51.52 Tables S-3 and S-4. See Sections 3.8 and 5.7.[10]	Waste generation is minimal; comparable to non-radioactive waste for proposed project.	784,000 tons/yr. of ash, spent catalyst; 728,000 tons/yr. of scrubber sludge requiring approx. 800 ac for disposal during the 40-year life of the plant.

TABLE 9.2-1 (Continued)

Environmental Impact Area	Proposed Project[2]	Combined Cycle Natural Gas	Coal
Human Health	Health impacts are consistent with 10 CFR 51.52 Tables S-3 and S-4. See Sections 3.8 and 5.7 (Note 10 of this table).	Overall impacts considered small.	Impacts lead to numerous areas of risks to workers and/or public related to mining and transportation of coal and limestone, waste disposal and inhalation of stack emissions. Regulations are set to minimize health impacts. Impacts are uncertain but are considered small in the absence of more quantitative data.
Socioeconomic	Construction workforce estimated at 3150, with construction period of 5 to 6 years. Temporary impact to community housing, services, and traffic. Mitigated by distribution over relatively large multiple county area and improved transportation routes. Some degree of offsetting benefits due to proportionally larger construction jobs opportunities and increased tax base during operations.	Construction workforce estimated at 1200 with construction period of 3 yrs. Temporary impact to community housing, services, and traffic.	Up to 2500 workers during the peak of the 5 yr. construction period. Temporary impact to community housing, services, and traffic.
Historical and Archeological Resources	Impacts are largely proportional to degree of land use during construction. No impacts of significance expected from proposed project.	Given projected land use, no significant impact from plant footprint. Land use for gas wells is larger and therefore has potential for impact; depends of nature of land on which wells are constructed. Studies of potentially impacted resources would be required; and, typically, impacts can be managed.	Substantial land use for plant footprint and fuel mining. Large potential for some degree of impact. Studies of potentially impacted resources would be required; and, typically, impacts can be managed.

TABLE 9.2-1 (Continued)

Environmental Impact Area	Proposed Project[2]	Combined Cycle Natural Gas	Coal
Environmental Justice	No significant adverse environmental or human health impacts; therefore, no disproportionate impacts to special population groups are expected.	Environmental justice not specifically evaluated since proposed project represented no likely disproportionate impacts.	Environmental justice not specifically evaluated since proposed project represented no likely disproportionate impacts.

NOTES:

1. See Section 9.2.2 for source of impact values for coal and gas alternatives.
2. Unless otherwise noted, the impacts presented are based on PPE values for the proposed project. See Chapter 3 of this report.
3. The coal plant land use requirement requires more land than is available at the GGNS site. While some portion of the coal plant could be sited at GGNS, the larger portion of land requirements would be made up by land procurement (if the GGNS area were selected for siting).
4. The "target site capacity" for proposed project is 2000 MWe. Environmental impacts for the proposed project are based on (bounding) PPE values. Because the PPE values are associated with total site capacities (for a given reactor type) of greater than 2000 MWe, this analysis of relative impacts is considered conservative and not limited to a final site capacity of 2000 MWe. See Section 9.2.2 for additional discussion.
5. Based on four 508 MWe net gas-fired units.
6. Based on four 508 MWe net coal-fired units.
7. The proposed project could utilize gas turbine generators for standby power as well. However, due to generally greater emissions from diesel generators, emissions estimates were based on using all diesels.
8. The coal facility's air quality impact would also include small amounts of mercury and other hazardous air pollutants and naturally occurring radioactive materials - mainly uranium and thorium.
9. The value listed is for PM_{10} (particulates of a size less than 10 micrometers). Data for total suspended particulates was not provided in NUREG-1437, Supplement 10 (Reference 8).
10. It is recognized that the subject tables were developed and apply directly to light-water-cooler reactor technologies. See detailed analysis provided in Sections 3.8 and 5.7 for application of studies supporting Tables S-3 and S-4 to gas cooled reactor designs.

TABLE 9.4-1

SCREENING OF ALTERNATIVE HEAT DISSIPATION SYSTEMS

Factors Affecting System Selection	Once Through Cooling	Mechanical Draft Wet Cooling Tower	Natural Draft Wet Cooling Tower	Wet Dry Cooling Tower	Dry Cooling Towers	Cooling Pond	Spray Canal
Land Use Onsite land requirements (acres) Terrain considerations	100 (Note 1)	30 - 40	30 – 40	More than wet tower	3 to 4 times acreage for wet towers	4000 to 6000 (~2 acre per MWe) [Reference 3]	750 Construction in flood plain area
Water Use (gpm)	2.4 x 10E6 24,000 (evaporative losses - Note 2)	40,000	40,000	20,000 to 27,000 (Note 3)	Minimal	Similar to other evaporative losses	Evaporative losses similar. Drift losses higher.
Legislative Restrictions	Possible NPDES limitations or restrictions	None	None	None	None	None	Possible issue with destruction of wetlands.
Alternative suitable for the GGNS site and proposed new facility? (Yes/No)	No, due to larger environmental (aquatic) impacts.	Yes	Yes	Yes	No, insufficient land available.	No, due to larger environmental impacts related to land use.	No, insufficient land available.

SOURCES:

GGNS Final Environmental Report (Reference 1)
NRC Final Environmental Statement for Grand Gulf, NUREG-1777 (Reference 3)
Technical Development Document for the Final Regulations Addressing Cooling Water Intake Structures for New Facilities (EPA-821-R-01-036) November 2001 (Reference 2)

NOTES:

1. Includes approx. 20 acres for pipelines from river to bluffs, 5 acres for discharge canal from Hamilton Lake to river, 10 acres for intake structure on bluffs, and 65 acres of Hamilton Lake for pre-discharge cooling.
2. Evaporative losses are directly from the receiving water body (river), downstream of the site.
3. Water usage of wet dry cooling towers can be up to one-third to one-half of wet tower water usage.