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A proposed onsite wastewater system for Dobbs site

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A PROPOSED ONSITE TERTIARY WASTEWATER DISPOSAL SYSTEM FOR THE DOBBS SITE IN BEDMINSTER, SOMERSET COUNTY, NEW JERSEY

AUGUST 31, 1984

RULS-AD-
1984-283

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August 31/ 1984

Honorable Eugene D. Serpentelli, J.S.C.
Superior Court of New Jersey
Ocean County Court House
Toms River, NJ 08753

Re: <u>Allan-Deane vs. Bedminster Township</u>

Dear Judge Serpentelli:

Enclosed please find my report entitled "A Proposed Onsite Tertiary Wastewater Disposal System for the Dobbs Site in Bedminster, Somerset County, New Jersey." The report is submitted in accordance with your letter of August 3, 1984.

Very truly yours,

Robert M. Hordon

Robert M. Hordon

RMH/mk

cc: Joseph L. Basralian, Esq.
Leonard Dobbs
Alfred L. Ferguson, Esq.
Henry A. Hill, Esq.
Kenneth E. Meiser, Esq.
Peter J. O'Connor, Esq.
George M. Raymond
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A. Summary and Conclusions

1. An onsite tertiary treatment plant with denitrification and subsurface disposal can be built expeditiously on the Dobbs site in Bedminster. The wastewater disposal system can accommodate the estimated flow of 278,400 gpd (gallons/day) from the total number of 1,160 units, of which 232 (or 20 percent) will be low and moderate income units.
2. The tertiary treatment plant will consist of a totally enclosed, architecturally compatible building which will house the Rotating Biological Contactors (RBC), clarifiers, and denitrification facilities. The building or buildings for a plant of this size can be accommodated on a one-acre tract and can be located close to residential units.

   The advantages of the RBC system are as follows:

   a. economics (low power requirements);
   b. low maintenance costs;
   c. minimal odor and fly nuisance;
   d. low noise levels;
   e. relatively rapid installation;
   f. takes up less space than other types of treatment plants.

   Since the RBC was developed in Europe in the late 1950's, over 700 have been installed in various locations in West Germany, France and Switzerland. The RBC units in New Jersey range in size from 100,000 to 16,000,000 gpd. Therefore, there is nothing unusual about the size proposed for the

Dobbs site (278,400 gpd).

3. Following denitrification, the highly treated effluent will be piped to onsite subsurface disposal fields. Based on the U.S. Soil Conservation Service report for Somerset County, the best soils on the Dobbs site for land disposal are the Birdsboro (BdB) soils. These soils are deep, well drained soils which developed on the terraces along the major rivers of the area, such as the Raritan.

The amount of Birdsboro (BdB) soil above the 500-year flood limit is estimated to be 18.8 acres. The area required for the disposal fields is estimated to be 13.4 acres; therefore, additional land is available for disposal fields if necessary. As a further back-up, several additional acres of adjoining Birdsboro (BdC) soils on the Dobbs site can be made available if necessary.

In addition to the sufficient onsite acreage, another major advantage of using the Birdsboro soils is the location and geometric configuration. The soils are located along the periphery of the tract near Routes 202/206 and are also long and linear. This shape provides a maximum perimeter which will help reduce any ground water mounding associated with effluent disposal.

From an environmental and water quality management viewpoint, subsurface disposal of treated effluent is highly desirable for the following reasons:

a. additional purification of the effluent is accomplished by percolation through the soil column;

b. the direct impact on the North Branch Raritan River (or any stream) is eliminated;

c. the ground water is recharged..

4. For a variety of reasons, it is difficult to estimate the amount of time that would be required for any wastewater disposal system to receive the necessary governmental reviews, permits and approvals. From a technical viewpoint, the onsite system proposed for the Dobbs tract can be operational in a relatively short time, since the plant incorporates established technology and the system is similar to several other systems in the state which have been reviewed expeditiously. Following treatment plant approval, it is estimated that both the wastewater disposal system and the first units of residential housing on the Dobbs site can be on-line in about one year.

In sum, an onsite tertiary treatment plant with subsurface disposal is seen as the most effective, environmentally preferred method of handling the effluent loadings from the Dobbs tract.

B. <u>Wastewater Flows</u>

According to the U.S. EPA (1980):

> The average daily wastewater flow from a typical residential dwelling is approximately 45 gal/capita/day (gpcd).... While the average daily flow experienced at one residence compared to that of another can vary considerably, it is typically no greater than 60 gpcd... and seldom exceeds 75 gpcd....

The standard estimators used by the NJDEP are 75 gpcd for multi-family dwellings and 100 gpcd for single family dwellings (NJDEP, 1978). In his various planning reports to Bedminster, R. T. Coppola used an estimator of 240 gal/day (gpd) per dwelling unit. If we assume that Coppola was referring to multi-family dwellings and if we use the NJDEP estimator of 75 gpcd, then the average number of persons/dwelling unit (DU) would be as follows:

$$\frac{240 \text{ gpd/DU}}{75 \text{ gpcd}} = 3.2 \textit{ persons}/\text{DU (dwelling unit)}$$

The average value of 3.2 persons/DU may be on the high side, considering recent demographic trends (fewer people per DU).

The proposed number of dwelling units on the Dobbs site is 1,160, of which 232 (20 percent) would be low and moderate income units. At this time, the exact mix of single family, townhouse, and garden apartment types of units has not been decided upon. Generally, garden apartments generate less wastewater/unit than townhouses which in turn generate less than single family dwellings. Therefore, the overall average estimator of 240 gpd/DU will be used for wastewater planning purposes, even though the estimator may be on the high side.

The wastewater flow from the Dobbs site is estimated as follows:

$$1160 \text{ DU } (240 \text{ gpd/DU}) = 278{,}400 \text{ gpd}$$

C. Rotating Biological Contactors (RBC)

The proposed treatment plant for the Dobbs site will use Rotating Biological Contactors (RBC) units. The RBC process was developed in Europe during the late 1950's and have now been installed in over 700 treatment plants in West Germany, France, and Switzerland (U.S. EPA, 1977). The design has since spread to the U.S. and is now incorporated in a number of installations in New Jersey.

As shown in Table 1, the design flow of the RBC units in New Jersey range from 100,000 to 16,000,000 gpd. Thus, most of the RBC units currently operating in New Jersey are considerably larger than the proposed units for the Dobbs site and therefore there would be no difficulty in handling the anticipated flows. The RBC units in New Jersey have been in existence for about 10 years (Telephone Interview with Dennis Palmer, NJDEP, February 6, 1984).

In brief, the RBC process consists of a series of plastic disks mounted on a horizontal shaft and placed in a tank with a contoured bottom (see Figure 1). The disks rotate slowly in the wastewater, having about 40 percent of the surface area submerged. As the disks rotate, they pick up a thin layer of wastewater which flows over the disk surface and absorbs oxygen from the air. The fixed biomass film on the surface of the disk removes both dissolved oxygen and organic material from the wastewater. As the disk (and fixed biomass) rotate and become

TABLE 1

ROTATING BIOLOGICAL CONTACTOR (RBC) UNITS IN NEW JERSEY

Treatment Plant	County	Design Flow (1,000 gpd)	Average Flow (1,000 gpd)
1. West Milford ("Bald Eagle")	Passaic	100	under construction
2. Chatham Township ("Chatham Glen")	Morris	120	" "
3. Washington Township MUA	"	216	327
4. Dobbs Site	Somerset	280	Proposed
5. Southampton Township	Burlington	500	210
6. Pennsville SA	Salem	1,250	1,280
7. Vorhees Township	Camden	1,650	1,206
8. Gloucester Township	"	4,500	2,400
9. North Bergen Township	Hudson	10,000	5,000
10. Hamilton Township	Mercer	16,000	8,300

Source: NJDEP files in Trenton; Personal Interview with John Laurita, NJDEP, August 23, 1984.

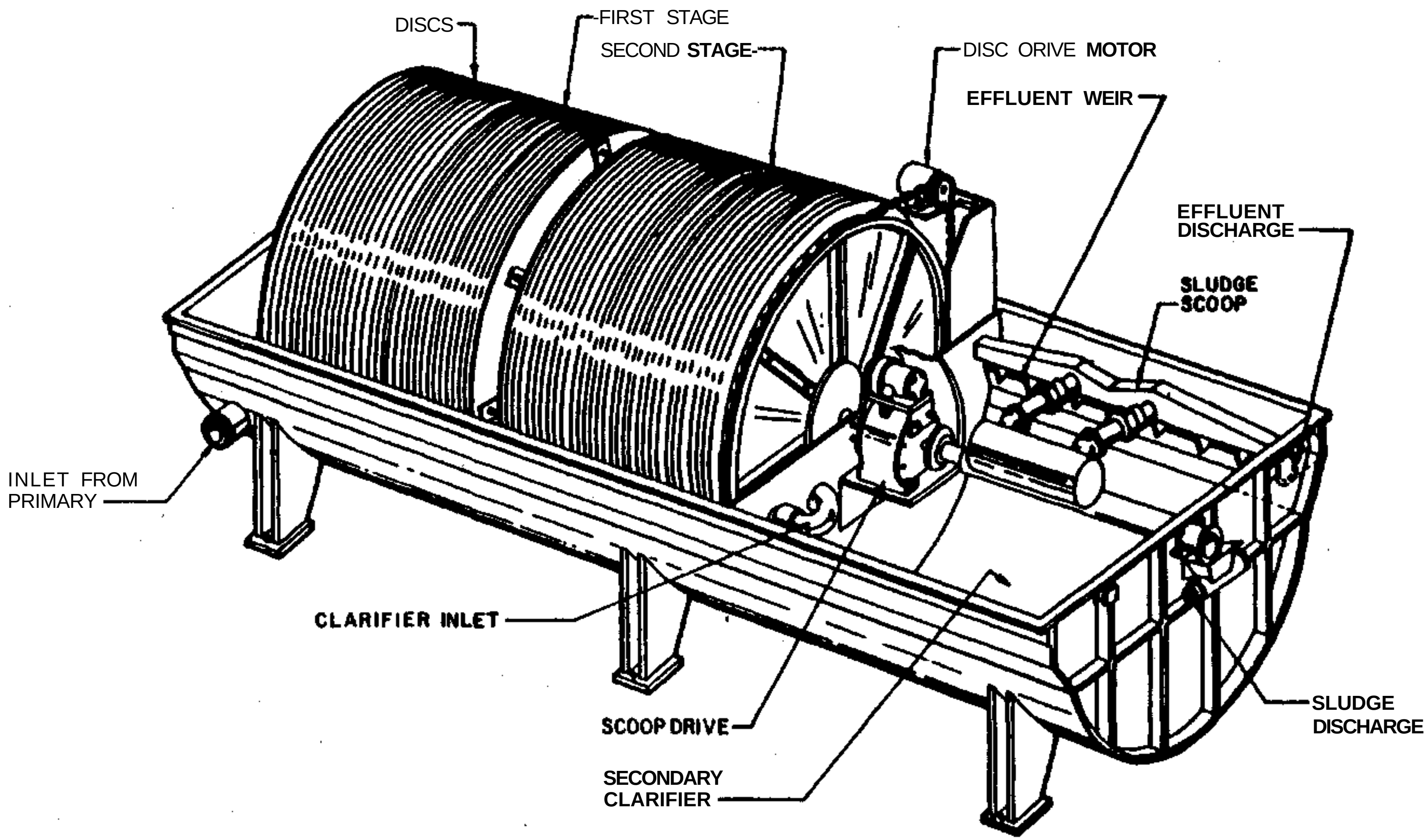


FIGURE 1

BIO-DISC TREATMENT PLANT

submerged in the wastewater, additional organic material is removed (U.S. EPA, 1977).

The shearing forces created by the rotation of the disks in the wastewater acts to continuously remove excess micro-organisms and other solids from the fixed biomass film on the disk surface. The rotation also causes mixing, which keeps the sloughed solids in suspension where they can eventually be carried out to a final clarifier (U.S. EPA, 1977).

The advantages of the RBC process are as follows (U.S. EPA, 1977):

1. simple operation and maintenance;
2. suitability for step and stage construction;
3. resistance to organic and hydraulic shock loads;
4. low power requirements;
5. minimal odor and fly nuisance;
6. low noise levels.

The main disadvantages of the RBC units (which can be easily overcome) is that the rotating biological disks must be covered in order to prevent wind damage and freezing. The disks can be covered either by a plastic enclosure or by placing the disks within a building. The latter procedure is common since the RBC units are fairly compact and do not require large amounts of space.

The fact that the RBC units require some form of enclosure can be turned to good advantage. For example, the 100,000 gpd treatment plant being built for a 440-unit townhouse development in West Milford ("Bald Eagle") in Passaic County will have all of the RBC units and associated filters enclosed in four buildings that will look like New England barns and therefore be architecturally compatible with surrounding townhouses which will be built across the street. Indeed, the plant will be at the very entrance to the townhouse development and will occupy only a portion of a one-acre site (Site visit on February 3/ 1984; Personal Interviews with Lawrence W. Edler, P.E., February 1, 1984 and Frank Loscalzo, Jr., P.E., February 3, 1984, respectively).

Note that the RBC units need not be housed separately. For example, the 32 RBC units plus 8 roto-strainers that are used in the 10,000,000 gpd North Bergen plant (see Table 1) are contained within one large building (Site visit and Personal Interviews with Brian Bigler and James Lydon, August 14, 1984).

Another advantage of using the RBC process is the relative rapidity of installation. Depending upon the size of the unit, the equipment can be provided in either a partially or completely assembled package. Larger units would require concrete tank construction whereas smaller units are designed to facilitate immediate installation on a concrete bed (U.S. EPA, 1977).

For the 280,000 gpd plant proposed for the Dobbs site, the estimated construction and installation time (following regulatory approval) is 30 weeks - 12 months (Personal Interviews with Gregory F. Burde, February 7, 1984 and Robert R. Bendlin, August 17, 1984). In this instance, the 120,000 gpd "Chatham Glen" RBC plant (see Table 1) took about one year for construction and installation (Telephone interview with G. F. Burde, August 13, 1984). Note that these estimates are substantially lower than the unreferenced 18 month estimate for construction used in the Callahan memo of April 6, 1984 (Callahan, 1984).

In sum, the RBC system can provide an effective, environmentally acceptable method of wastewater disposal for the Dobbs site. There are numerous advantages in using this proven technology. The final step is to dispose of the highly treated effluent, a step which we consider in the next section.

D. ~~Subsurface Disposal~~

Subsurface disposal of treated effluent provides an excellent means of recharging the ground water while avoiding any direct impact on the assimilative capacity of receiving surface waters. This is important, since there is some obvious finite limit to the ability of the North Branch Raritan to assimilate additional waste loadings. In addition, nutrient loads (nitrates and phosphates) coming from any treatment plant along the river pose a eutrophication threat to the proposed downstream Confluence Reservoir at the confluence of the North and South Branch Raritan Rivers.

Nitrates and phosphates in the effluent from the dwelling units on the Dobbs site would be handled as follows:

1. Nitrates would be removed by installing denitrification facilities right after the effluent passes through the RBC units;
2. Phosphates would tend to be adsorbed onto soil particles as

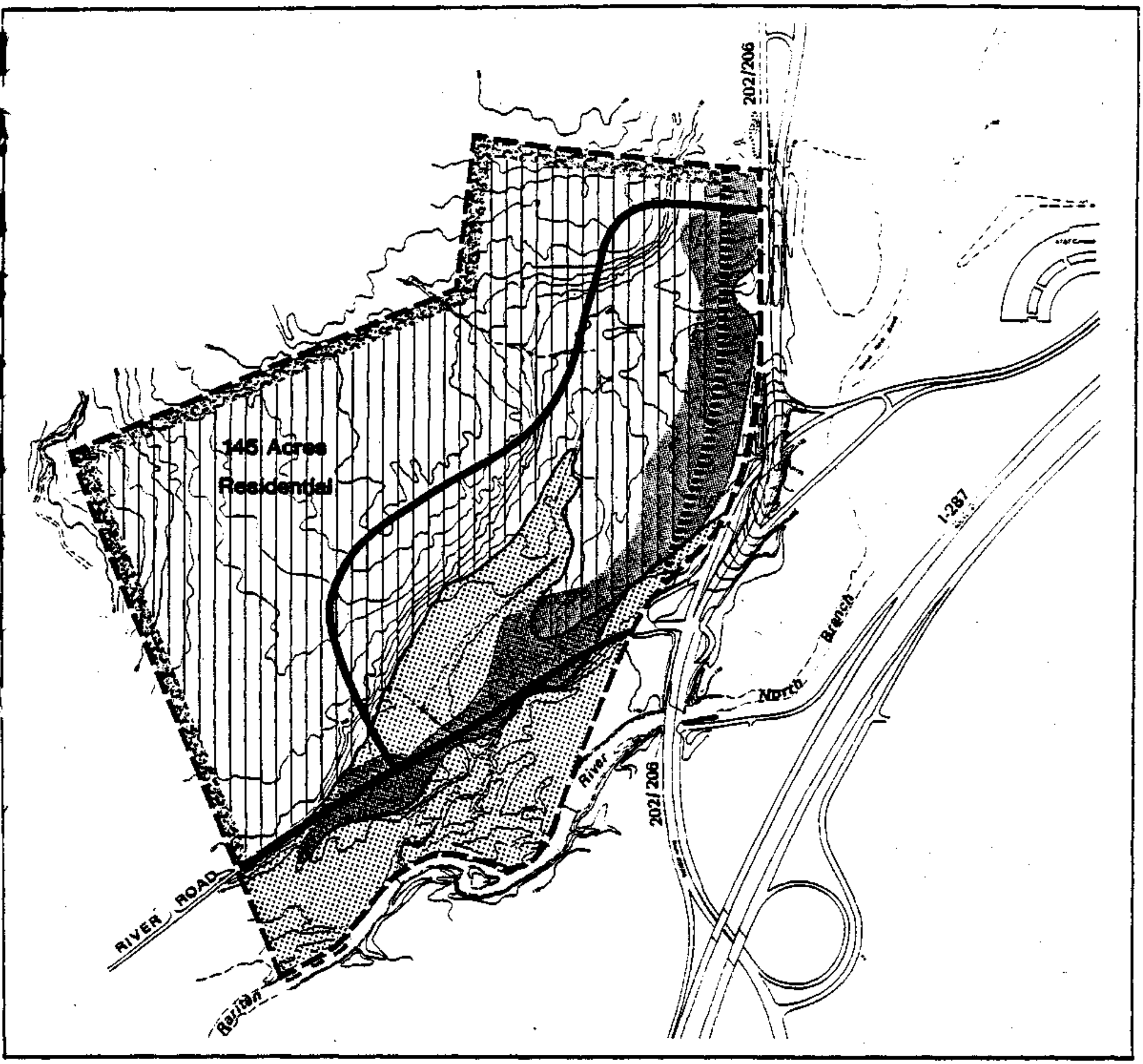
the treated effluent percolates through the soil column which is of course an integral part of the subsurface disposal plan.

Thus, the effluent from the proposed Dobbs treatment plant would not pose any nutrient threat to either the North Branch Raritan River or the proposed downstream Confluence Reservoir.

The key element in the viability of a subsurface disposal scheme is the ability of the soils and bedrock to absorb the effluent loadings and allow the liquid to drain through to the underlying ground water. In this context, it is interesting to note that Callahan (1984) mentions the potentially suitable soils on the Dobbs sites as a means of land based effluent disposal from the proposed expansion of the EDC plant when low flow conditions develop in the North Branch Raritan during the summer months. Similar comments are made in the Ferguson letter of April 6, 1984 to G. M. Raymond (Ferguson, 1984):

> Many studies have shown that the Dobbs' site contains good soils for spray irrigation. Accordingly, the Township will undertake to make available whatever portion of the Dobbs' tract is necessary for a spray field to accept any excess effluent from the EDC plant or the Township plant which cannot be discharged to the North Branch of the Raritan River because of environmental or administrative limitations.

At this point, it is important to clarify what is meant by land based effluent disposal. Ferguson (1984) specifies spray irrigation while Callahan (1984) just mentions discharging the effluent to ground water. The type of land based effluent disposal proposed for the Dobbs site is subsurface disposal through a series of underground pipes. The treated effluent will



PLANB

881 300 year Flood Plain	1160 Total Units
J Birdsboro Sott	232 Low and Moderate Income Units
200 ft Setback	928 Market Units
Landscaped Buffer	FIGURE 2

BEDMINSTER CENTER
SOMERSET COUNTY
NEW JERSEY

WRT

be piped from the treatment plant to properly sized disposal fields and then allowed to percolate through the soil column. Spray irrigation is not contemplated.

The best soils on the Dobbs site for subsurface disposal are the Birdsboro soils. These soils not only possess excellent characteristics for effluent disposal on the site but also have a favorable geometric configuration (long and linear) which will tend to minimize potential ground water mounding. In addition, the Birdsboro soils are located on the periphery of the property (see Figure 2) which means that the disposal fields will not interfere with the residential areas on the rest of the tract. Finally, there is enough acreage available to accommodate the expected effluent load.

The Soil Conservation Service (SCS) has prepared a soil survey of Somerset County. In their report (U.S. SCS, 1976), the SCS describes the Birdsboro series as consisting of deep, well-drained soils found on stream terraces along the major rivers in Central Jersey, including the Raritan. The Birdsboro soils formed in old stream sediment (or alluvium) which was derived from shale and sandstone.

The major characteristics of the Birdsboro soils as they pertain to subsurface disposal are as follows (U.S. SCS, 1976):

Depth to Bedrock: 6 to 10 feet or more

Depth to seasonal high water: greater than 4 feet

Permeability range for all soil horizons: 0.6 to greater than 6 in./hr.

Permeability range in the most restrictive horizon: 0.6-2.0 in./hr.

Texture in the lower part of the soil column (56-70 inches deep): stratified sand and gravel

Limitations for disposal fields: Birdsboro (BdB) - slight

Birdsboro (BdC) - moderate

The soil mapping units are delineated in the Somerset County Soil Survey Report (U.S. SCS, 1976) at a scale of 1" = 1320'. These maps were then photo-enlarged to a scale of I[11] = 200' for purposes of planimetry (areal measurement). However, the reliability is no greater than the original delineation at a scale of 1" = 1320* and no claim is made for greater accuracy.

The Birdsboro silt loam soils on the Dobbs tract consists of BdB (2-6 percent slopes) and BdC (6-12 percent slopes). The areas of these soils based on planimetry at a scale of 1" = 200' are as follows:

Soil Category	Acres
Birdsboro BdB above the 500-Year Flood Limit	18.8
•• " " " Flood Hazard Area as defined by DEP (100-Year Flood + 25%)	18.9
Birdsboro BdB above the 100-Year Flood Limit	22.9
Birdsboro BdC	16.8

The amount of land required for subsurface disposal depends on the amount of effluent, the percolation characteristics of the soil, sub-soil and bedrock. In the absence of onsite testing, the published soil survey can provide a preliminary estimate of the drainage characteristics of the soil.

The depth from the surface, USDA texture, and estimated permeability for each horizon in the Birdsboro soils are shown in Table 2. The relationship between permeability and percolation is complicated; thus the U.S. EPA in its Design Manual on Onsite Wastewater Treatment and Disposal Systems (U.S. EPA, 1980) has only three estimates of percolation for all of the classes of permeability. Therefore, in order to be on the safe side, this report will use the most restrictive horizon in the soil and the slowest percolation rate (45 min./in.) in order to estimate the minimum percolating area for the design flow.

The most conservative minimum bottom area from Table 2 is 2.10 square feet/gpd. Using this value and a design flow of 278,400 gpd, the required disposal area is calculated as follows:

278,400 gpd (2.10 sq. ft./gpd) = 584,640 sq. ft.
= 13.4 acres

The 13.4 acre disposal area estimate is well under the 18.8 acres of Birdsboro BdB which is at a higher elevation than the 500-Year Flood Limit. The additional acreage can be used for alternate disposal fields, allowing one field to rest while another field receives the effluent. In addition, several acres of Birdsboro (BdC) soils which adjoin the Birdsboro (BdB) soils in the northeastern portion of the tract could be made available if necessary.

Thus, the soils survey indicates that sufficient soils with requisite characteristics for percolation exist on site. It is of course recognized that onsite investigations would be

TABLE 2

ESTIMATED PERMEABILITY AND PERCOLATION RATES FOR BIRDSBORO SOILS.

Depth From Surface(1) (inches)	USDA Texture(1)	Permeability*(1) (inches/hour)	Percolation*(2) (min./in.)	Min. Bottom Area(3) (sq.ft./gpd)
0-12	Silt loam	0.6 - 2.0	10 - 45	0.96 - 2.10'
12-38	Silt loam, silty clay loam	0.6 - 2.0	"	"
38-56	Sandy loam	0.6 - 6.0	"	"
56-70	Stratified sand and gravel	2.0 - greater than 6.0	varies from 10 - 45 to less than 10	0.58 - 2.10

(1) U.S. SCS, 1976.

(2) U.S. EPA, 1980. Note that the EPA estimates for percolation are not available for each one of the SCS permeability classes; thus, the wide range in the estimates.

(3) NJDEP, 1978.

Robert M. Hordon, Ph.D.

necessary to determine not only the areal extent of the Birdsboro soils but also the depth to, and the nature of, the underlying shale bedrock. These soil and bedrock investigations can be done in a relatively short amount of time (1-2 months), as the Birdsboro soils are quite accessible to Routes 202/206 and are essentially open. Indeed, some consulting firms have already estimated that test holes, backhoe excavations, and numerous percolation tests could easily be done within 4-5 weeks. Pending this onsite investigation, the Somerset County Soil

Survey is considered to be the most reliable guide to the soils on the site.

Communal subsurface disposal systems are becoming more and more common in New Jersey (Personal Interview with Robert Gordon, NJDEP, August 15, 1984). Four recently approved systems in the non-coastal plain portion of the state (Northern New Jersey) are listed in Table 3. The fact that the proposed communal system for the Dobbs tract will be larger than the 100,000 gpd system in West Milford is not a problem in and of itself, as long as sufficient land for the disposal field is available (Personal Interview with Robert Gordon, NJDEP, August 20, 1984).

Another positive feature of the subsurface disposal plan is that passage through the soil acts as an additional purifier of the already highly treated effluent. The result is that the impact on the North Branch Raritan, which will be the eventual receiving watercourse, will be minimal.

TABLE 3

APPROVED COMMUNAL SUBSURFACE DISPOSAL
SYSTEMS IN NORTHERN NEW JERSEY.

Location	County	Design Flow (gpd)	Permit Approval
Clinton Township	Hunterdon	14,000	8/26/83
Jefferson "	Morris	22,500	6/15/84
Glen Gardner Borough	Hunterdon	58,217	"
West Milford	Passaic	100,000	1/23/84

Source: NJDEP Files, Trenton

E. Estimated Schedule for Plant Completion

The exact time required for treatment plant approval by local, county and state governmental units is difficult to predict. However, the approval time for treatment plants comparable in size and type to the one proposed for the Dobbs site has been about one year. Thus, the time frame suggested for the Dobbs proposal by Neil Callahan (President of the Environmental Disposal Corp.) in his April 6, 1984 memo is longer than necessary and not supported by recent experience.

Callahan (1984) made numerous assumptions in his time table, Some of his assumptions for the Dobbs site require correction, since it appears that Callahan's schedule for Dobbs is more pessimistic (and therefore longer) than his schedule for the EDC plant. For example, Callahan's 8-month estimate for detailed soil and site investigation for the disposal fields is substantially greater than the 1-2 month estimate offered by consulting firms which specialize in such work. Another discrepancy must be noted between the 18-month estimate used by Callahan for construction and the 30 weeks - 12 months estimate offered by local representatives who have built and are now building similar types of treatment plants in New Jersey. In this context, mention was made previously of the 120, 000 gpd Chatham Glen RBC plant in Morris County which was constructed and installed in approximately one year following the necessary governmental approvals.

The 100,000 gpd "Bald Eagle[11] townhouse development and treatment plant in West Milford, Passaic County has some very similar features to that proposed for the Dobbs site. Specifically, both plants would use an enclosed RBC process with denitrification and subsurface disposal. All of the necessary approvals for Bald Eagle were obtained in about one year and the plant is now under construction.

Tertiary treatment and subsurface disposal are becoming more and more common in this state/ particularly in those areas where regional sewer systems are not yet available. In addition, the State is in favor of ground water recharge wherever possible and appropriate. Thus, the Dobbs proposal would be viewed favorably by NJDEP in terms of water quality management.

It should also be noted that serious questions have been raised about the assimilative capacity of the North Branch Raritan River in the Bedminster reach, particularly during the low flow summer months. Any additional effluent discharges directly to the river would require detailed investigation and review. In comparison, while subsurface disposal of highly treated effluent would require investigation and review, the review time for subsurface disposal should be quicker.

In short, it is estimated that the onsite treatment facility proposed for the Dobbs site can be operational in about one year following regulatory approval. Construction of the housing units would commence simultaneously with the construction of the treatment plant so that residential units will be ready for occupancy upon completion of the plant.

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B.A. Brooklyn College - 1959
M.A. Columbia University - 1965
Ph.D. Columbia University - 1970

Military Service: Ensign and Lieutenant (j.g.), United States Navy, 1959-1962

Membership in Professional Societies:

American Association for the Advancement of Science
American Geographical Society
American Geophysical Union - Hydrology Section
American Water Resources Association
Association of American Geographers
Society of Sigma Xi
University Seminar on Water Resources, Columbia University

Positions Held in Professional Organizations:

President-Elect and President, New Jersey Section, American Water Resources Association, 1972-74.

Chairman, Local Arrangements Committee, National Symposium on Urban Runoff and Water Pollution Control, June 29 - July 2, 1975, Rutgers University. Sponsored by the American Water Resources Association and the Urban Water Resources Research Council of ASCE.

Member, Local Arrangements Committee, Annual Meeting of the Association of American Geographers, April 1976, New York City.

Chairman, Physical Geography Caucus, Association of American Geographers, 1975-76.

Secretary-Treasurer, Vice-President, and President, Middle States Division of the Association of American Geographers, 1976-78.

Rutgers University representative to the Inter-Agency Advisory Group to the Statewide Comprehensive Water Supply Master Plan, 1978-79.

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2. April 21-25, 1969. "The Application of Graph Theory to Metropolitan Water Supply Agency Transfers," Paper No. H-35 presented at the 50th Annual Meeting of the American Geophysical Union, Hydrology Section, Washington, D.C. Abstract published in Transactions, American Geophysical Union, April 1969, 50(4) :146.

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9. October 15, 1973. "Public Potable Water Demand for New Jersey," State Task Force on Planning, Trenton, New Jersey. Joint presentation with M.R. Greenberg.

10. November 1, 1973. "Water Quality Monitoring in the New York-New Jersey Metropolitan Region," Environmental Monitoring Conference sponsored by the National Science Foundation and the Regional Plan Association, New York City.

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15. April 18, 1975. "Floodplain Delineation and Computer Graphics," Institute for the Development of Riverine and Estuarine Systems, Hershey, Pennsylvania.

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Dr. Kordon has been a participant in two water research projects sponsored by the Office of Water Resources Research of the U.S. Department of the Interior. The first project concerned the development of a simulation model for the water supply networks of the New York-New Jersey metropolitan area. The same region (with all of its associated complexity) was used as a case study for an empirically-derived water quality simulation model. In both projects, Dr. Hordon was responsible for the acquisition, storage and retrieval of the pertinent hydrologic and geologic data.

Another study, sponsored by the Center for Urban Policy Research of Rutgers University, concerned an environmental assessment of a large housing development proposed for a site in Mahwah, New Jersey. Both onsite aspects and regional issues of water supply and wastewater disposal were considered. Dr. Hordon was a member of an interdisciplinary team at Rutgers University that prepared a large scale Environmental Impact Statement on the proposed Manasquan Reservoir Project for NJDEP. His areas of concern on the Manasquan Project pertained to the development of water demand projections for the study area *on* a purveyor by purveyor basis.

Dr. Hordon was a consultant to the Special Studies Branch of the Northeastern Water Supply Study (NEWS) of the U.S. Army Corps of Engineers in Mew York. He prepared a report on water supply agency interconnections in northern New Jersey. Additional consulting experiences include participation in a Natural Resources Inventory (NRI) for Chatham Township, New Jersey and the preparation of an NRI source--book for the Institute of Environmental Studies at Rutgers University. The latter work was sponsored by the Department of Community Affairs in Trenton*.

Academic degrees include a B.A. from Brooklyn College and an M.A. and Ph.D. in Geography from Columbia University. He has authored a number of technical reports and journal articles. Recently, he was Fresident-of the New Jersey Section of the American Water Resources Association. Dr. Hordon is a member of the Association of American Geographers, American Geophysical Union, American Geographical Society, Sigma Xi, and the American Water Resources Association.