WATER RESOURCES OF NORTHERN VIRGINIA,

PHASE I

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Prepared by the Staff of the

NORTHERN VIRGINIA REGIONAL PLANNING
AND
ECONOMIC DEVELOPMENT COMMISSION

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NORTHERN VIRGINIA REGIONAL PLANNING
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INTRODUCTION

The Northern Virginia Regional Planning and Economic Development Commission was founded in 1948 by its constituent members which now include the Counties of Arlington, Fairfax, Loudoun, and Prince William; and the Cities of Alexandria and Falls Church; and the Town of Manassas. The principal duties of the Commission are to advise and assist the local governments in planning matters of regional concern and to represent Northern Virginia in State and Metropolitan planning affairs. This report is part of a special regional planning program financed by the participating jurisdictions and by an urban planning assistance grant from the Housing and Home Finance Agency. The purposes of this program are to provide a pool of relevant information concerning the physical, economic, and social bases of the Region, and to promote an awareness of the interrelationships of the various jurisdictions.

Within several years the Regional Commission and the local governments will be called upon to help map and plan the future development of water resources in the Metropolitan Washington Area. It is important that basic information on this vital subject be made available for study and analysis. This report presents one phase of a regional water resources study for Northern Virginia. Its scope is limited to an inventory of the physical aspects of the Region, including climate, geology, soils, and ground water and surface water supplies. In addition, it presents data on public and private water systems operating within the Region. Phase II of the water resources study, to be undertaken at a later date, will be a program for the development and protection of water supplies.

This report is divided into four parts. Part I presents the physical features of the Region. Part II deals with ground water conditions as described from data supplied by the U. S. Geological Survey, the Division of Mineral Resources of the State of Virginia Department of Conservation and Economic Development, field surveys by the Loudoun County Sanitation Authority, and published documents concerning ground water. Part III presents information on the thirty-three public and private water systems of the Region. Part IV summarizes the report and presents general conclusions.

The Northern Virginia Regional Planning and Economic Development Commission acknowledges the assistance given in the preparation of this report by the above mentioned agencies, the V.P.I. Agricultural Extension Service, and the public and private water companies which provided staff assistance in the collection of data. The staff member responsible for the research and preparation of this report is Mr. Neil M. Walp, Planning Analyst.

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THE PHYSICAL SETTING

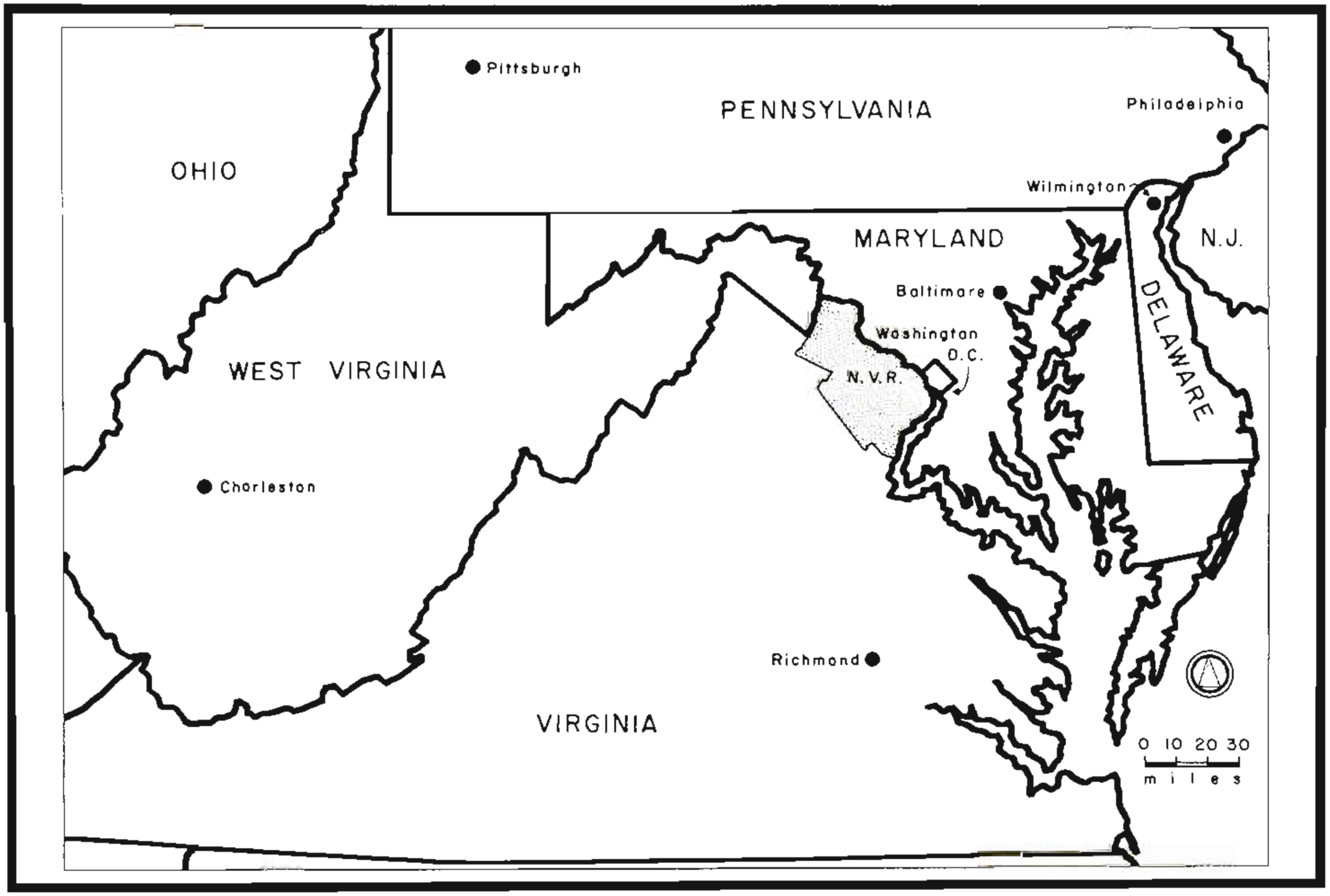
PART I

THE PHYSICAL SETTING

The Northern Virginia Region is an area of 1,304 square miles, situated in the northeast portion of Virginia adjacent to the District of Columbia, Figure 1. The Region includes six major political units and several small towns and villages. Loudoun County, with 521 square miles, accounts for about 39.9 percent of the total land area while the remaining five divisions, Fairfax County, Prince William County, Arlington County, Alexandria, and Falls Church, comprise 30.3 percent, 26.4 percent, 2.0 percent, 1.2 percent, and 0.2 percent, respectively, of the total land area. Railroads and highways connect the Region with the Shenandoah Valley, the southeast, and the great central lowland of the United States.

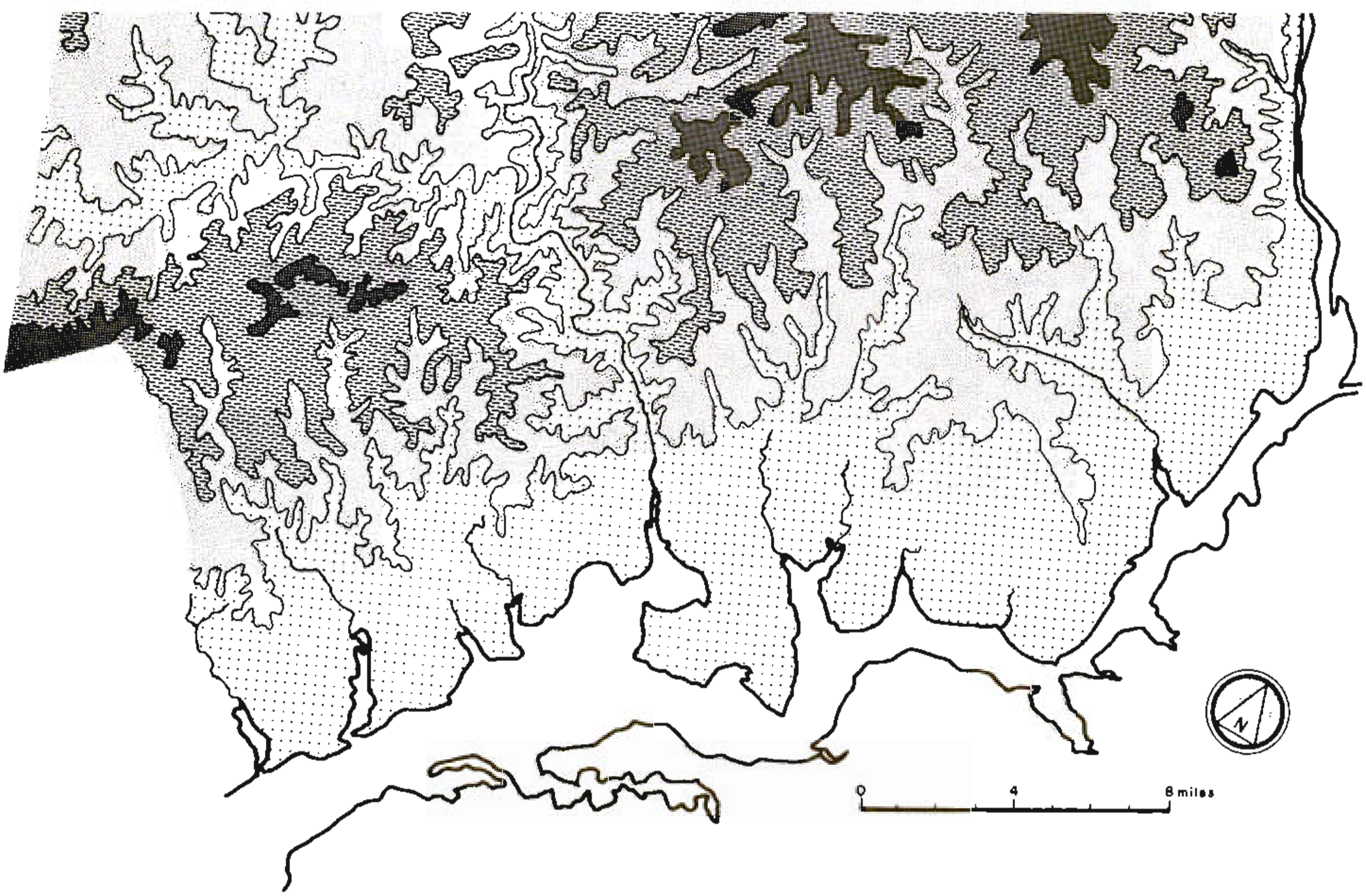
TOPOGRAPHY

It is impractical to present all the ramifications of local topography. Generally the Northern Virginia Region is dominated by elevations less than 500 feet above sea level, Figure 2. From an observation of Figure 2 it can be seen that about 85 percent of the Region has elevations less than 500 feet, with most of this land area lying between 200 and 500 feet. The lowest elevations, less than 200 feet, are confined to the eastern coastal areas in a belt about four to five miles in width to northern Arlington County. Steep slopes extend for nearly the entire length of the Potomac River.



NORTHERN VIRGINIA REGION - SITUATION MAP

Fig. 1



RELIEF MAP OF NORTHERN VIRGINIA REGION

- Less than 200'
- 200' to 300'
- 300' to 400'
- 400' to 500'
- 500' to 700'
- 700' and over

Fig. 2

Elevations gradually increase toward the northwest. Elevation increases very rapidly at the Bull Run Mountains, from about 600 feet at the base to over 1,100 feet at the summit. This ridge forms a portion of the western boundary of the Region. The Catoctin Mountain ridge is not nearly as discernible as Bull Run Mountain, but in the vicinity of Point of Rocks elevations do approach 800 feet from a base elevation of 500 feet. The southern extent of this ridge appears more as an extended mound than a noteworthy ridge.

There is an extremely rapid rise in elevation from about 600 feet to 1,400 feet at Short Hill in northeastern Loudoun County. This ridge, although narrow, extends nearly as deeply into Loudoun County from the Potomac River as Catoctin Mountain.

Forming the northwestern boundary of the Northern Virginia Region are the Blue Ridge Mountains. General land elevation increases to this point, from the east, to about 900 feet at the base of the Blue Ridge. From the base, elevation rapidly increases to over 1,500 feet in the southern portion. The northern portion of this Ridge, in comparison, barely reaches 1,000 feet in elevation from a base elevation of approximately 500 feet.

CLIMATE

Climate in general has been of much importance to the Northern Virginia Region, but probably it has been most significant in the past to the farmer rather than the urban resident. Mild temperatures and quite uniform yearly precipitation have resulted in excellent pasture land for the livestock enterprises common to the rural portions of the Region. Mild temperatures permit long periods for outdoor grazing.

In the last few years industry has become more cognizant of the role of climate in selecting sites for industry. Mild temperature, limited amounts of snow, and uniform precipitation are some of the common climatic features of interest to industrial site planners.

Precipitation is the source of all water supplies. Adequate ground water supplies depend on a uniform precipitation regime with a slight maximum during the summer months, or warm half of the year, to compensate for higher summer temperatures with their increased rate of evaporization. Concentrated precipitation results in surface runoff increases when the land surface becomes saturated, thus limiting percolation through aquifers to underground reservoirs. Adequate supplies of surface water, the dominant source of all Metropolitan Area water, are also dependent on quite uniform rainfall patterns. Extremely cold winter months cause a frozen soil condition which acts as an impervious shield. Heavy precipitation during these months can create surface water runoffs which result in flooding conditions in rivers and streams. A similar condition exists during warm months when excessive rainfall saturates the soil and induces large surface runoff and consequent flooding conditions. However, the maximum demand for surface water does not coincide necessarily with periods of peak stream flow.

Temperature - Table I shows that the Northern Virginia Region can be termed moderate in regard to temperature. The Region as a whole experiences an average annual temperature of 54.47° F. There is only about an eight degree variation between the eastern station at Alexandria Potomac Yards and the western station at Mt. Weather in Loudoun County. (For locations see Figure 3.) Much of this variation can be attributed to the factor of elevation. Temperature generally declines with altitude at a rate of approximately 3.3° F. per 1,000 feet of elevation.

Individual monthly temperatures show the same general temperature variation of eight to nine degrees. The Mt. Weather station experiences the lowest monthly average for each month while the highest average monthly temperatures are recorded at the eastern stations, generally the Episcopal High School station or the Alexandria Potomac Yards station.

Generally moderate temperatures are reflected in the regional averages by months. January is definitely the coldest month with an average temperature of 34.2° F. Mt. Weather is the sole station recording averages less than 32° F. Lincoln, Mt. Weather, and Quantico are the only stations which have recorded single day low temperatures below 0° F. Lincoln recorded a low of -25° F. prior to 1931. Quantico has reported lows of -16°F. and -20° F., while Mt. Weather has recorded a low of -10° F.

Precipitation - Precipitation within the Region during the warm season is most often the result of convectional activity, while frontal activity is more pronounced during the winter months. Occasional hurricanes do bring heavy, short-lived storms in late summer and early fall.

Thirteen stations within the Region were considered for this analysis of precipitation, as seen in Table II and Figure 3. There is a definite lack of complete data for all stations as well as a noteworthy variation in the length of individual records. The lack of general long periods of

TABLE I

AVERAGE TEMPERATURES, NORTHERN VIRGINIA REGION

STATION	MONTHLY AVERAGES (° F)												ANNUAL AVERAGE
	J	F	M	A	M	J	J	A	S	O	N	D	
Episcopal High School	39.1	39.4	46.3	56.9	65.8	73.5	78.3	76.1	69.7	60.4	47.8	37.4	57.3
Alexandria Potomac Yards	39.1	40.6	46.8	56.9	66.1	75.2	79.1	76.5	73.1	60.4	48.7	39.8	58.6
Falls Church	35.5	36.3	43.5	55.0	64.7	72.3	77.0	74.3	67.5	57.5	46.1	36.2	55.6
Quantico	35.5	35.9	45.1	54.7	64.5	72.8	77.2	74.8	68.8	57.7	46.1	36.8	55.8
Lincoln	34.0	34.9	44.1	54.0	64.5	77.5	76.6	74.9	67.6	57.1	44.4	37.6	55.2
Mt. Weather	30.1	30.9	39.2	49.1	59.7	67.5	71.8	70.0	63.8	52.8	42.3	32.8	50.8
Waterford	32.9	37.6	42.4	53.6	60.9	69.0	72.9	70.6	64.3	55.8	43.3	32.9	52.6
Waverly Hills	32.9	37.5	48.9	52.3	64.7	72.6	77.5	75.2	69.0	59.1	47.9	38.1	56.7
REGIONAL AVERAGE	34.2	35.1	43.5	55.8	63.4	72.7	78.2	73.6	67.3	56.5	44.7	36.1	54.5

Data Source: U. S. Department of Commerce recording is somewhat compensated by the fact that there is one station having at least a 19-year record in Arlington, Loudoun, and Prince William Counties. These stations provide good check points for stations having shorter lengths of record.

As can be seen in Table II, there is no consistency in mean annual precipitation. The means vary within a range of several inches from one station to another and there is also a slight, but definite, variation between littoral and more inland stations. From Alexandria to the Waverly Hills station there is a range in mean annual precipitation from 43.06 inches at Alexandria to a high of 46.15 inches at Waverly Hills. The Quantico station has consistently lower averages than any other station. In contrast to the eastern littoral locations, the western stations, from Fairfax and Manassas to Mount Weather and Lincoln, record means between a low of 40.81 inches at Mount Weather to a high of only 44.09 inches at Waterford.

Based on mean annual precipitation recorded by the thirteen stations, there can be an expected mean annual precipitation for the Region of 43.37 inches. The range is generally higher in the more eastern littoral locations, and slightly less in the more westerly locations.

Average minimum annual precipitation is 33.86 inches based on the statistics from the thirteen stations. The eastern segment of the Region exhibits more consistency in the total minimums. Excluding Quantico, the recording station at Clarendon Lyon Park has recorded the lowest annual precipitation, 33.96 inches. In contrast, the largest minimum annual precipitation has been recorded at the Alexandria Potomac Yards,

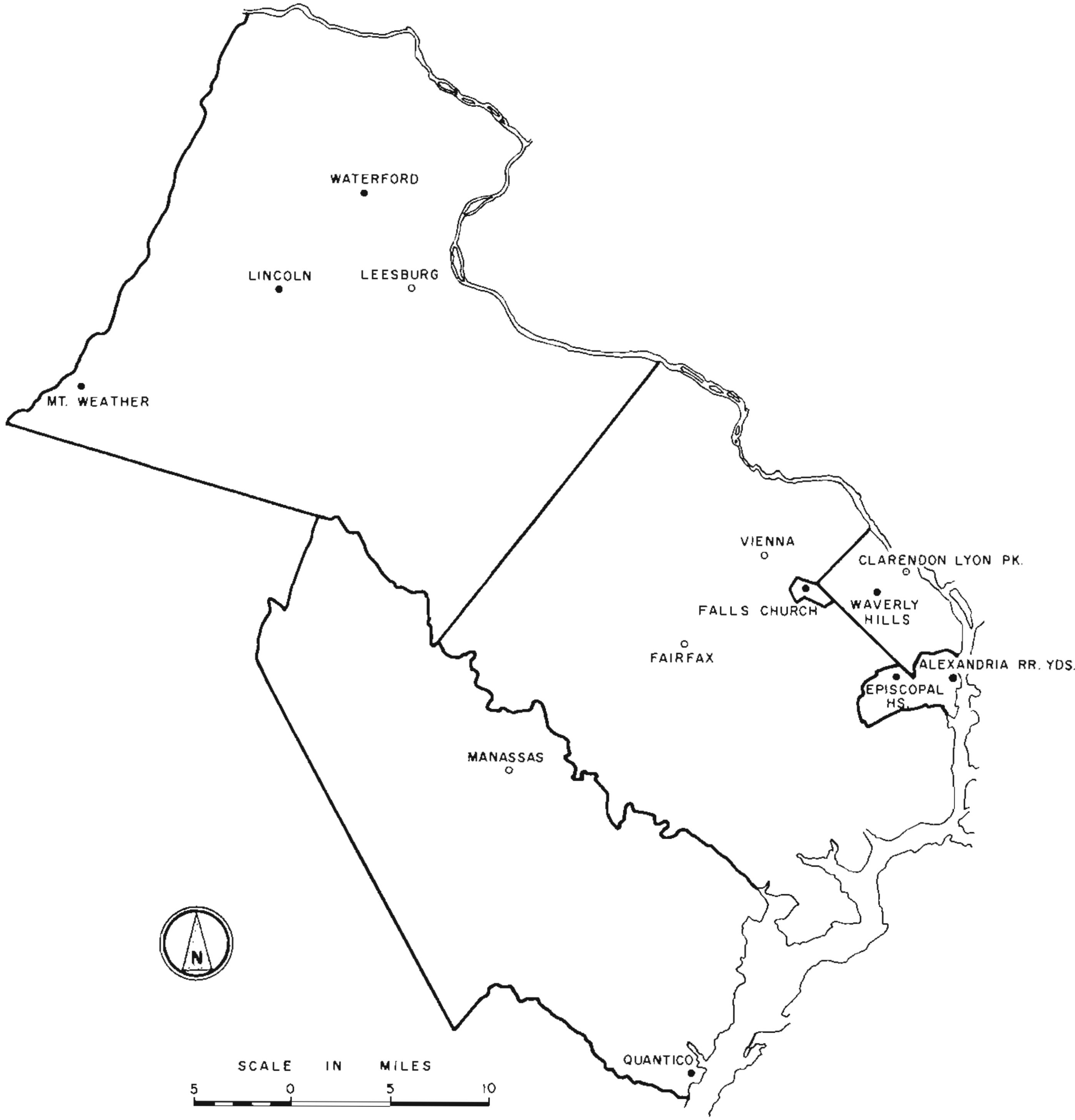
TABLE II

PRECIPITATION DATA FOR REGIONAL STATIONS
(1931 through 1952)

STATION	ELEVATION (feet)	LENGTH OF RECORD (years)	MEAN ANNUAL PRECIPITATION (inches)	MINIMUM ANNUAL PRECIPITATION (inches)	MAXIMUM ANNUAL PRECIPITATION (inches)
Quantico	12	22	39.21	24.77	52.56
Alexandria Potomac Yards	20	8*	43.06	37.79	57.28
Episcopal High School	250	8*	45.40	37.36	58.33
Waverly Hills	340	8*	46.15	34.77	55.69
Clarendon Lyon Park	225	22*	44.45	33.96	55.37
Falls Church	315	8*	44.15	34.90	57.19
Vienna-Dunn Loring	370	11*	45.77	35.92	57.36
Fairfax	440	7*	42.66	39.15	51.12
Manassas	156	19*	41.81	32.19	54.99
Leesburg	321	7*	43.23	31.75	51.40
Waterford	525	9*	44.09	39.04	52.91
Lincoln	500	22*	42.96	31.01	57.61
Mount Weather	1,725	22*	40.81	27.55	59.66
REGIONAL MEANS	-	-	43.37	33.86	55.50

* Incomplete Records

Data Source: U. S. Department of Commerce



REGIONAL WEATHER STATIONS

• TEMPERATURE AND PRECIPITATION DATA AVAILABLE

o TEMPERATURE DATA AVAILABLE

Fig. 3

37.79 inches. The western portion of the Region exhibits the most noteworthy extremes of minimum annual precipitation. Mount Weather has recorded the lowest annual precipitation of 27.55 inches while Fairfax has recorded a high minimum total of 39.15 inches. Waterford has recorded a high of 39.04 inches. It would not be acceptable to consider these two figures as representative of the actual minimum that would occur if data had been collected over a longer period. No other minimums approach these two for any station in the Region. While there are qualifying factors of the data, the mean Regional minimum precipitation for the thirteen stations is 33.86 inches. An average of four long-record stations (Clarendon Lyon Park, Manassas, Lincoln, and Mount Weather) gives a mean minimum of 31.18 inches.

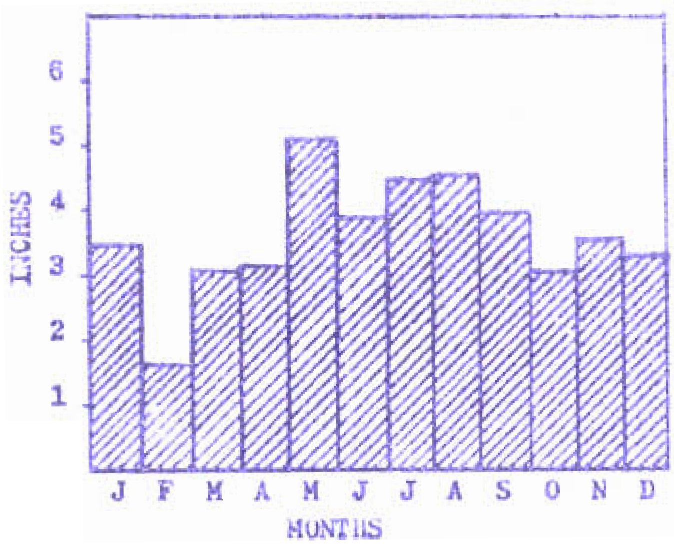
The eastern portion of the Region can also expect to receive the highest maximum annual amounts of precipitation. Again excluding the Quantico station, the Episcopal High School station has recorded the greatest maximum annual precipitation east of Vienna-Dunn Loring, 58.33 inches. The lowest maximum amount was recorded at Clarendon Lyon Park, 55.37 inches. The western segment of the Region, in contrast to the eastern portion, generally has a lower maximum of 51.12 inches while Mount Weather has recorded a maximum of 59.66 inches, a reflection of the initiation of a slight orographic precipitation effect. The mean maximum for the thirteen stations is 55.50 inches with the eastern segment experiencing above average precipitation and the western segment experiencing below average precipitation.

The mean annual precipitation for the Washington National Airport is recorded as 40.57 inches in comparison with the 43.37-inch mean Regional annual precipitation. Not only is the Airport average below the Regional average, it is also below the average for any station within the Region except Quantico.

Seasonality of Precipitation - Precipitation throughout the Region has no outstanding seasonality, but there is a noticeable maximum occurring during the summer half of the year, April through September. Figure 4 shows graphically the general precipitation regime for the Northern Virginia Region. Data for each station indicates that at least 54.8 percent of the yearly mean precipitation falls within this six-month interval. Variations in amount range as high as about 61 percent for the Waterford recording station. There is no detectable variation in seasonality between eastern and western segments of the county.

FIGURE 4

MEAN MONTHLY REGIONAL PRECIPITATION
(for 13 stations)



It should be noted from Figure 4 that May generally has the highest mean monthly precipitation for the Region. Eight of the thirteen stations have maximum precipitation occurring during May. A secondary period of maximum precipitation occurs during August at which time four stations record highest monthly mean precipitation. May, June, July, and August have 3, 1, 5, and 4 stations, respectively, which record the second highest mean monthly precipitation.

VEGETATION

Little, if any, of the virgin vegetation indigenous to the Northern Virginia Region remains. The cropping of land, plus the transformation of agricultural and forest lands to residential and associated uses has destroyed most of the original vegetative cover.

Other than agricultural land there is little additional vegetative cover except forested areas. From field checks and observations of aerial photographs, there appear to be limited intermediate types of vegetation between pastures and forests, such as scrub land and open, unused fields. Also, most of the forested areas are comprised of second, third, and probably other stage growth. Most of the upland forest stands have been cut over or burnt over several times since original settlement of the Region.

Forest Resources - Forest resources are of economic importance in the Region. Figure 5 presents in generalized form the distribution of significant stands of timber. Also shown are the characteristic types of timber as indicated in the Virginia forest survey of 1957. 1/

1/ Robert W. Larson and Mackay B. Bryan, Virginia's Timber, Forest Survey Release No. 54 (Asheville, N. C.: U. S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station, June, 1959) p. 73.

The 1957 survey of Virginia timber resources discloses that forested areas still dominate the land areas of Prince William and Fairfax Counties (see Table III), which have about 61.0 and 57.6 percent, respectively, of their total land area in timber.2/ Loudoun County has the smallest percentage of its land area in timber stands, 29.5 percent. The Region as a whole has approximately 47.0 percent of its total land area in forest resources.

Also to be observed from Table III is the fact that most timber resources are classified as commercial rather than non-commercial.3/ Over 94 percent of the Regional forest tracts are of commercial value, but there is a noteworthy variation among counties. Loudoun County is dominated by commercial stands, over 99 percent of the forest area is of commercial importance; but Prince William County has a significant percentage of non-commercial forests, over 13 percent. Fairfax, like Loudoun County, is dominated by commercial stand.,

Regarding ownership of the predominant commercial forest areas, it is again evident from Table III that most valuable timber lands are in

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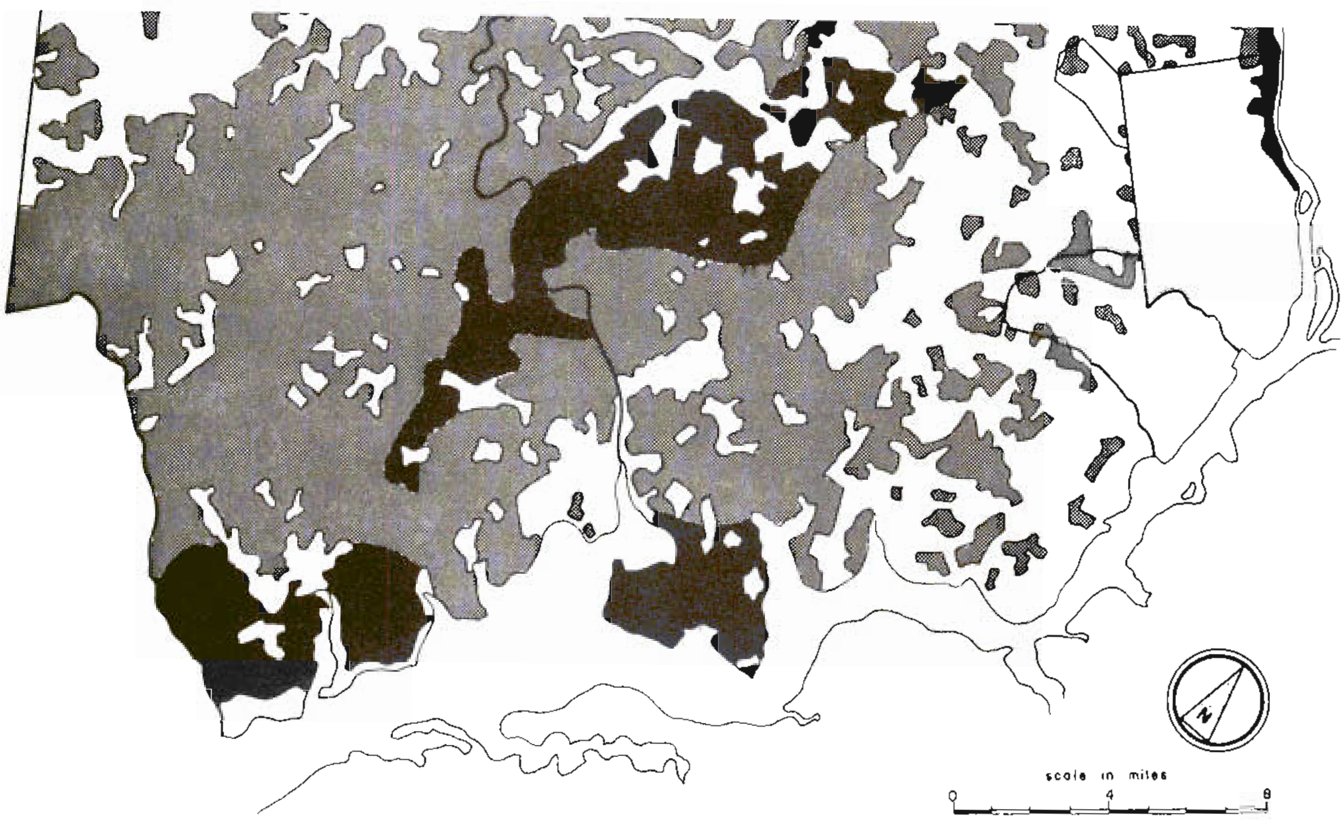
2/ According to the 1957 forest survey, individual county timber statistics can be subject to error because of the sampling method employed. County forest area statistics can contain an error of up to 6.6 percent.

3/ According to the 1957 forest survey report, commercial and non-commercial timber lands are classified as: Commercial - Forest land which is producing, or physically capable of producing, useable crops of wood economically available now or in the future, and not withdrawn from timber use; Non-Commercial - Forest land withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualifies as commercial forest land; or incapable of yielding useable wood products because of adverse site conditions; or so physically inaccessible as to be unavailable economically in the foreseeable future.



REGIONAL FOREST DISTRIBUTION

MAJOR FOREST TYPES

VIRGINIA PINE

HARDWOOD - PINE

OAK - HICKORY - SCRUB OAK

Fig. 5

private ownership; in fact, nearly 93 percent of all commercial forest acreage is privately owned. Virtually all of Loudoun County forests are in private ownership; this is also the case with Fairfax County which has only 4.3 percent public ownership. Prince William County has the largest percentage of publically owned forest land. This is the result of governmental ownerships at the Quantico Military Installation and Prince William County Forest Park.

TABLE III

NORTHERN VIRGINIA TIMBER RESOURCES, 1957

COUNTY a/	FOREST LAND			OWNERSHIP OF COMMERCIAL FORESTS	
	Non-Commercial (acres)	Commercial (acres)	Percent of Total Land	Private (%)	Public (%)
Loudoun	200	98,200	29.5	100.0	0.0
Prince William	17,800	118,000	61.0	83.4	16.6
Fairfax	1,100	144,200	57.6	95.7	4.3
TOTALS	19,100	360,400	47.0	92.8	7.2

Data Source: Robert W. Larson and Mackay B. Bryan, Virginia's Timber, Forest Survey Release No. 54, pp. 50-53.

a/ Arlington County and independent cities were excluded in survey.

Timber Types - The Northern Virginia forests can be categorized as predominantly hardwoods rather than softwoods. Estimates of the volume of hardwoods and softwoods, Table IV, present in this Region, indicate that the softwood volume of growing stock in Loudoun, Prince William, and Fairfax Counties comprises only eight percent, 31 percent, and 31 percent, respectively, of the total growing stock volume.

TABLE IV

NORTHERN VIRGINIA TIMBER TYPES AND VOLUME, 1957

COUNTY a/	GROWING STOCK NET VOLUME		
	Softwoods (thousands of cords)	Hardwoods (thousands of cords)	Total (Thousands of cords)
Loudoun	107	1,253	1,360
Prince William	572	1,259	1,831
Fairfax	648	1,438	2,086
TOTALS	1,327	3,950	5,277

Data Source: Robert W. Larson and Mackay B. Bryan, op. cit., pp. 58-59.

a/ Arlington County and independent cities were excluded in survey.

Of the softwood species present, the broad species group of yellow pines predominate. Within this group it is the Virginia pine which is outstanding rather than the loblolly, pond, shortleaf, white pine, or hemlock, and a great variety of other softwoods. Figure 5 indicates the general extent of Virginia pines which dominate the timber stands in eastern Loudoun County, most of Prince William County, and a large portion of Fairfax County.

The hardwood type forests are dominated by hard hardwoods in contrast to soft hardwoods. Figure 5 indicates that oak, hickory, and scrub oak timber types are most significant among the hard hardwoods. Western Loudoun County is dominated by the hard hardwoods while they occur in less continuous concentrations in Fairfax and Prince William Counties. It should also be observed from Figure 5 that there are only two significant areas within the Region where mixed hardwoods and pines occur.

MINERAL RESOURCES

Mineral resources are a minor asset of the Northern Virginia Region. There are no deposits of liquid or fossil fuels within the Region or in close proximity. The nearest area of coal production in Virginia is the extreme southwestern county portion comprising the counties of Buchanan, Dickinson, Lee, Russell, and adjacent counties. Petroleum and natural gas are produced in essentially the same southwestern counties as coal. Also, there are no commercial deposits of metallic minerals within the Region.

The only minerals of any significance which are and have been produced in any quantity within the Region are sand and gravel, stone, and clays. Extensive gravel deposits exist in Fairfax County near the Fall Line and the coastal plain portions of eastern Fairfax. The area east of Springfield is mined for sand and gravel. Crushed stone, primarily basalt, is mined and produced near Bull Run in western Fairfax County. Granite is mined north of the Town of Occoquan in Fairfax County. Most crushed stone is utilized for concrete aggregate and road stone. Limestone and basalt are mined in Loudoun County.

The only large clay mining operation within the Region is at Woodbridge, Prince William County, where miscellaneous clay deposits are mined at an open pit. Bricks and other heavy clay products are manufactured near the mining operations.4/

SOIL

During the last ten years, the Northern Virginia Region has been covered by intensive surveys of its soil conditions. The first such soil survey was completed in 1950 for Loudoun County, and in 1956 the Fairfax County soil survey was completed. Prince William County soils are presently being surveyed. About one-third of the County has been completed. The survey probably will not be finished for at least two to three years.

The detailed information recorded in these surveys is outstanding. Within Fairfax County 105 soil types were mapped and analyzed. Loudoun County has about 120 soil types.

While soil surveys were originally undertaken primarily for agricultural purposes, soil survey agencies have realized the importance of soil data for regional and city planning. They are now engaging in efforts to collect information to help highway engineers, planners, and construction personnel, to mention a few users of soil data.

4/ The above information was extracted in part from: Robert W. Metcalf, James L. Calver, and Mary E. Otte, The Mineral Industry of Virginia, Bureau of Mines, United States Department of the Interior (Washington: Government Printing Office, 1957) pp. 5-20.

Soil data applies to all phases of planning. One application is directly related to land use plans. Home site, zoning, highway construction, airport, and floodplain control planning can utilize soil surveys. Sewer and water line construction is facilitated by having a knowledge of soil conditions.

Within the Northern Virginia Region there have been recorded such data (in addition to individual soil types) as slope of land, erosion conditions, soil suitability for crops and capabilities for cultivation, texture and structure of subsoil, suitability for airports, highways, large buildings, pond building materials, and top dressing materials as well as engineering test data, and percolation ratings.

It is beyond the scope of this inventory to present a detailed study of Northern Virginia soils. Reference is made to the local soil survey offices for detailed information and reports. The following inventory will present broad generalities of soil conditions based on the three physiographic divisions found within the Region.

The smallest physiographic division within the Region is the Blue Ridge Province which includes the Blue Ridge Mountains, Short Hill, Catoctin and Bull Run Mountains. Here, soils tend to be generally shallow, especially on the slopes, and rocky or gravelly. Soils generally are classified as stony, stony silt loams, and stony loams. Soils on more level areas have a deeper, more well developed profile because of reduced erosion. Soils generally tend to be brown in color on the surface because of less leaching of organic constituents. Because of the general rocky character of these soils they are better suited to pasture or forest uses (their predominant use) rather than to cultivation. There are local occurrences of fertile soil, especially at lower elevations where eroded soils have accumulated, which would support crops if cultivation were not difficult.

The largest physiographic division of the Region is the Piedmont Province (more detailed discussion is included in the section on Geology). There are two major subdivisions within this broad Province, one underlain by crystalline rocks, the second underlain by Triassic sediments (see section on Geology). Deep soils generally have developed their own characteristics based on vegetative cover, temperature, and precipitation, while the more shallow soils have characteristics which reflect the underlying geologic structures.

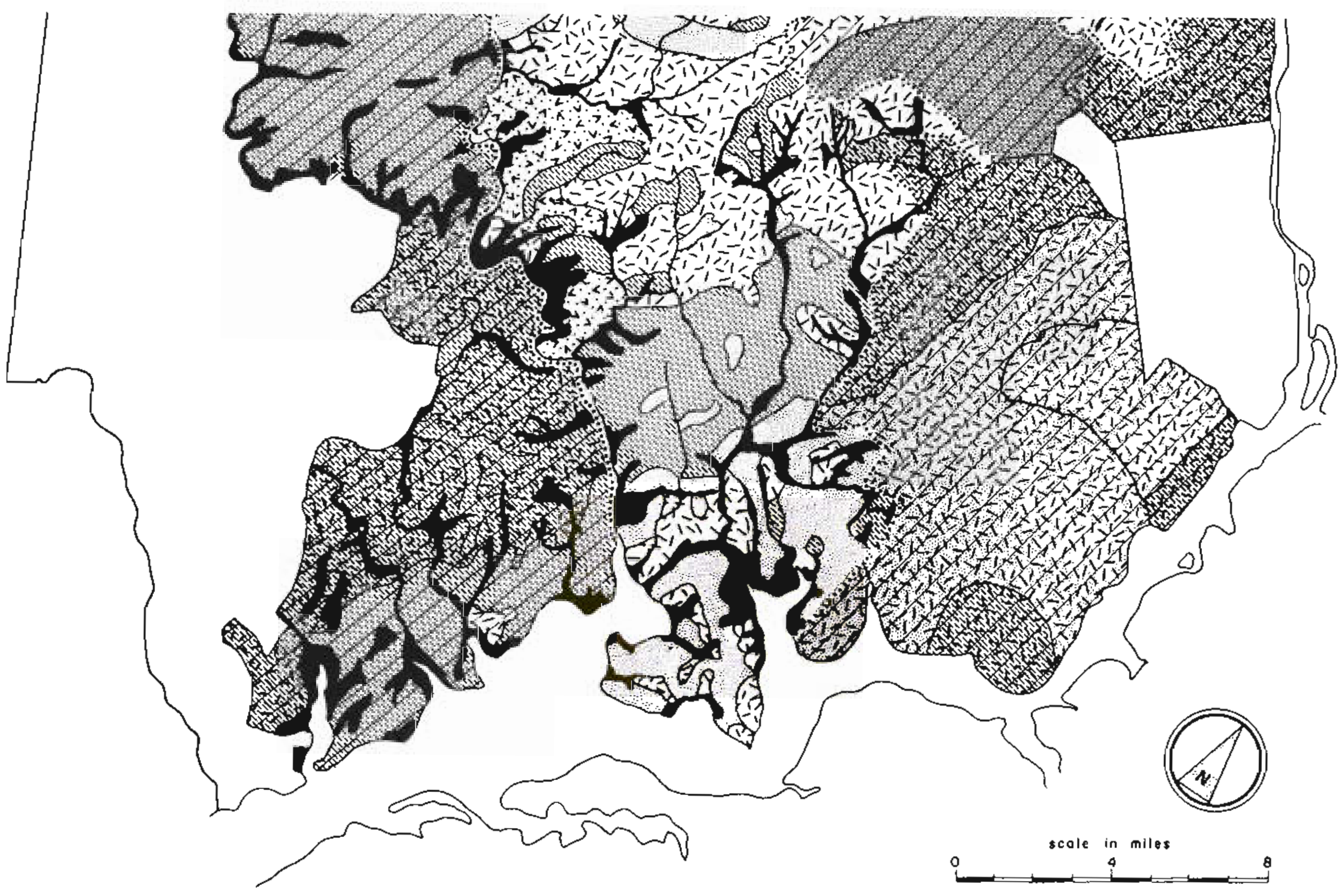
There is great diversity of soils due to the variation in geology. For the Province as a whole, the soils can be classified as loams, silt loams, and sandy loams. They are generally quite fertile and good for both pasture and crops in crystalline rock areas, but are generally best suited for pasture rather than crops in the Triassic areas. As would be expected for an area the size of the Piedmont Province, there is a great variation of soil depths. The harder, more resistant rocks of diabase, and some greenstones, have developed shallow profiles; while the schists and granites have often developed deep profiles, although this area has many exceptions.

Soils are generally brown to dark brown in the crystalline areas and tend to be more yellow-brown to reddish-brown and gray in the Triassic areas. Natural drainage is highly variable depending on slope, depth of soil profile, and nature of the parent material.

Soils of the Coastal Plain Province have not been studied in as much detail as those of the Piedmont. They are generally sandy, or are clays. They are often deep in profile, but clay hardpans are frequent and restrict internal water drainage (especially at the contact with the Piedmont Province). These soils derived from marine deposits, are probably best suited to pasture or forest, although much of this area is presently developed.

Soil Percolation - Because of the nature of the reports of this Commission and topical considerations, soil percolation ratings were the major physical soil element mapped and utilized in the Commission's report on Land Use and Usefulness. A generalized map of percolation ratings is presented on Page 23. For regional planning purposes, floodplains and land areas in excess of 15 percent slope have been considered marginal in nature and have been eliminated for future development, except as possible open spaces, parks, and recreation lands. The marginal land areas are shown in solid black on the percolation map. Also shown are areas having good, fair, and poor percolation ratings. "Mixed" percolation ratings are shown also. Because of the complexity of these areas, it was not attempted to present details. Areas in eastern Fairfax County and Prince William County were generalized from written reports of percolation ratings and extremely generalized percolation analyses based on field observations. Neither eastern Fairfax County nor eastern Prince William County have had soil surveys.

Whereas the traditional soil survey was undertaken primarily for agricultural purposes, the rapid growth of Northern Virginia required that more information than that pertaining to agriculture was needed. The



REGIONAL GENERALIZED SOIL PERCOLATION MAP

SURVEYED RATINGS

- GOOD
- FAIR
- POOR
- MIXED
- MARGINAL LAND
- INFORMATION NOT AVAILABLE

RECONNAISSANCE RATINGS

- GOOD
- FAIR
- GOOD - POOR
- GOOD - FAIR
- FAIR - POOR

Fig. 6

resultant soil percolation ratings, which are the rates at which water percolates through a given soil (measured in inches per hour), have proven of inestimable value in determining the proper use of land, and especially the most satisfactory size of a building lot without public sewer. For example, percolation ratings determine if a building site should be at least five acres in area due to extremely poor percolation ratings which require an extensive septic field, or whether a site can be as small as 15,000 square feet because percolation ratings are extremely good and only a small septic field is necessary to dispose of effluent. The percolation ratings are influenced by the character of each soil type, the presence of a subsurface hardpan or other impermeable layer, or possibly a generally high water table.

The generalized percolation ratings map indicates that in addition to areas defined as marginal, there are extensive areas in Loudoun County west of the Catoctin Mountains where ratings are for the most part good. Ratings generally become poorer in progressing east from the Catoctin Mountains into western Fairfax County. Much of this area is influenced by a hardpan or impermeable substrata. Ratings generally could increase if these layers are shattered or septic fields penetrated through the layers. There also is a substantial area shown as "mixed." This area includes soils having good, fair, and poor percolation ratings, plus considerable amounts of marginal land. Attempts were not made to generalize these conditions.

Central Fairfax County has large areas of good percolating soils, while ratings become fair to poor toward the southeast. Percolation ratings for the remaining portions of the Northern Virginia Region have been shown in accordance with reconnaissance surveys and general knowledge of percolation ratings of major soil groups known to occur within these areas. Much of Prince William County has not been surveyed at the time of this writing or existing data is not complete enough to be utilized. Such areas have been indicated. Portions of the area west of Manassas have been mapped and the generalized percolation ratings indicated.

The Commission's report on Land Use and Usefulness in the Northern Virginia Region covered an area of 772.23 square miles, roughly defined as an area within a radius of 30 to 35 miles from the District of Columbia. Within this area there are 606.08 square miles of vacant land, of which 8 percent has sewers, 21 percent has good percolation, 17 percent has fair percolation, 31 percent has poor percolation, and 23 percent is marginal because of floodplains or excessive slopes.

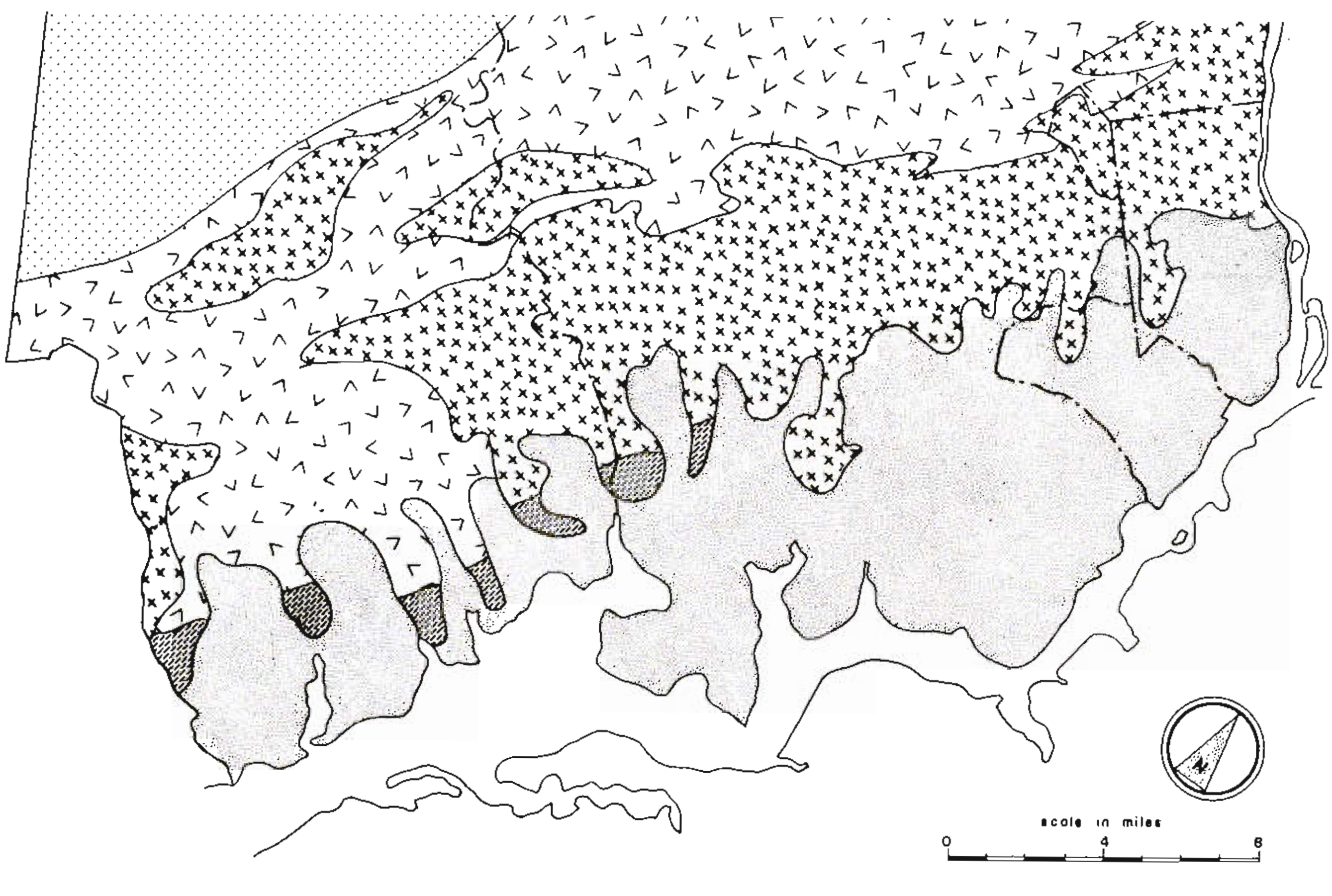
GEOLOGY

The Northern Virginia Region falls within three broad physiographic provinces: (1) the Blue Ridge, (2) the Piedmont, and (3) the Atlantic Coastal Plain. Each of these has experienced a long, complex period of evolution, and the geology of each is inherently complex and still not completely known. Each has been formed under varying physical conditions of great heat, pressure, crustal disturbance, and deposition of eroded sediments as well as water-lain sediments. The Blue Ridge Province, which includes the Blue Ridge and Short Hill, Catoctin and Bull Run Mountains, and the Piedmont Province have similar underlying geology; while the Coastal Plain exhibits its own individuality.

The geology of the Region also has a great age differential from east to west. The Northern Virginia Region can roughly be classified into three age groups: (1) recent, those formations formed in recent geologic history; (2) moderately recent, those formations created between the earliest geologic records containing animal and plant life and recent geologic formations; and (3) ancient, those formations created generally before animal and plant life, or at least visible evidence of plant and animal life.

The most recent geologic formations are those in the Atlantic Coastal Plain Province. These formations occur, as shown in Figure 7, as alluvium, terrace deposits, and deposits of the Potomac Group. This geologic formation, which occurs in a three to four mile wide north-south belt paralleling the Potomac River, has developed from both marine and non-marine deposition. This is generally a belt of unconsolidated sediments comprised chiefly of clays, sandy clays, silts, and sands. Elevations are generally low and streams are often slow moving and sluggish. These sediments abut against the Piedmont Province immediately to the west and generally become deeper progressing from west to east.

Immediately to the west is the Piedmont Province which is comprised of geologic formations of both ancient and moderately recent age. The oldest formations are shown in Figure 7 as Wissahickon schist and granite in the eastern belt. These two formations are of similar age as the Catoctin greenstone and Marshall granite formations west of Leesburg, their western counterpart. These dense, crystalline formations are extremely complex and consist of rocks like granite, diabase, greenstone, gneiss, schists, and quartzites. These ancient formations are bisected by a belt



GEOLOGIC MAP OF NORTHERN VIRGINIA REGION

ALLUVIUM, TERRACE DEPOSITS AND POTOMAC GROUP	QUANTICO SLATE
ANTIETAM SANDSTONE TO LOUDOUN FORMATION	GRANITE OF THE EASTERN BELT
NEWARK FORMATION	CATOCTIN GREENSTONE
WISSAHICKON SCHIST	DIABASE
MARSHALL GRANITE	

ADAPTED FROM: R. C. CADY, GROUND-WATER RESOURCES OF NORTHERN VIRGINIA

Fig. 7

of moderately recent formations of Triassic age. This belt is indicated as the Newark formation. The Newark formation is intersected by bands of Triassic diabase which were intruded as a result of volcanic activity. The Newark formations were deposited during a geologic interlude during which time this area was inundated by a sea. The rock structure here is generally comprised of sandstones, shales and conglomerates, which occur most significantly in the area to the north and northeast of Leesburg. These moderately recent formations have been faulted along their western margin and the entire formation generally dips westward to this fault. Streams of the Piedmont are generally broader, more rapid, and have cut into the rock structure.

Only a small portion of the Blue Ridge Province exists in the Northern Virginia Region, but that which does occur is generally of ancient age and is comprised primarily of greenstone rock formations. The Antietam sandstone and Loudoun formations were developed generally during the earliest periods of recorded plant and animal life.

A look at the geologic history of the Northern Virginia Region, as presented by R. C. Cady in his report on Ground-water Resources of Northern Virginia, published in 1938, presents a good chronology of events which have lead to the present geologic structures of Northern Virginia.

In what previously has been termed ancient times, much of the Northern Virginia Region was engulfed by a sea which extended from the West over much of eastern United States. During this period there was deposition on the sea-floor of calcareous materials from sea life which died and settled to the bottom. During this same period, possibly, there were depositions of mud in the eastern portion of the Region. After the sea receded there was a period of igneous, or volcanic, activity during which time the calcareous deposits of the western portion of the Region were overlain by a thick covering of basalt. After this deposition, there was more igneous activity during which time the existing eastern sediments were intruded by igneous materials which eventually became the granite in the eastern belt.

Following these depositions, there was a period of crustal disturbance. During this time the calcareous materials were altered by heat and pressure into white marble (found in some areas of Loudoun County), the igneous materials were converted into the Catoctin greenstones, and the muds were converted into Wissahickon schists. Certain areas of sand formations were changed to sandstones such as the Antietam sandstones.

Following this ancient period there was little building up of the land surface, and erosion was the dominant physical force affecting the Region. Just prior to the moderately recent geologic period occurred the great Appalachian Revolution. The western portion of the Region was folded and faulted to form the Appalachian Mountains. Erosion followed the eruption of the Appalachian system and the more resistant rocks remained and the less resistant formations were eroded. The Catoctin greenstone and Antietam sandstones, being more resistant than neighboring formations, remained after long periods of erosion in the form of the Blue Ridge and Catoctin Mountains.

An elongated basin began to develop in the eastern portion of the Piedmont during the Triassic, or moderately recent period. This area was finally aggraded with gravel, sand, and muds. Following this period, and possibly contemporaneously, there were intruded into this area sills, dikes, and stocks of igneous material (diabase); lava flows also covered portions of the surface. As a result there exists today zones of diabase and sedimentary formations of the Newark formation.

Later, during rises and recessions of the oceans, the recent Coastal Plain deposits were accumulated.

Importance of Geology to Regional Planning - Descriptive geology as such has little direct bearing on planning problems, but the information to be derived from each formation has a multitude of planning uses. The geology determines in large measure the character of the derived soils; it gives an excellent record of ground water conditions and potentials; it has a direct influence on the type of structure that can be erected above it; it gives an indication of the natural sewage disposal potentialities; and the geology determines the type and extent of natural resources available to the Region.

The preceding descriptive information is basic to further studies, and somewhat more detailed geologic information will be presented in Part II which deals with ground water resources of the Northern Virginia Region.

PART II

REGIONAL GROUND WATER RESOURCES

PART II

REGIONAL GROUND WATER RESOURCES

Governmental agencies within Northern Virginia and the Washington Metropolitan Area recognize the fact that present surface water supplies obtained from the Potomac River and Occoquan Creek will not be sufficient to meet the ever growing population needs without some measures to insure plentiful water supplies. There are at least three possible methods of insuring future water supply. One which has received much discussion, and which would probably be most effective, would entail the construction of one large dam or a series of smaller dams which would impound Potomac River water during periods of excessive flow for use during periods of low flow. A second method, regardless of actual feasibility, would be to change the source or supplement the Potomac River source with ocean water which would be piped to the area much like natural gas or petroleum is transported. Still a third alternative would be to supplement Potomac River water with ground water.

Ground water has received little consideration in the planning of future water systems in Northern Virginia. The Corps of Engineers has been investigating the use of ground water as a supplemental water source for the Potomac River Drainage Basin, which includes Northern Virginia and the Washington Metropolitan Area, but as yet there have been no published reports of their findings. Most references to ground water potential and suitability have been negative in character, generally discounting it as a suitable, reliable source to meet urban demands.

This section is not intended to present any definite proposals for ground water utilization, nor is it intended to make estimates of the extremely variable element of ground water reliability. It is the sole purpose of this section to continue the inventory-survey activities undertaken during the current fiscal year.

BACKGROUND AND PROCEDURE

There has been one comprehensive report of ground water conditions published for Northern Virginia. This report by R. C. Cady (Ground-water Resources of Northern Virginia, published in 1938 by the Virginia Geological Survey in cooperation with the U. S. Geological Survey) presents the results of a field survey conducted during the summer and fall of 1931. The data was tabulated and a detailed analysis was presented of ground water conditions in Fairfax, Prince William, Loudoun, Arlington, Frederick, Clark, and Fauquier Counties, by geologic formations. Since this report, there has been practically no attempt to supplement the study with more recent data, except for a current study being conducted in eastern Fairfax County, Arlington County, and Alexandria.

The outstanding population growth of Northern Virginia in the last decade necessitates a new prospectus of drilling trends and yields. Although there is an increasing trend to convert to surface water as the primary source of all water supply, there is also much activity in new well drilling to satisfy demands for new subdivisions, especially within still predominantly rural areas.

The following inventory has been approached as a survey of the geologic aquifers. The study is supplemented by the use of well depth and yield maps showing averages by separate aquifers. Also included is a location map of wells used in the inventory which indicates the type of well and also the date of completion. Most wells shown as completed before 1932 are from the Cady survey and more detailed data can be found in the Appendix. Tables of well yields also have been included which indicate the variations in yields within the aquifers with increasing depths. These tables present combined data of the Cady survey and data for more recent wells. When sufficient data is available since 1950, a comparison is made between well depths and yields of wells collected by R. C. Cady and wells completed since 1950.

Limitations of Survey - The primary usefulness of the ground water data presented here is that it provides a good indication of possible yields of wells at various depths in various aquifers. Specific usefulness of the data must be accepted with the following limitations:

1. Much of the well data utilized in the maps, tables, and presented in the Appendix, is for what can be termed "undeveloped wells." In most instances, a well owner is interested solely in obtaining a given yield per minute. Once the driller reaches the depth where the requested yield is obtained, operations are terminated. In most cases the well is neither treated nor tested for maximum yield.

2. There are also limitations due to the general accuracy of reported data which oftentimes is collected in the field from well owners who report data by memory and not by recorded data.

3. The average data for aquifers are actually possible figures and not optimum figures. There has been little attempt in Northern Virginia to develop test wells for the sole purpose of determining the optimum potential of a well within specific aquifers.

4. There has still not been enough well data collected to give a good sampling of each aquifer. Much of the well data collected is for wells within clusters which do not necessarily give good general averages.

AQUIFERS

For the purposes of this survey the Northern Virginia Region can be divided into nine water-bearing formations which are coincident with the nine geologic formations shown on the accompanying geologic map.

The most extensive aquifer is that corresponding to the Newark formation of eastern Loudoun County and western Fairfax County. About 26.9 percent of the Region is underlain by this formation. The next most extensive formation is that corresponding to the large belt of schists of the Wissahickon and Sykesville geologic horizons in central Fairfax and Prince William Counties. This schistic water bearing formation underlays about 18.0 percent of the Northern Virginia Region.

Catoctin greenstone found in Loudoun County accounts for at least another 14.4 percent of Regional water-bearing formations while the granite in the eastern belt, the alluvium, terrace deposits and Potomac group, diabase (trap), Marshall granite, Antietam to Loudoun formations, and slate water-bearing formations underlay 10.6, 10.5, 8.8, 7.3, 3.0, and 0.5 percent, respectively, of the Regional land area.

Newark Formation - The Newark formation's eastern border extends along a line which runs from east of Herndon north-south through Centreville and Manassas, to the southern boundary of the Region. Its western boundary corresponds to the Catoctin border fault which occurs just west of Leesburg and trends north-south into Prince William County.

This formation is comprised of three sedimentary formations. To the extreme northwest, north of Leesburg, there is an area of conglomerate comprised of rounded pebbles of limestone which are cemented together to form a rather dense rock structure. Due to the cementing of pebbles, this formation can be termed generally a fair water-bearing formation. More plentiful ground water can be expected if fractures occur in the rock which permit better water percolation. Cady's report indicates that most water is available from wells less than 200 feet in depth. Little data is available for deeper wells.

The remaining area of the Newark formation is comprised primarily of sandstones, which are red, yellow, or gray in color, and shales, which are red, gray, or bluish in color. Clay deposits occur locally. These sedimentary deposits are soft and in many places poorly consolidated, thus well drilling is an easy process. Water is generally quite plentiful within these sandstones and shales, and there is good evidence to indicate that more water is available at greater well depths as shown in Table V-A.

Average well depths and yields are shown in Figures 9 and 10 for this water-bearing formation. These averages are combined averages of Cady data and data for wells completed since 1950. The above mentioned figures and Table V-A show that the 341 wells investigated have yields ranging from 1/4 to 900 gallons per minute (gpm) and an average yield of 15 gpm. The average well depth for this formation is 128 feet.

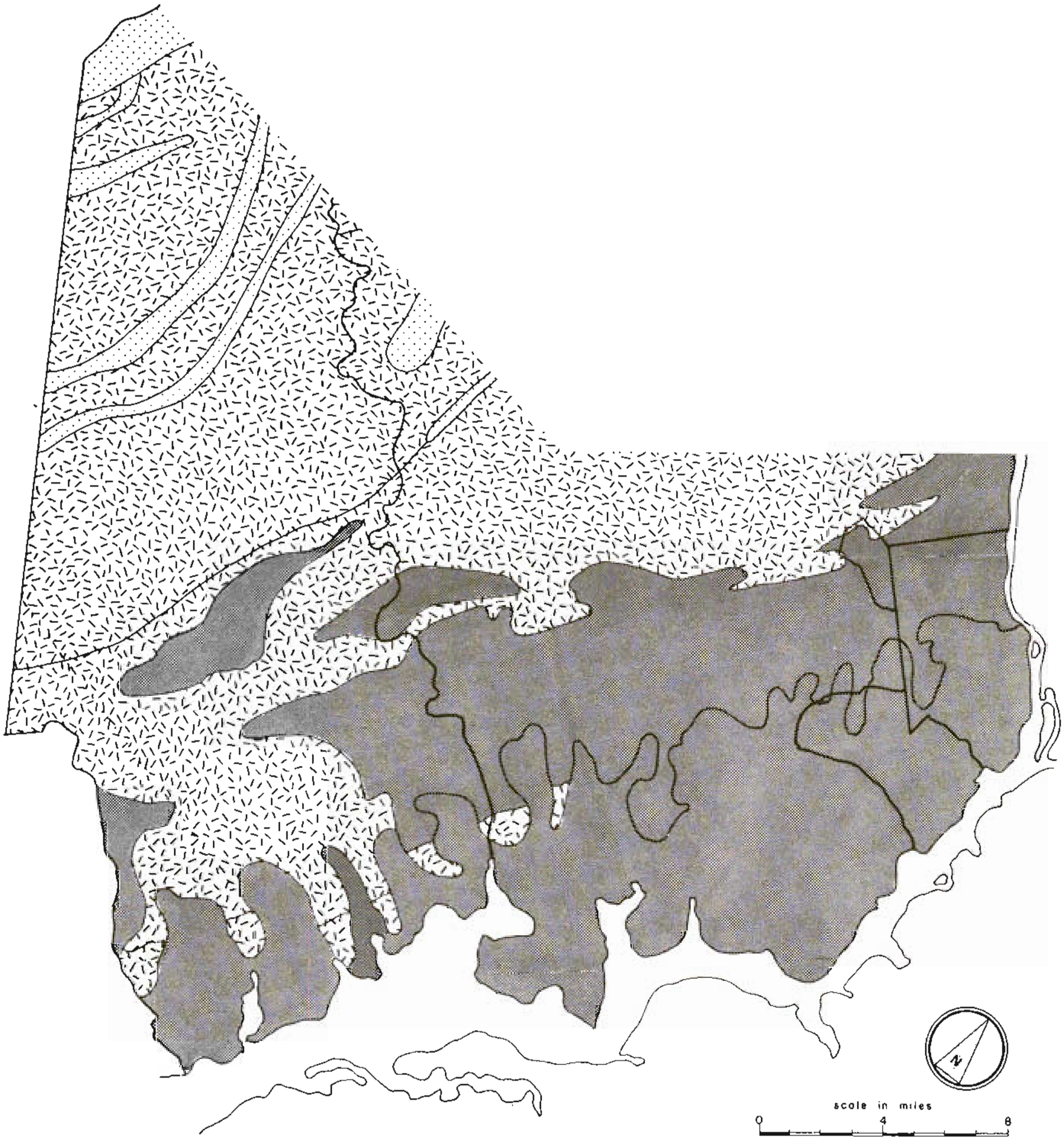
Of 341 wells surveyed which indicated the Newark formation as the source of water (264 from the Cady report and 77 wells completed since 1950, see Figure 8), 309 wells were less than 200 feet in depth and yielded averages of 6 and 9 gpm at under 100 feet and 101 to 200-foot depths, respectively. Yields ranged from 1/4 to 60 gpm. Wells within this depth range in Loudoun County, which were drilled since 1950 (54 wells) have yielded water quantities ranging from 1/2 to only 30 gpm or an average yield of about 16 gpm.

From Table V-A it can be seen that the range and average yields of wells increases considerably with increased well depths. An increase is evident in the well depth category of 201 to 300 feet, but the most noteworthy increases occur at depths below 300 feet. Cady had few wells within this depth category, but data on several additional wells drilled since 1950 have been obtained. Two very deep wells were developed at the site of the new Dulles International Airport at depths of 860 and 955 feet,

REGIONAL WELL TYPES AND DATES OF COMPLETION

TYPE		DATE OF COMPLETION			
•	DRILLED WELL	○	1950 - 1960	⊛	1932 - 1940
'	DUG WELL	⊙	1940 - 1950	' •	BEFORE 1932

Fig. 8



AVERAGE WELL DEPTHS BY GEOLOGIC FORMATION

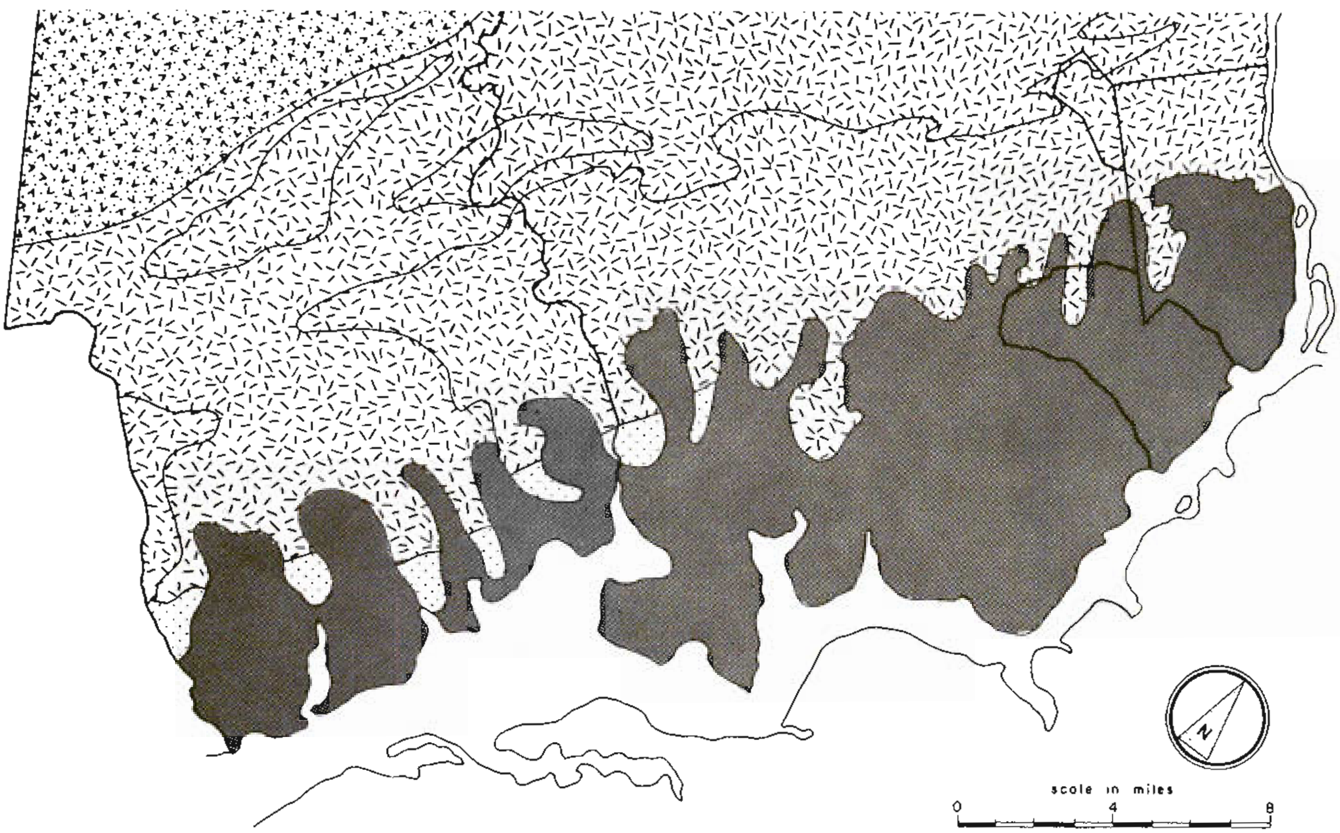
UNDER 99 FEET

100 – 119 FEET

120 – 139 FEET

OVER 139 FEET

Fig. 9



AVERAGE WELL YIELDS BY GEOLOGIC FORMATION

UNDER 4.9 GAL./MIN.
5.0 - 9.9 GAL./MIN.
10.0 - 14.9 GAL./MIN.
15.0 - 19.9 GAL./MIN.
OVER 20.0 GAL./MIN.

Fig. 10

respectively. Both of these wells which yield 327 and 900 gallons of water per minute, respectively, tap water in red shale formations. Equally impressive well depths and yields have been recorded by several new wells in the Manassas and Manassas Park areas of Prince William County. Four recent wells in this area which record water-bearing material as sandstone or shale, or a combination of these two materials, have depths of 1,000, 875, 485, and 807 feet and record yields of 210, 112, 66, and 120 gpm, respectively. The Town of Herndon in 1953 drilled a 403-foot well into sandstone formations and obtained a yield of 133 gpm. This well was also test pumped at 300 feet but yielded only one gallon of water per minute. Although these wells are isolated examples, they provide very good indications that large water yields at great depths are possible in the sediments of the Newark formation.

There has been considerable well drilling activity in Newark sediments in eastern Loudoun County north of Route #7. Many of these wells, Figure 8, have been developed to supply water to several subdivisions, primarily the Broad Run Farms Subdivision. Most of these wells are about 180 feet in depth and yield about 15 gpm. Geologic reports indicate that wells drilled within four to six miles of the Potomac River will generally produce commercial quantities of water.

Wissahickon Schist - The belt of schist formations of central Fairfax and Prince William Counties generally abut against the Newark formation to the west while the eastern border is less specifically defined but it contacts the granites of the eastern belt.

These bluish-green crystalline rocks have, according to Cady, lost much of their soluble mineral matter as a result of weathering. This in effect has created many small cavities for water storage and easy water movement. This zone of weathering probably extends to considerable depths. Below the zone of weathering influence it is felt that there are also numerous cavities and joints which do permit water storage but slower underground water movements.

Four hundred and five wells were analyzed in this schist formation. Because of the availability of much recent data pertaining to this formation, only 71 of Cady's original wells were included in the survey.

The water-bearing properties of this aquifer rank it as one of the better sources of water in the Northern Virginia Region. Analysis of available well data indicate that the average depth of wells in schist formations is 138 feet while the average yield is 14 gpm.

Data presented in Table V-B indicate that the more weathered zone from the surface to 300 feet has fairly consistent water yields. The 382 wells surveyed show a yield range from 1/4 to 100 gpm. Wells under 100 feet in depth, characteristic of most domestic wells, have average yields of 11 gpm and wells to 300 feet in depth, by 100-foot intervals, average 12 and 19 gpm, respectively.

A significant increase of yields occurs at depths below 300 feet. At the 301 to 400-foot interval, wells yield about 43 gpm. Yields then increase rapidly to over 69 gpm.

Wells within this aquifer have yields which range from 1/4 gpm to

212 gpm. Cady's original survey indicated a range of yields from 1/4 to only 70 gpm. The averages shown in Table V-B for schists are somewhat higher than those computed by Cady, thus indicating a general tendency for greater yields. Large yields can be attributed possibly to the existence of more data, better well development, or better reporting of recent well information. Water derived from schists is generally soft and low in dissolved mineral matter.

As can be seen from Figure 8, there is still noteworthy development of wells in schist aquifers of east-central Fairfax County. Most of this area is rapidly developing and public water is not available. Most wells are domestic and are associated with large lot home development rather than intensive development. The Mantua residential area east of Fairfax Town, south of Route #50, is characterized by lot sizes of 1/2-acre or more and domestic wells in schist formations.

Little development, and thus few wells have been developed in the Prince William County belt of schists. Consequently, little is known of actual water conditions, but yields are expected to be a reflection of yields in the Fairfax County area.

Catoctin Greenstone - Catoctin greenstone, the third most extensive aquifer of the Region, is the most widespread aquifer in Loudoun County. This greenish, crystalline rock outcrops in many areas of Loudoun County and is the primary rock type of the Catoctin Mountains and the Blue Ridge. It extends as two north-south trending belts west of Leesburg, bisected by a belt of Marshall granite.

This aquifer has a dense rock structure which as a whole has few openings to permit water percolation and movement. It is reported that the rock structure becomes more porous along its eastern margins. As a result of the dense structure, water resources are generally poor. Ninety-nine wells within greenstone were surveyed; 46 of these were drilled between 1950 and 1960, and the remainder were extracted from the Cady survey. Table V-C indicates that wells within greenstone formations will yield between 1/4 and 37 gpm with an average of 7 gpm. Best yields will generally occur above 400 feet with limited yield increases with depths greater than 400 feet. One well in excess of 500 feet, drilled since 1950, and reported to be in the greenstone formation, had a recorded yield of 37 gpm.

An analysis of recently drilled wells and Cady wells indicates that although there are consistent yields by depth intervals above 400 feet and little additional water to be found at greater depths, there has been a tendency for greater yields by 100-foot depth intervals for recently drilled wells. Whereas Cady's data indicated an average yield of about 5 gpm for wells to 400 feet deep, recent drilling records indicate average yields of about 10 gpm. The generally higher yields can possibly be attributed to better well development to secure maximum yields with minimum depths.

Most wells drilled in greenstone are for domestic purposes where extremely large yields are not required. Coupled with the excellent quality of the water, wells drilled in greenstone should suffice for most domestic uses.

Granite in the Eastern Belt - The dark bluish-gray granite aquifer of eastern Fairfax and Prince William County contacts schist formations at its western extremity. The irregular eastern boundary, which is also the eastern extent of the Piedmont, contacts and is overlain by sediments of the Coastal Plain. This aquifer is characterized as being a poor to fair source of ground water. It is quite massive and dense in most areas and any available water occurs as a result of numerous cracks and joints which store water and permit water movement. Most consistent yields generally occur at depths of 300 feet or less.

A survey of 48 wells reported as obtaining water from this granite aquifer (37 were drilled since 1950 and 11 were extracted from Cady's report), indicates that the average well is 143 feet deep and yields 14 gpm. The unusually high average yield is influenced by several high yielding wells. In actuality, 29 recently drilled wells had yields of less than 10 gpm.

Yield data from recently completed wells has a definite similarity to information compiled by Cady. The average well below 300 feet can be expected to yield no more than 7 to 10 gpm although there are isolated instances where greater yields might occur; for example, two wells completed since 1950 at depths of 143 and 102 feet had yields of 22 and 30 gpm, respectively. Most wells in excess of 300 feet do not produce appreciably larger yields, and sufficient data is not available for definite appraisals. Two wells at 400 and 545 feet, respectively, were reported to have had yields of 185 and 124 gpm from a granitic aquifer. There is some question as to the accuracy of the reported water-bearing strata. The location of these wells, which supply the Vienna Water Company, indicates that possibly the actual aquifer is a schist and not a granite.

Water from granite aquifers is generally soft, but hard water is extremely common.

Alluvium, Terrace Deposits, and Potomac Group - Because of the complexity of the sedimentary profile of the Coastal Plain Province, all aquifers of this generally unconsolidated belt have been grouped for discussion. The aquifers vary in their water-bearing properties, but large yields are characteristic or possible at all depths so long as the well does not penetrate the granite formations which underlie much of the Coastal Plain. Well yields tend to increase considerably on moving eastward since sediments are shallow at the western contact with the granites of the eastern belt and become progressively deeper at a rapid rate (reportedly increasing at a rate of 45 to 100 feet per mile) on progressing to the east and southeast.

Aquifers include strata and lenses of sand of the Potomac group, through silts and clays, to gravels, and sand and gravel mixtures. Sands are the most prolific aquifers while silts and clays tend to be poor sources of water. Due to their compactness, little pore space is available for holding large quantities of water. Also, because of their compact nature, much water adheres to individual particles and it is difficult to obtain large yields. Pure gravel deposits will yield copious amounts of water, while sand and gravel mixtures will also yield large amounts of water. The yield of sand and gravel mixtures will be appreciably reduced though if these materials are cemented. Alluvium deposits in estuaries and along streams yield large amounts of water, but there is considerable danger of water contamination, especially along the Potomac River.

Data compiled from 68 wells, 25 of which were drilled since 1950, indicate that there is an average depth of 219 feet for wells ending in Coastal Plain sediments. The average yield is 67 gpm, thus making these formations the most prolific water-bearing formations of the Region.

From Table V-E it can be seen that average well yields increase significantly with increased depths. It is also evident that there is a great range in yields for each 100-foot increase in depth. Actually the largest single yield was attributed to a 300-foot well drilled since 1950 which yielded 800 gallons of water per minute. Many wells have been drilled in the Coastal Plain area of the Quantico Military Reservation in past years which were at least 300 feet in depth and had yields which generally exceeded 125 gpm.

From the data in Table V-E it would seem that maximum yields could be obtained from wells which average 800 to 400 feet provided the wells are cased properly to assure against clogging by loose sediments. A deep well does not necessarily insure high yields, but rather it is the method in which the well is completed which will insure large and continuing yields.

Domestic wells in these formations will probably yield sufficient household supplies at fairly shallow depths. The water is generally soft, and in some areas it is reported to be high in iron and unsuited for most uses.

Diabase (trap) - Crystalline diabase aquifers occur in many bands and isolated masses in eastern Loudoun County and western Fairfax and Prince William County. These greenish-black masses are not specifically defined, but they occur generally as shown in Figure 7.

These dikes, sills, and stocks are next to the poorest sources of ground water in the Northern Virginia Region. The surface zones of weathered material yield the largest amounts of water although it is possible to obtain moderate yields to depths of 200 feet, Table V-F.

Little data for wells recently completed in diabase are available. Of the 94 wells utilized for diabase tabulations, only 15 have been completed since 1950 and these were drilled in Loudoun County. Data indicate that yields range between 1/4 and 60 gallons per minute. The formation is characterized by an average yield of 8 gpm. The average well depth is 96 feet. Table V-F shows that maximum yields are obtained at depths under 200 feet. There are no significant increases in yields with increasing depth.

Water from diabase formations is generally soft but hardness tends to increase with increasing depths.

Marshall Granite - This granitic aquifer is found only in Loudoun County dividing the previously discussed Catoctin greenstone formation. It is the third most extensive aquifer in Loudoun County.

This light gray, pink, and green granite is not a prolific yielder of water. Averages for the 97 wells surveyed show an average well depth of 101 feet and an average yield of 8 gpm. The rock structure is dense except for the upper zones of weathered material and moderate yields are equally possible at depths of less than 100 feet as in wells over 100 feet in depth. There do appear to be more consistent yields of approximately 10 gpm for wells 101 to 200 feet in depth. Wells under 100 feet have average yields nearer 5 gpm.

At depths over 200 feet the rock structure has been so altered that large yields can be expected only if the well taps water trapped in a joint or other undestroyed opening. Isolated wells have yielded large supplies of water. Cady reported one well of 550-foot depth which had a yield of 40 gpm. A municipal well at Middleburg, drilled in 1937 to a depth of 772 feet, had a yield of 70 gpm.

Twenty wells completed since 1950 were included in the averages tabulated in Table V-G These 20 wells indicate the same yield breakdowns by 100-foot intervals as discussed above and in Cady's original survey of Northern Virginia ground water. There is a trend indicated, though, which shows a general 5 to 6 gpm larger yield for each 100-foot depth interval. Water is generally of good quality and somewhat hard. It is good for household uses.

Antietam to Loudoun Formations - The light brown to dark gray sandstone, slates, and shales of the Antietam to Loudoun formations occur in narrow, elongated belts in central and western Loudoun County and western Prince William County.

Thirty-nine wells have been included in Table V-H, eight of which were extracted from the Cady report. There is some question about the inclusion of the remaining 31 wells without this group of formations as a result of the method of data collection. These wells, all completed since 1950, reportedly tapped sandstones, slates, and shales. Geologic formations were not indicated, but from the known locations of each well it has been assumed that these wells do penetrate the Antietam to Loudoun formations.

Although the average yield of this combined grouping is about 9 gpm, there is still insufficient reliable data to derive a realistic average. Sandstones of this grouping have the greatest potential while the slates and shales are generally minor sources of water.

With one exception, all wells surveyed are less than 200 feet in depth. Largest average yields tend to occur in wells less than 100 feet in depth and yields range from 1 to 40 gpm. At depths of 101 to 200 feet, twelve wells averaged 7 gpm and the yields ranged from 1/4 to 16 gpm. The average yield of wells drilled since 1950 is about 5 gpm greater than that reported in Cady's survey. Water from these formations is generally soft, but insufficient data is available.

Quantico Slate - The blue slate deposits which occur in isolated nodes in eastern Fairfax and Prince William Counties are extremely poor sources of water. The chances of having a dry well seem to be extremely large. The few wells which are shown in Table V-I indicate very small average yields and very limited ranges. Although the average well depth is 128 feet, the average water yield is only 3 gpm. There have been oral reports of wells in excess of 500 feet in the vicinity of Dumfries which were dry.

CONCLUSION

There is specific evidence to indicate that there has not been much change in the basic character of the aquifers of the Northern Virginia Region. Available data indicates that within the Newark formation large yields are possible with deep wells. Within the zone of schist aquifers there occasionally can be large yielding wells. Greater yields seem to be associated with deeper wells. Sedimentary deposits of the Coastal Plain are the most prolific aquifers of the Region and large yields can be expected with increasing well depths.

Most other aquifers are poor to fair sources of water, but occasional large yields are possible if a well taps water held in a joint or cavity, or along a fault. Diabase and Quantico slate are unreliable sources of ground water and an occasional large yield is exceptional.

TABLE V

REGIONAL WELL YIELD TABULATIONS BY DEPTHS
(For Geologic Formations)

A. Newark Formations

Depth (Feet)	No. of Wells	Yield (G/Min.)	
		Range	Average
0 - 100	184	¼ - 60	6
101 - 200	125	¼ - 45	9
201 - 300	16	½ - 55	17
301 - 400	6	10 - 300	106
401 - 500	3	50 - 133	83
Over 500	7	27 - 900	259
TOTALS	341	¼ - 900	15

B. Wissahickon Schists

Depth (Feet)	No. of Wells	Yield (G/Min.)	
		Range	Average
0 - 100	161	½ - 35	11
101 - 200	195	¼ - 60	12
201 - 300	26	1 - 100	19
301 - 400	9	2 - 135	43
401 - 500	3	2 - 110	56
Over 500	11	6 - 212	70
TOTALS	405	¼ - 212	14

C. Catoctin Greenstones

Depth (Feet)	No. of Wells	Yield (G/Min.)	
		Range	Average
0 - 100	67	¼ - 30+	6
101 - 200	20	½ - 30	8
201 - 300	5	¼ - 15	9
301 - 400	2	10 - 11¼	11
401 - 500	1	5	5
Over 500	3	1¼ - 37	19
TOTALS	99	¼ - 37	7

TABLE V (Continued)

D. Granite in Eastern Belt

Depth (Feet)	No. of Wells	Yield (G/Min.) Range	Yield (G/Min.) Average
0 - 100	25	2 - 18	7
101 - 200	16	½ - 30	11
201 - 300	3	4 - 12	8
301 - 400	2	1 - 185	93
401 - 500	0	-	-
Over 500	2	8 - 124	66
TOTALS	48	½ - 185	14

E. Alluvium, Terrace Deposits & Potomac Group

Depth (Feet)	No. of Wells	Yield (G/Min.) Range	Yield (G/Min.) Average
0 - 100	14	1 - 100	19
101 - 200	23	2½ - 60	17
201 - 300	15	1 - 800	116
301 - 400	8	12 - 325	152
401 - 500	4	18 - 278	123
Over 500	4	15 - 320	115
TOTALS	68	2½ - 800	67

F. Diabase (trap)

Depth (Feet)	No. of Wells	Yield (G/Min.) Range	Yield (G/Min.) Average
0 - 100	76	¼ - 60	5
101 - 200	14	¼ - 25	9
201 - 300	1	7	7
301 - 400	0	-	-
401 - 500	2	½ - 4	2
Over 500	1	3	3
TOTALS	94	¼ - 60	8

TABLE V (Continued)

G. Marshall Granite

Depth (Feet)	No. of Wells	Yield (G/Min.)	
		Range	Average
0 - 100	66	½ - 25	5
101 - 200	24	0 - 25	9
201 - 300	2	4 - 10	7
301 - 400	3	¼ - 28	11
401 - 500	0	-	-
Over 500	2	40 - 70	55
TOTALS	97	0 - 70	8

H. Antietam to Loudoun

Depth (Feet)	No. of Wells	Yield (G/Min.)	
		Range	Average
0 - 100	26	1 - 40	10
101 - 200	12	¼ - 16	7
201 - 300	1	2¼	2
301 - 400	0	-	-
401 - 500	0	-	-
Over 500	0	-	-
TOTALS	39	¼ - 40	9

I. Quantico Slates

Depth (Feet)	No. of Wells	Yield (G/Min.)	
		Range	Average
0 - 100	4	1½ - 5	3
101 - 200	2	¼ - 7	4
201 - 300	0	-	-
301 - 400	1	1	1
401 - 500	0	-	-
Over 500	0	-	-
TOTALS	7	¼ - 7	3

PART III

NORTHERN VIRGINIA WATER SYSTEMS

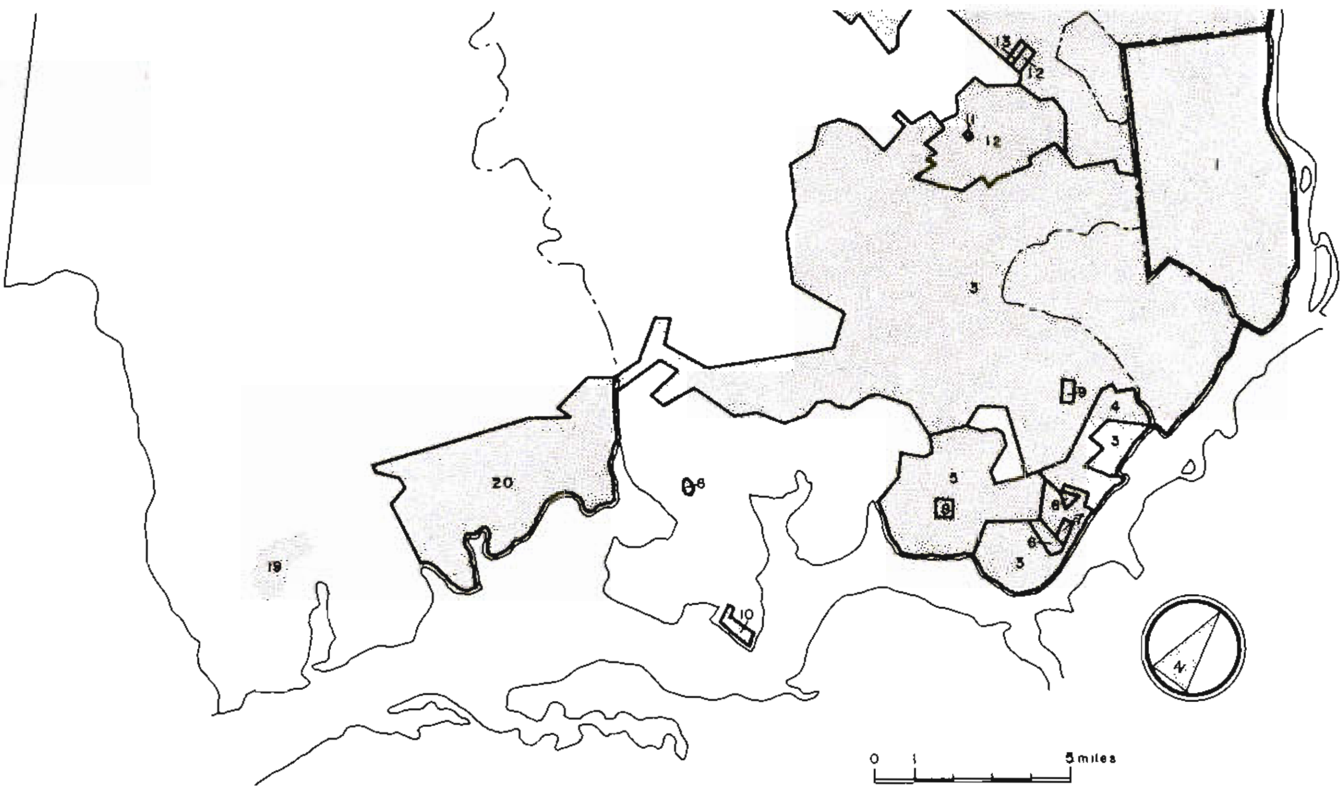
PART III

NORTHERN VIRGINIA WATER SYSTEMS

In 1959 the Northern Virginia Region obtained water from 33 public and private water systems, 32 of which are indicated in Figure 11. As would be expected, the predominance of companies served the more highly urbanized eastern portions of the Region in Fairfax and Arlington Counties, and the Cities of Falls Church and Alexandria. In 1959 these 32 companies served approximately 452,281 persons within the Northern Virginia Region, 75.2 percent of the Regional population which was estimated to be about 600,350 persons on January 1, 1960. The remaining 148,067 persons were still served by domestic wells.

Surface water is the principal source of water for the Region. In 1959 a total of at least 14,272.90 million gallons of water were distributed. Of this total 61.8 percent was derived from surface water sources, primarily the Potomac River and Occoquan Creek. The remaining 38.2 percent of distributed water was obtained from ground water sources. To further emphasize the importance of surface water to the Northern Virginia Region, 92.3 percent of the total served population consumed water from surface water sources.

There was a noticeable variation in per capita water consumption from eastern to western portions of the Region. The Region as a whole had a daily per capita water consumption of 87 gallons per day. The residential per capita water consumption (calculated as total daily residential water



NORTHERN VIRGINIA WATER SYSTEMS

WATER COMPANY SERVICE LIMITS

UNDEFINED SERVICE LIMITS

1 Arlington County
2 City of Falls Church
3 Alexandria Water Co.
4 Fairfax Hydraulics Water Co.
5 Woodlawn Water Co., Inc
6 Sydnor Pump & Well Co.
7 Tauxemont Community Assoc., Co.
8 Mt. Zephyr Construction Co.
9 Wilton Woods Water Works, Inc.
10 Mason's Neck Water Corp.
11 Wolfenden Subdivision
12 Fairfax County Water Authority
13 Tremont Water Co
14 Pimmit Service Corp.
15 Town of Vienna
16 Town of Fairfax
17 Fairfax County Water Authority
18 Town of Herndon
19 Sydnor Pump & Well Co.
20 Occoquan – Woodbridge Sanitary Dist.
21 Town of Manassas
22 Manassas Park
23 Yorkshire Water Co.
24 Aries Water Co.
25 Town of Leesburg
26 Town of Hamilton
27 Town of Purcellville
28 Town of Hillsboro
29 Town of Round Hill
30 Town of Middleburg
31 Town of Aldie
32 Foxcroft School
33 Sunnybrook Subdivision

Fig. 11

consumption divided by total population) was considerably lower, 54 gallons per day.

PROCEDURE

The following survey of Regional water systems was conducted in the field during January, 1960. Data on number of service connections and consumption for residential, public and institutional, industrial, and commercial uses was collected and tabulated and presented graphically in Figures 11 and 12. There are doubtlessly some errors in the tabulations due to methods of reporting data, estimations, and sampling. Due to the time involved to obtain complete data and the limited staff of some water companies, the statistics for many systems were determined from billing records for the last quarter of 1959 and this data was multiplied by four. Also, some companies would not report data nor could they provide detailed breakdowns. Data for unmetered systems was estimated by using consumption data for adjacent or similar water systems.

The field data is presented in detail by counties and county-city units on the following pages.

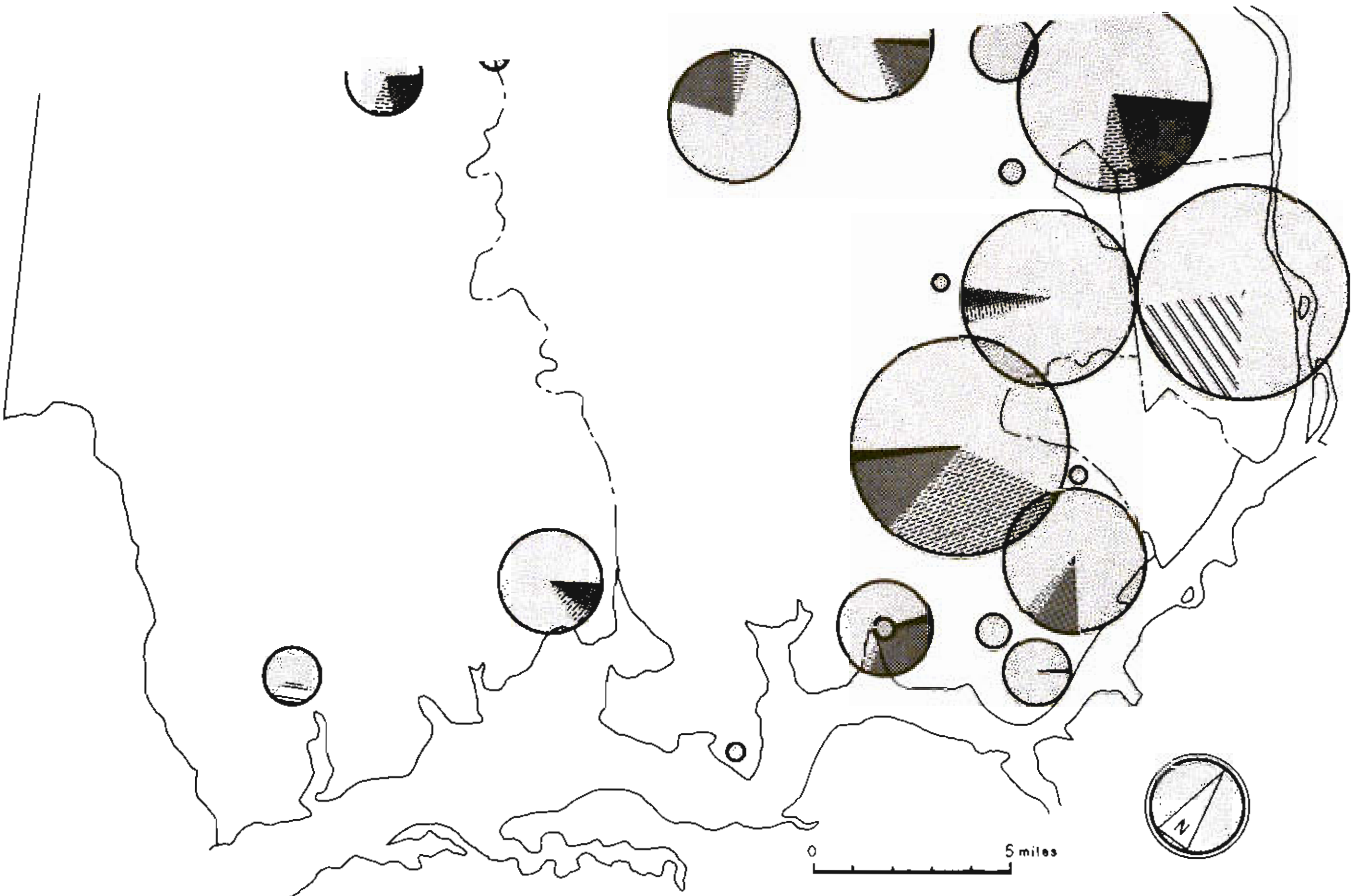
Arlington County Water System

The largest and one of the oldest water systems in the Northern Virginia Region serves highly urbanized Arlington County. Over 165,120 persons were served with public water in 1959. Nearly one-half of the served population were apartment dwellers.

To adequately serve this large population the County is criss-crossed by over 378 miles of transmission lines. Approximately 60 percent of this mileage is comprised of lines six inches in diameter. Another 28 percent of the total mileage is comprised of eight and ten-inch lines. The distribution system is generally termed adequate for present needs, although certain areas south of Columbia Pike will need larger mains to be efficiently served and to offset fluctuations in water pressure. The entire Arlington system is designed, or is being designed, to serve an ultimate population of 285,000 persons - approximately to the year 1985.

Arlington County is one of the few Northern Virginia areas which relies upon surface water, the Potomac River, to supply its water needs. During 1959, over 6,428 million gallons of water were obtained from the Dalecarlia Filtration Plant in the District of Columbia. Water is supplied to Arlington County at two points. The largest portion of the total supply enters the distribution system at Chain Bridge through a 24-inch main which supplies eastern Arlington County. The extreme southern portions of the County are supplied from a Key Bridge Feeder Main (30-inch) which also serves the Pentagon and National Airport areas.

All water entering the Arlington County distribution systems is



AVERAGE DAILY WATER CONSUMPTION (by water systems and uses)

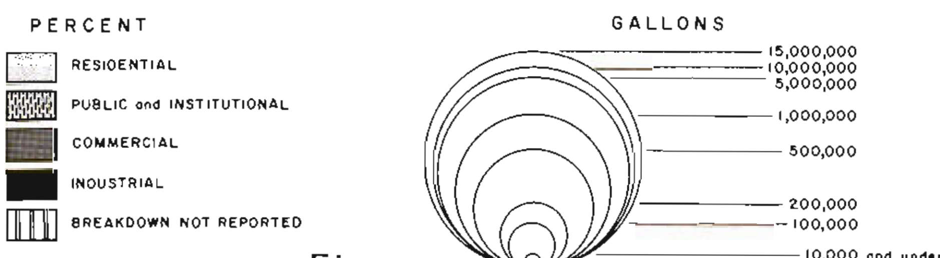


Fig. 12

pre-treated at the Dalecarlia Filtration Plant. Arlington County also has a water storage system with a capacity of 22,478,000 gallons in the form of three standpipes, four ground storage reservoirs, one elevated tank, and two storage tanks.

WATER CONSUMPTION

It was previously stated that in 1959 Arlington County purchased over 6,428 million gallons of water from the Dalecarlia Filtration Plant. During this same period Arlington County re-sold about 1,374.3 million gallons of their purchased water to the Falls Church Water Company. Thus, only about 5,054.13 million gallons of water were actually consumed by Arlington County users during 1959, or an average of 13,847.0 thousand gallons per day, see Table VI.

Reports of water purchases in Arlington County indicate that average daily water consumption for residential and apartment units in 1959 was about 10,939.1 thousand gallons, 79 percent of total daily water consumption. The remaining 21 percent of daily water consumption was accounted for by combined public and institutional, industrial, and commercial water users. No detailed breakdown was available.

Water Division reports state that there were 27,244 residential service connections in 1959, as well as 2,052 apartment connections. As most apartment developments have only one connection per building and not one per unit, 2,052 apartment connections do not reflect the actual number of apartment units served. Since essentially all apartment units are supplied with public water, it is more realistic to assume the estimated

25,342 apartment units in Arlington County as best representing apartment units served. The 27,244 residential connections plus 25,342 apartment units served provide a total of 52,586 dwelling units served.

From Table VI it can be seen that daily dwelling unit water consumption amounted to 208 gallons per day, or an average of 66 gallons of water per capita for served dwelling units. Gross per capita water consumption per day calculated as average daily water consumption divided by total population served amounted to about 84 gallons per day.

Based on an average of 3.14 persons per dwelling unit, there were approximately 165,120 persons supplied with public water. It is estimated that Arlington County had about 173,000 inhabitants in 1959, thus it is assumed that there was a small percentage of total County population not on the public water system.

TABLE VI

ARLINGTON COUNTY, FAIRFAX COUNTY, FALLS CHURCH, ALEXANDRIA
WATER CONSUMPTION STATISTICS, 1959
(By Water Systems)

Water System	Annual a/ (Millions of Gals.)	Average Daily (Thousands of Gals.)	Daily Residential (Thousands of Gals.)	Daily Residential % of Daily	Public & Institutional (% of Daily)	Industrial (% of Daily)	Commercial (% of Daily)	Dwelling Units (D.U.) Served	b/ Daily D.U. (Gals.)	Daily c/ Per Capita/ D.U. (Gals.)
Arlington	5,054.13	13,847.0	10,939.1	79.0	----------	21.0	---------	52,586	208	66
Alexandria	5,623.25	15,406.1	8,902.8	57.8	29.1	1.3	11.8	40,586	219	61
Falls Church	1,523.15	4,173.0	3,129.8*	75.0*	6.0*	1.5*	17.5*	Unknown	-	-
Fairfax Co. Water Authority	429.75	1,177.4	1,095.0	93.0	2.8	Neg	4.2	5,125	214	55
Fairfax Hydraulics	296.42	812.1	698.1	85.9	3.4	-	10.7	3,617	191	55
Town of Fairfax	260.25	713.0	515.0	72.2	5.6	Neg	22.2	2,850	181	52
Town of Vienna	219.00	600.0	480.0	80.0	3.3	2.1	14.6	2,409	199	52
Town of Herndon	34.74	95.2	70.0	73.5	7.0	0.5	19.5	405	173	47
Woodlawn	134.56	368.6	245.7	66.6	1.0	-	32.4	1,614	152	43
Sydnor Pump and Well	59.62	163.3	161.3	98.7	-----------	1.3	-----------	818	197	56
Pimmit Service Corp.	60.00*	164.4*	164.4*	100.0	-----------	neg	-----------	1,450**	113*	27*
Tauxemont Citizens Association	14.96*	40.9*	40.9*	100.0	-	-	-	208	197*	57*

TABLE VI (Continued)

Water System	Annual a/ (Millions of Gals.)	Average Daily (Thousands of Gals.)	Daily Residential (Thousands of Gals.)	Daily Residential % of Daily	Public & Institutional (% of Daily)	Industrial (% of Daily)	Commercial (% of Daily)	Dwelling Units (D.U.) Served	b/ Daily D.U. (Gals.)	Daily c/ Per Capita/ D.U. (Gals.)
Tremont	9.54*	26.1*	26.1*	100.0	-	-	-	132	198*	52*
Hilton Woods	3.79*	10.4*	10.4*	100.0	-	-	-	52**	200*	52*
Mt. Zephyr Construction Company	3.55*	9.7*	9.7*	100.0	-	neg	-	64	152*	43*
Mason's Neck	2.30*	6.3*	6.3*	100.0	--	-	-	32	197*	66*
Wolfenden Subdivision	2.04*	5.6*	5.6*	100.0	-	-	-	28**	200*	54*
TOTALS d/	8,676.92	23,772.1	15,561.1	65.0	20.5	1.2	13.3	71,390	185 c/	51 c/

* Approximations based on average residential consumption of other systems (systems have no meters or sufficient data was not reported).
** Estimated.
a/ Consumption figures are for dwelling units on distribution system.
b/ Consumption figures are for persons residing in serviced dwelling units (calculated as: Average Daily Dwelling Unit Consumption ÷ Persons per dwelling unit).
c/ Average.
d/ Does not include Arlington County.

Alexandria, Falls Church, and Fairfax County Water Systems

Because of the manner in which water system data is recorded and reported, it has not been possible to provide separate tabulations for the Cities of Falls Church and Alexandria. They have therefore been included with Fairfax County data.

Sixteen water companies here discussed include five public water systems located at Falls Church, Vienna, Fairfax, Herndon, and the Fairfax County Water Authority, as seen in Figure 11. Private water systems include the Alexandria Water Company, Fairfax Hydraulics Water Company, Tauxemont Community Association Company, Tremont Water Company, Wilton Woods Water Works, Pimmit Service Corporation, Wolfenden Subdivision, Woodlawn Water Company, Mt. Zephyr Construction Company, Sydnor Pump and Well, and Mason's Neck Water Company.

Fairfax County, of all jurisdictions within the Northern Virginia Region, has the largest number of separate water service systems. These systems impinge on each other in a highly complex manner as seen in Figure 11. About five to six years ago there was a strong local sentiment being developed in Fairfax County for an integrated County-wide water distribution system. As a result of this sentiment, there were several engineering studies made pertaining to a comprehensive water supply system. In September, 1957, the Fairfax County Board of Supervisors authorized the establishment of the Fairfax County Water Authority with the prime objective of providing a comprehensive system for supplying and distributing water in Fairfax County. The program of the Authority includes not only the construction of new facilities to serve areas not now served by privately or publicly owned systems, but also the acquisition of privately owned systems.

To fulfill the large task ahead of it, the Fairfax County Water Authority purchased the Annandale Water Company systems in January, 1959, and has subsequently acquired the Fenwick Park Water Company. In further attempts to assemble and develop a unified water system, the Authority has negotiated with the Pimmit Service Corporation for the purchase of the Pimmit Hills water system. Negotiations have been completed and a price agreed upon and purchase is imminent. The Authority is presently engaged in preliminary surveys of the Woodlawn Water Company in southeastern Fairfax County, Figure 11. Probably the most important proposed acquisition is the Fairfax County portion of the Alexandria Water Company. The purchase of this large private water company might be a joint venture of the Authority and the City of Alexandria, which would be furnished water at cost by the Authority. The Authority has also been approved by the Federal Aviation Agency to supply water to the Dulles International Airport. This program will have a favorable effect on water distribution in northern Fairfax County which at this time has no public water supply west of the Circumferential Highway.

Through the purchase of the Alexandria Water Company, the Authority could be assured of a large, reliable source of water in the Occoquan Reservoir. The Authority assumes that water from this reservoir will be sufficient to meet requirements in the southern portion of Fairfax County, the City of Alexandria, and the northeastern portion of Prince William

County. The Authority is looking toward the Potomac River to supply the water needs of northern Fairfax County either through interconnections with the Washington, Arlington County, and City of Falls Church systems or possibly through an independent treatment plant on the Virginia side of the River.

The Authority originally contemplated possible service to towns within the County, especially since they would be in an extremely favorable position to do so when transmission lines are laid to serve the Dulles Airport. Such hopes have been dissipated since the Town of Fairfax is constructing a dam on Goose Creek in Loudoun County to develop a dependable water supply of 3.5 million gallons per day. The Town has recently negotiated to supply water from their Goose Creek reservoir, on its completion, to the Town of Herndon.

During the past few years there developed a large controversy on the legal rights of the City of Falls Church to sell water, at a considerable profit, to adjacent sections of Fairfax County, as well as a controversy over the actual areas in Fairfax County which the Falls Church Water Company would be permitted to serve. These problems have since been clarified and a definite service area in Fairfax County has been defined as shown in Figure 11.

SOURCES OF SUPPLY

Water supplies for the area under discussion are obtained from three sources, wells, Occoquan Creek, and the Potomac River, as shown in Table VII.

Ground water is the principal source of supply of most of the water companies. Nine companies have indicated ground water as their only source of supply while six of the remaining seven companies also rely upon ground water for varying percentages of their total demand. The Falls Church Water Company relies solely upon surface water supplies which are presently obtained exclusively from the Dalecarlia Treatment Plant by way of purchase from Arlington County. By June, 1960, the Falls Church Water Company will be obtaining water directly from the Dalecarlia Treatment Plant through a 36-inch water line at Little Falls. This line will enable Falls Church to obtain approximately 40 million gallons of treated water per day.

The one well on the Alexandria Water Company system is not pumped continually, but generally operated only during periods of small stream flow during summer months. Only about 7 percent of the Fairfax County Water Authority demand is met through the use of ground water; 93 percent is purchased from the Alexandria Water Company. Approximately 60 percent of the Town of Fairfax water demand is met through the yield of twelve wells, while Vienna obtains at least 80 percent of its demand from well water. Both of these systems purchase their additional demand from Falls Church. The Fairfax Hydraulics System depends on wells to supply at least 57 percent of total demand with the remainder being supplied by the Alexandria Water Company. All other systems depend on ground water supplies to meet total demands although the actual number of wells supplying some systems was not indicated on field data questionnaires.

During 1959 approximately 9,285 million gallons of water were pumped into systems within the area under discussion. Although well water was the primary source of supply for most companies, only about 9 percent of total water demand was obtained from ground water reservoirs. Another 17 percent of the total yearly demand was obtained from the Dalecarlia Treatment Plant; the largest percentage of total yearly demand, 74 percent, was obtained from Occoquan Creek.

TABLE VII

SOURCES OF WATER SUPPLY
FAIRFAX COUNTY, ALEXANDRIA, and FALLS CHURCH
WATER SYSTEMS, 1959

WATER SYSTEM	SOURCE OF SUPPLY	
	WELLS	OTHER
Alexandria Water Co.	1 well	Occoquan Creek
Falls Church Water Co.	-	Potomac River (Dalecarlia T.P.)
Fairfax County Water Authority	4 wells	Alexandria Water Co. (Occoquan Creek)
Town of Fairfax	12 wells	City of Falls Church (Dalecarlia T.P.)
Town of Vienna	6 wells	City of Falls Church (Dalecarlia T.P.)
Town of Herndon	3 wells	-
Fairfax Hydraulics Water Co.	4 wells	Alexandria Water Co. (Occoquan Creek)
Pimmit Service Corp.	8 wells	-
Sydnor Pump and Well Co.	9 wells	-
Tauxemont Community Assoc.	3 wells	-
Tremont Water Co.	? wells	-
Mason's Neck Water Co.	1 well	-
Wilton Woods Water Works	? wells	-
Wolfenden Subdivision	? wells	-
Woodlawn Water Co.	7 wells	-
Mt. Zephyr Construction Co.	1 well	-

All companies have indicated that present sources of supply are adequate for immediate needs. Companies which rely upon water from the Dalecarlia Treatment Plant see no shortage in supply considering planned expansion of the Dalecarlia Treatment Plant. This plant presently has a filtering capacity of 104 million gallons per day while there are plans to increase the Dalecarlia capacity, between 1961 and 1990, to 217 million gallons per day. The Alexandria Water Company and Fairfax County Water Authority see no shortage until at least the year 2000 with the Occoquan Reservoir which presently has a safe yield of 30 million gallons per day and planned expansion to 50 million gallons per day. The Town of Fairfax, as previously indicated, is converting to surface water supplies. Also, Herndon will supplement its demand from the Fairfax system. Most companies relying entirely upon ground water are generally undecided about the sufficiency of future ground water sources. Many of these companies will continue to drill more wells to meet future demands, although some will no doubt have to supplement ground water supplies with purchased water. Some, if not all, will eventually be assimilated as an integrated system under the Fairfax County Water Authority.

WATER TREATMENT

Water companies within the Region which rely upon ground water resources do not have water treatment facilities. Due to the natural percolation of water to underground reservoirs and actual underground water movements, most well water is generally pure enough for immediate consumption without chlorination or filtration.

Surface water on the other hand has been subjected to many sorts of contamination which include raw sewage, partially treated sewage effluent, decaying organic materials, and industrial wastes. Such water must be chlorinated and purified. Also, there is generally an abundant amount of solid matter in surface water which must be removed by filtration.

All water entering systems which utilize surface water has been filtrated and treated to insure purity. The Dalecarlia Treatment Plant presently has a capacity of about 104 million gallons per day and a planned capacity of about 217 million gallons per day (as previously stated). In contrast, the only other plant presently treating water for this area is owned by the Alexandria Water Company. This installation filters, chlorinates and adjusts the acidity of Occoquan Creek water. Present capacity of this installation is about 28.8 million gallons per day although additional filtering facilities are planned.

WATER STORAGE FACILITIES

In addition to the Alexandria Water Company reservoir on Occoquan Creek, there are a multitude of storage tanks and standpipes associated with nearly all water systems receiving discussion. Data pertaining to storage was not reported on all questionnaires, but data reported indicates that there are storage facilities existing with a combined capacity well in excess of 24 million gallons. Alexandria Water Company has the largest storage capacity (about 21 million gallons) in the form of open reservoirs and storage tanks. The Fairfax Hydraulics system has five reservoirs of unreported capacities; Falls Church has reported storage facilities of

2.6 million gallons capacity. Storage facilities with 175,000 and 250,000 gallon capacities are available at the Pimmit Service Corporation and Woodlawn Water Company systems, respectively, while Mason's Neck Water Company and the Tauxemont Community Association water systems have reported reserve storage capacities of 5,500 and 31,000 gallons, respectively.

Other systems also have storage facilities the amount of which is generally a refelction of total daily water consumption.

WATER CONSUMPTION

Table VI presents a statistical description of water consumption within the area of Arlington County, Fairfax County, Falls Church, and Alexandria in 1959. This data is presented cartographically in Figure 12 where average daily water consumption for the various systems is shown by circles proportionate to daily consumption. Each circle has been divided to show percentage of total consumption attributed to residential, public and institutional, industrial, and commercial water consumers.

It should be stated that the following companies have no water meters on their systems: Tauxemont Community Association, Tremont Water Company, Mason's Neck Water Company, Wolfenden Subdivision, and Mt. Zephyr Construction Company. Data for the Sydnor Pump and Well systems was incomplete, and only extremely limited data was available for Wilton Woods Water Works and Pimmit Service Corporation systems. Data for systems having no meters was estimated by assigning an average daily dwelling unit water consumption figure to known numbers of service connections. Dwelling unit consumption figures were assumed to be similar to those of nearby water systems. Data for other systems listed above was calculated as accurately as possible from reported data.

During 1959 at least 8,676.92 million gallons of water were actually consumed by residential, public and institutional, industrial, and commercial water users. This figure is 608 million gallons less than reported figures of water pumped into all systems. The Alexandria Water Company reports that it cannot account for these 608 million gallons of water which were pumped into its distribution system (this was about 9.8 percent of total water pumped into its system). Approximately 64.8 percent of total water consumed was distributed within the Alexandria Water Company system which serves the City of Alexandria and a large portion of eastern Fairfax County adjacent to the City. Another 17.5 percent of all water consumed was utilized within the Falls Church Water Company system which serves the City of Falls Church and adjacent Fairfax County. The fourteen remaining water systems, all located within Fairfax County, accounted for only about 17.7 percent of total water consumption within the area under discussion, and nearly 5 percent of this can be attributed to the Fairfax County Water Authority.

Average daily water consumption for the area under discussion is about 23.77 million gallons with individual company averages reflecting the same size distribution as exist for total yearly consumption. A range occurs between 5.6 thousand gallons and 15,406 million gallons per day while median daily water consumption is about 163,500 gallons. Average daily demand for the sixteen individual companies is 1.58 million gallons.

Distribution of Consumption - All water consumption has been divided into four basic forms of use as was done with Arlington County water consumption and will be done with Prince William and Loudoun County consumption data. Within the area under discussion approximately 65 percent of total daily water consumption was attributed to residential uses. Seven of the sixteen companies had essentially 100 percent residential water uses; fourteen of the sixteen companies record at least 75 percent residential water consumption. While residential water consumption in the Alexandria Water Company service area accounted for only 57.8 percent of total daily water demand, this Company had the largest actual residential water consumption (over 8.9 million gallons per day as opposed to the estimated Falls Church consumption of over 3 million gallons per day). Breakdowns by type of consumption for Falls Church were not available and the percentages indicated in Table VI are estimates. The highly residential character of the Falls Church, Alexandria, and Fairfax County areas is readily apparent in Table VI.

The approximately 4.9 million gallons of water consumed daily by public and institutional uses accounted for only 20.5 percent of total daily consumption. Most exclusively residential areas had little or no demand for public or institutional water while the water systems recording this type consumption had public functions requiring water since they served towns such as Fairfax, Herndon, and Vienna or cities such as Falls Church and Alexandria. The significantly large demand on the Alexandria Water Company was the result of water service to portions of the Fort Belvoir Military Reservation which in 1959 consumed nearly 2.0 million gallons of water per day.

It is at once evident from Table VI that industrial water consumption was insignificant. Only about 1.2 percent of daily water consumption was attributed to industrial uses. Again, the Alexandria Water Company distributed the largest gallonage (about 200,000 gallons per day).

Except for water systems having only residential water consumption and the Alexandria Water Company system, all other systems reported commerical water consumers as the second largest source of demand. Reported data and estimations indicate that 13.3 percent of daily water consumption was attributed to commercial uses. Demand within individual water systems was generally in excess of 15 percent while it was estimated to be at least 32 percent of total demand within the Woodlawn Water Company service area.

While commercial consumption within the Alexandria Water Company system was only 11.8 percent of total daily consumption, the actual consumption more than equaled the combined commercial consumption of all other systems.

Dwelling Unit Consumption - Within the area under discussion there were approximately 71,390 dwelling units having public or private water. About one-tenth of these relied solely upon ground water for their water while nearly 90 percent obtained water from surface sources or a combination of surface and ground water sources. Knowing the total number of dwelling units served, it can be quite reliably estimated that at least 260,700 persons relied upon public and private water systems for water. Total population for this area was estimated to be 332,850 persons on January 1, 1959. Assuming a rate of growth equivalent to the rate for the past nine years, it can be assumed that the population numbered at least 351,100 persons on January 1, 1960. This assumption being valid, it can be assumed that at least 90,000 persons within this area still relied upon the traditional domestic well for water.

A detailed breakdown of served dwelling units is presented in Table VI. It is immediately evident that the Alexandria Water Company served the greatest number of residential units - over 50 percent of those served in the area. The number of residential units served within the Falls Church water system were not reported, but it is estimated that there were at least 12,000 considering a total of 14,338 service connections in 1959. Data has been omitted for this item for the Falls Church Water Company.

Daily dwelling unit water consumption also appears in Table VI. Consumption varied from a low of approximately 113 gallons per day at the Pimmit Service Corporation system to a high of 219 gallons per day for homes on the Alexandria Water Company system. Estimations shown were based on consumption figures for adjacent water systems or averages for several systems.

A further breakdown of dwelling unit water consumption indicates that per capita water consumption for served dwelling units ranged from a low of 27 gallons per person at Pimmit Service Corporation system to a high of 66 gallons for the Mason's Neck system. Since the latter system was not metered, its per capita consumption is probably high. The Alexandria high of 61 gallons per capita is the most realistic maximum when compared to data for metered systems. Fifty-two gallons per capita per day is median for the area as a whole.

Prince William County Water Systems

Prince William County has eight public and private water systems with varying degrees of service. The largest serves an area of approximately 20 square miles, which extends from the Town of Occoquan to the north through Woodbridge, and includes many new subdivisions along Route #1 as far south as Powell Creek. This area is known as the Occoquan-Woodbridge Sanitary District. The only other section served in eastern Prince William County is around Triangle and Dumfries, adjacent to the Quantico Military Reservation. Sydnor Pump and Well Company of Richmond, Virginia, owns the Triangle-Dumfries system, and enters into contract with each customer rather than operating as a public utility serving a franchised area approved by the State Corporation Commission.

The remaining six water companies, as seen in Figure 11, serve areas in western Prince William County. These areas include the Town of Manassas and adjacent subdivisions. One company which serves a number of homes and one new shopping center near Manassas refused to supply information.

SOURCE OF WATER SUPPLY

Ground water is still the predominant source of public water in Prince William County, although nearly 41 percent presently is obtained from surface water, all of which comes from Occoquan Creek. Table VIII shows a total of 27 wells being used presently to supply the 59 percent of total demand derived from underground sources. These 27 wells are deep. Most are in excess of 300 feet and yield large quantities of water. Sunnybrook Subdivision's well produced 375 gallons per minute on a 24-hour test.

Many new wells have yields which are equal to or are larger than 100 gallons per minute.

TABLE VIII

SOURCE OF WATER SUPPLY
PRINCE WILLIAM COUNTY WATER SYSTEMS, 1959

WATER SYSTEM	SOURCE OF SUPPLY	
	WELLS	OTHER
Town of Manassas	5	-
Sunnybrook Subdivision	1	-
Manassas Park	4	-
Yorkshire Water Company	5	-
Acres Water Company	5	-
Triangle-Dumfries (Sydnor Pump and Well Co.)	7	-
Occoquan-Woodbridge Sanitary District	0	Occoquan Creek - Alexandria Water Co.

In nearly all instances there is sufficient water available from underground sources to meet present demands. With moderate growth there appear to be no problems (according to field surveys) in meeting future demands, although it probably will be necessary to develop some new wells. The exception is the Triangle-Dumfries water system which is having difficulties meeting demands due to a lack of sufficient distribution facilities and poorly yielding wells. Additional supplies and improved distribution facilities are needed here.

Sufficient water is available for the Occoquan-Woodbridge Sanitary District. Demands for the future can be met from the present source although the distribution facilities will need considerable expansion. This is generally the same situation which exists within all Prince William County water systems.

WATER STORAGE FACILITIES

Water storage data is incomplete but it is known that all the systems do not have storage facilities. The Occoquan-Woodbridge Sanitary District has two storage facilities: one, a 300,000-gallon standpipe; the other, a 275,000-gallon tank. It is not known what facilities exist in the Triangle-Dumfries service area. Sunnybrook Subdivision, Yorkshire Water Company, and Acres Water Company have no storage facilities although a reservoir is contemplated at Sunnybrook Subdivision. Manassas Park has storage facilities of unreported capacity, while the Town of Manassas has two tanks with 300,000 and 85,000-gallon capacities and a ground reservoir with an 85,000-gallon capacity.

WATER TREATMENT FACILITIES

Water entering the Occoquan-Woodbridge Sanitary District transmission system is pre-treated by the Alexandria Water Company. The only other water treatment facilities in Prince William County are at the Town of Manassas where well water is chlorinated before entering the distribution system.

WATER CONSUMPTION

Table IX presents a statistical breakdown of water consumption and service connections. Sunnybrook Subdivision presently is under development and no data is available which would contribute to the statistical tabulations. No meters are in operation yet. Yorkshire Water Company and Acres Water Company do not have meters and their consumption figures are estimates based on averages from Manassas Park. These three areas have similar economic levels. Data for the Triangle-Dumfries water system has been calculated from general information supplied by the Sydnor Pump and Well Company. The data in Table IX is probably somewhat conservative because of incomplete data, plus the fact that one water company is not included.

From Table IX it can be seen that yearly water consumption in Prince William County was over 389 million gallons. A reported 159.59 million gallons (over 41 percent) were consumed within the Occoquan-Woodbridge Sanitary District, which had experienced the greatest rate of growth in Prince William County. The Town of Manassas, which consumed over 88 million gallons of water, had the second largest water demand. Manassas Park and the Triangle-Dumfries water systems have the only other noteworthy demands.

Daily water consumption, which was in excess of one million gallons, was primarily consumed by residential functions. Estimates place daily dwelling unit consumption at 83 percent of the total daily consumption. Manassas Park was entirely residential, while Yorkshire Water Company and Acres Water Company served only five and four commercial connections, respectively.

Water consumption by public and institutional functions accounted for only five percent of total daily consumption. The Town of Manassas had the only significant water consumption in this category.

TABLE IX

PRINCE WILLIAM COUNTY WATER CONSUMPTION STATISTICS, 1959
(By Water System)

Water System	Annual a/ (Millions of Gals.)	Average Daily (Thousands of Gals.)	Daily Residential (Thousands of Gals.)	Daily Residential % of Daily	Public & Institutional (% of Daily)	Industrial (% of Daily)	Commercial (% of Daily)	Dwelling Units (D.U.) Served	b/ Daily D.U. (Gals.)	Daily c/ Per Capita/ D.U. (Gals.)
Town of Manassas	88.40	242.2	161.8	66.8	9.7	4.9	18.6	653	248	63
Sunnybrook Subdivision d/	-	-	-	-	-	-	-	4	-	-
Manassas Park	67.07	183.8	183.8	100.0	neg	-	-	1,650	111	28
Yorkshire Water Co.	9.99*	27.4*	25.4*	92.7*	-	-	7.3	229	111*	28*
Acres Water Co.	9.91*	27.4*	25.8*	94.3*	-	-	5.7	233	111*	28*
Sydnor Pump & Well Co. (Triangle-Dumfries) e/	54.43	149.1	109.7	73.5	---------- 26.5 --------			439	249	49
Occoquan-Woodbridge Sanitary District	159.59	437.2	379.8	86.7	4.2	0.6	8.5	1,756	216	55
TOTALS	389.39	1,060.1	886.3	83.6	4.7	1.5	10.2	4,964	174 f/	41 f/

* No meters on system - consumption figures based on Manassas Park daily dwelling unit consumption.

a/ All water consumption figures are based on company records for the last quarter of 1959 which were multiplied by 4 to get estimated consumption, which is probably conservative.

b/ Consumption figures are for dwelling units on distribution system.

c/ Consumption figures are for persons residing in serviced dwelling units (calculated as: Average Daily Dwelling Unit Consumption ÷ Persons per dwelling unit).

d/ A new subdivision with water consumption for only four months with no meter readings (50 homes planned).

e/ Total annual consumption based on a written report stating that monthly consumption runs to 9,000 gallons per connection. Average daily residential consumption is based on an estimated monthly dwelling unit consumption of 7,600 gallons.

f/ Average.

The County's industrial water consumption was small. The Town of Manassas had an industrial demand from several large dairies.

Of the four consumption categories, the commercial function was second to the residential consumption. Over ten percent of daily consumption was attributed to commercial functions, with the Town of Manassas having the largest single demand. Rough estimates of water consumption in the Triangle-Dumfries water system indicate that commercial consumption was nearly as large as that of Manassas.

<u>Dwelling Unit Water Consumption</u> - Prince William County had about 4,964 dwelling units on public water systems, which served an estimated 20,850 persons or approximately 39.3 percent of the County's population. The remaining 60.7 percent of the County's population was served by domestic wells.

Table IX indicates that there was an average daily dwelling unit water consumption of 174 gallons. This was a daily average of 41 gallons per resident of a served dwelling unit, computed on an average of 4.24 persons per dwelling unit.

There was a substantial variation from the County average among the service areas. The daily consumption figures reflect variations in income level and type of dwelling unit. The highest dwelling unit consumption figure occurred in the Town of Manassas where an average home consumption of 248 gallons of water per day was reported. This amounted to 63 gallons per person. Although a larger consumption figure is indicated in Table IX for the Triangle-Dumfries service area, there is some unavoidable error in deriving this figure because of incomplete service area base data.

The Occoquan-Woodbridge Sanitary District had a significantly high dwelling unit consumption which was the result of rapid growth of population and the associated increase of new homes having many water consuming appliances.

Manassas Park, with generally lower cost homes than those of other County service areas, had a low dwelling unit consumption figure of 111 gallons per day. Since Yorkshire Water Company and Acres Water Company had no meters, it is estimated that daily dwelling unit consumption was similar to that of Manassas Park. Homes and income levels are quite similar to those existing in Manassas Park.

Loudoun County Water Systems

In Loudoun County there are seven public water companies - Leesburg, Purcellville, Hamilton, Round Hill, Hillsboro, Middleburg, and Aldie - and one noteworthy private system at Foxcroft Girls School. These water systems rely upon ground water from deep wells or springs for their water supply. The exception is Middleburg where a large portion, about 90 percent, of the needed supply is derived from surface sources, see Table X.

TABLE X

SOURCE OF WATER SUPPLY
LOUDOUN COUNTY WATER SYSTEMS, 1959

WATER SYSTEM	SOURCE OF SUPPLY	
	WELLS	OTHER
Town of Leesburg	3	1 Limestone spring
Town of Hamilton	2	-
Town of Purcellville	-	Catoctin Creek (3 springs)
Town of Round Hill	-	Small streams (spring water)
Town of Hillsboro	-	Spring
Town of Middleburg	1	Little River
Aldie Water Co.	-	3 Springs
Foxcroft School	4	-

According to water system officials, the present sources of water supply should be adequate for a considerable number of years. Some communities presently are expanding their water supply by developing new wells and enlarging reservoirs. The Loudoun County Sanitation Authority, although recently created, has completed studies on the impact of the Dulles International Airport. These studies point out the future population increases which can be expected in the Broad Run area. Through an agreement with the Town of Fairfax, water will be supplied to this section of Loudoun County from the water supply source on Goose Creek which is being developed by the Town.

WATER STORAGE FACILITIES

All communities have water storage facilities, mostly in the form of elevated tanks or larger storage tanks. Leesburg's combined daily water supply of approximately 451,120 gallons (about 83,290 gallons from the spring, 57,600 gallons from well No. 1, 86,400 gallons from well No. 2, and 223,200 gallons from well No. 3) is pumped to a 90,000-gallon elevated tank and two storage tanks with 65,000 and 1.5 million-gallon capacities.

Hamilton's two wells, each producing about 10 gallons per minute, supply a single 60,000-gallon elevated steel storage tank. Purcellville, in addition to a 60,000-gallon storage tank in town, has two reservoirs, in the Blue Ridge Mountains and on Short Hill, respectively. The Blue Ridge reservoir, with a capacity of 33,000,000 gallons, is fed by two springs; while the 1,000,000-gallon Short Hill reservoir is supplied by one spring. A six-inch line transports water from the reservoirs to Purcellville.

Round Hill has two open reservoirs about one mile west of the town with capacities of 200,000 gallons and 8,500,000 gallons, respectively. The latter has been used for approximately one year. Hillsboro has an enclosed spring on Short Hill from which water flows by gravity directly into the town water system.

In the southern portion of the County, Middleburg has a 60,000-gallon elevated storage tank in town and a small additional reserve storage of about 10,000 gallons in a well at the Little River pumping-filtration plant. Spring water at Aldie is pumped directly into the distribution system and to a 1,000-gallon storage tank.

The Foxcroft School supply serves only the school property, several miles northwest of Middleburg, consisting of dormitories, horse barns, dining halls, and miscellaneous facilities. The school has an 8,000-gallon concrete underground reservoir as well as a 100,000-gallon elevated storage tank.

WATER TREATMENT FACILITIES

In contrast to plentiful storage facilities (at least for present demands), there are fewer facilities for water treatment. Leesburg has liquid chlorine applied to the water system, while Hamilton and Hillsboro have no facilities and do not have water treatment. Purcellville has chlorination facilities at its 1,000,000-gallon reservoir to treat all water entering the town distribution system. Round Hill also chlorinates its water at the 200,000-gallon reservoir.

Aldie has no treatment facilities, while the Middleburg supply is filtered and treated with aluminum sulphate. Filter effluent is treated with liquid chlorine, as is the well water. Foxcroft has no water treatment.

WATER CONSUMPTION

Loudoun County is predominantly rural. In 1950 about 20 percent of the County population were residing in the seven communities having public water. In 1959, according to field reports, there were 5,611 persons supplied with public water, while 17,595 persons relied upon domestic wells. At least 75.8 percent of the County population obtained water from domestic wells.

From detailed field reports and statistical data it is possible to estimate the approximate total County public water consumption for 1959 - 152,460,000 gallons. The distribution of use can be seen in Table XI and Figure 12. Purcellville has the largest total water consumption; Leesburg is second in total consumption. The remaining five water systems have small consumptions in comparison. Foxcroft School consumes approximately 10,500,000 gallons of water annually. Round Hill, Hillsboro, and Aldie have no water meters on their systems, therefore, the consumption figures are derived by using known service connections and multiplying them by characteristic consumption figures from County metered systems.

The largest single water consumer on each system, other than the Foxcroft system, is the residential customer, which in 1959 accounted for 45.3 percent of total daily consumption, see Table XI. Individual systems have a much larger residential consumption which ranges from a low of

28 percent at Purcellville to a high of 96 percent at Hillsboro. Five of the seven systems having residential water consumption record at least 70 percent residential water use.

Public and institutional consumption is low for each system except Foxcroft School which is entirely institutional. Consumption ranges from negligible to about 9.2 percent for the other systems with Leesburg having the second largest consumption due to its county seat function.

Only about one-half of the Loudoun County water systems have what can be termed industrial water consumption. Purcellville has the most significant industrial water consumption; in fact, over 60 percent of the total Purcellville water goes to industrial uses. A slaughter house in Purcellville consumes over 36,400,000 gallons of water per year to make it the largest single industrial consumer within Loudoun County. Industrial uses were not differentiated from commercial uses in Leesburg. Because of the abattoirs at Purcellville, industrial water consumption accounts for over 27 percent of the public water in Loudoun County.

Commercial water consumption in the County is only slightly more significant than public and institutional uses. Locally, it is decidedly more significant. For instance, commercial uses in Middleburg account for over 24 percent of total daily consumption. An estimated 22 percent of Leesburg water consumption can be attributed to commercial uses.

<u>Dwelling Unit Water Consumption</u> - Records of service connections of Loudoun County water systems indicate that there are 1,588 dwelling units on public water systems, which serve 5,611 persons, based on a County average of 3.54 persons per dwelling unit.

TABLE XI

LOUDOUN COUNTY WATER CONSUMPTION STATISTICS, 1959
(By Water System)

Water System	Annual a/ (Millions of Gals.)	Average Daily (Thousands of Gals.)	Daily Residential (Thousands of Gals.)	Daily Residential % of Daily	Public & Institutional (% of Daily)	Industrial (% of Daily)	Commercial (% of Daily)	Dwelling Units (D.U.) Served	b/ Daily D.U. (Gals.)	Daily c/ Per Capita/ D.U. (Gals.)
Purcellville	60.59	166.0	45.9	27.6	3.7	60.2	8.5	408	113	35
Leesburg	56.76	155.5	91.6	58.9	9.2	---- 31.9 ----		661	139	40.4
Middleburg	8.61	23.6	16.9	71.8	3.9	-	24.3	173	98	27.8
Round Hill	7.24*	19.8*	17.4*	87.6	neg	-	12.4	155	112*	34.5*
Hamilton	6.55	17.9	15.2	84.8	5.5	6.4	3.3	137	111	34.1
Hillsboro	1.19*	3.3*	3.1*	95.7	-	-	4.3	28	112*	34.5*
Aldie	1.02*	2.8*	2.5*	89.3	neg	6.2	4.5	26	98*	27.8*
Foxcroft School	10.50	35.0**	-	-	100.0	-	-	-	-	-
TOTALS	152.46	423.0	192.6	45.4	13.6	27.3	13.7	1,588	122 d/	34.5 d/

* Approximations based on average residential consumption of other systems (these towns have no water meters).
** During school session estimated at 300 days.
a/ All water consumption figures are based on company records for the last quarter of 1959 which were multiplied by 4 to get estimated consumption, which is probably conservative.
b/ Consumption figures are for dwelling units on distribution system.
c/ Consumption figures are for persons residing in serviced dwelling units (calculated as: Average Daily Dwelling Unit Consumption ÷ Persons per dwelling unit).
d/ Average.

No recent studies of population within Loudoun County towns have been made, but it is known that there has been considerable growth within Leesburg and Purcellville. Comparisons of present population served, with 1950 population data (Table XII), show that estimated numbers of persons presently served at Middleburg, Hamilton, and Hillsboro are below the 1950 population within the towns, thus indicating substantial population increases within these towns and/or greater service to residential units adjacent to these towns.

TABLE XII

1950 TOWN POPULATIONS AND PERSONS PRESENTLY SERVED WITH PUBLIC WATER

TOWN	1950 POPULATION a/	PERSONS PRESENTLY SERVED b/
Purcellville	945	1,326
Leesburg	1,703	2,272
Hamilton	351	445*
Hillsboro	129	91
Round Hill	403	504
Middleburg	663	645

a/ SOURCE: 1950 CENSUS OF POPULATION

b/ Estimated figures

* 110 persons (34 dwelling units) are known to be outside the Town corporate limits

Table XI shows that daily dwelling unit water consumption ranges from a low of about 98 gallons at Middleburg to a known high of 139 gallons per day at Leesburg. These consumption figures are a good indication of the general income level of residents in these communities. Consumption levels for Hillsboro and Round Hill are based on Hamilton and Purcellville dwelling unit water consumption. Aldie's consumption figure was assumed to be about the same as exists for Middleburg.

The average person on a public water supply in Loudoun County consumes an average of 34.5 gallons per day. The highest per capita consumption for served units occurs in Leesburg where the average person on public water consumes 40.4 gallons of water per day.

PART IV

SUMMARY

PART IV

SUMMARY

The Northern Virginia Region is undergoing a rapid transformation from a predominantly rural to a highly urban community. The effects of urbanization, first felt in Arlington, Alexandria, Falls Church, and eastern Fairfax County, have spread to the western portion of the Region. Western Fairfax, Loudoun, and Prince William have braced for population expansions.

Water is a prime essential for continued urbanization. Domestic wells can supply adequate water for low density development, and municipal wells can be expected to continue to supply small water systems. Greater dependence will be placed, however, on surface sources to provide public water for the largest portion of the community.

Highlights of the preceding inventory of physical elements, ground water, and public water systems are outlined as follows:

1. Regional temperatures are moderate with extreme and protracted weather conditions occurring quite infrequently.

2. Precipitation is generally adequate and well distributed throughout the year.

3. Forested areas, primarily commercial grades which are privately owned, still constitute a major item in land

use. Many areas of Virginia pines, oaks, hickories, and scrub oaks are vital for soil and water conservation, and should be maintained in their natural stage. Some of these forested areas are ideal for park, recreation, and open space use.

4. The mining of mineral resources is limited to clays used in brick manufacture, and to granites and basalts used as crushed stone.

5. The best agricultural soils of the Region occur west of the Catoctin Mountains and in west-central Fairfax County. The remaining areas, as far as agriculture is concerned, are best suited for pasture and limited cultivation.

6. Percolation ratings are best to the west of the Catoctin Mountains and in west-central Fairfax County. The remaining surveyed areas generally have fair to poor percolation ratings, especially in eastern Loudoun County and western Fairfax County.

7. Ground water occurrences are directly related to Regional geology. Of nine aquifers, three can be termed good to excellent as sources of water (the Coastal Plain deposits, schist deposits, and Newark

formation). Four formations are generally fair sources of water (granite in the eastern belt, Catoctin greenstones, Marshall granites, and Antietam to Loudoun formations). Diabase and Quantico slate are generally poor sources of ground water.

8. Thirty-three water systems served about 75 percent of the Region's population in 1959, and combined residential, public and institutional, industrial, and commercial users consumed at least 14,272.90 million gallons of water. Residential water consumption is the predominant type of consumption. Nearly 62 percent of the total demand came from surface sources while 38 percent was attributed to ground water supplies.

9. Gross per capita and dwelling unit per capita water consumption declined from eastern to western portions of the Region. Gross per capita water consumption for the Region was 87 gallons per day, while dwelling unit per capita consumption was only 54 gallons per day. Lower per capita water consumption was evident in both rural areas and areas where lower incomes are prevalent.

BIBLIOGRAPHY

BIBLIOGRAPHY

Alexander Potter Associates. Comprehensive Water Supply Plan, Fairfax County, Virginia. Preliminary Report. New York, N. Y.: March 18, 1955.

_______. Report On Evaluation of Completed and Proposed Distribution System Improvements, Arlington County, Virginia. New York, N. Y.: September, 1959

_______. Report On Water Supply and Distribution System Improvements, Arlington County, Virginia. New York, N. Y.: March 1954.

Birrell, D. V. C. Water Consumption - Maryland, District of Columbia, Virginia Metropolitan Area. Washington: August 12, 1957. (Mimeographed)

Cady, R. C. Ground-water Resources of Northern Virginia, Bulletin 50. Richmond: Virginia Geological Survey, 1938.

Cederstrom, D. J. Chemical Character of Ground Water in the Coastal Plain of Virginia, Bulletin 68. Richmond: Virginia Geological Survey, 1946.

Clayton, J. W., et al. Use of Soil Survey in Designing Septic Sewage Disposal Systems, Bulletin 509. Blacksburg, Va: Virgini Agricultural Experiment Station, VPI, August, 1959

Epperson, G. R. Soils of Virginia, Bulletin 203, Blacksburg, Va.: Virginia Polytechnic Institute and U. S. Department of Agriculture, Revised, March, 1958.

Fairfax County Water Authority. Report of Activities, Year Ended June 30, 1959. (Mimeographed)

Industrial Sites and Economic Data, Loudoun County, Virginia. Richmond, Va.: Department of Conservation and Economic Development, Division of Industrial Development, December, 1959.

Larson, Robert W. and Mackay B. Bryan. Virginia's Timber, Forest Survey Release No. 54. Asheville, N. C.: U. S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station, June, 1959.

Metcalf, Robert W., James L. Calver, and Mary E. Otte. The Mineral Industry of Virginia, Bureau of Mines, United States Department of the Interior. Washington: Government Printing Office, 1957.

Soils of Fairfax County. 2nd Ed., Series No. 3, Prepared by Fairfax County in Cooperation with the Virginia Polytechnic Institute and Soil Conservation Service, Revised July, 1958.

Soils of Loudoun County. Prepared by the Agronomy Department of Virginia Polytechnic Institute and the Soil Conservation Service.

Somerset County Planning Board. The Water Resources of Somerset County. Somerville, N. J.: Somerset County Planning Board, October, 1958.

The Committee for a Fairfax County Water System. Public Report On A Proposed Water System for Fairfax County, Virginia. McLean, Va.; March 3, 1958. (Mimeographed)

U. S. Department of Agriculture. Climatic Summary of the United States, Section 91 - Potomac River Basin, Data from Establishment of Stations to 1930, inclusive. Washington: Government Printing Office, 1932.

_______. Climatic Summary of the United States, Section 93 - Central Virginia, Data from Establishment of Stations to 1930, inclusive. Washington: Government Printing Office, 1933.

U. S. Department of Commerce. Climate Summary of the United States - Supplement for 1931 through 1952, Virginia. Washington: Government Printing Office, 1955.

_______. Climatological Data - Virginia, Annual Summary, 1953, Vol. LXIII No. 13. Chattanooga, Tenn., 1954.

_______. Climatological Data - Virginia, Annual Summary, 1954, Vol. LXIV, No. 13. Asheville, N. C., 1955.

_______. Climatological Data - Virginia, Annual Summary, 1955, Vol. LXV, No. 13. Asheville, N. C., 1956.

_______. Climatological Data - Virginia, Annual Summary, 1956, Vol. LXVI, No. 13. Asheville, N. C., 1957.

_______. Climatological Data - Virginia, Annual Summary, 1957, Vol. LXVII, No. 13. Asheville, N. C., 1958.

_______. Climatological Data - Virginia, Annual Summary, 1958, Vol. LXVIII, No. 13. Asheville, N. C., 1959.

_______. Local Climatological Data, Washington, D. C., Washington National Airport, 1956. Asheville, N. C., 1957.

Water Supply. Staff Report Prepared for the Joint Committee on Washington Metropolitan Problems on Water Supply in the Washington Metropolitan Area, 85th Congress, 2d Session. Washington: Government Printing Office, 1958.