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ENVIRONMENTAL SITE ANALYSIS OF INDUSTRIAL PARK AREAS - CUMBERLAND, RHODE ISLAND

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ENVIRONMENTAL SITE ANALYSIS

OF

INDUSTRIAL PARK AREAS -

CUMBERLAND, RHODE ISLAND

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RESEARCH PROJECT

OF

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I. INTRODUCTION

With a 1980 population of 27,069, the Town of Cumberland contains 28 square miles (17,856 acres) in area. The triangular-shaped town is located in the extreme northeast corner of the state and is bordered by the Commonwealth of Massachusetts to the north and east; the Cities of Central Falls and Woonsocket to the south and northwest, respectively; and by the Blackstone River which forms the town's western border (see Figure 1).

Land use in Cumberland can be classified as relatively undeveloped in the north, moderately developed along state highways in central portions of the town, and heavily urbanized in southern sections (see Figure 2). According to the Rhode Island Statewide Planning Program (Industrial Zoning Guidelines, 1980), Cumberland has under its present zoning ordinance 1,052 acres of industrial land. Of this total acreage, 741 acres lie within flood hazard zones, while the remaining acreage has other physical constraints or other infrastructure limitations.

This study was initiated to identify quality industrial acreage in Cumberland by means of undertaking an environmental constraint/asset analysis of potential industrial park sites within the town. Six potential industrial sites were selected for the study following the identification of local concerns, policy and goals, along with existing land use, zoning, and geographic location factors. A detailed environmental/physical resource analysis was used to identify the potential

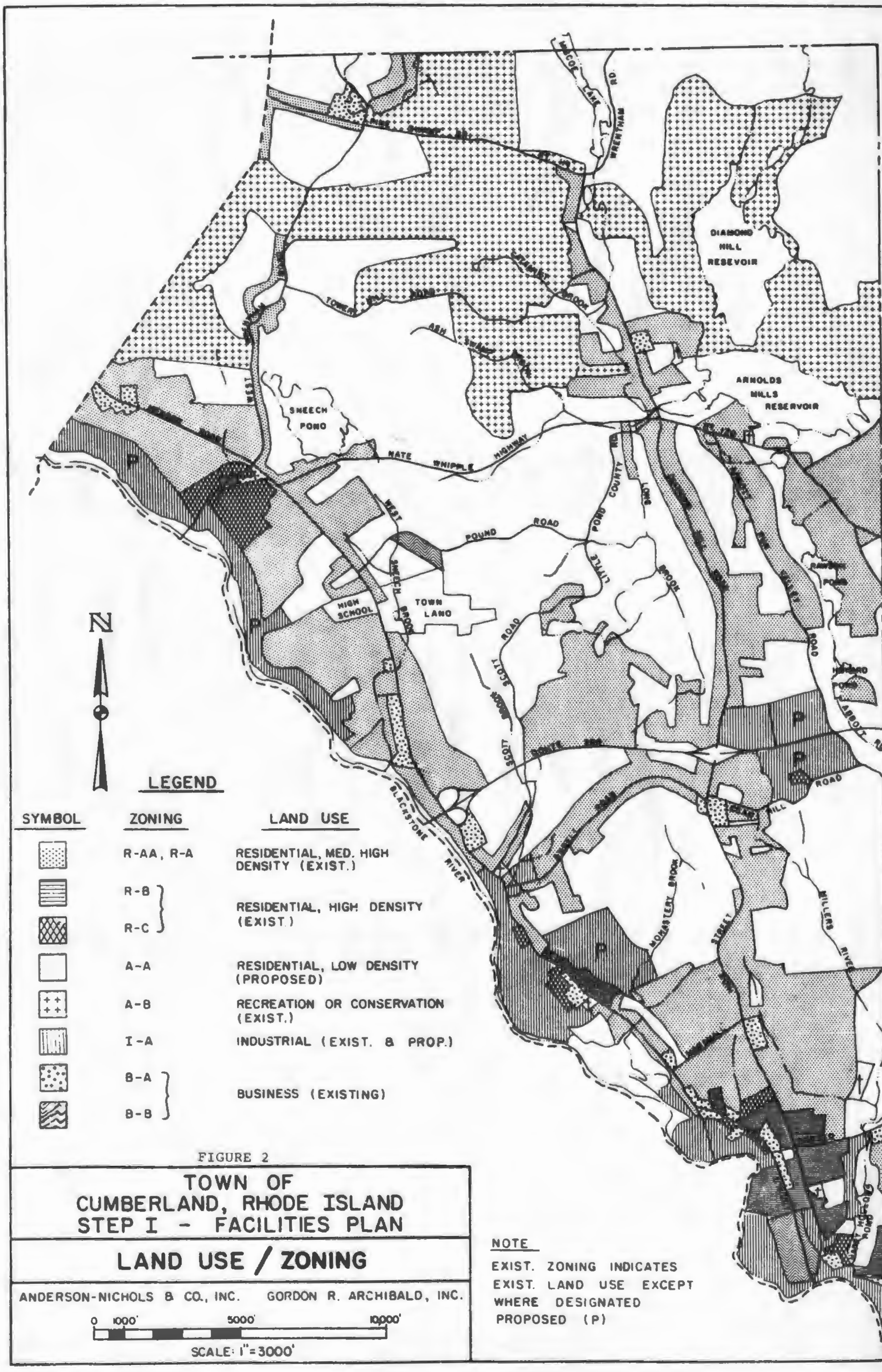


FIGURE 2

TOWN OF CUMBERLAND, RHODE ISLAND
STEP I - FACILITIES PLAN

LAND USE / ZONING

of each site to provide suitable conditions for industrial park development.

Each site was analyzed by a series of variables (see Methodology, Section III) to assess the development potential of each site. Use of this technique facilitates the identification of environmental and/or physical assets and liabilities at each site, as well as the determination of those sites that can most efficiently support varied industrial or business park development.

In order to evaluate each site on a comparative basis, a quantitative ranking methodology for the sites was developed. Based on a site's total point value, a means of prioritizing their development was formulated.

II. PURPOSE

This report is intended to assist the Cumberland Industrial Development Commission (IDC) in their preparation of a growth management plan pertaining to industrial and business development. As stated in the IDC's Preliminary Manufacturer's Survey Analysis (1982), the role of the Cumberland Industrial Development Commission, as formed by the Home Rule Charter, is "to promote and encourage the location and development of new business in the town as well as the maintenance and expansion of existing business."

An essential component of their growth management plan is a detailed environmental analysis of various land areas within the town where potential industrial park development could be feasible. Therefore, information from this report will assist the Industrial Development Commission and the local planner (who is presently developing a rezoning plan) in their respective decisions.

III. METHODOLOGY

Each industrial site was analyzed utilizing the same variables, methodologies, and information sources. A description of the variables follows:

Topography

Steep terrain is associated with problems in building construction, stormwater runoff, and erosion. The topography of an area directly affects planning and engineering costs. Information sources used to determine slope percentage included the United States Geological Survey (USGS) Pawtucket Quadrangle Topographic Map, 1975, and the Rhode Island Soil Conservation Service (SCS) Soil Survey Manual, 1976.

The application of a methodology referred to as "rise over run" was utilized (based on topographic contour lines at a scale of one inch equal to two-thousand feet). This method determines the slope of terrain by dividing vertical distances by horizontal distances. This calculation yields a site's slope percentage.

Three-quarters of an inch, or 1,500 feet, was selected as the horizontal constant (based on an assumption relating to accuracy). Therefore, if the vertical elevation rose 225 feet over a 1,500-foot area, it would be calculated as a 15 percent slope, and classified (by SCS) as steep terrain that is considered a constraint to development.

Another method used to determine slope percentage is through the analysis of SCS Soil Series Maps. Every lettered symbol [i.e., HkD (Hinkley), ChC (Canton)] represents not only soil characteristics, but also slope percentage calculations computed by the SCS. Table 1 explains how the SCS incorporates slope percentage into their lettered system of soil notation. The key to slope interpretation lies with the analysis of the extreme right letter in any lettered grouping; therefore, the last letter of every soil series is used as an indicator to represent slope classification.

TABLE 1

SLOPE BASED ON SOIL'S LETTERING

SOIL EXAMPLES	LAST LETTER	SLOPE CLASSIFICATION
Pits/Quarry (Pg)	g	0-25%
Canton (CdA)	A	0- 3%
Canton (CdB)	B	3- 8%
Hinkley (HkC)	C	8-15%
Hinkley (HkD)	D	15-35%
Urban (MV, Ur, CB, PD)	urban lands	not available
Ridgebury (Re, Rf)	wetlands	----
Carlisle (Co)	wetlands	----
Adrian (Aa)	wetlands	----

Each of the described methodologies were used in the determination of slope percentages. Both the USGS and the SCS maps were essential in ascertaining terrain elevations, stream flows, drainage patterns, geologic characteristics, and other pertinent topographic data.

Soil

Information sources were based on the interpretation of data provided in the Rhode Island Soil Conservation Service's Soil Survey Manual (1976). The SCS manual is the product of what is referred to as a "detailed" soil survey analysis. Included in such an analysis is soil-related information that is derived from the on-site mapping of individual soil types (series). Similar soil series are then grouped into specific categories based on soil structure, texture, slope, erosion, stoniness, and other related characteristics. Based on interpretative factors, the soil scientist plots the various soil series onto an aerial photograph of the corresponding area. Due to this process, the aerial photograph becomes a base map from which soil series are then plotted. Therefore, the SCS Soil Survey Manual (soil data), used in conjunction with aerial photographs, was essential in evaluating soil information.

Vegetation

Information pertaining to vegetation type was obtained from Statewide Vegetation Mapping (superimposed on USGS Pawtucket Quadrangle Map) conducted by Kupa and Whitman of the Department of Forestry, University of Rhode Island, in 1962. Upgrading of vegetation data was achieved through air-photo interpretation of local land use maps.

Groundwater

Data for the purpose of designating groundwater aquifer and recharge areas was obtained from either a town map, the

USGS Pawtucket Quadrangle Surficial Geology Map, 1975 (depicts groundwater characteristics), or from a map produced by the 1982 Anderson-Nichols & Company, Inc., 201 SEWER FACILITIES PLAN FOR CUMBERLAND.

For information pertaining to recharge areas, see the groundwater section of the North Cumberland Hill Site, and for aquifer information, please refer to the glossary section of this report.

Wetlands

The presence of wetland areas was determined through the analysis of the following: USGS Pawtucket Quadrangle Topographic and Surficial Geology Maps, 1975; SCS Soil Survey Manual Maps, 1976; and the State Vegetation Map, 1962.

Through the integration of data secured from each map, it was possible to denote wetland location, size and shape, vegetation type, and soil composition.

Floodplains

Based on the Flood Disaster Protection Act of 1973, it was determined that all Rhode Island cities and towns have designated flood-prone areas. These communities should adopt ordinances restricting new construction in flood zones, while protecting existing structures from flooding. However, Rhode Island's wetland law states that no development is allowed within wetland or floodplain areas, unless replacement of these water storage areas is compensated by other means. Alteration of these areas requires a permit from DEM (Department of Environmental Management).

The floodplain maps, created by the federal government for the National Flood Insurance Program, depicts 100-year storm flood zones, designated A8, and 500-year storm zones, denoted by the letter B. These maps also show roads, rivers, railroads, high and low elevation areas, and water bodies. Through the transposition of flood zones to local Tax Assessor's Plat Maps, it was possible to measure individual lot acreage that was situated within a flood zone (based on Tax Assessor's Records delineating lot acreage). A "dot grid" was used to measure acreage within flood zones.

Water

Review of Cumberland's Water Department Base Map, which delineates all publicly serviced areas by water pipe size (i.e., 6-inch, 8-inch, etc.), assisted in measuring distance from potential industrial sites to water lines. According to Mr. Thomas Walker, Town Engineer, an industrial park should be serviced by a water pipe with at least a 10-inch diameter to provide a sufficient quantity of water.

Based on fiscal, political, and/or policy constraints, it was assumed that water lines greater than one mile from potential industrial sites were unavailable for extensions.

Sewer

Cumberland's Sanitary Sewer Maps depict the location of sewer interceptors and laterals by street within the town. The Blackstone Valley District Commission (BVDC), created in 1947, is a regional sewage system that collects and transports all local wastewater to the regional treatment plant located in East Providence, Rhode Island. This wastewater facility is situated beneath the Providence-Worcester Railroad tracks along the town's western border and south of the Cumberland Industrial Park (see Figure 3).

Sewer locations within the town were superimposed on the local land use map (1977) for measuring purposes. It was assumed that sewer lines greater than one mile from any proposed industrial site were unavailable for extensions (based on local policy and financial constraints).

Natural Gas/Electricity

On-site inspections of potential industrial sites determined the location of available gas and electric lines. Based on financial constraints, it was assumed that extensions of these facilities should lie within one mile of a potential site.

Railroad

Cumberland's Tax Assessor's Plat Maps depict the location of railroad tracks throughout the town. Based on distance, road conditions, and finances, it was assumed that rail access was available only to industrial sites situated within one mile.

Airports

Based on the Rhode Island Department of Economic Development Highway Map, 1981, it was assumed that industrial access to major tri-state airports (MA, CT, RI) is feasible. However, to service most industrial freight-transport needs, a five-mile radius from any site was used to assess this variable (based on Statewide Planning industrial standards).

Transportation

The Rhode Island Department of Statewide Planning evaluates potential industrial sites based on their proximity to state and interstate highways. If highway access is within a five-mile radius of a potential site, then highway extensions are assumed feasible.

Cumberland's Official Map of Streets and Roads, field reconnaissance, and Rhode Island Department of Transportation (DOT) information, were used to qualitatively determine the capacity of state roads to service an influx of industrial-related traffic during afternoon peak-hour times (2:00-6:00 p.m., Monday-Friday).

Industrial Acreage

Total acreage for each industrial site was derived by:

1. defining site boundaries (based on physical barriers, land use, zoning, and/or planning department inquiries);
2. referral to Tax Assessor's Plat Maps;
3. analysis of Tax Assessor's Records;
4. determination of lot sizes (from number three or through measurement); and
5. totalling individual lot sizes on a site-by-site basis.

Developable Acreage

In order to determine the maximum potential developable land within each site, it was necessary to delete that portion of land made unuseable because of environmental, physical, and land use constraints. This process was accomplished by measuring and/or estimating those land areas (in acres) that posed a major constraint to development. The following variables were used in ascertaining constraint data: steep slopes (over 15%), wetlands, water bodies (streams, ponds), floodplain zones, roads, existing development, proposed roadways, and space for buffer zones (to protect environmentally sensitive areas, and/or separate land uses).

The "Blakerage Dot Grid Methodology" was useful in determining the measurement of variable acreage. By superimposing a series of dots (each dot representing a determined acreage) over a variable boundary, it was possible to calculate the number of acres within a site affected by a specific land constraint (i.e., flood zones). The number of overlay dots that lie within a predetermined area are multiplied by the area-factor each dot represents. On a map scale of RF 1:20,000, one dot equals 2.4 acres. Table 13, in Section V (Site Comparisons) of this report, depicts the acreage extracted for each variable on a site comparison basis.

Maps

A map of each industrial site is provided in each site analysis. They were made from data secured from local Tax Assessor's Plat Maps, SCS Maps, USGS Maps, Floodplain Maps, and local water, sewer, and land use maps. Frequent reference to these maps is encouraged throughout this analysis.

IV. ANALYSIS OF SITES

MANVILLE HILL

INDUSTRIAL SITE

Site Description

The Manville Hill Industrial Park Site lies north of Manville Hill Road at the Lincoln and Cumberland border (see Figure 4). The Blackstone River forms the western boundary of the site while the eastern border abuts an area zoned for residential development that extends to Mendon Road.

Every lot within this 109-acre site is currently owned by a single landowner as indicated by Tax Assessor's Records. At this time, the landowner maintains a sand and gravel mining operation on the site.

Site Market Potential

Contact with the landowner has been initiated by the Cumberland Industrial Development Commission as a means of promoting this site (which is zoned industrial) for the purpose of industrial business park development.

The Manville Site was selected as a potential business/ industrial park because of local policy and goals, current zoning, and willingness of the landowner to promote speculation of the property. According to the landowner, although this site would sustain sand and gravel mining for the next 10 years, he is now amenable to selling the property under favorable conditions.

Topography

The land at this site consists of a hilly landscape to the east and nearly level terrain to the west along the Blackstone River (see Figure 5). However, this site is characterized by hilliness and steep slopes resulting from the alteration of land due to the excavation for sand and gravel

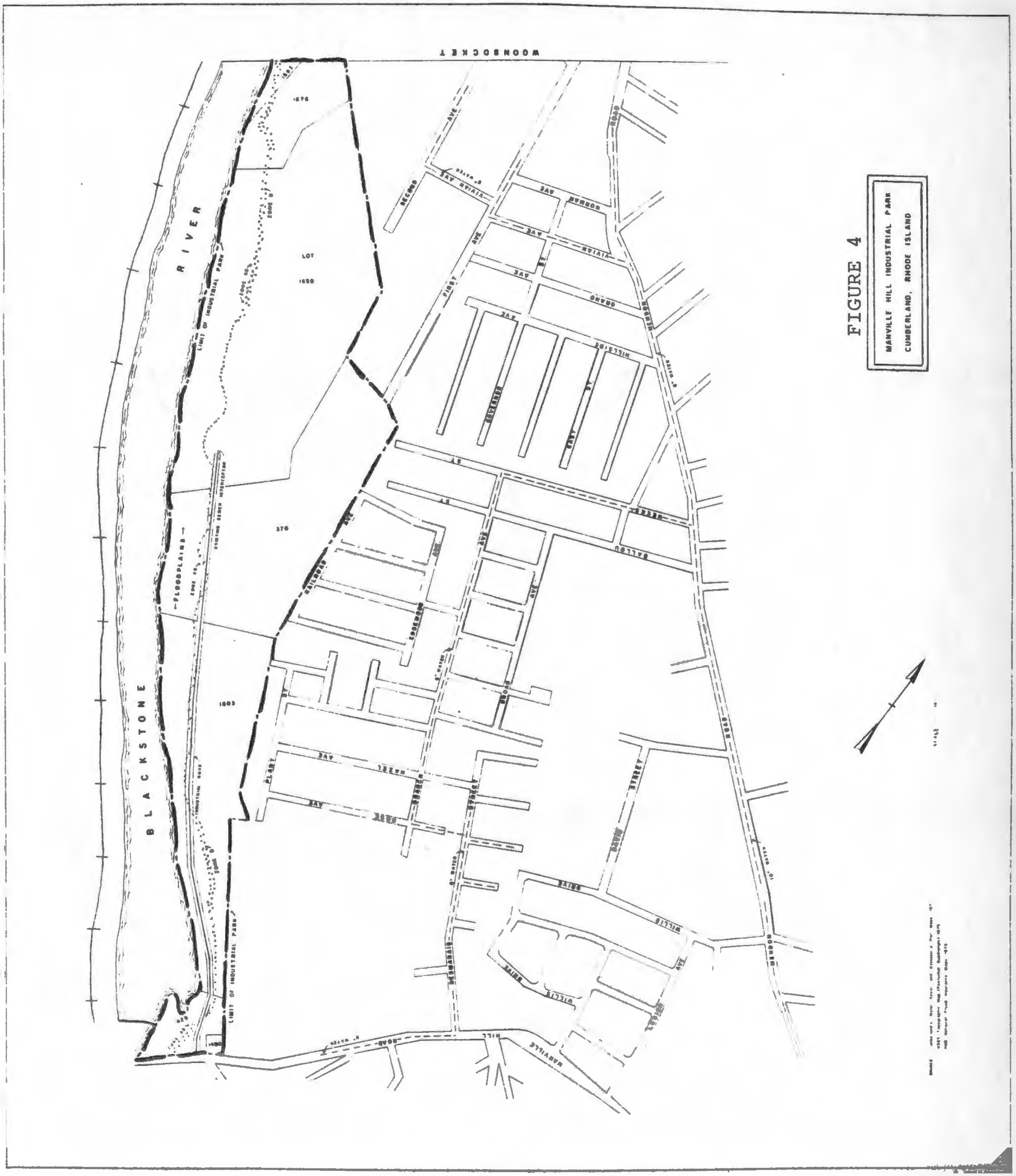


FIGURE 4

MANVILLE HILL INDUSTRIAL PARK
CUMBERLAND, RHODE ISLAND

mining. Landscape characteristics associated with gravel mining include numerous hills, terraces, and pits.

Based on the 1975 USGS Topographic Map (Pawtucket Quadrangle), site elevations range from 100 to 225 feet above sea level. According to soil series evaluations (information obtained and interpreted from the RISCS Soil Survey Manual), it was determined that numerous glacial formations (kames, eskers) are located throughout the Manville Site. Kames are irregularly-shaped conical mounds of layered sand and gravel, while eskers are narrow, winding ridges of poorly sorted or layered gravel. Therefore, stormwater runoff and erosion will occur due to the absence of on-site vegetation.

Every lot at the Manville Site includes inclines approaching 25 percent, with the exception of lot 370, which has a 3 to 8 percent slope (see Table 2, Figures 4 and 5). Based on field reconnaissance, lots 1683 and 1676 have inclines that vary from 0 to 8 percent in their unexcavated northeastern sections.

Despite the overall severity of altered slopes at the Manville Site, there are areas that offer minimum topographic constraints for industrial development. In a majority of the lots, grading the excavated landscape will be necessary to provide buildable sites (based on visual perspective). Significant portions of each lot at this site are currently without vegetation.

<u>Soil</u>

The soils found on the Manville Site are classified by the SCS as Pg (pits, quarries), HkC (Hinkley-Enfield), and

TABLE 2

PHYSICAL CHARACTERISTICS OF LOTS LOCATED AT THE MANVILLE SITE

LOT NUMBER	ACRES	SOIL SUITABILITY FOR DEVELOPMENT[1]	SLOPE %	% OF LAND IN FLOODPLAINS	WETLANDS	LOT OVER AQUIFER	ELECTRICITY (1 MILE)	RAILROAD (1 MILE)	AIRPORT (5 MILES)	FILL MATERIAL ON-SITE	TRANSPORTATION (5 MILES)	WATER/SEWER (½ MILE)
1683	5	Problem	0-25	30	N	Y	Y	Y	N	Y	S, I	Y
1676	12	"	0-25	18	N	Y	Y	Y	N	Y	S, I	Y
1650	42	"	0-25	20	N	Y	Y	Y	N	Y	S, I	Y
370	23	"	0-16	9	N	Y	Y	Y	N	Y	S, I	Y
1603	19	"	0-18	20	N	Y	Y	Y	N	Y	S, I	Y
1681	.25	"	0-16	0	N	Y	Y	Y	N	N	S, I	Y
1429	4	"	0-18	40	N	Y	Y	Y	N	Y	S, I	Y
Total Acres	109											
Acres Developable	85											

[1] SCS classification

Y = Yes
N = None
S = State Highway
I = Interstate Highway

FIGURE 5

MANVILLE TOPOGRAPHIC MAP

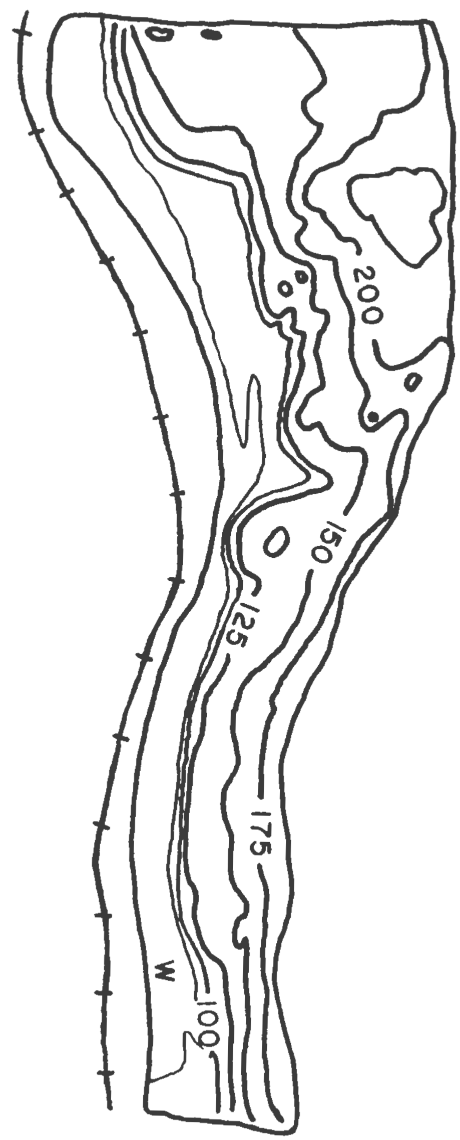
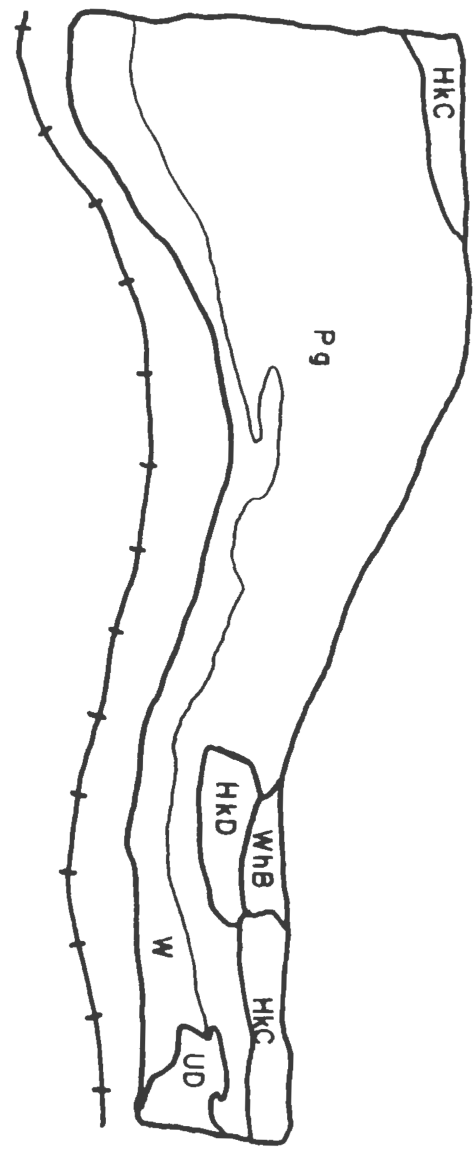


FIGURE 6

MANVILLE SOILS MAP



1" = 1,000'

HkD (Hinkley). Pg soils comprise over 75 percent of all soils located within the study area (see Figure 6). This soil series which technically are not soils, but site conditions (due to mining activities), are usually situated on outwash plains and terraces or stream valleys. Outwash plains are the result of the movement of material (medium to coarse sand and gravel imbedded with silt and clay) that was deposited in front of glacial ice by meltwater streams. Since outwash material absorbs, stores, and releases water readily, the presence of a groundwater aquifer is often a possibility.

HkC (Hinkley-Enfield) and HkD (Hinkley) soils share similar characteristics, except that slopes on HkD soils range from 15 to 35 percent. Both of these soil types have a rapid permeability rate (6 to 20 inches per hour) and unstable slopes in excavated sections (see lot 1603 on Figure 4, and Table 2 for a lot-by-lot analysis).

Contrary to the State Vegetation Mapping conducted by Kupa and Whitman, 1962 (see Figure 7), very little vegetation remains on-site due to the excavation process; therefore, it can no longer act as a stabilizing influence on the soil, nor assist in the retardation of stormwater runoff and erosion. Another negative consequence that occurs as a result of unvegetated, steep slopes is a problem with building-structure safety. As moisture increases in a soil, its "bearing capacity" also decreases. Bearing capacity refers to the maximum unit of pressure to which a building foundation may be subjected to without settling excessively, in a

FIGURE 7

MANVILLE VEGETATION MAP

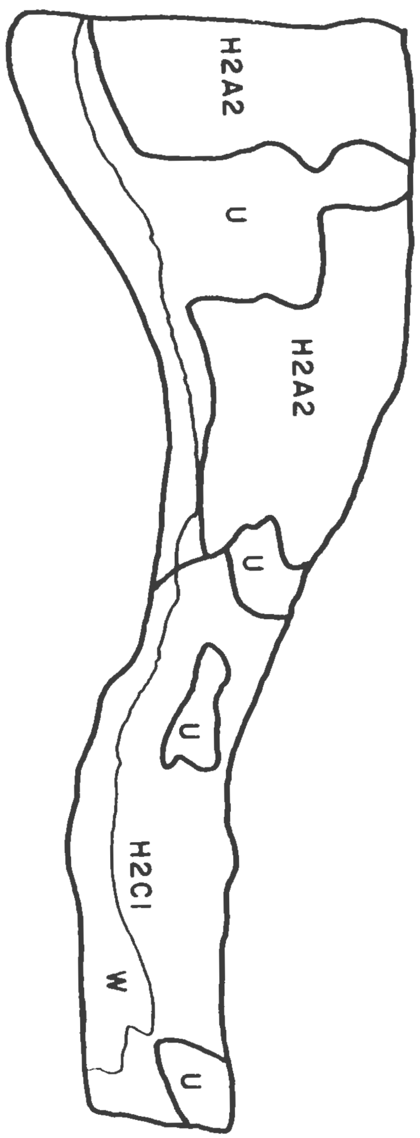
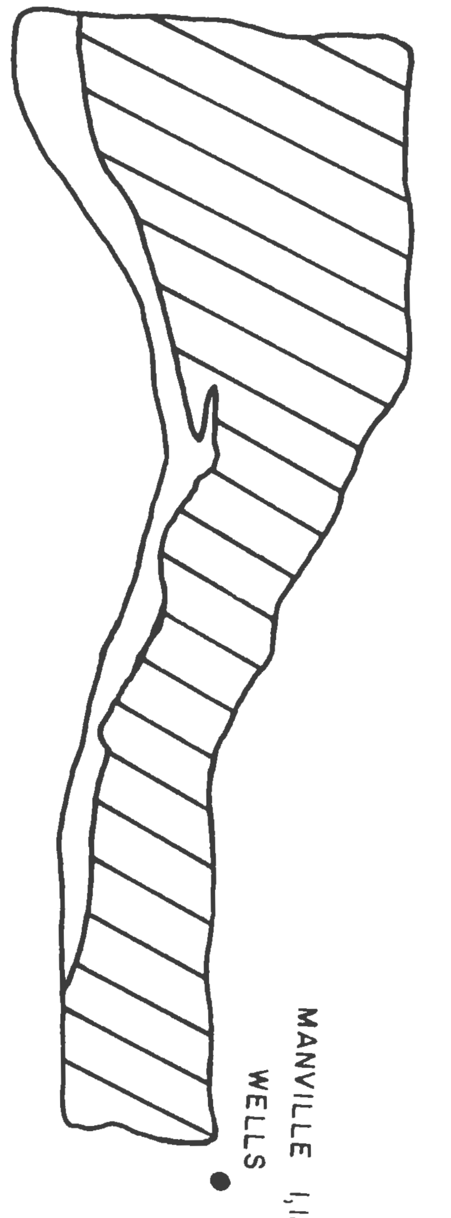


FIGURE 8

MANVILLE GROUNDWATER MAP



1" = 1,000'

U - Urban
W - Water
H2A2 - Hardwood Trees/Moderate Density
H2C1 - Hardwood Trees/Low Density

AQUIFER

manner detrimental to the structure.

Soils on the Manville Site are classified by the SCS as "problem" soils that have the following characteristics:

1. excessive stoniness;
2. rapid permeability rates (6 to 20 inches per hour);
3. problem of revegetation in sandy/gravelly soil due to loss of topsoil;
4. building structures require intensive engineering to prevent safety problems; and
5. soils are located over a groundwater aquifer.

Based on preceding information, soils throughout the Manville Site must be considered a constraint to development. Nonetheless, this constraint can be partially alleviated through the mandatory extensions of public water and sewer lines throughout the site. By extending these utilities, many potential water quality problems can be arrested (see page 23).

Fill Material

The regrading of excavated terrain is required before any on-site development could begin. According to map interpretation and on-site inspections, lots 370, 1650, 1676 and 1683 will require extensive filling and levelling, while lots 1603, 1681, and 1429 should not require as much alteration.

Although fill material can be recovered from on-site resources (sand, gravels, stones), the need for topsoil to revegetate and cover landscape areas may prove to be an expensive problem.

Groundwater

Based on information from the sewer facilities plan (1982, Anderson-Nichols & Company, Inc., 201 FACILITIES PLAN), it was determined that the Manville Site lies within a significant groundwater aquifer. An analysis of Surficial Geology at the site indicates the depth to bedrock and other geologic characteristics. The few borings available indicate that the bedrock floors of this valley area are 60 to 100 feet or more below the present river levels and that the valley fill is largely sand and gravel, which is generally favorable for the storage of groundwater. As indicated on the groundwater map (see Figure 8), two municipal wells, Manville I and II, are located just south of the Manville Site. According to the sewer facilities plan, these two wells produced in 1981, 159 and 146 million gallons of water, respectively (42 percent of local water supplies).

Since the surface water quality of the adjacent Blackstone River is classified D, according to State of Rhode Island Surface Water Quality Standards (suitable for navigation purposes only), it is imperative that precautionary measures are followed before and after construction to protect against further pollution. On-site sediment basins would prevent further environmental degradation of surface water quality while protecting groundwater quality of the Manville wells from runoff, erosion, and pollutant contaminants.

Wetlands

According to Figure 7, there appears to be no wetland areas within the 109 acres; however, pockets of low-lying relief are sporadically located along the Blackstone River. They could be beneficially used as drainage basins provided there is no violation of the Rhode Island Freshwater Wetlands Act. The Act states there can be no development within wetland areas unless a petition is approved by the State Department of Environmental Management (DEM).

Floodplains

Review of floodplain maps (National Flood Insurance Program directed by the Department of Housing and Urban Development) showed that the western border of six lots within the study area is exposed to potential flooding. Half of the access road that leads to the gravel pits is also within a designated 100-year storm flood zone (zone A8). West of the access road are 100-year storm zones while to the east are pockets of a 500-year storm zone (see Figure 4). The maximum mean elevation of the 100-year storm zone is 115 feet. As a result of the access road lying within the floodplain, changes must be made to the road before road extensions and building construction begins (in compliance with Rhode Island wetlands law).

Table 3 refers to those lots which have been divided into percentages of total land area that fall within 100 and 500-year storm flood zones, respectively.

TABLE 3

MANVILLE FLOODPLAIN AREA

LOT	TOTAL ACRES	% LAND IN 100-YEAR FLOOD ZONE (ZONE A8)	ACREAGE IN 100-YEAR ZONE	% LAND IN 500-YEAR FLOOD ZONE (ZONE B)	ACREAGE IN 500-YEAR ZONE	TOTAL FLOOD ZONE ACRES
1683	5.00	30	1.5	10	.5	2.0
1676	12.00	15	1.8	8	.9	2.7
1650	42.00	20	8.4	5	2.1	10.5
370	23.00	8	1.8	10	2.3	4.1
1681	.25	0	0.0	0	0.0	0.0
1429	4.00	40	1.6	5	.2	1.8
1603	19.00	20	3.8	5	.9	4.7
Total	109.00		19.0		7.0	26.0

Based on Table 3, 21 percent of the total land area in the Manville Site (19 acres) lies within a 100-year flood zone. Any existing or proposed development within a floodplain (i.e., access road, mined areas) will not be allowed under the Rhode Island wetlands law, unless replacement of these water storage areas is provided on-site--contingent on approval from the Department of Environmental Management.

Water

Examination of Cumberland's Water Department Base Map shows all public water service areas in the proximity of the Manville Site. Municipal water lines are located within 1,800 feet of the site (6-inch pipe); however, a larger pipe size will be essential to meet the need of an industrial park. Therefore, it would be necessary that a 10-inch water line be extended into the Manville Site by connecting with the 10-inch water main at Mendon Road, providing a west to east connection through Ballou or Acorn Streets (see Figure 4).

An alternative water line from the municipally-owned Manville Wells into the park is also considered feasible.

Sewer

A review of Cumberland's Sanitary Sewer Maps shows the location of sewer mains (see Figure 4). The Manville Site can be sewered by gravity connection to the existing Blackstone Valley District Commission (BVDC) interceptor (see Figure 4 and Figure 3), which is located beneath the access road extending from Manville Hill Road into the industrial site. The extension of sewer laterals should not prove to be a problem in development.

Natural Gas and Electricity

On-site inspection indicates that Blackstone Valley Gas Company lines are located along Manville Hill Road and would be available at the site. Extensions of natural gas and electrical lines are available from Manville Hill Road.

Railroad

Tax Assessor's Plat Maps indicate that access to the Providence and Worcester Railroad lies within one half-mile of the Manville Site. However, the tracks, themselves, are located on the Lincoln side of the Blackstone River (see Figure 6). Therefore, direct on-site access is not available.

Airport

There are no regional airports within five miles of the Manville Site; however, access to Logan Airport in Boston, Massachusetts (approximately 40 miles from the site); Green Airport in Warwick, Rhode Island (20 miles); and Bradley Airport outside of Hartford, Connecticut (120 miles) offer suitable access to the airways.

Based on the Rhode Island Department of Economic Development Highway Map, 1981, city and state airports are available within six miles of the site in the Cities of Woonsocket and Smithfield, respectively (North Central Airport).

Transportation

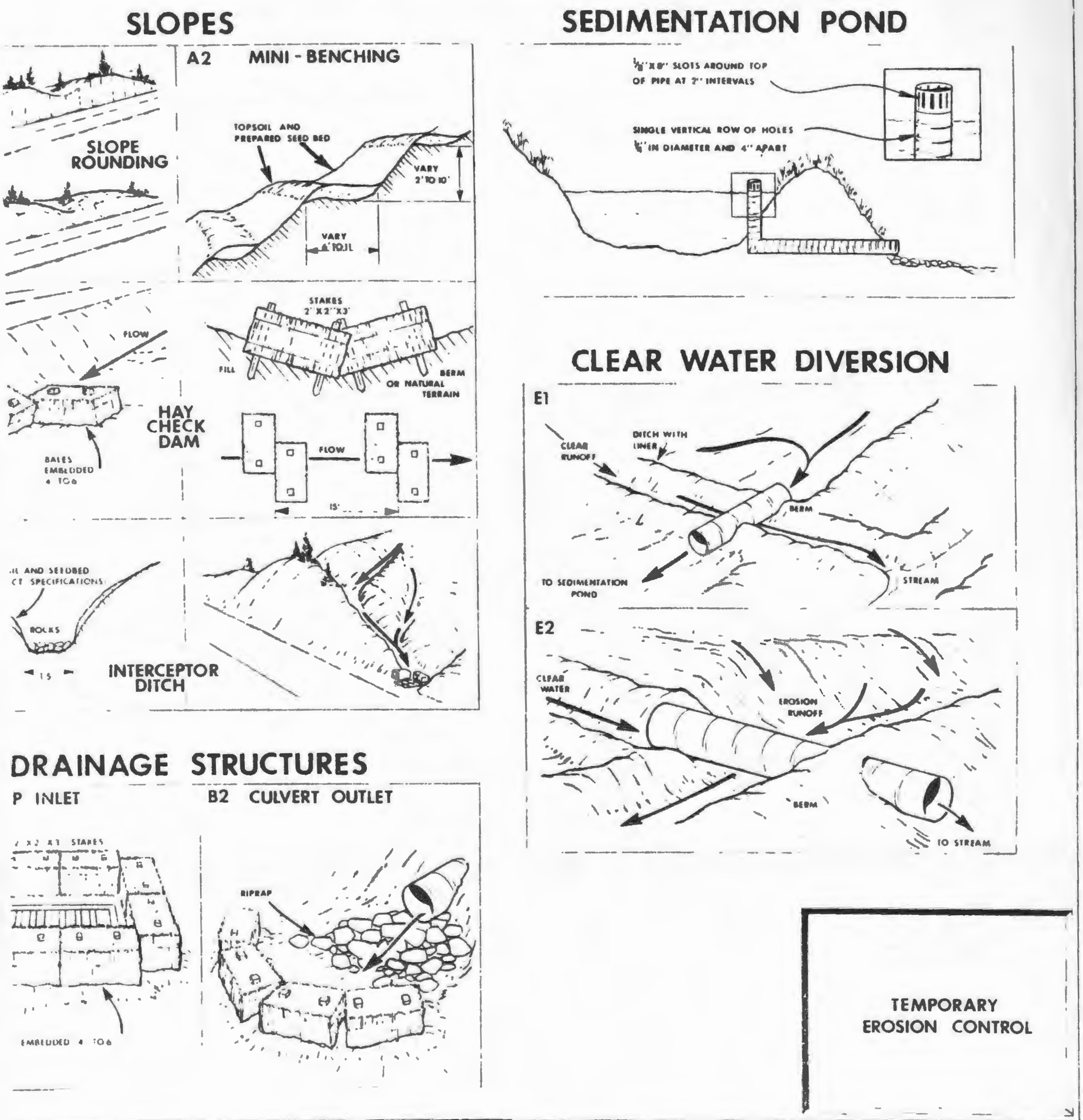
Review of Cumberland's Official Map of Streets and Roads shows that access to Interstate 295 is three miles from the access road (on-site) and the Manville Hill Road intersection. Route 122, Mendon Road (state highway), is used to link traffic fromthe site to I-295. Access to I-295 can also be obtained by travelling westward through parts of Lincoln. Nonetheless, all traffic resulting from the creation of an industrial park should be kept off of Mendon Road, since it appears to be operating beyond acceptable road capacity during peak hours (1,490 vehicles per peak-hour). The upgrading of Mendon Road is tentatively proposed by the town in their selection of a TIP (Transportation Improvement Program) site.

SITE DEVELOPMENT RECOMMENDATIONS

Due to severely sloping, unvegetated terrain resulting from on-site excavations, erosion from stormwater runoff is likely. Therefore, planned "sediment basins" should be a requirement for all businesses that plan to occupy this site (see Figure 9). These basins are designed to intercept,

FIGURE 9

EROSION CONTROL DEVICES



detain, and filter stormwater runoff. By slowing down the velocity, or movement of water, sediments are no longer in suspension. Consequently, sediments (pollutants generated as a result of construction (i.e., heavy metals, chemicals) are allowed to accumulate at the base of the basin, while allowing excess water to leave the basin via an overflow pipe. Although sediment basins are not considered to be a permanent solution to stormwater runoff pollution and erosion (sediments accumulate in the basins and must be periodically dredged), the containment of runoff sediment will preserve water quality and prevent excessive erosion from occurring. Since the Manville Site is situated over a groundwater aquifer that contributes to local drinking-water supplies, it is imperative that precautionary measures, like the sediment basin suggested, be assimilated into all building site plans. Mandatory extensions of public water and sewer lines throughout the site are also essential in preserving groundwater quality.

In conjunction with the above-mentioned site development concerns, the following recommendations are given to prevent and/or reduce environmental degradation during the construction process. These recommendations should be considered in the future development of the Manville Site for industrial purposes.

Development Concerns

1. All areas where the groundwater table is presently at or near the surface should be filled to at least four feet and regraded to avoid potential ground-

water contamination.

2. Unstable terrain in mined areas nullifies use of grass waterways, terraces, and slope diversion techniques (prevent erosion due to stormwater run-off) during the construction process.
3. Use of haybales and temporary slope diversions would prove effective during construction on excavated terrain.
4. Need for topsoil material is required on-site to plant vegetation, improve drainage, and stabilize terrain.
5. Renovation of the on-site "access road" is required to avoid flood zones.
6. Negotiations with Lincoln officials are required for access to railroad facilities located west of the Manville Site (create depot to "truck" resources to).
7. The upgrading of Mendon Road should be the TIP (Transportation Improvement Program) project for the town.
8. The on-site silt pond should be dredged by the landowner.
9. The landowner should regrade the terrain to ready the site for development.

Environmental Concerns

1. A permit is required from DEM (Department of Environmental Management) to alter any flood zone (i.e., add fill).
2. To protect groundwater aquifer there is a need for

mandatory gravity sewer hookups with the on-site BVDC interceptor.

3. On-site water extensions should tie in with Manville I Well or via Ballou Street to Mendon Road (10-inch mains).
4. Sediment basins should be required in site plans to protect groundwater resources.
5. Levees should be constructed along the Blackstone River to prevent flooding.
6. There should be no development petitions allowed within flood zones except for permission to construct sediment basins.
7. Due to the moderate slope of Manville Hill Road, and proximity of subdivisions to the Manville Site, potential air quality and noise impact should be tested (increased traffic).
8. Based on environmental concerns, this site should be promoted by the IDC for either light industry or office park development.

NORTH CUMBERLAND HILL

INDUSTRIAL SITE

Site Description

The North Cumberland Hill Industrial Site includes land south of Meeting House Road to the residential area north of Mendon Road, and west of Wrentham Road to the Woonsocket border (see Figure 10).

The 24 lots which comprise this 445-acre site are currently owned by 14 landowners. At this time, the site is presently undeveloped with minimal alteration of its natural landscape (based on local land use map).

Site Market Potential

Most of the land within this site is currently zoned for either two-acre residential development, or for recreation/conservation uses. Although the land is undeveloped, there are numerous physical constraints that impede extensive development of the 445-acre North Cumberland Hill Site (i.e., wetlands, rock outcrops).

This site was selected as a potential business/industrial park because of the possibility of Woonsocket officials extending the infrastructure of their adjacent industrial park into Cumberland (see Figure 10). In exchange for infrastructure extensions, Cumberland must allow the proposed Interstate 295-495 connector to be built on the Cumberland side of the border. Therefore, an environmental analysis of this section of town is needed.

Topography

Land elevations at the North Cumberland Hill Site range from 300 to 420 feet above sea level. The terrain is highly variable and consists of areas of rock outcrops (denoted on

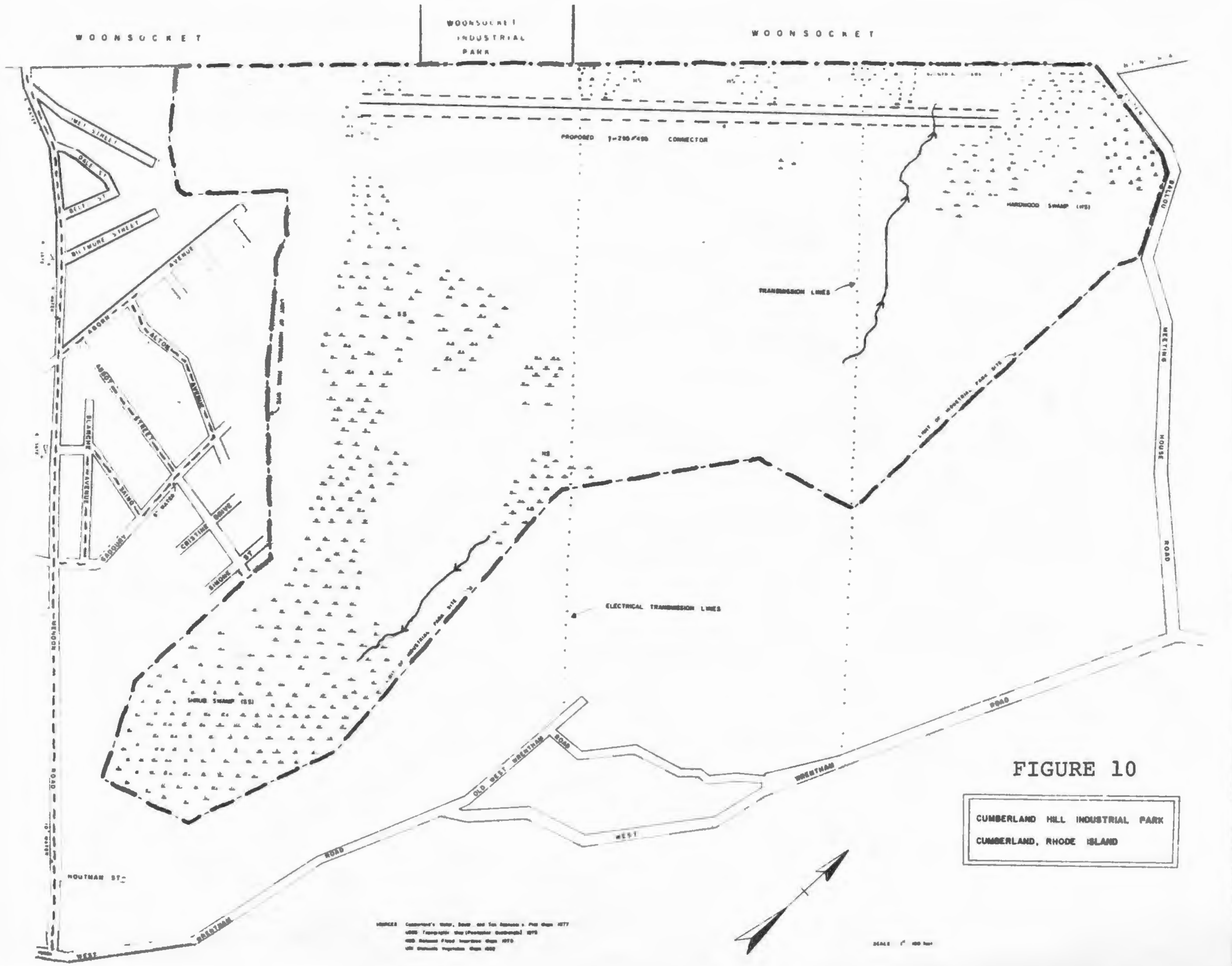


FIGURE 10

CUMBERLAND HILL INDUSTRIAL PARK
CUMBERLAND, RHODE ISLAND

Figure 11 as soils CaC, CaD, ChC, ChD), hills, and sharply sloped valleys. Wetlands occupy low areas and are extensive in the northern and southeastern sections of the site (see Figure 10 or Figure 12).

Slopes are relatively steep at various locations throughout the site, and in certain sections exceed 25 percent; however, most of the slopes on this site range from 8 to 25 percent. Problems associated with steep slope areas include stormwater runoff and erosion.

Many areas on the site may require the blasting of steep slope to develop in areas of rugged terrain. Blasting of rock outcrop must be considered a severe constraint to development based on financial costs that are included in such a process.

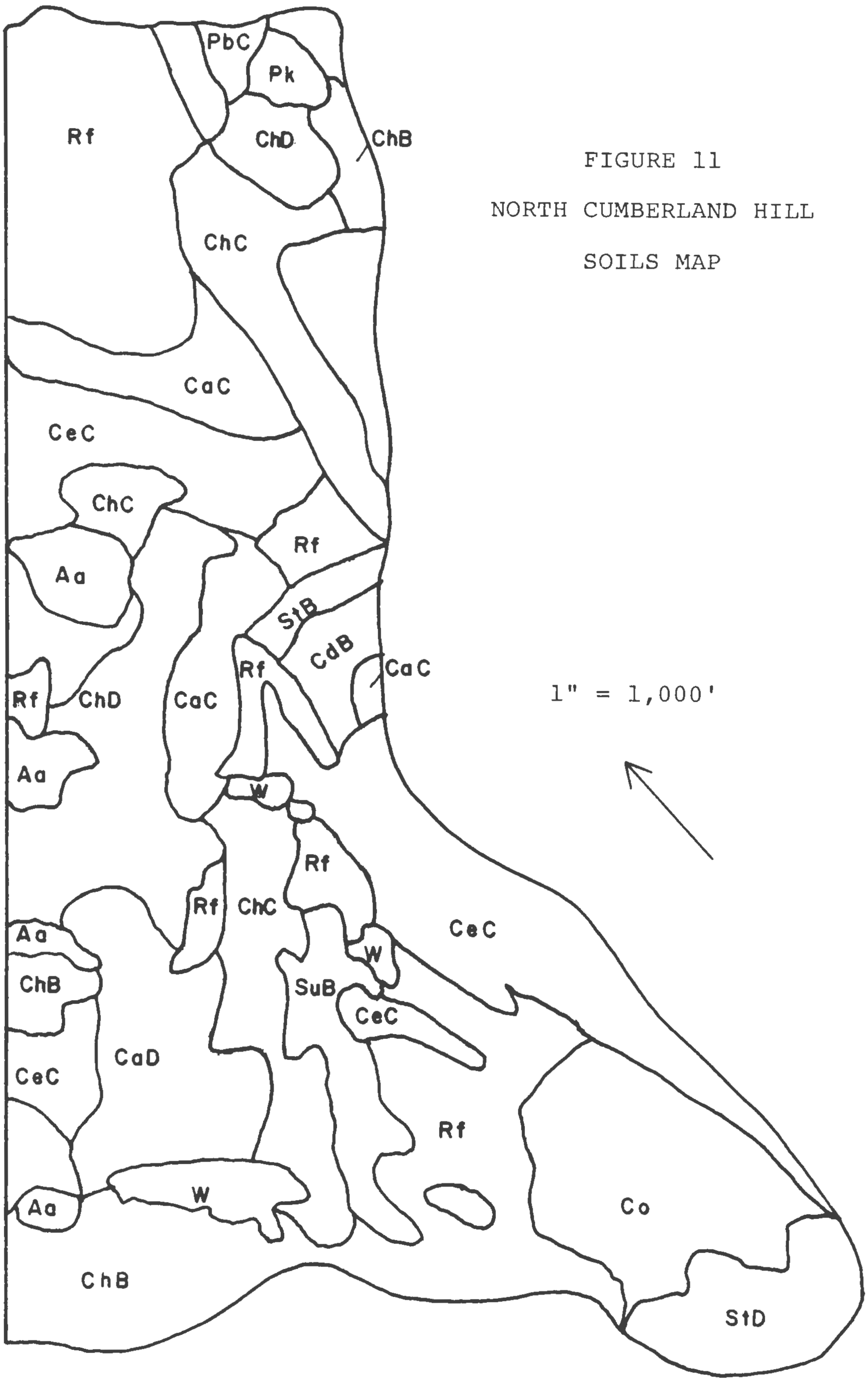
Soils

Soils on the North Cumberland Hill Site are generally classified as "problem" soils by the SCS (see Table 4). Included on-site are low-lying areas of soils (Co, Carlisle, Aa, Adrian, and Rf, Ridgebury) that occupy natural drainage basins juxtaposed to sloping areas [Canton-Charlton rock outcrops (see Figure 11)]. These low-lying soils, which are subject to surface wetness due to slow infiltration, are located south of Meeting House (Elder Ballou) Road and west of Alton, Christine and Lucille Streets (see Figure 10). These soils are considered unsuitable for building by the Soil Conservation Service. Carlisle, Adrian and Ridgebury soils are poorly-drained and do not possess adequate bearing capacity characteristics (i.e., building foundations tend

FIGURE 11

NORTH CUMBERLAND HILL

SOILS MAP



1" = 1,000'

FIGURE 12

NORTH CUMBERLAND HILL

TOPOGRAPHIC MAP

1" = 1,000'

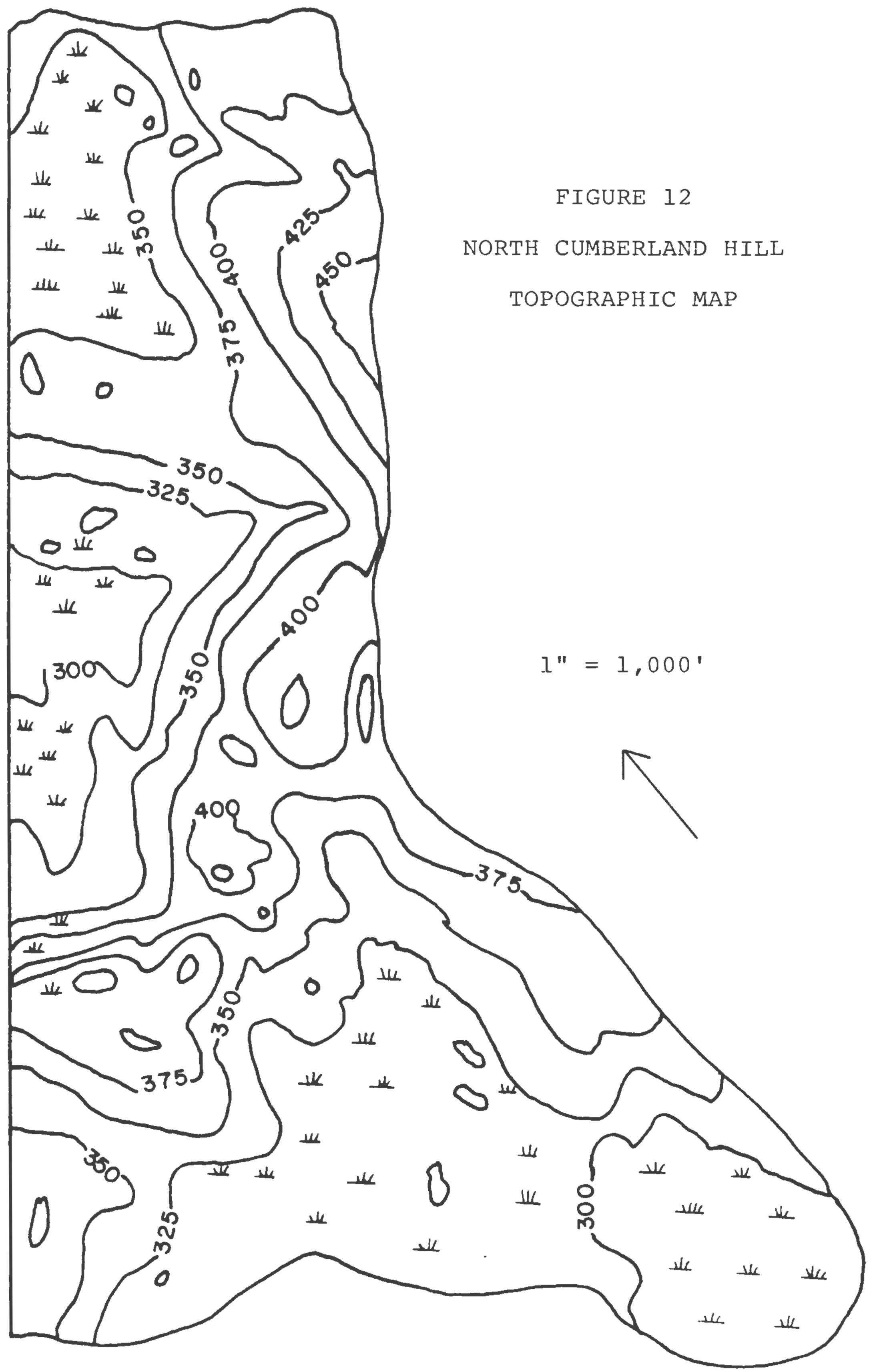


TABLE 4

GENERALIZED SITE CHARACTERISTICS OF THE NORTH CUMBERLAND HILL SITE

TOTAL ACRES	DEVELOPABLE ACRES	SOILS	SLOPE %	FLOODPLAINS	WETLANDS	AQUIFERS	RAILROAD (1MILE)	AIRPORT (5 MILES)	TRANSPORTATION (5 MILES)	WATER (1 MILE)	SEWER (1MILE)
445	193	rocky or wet (problem)	3-35 steep slope area or wetlands	Yes located on Co soil - extreme south on the map	Yes extreme north area and extreme south ↓ soils Aa, Rf and Co	No aquifers but a recharge area is found near the border	No	No	S, I	No	No

to be unstable due to high water tables). Therefore, these wet soils are not capable of supporting industrial buildings, but can be used as sediment basins for the collection of stormwater runoff (with DEM permission). As a consequence, the best areas for development, according to slope and soil characteristics only, are adjacent to the Woonsocket border. Despite numerous wet, low-lying areas and steep slopes, there are areas to the northeast of Comet Street and Art Avenue (see Figure 10) that offer few physical constraints to industrial development (see Figure 11, soils ChB, ChC, CeC).

Based on soils data in Table 5, an industrial park would incur lower development costs per acre if it is built on Canton soils: CdB, CeC, and ChC. Although CaC and CaD soils will require extra site preparation costs (i.e., rock blasting, erosion control, fill, sewerage pumping stations), these areas could be used for development with proper engineering.

TABLE 5

SOIL SERIES CHARACTERISTICS

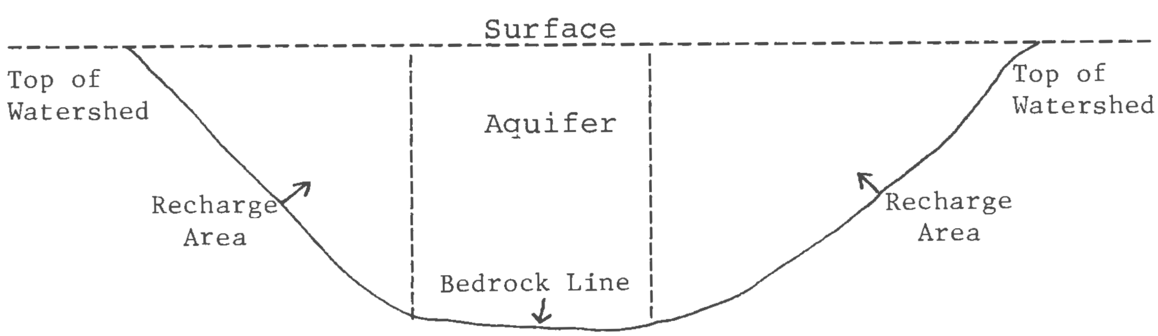
SOIL	SCS CLASS-FICATION	SOIL TEXTURE	DRAINAGE	BUILDING CONSTRAINT	ROAD BUILDING CONSTRAINT
CdB	suitable	sandy/loam	mod.-rapid	slight	slight
CeC	conditional	rocky	mod.-rapid	moderate	moderate
ChC	conditional	very stony	mod.-rapid	severe	moderate
CaC	problem	outcrop	mod.-rapid	severe	severe
CaD	problem	outcrop	mod.-rapid	severe	severe
Aa	unsuitable	organic muck	slow	severe	severe
Co	unsuitable	organic muck	slow	severe	severe
Rf	unsuitable	organic muck	slow	severe	severe

Groundwater

Based on the Anderson-Nichols 201 SEWER FACILITIES PLAN FOR CUMBERLAND, RHODE ISLAND, it was determined that some land located along the Cumberland/Woonsocket border lies within a groundwater recharge area (see Figure 13). Recharge areas are shallow mantle sections of a watershed that collect precipitation, and through underground movement of water, replenish groundwater aquifers. They are located in outwash material and can be delineated based on bedrock depths (see Figure 14).

FIGURE 14

DIAGRAM OF RECHARGE AREA



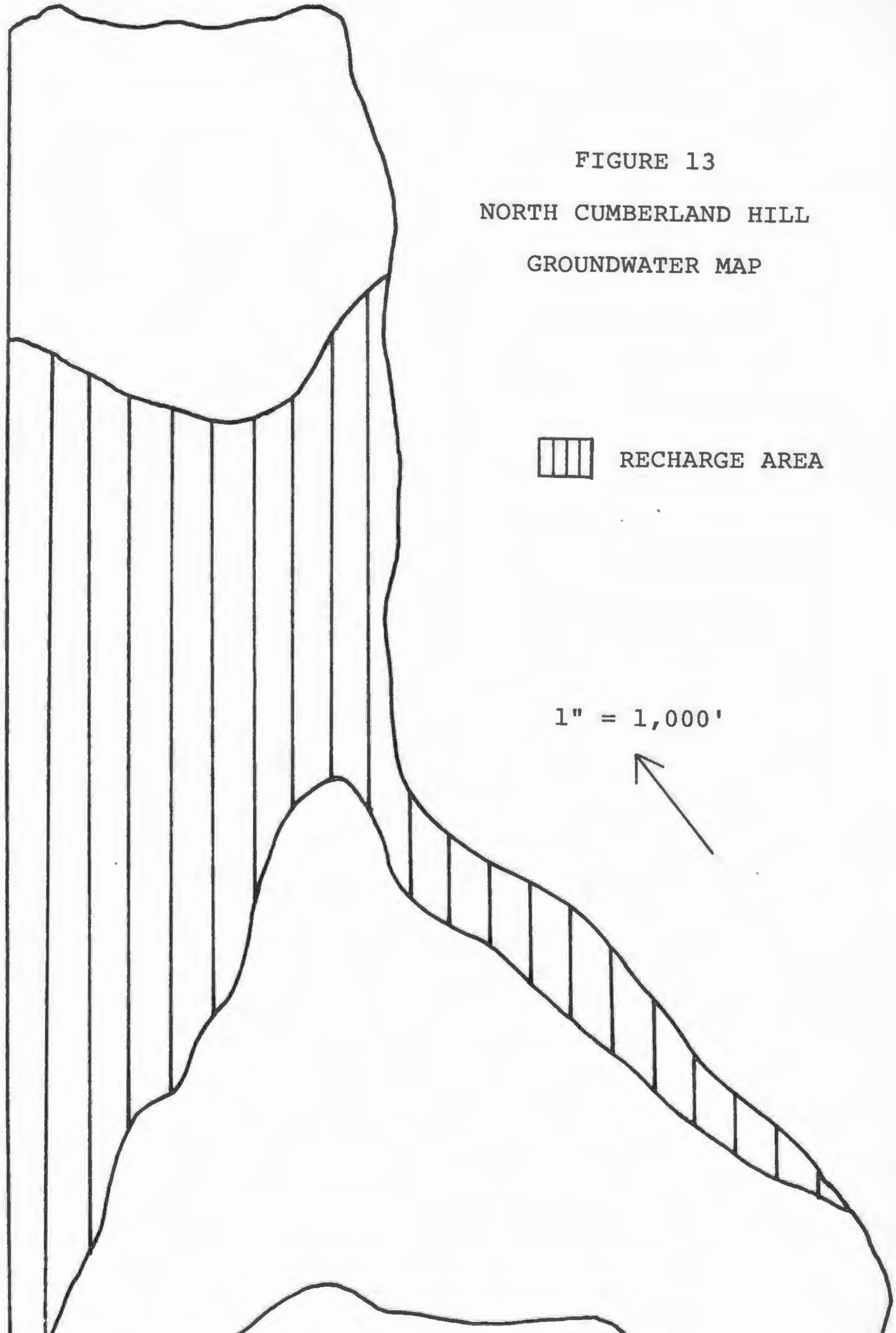


FIGURE 13

NORTH CUMBERLAND HILL

GROUNDWATER MAP

RECHARGE AREA

1" = 1,000'

Since there are permeable soils on the North Cumberland Hill Site, stringent controls of all land use activity within the recharge area should be established. Those lots, extraneous to recharge areas, are often situated within wetland territories (see Figure 15). Figure 12 shows the flow of surface water (see countour lines) flowing from the shrub swamp (SS), situated in the southeastern corner of the site, toward the Blackstone River and the Manville Wells. As a result, little land within this site holds ideal developmental conditions (i.e., flat terrain, moderate soil drainage rates, absence of aquifer and recharge areas, infrastructure proximity).

Wetlands

According to Figure 15, there are wetlands located throughout the site. As noted previously, wetlands cannot be altered except by permission of the Rhode Island Department of Environmental Management.

There are several wetland types found at the site including shrub swamps and wooded swamps. Also, there are five different streams on-site. As a result, wetland boundaries form a natural perimeter restricting site development.

Figure 16 shows on-site wetland areas by wetland type. This data was obtained by measuring wetland types (see Figure 15) with a dot grid. There are 174 wetland acres in the North Cumberland Hill Site. As a consequence, 39 percent of the total 445 on-site acres are wetlands.

Since wetlands assist in the protection of groundwater

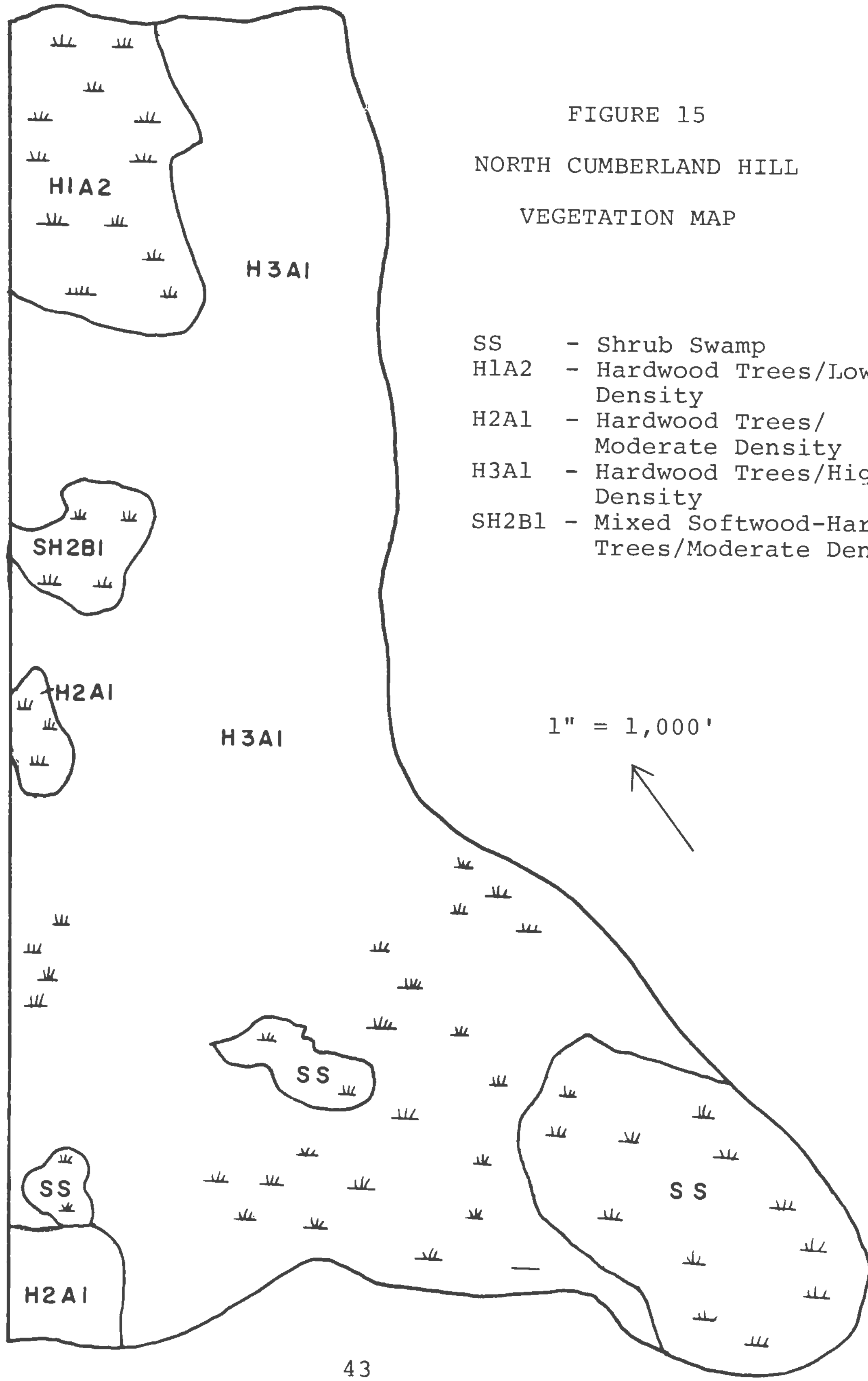


FIGURE 15

NORTH CUMBERLAND HILL

VEGETATION MAP

SS - Shrub Swamp
H1A2 - Hardwood Trees/Low Density
H2A1 - Hardwood Trees/ Moderate Density
H3A1 - Hardwood Trees/High Density
SH2B1 - Mixed Softwood-Hardwood Trees/Moderate Density

1" = 1,000'

quality (act as a filter), floodplain protection, stormwater runoff collectors, and provide wildlife diversity, it is recommended that a 100 to 150-foot buffer zone be established around the nine different wetland sites.

FIGURE 16

WETLAND CHARACTERISTICS

WETLAND TYPE	SYMBOL	ACREAGE
Shrub Swamp	SS	38.0
Shrub Swamp	SS	1.8
Shrub Swamp	SS	6.0
Wooded Swamp	$H1A_2$	39.6
Wooded Swamp	$H2A_1$	2.4
Wooded Swamp	$H2A_1$	7.2
Wooded Swamp	$H3A_1$	62.4
Wooded Swamp	$SH2B_1$	7.2
TOTAL ACREAGE..................		174.0

Floodplains

Review of floodplain maps shows the only designated floodplain zone on this site is situated in the south-eastern section near a residential subdivision (see Figure 10). Therefore, this 100-year storm zone, which is also a shrub swamp wetland, forms a natural buffer area that restricts development.

Water

Review of the local map shows that municipal water lines end at the Mendon Road/West Wrentham Road intersection, 1,300 feet south of the industrial site (see Figure 10).

An extension of municipal water from this intersection into the site would constitute a project ranging from 4,000 to 8,000 feet (avoiding wetlands). Based on the 201 SEWER FACILITIES PLAN FOR CUMBERLAND, RHODE ISLAND, the cost of municipal water line extensions to service the 4,000 to 8,000-foot site area would range from $265,000 to $350,000.

A possible alternative would be to secure water by extending Woonsocket's Industrial Park water mains into the North Cumberland Hill Site. This project, depending on site location development, would range from 800 to 4,800 feet in total distance.

If Cumberland officials plan on expanding industrial development into this "rural" section of town, the latter method must be seriously considered due to economic and environmental factors.

<u>Sewer</u>

Local sewer maps indicate that no sewer service is presently available on or near the site. The nearest sewer interceptor is 5,000 feet from the southernmost part of the site. A cost-saving alternative is to negotiate with Woonsocket officials for the extension of facilities located in their industrial park (800 to 4,800 feet away).

The sloping nature of on-site terrain suggests the need for a pumping station if the latter suggestion is adhered to. Total costs for a sewage pumping station and extensions of gravity sewer lines (according to 201 SEWER FACILITIES PLAN) would range from $546,000 to $682,000 ($90,000 to $180,000 for a pump station and $366,000 to

$385,000 for gravity sewer mains). Gravity sewers are costly whenever they are installed into areas of ledge, high groundwater tables (wetlands), and in locations of severe topographic relief.

Natural Gas and Electricity

Although there are no facilities on-site, gas transmission lines are located on Mendon Road and can be extended to the site. In addition, other sources from the Woonsocket Industrial Park are also available to the site.

Electrical service is available to the site from Mendon Road and West Wrentham Roads, or from transmission lines that bisect the site (see Figure 10).

Railroad

Direct on-site railroad access is not available to the North Cumberland Hill Site; however, the nearest connection with the Providence and Worcester Railroad is located 5,500 feet from the extreme southern section of the site. Vehicle access to the railroad could be obtained via Mendon Road, to Manville Hill Road (which fronts the Manville Hill Industrial Site), to the tracks situated at the Lincoln/Cumberland border.

Airport

Access to Woonsocket's city airport, which is 2,000 feet from the northern boundary of the North Cumberland Hill Site, is available via Meeting House (Elder Ballou) Road. The North Central State Airport in Smithfield, Rhode Island, lies six miles southwest of the site.

Transportation

There are no access roads within the North Cumberland Hill Site, but local roads are situated nearby. Meeting House Road, which forms the site's northern boundary, is a two-lane road that provides access to Woonsocket to the west, and connects with West Wrentham Road to the east (see Figure 10). West Wrentham Road provides access to Wrentham, Massachusetts to the north, and intersects Mendon Road to the south. Neither road has large traffic volumes due to the rural nature of the area resulting partially from severe physical constraints north of the site (i.e., large swamps and rock outcrops in Wrentham, Massachusetts). Therefore, both roads, which have 24-foot widths and moderate upkeep, are not solely capable of safely accommodating the intensive traffic associated with future industrial park development.

Mendon Road, classified as a principal arterial state highway, is a two-lane road located 1,400 feet from the southeastern corner of the site (see Figure 10). It is currently operating beyond acceptable road capacity during peak-hour traffic (see Manville Hill Site); therefore, additional traffic resulting from industrial development should be kept off the road until upgrading is initiated.

Due to spatial constraints of existing roads, a road extension from Woonsocket's Industrial Park into the North Cumberland Hill Site would be feasible. This action would route some traffic away from congested streets in Cumberland, toward Route 146 in the Cities of Lincoln, Woonsocket, and

North Smithfield. Route 146 can receive an influx of additional traffic due to better road conditions.

Since the North Cumberland Hill Site does not have frontage with West Wrentham Road, negotiations with those lot owners should be initiated to secure access into the site from eastern Cumberland.

Nonetheless, the development of this site is contingent on the extension of the interstate highway through the entire North Cumberland Hill Site (see Figure 10). The proposed I-295-495 connector would bisect the site as it links I-295 in Lincoln with I-495 in Wrentham, Massachusetts. This connector would provide quick access to the Woonsocket Industrial Park and the Cumberland Site from most directions.

SITE DEVELOPMENT RECOMMENDATIONS

Based solely on physical characteristics, current land use, and lack of infrastructure (utilities, roads, water, sewer), this site is not an ideal location for industrial development (see Table 4). However, because of the proximity of the Woonsocket Industrial Park (including its infrastructure) contiguous with the Cumberland/Woonsocket border, and of the proposal to erect the I-295-495 connector along the border, an opportunity exists for Cumberland to locate an industrial park into this environmentally sensitive section of town. Nonetheless, the following on-site physical characteristics create difficulties for industrial development: rock outcrops, wetlands, and vegetation diversity which harbors abundant variations of wildlife species. Therefore, hardwood and softwood forests, wetlands, and prime farmland must be taken into account when determining the on-site location of I-295-495. If any wetland areas are destroyed (upon DEM approval) due to the I-295-495 connector and/or industrial development, it is recommended that reconstruction of new wetland areas be undertaken to offset reclaimed wetlands. The SCS, in cooperation with the Rhode Island Division of Fish and Wildlife, will provide the expertise and assistance in the creation of new wetland areas.

Despite the physical constraints associated with the site, the willingness of Woonsocket officials to negotiate the extension of their infrastructure in exchange for the construction of I-295-495, makes portions of this site suitable for development. Based on site characteristics and legal regulations, development should concentrate near the town border rather than in excessively wet and/or sloping interior areas.

It would appear the biggest dilemma confronting local officials, at this time, is to determine whether it is in the best interest of the town to expand into the northwest section. A natural consequence of highway and industrial development is the encroachment of commercial and residential development into this area.

Assuming development does occur, the following recommendations should also be considered in the future development of the North Cumberland Hill Site for industrial purposes.

Development Concerns

1. All areas where the groundwater table is presently at or near the surface should be filled to at least four feet and regraded to avoid potential groundwater contamination.
2. The blasting of rock outcrops may be necessary to tie in with Woonsocket's Industrial Park infrastructure.
3. Wetland areas should be used as detention basins that collect stormwater runoff.
4. Due to poor road systems in the area, the I-295-495 connector is a requirement for industrial development.
5. The town should develop access into the site via West Wrentham Road and/or Meeting House Road.
6. There is a need for temporary and permanent erosion/sediment control measures near all development.
7. Electrical extensions could connect with the transmission lines that pass through the site.

Environmental Concerns

1. There should be no development on-site unless Woonsocket's infrastructure is extended.
2. Negotiations with Woonsocket officials are needed to determine the location of highway ramps.
3. Site location of I-295-495 should avoid wetland and recharge areas as much as possible.
4. Any filled wetlands should be compensated by constructing new wetlands nearby (provide habitats

for dislocated wildlife).

5. Wetlands can be protected by creating a floating buffer zone ranging from 100 to 300 feet (based on environmental and wildlife sensitivity).
6. Due to distance, cost, and environmental factors, water and sewer connections must tie in with Woonsocket's Industrial Park infrastructure.
7. Due to rolling terrain, a sewerage pumping station is required to pump sewage uphill to Woonsocket's infrastructure.
8. Groundwater recharge areas located along the border dictates the need for stringent control of runoff and preservation of natural vegetation.
9. The environmental sensitivity of this site dictates that small, select areas are selected for industrial development.

CUMBERLAND INDUSTRIAL PARK

AND

ABBOTT RUN BUSINESS PARK

Site Description

The Cumberland Industrial Park, which includes 116 acres situated north of Interstate Highway 295, borders Diamond Hill Road (Route 114) to the west, and Abbott Run Valley Road (Lanesville Road) to the east (see Figure 17). Substantial residential development is situated to the west of Route 114, and due north of the Industrial Park. To the east of Abbott Run Valley Road is Howard Pond. To the south, the park borders I-295 and the area that is proposed as the Abbott Run Business/Office Park. As a consequence of relative site proximity (see Figure 17), the Cumberland Industrial Park (CIP) and the Abbott Run Business Park (ARBP) are discussed together whenever applicable.

The Abbott Run Business Park is bordered on the south by Bear Hill Road, and I-295 and CIP to the north (see Figure 17). To the east, this proposed 33-acre business park fronts Abbott Run Valley Road and a municipal well bearing the same name (see Figure 17), while to the south is two-acre residential housing located along the southern side of Bear Hill Road. Situated along the vegetated western boundary lies Mossberg Inc., Bear Hill Village (subdivision), Elderly Housing, and a large subdivision that fronts on Route 114. The most significant characteristic of this site is the panoramic view of hilly terrain located in adjacent communities--Attleboro and Wrentham, Massachusetts to the east and north, respectively.

Site Market Potential

The CIP has developed one-half the acreage within its

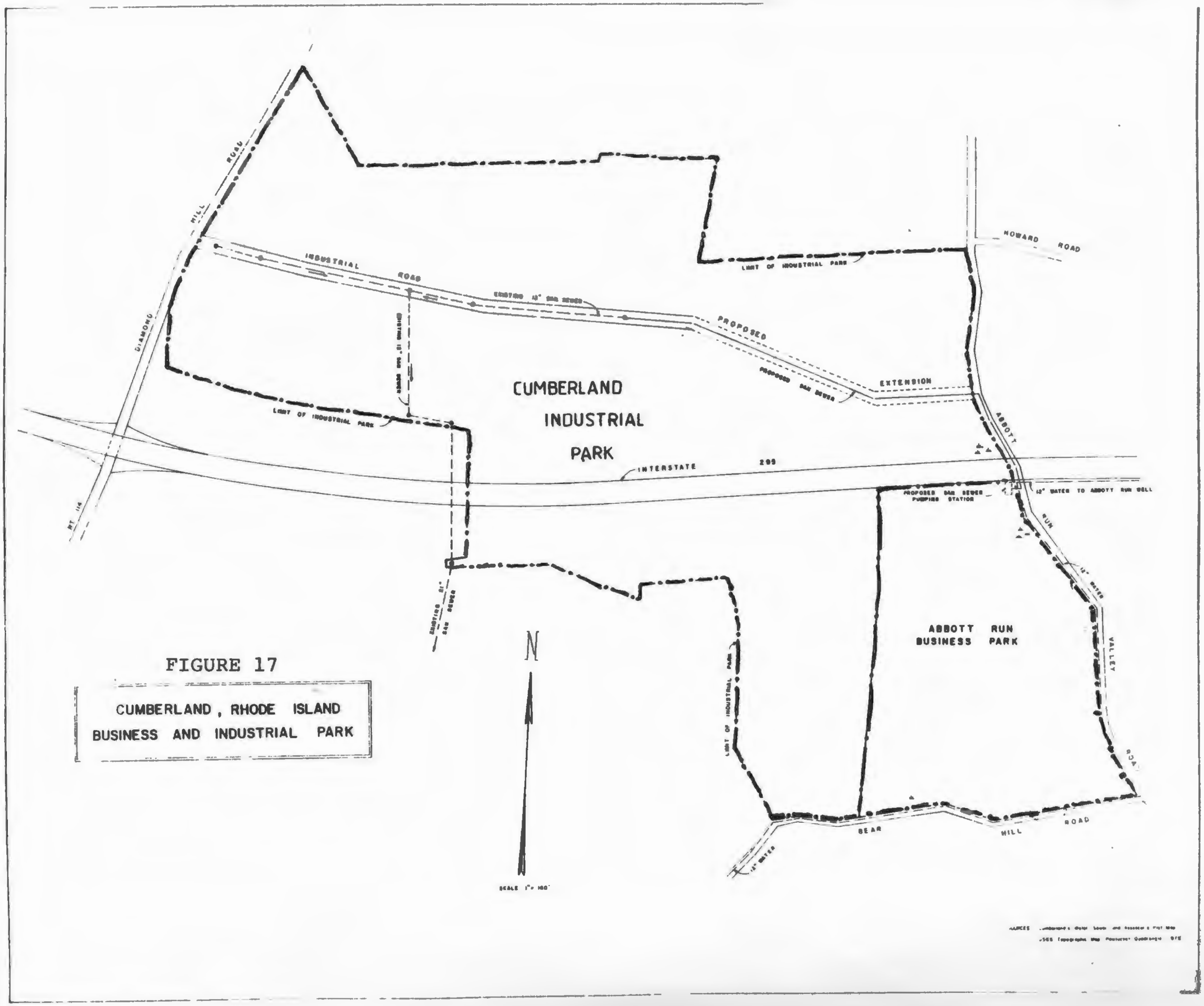


FIGURE 17

CUMBERLAND, RHODE ISLAND BUSINESS AND INDUSTRIAL PARK boundary and currently houses numerous businesses. However, the eastern half of the site remains in an unaltered natural state. The ARBP is an undeveloped industrially-zoned area.

These sites were selected for analysis based on the following: industrial park location (created due to construction of I-295, 15 years ago), willingness of a landowner to sell numerous parcels, political support, and high aesthetic value and amenities of the surrounding area.

Topography

Slope percentages were calculated for unaltered lots within each site. Reference to Table 6 shows the results of a lot-by-lot analysis.

Cumberland Industrial Park

The western section of the site is currently developed on 0 to 3 percent slope in elevations of 230 to 240 feet above sea level. In the undeveloped eastern section, the elevation varies from a high point of 240 feet to 115 feet near Abbott Run Valley Road. Before the industrial park was created, the western section was cultivated prime farmland adjacent to wetlands that drained into the Miller Stream (see Figure 18). To the east lies steeper terrain, 8 to 18 percent slope (lots 97, 2, 15), where elevation descends 125 feet over a 1,000-foot area. This descent results from glacial till material [unstratified glacial materials (boulders, stones, silts, clays) deposited by ice] situated adjacent to low-lying outwash material located by Abbott Run Valley Road. As a result, engineering for water and sewer extensions, buildings, runoff, and roadway extensions will be affected by steep terrain (see Figure 17).

TABLE 6

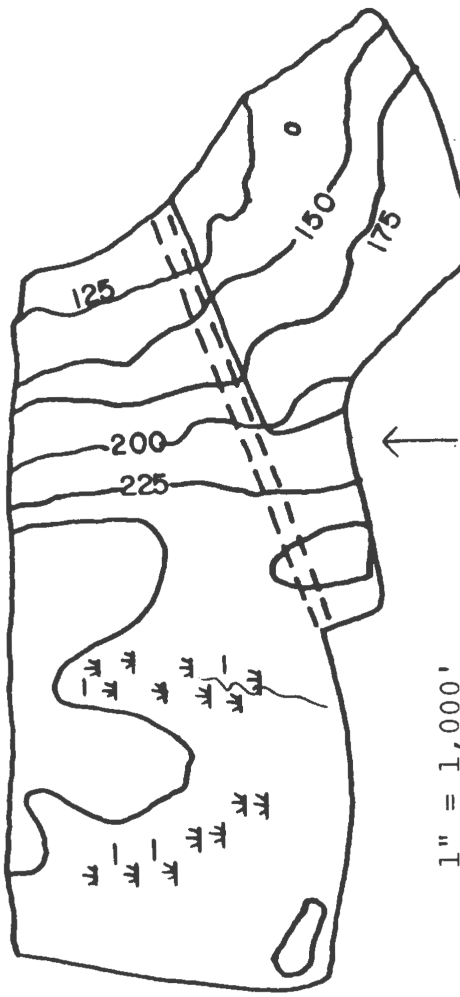
PHYSICAL CHARACTERISTICS OF LOTS LOCATED AT THE CUMBERLAND INDUSTRIAL PARK AND ABBOTT RUN BUSINESS PARK

SITE	ACRES	SOIL	SLOPE %	FLOODPLAINS	WETLANDS	LOT OVER AQUIFER	ELECTRICITY AND GAS (1 MILE)	RAILROAD (1 MILE)	AIRPORT (5 MILES)	TRANSPORTATION (5 MILES)	WATER (1 MILE)	SEWER (1 MILE)
Cumberland Industrial Park												
2	25	fair	8-15	N	Y	N	Y	N	N	S, I	Y	Y
97	8	poor (rocky)	8-18	N	Y	N	Y	N	N	S, I	Y	Y
15 North of I-295	16	fair	3- 8	N	Y	N	Y	N	N	S, I	Y	Y
331	7	good	0- 3	N	Y	N	Y	N	N	S, I	Y	Y
815/755	4.5	good	0- 3	N	Y	N	Y	N	N	S, I	Y	Y
Others	51	f-g	0- 3	N	Y	N	Y	N	N	S, I	Y	Y
15 South of I-295	4.8	good	3- 8	N	Y	N	Y	N	N	S, I	Y	Y
Total Acres	116 (Developable 50)											
Abbott Run Business Park												
66	10	fair	3-15	N	N	N	Y	N	N	S, I	Y	Y
12	23	f-g	3-15	N	Y	N	Y	N	N	S, I	Y	Y
Total Acres	33 (Developable 30)											

Y = Yes S = State Highway
N = None I = Interstate Highway

FIGURE 18

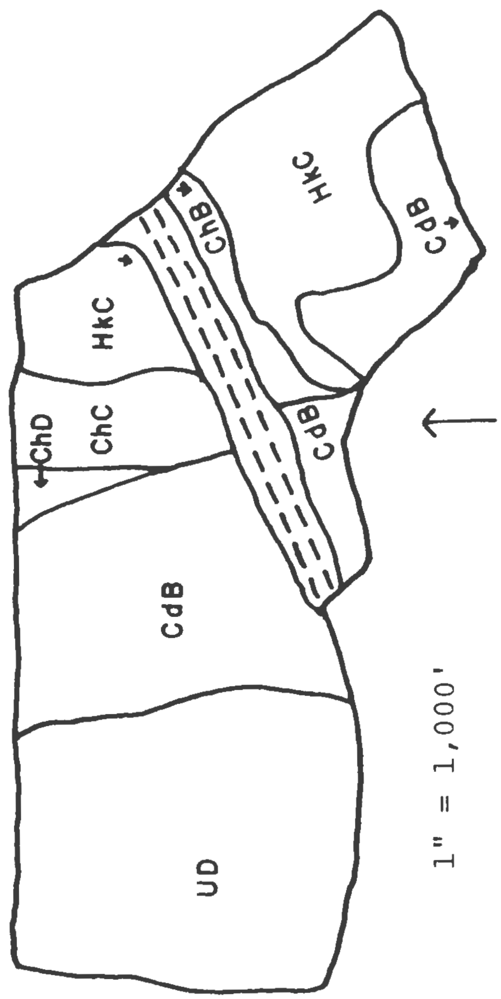
CUMBERLAND/ABBOTT RUN
TOPOGRAPHIC MAP



1" = 1,000'

FIGURE 19

CUMBERLAND/ABBOTT RUN
SOILS MAP



1" = 1,000'

Abbott Run Business Park

The landscape has a natural terracing appearance with elevations ranging from 220 feet northwest of Bear Hill to 120 feet near Abbott Run Valley Road. Based on watershed characteristics, stormwater runoff will flow easterly toward Abbott Run Valley Road and the groundwater aquifer due east of the road.

While sloping terrain adds aesthetic beauty to the site (i.e., scenic panoramic views of 200 to 450-foot hilly terrain), and assists in the promotion of this site as a business/office park, the severity of the terrain in the industrial park represents higher development costs (i.e., infrastructure extension).

Soil

Based on information obtained from the SCS Soil Survey Manual, an analysis of soil conditions on unaltered lots was undertaken (see results Table 6). Most soils on both sites are classified as suitable or conditional for development by the SCS. Conditional soils require minor adjustments in building and road placement. Problem soils, ChD (Canton), are found on the CIP site. These soils have major limitations (associated with steep terrain) that affect industrial development. Therefore, slope over 15 percent requires special care to insure against mass movement of soil and structures during and after construction. As a consequence, careful siting of building, roads, and stormwater management structures is required in areas of ChD soil.

Soils data in Table 7 show important characteristics associated with each soil series. HkC (Hinkley) soils are located on both sites (see Figure 19). These conditional soils are classified as having rapid permeability rates, 6 to 20 inches per hour. This rate is a positive characteristic in sloping areas since some stormwater is absorbed by the soil rather than generating runoff flows. Since Hinkley soils are located on terraces, glacial eskers and kames, and are droughty at times due to a rapid permeability rate, prevention of erosion during development can be effectively controlled.

Canton soils (CdB, ChB, ChC, ChD) are also well-drained, and often located contiguous with the base of glacial hills and ridges (bottom lowland). CdB soils are located on both sites, while ChB, ChC, and ChD soils are within the CIP.

Since the soils on these sites are not located over any groundwater aquifers, they are considered a slight-moderate constraint to development; otherwise, they would be classified as problem soils by the SCS (see Manville Site). Nonetheless, because the eastern portion of the industrial park (lots 2, 15, 97) has steep, unstable terrain, problems concerning building bearing capacity must be addressed by engineers.

TABLE 7

SOIL SERIES CHARACTERISTICS

SOIL	SCS CLASSIFICATION	SOIL TEXTURE	DRAINAGE	BUILDING CONSTRAINT	ROAD BUILDING CONSTRAINT
CdB	suitable	sandy/loam	mod.-rapid	slight	slight
ChB	conditional	stoniness	mod.-rapid	moderate	slight
ChC	conditional	very stony	mod.-rapid	severe	moderate
ChD	problem	very stony	mod.-rapid	severe	severe
HkC	conditional	gravelly	rapid	severe	moderate

Groundwater

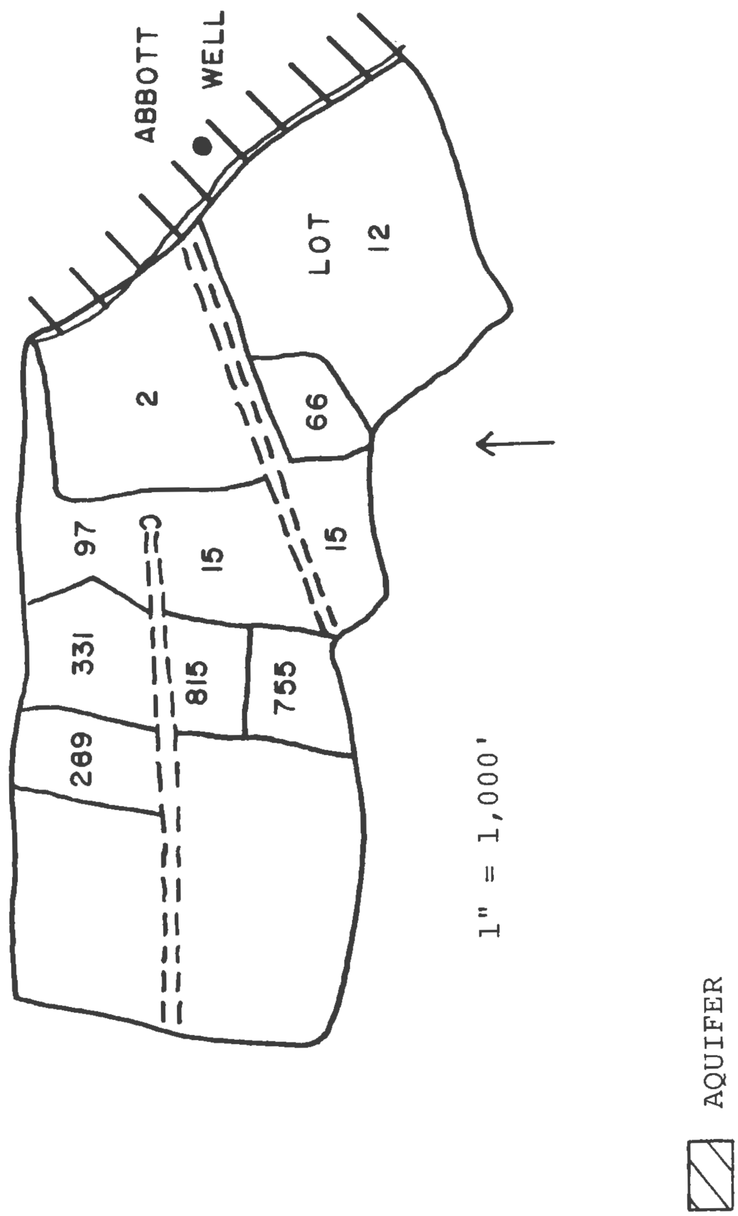
Cumberland Industrial Park

North of Interstate Highway 295, there are no groundwater aquifer or recharge areas within unaltered parcel boundaries. However, approximately 100 feet east of Abbott Run Valley Road (which fronts lots 2 and 97), there exists a groundwater aquifer that extends easterly to the North Attleboro, Massachusetts border (see Figure 20). This aquifer is of major significance because it contributes to the municipally-operated Abbott Run Valley Well. Test borings indicate that the bedrock floors of this outwash valley area are 76 feet below the surface. According to the sewer facilities plan, this well produced in 1981, 56 million gallons of water (8 percent of local water supplies).

Since the slope of the terrain directs runoff material toward the aquifer, strategic planning that will divert stormwater runoff and its pollutants away from the aquifer (i.e., road salts, phosphates) must be considered. Therefore,

FIGURE 20

CUMBERLAND/ABBOTT RUN GROUNDWATER MAP



lots 2 and 97 must be subjected to mandatory runoff plans.

Abbott Run Business Park

Technically, unaltered lots 66 and 12 do not lie within the boundaries of the aquifer, nor are they classified as recharge areas (according to sewer facilities plan). However, since the topography of the proposed business park depicts similar drainage patterns as the CIP (easterly toward the town well), precautionary plans must be initiated to preserve groundwater quality. Therefore, mandatory sanitary sewer and water extensions, buffer zones, and detention basins must be created.

Wetlands

According to state vegetation mapping conducted by Kupa and Whitman, 1962, 22 acres of wooded wetlands (hardwood treed) were located in the CIP Site. Due to the creation of the industrial park and I-295, these wetlands were filled and built upon.

Based on the SCS Soil Survey Map, wet areas are located in the Cumberland Industrial Park. Field reconnaisance determined one acre of wooded swamp (softwood) located on the southeast corner of lot 2 (see Figure 20). In the Abbott Run Site, wet areas are situated on the northeast and southwest sections of lot 12 (one acre fresh marsh and one-half acre wooded swamp, respectively).

These wet areas are significant because they can be beneficially used as stormwater collection basins. Therefore, the quality of the nearby groundwater aquifer should be somewhat protected.

Floodplains

According to the floodplain maps created for the National Flood Insurance Program, there are no designated floodplain zones within either site.

Water

The Cumberland Industrial Park is serviced by 10-inch water lines that extend from Diamond Hill Road (Route 114) on to Industrial Drive, which is located within the park (see Figure 17).

The Abbott Run Well is located 750 feet east of the Abbott Run Business Park, and 200 feet south of Interstate 295. Twelve-inch water mains extend from the town well onto Abbott Run Valley Road, Bear Hill Road, and Diamond Hill Road.

The size and proximity of the water mains near each site suggest no significant problems concerning water availability for the undeveloped lots; however, water lines must be extended into each site in addition to the expansion of Industrial Drive to Abbott Run Valley Road (see Figure 17). This distance would cover nearly 3,000 feet.

Sewer

The Abbott Run Valley Interceptor (ARVI) is a municipally owned collector sewer system that ties into the regional interceptor owned by the Blackstone Valley District Commission (BVDC). Wastewater from the ARVI collector system is transported via the BVDC interceptor to the regional wastewater treatment facility located in East Providence, Rhode Island [Bucklin Point (see Figure 3)].

Cumberland Industrial Park

The Abbott Run Valley Interceptor, which is situated parallel to Diamond Hill Road (see Figure 17), receives wastewater from sewer laterals located on Industrial Drive. To develop lots 2, 97, and 15, an extension of sewer laterals should coincide with the eastward extension of Industrial Drive to Abbott Run Valley Road. This effort will assist in the preservation of groundwater quality.

Abbott Run Business Park

Although the ARVI is situated 2,100 feet west of the ARBP, direct connections cannot be secured from the business park due to spatial constraints (I-295 right-of-way, conflicting land uses). Therefore, sewer connections must extend from the ARBP to the CIP to reach the ARVI (via Abbott Run Valley Road and Industrial Drive).

Due to the sloping nature of undeveloped CIP lots, the need for a pumping station will be required to force the wastewater from the ARBP uphill to the CIP. Then, via gravity sewers, the wastewater can flow into the ARVI, the BVDC interceptor, and eventually to the regional treatment plant in East Providence (see North Cumberland Hill Site for sewer costs, p. 45).

According to the sewer facilities plan, the ARVI has adequate available capacity to accommodate additional development.

Natural Gas and Electricity

On-site reconnaisance determined that the Blackstone Valley Gas Company has lines positioned within the industrial park and along Bear Hill Road; therefore, extensions are available. Electrical lines are available from Industrial Drive, Bear Hill Road, and Abbott Run Valley Road.

Railroad

Tax Assessor's Plat Maps indicate there are no active railroads within the vicinity.

Airports

Access is available via I-295 to the North Central Airport in Smithfield, the City Airport in Woonsocket, and regional airports in Boston, Massachusetts (Logan), Warwick, Rhode Island (Green), and Windsor, Connecticut (Bradley).

Transportation

Based on Cumberland's Official Map of Streets and Roads, state and interstate highways are located within one mile of both sites [Route 114 and I-295 (see Figure 17)]. Route 114 (Diamond Hill Road) is a bidirectional two-lane principal arterial that serves 12,300 (ADT) vehicles per day. Bear Hill Road and Abbott Run Valley Road are lightly travelled two-lane rural roads situated on the eastern border of both sites. While there are no access roads in the ARBP, Industrial Drive extends into the developed portions of the CIP. The only entrance onto Interstate 295 is located at the junction of Route 114 (Diamond Hill Road) and I-295 [located west of the business park (see Figure 17)]. Therefore, planning for access to the interstate highway from the business park (south of I-295) must be considered.

Scenario 1: At present, a proposal exists to extend Industrial Drive through lot 2 (industrial park) to connect with Abbott Run Valley Road. Simultaneously, plans must be created that severely deter business park traffic from driving westward via Bear Hill Road through residential subdivisions in order to connect with Route 114 and I-295. Therefore, entrance onto I-295 is planned for by requiring business park employees to drive onto Abbott Run Valley Road, turn left onto Industrial Drive (through the industrial park), travel south onto Route 114, then turn onto the I-295 connector.

Scenario 2: Another proposal is to create a cloverleaf-styled ramp entrance at the junction of Abbott Run Valley Road and I-295. However, spatial limitations, financial constraints, and environmental and legal factors prohibit this scenario from occurring.

Based on present and future land use trends in the area, scenario number one appears to be a logical solution for business park traffic.

SITE DEVELOPMENT RECOMMENDATIONS

Based on environmental characteristics, current land use, and infrastructure location, these two sites appear to be promising locations where industrial and business development can successfully coexist in a contiguous environment.

Due to the high aesthetic value associated with the Abbott Run Site, it is recommended that the creation of an office park that attracts consulting and architectural firms be established. This policy would diversify the local economy and provide the stimulus to fill vacant lots in the Cumberland

Industrial Park.

To assist in site preparation, the following recommendations are intended to provide guidelines in the development process:

Cumberland Industrial Park

Development Concerns

1. Industrial Drive should be connected with Abbott Run Valley Road.
2. Erosion should be controlled by haybales, terraces, or diversion techniques.

Environmental Concerns

1. Water extensions should connect with Abbott Run Valley Road.
2. Sewer extensions should connect with Abbott Run Valley Road so as to receive Abbott Run Business Park sewage.
3. There is a need for a pumping station to force ARBP waste uphill to CIP's interceptor connection.
4. Protection of existing vegetation on lots 97, 2, and 15 to assist in drainage control is suggested.

Abbott Run Business Park

Development Concerns

1. Scenic views must be accentuated in all site plans.
2. Erosion should be controlled by terraces, haybales, and diversion techniques.
3. Wet areas on lots 12 and 66 could be enlarged into detention basins that collect runoff.
4. The design of one access road going through the

entire site should connect Bear Hill and Abbott Run Valley Roads.

5. All traffic should enter and exit the park via CIP's Industrial Drive (to gain access onto I-295).

Environmental Concerns

1. Water extensions must connect with Abbott Run Valley Road.
2. On-site gravity sewer extensions must connect with Abbott Run Valley Road.
3. All sewage can be forced uphill to the CIP interceptor connection via the pumping station by way of Industrial Drive.
4. The pumping station should be located on the southern side of I-295, east of Abbott Run Valley Road (land available).
5. There must be regulation of road salting applications and street sweeping practices due to proximity of the town well.
6. Based on environmental characteristics, this site should be promoted as an office park.

NEW RIVER

INDUSTRIAL SITE

Site Description

The north/south boundaries of the New River Industrial Park Site include Martin Street to the north, and Lennox Street to the south (see Figure 21). The western boundary of the site is the Blackstone River, which separates Cumberland from the City of Lincoln. North of Martin Street there is industrial development, while to the east and south, there is small-lot residential and commercial development along Mendon Road (Route 122).

The 15 lots which comprise this 127-acre site are currently owned by 11 landowners. At this time, business and/or industrial development is established on lots fronting Martin Street, while a sand and gravel mining operation is located in central and southern sections of the site.

Site Market Potential

The New River Site is zoned for industrial development. Despite the fact that 22 acres are currently inhabited by industry, it has been selected for analysis due to local policy that has historically encouraged industrial development along the Blackstone River (see Figure 2).

The following site-related characteristics increase the market potential of the New River Site:

1. The Providence and Worcester Railroad bisects the site (see Figure 21).
2. The Blackstone Valley District Commission (BVDC) sewer interceptor is situated beneath the railroad tracks (same interceptor that extends northward onto

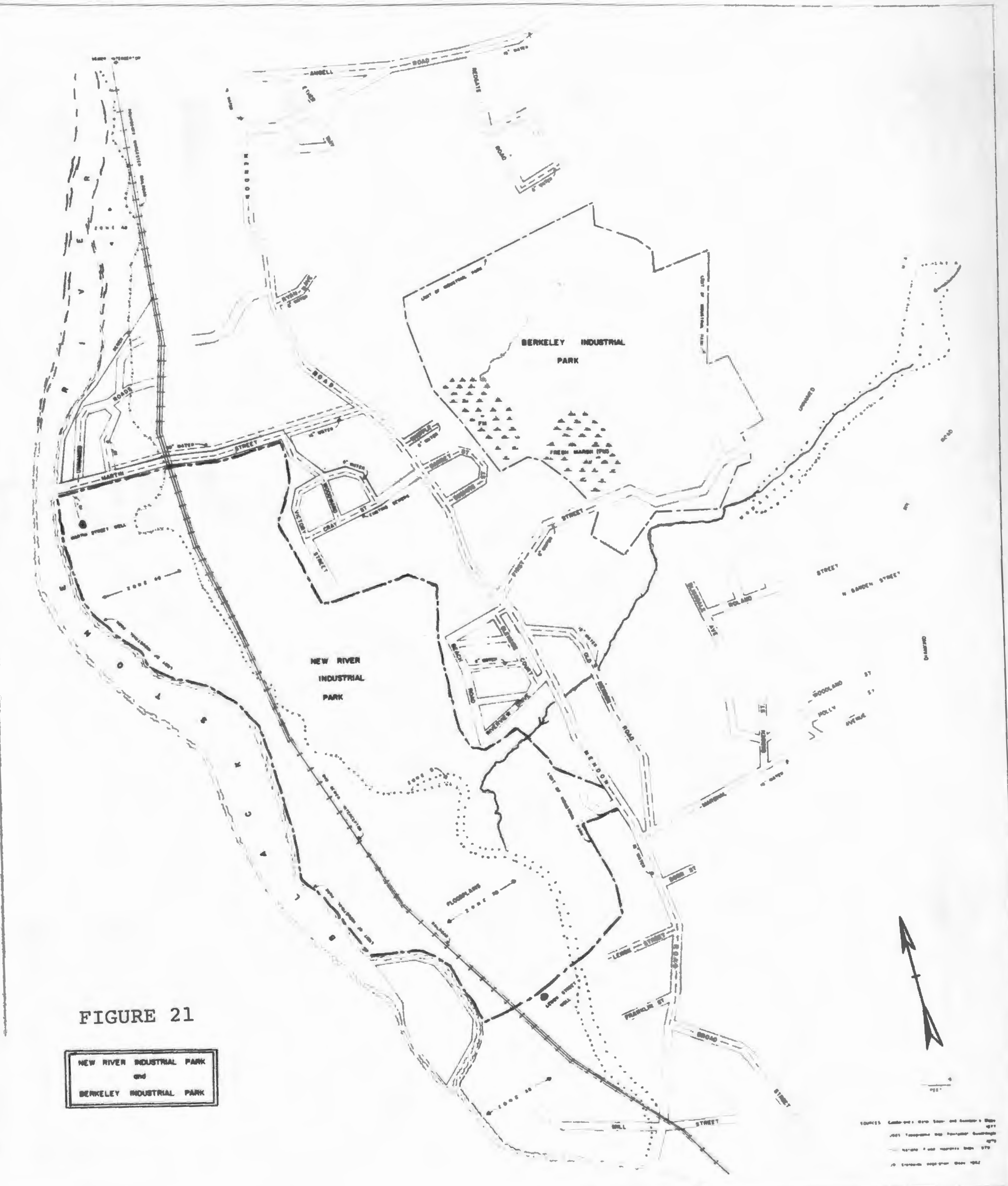


FIGURE 21

NEW RIVER INDUSTRIAL PARK and BERKELEY INDUSTRIAL PARK the Manville Hill Site).

3. The sand and gravel mining operation, which encompasses 62 acres, has depleted available resources in various sections of the site (based on field reconnaisance).

Topography

Contour lines depict land elevations ranging from 70 feet along the Blackstone River to 140 feet along the eastern ridge (see ridge, Figure 22). The terrain consists of two geological physical features--outwash plains and stream valley terraces. Both features are the result of the deposit of materials (coarse sand and gravel imbedded with silts and clays) due to the movement of meltwater streams directly in front of glacial ice formations some 10,000 years ago. Therefore, many stream valleys contain outwash material, both as valley fills and as terraces (series of flat platforms of earth with sloping sides).

Lot configurations taken from Tax Assessor's Plat Maps were transferred to the SCS soils map for visual analysis (see Figure 23). Based on topographical maps, slope percentages were calculated on a lot-by-lot basis (see Table 8).

While stream valley terrace lots 235, 255, 136, 1, 2, and 4 depict terrain ranging in slope from 0 to 25 percent (of which 62 acres are currently a sand and gravel mining operation (lots 236, 1, 2, 4), the remaining lots, situated on outwash plains along the Blackstone River, have 0 to 3 percent slopes that are subject to flooding.

Based on drainage characteristics, stormwater runoff

FIGURE 22

NEW RIVER TOPOGRAPHIC MAP

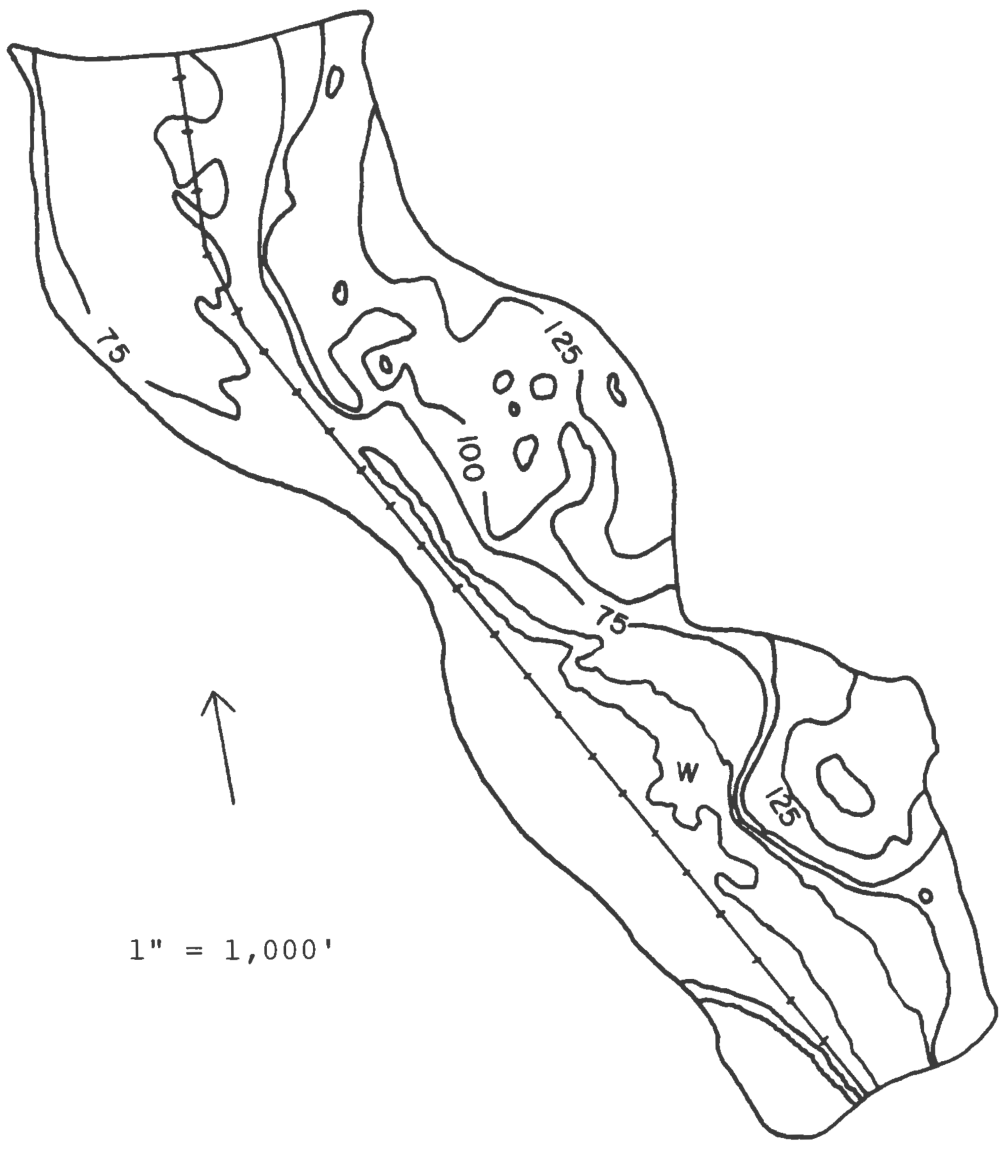


FIGURE 23

NEW RIVER SOILS MAP

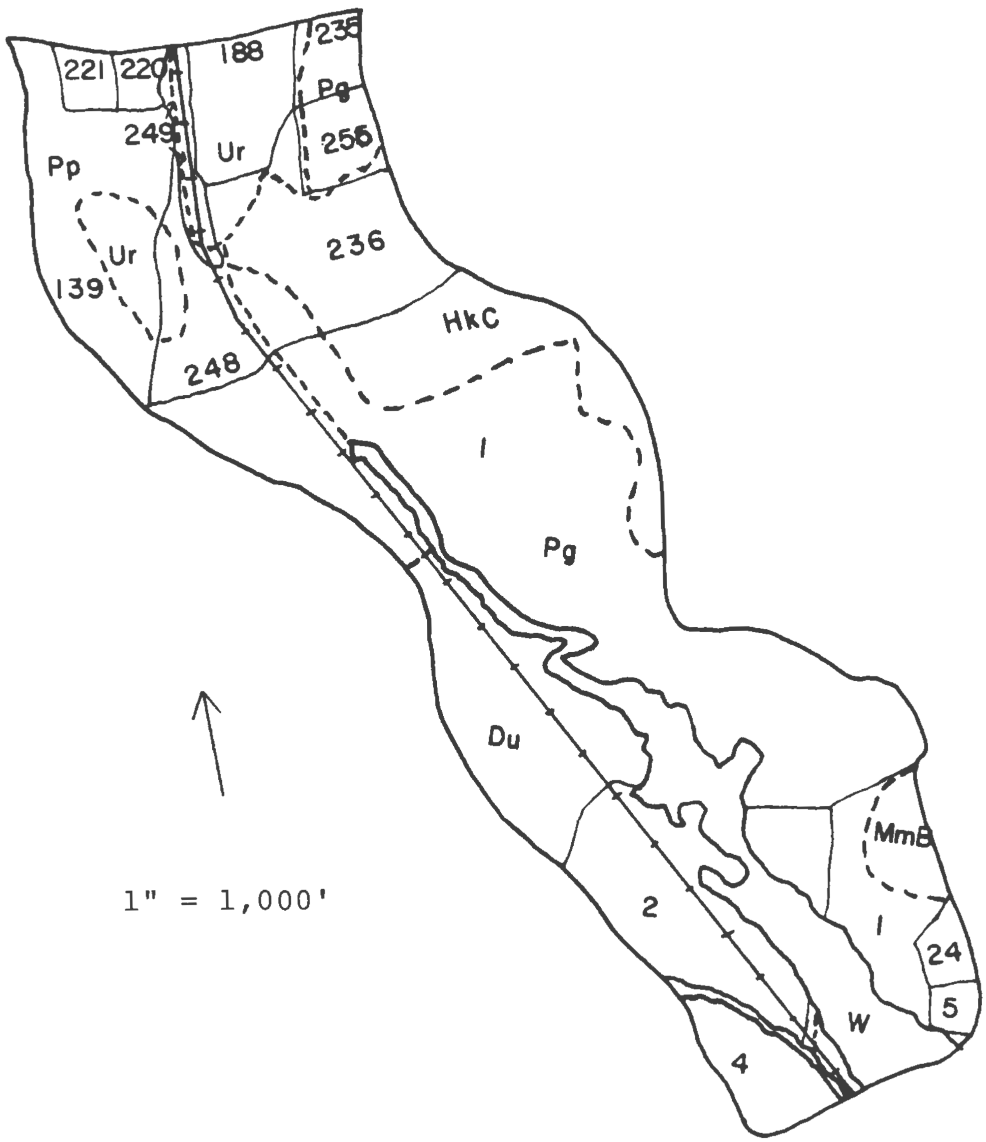


TABLE 8

PHYSICAL CHARACTERISTICS OF LOTS LOCATED AT THE NEW RIVER SITE

SITE LOT (PLAT)	ACRES	SOIL	SLOPE %	% LAND AREA IN FLOODPLAINS	LOT OVER AQUIFER	WETLANDS	ELECTRICITY AND GAS (1 MILE)	RAILROAD (1 MILE)	TRANSPORTATION (5 MILES)	WATER (1 MILE)	SEWER (1 MILE)	FILL ON-SITE
139 (34)	25	problem (wet)	0- 3	100	Y	N	Y	Y	S, I	Y	Y	N
221	5	problem	0- 3	100	Y	N	Y	Y	S, I	Y	Y	N
220	7.5	problem	0- 3	100	Y	N	Y	Y	S, I	Y	Y	N
188	5.5	suitable	0- 3	20	Y	N	Y	Y	S, I	Y	Y	N
235	4	problem (rocky)	0-25	0	Y	N	Y	Y	S, I	Y	Y	Y
255	2.9	problem	0-25	0	Y	N	Y	Y	S, I	Y	Y	Y
248	2.6	problem	0- 3	90	Y	N	Y	Y	S, I	Y	Y	N
249	4	problem	0- 3	90	Y	N	Y	Y	S, I	Y	Y	N
1 (15)	26	problem	0-25	40	Y	N	Y	Y	S, I	Y	Y	Y
1 (14)	7	problem (rapid perm.)	0- 3	75	Y	N	Y	Y	S, I	Y	Y	Y
2	16.5	problem	0-25	75	Y	N	Y	Y	S, I	Y	Y	Y
4	2	problem	0-25	100	Y	N	Y	Y	S, I	Y	Y	Y
5	.5	problem	0- 3	0	Y	N	Y	Y	S, I	Y	Y	N
24	.4	problem	0- 3	0	Y	N	Y	Y	S, I	Y	Y	N
236	18.3	problem (rapid perm.)	3-15	5	Y	N	Y	Y	S, I	Y	Y	Y

Total Acres	127
Developable	51

Y = Yes
N = None
S = State Highway
I = Interstate Highway

flows westerly toward the Blackstone River. Erosion will occur on-site due to the absence of vegetation on excavated lots. Because of the mining operation, the landscape has been nearly levelled in many areas [lots 236, 2, 4 (based on field reconnaisance)]. As a consequence, industrial development can occur on-site upon removal of exposed rock and complete levelling of altered terrain.

Soil

The following soil series are found on the New River Site: Pg (Pits/Quarries), HkC (Hinkley-Enfield), Pp (Podunk), Du (Dump), and Ur (Urban Land). Hinkley-Enfield soils, located on lots 1 and 236, share similar soil characteristics with Pits/Quarries. The only difference between them is in slope percentage and vegetation cover. Hinkley soil has hardwood vegetation that slopes from 8 to 15 percent, versus relatively unvegetated, 0 to 25 percent slope found on quarry sites (see Figure 22). Common soil characteristics of Pg and HkC soils consist of the following:

1. excessive stoniness;
2. bedrock exposures;
3. poor bearing capacity (soil factors contribute to instability of building foundations);
4. soils located over groundwater aquifer;
5. problem of revegetation on sandy-gravelly soil;
6. need of topsoil material.

Podunk soil [one-time farmland (see Figure 23)] has a fine sandy/loam texture that is moderately well-drained; however, it is found exclusively over floodplain zones.

Consequently, an annual high water table will confine this soil's land development potential (see lots 139, 248, 220, 221, 249, and sections of 1 on Figure 23).

An abandoned dumpsite (Du) is located in the south-western sections of lot 1 along the Blackstone River. Due to the precarious positioning of this dumpsite over a groundwater aquifer (see Figure 23 and Figure 24), this land should not be industrially developed.

Urban land (Ur) signifies completely developed land that has rendered the original soil type relatively obscure (according to SCS). Therefore, most developed land (lots 188 and 139) is classified by the SCS as urban land.

Reference to Table 8 depicts a lot-by-lot summary of soil conditions based on SCS soil classifications.

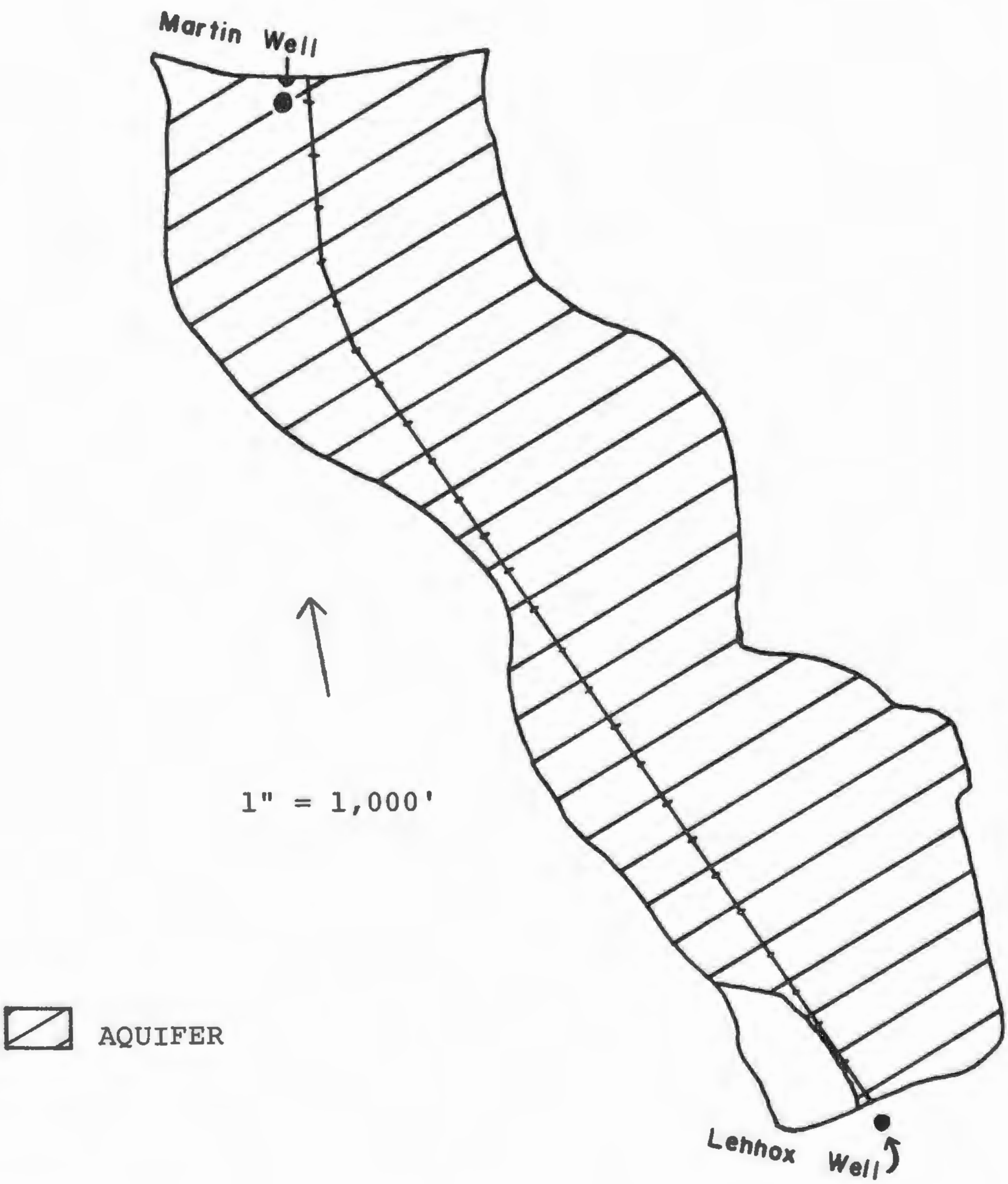
Groundwater

Geologically speaking, since outwash material is generally permeable due to the presence of sand and gravel, it is usually an ideal area for groundwater resources. This is verified on the New River Site by test borings that indicate the depth of on-site wells ranging from 54 to 104 feet. However, the Blackstone River currently has a water quality designation of Class D (based on state standards). This classification signifies that this section of the river is suitable only for navigation purposes.

Within this industrial site, two contaminated town wells are located: the Martin Street Well (south of Martin Street), and the Lennox Street Well [southwest of Marshall Street (see Figure 24)]. According to the local sewer facilities

FIGURE 24

NEW RIVER GROUNDWATER MAP



plan, the Martin Street Well was shut down in 1970 due to high levels of iron and manganese, and the Lennox Street Well was closed in 1979 due to volatile organic concentration.

Therefore, based on soil, topographical, and groundwater characteristics, special precautionary measures must be adopted, before and after construction, to avoid further contamination of groundwater resources.

Wetlands

There are no wetland areas on-site; however, analysis of the vegetation map (see Figure 25) depicts pockets of low-lying relief along the Blackstone River. Drainage basins could be established in select areas provided there is no violation of the Rhode Island Freshwater Wetlands Act (includes any water bodies subject to flooding). The Act states no alteration of flood-prone or stormwater collection areas is allowed unless a petition is approved by DEM.

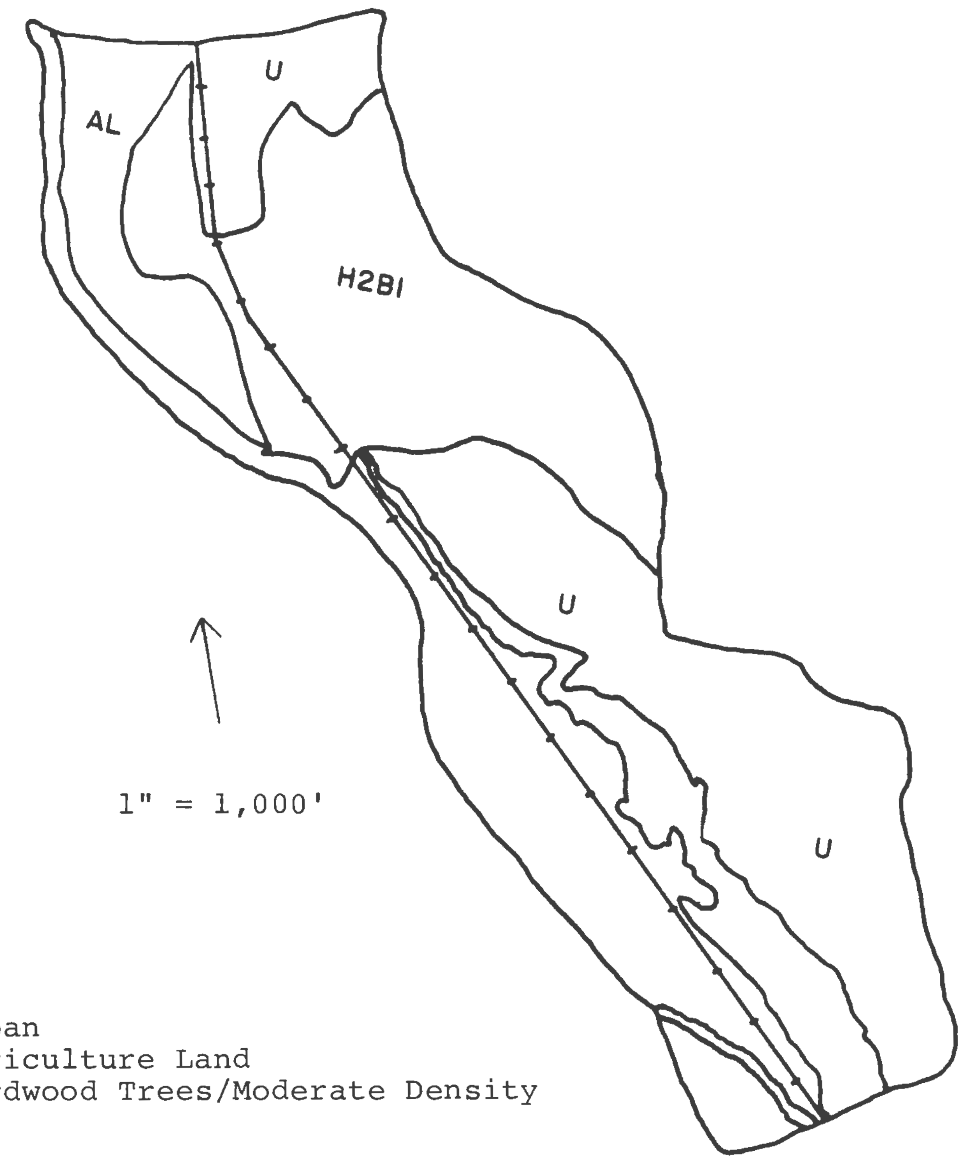
Floodplains

Review of floodplain maps shows 100 and 500-year storm zones (lettered A8 and B, respectively) situated along the banks of the Blackstone River, extending from Martin Street in the north, to Lennox Street due south. They infringe on approximately 73 percent (11 of 15) of the lots within the New River Site (see Table 8 and Figure 21).

Table 9 refers to those lots which have been divided into percentages of total land area that lie within 100 and 500-year storm flood zones, respectively.

FIGURE 25

NEW RIVER VEGETATION MAP



1" = 1,000'

U - Urban
AL - Agriculture Land
H2B1 - Hardwood Trees/Moderate Density

TABLE 9

NEW RIVER FLOODPLAIN AREA

LOT (PLAT)	TOTAL ACREAGE	% LAND IN ZONE A8	ACRES IN ZONE A8[1]	% LAND IN ZONE B	ACRES IN ZONE B[2]	TOTAL FLOOD-PLAIN ACRES
139	25.0	100	25.0	--	--	25.0
221	5.0	100	5.0	--	--	5.0
220	7.5	100	7.5	--	--	7.5
188	5.5	10	.5	10	.5	1.0
248	2.6	85	2.2	5	.1	2.3
249	4.0	90	3.6	--	--	3.6
1 (15)	26.0	20	5.2	20	5.2	10.4
1 (14)	7.0	50	3.5	25	1.7	5.2
2	16.5	55	9.0	20	3.3	12.3
4	2.0	100	2.0	--	--	--
236	18.3	--	--	5	.9	.9
235	4.0	--	--	--	--	--
255	2.9	--	--	--	--	--
24	.4	--	--	--	--	--
5	.5	--	--	--	--	--
Total	127.0		63.5		11.7	75.2

Based on Table 9, 11 of 15 on-site lots, or 119 of 127 total site acres (90 percent) are exposed to a designated flood zone(s). Refining this data, 63.5 acres, or exactly 50 percent of total land area in the New River Site, lies within a 100-year flood zone. As a consequence, any proposed development that should lie within a 100-year zone must be considered a severe environmental, economic, and legal risk.

Water

It was determined that 10, 12 and 16-inch water mains are situated at Martin Street, while 10 and 16-inch mains are located at the Mendon/Marshall Avenue intersection (see Figure 21). Therefore, 800 to 1,600-foot extensions are required to connect municipal water lines with any lot on-site.

Sewer

Sewer laterals are situated beneath Drummond and Victory Streets (subdivision located south of Martin Street), while the BVDC interceptor, which is located below the railroad tracks, passes through the length of the site. To avoid groundwater contamination, mandatory gravity sewer laterals must be required on-site and connected with the BVDC interceptor. Extensions of gravity sewers to all lots will cover a distance between 100 to 1,300 feet.

Natural Gas and Electricity

On-site inspection indicates gas lines are available for extension from Martin Street and Mendon Road. Extension of electrical lines are available from transmission lines that bisect the site, and from surrounding streets.

Railroad

Every lot has direct access to the on-site Providence and Worcester Railroad (see Figure 21).

Airports

Logan Airport in Boston, Massachusetts, Green Airport in Warwick, Rhode Island, and Bradley Airport outside of Hartford, Connecticut offer unlimited access to the airways.

Each airport is located within a one to one and one-half hour driving time from the New River Site. Access is available to the city airport in Woonsocket, Rhode Island and the state airport in Smithfield, Rhode Island.

Fill Material

Excavated sand and gravel mining areas require alteration of slope, and the addition of fill material to low-lying areas before development can occur. While fill material is available from on-site resources, there is a need for topsoil (i.e., grow vegetation, control erosion).

Transportation

Route 122 (Mendon Road) is a bidirectional two-lane principal arterial highway. It fronts the New River Site only on lot 2, where a dirt access road has been created for the sand and gravel mining operation. This is currently the only access road available to the site (see Figure 21). Martin Street, a bidirectional two-lane rural highway, forms the site's northern border and intersects with Mendon Road.

Interstate 295 is situated two miles north of the site via Mendon Road. However, based on field reconnaissance, major traffic "bottlenecks" are in existence during peak-hour traffic times (2:00 to 6:00 p.m.) along Mendon Road. Therefore, during late afternoons, Mendon Road is operating in excess of its designed level of service. This means that current traffic volume (16,200 ADT) exceeds designed capacities. As a consequence, during late afternoons, traffic delay prevents free-flowing access to I-295 to the north, and I-95 to the south. Vehicle delay is also due to business and/or industrial related traffic occurring from establishments adjacent to Mendon Road.

Since much of the area west of Mendon Road to the Blackstone River has been historically developed to date in Cumberland (see Figure 2), future business and/or industry that involves extensive traffic will add more congestion to existing roadways.

SITE DEVELOPMENT RECOMMENDATIONS

The New River Site is not considered a prime area for development because of the various environmental and physical constraints that were referred to in this analysis. However, the proximity to infrastructure (sewer, water, railroad) lessens the impact of various physical constraints. Mandatory extensions of water and sewer lines are of necessity.

Since the only access road into the site is from lot 2 on Mendon Road (southern section of the site), it is imperative that access is established in another section. Therefore, an access road from the site's northern border, Martin Street, should be established from lot 188, where a parking lot is located for nearby industry (industry currently fronts Martin Street). As a result, a direct connection could then be established with the current on-site access road, which would link the New River Site with Martin Street and Mendon Road.

Further industrial expansion is conceivable on the New River Site provided that the type(s) of businesses brought into the site are not classified as "heavy polluters." Therefore, it is suggested that light manufacturers (minimal polluters) be pursued by the Industrial Development Commission as occupants for the site.

In conjunction with the above-mentioned site development concerns, the following recommendations are intended to prevent environmental damage during the construction process:

Development Concerns

1. An expansion of the existing access road on lots 2 and 188 should occur.
2. On-site ponds should be used as sediment basins (DEM approval).
3. All areas where the groundwater table is presently at or near the surface should be filled to at least four feet and regraded to avoid potential groundwater contamination.
4. The construction of a retaining wall near abutting residential sections on Mendon Road is suggested to prevent slope instability (lots 1, 2, 236).
5. The creation of a car pooling program could alleviate traffic congestion on Mendon Road.
6. A need for topsoil material is essential to revegetate the site.

Environmental Concerns

1. The abandoned dumpsite should not be developed due to emissions of methane gases.

2. The abandoned dumpsite could be cleansed of contaminants by pumping polluted groundwater through charcoal beds and filter machines (contact Environmental Protection Agency).
3. Polluted town wells should be decontaminated.
4. The construction of levees will assist in flood prevention (DEM approval).
5. Water extensions should connect with Martin Street to the north, and with the Mendon Road/Marshall Street intersection (via lot 2).
6. Gravity sewer extensions should connect with the on-site BVDC interceptors.
7. Due to excessive traffic on Mendon Road, and proximity of subdivisions and commercial sections, the potential air quality and noise impacts of an industrial park should be tested.

BERKELEY

INDUSTRIAL SITE

Site Description

The Berkeley Industrial Park Site lies east and northeast of the New River Site. The sites are separated by Mendon Road and small-lot commercial and residential areas (see Figure 26). East of the Berkeley Site is the abandoned Cistercian Monastery, which is presently municipal surplus property. To the north lies hardwood forest, agricultural land, and a residential subdivision. To the south and southeast are hardwood forest, Monastery Brook, fresh marsh wetlands, and residential development along Blissdale Avenue, Overhill Road, and Mendon Road (see Figure 26).

The four lots within this 95-acre site are owned by a single landowner who uses the site as a sand and gravel mining operation. Approximately 65 percent of the land at the site has been altered by the gravel operation (determined from aerial photographs).

Site Market Potential

Contact with the landowner has been initiated by the Industrial Development Commission to promote the Berkeley Site, which is zoned industrial, for future industrial or business park development.

The Berkeley Site is selected as a potential industrial site based on three factors:

1. current zoning;
2. sand and gravel operations have a finite life span (based on rate of resource depletion);
3. landowner's willingness to sell property upon completion of resource excavation.

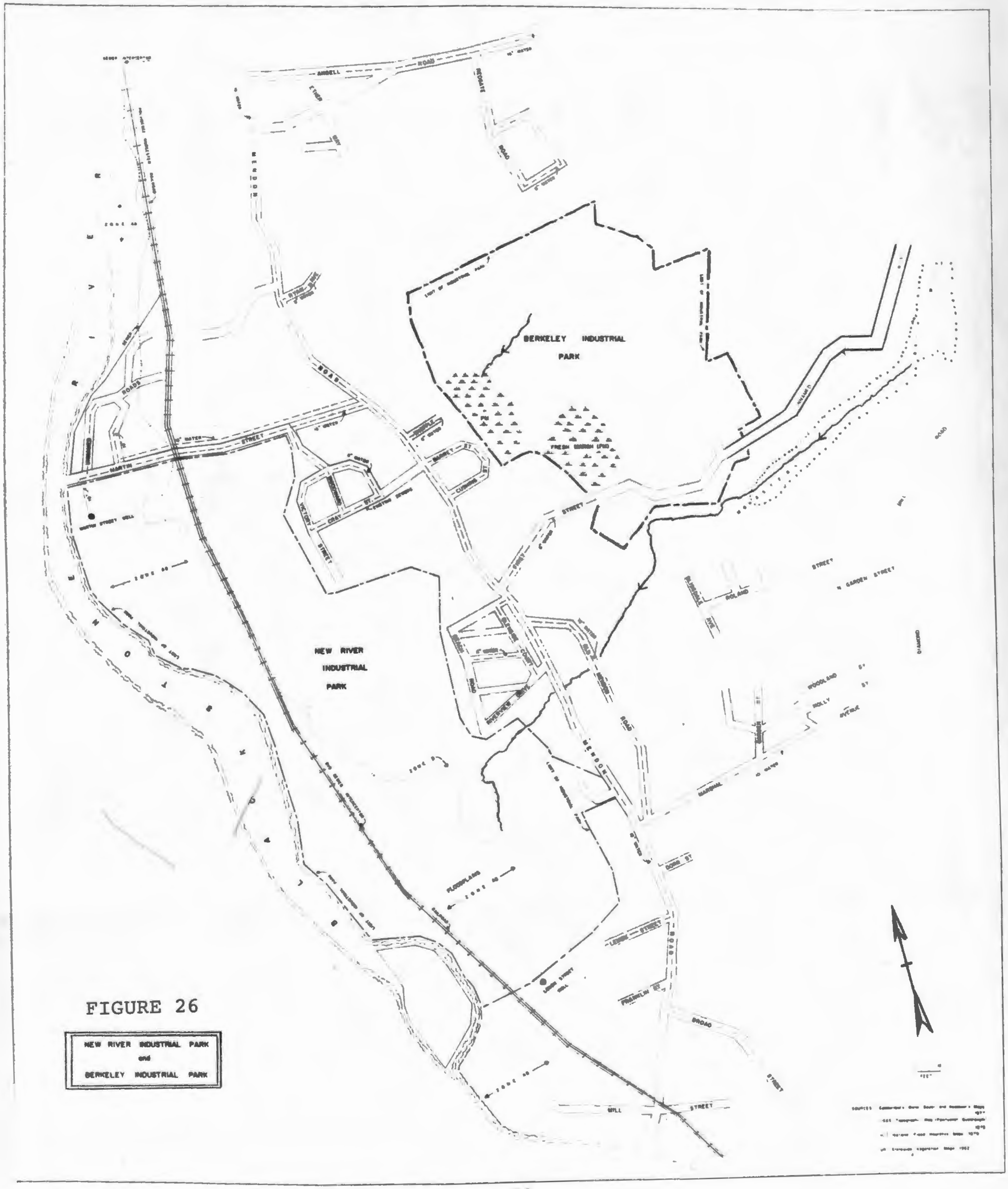


FIGURE 26

NEW RIVER INDUSTRIAL PARK
and
BERKELEY INDUSTRIAL PARK

Even though sand and gravel resources are still plentiful on-site, planning the future land use for this disturbed land area should begin at the present time.

Topography

This site is characterized by its hills, terraces, gravel pits, and steep slopes which have been altered due to sand and gravel excavations. Contour lines show a maximum elevation of 300 feet in the northeast and northwest sections of the site to 130 feet near the west and southwest border (see Figure 27).

The terrain is characterized by two separate summits (ridge-tops) with 300-foot elevations. They are separated by a stream valley terrace that collects and sends stormwater runoff to downstream fresh marsh wetlands (see Figure 27). Before mining excavations were allowed on-site, the southern section consisted of fresh marsh wetlands and hardwood forests. However, landscape alterations (filling, levelling) have encroached on these natural resources.

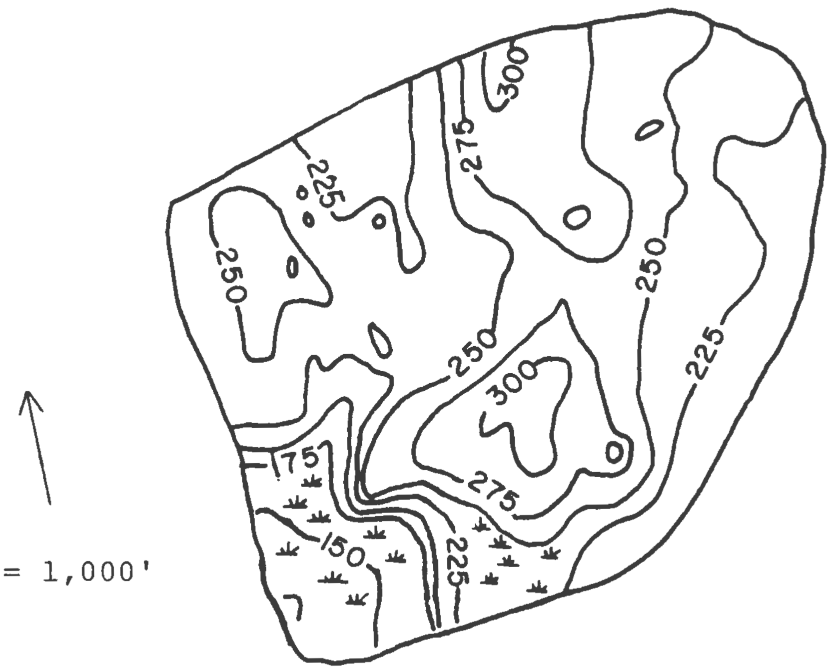
Although gravel excavations have been intensive in the southern half of the site, the northwest summit remains in an unaltered, vegetated state (mixed hardwood and softwood forest). Table 10 shows the results of a lot-by-lot analysis of slope and other land related variables.

Soil

Soil series found on the Berkeley Site are as follows: Pk (Pits/Quarries), CdB (Canton), CaD (Canton rock outcrop), ChB (Canton-Charlton), and Re [Ridgebury (see Figure 28)]. These soils encompass the four classifications created by

FIGURE 27

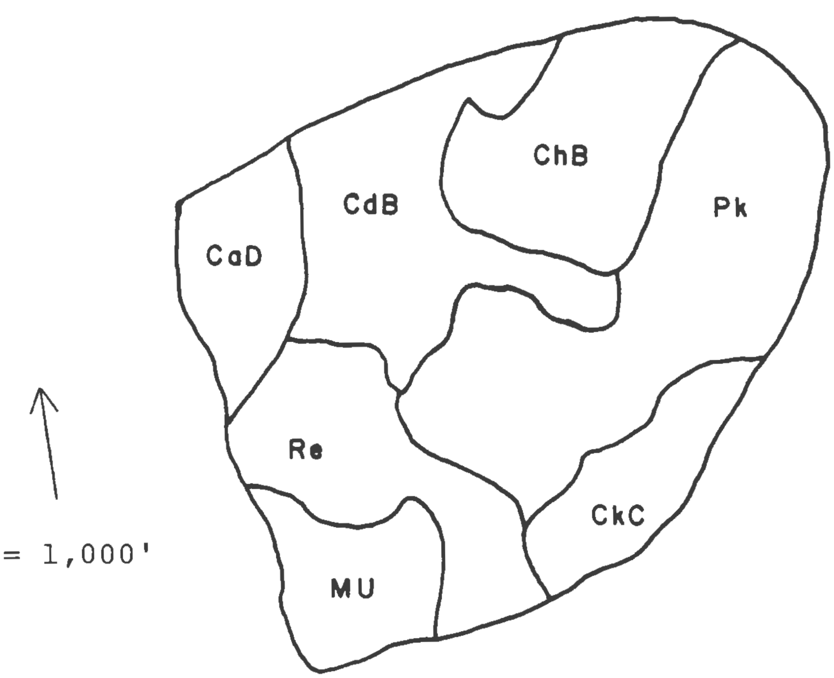
BERKELEY TOPOGRAPHIC MAP



1" = 1,000'

FIGURE 28

BERKELEY SOILS MAP



1" = 1,000'

TABLE 10

PHYSICAL CHARACTERISTICS OF LOTS LOCATED AT THE BERKELEY SITE

SITE (LOT)	ACRES	SOIL	SLOPE %	FLOODPLAIN	WETLAND	LOT OVER AQUIFER	ELECTRICITY AND GAS (1 MILE)	RAILROAD (1 MILE)	TRANSPORTATION (5 MILES)	WATER (1 MILE)	SEWER (1 MILE)	FILL ON-SITE
92	67	conditional/ suitable rocks - west sandy/loam - center	3-25 south 3- 8 north	N	Y	N	Y	Y	S, I	Y	Y	Y
207	12.5	unsuitable stoniness/ wet	0- 3 east 0-25 west	N	Y	N	Y	Y	S, I	Y	Y	Y
127	11.5	problem stoniness	3-25	N	N	N	Y	S	S, I	Y	Y	Y
52	3.6	problem stoniness	3-25	N	Y	N	Y	Y	S, I	Y	Y	Y

Total Acres 95

Developable 65

Y = Yes
N = None
S = State Highway
I = Interstate Highway

the SCS (see Table 10). Pk soils, which technically are not soils, but site conditions, are usually situated on terraces and stream valleys. They are characterized by excessive stoniness, rapid permeability rates (6 to 20 inches per hour), and unvegetated terrain which causes increased stormwater runoff, soil erosion, and slope instability. CdB soil is located through the central stream valley area in the site. The SCS classifies this soil series as soil of prime farmland significance. ChB soils, located to the east, are situated on the sides of glacial hills while Re soil is noted for having a high groundwater table and surface wetness due to poorly-drained soil characteristics (fresh marsh area). Although CaD soil is associated with rock outcrop (northwest area), and will require extra costs to prepare for development (i.e., rock blasting, erosion control), this area can be developed. Reference to Table 11 indicates soil characteristics associated with each on-site soil series.

TABLE 11

SOIL SERIES CHARACTERISTICS

SOIL	SCS CLASSI- FICATION	SOIL TEXTURE	DRAINAGE	BUILDING CONSTRAINT	ROAD BUILDING CONSTRAINT
Pk	problem	stoniness	rapid	severe	severe
CdB	suitable	sandy/loam	mod.-rapid	slight	slight
CaD	problem	outcrop	mod.-rapid	severe	severe
ChB	conditional	very stony	mod.-rapid	moderate	moderate
Re	unsuitable	organic muck	slow	severe	severe

Groundwater

The land area within this site does not lie over a groundwater aquifer. However, the fresh marsh areas, which receive runoff from northern ridges, do border the aquifer associated with the New River Site (see Figure 29). Also, Monastery Brook (see Figure 26) recharges the aquifer with runoff from the easternmost on-site ridge. Therefore, any development on these ridges should be publicly sewered to preserve groundwater quality.

Wetlands

Figure 30 shows that 27 acres of fresh marsh wetlands were located in the western sections of the site (Kupa and Whitman op. cit.). However, due to gravel excavations, these areas have been altered. Reference to Figure 28 also shows these wetland areas situated on Ridgebury soils.

Since these remaining wetland areas are receptacles for stormwater runoff, and recharge the adjacent groundwater aquifer, they should be preserved.

Floodplains

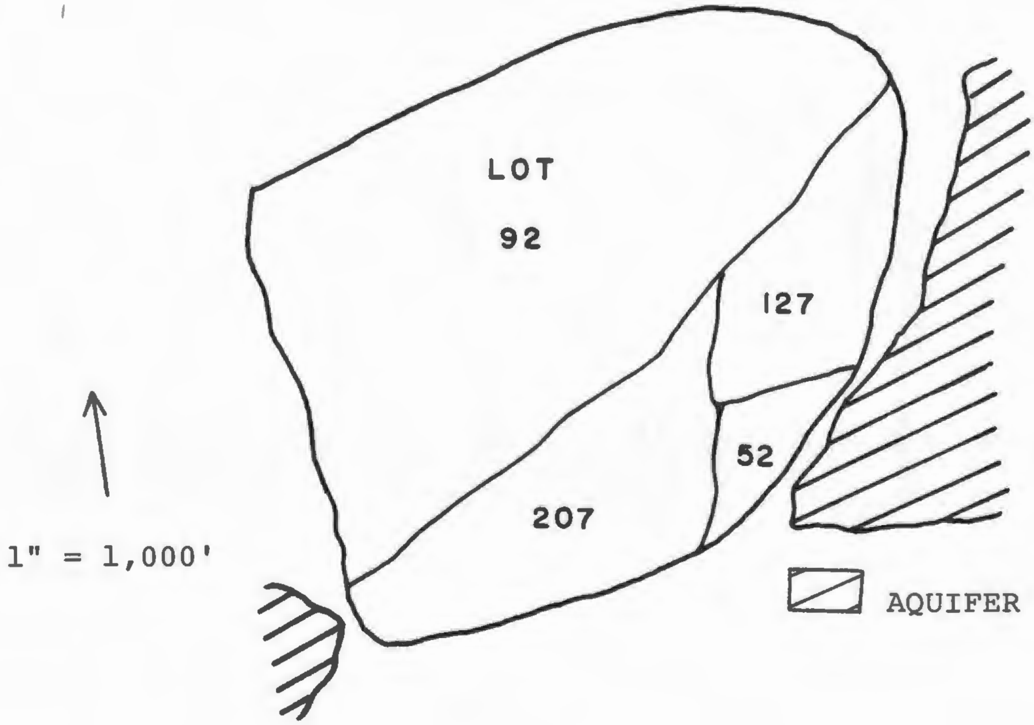
Review of floodplain maps indicates there are no flood zones within the Berkeley Site.

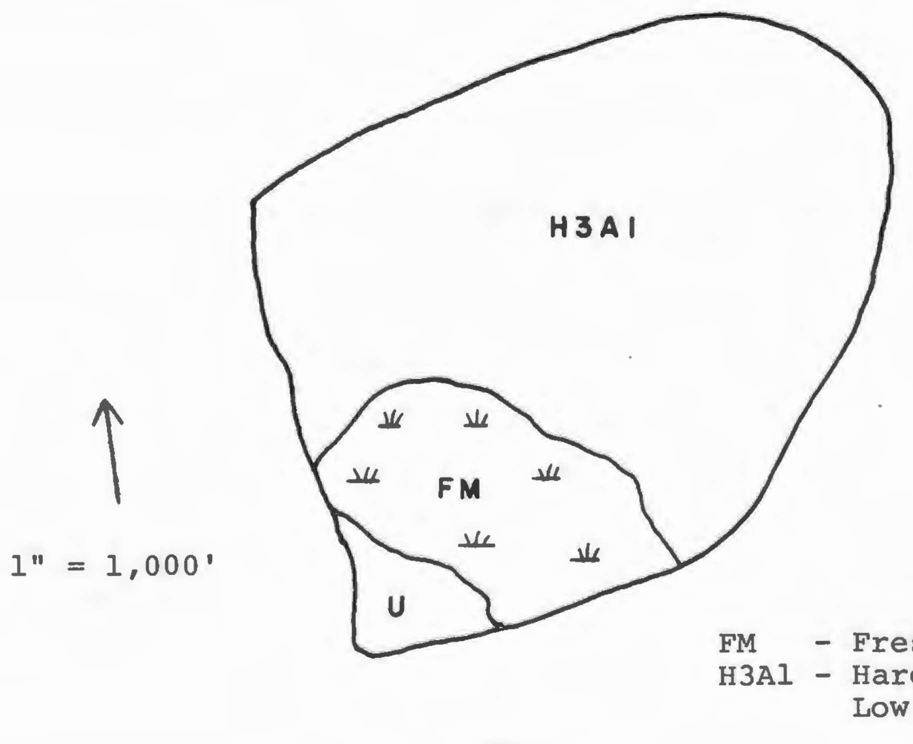
Water

There are 8-inch water mains at Mendon Road, Whipple, Barret, and First Streets; however, extensions should be made from Martin Street where 10 and 12-inch mains are available to offer greater quantities of water to the site (see Figure 26). Water extensions from Martin Street are within 1,600 feet of the site but they must pass through

FIGURE 29

BERKELEY GROUNDWATER MAP





FM - Fresh Marsh
H3A1 - Hardwood Trees/
Low Density

bedrock outcrops on lot 92 (see Figure 28).

Sewer

A review of Cumberland's Sanitary Sewer Maps shows that lateral connections can be made with Martin Street, where a 1,600 to 3,000-foot extension would be required (see Figure 26). A sewerage pumping station will be required on-site due to severely sloping terrain.

Natural Gas and Electricity

Extensions of electrical lines, and Blackstone Valley Gas lines, are available from Mendon Road.

Railroad

Access to the Providence and Worcester Railroad is within 4,000 feet of the Berkeley Site. It can be reached by vehicle either from Martin Street, or via access to the New River Industrial Site off Mendon Road.

Airports

Access is available to those airports stated in the previous sections on other sites.

Fill Material

Excavated areas require the alteration of slope and the addition of fill material to low-lying areas in an effort to raise and/or level the terrain. Sufficient amounts of fill (sub-topsoil stones and dirt) and topsoil material can be recovered from on-site lots.

Transportation

Access into the site is from Whipple and First Streets; however, infrastructure extension (access road, sewer, water, pumping station) should be developed from Martin Street (see

Figure 26). Access to Interstate Highway 295 is several miles north of the Berkeley Site (via Mendon Road, Route 122). However, access to Interstate 95 (south), or to Interstate 116 (a left-hand turn off Mendon Road heading westward into the City of Lincoln) is difficult during peak-hour afternoon traffic (2:00 to 6:00 p.m.). This is due to commercial and industrial establishments currently located along Mendon Road.

Mendon Road is currently exceeding its designed road capacity during peak-hour times (see New River Site). Therefore, local officials should determine which of the two sites, the New River or the Berkeley Site, should receive relative priority for industrial development. It does not appear that Mendon Road is capable of handling complete development within both sites at its present service level (road volume design).

SITE DEVELOPMENT RECOMMENDATIONS

This industrially zoned site is capable of complete development despite the various physical constraints presented in this analysis. However, this notion is predicated on the upgrading of current infrastructure. Since the site is presently being excavated, it is suggested that growth management plans be created to provide an orderly transition from mining to industrial/business park development. The Industrial Development Commission should initiate plans that are complementary to the physical characteristics of the site.

To assist in site preparation, the following recommendations should be considered in the future development of the Berkeley Site for industrial purposes:

Development Concerns

1. This site should be preserved for future development due to the current sand and gravel mining operation.
2. There should be an effort to annex additional industrial park land from the town-owned Cistercian Monastery (surplus land) due east of the site.
3. Due to site characteristics, lots 92 and 127 should receive more concentrated development.
4. Topsoil can be recovered from Canton soils on lot 92; this will assist in the revegetation of excavated areas.
5. Access to New River's railroad system can be reached by truck via Mendon Road and the access road to be developed on lot 2 in the New River Site.

Environmental Concerns

1. The preservation of Ridgebury (Re) soils on lots 92 and 207 is needed for drainage purposes.
2. The preservation of fresh marsh and softwood forest vegetation on lots 92 and 207 is essential for wildlife diversity and protection of the nearby aquifer.
3. Hydroseeding and mulching techniques should be used to revegetate mined areas.

4. Water extensions should be connected among Martin Street's 10, 12 and 16-inch mains.
5. The blasting of rock outcrop (lot 97) is required for water, sewer, and road connections with Martin Street.
6. Sewer extensions should connect with Martin Street unless the town adopts the 201 Facilities Plan recommendation to sewer this section of town (based on distance and pipe size).
7. A sewerage pumping station should be installed near the new access road (created through the rock outcrops on lot 92).

V. SITE COMPARISONS

Table 12 depicts the composite results of each variable used in this environmental analysis on a site comparison basis. Although the information pertaining to certain variables is generalized (i.e., soil assessment and slope percentage), it provides an overview of each potential industrial site.

Developable Land

Table 13 delineates the acreage extracted for each variable on a site comparison basis. Based on the deletion of environmental, physical, and land use constraints from total site acreage, the potential developable acreage within each industrial site was determined.

Table 13 also indicates the percentage of total land area that is developable within each site on a site comparison basis. The weighted or mean percentage for combined industrial sites equals 51 percent. When compared with statewide statistics (obtained from the Rhode Island Statewide Planning Program), it is of interest to note that 41 percent of the approximate 35,000 acres of land industrially zoned in Rhode Island are considered "feasible" for development.

Prioritizing Sites Based on Criteria Estimates

Although each potential industrial site has limitations of different magnitudes, there appears to be ample "suitable" acreage within the town (474 acres) to meet future industrial demands. To assist local officials in policy for-

TABLE 12

SITE COMPARISON CHARACTERISTICS

SITE	ACRES (TOTAL)	SOIL	SLOPE %	FLOODPLAIN %	WETLANDS	AQUIFER RECHARGE AREA	ELECTRICITY AND GAS (1 MILE)	RAILROAD (1 MILE)	TRANSPORTATION (5 MILES)	WATER (1 MILE)	SEWER (1 MILE)	FILL ON-SITE	TOTAL DEVELOPABLE ACRES
Manville Hill	109	problem	0-25	23	N	Y	Y	Y	S, I	Y	Y	Y	85
New River	127	problem	0-20	45	N	Y	Y	Y	S, I	Y	Y	Y	51
N. Cumb. Hill	445	problem	3-25	8	Y	Y	Y	N	S, I	N[1]	N[1]	Y	193
Cumb. Ind. Park	116	conditional	0-20	0	Y	N	Y	N	S, I	Y	Y	Y	50
Abbott Run Bus. Park	33	conditional	3-15	0	Y	N	Y	N	S, I	Y	Y	N	30
Berkeley	95	problem	3-25	0	Y	N	Y	Y	S, I	Y	Y	Y	65
TOTAL ACRES	925												474

[1]Available through Woonsocket Industrial Park.

Y = Yes
N = None
S = State Highway
I = Interstate Highway

TABLE 13

DETERMINATION OF DEVELOPABLE LAND (ACRES) DUE TO ACREAGE DELETION BY CONSTRAINT TYPE

SITE	TOTAL SITE ACREAGE	SLOPE %	WETLANDS	WATER BODIES	FLOODPLAINS	ROADS	EXISTING DEVELOPMENT	PROPOSED ROADWAYS	BUFFER ZONES	TOTAL ACREAGE DELETED	DEVELOPABLE ACRES PER SITE	% AREA DEVELOPABLE
N. Cumb. Hill	445	30	174	3	--	--	--	2.5	20	314	193	43%
Manville Hill	109	--	--	.5	20	.5	--	1	2	24	85	78%
Cumb. Ind. Park	116	3	1	--	--	1.5	53.5	1.5	6	66	50	43%
Abbott Run Bus. Park	33	--	1	--	--	--	--	1	1.5	3	30	91%
New River	127	--	--	.5	67	--	22	1.5	5	96	51	40%
Berkeley	95	12	8	3	--	.5	.5	1	5	30	65	68%
TOTAL ACRES	925										474	51%

mation, the creation of a declining scale penalty ranking system was used to quantitatively evaluate each site on a comparative basis (lower the point total, better the site). Therefore, a means of prioritizing site development evolved through the application of weighted numbers to specific site constraints.

The methodology used in the creation of a site comparative ranking system was contingent on various environmental and physical features (variables) that influence industrial development. Reference to Table 14 depicts the designation of points allocated to each variable and the assumptions underlying them. These criteria are subjective based on estimates of area within each variable category. A description of each variable included in the quantitative ranking analysis follows.

Slope: Slope was divided into three categories based on soil conservation service recommendations--0 to 8 percent, 8 to 15 percent, and greater than 15 percent. Whichever slope percentage dominated the land area within each site, that percentage equalled the estimated points.

Soil: Based on SCS classifications, soil was divided into three categories based on development potential: conditional, problem, and unsuitable. Whichever soil type dominated the land area within each site, that type was used as the designated soil type.

Floodplains: If at least 10 percent of all land area on a site was within a 100-year storm zone (A8), it was administered the estimated points.

Wetlands: Wetlands were evaluated based on percentage of total land area occupied, type of wetland (i.e., Shrub Swamp, Fresh Marsh, Wooded Swamp), and general proximity to urban development.

Aquifers: If at least 50 percent of the total land area within a site was over a groundwater aquifer, it was administered the estimated points.

Railroad Access: Access was based on whether there were on-site facilities available.

Transportation: Based on current peak-hour road volume number of vehicles), and a potential influx of industrial related traffic, it was estimated qualitatively whether current road conditions could tolerate additional traffic volumes. Assessments were made for each site based on suitable access to highways, poor access, or whether road modifications would be required.

Water: Distance to public water lines and the need for extensions were used to evaluate this variable.

Sewer: Distance to public sewer mains and the need for extensions were used to evaluate this variable.

Pumping Station: If a site consisted of numerous valleys contiguous with steep slopes (15%), it was assumed a sewerage pumping station would be necessary to remove wastewater from the site.

Road Frontage: Each site was evaluated based on direct access to roadways.

TABLE 14

QUANTITATIVE RANKING ANALYSIS

BASED ON ESTIMATES OF SITE CRITERIA

VARIABLES	POINTS	CRITERIA
1. Slope:		
a. 0- 8%	0	>50% of site
b. 8-15%	5	>50% of site
c. 15+%	10	>50% of site
2. Soil Type:		
a. conditional	0	
b. problem	5	>50% of site
c. unsuitable	10	
3. Floodplains:		
a. not in flood hazard area	0	<10% of site
b. 100-year storm	10	>10% of site
4. Wetlands:	0	none
(area)	5	10-33% of site
	10	> 33% of site
5. Aquifer:	0	none on site
(on-site)	5	< 50% of site
	10	>50% of site
6. Railroad Access:	0	on-site access
	10	no access
7. Transportation:	0	suitable access to interstate/state highways
	10	poor access to highways
	15	modifications needed
8. Water:	0	on-site
	5	within 1 mile of extensions
	10	> 1 mile

TABLE 14, CONTINUED

QUANTITATIVE RANKING ANALYSIS

BASED ON ESTIMATES OF SITE CRITERIA

	VARIABLES	POINTS	CRITERIA
9.	Sewers:	0	on-site
		5	within 1 mile
		10	>1 mile
10.	Pumping Station:	0	not necessary on-site
		10	necessary on-site
11.	Road Frontage:	0	on-site
		20	none available
12.	Potential Percent of Land Area Developable:	0	ARBP 91%
		5	Manville 78% Berkeley 68%
		10	CIP 43% N.R. 41% NCHS 43%
13.	Site Infrastructure Needs:	5	water extension
		5	sewer extension
		5	pumping station
		5	road extension
		5	electricity extension
		5	major renovations of nearby road systems
14.	Time to Ready Site:	0	6 months
		5	<1 year
		10	>1 year
15.	Aesthetics:	0	scenic view
		5	moderate scenery
		10	no scenery
16.	Proximity to Residential Areas:	0	little interference--(within 1 mile)
		5	some interference
		10	close proximity

Potential Percent of Land Area Developable: Various scoring categories were created based on a comparison between total site acreage with potential developable acreage (percentages). It was assumed that larger areas were more desirable to develop.

Site Infrastructure Needs: Estimated points were attributed to any site lacking stated utilities and/or services.

Time to Ready Site: Based on reported information (from site lot owners), an estimate of required time necessary to alter the physical and environmental constraints of a site to make it available for development, was made.

Aesthetics: Estimated points were attributed to evaluation of on-site inspections; criteria included assessment of scenic views, site accommodations, and accessibility.

Proximity to Residential Areas: Potential health effects on nearby residential sectors were qualitatively evaluated based on the possibility of noise, light, air, water, and traffic pollution and/or interference.

Results of Ranking Analysis

The data in Table 15 indicates that the Abbott Run Business Park (40 points) proves deserving of "first priority treatment" from local decision-makers. It has the lowest negative ranking, and hence, may offer the best opportunity for environmentally sensitive development. Therefore, priorities on development (planning, engineering, site preparation), advertisement/marketing, and recruitment of occupants should be delegated to the business park. Cumberland Industrial Park, with 65 total points, should also receive comparable recog-

TABLE 15

PRIORITIZING SITES BASED ON CRITERIA ESTIMATES

SITE	TOTAL POINTS	SLOPE	SOIL	FLOODPLAINS	WETLANDS	AQUIFER	RAILROAD	TRANSPORTATION	WATER	SEWER	PUMPING STATION	ROAD FRONTAGE	POTENTIAL % LAND AREA DEVELOPABLE	SITE INFRA-STRUCTURE NEEDS	TIME TO READY SITE	AESTHETICS	PROXIMITY TO RESIDENTIAL AREAS
Abbott Run Bus. Park	40	5	0	0	0	0	10	0	5	5	0	0	0	15	0	0	0
Cumb. Ind. Park	65	5	0	0	0	0	10	15	0	0	10	0	10	15	0	0	0
Berkeley	90	5	5	0	5	0	0	15	5	5	0	0	5	25	10	5	5
Manville Hill	100	10	10	10	0	10	10	10	5	0	0	0	5	20	0	5	5
New River	110	0	10	10	0	10	0	15	5	0	10	0	10	20	10	10	10
N. Cumb. Hill	155[1]	5	10	0	10	5[2]	10	15	10	10		20	10	30	10	0	0

[1] Connection with Woonsocket infrastructure would reduce total points to 100.

[2] Recharge Area.

nition from local officials (based on geographical and infrastructural linkage to ARBP, second lowest total score, and remaining land available for development). The addition of new tenants into the remaining portions of the industrial park should prove to be a high priority consideration. Based on the numerical and environmental analysis, it is apparent that these two interlinked sites represent the two most conducive areas in town where industrial and/or office park development should occur with the least environmental impact.

According to Table 15, the Berkeley Site would be the next logical area to develop (if this system was adopted). However, this site currently exists as a profitable sand and gravel mining operation. Therefore, this site must be regarded as a future industrial park unless local policy should change.

The Manville Site, with 100 total points, and the New River Site, with 110 points, should be developed according to their ranking. The North Cumberland Hill Site, with its potential access to Woonsocket's infrastructure, would receive priority over the previous two sites if local policy should support the extension of the Interstate 295-495 connector through the site. Access to Woonsocket's Industrial Park would alter the interpretation of data secured through the numerical analysis. If negotiations with Woonsocket officials should terminate, the North Cumberland Hill Site would receive the highest point total, providing the most significant negative development opportunity.

Although the numerical analysis provides a general environmental framework for evaluating the sites on a comparison basis, the results should not bind local policy-makers in adopting the same rank priorities in developmental practice. Economic, social, and political factors must be integrated with environmental data before any ranking system should be considered binding.

Composite Recommendations

Table 16 depicts general recommendations that are applicable to each site. This composite representation separates recommendations into two categories: structural and non-structural. Structural suggestions pertain to physical alterations, while non-structural recommendations depend on policy related decisions.

TABLE 16

COMPOSITE RECOMMENDATIONS

STRUCTURAL RECOMMENDATIONS	MANVILLE	N. CUMB. HILL	CUMB. PARK	ABBOTT PARK	BERKELEY	NEW RIVER
Add fill	*	*			*	*
Sediment basins	*	*	*	*	*	*
Grass waterways				*		
Slope diversions			*	*		
Haybales	*		*	*	*	*
Add topsoil	*				*	*
Noise barrier					*	
Retaining wall	*					*
Levees	*					*
Channelize stream						*
Alter access road	*		*			
Create access road		*		*	*	*
Revegetation	*				*	*
Water/sewer extensions	*	*	*	*	*	*
Combined sewers	*		*	*		*
Pumping stations		*	*		*	
Blast rock outcrop		*			*	

TABLE 16, CONTINUED

COMPOSITE RECOMMENDATIONS

NON-STRUCTURAL RECOMMENDATIONS	MANVILLE	N. CUMB. HILL	CUMB. PARK	ABBOTT PARK	BERKELEY	NEW RIVER
No building on steep slope	*	*	*	*	*	*
No building in flood zone	*					*
No building in wetlands	*		*	*	*	*
Fill wetland		*				
Compensatory wetland		*				
Preserve wetland		*			*	
Preserve prime farmland		*				
Clean dumpsite						*
Clean wells						*
Buffer zones	*	*	*	*	*	*
Hydroelectric dam	*					
Drainage regulations	*	*	*	*	*	*
Transit program						*
Regulate road salting	*			*		*
Renovate Mendon Road					*	*
Create I-295-495		*				
Owners alter landscape	*				*	*
Tax Base Sharing		*				
Tax Increment Financing		*				
Present Development	*		*	*		*
Future Development		*			*	

VI. CONCLUSION

The factors affecting how and when land is developed are many and complex. In the simplest analysis, there are positive factors (opportunities) and negative factors (constraints) affecting land development. The negative constraints affecting land development may include poor economic and/or market conditions, local politics, or limiting physical site characteristics.

When considering industrial development in Cumberland, physical site characteristics have been addressed in this report; however, an economic analysis should be conducted to determine market characteristics and fiscal capacities (town costs and revenue sources) of the town. A statistical analysis of these variables, in conjunction with the environmental analysis, would provide the analytical means essential to the creation of a local growth management plan. Through the assimilation of this information, local officials would then be afforded the luxury of pursuing the types of industry and/or business that are most compatible with local resources.

Since the local Planning Department is in the process of developing a rezoning plan for the town, the opportunity now exists to integrate economic, social and environmental data into a comprehensive economic development growth management plan for the community. Therefore, this report should not be regarded as the only component in shaping a growth management stragegy, but as an input to the work that remains to be completed.

VII. APPENDIX

APPENDIX I

GLOSSARY

Access Road: refers to any road(s) within an industrial site.

Aquifer: underground layer of porous sand, gravel, and rock containing water, into which wells can be established.

ARVI: Abbott Run Valley Interceptor.

Bearing Capacity: maximum unit pressure to which a foundation may be subjected without permitting a structure to settle or shift.

BVDC: Blackstone Valley District Commission; oversees regional sewerage facilities

BVI: Blackstone Valley Interceptor.

Buffer Zone: designated open space area separating two different land uses or physical land features.

Combined Sewer: a sewer intended to receive both wastewater and storm or surface water.

Combined Sewerage and Wastewater: a mixture of surface runoff and other wastewater such as domestic and industrial wastewater.

Culvert: a pipe-like conduit used for drainage that passes under a road, railroad track, or through an embankment.

Detention Basin: any man-made or natural earth depression that collects and detains stormwater runoff.

Diversion: a technique to control erosion due to runoff from steep terrain, designed to intercept and retard runoff velocity.

Dot Grid: a device used to measure acreage.

Erosion: the removal of soil due to stormwater runoff.

Esker: a narrow, winding ridge of poorly sorted or layered gravel.

Facilities Plan (201): the sewerage study done for Cumberland by Anderson-Nichols & Company, Inc.

Fill: land elevation artificially raised with additions of earth and gravel.

Flood Zone A: designated low-lying terrain subject to periodic water inundation (100-year storm zone).

Flood Zone B: designated low-lying terrain subject to periodic water inundation (500-year storm zone).

Force Sewer: pipe that carries sewerage up steep terrain via a pressurized pumping station.

Fresh Marsh: a tract of low-lying, wet, spongy land subject to varieties of plant vegetation and wildlife.

Grass Waterway: a technique to control erosion due to runoff from steep terrain, designed to channelize runoff from a slope.

Gravity Sewer: a pipe that carries sewage downhill due to force of gravity.

Groundwater: water found underground in porous rock strata and soils.

Hardwood: trees that shed their leaves annually.

Haybale: technique to control erosion due to runoff, which entraps silt particulates found in moving water.

Infrastructure: basic installations and facilities within a town.

Interceptor: a common sewer controlled by the Blackstone Valley District.

Kame: a low, irregularly shaped, conical mound of layered sand and gravel.

Lateral: sewer lines that branch off sewer mains or interceptors.

Levee: embankment built alongside a river to prevent high water from flooding bordering land.

Mulching: application of straw, peat moss, and wood chips to unstable landscape.

Outcrop: surficial emergence of minerals or rocks from the earth.

Outwash: sand and gravel deposited by meltwater streams in front of glacial ice.

Plat Map: town locus maps that depict recorded lots.

Pumping Station: series of pumps used to force sewage uphill toward existing sewer mains.

Recharge Area: main shallow mantle area of a groundwater aquifer that contributes to replenishment of lost water resources.

Road Capacity: maximum vehicles a road can accommodate under a given set of conditions.

Runoff: stormwater not absorbed by the ground.

Sanitary Sewer: carries liquid and water-carried wastes from various land uses with minor quantities of ground, storm, and surface waters not admitted intentionally.

Sediment Basin: any man-made or natural earth depression that collects and retains sediment (matter) found in runoff.

Service Volume: maximum number of vehicles associated with specific road conditions.

Sewer: pipe or conduit that carries wastewater and/or stormwater.

Sheer Strength: soil's ability to resist sliding off steep terrain due to wetness.

Shrub Swamp: wet, spongy land consisting of low, woody plants with several permanent stems.

Silt: fine grained soil particles deposited or carried as sediment by moving water.

Softwood: evergreen trees whose fruits are born in cones.

Stream Flow: determining direction of water movement from contour lines.

Tax Base Sharing: pooling of areawide property taxes of several communities to disperse amongst needed areawide projects.

Tax Incremental Finance: joint public/private planning and financing of development within a community.

Terrace: a raised, flat mound of earth with sloping sides.

Topsoil: the upper or surface layer of soil.

Transit Program: pertaining to a system of urban public transportation.

Treed Swamp: wet, spongy land with tree-like vegetation.

Wastewater: the spent groundwater, surface water, and sewage of a community.

Water Main: refers to water pipe location and circumference.

Wetland: wet, low-lying land of seasonal or annual high groundwater tables with variations of vegetation/wildlife.

VIII. LITERATURE CITED

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