PPRP-CEIR-6

PPRP

Maryland Power Plant Research Program

POWER PLANT CUMULATIVE ENVIRONMENTAL IMPACT REPORT FOR MARYLAND

Draft

June 1988

MARYLAND POWER PLANT RESEARCH PROGRAM

MARYLAND DEPARTMENT OF NATURAL RESOURCES
MARYLAND ENERGY ADMINISTRATION

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09 June 1988

Mr. Thomas E. Magette
Maryland Department of Natural Resources
Power Plant Research Program
Tawes State Office Building (B-3)
Annapolis, Maryland 21401

Dear Tom:

I have enclosed eight copies of the June 1988 draft of the Cumulative Environmental Report for internal and DNR management review. This draft addresses the utility and PPRAC comments on the previous draft.

Should you require additional copies or wish to discuss changes to the report, please do not hesitate to call Bob Keating or me at any time.

Sincerely,

Jerry

Jerry DeMuro

JD:kss
Enclosures
cc: R. Keating
W. Richkus

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CHAPTER I

PROJECTED ENVIRONMENTAL IMPACT

The Cumulative Environmental Impact Report (CEIR) is issued biennially as required by the Maryland Power Plant Research Act in Section 3-304 of the Natural Resources Article in the Annotated Code of Maryland. The objective of this CEIR is to summarize the information available that address the actual and potential environmental impacts of power plants on Maryland's natural and human environment. Topic areas addressed in this edition are those considered necessary by the Maryland Power Plant Research Program to understand potential environmental impacts.

Understanding the environmental impacts requires an understanding of the following two subjects:

- the sources of these impacts, namely the generating facilities that produce electric power in the State, and

- the receptors of these impacts, namely of air, surface water, ground water, and terrestrial resources.

The chapters contained in this report describe the effects of power generation on each of these environmental media. Additional chapters discuss the impacts from acid deposition (Chapter VIII) and nuclear power generation (Chapter V) on each environmental medium. In addition, Chapter II (The Outlook for Electric Power Supply and Demand in Maryland) presents an overview of the electric utility industry in Maryland and a description of utility plans for meeting anticipated growth in demand over the next 15 years. This first chapter is designed to orient the reader to the topic of the cumulative impact of power plants by summarizing the principal effects of each power generation technology used in Maryland on specific environmental pathways. The chapter also highlights the cumulative impact of electric power generation from the operation of all power plants in the state.

A. Electric Power Generation in Maryland

The vast majority of electricity in this state is produced in conventional central station power plants operated by investor-owned electric utilities. Five companies in particular, Baltimore Gas & Electric (BG&E), Potomac Electric Power Company (PEPCO), Delmarva Power and Light (DP&L), Potomac Edison (PE), and Philadelphia Electric Company (PECO) account for virtually all of the electric power generated in the State. Table I-1 summarizes characteristics of the large power plants in and around Maryland operated by these utilities. The locations of these power plants are shown in Figure I-1.

The four main generation technologies used at the plants in Maryland are (generating capacities are 1986 ratings):

- *Fossil-Fueled Steam Turbines.* Forty-three oil or coal-fired steam turbine units provide a total combined generating capacity of approximately 7,800 MW in Maryland.

- *Nuclear-Fueled Steam Turbines.* Two units at the BG&E Calvert Cliffs Nuclear Power Plant provide approximately 1,650 MW of generating capacity.

- *Fossil-Fueled Combustion Turbines.* Forty-three combustion turbine units provide a total combined generating capacity of approximately 1,200 MW.

- *Hydroelectric Power.* Eleven units of the Conowingo Hydroelectric Power Plant provide approximately 500 MW.

Most electricity produced in Maryland is generated by steam turbine power plants. These plants use either fossil fuel (coal, oil, or natural gas) or nuclear fission to generate steam. The steam then drives a steam turbine. A steam turbine is an enclosed rotary turbine in which the heat energy is converted to mechanical energy by forcing the steam against rows of radial blades attached to a central shaft. The rotating blades turn generators which produce electricity. As

TABLE I-1

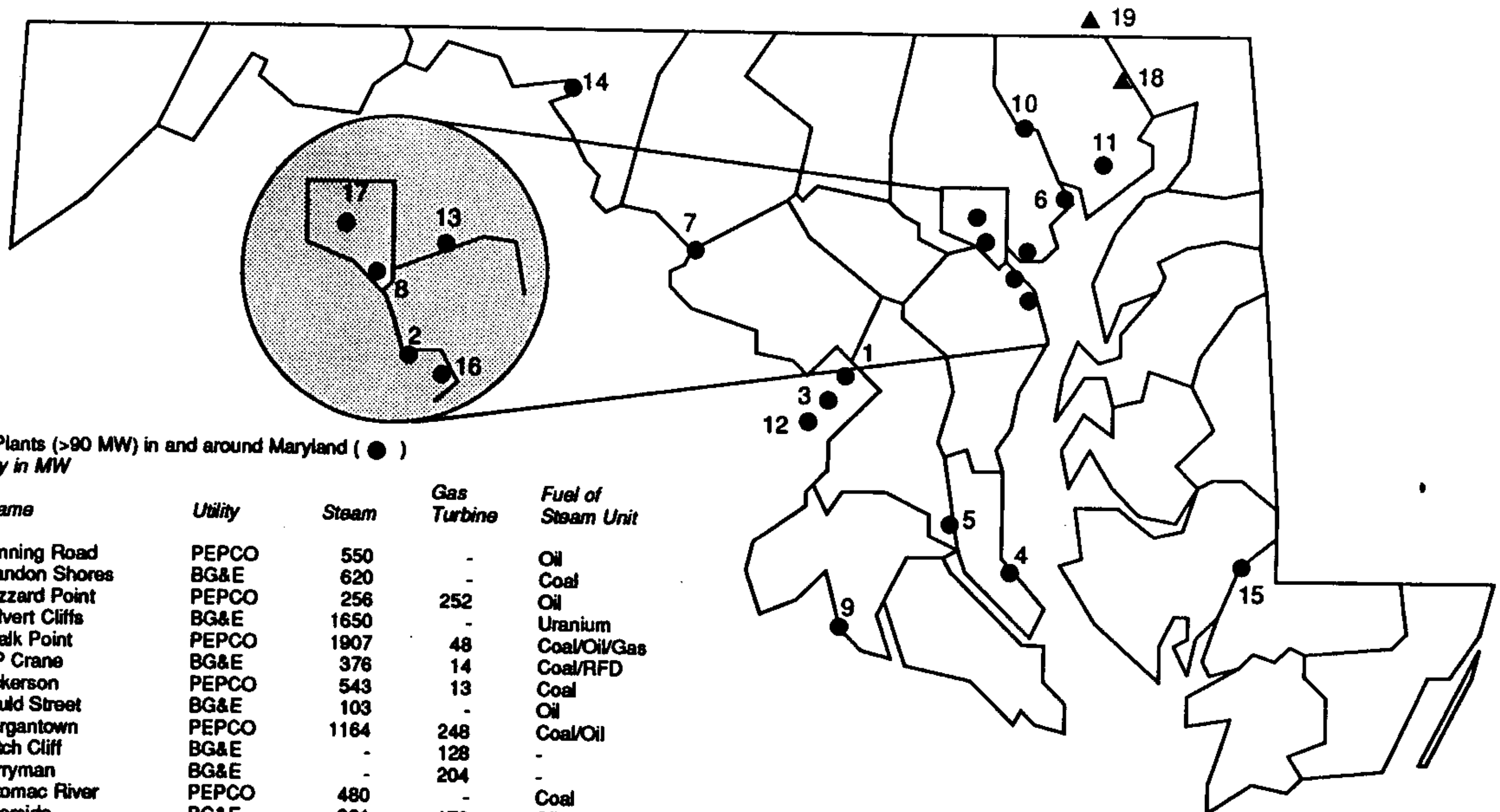
Characteristics of Maryland Power Plants

Plant	Original Construction Date	Date Last Unit Installed	Type Of Unit	1986 Total Capacity (MW)	Number Of Units	Fuel
BG&E						
Brandon Shores	1984	1984	Steam	620	1	Coal
Calvert Cliffs	1975	1977	Nuclear	1,650	2	Uranium
C.P. Crane	1961	1963	Steam	376	2	Oil/Coal
	1967	1967	Combustion Turbine	14	1	Gas/Oil
Gould Street	1926	1962	Steam	103	1	Oil
Westport	1906	1950	Steam	126	5	Oil
	1969	1969	Combustion Turbine	118	1	Gas
Riverside	1942	1953	Steam	321	5	Oil/Gas
	1970	1970	Combustion Turbine	172	3	Gas
Wagner	1956	1972	Steam	988	3	Coal/Oil
	1967	1967	Combustion Turbine	14	1	Gas
Notch Cliff	1969	1970	Combustion Turbine	128	8	Gas
Perryman	1972	1972	Combustion Turbine	204	4	Oil
PEPCO						
Dickerson	1959	1962	Steam	543	3	Coal
	1967	1967	Combustion Turbine	13	1	Oil

TABLE I-1 (continued)

Characteristics of Maryland Power Plants

Plant	Original Construction Date	Date Last Unit Installed	Type Of Unit	1986 Total Capacity (MW)	Number Of Units	Fuel
Morgantown	1970	1971	Steam	1,164	2	Coal/Oil
	1970	1973	Combustion Turbine	248	6	Oil
Chalk Point	1964	1981	Steam	1,907	4	Coal/Oil/Gas
	1967	1967	Combustion Turbine	48	2	Oil
DP&L						
Vienna #8	1928	1971	Steam	150	1	Oil
PE						
R.P. Smith	1923	1958	Steam	114	2	Coal
PECO						
Conowingo	1928	1964	Hydroelectric	512	11	



Power Plants (>90 MW) in and around Maryland (●)
Capacity in MW

Plant Name	*Utility*	*Steam*	*Gas Turbine*	*Fuel of Steam Unit*
1. Benning Road	PEPCO	550	-	Oil
2. Brandon Shores	BG&E	620	-	Coal
3. Buzzard Point	PEPCO	256	252	Oil
4. Calvert Cliffs	BG&E	1650	-	Uranium
5. Chalk Point	PEPCO	1907	48	Coal/Oil/Gas
6. C P Crane	BG&E	376	14	Coal/RFD
7. Dickerson	PEPCO	543	13	Coal
8. Gould Street	BG&E	103	-	Oil
9. Morgantown	PEPCO	1164	248	Coal/Oil
10. Notch Cliff	BG&E	-	128	-
11. Perryman	BG&E	-	204	-
12. Potomac River	PEPCO	480	-	Coal
13. Riverside	BG&E	321	172	Oil
14. R P Smith	PE	114	-	Coal
15. Vienna	DP&L	150	-	Oil
16. Wagner	BG&E	955	14	Oil/Coal
17. Westport	BG&E	126	118	Oil

Owned by Out-of-State Utilities (▲)

18. Conowingo	PECO	512	-	Hydro
19. Peach Bottom	PECO	1800	-	Uranium

Figure I-1. Location of power plants in and around Maryland

shown in Table I-1, the steam electric stations in Maryland burn mostly pulverized coal, reflecting a national trend since the mid-1970's toward coal-fired capacity and away from oil-fired capacity.

Combustion turbines use compressors and combustors to draw in air from the atmosphere, and then pressurize and heat it. The heated air/combustion product mixture is converted to mechanical energy in the turbine to drive generators which produce electricity. Combustion turbines in the state are mostly used to provide peak power, that is, for helping meet short-term demand for electricity when demand is highest.

Hydroelectric power uses the energy of moving water to produce electricity. Potential energy in the form of stored water behind a dam is converted to kinetic energy when sluiced by gravity through the dam's conduits. Flowing water pushes against turbine blades to drive generators and produce electricity.

B. Environmental Media Affected by Power Plants

For discussion purposes, we have designated the four principal components of environmental resources--air, surface water, ground water, and terrestrial--as environmental media which have the potential to be affected by electric power generation in the following ways:

- *Air.* Combustion of fossil fuels is a major source of pollutants released to the air, particularly sulfur dioxide, nitrogen oxides and particulate matter.

- *Surface Water.* Rivers, lakes and estuaries are associated with power plant operations in that they serve as sources of cooling water, receiving bodies for effluents, and sites for hydroelectric generation.

- *Ground Water.* Operation of power plants affect ground water in two ways; 1) the significant quantity of ground water used by power plants can contribute to the lowering of water levels in regional aquifers, and 2) the runoff from coal piles, spillage of petroleum fuels, or the leachate derived from combustion by-product landfills have the potential to degrade ground water quality.

- *Terrestrial.* The construction and operation of power plants and their associated by-product landfill and transmission facilities can affect terrestrial resources directly through destruction of local ecosystems, or indirectly through the interaction with pollutants transported to terrestrial resources through one of the other three media.

Before beginning a discussion of the impacts of various power generation technologies on these four environmental media, it must be understood that impacts to each medium are measured differently. For instance, air impacts are generally determined by comparing measured emissions of pollutants to pollutant levels that are defined as acceptable by federal regulations. On the other hand, ground water impacts are determined by evaluating and interpreting regional ground water contour maps in order to assess acceptable drawdown in the aquifer from power plant withdrawals. Different methods for determining impacts as well as the major impacts to environmental media are presented below.

<u>Fossil Fuel Powered Generation</u>

Fossil fuel powered generation includes any power generation technology that requires combustion of oil, gas, or coal either to drive turbines directly or to produce steam to drive steam turbines. Figure I-2 provides a schematic representation of the various potential modes of impact of fossil fuel power plants on the four environmental media. The major elements of these impacts are described below.

- Air

Combustion of fossil fuels produces emissions to the air. Sufficiently high concentrations of these emissions can degrade air quality, which adversely affects human health. During fossil fuel combustion, power plants can degrade air

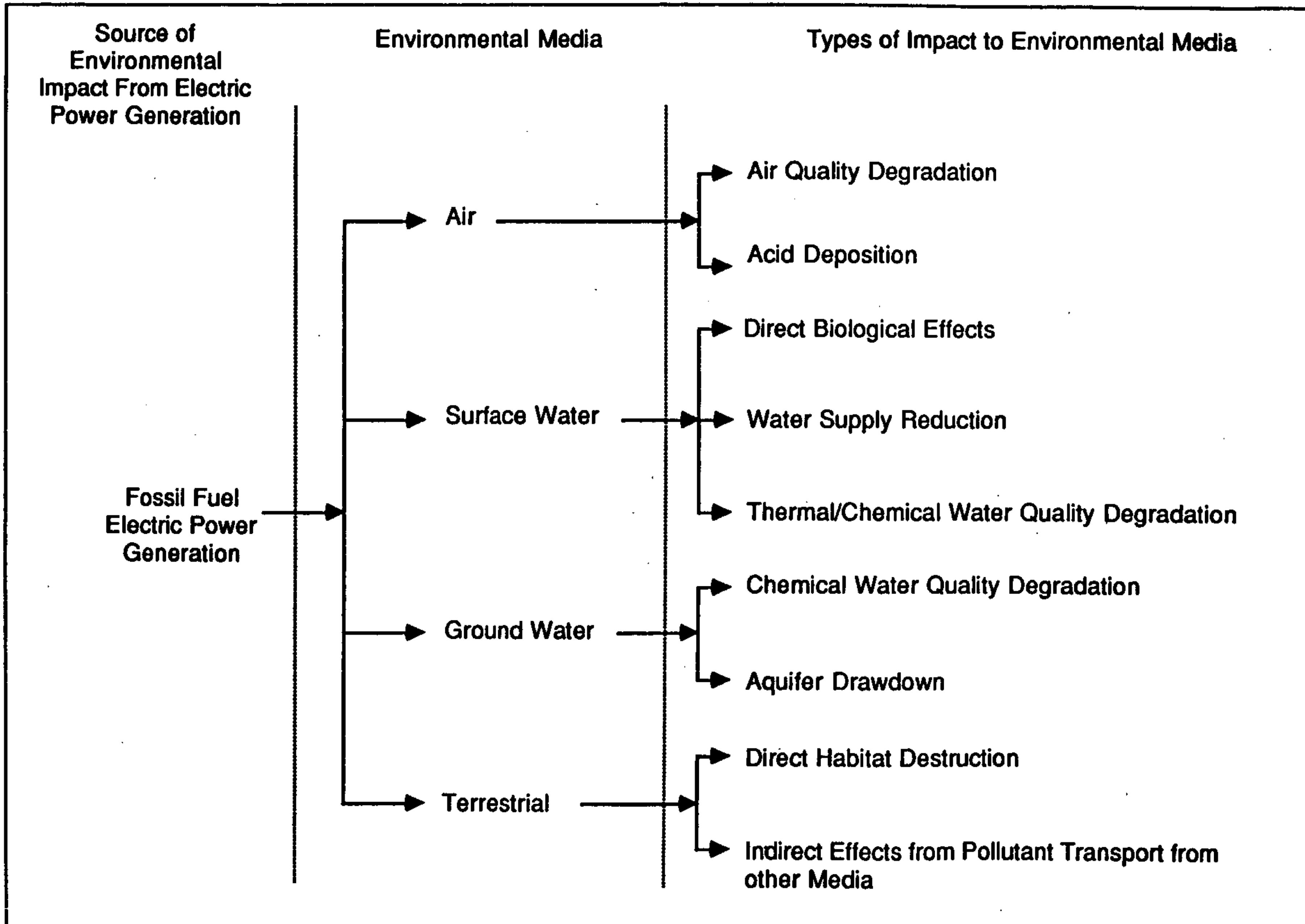


Figure I-2. Projected environmental impact from fossil fuel power generation

quality by emitting substances known as criteria pollutants (sulfur dioxide, nitrogen oxides, particulate matter, ozone, lead, and carbon monoxide). The criteria pollutants are those for which the U.S. EPA has carried out comprehensive health effects assessments and established national ambient air quality standards designed to protect health and welfare. The ambient standards were instituted with the intent of limiting pollutant emissions to minimize the resultant impacts. Power plants also emit so-called non-criteria pollutants, for which national ambient air quality standards have not been developed. Non-criteria pollutants can also cause adverse health effects if emitted in significant quantities. However, most power plant emission rates for non-criteria pollutants are relatively low.

Determining the impact of one particular category of pollutant source, such as power plants, on air quality is complex. In general, it is very difficult to relate quantities of pollutants emitted by power plants to the concentrations of pollutants measured near the ground. No particular patch of air contains an easily detectable "label" identifying the source of its pollution. Air quality modeling is used, therefore, to simulate atmospheric dispersion in order to assess the effects that particular sources like power plants have on air quality. Working backwards, the same kind of modeling can give estimates of the maximum emissions that can be allowed from a source if air quality must be kept within certain regulatory limits. Hence, the discussion of the air quality impact from power plant operations in Chapter III (Air Impact) examines the results of air quality modeling used to simulate air quality impact.

An indirect impact of fossil fuel combustion is the formation and subsequent deposition of acidic materials, typically referred to as acid deposition, or "acid rain." Two abundant fossil-fuel combustion emissions, sulfur dioxide (SO_2) and oxides of nitrogen (NO_x), react with other materials in the atmosphere to produce acids which are deposited in the form of either precipitation or dry deposition. As stack emissions of SO_2 and NO_x are dispersed and transported by wind currents, they react with water vapor, sunlight, and other atmospheric pollutants (particularly ozone) to produce sulfate (SO_4) and nitrate (NO_3). The deposition of these acidic compounds may adversely affect terrestrial and aquatic resources. As is discussed in Chapter VIII (Acid Deposition), the nature and extent of impact to these resources has yet to be fully understood or defined.

- Surface Water

For steam electric power generation, impacts to surface water resources can be classified into three categories: water supply, direct biological effects, and thermal/chemical water quality degradation effects. Each of these impacts is discussed briefly below. Detailed studies examining the extent of these impacts to surface waters of the State are presented in Chapter IV (Aquatic Impact).

- *Direct Biological Effects.* Direct impacts can occur through impingement or entrainment of aquatic biota. Impingement occurs when larger aquatic organisms become trapped in barriers protecting internal power plant structures where the organisms may become injured. Entrainment occurs when smaller organisms, such as fish eggs or larvae are transported through the power plant cooling system. Once entrained, the organisms are exposed to high-velocity water, extreme changes in heat, and chemicals used to prevent biofouling, all of which may cause mortality.

- *Water Supply.* Power plants can be large consumers of water, which can impact surface water supplies for other users.

- *Thermal/Chemical Water Quality Degradation.* Behavioral and physiological changes result from the exposure of aquatic biota to heated effluents, chemicals used to control biofouling, metals eroded from internal plant structures, or chemicals concentrated in routine cooling tower blowdown.

- Ground Water

Steam electric power plants require large volumes of high-quality water for equipment cooling, boiler make-up, potable water supply, and air pollution control equipment. These water usage requirements are typically satisfied by drawing upon local ground water sources. The significant quantity of ground water used by some power plants in southern Maryland has raised concerns regarding the lowering of water levels in two critical regional Coastal Plain aquifers, the Magothy and Aquia aquifers.

Concerns regarding potential impacts on ground water quality arise from the handling and storage of fuel oil and coal, the landfilling of oil and coal combustion by-products, and the handling of other low-volume waste generated from routine operations and maintenance.

- Terrestrial

A certain portion of the local terrestrial ecosystem is destroyed from the placement of the power plant itself, and the construction of ancillary facilities such as transmission lines and combustion by-product landfills. Besides the obvious direct impacts to terrestrial resources, more subtle effects are produced from transport of pollutants through the other media into terrestrial ecosystems. For example, sulfur and nitrogen oxide emissions can cause acute or chronic injury to certain vegetation or animal species.

<u>Nuclear Fuel Powered Generation</u>

Nuclear power generation at the Calvert Cliffs Nuclear Power Plant, as well as at the nearby Peach Bottom Atomic Power Station and Three Mile Island Nuclear Station, has the potential to affect air, surface water, ground water, and terrestrial media. The impacts to these four environmental media are described briefly below, and the nature of the impacts on each of these media is illustrated in Figure I-3.

- Air

Radionuclides released to the atmosphere may result in direct doses to humans or indirect exposure from contact with radionuclides deposited on or taken up by plants and animals. The atmospheric releases from Calvert Cliffs, Three Mile Island and Peach Bottom are monitored by the utilities and the State of Maryland. In order to evaluate potential impacts, comparisons are made with natural background doses, operating license restrictions, and environmental radionuclide concentrations present in previous years.

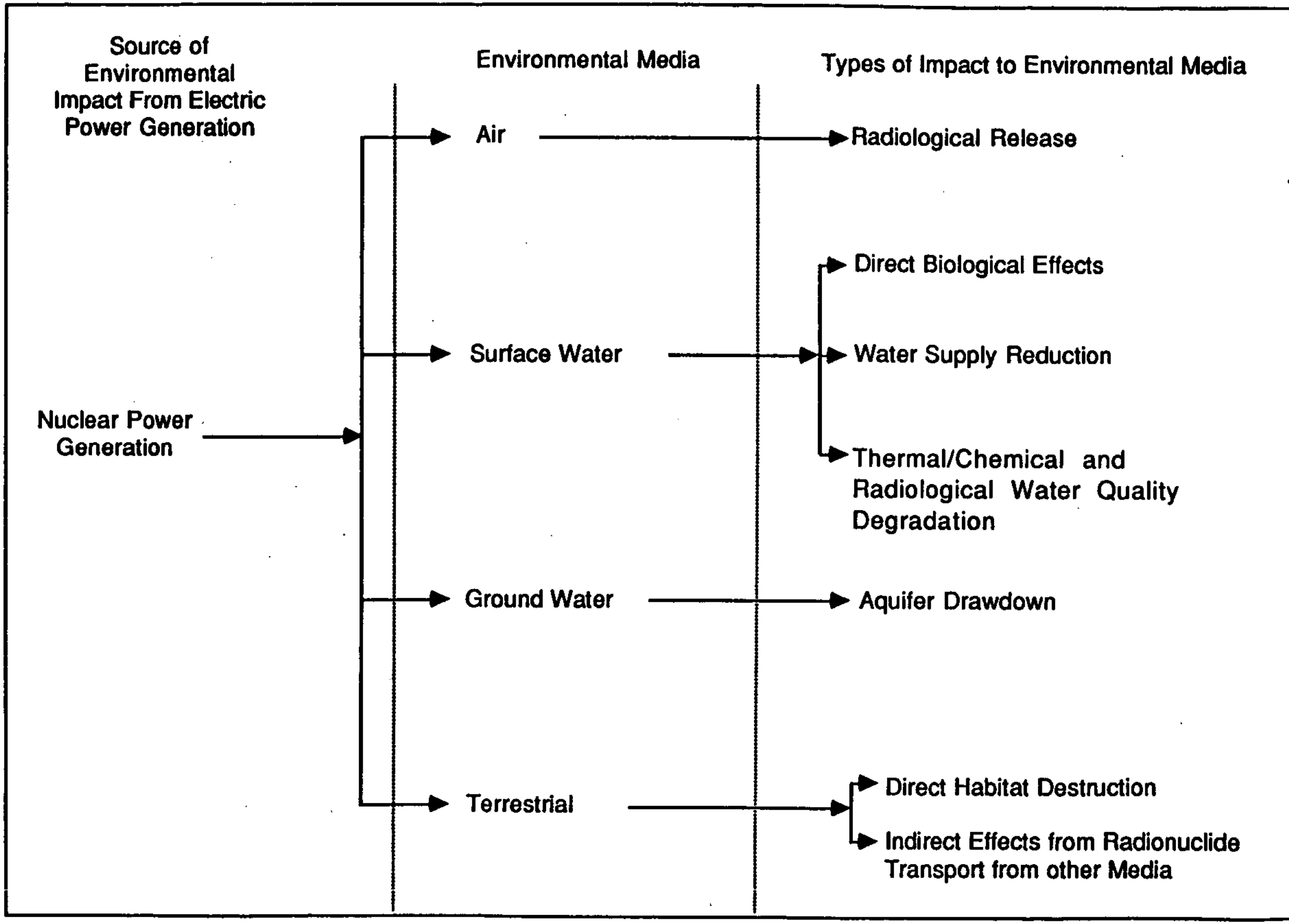


Figure 1-3. Projected environmental impact from nuclear power generation

- Surface Water

Radionuclides released in cooling water or stormwater discharge may impact both human and aquatic receptors. To evaluate potential impacts, radionuclide levels in the water are monitored and these levels are compared with natural background doses, operating license requirements, and radionuclide concentrations present in previous years. In Maryland, the release of radionuclides from Calvert Cliffs, as well as from Three Mile Island and Peach Bottom, both of which are located on the Susquehanna River, has the potential to impact the Chesapeake Bay.

Surface water impacts discussed for fossil fuel steam plants are also associated with nuclear powered steam generation. Intake of water from surface water sources may limit available water supplies, or cause direct biological effects. In addition, heated effluents, chemicals used to control biofouling, metals eroded from plant structures, or chemicals concentrated in routine chemical blowdown can cause water quality degration.

- Ground Water

Nuclear fueled steam power plants have high quality water requirements very similar to those previously identified for fossil-fuel steam electric power plants. At Calvert Cliffs, most of the high quality water requirements are met through ground water withdrawal, creating concern over potential lowering of the water level in the Aquia aquifer.

- Terrestrial

As with fossil fueled steam plants, the construction and operation of a nuclear plant has the potential to cause impacts to terrestrial resources by directly altering or destroying their habitats. Indirect impacts may result from the uptake of radionuclides by plants and animals.

Hydroelectric Power Generation

As shown in Figure I-4, hydroelectric facilities can affect surface water and terrestrial media. The nature of these impacts is discussed in detail in Chapters IV (Aquatic Impact) and VII (Terrestrial Impact) respectively, and are summarized below.

- Surface Water

The development and operation of hydroelectric facilities can cause four types of impact to surface water:

- *Alterations of Water Quality.* Hydroelectric generation can affect dissolved oxygen concentrations, nutrient concentrations, and water temperature both upstream and downstream of the dam.

- *Fluctuations in Water Level and Flow Reductions.* Unnatural water level fluctuations occur in impoundments and in aquatic habitats downstream of dams when hydroelectric facilities are operated in a peaking or storage mode. Certain aquatic organisms cannot tolerate rapid or sporadic flow fluctuations.

- *Loss of Habitat.* Development of hydroelectric facilities can significantly alter the environmental characteristics of streams and rivers which can significantly change the types of aquatic organisms that inhabit these waters.

- *Prevention of Successful Fish Passage.* Hydroelectric development can prevent the upstream and downstream movement of fish past the dam.

- Terrestrial

Impoundments created by hydroelectric dams can create direct impact to terrestrial resources by flooding large acreages causing displacement of sensitive habitats and destruction of historical or archaeological resources.

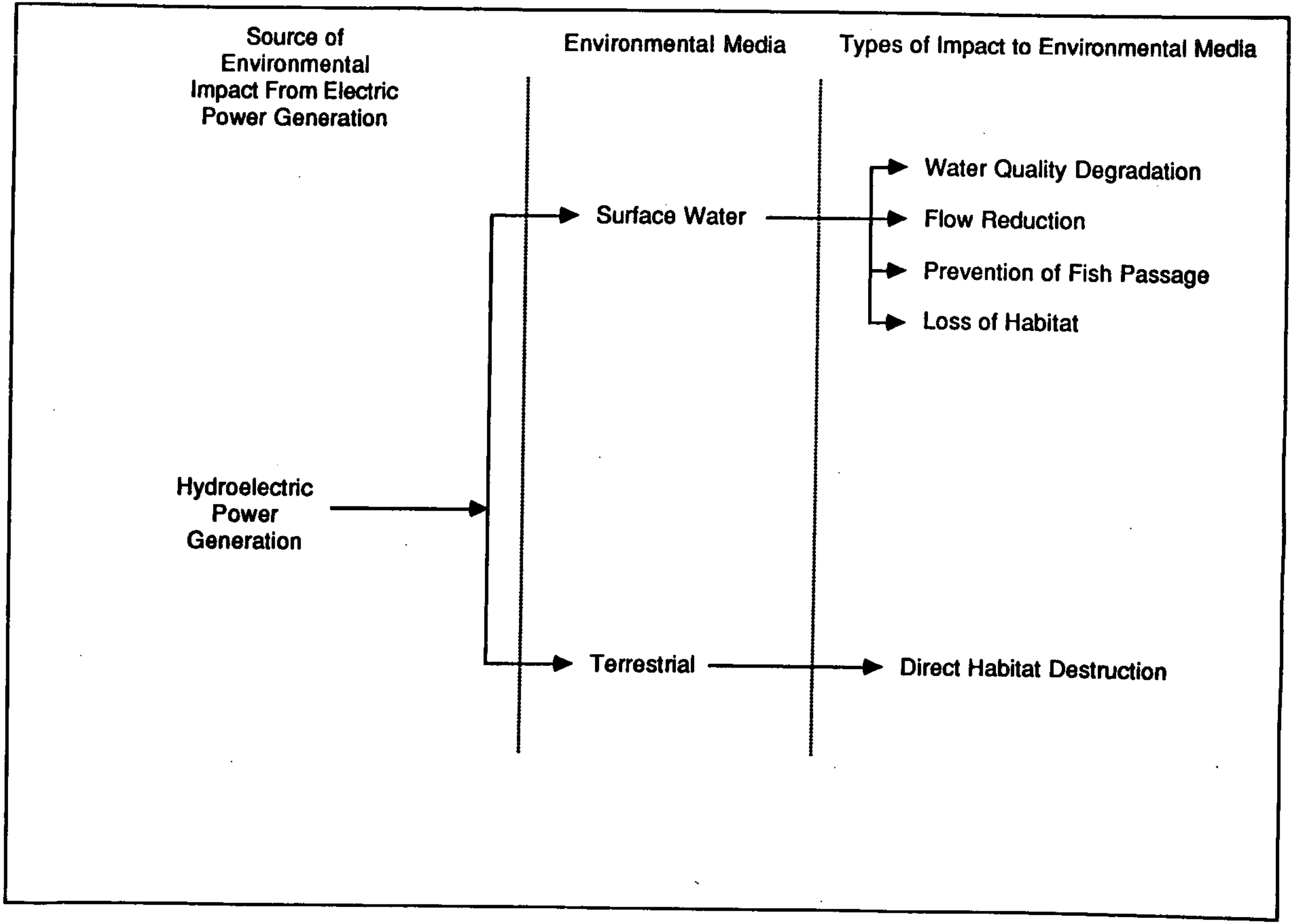


Figure I-4. Projected environmental impact from hydroelectric power generation

C. Cumulative Impacts From Maryland Power Plants

PPRP conducts monitoring programs and reviews information from utilities and other agencies to evaluate the impact of electric power generation on the environment. Data collected from these programs are used to assess the localized impact attributable to each power plant as well as evaluate the regional effect to each environmental medium. Furthermore, the results are used to evaluate the cumulative effects of power generation in Maryland. In this section, the cumulative effects of power plants on the state's air, surface water, ground water, and terrestrial resources are summarized.

Air Impact

- Modeled Impacts of Maryland Power Plants

The combined ground-level impacts of power plants in Maryland cannot be determined easily, if at all, from ambient monitoring. One way to estimate these impacts is to use predictive atmospheric dispersion models. Many air quality modeling studies have been performed to determine the current or future impact of single power plant facilities in Maryland. In fact, modeling studies have been performed for almost all existing and planned power plants in the state. Very few studies, however, have examined the combined impact of several power plants.

A particularly useful tool for this purpose is PPRP's database of air pollution dispersion modeling results known as the Model States Program. The Model States Program was used to estimate the combined annual air quality impact due solely to power plants in Maryland for three years--1979, 1980, and 1984--chosen for data availability and air quality representativeness. The modeling exercise examined fourteen power plants comprising approximately 80 separate stack sources, using emission rates reported by the Maryland Air Management Administration's annual source inventories. The model furnished estimates of ground-level concentrations of SO_2, NO_2, and total suspended particulates (TSP) at a spatial resolution of 2.5 km. Several assumptions were made in order to run the model, including flat terrain, nonreactive pollutants that disperse as gases, uniform meteorology across the region, and the presence of stack emissions only.

Power plants themselves are the only pollutant sources examined in the Model States analysis, thus plots of the modeling results show higher pollutant concentrations near the actual plants, increasingly lower concentrations away from and downwind of them, and zero concentrations in areas far from power plants. Pollutant concentrations around isolated plants in more remote areas, such as the Vienna plant in Dorchester County or R.P. Smith in Washington County, show up distinctively, and can be attributed directly to them. Concentrations around individual plants in and around Baltimore are indistinguishable, however, and represent the combined impacts of several power plants. The results of this modeling effort for 1984 are discussed briefly below.

- *SO_2.* The highest projected annual average was 5.2 $\mu g/m^3$, projected to occur northeast of Baltimore in the Chesapeake Bay (Figure III-10, Chapter III). That concentration amounts to only about one-sixth of the average ambient SO_2 level measured at the three state of Maryland SO_2 monitors east of Baltimore. Ambient levels reflect the total of all background, power plant, and non-power plant sources. This comparison suggests that, although Maryland power plants are a significant contributor to annual average ground-level SO_2 values, they are not the major contributor. This is most likely due to the effective distribution of stack effluents over a broad geographic area.

- *Particulates.* Modeled particulate levels due to combined Maryland power plant stack emissions in 1984 were extremely low -- below a projected annual average of 0.2 $\mu g/m^3$, or about two orders of magnitude less than ambient particulate levels measured in the Baltimore area. From these results alone, it would appear that Maryland power plants have very little impact on ground level atmospheric particulate values in Maryland. However, the coal-fired plants' major contributions to particulate levels are from fugitive dust sources rather than stack emissions. Since fugitive sources were not included in these analyses, power plant impacts on ambient particulate levels are probably somewhat greater than accounted for here.

- *NO_2.* The greatest ambient annual average NO_2 concentration, 1.5 $\mu g/m^3$, occurred in the vicinity of Vienna (Figure III-13, Chapter III). The greatest modeled annual average NO_2 concentration attributable to the Baltimore power plants (just under 1.5 $\mu g/m^3$) occurred east of Baltimore. This value was only 4 percent of the actual ambient level (39 $\mu g/m^3$) measured east of Baltimore. These results suggest that, as with SO_2, Maryland power plants have a relatively small impact on ambient ground level NO_2 values.

The results of the modeling study indicated that, when rough comparisons between power plant emissions and measured ground-level concentrations were made, as in the Baltimore area, combined Maryland power plant emissions contributed only a small fraction to the annual average concentrations of SO_2, NO_2, and particulates. The reasons for the large difference between measured ground-level concentrations and modeling results of power plant emissions is discussed below.

- Power Plant Emission Trends

Although total emissions of SO_2 and NO_2 from power plants in Maryland remained fairly constant over the past 10 years, and emissions of particulates decreased, measurements of those pollutants at ground level in recent years have not reflected those trends. Monitored ambient levels of SO_2 have decreased, NO_2 levels have increased and particulate levels have remained about the same. This suggests that there is little correlation between Maryland power plant emissions and ambient ground-level air quality as measured by state-operated monitors. A likely explanation is that pollutant monitors are intentionally located in areas where high levels of pollution, from all sources, are expected to occur, which is not necessarily in the vicinity of power plants. Thus, while the state monitoring system provides a picture of ambient air quality in a given area, it does not specifically measure the impacts of power plant emissions.

- Atmospheric Radionuclide Distributions

No power plant-related radionuclides were detected in particulate or precipitation samples collected during 1985-1986 in the vicinity of Calvert Cliffs. In addition, no radioactivity attributable to atmospheric releases by Peach Bottom or Three Mile Island were detectable at any time during 1985 or 1986. In contrast, other radionuclides from weapons-tests and fission products from the Chernobyl accident were detected in Maryland in May and June of 1986. With the exception of very low levels of radiocesium, Chernobyl radioactivity was not detectable in our region after two months.

- Acid Deposition

Studies have shown that acid deposition has the potential to affect some aquatic and forest resources. So far, however, evidence of its effects on human health or crops remains inconclusive. The nature and extent of these impacts in Maryland are not yet fully understood. The contribution of Maryland power plants to acid deposition in Maryland was estimated to be between 20 and 50 percent of the measured wet sulfur deposition and 4 to 7 percent of measured wet nitrate deposition around the Chesapeake Bay in 1984. Published estimates from long-range transport models suggest that at least two-thirds of the sulfur deposition in Maryland is from out of state sources. Maryland contributes about 9 percent of the sulfur oxides (principally SO_2) and 12 percent of the nitrogen oxides emitted into the atmosphere in the five-state area that includes Maryland, Virginia, West Virginia, Delaware, and Pennsylvania. Approximately 70 percent of the SO_2 emissions and 30 percent of the NO_x emissions generated in Maryland come from power plants. Advanced acid deposition models relating SO_2 and NO_x emissions to deposition are under development at the federal level.

Monitoring studies measuring "wet" acid deposition are underway at the state and national level. (Dry deposition of acid material is difficult to measure, although it is estimated to equal wet deposition in many areas.) Studies have shown that Maryland is in a region of the country where the amount of sulfate deposited in precipitation is high. Wet sulfate deposition across Maryland is estimated to be 20-30 kg/ha (18-27 lbs/acre) while wet nitrate deposition is estimated to be between 14-26 kg/ha (12-23 lbs/acre). Studies to quantify environmental impacts caused by acid deposition in Maryland are continuing.

Surface Water Impacts

- Direct Biological Effects

Over the past 14 years, PPRP has monitored the direct biological effects from intake of surface water at steam electric stations. In general, these studies have shown that impingement and entrainment have not significantly adversely affected the aquatic biota in the state's surface water bodies. Any impacts observed have been localized.

Impingement and entrainment impacts to the state's surface waters from power plant withdrawals are summarized below.

- *Potomac River.* No measurable impacts related to impingement or entrainment losses have occurred at the R. P. Smith or Dickerson power plants. High impingement episodes were detected at Morgantown; however, overall impacts related to impingement losses are small. Entrainment losses at Morgantown did not result in nearfield depletions.

- *Nanticoke River.* The rate of entrainment of planktonic organisms at Vienna is estimated to be low and impingement of fish is estimated to be negligible.

- *Patuxent River.* Chalk Point entrains many planktonic organisms in the Patuxent River. However, most plankton populations recover rapidly from entrainment losses resulting in no regional population decreases. One exception may be the entrainment of eggs and larvae of important forage fishes where entrainment losses are projected to crop over one-half of the annual production of these fishes annually. The magnitude and consequence of these impacts are presently being assessed. Total impingement, which, had been estimated to be very high in the past, has been dramatically reduced by the use of barrier nets.

- *Chesapeake Bay.* At Crane, some impingement and entrainment effects have been measured, however, overall losses are too small to have a detectable effect on regional aquatic populations. At Calvert Cliffs, some potentially significant impingement and entrainment losses have been noted; however, no effect on regional populations is indicated.

- *Baltimore Harbor.* Entrainment losses of plankton populations have not been directly measured at the five plants (Gould Street, Riverside, Wagner, Westport, and Brandon Shores) located in Baltimore nor have any nearfield depletions been found that can be attributed to power plant operations. Impingement losses at these plants are expected to be of minimal consequence to regional stocks of fishes.

- Water Quality Impacts

Discharges of chemical, thermal, or radionuclide effluents have affected surface water quality in the vicinity of several power plants; however, no regional effects on water quality have been detected. Fish and crabs are variously attracted to and repelled from plant discharges, but fish migration, spawning activity, and growth are not adversely affected. Benthic abundance and productivity are generally higher in thermally affected areas; however, increases in secondary productivity do not impact local or regional food web dynamics. Changes in biota from the long-term degradation of water quality due to chemical discharges are negligible compared to water quality degradation from other sources.

Radionuclides from the generation of nuclear power is another source of potential water quality degradation in the state. For instance, radionuclides associated with liquid effluents from Calvert Cliffs were detected in sediments 3 miles south of the plant, indicating that plant-related radioactivity is transported in sediment down the Chesapeake Bay. Although, low levels of radionuclides attributable to Calvert Cliffs have been detected in fish, oysters, and blue crabs, the maximum radionuclide concentrations detected in these biota were orders of magnitude lower than those resulting from natural radioactivity present in the environment. Consumption of fin fish or Chesapeake Bay water would produce an extremely small radiation dose increment, well within regulatory limits. Releases from Peach Bottom to the Susquehanna River have been measured in aquatic biota and sediments. Radioactivity levels in sediments are highest in the Conowingo Pond, and are detectable at lower concentrations on the lower Susquehanna River and Upper Chesapeake Bay. Once again, this is not of health concern since consumption of finfish or Susquehanna River water would produce only an extremely small radiation dose increment, well within regulatory limits. Releases of radioactivity by Three Mile Island to the Susquehanna have generally been environmentally insignificant.

- Hydroelectric Impacts

The Conowingo hydroelectric facility affects aquatic life and surface water quality in the Susquehanna River in many ways:

- *Flow Cessation and Fluctuation of Water Levels.* Releases of water from the dam have been based primarily on electrical generation requirements. Consequently, flows have been commonly reduced to virtually zero for extended periods (typically nights and weekends). During the day, the flow is increased to levels far beyond natural inflow. This results in the destruction of viable aquatic habitat in the riverine stretch below the dam.

- *Reduction of Water Quality.* Stratification of Conowingo Pond during low-flow summertime conditions can result in releases of anoxic water from the dam that can be of significant harm to aquatic life for several miles downstream. This violates the State's water quality standard for oxygen. Physical modification of the dam is underway to improve the situation along with studies to estimate the effectiveness of various techniques to add oxygen to the discharges of the turbines.

- *Prevention of Successful Fish Passage.* The physical presence of the dam has denied anadromous fish access to spawning areas upstream. Improved facilities to transport fish above the dam have been ordered by the federal licensing agency. These facilities should be in place by the 1991 spring spawning run.

The Conowingo facility is the source of impact to aquatic life and water quality in the Susquehanna River. However, these impacts are being addressed through both the federal licensing process and agreements between Maryland and the utility.

Ground Water Impacts

- Aquifer Drawdown

The Calvert Cliffs, Chalk Point, Vienna, and Morgantown power plants rely on ground water resources from the Aquia, Magothy, Columbia, and Patapsco aquifers, respectively, to supply high quality water needed for plant operation. In 1985 and 1986, these four facilities combined withdrew an approximate average of 1.8 million gallons per day (mgd) from these four aquifers. Although this amount represents less than one percent of the ground water use throughout the state, these facilities have contributed to long-term impacts to regional ground water resources in some of the Coastal Plain aquifers. Calvert Cliffs and Chalk Point power plants have contributed to overall declining water levels in the Aquia and Magothy aquifers. Despite the water level declines observed to date, the potentiometric surfaces of these aquifers indicate that hydraulic heads are still adequate to ensure continuous water supplies at current pumping rates for many years. Furthermore, should these power plants significantly reduce pumping or cease pumping, the water levels in these aquifers are expected to recover quickly. Although the declines in the Magothy and Aquia aquifers have been significant, they do not appear to have adversely affected other ground water users. Aquifer use restrictions imposed by the State will limit future large quantity withdrawals benefitting small domestic users.

- Water Quality Degradation

Currently there are seven coal-fired and six oil-fired steam generating power plants in Maryland. Mismanagement or mishandling of either of these fossil fuels or the combustion by-products of these fuels can result in the release of organic or inorganic solutes into the subsurface, which could potentially impact ground water quality.

Very little information is available that documents the impact of power plant fuel oil or coal pile runoff on Maryland's ground water resources. Preliminary studies have been conducted to determine potential effects of coal pile runoff and fuel oil on ground water quality. The results of these studies indicate that although the potential exists for these fuels to degrade ground water quality, there have been no reported cases to indicate that ground water quality degradation from power plant fuels is of real concern. However, further study is needed in this area to determine if the potential for ground water quality degradation is being realized at any power plant sites.

PPRP has conducted environmental assessments at both operating and closed coal ash sites to evaluate the effectiveness of their design and operation in protecting ground water resources. The results of these studies generally indicate that although ground water quality has been impaired at a few sites, these impacts are localized and minimal. In general, it appears that the ground water quality has not been adversely affected by the operation of power plants on anything other than a very localized level.

Terrestrial Impacts

- Direct Habitat Alterations

Power plants, whether steam electric, combustion turbine, or hydroelectric, displace a certain amount of terrestrial habitat. Ancillary facilities and structures, such as transmission corridors and combustion by-product landfills, similarly eliminate or modify additional acreages of habitat. There are currently 14 power plants in Maryland of greater than 100 MW capacity, nine of which are located in rural areas and five in urban, developed areas. Clearly, power plant sites occupy an insignificant portion of Maryland's 6.3 million acres. In addition, none of these power plant facilities can be considered to have eliminated a significant portion of Maryland's natural wildlife habitats.

In Maryland, the largest impoundment created by a hydroelectric facility is formed by the Conowingo Dam. The impoundment lies primarily in Pennsylvania. If that impoundment is excluded from the total, the area inundated by other impoundments created for small-scale hydroelectric power generation in Maryland represents approximately 0.1% of Maryland's total acreage. None of the hydroelectric sites is known to have been constructed in a critical or unique habitat, and the existing facilities cannot be considered to have eliminated a significant portion of Maryland's total riparian habitat.

- Indirect Impacts

Pollutants transported through each of the three other environmental media has the potential to alter portions of the existing ecosystem. Some examples of these impacts, such as acid deposition, have been discussed previously. Many of the potential indirect impacts have not been studied in Maryland, and as a result, cumulative impacts have not been rigorously quantified.

Future Impacts

Over the past several years, Maryland electric utilities have taken a number of steps to add resources to their systems through planned new power plant construction. PEPCO has submitted an application to the Maryland PSC to obtain a certificate for their proposed "Station H" facility to be sited at PEPCO's Dickerson power station in Montgomery County. The Southern Maryland Electric Cooperative (SMECO), a company that distributes purchased power, has also filed for a certificate to develop a combustion turbine peaking facility at PEPCO's Chalk Point site. In addition, BG&E has proposed constructing a coal-fired power plant at Perryman in Harford County, and DP&L is preparing to expand its Vienna plant in Dorchester County.

PPRP is in the process of conducting several studies at each of these proposed power plant sites to address future impacts to air, surface water, ground water, and terrestrial media. At the Perryman site, several surface and ground water studies have been completed to address what was considered to be the most likely areas of impact. The results of these studies showed that these resources will not be adversely affected by siting a coal-fired power plant at the Perryman site.

Preliminary Site Evaluation Reports (PSER) have been prepared for the other sites which specifically addressed any future environmental impacts associated with the construction and operation of power plants. These reports have identified specific issues that require focus for future investigations. In fact, several studies addressing water supply, combustion by-products disposal, and air emissions are underway at the proposed Station H facility.

Summary

The generation of electric power in Maryland has caused some localized impacts to air, surface water, ground water, and terrestrial resources. Of the four principal environmental media, power plant impacts on air quality are the most difficult to determine because of the difficulty in measuring the relationship between stack emissions and ambient air quality. Consequently, it is difficult to distinguish the effect of power plant emissions from other regional industrial sources. Plant emissions do vary over time according to the amount and type of fuels burned and emissions control equipment in place. Modeling results suggest that SO_2, NO_x, and particulate from power plant sources in Maryland are localized.

Surface water impacts due to direct biological effects, water quality degradation, and hydroelectric power appear to be localized in the area surrounding each power plant. Direct biological effects in the form of impingement and entrainment have not adversely affected the aquatic biota in the state's surface water. In addition, discharges of chemical, thermal, or radionuclide effluents have had only localized effects in the vicinity of several power plants, with no regional effects to water quality or biota. The Conowingo facility, on the other hand, is causing some regional impact to aquatic life and water quality in the Susquehanna River; however, studies are underway to determine ways to mitigate these effects.

Although the Calvert Cliffs and Chalk Point power plants have contributed to overall declining water levels in the Aquia and Magothy aquifers, there are still adequate supplies available to meet current demands and some increases in future demand. From the data that is available, it appears that ground water quality has been impaired at several combustion by-product landfill sites; however the impacts are localized and minimal.

Power plants and supporting facilities displace a certain amount of terrestrial habitat, although none of these power facilities can be considered to have eliminated a significant portion of Maryland's natural wildlife habitats. Indirect effects from pollutants transported through other environmental media have not been studied in Maryland, and as a result, cumulative impacts have not been rigorously quantified.