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addition to the basic project purpose. The overall project purpose establishes the scope of the alternatives analysis and is used for evaluating practicable alternatives under the Environmental Protection Agency's (EPA's) Clean Water Act 404(b)(1) Guidelines (40 CFR Part 230). In accordance with the Guidelines and USACE Headquarters guidance (HQUSACE 1989), the overall project purpose must be specific enough to define the applicant's needs, but not so narrow and restrictive as to preclude a proper evaluation of alternatives. The Corps is responsible for controlling every aspect of the Guidelines analysis. In this regard, defining the overall project purpose is the sole responsibility of the Corps. While generally focusing on the applicant's statement, the Corps will, in all cases, exercise independent judgment in defining the purpose and need for the project from both the applicant's alternatives and the public's perspective (33 CFR Part 325 Appendix B (9)(c)(4); see also 53 FR 3120, February 3, 1988).

Section 230.10(a) of the Guidelines requires that "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." Section 230.10(a)(2) of the Guidelines states that "an alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purposes. If it is otherwise a practicable alternative, an area not presently owned by the applicant that could reasonably be obtained, utilized, expanded, or managed in order to fulfill the basic purpose of the proposed activity may be considered." Thus, this analysis is necessary to determine which alternative is the least environmentally damaging practicable alternative (LEDPA) that meets the project purpose and need. The UniStar onsite and offsite LEDPA Analysis is included in Appendix J.

Where the activity associated with a discharge is proposed for a special aquatic site (as defined in 40 CFR Part 230, Subpart E), and does not require access or proximity to or siting within these types of areas to fulfill its basic project purpose (i.e., the project is not "water dependent"), practicable alternatives that avoid special aquatic sites are presumed to be available, unless clearly demonstrated otherwise (40 CFR 230.10(a)(3)).

The NRC's determination as to whether an alternative site is environmentally preferable to the proposed site for Calvert Cliffs Unit 3 is independent of the Corps' determination of a LEDPA pursuant to the Clean Water Act Section 404(b)(1) Guidelines at 40 CFR Part 230. The Corps will conclude its analysis of both offsite and onsite alternatives in its Record of Decision (ROD).

9.1 No-Action Alternative

For purposes of an application for a COL, the no-action alternative refers to a scenario in which the NRC would deny the COL requested by UniStar. Likewise, the Corps could also take no action as a result of the applicant electing to modify the proposal to eliminate work under the

jurisdiction of the Corps or by the denial of the permit. Upon such a denial by the NRC, the construction and operation of a new nuclear unit at the Calvert Cliffs site in accordance with 10 CFR Part 52 would not occur and the predicted environmental impacts associated with the project would not occur. Preconstruction impacts associated with activities not within the definition of construction in 10 CFR 50.10(a) and 51.4 may occur. The no-action alternative would result in the proposed facility not being built. If no other power plant were built or electrical power supply strategy implemented to take its place, the benefits of the additional electrical capacity and electricity generation to be provided by the project would not occur. If no additional measures (e.g., conservation, importing power, restarting retired power plants, and/or extending the life of existing power plants) were enacted to realize the amount of electrical capacity that would otherwise be required for power in the ROI, then the need for baseload power, discussed in Chapter 8 of this EIS, would not be met. Therefore, the purpose and need of this proposed project would not be satisfied if the no-action alternative was chosen, and the need for power was not met by other means.

If other generating sources were built either at another site or using a different energy source, the environmental impacts associated with these other sources would eventually occur. As discussed in Chapter 8, there is a demonstrated need for power. It is reasonable to assume that the Maryland Public Service Commission (MPSC) would confirm that the need for power would be met. This needed power may be provided and supported through a number of alternatives that are discussed in Sections 9.2 and 9.3. Therefore, this section does not include a discussion of other energy alternatives (discussed in Section 9.2) and alternative sites (discussed in Section 9.3) that could meet the need for power.

9.2 Energy Alternatives

The purpose and need for the proposed project identified in Section 1.3. of this EIS is to generate baseload power for use by the applicant and for possible future sale on the wholesale market. This section examines the potential environmental impacts associated with alternatives to construction of a new baseload nuclear generating facility. Section 9.2.1 discusses energy alternatives not requiring new generating capacity. Section 9.2.2 discusses energy alternatives requiring new generating capacity. Other alternatives are discussed in Section 9.2.3. A combination of alternatives is discussed in Section 9.2.4. Section 9.2.5 compares the environmental impacts from new nuclear, coal-fired, and natural gas-fired generating units at the Calvert Cliffs site. For analysis of energy alternatives, UniStar assumed a target installed capacity of 1600 MW(e) electrical output (UniStar 2009a). The review team also used this level of output in analyzing energy alternatives.

9.2.1 Alternatives Not Requiring New Generating Capacity

Four alternatives to the proposed action that do not require UniStar to construct new generating capacity are to:

- purchase the needed electric power from other suppliers
- reactivate retired power plants
- extend the operating life of existing power plants
- implement conservation or demand-side management programs.

As discussed in Chapter 8, Maryland already is a large importer of electricity and faces constraints to further electricity imports. The MPSC concluded that a balanced approach is required to provide adequate electricity supplies for Maryland, including adding new generation, upgrading the transmission system, preserving existing generating resources, and encouraging cost-effective conservation and demand response actions on the part of energy consumers (MPSC 2007).

If power to replace the capacity of the proposed new nuclear unit were to be purchased from sources within the United States or from a foreign country, the generating technology likely would be one that could provide baseload power (e.g., coal, natural gas, or nuclear, as discussed later in this section), as previously described by the NRC in its GEIS (NUREG-1437) (NRC 1996). NUREG-1437's description of the environmental impacts of other technologies is representative of the impacts associated with the construction and operation of a new generating unit at the Calvert Cliffs site. Under the purchased power alternative, the environmental impacts of power production would still occur but would be located elsewhere within the region, nation, or in another country. The environmental impacts of coal-fired and natural gas-fired plants are discussed in Section 9.2.2.

If the purchased power alternative were to be implemented, the most significant environmental unknown would be whether new transmission line corridors would be required. The construction of new transmission lines could have environmental consequences, particularly if new transmission line corridors were needed. The review team concludes that the local environmental impacts from purchased power would be SMALL when existing transmission line corridors are used and could range from SMALL to LARGE if acquisition of new corridors is required. The environmental impacts of power generation would depend on the generation technology and location of the generation site and, therefore, are unknown. However, as discussed in Section 9.2.5, the review team concluded that from an environmental perspective, none of the viable energy alternatives would be clearly preferable to construction of a new baseload nuclear power generation plant located within UniStar's ROI.

Retired generating plants, predominately coal-fired and natural gas-fired plants that potentially could be reactivated, would ordinarily require extensive refurbishment prior to reactivation.

Such vintage plants would typically require costly refurbishment to meet current environmental requirements. The environmental impacts of any reactivation scenario would be bounded by the impacts associated with coal- and natural gas-fired alternatives (Section 9.2.2), which the review team concludes are not environmentally preferable to the proposed actions (Section 9.2.5). Given both these refurbishment costs and the environmental impacts of operating such facilities, the review team concludes that reactivating retired generating plants would not be a reasonable alternative to the proposed action.

Nuclear power facilities are initially licensed by the NRC for a period of 40 years. The operating license can be renewed for up to 20 years, and NRC regulations provide for the possibility of additional license renewal. The owner of proposed Unit 3 would be UniStar (2009a). Constellation Energy Nuclear Group, LLC (Constellation) owns the two existing nuclear units at the Calvert Cliffs site, a nuclear generation unit at the R.E. Ginna site in New York State, and two nuclear generating units at the Nine Mile Point site in New York State. Constellation has received renewed operating licenses for all of its nuclear units from the NRC. The environmental impacts of continued operation of a nuclear power plant are significantly less than construction of a new plant. However, continued operation of the existing nuclear plants has already been accounted for in energy planning.

Older existing fossil-fueled plants, predominately coal-fired and natural gas-fired plants, are likely to need refurbishing to extend plant life for an extended period (the proposed action assumes a minimum operating period of 40 years), and meeting current environmental requirements would also be costly. UniStar identified four older power plants scheduled for retirement in New Jersey, but none in Maryland (UniStar 2009a). The MPSC stated that no generating facilities in Maryland were scheduled for retirement as of early 2009 (MPSC 2009b). The ReliabilityFirst Corporation (RFC) expects retirement of approximately 1700 MW of existing generation capacity in its region through 2018 (RFC 2009). RFC is one of the eight approved regional entities in North America under the North American Electric Reliability Corporation. Maryland is included in the RFC region. Given both the costs of refurbishment and the environmental impacts of operating such facilities (Sections 9.2.2 and 9.2.5), the review team concludes that extending the life of existing generating plants would not be a reasonable alternative to the proposed action.

Improved energy efficiency can cost less than construction of new generation and provide a hedge against market, fuel, and environmental risks. Baltimore Gas and Electric Company (BGE), the regulated electric distribution affiliate of Constellation Generation Group, has residential, commercial, and industrial programs designed to reduce both peak demands and daily energy consumption. Program components include the following elements (UniStar 2009a):

- Peak clipping programs – Including energy saver switches for air conditioners, heat pumps, and water heaters, allowing interruption of electrical service to reduce load during periods of

peak demand; dispersed generation, giving dispatch control over customer backup generation resources; and curtailable service, allowing customers' load to be reduced during periods of peak demand.

- Load shifting programs – Using time-of-use rates and cool storage rebate programs to encourage shifting loads from peak to off-peak periods.
- Conservation programs – Promoting high-efficiency heating, ventilating, and air conditioning; encouraging construction of energy-efficient homes and commercial buildings; improving energy efficiency in existing homes; providing incentives for use of energy-efficient lighting, motors, and compressors.

UniStar estimates the BGE program results in an annual peak demand generation reduction of about 700 MW(e) and believes that generation savings can continue to be increased under the programs. Based on existing programs, the load growth projection anticipates a savings of approximately 1000 MW(e) in 2016 (UniStar 2009a).

In 2007, the MPSC approved the following BGE "fast track" Energy Star conservation and energy efficiency programs: compact fluorescent light bulbs, window air conditioner replacement, and rebates for certain large appliances (MPSC 2008a).

In 2008, BGE started implementation of its voluntary demand response initiative for residential customers. Under the program, BGE will cycle off customers' air conditioning units during specified periods. Overall, BGE estimates a benefit of 600 MW of demand reduction from implementing the demand response initiative (MPSC 2008a).

The Maryland General Assembly enacted the EmPower Maryland Energy Efficiency Act in April 2008. Under the Act, each Maryland utility is required to develop and implement cost-effective programs and services that encourage and promote the efficient use and conservation of energy by consumers and utilities alike. The Act also establishes long-term target reduction goals for electric consumption and demand based on a per capita basis and a 2007 energy consumption baseline (MPSC 2009b).

The MPSC issued an Order on December 31, 2008, approving for implementation a series of energy efficiency and demand response programs proposed by BGE (MPSC 2008c). The proposed programs include new proposals, as well as its already-approved demand response programs. The programs are designed to achieve an estimated reduction in peak demand of approximately 1190 MW for 2011. The programs cover six residential, two small commercial, and three large commercial programs.

As discussed in Chapter 8, the MPSC took account of demand-side management, demand response, and distributed generation in preparing its *Electric Supply Adequacy Report of 2007* (MPSC 2007). In the report, the MPSC determined there was a need for power in Maryland,

even taking into account conservation and demand-side management programs. The role of conservation was also addressed in MPSC's Order granting a Certificate of Public Convenience and Necessity (CPCN) to UniStar for proposed Unit 3 (MPSC 2009a).

Based on the preceding discussion, the review team concludes that the options of purchasing electric power from other suppliers, reactivating retired power plants, extending the operating life of existing power plants, and conservation and demand-side programs are not reasonable alternatives to providing new baseload power generation capacity.

9.2.2 Alternatives Requiring New Generating Capacity

Consistent with the NRC's consideration of alternatives in its EIS evaluating the renewal of operating licenses for nuclear power plants, a reasonable set of energy alternatives to the construction and operation of one or more new nuclear units at the Calvert Cliffs site should be limited to analysis of discrete power generation sources, a combination of sources, and those power generation technologies that are technically reasonable and commercially viable (NRC 1996). The current mix of baseload power generation options in Maryland is one indicator of the feasible choices for power generation technology within the State. As of January 2009, the generation capacity profile in Maryland was approximately as follows: coal (39 percent), dual-fueled (petroleum and natural gas) (26 percent), nuclear (14 percent), natural gas and other gases (9 percent), petroleum (7 percent), hydroelectric (4 percent), and other renewable sources (1 percent) (MPSC 2009b). Coal and nuclear power plants typically operate in a baseload manner. Consequently, in 2007 coal-fired power plants were the source of 59.4 percent of the electricity generated in Maryland and nuclear plants 28.7 percent (MPSC 2009b).

This section discusses the environmental impacts of energy alternatives to the proposed action that would require UniStar to construct new generating capacity. The three primary energy sources for generating electric power in the United States are coal, natural gas, and nuclear energy (DOE/EIA 2007). Coal-fired plants are the primary source of baseload generation in the United States (DOE/EIA 2007). Natural gas combined-cycle generation plants are often used as intermediate generation sources (DOE/EIA 2007), but are also used as baseload generation sources.

Each year, the Energy Information Administration (EIA), a component of the U.S. Department of Energy (DOE), issues an annual energy outlook. In its *Updated Annual Energy Outlook 2009*, EIA's reference case projects that total electric generating capacity additions between 2007 and 2030 will use the following fuel types in the approximate percentages: natural gas plants (55 percent), renewables (27 percent), coal-fired plants (14 percent), and nuclear plants (5 percent) (DOE/EIA 2009). The EIA projection includes baseload, intermittent, and peaking units and is based on the assumption that providers of new generating capacity would seek to minimize cost while meeting applicable environmental requirements.

The discussion in this section is limited to the individual alternatives that appear to the review team to be viable baseload generation sources: coal-fired and natural gas combined cycle-fired generation. The impacts discussed here are estimates based on present technology. Section 9.2.3 addresses alternative generation technologies that have demonstrated commercial acceptance but may be limited in application, total capacity, or technical feasibility when based on the need to supply reliable, baseload capacity.

The review team assumed that (1) new generation capacity would be located at the Calvert Cliffs site for the coal- and natural gas-fired alternatives; (2) a mechanical draft cooling tower with plume abatement, as proposed by UniStar for Unit 3, would be used for plant cooling; and (3) no new offsite transmission corridors would be needed, which is consistent with UniStar's COL application for Unit 3.

9.2.2.1 Coal-Fired Generation

For the coal-fired generation alternative, the review team assumed construction of supercritical pulverized coal-fired units at the Calvert Cliffs site. Supercritical pulverized coal-fired plants are similar to conventional pulverized coal-fired plants except they operate at slightly higher temperatures and higher pressures, which allows for greater thermal efficiency. Supercritical coal-fired plants are commercially proven and represent an increasing proportion of new coal-fired power plants.

The review team also considered an integrated gasification combined cycle (IGCC) coal-fired plant. IGCC is an emerging technology for generating electricity with coal that combines modern coal gasification technology with both gas turbine and steam turbine power generation. The technology is cleaner than conventional pulverized coal plants because major pollutants can be removed from the gas stream before combustion. The IGCC alternative also generates less solid waste than the pulverized coal-fired alternative. The largest solid waste stream produced by IGCC installations is slag, a black, glassy, sand-like material that is potentially a marketable byproduct. The other large-volume byproduct produced by IGCC plants is sulfur, which is extracted during the gasification process and can be marketed rather than placed in a landfill. IGCC units do not produce ash or scrubber wastes. In spite of the preceding advantages, the review team concludes that, at present, a new IGCC plant is not a reasonable alternative to a 1600-MW(e) nuclear power generation facility for the following reasons: (1) IGCC plants are more expensive than comparable pulverized coal plants (NETL 2007), (2) existing IGCC plants have considerably smaller capacity than that of the proposed 1600-MW(e) nuclear plant, (3) system reliability of existing IGCC plants has been lower than pulverized coal plants, (4) the existing IGCC plants have had an extended (though ultimately successful) operational testing period (NPCC 2005), and (5) a lack of overall plant performance warranties for IGCC plants has hindered commercial financing (NPCC 2005). For these reasons, IGCC plants are not considered further in this EIS.

A 1600-MW(e) coal-fired plant sited at Calvert Cliffs would consume approximately 4.5 million tons of coal per year (NETL 2007). It is assumed that coal and lime (calcium oxide or calcium hydroxide) or limestone (calcium carbonate) for a coal-fired plant would likely be delivered to the Calvert Cliffs site by barge. There is no direct rail access in Calvert and St. Mary's Counties within an 8-mi vicinity of the Calvert Cliffs site (UniStar 2008b). UniStar assumed that the plant would burn bituminous coal (UniStar 2009a). Lime or limestone, used in the scrubbing process for control of sulfur dioxide (SO_2) emissions, is injected as a slurry into the hot effluent combustion gases to remove entrained SO_2. The lime-based scrubbing solution reacts with SO_2 to form calcium sulfite, which precipitates and is removed from the process as sludge. Approximately 450,000 tons/yr of limestone would be needed for flue gas desulfurization (NETL 2007).

Air Quality

The impacts on air quality from coal-fired generation would vary considerably from those of nuclear generation because of emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM), and hazardous air pollutants (such as mercury). Particulate matter would consist of total suspended particulates (TSP) and PM_{10} (particulates with a diameter of 10 micrometers or less). In its COL application, UniStar assumed a coal-fired plant design that would minimize air emissions through a combination of boiler technology and post-combustion pollutant removal. The review team estimates that the coal-fired alternative emissions would be approximately as follows:

- SO_x – 8800 tons/yr
- NO_x – 1240 tons/yr
- TSP – 320 tons/yr
- PM_{10} – 73 tons/yr
- CO – 1240 tons/yr.

The preceding estimates are scaled from emissions estimated for an alternative coal-fired power plant in Table 8-2 of the final supplemental EIS for the Beaver Valley Power Station (NRC 2009k). The estimates reflect EPA emission factors. The Beaver Valley EIS was selected because of (1) its geographic proximity (Pennsylvania), (2) it represented a recent staff evaluation, and (3) the coal plant evaluated in the EIS is of comparable size (1842 MW(e)) to proposed Unit 3. The alternative coal plant would emit small amounts of mercury and other hazardous air pollutants, and some naturally occurring radioactive materials. UniStar estimates that the plant would also emit approximately 12,400,000 tons/yr of carbon dioxide (CO_2) emissions (UniStar 2009a) that could affect climate change.

The acid rain requirements of the Clean Air Act capped the nation's SO_2 emissions from power plants. UniStar would need to obtain sufficient pollution credits either from a set-aside pool or purchases on the open market to cover annual emissions from the plant.

A new coal-fired generation plant at the Calvert Cliffs site would likely need a prevention of significant deterioration (PSD) permit and an operating permit from the Maryland Department of the Environment (MDE). The plant would need to comply with the new source performance standards for such plants in 40 CFR Part 60, Subpart Da. The standards establish emission limits for PM and opacity (40 CFR 60.42Da), SO_2 (40 CFR 60.43Da), NO_x (40 CFR 60.44Da), and mercury (40 CFR 60.45Da).

The EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in an area designated as in attainment or unclassified for criteria pollutants under the Clean Air Act (40 CFR 51.307(a)). Criteria pollutants under the Clean Air Act are lead, ozone, particulates, CO, NO_2, and SO_2. Ambient air quality standards for criteria pollutants are in 40 CFR Part 50. As discussed in Section 2.9.2, with the exception of the 8-hour National Ambient Air Quality Standard for ozone, the Calvert Cliffs site is in an area designated as in attainment or unclassified for all criteria pollutants (40 CFR 81.344).

Section 169A of the Clean Air Act (42 U.S.C. 7491) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment occurs because of air pollution resulting from human activities. In addition, EPA regulations provide that for each mandatory Class I Federal area located within a State, the State must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for those days on which visibility is most impaired over the period of the implementation plan and confirm no degradation in visibility for the least visibility-impaired days over the same period (40 CFR 51.308(d)(1)). If a new coal-fired power generation station were located close to a mandatory Class I area, additional air pollution control requirements could be imposed. There are no mandatory Class I Federal areas within 50 mi of the Calvert Cliffs site. The fugitive dust emissions from building activities would be mitigated using best management practices (BMPs). Such emissions would be temporary.

The GEIS for license renewal mentions global warming from unregulated carbon dioxide emissions and acid rain from SO_x and NO_x emissions as a potential impact (NRC 1996). Adverse human health effects, such as cancer and emphysema, have been associated with byproducts of coal combustion. Overall, the review team concludes that air quality impacts from new coal-fired power generation at the Calvert Cliffs site would be MODERATE. The impacts would be clearly noticeable but would not destabilize air quality.

Waste Management

As the NRC has described in NUREG-1437 (NRC 1996) and verified during its preparation of operating license renewal supplemental EIS analyses since the publication of that document, coal combustion generates waste in the form of ash, and equipment for controlling air pollution

generates additional ash, spent selective catalytic reduction (SCR) catalyst, and scrubber sludge. UniStar estimates that landfill disposal of the ash and scrubber sludge generated by a 1600-MW(e) coal-fired plant over a 40-year plant life would require approximately 600 ac (UniStar 2009a). Approximately 89,000 tons/yr of scrubber sludge and 356,000 tons/yr of ash would be generated by the plant (NETL 2007).

In May 2000, EPA issued a "Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels" (65 FR 32214). The EPA concluded that some form of national regulation is warranted to address coal combustion waste products because of health concerns. Accordingly, EPA announced its intention to issue regulations for disposal of coal-combustion waste under Subtitle D of the Resource Conservation and Recovery Act of 1976, as amended (RCRA). EPA issued a proposed rule on June 21, 2010 (75 FR 35127) to regulate coal combustion residuals under RCRA.

Waste impacts on groundwater and surface water could extend beyond the operating life of the plant if leachate and runoff from the waste storage area occurs. Disposal of the waste could noticeably affect land use (because of the acreage needed for waste) and groundwater quality, but, with appropriate management and monitoring, it would not destabilize any resources. After closure of the waste site and revegetation, the land could be available for other uses. Construction-related debris would be generated during plant construction activities, and would be disposed of in approved landfills.

For the reasons stated above, the review team concludes that the impacts from waste generated at a coal-fired plant would be MODERATE. The impacts would be clearly noticeable but would not destabilize any important resource.

Human Health

Coal-fired power generation introduces worker risks from coal and limestone mining, worker and public risk from coal and lime/limestone transportation, worker and public risk from disposal of coal-combustion waste, and public risk from inhalation of stack emissions. In addition, the discharges of uranium and thorium from coal-fired plants can potentially produce radiological doses in excess of those arising from nuclear power plant operations (Gabbard 1993).

Regulatory agencies, including the EPA and State agencies, base air emission standards and requirements on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. Given the regulatory oversight exercised by the EPA and State agencies, the review team concludes that the human health impacts from radiological doses and inhaled toxins and particulates generated from coal-fired generation would be SMALL.

Other Impacts

Approximately 300 ac would need to be converted to industrial use for the power block, infrastructure and support facilities, coal and limestone storage, and handling sludge (UniStar 2009a). Land-use changes would also occur offsite in an undetermined coal-mining area to supply coal for the plant and for landfill disposal of ash and scrubber sludge. In NUREG-1437, the NRC staff estimated that approximately 22,000 ac would be needed for coal mining and waste disposal to supply a 1000-MW(e) coal-fired power plant over its operating life (NRC 1996), which would scale up to over 35,000 ac for a 1600-MW(e) facility. Based on the amount of land affected for both the site and mining, the review team concludes that land-use impacts would be MODERATE.

The amounts of water used and the impacts on water use and quality from constructing and operating a coal-fired plant at the Calvert Cliffs site would be comparable to those associated with a new nuclear plant. All discharges would be regulated by the MDE through a National Pollutant Discharge Elimination System (NPDES) permit. Indirectly, water quality could be affected by acids and mercury from air emissions. However, these emissions are regulated to minimize impacts. In NUREG-1437, the NRC staff determined that some erosion and sedimentation would likely occur during construction of new facilities (NRC 1996). These impacts would be similar to those for a new nuclear plant. Overall, the review team concludes that the water-use and water-quality impacts would be SMALL.

The coal-fired generation alternative would introduce ecological impacts from construction and new incremental impacts from operation. The impacts would be similar to those of the proposed action at the Calvert Cliffs site. The noticeable impacts would include loss of wetland area and function, elimination of onsite streams and ponds, forest fragmentation, habitat loss for important species, and disruption and conversion of benthic habitats in Chesapeake Bay. Some of the impact at the Calvert Cliffs site would occur in areas that were previously disturbed during the construction of Calvert Cliffs Nuclear Power Plant (CCNPP) Units 1 and 2, thereby limiting potential ecological effects. Disposal of waste products ash could affect aquatic and terrestrial resources. Impacts on threatened and endangered species would likely be similar to the impacts from a new nuclear facility located at the Calvert Cliffs site. Although the expected impact footprint for a coal-fired plant would be somewhat smaller than that for a nuclear facility (assuming waste disposal at another location), the review team concludes that the ecological impacts would be MODERATE.

Socioeconomic impacts would result from the workers needed to construct and operate the plant, demands on housing and public services during construction, and the loss of jobs after construction. Construction and operation of a coal plant is smaller in scale than a nuclear plant of comparable size due to the shorter construction timeline and smaller construction and operation workforce needed. Overall, because the scale of activity for coal-fired power generation would be smaller than that for Calvert Cliffs Unit 3, but still significant in Calvert

County, the review team concludes that these impacts would be similar to those for a new nuclear plant: SMALL to MODERATE. UniStar would pay significant property taxes for the plant to Calvert County. Considering the population and economic condition of the county, the review team concludes that the taxes would have a MODERATE beneficial impact to Calvert County with SMALL beneficial impacts elsewhere in the region.

The coal-fired power block units and cooling tower may be visible from Chesapeake Bay. The hybrid cooling tower would not produce any visible plume (UniStar 2009a). The exhaust stacks would be as much as 600 ft high and would be visible from Chesapeake Bay. The stacks and associated emissions would likely be visible in daylight hours for distances greater than 10 mi. The power block units and associated stacks would also be visible at night because of outside lighting. The Federal Aviation Administration (FAA) generally requires that all structures exceeding an overall height of 200 ft above ground level have markings and/or lighting so as not to impair aviation safety (FAA 2007). The visual impacts of a new coal-fired plant could be mitigated by landscaping and color selection for buildings that is consistent with the environment. Visual impacts at night could be mitigated by reduced use of lighting, enhanced use of downfacing lighting (provided the lighting meets FAA requirements), and appropriate use of shielding. Overall, the review team concludes that the aesthetic impacts associated with new coal-fired power generation at the Calvert Cliffs site would be MODERATE.

Coal-fired power generation would introduce mechanical sources of noise that would be audible offsite. Sources contributing to the noise produced by plant operation are classified as continuous or intermittent. Continuous sources include the mechanical equipment associated with normal plant operation. Intermittent sources include the equipment related to coal handling, solid-waste disposal, transportation related to coal and limestone delivery, use of outside loudspeakers, and the commuting of plant employees. Noise impacts associated with barge delivery of coal and lime/limestone would be minimal. The review team concludes that the impacts of noise on residents in the vicinity of the facility would be SMALL. Noise and light from the plant would be detectable offsite.

Historic and cultural resource impacts for a new coal-fired plant located at the Calvert Cliffs site would be similar to the impacts for a new nuclear plant, as discussed in Sections 4.6 and 5.6 of this EIS. A cultural resources inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, acquired to support the plant would also likely need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of the adverse effect from ground-disturbing actions. The studies would likely be needed for all areas of potential disturbance at the plant site; any offsite affected areas, such as mining and waste-disposal sites; and along associated corridors where new construction would occur, such as roads. Because adverse effects are likely to affect three National Register of Historic Places (NRHP)-eligible resources, the review team concludes the historic and cultural resource impacts would be LARGE.

As discussed in Section 2.6 of this EIS, there are minority and low-income persons in the population near the Calvert Cliffs site. However, environmental impacts on minority and low-income populations associated with a new coal-fired plant located at the Calvert Cliffs site would be similar to those for a new nuclear plant, which the review team has concluded are SMALL. The review team's characterizations of the construction and operation impacts of coal-fired power generation at the Calvert Cliffs site are summarized in Table 9-1.

9.2.2.2 Natural Gas-Fired Generation

For the natural gas alternative, the review team assumed construction and operation of a natural gas-fired plant located at the Calvert Cliffs site. The review team assumed that the plant would use combined-cycle combustion turbines.

Air Quality

Natural gas is a relatively clean-burning fuel. When compared to a coal-fired plant, a natural gas-fired plant would release similar types of emissions, but in lower quantities.

A new natural gas-fired power generation plant would likely need a PSD permit and an operating permit from the MDE. A new natural gas-fired combined-cycle plant would also be subject to the new source performance standards in 40 CFR Part 60, Subparts Da and GG. These regulations establish emission limits for particulates, opacity, SO_2, and NO_X.

The EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any new major stationary source in areas designated as in attainment or unclassified under the Clean Air Act. As discussed in Section 2.9.2, with the exception of the 8-hour National Ambient Air Quality Standard for ozone, the Calvert Cliffs site is in an area designated as in attainment or unclassified for criteria pollutants (40 CFR 81.32).

Section 169A of the Clean Air Act (42 U.S.C. 7401) establishes a national goal of preventing future impairment of visibility and remedying existing impairment in mandatory Class I Federal areas when impairment is from air pollution caused by human activities. In addition, EPA regulations provide that for each mandatory Class I Federal area located within a State, the State must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most impaired days over the period of the implementation plan and verify no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). If a new natural gas-fired power plant were located close to a mandatory Class I area, additional air pollution control requirements could be imposed. There are no mandatory Class I Federal areas within 50 mi of the Calvert Cliffs site.

Table 9-1. Summary of Environmental Impacts of Coal-Fired Power Generation

Impact Category	Impact	Comment
Land use	MODERATE	Uses approximately 900 ac for the power block, infrastructure and support facilities, coal and limestone storage and handling, and landfill disposal of ash and scrubber sludge. Mining activities would have additional impacts offsite.
Air quality	MODERATE	Estimated emissions: SO_x – 8800 tons/yr NO_x – 1240 tons/yr PM – 320 tons/yr of TSP 73 tons/yr of PM_{10} CO – 1240 tons/yr CO_2 –12.4 million tons/yr Small amounts of hazardous air pollutants.
Water use and quality	SMALL	Impacts would be comparable to the impacts for a new nuclear power plant located at the Calvert Cliffs site.
Ecology	MODERATE	The impacts on and around the site would be similar to those of the proposed action. The noticeable impacts would include loss of wetland area and function, elimination of onsite streams and ponds, forest fragmentation and habitat loss for important species, and disruption and conversion of benthic habitats in the Bay. Impacts on threatened and endangered species would be similar to the impacts from a new nuclear facility at the Calvert Cliffs site.
Waste management	MODERATE	Approximately 89,000 tons/yr of scrubber sludge and 356,000 tons/yr of ash would be generated.
Socioeconomics (except Taxes and Economy)	SMALL to MODERATE	Impacts related to building the facilities would be noticeable. Depending on where the workforce lives, the building-related impacts would be noticeable or minor. Impacts of coal transportation during operation would be noticeable. The plant would have aesthetic impacts. Some offsite noise impacts would occur.
Socioeconomics (Taxes and Economy)	SMALL to MODERATE (Beneficial)	Local property tax base would benefit mainly during operation.
Human health	SMALL	Regulatory controls and oversight are assumed to be protective of human health.
Historic and cultural resources	LARGE	Adverse effects are likely to three NRHP-eligible resources.
Environmental justice	SMALL	There are minority and low-income persons in the local population; however, impacts to such persons would likely be minimal.

The review team estimates that a natural gas-fired plant equipped with pollution control technology to meet emission limits would have approximately the following emissions:

- SO_x – 112 tons/yr
- NO_x – 370 tons/yr
- PM_{10} – 65 tons/yr
- CO – 77 tons/yr.

The preceding estimates are scaled from emissions estimated for an alternative natural gas-fired power plant in Table 8-3 of the final supplemental EIS for the Beaver Valley Power Station (NRC 2009k). The estimates reflect EPA emission factors. The Beaver Valley EIS was selected because of (1) its geographic proximity (Pennsylvania), (2) it represented a recent staff evaluation, and (3) the natural gas plant evaluated in the EIS is of comparable size (2000 MW(e)) to proposed Unit 3. The alternative natural gas plant would emit small amounts of hazardous air pollutants. UniStar estimates that the plant would also emit approximately 5.6 million tons/yr of CO_2 (UniStar 2009a).

The combustion turbine portion of the combined-cycle plant would be subject to EPA's National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines (40 CFR Part 63, Subpart YYYY) if the site is a major source of hazardous air pollutants. Major sources have the potential to emit 10 tons/yr or more of any single hazardous air pollutant or 25 tons/yr or more of any combination of hazardous air pollutants (40 CFR 63.6085(b)). The fugitive dust emissions from construction activities would be mitigated using BMPs; such emissions would be temporary.

The impacts of emissions from a natural gas-fired power generation plant would be clearly noticeable, but would not be sufficient to destabilize air resources. Overall, the review team concludes that air quality impacts resulting from construction and operation of new natural gas-fired power generation at the Calvert Cliffs site would be SMALL to MODERATE.

Waste Management

In NUREG-1437, the NRC staff concluded that waste generation from natural gas-fired technology would be minimal (NRC 1996). The only significant waste generated at a natural gas-fired power plant would be spent SCR catalyst, which is used to control NO_x emissions. The spent catalyst would be regenerated or disposed of offsite. Other than spent SCR catalyst, waste generation at an operating natural gas-fired plant would be largely limited to typical operation and maintenance waste. Construction-related debris would be generated during construction activities. Overall, the review team concludes that waste impacts from natural gas-fired power generation would be SMALL.

Human Health

Natural gas-fired power generation introduces public risk from inhalation of gaseous emissions. The risk may be attributable to NO_x emissions that contribute to ozone formation, which, in turn, contribute to health risk. Regulatory agencies, including the EPA and State agencies, base air emission standards and requirements on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. Given the regulatory oversight exercised by the EPA and State agencies, the review team concludes that the human health impacts from natural gas-fired power generation would be SMALL.

Other Impacts

A natural gas-fired generating plant would require approximately 60 ac for the power block and support facilities (UniStar 2009a). Construction of a natural gas pipeline from the Calvert Cliffs site to the closest natural gas distribution line would require approximately 10 ac (UniStar 2009a). The Cove Point Liquid Natural Gas (LNG) pipeline runs parallel to Maryland State Route (SR) 2/4 and would be the closest natural gas pipeline to the Calvert Cliffs site. Thus, the total land commitment locally would be approximately 70 ac. A small amount of additional land would also be required for natural gas wells and collection stations. Overall, the review team concludes that the land-use impacts from new natural gas-fired power generation at the Calvert Cliffs site would be SMALL.

The amount of water used and the impacts on water use and quality from constructing and operating a natural gas-fired plant at the Calvert Cliffs site would be somewhat less than the impacts associated with constructing and operating a new nuclear facility. The impacts on water quality from sedimentation during construction of a natural gas-fired plant were characterized in NUREG-1437 as SMALL (NRC 1996). The NRC also noted in this document that the impacts on water quality from operation would be similar to, or less than, the impacts from other generating technologies (NRC 1996). Overall, the review team concludes that impacts on water use and quality would be SMALL.

A natural gas-fired plant at the Calvert Cliffs site would have less extensive ecological impacts than a new nuclear facility. Most of the impacts could be limited to areas that were previously disturbed during the construction of Units 1 and 2. Although constructing a new underground gas pipeline to the site would result in conversion and fragmentation of about 10 ac of terrestrial habitat, no important ecological attributes would be noticeably altered. Impacts on threatened and endangered species would likely be similar to the impacts from a new nuclear facility located at the Calvert Cliffs site. Overall, the review team concludes that ecological impacts would be SMALL.

Socioeconomic impacts would result from the workers needed to construct and operate the plant, demands on housing and public services during construction, and the loss of jobs after construction. Overall, the review team concludes that these impacts would be SMALL because of the mitigating influence of the site's proximity to the surrounding population area and the relatively small number of workers needed to construct and operate the plant in comparison to nuclear and coal-fired generation alternatives. UniStar would pay property taxes for the plant to Calvert County. Considering the population and economic condition of the county, the review team concludes that the taxes would have a MODERATE beneficial impact on Calvert County with SMALL beneficial impacts elsewhere in the region.

The turbine buildings, four exhaust stacks (approximately 200 ft tall) and associated emissions, cooling towers, condensation plumes from the cooling towers, and the gas pipeline compressors would be visible during daylight hours from offsite. Noise and light from the plant would be detectable offsite. An ameliorating factor is that the Calvert Cliffs site is currently an industrial site located in a rural, forested area. Overall, the review team concludes that the aesthetic impacts associated with new natural gas-fired power generation at the Calvert Cliffs site would be similar to those for a nuclear plant and, therefore, SMALL.

Historic and cultural resource impacts for a new natural gas-fired plant located at the Calvert Cliffs site would be similar to the impacts for a new nuclear plant as discussed in Sections 4.6 and 5.6 of this EIS. A cultural resources inventory would likely be needed for any onsite property that has not been previously surveyed. Other lands, if any, acquired to support the plant would also likely need an inventory of field cultural resources, identification, and recording of existing historic and archaeological resources, and possible mitigation of the adverse effect from ground-disturbing actions. The studies would likely be needed for all areas of potential disturbance at the plant site; any offsite affected areas, such as mining and waste disposal sites; and along associated corridors where new construction would occur, such as roads. Because adverse effects are likely to three NRHP-eligible resources, the review team concludes that the historic and cultural resource impacts would be LARGE.

As described in Section 2.6, there are minority and low-income persons in the population around the Calvert Cliffs site. The impacts of a natural gas-fired plant at the Calvert Cliffs site on minority or low-income populations would be similar to the impacts for a nuclear plant and, therefore, SMALL.

The construction and operational impacts of natural gas-fired power generation at the Calvert Cliffs site are summarized in Table 9-2.

Table 9-2. Summary of Environmental Impacts of Natural Gas-Fired Power Generation

Impact Category	Impact	Comment
Land use	SMALL	Approximately 70 ac would be needed for the power block and support systems and connection to a natural gas pipeline.
Air quality	SMALL to MODERATE	Estimated emissions: SO_x – 112 tons/yr NO_x – 370 tons/yr PM_{10} – 65 tons/yr CO – 77 tons/yr CO_2 – 5.6 million tons/yr Small amounts of hazardous air pollutants.
Water use and quality	SMALL	Impacts would be somewhat less than the impacts for a new nuclear power plant located at the Calvert Cliffs site.
Ecology	SMALL	Most of the impacts would be limited to areas that were previously disturbed during the construction of Units 1 and 2. Although constructing a new underground gas pipeline to the site would result in permanent loss of some terrestrial and aquatic function and conversion and fragmentation of about 10 ac of terrestrial habitat, no important ecological attributes would be noticeably altered. Impacts on threatened and endangered species would be less than or similar to the impacts from a new nuclear facility at the Calvert Cliffs site.
Waste management	SMALL	The only significant waste would be from spent SCR catalyst used for control of NO_x emissions.
Socioeconomics (except Taxes and Economy)	SMALL	Construction and operation workforces would be relatively small. Impacts during operation would be minor because of the small workforce involved. The plant would have aesthetic impacts.
Socioeconomics (Taxes and Economy)	SMALL to MODERATE (Beneficial)	Additions to the property tax base, while smaller than for a nuclear or coal-fired plant, would still be noticeable.
Human health	SMALL	Regulatory controls and oversight are assumed to be protective of human health.
Historic and cultural resources	LARGE	Adverse effects are likely to three NRHP-eligible resources.
Environmental justice	SMALL	There are minority and low-income persons in the local population; however, impacts to such persons would likely be minimal.

9.2.3 Other Alternatives

This section discusses other energy alternatives, the review team's conclusions about the feasibility of each alternative, and the review team's bases for those conclusions. A new nuclear unit at the Calvert Cliffs site would be a baseload generation plant. Any feasible alternative to the new unit would need to generate baseload power. In performing its initial evaluation in the ER, UniStar used the findings documented in NUREG-1437 (NRC 1996; UniStar 2009a). The review team also reviewed the information submitted by UniStar, conducted an independent review, and determined the other energy alternatives are not reasonable alternatives to a new nuclear unit that would provide baseload power.

The review team has not assigned significance levels to the environmental impacts associated with the alternatives discussed in this section because, in general, the generation alternatives would have to be installed at a location other than the Calvert Cliffs site. Any attempt to assign significance levels would require the review team's speculation about the unknown site.

9.2.3.1 Oil-Fired Generation

In its updated *Annual Energy Outlook 2009,* EIA's reference case projects that oil-fired power plants will not account for any new electric power generation capacity in the United States through the year 2030 (DOE/EIA 2009). Oil-fired generation is more expensive than nuclear, natural gas-fired, or coal-fired generation options. In addition, future increases in oil prices are expected to make oil-fired generation increasingly more expensive. The high cost of oil has resulted in a decline in its use for electricity generation. In Section 8.3.11 of NUREG-1437, the NRC staff estimated that construction of a 1000-MW(e) oil-fired plant would require about 120 ac of land (NRC 1996). Operation of an oil-fired power plant would have environmental impacts that would be similar to those of a comparably sized coal-fired plant (NRC 1996).

For the preceding economic and environmental reasons, the review team concludes that an oil-fired power plant would not be a reasonable alternative to construction of a 1600-MW(e) nuclear power generation facility that would be operated as a baseload plant within UniStar's ROI.

9.2.3.2 Wind Power

The Maryland Department of Natural Resources (MDNR) Power Plant Research Program (PPRP) has estimated Maryland's onshore wind energy potential as between 627 and 1078 MW (MDNR PPRP 2008). The MPSC considered the potential for wind power in Maryland in a 2008 report (MPSC 2008b) and concluded the economic benefits from renewables remain uncertain and challenging. Onshore wind yields net economic benefits, albeit on a small scale. Offshore wind, as modeled in the report, does not yield economic benefits. Actual use of wind energy in Maryland on a utility scale is consistent with these conclusions with only two moderate-sized projects (50 and 70 MW) under construction onshore (Cumberland Times-News 2010;

Constellation 2010), and none yet approved offshore. The Criterion onshore wind project went online in December 2010, and the other onshore wind project, Roth Rock, is expected to be online in December 2011 (Gray 2011). While the MPSC considers economic benefits of developing power projects, the review team would not consider economics unless the alternative is environmentally preferable (NRC 2000a).

Newer wind turbines typically operate at approximately a 36 percent annual capacity factor (DOE 2008a). In comparison, the average capacity factor for a nuclear generation plant in 2008 in the United States was approximately 91.5 percent (NEI 2009). Wind turbines generally can serve as an intermittent baseload power supply (NPCC 2005). Wind power, in conjunction with energy storage mechanisms such as pumped hydroelectric or compressed air energy storage (CAES), or another readily dispatchable power source, such as hydropower, might serve as a means of providing baseload power.

EIA is not projecting any growth in pumped storage capacity through 2030 (DOE/EIA 2009). In addition, the review team concludes in Section 9.2.3.4 that the potential for new hydroelectric development in Maryland is limited. Therefore, the review team concludes that the use of pumped storage in combination with wind turbines to generate 1600 MW(e) is unlikely in Maryland.

A CAES plant consists of motor-driven air compressors that use low-cost, off-peak electricity to compress air into an underground storage medium. During high electricity demand periods, the stored energy is recovered by releasing the compressed air through a combustion turbine to generate electricity (NPCC 2009). Only two CAES plants are currently in operation. A 290 MW plant near Bremen, Germany began operating in 1978. A 110-MW plant located in McIntosh, Alabama has been operating since 1991. Both facilities use mined salt caverns (Succar and Williams 2008). A CAES plant requires suitable geology such as an underground cavern for energy storage. A 268-MW CAES plant coupled to a wind farm, the Iowa Stored Energy Park, has been proposed for construction near Des Moines, Iowa. The facility would use a porous rock storage reservoir for the compressed air (Succar and Williams 2008). Other pilot, demonstration, prototype, and research projects involving CAES have been announced including projects in California, New York, and Texas. However, the review team is not aware of a CAES project approaching the scale of a 1600-MW(e) facility that has an announced construction date, and the review team is not aware of any known or proposed projects in Maryland for wind generation with storage. Therefore, the review team concludes that the use of CAES in combination with wind turbines to generate 1600 MW(e) in Maryland is unlikely.

Southern Company and the Georgia Institute of Technology (GIT) studied the viability of offshore wind turbines in the southeast (Southern and GIT 2007). Among the conclusions of the study authors were the following: (1) the available wind data indicates that a wind farm located offshore of Georgia would likely have an adequate wind speed to support a project, although offshore project costs run approximately 50 to 100 percent higher than land-based systems;

(2) based on today's prices for wind turbines, the 20-year levelized cost of electricity produced from an offshore wind farm would be above the current production costs from existing power generation facilities; (3) the current commercially available offshore wind turbines are not built to withstand major hurricanes above a Category 3 or a 1-minute sustained wind speed of 124 mph; and (4) the U.S. Department of Interior Minerals Management Service (MMS) has jurisdiction, as authorized in the Energy Policy Act of 2005, over alternative energy-related projects on the outer continental shelf (OCS), including wind power developments.

Wind potential varies along the Atlantic Coast. According to the National Renewable Energy Laboratory (NREL), Maryland has a somewhat better offshore wind resource than Georgia (Schwartz et al. 2010), which suggests a somewhat higher capacity factor for wind, which in turn suggests that the 20-year levelized cost of electricity could be less for a wind farm off the coast of Maryland than a comparable wind farm off the coast of Georgia. Nevertheless, the review team believes that the preceding conclusions in the Southern/GIT report would generally apply to a wind farm located offshore of Maryland based on similarities in the physical and regulatory environments. Moreover, as noted above, offshore wind power for Maryland as modeled in MPSC (2008b) was not shown to yield economic benefits.

In its final *Programmatic EIS for Alternative Energy Development and Production and Alternate Uses of Facilities on the Outer Continental Shelf* (MMS 2007), the MMS considered the potential environmental, social and economic impacts from wind energy (among other) projects on the OCS. The MMS indicated that the technologies used to extract energy on the OCS are "… relatively new and untested in the offshore environment of the OCS." In developing the programmatic EIS, the MMS focused on "… those technologies that are likely to be initiated–for research, demonstration, or commercial scale—within the 5- to 7-year time frame." In the 3 years since the Programmatic EIS was finalized, no projects were initiated on the OCS. MMS (now the Bureau of Ocean Energy Management, Regulation and Enforcement) issued final regulations in April 2009 (74 FR 19638) to establish a program to grant leases, easements, and rights-of-way for renewable energy project activities on the outer continental shelf.

NREL issued an analysis of "Large-Scale Offshore Wind Power in the United States—Assessment of Opportunities and Barriers" (Musial and Ram 2010). As NREL indicates "… the opportunities for offshore wind are abundant, yet the barriers and challenges are also significant. … Technological needs are generally focused on making offshore wind technology economically feasible and reliable and expanding the resource area to accommodate more regional diversity for future U.S. offshore projects." When energy policies mature and large-scale offshore wind energy projects become technically feasible, then it can play a significant role in future U.S. energy markets.

The NREL report considers the offshore wind energy potential and the proposed U.S. offshore wind projects and capacities. It divides wind energy projects into two groups: those within State boundaries (within 3 nautical miles) and those in Federal waters. The NRG Bluewater Wind

project off the Delaware coast in Federal waters is currently planned to have a capacity of 450 MW(e), of which a 293 MW(e) power purchase agreement has been executed with Delmarva Power (Musial and Ram 2010). The project would be located approximately 11 mi east of Dewey Beach, Delaware (DOI 2011). In March 2011, the Department of the Interior (DOI) initiated the process to offer the first commercial wind lease under DOI's "Smart from the Start" Atlantic Offshore Wind program. The lease would cover an area off the coast of Delaware, including the area proposed for the Bluewater Wind project. In its press release, DOI stated that "…several steps remain before a lease can be issued, including environmental reviews and consultation with other federal, state, local and tribal organizations. Additionally, once a lease is issued, the developer will be required to submit a detailed construction and operation plan that will be subject to further environmental review and public comment before any final decision is made on a proposed project" (DOI 2011). No other wind energy projects were identified by NREL off the coast of Maryland or its adjoining States (Delaware and Virginia) in either State or Federal waters.

The construction and maintenance of land-based wind-energy facilities alters ecosystem structure through vegetation clearing, soil disruption, and the potential for erosion. Wind energy facilities can also result in avian mortality (National Research Council 2007). Building and operating offshore wind turbines could impact the marine ecosystem (species and habitat) and avian species. In addition, there could be impacts related to water quality, cultural resources, aesthetics, noise, and socioeconomics (e.g., tourism and property values).

For the preceding reasons, the review team concludes that a wind energy facility would not currently be a reasonable alternative to construction of a 1600-MW(e) nuclear power generation facility that would be operated as a baseload plant within UniStar's ROI.

9.2.3.3 Solar Power

Solar technologies use energy and light from the sun to provide heating and cooling, light, hot water, and electricity for consumers. Solar energy can be converted to electricity using solar thermal technologies or photovoltaics. Solar thermal technologies employ concentrating devices to create temperatures suitable for power production. Concentrating thermal technologies are currently less costly than photovoltaics for bulk power production. They can also be provided with energy storage or auxiliary boilers to allow operation during periods when the sun is not shining (NPCC 2006). The largest operational solar thermal plant is the 310-MW Solar Energy Generating System located in the Mojave Desert in Southern California (NextEra Energy 2009).

Solar radiation has a low energy density relative to other common energy sources. Consequently, a large total acreage is needed to gather an appreciable amount of energy. Typical solar-to-electric power plants require 5 to 10 ac for every MW of generating capacity (TSECO 2008). Thus, approximately 8000–16,000 ac would be needed for a hypothetical

1600-MW(e) solar power plant. For a large solar plant to be practical, a means to store large quantities of energy (those discussed in Section 9.2.3.2) for distribution when the plant is producing less than 1600 MW(e) would be needed. However, the use of these storage mechanisms on this scale in Maryland is unlikely, as discussed in Section 9.2.3.2.

Looking at the specific technologies, for flat-plate photovoltaic collectors, DOE states that Maryland has a good, useful solar resource throughout most of the State. For concentrating collectors, Maryland has a marginal solar resource. Although certain technologies may work in specific applications, most concentrating collectors are not effective with Maryland's solar resource (DOE 2008b).

The MPSC considered the potential for solar power in Maryland in a 2008 report (MPSC 2008b) and concluded the economic benefits from renewables remain uncertain and challenging. For solar energy, the MPSC concluded that the overall economics of solar remain negative, but could improve if technology progresses much faster than contemplated in the report and various financial incentives continue over the long term. In addition, DOE/EIA does not project the addition of any utility-scale solar thermal or solar photovoltaics power in the Mid-Atlantic Council (which includes Maryland) through the year 2035 (DOE/EIA 2010).

For the preceding reasons, the review team concludes that solar energy facilities would not currently be a reasonable alternative to construction of a 1600-MW(e) nuclear power generation facility that would be operated as a baseload plant within UniStar's ROI.

9.2.3.4 Hydropower

Maryland has a relatively low hydropower resource as a percentage of the State's electricity generation (DOE 2008b). The Conowingo Hydroelectric Plant on the Susquehanna River, one of Maryland's largest generation facilities, provides almost all of the State's hydroelectricity (DOE/EIA 2008). A 1997 study by the Idaho National Engineering and Environmental Laboratory (INEEL) identified an approximate additional 29 MW of undeveloped hydro resource in Maryland (Conner and Francfort 1997).

EIA's reference case in its *Updated Annual Energy Outlook 2009* projects that U.S. electricity production from hydropower plants will remain essentially stable through the year 2030 (DOE/EIA 2009).

In NUREG-1437, the NRC staff estimated that land requirements for hydroelectric power are approximately 1 million ac per 1000 MW(e) (NRC 1996). Because of the relatively low amount of undeveloped hydropower resource in Maryland and the large land-use and related environmental and ecological resource impacts associated with siting hydroelectric facilities large enough to produce 1600 MW(e), the review team concludes that hydropower is not a

feasible alternative to construction of a new 1600 MW(e) nuclear power generation facility operated as a baseload plant within UniStar's ROI.

9.2.3.5 Geothermal Energy

Hydrothermal resources – reservoirs of steam or hot water – are available primarily in the western states, Alaska, and Hawaii. However, Earth's energy can be tapped almost anywhere with geothermal heat pumps and direct-use applications. Sources of other geothermal resources (e.g., hot dry rock or magma) require further technology development (DOE 2006).

Geothermal energy has an average capacity factor of 90 percent and can be used for baseload power where available. However, geothermal technology is not widely used as baseload power generation because of the limited geographical availability of the resource and immature status of the technology (NRC 1996). Geothermal systems have a relatively small footprint and minimal emissions (MIT 2006). A recent study led by the Massachusetts Institute of Technology (MIT) concluded that a $300 to $400 million investment over 15 years would be needed to make early-generation enhanced geothermal system power plant installations competitive in the evolving U.S. electricity supply markets (MIT 2006). Maryland has vast low-temperature resources suitable for geothermal heat pumps. However, Maryland does not have sufficient resources to use other geothermal technologies (DOE 2008b).

For the preceding reasons, the review team concludes that one or more geothermal energy facilities would not currently be a reasonable alternative to construction of a 1600-MW(e) nuclear power generation facility operated as a baseload plant within UniStar's ROI.

9.2.3.6 Wood Waste

In NUREG-1437, the NRC staff determined that a wood-burning facility can provide baseload power and operate with an average annual capacity factor of around 70 to 80 percent and with 20 to 25 percent efficiency (NRC 1996). The fuels required are variable and site-specific. A significant impediment to the use of wood waste to generate electricity is the high cost of fuel delivery and high construction cost per megawatt of generating capacity. The larger wood-waste power plants are only 40 to 50 MW(e) in size. Estimates in NUREG-1437 suggest that the overall level of construction impacts per megawatt of installed capacity would be approximately the same as that for a coal-fired plant, although facilities using wood waste for fuel would be built at smaller scales (NRC 1996). Similar to coal-fired plants, wood-waste plants require large areas for fuel storage and processing and involve the same type of combustion equipment. The staff has estimated that 400,000 to 800,000 ac could be affected to support a large wood-waste plant (NRC 1996).

Because of uncertainties associated with obtaining sufficient wood and wood waste to fuel a baseload power plant, the ecological impacts of large-scale timber cutting (for example, soil erosion and loss of wildlife habitat), and high inefficiency, the review team concludes that wood

waste-based generation would not be a reasonable alternative to a 1600-MW(e) nuclear power generation facility operated as a baseload plant within UniStar's ROI.

9.2.3.7 Municipal Solid Waste

Municipal solid-waste combustors incinerate the waste and use the resultant heat to produce steam, hot water, or electricity. The combustion process reduces the volume of waste and the need for new solid waste landfills (EPA 2009a). Municipal waste combustors use three basic types of technologies: mass burn, modular, and refuse-derived fuel (DOE/EIA 2001). Mass burning technologies are most commonly used in the United States. This group of technologies processes raw municipal solid waste "as is," with little or no sizing, shredding, or separation before combustion. In NUREG-1437, the NRC staff determined that the initial capital cost for municipal solid-waste plants is greater than a comparable steam-turbine technology at wood-waste facilities because of the need for specialized waste-separation and waste-handling equipment for municipal solid waste (NRC 1996).

Municipal solid-waste combustors generate an ash residue that is buried in landfills. The ash residue is composed of bottom ash and fly ash. Bottom ash refers to that portion of the unburned waste that falls to the bottom of the grate or furnace. Fly ash represents the small particles that rise from the furnace during the combustion process. Fly ash is generally removed from flue gases using fabric filters and/or scrubbers (DOE/EIA 2001).

Currently, approximately 87 waste-to-energy plants are operating in the United States (EPA 2009a). These plants collectively generate approximately 2500 MW(e), or an average of approximately 29 MW(e) per plant (EPA 2009a). Given the small size of existing plants, the review team concludes that generating electricity from municipal solid waste would not be a reasonable alternative to a 1600-MW(e) nuclear power generation facility operated as a baseload plant within UniStar's ROI.

9.2.3.8 Other Biomass-Derived Fuels

In addition to wood and municipal solid-waste fuel, several other biomass-derived fuels are available for fueling electric generators, including burning crops, converting crops to a liquid fuel (such as ethanol), and gasifying crops (including wood waste). EIA estimates that wind and biomass will be the largest source of renewable electricity generation among the nonhydropower renewable fuels through the year 2030 (DOE/EIA 2009). However, in NUREG-1437, the NRC staff determined that none of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a large baseload generating plant (NRC 1996).

Co-firing biomass with coal is possible when low-cost biomass resources are available. Co-firing is the most economic option for the near future to introduce new biomass power

generation. These projects require small capital investments per unit of power generation capacity. Co-firing systems range in size from 1 to 30 MW(e) of biopower capacity (DOE 2008c).

Biomass-fired plants have environmental impacts associated with the land used to grow the biomass. Such plants also have air emissions and can affect the aquatic environment.

The review team concludes that given the relatively small size of biomass generation facilities, biomass-derived fuels do not offer a reasonable alternative to a 1600-MW(e) nuclear power generation facility operated as a baseload plant within UniStar's ROI.

9.2.3.9 Fuel Cells

Fuel cells work without combustion and its associated environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode, air over a cathode, and then separating the two by an electrolyte. The only byproducts are heat, water, and carbon dioxide. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Natural gas is typically used as the source of hydrogen.

Phosphoric acid fuel cells are generally considered first-generation technology. Higher-temperature, second-generation fuel cells achieve higher fuel-to-electricity and thermal efficiencies. The higher temperatures contribute to improved efficiencies and give the second-generation fuel cells the capability to generate steam for cogeneration and combined-cycle operations.

During the past three decades, significant efforts have been made to develop more practical and affordable fuel cell designs for stationary power applications, but progress has been slow. The cost of fuel cell power systems must be reduced before they can be competitive with conventional technologies (DOE 2008d).

The review team concludes that, at the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation. Future gains in cost competitiveness for fuel cells compared to other fuels are speculative.

For the preceding reasons, the review team concludes that a fuel cell energy facility would not currently be a reasonable alternative to construction of a 1600-MW(e) nuclear power generation facility operated as a baseload plant within UniStar's ROI.

9.2.4 Combination of Alternatives

Individual alternatives to the construction of a new nuclear unit at the Calvert Cliffs site might not be sufficient on their own to generate UniStar's target value of 1600 MW(e) because of the small size of the resource or lack of cost-effective opportunities. Nevertheless, it is conceivable that a combination of alternatives might be cost-effective. There are many possible

combinations of alternatives. It would not be reasonable to examine every possible combination of energy alternatives in an EIS. Doing so would be counter to CEQ's direction that an EIS should be analytic rather than encyclopedic, shall be kept concise, and shall be no longer than absolutely necessary to comply with NEPA and CEQ's regulations (40 CFR Part 1502.2(a), (b)). Given that UniStar's objective is for a new baseload generation facility, a fossil energy source, most likely coal or natural gas, would need to be a significant contributor to any reasonable alternative energy combination.

Section 9.2.2.2 assumes the construction of natural gas combined-cycle generating units at the Calvert Cliffs site using the cooling technology proposed by UniStar for Unit 3. For a combined alternatives option, the review team assessed the environmental impacts of electrical energy produced from a combination of energy sources that could be installed within Maryland (including offshore waters of the State of Maryland and Federal waters); such energy sources need not be co-located, but would need accessibility to the grid. The review team assumed the following as its reasonable alternative: 1200 MW(e) of natural gas combined-cycle generating units at the Calvert Cliffs site; 25 MW(e) from hydropower; 75 MW(e) from solar power; 100 MW(e) from biomass sources, including municipal solid waste; 100 MW(e) from conservation and demand-side management programs (beyond what is currently planned); and 100 MW(e) from wind power. The conservation and demand-side programs are assumed to be implemented by BGE. The wind and solar power would need to be coupled with a storage mechanism such as CAES to provide baseload power. Ranges surrounding the values listed above were considered before establishing the reasonable alternative. For wind power, 100 MW(e) equates to at least 250 to 300 MW(e) of installed capacity[a] coupled with a 100 MW(e) CAES plant. The assumed contribution from solar is smaller based on the marginal solar power potential for large-scale projects in this region. For both wind and solar, the review team included these contributions even though generation with storage of this magnitude is not currently proposed, approved, or under construction in Maryland.

Based on the information presented in the preceding sections of this chapter, the review team believes that these contributions are reasonable and representative. A summary of the review team's characterization of the environmental impacts associated with the construction and operation of the preceding combination of energy alternatives is shown in Table 9-3.

The review team also considered the result if wind generation coupled with storage was far greater than it assumed. If the wind contribution was quadrupled to 400 MW(e) of baseload power, equivalent to an installed capacity of at least 1000 to 1200 MW(e) with a 400-MW(e) CAES plant, the combination alternative would still require 900 MW(e) from natural gas. Note that the CAES plant in this scenario is larger than any such facility worldwide. Also note that

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(a) Note that this amount of capacity is based simply on the capacity factor of wind. It ignores the fact that there will be periods of low wind that will exceed the storage capacity of the CAES facility, requiring some other source of electrical power to back up the wind/CAES combination.

Table 9-3. Summary of Environmental Impacts of a Combination of Power Sources

Impact Category	Impact	Comment
Land use	MODERATE	A natural gas-fired plant would have land-use impacts for the power block, cooling towers and support systems, and connection to a natural gas pipeline. Wind, solar, hydroelectric, and biomass facilities and associated transmission lines would have land-use impacts in addition to the land-use impacts of the natural gas-fired plant. Both offshore wind development and hydropower plants would potentially impede navigation.
Air quality	SMALL to MODERATE	Emissions from the natural gas-fired plant would be approximately: SO_x – 84 tons/yr NO_x – 277 tons/yr PM_{10} – 49 tons/yr CO – 58 tons/yr CO_2 – 4.2 million tons/yr. Small amounts of hazardous air pollutants would be emitted. Municipal solid waste and biomass facilities would also have emissions.
Water use and quality	SMALL	Impacts would be somewhat less than the impacts for a new nuclear power plant located at the Calvert Cliffs site.
Ecology	MODERATE	Wind energy facilities could result in some avian mortality and also affect aquatic resources if placed in the Chesapeake Bay or offshore. Hydropower facilities would permanently convert substantial amounts of terrestrial and aquatic habitat (by inundation or completely changed flow regime) and species.
Waste management	SMALL to MODERATE	The only significant waste would be from spent SCR catalyst used for control of NO_x emissions and ash from biomass and municipal solid waste sources.
Socioeconomics (except Taxes and Economy)	SMALL to MODERATE	Construction and operation workforces would be relatively small. Construction-related impacts would be noticeable. Impacts during operation would be minor because of the small workforce involved. The plants would have aesthetic impacts.
Socioeconomics (Taxes and Economy)	SMALL to MODERATE (Beneficial)	Addition to property tax base, while smaller than for a nuclear or coal-fired plant, might still be quite noticeable.
Human health	SMALL	Regulatory controls and oversight would be protective of human health.
Historic and cultural resources	LARGE	Adverse effects are likely to three NRHP-eligible resources.
Environmental justice	SMALL	Some impacts on housing availability and prices during construction may occur, as might beneficial impacts from property tax revenues.

offshore wind capacity of this magnitude exceeds by a factor of five or more the amount of offshore wind projected by DOE/EIA for the entire United States by the year 2030 (DOE/EIA 2009). Under this scenario, the impact categorizations in Table 9-3 would not change, except that impacts to land use and ecology might become LARGE if onshore wind energy is used. If offshore wind is used, increased impacts to aquatic ecology are likely. Based on what is known about the limited proposals for onshore and offshore wind in Maryland, this scenario could not be implemented in time to meet the need for power. In addition, the environmental impacts of this scenario are still greater than the impacts of the proposed action, so this scenario is not environmentally preferable.

9.2.5 Summary Comparison of Energy Alternatives

Table 9-4 contains a summary of the review team's environmental impact characterizations for constructing and operating new nuclear, coal-fired, and natural gas-fired combined-cycle generating units at the Calvert Cliffs site. The combination of alternatives shown in Table 9-4 assumes siting of natural gas combined-cycle generating units at the Calvert Cliffs site and siting of other generating units within UniStar's ROI. The review team's impact characterizations for the nuclear option in Table 9-4 reflect the nuclear fuel cycle impacts discussed in Chapter 6 of this EIS.

Table 9-4. Summary of Environmental Impacts of Construction and Operation of New Nuclear, Coal-Fired, and Natural Gas-Fired Generating Units and a Combination of Alternatives

Impact Category	Nuclear	Coal	Natural Gas	Combination of Alternatives
Land use	SMALL	MODERATE	SMALL	MODERATE
Air quality	SMALL	MODERATE	SMALL to MODERATE	SMALL to MODERATE
Water use and quality	SMALL	SMALL	SMALL	SMALL
Ecology	MODERATE	MODERATE	SMALL	MODERATE
Waste management	SMALL	MODERATE	SMALL	SMALL to MODERATE
Socioeconomics (except Taxes and Economy)	SMALL to MODERATE Adverse	SMALL to MODERATE Adverse	SMALL Adverse	SMALL to MODERATE Adverse
Socioeconomics (Taxes and Economy)	SMALL to LARGE Beneficial	SMALL to MODERATE Beneficial	SMALL to MODERATE Beneficial	SMALL to MODERATE Beneficial
Human health	SMALL	SMALL	SMALL	SMALL
Historic and cultural resources	LARGE	LARGE	LARGE	LARGE
Environmental justice	SMALL	SMALL	SMALL	SMALL

The review team reviewed the available information on the environmental impacts of power generation alternatives compared to the construction of a new nuclear unit at the Calvert Cliffs site. Looking at the alternatives to a nuclear power plant, use of a natural gas plant has the least impacts. Comparing nuclear and natural gas, the gas plant would have less impacts to ecology while having greater impacts on air quality. And, while some socioeconomic impacts are reduced because of the smaller workforce, at the same time, the County and the local economy would accrue fewer benefits from the project. On balance, the review team concludes that the environmental impacts of these two options would be similar. Based on this review, the review team concludes, from an environmental perspective, none of the viable energy alternatives are clearly preferable to construction of a new baseload nuclear power generating plant located within UniStar's ROI.

Because of current concerns related to greenhouse gas (GHG) emissions, the review team believes that it is appropriate to specifically discuss the differences among the alternative energy sources regarding carbon dioxide emissions. Carbon dioxide emissions for the proposed action and energy generation alternatives are discussed in Sections 5.7.2, 9.2.2.1, 9.2.2.2, and 9.2.4. Table 9-5 summarizes the CO_2 emission estimates for a 40-year period for the alternatives considered by the review team to be viable for baseload power generation. These estimates are limited to the emissions from power generation and do not include CO_2 emissions for workforce transportation, construction, fuel-cycle, or decommissioning. Among the viable energy generation alternatives, the CO_2 emissions for nuclear power are a small fraction of the emissions of the other viable energy generation alternatives. Adding the transportation emissions for the nuclear plant workforce and fuel cycle emissions would increase the emissions for plant operation over a 40-year period to about 32,000,000 metric tons. This number is still significantly lower than the emissions for any of the other alternatives.

Table 9-5. Comparison of Direct Carbon Dioxide Emissions for Energy Alternatives

Generation Type	Years	CO_2 Emission (metric tons)
Nuclear Power[(a)]	40	190,000
Coal-Fired Generation[(b)]	40	451,000,000
Natural Gas-Fired Generation[(c)]	40	204,000,000
Combination of Alternatives[(d)]	40	153,000,000

(a) From Section 5.7.2
(b) From Section 9.2.2.1
(c) From Section 9.2.2.2
(d) From Section 9.2.4 (assuming only natural gas generation has significant CO_2 emissions)

On June 3, 2010, EPA issued a rule tailoring the applicability criteria that determines which stationary sources and modifications to existing projects become subject to permitting requirements for GHG emissions under the PSD and Title V programs of the Clean Air Act (75 FR 31514). According to the Tailoring Rule, GHG emissions are a regulated new source review

(NSR) pollutant under the PSD major source permitting program if the source (1) is otherwise subject to PSD (for another regulated NSR pollutant) and (2) has a GHG potential to emit equal to or greater than 75,000 tons per year of CO_2 equivalent (i.e., “carbon dioxide equivalent” adjusting for different global warming potentials for different GHGs). Such sources would be subject to best available control technology (BACT). The use of BACT has the potential to reduce the amount of GHGs emitted from stationary source facilities. The implementation of this rule could reduce the amount of GHGs from the values indicated in Table 9-5 for coal and natural gas, as well as from other alternative energy sources that would otherwise have appreciable uncontrolled GHG emissions. The GHG emissions from the production of electricity from a nuclear power source are primarily from the fuel cycle and such emissions could be reduced further if the electricity from the assumed fossil fuel source powering the fuel cycle is subject to BACT controls. GHG emissions from the production of electrical energy by a nuclear power source are orders of magnitude less than those of the reasonable alternative energy sources. Accordingly, the comparative relationship between the energy sources listed in Table 9-5 would not change meaningfully, even if the GHG emissions from nuclear fuel cycle reductions are ignored, because GHG emissions from the other energy source alternatives would not be sufficiently reduced to make them environmentally preferable to the proposed project.

Carbon dioxide emissions associated with generation alternatives, such as wind power, solar power, and hydropower, would be associated with workforce transportation, construction, and decommissioning of the facilities. Because these generation alternatives do not involve combustion, the review team considers the emissions to be minor and concludes the emissions would have a minimal cumulative impact. Other energy generation alternatives involving combustion of oil, wood waste, municipal solid waste, or biomass-derived fuels would have CO_2 emissions from combustion, as well as from workforce transportation, plant construction, and plant decommissioning. It is likely that the CO_2 emissions from the combustion process for these alternatives would dominate the other CO_2 emissions associated with the generation alternative. It is also likely that the CO_2 emissions from these alternatives would be the same order of magnitude as the emissions for the fossil-fuel alternatives considered in Sections 9.2.2.1, 9.2.2.2, and 9.2.4. However, because these alternatives were determined by the review team not to meet the need for baseload power generation, the review team has not evaluated the CO_2 emissions quantitatively.

As discussed in Chapter 8, the review team has concluded that the need for the additional baseload power generation has been demonstrated. Also, as discussed earlier in this chapter, the review team concludes the viable alternatives to the proposed action all would involve the use of fossil fuels (coal or natural gas). The review team concludes the proposed action results in the lowest level of emissions of GHGs among the viable alternatives.