Chapter 9 Alternatives to the Proposed Action

This chapter assesses alternatives to siting and developing nuclear power plants at the North Anna ESP site.

9.1 No-Action Alternative

The no-action alternative on a proposed ESP is non-issuance of that permit (i.e., NRC declining to determine whether a proposed site is suitable for new nuclear plants). In this context, no-action would accomplish none of the benefits intended by the ESP process, which would include early resolution of siting issues prior to large investments with financial capital and human resources in new plant design and construction, early resolution of issues on the environmental impact of construction and operation of reactors that fall within the site parameters, and the ability to bank sites on which nuclear plants may be located, and the facilitation of future decisions on whether to build new nuclear plants. This no-action alternative would avoid no significant environmental impacts, because no such impacts are caused by a site suitability determination. The only activities that are permissible under an ESP are limited work activities allowed by 10 CFR 50.10(e)(1), and those activities are permissible only if the final environmental impact statement concludes that the activities will not result in any significant environmental impacts that cannot be redressed.

With respect to a future proposal to construct and operate new nuclear units, the no-action alternative at that stage would constitute denial of the construction permit and operating license (eliminating nuclear units as the source of generation to meet the power needs at that time. The alternative of not licensing the construction and operation of new units would obviously avoid the environmental impacts associated with such construction and operation. However, depending on the need for power and impacts associated with alternative energy sources at the time when construction of new nuclear units may be proposed, the alternative of not licensing the construction and operation of the new nuclear units might result in other site and area environmental impacts, such as the impacts of constructing and operating a large, base-load coal-fired plant. Consideration of the reasonableness of this alternative involves need for power and alternative energy sources, which are topics that would be addressed during the combined construction and operating license stage.

9.2 Energy Alternatives

This subject is not addressed in the ESP application.

9.3 Alternative Sites

This section presents the alternative site evaluation to determine whether there is any obviously superior site when compared to the ESP site. The ROI for the proposed action is defined, the concept of candidate sites within the ROI is presented, the sites selected as reasonable alternatives are identified, and the preferred site, (i.e., the ESP site) is selected.

This section includes a description of the screening process for identifying candidate sites and the methodology used in evaluating alternative sites.

9.3.1 Technical Approach

The candidate site criteria described in NUREG-1555, Section 9.3, were used to screen for candidate sites (Reference 1, Section 9.3) in the ROI.

The alternative site evaluation was performed using 45 suitability criteria as part of a study that reviewed previous nuclear industry siting information and current power plant siting approaches (Reference 2). These suitability criteria were grouped into four major categories: economic, engineering, environmental and sociological. A ranking or score for each criterion was assigned (from 0 to 5, with 5 being the most favorable). The relative importance of each criterion to the overall evaluation was established by assigning weights that reflect the collective judgment of experts involved in the process. The sum of the weighted scores for all criteria represented a total site merit score. The preferred site (i.e., the ESP site) was chosen based on the highest site merit score.

9.3.2 Region Of Interest

Prior to deregulation of the power industry, alternative sites were typically located within a utility's ROI, usually its service territory. Under deregulation, power producers cannot recover construction and operation costs associated with development of a commercial power generation facility through the cost-of-service rates process. Instead, a newly completed power generation facility has to generate power for sale to consumers in a competitive marketplace. Dominion would only proceed with the development of such a new facility if it is economically viable.

As the parent company for Dominion, DRI's energy interests are to continue to operate and grow to a more substantial position as a natural gas and electric power provider serving customers in America's most energy-intense market: the Mid-Atlantic, Northeast, and Midwest. This energy-intense market region comprises approximately a quarter of the nation's land, but it accounts for 40 percent of the energy consumed. This market is home to DRI's ever-growing base of 4 million retail utility customers, and 1.1 million others served by DRI in the deregulated marketplace. DRI has defined its ROI for power generation to be the eastern quadrants of the United States, as shown in Figure 9.3-1. This defined ROI is based on the locations of the load centers to be supplied by the new units that would be constructed and operated at the ESP site.

9.3.3 Identification of Candidate Sites

In developing a list of reasonable candidate sites, multiple categories of sites were evaluated including federal facility sites and existing nuclear power plant sites within the identified ROI. The federal sites were considered under the assumption that such sites could accommodate new reactor technologies. The use of existing nuclear power plant sites for new power generation has many environmental and cost benefits. Additionally, Dominion evaluated the relative impacts of construction and operation of a new nuclear plant at a generic greenfield site. The review of a greenfield site was made to ensure that there are no sites that are obviously superior.

9.3.3.1 **Site Screening Criteria**

The candidate site criteria described in NUREG-1555 were used to screen for candidate sites. By using the criteria, sites were selected that:

- Did not pose significant issues that would preclude the use of the site for a nuclear power plant
- Did not cause significant impacts or degradation of local natural resources on the site that would be created
- Did not pose significant impacts to surrounding terrestrial and aquatic ecosystems
- Were not located in proximity to major population centers
- Did not affect site development costs significantly, when compared to the proposed site

9.3.3.2 **Federal Site Review**

Two of the DOE sites within DRI's ROI – Portsmouth, Ohio, and Savannah River, South Carolina – were selected as candidate sites because:

- The sites represent valuable national assets with prior or existing nuclear energy potential.
- New nuclear power facilities would represent potentially promising new missions for these sites.
- The sites have the potential to support reactor demonstrations and/or commercial reactor development.
- There is extensive site information and an available infrastructure that could help to reduce site development costs.
- Because of the partially or fully developed site environment and the available infrastructure, the incremental environmental impacts associated with the new plant construction and operation on land use, ecological resources, aesthetic, and local transportation network are reduced.
- The sites are not in proximity to major population centers.

The Portsmouth site, which is a previously developed industrial site, is a 3700-acre parcel of DOE-owned land located in a sparsely populated, rural area about 65 miles south of Columbus, Ohio. A major portion of the site and existing facilities are leased to USEC, Inc. for the Portsmouth Gaseous Diffusion plant. The Portsmouth site has substantial site characterization information and available electrical transmission facilities that were used to support operation of the diffusion plant prior to the decision to cease operations at this facility.

The 198,000-acre Savannah River site is about 25 miles southeast of Augusta, Georgia, and 19.5 miles south of Aiken, South Carolina. Augusta is the largest city in the vicinity with a 2000 Census population of 195,182. The site is located in a generally rural area on the Savannah River in southwest South Carolina. The entire area within a 5-mile radius about the center of the site is government-owned property, with approximately 95 percent of the site undeveloped. The Savannah River site has an extensive history of nuclear facilities, with substantial site characteristic information and infrastructure available to support DOE and new nuclear-related missions.

9.3.3.3 **Generic Greenfield Site Review**

Consideration of the effects of replacing power generation from the existing units by construction of a new unit at a greenfield site was provided in Supplement 7 of the GEIS (Reference 3). Results of the Supplement 7 evaluation indicated that the associated environmental impacts for the replacement plant located at a greenfield site were worse than the extension scenario of the existing units (see Table 9.3-1). A generic greenfield site is not a reasonable candidate ESP site for the following environmental reasons:

- A large area would need to be disturbed to build new plants which would cause large impacts on land use, ecological resources, aesthetics, and the local transportation network.
- New transmission lines and corridors may be needed to connect the new plant to the power grid, and local transportation routes and access roads may need to be built or upgraded. Such improvements could lead to additional land use, ecological resource, and aesthetic impacts.
- It is unlikely that a site in a remote area with the water supply needed by a large power plant and an adequate local transportation network would be available in the ROI.
- For a site in a rural area, the socioeconomic impacts associated with plant construction and operation would be largely due to the number of workers that would have to move into the area.

In addition, the site development costs for a greenfield site are substantial, especially with regard to building the required infrastructure and conducting the site characterization.

Finally, community acceptance of a new nuclear power plant in an area that is not familiar with their operational record is an unknown factor. This would have an impact on the ability to finance a project.

Based on the above considerations, Dominion has concluded that a generic greenfield site is not an obviously superior alternative for siting new units. Therefore, no further evaluation of greenfield sites was performed.

9.3.3.4 **Existing Nuclear Sites Review**

9.3.3.4.1 **Benefits of Existing Nuclear Power Plant Sites**

There are obvious benefits offered by locating a new nuclear power plant at an existing nuclear site rather than a non-nuclear site. These benefits are summarized below:

- Environmental Benefits
  - The existing environmental conditions and the environmental impacts of an existing nuclear station are known from data collected during years of monitoring air, water, ecological, and other parameters. Based on the knowledge of the various reactors and ancillary facilities being considered in the Generic PPE, it is reasonable to assume that the impacts of additional units would be comparable to those of the operating units.
  - Construction of new transmission corridors may be avoided if the existing transmission system (lines and corridors) can accommodate the increased power generation. This could substantially reduce environmental impacts associated with construction of the new plant.
  - No additional land acquisitions would be necessary if a new transmission corridor can be avoided, and the resulting land use impacts of the new plant would be small.
  - The sites have already been subject to the alternative review process mandated by the NEPA.
  - The sites have extensive environmental studies performed during the original site selection process, which could be updated and used for new units.
- Constructability and Cost Benefits
  - Site physical criteria, including primarily geologic/seismic suitability, have been characterized at existing nuclear sites.
  - No additional land acquisitions would be necessary, if a new transmission corridor can be avoided and the site can accommodate the land requirements of the new units.
  - Plant construction, operation, and maintenance costs would be reduced because of existing site infrastructure (e.g., roads, transmission lines, water source, intake/discharge system) and its maintenance.
- Other Benefits
  - The existing sites have nearby power markets.
  - Existing nuclear plants are likely to have gained local community acceptance and support.
  - Existing nuclear sites have relevant nuclear experience.

9.3.3.4.2 Nuclear Power Station Sites Owned by DRI Subsidiaries

Existing nuclear power plants where Dominion could more readily obtain access and control are preferred over other nuclear sites. Sites that were originally designed for more generation than actually constructed also received preference.

Various DRI subsidiaries own and control three nuclear power stations within the ROI: NAPS and Surry Power Station in Virginia, and Millstone Power Station in Connecticut. The following paragraphs examine these sites for further consideration as alternative sites.

- North Anna Power Station
  - The 1803-acre NAPS site is located on Lake Anna in northeastern Virginia. Lake Anna, built to supply cooling water for the power station, is approximately 17 miles long and has 272 miles of shoreline. Two 944 MWe PWRs are currently in operation at North Anna. The site is located approximately 40 miles north-northwest of Richmond, 36 miles east of Charlottesville, and 22 miles southwest of Fredericksburg. The NAPS site was originally issued construction permits for two additional units.
- Surry Power Station
  - The 840-acre Surry site is located on the Gravel Neck Peninsula on the south side of the James River in Surry County, Virginia. The Hog Island Wildlife Management Area is situated on the tip of the peninsula. Two 855 MWe PWRs are currently in operation at Surry. The site is 7 miles south of two large tourist attractions: Colonial Williamsburg and Busch Gardens Amusement Park. Urban areas of Hampton Roads, Virginia, are 10 to 30 miles north and east of the site. The Surry site was originally issued construction permits for two additional units.
- Millstone Power Station
  - The 500-acre Millstone Power Station site sits on a peninsula on the eastern end of Long Island Sound, in Waterford, Connecticut. The station consists of three units. Unit 2, an 878 MWe PWR, and Unit 3, a 1152 MWe PWR, are currently in operation. Unit 1 is undergoing decommissioning. Parts of Connecticut, Rhode Island, and New York, including the major population centers of the Hartford and New Haven metropolitan areas in Connecticut and the Warwick and Newport areas in Rhode Island are within a 50-mile radius of the site. The east-west running portion of Interstate 95 along Long Island Sound in Connecticut passes within five miles of the site. Harkness Memorial State Park, three miles east of the site, is designed to accommodate and is used frequently as recreational facilities for persons with special needs. Rocky Neck State Park is 5 miles west of the site.

    This site was eliminated from further evaluation as an alternative site because of its proximity to a special recreational facility; an ongoing feasibility study that evaluates once-through cooling system impacts; and the potential for fogging and/or icing impacts associated with wet mechanical draft cooling towers. Furthermore, the site had not been licensed for additional units to those constructed.

9.3.4 **Alternative Sites Evaluation**

Four candidate sites: North Anna, Surry, Savannah River, and Portsmouth were identified as alternative sites. These four sites were further examined and evaluated to select the preferred site. The evaluation process and methodology used, and the findings of the evaluation are described in Reference 2.

9.3.4.1 A Summary of the Evaluation Process

Each site was evaluated against 45 suitability criteria, grouped into four major categories:

1. Environmental – Includes criteria (e.g., local population, groundwater, aquatic habitat and organisms) for assessing the potential adverse impacts of plant construction, operation, and decommissioning on the site, the surrounding environment, and the people.
2. Sociological – Includes criteria (e.g., socioeconomic benefits, present/planned land use, environmental justice) for assessing the potential impacts of plant construction, operation, and decommissioning on sociological issues.
3. Engineering – Includes regional, environmental, site, or other characteristics (e.g., cooling water source, site size, emergency planning requirements, site-specific seismic concerns, environmentally sensitive areas) that have the potential to impact the design, construction, operation, or decommissioning of a nuclear facility.
4. Economic – Includes criteria for assessing electricity and market projections, transmission line access, stakeholder support, and site development costs.

Table 9.3-2 provides a listing of these 45 criteria by category.

A ranking or score was assigned for each criterion. The sum of the weighted scores for all criteria is the total site merit score. In addition, a “bounding plant” was evaluated to establish a ranking score that would envelop the selected advanced reactor designs.

9.3.4.2 Discussion of Ranking Results

The bounding plant site merit scores are provided in Table 9.3-3. A “site merit” score of 500 is the maximum that can be achieved for the “total site merit” of any criteria subgroup. Results show a narrow total score spread (i.e., ranging from 351 to 377) with the North Anna ESP site ranking highest. These results further indicate that all four sites are suitable locations for additional nuclear generating units.

Based on the results of the evaluation, Dominion decided to locate the ESP site within the NAPS site. This basis included the special case provision noted in NUREG-1555, ESRP 9.3 (Subsection III(8)), that a new facility to be constructed can be located at an existing nuclear power plant site previously found acceptable from a NEPA review and/or demonstration of satisfactory environmental operating experience (Reference 1). Although the other sites were found to be environmentally acceptable, Dominion concluded that there are no obviously superior sites to the North Anna ESP site.

Subsequent to completion of the alternative site evaluation, additional evaluations of cooling water alternatives for the ESP site were conducted. Dominion decided to use a closed-cycle, combination wet and dry cooling tower approach for Unit 3 instead of the once-through cooling system originally proposed. Due to the change in the cooling system design, a review of the alternative site evaluation was conducted to determine the impact, if any, on the North Anna site merit score and conclusions reached by this evaluation. Based on this review, it was determined that alternative approaches for the cooling system, including the use of dry or wet cooling towers, were considered as part of the rankings assigned to suitability criteria for the North Anna site. Therefore, the changes in the cooling system design have minimal impact on the North Anna site ranking versus the alternative sites, and do not affect the overall conclusion reached in the site evaluation that there are no obviously superior sites to the North Anna ESP site.

Section 9.3 References

1. NUREG-1555, *Environmental Standard Review Plan*, U.S. Nuclear Regulatory Commission (USNRC), October 1999.

2. *Study of Potential Sites for the Deployment of New Nuclear Plants in the United States,* U.S. Department of Energy Cooperative Agreement No. DE-FC07-02ID14313, Prepared by Dominion Energy, Inc. and Bechtel Power Corporation, September 2002. np2010.ne.doe.gov/ESP_Study/ESP_Study_Dominion.pdf

3. NUREG-1437, *Generic Environmental Impact Statement for License Renewal of a Nuclear Plant,* Supplement 7, Regarding North Anna Power Station, Units 1 and 2, Final Report, U.S. Nuclear Regulatory Commission, November 2002.

Table 9.3-1 Summary of Environment Impacts For New Nuclear Units

Impact Areas	Phase of Project	At Existing Nuclear Site	At Generic Greenfield Site
Land Use		Moderate	Moderate to Large
Water Quality		Small	Small to Moderate
Air Quality		Small	Small
Ecological Resources		Moderate	Moderate to Large
Human Health		Small	Small
Socioeconomic Non-Transportation	During Construction During Operation	Small to Moderate Small	Large Small to Moderate
Socioeconomic Transportation	During Construction During Operation	Moderate to Large Small	Moderate to Large Small to Moderate
Waste Management		Small	Small
Aesthetics		Small	Large
Cultural Resources: Historical & Archaeological Resources		Small	Small
Environmental Justice		Small	Small to Large

Source: Supplement 7 of GEIS, November 2002

Table 9.3-2 Suitability Criteria

Economic	Engineering	Environmental	Socioeconomic
Electricity Projections Transmission System Stakeholder Support Site Development Costs	Site Size Site Topography Environmentally Sensitive Areas Emergency Planning Labor Supply Transportation Access Security Hazardous Land Use Ease for Decommissioning Water Rights and Air Permits Regulatory Schedule Geologic Hazards Site-Specific SSE Capable Faults Liquefaction Potential Bearing Material Near-Surface Material Groundwater Flooding Potential Ice Formation Cooling Water Source Temperature & Moisture Winds Rainfall Snow Atmospheric Dispersion	Terrestrial Habitat Terrestrial Vegetation Aquatic Habitat/ Organisms Groundwater Surface Water Population	Present/Planned Land Use Demography Socioeconomic Benefits Agricultural/ Industrial Aesthetics Historic/ Archaeological Transportation Network Environmental Justice

Source: Part 2, Table 6-2 of “Study of Potential Sites for the Deployment of New Nuclear Plants in the United States”, U.S. Department of Energy Cooperative Agreement No. DE-FC07-02ID14313, Prepared by Dominion Energy, Inc. and Bechtel Power Corporation, September 2002.

Table 9.3-3 Site Merit Scores for the Four Alternative Sites

Site	Economic	Engineering	Environmental	Sociological	Total
North Anna	392	326	359	418	377
Savannah River	323	382	344	489	372
Portsmouth	321	348	345	453	358
Surry	348	304	339	416	351

Source: Extract from Executive Summary, Table 2 of “Study of Potential Sites for the Deployment of New Nuclear Plants in the United States”, U.S. Department of Energy Cooperative Agreement No. DE-FC07-02ID14313, Prepared by Dominion Energy, Inc. and Bechtel Power Corporation, September 2002.

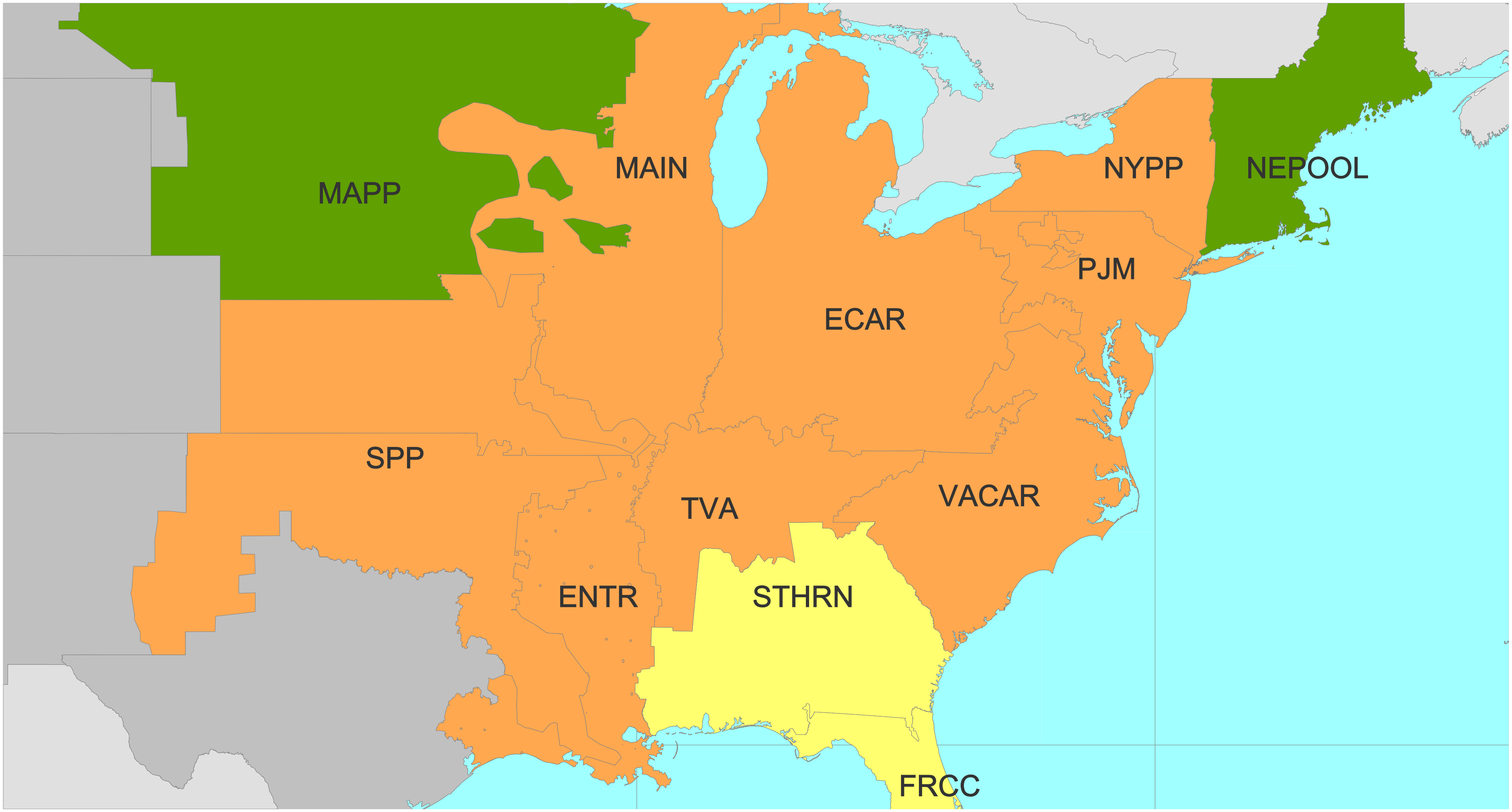

Figure 9.3-1 Region of Interest

9.4 Alternative Plant and Transmission Systems

This section describes the evaluation of the alternative plant and transmission systems for heat dissipation, circulating water, and power transmission, in accordance with NUREG-1555 (Reference 1, Section 9.4).

The evaluation of alternatives is segregated into the following topics:

- Heat dissipation systems
- Circulating water systems
- Transmission systems

9.4.1 Heat Dissipation Systems

This evaluation focuses on identifying alternative heat dissipation systems that are feasible, legislatively compliant, and environmentally preferable. In accordance with NUREG-1555, this evaluation first compares these alternatives with the proposed system using standardized criteria that include land use, water use, thermal and physical impacts, atmospheric effects, noise generation, aesthetics and recreational benefits, generating efficiency, and operating and maintenance experience with similar units. (Reference 1, Section 9.4.1)

The proposed system and alternatives that prove to be feasible, legislatively compliant, and environmentally preferable have been economically evaluated. This economic evaluation is limited to a comparison of the relative costs of these screened alternatives.

Heat from the new units would be dissipated by two independent systems: 1) a closed-cycle, dry and wet tower cooling system for Unit 3, and 2) a closed-cycle dry tower system for Unit 4. The “base case” for Unit 3 is a closed-cycle, with a combination of dry and wet mechanical draft towers. The dry cooling tower would consist of a series of moderate-profile, rectangular structures that house large fans and piping, and the wet cooling towers would consist of a series of multi-cell, rectangular cooling tower banks. Associated intake/discharge, pumping, and piping systems would be required. Cooled water from the towers would be pumped first through the condenser, where it would be heated. The heated water would then be circulated through the dry and wet towers where it would reject heat to ambient air. Make-up water would be obtained from the North Anna Reservoir, and wet cooling tower blowdown would be discharged to the head of the existing discharge canal. The Unit 3 base case system is compared with the following heat dissipation alternatives:

- Once-through system (Alternative 1): This alternative would include a once-through system with its intake and pumping system on the North Anna Reservoir, and discharges at the head of the discharge canal.

- Once-through system with helper tower (Alternative 2): This alternative would include the once-through system and a small multi-cell mechanical draft cooling tower system. The helper tower would operate on an as-needed basis during the warmest summer months to mitigate the peak temperatures in the WHTF and the North Anna Reservoir by transferring heat to the environment via evaporation, and directly to the atmosphere. Water would be withdrawn from the North Anna Reservoir and cooling tower blowdown would be returned to the discharge canal.
- Natural draft cooling tower system (Alternative 3): This alternative would consist of a number of free-standing, hyperbolic towers and associated intake/discharge, pumping, and piping systems. This closed-cooling system would withdraw water from the North Anna Reservoir and transfer heat to the environment via evaporation and directly to the atmosphere. Minor cooling tower blowdown discharges would be released to the existing discharge canal.
- Mechanical draft cooling tower system (Alternative 4): This alternative would consist of four multi-cell, rectangular cooling tower banks and associated intake/discharge, pumping, and piping systems. This closed-cooling system would withdraw water from the North Anna Reservoir and transfer heat to the environment via evaporation and directly to the atmosphere. Minor cooling tower blowdown discharges would be released to the existing discharge canal.
- Spray ponds (Alternative 5): This alternative would involve the addition of new surface water bodies on site and the addition of an extensive matrix of spray modules to promote evaporative cooling in the new ponds. Additional pumping and piping systems would be required.
- Dry tower system (Alternative 6): This alternative would consist of a series of moderate profile (150-foot high) rectangular structures that house large fans and piping. There would be little other resources required (e.g., water, wastewater) besides land.

The Unit 4 base case would consist of a dry tower system. The Unit 4 base case system is compared with the following heat dissipation alternatives:

- Once-through system (Alternative 7)
- Once-through system with helper tower (Alternative 8)
- Natural draft cooling tower system (Alternative 9)
- Mechanical draft cooling tower system (Alternative 10)
- Spray ponds (Alternative 11)

9.4.1.1 Technical, Regulatory, and Environmental Review of Heat Dissipation Systems – Unit 3

The Unit 3 base case and alternative heat dissipation systems are evaluated and compared in Table 9.4-1 through Table 9.4-3.

The Unit 3 evaluation concludes that the following heat dissipation systems are feasible, legislatively compliant, and environmentally preferable or equivalent to the base case:

- Natural draft cooling tower system (Alternative 3)
- Mechanical draft cooling tower system (Alternative 4)
- Dry towers (Alternative 6)

The once-through system (Alternative 1), once-through system with helper tower (Alternative 2) and the spray pond system (Alternative 5) posed regulatory approval barriers, as presented in Table 9.4-2, and therefore have been removed from further consideration.

9.4.1.1.1 **Relative Economic Evaluation of Heat Dissipation Systems – Unit 3**

The Unit 3 capital costs would be the highest for dry towers (Alternative 6). The capital cost for alternatives using wet cooling towers (Alternatives 3 and 4), including the base case, would be lower than dry towers. The operating costs of wet cooling tower alternatives, including the base case, are lower than dry towers (Alternative 6), primarily because dry tower fans use more power.

9.4.1.1.2 **Alternative Heat Dissipation System Summary – Unit 3**

Table 9.4-3 offers a summary comparison of the relative natural resource (i.e., land, water) requirements, environmental impacts, regulatory barriers, operating issues, and energy/economic considerations for the base case and the alternative heat dissipation systems for Unit 3. This table identifies the closed-cycle, dry and wet tower system (base case) as the preferred cooling system option because of its advantages from regulatory, water usage, and thermal impact perspectives. The once-through cooling systems (Alternatives 1 and 2) offers advantages with respect to land use, aesthetics (no visual impact or noise), superior operating experience, and low impact on generating efficiency. However, the once-through systems raised concerns involving discharge water temperature to the WHTF, resultant increase in lake water temperature, water usage from the North Anna Reservoir, potential impacts on striped bass population, and difficulty in obtaining regulatory approval. Therefore, the once-through systems were determined to be unacceptable alternatives for Unit 3. While the remaining wet and dry tower systems (Alternatives 3, 4 and 6) scored lower on key attributes than the base case, they did not present any fatal flaws, and thus, they were also deemed appropriate for further energy and economic review.

Subsequent cost comparisons show that the capital and operating costs of dry towers alone (Alternative 6) would be higher than wet towers or combination dry and wet towers. A 100 percent dry cooling tower system would require significantly more fans to dissipate condenser rejected heat. It is estimated that up to 80 MW would be required to power dry tower fans under design operating conditions. Even when compared to operation in the MWC mode (dry towers operating and removing at least one-third of condenser heat duty) under design conditions, the 100 percent dry cooling system fans require more than three times the power of the combination dry and wet cooling tower circulating water system fans. The lower efficiency of the dry tower system represents a significant increase in fuel requirements over the lifetime of the plant. In addition, evaluations show that the all-dry system (three-thirds dry cooling capacity) material cost is more than 500 percent higher than a one-third minimum dry cooling capacity system and the dry system contains significantly more active components, which would increase maintenance costs. Also, the dry tower system alone is unable to produce the needed performance required during periods of high ambient dry bulb temperature (>95°F), which could occur during the summer season, without having periods of power reduction. Thus, a partially wet cooling tower system is required to lower the cooling water temperature sufficiently to operate the plant without a reduction in unit power output. Dry cooling towers can require as much as 10 times the area of a wet tower with a comparable cooling capacity, depending on the technology selected. Because of its thermal performance limitations when air ambient temperature is high, a dry tower array would become very large, using significant acreage, and could have a higher profile.

The capital and operating costs of wet tower systems would be lower than combination dry and wet tower systems. However, the natural-draft and mechanical-draft cooling towers (Alternatives 3 and 4) would not provide the operational flexibility of the base case with respect to water usage and reduced downstream water flow. When water usage has to be reduced during drought conditions and low lake levels, the base case, which has the dry towers, would afford the ability to continue to operate Unit 3 with a minimum of one-third of the heat dissipation achieved through the use of the dry towers and, depending on prevailing ambient conditions, a significantly higher than one-third of the heat dissipation could be achieved through the dry towers. Therefore, the combination wet and dry tower system is superior on the most important environmental factors essential for obtaining regulatory approval and preserving lake water under normal and severe drought conditions.

Thus, Table 9.4-3 illustrates that the Unit 3 base case is the preferable heat dissipation system.

9.4.1.1.3 **Thermal Impact and Water Level Enhancements – Unit 3**

As demonstrated in previous sections, Lake Anna would dissipate the negligible waste heat from the continuous blowdown of Unit 3 wet towers. Because blowdown is taken from water already cooled in the towers, any additional waste heat to Lake Anna would be negligible. From a water level perspective, operation of dry towers during the MWC mode of operation would reduce water consumption from Lake Anna. Therefore, Dominion has not considered any other supplemental options to mitigate decreases in lake level from operation of the preferred Unit 3 combination dry and wet tower cooling system.

9.4.1.2 **Technical, Regulatory, and Environmental Review of Heat Dissipation Systems – Unit 4**

The Unit 4 base case and alternative heat dissipation systems are evaluated and compared in Table 9.4-4 through Table 9.4-6.

This tabular evaluation (Table 9.4-4 and Table 9.4-5) indicates that once through options (Alternatives 7 and 8), wet cooling tower options (Alternatives 9 and 10), and the spray pond system (Alternative 11) would have to overcome significant regulatory barriers with respect to water usage from the North Anna Reservoir. In particular, even with natural-draft or mechanical cooling towers, a supplemental source of cooling water would be required during drought conditions to maintain minimum lake levels and downstream flows. The need for a supplemental source of cooling water would result in additional impacts, such as consumption of water from remote supplies and the impacts of transporting the water (e.g., the impacts of building a pipeline). In the absence of any identifiable and readily available source, none of these alternatives is currently deemed feasible.

9.4.1.2.1 **Relative Economic Evaluation of Heat Dissipation Systems – Unit 4**

Because none of the alternatives to the base case currently appears feasible, energy and economic considerations are not relevant.

9.4.1.2.2 **Alternative Heat Dissipation System Summary – Unit 4**

Table 9.4-6 offers a summary comparison of the relative land and water resource needs, environmental impacts, regulatory barriers, operating issues, and economic considerations for the base case and the alternative heat dissipation systems for Unit 4. This comparison illustrates that the Unit 4 base case dry tower system is the preferable heat dissipation system.

9.4.2 **Circulating Water Systems**

As presented in Section 9.4.1, the proposed heat dissipation systems for the new units at the ESP site are a closed-cycle, dry and wet cooling tower system for the first new unit (Unit 3), and a closed-cycle dry tower system for the second new unit (Unit 4). Since the proposed systems for Units 3 and 4 do not comprise an open-loop circulating water system, there is no need to evaluate circulating water system alternatives. The closed-loop circulating water system for Unit 3 would, however, require continuous make-up water to the wet cooling tower basin to compensate for the evaporative losses and cooling tower blowdown when waste heat cannot be rejected via the dry towers alone. The quantity of make-up is only about 2 percent of what would be required to be withdrawn for a once-through system, so the intake water for Unit 3 would be very small compared to the existing units’ intake. This evaluation focuses on identifying feasible make-up water intake systems that are legislatively compliant, environmentally preferable, and economically viable. In accordance with NUREG-1555 guidance, this evaluation first compares alternative intake water systems against the base case system using standardized criteria that include construction impacts, aquatic issues, water use, land use, and compliance with regulations (Reference 1, Section 9.4.2). As stated in NUREG-1555, the proposed system and alternatives that prove to be feasible, legislatively compliant, and environmentally preferable are then evaluated on an economic basis. In this case, a comparison of alternate intake water system components has not revealed alternatives that are preferable on an environmental basis. Therefore, further economic analysis of alternatives is not warranted.

The base case intake water system for Unit 3 comprises:

- Intake System: Shoreline
- Intake Location: Adjacent to existing intake structure on Lake Anna
- Discharge System: Shoreline
- Discharge Location: Existing discharge canal
- Water Supply: Lake Anna
- Water Treatment: Mechanical condenser cleaning and chemical biocide/corrosion/antiscalant treatment (cooling tower systems)

The following sections evaluate this base case against a list of potential alternative system components that address intake, discharge, water supply, and water treatment issues for Unit 3 only.

9.4.2.1 **Intake System**

While NUREG-1555 suggests that the intake system evaluation address alternative intake systems, locations, pumping arrangements, defouling processes and screens; the base case design has not matured sufficiently to support evaluation of alternative pumping, defouling and screen systems. Consequently, the evaluation of the intake base case and alternatives is limited to the intake system and intake location. Table 9.4-7 and Table 9.4-8 provide an evaluation or comparison of the following base case and alternative intake systems and locations:

- Systems
    - Shoreline Intake System (Base Case): Partially submerged concrete inlet structure positioned along the shoreline.
    - Offshore Intake (Alternative 1): Completely submerged intake structure(s) positioned just above the bottom of the body of water supply source, some distance from shore.
- Locations
    - Existing Intake location (Base Case): Intake location immediately adjacent to existing units intake on Lake Anna
    - Alternate intake location on Lake Anna (Alternative 2): Intake location at least several hundred feet away from the existing intake structure
    - Lower North Anna River (Alternative 3): Intake location downstream of the North Anna Dam along the North Anna River

This evaluation concludes that: 1) an offshore intake system or alternate intake locations would be difficult to permit, 2) the alternatives could generate larger environmental impacts relative to the base case intake system arrangement, and finally 3) they could trigger costly additional permitting, stakeholder consultations, and environmental restoration. Therefore, further economic evaluation of the base case and alternative intake systems is unwarranted.

9.4.2.2 **Discharge System**

While NUREG-1555 also suggests that the discharge system evaluation address alternative discharge systems, locations, and discharge port technology, the incomplete base case discharge design can only support consideration of alternate discharge systems and locations. The discharge water quantity is smaller than the intake because the discharge comprises cooling tower blowdown only, whereas the intake comprises make-up for evaporative losses, drift losses, and blowdown. Table 9.4-9 and Table 9.4-10 provide comparisons of the following base and alternative discharge systems and locations.

- Discharge Systems
  - Shoreline Discharge (Base Case): Concrete, partially submerged, discharge structure along shoreline of receiving body of water
  - Offshore Discharge (Alternative 4): Completely submerged discharge structure(s) positioned just above the receiving water body bottom, some distance from shore
- Discharge Location
  - Existing discharge location (Base Case): Discharge location (shoreline) at the head of the Discharge Canal immediately adjacent to the existing units discharge structures
  - Waste Heat Transfer Facility (WHTF) Location (Alternative 5): Discharge location (shoreline) in a portion of the WHTF outside of the discharge canal
  - Lake Anna (Alternative 6): Discharge location (shoreline) in publicly accessible portion of Lake Anna

This evaluation concludes that: 1) the all of the discharge system alternatives may be more difficult to permit than the base case, and 2) they could generate larger adverse environmental impacts relative to the base case intake system arrangement. Further economic evaluation of the base case and alternative discharge systems is unwarranted.

9.4.2.3 **Water Supply**

The evaluation of alternative water supplies prescribed by NUREG-1555 is amended herein because of the certainty of water supply (Lake Anna) for the Unit 3 preferred closed-cycle, dry and wet cooling tower system and because of the application of the closed-cycle dry tower system for Unit 4.

9.4.2.4 **Water Treatment**

The evolving water treatment system design is not sufficiently mature to support all of the NUREG-1555 suggested water treatment evaluation processes: water treatment processes, chemical additives, and operating mode. Consequently, the evaluation of the water treatment processes focuses herein only on water treatment system issues for Unit 3. Table 9.4-11 provides a tabularized evaluation of the following base case and alternative water treatment systems.

- Water Treatment Systems
    - Mechanical Treatment (Base Case): Periodic mechanical cleaning of condenser tubing
    - Chemical Treatment (Alternative 7): Cooling water biofouling, corrosion and pH control chemical additives
    - Non-chemical Treatment (Alternative 8): Ultraviolet light sterilization

This evaluation demonstrates that the Unit 3 base case mechanical condenser cleaning option poses smaller adverse environmental impacts than the other technically-feasible alternative treatment system—the chemical treatment system. The mechanical cleaning system represents the environmentally-preferred treatment system for the Unit 3 condenser. However the mechanical cleaning process is not practical for the cooling towers. Therefore, chemical treatment (Alternative 7) would be necessary. A chemical treatment system would be selected that meets environmental impact limits. The dry tower system for Unit 4 poses minimal water treatment requirements. Further economic evaluation of the base case and alternative water treatment systems is unwarranted.

9.4.2.5 **Summary**

The evaluation of the key components (excluding water supply) of the base case and alternative intake water systems for Unit 3 indicates that the following base case configuration collectively represents the only environmentally preferable circulating water system:

- Intake System: Shoreline
- Intake Location: Adjacent to existing intake structure on Lake Anna
- Discharge System: Shoreline
- Discharge Location: Adjacent to existing discharge structure on discharge canal
- Water Supply: Lake Anna
- Water Treatment: Mechanical condenser cleaning and chemical biocide/corrosion/pH adjustment treatment, as required for cooling towers

9.4.3 **Transmission Systems**

NUREG-1555, Section 9.4.3, provides guidelines for the preparation of a summary discussion that identifies the feasible and legislatively compliant alternative transmission systems. Based on an initial evaluation, the current ESP site transmission lines and corridors have sufficient capacity for the total output of the existing and new units. There are no environmentally equivalent or more advantageous alternatives to “no action.”

Section 9.4 References

1. NUREG-1555, *Environmental Standard Review Plan* U.S. Nuclear Regulatory Commission, October 1999.

2. *Platts Power Magazine*, "Cooling Options Change for a Hot, Thirsty Industry," September 2002.

3. Vermeyen, T, "Use of Temperature Control Curtains to Control Reservoir Release Water Temperatures," Report No. R-97-09, Water Resources Research Lab., Bureau of Reclamation, Denver, December 1997.

4. *New All Organic Chemistry for Treatment of Closed Cooling Tower Systems*, Paper No. TP-07, Cooling Tower Institute, 2002.

5. CWA §316(b), Technical Development Document for the Final Regulations (EPA-821-R-01-036), *Chapter 3: Energy Penalties, Air Emissions, and Cooling Tower Side Effects*, U.S. Environmental Protection Agency, http://www.epa.gov/waterscience/316b/technical/ch3.pdf, November 2001.

Table 9.4-1 Screening of Unit 3 Alternative Heat Dissipation Systems (Base Case & Alternatives 1–2)

Factors Affecting System Selection	Combination Dry and Wet Towers (Base Case)	Once-Through (Alternative 1)	Once-Through with Helper Tower (Alternative 2)
Land Use: Onsite Land Considerations	A combination dry and wet mechanical draft cooling tower (CDWMDCT) system would require more land (as compared to the OT system) to site widely spaced dry and wet towers. A CDWMDCT system could be placed within the confines of the existing NAPS site.	The once-through (OT) system would have the smallest land requirements. The OT system could be placed within the confines of the existing NAPS site.	A once-through and helper tower (OTHT) system would require marginally more land than is required by the OT system alone, but less than other cooling tower systems. The OTHT system could be placed within the confines of the existing NAPS site.
Land Use: Terrain Considerations	CDWMDCT system withdraws less water and so is less affected by significant terrain variations. Terrain features of the site are suitable for a CDWMDCT system.	OT systems require flat or gently rolling terrain to minimize pump head requirements. Terrain features of the site would not preclude the use of the OT system.	OTHT systems require flat or gently rolling terrain situations. Terrain features of the site are suitable for an OTHT system.
Water Use	The closed wet cooling tower system would have considerable evaporative losses to the atmosphere, but these losses could be reduced by operation of the dry towers in the MWC mode, thus reducing the water usage and conserving water during drought conditions.	An OT system would have an intake requirement of nearly 50 times more water than a mechanical draft wet cooling tower (MDCT) system. OT - 1,140,000 gpm Wet cooling systems - 23,950 gpm Despite this increased water intake requirement, the OT system would return most of the withdrawn water. However, the evaporative loss due to the increased temperature in the WHTF and the lake would exceed the consumption of the CDWMDCT (base case) in the MWC mode.	An OTHT system would require the second largest water supply. Although the helper tower system would reduce water intake requirements, its use would not reduce water usage to below the combined dry and wet tower operation.

Table 9.4-1 Screening of Unit 3 Alternative Heat Dissipation Systems (Base Case & Alternatives 1–2)

Factors Affecting System Selection	Combination Dry and Wet Towers (Base Case)	Once-Through (Alternative 1)	Once-Through with Helper Tower (Alternative 2)
Regulatory Restrictions	An intake structure for a CDWMDCT system would meet Section 316(b) of the CWA and the implementing regulations, as applicable. The VPDES discharge permit thermal discharge limitation to the WHTF would need to be modified to account for the minor additional thermal load rejected by the new CDWMDCT system. These regulatory restrictions would have small impacts on this heat dissipation system.	The intake structure for the OT system would meet Section 316(b) of the CWA and the implementing regulations, as applicable. Because of concerns with thermal impacts and water consumption, permitting would be difficult.	An intake structure for the OTHT systems would meet Section 316(b) of the CWA and the implementing regulations, as applicable. While the helper tower would temper the thermal loading to the WHTF during the hottest summer season periods, concerns with thermal impacts and water consumption would pose an impediment to permitting.
Atmospheric Effects	The CDWMDCT system would emit water droplets (drift) and intermittently produce a visible vapor plume. The drift droplets would be a minor source of particulate matter and salt deposition. The water vapor plume would result in minimal additional fogging but no icing conditions on local road systems. Aesthetic impacts from the visible plume would be small.	Since OT systems do not produce a visible plume and the associated pond-induced fogging (steam fog) is minimal, atmospheric effects would be small.	An OTHT system would emit water droplets (drift) and produce visible plumes during periods when the helper tower is in operation. The particulate, salt deposition and fogging and aesthetic impacts would not be significant from the infrequent/intermittent operation of this small cooling tower.
Thermal and Physical Effects	The CDWMDCT system would discharge a significantly smaller thermal load to the WHTF (compared to OT systems) because 65–85% of the heat removal in cooling towers is associated with evaporation (Reference 2). Most of the remaining heat is dissipated directly to the atmosphere. The small amount of heat from blowdown to the WHTF would be additive to the OT thermal load from the existing units. The VPDES permit thermal discharge criteria would need to be revised to reflect this minor addition.	The OT system would add thermal load to the WHTF, resulting in the greatest temperature increase to the WHTF and the lake. The VPDES permit thermal discharge criteria would need to be revised to reflect this addition of thermal load.	An OTHT system would add thermal load to the WHTF. The helper tower would temper the thermal loading to the WHTF during the hottest summer season periods, but the thermal impact would be greater than the base case. The VPDES permit thermal discharge criteria would need to be revised to reflect this addition of thermal load.

Table 9.4-1 Screening of Unit 3 Alternative Heat Dissipation Systems (Base Case & Alternatives 1–2)

Factors Affecting System Selection	Combination Dry and Wet Towers (Base Case)	Once-Through (Alternative 1)	Once-Through with Helper Tower (Alternative 2)
Noise Levels	CDWMDCT operation would generate noise from fan and pump operation and from cascading water in the towers. The results of the Section 5.3.4 noise evaluation for combination dry and wet tower system suggests that noise impacts for the CDWMDCT would also be below the NRC-defined significance levels (65 dBA) at the EAB. Construction related noise impacts would be small.	OT system operation would generate small noise impacts from pump operation. Construction-related noise impacts would be small.	OTHT operation would generate noise from fan and pump operation and from cascading water in the towers during the periods when the helper tower is needed. The associated noise impacts would be less than the dry tower system impacts, which were below the NRC-defined significance levels (65 dBA) at the EAB as described in Section 5.3.4. Construction-related noise impacts would be small.
Aesthetics and Recreational Benefits	The CDWMDCT system would be wholly situated on the existing NAPS site and the primary external impact would be the minor discharge of heated water to the North Anna Reservoir via the WHTF. Discharges to the North Anna Reservoir, a popular recreational resource, would produce no tangible aesthetic or recreational benefits.	The OT system would be wholly situated on the existing NAPS site and its primary external impact would be the discharge of a large quantity of heated water to the North Anna Reservoir via the WHTF. Discharges to the North Anna Reservoir, a popular recreational resource, would produce no tangible aesthetic or recreational benefits.	An OTHT system would be wholly situated on the existing NAPS site and its primary external impact would be the discharge of large quantity of heated water to the North Anna Reservoir via the WHTF. Discharges to the North Anna Reservoir, a popular recreational resource, would produce no tangible aesthetic or recreational benefits.
Operating and Maintenance Experience	Dry and wet tower systems are common to power plants (both fossil and nuclear) and are considered highly reliable.	OT systems are common to older power plants (both fossil and nuclear) and they are considered highly reliable.	While OTHT systems are less common than OT systems, they do not pose any greater operating and maintenance risks than other cooling tower systems.
Generating Efficiency Penalty	The energy penalty (% reduction in plant output) of CDWMDCT systems versus OT systems is 1.7 to 4 percent. (extrapolated from Reference 5, Tables 3-1 and 3.2).	The OT system has the least energy requirement. The energy penalty (% reduction in plant output) of wet tower systems versus OT systems is 1.7 to 1.9%. The energy penalty of dry tower systems versus OT systems is 8.5 to 11.4%. (Reference 5, Tables 3-1 and 3-2)	The additional energy requirements associated with cooling tower operation do not alter this system’s energy efficiency advantages over wet cooling tower only systems.
Is this a suitable heat dissipation system?	Yes	No	No

Table 9.4-2 Screening of Unit 3 Alternative Heat Dissipation Systems (Alternatives 3–6)

Factors Affecting System Selection	Natural Draft Cooling Towers (Alternative 3)	Mechanical Draft Cooling Towers (Alternative 4)	Spray Ponds (Alternative 5)	Dry Towers (Alternative 6)
Land Use: Onsite Land Considerations	A natural draft cooling tower (NDCT) system would require less land (as compared to a CDWMDCT system) to accommodate the hyperbolic towers. An NDCT system could be placed within the confines of the existing NAPS site.	An MDCT system would require less land (as compared to the CDWMDCT system) to site the towers. An MDCT system could be placed within the confines of the existing NAPS site.	A spray pond-cooling alternative would involve the development of significant additional surface water impoundments and consequently pose the additional land requirements. It is unlikely that new spray ponds of sufficient size could be placed within the confines of the existing NAPS site.	A dry tower system would require more land than wet cooling tower systems. The dry tower system would require up to 10 times the land use area of the CDWMDCT system (base case). Dry towers could be situated within the confines of the existing NAPS site.
Land Use: Terrain Considerations	NDCT systems withdraw less water and so are less affected by substantial terrain variations. Terrain features of the site are suitable for an NDCT system.	MDCT systems withdraw less water and so are less affected by significant terrain variations. Terrain features of the site are suitable for a MDCT system.	Since spray pond construction involves substantial earthwork, such systems are most appropriate for flat or gently rolling terrain. Terrain features of the site are suitable for the addition of spray ponds.	Dry tower systems are unaffected by terrain considerations.
Water Use	The water intake requirements for the NDCT system and the CDWMDCT system are approximately the same when the unit is in the EC mode. However, when dry towers are in operation, the CDWMDCT system (base case) would have lower evaporative losses.	The water intake requirements for the MDCT system and the CDWMDCT system are approximately same. When dry towers are in operation, the CDWMDCT system (base case) would have lower evaporative losses	A spray pond would require large volumes of water and would likely require offsite sources of water.	A dry tower system would have no comparable evaporative water losses when compared with MDCTs or spray ponds. A dry tower system would require minimal service water.

Table 9.4-2 Screening of Unit 3 Alternative Heat Dissipation Systems (Alternatives 3–6)

Factors Affecting System Selection	Natural Draft Cooling Towers (Alternative 3)	Mechanical Draft Cooling Towers (Alternative 4)	Spray Ponds (Alternative 5)	Dry Towers (Alternative 6)
Regulatory Restrictions	An intake structure for an NDCT system would meet Section 316(b) of the CWA and the implementing regulations, as applicable. The VPDES discharge permit thermal discharge limitation to the WHTF would need to be modified to account for the small additional thermal load from NDCT blowdown.	An intake structure for an MDCT system would meet Section 316(b) of the CWA and the implementing regulations, as applicable. The VPDES discharge permit thermal discharge limitation to the WHTF would need to be modified to account for the minor additional thermal load from the MDCT blowdown.	Additional land would have to be obtained and developed to support the spray pond option. The development of this land may entail a substantial and lengthy federal, state, and local permit and approval process.	There would be little or no permit or approval-related impacts to the dry tower system alternative.
Atmospheric Effects	An NDCT system would emit water droplets (drift) and intermittently produce a visible plume. The drift droplets would be a minor source of particulate matter and salt deposition. The water vapor plume would not encourage any additional fogging or icing conditions on local road systems. Visible plume aesthetic impacts would be small.	The MDCT system would emit water droplets (drift) and intermittently produce a visible vapor plume. The drift droplets would be a minor source of particulate matter and salt deposition. The water vapor plume would result in minimal additional fogging but no icing conditions on local road systems. Aesthetic impacts from the visible plume would be small.	A spray pond system could produce a low-level visible water droplet plume and encourage formation of fog above the heated pond. These impacts would be localized and short-lived, and consequently small.	A dry tower system would not produce a visible plume or pose particulate emission or salt deposition impacts.

Table 9.4-2 Screening of Unit 3 Alternative Heat Dissipation Systems (Alternatives 3–6)

Factors Affecting System Selection	Natural Draft Cooling Towers (Alternative 3)	Mechanical Draft Cooling Towers (Alternative 4)	Spray Ponds (Alternative 5)	Dry Towers (Alternative 6)
Thermal and Physical Effects	An NDCT system would produce a small thermal load to the WHTF because 65–85% of the heat removal in these towers is associated with evaporation (Reference 2) and most of the remaining heat is dissipated directly to the atmosphere. The NDCT thermal load would be greater than the thermal load from the CDWMDCT system (base case) operating in the MWC mode. The small NDCT thermal load rejected to the WHTF would be additive to the OT thermal load from the existing units. The VPDES permit thermal discharge criteria would need to be revised to reflect this addition of thermal load.	The MDCT system would discharge a small thermal load to the WHTF because 65–85% of the heat removal in cooling towers is associated with evaporation (Reference 2). Most of the remaining heat is dissipated directly to the atmosphere. The MDCT thermal load would be greater than the thermal load from the CDWMDCT system (base case) operating in the MWC mode. The small MDCT thermal load rejected to the WHTF would be additive to the OT thermal load from the existing units. The VPDES permit thermal discharge criteria would need to be revised to reflect this small thermal load addition.	Since the thermal load would be rejected to the spray pond and that pond would be wholly dedicated to industrial use, the thermal impacts external to the pond would be none to small.	A dry tower system would direct an invisible heated plume of air into the atmosphere, and impacts would be small.
Noise Levels	An NDCT system would produce less noise than a wet and dry tower system because of the absence of fan-generated noise. Construction-related noise impacts would be small.	MDCT operation would generate noise from fan and pump operation and from cascading water in the towers. The results of the Section 5.3.4 noise evaluation suggests that noise impacts for the MDCT would also be below the NRC-defined significance levels (65 dBA) at the EAB. Construction-related noise impacts would be small.	Spray pond system operation would generate noise from the spray operations. Since the location of the spray ponds and associated receptor boundaries are presently undefined, the associated noise impacts cannot be evaluated at this time. Construction-related noise impacts would be small.	A dry tower system would generate operational noise from fan operation. The Section 5.3.4 noise evaluation for a dry tower system indicates that noise contributions from a dry tower system would produce impacts below the NRC-defined significance levels (65 dBA) at the EAB. Construction-related noise impacts would be small.

Table 9.4-2 Screening of Unit 3 Alternative Heat Dissipation Systems (Alternatives 3–6)

Factors Affecting System Selection	Natural Draft Cooling Towers (Alternative 3)	Mechanical Draft Cooling Towers (Alternative 4)	Spray Ponds (Alternative 5)	Dry Towers (Alternative 6)
Aesthetics and Recreational Benefits	An NDCT system would be wholly situated on the existing NAPS site and its primary external impact would be the discharge of heated water to the North Anna Reservoir via the WHTF. Discharges to the North Anna Reservoir, a popular recreational resource, would produce no tangible aesthetic or recreational benefits.	The MDCT system would be wholly situated on the existing NAPS site and the primary external impact would be the discharge of heated water to the North Anna Reservoir via the WHTF. Discharges to the North Anna Reservoir, a popular recreational resource, would produce no tangible aesthetic or recreational benefits.	The spray ponds would be at least partially situated on land outside of the NAPS site. The resulting commitment of previously undeveloped property to industrial use would produce no tangible aesthetic or recreational benefits.	A dry tower system would be wholly situated on the existing NAPS site and their primary external impact would be the discharge of heated air and noise to the atmosphere. These discharges would produce no tangible aesthetic or recreational benefits.
Operating and Maintenance Experience	NDCT systems are common to older power plants (both fossil and nuclear) and they are considered highly reliable.	MDCT systems are common to power plants (both fossil and nuclear) and are considered highly reliable.	Spray pond systems have been used on power plant sites and they pose no operational and maintenance constraints.	Dry tower systems are becoming more popular at power plants. Their more limited operating experience indicates that their reliability is similar to wet cooling towers. While dry tower systems are less common, they do not pose any greater operating and maintenance risks than other cooling systems.

Table 9.4-2 Screening of Unit 3 Alternative Heat Dissipation Systems (Alternatives 3–6)

Factors Affecting System Selection	Natural Draft Cooling Towers (Alternative 3)	Mechanical Draft Cooling Towers (Alternative 4)	Spray Ponds (Alternative 5)	Dry Towers (Alternative 6)
Generating Efficiency Penalty	Natural draft cooling tower energy requirements would be less than the CDWMDCT and the mechanical draft systems. (Reference 5, Tables 3-1 and 3-2)	The energy requirements for MDCTs would be more than the NDCT system, but less than the CDWMDCT system, because of the potential for operating the dry and wet towers together under certain conditions.	Spray ponds' efficiency penalty is greater than OT systems, but smaller than all the other cooling tower system based alternatives.	The energy penalty (% reduction in plant output) of dry tower systems would be approximately 7% greater than the CDWMDCT system (base case) (extrapolated from Reference 5, Tables 3-1 and 3-2). The dry tower system can not produce the needed performance required during periods of high ambient dry bulb temperature (>95°F) without periods of significant power output reduction.
Is this a suitable alternative heat dissipation system?	Yes	Yes	No	Yes

Table 9.4-3 Summary Comparison of Unit 3 Heat Dissipation Systems Impacts

	Base Case	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Criteria	**CDWMDCT**	**OT**	**OTHT**	**NDCT**	**MDCT**	**SD**	**Dry Tower**
Land Use	Medium	Low	Low	Low	Medium	High	High
Water Use	Medium	High	High	Medium	Medium	High	Low
Regulatory Barriers	Low	High	High	Low	Low	High	Low
Air Impacts	Medium	Low	Low	Medium	Medium	Low	Low
Thermal/Physical Impacts	Low	High	High	Medium	Medium	Medium	Low
Noise Impacts	Medium	Low	Low	Medium	Medium	Low	Medium
Aesthetics & Recreational Benefits	None	None	None	None	None	None	None
Operating and Maintenance Experience	High	High	Medium	High	High	Medium	Low
Generating Efficiency Penalty	Medium	Low	Low	Low	Medium	Low	High
Overall Environmental & Operability Ranking	Preferable	Unacceptable	Unacceptable	Acceptable	Acceptable	Unacceptable	Acceptable
Capital Costs	Medium	Not evaluated	Not evaluated	Medium	Medium	Not evaluated	High
Operating Costs	Medium	Not evaluated	Not evaluated	Low	Medium	Not evaluated	High
Costs Ranking	Acceptable	Not evaluated	Not evaluated	Acceptable	Acceptable	Not evaluated	Unacceptable
Overall Preference	X						

Table 9.4-4 Initial Screening of Alternative Heat Dissipation Systems - Unit 4 (Base Case & Alternatives 7–9)

Factors Affecting System Selection	Dry Towers (Base Case)	Once-Through (Alternative 7)	Once-Through with Helper Tower (Alternative 8)	Natural Draft Cooling Towers (Alternative 9)
Land Use: Onsite Land Considerations	A dry tower system would require more land than a wet cooling tower system. Since dry towers could be situated within the confines of the existing site, impacts would be none to small.	An OT system would have the smallest land requirements.	An OTHT system would require marginally more land than is required by the OT system alone, but less than other cooling tower system. The OTHT system could be placed within the confines of the existing NAPS site.	An NDCT system could be placed within the confines of the existing NAPS site.
Land Use: Terrain Considerations	Dry tower systems are unaffected by terrain considerations.	OT systems require flat or gently rolling terrain to minimize pump head requirements. Terrain features of the site would not preclude the use of an OT system.	OTHT systems require flat or gently rolling terrain situations to minimize pump head requirements. Terrain features of the site are suitable for a OTHT system.	NDCT systems withdraw less water than OT systems and are less affected by substantial terrain variations. Terrain features of the site are suitable for a NDCT system.
Water Use	Dry tower systems have no comparable evaporative water losses when compared with MDCTs or spray ponds. Dry tower systems require minimal service water.	A OT system would require nearly 50 times more water than the MDCT system. Despite this increased water intake requirement, a OT system would return most of the water withdrawn, while the MDCT system would lose a considerable portion of the lesser water withdrawal to the atmosphere through evaporation. Hydrological and thermal modeling results (Section 3.4.1) indicate that Lake Anna cannot support operation of Unit 4 with OT cooling.	A OTHT system would require less water than a pure OT system. Despite this reduction, hydrological/thermal modeling results (Section 3.4.1) indicate that Lake Anna cannot support operation of Unit 4 with this modified OT system.	A OT system would require nearly 50 times more water than a NDCT system. Despite the reduced water intake requirements, a NDCT system would lose a considerable portion of the lesser water withdrawal to the atmosphere through evaporation. The overall evaporative losses would be somewhat greater for closed wet cooling tower systems compared to open cooling systems.

Table 9.4-4 Initial Screening of Alternative Heat Dissipation Systems - Unit 4 (Base Case & Alternatives 7–9)

Factors Affecting System Selection	Dry Towers (Base Case)	Once-Through (Alternative 7)	Once-Through with Helper Tower (Alternative 8)	Natural Draft Cooling Towers (Alternative 9)
Regulatory Restrictions	There are little or no permit or approval-related impacts to the dry tower system alternative.	An intake structure for OT system would meet Section 316(b) of the CWA and the implementing regulations, as applicable. Since the thermal load contribution of a Unit 4 OT system could produce undesirably high temperatures in the WHTF, it is unlikely that an additional once-through system could be successfully permitted.	An intake structure for OTHT system would meet Section 316(b) of the CWA and the implementing regulations, as applicable. While the helper tower for Unit 4 would temper the thermal loading to the WHTF during the hottest summer season periods, it is unlikely that an additional once-through system could be successfully permitted.	Although the water withdrawal of the NDCT is moderate, Lake Anna does not have the capacity to provide a water source for this cooling option. A supplemental source of cooling water would be required during drought conditions to maintain minimum lake levels and downstream flows. The need for a supplemental source of cooling water would result in additional impacts, such as consumption of water from remote supplies and the impacts of transporting the water (e.g., the impacts of building a pipeline). In the absence of any identifiable and readily available source, this alternative is not deemed feasible.
Atmospheric Effects	Dry towers systems do not produce visible plume or pose particulate emission or salt deposition impacts.	Since OT systems do not produce a visible water droplet plume and the associated pond induced fogging (steam fog) would be minimal, atmospheric effects would be none to small.	An OTHT system would emit water droplets (drift) and produce visible plumes during periods when the helper tower is in operation. The particulate, salt deposition, and fogging and aesthetic impacts would not be significant from the infrequent/intermittent operation of this small cooling tower.	An NDCT system would emit water droplets (drift) and may intermittently produce a visible plume. The drift droplets would be a minor source of particulate matter and salt deposition. The water vapor plume would not encourage any additional fogging or icing conditions on local road systems. Visible plume aesthetic impacts would be small.

Table 9.4-4 Initial Screening of Alternative Heat Dissipation Systems - Unit 4 (Base Case & Alternatives 7–9)

Factors Affecting System Selection	Dry Towers (Base Case)	Once-Through (Alternative 7)	Once-Through with Helper Tower (Alternative 8)	Natural Draft Cooling Towers (Alternative 9)
Thermal and Physical Effects	A dry tower system would direct an invisible heated plume of air into the atmosphere, and impacts would be none to small.	Hydrological and thermal modeling results (Section 3.4.1) indicate that Lake Anna cannot support operation of Unit 4 with an OT system.	While an OTHT system would minimize the thermal loading to the WHTF during the hottest summer season periods, hydrological/thermal modeling results (Section 3.4.1) indicate that Lake Anna cannot support operation of Unit 4 with this modified OT system.	An NDCT system would produce a significantly smaller thermal load on the WHTF (compared to OT systems) because 65–85% of the heat removal in cooling towers is associated with evaporation (Reference 2). Most of the remaining heat is dissipated directly to the atmosphere. In this case the smaller NDCT thermal load rejected to the WHTF would be additive to the existing OT thermal load. The VPDES permit thermal discharge criteria would need to be revised to reflect this minor thermal addition.
Noise Levels	The Section 5.3.4 noise evaluation for a dry tower system indicates that noise contributions from this system would produce impacts below the NRC-defined significance levels (65 dBA) at the EAB. Construction-related noise impacts would be small.	OT system operation would generate minimal noise from pump operation. Construction-related noise impacts would be small.	OTHT operation would generate noise from fan and pump operation and from cascading water in the towers during the periods when the helper tower is needed. The associated noise impacts would be less than dry towers impacts which were below the NRC-defined significance levels (65 dBA) at the EAB as described in Section 5.3.4. Construction-related noise impacts would be small.	An NDCT system would produce less noise than a dry tower system because of the absence of fan generated noise. Dry tower noise levels were evaluated to be below NRC-defined significance levels (65 dBA) at the EAB (see Section 5.3.4). Construction-related noise impacts would be small.

Table 9.4-4 Initial Screening of Alternative Heat Dissipation Systems - Unit 4 (Base Case & Alternatives 7–9)

Factors Affecting System Selection	Dry Towers (Base Case)	Once-Through (Alternative 7)	Once-Through with Helper Tower (Alternative 8)	Natural Draft Cooling Towers (Alternative 9)
Aesthetics and Recreational Benefits	A dry tower system would be wholly situated on the existing NAPS site and its primary external impact would be the discharge of heated air and noise to the atmosphere. These discharges would not produce tangible aesthetic or recreational benefits.	An OT system would be wholly situated on the existing NAPS site and its primary external impact would be the discharge of heated water to the North Anna Reservoir via the WHTF. Discharges to the North Anna Reservoir, a popular recreational resource, would produce no tangible aesthetic or recreational benefits.	An OTHT system would be wholly situated on the existing NAPS site and its primary external impact would be the discharge of heated water to the North Anna Reservoir via the WHTF. Discharges to the North Anna Reservoir, a popular recreational resource, would produce no tangible aesthetic or recreational benefits.	An NDCT system would be wholly situated on the existing NAPS site and its primary external impact would be the discharge of heated water to the North Anna Reservoir via the WHTF. Discharges to the North Anna Reservoir, a popular recreational resource, would produce no tangible aesthetic or recreational benefits.
Operating and Maintenance Experience	Dry tower systems are becoming more popular at power plants. Their more limited operating experience indicates that their reliability is similar to wet cooling towers. While dry tower systems are less common, they do not pose any greater operating and maintenance risks than other cooling systems.	OT systems are common to power plants (both fossil and nuclear) and they are considered highly reliable.	While OTHT systems are less common than OT systems, they do not pose any greater operating and maintenance risks than other cooling tower systems.	NDCT systems are common to power plants (both fossil and nuclear) and they are considered highly reliable.
Generating Efficiency Penalty	The energy penalty (% reduction in plant output) of dry tower systems versus wet tower systems is 6.8 to 9.6%. The energy penalty of dry tower systems versus OT systems is 8.5 to 11.4%. (Reference 5, Tables 3-1 and 3-2)	The energy penalty (% reduction in plant output) of dry tower systems versus OT systems is 8.5 to 11.4%. (Reference 5, Tables 3-1 and 3-2)	The additional energy requirements associated with cooling tower operation do not alter this system's energy efficiency advantages over wet cooling tower only systems.	The energy penalty (% reduction in plant output) of dry tower systems versus wet cooling tower systems is 6.8 to 9.6%. (Reference 5, Tables 3-1 and 3-2)

Table 9.4-4 Initial Screening of Alternative Heat Dissipation Systems - Unit 4 (Base Case & Alternatives 7–9)

Factors Affecting System Selection	Dry Towers (Base Case)	Once-Through (Alternative 7)	Once-Through with Helper Tower (Alternative 8)	Natural Draft Cooling Towers (Alternative 9)
Is this a suitable heat dissipation system?	Yes	No	No	No

Table 9.4-5 Screening of Unit 4 Alternative Heat Dissipation Systems (Alternatives 9 & 10)

Factors Affecting System Selection	Mechanical Draft Cooling Towers (Alternative 10)	Spray Pond (Alternative 11)
Land Use: Onsite Land Considerations	An MDCT system would require more land to site widely spaced towers. An MDCT system could be placed within the confines of the existing NAPS site property.	The spray pond cooling alternative would involve the development of significant additional surface water impoundments and consequently pose the greatest new land requirements. It is unlikely that spray ponds of sufficient size could be placed within the confines of the existing site.
Land Use: Terrain Considerations	MDCT systems withdraw less water than OT systems and are less affected by substantial terrain variations. Terrain features of the site are suitable for an MDCT system.	Since spray pond construction involves substantial earthwork, such systems are most appropriate for flat or gently rolling terrain. Terrain features of the site are suitable for the addition of spray ponds.
Water Use	An OT system would require nearly 50 times more water than an MDCT system. Despite the reduced water intake requirements, an MDCT system would lose a considerable portion of the lesser water withdrawal to the atmosphere through evaporation. The overall evaporative losses are somewhat greater for closed wet cooling tower systems compared to open cooling systems.	Spray ponds would require large volumes of water and would likely require offsite sources of water.
Regulatory Restrictions	Although the water withdrawal of the MDCT is moderate, Lake Anna does not have the capacity to provide a water source for this cooling option. A supplemental source of cooling water would be required during drought conditions to maintain minimum lake levels and downstream flows. The need for a supplemental source of cooling water would result in additional impacts, such as consumption of water from remote supplies and the impacts of transporting the water (e.g., the impacts of building a pipeline). In the absence of any identifiable and readily available source, this alternative is not deemed feasible.	Additional land would have to be obtained and developed to support a spray pond option. The development of this land would entail a substantial and lengthy federal, state, and local permit and approval process.

Table 9.4-5 Screening of Unit 4 Alternative Heat Dissipation Systems (Alternatives 9 & 10)

Factors Affecting System Selection	Mechanical Draft Cooling Towers (Alternative 10)	Spray Pond (Alternative 11)
Atmospheric Effects	An MDCT system would emit water droplets (drift) and intermittently produce a visible plume. The drift droplets would be a minor source of particulate matter and salt deposition. The water vapor plume is expected to encourage some minor supplemental hours of fogging annually and no icing conditions on local roads would encourage some additional fogging. Visible plume aesthetic impacts would be small.	Spray pond systems could produce a low-level visible water droplet plume and encourage formation of fog above the heated pond. These impacts would be localized and short-lived, and consequently small.
Thermal and Physical Effects	An MDCT system would produce a significantly smaller thermal load on the WHTF (compared to OT systems) because 65–85% of the heat removal in cooling towers is associated with evaporation (Reference 2). Most of the remaining heat is dissipated directly to the atmosphere. In this case the smaller MDCT thermal load rejected to the WHTF would be additive to the existing OT thermal load. The VPDES permit thermal discharge criteria would need to be revised to reflect this minor thermal addition.	Since the thermal load would be rejected to the spray pond that would be wholly dedicated to industrial use, the thermal impacts external to the pond would be none to small.
Noise Levels	MDCT operation would generate noise from fan and pump operation and from cascading water in the towers. Results from a noise impact analysis of dry towers operation described in Section 5.3.4 suggest that MDCT impacts will be below the NRC-defined significance levels (65 dBA) at the EAB. Construction-related noise impacts would be small.	Spray pond system operation would generate noise from the spray operations. Since the location of the spray ponds and associated receptor boundaries are presently undefined, the associated noise impacts cannot be evaluated at this time. Construction-related noise impacts would be small.
Aesthetics and Recreational Benefits	An MDCT system would be wholly situated on the existing NAPS site and its primary external impact would be the discharge of heated water to the North Anna Reservoir via the WHTF. Discharges to the North Anna Reservoir, a popular recreational resource, would produce no tangible aesthetic or recreational benefits.	The spray ponds would be at least partially situated on land outside of the NAPS site. The resulting commitment of previously undeveloped land to industrial use would produce no tangible aesthetic or recreational benefits.
Operating and Maintenance Experience	MDCT systems are common to power plants (both fossil and nuclear) and they are considered highly reliable.	Spray pond systems have been used on power plant sites and they pose no operational or maintenance constraints.

Table 9.4-5 Screening of Unit 4 Alternative Heat Dissipation Systems (Alternatives 9 & 10)

Factors Affecting System Selection	Mechanical Draft Cooling Towers (Alternative 10)	Spray Pond (Alternative 11)
Generating Efficiency Penalty	The energy penalty (% reduction in plant output) of dry tower systems versus wet cooling tower systems is 6.8 to 9.6%. (Reference 5, Tables 3-1 and 3-2)	Spray ponds' efficiency penalty is greater than OT systems, but smaller than all the other cooling tower system based alternatives.
Is this a suitable heat dissipation system?	No	No

Table 9.4-6 Summary Comparison of Unit 4 Heat Dissipation Systems Impacts

	Base Case	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11
Criteria	**Dry Towers**	**OT**	**OTHT**	**NDCT**	**MDCT**	**SP**
Land Use	High	Low	Low	Medium	Medium	High
Water Use	Low	High	High	Medium	Medium	High
Regulatory Barriers	Low	High	High	High	High	High
Air Impacts	Low	None	Low	Medium	Medium	Low
Thermal/Physical Impacts	Low	High	High	Medium	Medium	Medium
Noise Impacts	Medium	Low	Low	Medium	Medium	Low
Aesthetics & Recreational Benefits	None	None	None	None	None	None
Operating and Maintenance Experience	Low	High	Medium	High	High	Medium
Generating Efficiency Penalty	High	Low	Low	Medium	Medium	Low
Overall Environmental & Operability Ranking	Preferable	Unacceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Capital Costs	High	Not Evaluated	Not Evaluated	Not Evaluated	Not Evaluated	Not Evaluated
Operating Costs	High	Not Evaluated	Not Evaluated	Not Evaluated	Not Evaluated	Not Evaluated
Costs Ranking	Preferable	Not Evaluated	Not Evaluated	Not Evaluated	Not Evaluated	Not Evaluated
Overall Preference	X					

Table 9.4-7 Screening of Alternatives to the Proposed Intake System (Base Case & Alternative 1)

Factors Affecting System Selection	Intake System - Base Case Addition of Shoreline Intake on Lake Anna	Intake System - Alternative 1 Offshore Intake System
Construction Impacts	Since development of the intake shoreline would result in disruptions of the littoral zone (i.e., area of more concentrated biological resources), there could be localized adverse impacts to this disturbed zone. Since previous development in this zone and the new intake would be adjacent to an operational water intake system, these impacts would be small. Experience has shown that impacts near shorelines (i.e., transportation of silt) are more readily controllable near the shoreline than offshore.	If the offsite intake system is installed using an open trench construction process, there could be large adverse impacts to both the littoral zone and to deeper areas of the lake. This process would result in greater lakebed disruptions and larger increases in the turbidity of Lake Anna water. The resulting adverse impact to the lake water quality could be large during the construction phase of work.
Aquatic Impacts	The potentially large adverse operational impacts to aquatic life could be mitigated by reducing intake velocities and using traveling screens to reduce impingement, entrapment and entrainment of aquatic life.	Situated in areas with relatively less abundant aquatic resources, submerged offsite intake systems generally pose fewer impacts to aquatic life during operation.
Land Use Impacts	Since the commitment of land for the shoreline intake is small and this development would occur on the NAPS site, land use impacts would not be an important differentiating factor for intake systems.	Through offshore intake systems have somewhat lesser land requirements then shoreline intake systems, land use impacts would not be an important differentiating factor.
Water Use Impacts	The relative position of the intake (shoreline or offshore) would have no differentiating impact on the water use requirements and therefore, it would not be an important factor.	The relative position of the intake (shoreline or offshore) would have no differentiating impact on the water use requirements, and therefore, it would not be an important factor.
Compliance with Regulations	The intake structure for the new units at the ESP site would meet Section 316(b) of the CWA and the implementing regulations, as applicable. The applicable VPDES permit and current Section 316(b) considerations (aquatic species entrainment-impingement-entrapment) issues would need to be modified in response to the additional intake. These regulatory restrictions would not be an important differentiating factor.	The intake structure for the new units at the ESP site would meet Section 316(b) of the CWA and the implementing regulations, as applicable. The applicable VPDES permit and current Section 316(b) considerations (aquatic species entrainment-impingement-entrapment) issues would need to be modified in response to the additional intake. These regulatory restrictions would not be an important differentiating factor.
Environmentally preferred or equivalent? (Yes/No)	Yes	No

Table 9.4-8 Screening of Alternatives to the Proposed Intake System (Base Case & Alternatives 2 & 3)

Factors Affecting Location Selection	Intake Location - Base Case Adjacent to Existing Intake	Intake Location - Alternative 2 Alternative Location on Lake Anna	Intake Location - Alternative 3 Lower North Anna River
Construction Impacts	Construction impacts would be minimized if the intake structure is located adjacent to the existing NAPS site intake. Already cleared and graded in support of the original intake system development, this area has less ecological resources than other shoreline locations. Proximity to shore would allow use of best management practices to control the movement of silt and minimize impact on North Anna Reservoir waters.	Construction impacts from the disruption of shoreline environment would be larger for alternative shoreline locations along Lake Anna, since these areas have not been impacted by previous construction activities.	Construction impacts would be more significant in the lower North Anna River, since the affected body of water is smaller and more prone to turbidity impacts. The adjacent river shoreline is less developed and likely offers more diverse ecosystems.
Aquatic Impacts	The potentially large adverse operational impacts to aquatic ecosystems could be mitigated and rendered small by applying management techniques in use at the existing intake (e.g., minimized intake velocity, screens).	The potentially large adverse operational impacts to aquatic ecosystems could be mitigated and rendered small by applying management techniques in use at the existing intake (e.g., minimized intake velocity minimization, screens).	The potentially large adverse operational impacts to aquatic ecosystems could be somewhat mitigated by applying management and screening techniques in use at the existing intake. The more confined, potentially richer biological environment along the river shoreline would make it more difficult to effectively mitigate adverse impacts relative to the base case.
Land Use Impacts	Since the new intake would reside totally within the confines of the NAPS site, its location adjacent to another intake, poses the smallest land use impacts.	Land use designations outside of the NAPS site do not support the installation or operation of industrial facilities. Thus, development of intake locations in these areas would trigger potentially onerous land use amendment processes, which would make this alternative less desirable than the base case.	Land use designations along the lower North Anna River do not support the installation and operation of industrial facilities. Thus, development of intake locations in these areas would trigger potentially onerous land use amendment processes.

Table 9.4-8 Screening of Alternatives to the Proposed Intake System (Base Case & Alternatives 2 & 3)

Factors Affecting Location Selection	Intake Location - Base Case Adjacent to Existing Intake	Intake Location - Alternative 2 Alternative Location on Lake Anna	Intake Location - Alternative 3 Lower North Anna River
Water Use Impacts	Since Lake Anna represents the largest source of water for industrial use in the NAPS site area, the related water use impacts of an adjacent intake system would be small relative to other potential locations.	Since Lake Anna represents the largest source of water for industrial use in the NAPS site area, the related water use impacts of a new adjacent intake system would be small relative to potential impacts from using other locations.	The lower North Anna River does not have sufficient water capacity to supply the proposed circulating water system. The alternative is not technically viable.
Compliance with Regulations	The intake structure for the new units at the ESP site would meet Section 316(b) of the CWA and the implementing regulations, as applicable. The applicable VPDES permit and current Section 316(b) issues (aquatic species entrainment-impingement-entrapment) issues would need to be modified in response to the additional intake. Thus, these regulatory restrictions would not be an important differentiating factor.	The intake structure for the new units at the ESP site would meet Section 316(b) of the CWA and the implementing regulations, as applicable. The applicable VPDES permit and current Section 316(b) issues (aquatic species entrainment-impingement-entrapment) issues would need to be modified in response to the additional intake. Thus, these regulatory restrictions would not be an important differentiating factor.	The intake structure for the new units at the ESP site would meet Section 316(b) of the CWA and the implementing regulations, as applicable. Since construction of the intake structure would likely impact wetland areas and other important habitats, additional federal and state-sponsored permitting processes would also be triggered. Consequently, the environmental permitting process for this intake structure location could represent a large barrier to this alternative.
Environmentally preferred or equivalent? (Yes or No)	Yes	No	No

Table 9.4-9 Screening of Alternatives to the Proposed Discharge System (Base Case & Alternative 4)

Factors Affecting System Selection	Discharge System – Base Case	Discharge System - Alternative 4
	Shoreline Discharge & Discharge Canal	Offshore Submerged Discharge System
Construction Impacts	Since development of the shoreline discharge would result in disruptions of the littoral zone (area of more concentrated biological resources), there could be localized moderate adverse impacts on this disturbed zone.	If the offsite discharge system is installed using an open trench system, there could be large adverse impacts on both the littoral zone and other areas of the lake. Open trench activities would result in greater lakebed disruptions and larger increases in the turbidity of Lake Anna water. The resulting adverse impact on the lake water quality could be large during the construction phase of work.
Aquatic Impacts	Situated in the more biologically important littoral zone areas, shoreline discharges would have the potential to disturb the local aquatic ecosystem. Such systems pose greater impacts than offshore discharge systems.	Situated in areas with relatively less abundant aquatic resources (outside of more ecologically abundant littoral zone), submerged offsite intake systems generally pose fewer impacts on the aquatic ecosystem.
Land Use Impacts	Since the commitment of land for the shoreline discharge is not significant, land use impacts would not be an important differentiating factor.	Through offshore discharge systems have somewhat lesser land requirements than shoreline intake systems, land use impacts would not be an important differentiating factor. Note that the submerged systems would likely be situated deep enough to avoid direct interference with recreational water uses.
Water Use Impacts	The relative position of the shoreline discharge would have little impact on the water use requirements and, therefore, it would not be an important differentiating factor.	The relative position of the discharge would have little impact on the water use requirements and, therefore, it would not be an important differentiating factor. Note that the submerged systems would likely be situated deep enough to avoid direct interference with recreational water uses.
Compliance with Regulations	The discharge system would meet the requirements of Section 316(a) of the CWA, and the implementing regulations, as applicable. The applicable VPDES permit and Section 316(a) thermal impact considerations would need to be evaluated in response to the additional discharge. These regulatory restrictions would not be an important differentiating factor.	The discharge system would meet the requirements of Section 316(a) of the CWA, and the implementing regulations, as applicable. The applicable VPDES permit and Section 316(a) thermal impact considerations would need to be evaluated in response to the additional discharge. These regulatory restrictions would not be an important differentiating factor.
Environmentally preferred or equivalent?	Yes	No

Table 9.4-10 Screening of Alternatives to the Proposed Discharge System Location (Base Case & Alternatives 5 & 6)

Factors Affecting Location Selection	Discharge Location Base Case Adjacent to Existing Discharge	Discharge Location Alternative 5 Discharge along WHTF	Discharge Location Alternative 6 Discharge on Lake Anna
Construction Impacts	Construction impacts would be minimized if the discharge structure is located adjacent to the existing discharge structure at the head of the discharge canal. Already cleared and graded in support of the original discharge system, this area boasts less ecological resources than other undeveloped areas.	Construction impacts (surface disruption and turbidity increases) would be more significant at less developed alternative discharge structure sites along the WHTF shoreline.	Construction impacts (surface disruption and turbidity increases) would be the greatest for the undeveloped or less developed alternative shoreline discharge structure sites along the shore of Lake Anna.
Aquatic Impacts	The thermal and chemical impacts of effluent discharges would be effectively mitigated (through mixing and dilution) in the discharge canal and downstream WHTF.	The thermal and chemical impacts of effluent discharges would be effectively mitigated (mixing and dilution) in the WHTF.	Effluent that is discharged directly to Lake Anna may significantly impact local aquatic resources, since the effluent would not be subject to the beneficial mixing and dilution actions from travel through the discharge canal and WHTF.
Land Use Impacts	Since the new discharge would reside totally within the confines of the NAPS site, its location adjacent to another discharge structure would pose the smallest land use impacts.	Although the new discharge would reside totally within the confines of the NAPS site, its location along a relatively undeveloped shoreline of the WHTF would require a greater commitment of land resources.	Land use designations along Lake Anna areas outside the NAPS site do not support the installation or operation of industrial facilities. The lake also offers substantial recreational benefits to the local community, which could be adversely impacted by the construction of a discharge structure. Thus, development of discharge systems in these more ecological important and community-valued areas would trigger potentially onerous land use amendment processes.

Table 9.4-10 Screening of Alternatives to the Proposed Discharge System Location (Base Case & Alternatives 5 & 6)

Factors Affecting Location Selection	Discharge Location Base Case Adjacent to Existing Discharge	Discharge Location Alternative 5 Discharge along WHTF	Discharge Location Alternative 6 Discharge on Lake Anna
Water Use Impacts	The additional effluent released through the discharge structure would pose the smallest water use and cumulative impacts since the release is consistent with current discharge practices into the WHTF; an industrial facility already designed and constructed to receive heat dissipation system discharges.	The additional effluent released to the WHTF in an alternate location would pose the smallest water use impacts, because this activity is consistent with current discharge practices into the WHTF; an industrial facility designed and constructed to receive heat dissipation system discharges.	The new discharge of effluent directly to Lake Anna could have moderate water use impacts to this receiving water body. Lake Anna is a multi-use water resource that is not compatible with direct industrial discharges. Note the thermal and chemical impacts of this discharge would not be subject to the beneficial dilution and mixing actions from travel through the discharge canal and WHTF.
Compliance with Regulations	The discharge system would meet the requirements of Section 316(a) of the CWA, and the implementing regulations, as applicable. The applicable VPDES permit and current associated 316(a) considerations would need to be modified in response to the additional discharge system. These regulatory restrictions would offer only small impacts to the design and operation of a new a discharge system sited with the existing discharge canal.	The discharge system would meet the requirements of Section 316(a) of the CWA, and the implementing regulations, as applicable. The applicable VPDES permit and current associated 316(a) considerations would need to be modified to respond to the additional discharge system. These regulatory restrictions would offer only small impacts to the design and operation of a new discharge system sited in the WHTF.	The discharge system would meet the requirements of Section 316(a) of the CWA, and the implementing regulations, as applicable. Since construction of the discharge structure is likely to impact wetland and important habitat areas, additional federal and state-sponsored permitting processes could also be triggered. The environmental permitting process for this discharge structure location could represent a barrier to development.
Environmentally preferred or equivalent?	Yes	No	No

Table 9.4-11 Screening of Alternatives to the Proposed Water Treatment System (Base Case & Alternatives 7 & 8)

	Water Treatment Base Case	Water Treatment System Alternative 7	Water Treatment System Alternative 8
Factors Affecting System Selection	**Mechanical Condenser Cleaning**	**Chemical Treatment: Biocide, Corrosion Inhibitor, pH Adjustment**	**Non-chemical Treatment: Ultraviolet (UV) Treatment**
Chemicals Used	Mechanical cleaning would involve periodic removal of organic and inorganic residue and debris on circulating system condenser piping and related equipment. No chemicals are used.	Biocide – chlorine, sodium-hypochlorite, ozone Corrosion inhibitors (cooling tower systems only) – oxidizer (nitrates, molybates), filming (nitrogen compounds), polymer (polymeric carboxylate). pH adjustment (cooling tower systems only) – acids (sulfuric acid) and caustics (sodium hydroxide) (Reference 4)	None
Construction Impacts	Periodic mechanical cleaning of the condenser system would not require any substantial construction activities and there would be no related environmental impacts.	Installation of the chemical treatment systems would result in additional commitments of land. Associated soil erosion and sediment impacts, however, would be small.	Installation of the UV treatment systems would result in additional commitments of land. Associated soil erosion and sediment impacts, however, would be small.
Aquatic Impacts	While mechanical cleaning measures would remove biological materials from condenser system surfaces, these measures would not pose systemic impacts on aquatic resources in Lake Anna.	Residual chemicals from this treatment process could impact aquatic resources in the WHTF and downstream North Anna Reservoir. Biocides, corrosion inhibitors, and pH adjustment chemicals are potentially toxic to aquatic life. Polymeric corrosion inhibitors are proposed and would represent a much less toxic option. (Reference 4)	The UV treatment would have no residual impacts on aquatic resources in the receiving body of water. UV systems, however, have not been proven effective on large-scale cooling systems; therefore, they may prove infeasible or unreliable.
Land Use Impacts	Mechanical cleaning measures would not require any additional commitment of land.	Since the chemical treatment systems do require additional land, these systems would be wholly-confined to the existing NAPS site. There would be no appreciable land use impacts.	While these UV treatment systems do require additional land, these systems would be wholly-confined to the existing NAPS site. There would be no appreciable land use impacts.
Water Use Impacts	Mechanical cleaning would not impact water withdrawal requirements.	Chemical treatment systems would not impact water withdrawal requirements.	UV treatment systems would not impact water withdrawal requirements.

Table 9.4-11 Screening of Alternatives to the Proposed Water Treatment System (Base Case & Alternatives 7 & 8)

Factors Affecting System Selection	Water Treatment Base Case Mechanical Condenser Cleaning	Water Treatment System Alternative 7 Chemical Treatment: Biocide, Corrosion Inhibitor, pH Adjustment	Water Treatment System Alternative 8 Non-chemical Treatment: Ultraviolet (UV) Treatment
Compliance with Regulations	Mechanical condenser cleaning is a continuation of current practice and fully compliant with the applicable regulations and existing and pending permit conditions.	The addition of chemical treatment systems would impact the current NAPS VPDES discharge permit. This permit would need to be revised in response to the revised characterization of the chemically-treated cooling system effluent.	The addition of UV treatment systems may impact the current NAPS VPDES discharge permit. This permit may need to be revised in response to the new characterization of the treated cooling system effluent.
Environmentally preferred or equivalent?	Yes	Yes	No