CHAPTER VI

SOCIO-ECONOMIC IMPACT

The construction and operation of an electric generating station may have significant economic and social impact upon the community where it is located. Among the many possible effects usually considered are changes in:

- population, housing and school enrollment
- land use patterns
- transportation and congestion
- income, employment, and business activity
- local government spending and tax revenues

For convenience, these effects are usually divided into changes affecting the social and economic functions of the private sector and changes affecting tax revenues and the demand for services in the public sector.

The socio-economic effects of power plant construction stem from the rapid increase in population resulting from a sudden increase in the local work force during plant construction. The influx of workers who relocate within the area, as well as commuters, can potentially create demands that exceed the capacity of the public and private services, facilities, markets, and institutions -- the local social and economic infrastructure -- which serve a given community, county, or region. The magnitude of these social and economic effects depends on several factors, particularly the size of the construction project, the size and diversity of the economic base of the local economy, and the infrastructure of the local community. Jurisdictions with a large and well developed economic base are generally more able to meet the service, employment, and economic requirements of major construction projects more readily than jurisdictions lacking this asset.

The most recent major power plant construction project in a rural Maryland community was Calvert Cliffs (completed in 1975). Some preliminary data about the socio-economic effects of this project has been released (1,2) and the results from a more comprehensive study will be available in 1982. These studies showed the need for a means of predicting impacts on the predominantly rural communities which are the proposed sites for future power plants in Maryland. Consequently the Maryland Power Plant Siting Program (PPSP) supported the development of a socio-economic impact assessment model (3). This model, which was subsequently computerized (4), was first applied as part of the Eastern Shore Power Plant Siting Study which evaluated four sites potentially suitable for fossil and nuclear power plant development on the Eastern Shore ot Maryland (5). An estimate of the socio-economic impacts that would result if these sites were developed for power plant use were described in the 1978 Cumulative Environmental Impact Report.

Most recently, this model has been used to estimate the social and economic effects of the expansion of the existing Vienna generating station by Delmarva Power and Light Company (DP&L). DP&L has applied for a Certificate ot Public Convenience and Necessity to construct a 500 MW coal-fired generating unit, Vienna Unit 9. Because the application included the option of constructing capacity of up to 600 MW, social and economic impact studies of the Vienna expansion were based on a 600 MW plant design.

The Vienna analysis provides the most recent data illustrating the potential effects of power plant development within Maryland. The results of this analysis are presented here as an illustration of typical socio-economic effects. This analysis is particularly significant since the Vienna location is typical of the rural Maryland setting where future power plant development is most likely to occur.

A. Employment, Population, Housing and Fiscal Effects

The magnitude of socio-economic effect is determined by a variety of very specific factors, including:

- the size of the plant under construction and its design, both of which influence labor force size
- the location of the plant site with respect to the nearest major cities, which influences the proportion of the work force that commutes rather than becomes immigrant
- the size and economic base of the local communities, which influence the extent to which local municipal and county governments experience increased revenues due to increased local business activity.

The driving force for socio-economic effects is the large labor force necessary for the construction of a modern power plant. It has been estimated that at the peak of construction activity, some 3,200 workers would be involved in the construction of a two-unit, 2,400-MW nuclear power plant (5). At the peak, the work force for a single unit, 600 MW station has been estimated to be approximately 1,000 workers (6).

While construction goes on, these workers purchase goods and services from the local retail economy, increasing local business retail activity. This, in turn, leads to increased wholesale business activity. The result is an increase in local income and employment. It is the sum of these employment gains (direct construction labor plus the additional employment induced by the increase in local business activity) that is the principle driving force for the local effects which occur during the construction phase.

The scale of the effects that these employment changes have on local social and economic conditions depends primarily on two factors: the ability of the local region or county to provide workers from its own population, and the ability of the local community to absorb the new workers who decide to move in during the construction period. These factors are a function of the existing population base and the size and economic integration of the local economy.

Most of the rural counties of the State are located within a relatively short distance (measured in driving time) from the more populous counties and larger metropolitan areas. As a result, even in these rural counties, many of the more severe social and economic effects that may result from large construction projects are mitigated by the relative proximity to large labor force concentrations and urban centers.

Vienna Study

The analysis of the proposed Vienna Unit 9 provides an indication of the scale of the impacts which are likely to result from the construction of what is by current standards a smaller size generating station in a rural, non-suburban Maryland county. In order to understand the impacts of development on a rural economy in Maryland, it is necessary to understand the economic structure of the local community. Because the town of Vienna is located on the border between Dorchester and Wicomico Counties, it is likely that the presence of two urban centers, Cambridge and Salisbury, will serve to buffer adverse impacts because of their relatively well-developed economic base and infrastructure. At the same time, the presence of these cities is likely to improve the ability of the area's economy to obtain maximum benefit from power plant development.

Vienna is almost exactly equidistant from Cambridge (1980 population: 11,703) and Salisbury (1980 population: 16,429) both of which are 16 miles from the town. The town of Hurlock, approximately 10 miles to the north, is the closest moderately sized community (1980 population: 1,690). The Vienna Unit 9 site is immediately north of the existing Delmarva Power and Light Company (DP&L) plant on the north side of the community of Vienna.

Land use and development trends in the vicinity of the Vienna site are typical of many portions of rural Maryland. There have been almost no new homes built within the town of Vienna and its immediate environs during the 1970's. Commercial and industrial development has also been minimal during this period. The market for residential development in the area is quite limited, and the lack of vacant land within the town, problems of failing septic systems, and the reluctance of surrounding property owners (primarily farmers) to develop their property have all contributed to the lack of development (7).

Most of the adverse socio-economic effects of power plant development result from the influx of a large construction work force. These effects are usually largest when the number of workers who move into the local area during the construction period represents a significant proportion of the local population. In the case of the Vienna plant, most workers would be hired from outside of the immediate Dorchester - Wicomico County area because the local labor force does not contain a large enough pool of workers with the appropriate heavy construction skills.

DP&L has provided estimates of the number of workers required to construct and operate the Vienna plant as shown in Table VI-1. The construction of a 600 MW unit at Vienna is estimated to require a maximum of 1,005 workers at the peak of the five year construction period. Of those workers, most are expected to be hired from outside the local economy, only 12.5 percent of the peak work force would come from the Dorchester - Wicomico labor force. Some of these "outside hires" are expected to relocate to the general vicinity of the construction site. Approximately 30 percent of the workers who do relocate are projected to move into Dorchester County.

TABLE VI-1
Workers Required to Construct And Operate Proposed
Vienna Power Plant
1983-1988

Year	Outside Hires	Local Hires	Total Hires
	Construction Period		
1983	57	29	86
1984	468	121	589
1985	879	126	1005
1986	737	98	835
1987	348	96	444
	Operating Period		
1988[1]	30	70	100

[1]First full year following start of plant operations. The number of workers required to operate Vienna 9 is expected to remain constant at the 1988 level during the life of the plant.
Data from Reference 8.

The total number of jobs likely to be generated in the local economy by the Vienna power plant is shown in Table VI-2. Approximately 300 county residents are expected to be employed by DP&L and local employers on or off the construction site during the peak construction year. This effect on employment is likely to be well within the ability of the local economy to absorb. This estimate represents only 2 percent of the employed Dorchester County work force and 20 percent of the total unemployed labor pool in 1977. Although some of these jobs would be filled by workers shifting from their existing occupations to higher paying jobs at the construction site or in the local area, the number of these workers is likely to be too small to adversely affect the labor supply of existing firms.

The workers who gain employment on or off the construction site as a result of the Vienna power plant construction and who relocate into Dorchester County are not expected to have a significant impact on county population, housing demand, or schools. County population at the time of peak construction activity is expected to increase by approximately 150 people, with an increase in school population of approximately 30 students. The total population increase translates to an increase in housing demand of less than 50 units at peak. This additional demand for housing represents only 14 percent of the 350 housing vacancies that are currently projected as the number of units available for rent or sale in 1985 in the absence of

TABLE VI-2

Jobs Generated by Vienna Power Plant in Dorchester County
Direct and Secondary

1983-1988

Year	At Construction Site: County Residents	At Construction Site: Immigrants[1]	At Construction Site: Subtotal	Secondary Jobs[2]	Total
Construction Period					
1983	13	2	15	24	39
1984	55	21	76	136	212
1985	57	55	112	247	359
1986	44	37	81	112	193
1987	43	13	56	21	77
Operating Period					
1988[3]	32	9	41	3	44

[1]Number of workers hired from outside the local area who reside in Dorchester County as of the given year. Excludes employees who stay in motels during the week and commute to their homes on weekends.

[2]Filled by county residents.

[3]First full year following start of plant operations. The number of jobs generated by the power plant is expected to decline to 41 by 1990 and then stabilize for the remainder of the operating period.

Data from Reference 6.

power plant construction. Sufficient rental units of all types are projected to be available to meet this demand. The additional demand of 50 units in a county of the size of Dorchester is not expected to have a significant effect on the local housing market other than to reduce the average monthly housing vacancy rate. These effects are summarized in Table VI-3.

The increase in the number of workers during the construction phase will result in an increase in the demand for public services. This increase stems in part from the variety of services, such as police and fire, required by the total increase in work force, including commuters. Most of this increase comes from those workers who move into the county and make use of schools, fire and police protection, water and sewage treatment, social services and general public administrative functions.

In response to this increased demand for services, local governments have several options available. Public officials may choose to maintain services at the existing per capita level, which would require increasing the local government budget in proportion to the population increase. Alternatively, recognizing the short-term nature of the increase, public officials may permit the per capita level of services to decline by not expanding them in proportion to the population change. At the limit, services may not be expanded at all. Because the population increases and increased service requirements that do occur are likely to be relatively small and of short-term duration, local officials have frequently found it unnecessary to greatly expand services and budgets.

Balanced against this demand for services is an increase in revenues. Before the plant comes on line, increased housing prices, new construction of houses, increased local income and business activity will all increase tax revenues. After the plant begins to operate, the county receives revenues from property and capital taxes of the plant.

Table VI-4 summarizes the fiscal effects on several jurisdictions during plant construction and operation. The estimates are based on the assumption that average per capita services are maintained by increased provision of services and represent <u>additional</u> local tax revenues and public expenditures which result from power plant development.

It is seen that throughout the construction period, neither the local municipality of Vienna nor the City of Cambridge (the county seat) are likely to experience significant fiscal effects, and that throughout the period additional tax revenues from construction-related economic activity will more than offset any additional expenditures. Throughout the construction period, Dorchester county government is expected to experience an increase in revenues which exceeds projected increases in expenditures.

Table VI-4 also shows the expected total revenues and total expenditures during the operating period. The net fiscal effect on Vienna and Cambridge during the plant's operating years is expected to be neutral. However, in the case of Dorchester County, the fiscal impact of the operation of Vienna 9 is likely to be substantial, approximately $4.8 million annually in 1978 dollars. That revenue represents approximately 400 percent of the County's Fiscal Year 1981 budget, and is an understatement of the fiscal effect due to the use of 1978 dollar estimates for revenues. These revenues stem largely from the property taxes paid by the utility.

TABLE VI-3

Total Housing Demand Population and School Children from Proposed Vienna Power Plant Estimated by Year

1983-1988

Year	Immigrating Workers	Housing Demand	Cumulative Population	Additional School Children: Grade School	High School	College	Total
			Construction Period				
1983	2	2	5	1	0	0	1
1984	21	19	58	7	3	1	11
1985	55	48	151	19	8	2	29
1986	37	33	103	13	5	1	20
1987	13	11	35	4	2	0	7
			Operating Period				
1988[1]	9	8	25	3	1	0	5

[1]First full year following start of plant operations. Total housing demand, population and school children during 1989 and the remainder of the operating period are expected to remain constant at 1988 levels.

Data from Reference 6.

In Wicomico County only the city of Salisbury is expected to experience a construction period deficit. That deficit is likely to be very small, and is subsequently offset by small operating surpluses.

Table VI-4
Net Fiscal Impacts for
Plant at Vienna

Jurisdiction	Total During Construction	Yearly Total During Operation
Dorchester Co.	$ 261,600	$4,840,700
Cambridge	15,000	1,700
Vienna	700	500
Wicomico Co.	114,000	27,000
Salisbury	(-6,300)	3,500
State of Maryland	3,320,500	461,500

Data from Reference 6.

Eastern Shore Study

Local fiscal effects of power plant construction are strongly affected by local tax rates. As a result, these effects vary from locality to locality. The variability in these effects can best be illustrated from data prepared for an evaluation of four alternative power plant locations on Maryland's Eastern Shore. These results are summarized in Table VI-5 which show the fiscal effects of the construction of a plant with a peak work force of 3,200 workers.

The variations that exists between counties are the result of differences in the various tax rates and in the extent to which workers move into the county and provide increased tax revenues through increased property values and taxes, increased sales taxes, and business taxes. Dorchester and Wicomico Counties, which experience the largest absolute increase in population, and which also have more extensively developed infrastructures, experience a balanced flow of revenues and expenditures. The other counties and all of the cities (which experience much of the population impacts but less of the revenue benefits because of plant location) experience deficits throughout the construction phase.

As seen in Table VI-5, the county deficits are signficiant, but are manageable in size. In the case of three of the four cities, however, the deficits are of very substantial proportions. Those municipal deficits would require either outside assistance, local tax inreases, or potentially significant reductions in the per capita level of services provided. At both the county and municipal levels, service reductions or tax increases may aggravate the congestion, housing and other difficulties experienced during construction.

Table VI-5

Projected Fiscal Impacts of
2400 MW Power Plant Development,
Various Jurisdictions, Peak Construction Year
and Operating Period[(a)]

(1977 Dollars)[(b)]

Jurisdiction	Peak Construction Year: Total Revenues	Peak Construction Year: Total Expenditures	Peak Construction Year: Surplus (Deficit)	Deficit as % of Revenues[(c)]	Operating Period Revenues
Kent County	$735,600	$912,700	$(177,100)	4.0%	$36,000,000
Chestertown	50,100	84,700	(34,600)	13.8%	
Queen Annes	565,200	650,100	(84,900)	1.9%	27,000,000
Centreville	24,500	46,400	(21,900)	21.3%	
Dorchester	1,010,000	982,900	27,100	--	40,000,000
Cambridge	189,800	329,000	(139,200)	13.3%	
Wicomico	1,116,800	1,088,800	28,000	--	28,000,000
Salisbury	113,700	195,800	(82,100)	2.9%	

(a) This study was done for a two unit 2400 MW nuclear plant. No nuclear plant is under consideration for the Eastern Shore. The socio-economic impacts do not depend on the type of plant, therefore the study is representative of any plant requiring the stated labor force.

(b) Rounded to nearest $100.

(c) Deficit shown as percentage of total local revenues, including power plant-induced revenues.

Data from Reference 5.

B. Coal Transportation Effects

DP&L's 600 MW Vienna Unit 9 would use 1.5 million tons of coal a year at an annual capacity factor of 68 percent. On a weekly basis, coal consumption would range between 28,800 and 42,300 tons at 68 and 100 percent capacity factors, respectively. For coal shipped by rail, DP&L expects to rely largely on 100 car unit trains with a capacity of 100 tons of coal per car. On this basis there would be between 2.9 and 4.2 unit trains per week traveling each way to maintain the coal supplies. There would be at least 15,000 coal cars a year traveling over the Delmarva rail system each way. By comparison, approximately 1,000 carloads are expected on the Dorchester segment of the Cambridge to Seaford line in Fiscal Year 1980.

There are two positive effects on the Eastern Shore economy resulting from a decision to transport coal to Vienna by rail: an improvement in rail service due to the upgrading of track conditions in order to serve the heavy loads of coal trains, and long-term assurance that rail operations would be profitable along the applicable branch rail lines. The possibility that rail service might be abandoned would therefore be reduced.

More efficient rail service and reduced travel time between the Eastern Shore and potential markets for local industries could allow rail users to compete in more distant markets and/or improve local profit margins. In addition firms considering the Eastern Shore as a possible location would find the area more attractive with improved rail service. Although the quality of rail service is only one of the many factors a firm would consider in making a locational choice, industries dependent on shipping bulk goods long distances would weigh this factor highly.

If the Vienna site is approved for the power plant and coal is transported by rail, the incentive to maintain rail service on the entire Cambridge to Seaford line would be even stronger than it has been. This could prevent rail abandonment of the Cambridge segment of the line, and could have a significant effect on the Dorchester and Caroline County economies.

In a period of failing local rail service through many areas of Maryland, the impact of improved rail service to present and potential future users can be an important economic benefit from the development of a coal-fired power plant.

There is also a potentially adverse impact of coal shipment by rail: the inconvenience which results from traffic crossings and local noise. Both effects are determined by site-specific conditions.

At Vienna, trains would cross a number of highways at grade at relatively slow speed, causing periodic delays for cars, trucks and other highway users. The amount of delay is dependent on the train speeds, which in turn are controlled by the quality of the track and roadbed. Specific plans for upgrading the Cambridge to Seaford line have not yet been formulated. It appears reasonable to assume, however, that the line would be upgraded to Class II standards, allowing a speed of 25 mph. On that basis, the 100 car unit trains, which would be approximately 5,000 feet long, would take between 2 and 3 minutes to cross an intersection. Warning devices and driver hesitation would increase the delays somewhat, perhaps up to 4 minutes. It is possible that the trains would travel more slowly, particularly through towns such as Hurlock. If the trains travel at only 5 mph, they would take between 11 and 12 minutes to cross an intersection. Adding delay time may increase this period to about 13 minutes.

C. Traffic Congestion Effects

Increased numbers of resident and commuting workers to a power plant site during the construction period frequently produce traffic congestion. The impact on traffic conditions is a function of the increase in the number of commuters and the available carrying capacity of the relevant local transportation routes. Because the severity of traffic congestion is likely to be dictated by local conditions it is not possible to reach a general conclusion about the extent to which traffic congestion during plant construction can be mitigated. With adequate advance planning, severe congestion problems that result from existing bottlenecks can be eliminated by altering highway improvement schedules. Congestion resulting from construction period overcrowding of otherwise adequate roads and bridges may be reduced by adjusting work schedules and traffic flow patterns. The extent to which mitigation measures will succeed in reducing traffic congestion depends on the ability to make the appropriate long-range planning decisions.

Vienna Study

Traffic impacts for the Vienna site were examined in detail for the 1985 peak construction year (6). This analysis revealed that the highway level of service on the two lane segment of U.S. Route 50 in the Vienna area will be unacceptable in 1985 even without the incremental effect of commuting construction workers. The incremental impact of commuting construction workers would increase traffic congestion on this highway segment, particularly for the highway west of the interchange at Route 331. However, plans by the State Highway Administration (SHA) to construct a northern bypass around Vienna to reduce traffic flow through the town will reduce or eliminate this problem.

Traffic impacts at the U. S. Route 50-Route 331 intersection at Vienna were also examined for 1985. This analysis revealed that the incremental traffic resulting from the commuting construction workers would result in an unacceptable level of highway service through this intersection during the summer months. As part of its review of the Vienna plant, SHA proposed highway improvements at the intersection to minimize backups and the potential for intersection related accidents. These improvements are estimated to cost $120,000 in 1980 dollars and would normally be paid for by the utility, and would greatly reduce the projected congestion problems.

Other Studies

The study of four Eastern Shore counties estimated (3) that the increase in the number of commuters coming into the counties ranged from 103 percent (2,524) to 664 percent (3,101). The county receiving the largest increase (relative and absolute) in the number of commuters was the least likely to experience significant traffic congestion because of the capacity of the major roads leading to the area. For each of the other three counties, significant traffic congestion was projected to occur at particular points. Those congestion points were all located at two-lane bridges crossing rivers in the area. In each case, the congestion point had been previously identified by the Maryland Department of Transportation in its long-range plan.

In the case of Calvert Cliffs, a traffic increase of an estimated 1,200 vehicles was experienced during the morning shift. That increase represented 150 percent of the hourly capacity per lane of the major two-lane road used to reach the plant, resulting in significant rush hour congestion (1).

D. Cumulative Local Tax Revenues from Maryland Electric Utilities

Once a power plant comes on line, the local county government receives a significant increase in tax revenue from the utility. The revenues received by local governments once a plant begins to operate provide new flexibility in the options availabe to the locality, including capital improvements, improvement of the local housing stock, expansion of social service activities, and reductions in tax rates. Table VI-5 provided estimates of tax receipts projected for four Eastern Shore counties during the construction and operation of a new power plant. The variation in the tax receipts during the operating period is largely the result of differences in tax rates among the counties. However, in all cases the increase in tax receipts after the plant comes on line is substantial.

Due to very high capital cost of modern base-load units, tax receipts from these facilities tend to be substantial. Tax revenues received from a power plant can dwarf other revenues and expenses in the budget of a rural county. It is not uncommon in such cases for the county to reduce tax rates significantly, which has the effect of reducing power plant tax revenues as well. The rate reductions have occurred in Calvert County as a result of the tax revenues received form the Calvert Cliffs nuclear plant (2).

Table VI-6 gives the revenues received by all Maryland counties from electric utlities and also indicates the size of the revenue increase relative to the county budgets. These tax payments vary substantially, and depend largely on the size, age, and fuel type of the facilities owned by utilities in each county, as well as on local tax rates. The presence of power plants in Anne Arundel, Baltimore, Calvert, Montgomery, and Prince George's Counties and in Baltimore City are evident in the tax receipts of these counties. The impact of a large facility on the budget of a largely rural county is most evident in Calvert County. However, even the presence of an older plant in a rural county has some impact, as may be seen in the cases of Charles and Dorchester Counties.

Table VI-6

Electric Utility Tax Payments to Maryland Counties
Fiscal Year 1980-81

County	BG&E	DP&L	APS/PE	PEPCO	Total	% of County Budgeted Total tax receipts	% of County Operating Budget
Allegany	976		262,597		263,573	1.50	1.18
Anne Arundel	5,110,573		18		5,110,591	3.44	1.75
Baltimore City	18,905,402		2,041		18,907,443	5.83	1.61
Baltimore County	10,291,334		55		10,291,389	3.31	2.52
Calvert	11,089,717		4		11,089,721	49.43	50.62
Caroline	1,120	231,080			232,200	4.89	3.83
Carroll	678,730		82,916		761,646	2.47	1.91
Cecil[a]	46,854	7,331			54,185	.34[a]	.25
Charles	475			3,838,019	3,838,494	15.40	12.10
Dorchester	1,707	585,197			586,904	7.64	5.44
Frederick	68,814		1,163,251	30,127	1,262,192	3.14	2.80
Garrett	151		344,583		344,734	3.43	3.07
Harford[a]	1,773,674		3		1,773,677	3.72	2.61
Howard	1,515,004		10,286		1,525,290	2.50	1.72
Kent	1,013	163,180	23		164,216	3.34	2.45
Montgomery	102,795		351,223	10,055,283	10,509,301	2.77	1.59
Prince George's	891,161		57	12,301,680	13,192,898	5.35	2.79
Queen Anne's	1,674	196,176			197,850	2.61	2.20
St. Mary's	553			168,704	169,257	1.18	.81
Somerset	744	121,934			122,678	3.49	2.29
Talbot	3,982	59,649			63,541	.89	.55
Washington	2,973		685,356		688,329	2.21	1.90
Wicomico	1,752	377,696			379,448	2.33	1.40
Worcester	968	246,613			247,581	2.01	1.49
TOTAL	50,492,056	1,988,856	2,902,413	26,393,813	81,777,138		

(a) Also receives taxes from Conowingo Power Co., (not included).

Data from Reference 9.

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CHAPTER VII

NOISE IMPACT

An evaluation of the impact of a power plant includes an evaluation of noise (1). This evaluation will typically consist of the following steps:

- Identification of the noise sources of the facility and a description of the nature of the emissions,
- Analysis of noise propagation to off-site areas,
- Evaluation of already existing noise (ambient noise) in off-site areas,
- Evaluation of the effects of the intruding noise on people,
- Consideration of constraints and mitigation if necessary.

Noise can be described either by spectrum components or overall energy levels. The more complete description is by spectrum components in which sound energy is quantified at different frequencies. This is an important method of characterizing sound since the human ear has a sensitivity which varies markedly with frequency. Propagation characteristics are also frequency dependent. Typically, a spectrum description will use nine separate octave bands,[1] centered at intervals between 31 and 8000 Hz. The sound energy is reported in decibels (dB).[2]

The individual octave bands are weighted according to the frequency sensitivity of the human ear. An overall sound level, described as the "A-weighted sound pressure level", reported in units of dBA can be obtained. Table VII-1 lists several common sources of noise in terms of their overall dBA levels.

Since many noise sources fluctuate over time, statistical descriptions of the A-weighted sound can be defined. The following descriptors are frequently used:

L_{eq} (equivalent sound level), is the A-weighted sound pressure level averaged over a 24-hour period,

L_{dn} (day/night sound level), is the dBA sound level averaged over a 24-hour period, but where the noise levels between the hours from 10 PM to 7 AM are treated as if they were 10 dB greater than the actual level,

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[1]An octave is a doubling of frequency. An octave band analyzer will add up all the energy that exists in a particular band of frequencies that is one octave wide.

[2]A decibel description of sound energy needs to state a unit of reference. For acoustics, as applied to noise and human hearing, the reference (zero dB) is approximately the quietest sound a person with good hearing can hear (20 $\mu N/m^2$). The decibel is a logarithmic unit, an increase of 3 dB corresponds to a doubling of the energy level.

TABLE VII-1.
Typical A-Weighted Sound Levels Measured with a Sound-Level Meter

	DECIBELS	
	140	
50 HP Siren (100')		
	130	
Jet Takeoff (200')		
	120	
Riveting machine	**110**	
	100	
Textile Weaving Plant Subway Train (20')		
	90	Boiler Room
Pneumatic Drill (50')		
	80	Inside Sport Car (50 MPH)
Freight Train (100') Vacuum Cleaner (10') Speech (1')	**70**	
		Near Freeway (Auto Traffic)
	60	Large Store
Large Transformer (200')		Private Business Office
	50	
		Average Residence
	40	Nightime Residential areas
Soft whisper (5')		
	30	
	20	
	10	
Threshold Of Hearing	**0**	

Note: These values are taken from the literature. Sound-level measurements give only part of the information usually necessary to handle noise problems, and are often supplemented by analysis of the noise spectra.

L_{10}, L_{50}, L_{90} are dBA sound levels that are exceeded for 10, 50, and 90 percent of the time, respectively.

A. Noise Sources

Major power plant noise sources can usually be categorized as follows:

- The primary generating facility, consisting of turbines, generators, and associated equipment,
- Cooling towers (natural or mechanical draft),
- Coal handling machinery, consisting of bulldozers, conveyors, and crushers,
- Large vehicles (trucks and trains).

The first category, the primary generating facility, contains a multitude of individual noise sources, such as fans, furnaces, turbines, generators, outdoor paging systems, etc.

Cooling towers can also be a significant source of noise from a power plant. Natural draft cooling tower noise is produced by the sound of falling water, a mechanical draft tower generate additional fan noise. Fan noise generally dominates the noise spectrum for frequencies below 2000 Hz, while water noise dominate above. Table VII-2 lists octave band and dBA levels for noise measured at various points surrounding several plants. Five plants are listed ranging from a small diesel plant (48 MW) to a large nuclear plant (1645 MW). The lowest noise emissions was from the nuclear facility. The small diesel plant produced noise levels comparable to the largest coal-fired plant. The noise from such a small plant, when propagated to neighboring areas, can actually be more significant than that from a larger facility, because of the relatively small land area often allocated to a small facility.

In addition to the broad band noise sources discussed above, discrete tones must also be considered. A discrete tone results from concentration of sound energy into a narrow band of frequencies. For a given amount of energy, a discrete tone is more noticeable than broadband noise. Because a relatively small addition of energy in the form of a discrete tone can increase the annoyance value of a noise, noise regulations often require a 5 dB lower noise level if prominent discrete tones are contained in the intruding noise.

Noise emissions from most power plants do contain discrete tones, usually related to the rotation rates of large generating machinery. However, with one exception, past studies did not find discrete tones strong enough to increase the annoyance potential of the noise emissions.

Table VII-2

Octave-Band Noise Under Full Load at 1000 Feet from Plant Edge.[a] Plants Under Full Load

Band Center (Hz)	Coal-Fired PLANT I (550 MWe)	Coal-Fired PLANT II (550 MWe)	Coal-Fired PLANT III (1,500 MWe)	Nuclear PLANT IV - (1,645 MWe)			Diesel PLANT V- (48MWe)		
				Front	Sides	Back	Front	Sides	Back
31	64.1	60.1	70.9	55.7	52.7	59.7	68.0	67.0	73.0
62	62.1	58.1	69.9	54.7	53.7	59.7	59.0	65.0	68.0
125	57.1	57.2	68.0	52.8	50.8	59.8	56.9	63.9	67.0
250	53.2	49.2	59.1	47.8	45.8	50.8	54.9	56.9	59.9
500	52.4	48.5	56.3	42.0	39.0	47.0	50.6	52.7	54.7
1K	46.8	43.0	53.7	39.5	33.5	41.5	45.1	55.1	56.1
2K	38.9	35.5	52.3	32.8	29.8	39.8	40.6	51.6	48.6
4K	24.8	27.3	52.0	22.2	17.2	30.2	32.9	43.9	41.9
8K	2.1	17.7	40.0	12.5	-1.5	18.3	18.4	26.4	25.4
dBA	52.7	49.3	60.7	45.2	42.1	49.7	52.4	58.9	59.7

[a] Values in dB with reference to 20 $\mu N/m^2$

B. Noise Propagation

Calculations are required to determine the noise levels that will be propagated from a noise source to off-site areas. In this process, it is necessary to consider the following points:

- geometric spreading (the dilution of sound energy as it propagates away from a source);
- atmospheric absorption (the loss of sound energy as it is converted into heat in the air);
- absorption by vegetation (usually trees);
- obstruction by barriers (terrain or buildings which block the line-of-sight path between the source and listener).

The overall noise is the sum of the noise energy propagated from each source to a given point.[1]

These calculations must be performed for numerous points surrounding the plant. The results can be summarized in terms of dBA contours, i.e., the line which connects points which have equal dBA levels. Figures VII-1 and VII-2 show examples of dBA contours for two typical facilities. Figure VII-1 refers to a coal burning facility consisting of an existing 550 MW plant and two proposed 850 MW units. Figure VII-2 applies to a diesel generating facility consisting of eight units, each of 6 MW capacity. The effect of shielding by trees is included. As mentioned earlier, the small diesel facility propagates considerably more noise beyond the plant site boundaries than the large coal-fired facility.

C. Effects of Noise on People

Several indices may be examined to determine how people will be affected by intruding noise. One such method correlates noise levels to various social/physiological functions; i.e.,

- actions taken by citizens, such as formal complaints or lawsuits,
- people's responses on social survey questionaires,
- interference with understanding of speech,
- interference with sleep.

Figure VII-3 shows an example of an evaluation procedure documented by the U.S. Environmental Protection Agency (EPA) in which the intruding noise is correlated with observed community actions. Table VII-3 shows a number of correction factors in the EPA method which account for conditions that could make a given problem more or less sensitive compared with a base-case. In

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[1] It is not correct to add dBA levels arithmetically when computing the combined noise from several sources. For example, two sources each at 50 dBA would have a combined level of 53 dBA.

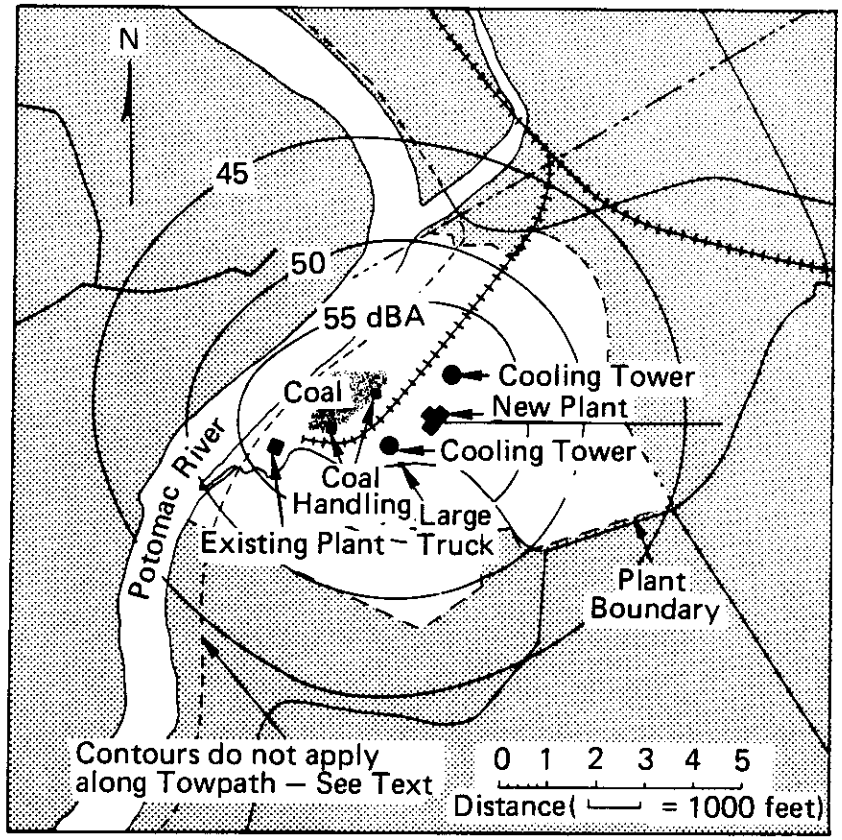

Fig. VII-1 Noise Contours Calculated for Coal Burning Plant

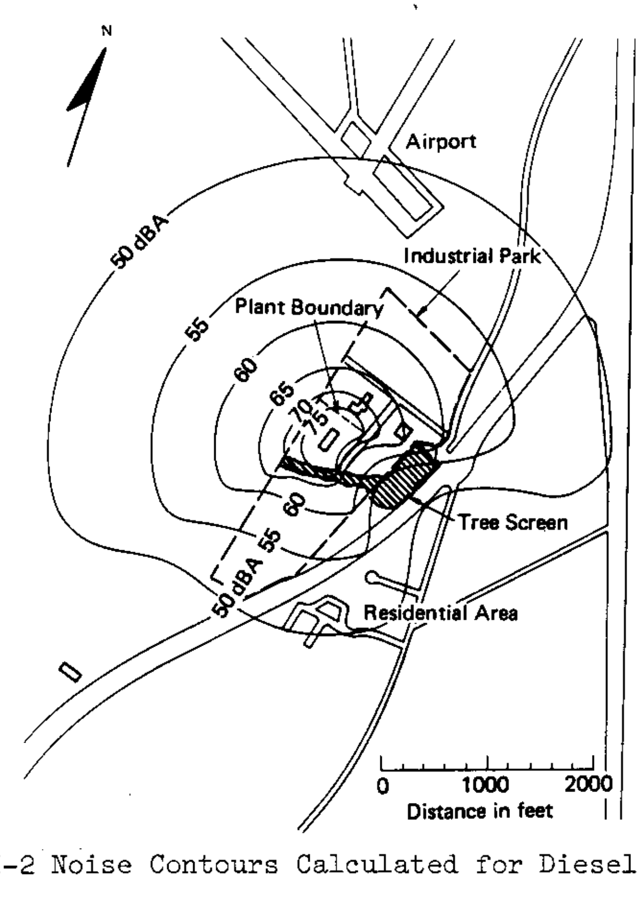

Fig. VII-2 Noise Contours Calculated for Diesel Plant

Table VII-3
Corrections to be Added to the Measured Day-Night Sound Level (L_{dn})
of Intruding Noise to Obtain Normalized (L_{dn})
(As recommended by Enviromental Protection Agency)

Type of Correction	Description	Amount of Correction to be Added to Measured L_{dn} in dB
Seasonal Correction	Summer (or year-round operation)	0
	Winter only (or windows always closed)	-5
Correction for Outdoor Noise Level Measured in Absence of Intruding Noise	Quiet suburban or rural community (remote from large cities and from industrial activity and trucking)	+10
	Normal suburban community (not located near industrial activity)	+5
	Urban residential community (not immediately adjacent to heavily traveled roads and industrial areas)	0
	Noisy urban residential community (near relatively busy roads or industrial areas)	-5
	Very noisy urban residential community	-10
Correction for Previous Exposure and Community Attitudes	No prior experience with the intruding noise	+5
	Community has had some previous exposure to intruding noise but little effort is being made to control the noise. This correction may also be applied in a situation where the community has not been exposed to the noise previously, but the people are aware that bona-fide efforts are being made to control the noise.	0
	Community has had considerable previous exposure to the intruding noise and the noise maker's relations with the community are good	-5
	Community aware that operation causing noise is very necessary and it will not continue indefinitely. This correction can be applied for an operation of limited duration and under emergency circumstances.	-10
Pure Tone or Impulse	No pure tone or impulsive character	0
	Pure tone or impulsive character present	+5

Figure VII-3, the assumptions are that the plant noise is continuous, the surrounding community is of a quiet suburban or rural type with some prior exposure to the intruding noise, windows of residences are assumed to be partially open, and the noise does not contain prominent discrete tones.

D. State Noise Regulations

The State of Maryland has noise regulations which restrict the noise levels that a person may cause or permit. As shown in Table VII-4, the State noise constraints are categorized by zoning district and time of day. Daytime hours are 7 AM to 10 PM, and nighttime hours 10 PM to 7 AM. Allowable discrete tones are 5 dBA lower than the levels listed in the table.

Construction noise is exempt from the regulations of Table VII-4, Also exempt are railroad noises associated with train passbys, as well as auditory warning devices. State noise regulations concerning construction noise are as follows:

A person may not cause or permit levels emanating from construction or demolition site activities which exceeds:

a) 90 dBA during daytime hours

b) the levels specified in Table VII-4 during night-time hours.

E. Site Evaluations

Noise evaluations completed on six power facilities are briefly described here.

Brandon Shores

A coal-fired plant of 1240 MW capacity is planned to be added adjacent to an existing facility known as Wagner. The Public Service Commission (PSC) imposed a constraint of 45 dBA in areas zoned for residential use in order to protect against annoyance. Subsequenly, the utility filed for a revised restriction to 50 dBA at night, and 60 dBA during the day. Additionally, the utility has requested that the noise criteria should apply to the emissions from the new facility only, rather than the total noise from the combined facility. These issues remain unresolved at this time.

Dickerson

An 850 MW coal-fired plant is planned to be added to an existing 550 MW facility. Since the site was situated in a rural/suburban community, noise was an important consideration. Potential disturbances along a U. S. Park Service hiking path was questioned by intervenors. In order to protect against annoyance, the PSC imposed a 45 dBA noise limit, as well as individual octave band constraints. The utility petitioned to have a relaxation of the octave-band constraints. It was subsequently recommended that

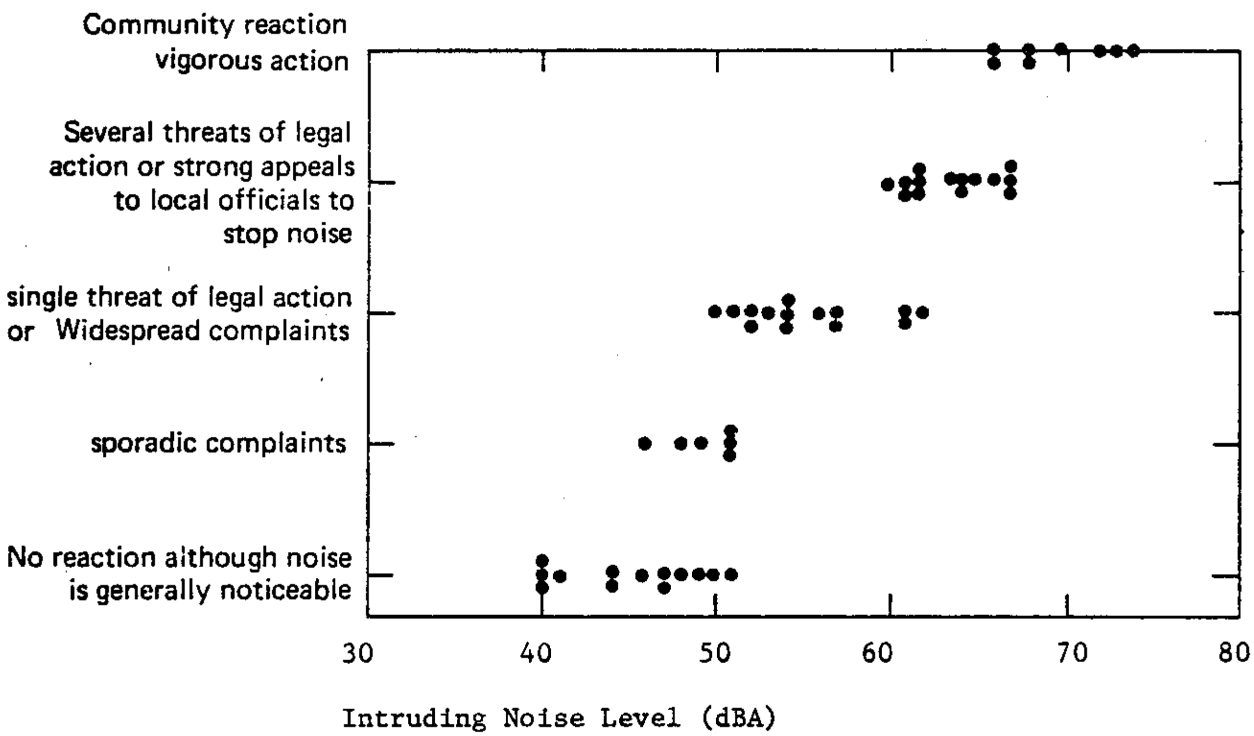

Fig. VII-3. An example of community reactions to plant noise levels. Graph applies to a quiet suburban or rural community, with some prior exposure to the intruding noise. Windows of residences are assumed to be parially open, and intruding noise is continuously present.

Table VII-4

State Noise Regulation

	Maximum Allowable Noise Levels by Zoning Category (dBA)		
	Industrial	Commercial	Residential
Day	75	67	60
Night	75	62	50

the octave band constraints could be relaxed in certain respects without serious additional annoyance.

Douglas Point Site

A nuclear facility of 2356 MW capacity was planned in a quiet rural area along the lower Potomac River. The evaluation revealed that noise would not be a significant source of annoyance. The application has, however, been withdrawn.

Easton

A 48 MW diesel facility is planned adjacent to the community. Due to the small land area and relatively large noise emissions, the PPSP study judged that noise might create annoyance in residential areas if current construction practices were followed. The PSC has ordered the utility to submit a constuction plan that included provisions for noise abatement.

Sollers Point

A gas turbine facility was planned to be added to a facility which already contained several other gas-turbine peaking units. Due to the design and placement of the proposed addition it was judged to be a potential source of annoyance if conventional design practices were followed. The utility agreed to accept design constraints which would allow the unit to be operated without causing annoyance. The utility has since decided not to implement this expansion.

Vienna

A 500 MW coal-fired unit is planned by Delmarva Power and Light for the Eastern Shore of Maryland. The site location favored by the utility would place this unit at a facility already containing several smaller units. A re-routing of a major highway around the plant was also being planned by the State Highway Administration. With the new route, ambient noise levels in the town of Vienna would drop significantly, and plant noise could cause annoyance if proposed design practices were followed. In addition, for certain conditions of operation, it was concluded that State noise regulations would be exceeded by a few dBA. At the present time, PSC hearings have not been concluded.

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2. J.P. Reilly, "Cooling Tower Noise Impact", Chapter III of Addendum to "Power Plant Site Evaluation - Brandon Shores Site", PPSE 1-2, January 1973.

3. J.P. Reilly, "Potential Impact on Community Noise Levels", Chapter 6 of "Addendum to Power Plant Site Evaluation, Dickerson Site", The Johns Hopkins University Applied Physics Laboratory, Report Number 3-1, January 1974.

4. J.P. Reilly, "Noise Impact", Chapter 9 of "Power Plant Site Evaluation Report - Douglas Point", The Johns Hopkins University Applied Physics Laboratory, Report Number PPSE 4-1, Vol 2, May 1974.

5. J.P. Reilly, "Noise Impact", Chapter 4 of "Power Plant Site Evaluation Final Report - Easton Utilities Commission Plant No. 2", The Johns Hopkins University Applied Physics Laboratory, Report Number PPSE 5-2, March 1975.

6. J.P. Reilly, "Power Plant Noise Models for Community Impact Studies", Proc. of the Technical Program, NOISEXPO 75, Atlanta, GA, April 30-May 2, 1975.

7. M. Cwiklewski, "Models for the Prediction of Traffic Noise". The Johns Hopkins University Applied Physics Laboratory, Report CPE-76-067, June 7, 1976.

8. M. Cwiklewski, "Present and Projected Neighborhood Ambient Noise Levels in the Sollers Point Area", Johns Hopkins University Applied Physics Laboratory, Report Number CPE-76-100, August 18, 1976.

9. M. Cwiklewski, "Noise Impact of the Four Gas Turbine Electrical Generating UnitsProposed for BG&E Sollers Point Facility", The Johns Hopkins University Applied Physics Laboratory Report CPE-76-077, June 24, 1976.

10. M. Cwiklewski, "Prediction of Noise Impacts by the Proposed Vienna Unit No. 9", The Johns Hopkins University Applid Physics Laboratory Report PPSE 8-2,February 1980.

CHAPTER VIII

GROUNDWATER IMPACT

In addition to condenser cooling water, power plants also need freshwater for boiler make-up, pump cooling, sanitary water supply, and pollution control equipment. A diagram showing typical uses is shown in Figure VIII-1. These uses can be considerable - up to 1.6 million gallons of water daily for 2,000 MW of fossil-fuel capacity and 500,000 gallons daily for a 2,000 MW nuclear plant. Much of this water demand comes from the requirement for extremely clean (demineralized) water in modern high pressure super-critical boilers, thus leading to the requirement of multiple filtration and backwash systems and limited reuse (1). This water can be drawn from four sources, depending on location of the plant.

- Non-tidal river - Usually, the water is withdrawn from the river and purified for use. Examples of plants using this type of withdrawal are Dickerson and R.P. Smith.

- Industrial water supply - Large cities like Baltimore and Washington provide water of industrial quality to power plants and other large users.

- Groundwater/Desalination - For plants located near brackish surface water, but remote from municipal supplies, there are two alternatives: to desalinate the surface water or to use groundwater. For four of the Maryland plants (Morgantown, Chalk Point, Calvert Cliffs, and Vienna), the choice has been to use groundwater. The potential impact of these wells on adjacent users is discussed below.

The potential impact of the use of groundwater lies both in a reduction of the quantity of water available, and in a decrease in the hydraulic head or "potentiometric surface" in the area surrounding the point of withdrawl. This surface represents the level to which the water would rise if a well were drilled into the aquifer in question. As the well is pumped, a "cone of depression" centered around the well is created in this surface. If pumpage lowers the surface below the intake level of the pump of a neighboring well in the same aquifer, then that well becomes "dry". In such a case, the pump would have to be lowered to a depth that would remain below future lowerings of the potentiometric surface.

The Calvert Cliffs plant has 3 wells averaging 620 feet in depth that withdraw water from the Aquia aquifer. The average monthly usage (Figure VIII-2) is far below the allowed average and maximum appropriations of 600,000 gpd and 865,00 gpd, respectively. Water levels showed an initial decline of about 10 feet, but observations taken since that time show no further lowering. PPSP, through the U.S. Geological Survey, is instrumenting a permanent observation well at this site.

The Morgantown plant has 5 wells, averaging 1,100 feet in depth, that withdraw water from the Patuxent aquifer. The average withdrawal (Figure VIII-3) is eight hundred thousand gallons daily. Water levels of the

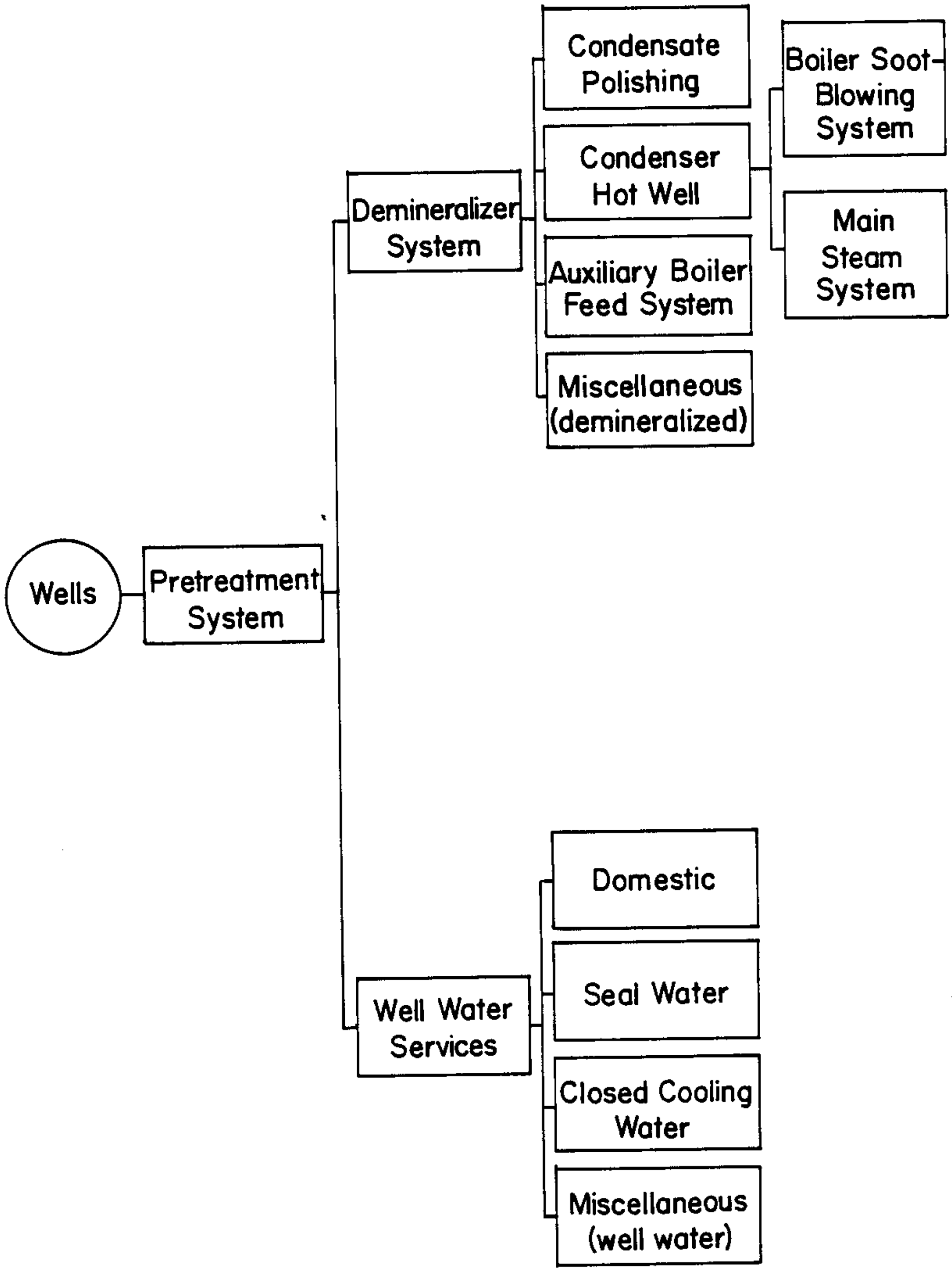

Figure VIII-1. Typical freshwater uses for a fossil-fueled power plant.

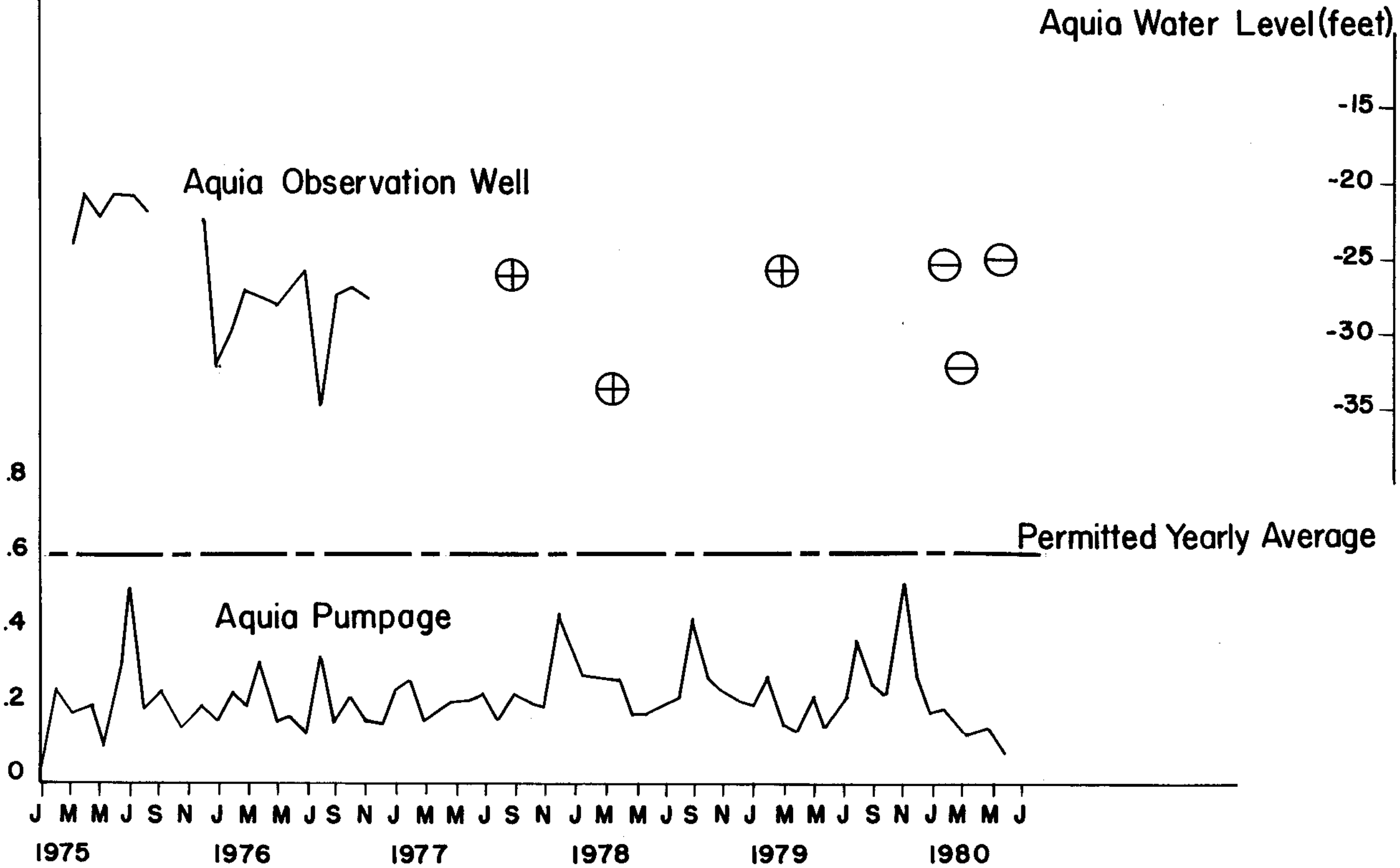

Fig. VIII-2. Pumpage and water levels of the Aquia Aquifer at the Calvert Cliffs Nuclear Plant. The circled readings represent point measurements rather than monthly averages.

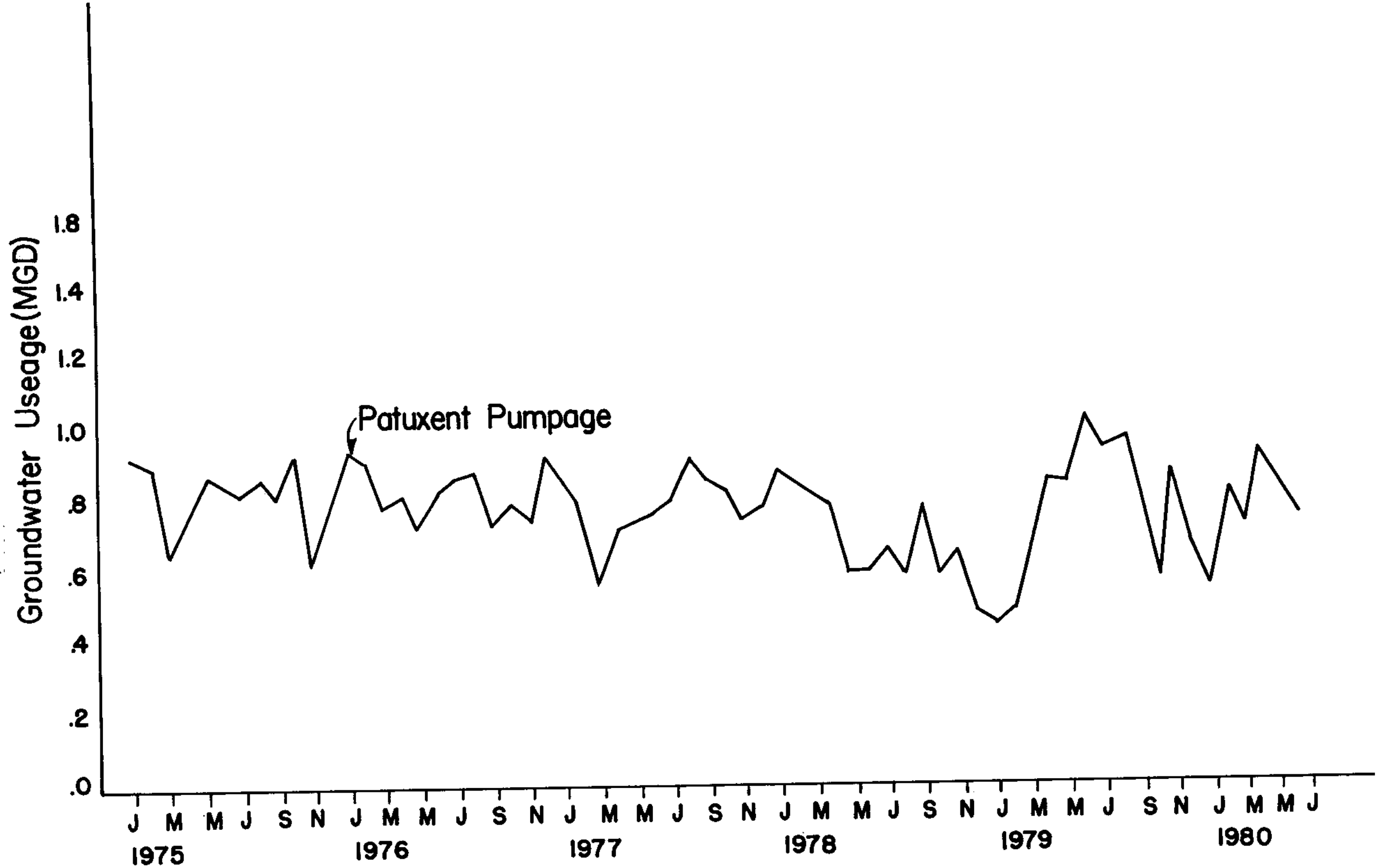

Fig. VIII-3. Pumpage from the Patuxent aquifer at the Morgantown Power Plant.

Patuxent aquifer have declined 90 - 100 feet since plant operation began in 1971, as measured by an observation well near the plant (2). Water levels of the upper aquifers have declined at rates basically unchanged since before PEPCO began pumping, indicating that the plant is not directly linked to the decline (2). At the request of the Power Plant Siting Program, the U.S. Geological Survey has installed a continuous water-level recorder on an observation well screened in the Patuxent aquifer at this site.

Vienna presently draws from 5 wells, four are screened in an unconfined aquifer (Pleistocene) (35 - 54 feet) and one draws from the Nanticoke aquifer (310 feet) (3). The average withdrawal rate for both aquifers is shown in Figure VIII-4. With the retirement of Units 5-7, useage is expected to decline until start-up of Unit 9 in 1988. The expected yearly average withdrawal from Unit 9 is 0.39 mgd (4). Because of the high yield of this aquifer, no water supply problems are anticipated for the area (5).

The Chalk Point plant draws from two aquifers, the Patapsco (1,066 feet) and the Magothy (630 feet). The average withdrawals, shown in Figure VIII-5, indicate that the plant exceeded the maximum monthly average of 1 mgd for the Magothy aquifer twice since 1979. The water level (shown in Figure VIII-5) in the Magothy has consistently decreased since operations began in 1963, reaching a level of -55 feet during 1979-80. The plant does not pump from the upper aquifer (Aquia) used for domestic wells in the area. There are no other users of the Magothy in the immediate vicinity of the plant (< 8 miles). Plant influence can be put in perspective by looking at the effect of these withdrawals on the potentiometric surface in the area. Figures VIII-6 and VIII-7, surveys (USGS) of the Magothy surface taken during early September 1979, and August 1980, shows a "cone of depression" near the plant. Similar cones exist near Waldorf (as shown on map), Annapolis, and Severna Park.

Comparison of the September, 1977 map in the 1978 CEIR (6) to the August, 1980 map indicates that changes have taken place. This comparison is accomplished in Figure VIII-8, a difference map of the two potentiometric surfaces. In the Northern section of the aquifer, levels have risen or remained fairly constant. However, the Chalk Point/Waldorf areas show large declines reflecting increased pumping rates and drawdown. These declines are large enough that users who can not adjust their pumps with water level ("telescopic wells") may be affected. The demand for water in the La Plata/Waldorf and Chalk Point areas is expected to increase within the next few years (7). In particular, the power plant has an additional unit scheduled for completion in 1982. To meet this demand, PEPCO has indicated that they will drill at least one more deep well into the Patapsco Aquifer (8). Since an adequate supply of water is available from this level, the power plant operation should not affect the areas water supply. Also, a PPSP-sponsored study of water use at this site may indicate cost-effective methods of reduced consumption (9).

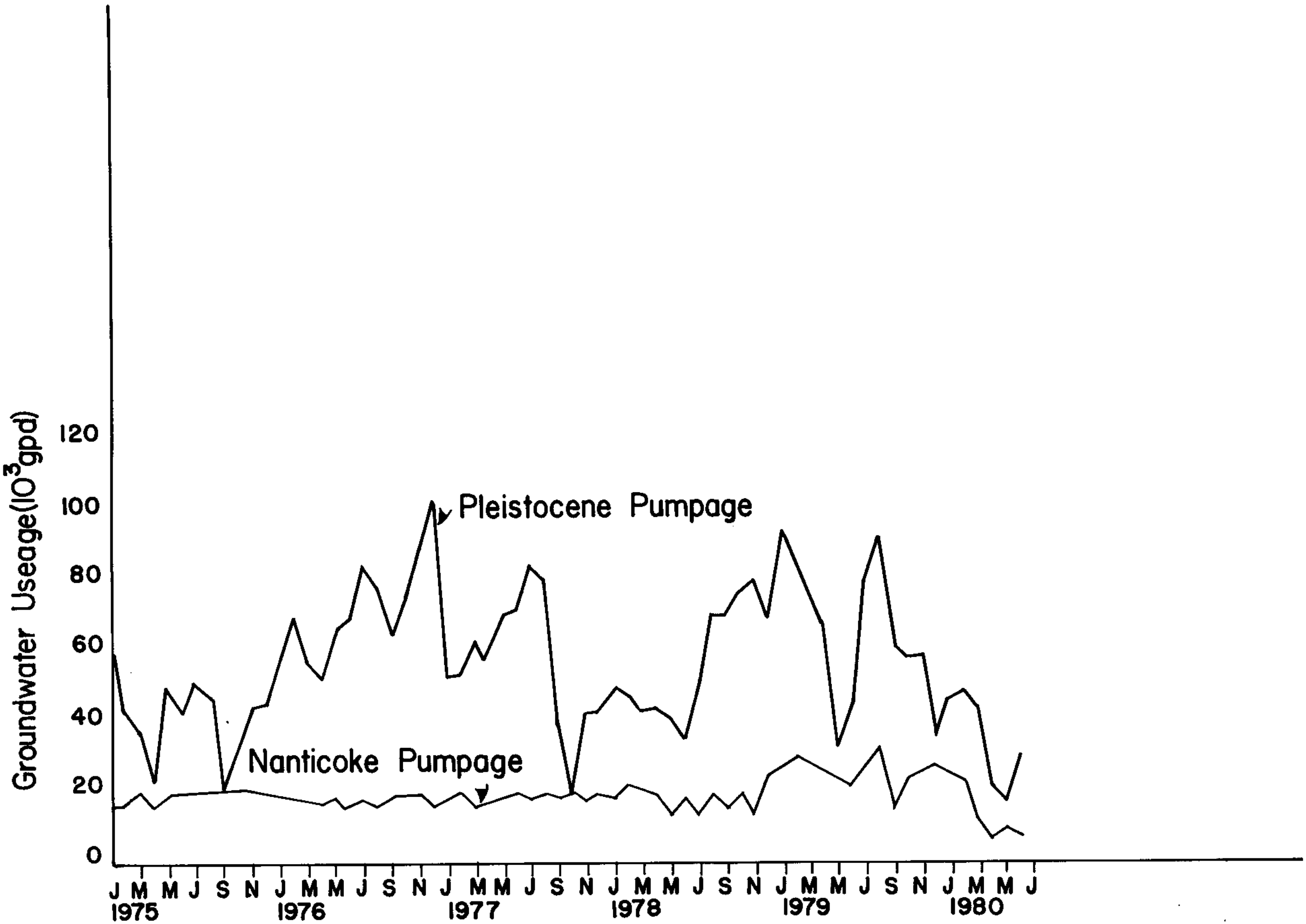

Fig. VIII-4. Pumpage from the Pleistocene and Nanticoke aquifers at the Vienna Power Plant.

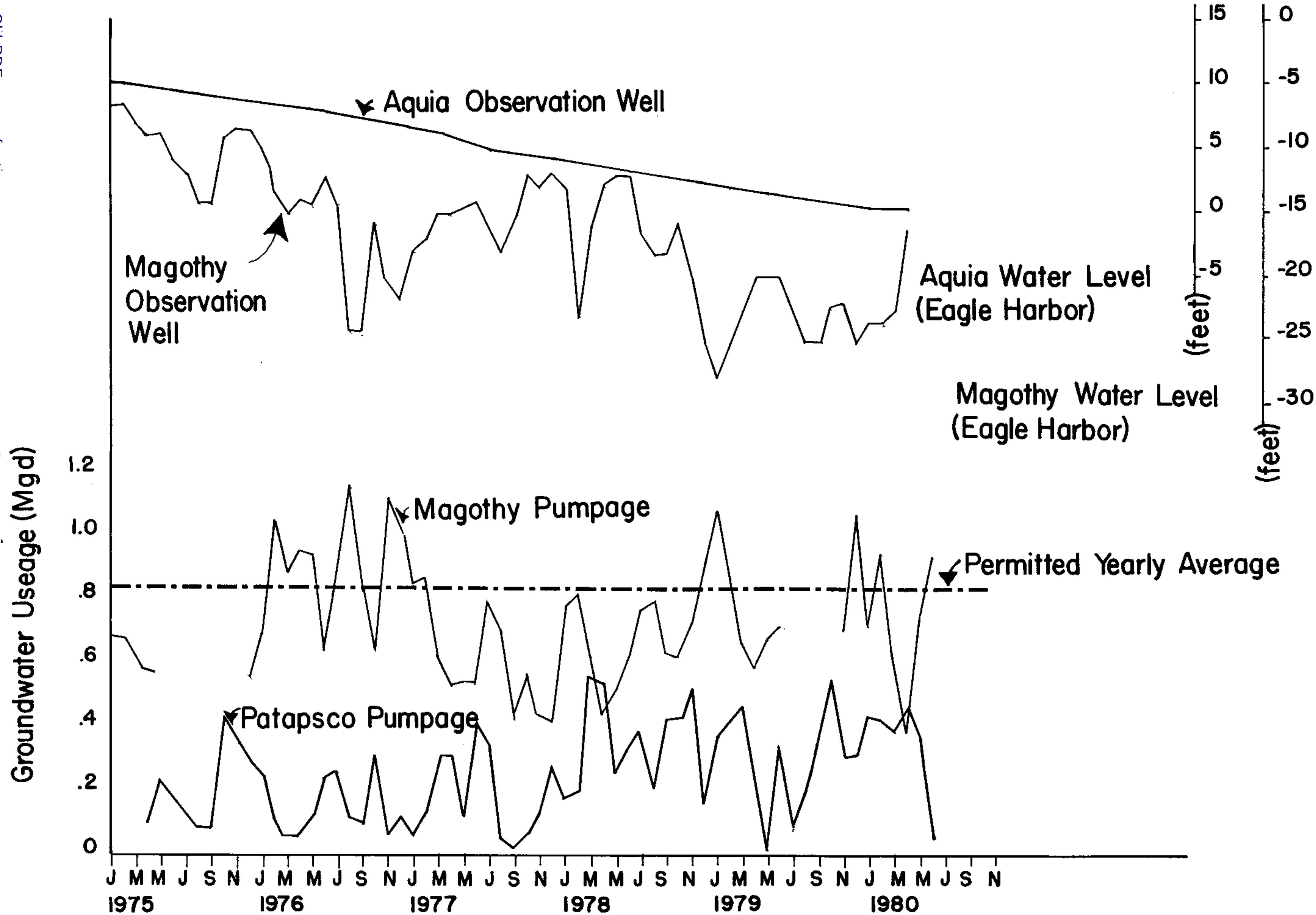

Fig. VIII-5. Pumpage from the Magothy and Patapsco aquifers at Chalk Point. Also included are water levels at test wells in Eagle Harbor, approximately 2 miles north of the plant.

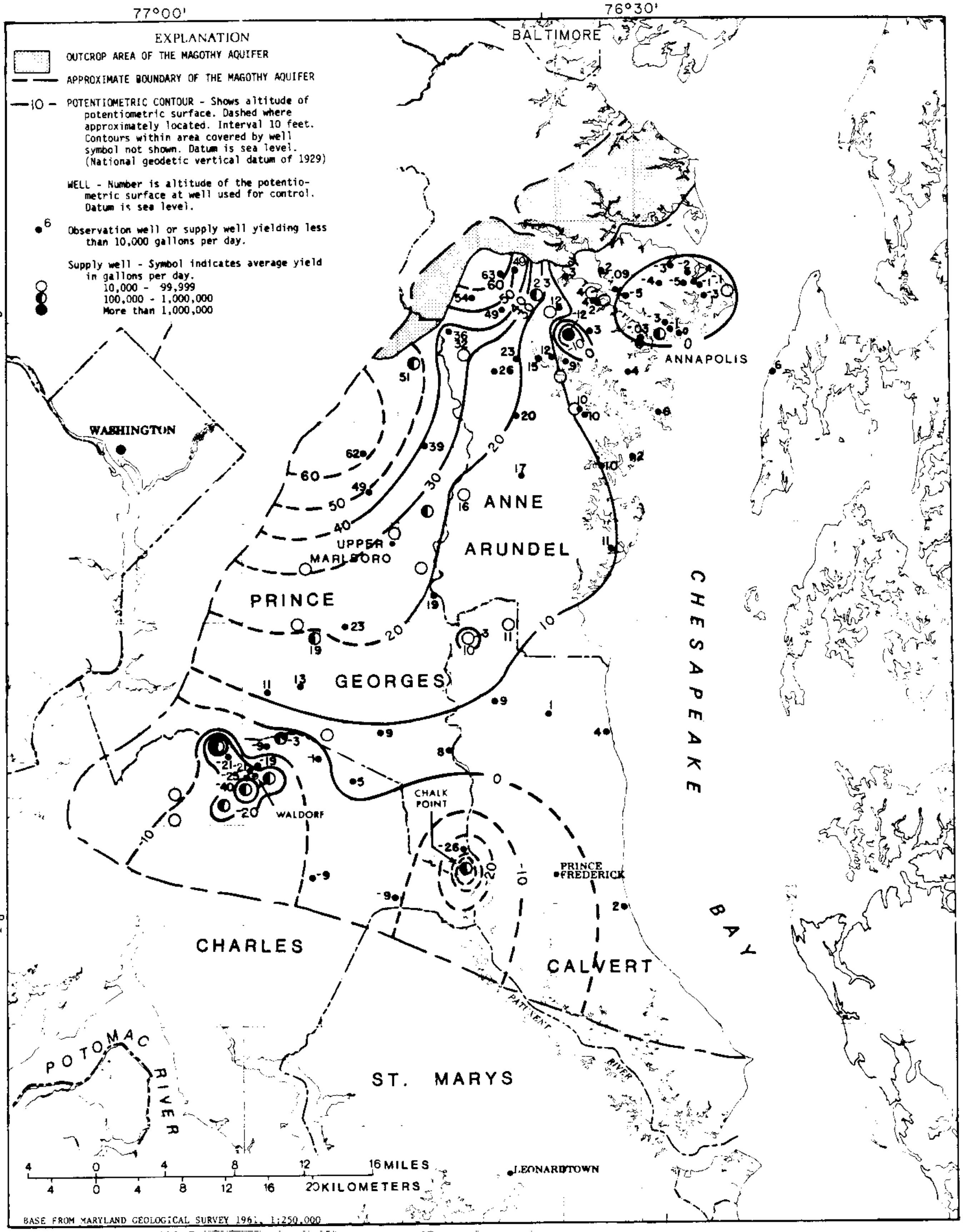

Fig. VIII-6. Map showing the potentiometric surface of the Magothy aquifer in southern Maryland. September, 1979.

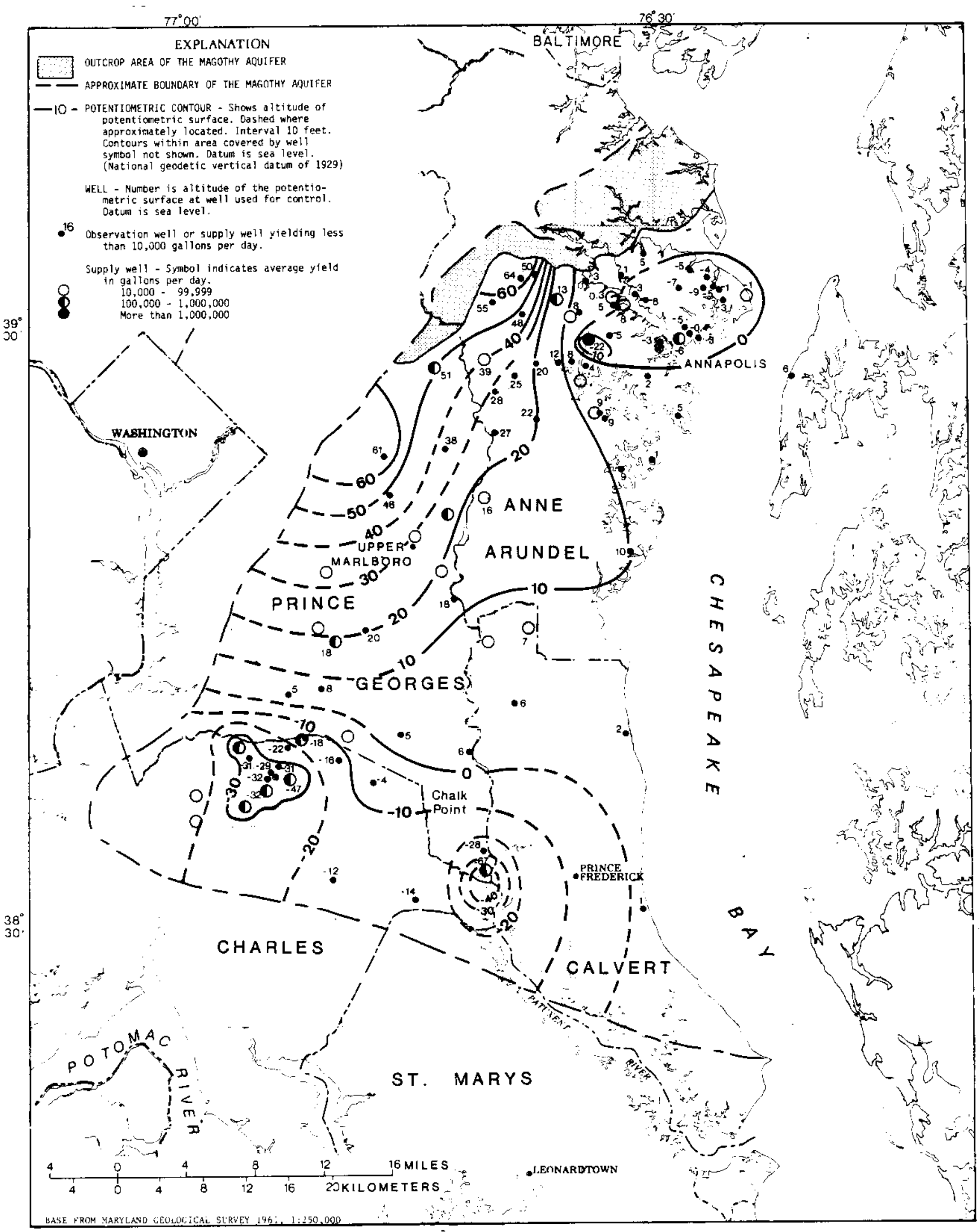

Fig. VIII-7. Map showing the potentionmetric surface of the Magothy aquifer in southern Maryland. August, 1980.

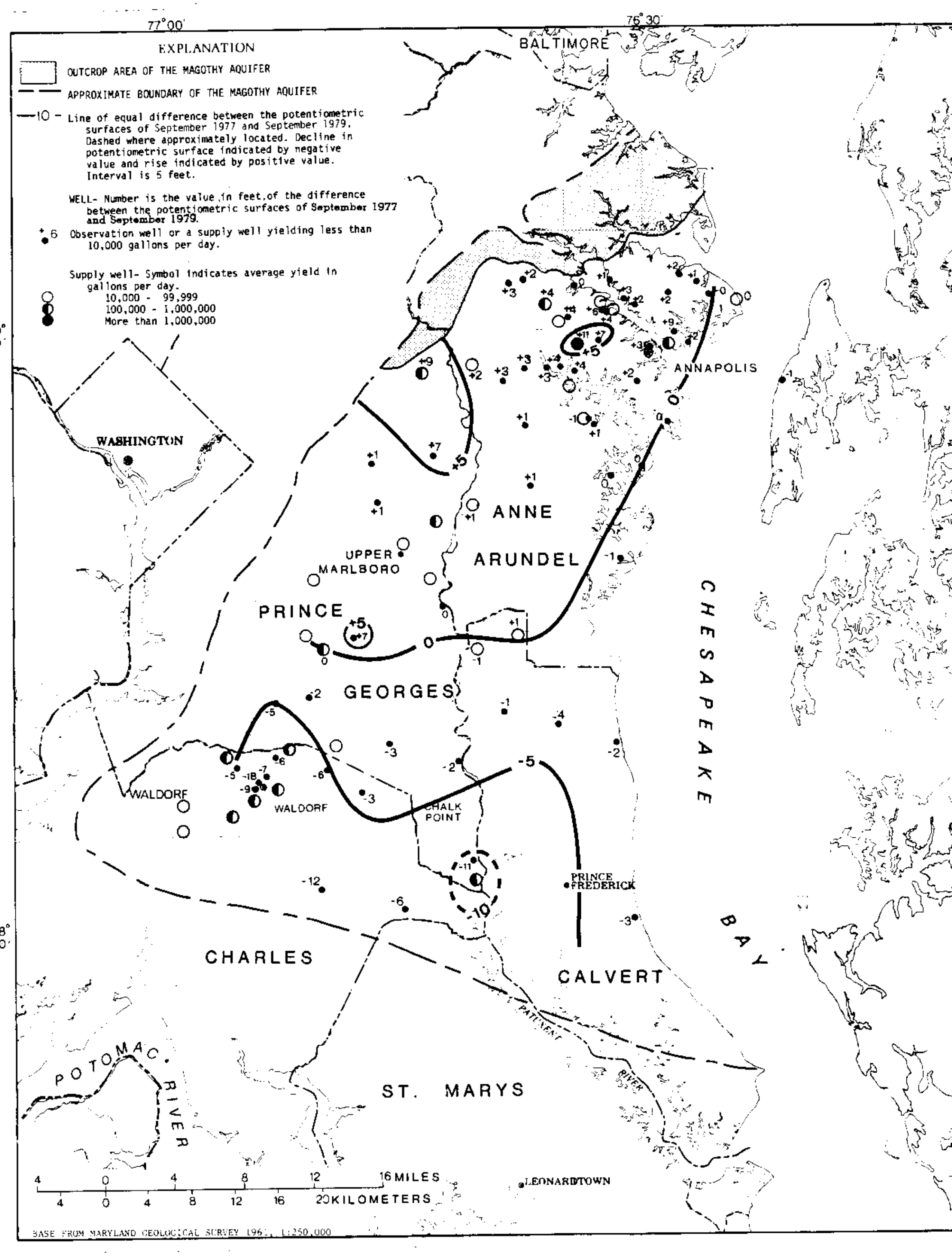

Fig. VIII-8. Map showing the difference in the potentiometric surface of the Magothy aquifer from September, 1977 to August, 1980.

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