~~[illegible]~~ - E - Ringwood 08/8/1983
ML

Environmental Report in the matter of Countryside properties v Ringwood Borough.

pg. 21
double sided.

Attachment: Table III - 1 public water supply wells pgs.
Table III - 2 1982 av. water consumption
Table III - 3. aver. annual water consum.
Table III - 4 1982 av. water. cons.

E. - wastewater disposal issues in Ringwood p 5 double-sided

Steep slope issue in Ringwood pgs. 12 double sided

Trout waters in Ringwood pgs 7 double sided

Environmental factors and zoning. pgs 11 double sided.

67 pages

~~[illegible]~~
ML 000593 E

ML000593E

CZT7

Robert M. Hordon, Ph.D.

Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824
(201) 297-8899

ENVIRONMENTAL REPORT

in the matter of

COUNTRYSIDE PROPERTIES, INC.

AND WALLACE & CZURA LAND CO.

versus

RINGWOOD BOROUGH

Prepared for:

Lawrence D. Katz, Esq.
Scangarella, Feeney & Katz
Pompton Plains, New Jersey

August 8, 1983

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824
(201) 297-8899

October 3, 1984

Mrs. Barbara Walsh
Land Use Administrator
Ringwood Borough
Ringwood, New Jersey 07456

Dear Mrs. Walsh:

Pursuant to your recent request, enclosed please find copies of the following reports:

1. "Environmental Report in the matter of Countryside Properties, Inc. and Wallace & Czura Land Co. versus Ringwood Borough", August 8, 1983, 115 pp.

2. "Environmental Factors and Planning: A Brief Review of Selected State Documents", December 15, 1983, 10 pp.

3. "Environmental Factors and Planning: Ringwood's Designation under the State Development Guide Plan" December 30, 1983, 9 pp.

Very truly yours,

Robert M. Hordon

Robert M. Hordon

RMH/mk

Encs.

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824
(201) 297-8899

August 10, 1983

Lawrence D. Katz, Esq.
Scangarella, Feeney & Katz
Box 216
Pompton Plains, NJ 07444

Dear Larry:

Enclosed please find my Environmental Report re: Countryside Properties, Inc. versus Ringwood Borough.

Please feel free to contact me at any time if you need additional information or clarification. I expect to be in New Jersey for the remainder of August except for the week of August 29 - September 2, 1983.

Very truly yours,

Robert M. Hordon

RMH/mk

Encls.

cc: Mr. George N. Holzapfel, Jr.
Mr. Malcolm Kasler

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824
(201) 297-8899

ENVIRONMENTAL REPORT FOR RINGWOOD

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824

(201) 297-8899

I. SUMMARY AND CONCLUSIONS

1. The total population in Ringwood in 1980 was estimated to be 12,625, of which an estimated 10,380 (or 82.2 percent of the total population) depended wholly on public water systems.

2. The Windbeam and Skyline public water systems serve an estimated population of 10,000 in the eastern part of the borough. The average annual consumption was 0.52 mgd (million gallons/day) in 1982 which is much less than the diversion rights for the 8 wells in the two systems (including the Beattie Lane well) of 1.58 mgd.

The Windbeam and Skyline systems are in the process of becoming one integrated system, whereas the Upper Ringwood or Mine area supply remains a small separate system.

3. Ringwood can also purchase up to 2.0 mgd from the Passaic Valley Water Commission at Wanaque Reservoir in addition to supplementary purchases from Wanaque Borough.

4. The major problem with the Ringwood public water system is one of distribution rather than supply. Specifically, old undersized pipes in the Windbeam system and limited ability

to transfer water from the Skyline system where the new Beattie Lane well is located represent distributional problems. The favorable supply factors for Ringwood include the addition of the high yielding Beattie Lane well (510 gals/minute) and the ability to purchase up to 2.0 mgd of treated water from a major purveyor whenever it is needed.

5. Approximately 2,245 persons (or 17.8 percent of the total population) are not served by public water systems and are therefore, dependent on domestic wells. The dry year yield from the Precambrian bedrock formations is estimated to be in the range of 0.12 - 0.20 mgd/square mile. Based on an estimated per capita consumption rate of 75 gals/person/day and assuming 3 persons/dwelling unit, it takes about one acre to supply each dwelling unit with sufficient ground water. This residential density recommendation is based only on water supply and excludes water quality considerations.

6. The overwhelming majority of residences in Ringwood (97 percent) rely on onsite septic system disposal. Only 122 residences (out of a total of 3,853 residences in the borough) are connected to two small package treatment plants.

The James Drive package plant on High Mountain Brook serves 108 residences and generally operates at or above its design capacity of 36,000 gallons/day. Expansion of the plant may not be cost-effective since some form of advanced waste treatment and nutrient removal may be required in order to avoid potential eutrophication problems in Skyline Lakes which are only 0.6 miles downstream of the outfall location.

Since the bulk of the population in Ringwood is not served by public sewers, it is important to recognize the physical properties of the soil that affect the long-term viability of onsite septic disposal systems. These properties include:

a. soil permeability (ability of water to move through the soil);
b. depth to seasonal high water (must be at least 4 feet);
c. depth to bedrock (must be at least 10 feet below the finished ground surface);
d. slope;
e. rock outcrops.

Based on these physical properties, the Soil Conservation Service classifies all soils as having either slight, moderate, or severe limitations for development, including septic tank disposal fields. The vast majority of the soils in Ringwood (about 89 percent) have moderate-severe and severe limitations for development. Only 5 percent of the soils in the borough have moderate or slight limitations for development.

8. A nitrate dilution model for onsite disposal of domestic wastewater provides for the determination of residential land use densities (i.e., minimum lot sizes) based on the amount of nitrates originating from septic systems that can be released into an aquifer without contravening water quality standards. Application of the model to those areas in Ringwood without public water and sewer indicates that residential lot sizes ranging from 2.3 - 3.9 acres/dwelling unit (depending upon soil type) will prevent potential ground water contamination by nitrates.

9. A brief history of the sewering issues in Ringwood reveals that some of the numerous factors underlying the long sewering versus non-sewering controversy include, but are not limited to, the following:

a. existing dry sewers (mostly around Cupsaw Lake but also in other parts of the lakes study area);
b. existing small package plants with limited service areas which are operating at or above their design capacity;
c. presumed septic system failures and questions about whether or not they can be repaired;
d. older homes on small rocky lots built right along the shores of recreational lakes;

e. a preponderance of soils with severe limitations for onsite septic systems;

f. proposals for development densities that could lead to potential nitrate contamination of wells;

g. development pressures for multi-family housing;

h. public opposition to sewers.

10. Alternative designs for onsite wastewater disposal systems may be considered when site conditions preclude the use of conventional septic disposal. These alternative designs include mound systems, artificial drainage systems (curtain drains), denitrification systems, aerobic (extended aeration) units, and cluster or communal systems.

Many of these designs are more costly than conventional systems, and also have continuing operation and maintenance expenses. The selection of a particular type of alternate design depends upon detailed site investigation.

11. Until the sewering question is resolved, it is difficult to see how any high density development such as multi-family housing can occur in Ringwood. In specific cases, some type of alternative (and expensive) disposal design may be adopted, but each design would have to be considered carefully in order to evaluate its efficacy in removing contaminants. It is worthwhile noting here that aerobic systems, one common

type of alternative design, does not remove nitrates from the effluent.

In the absence of public sewers, admittedly a distinct possibility in Ringwood for years to come, wastewater disposal options in the borough would mainly rest on the capability of the soils to handle septic system effluent, both quantitatively (hydraulically) and qualitatively (contaminant removal). In this instance, given the physical limitations found in the soils of Ringwood, the establishment and/or continuance of some form of low density zoning is justified.

12. Steep slopes represent one important form of a critical area. Numerous communities, both in New Jersey and in other states, have recognized that construction activities on hill-sides can result in severe erosion and runoff problems. Consequently, many of these communities have adopted some form of slope-density regulation governing permissible development densities on steep slopes. Ringwood's slope-density ordinance is therefore quite typical in this regard.

Ringwood happens to be located in that portion of New Jersey (the Highlands region) where steep slopes are the rule rather than the exception. This means that large portions of the borough are environmentally sensitive and it is only reasonable to expect that this factor be taken into considera-tion in the zoning process.

13. Anthropogenic activities from both point and non-point sources may introduce pollutants into the aquatic environment and degrade water quality. One recognized method of avoiding degradation of the aquatic environment is to protect the most sensitive species within the aquatic community, thereby presumably protecting the entire system. Trout require very high quality waters and are particularly sensitive to changes in environmental conditions. Thus, if we base water quality and physical habitat recommendations for trout waters on trout requirements, sufficient protection and preservation of aquatic life in these waters from degradation should result.

Almost the entire borough of Ringwood has either trout production or trout maintenance waters. The only part of the borough that has non-trout waters is the Skyline's Lakes section south of High Mountain Brook.

Potential storm water runoff contamination assumes even greater importance when receiving waters are classified as either trout maintenance or trout production. Nonpoint source pollutants from stormwater runoff generally increase as development density increases, although mitigative measures can be employed so as to reduce anticipated loads. These mitigative measures are somewhat more difficult to employ on steeply sloping lands as they are expensive and require more land.

14. Several major state documents (Northeast New Jersey Water Quality Management Plan, State Development Guide Plan, and New Jersey Stormwater Quantity/Quality Management Manual) and judicial decisions (Mount Laurel II) clearly indicate that environmental factors should play an important role in the zoning process. All of the aforementioned reports stress the relationship between water quality, land use and critical environmental areas. Furthermore, the Municipal Land Use Law requires municipalities to take environmental factors into account in the preparation of master plans.

Environmentally-based master planning can identify areas where development could result in substantial local and regional water quality problems. Ringwood is located in that part of New Jersey where environmentally-sensitive lands (steep slopes, soils with severe limitations for onsite septic systems, wetlands, woodlands, etc.) predominate. In addition, all of Ringwood is located within a headwater area. Most of Ringwood drains into Wanaque Reservoir while the southeastern section of the borough drains into the Wanaque River and then the Passaic River which is used as a source for public potable water supply. The important thing is that uncontrolled development in headwater areas can result in substantial local and regional water quality impacts.

In conclusion, it is only reasonable for good planning in Ringwood to include environmental factors in the zoning process.

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824
(201) 297-8899

II. BACKGROUND

As a consequence of litigation in the matter of Countryside Properties, Inc., et als., v. Mayor and Council of the Borough of Ringwood, Docket No.: L-67718-80, in the Passaic County Superior Court, R. M. Hordon (hereinafter designated as "Consultant") was contacted by Richard J. Clemack, Esq. in a letter dated October 9, 1981, to assist defending the borough in the lawsuit. An Agreement between the Consultant and the governing body of Ringwood was made on November 20, 1981 wherein the Consultant would perform such geographical, hydrological, soils, environmental, and other studies that would be appropriate to the case.

Following the adoption of a new comprehensive zoning ordinance, the plaintiffs instituted a new action entitled: Countryside Properties, Inc., a N.J. Corporation and Wallace and Czura Land Co., a N.J. Partnership versus Mayor and Council of the Borough of Ringwood and the Planning Board of the Borough of Ringwood, Docket No.: L-42095-81. Consequently, an addendum to the November 20, 1981 Agreement was made on

May 11, 1982 wherein the services of the Consultant were to be retained to aid in the defense of the borough.

The enclosed report covers the environmental areas mentioned in the agreement.

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824

(201) 297-8899

III. WATER SUPPLY IN RINGWOOD

Outline

A. Summary and Conclusions

B. The Windbeam Water System

C. The Skyline (Main) System

D. The Upper Ringwood (Mine Area) System

E. Domestic Wells

List of Tables

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824
(201) 297-8899

III. WATER SUPPLY IN RINGWOOD

A. Summary and Conclusions

1. The total population in Ringwood in 1980 was estimated to be 12,625. Out of this total, an estimated 10,380. (or 82.2 percent) depend wholly or partly on municipally supplied public potable water.

2. The three public water systems serving Ringwood are as follows:

Water System	1982 Estimated Population Served	Average Consumption in 1982 (MGD)
Skyline (Main)	5,000	0.277
Windbeam	5,000	0.243
Upper Ringwood (Mine)	380	0.030
	10,380	0.550

3. The Windbeam and Skyline systems obtain water from 5 wells and 3 wells, respectively. A new high-yielding well (Beattie Lane) is expected to come on line by August, 1983 for the Skyline system.

4. The Windbeam and Skyline systems are in the process of becoming one integrated system, whereas the Upper Ringwood (Mine area) supply remains a small, separate system.

5. Ringwood can also purchase up to 2.0 mgd (million gallons/ day) from the Passaic Valley Water Commission at a wholesale rate of $515 per million gallons. This surface water is obtained from

a 16" connection through Wanaque Borough to a transfer point below the North Jersey District Water Supply Commission water treatment plant near the Wanaque Reservoir.

6. In addition, Ringwood purchases 5-6 million gallons per year from Wanaque Borough, at a cost of $800/MG (million gallons) through an 8" connection. This water is used to supplement water distribution in portions of the Skyline system.

7. The total diversion rights for the Skyline and Windbeam systems are 1.58 mgd, as follows:

Existing diversion rights for Ringwood:	0.856 mgd
Diversion rights for Beattie Lane:	0.724 mgd
Total diversion rights:	1.580 mgd

8. The major problem with the Ringwood public water system is one of distribution rather than supply. Specifically, undersized pipes in the Windbeam system and limited ability to transfer water from the Skyline system where the new Beattie Lane well is located to the Windbeam system represent distributional problems. The favorable supply factors for Ringwood include the addition of the high yielding Beattie Lane well and the ability to purchase up to 2 mgd of finished water from a major purveyor whenever it is needed.

9. Per capita consumption of water in Ringwood for 1982 averaged 55 and 49 GPCD (gallons/capita/day) for the Skyline and Windbeam systems, respectively. These GPCD rates are lower than other communities in New Jersey and are probably caused by one or more of the following factors:

a) the use of existing, onsite domestic wells as a supplementary source of water,*

b) the presence of septic systems which tends to reduce water usage;

c) the lag effect of drought-imposed restrictions in 1981.

10. Approximately 2,245 persons (or 17.8 percent of the total population of Ringwood) are not served by public water systems and are therefore dependent on domestic wells. The dry year yield from the underlying Precambrian bedrock is estimated to be in the range of 0.12 - 0.20 mgd/sguare mile. Based on an estimated per capita consumption rate of 75 GPCD and 3 persons/dwelling unit, it takes about one acre to supply each dwelling unit with sufficient ground water. This residential density recommendation is based only on water supply and excludes water quality considerations.

B. The Windbeam Water System

The Windbeam Water Company was a small private purveyor servicing homes in the Erskine and Cupsaw Lakes areas of Ringwood. The system was purchased by Ringwood in 1978 and the diversion rights of the Windbeam company were transferred to the borough on December 12, 1980.

As shown in Table 1, the Windbeam system consists of 5 wells, three of which are drilled in bedrock and the remaining two in sand and gravel. Some of the yields from the bedrock wells have been decreasing in recent years, presumably reflecting the limited storage within the Precambrian bedrock.

The average water consumption for the Windbeam system in 1982 is shown in Table 2. The consumption ranged from a low of 0.215 mgd in July to a high of 0.268 in May, averaging 0.243 mgd for the year. The relatively low maximum month/minimum month ratio of 1.25 indicates the limited variation from month to.month during the study.

Based on an estimated population served of 5,000, the per capita consumption of water for the Windbeam system in 1982 was 49 GPCD (gals/person/day). All residents in the Windbeam service area at present are on their own septic systems. In addition, the low per capita consumption may be caused by the fact that some of the homes in the area use older, onsite wells to supplement the municipal supply (Malcolm Pirnie, 1979).

One of the major problems in the Windbeam system is the existence of undersized and shallow pipes - some of the lines are as small as 1-1/2". Shallow pipes of course are prone to frost damage and should have been dug at greater depths in the ground.

The Windbeam system is now connected to the main Ringwood supply by an 8" line along James Drive to Old Forge Road (see Fig. 1). As the new sources of water for eastern Ringwood are developed (Beattie Lane and the PVWC connection) in the Skyline Lakes section, the ability to transfer water from the main Ringwood supply to the Windbeam section becomes paramount. This is considered to be a distributional problem rather than one of inadequate source supply (Zaniello interview, Dec. 1, 1982).

C. The Skyline (Main) System

Ringwood Borough acquired the distribution system in the Skyline Lakes area on January 1, 1969 (Water Supply Application No. 1439, NJDEP, Trenton). The High Point distribution system and wells was acquired from the developer by Ringwood and added to the Skyline system later on (Water Supply Application No. 1445, NJDEP, Trenton).

The Skyline system now consists of 3 wells (soon to be 4). Two of these wells are drilled in bedrock and the other two are in sand and gravel (see Table 1).

The water consumption in 1982 for the Ringwood system is shown in Table 2. The values range from 0.198 mgd in April to a high of 0.471 mgd in July, averaging 0.277 for the year. The maximum month/minimum month ratio for the Skyline system alone was 1.66 which is slightly greater than the ratio of 1.25 for the Windbeam system (see Table 2).

The diversion records for the Skyline and Windbeam systems for part of 1982 were affected by the purchase of water from the Passaic Valley Water Commission (PVWC). Ringwood has a 16" connection with the PVWC through Wanaque Borough (Kane interview, Dec. 3, 1982). The Ringwood contract with the PVWC was made on Oct. 3, 1979 and allow the purchase of up to 2 mgd of finished water from the

PVW^s allotment of Wanaque Reservoir water at a wholesale price of $515/million gallons. The contract runs for 15 years and also does not require a minimum purchase (Inhoffer phone interview, Dec. 10, 1982).

The per capita consumption of water for the Skyline system was 55 GPCD in 1982, based on an estimated population served of 5,000. Note that this per capita consumption rate (55 GPCD) was slightly greater than that for the Windbeam system (49 GPCD) for 1982. However, both per capita values are lower than what one would expect from single family homes. Again, the fact that some of the homes in the Skyline service area have their own wells to supplement the municipal supply helps to explain the lower consumption values.

Table 3 shows the average annual water consumption for the Skyline system from 1969 to 1982. Note that the consumption has been reasonably steady for the past 5 years.

The Beattie Lane well represents the newest addition to the Ringwood list of wells. It is an 8" well drilled in 1981 to a depth of 89 feet in a sand and gravel deposit. The new well (now known as Ringwood Well No. 9) has a reported yield of 510 GPM (or 0.734 mgd) based on a 72-hour drawdown test conducted during Jan. 5-8, 1981 (Water Supply Application No. 1856, NJDEP, Trenton). The specific capacity, which is a measure of the hydraulic properties of a well (yield divided by drawdown), is a very high 39.23 gallons/ foot of drawdown. This well is productive enough to supply all of the existing served areas of the Windbeam and Skyline systems if the distribution system could be strengthened in the form of additional pump houses and storage tanks. The Beattie Lane well is expected to come on line by August, 1983 (McDowell phone interview, June 23, 1983).

Ringwood has been granted diversion rights of 22,032,000 gallons/month (or 0.724 mgd) for a maximum month for the Beattie Lane well (Water Supply Application No. 1856, NJDEP, Trenton). This amount alone (0.724 mgd) is more than the combined 1982 average annual pumpage of 0.550 mgd for the entire borough of Ringwood which is served by public water. This easily explains the significance of the Beattie Lane well to the overall water supply picture in Ringwood.

The Beattie Lane diversion rights of 0.724 mgd is in addition to the existing diversion rights of Ringwood for 0.856 mgd. This brings the total diversion rights for the Skyline and Windbeam systems to 1.58 mgd which is well in excess of the anticipated demand.

Ringwood can also purchase additional water from Wanaque Borough through an 8" connection at a wholesale cost of $800/million gallons. Given the PVWC connection and the Beattie Lane well, it is expected that the Wanaque Borough connection would be used only for emergency purposes.

The combined Skyline and Windbeam systems served an estimated 10,000 people in 1982 with an annual average consumption of 0.519 mgd. The overall per capita consumption rate was 52 GPCD (see Table 2).

D. The Upper Ringwood (Mine Area) System

The upper Ringwood or mine area is supplied by an open spring opposite the municipal building on Margaret King Ave. The average consumption in 1982 was 30,000 GPD (gallons/day), which when combined with an estimated population served of 380 results in a per capita consumption rate of 79 GPCD (see Table 4).

The diversion rights for the mine area of 75,000 GPD dates back to an agreement with the people who owned the upper Ringwood mines prior to the construction of the Wanaque Reservoir and the North Jersey District Water Supply Commission (NJDWSC). The agreement is in the form of deed reservations which reflect use restrictions from the mining days for the mine area (Peck phone interview, Feb. 11, 1983).

The NJDWSC has no objections to the use of the 75,000 GPD either within or outside the immediate mine area for either residential, commercial or industrial uses (Noll interview, March 2, 1983). This means that part of the 75,000 GPD could be transferred to the Windbeam system if a pipeline were constructed to connect the two systems. However, the NJDWSC would oppose any surface water diversion greater than 75,000 GPD in the mine area (Noll, phone interview, June 23, 1983).

Interestingly, ground water diversions would be permissible in the mine area subject to NJDEP regulations governing diversions greater than 100,000 GPD. The difference between the NJDWSC concern over surface vs. ground water diversions presumably reflects the uncertainties over ground water flow into the Wanaque Reservoir.

In sum, the upper Ringwood supply is a small water system which is not now connected to any other public system in Ringwood. The current usage of 30,000 GPD is less than half that of the 75,000 GPD diversion, indicating that the system has additional capacity to take on new customers in the future.

E. Domestic Wells

The total population of Ringwood in 1980 was estimated to be 12,625. The estimated population served by public water systems was 10,380 (or 82.2 percent of the total). This leaves an estimated 2,245 persons (or 17.8 percent of the total Ringwood population) dependent on local, onsite domestic wells. Most of this population is located in Stonetown.

Well yields in unconsolidated formations (such as sand and gravel deposits) are primarily a function of the degree of "primary porosity" of the underlying formation. In this instance, water is stored within the pore spaces surrounding the individual grains of the earth material. In contrast, well yields in consolidated formations (such as Precambrian bedrock) depend upon the degree of "secondary porosity" within the formation. The term "secondary porosity" refers to the amount of space that is available within a formation to store water as a consequence of fracturing and faulting. Obviously, the more numerous, larger and interconnected the fractures are within a formation, the higher the anticipated yields.

Well yields in fractured formations are also more difficult to predict, inasmuch as the "internal plumbing[11] and degree of fracture interconnection is extremely variable. This helps explain why well yields can vary widely within a short distance; the higher yielding well simply intersected a larger and more interconnected set of fractures.

The underlying geologic formation in Ringwood is Precambrian bedrock. Although there are mineralogical and structural differences among the various Precambrian formations, they can be grouped together as one based on similar geohydrologic properties, i.e., water-yielding attributes in the absence of detailed aquifer tests. Thus the same yield estimates will be applied to all of the Precambrian rocks.

The estimated dry year yields from unweathered Precambrian granite and gneiss formations in Ringwood ranges from 0.12 to 0.20 mgd/square mile, as follows:

Reference	Drv Year Yield in mad/square mile
NJDEP (1974)	0.12 - 0.17
Vecchioli & Miller (1973)	0.12
Posten (1982)	0.18 - 0.20

The amount of ground water available for development is a function of the number of consumers, the yield of the aquifer, and the per capita demand. This relationship can be expressed in the following equation:

$$Dws = \frac{Y}{640\ (Qs)\ P}$$

where Dws = development density in dwelling units (DU)/acre based on water supply

Y = ground water yield in gals/day/square mile

640 = conversion factor in acres/square mile

Qs = water supply demand in GPCD

P = number of people/DU

The following assumptions were made in applying the equation to Ringwood:

Y = 0.16 mgd/sq. mi. or 160,000 GPD/sq. mi.

Qs = 75 GPCD

P = 3 persons/DU

Substituting in the equation,

$$Dws = \frac{160,006}{640\ (75)\ 3} = \text{1B11 DU/acre}$$

or 0.9 acre/DU

Therefore, it is estimated that it would take about one acre to support each dwelling unit in those portions of Ringwood which do not have water supply infrastructure. Note that the 75 GPCD estimate is somewhat higher than the 49 and 55 GPCD estimates for the Windbeam and Skyline public water systems, inasmuch as a portion of the Erskine and Skyline Lakes homeowners have their own wells and use them to supplement municipal water. Thus, the real per capita values are probably higher than the estimated ones reported herein.

In sum, in **the** absence of water supply infrastructure, it takes about **one acre to** supply the average dwelling unit in Ringwood with sufficient ground water from the Precambrian bedrock. Note that this value does not include water quality and slope considerations, factors which are discussed in other sections of this report.

Table UI-1

PUBLIC WATER SUPPLY WELLS IN RINGWOOD, N.J.

Location	New Well No.	Old Well No.	Year Drilled	Diameter (inches)	Aquifer	Depth (feet)	Yield (GPM)
			A. Windbeam System				
Brooksyde Ave. & Orchard Rd.	1	1	1927	6	Bedrock	164	30
Valley Rd. near Longview Ave.	2	2	196?	8	"	190	105
Brooksyde Ave. near Tice Place	3	3	1931	6	"	180	69
Sand pit at bottom of ^Skyline Jbrive	4	4	1937	8	Sand and Gravel	100	58
Sand pit off Skyline Drive	8	6	1969	12	Sand and Gravel	50	200
			B. Sky1ine (Main) System				
Skyline Drive off James Drive (Kozy Court Well)	5	1	1967	8	Bedrock	304	28
Skyline Drive near Edward Drive (Skyline Drive Well)	6	2	1968	8	"	294	36
Skyline Lakes Drive near Edgewood Road	7	1	19^8	8	Sand and Gravel	50	250
Beattie Lane	9	--	1981	8	Sand and Gravel	89	510
			C. Upper Ringwood (Mine Area) System				
Margaret King Ave. near Sloatsburg Rd.		Cistern fed by open spring					

Table III-2

1982 AVERAGE WATER CONSUMPTION FOR THE SKYLINE (MAIN) AND WINDBEAM WATER SYSTEMS (IN MGD)

	PVWC (1)	Skyline	Skyline and PVWC	Windbeam	Grand Total
Jan	-	0.205	0.205	0.251	0.456
Feb	-	0.217	0.217	0.249	0.466
Mar	-	0.206	0.206	0.244	0.450
Apr	-	0.198	0.198	0.253	0.451
May	-	0.231	0.231	0.268	0.499
June	-	0.264	0.264	0.256	0.520
July	0.143	0.328	0.471	0.215	0.686
Aug	0.095	0.262	0.357	0.255	0.612
Sept	0.121	0.243	0.364	0.239	0.603
Oct	0.101	0.240	0.341	0.224	0.565
Nov	-	0.234	0.234	0.218	0.452
Dec	-	0.230	0.230	"0.238	0.468
Average Annual	0.038	0.238	0.277	0.243	0.519
Est. Pop. Served	-	-	5,000	5,000	10,000
No. of Connections	-	-	1,500	1,400	2,900
Max. Month/ Min. Month	-	1.66	2.38	1.25	1.52
GPCD (2)	-	-	55	49	52

(1) Water purchased from the Passaic Valley Water Commission.

(2) Gallons/capita/day

Source: Personal interview with Harold McDowell, Ringwood Sup't. of Public Works, February 2 and 10, 1983.

^N

Table III-3

AVERAGE ANNUAL WATER CONSUMPTION FOR

THE SKYLINE (MAIN) SYSTEM, 1969-82

Year	MGD
1969	0.016
70	0.087
71	0.105
72	0.119
73	0.159
74	0.190
75	0.190
76	0.205
77	0.246
78	0.298
79	0.287
80	0.276
81	0.275
1982	0.277

Source: Quarterly Reports, File No. 373, NJDEP, Trenton.

~N

Table III-4

1982 AVERAGE WATER CONSUMPTION IN THE UPPER RINGWOOD (MINE) AREA

Month	MGD
Jan	0.049
Feb	0.064
Mar	0.032
Apr	0.023
May	0.026
June	0.024
July	0.033
Aug	0.021
Sept	0.020
Oct	0.025
Nov	0.017
Dec	0.021
Annual Average	0.030
Estimated Population Served	380
No. of Connections	40
Max. Month/Min. Month	3.76
Gallons/capita/day	79

Source: Personal interview with Harold McDowell, Ringwood Sup't. of Public Works, February 2, 1983.

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824
(201) 297-8899

IV. WASTEWATER DISPOSAL ISSUES IN RINGWOOD

A. Introduction

B. Existing Waste-water Treatment Plants

1. James Drive Treatment Plant
2. Other Treatment Plants

C. Septic Systems

D. Soil Survey of Passaic County

E. Nitrate Dilution Model

1. Introduction
2. Nitrogen Transformation and Transport
3. Lot Size Recommendations in the Literature
4. The Nitrate Dilution Model
5. Infiltration to Ground Water Recharge
6. Public Health Standards for Nitrates
7. Denitrification
8. Nitrogen Concentrations in Septic Effluent
9. Per Capita Effluent Generation
10. Dwelling Unit Occupance
11. Application of the Model to Ringwood
12. Discussion

F. Sewering Issues

1. Introduction
2. Brief History of Ringwood and Regional Sewer Plans
3. Septic System Mail Survey
4. Weston Air Photo Survey

G. Alternative Onsite Systems

1. Introduction
2. Mound Systems
3. Artificial Drainage Systems
4. Denitrification Systems
5. Aerobic Systems
6. Communal Systems
7. Conclusion

H. Discussion

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824
(201) 297-8899

List of Tables

IV. WASTEWATER DISPOSAL ISSUES IN RINGWOOD

A. Introduction

Wastewater disposal in Ring-wood has been one of the most contentious issues facing the community in both intensity and duration. Ringwood has been embroiled in sewering versus non-sewering controversies for the past 13 years and which still continue today. The sewering situation has been clouded by obvious differences of opinion among local residents as well as by shifting support for funding by state and federal sources. There is even considerable disagreement about the extent of septic system failures and the possibility of repair of these systems. It is beyond the scope of this report to completely condense the voluminous materials and reports that have been prepared by a variety of consulting firms to help resolve the sewering question. However, it would be helpful to provide at least an overview of the major wastewater disposal issues.

To begin with, only a small portion of Ringwood has public sewer infrastructure. A total of 122 residences are connected to two small package plants. This amounts to only 3.2 percent of the total number (3,853) of dwelling units in the borough. Therefore, the overwhelming majority of residences in Ringwood (97 percent) rely on onsite septic system disposal.

The physical properties that affect the long-term viability of septic disposal systems include:

a. soil permeability (ability of water to move through the soil);

b. depth to seasonal high water (must be at least 4 feet);

c. depth to bedrock (must be at least 10 feet below the finished ground surface);

d. slope;

e. rock outcrops.

Based on these physical properties, the SCS classifies all soils as having either slight, moderate, or severe limitations for development, including septic tank disposal fields. The bulk of the soils in Ringwood (about 89 percent) have moderate-severe and severe limitations for development. Only 5 percent of the borough has moderate or slight limitations for development.

A brief history of the sewering issues in Ringwood indicates that some of the numerous factors underlying the long-simmering sewering versus non-sewering controversy include, but are not limited to, the following:

a. existing dry sewers (mostly around Cupsaw Lake but also in other parts of the lakes study area);

b. existing small package plants with limited service areas which are operating at or above their design capacity;

c. presumed septic system failures and whether or not they can be repaired;

d. older homes on small, rocky lots built right along the shores of recreational lakes;

e. a preponderance of soils with severe limitations for septic systems;

f. development densities that could lead to potential nitrate contamination of wells;

g. development pressures for multi-family housing;

h. public opposition to sewers.

As with water supply, Ringwood can be divided into several study areas on the basis of wastewater disposal. As indicated before, a very small fraction of the community is already connected to package treatment plants. Another larger section of Ringwood has public water but no sewers. Consequently, development densities in this area (in terms of wastewater disposal) would depend on the hydraulic capability of the soil to absorb septic effluent. Development densities in the third section of Ringwood, as exemplified by Stonetown which has no public water or sewer, would depend on the capability of the soils to handle septic system effluent both quantitatively (hydraulically) and qualitatively (contaminant removal). In the latter instance, a nutrient dilution model can be employed to assist in the determination of a minimum lot size.

In sum, Ringwood can be grouped into the following areas based on wastewater disposal:

1) Sewer infrastructure available (example: High Point Homes near James Drive);
2) Public water available but continued reliance on septic system disposal (example: lakes area);
3) No public water or sewer infrastructure (example: Stonetown).

It is obvious that sewering will have a dramatic impact on development densities. Given the current sewering versus non-sewering controversy in Ringwood, it would be difficult within the context of this report to specify what areas of the borough would be sewered. Accordingly, this report will consider the zoning densities in terms of wastewater disposal for the aforementioned three areas of Ringwood, recognizing that sewering or alternative types of treatment could change the density.

B. Existing Wastewater Treatment Plants

1. James Drive Treatment Plant

The Ringwood Borough Sewerage Authority (RBSA) operates a secondary package sewage treatment plant near the intersection of James Drive and Skyline Drive (see Fig. IV-1). The outfall location is 150 yards east of Skyline Drive on High Mountain Brook and approximately 3300 feet (0.63 miles) upstream of Skyline Lake.

The design capacity of the plant which serves 108 residential dwellings is 36,000 gals/day (gpd). According to Permit No. NJ-

0027006, the 30-day average effluent flow should not exceed 36,000 gpd. However, the limit was exceeded most of the time during 1981-82 (10 months in 1981 and 9 months in 1982). The average annual effluent discharge was 40,000 and 44,300 gpd in 1981 and 1982, respectively. Presumably, the excess inflow is caused by a high water table in the area, infiltration, and possible illegal sump pump connections.

The plant has been improved recently with the addition of new filter beds and other modifications (Wichterman, 1982). These improvements have resulted in average monthly final effluent concentrations for biochemical oxygen demand (BOD) and suspended solids (SS) for 1981 and 1982 to fall well within permit limitations. For example, the average annual BOD and SS removal was 91 and 95 percent, respectively, during the period June 1982-April 1983.

In short, although the plant has been operating in excess of its design capacity for many years, BOD and SS'removal rates are generally satisfactory. As the infiltration problems are taken care of by the borough, it is anticipated that the excess flows coming into the plant will be reduced.

It is apparent from the foregoing discussion that the James Drive plant is at capacity and that no new connections can be accepted. However, the plant could be expanded by adding on 12,000 or 24,000 gpd modules since the one-acre site is large enough to accommodate these modules (Rakowsky, 1982).

Perhaps the biggest stumbling block to plant expansion in ecological terms would be the impact of nutrients (nitrates and phosphates) on Skyline Lake. Only about 30 percent of the total average phosphorous concentration of 10 mg/1 which is present in municipal wastewater is removed in a secondary treatment plant (Linsley and Franzini, 1972). The remaining 70 percent of the incoming phosphorous is normally discharged with the plant effluent. With nitrogen, secondary treatment usually removes about 40 percent of the incoming average total nitrogen concentration of about 25 mg/1. The remaining 60 percent is discharged with the plant effluent.

Nutrient removal by chemical precipitation, air stripping, biological nitrification and denitrification, or by ion exchange is expensive and would add considerably to plant costs. Without nutrient removal, any additional load of nitrates and phosphates to High Mountain Brook by plant expansion could potentially increase eutrophication in Skyline Lake.

Another important ecological factor regarding plant expansion pertains to the reclassification of High Mountain Brook from nontrout to trout production waters. The revised classification pertains to the entire High Mountain Brook watershed from its source downstream to, but not including, Skyline Lake (NJDEP, 1983).

Since the present outfall of the James Drive plant is in that portion of High Mountain Brook which will have more stringent water quality standards, any expansion of the plant would necessitate substantial upgrading of effluent quality. This would mean some form of advanced waste treatment which is very expensive.

The U.S. Geological Survey does not have published discharge values for High Mountain Brook. Therefore, in order to estimate the flow, one method is to use the discharge/unit area relationship for nearby watersheds underlain by similar geologic formations. Fortunately, several nearby watersheds not only drain Precambrian rocks (similar to High Mountain Brook) but also were analyzed by the U.S. Geological Survey in terms of flow-duration characteristics. Flow-duration data enables one to estimate discharge in a stream at different levels of probability.

Flow-duration data at low flow for selected watersheds in the Ringwood area is shown in Table IV-1. For example, the flow in Ringwood Creek near Wanaque is expected to equal or exceed 73,000 gpd/mi.^{2} in order to equilibrate watersheds of varying size.

The area of High Mountain Brook watershed from its source to Skyline Lake as measured on USGS maps at a scale of 1" = 2,000' is 2.17 mi.^{2} The area of the High Mountain Brook watershed above the James Drive plant outfall is 1.96 mi.^{2} Based on the average of the 4 watersheds shown in Table IV-1, the estimated flow in the High Mountain Brook at the outfall point at various probability levels is shown in Table IV-2. For example, the flow is expected to equal or exceed 133,000 gpd 90 percent of the time. When we

Table IV-1

FLOW-DURATION DATA FOR SELECTED WATERSHEDS IN THE RINGWOOD AREA

(in 1,000 gpd/mi.^{2})

Watershed	Percent on Flow-Duration Curve 50	70	90	Q_{7-10}*
Ringwood Creek near Wanague #3845 (19.1 mi.^{2})	710	318	73	14
Cupsaw Brook near Wanague #3850 (4.38 mi.^{2})	543	138	42	0
West Brook near Wanague #3860 (11.8 mi.^{2})	788	343	114	33
Blue Mine Brook near Wanague #3865 (1.71 mi.^{2})	442	173	43	0
Average	621	243	68	12

*Q_{7-10}: average annual minimum discharge for 7 consecutive days with a recurrence interval of 10 years.

Source: Gillespie and Schopp (1982).

Table IV-2

ESTIMATED FLOW FOR HIGH MOUNTAIN BROOK IN RINGWOOD, N. J.

(in 1,000 gpd)

	Probability Level in Percent			
	50	70	90	Q_{7-10} (1)
High Mountain Brook at James Drive plant outfall (2)	1,217	476	133	24
Effluent discharge (3)	44.3	44.3	44.3	44.3
Ratio: streamflow/effluent discharge	27.5	10.7	3.0	0.5

(1) Q_{7-10} average annual minimum discharge for 7 consecutive days with a recurrence interval of 10 years.

(2) Average of 4 watersheds from Table IV-1.

(3) Average annual discharge for the James Drive plant for 1982

compare the 1982 average annual effluent discharge of 44,300 gpd to the estimated flows in Table IV-2, the streamflow/effluent discharge ratios vary from 27.5 at 50 percent to a low of only 0.5 at the Q_{7-10} value.

This estimation procedure is of course only approximate. If discharge measurements were available at baseflow conditions, estimating equations could be calculated between High Mountain Brook and nearby watersheds which have continuous mean daily discharge records. If the calculated correlation coefficients are high enough, the estimated flow from this procedure is considered to be more accurate than the average discharge/unit area method shown in Table IV-1.

The point of the foregoing discussion is that even if we do not have exact flow values for High Mountain Brook, the stream has a limited assimilative capacity for effluent discharge. Although it is beyond the scope of this report to prepare a detailed analysis of the assimilative capacity of High Mountain Brook at the outfall location, it is reasonable to expect that any increase in effluent discharge from the James Drive plant will necessitate some form of advanced waste treatment, particularly since High Mountain Brook is being reclassified as FW-2 trout production waters.

Finally, Weston Engineers (1982) did not recommend plant, expansion since it was not considered cost-effective. This recommendation will be included in the final report by Weston Engineers (Ciotoli, 1983).

2. Other Treatment Plants

The Ringwood Plaza Shopping Center and 14 neighboring residences are served by a privately-owned treatment plant operated by Rachlin & Company in Newark. The plant is operating above its design capacity of 12,000 gpd. Treated effluent is discharged to an unnamed intermittent tributary to Skyline Lake. Although Rakowsky (1983) indicates that there is sufficient land at the site for expansion, Malcolm Pirnie (1979) did not consider the Rachlin plant to be worthwhile expanding due to its limited capacity and poor location. Also, Ciotoli (1983) of Weston Engineers raises the question of cost-effectiveness vis-a-vis plant expansion.

The Robert Erskine School treatment plant serves 400 pupils and is operated by the Ringwood Borough Board of Education. The effluent is discharged to a tributary which flows into Wanaque Reservoir. The plant is operating at about 50 percent of its design capacity of 10,500 gpd (Malcolm Pirnie, 1979).

The Ringwood Borough Board of Education also operates a small package plant for the Peter Cooper School with about 325 students. The effluent is discharged into an unnamed stream which flows into Meadow Brook and then into the Wanaque River below the Wanaque Reservoir. The plant is operating at about 55 percent of its design capacity of 10,500 gpd (Malcolm Pirnie, 1979).

The State of New Jersey has constructed a 50,000 gpd package plant near Morris Road to serve Skyland Manor and Shepard Lake. The plant is expected to become operational in the near future (Kasler, 1981).

C. Septic Systems

With the exception of the aforementioned small package plants, the bulk of the population in Ringwood depends on septic tanks and leaching fields for wastewater disposal. Even the commercial stores in the Fieldstone shopping center use a modified septic system with disposal beds occupying a portion of the parking lot with resultant loss of parking spaces.

Onsite wastewater disposal usually consists of raw sewage entering an underground concrete chamber which is large enough to provide a detention period of 8-12 hours. In Ringwood, Ordinance No. 1981-01 of the Board of Health specifies that the septic tank must provide at least 1,500 gallons of liquid capacity. The effluent from a septic tank is foul, usually containing 50-70 percent of the suspended solids, and has a high BOD (Linsley and Franzini, 1972).

The effluent flows into an underground tile-drain field which facilitates percolation of the wastewater through the soil. Soils which have low infiltration rates (such as clays) will not be able to accept the effluent fast enough so that surface ponding or sogginess may result. On the other hand, soils with high infiltration rates (such as sands and gravels) may not allow enough time for the effluent to percolate through the soil and thereby limit or reduce the amount of renovation.

The disposal field must be at least 4 feet above the seasonal high water table. The 4 feet of soil generally provides sufficient earth material for soil microorganisms to renovate the effluent; i. e., facilitate removal of bacteria and viruses. Phosphates tend to be adsorbed onto soil particles and generally do not travel far from the disposal field. However, phosphates from septic system leachate can enter lakes and streams if the disposal fields are too close to the receiving watercourse.

Nitrates are highly soluble and represent a major potential contaminant in ground water systems. Only a portion of the nitrates present in septic effluent is renovated by the soil medium; the remainder easily enters the ground water where it can become part of the water supply source for both domestic and municipal wells. Contravention of drinking water standards for nitrates is a distinct possibility if septic system density becomes too great. This issue of nitrates and septic systems is discussed in greater detail later on.

Effluent from septic system disposal fields may surface in downslope locations if the land is too steeply sloping. Thus, topography is an important element to consider when onsite wastewater disposal systems are being thought of for an area.

In sum, septic systems may provide an environmentally acceptable mode of onsite wastewater disposal as long as soil, slope, and density considerations are taken into account.

D. Soil Survey of Passaic County

The Soil Conservation Service (SCS) of the U.S. Department of Agriculture prepared a soil survey of Passaic County based on field work during 1967-69. The report was issued in 1975. Soil mapping units were delineated at a scale of 1:20,000 or 1" = 1,667* (Soil Conservation Service, 1975).

County soil surveys were meant to provide mesoscale information for a variety of users, such as farmers, planners, engineers, and developers. They were not designed to provide detailed information about a tract of land which could only be obtained through onsite investigation. Furthermore, photo-enlargement of the soil maps can provide erroneous interpretations, as the enlarged maps do not show the small areas of contrasting soils that could have been shown at a larger mapping scale, such as 1" = 1,000'. Subject to these caveats, the soil survey contains much useful information at its scale of delineation that could guide municipalities in planning community development.

The SCS has developed a rating system for soil properties (slight, moderate and severe) that is designed to provide information on limitations for selected uses of the land. This rating system is only at the ordinal level of measurement, which means that we cannot specify how much greater one group is compared to another. Thus, we can only say that a soil with moderate limitations for a certain type of community development is worse than another soil with slight limitations. We cannot say that a soil with moderate limitations is twice as bad, or three times as bad, as a soil with slight limitations. This ordinal level of measurement differs from the next higher level of measurement, called interval, wherein the distances between any two numbers on the scale are of known size (Siegel, 1956). For example, we measure temperature in Centigrade or Fahrenheit on an interval scale. Thus, the SCS rating system only implies a ranking of one category with respect to another and we can only say that one soil has "more" or "less" limitations with respect to. another soil.

The SCS rating categories are defined as follows (Soil Conservation Service, 1975):

Slight - soil properties are usually favorable for the indicated use; limitations for development are minor and easily overcome.

Moderate - some of the soil properties are unfavorable but may be overcome by good design and management.

Severe - soil properties are so unfavorable that special designs or intensive maintenance would be reguired. Overcoming the limitations could be accomplished, but only at considerable cost in land improvement.

For septic tank absorption fields, the soil properties that are considered are those that affect both effluent absorption and the construction and operation of the system. The soil properties that affect absorption are permeability, depth to a water table (perched or otherwise), and potential for flooding. Slope not only affects the difficulty of layout and construction but also soil erosion potential, lateral seepage, and downslope effluent flow. Rock outcrops would also have an obvious impact on construction costs.

A soil association usually consists of one or more major soils and some minor soils and is named for the major soil. As delineated on the general soil map of Passaic County at a scale of 1" - 3 miles, the dominant soil association in Ringwood is the Rockaway - Rock outcrop - Hibernia association (Soil Conservation Service, 1975). This association consists of the following soils:

Soil Series	Percent of Association in Passaic County (SCS, 1975)	Percent of Association in Ringwood (Kasler, 1981)
Rockaway	40	52
Rock outcrop	20	19
Hibernia	10	13
Ridgebury, Netcong and other soils	30	12
	100	96*

*Other soils make up the remaining 4 percent.

Rockaway soils are moderately well drained and are found on hilltops and the upper parts of hillsides. They are very stony with slowly permeable subsoils. Slopes range from 3-25 percent.

Rock outcrop is mostly hard granitic gneiss on steep slopes. Any excavation usually requires blasting. Accessibility is very difficult where the rock outcrops are numerous.

Hibernia soils are poorly drained and extremely stony. The subsoil is slowly permeable and slopes range from 3-15 percent.

Ridgebury soils have a high seasonal water table which severely limits use of the soils for urban development. In contrast, Netcong soils are well drained and provide only slight limitations for development purposes.

The actual areas delineated on a county soil survey map are called "mapping units". These units may consist of one soil phase, which is a subdivision of a soil series based on some differences in surface layer texture, slope, or stoniness. Other mapping units may consist of soils of different series or of different phases within one series. Still other mapping units, such as alluvial land, are not even members of a soil series but are included in the county report (Soil Conservation Service, 1975).

In sum, the classification of soils within a county soil survey is as follows:

Category	Example
Soil Association	Rockaway - Rock outcrop - Hibernia
Soil Series	Rockaway
Soil Phase	Rockaway extremely stony sandy loam
Mapping Unit	RnC

In the Ringwood Master Plan, Kasler (1981, Table A-14) calculated the distribution of soils throughout the borough. The four largest mapping units were as follows:

Mapping Unit	Percent of Total Area of Rincrwood
Rockaway extremely stony sandy loam (RnC)	19.8
Rock outcrop - Rockaway complex (RxE)	19.5
Hibernia extremely stony loam (HpC)	13.2
Rockaway - Rock outcrop complex (RsC)	12.8
Total	65.3

Based on a slight modification of the SCS rating system, Kasler (1981, Table 9) calculated that 76 percent of the borough had severe limitations for development. Another 13 percent had moderate-severe limitations depending upon specific soil variations within the mapping unit. Only 5 percent of the borough had moderate or slight limitations for development.

It is interesting to speculate, and also quite possible, that the land now covered by the Wanaque Reservoir is more suitable for development. After all, the reservoir was formed in the valley of the Wanaque River which may have had different slopes and soils from the other parts of Ringwood. Thus, the more developable part of Ringwood may now be under Wanaque Reservoir. This premise may partly explain why such a large proportion of the current land area in Ringwood has some form of development limitation.

In conclusion, the bulk of the soils in Ringwood (about 89 percent) are classified by the SCS as having moderate-severe and severe limitations for development. It is thus apparent that most of Ringwood is mantled with soils which pose particular difficulties for development which can only be overcome by considerable expenditures for land improvement. It is further apparent that the zoning in the borough should reflect, at least in part, upon the characteristics of these soil properties.

E. Nitrate Dilution Model

1. Introduction

The operation of septic systems adds sewage to the soil and can eventually change the chemical composition of ground water. Properly functioning septic systems can handle most of the biological problems associated with wastewater disposal, such as coliform bacteria. Although virus organisms frequently survive passage through the septic tank, they generally do not travel far from the disposal field. Thus, these health hazards are normally minimized in well-designed systems.

Septic system effluent, however, can contain large amounts of nitrates. These nitrates will eventually leach down to the ground water. When that occurs, nitrate concentrations may increase above acceptable levels. Current standards for nitrates in drinking water are 10 mg/1. In some areas of special ecological interest, even more restrictive levels have been established. For example, the Pinelands Commission in New Jersey has established allowable nitrate levels in ground water to be no more than 2 mg/1.

Many instances of problems caused by septic disposal systems can be cited in the literature. For example, in a study of ground water contamination in the northeastern United States, Miller, DeLuca, and Tessier (1974) found that septic systems were one of the principal sources of ground water contamination. In another study in Delaware, Miller (1975) indicated that 25 percent of the shallow wells (defined as less than 50 feet deep) in the state had nitrate levels that were beginning to show contamination of the water-table aquifer by septic systems. Nightingale and Bianchi (1977) reported that nitrate concentrations reached the public health standard limit for potable water in a water-table aquifer serving a community in the Central Valley of California with a density of one septic tank/1.5 acres.

Closer to New Jersey, numerous studies of nitrate contamination by septic systems have also been made in Nassau and Suffolk County, Long Island, New York. Some of these investigations were made for the Areawide Waste Treatment Management (208) study for the Nassau-

Suffolk Regional Planning Board (1978). For example, population density and median nitrogen concentrations in ground water were obtained from wells screened in the Upper Glacial Aquifer in areas which were entirely unsewered during the period 1972-76. Analysis of this data revealed that nitrate levels increased as population density increased. Although there was considerable scatter, the association between nitrate levels and population density in unsewered areas was positive and significant.

Therefore, the purpose of this section is to provide an approach to the problem of residential density based on onsite wastewater disposal. A nitrate dilution model allows one to objectively calculate the housing density which will not degrade the quality of the ground water.

The initial formulation of the model was developed by L. Douglas and J. Trela of Rutgers University (Trela and Douglas, 1978). This model was modified and will be discussed in greater detail in this report (see also Pizor, et al, 1982).

2. Nitrogen Transformation and Transport

Most of the nitrogen leaving the septic tank is in the organic (NH_3) or ammonia (NH_4^+) form (Hall, 1975). In a properly functioning absorption field, these forms will generally be converted to nitrate (NO_3^-) within the first few inches of aerobic soil (where oxygen is present) that surrounds the absorption field. Nitrate is very soluble and chemically inactive in aerobic soils. Therefore, it is easily mobilized by soil and ground water. The nitrate will not undergo further transformation unless biological denitrification occurs.

Denitrification is the major process occurring in soil which actually removes nitrogen from the effluent, giving off gaseous oxide or elemental nitrogen in the process (Trela and Douglas, 1978). Denitrification can only occur in the presence of denitrifying bacteria under anaerobic conditions (where oxygen is absent) when a carbon source (such as soil organic matter or effluent organics) and nitrate are available. This situation does not always exist in most absorption fields.

Thus, most of the nitrogen in septic tank effluent is ultimately converted to the nitrate form which can easily move through soil-water systems and eventually enter ground or surface waters (Hall, 1975).

3. Lot Size Recommendations in the Literature

Although the literature is replete with examples of septic system failures and problems, there is a remarkable dearth of studies suggesting minimum lot sizes for residential dwellings without water and sewer infrastructure. This situation may be attributed to the enormous heterogeneity of soil types and geologic formations found in the United States. The resultant complex interaction of infiltration capacity, soil texture, rock type, etc., makes it difficult to provide recommended lot sizes on a national basis.

The U.S. Soil Conservation Service (SCS) provides a great deal of information about the relative degree of limitation of each soil in a county for specific uses related to town and county planning. Each mapping unit in a county soil survey is rated as either having slight, moderate, or severe limitations for onsite septic effluent disposal (Soil Conservation Service, 1975). These limitations are based on consideration of soil properties which include flood hazard, depth to seasonal high water, slope, depth to and kind of bedrock, rockiness, stoniness, and permeability at a depth of about 30 inches. However, the SCS does not recommend minimum lot sizes for residential areas.

A guide for lot size determination for single family dwellings with and without water and sewerage facilities was prepared by the Massachusetts Federation of Planning Boards (1975). Relying heavily *on* soils information as assembled by the local SCS, the guide lists a recommended lot size for each soil and land type in the study area. Without water and sewer infrastructure, the lot sizes are listed as either 40,000 square feet, 60,000 square feet, or simply "not feasible" because of the severe limitations for the particular soil. Note that the lot size recommendations are applicable only to the soils found in Massachusetts and application elsewhere would be inappropriate.

The New Jersey Bureau of Geology (1974) and Halasi-Kun (1979) recommended minimum residential lot sizes for many of the geologic formations in the state. A similar effort for Sussex and Warren

Counties was made by Miller (1974). These recommendations were based on considerations of the availability of ground water sufficient for onsite domestic wells and septic system disposal capability. These reports are valuable since they cover a large variety of bedrock types for many different areas in the state and can be used in conjunction with already existing geologic overlay maps at a scale of 1" = 1 mile. However, the reports do not include a full discussion of the methodology underlying the recommended lot sizes.

For dry year conditions, the recommended minimum lot sizes for areas underlain by Precambrian bedrock (such as in Ringwood) ranged from 3 - 5 acres/dwelling unit (see Table IV-3).

TABLE IV-3

RECOMMENDED MINIMUM LOT SIZES
FOR PRECAMBRIAN BEDROCK AREAS IN NEW JERSEY

Reference	Minimum Lot Size (acres)
N.J. Bureau of Geology (1974)	3 - 4
Miller (1974)	3 - 4
Halasi-Kun (1979)	3.7 - 5

Trela and Douglas (1978) made a pioneering study of soils, septic systems, and carrying capacity in the Pinelands of New Jersey. Depending upon soil type and other assumptions, various housing densities were recommended. One of the most useful parts of the Trela-Douglas nitrate dilution model was the inclusion of a methodology wherein all of the assumptions underlying the use of the model were clearly specified; thus, this model was adopted for application to other parts of the state. The New Jersey Pinelands Commission has recently adopted a similar type of mass balance, nitrate dilution model for use in the Pinelands (Brown and Associates, 1980).

The Nitrate Dilution Model

The model is formulated as follows:

$$D_{wq} = \frac{I\ (C_l)}{640\ (R)\ C_e\ (Q_e)\ P}$$

where D_{wq} = development density based on water quality for septic systems (acres/DU)

I = infiltration to ground water recharge (gpd/mi.^{2})

C_l = pollutant concentration limit (mg/1)

640 = conversion factor (acres/mi.^{2})

R = pollutant renovation factor (decimal fraction)

C_e = pollutant concentration in septic system effluent (mg/1)

Q_e = septic system effluent generation (gals/capita/day; gpcd)

P = number of people/dwelling unit (DU)

The major assumptions of the model are briefly noted below and are discussed in more detail in later parts of this report. The assumptions are as follows:

1. The amount of water (I) that can infiltrate the soil to recharge the ground water is available to dilute the septic system effluent. For Ringwood, the recharge is estimated to be 160,000 gpd/mi.^{2}

2. The pollutant concentration limit (C_1) for nitrates in drinking water is set by law at 10 mg/1.

3. The denitrification of the septic effluent varies from 10 percent for well drained Rockaway soils to 40 percent for Ridgebury soils; therefore the pollutant renovation factor (R) varies from 0.9 to 0.6.

4. The pollutant concentration (C_e) for nitrates in septic system effluent is 29.6 mg/1 based on 100 gpcd.

5. Septic system effluent generation (Q_e) is 100 gpcd.

6. The number of persons/dwelling unit (P) in Ringwood is estimated to be 3.3.

3 5* <u>Infiltration to Ground Water Recharge</u>

One of the major assumptions of the model is that the amount of water that can infiltrate through the soil column to recharge the ground water is available to dilute the septic effluent. Hall (1975) states that most of the nitrogen introduced by septic systems will eventually enter ground or surface waters without substantial denitrification. Thus, an estimate of ground water recharge becomes extremely important because the recharge indicates how much water will be available for effluent dilution (Holzer, 1975).

Sustained ground water yield can be defined as that quantity of water which can be withdrawn from an aquifer without causing a long-term decline in the water table or in ground water storage. Thus, withdrawals should not exceed recharge over the long run; otherwise, the ground water will be mined and base flow to the streams will be affected.

Several estimates of sustained ground water yield for unweathered Precambrian bedrock in northern New Jersey for both dry year and average year conditions are shown in Table IV--4. Differences in the yield estimates can be attributed to methodological variations employed in the respective studies as well as natural variations among the drainage areas selected. These natural or physical variations would include such things as the degree of rock fracturing within a basin, the extent of glacial

TABLE IV-4

ESTIMATED GROUND WATER YIELDS FOR

•UNWEATKERED PRECAMBRIAN BEDROCK FORMATIONS IN NORTHERN NET; JERSEY.

Drainage Basin or Area	Estimated Yield (1,000 gpd/mi.^{2}) Dry Year	Average Year	Reference
Bear Swamp Erook, Bergen County	120	160	Vecchioli and Miller, 1973
Northern New Jersey	120-170	200-250	N.J. Bureau of Geology, 1974
" " "	120	180	Ealasi-Kun, 1979
West Brook, Passaic County	180	590	Posten, 1982
Blue Mine Brook, Passaic County	200	490	Posten, 1982
Mid-point Value	160	380	

scour and deposition, and the period of record used in the analysis.

As shown in Table IV-4, the estimated dry year yields range from 120,000 to 200,000 gpd/mi.^{2} The average year yields range from 160,000 to 590,000 gpd/mi.^{2} Since all of the estimates in Table IV-4 presume undeveloped conditions without the loss in recharge due to impervious cover, and since nitrate contamination directly concerns public health and safety, it would be prudent to select dry year estimates for inclusion in the model. Thus, a conservative but reasonable estimate of 160,000 gpd/mi.^{2} was selected. The 160,000 value simply represents the mid-point value of the range of dry year yield estimates.

6. Public Health Standards for Nitrates

Nitrates become toxic to humans and other warmblooded animals only under certain conditions in which they may be reduced to nitrite. This reduction can occur in the gastrointestinal tract, after which the nitrite may reach the bloodstream and react directly with the blood pigment, hemoglobin, to form methemoglobin. Once this occurs, the blood pigment can no longer effectively transport oxygen from the lungs to the tissues and the physiological result is anoxia, or lack of oxygen.

Infants are more susceptible to methemoglobinemia than adults because their fluid intake per unit of body weight is greater, and the pH in the gastrointestinal tract is often high enough to permit nitrate-reducing bacteria to survive. Recognizing this hazard, the U.S. Public Health Service in 1962 adopted a standard for nitrate (measured as nitrogen) of 10 mg/1 in drinking water. The same standard has been maintained as a maximum contaminant level in the Interim Primary Drinking Water Regulations of the Safe Drinking Water Act of 1974 (P.L. 93-523) which has also been adopted by the State of New Jersey.

7. Denitrification

As discussed earlier, denitrification is the major process occurring in soil which actually removes nitrogen from the septic effluent, giving off gaseous nitrous oxide or elemental nitrogen. Denitrification occurs only in the presence of denitrifying bacteria under anaerobic conditions when a carbon source, such as soil organic matter or effluent organics, and nitrate are available. Although denitrifying bacteria are ubiquitous in soils and carbon sources may be available in the soil in limited amounts, little nitrogen is removed during unsaturated flow and most of the nitrogen passes out of the soil as nitrate (Trela and Douglas, 1978).

Denitrification decreases as soil texture becomes coarser (sandier) and the rate of percolation increases. The amount of nitrogen removed by denitrification, as a function of soil drainage characteristics, has been estimated to range from 0-50 percent (as noted by Posten, 1982, p. 224); see Table IV-5.

TABLE IV-5

ESTIMATED PERCENT DENITRIFICATION AS A FUNCTION OF SOIL DRAINAGE

Drainage Classification	Estimated Percent Denitrification
Excessively well drained	0
Well drained	10
Moderately well drained	20
Somewhat poorly drained	30
Poorly drained	40
Very poorly drained	50

In terms of drainage, the soils of Ringwood range from excessively well drained Otisville soils to poorly drained Hibernia soils. Using the estimates of denitrification listed in Table IV-5, the pollutant renovation factor (R) for the soils in Ringwood are listed in Table IV-6.

TABLE **IV-6**

POLLUTANT **RENOVATION** FACTORS FOR THE SOILS IN RINGWOOD

Soil Type	Estimated Percent Denitrification	Pollutant Renovation Factor (R)
Hibernia	30	0.7
Netcong	10	0.9
Otisville	0	1.0
Parsippany	40	0.6
Pompton	30	0.7
Preakness	40	0.6
Ridgebury	40	0.6
Riverhead	10	0.9
Rockaway	20	0.8

8. Nitrogen Concentrations in Septic Effluent

The average total nitrogen load per person is estimated by Kuhner et al. (1977) and Siegrist et al. (1977) to be 11.2 grams/ day. It is recognized that the nitrogen load from person to person will vary based on physiological and dietetic differences. However, the 11.2 value is considered to be a reasonable mid-range estimate.

Given an average nitrogen loading of 11.2 gms/capita/day, which is the same as 11,200 mg/capita/day, we can calculate the nitrogen **concentration** in mg/1 as **follows:**

$$\frac{11,200 \text{ mg/capita/day}}{379 \text{ liters}} = 2\text{q}.6 \text{ m yi}$$

The nitrogen concentrations that correspond to varying septic effluent flows are shown in Table IV-7. Since the State mandates a flow rate estimate of 100 gpcd for single family residences, a nitrogen concentration (C_e) of 29.6 mg/1 was used in this report.

TABLE IV-7.

EFFLUENT FLOWS AND NITROGEN CONCENTRATIONS.

Effluent Flows liters	Effluent Flows gallons	Nitrogen Concentration (mg/1)
227	60	49.3
284	75	39.4
379	100	29.6

9. Per Capita Effluent Generation

Most estimates of domestic wastewater generation range from 60 to 100 gpcd (gals/capita/day). However, the State stipulates a wastewater flow estimate of 100 gpcd for single family dwellings utilizing individual subsurface sewage disposal systems (New Jersey, 1978). Therefore, the effluent generation value (Q_e) selected was 100 gpcd.

Since the nitrogen concentration in the effluent is a function of the septic flow, it does not matter in the model what per capita effluent generation value is selected. What does matter is the assumption that the average nitrogen loading is 11.2 gms/capita/day.

10. Dwelling Unit Occupance

The population and number of dwelling units in Ringwood in 1980 was estimated to be 12,625 and 3,853, respectively (Kasler, 1981). Therefore, the number of people/dwelling unit in Ringwood is calculated to be:

$$\frac{12{,}625 \text{ persons}}{3{,}853 \text{ dwelling units}} = 3.3 \text{ persons/DU}$$

11. Application of the Model to Ringwood

The application of the nitrate dilution model to Ringwood, based on moderately well drained Rockaway soils and the other aforementioned assumptions, is as follows:

$$D_{wq} = \frac{I \, (C_x)}{640 \, (R) \, C_e \, (Q_e) \, P}$$

where D_{wq} = development density based on water quality (acres/DU)

I = 160,000 gpd/mi.^{2}

C_x = 10 mg/1

R = 0.8

C_e = 29.6 mg/1

Q_e = 100 gpcd

P = 3.3

$$D_{wq} = \frac{160{,}000\ (10)}{640\ (0.8)\ 29.6\ (100)\ 3.3} = \text{-- -- DU/acre}$$

= U ı i2 DU/acre

= 3.1 acres/DU

Application of the model to the other soil types in Ringwood results in recommended densities ranging from 2.3 - 3.9 acres/DU, as shown in Table IV-8.

TABLE IV-8.

RECOMMENDED DEVELOPMENT DENSITIES IN RINGWOOD WITHOUT PUBLIC WATER AND SEWER.

Soil Type	Development Density (acres/DU)
Hibernia	2.7
Netcong	3.5
Otisville	3.9
Parsippany	2.3
Pompton	2.7
Preakness	2.3
Ridgebury	2.3
Riverhead	3.5
Rockaway	3.1

12. Discussion

The nitrate dilution model results in minimum lot sizes (2.3 - 3.9 acres/DU) that is close to, but somewhat less than, the 3 - 5 acres/DU estimate mentioned earlier (see Table IV-3). The difference between the estimates are of course based on the varying assumptions underlying the particular model used.

The current formulation of the dilution model does not incorporate nitrogen inputs from precipitation, lawn fertilizer, and animal excreta. Nor does it account for ambient levels of nitrogen that may already exist in the ground water. These background levels may result from existing septic tank effluent discharges as well as from natural sources. The exclusion of these factors suggests that the recommended densities should be decreased.

On the other hand, however, the dilution model does not account for nitrogen uptake by vegetation which is cut and may be removed from the site (grass clippings and leaves, for example). Also, residential areas surrounded by undeveloped lands would benefit by having additional water available for dilution. These factors would suggest that the development density could be increased.

Since all of the factors mentioned in this section have not been included in the model since they have not been quantified at this time, it is presumed that they balance out in the overall nitrogen accounting. It is recognized that this presumption may not be entirely correct and may be changed in the future, but for the present it is considered to be reasonable.

The nitrate dilution model was meant to provide recommended density levels based on soils and geology for those areas without public water and sewer infrastructure at the mesoscale or township level of planning. It was not meant to provide onsite levels of detail where factors such as requisite depth to bedrock and seasonal high water, slope, and percolation would determine septic suitability on a lot by lot basis. The dilution model is useful since it provides environmental information that can assist in the zoning process within a community where public water and sewer infrastructure do not exist.

F. Sewering Issues

1. Introduction

As of the summer of 1983, the sewering controversy still continues. There are some groups who would like to see certain parts of Ringwood tie into the proposed new plant in Wanaque. Others contend that sewers are unnecessary and that some form of onsite septic wastewater management district would be preferable. Considering the importance of wastewater disposal in the zoning process, it would be helpful to provide a brief history of Ringwood and the regional sewer plans.

·TZr*

2. <u>Brief History of Ringvood and Regional Sever Plans</u>

<u>April, 1969</u>. Ringwood received a grant offer from the U.S. Department of Housing and Urban Development (HUD) to construct a sewer collection system in the Cupsaw Lake area.

<u>Jan., 1974</u>. Ringwood secured permanent bonding valued at $7,4 million for the collection system since it did not receive grants for construction.

<u>1975</u>. A regional facilities plan which recommended a sewage collection system for the Skyline Lake, Erskine Lake and Cupsaw Lake areas of Ringwood was prepared by Pandullo Chrisbacher and Associates for the Wanaque Valley Regional Sewerage Authority (WVRSA). The sewage flow from these areas in Ringwood was to be conveyed to the WVRSA plant on the Wanaque River in Wanaque Borough. The report was deemed deficient in complying with the PRM 77-8 requirements which was a newly enforced EPA policy on collection system projects.

<u>Dec., 1977</u>. A Facilities Plan Supplement Report was prepared by Pandullo Quirk Associates (PQA) in order to comply with the PRM 77-8 requirements. The report did not satisfy EPA requirements for the following reasons (NJDEP, 1981):

a. The tax maps should have been on a larger scale.

b. The needs documentation did not include the type, number and location of existing subsurface disposal systems which were malfunctioning at the time the report was prepared.

c. A cost-effective analysis was not performed on a block by block basis. This analysis should have included discussion of potential utilization of low pressure grinder pump systems and septic tank effluent pump systems where sewer installation would have necessitated rock excavation.

1978. Ringwood citizens express a need for documentation of septic tank failures and associated water quality issues.

Dec, 1978. A committee consisting of Ringwood Borough officials, NJDEP, and concerned citizens was formed to resolve the sewer project issues. The committee jointly selected Malcolm Pirnie Engineers to prepare another study.

March, 1979. A comprehensive mail-in questionnaire regarding septic system problems was prepared by Malcolm

Pirnie on behalf of the Ringwood Borough Sewerage Authority (RBSA). Although the questionnaire was sent to all parts of Ringwood, the RBSA decided to focus the evaluation of the questionnaires only on the tax blocks within the lakes study area (Malcolm Pirnie, 1979). Partial results of the survey for the remainder of Ringwood are presented in a later part of this report.

June, 1979. Malcolm Pirnie, Inc. (MPI) prepared a Supplemental Facilities Planning Study (Malcolm Pirnie, 1979) for the Ringwood Borough Sewerage Authority. Although the MPI study indicated that enough septic systems are failing to warrant some type of corrective action, the report did not provide sufficient documentation. Specifically, the MPI study was deemed to be inadequate for the following reasons (NJDEP, 1981):

a. Soil types, the needs survey and additional field data should have been presented on tax maps at a scale of 1" = 100'.
b. All failing septic systems should have been located on the large-scale tax maps.
c. A block by block cost-effective analysis should have been made in those areas where the population density is less than 10 persons/acre.

Feb., 1980. Step 2 of the Ringwood Project was certified to EPA by NJDEP.

Feb. 29, 1980. The U.S. EPA concluded that no significant environmental impact will result from the proposed Ringwood project (U.S. EPA, 1980).

April, 1980. A Step 2 grant was awarded to Ringwood to cover the costs of previous work and to prepare specifications for the selected plan.

July, 1980. A Basis of Design Report was prepared by MPI for the RBSA. The purpose of the report was to present the data needed for detailed engineering design of the recommended sewer plan (Malcolm Pirnie, 1980).

Sept., 1980. NJDEP received an application from the WVRSA to amend the existing Step 2 grant offer so as to reduce the design capacity of the regional treatment plant from 2.5 MGD to 1.2 MGD.

Oct., 1980. The Wanaque Borough Sewerage Authority was awarded a Step 3 construction grant of nearly $1.57 million.

May 4, 1981. NJDEP concluded that the proposed Ringwood Project cannot be accepted due to inadequate needs documentation and substantial public opposition. NJDEP recommends that EPA prepare an Environmental Impact Statement on the project (NJDEP, 1981). ,

May 14, 1981. Arthur A. Hughson, Ringwood Health Officer, states in a letter to Edward Marcus, USEPA, that only 12 of the 81 properties in Ringwood that were declared irreparable during a 1979 survey by Malcolm Pirnie were malfunctioning in May 1981 (Hughson, 1981).

March, 1982. Roy Weston Engineers are selected by NJDEP, EPA, and RBSA to perform an independent analysis of the wastewater management alternatives in Ringwood (Lynch, 1982). The purpose of this latest study is to determine if there is a need for sewers, and if so, what would be the most cost-effective system,

August 6, 1982. Weston issued an Interim Report entitled "Problem Assessment and Wastewater Management Alternatives" (Weston, 1982). Among other things, the preliminary recommendations included sewering for portions of the lakes study area, as follows:

a. Limited Service Area: 946 homes immediately adjacent to the lakes would be sewered.

b. Expanded Service Area: 1926 homes which would include areas where septic system problems might develop in the future would be sewered.

c. The remainder of the homes in the lakes study area which were beyond the limited and expanded service areas were not going to be sewered and would therefore be included in an onsite septic system management program.

Winter, 1982-83. Defeasement of bonds discussed by RBSA.

Feb. 10, 1983. Kenneth Wiswall of Weston Engineers presents a summary of an evaluation of alternatives to the Citizens Advisory Committee. In terms of implementability, Weston recommends an onsite septic systems management district for the study area.

~~July 18, 1983.~~ Weston Engineers will prepare a final report on their investigation to NJDEP by the late summer of 1983. The report will embody most of the recommendations contained in the June 1982 Interim Report (Cistoli, 1983).

3. Septic System Mail Survey

In order to determine the extent and distribution of septic system problems within Ringwood, the Ringwood Borough Sewerage Authority (RBSA) requested Malcolm Pirnie to prepare a comprehensive questionnaire in March 1979. This questionnaire was originally mailed to all property owners in the three tax districts surrounding Skyline, Erskine and Cupsaw Lakes. Following a public meeting on March 7, 1979, the mailing was expanded to include the remainder of the Borough. However, the RBSA decided to focus the evaluation of the questionnaires only on the tax blocks within the lakes study area.

A total of 3,758 questionnaires were sent out to all parts of the Borough. The useful responses were as follows:

	Number of Questionnaires Sent Out	Number of Useful Responses Returned	Useful Responses as a % of Total
Lakes study area (tax blocks 700-999)	3,241	1,406	43
Remainder of Borough	517	178	21
Total	3,758	1,584	42

The major conclusions of the survey for the lakes study area was as follows:

a. About 27 percent of the respondents reported having had some difficulty with their septic system.

b. The percentage of septic problems around the lakes was as follows:

Cupsaw:	32 percent
Erskine:	26 "
Skyline:	25 "

c. Those homeowners experiencing septic system problems tended to be on small lots with poor soils.

d. About 63 percent indicated that their septic system was adequate for their future needs.

It would be useful to compare the responses between the lakes study area and the rest of Ringwood to see if there are any differences. This comparison is presented below for selected questions in the survey.

<u>Question No. 4</u>. About how many years old is your present home?

	Lakes Study Area		Remainder of Borough	
	Number	Percent	Number	Percent
Less than 5 years:	102	8	27	16
5 - 9 years:	151	11	18	11
10 - 14 years:	281	21	19	11
15 - 19 years:	248	19	30	18
20 years or older:	521	39	72	41
Don't know:	30	2	5	3
Total	1,333	100	171	100

Question No. 14a. About how often is your tank pumped out?

	Lakes Study Area		Remainder of Borough	
	Number	Percent	Number	Percent
More than once a year	17	2	5	6
Once a year	52	7	2	2
Every two years	134	18	14	17
3 - 5 years	287	39	30	36
6 years or more	249	34	33	39
Total	739	100	84	100

<u>Question No. 15a.</u> Have you ever experienced difficulty with your septic tank?

	Lakes Study Area		Remainder of Borough	
	Number	Percent	Number	Percent
Yes	383	29	29	17
No	940	71	138	83
Total	1,323	100	167	100

<u>Question No. 15c</u>. If the septic problems are seasonal, in what season(s) do they occur?

	Lakes Study Area		Remainder of Borough	
	Number	Percent	Number	Percent
Spring	100	23	7	26
Summer	28	6	0	0
Fall	24	5	0	0
Winter	40	9	2	7
Not Seasonal	249	57	ii	67
Total	441	100	27	100

Question No. 20e. Has your well ever appeared contaminated?

	Lakes Study Area		Remainder of Borough	
	Number	Percent	Number	Percent
Yes	18	4	8	6
No	467	96	127	94
Total	485	100	135	100

Question No. 21. Do you have local flooding on your property as a result of heavy rains?

	Lakes Study Area		Remainder of Borough	
	Number	Percent	Number	Percent
Yes	290	22	28	16
No	1,048	78	148	84
Total	1,338	100	176	100

In general, there does not appear to be any substantial difference between the responses of the lakes study area and the remainder of the borough, based on the selected questions presented above. This result is not unexpected, inasmuch as similar geologic and soil properties prevail throughout the borough. Perhaps the only difference shows up in Question No. 15a, where a larger fraction of the residents in the lakes area reported septic difficulties as compared with the remainder of the borough (29 versus 17 percent). This difference may be attributed to smaller lots in the lakes study area.

4. Weston Air Photo Survey

An aerial infrared photographic survey of eastern Ringwood was made in March 1982 by one of Weston's sub-contractors. The use of this technique facilitates detection of surface malfunction of septic systems. Early spring is best for these surveys as ground water levels are generally highest and deciduous tree cover is minimal.

The aerial survey, in conjunction with field checks, yielded a total of 110 failures, of which 46 (or 42 percent) were considered overt failures (Weston, 1982). Weston also identified another 11 failures during their household survey. Out of the total of 121 failures (110 + 11 = 121) detected during the Weston survey, 9 were repaired by August 1982. Thus, only about 3 percent of the 3,253 homes in the lakes study area experienced some form of septic failure. Note that this observation does not include potential nitrate contamination of well and potential nutrient enrichment to the lakes by septic systems. These deleterious effects are not detected by aerial photography.

G* Alternative Onsite Systems

1. Introduction

A variety of alternative onsite system designs may be considered when site constraints preclude the use of a standard septic system. It is beyond the scope of this report to go into detailed examination of the various systems; rather, the intent is to provide a brief listing of selected designs that could be employed.

Two very useful references in this matter are a report prepared by Wiswall, Dabagian and Wegmann (1982) for Sussex County, and the EPA Design Manual for onsite wastewater treatment systems (1980).

2. Mound Systems

Imported sand can be used to construct an artificial soil depth when the depth of natural soil is less than the required 4 feet. As much as 2 feet of sand can be mounded over the natural soil. Mound systems are not recommended when an impermeable limiting zone (such as bedrock or an impermeable soil layer) exists within 4 feet of the natural ground surface.

3. Artificial Drainage Systems

These systems intercept and divert groundwater away from the disposal area. Curtain drains should be located 10 - 15 feet upslope of the drainfield and outlets must be provided to allow discharge of the intercepted groundwater. Artificial drainage systems should not be employed in poorly drained soils where the groundwater can come within 2 feet of the ground surface.

The Painted Forest and Bald Eagle developments in Ringwood have experienced septic failures within five years of construction even though curtain drains were employed. The homes are on 1/2-acre lots with clustering. A combination of site conditions and installation problems may be responsible.

4. Denitrification Systems

Wiswall Dabagian and Wegmann (1982) refer to the 208 Plan for Sussex County which notes that onsite systems appear to be major contributors of nitrate pollution. Thus, denitrification systems may be appropriate where groundwater contamination is a concern. These systems treat the effluent after the ammonia has been converted to nitrate (i.e. the process of nitrification).

Anaerobic filters are generally used in the denitrification process. A carbon food source such as methanol is added to the system in order to sustain the denitrifying bacteria. Design and operation of these denitrification systems is obviously more complicated than a conventional septic system.

A denitrification unit is being planned as part of a package treatment plant for a 440-unit housing development above Pinecliff Lake in West Milford. The treated and denitrified effluent will then be discharged into the ground. Since the project has not yet been completed, operational data for the system are not available.

5. Aerobic Systems

An extended aeration (aerobic) system represents a modification of the conventional anaerobic septic disposal system. Air is pumped into an aeration tank where it is mixed with wastewater. Oxygen-using (aerobic) bacteria grow, digest the sewage and liquify most of the solids. The liquid effluent is discharged to an absorption field where treatment can continue.

An aerobic tank should produce a higher quality effluent when it is properly functioning as compared to a conventional septic system. In particular, suspended solids should be reduced. However, maintenance is essential and energy is used for the pump at the rate of about 2.5 - 10 kWh/day.

Nitrates still remain a problem with extended aeration systems. Indeed, nitrification may even be increased since hydraulic and solids retention times are high.

6. Communal Systems

A cluster or communal system means that two or more homes are served by a common treatment and disposal method. The homes could also have onsite conventional septic or aerobic tanks with the liquid effluent being piped to some communal absorption field. Clusters of homes could also use other types of alternative systems, such as mounds, pressure sewers and sewage treatment lagoons.

One of the major advantages in using communal systems is that the most suitable soils on the site can be reserved for effluent disposal. This frees up other portions of the site for building lots. Thus, onsite disposal with cluster systems implies wastewater treatment beyond the confines of an individual owner's property but within or very close to the confines of the subdivision.

In addition to the purely technical details of these systems, NJDEP is concerned about the management. Consequently, approval is contingent on the verification that some form of organization, such as a homeowner's association, MUA or a sewerage authority, is either available or will be created so as to assume responsibility for operation and maintenance.

7. Conclusion

Alternative designs for onsite wastewater disposal systems may be properly employed when site considerations render conventional septic disposal unsuitable. Many of the designs are more costly than conventional systems and also have continuing operation and maintenance expenses. The selection of an alternate design depends upon detailed site investigation. Finally, alternative systems may be used for homes on either an individual or clustered basis.

H. Discussion

Wastewater disposal problems in the lakes portion of eastern Ringwood have ranked among the most contentious in the entire State. Existing dry sewers, small package plants which are operating at or above their design capacity, presumed septic system failures and whether or not they are irrepairable, homes on small, rocky lots on the shores of recreational lakes, a preponderance of soils with severe limitations for septic systems, development densities in some instances that could lead to potential nitrate contamination of wells, development pressures for multi-family housing, substantial public opposition to sewers in any form, changing federal formulas for reimbursement—all of these factors and more have been key ingredients in the controversy over wastewater disposal.

Two more studies are nearing completion at this time - the Weston study on wastewater management alternatives and the Arthur Young study on the financial aspects of the Ringwood Borough Sewerage Authority (RBSA). Among other things, the Arthur Young study recommended defeasement of the RBSA bonds. The Weston report will contain many of the recommendations that were included in their June 1982 Interim Report (Ciotoli, 1983).

It is difficult to discuss the outlook for sewers in Ringwood prior to completion of the Weston report and subsequent commentary by NJDEP and the community. At this time, however, it is difficult to see how any large-scale development such as multi-family housing can occur in Ringwood until either the sewering question is resolved or some type of alternative (and expensive) onsite disposal system is adopted. In the latter instance, each alternative design would have to be considered on a case by case basis in order to evaluate its efficacy in removing contaminants. In this context, it is worthwhile to note that aerobic systems by themselves do not remove nitrates.

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824

(201) 297-8899

V. STEEP SLOPE ISSUES IN RINGWOOD

Outline

A. Introduction

B. Erosion

C. Hillside Drainage Patterns

D. Slope-Density Regulations

E. Steep Slope Provisions in Other New Jersey Municipalities

1. Princeton Township, Mercer County
2. Washington Township, Morris County
3. Bridgewater Township, Somerset County
4. Wantage Township, Sussex County
5. Far Hills Borough, Somerset County
6. Hillsborough Township, Somerset County
7. Jefferson Township, Morris County

F. Calculation of Average Slope

G. Conclusions

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov place
Kendall Park, N. J. 08824
(201) 297-8899

V. STEEP SLOPE ISSUES IN RINGWOOD

A. Introduction

Hillsides represent a particular kind of critical area. They are not a renewable resource like ground water. Hillsides are geological features of the landscape where the slope and soils are in a balance with the vegetation, geology and precipitation. Development on hillsides can affect the equilibrium of vegetation, geology, slope, soil, and precipitation in the following major ways (Thurow, Toner and Erley, 1975) :

1. Hillside development can result in the loss of slope and soil stability in addition to increased erosion. Vegetation removal deprives the soil of the stabilizing function of roots. Loss of soil stability increases erosion and thereby degrades downstream water quality as a' consequence of siltation.

2. Runoff can be increased when hillsides are disturbed. The natural drainage pattern can be changed which could result in increased runoff and erosion. Removal of vegetation decreases the amount of precipitation that can infiltrate into the soil, thereby increasing runoff and decreasing ground water recharge.

3. The aesthetic resources of a community can be destroyed by hillside disturbances. Hills may mark a community's boundaries in sloping areas. Hillside degradation in the form of erosion and vegetation loss may deprive a community of its scenic vistas and distinctive setting.

B. Erosion

Erosion is a function of the degree of slope, soil type and vegetative cover. The greater the degree of slope, the more vulnerable the hillside to erosion. The rate of erosion is also dependent upon slope length, but to a lesser extent.

Potential sediment production is positively related to slope. In a major study involving many experimental watersheds, Musgrave (1947) found that the rate of erosion is proportional to the 1.35 power of land slope and to the 0.35 power of the slope length. Another way of looking at this relationship between sediment production, slope and slope length is to compare two slopes of 5 and 10 percent. Doubling of the slope would increase the erosion rate by 2.3 times (or 230 percent), whereas doubling the slope length would increase the erosion rate by only 22 percent (Leopold, 1968).

Since a slope of 10 percent drops 10 vertical feet in a 100-foot horizontal, temporary storage in the form of depressions in the hillside which might hold silt would be practically absent. For slopes in excess of 10 percent, small depressions in the stream channel which could hold up sediment as it moves downhill would also tend to be absent. Thus, Leopold (1968) suggests that construction activities on slopes steeper than 10 percent could be important producers of sediment.

In addition to vegetative cover removal, the mechanical alteration of slopes by grading or leveling can change the character of the slope. For example, the degree of slope may be increased which would lead to an increase of erosion and more easily eroded soils or rocks may be unearthed. The important thing is that any alteration of a slope can affect the equilibrium of a slope, the negative effects of which could be propagated downstream within the larger watershed (Thurow, Toner and Erley, 1975).

In sum, as a slope becomes steeper, the velocity of the runoff water increases which leads to an increase in the power of the runoff water to detach particles from the soil mass and to transport them from the area (Beasley, 1972). Specifically, if you hold slope length constant, at say 300 feet, the doubling of slope from 6 to 12 percent nearly triples the soil-loss ratio (from 1.09 to 3.07).

C. Hillside Drainage Patterns

The development of a stable drainage system is important in stabilizing hillsides. The drainage pattern is relatively stable on a vegetated, mature hillside. Earth movement in the form of grading and leveling of slopes forces the runoff water to establish new channels. This development of a new drainage system increases erosion and the rate of runoff flow, which could result in downstream siltation and flooding problems.

The increase in impervious cover on a hillside is one of the usual ways in which hillside drainage is changed by development. Roads can cut across stream channels, and along with parking lots and buildings can increase runoff by decreasing the amount of water permitted to infiltrate into the soil. Ground water recharge is accordingly reduced by the amount of impervious cover permitted in the area.

D. Slope-Density Regulations

Slope-density regulations decrease permitted development densities as slope increases. The environmental rationale for the regulation is simple and has been stated before: the potential for environmental degradation increases as slope increases. Limiting development in accordance with the degree of slope directs development to those portions of a community which have lesser potential for environmental damage while protecting the steeper and more environmentally sensitive lands.

The major variations on the slope-density approach are as follows (Thurow, Toner and Erley, 1975):

1. Slope-lot size: minimum lot size increases with average slope. This is the approach currently used by Ringwood.

2. Slope-natural area: the amount of land to be left in its natural state increases with slope.

3. Slope-dwelling unit: the number of allowable dwelling units decreases as slope increases.

E. Steep Slope Provisions in Other New Jersey Municipalities

Many communities in New Jersey are cognizant of the potential problems that may result from construction activities on steep slopes. The purpose of this section, therefore, is to provide some examples of how these communities regulate developments on slopes.

1. Princeton Township, Mercer County

   a. Date of Adoption: August, 1979.

   b. Sect. 10B:125.1.

   "No development or improvements shall be permitted on that portion of a lot having slopes of 25% or higher for a single family residential development or slopes of 15% or higher for any other type of land development.... Slope calculation shall be based on elevation intervals of H) feet..." (underlining added).

2. Washington Township, Morris County

   a. Date of Adoption: January, 1981.

b. Sect. 17-6.8a.

"The minimum area required for a building lot in any residential zone, except R-5, shall be increased in areas with slopes 15 percent or greater, but in no event shall the minimum area be increased to more than 200,000 square feet. The increase shall be determined by application of the formula below,..." (underlining added):

Slope (Percent)	Factor
30 or greater	0
21-29	0.2
15-20	0.5
0-14	1.0

c. Sect. 17-6.8b

"The maximum number of dwelling units allowed on any tract shall be computed as follows:

(land with slopes of 30 percent or more x 0) +

(land with slopes of 21 to 29 percent x 0.2) +

(land with slopes of 15 to 20 percent x 0.5) +

(land with slopes of 0 to 14 percent x 1.0) =

total land available for development."

d. Sect. 17-6.8c.

"No development or improvements shall be permitted on slopes of 30 percent or higher." (underlining added).

e. Sect. 17-6.8d.

"Slopes shall be computed...by calculation between two-foot contours." (Underlining added).

3. Bridgewater Township, Somerset County

a. Date of Adoption: December, 1976.

b. Sect. 126-261. Purpose.

"It is the purpose of this Part II to protect the health, safety and welfare of people and property within...Bridgewater from improper construction, building and development on steep slope and hill-side areas..., and ...to reduce the peculiar hazards which exist in hillside areas by reason of erosion, siltation, flooding, soil slippage, surface water runoff, pollution of potable water supplies from nonpoint sources, destruction of unique and predominant views, and it is a further purpose of this Part II to encourage appropriate planning, design and development sites within hillside areas which preserve and maximize the best use of the natural terrain and maintain ridgelines and skylines intact."

c. Sect. 126-266A(1).

"The...density of development shall be modified in areas of slopes greater than 1£ percent. The modification shall be determined by multiplying the total land area in various slope categories by the following factors:" (underlining added)

Slopes (Percent)	Factor
30 or greater	0
20-29	0.2
11-19	0.5
0-10	1.0

d. Sect. 136-266A(1).

"Slope calculations shall be based on elevation inter-vals of 10 feet." (underlining added).

e. **Sect. 126-266A(2).**

"The maximum number of dwelling units allowed on any tract shall be computed as follows:"

(Land with 30 percent or more slopes x 0) +

(Land with 20-29 percent or more slopes x 0.2) +

(Land with 11-19 percent or more slopes x 0.5) +

(Land with 0-10 percent or more slopes) =

Total land available for development.

f. Sect. 126-266B.

"No development or improvements shall be permitted on slopes of 2P. percent or higher." (underlining added).

4. Wantage Township, Sussex County

a. Date of Adoption: May, 1979.

b. Minimum lot sizes shall be as follows:

Constraint	Lot Sizes(acres)
Slopes: 25 percent or more	5
Slopes: 15-24 percent, deep soils	3

5. Far Hills Borough, Somerset County

a. Date of Adoption: June, 1981.

b. Art. 6.1.

"Development in...those areas having slopes L5 percent or greater increase the risk of...erosion both on and off-site. Therefore, development in these areas must be minimized and carefully regulated to protect the public safety and welfare." (underlining added).

6. Hillsborough Township, Somerset County

a. Date of Adoption: June, 1975

b. Art. 81-5K(6). Critical impact areas include slopes greater than 12 percent. A developer must prepare an EIS for any development which includes critical impact areas. The EIS must include protective measures and procedures to minimize dangers to these areas.

7. Jefferson Township, Morris County

The Natural Resource Inventory for Jefferson Township (1977) states that relatively low densities should prevail in areas of steep slopes and that environmentally sensitive areas should be set aside for open space. Among other things, development potentials are reflected in the following three slope categories:

Slope (Percent)	Development Potential
0-10	developable
10-15	developable with limitations
greater than 15	restrictive limited development

F. Calculation of Average Slope

The average slope of a parcel can be determined by the following formula (Thurow, Toner and Erley, 1975):

$$S = \frac{0.0023\ (I)L}{A}$$

where S = the average slope in percent

0.0023 = conversion factor of square feet to acres

I_i = contour interval in feet

h_i = combined length of the contour lines in scale feet

A = the gross area in acres of the parcel or lot

Thurow, Toner and Erley (1975) state that the contour interval must be 10 feet or less in order for the equation to be accurate to one percent. A contour interval of 20 feet, which is common on most USGS topographic maps of North Jersey at a scale of 1" = 2,000', results in an error of 5 percent. Also, the horizontal map scale should be at least 1" = 200' which is a much larger scale than the standard USGS topographic maps.

Application of the formula to three areas in Ringwood that are or were owned by Countryside Properties, Inc. results in the following average slopes:

Location	Area (acres)	Contour Interval (feet)	Horizontal Scale	Average Slope (Percent)
Block 752, Lot 1	66	10	1" = 60'	25.5
Block 752, Lot 3 (Kensington Woods)	67	10	1" = 100'	15.8
Block 877, Lot 16	62.9	25*	1" = 100'	22.4

* only 25-foot contours were available for this area.

It is interesting to note that the average slope for the proposed townhouses in Block 752, Lot 1 (25.5 percent) is considerably more than the Kensington Woods development (15.8 percent) which is further downslope. Although the two parcels are adjacent, the property further up Skyline Drive is considerably steeper, as might be expected.

Although 5-foot contours were obviously available for Block 877, Lot 16, the map that was made available to the author had only 25-foot contours delineated on the property in question. The resulting 22.4 percent average slope for the parcel which adjoins Skyline Drive and the Fieldstone Shopping Center is steeper than Kensington Woods (15.8 percent).

Detailed topographic maps of the 122-acre Margaret King Ave. parcel owned by Countryside Properties, Inc. (Block 508, Lot 2) were not available to the author. Therefore, average slope using the Thurow, Toner and Erley (1975) equation could not be obtained. However, Kasler (1982) estimated that nearly 33 percent of the site has slopes in excess of 15 percent.

G. Conclusions

Steep slopes represent one important form of critical area. Numerous communities, both in New Jersey and other states, have recognized that construction activities on hillsides can result in severe erosion and runoff problems. As a consequence, many of these communities have adopted some form of slope-density regulation governing permissible development densities on steep slopes. Ringwood's slope-density ordinance is therefore quite typical in this regard.

Ringwood happens to be located in a portion of New Jersey where steep slopes are the rule rather than the exception. This means that large portions of the borough are environmentally sensitive and it is only reasonable to expect that the zoning reflect this physical reality.

The two Countryside Property parcels adjoining Skyline Drive (Block 752, Lot 1 and Block 877, Lot 16) have average slopes of 25.5 and 22.4 percent, respectively. These values are higher than the 15.8 percent average slope calculated for the Kensington Woods development (Block 752, Lot 3). It is considered reasonable, therefore, to group the first two parcels in the steeply sloping and therefore environmentally sensitive category.

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824
(201) 297-8899

VI. TROUT WATERS IN RINGWOOD

Outline

A. Introduction

B. Classification of Trout Waters

C. Recognition in NJDEP Programs

  1. NJDEP Surface Water Quality Standards

  2. NJDEP Draft Stream Encroachment Regulations

D. Trout Waters in Ringwood

  1. Trout Production

  2. Trout Maintenance

  3. Nontrout

E. Discussion

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824

(201) 297-8899

VT. TROUT WATERS IN RINGWOOD

A. Introduction

Almost all of the most productive waters in New Jersey for trout are found in the northwestern portion of the state which includes Ringwood. In 1979 the NJDEP Division of Fish, Game and Wildlife began a program to increase the recognition of these trout waters by all levels of government and to recommend programs for their protection and restoration. Thus, one of the purposes of this report is to summarize how existing NJDEP Surface Water Quality Standards and draft NJDEP Stream Encroachment Regulations of April, 1982 affect trout waters.

On a national basis, the federal Clean Water Act provides a basis for water pollution control activities. One of the goals of the Act is the maintenance, wherever possible, of "water quality which provides for the protection and propagation of fish . . ." Similar goals are included in New Jersey's Water Pollution Control Act (N.J.S.A. 58:10A-l et seer.) and in the Water Quality Planning Act (N.J.S.A. 58:11A-1 et seer.).

Certain types of land and stream channels are viewed as being particularly sensitive for water quality in New Jersey. Anthropogenic activities which may alter these areas and introduce pollutants can negatively impact the viability of trout populations by degrading habitat and water quality.

Pollutant sources include both point and nonpoint activities. A wastewater discharge from a sewage treatment plant with a known outfall would be classified as a point source. Nonpoint sources include construction, onsite wastewater disposal, and storm water runoff. The major pollutants associated with nonpoint pollution are sediment, nutrients, heat, microbial pollutant, and heavy metals.

One recognized method of avoiding degradation of the aquatic environment is to protect the most sensitive species within the aquatic community, thereby presumably protecting the entire system. Trout require very high quality waters and are particularly sensitive to changes in environmental conditions. Thus, if we base water quality and physical habitat recommendations for trout waters on trout requirements, sufficient protection and preservation of aquatic life in these waters from degradation should result.

B. <u>Classification of Trout Waters</u>

In terms of their ability to sustain trout, the waters of New Jersey are defined in the NJDEP Surface Water Quality Standards (N.J.A.C. 7:9-4.1 <u>etseq</u>.) as follows:

1. <u>Trout Production</u>: waters that are used by trout for spawning or nursery purposes during their first summer or which are considered to have high potential for such purposes following the correction of short-term environmental changes.

2. Trout Maintenance: waters that support trout throughout the year or which have high potential for such use following the correction of short-term environmental changes.

3. Nontrout: waters that are not suitable for trout because of their physical, chemical or biotic characteristics but are suitable for many other fish species.

C. Recognition in NJDEP Programs

NJDEP has recognized the importance of maintaining and protecting trout waters by giving them special protection in its Surface Water Quality Standards (N.J.A.C. 7:9-4.1 et seg.) and in draft Stream Encroachment Regulations.

1. NJDEP Surface Water Quality Standards

The New Jersey Department of Health adopted the first water guality standards for trout waters in 1964. The New Jersey Department of Environmental Protection (NJDEP) was established in 1970 and has always distinguished between "trout production," "trout maintenance," and "nontrout" waters in its official surface water quality standards. The current standards (N.J.A.C. 7:9-4.1 et seg.) were adopted on March 3, 1981 pursuant to the authority of the Water Pollution Control Act (N.J.S.A. 58:10A-l et seg.), the Water Quality Planning Act (N.J.S.A. 58:11A-1 et seg. and N.J.S.A. 13:I'D-1 et seg.), and are the pertinent water quality standards under section 303 (c) of the federal Clean Water Act.

The water quality standards include statements of policy, use classifications (FW-1, FW-2, etc.), and corresponding quality criteria. The FW-2 classification, which includes most of New Jersey's fresh surface waters, is divided into the following three categories:

a. FW-2 Trout Production

b. FW-2 Trout Maintenance

c. FW-2 Nontrout

The criteria for suspended solids, dissolved oxygen, temperature, and ammonia are more stringent for trout waters than they are for nontrout waters. In addition, the Surface Water Quality Standards identifies trout production, trout maintenance, and non-trout waters upstream of trout production waters as "High Quality Waters - Category One." This "antidegradation" policy states in part:

> ". . . The uses of these high quality waters are so sensitive to any change in chemical or physical characteristics that it is presumed that any measurable or calculable degradation of the instream characteristics will lead to eventual change or harm to the uses in these surface waters. The existing biological, chemical, or physical characteristics of High Quality Waters - Category One which are critical to the maintenance of existing stream uses will be protected from any measurable or calculable changes . . . "

As might be expected, variances from the antidegradation policy are permissible. For example, water quality based effluent limitations can be modified for individual point discharges (N.J.A.C. 7:9-5.6(a)15 and N.J.A.C. 7:9-5.12) and waterway segments can be reclassified for less restrictive uses per N.J.A.C. 7:9-5.13.

2. NJDEP Draft Stream Encroachment Regulations

NJDEP released in April 1982 draft stream encroachment regulations to implement the Flood Hazard Area Control Act (N.J.S.A. '58:16A-50 et seg.). Special provisions for the protection of trout streams are included in these draft regulations.

The draft regulations attempt to balance the protection of trout waters with other elements of public health, safety and welfare which may require stream encroachment. The special provisions for trout-associated streams in the draft regulations are found mainly in sections 7:13-5.2(c) and 7:13-5.6, and are as follows:

a. Provisions to discourage woodland removal along the stream and particularly along the shade-producing southerly bank;
b. Provisions to discourage the operation of construction equipment in the stream;
c. Provisions to discourage certain kinds of stream encroachments during certain seasons;
d. Provisions to require that pools and riffles be included in channelization projects if such features were present before channelization.

D. Trout Waters in Rincrwood

Almost the entire borough of Ringwood has either trout production or trout maintenance waters. The only part of the borough that has non-trout waters is the Skyline Lakes section south of High Mountain Brook.

The trout-associated waters of Ringwood are as follows:

1. Trout Production Waters

   a. Burnt Meadow Brook (entire length)

   b. West Brook (entire length)

   c. High Mountain Brook above Skyline Lakes

The High Mountain Brook is in the process of being reclassified from nontrout to trout production waters. The revised classification pertains to the entire High Mountain Brook watershed from its source downstream to, but not including, Skyline Lakes.

2. Trout Maintenance Waters

   a. Wanague River (upstream of Wanague Reservoir)

   b. Wanaque Reservoir

   c. Ringwood Brook (entire length)

   d. Sheppard Lake

3. Nontrout Waters

   a. Skyline Lakes

   b. Tributary to Meadow Brook (starting in the Painted Forest area near Skyline Drive)

E. Discussion

Approximately one-half of the Countryside Property parcel (Block 752, Lot 1) drains into High Mountain Brook (trout production) while the other half drains into a tributary to Meadow Brook (non-trout). About the same ratios hold for the Countryside Property parcel (Block 877, Lot 16) near Grand Union, where one-half drains into High Mountain Brook (trout production) and the other half drains into Skyline Lakes (nontrout). All of the third Countryside " Property parcel south of Margaret King Avenue (Block 508, Lot 2) drains into the Wanaque Reservoir (trout maintenance)..

Several implications follow from these observations, as follows:

1. Any expansion of the James Drive sewage treatment plant would necessitate substantial upgrading of effluent quality. This could mean tertiary treatment (advanced waste treatment) which is very expensive. The determination of just how much additional waste load can be put into High Mountain Brook would of course rest with NJDEP.

2. Potential storm water runoff contamination assumes even greater importance when the receiving waters are classified as trout maintenance or trout production. Nonpoint source pollutants from storm water runoff generally increase as development density increases, although it is recognized that mitigative measures can be instituted so as to reduce anticipated loads. These mitigative measures are somewhat more difficult to employ on steeply sloping lands as they are expensive and require more land.

3. Since High Mountain Brook has been proposed for NJDEP for reclassification as a trout production stream, development densities within the watershed have to be regulated so as to comply with the antidegradation policies for High Quality Waters - Category One.

Robert M. Hordon, Ph.D.
Water Resources Consultant
8 Dov Place
Kendall Park, N. J. 08824
(201) 297-8899

VII. ENVIRONMENTAL FACTORS AND ZONING: AN OVERVIEW

Outline

1. Northeast **New Jersey** Water Quality Management Plan
   a. **Wetlands**
   b. **Stream Corridors**
   c. **Headwater Areas**
   d. **Steep Slopes**
   e. **Woodlands**
2. State **Development** Guide Plan
3. New Jersey Stormwater Quantity/Quality Management Manual
4. **Discussion**

VII. ENVIRONMENTAL FACTORS AND ZONING: AN OVERVIEW

Examination of a variety of major state documents and judicial decisions (Mount Laurel II) clearly indicates that environmental factors should play a role in the zoning process. The reports stress the relationship between water quality, land use, and critical environmental areas. Therefore, the purpose of this section is to provide an overview of environmental factors and zoning in general.

1. Northeast New Jersey Water Quality Management Plan

The Northeast New Jersey Water Quality Management Plan (hereinafter called the Plan) was prepared by NJDEP in 1979, adopted by the State on March 12, 1980 and approved by EPA, Region 2 in April, 1980 (NJDEP, 1979). The Plan was prepared under Sections 208 and 303(e) of the Federal Water Pollution Control Act Amendments of 1972 and 1977.

The Plan is a voluminous document, consisting of 576 pages of text, tables and figures. The protection and management of environmentally sensitive areas is a major component of the Plan. The document recognizes that certain lands have a more direct relationship with water resources than other lands. These lands may have substantial development constraints because of physical and hydrological factors. Unrestricted development of these lands can result in intensified water quality problems.

In short, NJDEP (1979) has identified several environmental factors which should receive special attention in any local or regional land use decision-making process.

A partial list of these environmental factors includes the following:

a. <u>Wetlands</u>: are those areas where the water table is close enough to the ground surface to normally support vegetation which can exist under saturated soil conditions. Wetlands provide (NJDEP, 1979, p. IV-56):

> "...natural flood control, recharge of aquifers, natural purification of waters, stabilization of stream flow, and habitats for a diversity of terrestrial and aquatic wildlife. Wetlands act as sediment and pollutant traps, and remove nutrients from water under certain conditions."

Wetlands in Ringwood have been delineated on a map prepared by Kasler & Associates, at a scale of 1" = 1200[1].

b. <u>Stream Corridors</u>: are located along streams and form buffers against water pollutants. Riparian vegetation acts as a filter for overland runoff entering a stream and also maintains cooler water temperatures by providing shade. Disturbance of the vegetation along stream corridors can result in sedimentation from accelerated bank erosion.

Stream corridors should be left in their natural vegetated condition as much as possible. Buffer strip widths of at least 50 - 100 feet are recommended.

c. Headwater Areas: are land areas which drain into ephemeral and intermittent streams. As defined by NJDEP (1979), ephemeral streams carry water only during and immediately following a period of rain. Intermittent streams are defined by NJDEP (1979) as streams with a Q7-10 low flow of less than 0.1 $ft.^3$/second (64,600 gpd).

A broader and less restrictive definition of headwater areas is provided in the revised Glossary of Geology (Bates & Jackson, 1980) which simply includes the upper part of a drainage basin. In the latter instance, all of Ringwood is located within a headwater area. Most of Ringwood drains into

Wanaque Reservoir while the southeastern section drains into the Wanaque River and then the Passaic River which is used as a source for public potable water supply. Thus, all of Ringwood drains the upper portions of watersheds which are used by the North Jersey District Water Supply Commission and the Passaic Valley Water Commission for public potable water supply purposes.

In any event, improper development in headwater areas can result in substantial local and regional water quality impacts. For example, (NJDEP, 1979, p. IV-57):

> "At a local scale, development in headwater areas can result in contaminated runoff entering streams which have little or no capacity to assimilate the polluted runoff. The impervious cover associated with development can result in increased runoff and decreased ground water recharge, and thus, a reduction in base flow. A reduction in base flow effectively reduces stream assimilative capacity."

> "At a watershed scale, downstream reaches can be significantly degraded by the cumulative contribution of contaminated headwater streams. Good water quality downstream is highly dependent on headwater areas supplying adequate amounts of unpolluted water."

d. Steep Slopes: refer to the vertical change in elevation per horizontal distance. Slopes of 12 percent or greater are potentially unstable. Developments on steep slopes can result in accelerated erosion and sedimentation, increased runoff, and flooding.

Steep slope issues are discussed in greater detail in another section of this report.

e. Woodlands; are forested areas generally larger than 20 contiguous acres, as defined by NJDEP (1979). Woodlands provide environmental benefits as they retard runoff, minimize erosion, and filter out pollutants before they can reach ground or surface waters. Woodlands are often associated with other natural features of the landscape, such as steep slopes, stream banks, and wetlands.

'~ZZ? 2« State Development Guide Plan

The revised State Development Guide Plan (NJDCA, 1980) is a generalized policy guide which recommends where future development and conservation efforts in New Jersey should be concentrated. The Guide Plan makes recommendations where growth-inducing developments, such as highways and water and sewer infrastructure should or should not be made.

The entire borough of Ringwood falls within the Conservation Area on the concept maps contained in the Guide Plan. Conservation areas meet the following criteria:

a. low density development with minimal public water and sewer infrastructure;

-J b. large areas of environmentally-sensitive land proximate to existing public holdings;

c. limited accessibility from population and employment centers by major road and rail facilities.

In essence, the concept of conservation areas- implies the recognition of the need to protect wetlands, steep slopes, stream corridors and other environmentally critical areas from improper development.

3. <u>New Jersey Stormwater Quantity/Quality Management Manual</u>

Stormwater runoff from developed areas has been recognized by many agencies as a major water quality problem. Since a large portion of the damage to stream beds and water quality occurs in suburbanizing watersheds, it is considered more efficient and cost-effective to work on preventive measures for developing areas rather than rely on expensive remedial controls after the damage is done. Consequently, a Stormwater Quantity/ Quality Management Manual (hereinafter called the Stormwater Manual) was prepared by the Delaware Valley Regional Planning Commission for use by NJDEP (1981).

Many of the recommendations contained in the Stormwater Manual pertained to land use management practices. These practices included recommendations to plan growth to protect clean water and also to limit development affecting sensitive hydrologic areas (water supply sources, wetlands, woodlands, and stream buffer zones). The land use management practices can be categorized as follows (NJDEP, 1981):

a. <u>Establish regional and local growth policies</u>: this implies an evaluation of growth limits and population shifts between developing areas which can result in better water quality protection. Note that total pollutant loads consist of both point and non-point sources.

b. Plan open space and rural land uses: providing for ample open space and protection of rural lands leads to higher levels of water quality protection.

c. Protect water supply watersheds: a variety of pollutants contained in urban runoff (heavy metals, nutrients, and hydrocarbons) can seriously degrade streams and reservoirs. Conventional water supply treatment processes does not completely remove many of these pollutants and in certain cases may even make things worse. For example, disinfecting with chlorine may result in the creation of chlorinated hydrocarbons.

NJDEP (1981) recommends that major growth be directed away from water supply watersheds in order to insure proper protection.

d. Preserve wetlands: improper development in upland areas can result in large amounts of nutrients and sediment being transported to wetlands. Protection is needed to guard against potential eutrophication and siltation.

e. Preserve woodlands: areas left in woods can reduce the impact of flooding and limit erosion and siltation. In this context, cluster developments may be beneficial since smaller amounts of land are disturbed.

f. Preserve stream buffer zones: the adverse impacts of urban development can be mitigated by maintaining vegetated corridors along the streams. Where appropriate, adjacent areas with steep slopes and woodlands should be included in the buffer zone.

4. Discussion

Management of environmentally sensitive lands requires a combination of local and state involvement. Local involvement is necessary inasmuch as land use regulation rests mainly with the municipality. Furthermore, the Municipal Land Use Law requires municipalities to take environmental factors into account in the preparation of master plans.

Knowledge of environmental features in a municipality along with socio-economic information facilitates effective master planning. Environmentally-based master planning can identify areas where development could cause substantial water quality problems. On the other hand, areas could be identified where development could occur because of more favorable environmental conditions.

Ringwood occupies that part of New Jersey where environmentally-sensitive lands (steep slopes, severe limitations for onsite septic systems, etc.) predominate. It is only reasonable and good planning, therefore, that this environmental information be included in the zoning process.

Robert M. Hordon, Ph.D.
WaterResourcesConsultant
8 Dov Place
Kendall Park, N. J. 08824
(201) 297-8899

VIII. REFERENCES CITED

1. Bates, R. L. & Jackson, J. A. (eds.). Glossary of Geology. Falls Church, Va.: American Geological Institute, 2nd. ed. 1980, 749 pp.

2. Beasley, R. P. Erosion and Sediment Pollution Control. Iowa State University Press, Ames, Iowa. 1972, 320 pp.

3. Brown, K. W. and Associates. "An Assessment of the Impact of Septic Leach Fields, Home Lawn Fertilization and Agricultural Activities on Groundwater Quality." Report prepared for the New Jersey Pinelands Commission by K. W. Brown and Associates, College Station, Texas. 1980, 104 pp.

4. Ciotoli, Peter A. (Roy Weston Engineers). Telephone interview on July 18, 1983.

5. Gillespie, B. D. & Schopp, R. D. Low-Flow Characteristics and Flow Duration of New Jersey Streams. U.S. Geological Survey Open-File Report 81-1110, Trenton, N.J. 1982, 164 pp.

6. Halasi-Kun, G. J. "Regional Water Supply Planning - Ground Water Estimate Based on Hydrologic Survey in New Jersey." Proceedings University Seminar on Pollution and Water Resources, Vol^ 12, 1978-79, Columbia University, pp. E1-E12, New Jersey Bureau of Geology Bulletin 75-F, 1979.

7. Hall, M. W. "A Conceptual Model of Nutrient Transport in Subsurface Soil Systems," in Water Pollution Control in Low Density Areas, W. J. Jewell and R. Swan (eds.) University Press of New England, Hanover, New Hampshire, 1979, pp. 55-64.

8. Holzer, T. L. "Limits to Growth and Septic Tanks," in Water Pollution Control in Low Density Areas, W. J. Jewell and R. Swan (eds.), University Press of New England, Hanover, New Hampshire, 1975, pp. 65-74.

9. Hughson, Arthur A. Letter from A. A. Hughson, Ringwood Borough Health Officer to E. J. Marcus, U.S. EPA, New York, May 14, 1981.

10.______________. Personal interview on November 12, 1982.

11. Inhoffer, Wendell. Chief Engineer, Passaic Valley Water Commission. Telephone Interview on December 10, 1982.

12. Jefferson Township. Natural Resource Inventory. Report prepared by Sartor Associates, Watchung, N.J. 1977.

13. Kane, Thomas. Ringwood Borough Manager. Personal interview on December 3, 1982, and February 10, 1983.

14. Kasler, Malcolm. Ringwood Borough Master Plan. Report prepared for Ringwood Borough by Malcolm Kasler and Associates, Hackensack, N.J., 1981, 104 pp.

15.______________. "Planning Report in the matter of Countryside Properties, Inc. and Wallace & Czura Land Co. vs. Borough of Ringwood," 1982.

16. Kuhner, J. , et al. "Water Use and Wastewater and Residuals Generation in Households: Potentials for Conservation," in Proceedings of the Second National Home Sewage Treatment Symposium, American Society of Agricultural Engineers, St. Joseph, Michigan, 1977, pp. 260-267.

17. Leopold, L. B. "Hydrology for Urban Land Planning - A Guidebook on the Hydrologic Effects of Urban Land Use," U.S. Geological Survey Circular 554, 1968, 18 pp.

18. Linsley, R. K. and Franzini, J. B. Water-Resources Engineering. 2nd Ed. McGraw-Hill Book Co., New York, 1972, 690 pp.

19. Lynch, Donald, P.E. Engineer, Construction Grants Division, NJDEP. Personal interview on January 12, 1982.

20. McDowell, Harold. Sup't., Dept. of Public Works, Ringwood. Personal interviews on July 14, 1982; December 15, 1982; February 2, 1983; and February 10, 1983. Telephone interview on June 23, 1983.

21. Malcolm Pirnie, Inc. Supplement Facilities Planning Study. Report prepared for the Ringwood Borough Sewerage Authority, June 1979.

22. ______________, Basis of Design. Supplemental Facilities Planning Report for the Ringwood Borough Sewerage Authority, July 1980.

23. Massachusetts Federation of Planning Boards, Inc. Planners Handbook. Mass. Fed. of Planning Boards, Braintree, Mass. 1975, 70 pp. + app.

24. Miller, D. W., DeLuca, F. A., and Tessier, T. L. Ground Water Contamination in the Northeast States. EPA-660/ 2-74-056, U.S. Environmental Protection Agency, Washington, D.C., 1974, 325 pp.

25. Miller, J. C. "Nitrate Contamination of the Water-Table Aquifer by Septic Tank Systems in the Coastal Plain of Delaware," in Water Pollution Control in Low Density Areas, W. J. Jewell and R. Swan (eds.), University Press of New England, Hanover, New Hampshire, 1975, pp. 121-133.

26. Miller, J. W., Jr. "Geology and Ground Water Resources of Sussex County and the Warren County Portion of the Tocks Island Impact Area," New Jersey Bureau of Geology Bulletin 73, Trenton, N.J., 1974, 143 pp.

27. Musgrave, G. W. "Quantitative Evaluation of Factors in Water Erosion - First Approximation," Journal of Soil and Water Conservation, 1947, 2(3):133-138.

28. Nassau-Suffolk Regional Planning Board. Areawide Waste Treatment Management (208). Hauppauge, Long Island, New York. kummaryTlan, Interim Report Series: 7, 1978, 250 pp.

29. New Jersey Bureau of Geology. "Land Oriented Reference Data System (LORDS)," Bulletin 74, Trenton, N.J., 1974, 151 pp.

30. New Jersey Dept. of Community Affairs (NJDCA). State Development Guide Plan. Revised Draft. 1980, 179 pp.

31. NJDEP (Department of Environmental Protection). Division of Water Resources, Trenton. Quarterly Report Files No. 312 and 373. Various years.

32. ______________. "Standards for the Construction of Individual Subsurface Sewage Disposal Systems," N.J.A.C. 7:9-2.1 to 7:9-2.98, Trenton, N.J., 1978, 32 pp.

33. ________________. Northeast New Jersey Water Quality Management Plan. 1979, 576 pp.

34. ________________. Memo from Water Resources Director Arnold Schiffman to DEP Commissioner Jerry English, May 4, 1981.

35. _____________^_. Ringwood Water Supply Application No. 1856 of 9/14/81 on file in the Division of Water Resources, Trenton.

36. ________________. New Jersey Stormwater Quantity/Quality Management Model. 1981, 318 pp.

37. ________________. Basic Information About New Jersey Trout Waters. (Revised). 1983, 76 pp.

38. Nightingale, H. I., and Bianchi, W. C. "Ground-Water Chemical Quality Management by Artificial Recharge," Ground Water, 1977, 15(l):15-22,

39. Peck, Shephard. Ringwood Planning Board Attorney. Telephone interview on February 11, 1983,

40. Pizor, Peter J., et al. Managing Growth in Developing Communities. New Jersey Agricultural Experiment Station Publication No. R-17901-1-82. 1982, 132 pp.

41. Posten, Stephen E. "Estimation of Mean Groundwater Runoff and Safe Yield Using Hydrograph Analysis in Selected New Jersey Hard Rock Aquifers." MS Thesis, Geography Dept., Rutgers University, 1982, 336 pp.

42. Rakowsky, Edward L. Operator for High Point Homes and Ringwood Plaza Waste Treatment Plants. .Personal interview on December 8, and December 15, 1982. Telephone interview on July 18, 1983.

43. Ringwood Environmental Commission. Natural Resources Inventory. 1981.

44. Siegel, Sidney. Nonparametric Statistics. McGraw-Hill Book Co., New York. 1956, 312 pp.

45. Siegrist, et al. "Water Conservation and Wastewater Disposal," in Proceedings of the Second National Home Sewage Treatment Symposium, American Society of Agricultural Engineers, St. Joseph, Michigan. 1977, pp. 121-136.

46. Soil Conservation Service. Soil Survey of Passaic County, New Jersey. L. R. Seglin and R. A. Shook. 1975, 69 pp.

47. Thurow, C., Toner, W., and Erley, D. Performance Controls for Sensitive Lands: A Practical Guide for Local Administrators. U.S. Environmental Protection Agency, Report No. EPA-600/5-75-005. 1975, 523 pp.

48. Trela, J. J., and Douglas, L. A. "Soils, Septic Systems and Carrying Capacity in the Pine Barrens," paper presented at the First Annual Pine Barrens Research Conference, Atlantic City, N.J. May 22, 1978, 34 pp.

49. U.S., Environmental Protection Agency. "Environmental Review of the Ringwood Borough Sanitary Sewage Collection System." Region 2, New York. February 29, 1980.

50. ______________. Design Manual: Onsite Wastewater Treatment and Disposal Systems. 1980, 391 pp.

51. Vecchioli, J., and Miller, E. G. "Water Resources of the New Jersey Part of the Ramapo River Basin," U.S. Geological Survey Water-Supply Paper 1974. 1973, 77 pp.

52. Weston Engineers. "Interim Report: Problem Assessment and Wastewater Management Alternatives." August 6, 1982, 74 pp.

53. Wichterman, Jack. Chairman, Ringwood Borough Sewerage Authority. Personal interview on December 3, 1982.

54. Wiswall, K. C., Dabagian, L. A., & Wegmann, P. C. "Innovative and Alternative Technology Guide for On-Site Wastewater Disposal Systems in Sussex County, New Jersey." Report prepared for Sussex County Board of Chosen Freeholders by Weston Engineers. 1982, 49 pp.

55. Zaniello, Joseph A. Yurasek Associates, Mahwah, N.J. Personal interview on December 1, 1982.

56. Zeppenfeld, S. Dan. Engineer, Construction Grants Division, NJDEP. Personal interview on December 10, 1982.