VOLUME ONE

WATER RESOURCES PROTECTION PLAN

MANCHESTER, MASSACHUSETTS

JUNE 1990

PREPARED FOR:

TOWN OF MANCHESTER
WATER RESOURCE PROTECTION COMMITTEE

PREPARED BY:

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INTRODUCTION

INTRODUCTION

This report was prepared for the Manchester Water Resources Protection Committee by Horsley Witten Hegemann, Inc. (HWH), consultants in water resources and land planning. The primary purpose of the investigation was to delineate the critical land areas which contribute to the Town's water resources and to develop a protection strategy to protect these resources from contamination. In addition, the report includes an analysis of historic and predicted water use, an inventory of contaminant sources, an assessment of water quality and a detailed land use analysis of the Town.

The Town is currently served by two water supplies--the Lincoln Street well and Gravelly Pond. The Lincoln Street well was constructed in 1958, and supplies 43% of the Town's water. The water drawn from this well occasionally exhibits elevated sodium and chloride levels, requiring notification of service customers.

Gravelly Pond is a surface supply, located in the Town of Hamilton, and supplies 57% of the Town's water. This pond has been used by the Town of Manchester since the late 1800's. Water rights to the pond were formalized in 1908 through a mandate, followed by several land takings. Water drawn from this source is generally within drinking water standards, however, two closed landfills in close proximity to the pond are cause for concern.

In addition to the primary sources, the Town has a third, emergency water supply source, which consists of several developed wells located immediately north of Round Pond, in Hamilton. When water levels in Gravelly Pond become critically low, these wells can be used to augment water levels in the Pond. However, because of poor water quality (high iron and manganese), water from these wells can only be used with DEP permission, and must be pumped to a lagoon at the northern end of Gravelly Pond, treated with chlorine, and allowed to settle prior to being discharged to Gravelly Pond.

PREVIOUS INVESTIGATIONS

PREVIOUS INVESTIGATIONS

Numerous reports have been written on various aspects of the water resources in Manchester and vicinity since the 1950s. Prior to beginning our field investigations, we reviewed thirteen existing reports and compiled data on previous drilling and seismic explorations conducted throughout the Town. An annotated bibliography was prepared summarizing the contents of each report and is included as Appendix A. In addition, locations of all borings were plotted on Plate 1 and a complete collection of boring logs are presented in Appendix C.

Three of the reports reviewed involved investigations for new water supplies. Whitman and Howard (1969) and Metcalf and Eddy (1979) investigated potential ground water sources through drilling and seismic explorations. More recently, Whitman and Howard (1987) evaluated Round Pond as a potential surface supply. Although a few viable sources were identified in these reports (Cedar Swamp and Round Pond) none have been unequivocally identified within the Town's boundaries, and all would require extensive pre-treatment to meet drinking water standards.

SURFACE HYDROLOGY

SURFACE HYDROLOGY

The Town of Manchester encompasses a total area of 7.7 square miles. However, because of the surface topography in this region, and the location of Gravelly Pond, our investigation extended well beyond the Town's boundaries.

The Town contains a wide variety of surface water features, including streams, ponds, wetlands and coastal resources. Drainage basins to the Town's primary surface water resources were delineated on the basis of topography, using a U.S. Geological Survey (USGS) topographic basemap. Five major watersheds were delineated, including the Round Pond/Gravelly Pond watershed; Chubb Creek watershed; Manchester Harbor/Sawmill Brook/Causeway Brook watershed; Kettle Cove watershed; and Magnolia Harbor watershed. The watershed map presented as Figure 1 reveals that most of the Town's streams originate beyond the Town's boundaries; therefore, a large proportion of their contributing watersheds are located in the Towns of Essex, Gloucester, Hamilton, Wenham and Beverly. Table 1 summarizes the watershed areas of each of the Town's surface waters, and the proportion located within other Town boundaries. For example, only 37% of the Round Pond/Gravelly Pond watershed is located in the Town of Manchester, with the remainder in the Towns of Hamilton, Wenham, and Beverly.

Because of the large areas of exposed bedrock and shallow, poorly drained soils associated with much of the watershed area, surface run-off provides a significant proportion of the water which maintains the Town's streams, ponds and wetlands. This is reflected in the "flashy" response of streams to heavy rainfall events. Consequently, surficial sources of contamination, such as road run-off must be controlled to protect the water quality of these resources.

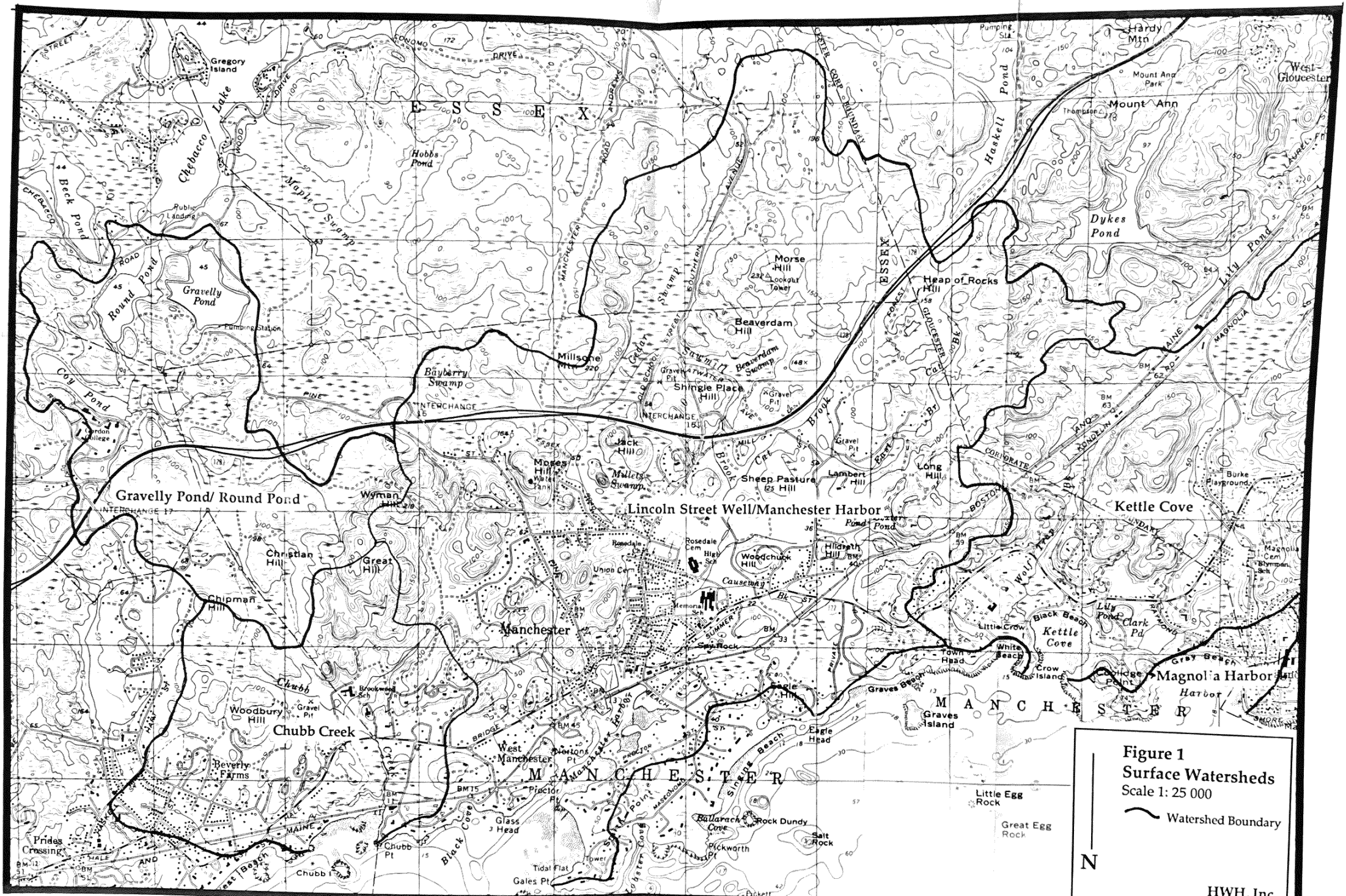

Gravelly Pond/ Round Pond
Lincoln Street Well/Manchester Harbor
Kettle Cove
Chubb Creek
Magnolia Harbor
Manchester
ESSEX
MANCHESTER
Figure 1
Surface Watersheds
Scale 1: 25 000
Watershed Boundary
N
HWH, Inc.

TABLE 1 Surface Watersheds

	Total Area (acres)	Percent in Manchester	Percent in Other Towns
Round/Gravelly Pond	1201	37%	63%
Chubb Creek	1201	48%	52%
Manchester Harbor	4177	73%	27%
Kettle Cove	1679	33%	67%
Magnolia Harbor	50	34%	66%

HYDROGEOLOGY

HYDROGEOLOGY

The Town's water resources are dependent on a complex interaction between surface and ground water, dictated by the underlying geology. A clear understanding of these interactions is crucial in the effective management of these resources.

Geology

The entire North Shore is underlain by intrusive igneous rocks of the Cape Ann Plutonic Series. These granites and other rock types were formed approximately 400 million years ago and are exposed as hills and ridges throughout much of the Town. A series of northeast - southwest trending faults and joints dissect this bedrock, and are topographically expressed as swamp- and pond-filled valleys.

Approximately 15,000 years ago, the ice sheets of the Wisconsinan Glaciation occupied this area. As the ice sheets advanced, they deposited a thin veneer of till over the surface of the bedrock. Later, as the ice sheets melted and retreated, the meltwater streams deposited sands, silts and gravels as outwash deposits. These outwash deposits are concentrated primarily within the Town's bedrock valleys. As the glaciers continued to melt, sea level rose and fine-grained marine clays and silts were deposited in the flooded areas. These distinctive "blue" clays are widespread in the Town at elevations below 50 feet mean sea level (MSL).

Figure 2 is a surficial geologic map of the Town which illustrates the spatial distribution of the geologic deposits described above. This map was developed from a compilation of data from Carnevale (1979), SCS (1984), and boring logs collected from a variety of sources. Surficial geologic maps represent geologic deposits exposed at or near the land surface, but do not reflect subsurface conditions. To document subsurface geology, a series of cross-sections were constructed using boring logs collected from previous investigations, augmented with additional seismic and boring data obtained as part of this study. These cross-sections are included in Appendix C, and are discussed in the following section on the Lincoln Street well.

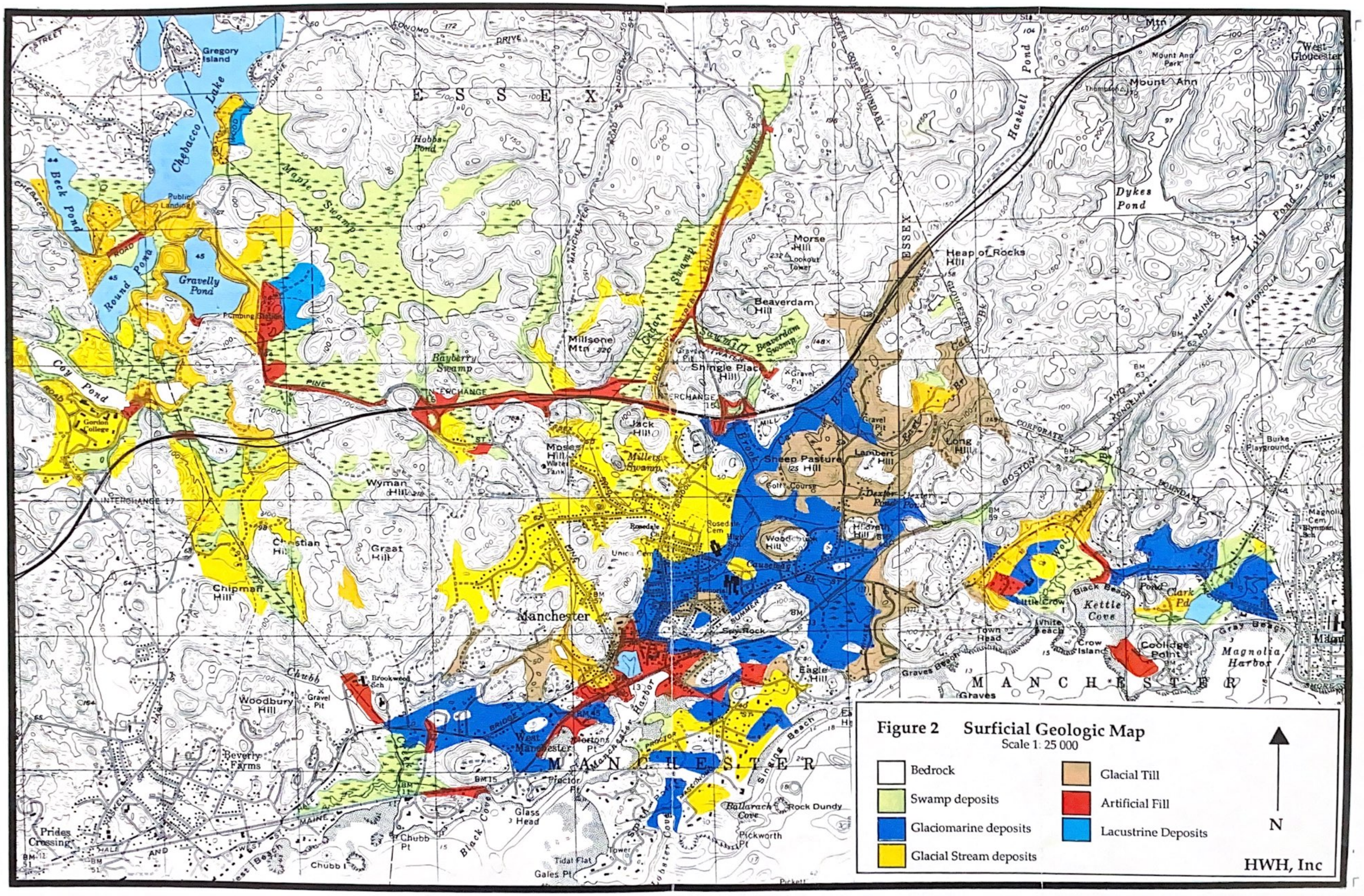


Figure 2 Surficial Geologic Map
Scale 1: 25 000
Bedrock
Swamp deposits
Glaciomarine deposits
Glacial Stream deposits
Glacial Till
Artificial Fill
Lacustrine Deposits
N
HWH, Inc
E S S E X
M A N C H E S T E R
Manchester
Chebacco Lake
Gregory Island
Beck Pond
Round Pond
Gravelly Pond
Coy Pond
Maple Swamp
Hobbs Pond
Bayberry Swamp
Millsone Mtn
Cedar Swamp
Beaverdam Hill
Beaverdam Swamp
Shingle Place Hill
Morse Hill
Heap of Rocks Hill
Haskell Pond
Dykes Pond
Mount Ann
Lily Pond
Jack Hill
Moses Hill
Millets Swamp
Wyman Hill
Sheep Pasture Hill
Lambert Hill
Long Hill
Woodchuck Hill
Great Hill
Chipman Hill
Woodbury Hill
Beverly Farms
Prides Crossing
West Manchester
Kettle Cove
Magnolia Harbor
Coolidge Point
Eagle Hill
Graves
Glass Head
Black Cove
Gales Pt
Tidal Flat
Pickworth Pt
Rock Dundy
Ballarach Cove
INTERCHANGE 17

Subsurface Investigation

A field program was developed to augment the existing subsurface data base compiled from previous investigations. This program focused on the area surrounding the Lincoln Street well and included a seismic refraction survey and a series of geologic borings.

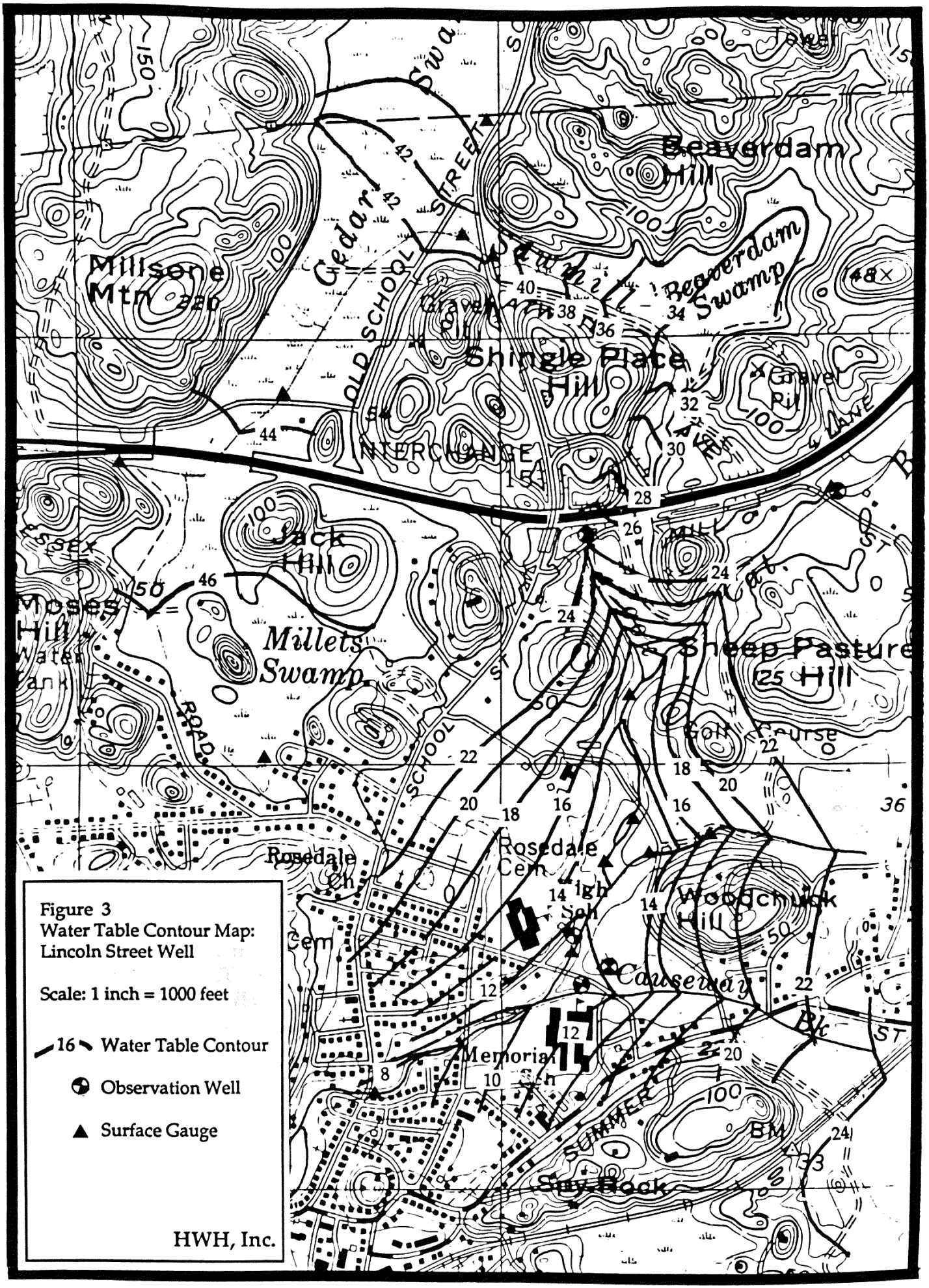
The seismic refraction survey was conducted between 25 and 27 September, 1989 and consisted of a total of 18 seismic lines. These lines were shot at numerous locations throughout the Essex County Club, the Middle/High School, the Memorial School and the Lincoln Street wellfield. Details on the equipment used, procedures and output data are provided in Appendix D. The data obtained from this seismic survey provided information on the depth to bedrock and layering of different deposits in the vicinity of the Lincoln Street wellfield.

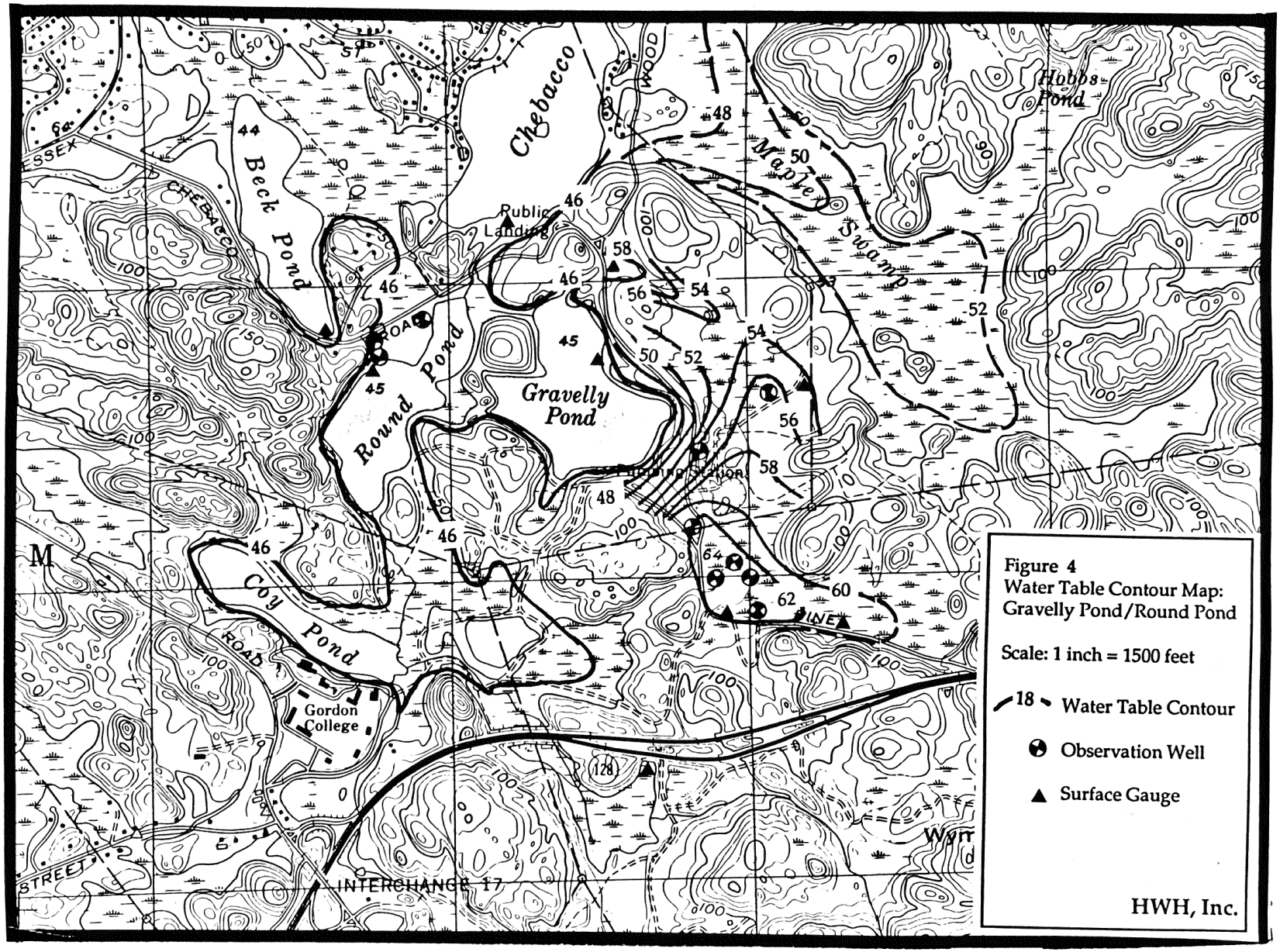
Based on the results of the seismic survey, a series of seven borings were conducted during October and December of 1989. These borings were drilled using a hollow-stem auger rig, operated by Desmond Well Drilling, of Brewster, Massachusetts. Split-spoon samples were obtained every five to ten feet and logged by a geologist. Borings were drilled to refusal and ranged from 19 to 72 feet in depth. Boring logs are provided in Appendix B.

Observation wells were installed in six of the seven borings. These wells consisted of threaded 2-inch, schedule 40 PVC risers with 10 to 20 foot PVC screens. Annular bentonite seals and surficial cement seals were part of the well construction and all wells were protected with a 4-inch diameter, cast-iron water main box. All wells were screened at the bottom of the boring, with the exception of a set of multi-level wells installed 75 feet north of the Lincoln Street well (HWH-1D and 1S). Details on well construction are included with the boring logs in Appendix B.

Water Table

Ground and surface water elevations were established throughout the Town and in the vicinity of Gravelly Pond. Water level measurements were made at a total of 49 different locations: 27 observation wells and 22 surface gauges. The observation wells included 17 pre-existing wells and ten wells installed by HWH for this study. The surface gauges were also installed as part of this investigation and consisted of oak stakes driven into streambeds and ponds. The location of each of the wells and gauges used are shown in Figures 3 and 4.


Millsone Mtn
Beaverdam Hill
Beaverdam Swamp
Shingle Place Hill
Gravel Pit
Jack Hill
Millets Swamp
Sheep Pasture Hill
Golf Course
Rosedale Cem
Woodchuck Hill
Causeway
Memorial
Spy Rock
OLD SCHOOL STREET
SCHOOL ST
SUMMER ST
INTERCHANGE
ROAD
LANE
Figure 3
Water Table Contour Map:
Lincoln Street Well
Scale: 1 inch = 1000 feet
16 Water Table Contour
Observation Well
Surface Gauge
HWH, Inc.


Chebacco
Beck Pond
Round Pond
Gravelly Pond
Coy Pond
Hobbs Pond
Maple Swamp
Public Landing
Gordon College
INTERCHANGE 17
ESSEX
STREET
ROAD
Figure 4
Water Table Contour Map:
Gravelly Pond/Round Pond
Scale: 1 inch = 1500 feet
18 Water Table Contour
Observation Well
Surface Gauge
HWH, Inc.

The top of each surface gauge and observation well was surveyed to mean sea level by HWH staff. Water levels were measured in November and December of 1989, and water table elevations were then calculated by subtracting the measured depth to water from the surveyed elevation of the top of well or gauge. Specific water elevation data is provided in Table 2.

The water level data described above was used to construct detailed water table maps for the area surrounding Gravelly Pond (Figure 3) and the Cedar Swamp/Sawmill Brook/Lincoln Street well area (Figure 4). These water table maps represent unconfined shallow aquifer conditions and for this reason do not include data from the deep wells around the Lincoln Street well. A separate series of water table maps were developed for this semi-confined aquifer and are discussed in the following section.

TABLE 2 WATER TABLE DATA

Well/Surface gage	Elevation	Depth to H20	Water Table elevation	Date meas.	Description
HWH-1S	17.93	5.10	12.83	19-Dec-89	Lincoln St
HWH-1D	18.21	8.16	10.05	19-Dec-89	Lincoln St
HWH-2	24.16	7.30	16.86	19-Dec-89	Golf Course
HWH-4	46.48	22.88	23.60	19-Dec-89	School Street
HWH-5	32.47	12.25	20.22	19-Dec-89	Football Field
HWH-6	16.59	7.07	9.52	19-Dec-89	Lincoln Street
HA-1	41.09	4.17	36.92	7-Nov-89	Mill St Cat Brook
HA-2	30.06	1.72	28.34	7-Nov-89	Summer St
HA-3	11.72	0.68	11.04	7-Nov-89	Lincoln St
HA-4	25.68	1.89	23.79	7-Nov-89	Mill St Sawmill Brook
HA-5	48.65	2.69	45.96	7-Nov-89	Forest St Cat Brook Trib
8" TEST (OW-C)	14.64	1.21	13.43	19-Dec-89	Lincoln St
2.5 " TEST (OW-D)	14.97	2.42	12.55	19-Dec-89	Lincoln St
OW-E	14.42	2.76	11.66	19-Dec-89	Golf Course
IRR. WELL (OW-I)	17.29	artesian		19-Dec-89	Golf Course
SG-1	13.95	2.31	11.64	7-Nov-89	Golf Course
SG-2	15.18	2.63	12.55	7-Nov-89	Golf Course
SG-3	15.19	1.80	13.39	7-Nov-89	Golf Course
SG-4	18.92	5.79	13.13	7-Nov-89	Golf Course
SG-5	21.39	3.77	17.62	7-Nov-89	Golf Course
SG-6	16.69	2.00	14.69	7-Nov-89	Golf Course
SG-7	30.68	1.90	28.78	7-Nov-89	Summer St
SG-8	38.38	3.10	35.28	7-Nov-89	Mill St Cat Brook
SG-9	48.87	1.04	47.83	7-Nov-89	Pleasant St
SG-10	47.43	1.99	45.44	7-Nov-89	School St N-end Cedar Sw
SG-11	64.49	2.63	61.86	24-Nov-89	Pine St 128
SG-12	55.97	1.68	54.29	24-Nov-89	Hamilton Landfill
SG-13	65.76	3.11	62.65	24-Nov-89	Pine St/ Manch Landfill
SG-14	49.06	3.60	45.46	24-Nov-89	Gravelly Pond
SG-15	62.09	2.95	59.14	24-Nov-89	Pine St Public landing
SG-16	47.96	3.49	44.47	24-Nov-89	Chebacco Lake
SG-17	48.63	3.38	45.25	24-Nov-89	Round Pond
SG-18	47.51	2.40	45.11	24-Nov-89	Beck Pond
SG-19	51.99	2.45	49.54	24-Nov-89	Rte 128 Grapevine Rd
SG-20	48.23	3.06	45.17	7-Nov-89	Rte 128 Pine St
SG-21	41.88	0.28	41.60	7-Nov-89	Old School St P lot
SG-22	45.49	2.49	43.00	7-Nov-89	Cedar Swamp
HAM-A	67.05	12.97	54.08	24-Nov-89	Hamilton Landfill
HAM-B	60.75	4.28	56.47	24-Nov-89	Hamilton Landfill
MLF-2	68.46	5.28	63.18	24-Nov-89	Manchester Landfill
MLF-3	65.50	2.47	63.03	24-Nov-89	Manchester Landfill
MLF-4	67.15	4.40	62.75	24-Nov-89	Manchester Landfill
MLF-5	67.70	5.28	62.42	24-Nov-89	Manchester Landfill
MLF-A	67.57	4.63	62.94	24-Nov-89	Manchester Landfill
MLF-C	64.94	4.16	60.78	24-Nov-89	Manchester Landfill
GLOUCESTER B	47.48	5.80	41.68	7-Nov-89	Gloucester well Cedar Sw
TEXACO 1	23.39	8.12	15.27	19-Dec-89	76 Summer St
TEXACO 2	23.68	7.30	16.38	19-Dec-89	76 Summer St
TEXACO 3	24.90			19-Dec-89	76 Summer St
TEXACO 4	35.32	18.44	16.88	19-Dec-89	76 Summer St

LINCOLN STREET WELL

LINCOLN STREET WELL

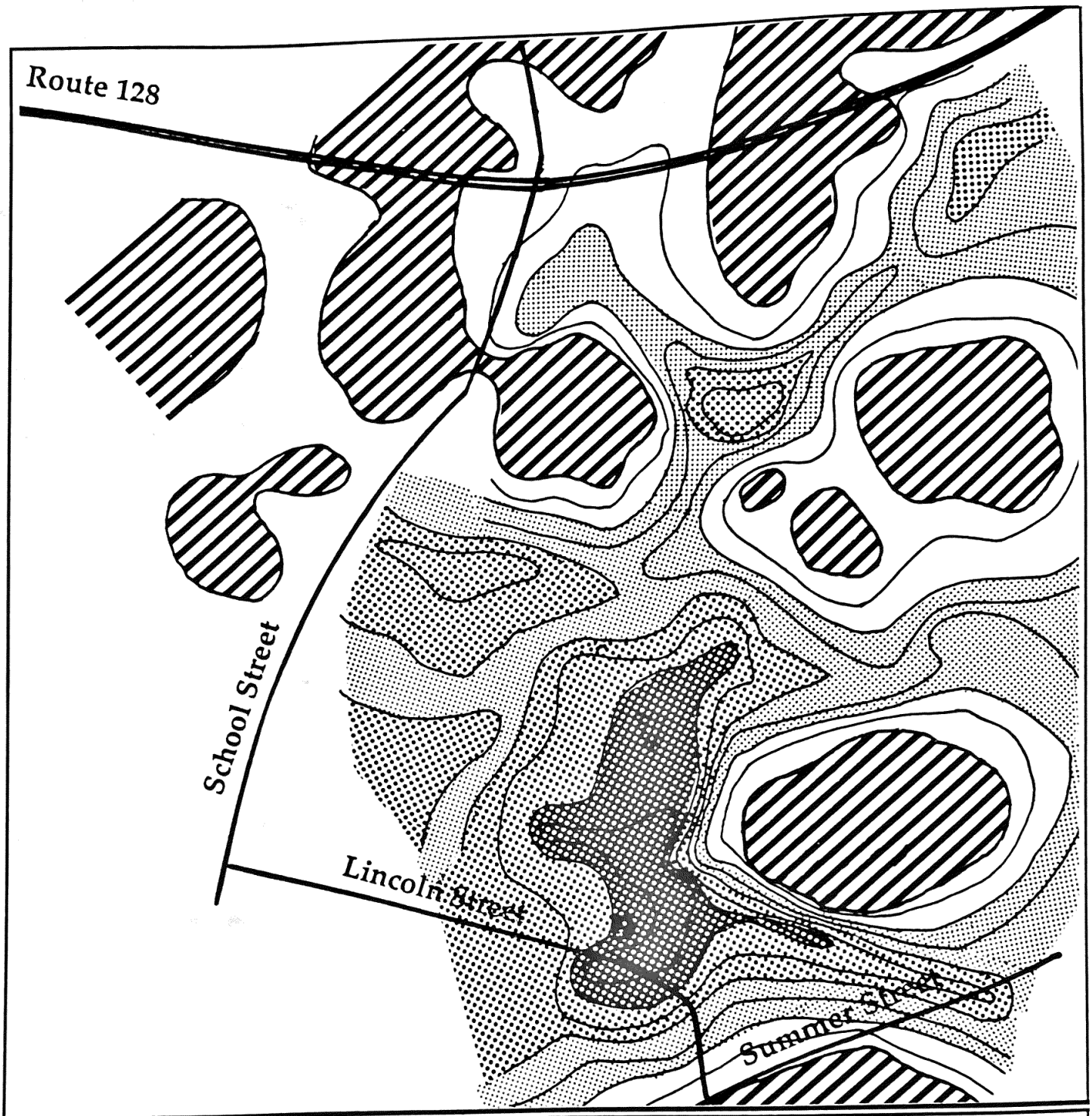
The Lincoln Street well supplies approximately 43% of the Town's drinking water and is the only water supply located in the Town of Manchester. Therefore, a primary focus of this investigation was the identification of the zone of contribution to this well so that appropriate protection strategies could be developed for this area. The following sections discuss the geology and hydrology of this area in detail, and document the pump test and hydrogeologic modeling performed for this wellfield. A Zone II application for the Lincoln Street well was filed with the DEP, Division of Water Supply in January of 1990. This document contains additional data and appendices which are not repeated in this report.

Geology

The Lincoln Street well draws water from a buried valley aquifer system which lies in the valley occupied by Sawmill Brook. There are four main geologic units in this valley; the bedrock forming the base and walls of the valley, a low permeability sandy till overlying the bedrock, the sand and gravel deposits in which the production well is screened and a low permeability marine clay overlying the sand and gravel deposits throughout most of the valley. The relationships between the different geologic units was determined based on data from 27 geologic borings and 18 seismic refraction lines.

The bedrock which forms the walls and base of the valley consists of granite which has been mapped as part of the Cape Ann Complex (Zen, 1983). It forms the hills which outcrop on the sides of the valley such as Woodchuck Hill, Sheep Pasture Hill, Spy Rock and the hills separating the Lincoln Street aquifer from Millets Swamp. This bedrock is overlain in places by a thin layer of low permeability till which consists of poorly sorted sands, gravels, silts, and clays. The depth to the top of the bedrock and/or till formation has been mapped and shows the configuration of the valley which contains the Lincoln Street aquifer (Figure 5).

In most areas of the valley unconsolidated sands and gravels were deposited over the bedrock/till formations. These permeable sands and gravels consist of glacial outwash deposits and range from 0 to 68 feet in thickness (Figure 6). The thickest deposits are located immediately southeast of the Lincoln Street well, and thin to the northwest towards School Street and to the east, both north and south of Woodchuck Hill.



LEGEND

FIGURE 5
DEPTH TO BEDROCK

Scale: 1 inch = 800 feet
Contour Interval = 10 feet

Bedrock

Manchester Ground Water Study, Manchester, MA

0-20 feet

20-40 feet

40-60 feet

>60 feet

Lincoln Street Well

N

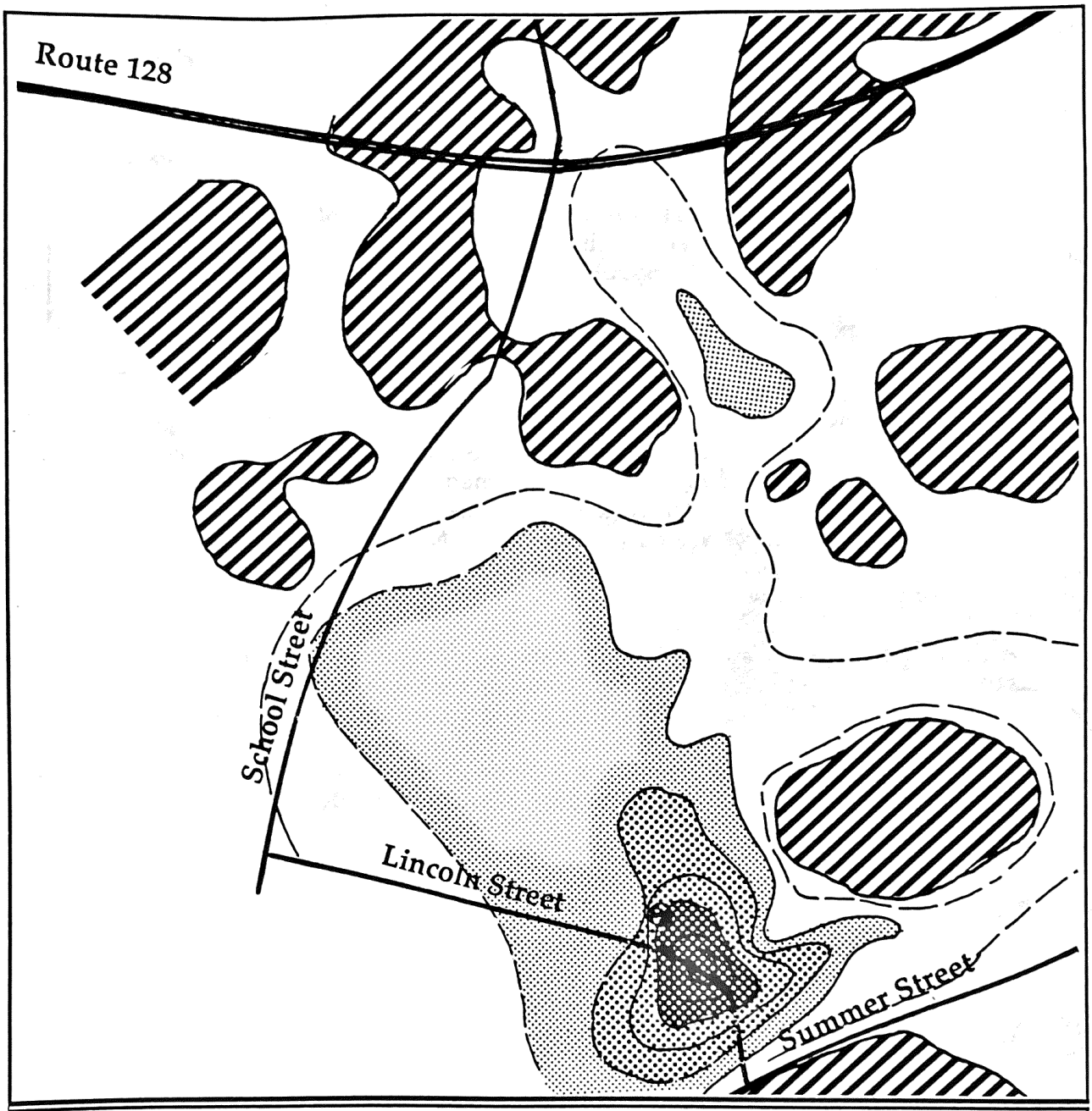


FIGURE 6
THICKNESS OF SAND AND GRAVEL AQUIFER

Scale: 1 inch = 800 feet
Contour Interval = 10 feet

Bedrock

Manchester Ground Water Study, Manchester, MA

LEGEND

0-10 feet

10-20 feet

20-40 feet

>40 feet

Lincoln Street Well

N

A very low permeability, marine clay overlies the sand and gravel deposits and extends throughout most of the valley. This clay ranges from 0 to 40 feet in thickness (Figure 7). The areas with the greatest thickness of clay include the area around the Lincoln Street well, south of Woodchuck Hill in the Causeway Brook valley, and north of Woodchuck Hill, along the Cat Brook and Sawmill Brook valleys. In some areas, notably in the vicinity of the high school and the western and southern portions of the country club, this clay appears to be discontinuous and patchy.

A series of geologic cross sections were prepared to clarify the relationships between the unconsolidated deposits in the Lincoln Street aquifer valley. These are presented in Appendix C along with a locus map showing their locations and the individual boring logs used to create the cross sections. Cross section C-C' illustrates how the sand and gravel aquifer pinches out to the north of the production well. Cross section A-A' shows how the clay thickens and the sand and gravel thins to the east-southeast of the well.

An additional hydrogeological cross section was prepared extending from well HWH-4 in the west through the Lincoln Street well to Well HWH-2 in the east (Figure 8). This cross section illustrates how the sand and gravel deposits outcrop on the western side of the valley, where they appear to be only partially covered by the marine clay. The sand and gravel deposits extend across the entire valley in this area, with the central and eastern portions overlain with what appears to be a continuous layer of the marine clay.

Hydrology

The Lincoln Street aquifer exhibits characteristics of both confined and unconfined conditions. The ground water in the sand and gravel deposits underneath the clay layer is confined and has a potentiometric surface that differs from the unconfined water table in the clay and in the sand and gravel deposits which outcrop on the western side of the valley.

Ground water in the valley flows from the valley walls to the north, east and west, down toward Sawmill Brook and out of the southern end of the valley. This is shown in the water table map drawn from water level measurements taken under static conditions, when the production well had been shut down for over 60 hours (See Table 3 for water level readings and Figure 9 for ground water flow directions).

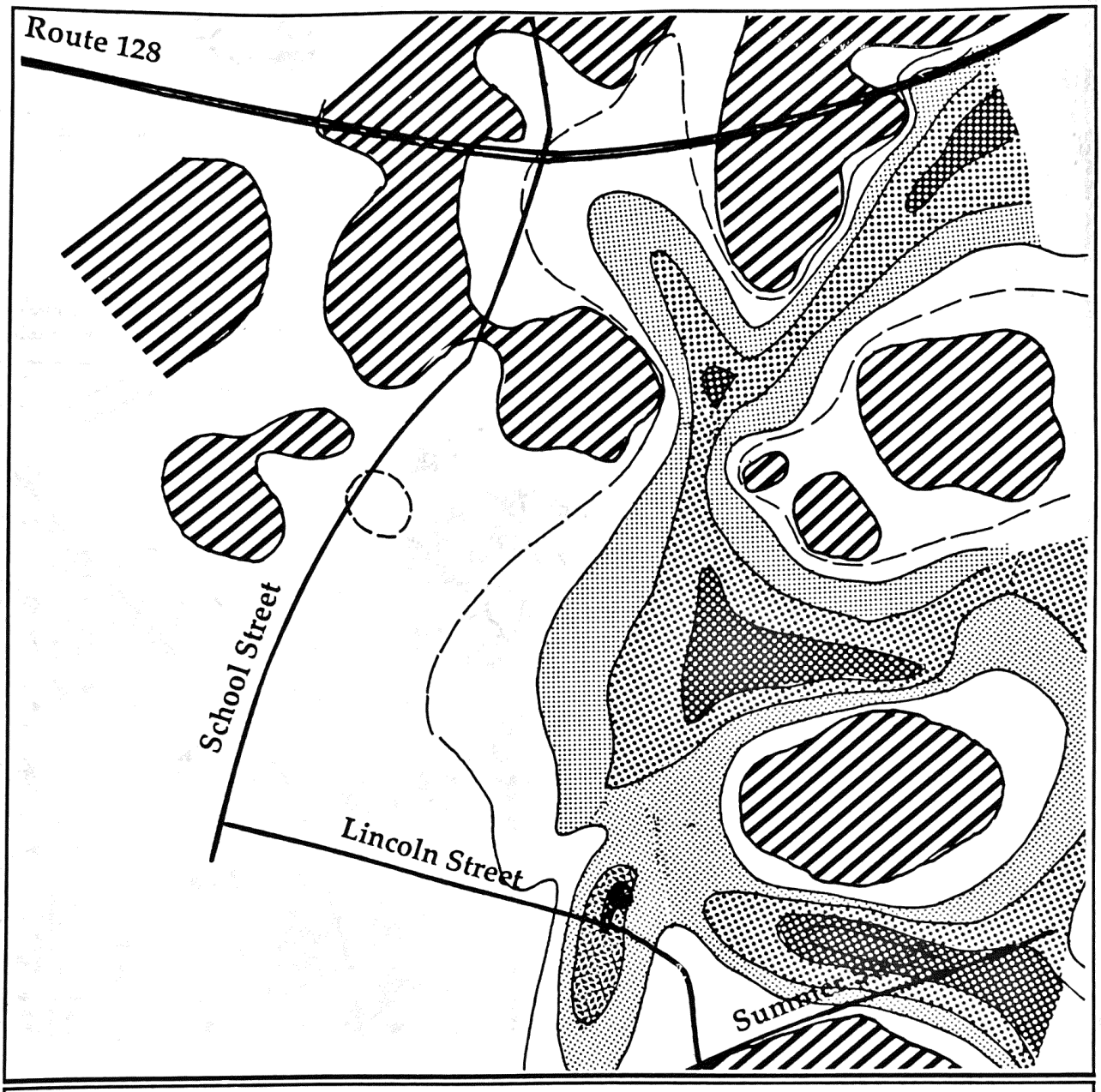


FIGURE 7
THICKNESS OF OVERLYING CLAY LAYER

Scale: 1 inch = 800 feet
Contour Interval = 10 feet
Bedrock
Manchester Ground Water Study, Manchester, MA

LEGEND

0-10 feet
10-20 feet
20-30 feet
>30 feet
Lincoln Street Well

N

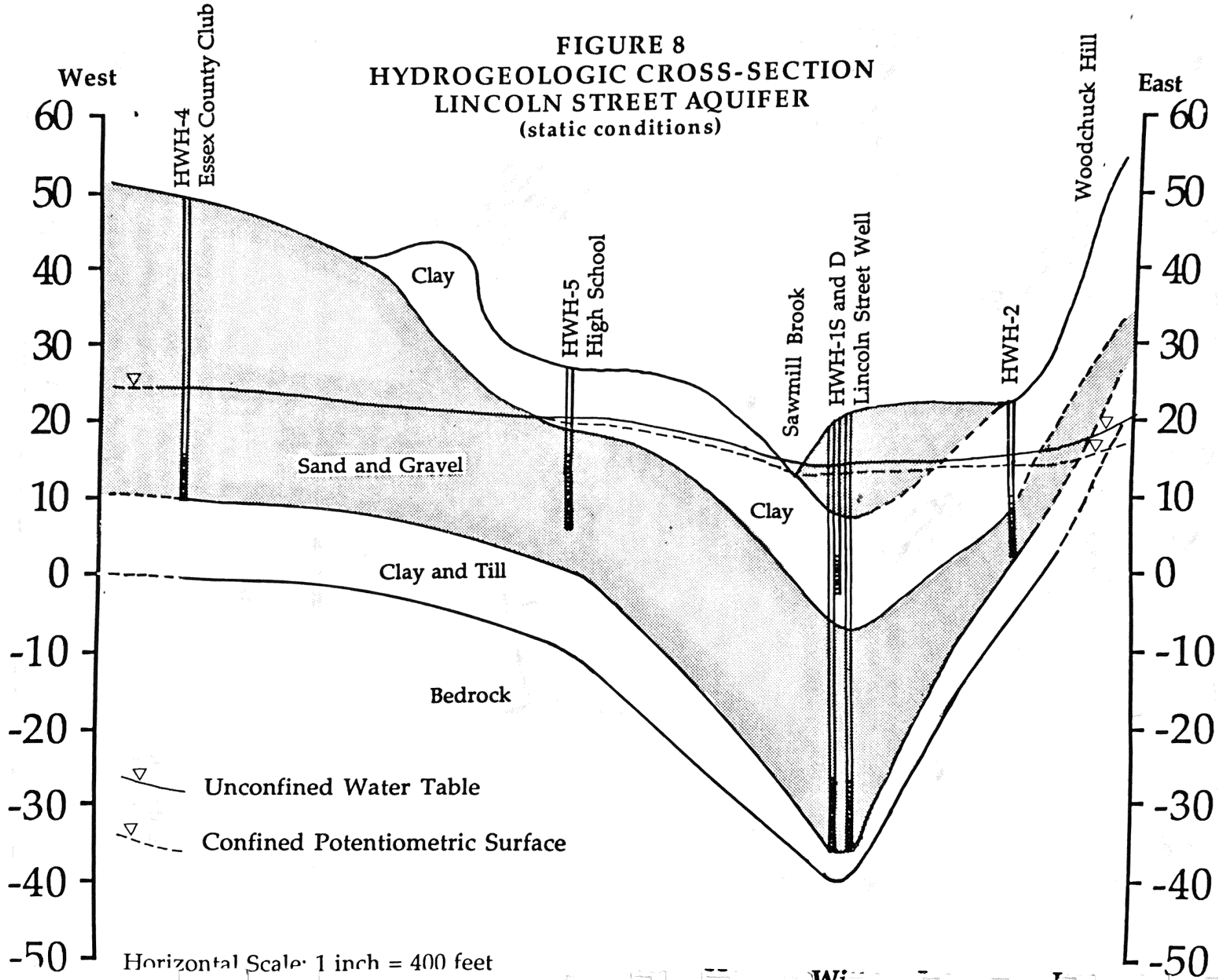


FIGURE 8
HYDROGEOLOGIC CROSS-SECTION
LINCOLN STREET AQUIFER
(static conditions)
West
East
HWH-4
Essex County Club
HWH-5
High School
Sawmill Brook
HWH-1S and D
Lincoln Street Well
HWH-2
Woodchuck Hill
Clay
Sand and Gravel
Clay
Clay and Till
Bedrock
Unconfined Water Table
Confined Potentiometric Surface
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
Horizontal Scale: 1 inch = 400 feet

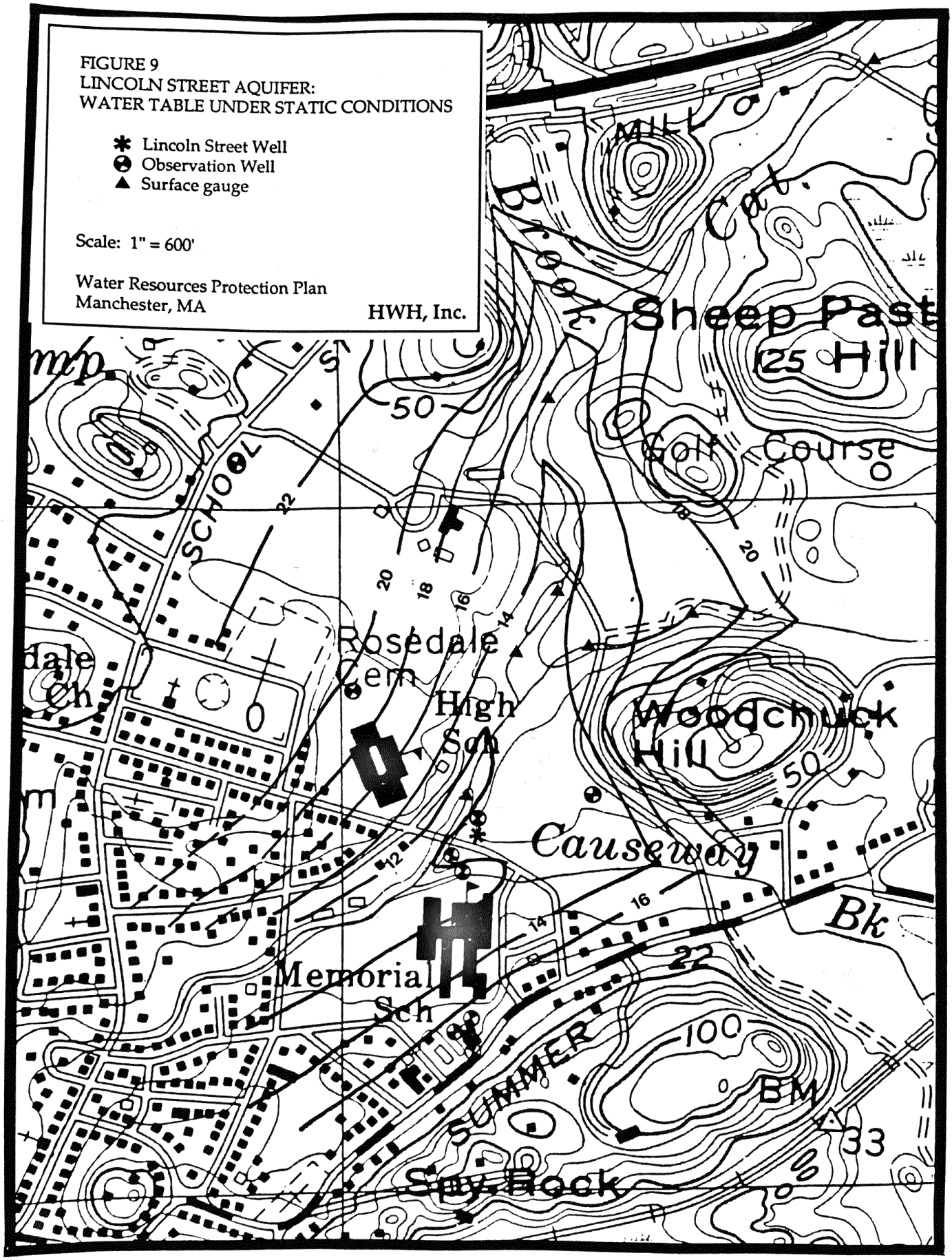


FIGURE 9
LINCOLN STREET AQUIFER:
WATER TABLE UNDER STATIC CONDITIONS
Lincoln Street Well
Observation Well
Surface gauge
Scale: 1" = 600'
Water Resources Protection Plan
Manchester, MA
HWH, Inc.
Sheep Past
Hill
Golf Course
Rosedale
Cem
High
Sch
Woodchuck
Hill
Causeway
Memorial
Sch
SUMMER
Spy Rock
BM
SCHOOL
Bk
50
22
20
18
16
14
12
100
33

TABLE 3 Lincoln Street Well Aquifer: Water Levels Under Static Conditions

Well	Elevation	Depth to Water	Water Table Elevation
HWH-1D	18.21	5.45	12.76
HWH-1S	17.93	4.86	13.07
HWH-2	24.16	11.31	12.85
HWH-4	46.48	23.45	23.03
HWH-5	32.47	12.76	19.71
HWH-6	16.38	4.11	12.27
SG-1	13.95	2.59	11.36
SG-2	15.18	2.91	12.27
SG-3	15.19	2.01	13.18
SG-4	18.92	3.85	15.07
SG-5	21.39	3.85	17.54
SG-6	16.69	2.40	14.29

The relationship of the potentiometric surface of the confined sand and gravel aquifer to the unconfined water table in the overlying clay layer is shown in Figure 8. The confined potentiometric surface is at a lower elevation than the unconfined water table in the vicinity of the production well under static conditions. This slight downward vertical gradient indicates that ground water flows from the overlying clay deposits down into the sand and gravel aquifer. The hydraulic conductivity of the clay determines the rate of this vertical flow.

Hydrologic Setting of Sawmill Brook

The relationship of Sawmill Brook to the surrounding aquifer was investigated both during the pump test and at a time when the well was pumping under average conditions. During the pump test the water level in Sawmill Brook was monitored in six locations. The only observed change was a drop in the level in the stream immediately adjacent to the pumping well.

With the use of mini-piezometers, the relationship of the stream level to the piezometric surface of the underlying ground water was determined under average pumping conditions. In areas upstream of the production well it appeared that

Sawmill Brook was a gaining stream, receiving water from the underlying aquifer. In the vicinity of the well the reverse was true. Water appeared to flow from the stream into the aquifer below. Because downward flow only occurred in the vicinity of the pumping well, it is possible that under static conditions Sawmill Brook is a gaining stream along its whole length. The pumping of the well may then cause induced recharge from the stream into the aquifer.

It was difficult to obtain detailed water level data in the mini-piezometers and in the stream due to tight streambed soils and adverse weather conditions at the time the measurements were made. This information obtained does, however, provide valuable, qualitative information on the stream/aquifer relationships. These relationships will be discussed further in the section on numerical modeling.

Prolonged Pump Test

From 25 to 28 October, 1989 a prolonged pump test was conducted to determine the transmissivity, hydraulic conductivity and storativity of the sand and gravel aquifer and the overlying clay deposits. The test consisted of 48 hours of drawdown measurements with the well pumping at a consistent rate of 510 gallons per minute, followed by 24 hours of recovery measurements after the well had been turned off.

Drawdown and recovery measurements were taken in five observation wells, and the production well. In addition, six staff gauges in Sawmill Brook were measured to record any changes in the stream level (See Figure 10 for locations of wells and staff gauges). The five observation wells included one well (TW-4) located in Cedar Swamp, north of the pumping well, to record any changes in the ambient water table not associated with the pump test. Two observation wells (HWH-1D and HWH-2) were screened within the sand and gravel aquifer, 75 feet and 530 feet from the production well, respectively. Wells HWH-1S and OW-D were screened in the clay layer overlying the aquifer.

The pump test was initially planned to continue for 72 hours, followed by 24 hours of drawdown measurements. After 48 hours the drawdown recorder in the production well indicated a level of zero, prompting the Water Superintendent, Earl Richards, to halt the pump test. Later it was determined that the recorder had malfunctioned and that the water level had not actually dropped below its normal drawdown. Recovery measurements were started immediately after the pump was stopped and were continued for 24 hours at approximately the same intervals as the drawdown measurements.

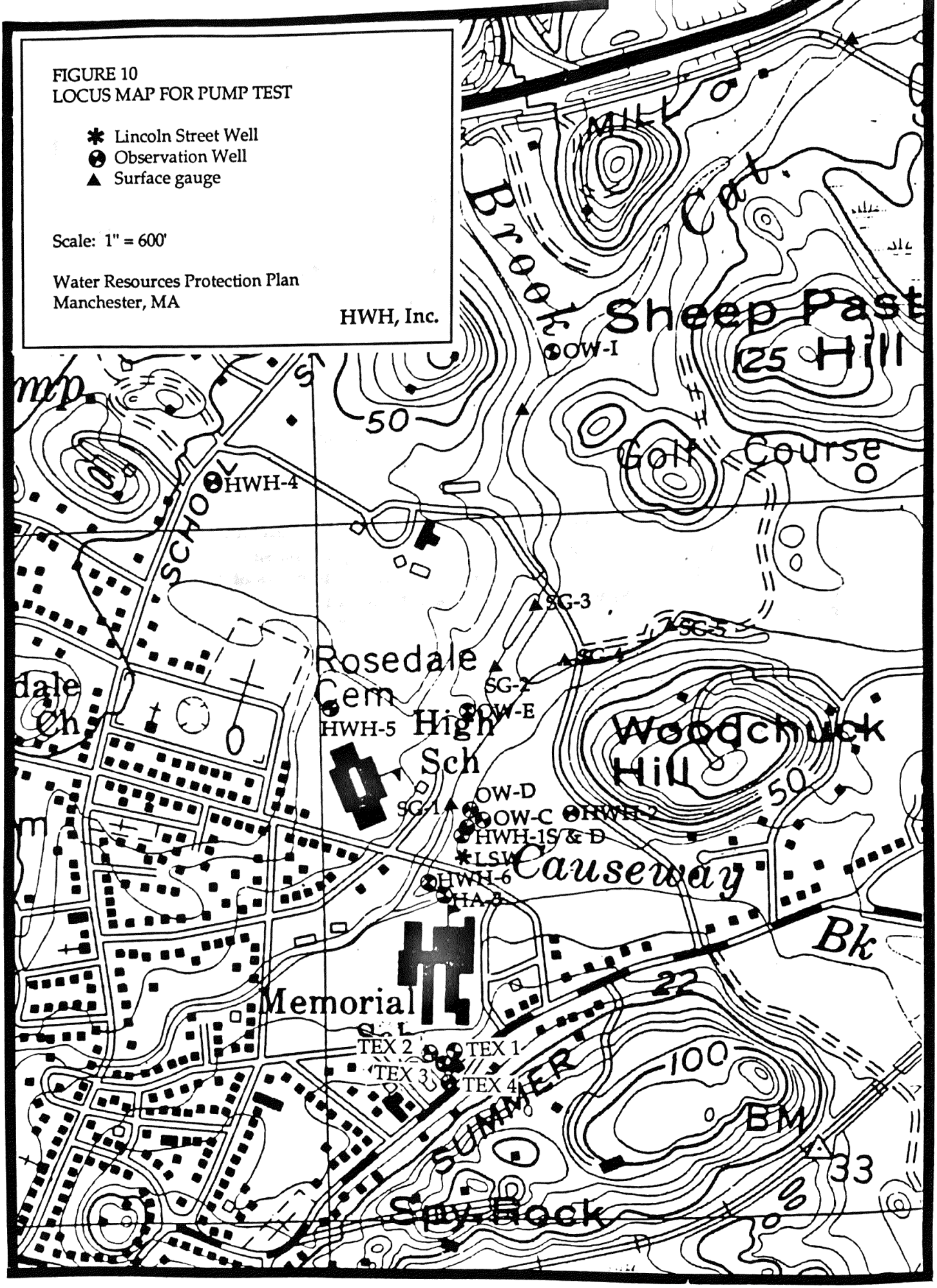


FIGURE 10
LOCUS MAP FOR PUMP TEST
Lincoln Street Well
Observation Well
Surface gauge
Scale: 1" = 600'
Water Resources Protection Plan
Manchester, MA
HWH, Inc.
Brook
Cat
Sheep Past
Hill
OW-I
Golf Course
HWH-4
SCHOOL
SG-3
SG-5
SG-4
SG-2
OW-E
Rosedale
Cem
HWH-5
High
Sch
Woodchuck
Hill
OW-D
SG-1
OW-C
HWH-2
HWH-1S & D
LSW
HWH-6
HA-8
Causeway
Bk
Memorial
TEX 2
TEX 1
TEX 3
TEX 4
SUMMER
100
BM
33
Spy Rock

Measured drawdowns in the sand and gravel aquifer ranged from 22.5 feet in the production well, to 10 feet in well HWH-1D, and to 4 feet in well HWH-2 located 530 feet from the production well. The drawdown in well HWH-2 may have been amplified because of the close proximity of Woodchuck Hill which acts as a boundary to the aquifer system. Drawdown in the clay layer overlying the aquifer was only 0.3 feet as measured in well HWH-1S. This drawdown data was used to construct a water table map of the aquifer representative of pumping conditions (Figure 11).

The hydraulic characteristics of the sand and gravel aquifer were calculated from drawdown readings in wells HWH-1D, HWH-2 and the Lincoln Street Well using four different methods. Transmissivity and storage coefficient values averaged 3729 ft^2/day and 0.0025, respectively. Given an average thickness of 35 - 40 feet, the average hydraulic conductivity of the sand and gravel aquifer was calculated at 100 ft/day. The hydraulic conductivity (k) of the clay layer overlying the aquifer was calculated at 0.005 ft/day.

In general, the pump test results provide realistic, reproducible data on the characteristics of the Lincoln Street aquifer which were used in the computer model to determine the zone of contribution to the Lincoln Street well. Additional details on the pump test methodology and results are provided in the Zone II Application submitted to DEP.

Safe Yield Calculations

The safe yield of the Lincoln Street well is 261 gallons per minute (gpm), as determined using the procedures described in the "Guidelines for Public Water Supplies" (DEP; May, 1989. p31). According to this procedure, the safe yield is calculated as the available water in the well times the specific capacity of the well times a safety factor of 0.75. The available water equals the depth of the pumping well minus the length of the screen, the static water level, and a five foot safety factor. It is the amount of drawdown that can safely be allowed within the well. The specific capacity is the pumping rate divided by the actual drawdown in the well at that rate.

The safe yield calculated in this way provides an estimate of the volume of water that can be withdrawn from the well without causing excessive drawdowns that may damage the pumping equipment. The normal pumping rate of the Lincoln Street well over the last two years has been 206 gpm when averaged over a 24-hour period. This is 79% of the calculated safe yield of 261 gpm.

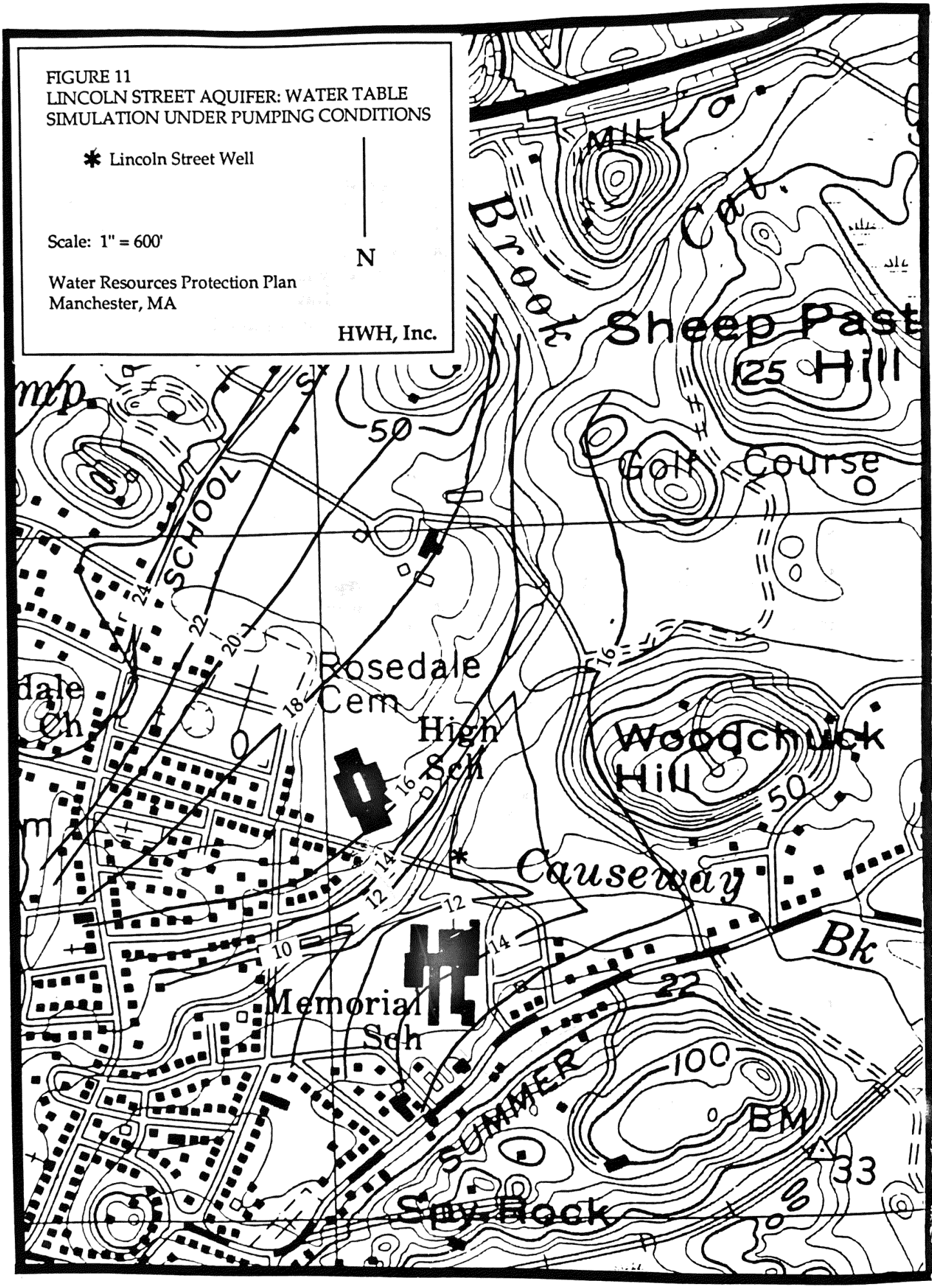


FIGURE 11
LINCOLN STREET AQUIFER: WATER TABLE
SIMULATION UNDER PUMPING CONDITIONS
* Lincoln Street Well
Scale: 1" = 600'
N
Water Resources Protection Plan
Manchester, MA
HWH, Inc.
Brook
Sheep Past
Hill
Golf Course
SCHOOL
Rosedale
Cem
High
Sch
Woodchuck
Hill
Causeway
Memorial
Sch
SUMMER
Bk
BM
Spy Rock
50
25
24
22
20
18
16
14
12
10
100
33

Numerical Modeling

The purpose of the numerical modeling described below was to delineate the zone of contribution to the Lincoln Street well according to the Zone II guidelines specified by the DEP's Division of Water Supply. These guidelines include the assumption that the well is pumped continually at its safe yield rate for 180 days without any recharge to the aquifer from precipitation. Once the Zone II boundaries for the wellfield were determined, the Zone III area, or the area that contributes overland run-off to the Zone II area, was delineated as well.

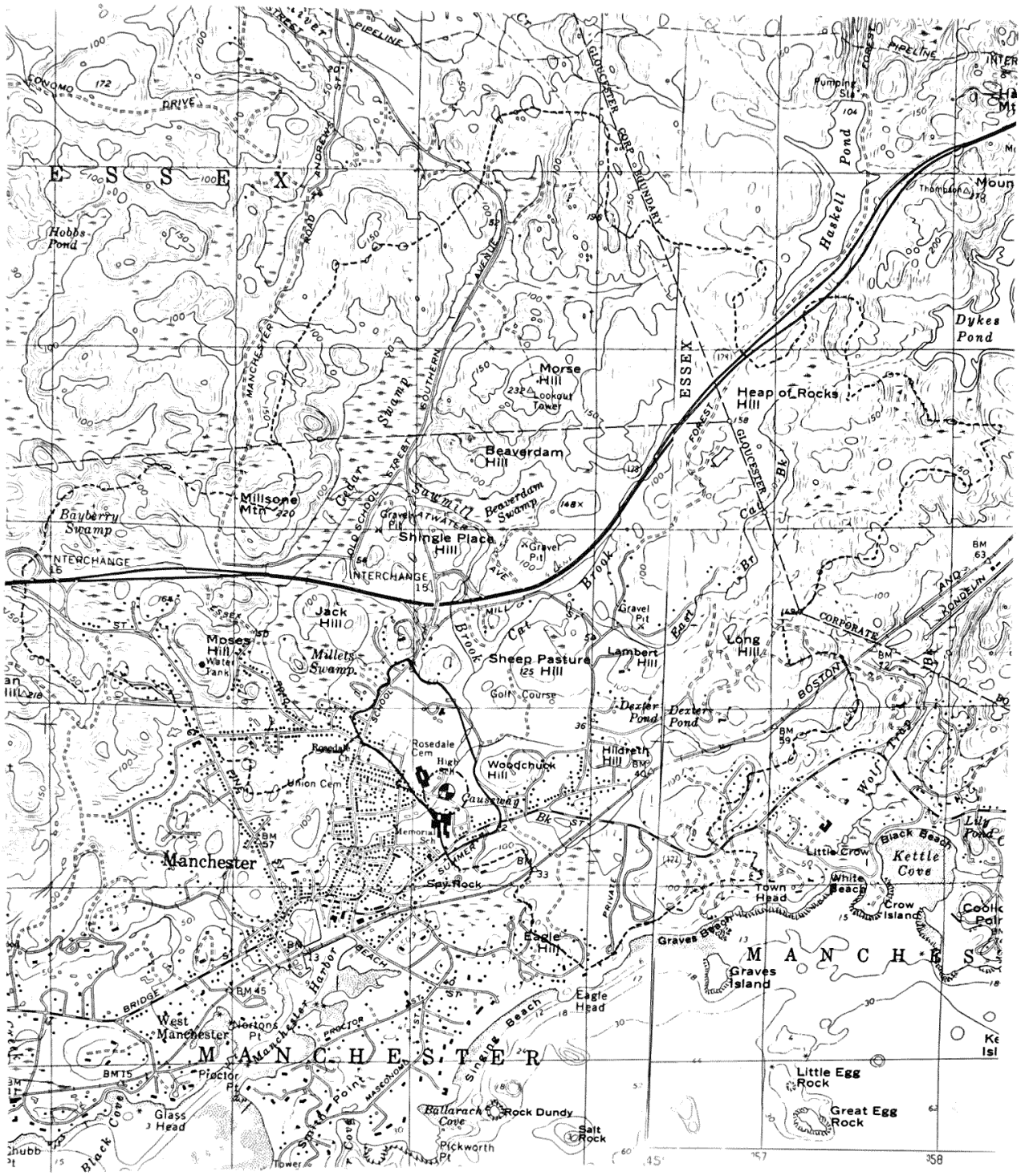
The numerical model chosen to delineate the Zone II area was the U.S. Geological Survey three dimensional ground water flow model MODFLOW (McDonald and Harbaugh, 1984). The model system developed for the Lincoln Street aquifer was first calibrated against the static water table measured before the start of the pump test. It was then validated against the drawdown measurements taken at the end of the pump test to ensure that it could reasonably simulate the actual physical conditions of the aquifer. Finally, predictive simulations were conducted to determine the boundaries of the Zone II area. Details on the modeling assumptions, methods, calibration and sensitivity analysis are included in the Zone II application submitted to DEP and are not repeated here.

Delineation of Zones I, II and III

Figure 12 illustrates the locations of Zones I, II and III, with respect to the Lincoln Street well. Zone I is defined as a radius of 400 feet surrounding the well itself, and is afforded the highest level of protection.

Zone II is defined as that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation). It is bounded by the ground water divides which result from pumping the well and by the contact of the aquifer with less permeable materials such as till or bedrock. In all cases, Zone II shall extend upgradient to its point of intersection with prevailing hydrogeologic boundaries (a ground water flow divide, a contact with till or bedrock, or a recharge boundary).

For the Lincoln Street aquifer the Zone II boundaries to the north, east and west are the geologic contacts between the sand and gravel aquifer and the neighboring bedrock/till and clay formations. The southern boundary of the Zone II is the ground water divide resulting from the pumping of the well.



• MUNICIPALITY	Manchester, MA
• PWS IDENTIFICATION NUMBER	3166000
• NAME OF WATER SUPPLY	Lincoln Street Well
• WATER PURVEYOR	Town of Manchester
• SOURCE IDENTIFICATION NUMBER	166-01G
• PROJECT PROPONENT	Town of Manchester
• TITLE OF STUDY/PURPOSE OF DELINEATION	Water Resources Protection Plan
• U.S.G.S. QUADRANGLE NAMES	Marblehead North, Gloucester
• CONSULTANT/DATE OF STUDY SUBMITTAL	Horsley Witten Hegemann, Inc./ January 1990
• LATITUDE/LONGITUDE OF SOURCE	70° 45' 51"/42° 34' 24"

SIGNATURES

		DATES
• WATER PURVEYOR	Robert W. Mooney P.E.	29 JAN 90
• CONSULTANT	Christine Coughlin	1 Feb '90
• PROJECT PROPONENT	Paul Bockelman	1/29/90
• REGIONAL WATER SUPPLY CHIEF		

EXPLANATION OF MAP SYMBOLS

Zone I

Zone II

Zone III

Lincoln Street Well

MAP SCALE 1 : 25000

Figure 12

HWH, Inc.

Zone III is defined as the surface watershed area that contributes recharge to the aquifer through overland run-off. For the Lincoln Street well, this surface run-off is contributed in two ways: 1) overland run-off from the sides of the valley which recharges directly into the outcropping sand and gravel aquifer material; and 2) run-off into the streams, a portion of which enters the aquifer via induced infiltration. The streams that contribute in this manner are Sawmill Brook, its tributary Cat Brook, and Causeway Brook. The induced infiltration from these streams makes up approximately 15 percent of the water entering the aquifer under Zone II pumping conditions (see Zone II application).

The watersheds to the streams encompass a large area to the west, north and east of the aquifer. The areas that provide direct run-off to the aquifer include the hills on the east and west sides of the aquifer, and a small area on the southwest side of the Zone II area, where precipitation falls on surface clay sediments and flows down into the sand and gravel sediments within Zone II.

In addition to the protection areas described above, HWH also delineated the zone of contribution to the Lincoln Street well under average pumping conditions. This average ZOC, depicted in Figure 13, is slightly narrower than the Zone II area described above.

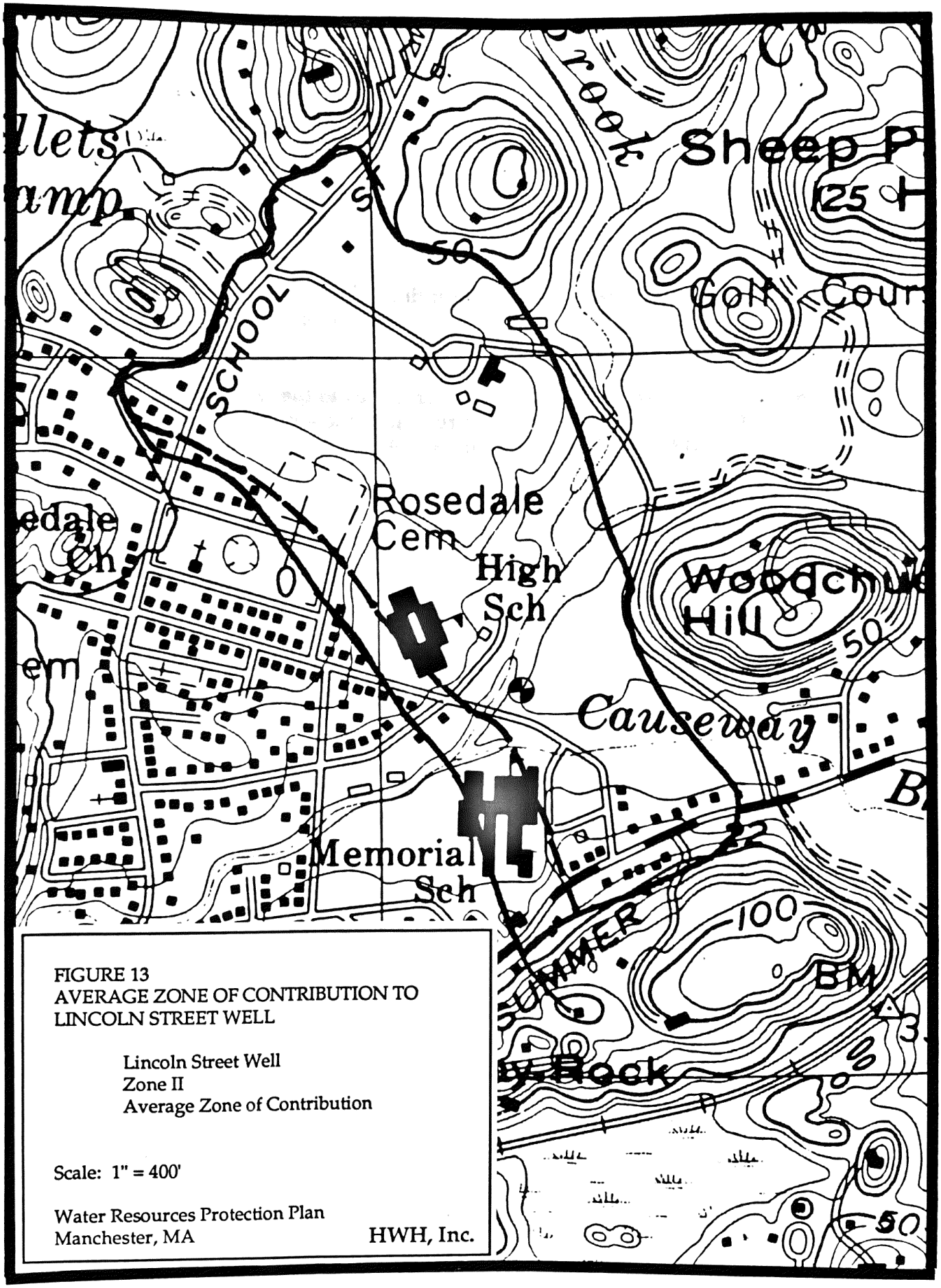


FIGURE 13
AVERAGE ZONE OF CONTRIBUTION TO
LINCOLN STREET WELL

Lincoln Street Well
Zone II
Average Zone of Contribution

Scale: 1" = 400'

Water Resources Protection Plan
Manchester, MA

HWH, Inc.

GRAVELLY POND/ROUND POND

GRAVELLY POND/ROUND POND

Gravelly Pond is one of a series of five lakes in the Hamilton/Wenham/Essex area, and is unique in that it is isolated from the other four lakes and has a very small watershed. This watershed is made up of a combination of granitic bedrock outcrops, sand and gravel outwash deposits and swamp deposits. Gravelly Pond has no inlets or outlets; thus under normal conditions its water budget is controlled by precipitation and limited surface and ground water inputs.

Because of the periodic influx of Round Pond well water, however, Gravelly Pond is indirectly linked to Round Pond, and thus to the Round Pond watershed. This watershed extends south into the Towns of Wenham, Beverly and Manchester and is characterized by large areas of wetlands. Bedrock outcrops make up most of the watershed, with lesser amounts of sand and gravel outwash. Surface run-off is an important component of Round Pond's water budget, because of the surrounding geology.

POPULATION STATISTICS AND PROJECTIONS

POPULATION STATISTICS AND PROJECTIONS

According to a report by MAPC (1988), Manchester's population in 1986 was estimated at 5260. The Town's growth increased 1.8 times between 1950 and 1970, but has stabilized and declined since 1970. Between 1980 and 1986, the population declined by 3%.

Population projections for the Town have been developed by MAPC (1988) and DEM (1987) for the years 1990 through 2020, and are presented in Table 4 below. Neither MAPC or DEM project any significant rise or change in population over the next thirty years. In addition, the 1987 Affordable Housing Study prepared for Manchester noted that projections for Cape Ann communities indicated slow population growth to the year 2010.

TABLE 4 Population Projections: Town of Manchester

Source	1990	2000	2010	2020
MAPC	5400	5400	5400	5400
DEM	5478	5467	5435	

LAND USE

LAND USE

Existing land uses in the Town of Manchester are predominantly residential and are concentrated near the Town Center. According to the MacConnell land use study, developed land uses tripled in Manchester between 1951 and 1980. This study (based on the interpretation of aerial photographs) indicated that in 1980, 36% of the land in the Town was developed and 66% was undeveloped. Of the developed area, 78% was residential. According to our analysis of recent assessor's and tax records, there are currently 1825 primary structures in the Town, the vast majority of which are residential. Commercial uses are restricted primarily to the Town Center and to a Limited Commercial District located north of Route 128.

The Town's Zoning Bylaw divides the Town into six different districts, with minimum lots sizes ranging from 6000 square feet to five acres. Minimum zoning requirements for each district are summarized in Table 5.

TABLE 5 Zoning Criteria By District

Zoning District	Minimum Lot Size	Minimum Frontage
Single Residential A	22,500 SF	150 ft
Single Residential B	15,000 SF	75 ft
Single Residential C	45,000 SF	150 ft
Residence D	6,000 SF	60 ft
Limited Commercial	5 acres SF	---
General	6,000 SF	60 ft

The majority of the Town is serviced by Town water with the exceptions of Loading Place Road and areas north of Route 128. Most of the central portion of the Town is sewering while outlying areas rely on individual septic systems. Areas not currently serviced are identified in Figures 14 and 15. Due to severe limitations on new water and sewer capacity, any substantial expansion of these services is unlikely.

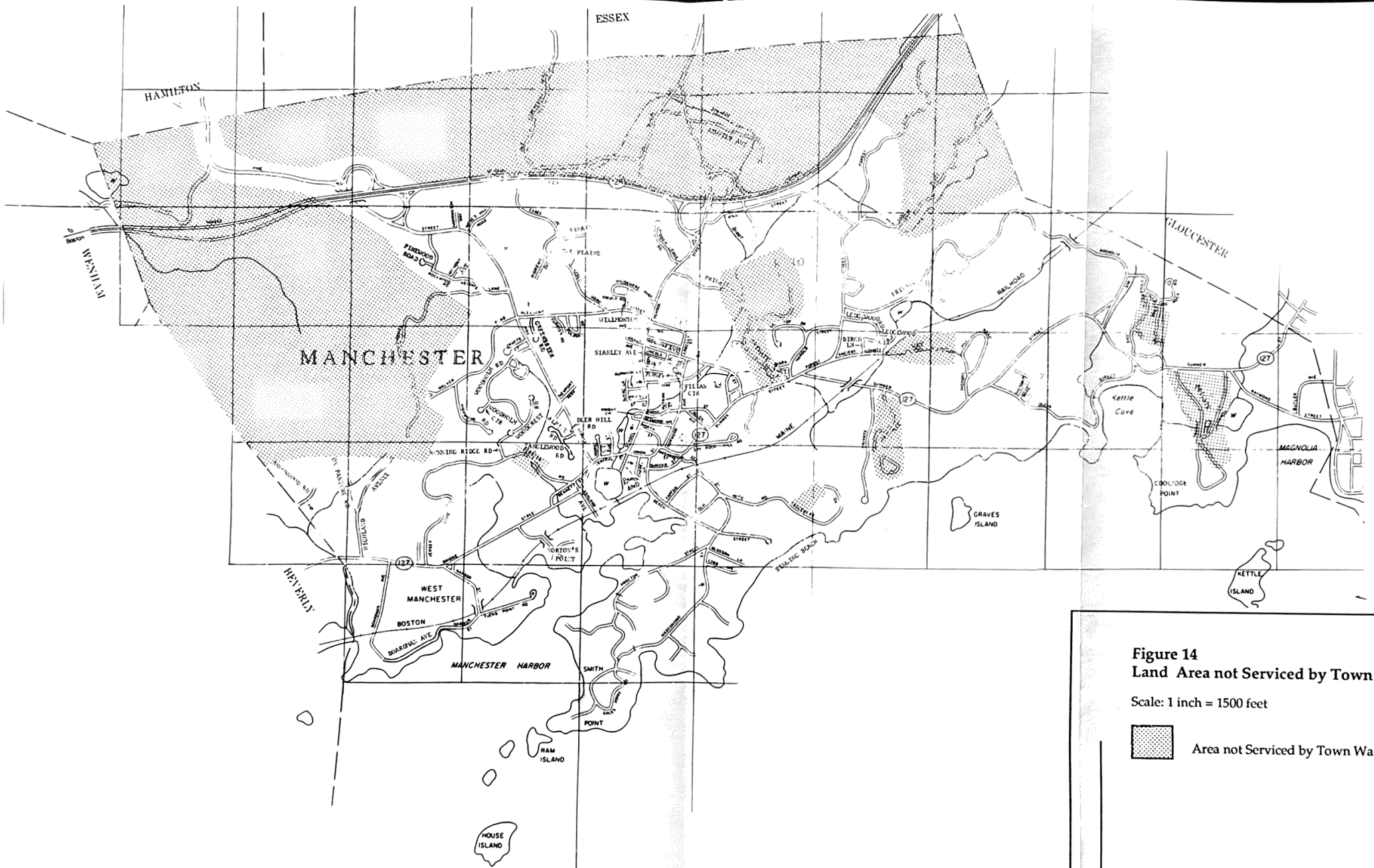


Figure 14
Land Area not Serviced by Town Water

Scale: 1 inch = 1500 feet

Area not Serviced by Town Water

N

HWH, Inc.

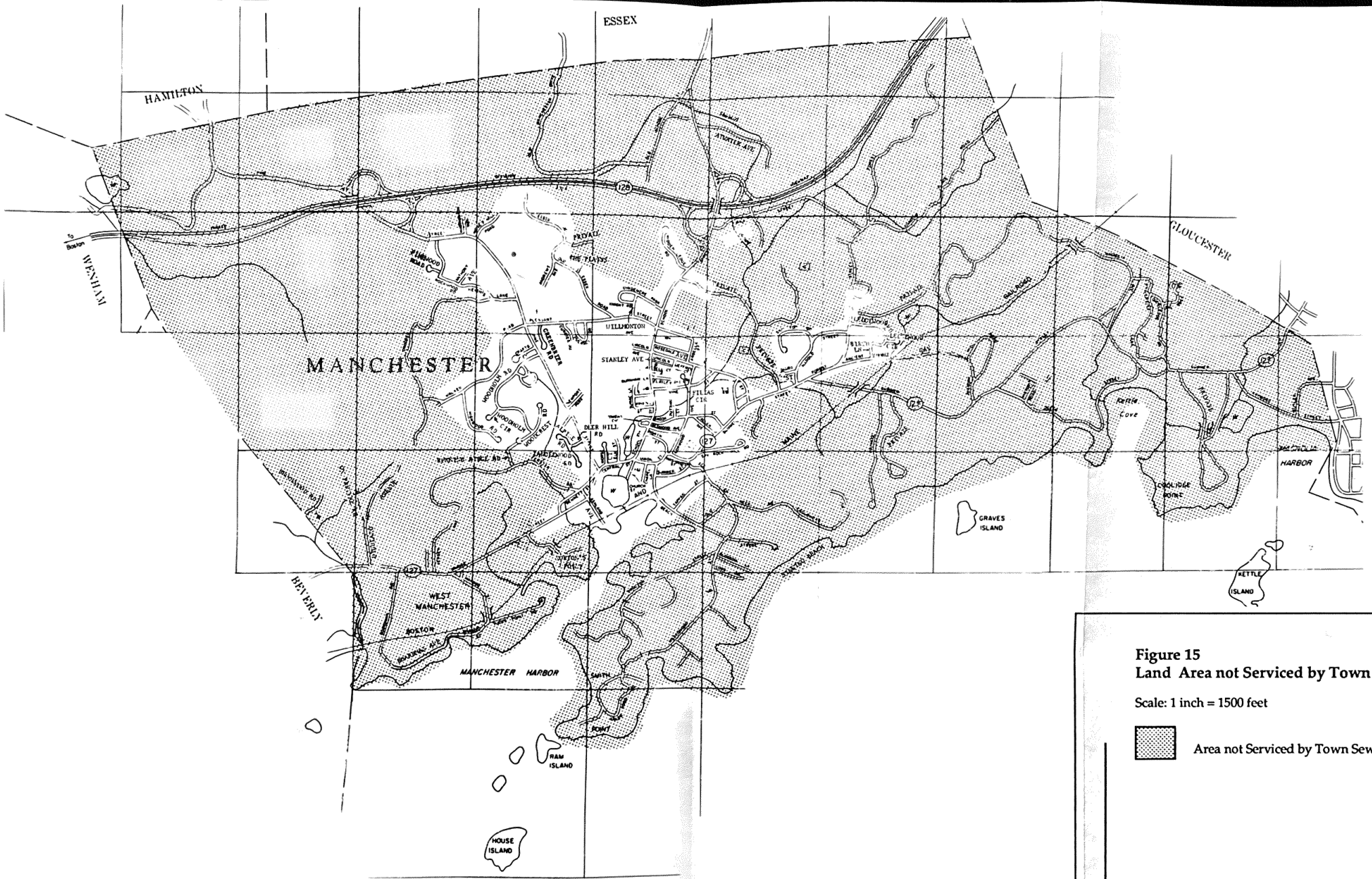


Figure 15
Land Area not Serviced by Town Sewer

Scale: 1 inch = 1500 feet

Area not Serviced by Town Sewer

N

HWH, Inc.

Build-out Analysis

State land use enabling legislation within Massachusetts dictates that once a community programs itself through zoning and subdivision control, it is tied into a development "blueprint" which is difficult to alter. This blueprint may result in land development which exceeds the sustainable use of resources such as drinking water, and may exceed the assimilative capacity of ground and surface water resources, particularly with respect to nitrogen loading. A particularly difficult issue to evaluate and resolve, in controlling land use within critical areas, is that of "grandfathered" lots. Manchester's zoning bylaw allows for significant protection of subdivided but still vacant land. In Massachusetts, once a definitive subdivision plan has been filed with the planning board, the property owner is protected from any new zoning changes for a period of 8 years. If, during that time, individual lots are sold to different property owners, the right to build upon these lots may be protected indefinitely. Consequently, contributing areas to surface and ground water resources may contain a significant number of small, vacant lots, which, if developed, could result in significant degradation in water quality.

In order to evaluate the impacts of both existing and potential development on Manchester's water resources, a build-out or developable lot analysis was completed. The purpose of this analysis was two-fold: first to assess future water needs within the Town and second, to evaluate the impacts of changing land use on water quality.

To project maximum future water needs, the developable lot analysis completed for the Town in 1987 was updated and entered into a computerized spreadsheet format. Using this data base (summarized in Table 6), the number of existing structures, vacant "grandfathered" lots, and subdividable lots was determined. All vacant parcels larger than two times the minimum lot size in a given zoning district were considered to be subdividable. The number of subdividable lots for each parcel was determined by subtracting out 15% of the lot area for roads and dividing the remaining area by the minimum lot size. Parcels owned by the Town or Conservation organizations were not considered subdividable.

The results of the town-wide analysis indicate that there are currently 1825 existing structures in the Town, 171 vacant "grandfathered" lots and 2017 lots which could be created through the subdivision process. Approximately 16% of Manchester (800 acres) is currently owned by the Town or various conservation groups.

TABLE 6 BUILDOUT ANALYSIS RESULTS: ENTIRE TOWN

Map	Exist DU	VGF	Subdiv.	Cons. (acres)	Lim. Comm.		
1	65	11	61	0.4			
2	18	3	64				
3	15	2	34				
4	3		20				
5	37	10	10	8			
6	40	3	27	3			
7	18	4	11	2.4			
8	6		3	3.8			
9	8		39				
10	17		25				
11	14	1	51	44.4			
12	7		34				
13	33	9	21				
14	33		36	12.3			
15	52	2	15				
16	28	3	11	7.2			
17	24	1	3	13.5			
18	19	2	29				
19	16	3	14				
20	20	3	12				
21	33	4	10				
22	26	2	8				
23	19		27	0.5			
24	19	2	16				
25	9	1	7		Brookwood School not counted		
26	24	5	24	1			
27	14		11	20.8			
28	64	3	37				
29	31	5	36	5.5			
30	71	6	33				
31	2	2	20	27.1			
32	99	16	118	7.3			
33	18	8	28				
34	34		26				
35	43	2	14				
36	14	3	120	19.4			
37	28	4	200	25	76.8		
38	18		339	9.8			
39	61	8	3				
40	16		8	22.7	High School not counted		
41	99	5	15	24.3			
42	30		9	30.5			
43	1			110.3	55		
44	20	1					
45	31						
46	25						
47	11	2			Memorial School not included		

TABLE 6 BUILDOUT ANALYSIS RESULTS: ENTIRE TOWN

48	24				5.5 Acres Cemetary		
49	55	2	5				
50	48		18				
51	78	1	8	0.5			
52	41						
53	41	4		2			
54	28		4	0.5			
55	22	1	6				
56	21	2	8				
57	20	1	37				
58	56	4	144	22	9 ac AH x8 units/ac included in subdiv		
59	15	3	13	21.9			
60	43	2	39	105	45		
61				111	12.3		
62		10	56	23.5	83.5		
63		5	37	40.5	115.4		
64			13	87	8.5		
TOTALS	**1825**	**171**	**2017**	**813.1**	**396.5**		

Lincoln Street Well

Existing land uses within the Zone II are primarily recreational, municipal and residential. The Essex County Club occupies over half of this critical area, the Middle/High schools occupy another 10 to 20%, and the remaining area includes approximately 50 single family residences several pre-existing, non-conforming commercial uses, and a cemetery. All of this area is currently serviced by Town sewer. Zoning within the Zone II is predominantly SR-A (minimum lot size of 22,500 square feet), with lesser areas of RD and GD (minimum lot size of 6,000 square feet) along the southern and western margin of the Zone II. The results of the build-out analysis for this area are presented in Table 7 and indicate that up to 100 units could be constructed within the Zone II, based on current zoning requirements. This assumes full subdivision of the Essex County Club Property.

Existing land uses within the Zone III area again are primarily residential, with the exception of some limited light commercial and industrial uses to the north of Route 128. Most of this area is served by Town sewer, however, some areas are on on-site sewage disposal systems. Five hundred twenty-six existing structures were identified within this area. The results of the build-out analysis for the Zone III area are presented in Table 8 and indicate that under full build-out conditions, 1066 additional units could be constructed in this area based on existing zoning requirements. This includes only land area within the boundaries of Manchester. Zone II further includes land in the Town of Essex and the City of Gloucester. The Town of Essex currently has no zoning.

Gravelly Pond/Round Pond

Because of the indirect connection between Round Pond and Gravelly Pond through periodic pumping of Round Pond well water, land uses in the surface watersheds to both ponds may ultimately affect water quality in Gravelly Pond. As mentioned previously, the combined watersheds of these ponds fall within four different towns. Therefore, an effective protection strategy for this water supply must include the entire watershed.

The portion of the watershed that lies within the Town of Manchester is characterized by very low density development and large areas of undevelopable open space. In addition, two existing landfills (Hamilton and Manchester) lie partially within the contributing area to the pond. Zoning within this area is predominantly SR-C (45,000 square foot minimum lot size) south of 128 and LC (5 acre minimum lot size) north of 128.

TABLE 7 BUILDOUT RESULTS: ZONE II

Map	Exist DU	VGF	Subdiv.	Cons. (acres)	Lim. Comm.		
14	9			0.3			
38	3		86				
39	6						
40	14		8	22.7	High School not counted		
47	7				Memorial School not included		
48					2.5 Acres Cemetary		
54	2						
55	9	1	2				
57			2				
59	4	1					
TOTALS	**54**	**2**	**98**	**23**	**0**		

TABLE 8 BUILDOUT ANALYSIS RESULTS: ZONE III

Map	Exist DU	VGF	Subdiv.	Cons. (acres)	Lim. Comm./Comments	Sewered /Non sewered
9	2		13			N
10	17		25			N
11	14	1	51	44.4		S
12	7		25			N
13	6		2			N
14	14		8	9		S
32	39	5	8			S
33	2	1	14			N
34	11		12			N
35	40	2	8			S
35	3	1	6			N
36	14	3	34	19.4		N
36				79		S
37	28	4	200	25	76.8	N
38	18		339	9.8		N
39	61	8	3			S
40	14		8	22.7	High School not counted	S
41	49	8	17	12		S
43	1			110.3	55	N
47	7				Memorial School not included	S
48					2.5 Acres Cemetary	S
54	2					S
55	22	1	6			S
56	21	2	8			S
57	20	1	37			S
58	56	4	144	22	AH not included	S
59	15	3	13	21.9		S
60	43	2	39	79	45	N
61				25		N
64				25		N
TOTALS	526	46	1020	504.5	176.8	

WATER SUPPLY AND DEMAND

WATER SUPPLY AND DEMAND

Manchester's annual water use was tabulated and graphed for the years of 1970 through 1989 (Figure 16). According to this data, annual water use has been relatively consistent since 1975, and averages 253 MGY. In addition, monthly pumping records for the Lincoln Street well and Gravelly Pond were compiled and analyzed for the period between 1981 and 1989, inclusive (see Figure 17). According to this data, Manchester's average monthly water demand during this time was 21,933,966 gallons, or 721,117 gallons/day. Peak daily demands have been documented at 1.6 million gallons/day (Whitman and Howard, 1985).

Per capita water consumption is estimated at 133 gallons/day. This value is much higher than average; typical per capita consumption rates are on the order of 65 GPD. The reasons for these discrepancies could include undetected leaks in the distribution system, faulty metering systems and higher than average use of municipal water for irrigation purposes.

Lincoln Street Well

The Lincoln Street well provides approximately 43% of the town's water and has a rated pumping capacity of 600 gallons/minute (864,000 gallons/day), but is rarely pumped continuously. The average annual pumping rate has been 113 MGY over the past 9 years. The average monthly pumping rate for this well is 9,432,012 gallons, or 310,094 gallons/day. Monthly pumping rates for the period of 1981 to 1989 are graphed in Figure 18.

Gravelly Pond

The Gravelly Pond water supply provides approximately 57% of the town's water and has a rated pumping capacity of 950 gallons/minute. The average annual pumping rate for this supply has been 150 MGY over the past 9 years. The average monthly pumping rate for this well is 12,501,954 gallons, or 411,023 gallons/day. Monthly pumping rates for the period of 1981 to 1989 are graphed in Figure 19.

FIGURE 16

Annual Total Pumping Rates: 1970-1989
in million gallons per year

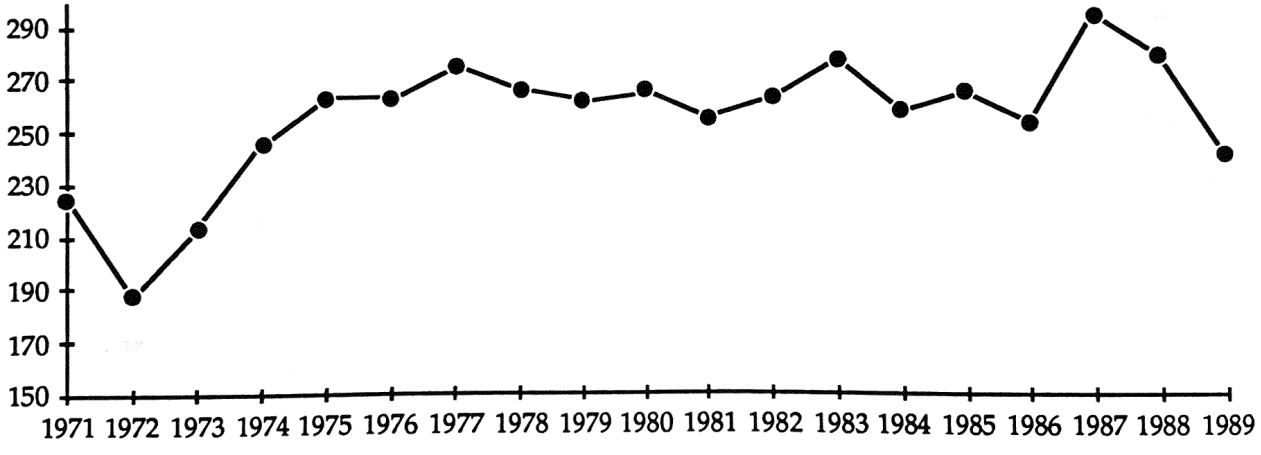


Figure 17
Monthly Total Water Use
Town of Manchester, 1981-1989
(in gallons)

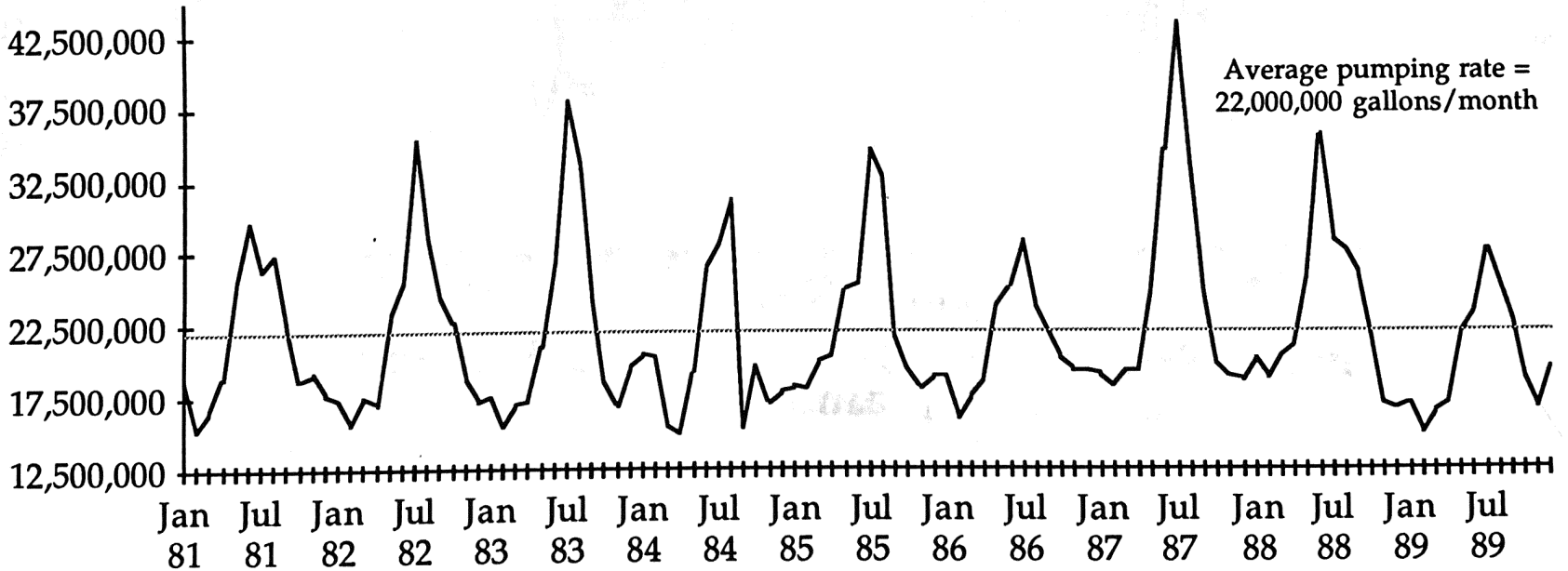


Figure 18
Monthly Total Yield of Lincoln Street Well
(in gallons)

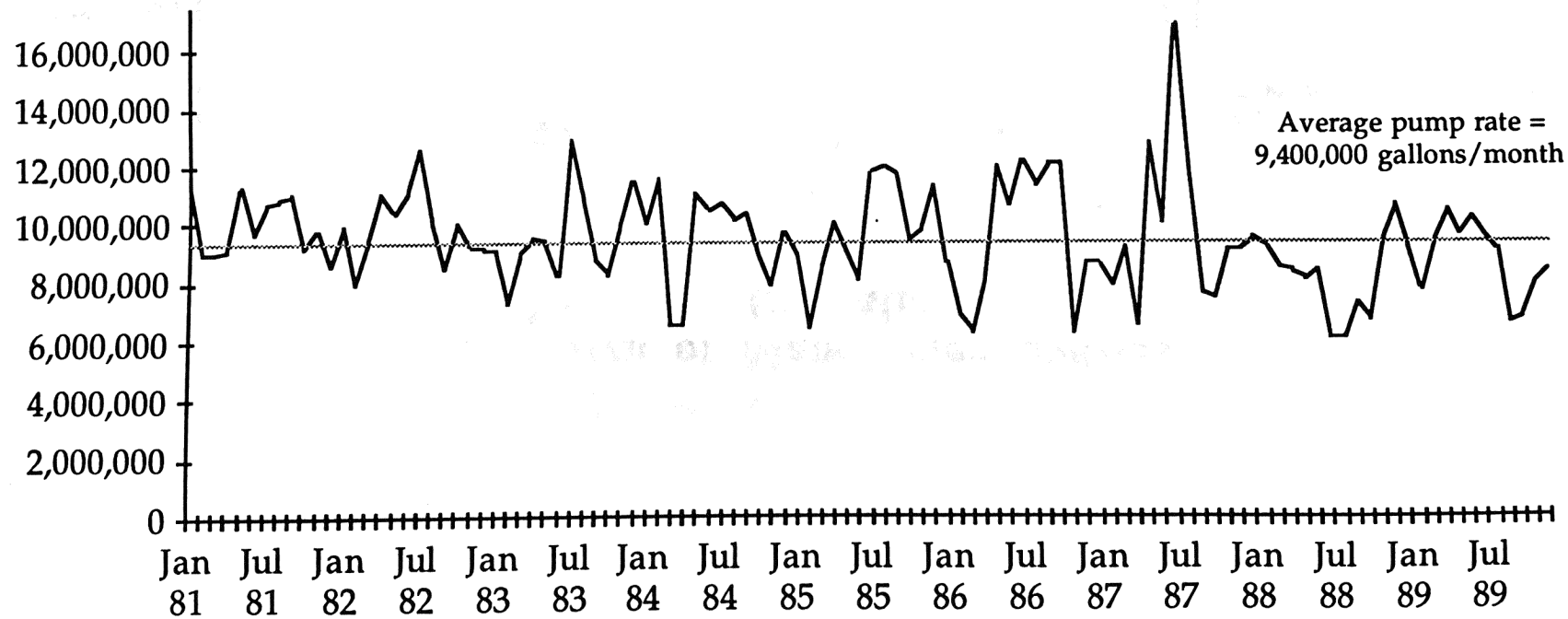
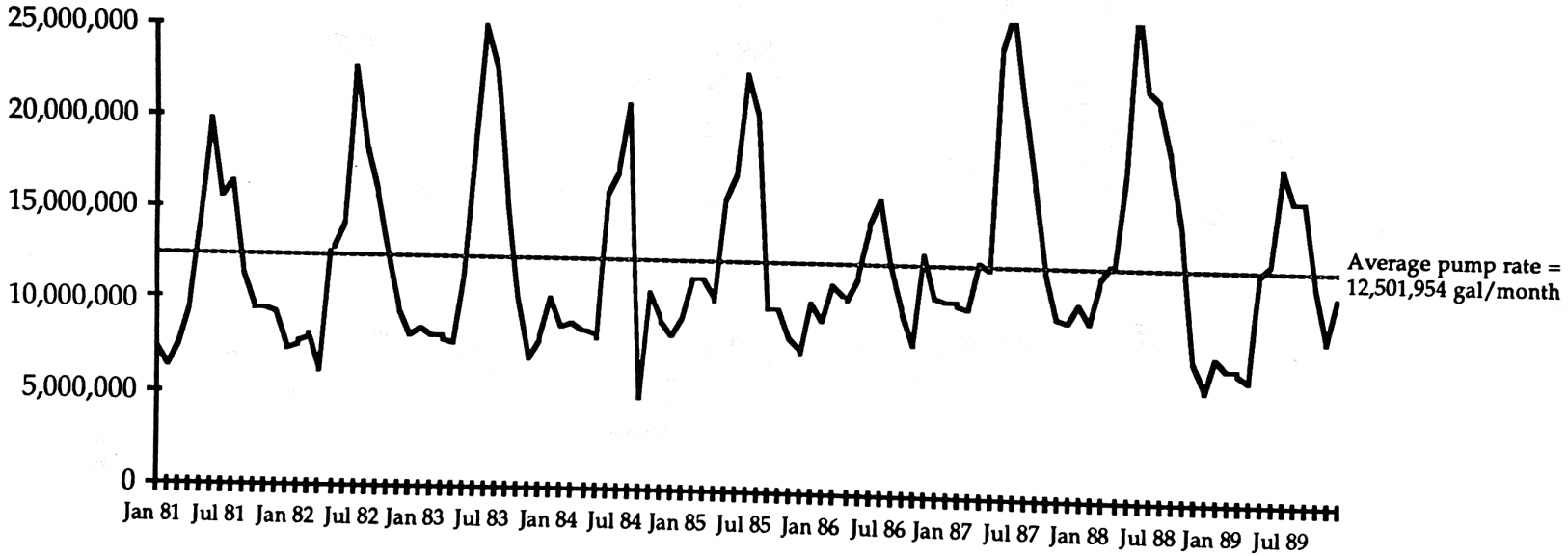


Figure 19
Monthly Total Yield of Gravelly Pond
(in gallons)



Private Wells

According to records obtained from the Manchester Board of Health and Essex County Club, 19 private wells have been installed in the Town of Manchester in the past one to two years. Information on these wells is provided in Table 9. The majority of these wells are used for irrigation, and consist of deep wells, drilled into bedrock. Pumping rates are generally less than 50 gallons/minute, with the exception of a bedrock well drilled at 134 School Street (185 GPM) and the Essex County Club irrigation well, which was drilled in a sand and gravel aquifer and yields up to 151 gallons/minute. The results of the geologic study of the Lincoln Street aquifer and pump test of the Lincoln Street well indicate that there is little if any hydrologic connection between the irrigation well and the Lincoln Street well.

Comparing the water supply figures with the population projections suggests that additional water supplies may not be necessary to meet future population demands. However, present water supplies are often overworked during the summer months and water conservation measures are occasionally needed. One reason for this may be the high per capita water consumption that could be the result of physical problems with the distribution system.

A source of additional water within the Town could alleviate the need to restrict water usage during the summer months. It would also provide a replacement supply of water if either the Lincoln Street Well or Gravelly Pond had to be shut down for mechanical or contamination reasons.

TABLE 9 PRIVATE WELL DATA, MANCHESTER BOARD OF HEALTH, 1989

Owner	Address	Driller	Well Depth	Water Depth	Date	Depth to BR	GR/BR	Waterbearing zone	Rate pumped	Comments
B. Gannett	Smith's Point	Rollins								
D. & B. Almy	27 Proctor St		280'	29' (salty)		1'6"	BR	266-267'	20 GPM	
H. Spaulding	19 Smith Point		330'	76' (salt)		2'	BR	323-324		
P. DeBeaumont	28 Masconomo Rd		57'	35'8"		55'	GR			
A.C. Forbes	4 Blossom Lane	Robinson	224'	35'		64'	BR		5-8 GPM	150' drawdown @ 4 hrs.
F. Thorne	134 School St.		300'	5.5'		16'6"	BR		185 GPM	
J. Kaneb	34 Masconomo Rd.	Viera	185'	30'		5'	BR	180-185'	30 GPM	185' drawdown @ 2 hrs.
J. Henderson	17 Old Neck Rd.	Viera								
J. Donavan	17 Smith's Point		445'	31'		5'	BR	80-100;200-300	10 GPM	405' drawdown @ 2 hrs.
Putnam	36 Proctor St.	Viera								
Modgdon	48 Forster Rd.	Viera								
D. Willis	18 Rockwood Heights									
J. Bradley	27 Eagle Head Rd.	Viera	325'	35'	3/24/89	2'	BR	180-200;290-300	20 GPM	325' drawdown @ 2 hrs.
M. Needham	80 Bridge St.	Armstrong	280'	20'	2/24/89	30'	BR	30-280'		30' till over BR
S. Kasnet	1 University Lane	Maher	100'	artesian	4/11/89	6'	BR			
T. Spang	Summer St.	Whipple	245'	37'	8/26/89	3'	BR		8 GPM	208' drawdown @ 24 hrs
P. George	16 Eaglehead Rd.	Rollins	380'	24'	6/16/89	2'	BR	369-370		
M. Weld	12 Lincon Ave.	Maher	440'	artesian	4/14/89	6'9"	BR			

WATER QUALITY

WATER QUALITY

Water quality data collected by the Town's Water Department was reviewed for each of the the two water supply sources. Each water supply source is tested monthly for bacteria (total and fecal coliform), quarterly for the basic drinking water standard parameters, and tested annually for heavy metals and radioactivity. In the past year, the Town has also started quarterly testing for volatile organic compounds (VOCs). Our findings for each water supply source are summarized below and water quality data for selected parameters are shown graphically.

Lincoln Street Well

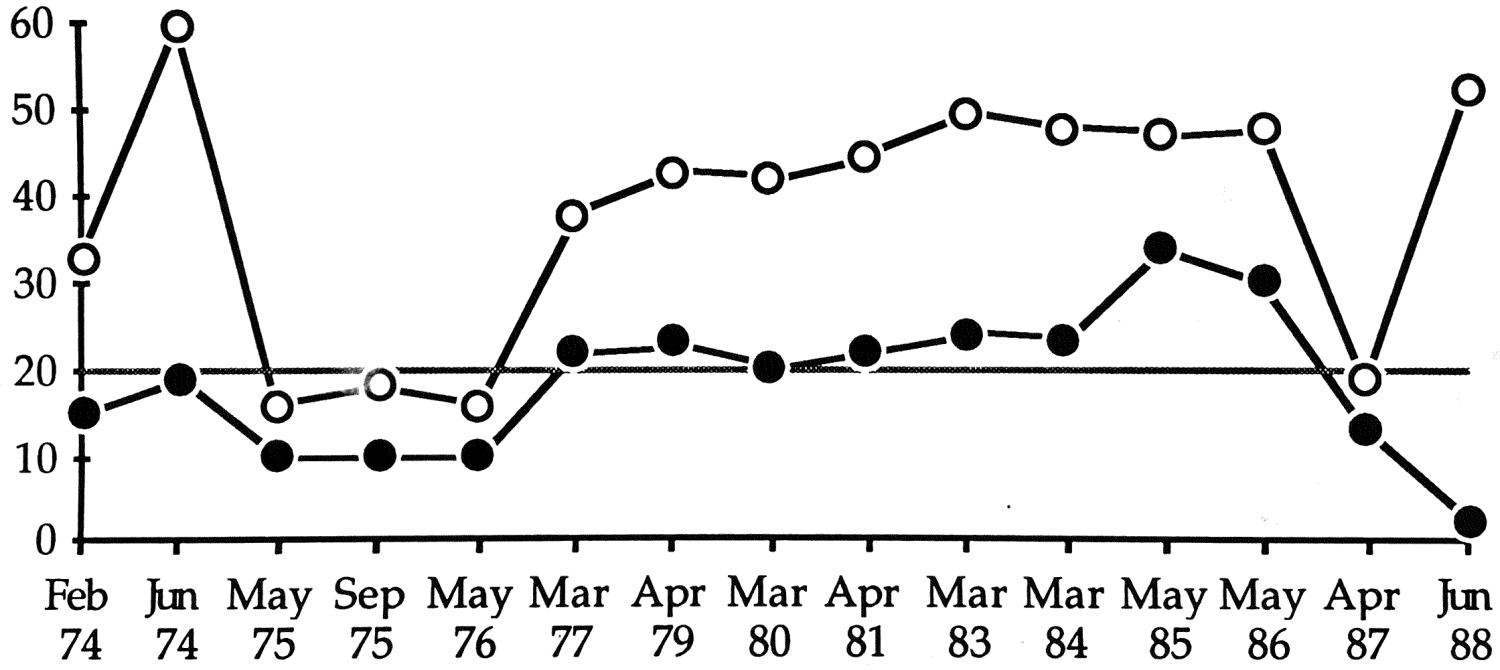
Ground water pumped from the Lincoln Street well is characterized by relatively low pH and alkalinity resulting in high corrosivity. Sodium and chloride levels are graphed in Figure 20 and frequently exceed drinking water standards. Figure 21 shows nitrate-nitrogen levels, which are low-to-moderate (BDL to 1.5 mg/l). Iron concentrations are also generally low to moderate, however, manganese levels are frequently elevated above drinking water standards (Figure 22).

Several water treatment chemicals are added to the water pumped from the Lincoln Street well, including sodium tri-polyphosphate for corrosion control and sodium fluoride for fluoridation. Previous investigations have suggested that these chemicals may contribute to the high sodium levels documented in the well water (Whitman and Howard, 1986).

Gravelly Pond

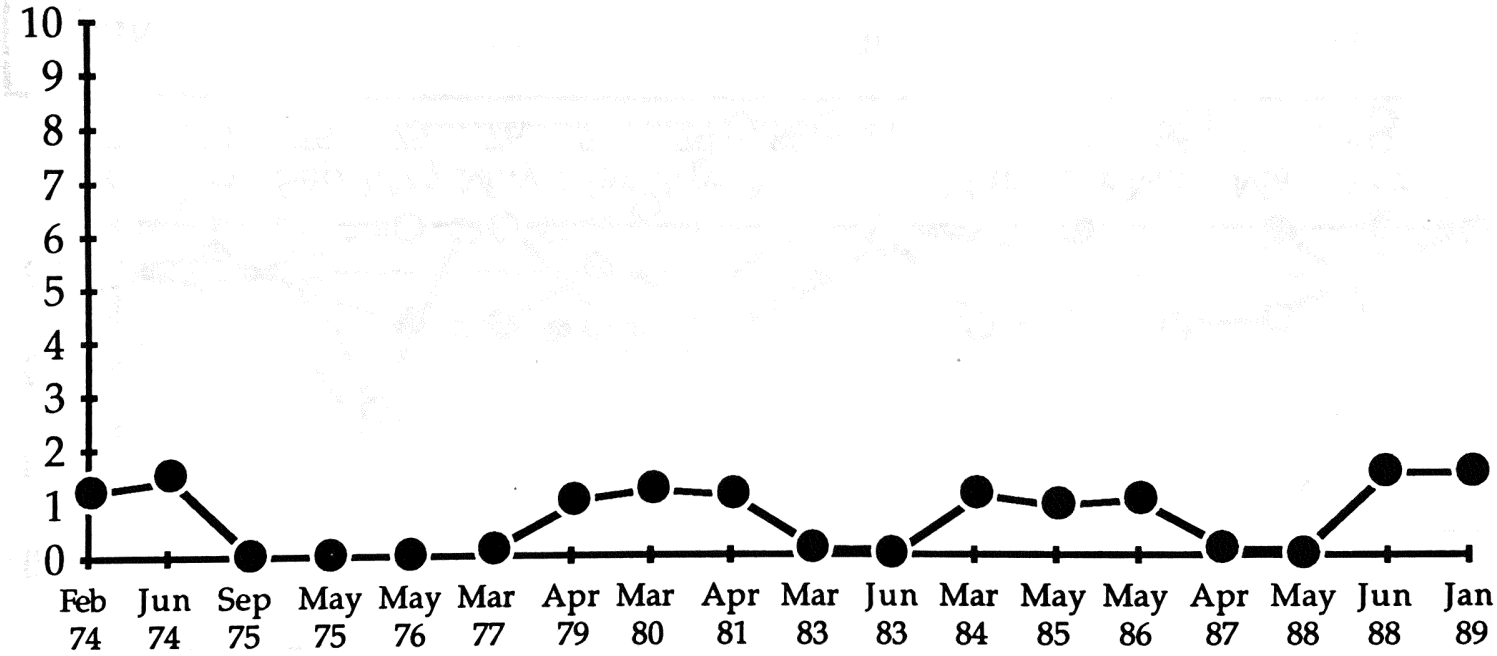
Surface water pumped from Gravelly Pond is characterized by slightly higher pH and alkalinity than the Lincoln Street well, but still has corrosive tendencies. Sodium and chloride levels are generally much lower than those measured at the Lincoln Street well and meet drinking water standards (Figure 23). Nitrate-nitrogen levels are consistently very low, with the exception of a single sample which may be erroneous (Figure 24). Iron and manganese concentrations fluctuate, probably in response to periodic influxes of water from Round Pond. Iron levels are generally within drinking water standards, but manganese levels frequently exceed those levels (Figure 25).

Figure 20
Sodium/Chloride Levels: Lincoln Street Well (in mg/liter), February 1974 to June 1988



Note: Federal and Massachusetts chloride standard is 250 mg/l

Figure 21
Nitrate-Nitrogen Levels: Lincoln Street Well (in mg/l), February 1974 to January 1989



Note: Federal drinking water standard is 10 mg/l

Figure 22
Iron/Manganese Levels: Lincoln Street Well (in mg/l), February 1974 to June 1988

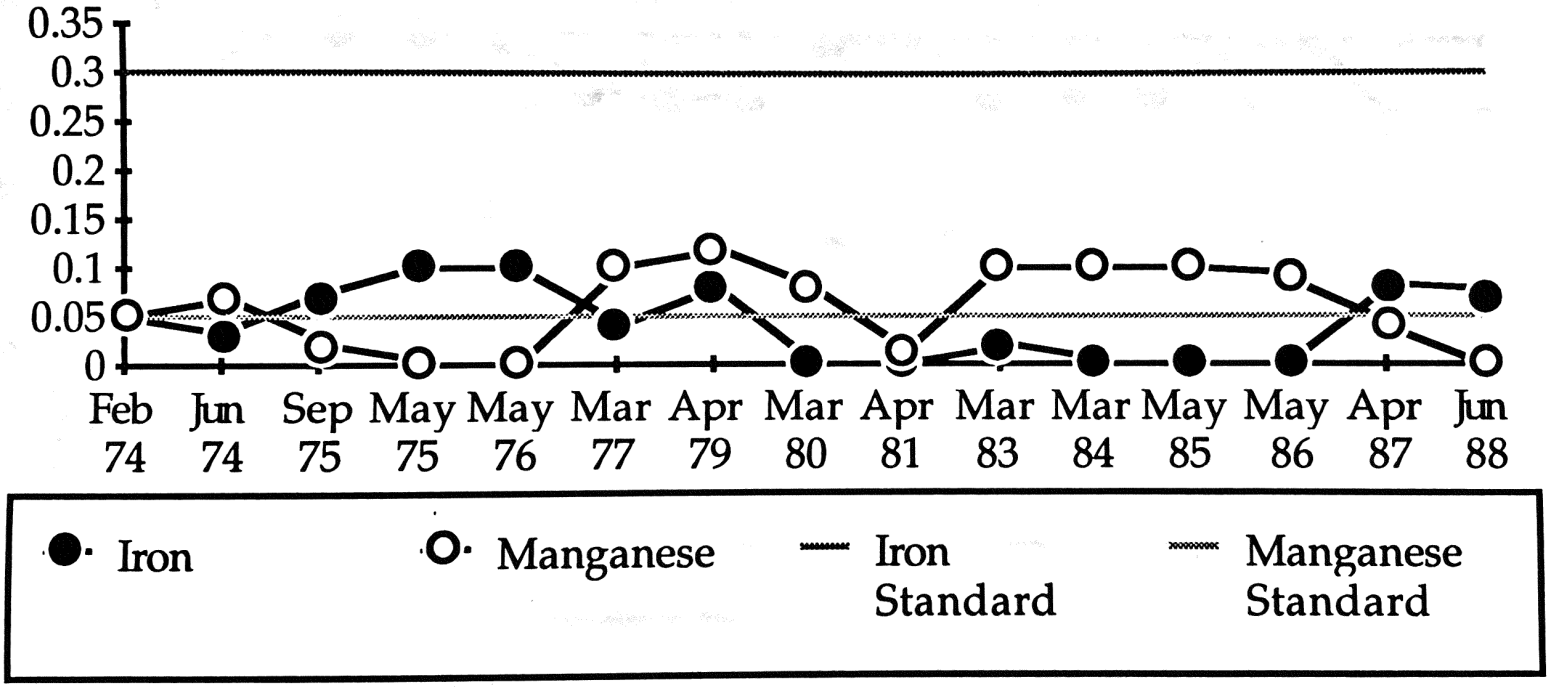
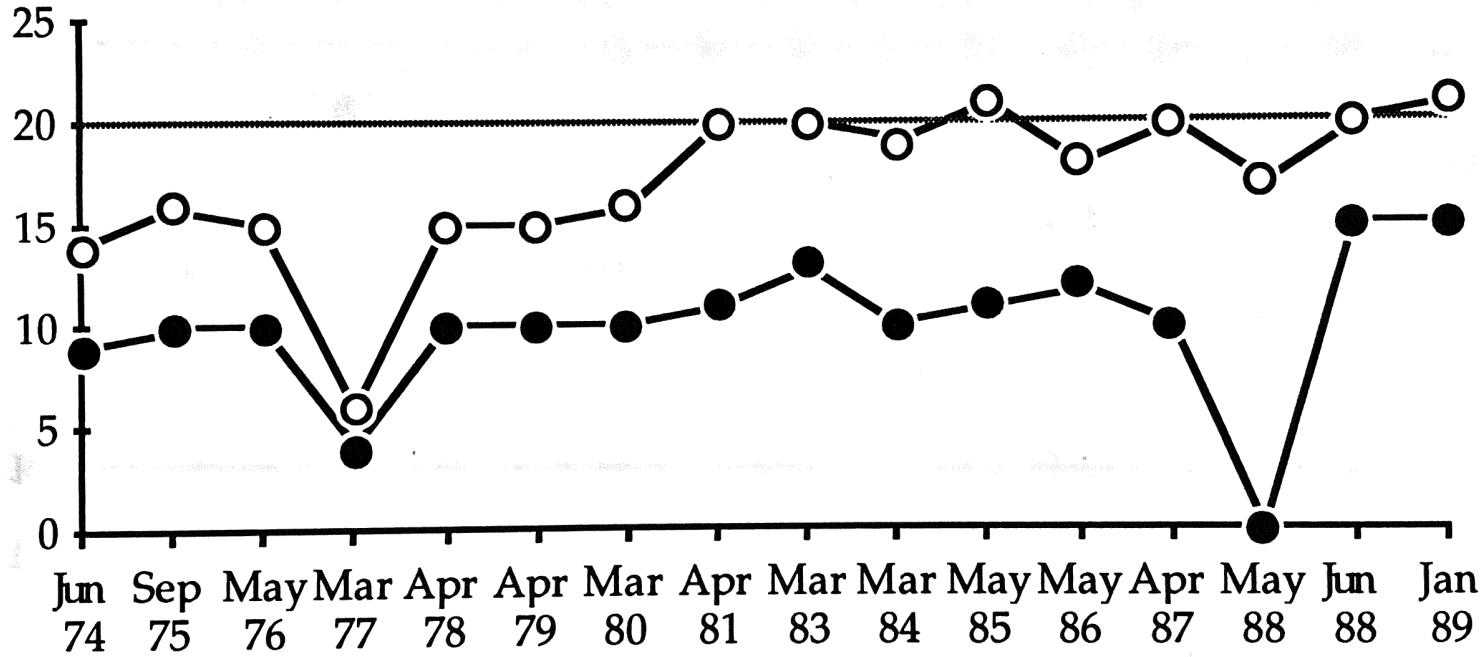
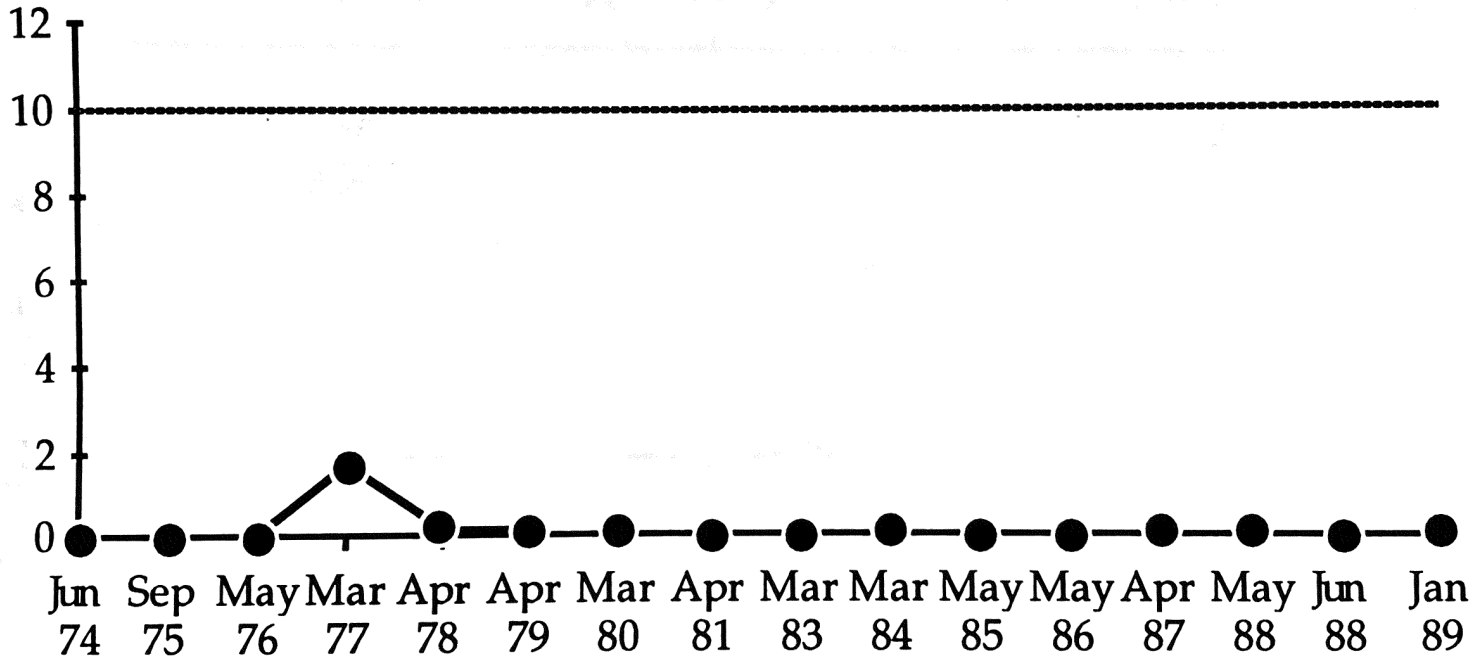


Figure 23
Sodium/Chloride Levels: Gravelly Pond (in mg/liter), June 1974 to January 1988



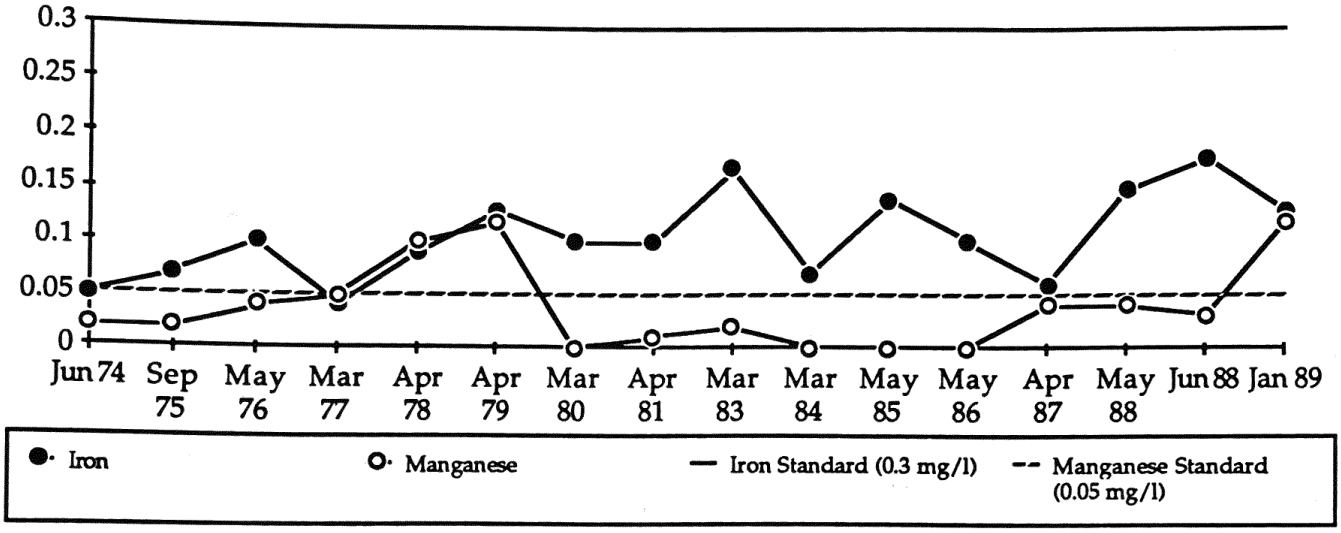
Note: Federal and Massachusetts chloride standard is 250 mg/l

Figure 24
Nitrate-Nitrogen Levels: Gravelly Pond (in mg/liter), June 1974 to January 1989



Note: Federal drinking water standard is 10 mg/l

Figure 25
Iron/Manganese levels: Gravelly Pond (in mg/liter), January 1974 to June 1988



Water treatment chemicals added to water from Gravelly Pond include sodium triphosphate for corrosion control, sodium fluoride for fluoridation, and chlorine for disinfection and oxidation of iron and manganese.

POTENTIAL CONTAMINATION SOURCES

POTENTIAL CONTAMINATION SOURCES

A variety of contaminant sources have the potential to contaminate ground and surface water resources in the Town of Manchester. These can be broadly grouped into point and non-point sources of contamination. Potential point sources of contamination include confirmed hazardous waste release sites, sewage treatment plants and large on-site sewage disposal systems, underground storage tanks, landfills, road salt storage areas, and warehouses or businesses storing large quantities of fertilizers, pesticides, herbicides or other chemicals. Potential point sources of contamination, if identified and carefully managed, can usually be controlled. Potential non-point sources of contamination include small on-site sewage disposal systems, residential lawn and garden fertilizers, pesticides and herbicides and road run-off. In contrast to potential point sources, non-point sources of contamination are very difficult to identify and control. A discussion of potential contaminant sources to the Town of Manchester's water resources is provided below. Specific sources within the contributing areas to the Lincoln Street well and Gravelly Pond are mapped in Figures 26 and 27.

Point Sources

Hazardous Waste Release Sites

A release of hazardous materials within the Town of Manchester was recently reported to the Town by the Division of Hazardous Materials at DEP. The site is an old Texaco Station located at 76 Summer Street, approximately 1000 feet south of the Lincoln Street well. According to measurements made at the site on 13 December 1989, 2.55 feet of floating product was documented within an observation well on the property. Although the site is underlain by approximately 10-15 feet of blue clay, the contamination appears to have entered the underlying sand and gravel aquifer. This site is located on the border of the Zone II zone of contribution to the Lincoln Street well. Under average pumping conditions the site is outside the zone of contribution to the well.

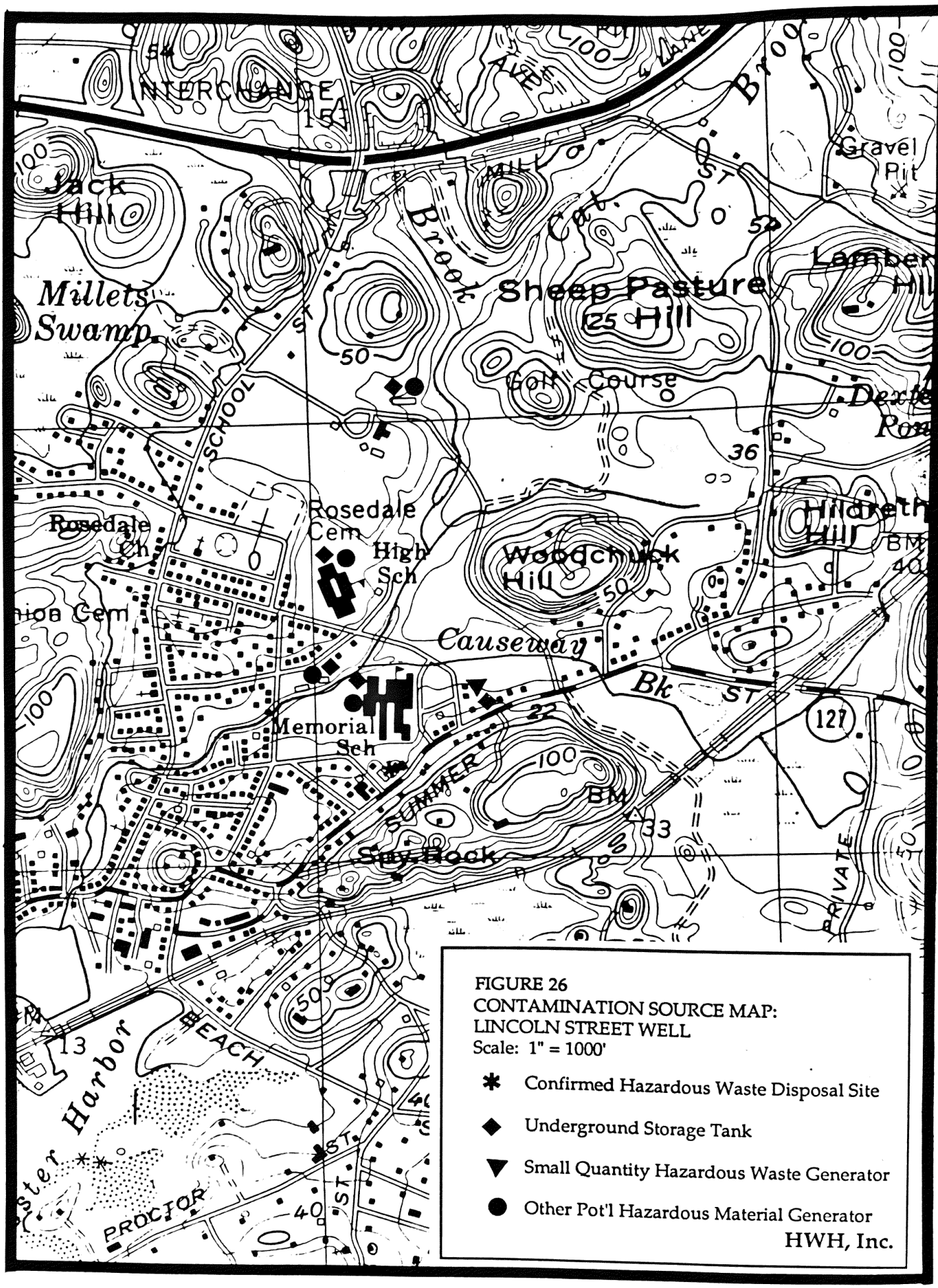


FIGURE 26
CONTAMINATION SOURCE MAP:
LINCOLN STREET WELL
Scale: 1" = 1000'

✱ Confirmed Hazardous Waste Disposal Site

◆ Underground Storage Tank

▼ Small Quantity Hazardous Waste Generator

● Other Pot'l Hazardous Material Generator

HWH, Inc.

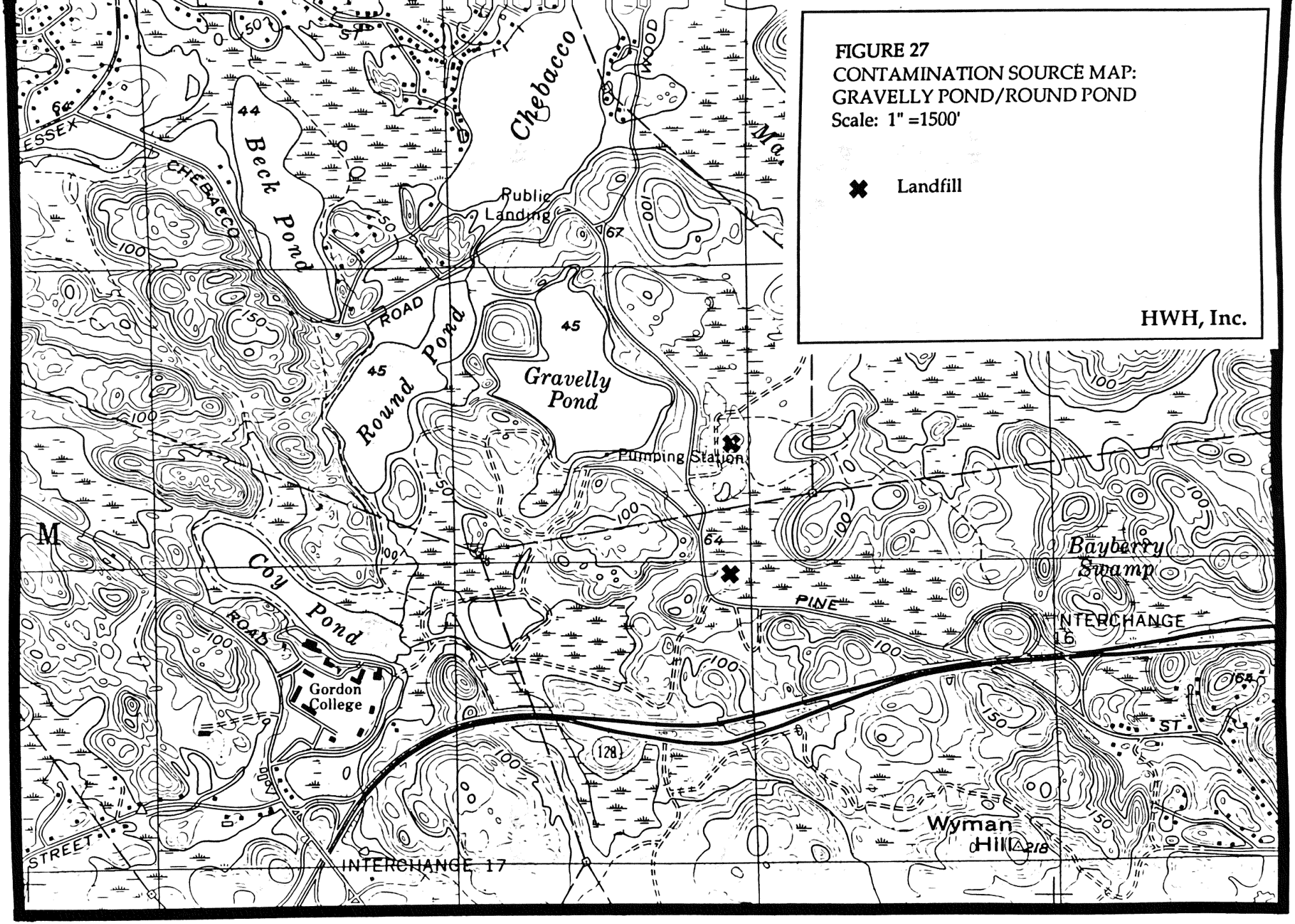


FIGURE 27
CONTAMINATION SOURCE MAP:
GRAVELLY POND/ROUND POND
Scale: 1" =1500'

✖ Landfill

HWH, Inc.

Landfills

Three landfills in the Towns of Hamilton, Manchester and Essex are located within close proximity to existing or potential drinking water supplies to the Town of Manchester. The Hamilton landfill is located less than 1000 feet directly east of Gravelly Pond. According to the ground water contour map prepared as part of Phase One of this study, ground water flowing beneath portions of this landfill may discharge to Gravelly Pond. Two monitoring wells have been installed at the site and have been sampled for a variety of water quality parameters. We are awaiting further information on this from the Hamilton DPW. Results were not available as of the publication of this report (May, 1990).

The Manchester landfill is located approximately 1500 feet to the southwest of Gravelly Pond and consists of a 10 acre, unlined landfill which stopped accepting refuse in 1981. The landfill still accepts non-refuse materials however, including leaves, brush, pavement and boulders. Eight monitoring wells have been installed on or adjacent to this site. Two of these wells and a brook are sampled quarterly for color, pH, alkalinity, COD, BOD, TDS, chlorides, specific conductance and iron.

An abandoned dump has also been identified in the Town of Essex, located off the old fire tower road to the north of the Cedar Swamp. The Cedar Swamp has previously been identified as a potential source of drinking water for the Town of Manchester. The Essex DPW was not able to provide details regarding the size, age and nature of this disposal area.

Sewage Treatment Plant

Manchester's sewage treatment plant is a secondary, extended air treatment facility, located near Manchester Harbor in the Town center. The treatment plant outfall is located in Massachusetts Bay, approximately 8700 feet off Manchester Harbor. This outfall is scheduled for repairs/replacement in the near future, however no changes are proposed in its location. No water quality analyses are routinely conducted in the vicinity of this outfall pipe, however, a series of dispersion tests were conducted prior to its construction.

Salt Storage

Uncovered salt storage areas have been known to leach large quantities of sodium chloride, resulting in the contamination of drinking water supplies through direct surface run-off or infiltration into ground water. Once in solution, sodium chloride can travel long distances and is a health hazard to people with high blood pressure and heart conditions Two salt storage areas are located within the Town of Manchester, one operated by the Commonwealth of Massachusetts and the other

operated by the Town DPW. The Commonwealth's salt storage area is located on Pine Street and is used to store up to 2000 tons of salt, in covered sheds.

The salt storage area used by the Manchester DPW is located on Pleasant Street. Approximately 80 to 100 tons of salt and 200 tons of salt/sand mix are stored here in a covered shed. A small quantity is located outside the shed for use by the general public. The Town uses approximately 300 tons of salt per year for road maintenance.

Underground Storage Tanks

Petroleum products stored in underground tanks pose a severe threat to ground water quality. The volatile organic compounds found in gasoline and other petroleum products (benzene, toluene and xylene, for example) are known human carcinogens. The Environmental Protection Agency has estimated that approximately one-third of all underground storage tanks are leaking, nationwide. The average expected lifespan for steel tanks in acidic soils is estimated at 15 years; after this point, small pin-hole leaks may develop, resulting in a discharge of hazardous materials to the subsurface environment. A spill or leak of as little as 10-50 gallons may be sufficient to contaminate a drinking water supply.

According to records maintained by the Manchester Fire Chief, there are 11 known underground storage tanks in the vicinity of the Lincoln Street wellfield, which are primarily used in storing fuel oil, gasoline and waste oil, including two fuel oil tanks at the Junior/Senior High School, two fuel oil tanks at the Memorial School, five gasoline and oil tanks located at Bailey's gas station and a gasoline tank at the Essex County Club. Further details on these storage tanks are provided in Table 11.

Industrial/Commercial/Agricultural Uses

A variety of chemicals are used or stored in industrial, commercial or agricultural businesses which may pose a threat to water quality through misuse, spills or fires. These include fertilizers, pesticides, herbicides, solvents, petroleum products, paints, etc. A listing of typical hazardous materials used in conjunction with a variety of land uses is provided as Table 10. Specific industrial, commercial and other entities which use or store hazardous materials in the Town of Manchester are summarized in Table 11, and include the schools, the DPW, Essex County Club, greenhouses and nurseries, marinas, dry cleaners, auto repair shops, etc. Eight of these have been issued small hazardous waste generator licenses by the DEP, Division of Hazardous Materials.

TABLE 10

HAZARDOUS MATERIALS/LAND USES

Land Use Category	Potential Hazardous Materials/Wastes Practices
Transportation services Auto, bus, truck and trailer rental Trucking and warehousing Commercial parking lots Railroad transportation terminal	Fuel tanks, repair shop wastes (chemical substances may be hauled), waste oils, solvents, acids, paint, waste hydraulic fluids, miscellaneous cutting oils.
Mailing, reproduction, commercial art stenographic services	Solvents, inks, dyes, oils, miscellaneous organics, photographic chemicals (note that solvents with ink in them may be collected by solvent recovery firms; ink contains heavy metals and may be returned to ink supplier for recovery and reuse; silver in photographic chemicals is recoverable).
Special Trade/Contractors Yard	Solvents, asbestos, paints, glues, adhesives, lacquers, tars, sealants, miscellaneous chemicals, epoxy waste.
Manufacturing and kindred products	Nitric, hydrochloric and sulfuric acid wastes, heavy metal sludges, copper-contaminated etchant (e.g. ammonium persulfate), cutting oil and degreasing solvent (trichlorethane, freon or trichloroethylene), waste oils, corrosive soldering flux, paint sludge, waste plating solution.
Manufacturing lumber and wood products	Treated wood residue and containers (use copper quinolate, mercury, sodium bazide to control stains and fungus) (use tanner gas to prevent lines from freezing). Paint sludge solvents, creosote, coating and glueing wastes.

TABLE 10 (continued)

HAZARDOUS MATERIALS/LAND USES

Land Use Category	Potential Hazardous Materials/Wastes Disposal Practices
Manufacturing furniture and fixtures	Paints, sludges, solvents, empty containers, degreasing sludges, solvent recovery sludges.
Manufacturing printing and publishing	Solvents, inks, dyes, oils, miscellaneous organics, photographic chemicals (note that solvents with ink in them may be collected by solvent recovery firms; ink contains heavy metals and may be returned to ink supplier for recovery and re-use; silver in photographic chemicals is recoverable).
Manufacturing stone, clay and glass products	Solvents, oils and grease, alkalis, acetic wastes, asbestos, heavy metal sludges, phenolic solids or sludges, metal-finishing sludge.
Research and development office	Numerous hazardous materials may be utilized depending upon specific type of research and development activity.
Local and commuter passenger transport terminal, motor vehicle service and repair including service station, self-service fuel station, auto body and paint shop	Fuel tanks, repair shop wastes, (chemical substances may be hauled), waste oils, solvents, gasoline storage, miscellaneous wastes, paints.
Public utilities	PCB's from transformers and capacitors, oils, solvents, sludges, acid solution, metal plating solutions (chromium, nickel, cadmium).

TABLE 10 (continued)

HAZARDOUS MATERIALS/LAND USES

Land Use Category	Potential Hazardous Materials/Wastes Disposal Practices
Golf course	Pesticides, herbicides, insecticides, fertilizers.
Hospital, nursing and professional care facility	X-ray developers and fixers (contain reclaimable silver, glutaldehyde, hydroquinone, phenedone, potassium bromide, sodium sulfite, sodium carbonate, thiosulfates and potassium allum) infectious wastes, radiological wastes, biological wastes, miscellaneous chemicals, disinfectants, asbestos, beryllium, acids.
Manufacturing of fabricated metal products	Paint wastes, acids, heavy metals, metal sludges, plating wastes, oils, solvents, explosive wastes.
Manufacturing of machinery except electrical	Oils, solvents, metals, miscellaneous organics, sludges, oily metal shavings, lubricant & cutting oils, degreasers (TCE), metal marking fluids ("blueing"), mold release agents.
Manufacturing of transportation equipment	Paint wastes, acids, heavy metals, metal sludges, plating wastes, oils, solvents, explosive wastes, oxygen/acetylene tanks.
Miscellaneous repair shops and related services	Solvents, acids, alkalis, paint sludges, metals, organics, miscellaneous chemicals.
Miscellaneous manufacturing	Numerous hazardous materials may be utilized depending upon specific type of manufacturing activity.

TABLE 11 INVENTORY OF CONTAMINANT SOURCES: MANCHESTER MASSACHUSETTS

Confirmed Hazardous Disposal Sites and Locations to be Investigated

1 Old Texaco Station, 76 Summer St. (2-3 feet floating product)

Underground Storage Tanks

	Owner	Address	Tank Size	Contents	Age	Comments
1	Jr/Sr High School	Lincoln St.	12,500 gal (2)	#2 fuel oil	1962	
2	Memorial School	Lincoln St.	10,000 gal (2)	#4 fuel oil	1951	
3	Magnuson Greenhouse	Vine St.	2500 gal	fuel oil		empty, in process of being removed
4	Bailey's Gas Station	Summer St.	12,000 gal	gas	? 1970s?	tightness tested in 1985; no 21E
			8000 gal	gas	? 1970s?	tightness tested in 1985; no 21E
			6000 gal	gas	? 1970s?	tightness tested in 1985; no 21E
			500 gal	waste oil	? 1970s?	tightness tested in 1985; no 21E
			500 gal	#2 fuel oil	? 1970s?	tightness tested in 1985; no 21E
5	Essex County Club	School St.	3000 gal	gas	1972	in process of being replaced

Salt Storage

1	Manchester DPW	Pleasant St.	80-100 tons salt; approx. 200 tons salt/sand mix
2	Commonwealth	Pine St.	

Landfills

1	Manchester	Pine St.	approx.10 ac.	closed for refuse since 1981
2	Hamilton	Pine St.		
3	Essex			

TABLE 11 INVENTORY OF CONTAMINANT SOURCES: MANCHESTER, MASSACHUSETTS (continued)

Small Quantity Hazardous Waste Generators (licensed)

1	Bailey's Service Station	76 Summer St.
2	Bevilacqua Trucking	Atwater Ave.
3	Coastal Auto Repair	Atwater Ave.
4	Dryclng by Raymond	Summer St.
5	LAD Co., Inc.	Atwater Ave.
6	Landmark School	Bridge St.
7	Manchester Auto Body	Elm St.
8	Manchester Auto Clinic	Pine St.
9	Seaside Auto Body	Pine St.

Other Commercial, Public or Private Entities Using or Storing Hazardous Materials

1	Manchester DPW	Pine St.	Salt, fertilizers, pesticides, herbicides
2	Essex County Club	School St.	Fertilizers, pesticides, herbicides, solvents, waste oil
3	Magnusons Greenhouse	Vine St.	Fertilizers, pesticides, herbicides
4	Wetterlow Greenhouse	Brook St.	Fertilizers, pesticides, herbicides
5	Jr/Sr High School	Lincoln St.	Fertilizers, pesticides, herbicides
6	Memorial School	Lincoln St.	Fertilizers, pesticides, herbicides
7	Manchester Marine	Ashland Ave.	Paints, solvents, oil
8	Crocker Boatyard	Ashland Ave.	Paints, solvents, oil
9	Trisail Marine	Ashland Ave.	Paints, solvents, oil

Other

1	Cemetery	
2	Road run-off	
3	Septic Systems	Mills Street
4		Atwater Ave.
5		Forest Lane
6		Loading Road

Non-point Sources

Individual Sewage Disposal Systems

Although most of the densely developed portions of Town are sewered, there are a few areas still serviced by on-site sewage disposal systems, including residences and commercial buildings located on Mill Street, Atwater Avenue, Forest Lane and Loading Road. On site sewage disposal systems discharge a variety of contaminants into ground water, including pathogens, nutrients and synthetic compounds associated with septic system cleaners.

Fertilizers

Fertilizers are widely used for agricultural, recreational and residential purposes and contribute varying amounts of nitrogen and phosphorus to surface and ground water. The amount of nutrients that ultimately leach into ground water or enter surface waters as runoff is a function of the slope, soil characteristics, type of ground cover, climate, type of fertilizer used, application rates and extent of irrigation.

A detailed literature review completed for a previous investigation (HWH, 1990), suggests that for nitrogen, 30% of the nitrogen applied to lawns and golf courses typically leaches into ground water in this region. The degree of surface run-off is much more variable, and depends on slope and soil characteristics. Although golf courses tend to be intensively maintained, fertilizer application rates are usually carefully controlled, and the use of slow-release fertilizers is commonplace. Therefore, nutrient inputs from golf courses are probably similar or less than those for residential lawns, on a per acre basis. Clearly, the area of fertilized turf is proportionally much larger, however, and must be taken into account.

Road Run-off

Typical contaminants found in road run-off include sodium chloride from road salt, oil and grease, gasoline, heavy metals, nutrients, bacteria and silt. The majority of Manchester's road run-off is directed to streams, ponds and other surface waters, most of which ultimately discharges to Manchester Harbor. Leaching catch basins, detention/retention basins and similar drainage mechanisms are uncommon in the Town. The Sawmill Brook/Causeway Brook watershed directs a large volume of run-off to these streams, both of which pass within 100 feet of the Lincoln Street wellfield.

Nitrogen Loading Analysis

In drinking water supplies, elevated nitrate-nitrogen levels can cause an illness variously known as infant cyanosis, methemoglobinemia or "blue-baby syndrome" in infants, caused by the alteration of hemoglobin and subsequent problems with oxygen transport. In addition, high nitrate-nitrogen levels have been linked to the formation of carcinogenic nitrosamines. To reduce potential health risks, both the U.S. EPA and Massachusetts DEP have established a drinking water standard of 10 mg/l. Cape Cod Planning and Economic Development Commission (CCPEDC) and numerous towns across the state have established a more conservative concentration of 5 mg/l, as a conservative planning guideline.

A nitrogen loading analysis was performed for Zones II and III of the Lincoln Street well to evaluate potential nitrogen concentrations in this aquifer under full build-out conditions. A mass balance approach was used, wherein annual nitrogen inputs from sewage, fertilizers, road run-off and precipitation are diluted by recharge from precipitated and other sources. The nitrogen loading values used in this analysis are provided as Table 12.

The results for Zone II analysis indicate that if this area were developed to saturation capacity (including complete residential development of the Essex County Club), nitrate-nitrogen levels in the Lincoln Street well could eventually reach 6.72 mg/l (Table 13). Clearly, this represents a worst-case scenario as this analysis assumes all new structures wold use on-site sewage disposal systems. If, in fact, on-site systems were to be used in this area, HWH recommends an increase in the minimum lot size to 30,000 SF.

The nitrogen loading analysis for Zone III only included the area within the Town of Manchester. A nitrate-nitrogen concentration of 4.33 mg/l is projected for this area, which is well within drinking water guidelines. See Table 14 for details. Calculated expected future nitrogen concentrations in the Zone III area outside of Manchester was not included in this analysis as the water quality concern with this area is from surface water runoff, not ground water.

TABLE 12 NITROGEN LOADING VALUES

Source	Concentration	Loading Rate	Flow/Recharge
Sewage	40 mg N/liter	(6.72 lbs N/Person-yr)	55 gallons/person-day (165 gal/dwelling)
Fertilizer		(0.9 lbs N/1000 sq ft-yr)	12 inches/year
Pavement Runoff	1.5 mg N/liter	(0.31 lbs·N/1000 sq ft-yr)	40 inches/year
Roof Runoff	0.75 mg N/liter	(0.15 lbs N/1000 sq ft-yr)	40 inches/year
Natural Land	0.05 mg N/liter	(.005 lbs N/1000 sq ft-yr)	12 inches/year
Average Loading Rate Per Dwelling			(25.3 lbs/yr)

Reference: Adapted from Nelson et al., 1988

HORSLEY WITTEN HEGEMANN, INC
NITROGEN LOADING CALCULATIONS
Manchester, MA Zone II Potential Future

TABLE 13

INPUT FACTORS

Number of Residential units (sewered)	54
Number of Residential units (unsewered)	100
Sewage flow per house (gal/day)	165
N-conc. in effluent (mg/l)	40
Lawn area per house (square feet)	5000
Pavement per house (square feet)	500
Road area (square feet)	187200
Roof area per house (square feet)	1500
Total recharge area (acres)	109
Recharge rate for pervious area (in/yr)	12
Recharge rate for impervious area (in/yr)	41.5

INPUT	CALCULATIONS	RESULTS
		CALCULATED LOADING (LBS/YR)
Sewage (gal/day)		
16,500	x N-conc (mg/l) x 3.785 l/gal x 365 days/yr : 454000 mg/lb	2008
Lawn area (sq ft)		
770,000	x 0.0009 lb N/sq ft	693
Pavement area (sq ft)		
264,200	x 0.00031 lb N/sq ft	82
Roof area (sq ft)		
231,000	x 0.00015 lb N/sq ft	35
Natural area (acres)		
80	x 43560 sq ft/acre x 0.000005 lb N/sq ft	17
	TOTAL NITROGEN LOADING (LBS/YR)	2835
		TOTAL RECHARGE (MG/YR)
Recharge from sewage (gal/day)		
16,500	x 365 days/yr : 1,000,000 gal/million gal	6.02
Total pervious area (sq ft)		
4,252,840	x 12 in/yr /12 in/ft x 7.48 gal/cu ft : 1,000,000 gal/million gal	31.81
Total impervious area (sq ft)		
495,200	x 41.5 in/yr /12 in/ft x 7.48 gal/cu ft : 1,000,000 gal/million gal	12.81
	TOTAL RECHARGE (MGAL/YR)	50.64
TOTAL NITROGEN LOAD/TOTAL RECHARGE X 454,000 MG/LB : 3,785,000 L/MGAL		
	=RECHARGE NITROGEN CONCENTRATION (mg/l or ppm)	6.72

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HORSLEY WITTEN HEGEMANN, INC
NITROGEN LOADING CALCULATIONS
Manchester, MA Zone III Potential Future with
Commercial Zoned Land Builtout

TABLE 14

INPUT FACTORS

Number of Residential units (sewered)	453
Number of Residential units (unsewered)	1139
Acres of Limited Commercial Zoning	176.8
Sewage flow per house (gal/day)	165
N-conc. in effluent (mg/l)	40
Lawn area per house (square feet)	5000
Pavement per house (square feet)	500
Road area (square feet)	2437260
Roof area per house (square feet)	1500
Total recharge area (acres)	2176
Recharge rate for pervious area (in/yr)	12
Recharge rate for impervious area (in/yr)	41.5

INPUT	CALCULATIONS	RESULTS
Sewage (gal/day)		CALCULATED LOADING (LBS/YR)
303,456	x N-conc (mg/l) x 3.785 l/gal x 365 days/yr : 454000 mg/lb	36937
Lawn area (sq ft)		
7,960,000	x 0.0009 lb N/sq ft	7164
Pavement area (sq ft)		
3,233,260	x 0.00031 lb N/sq ft	1002
Roof area (sq ft)		
2,388,000	x 0.00015 lb N/sq ft	358
Natural area (acres)		
1,864	x 43560 sq ft/acre x 0.000005 lb N/sq ft	406
	TOTAL NITROGEN LOADING (LBS/YR)	45867
		TOTAL RECHARGE (MG/YR)
Recharge from sewage (gal/day)		
303,456	x 365 days/yr : 1,000,000 gal/million gal	110.76
Total pervious area (sq ft)		
89,165,300	x 12 in/yr /12 in/ft x 7.48 gal/cu ft : 1,000,000 gal/million gal	666.96
Total impervious area (sq ft)		
5,621,260	x 41.5 in/yr /12 in/ft x 7.48 gal/cu ft : 1,000,000 gal/million gal	145.41
	TOTAL RECHARGE (MGAL/YR)	923.13
TOTAL NITROGEN LOAD/TOTAL RECHARGE X 454,000 MG/LB : 3,785,000 L/MGAL		
	=RECHARGE NITROGEN CONCENTRATION (mg/l or ppm)	5.96

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WATER RESOURCE PROTECTION STRATEGY

WATER RESOURCE PROTECTION STRATEGY

Introduction

The land areas that contribute ground and surface waters to the Town's public water supplies were delineated in the first phase of this investigation and were based on hydrologic and hydrogeologic data. Following the delineation of the water resource protection districts, a developable lot analysis was conducted to assess existing and potential levels of development within these critical areas. To supplement the developable lot analysis, potential contamination sources were identified. Finally, water quality data for Gravelly Pond and the Lincoln Street well were analyzed as were the patterns of water supply and demand

The results of these investigations indicate that Manchester's water supply is threatened by a variety of existing and potential land uses and activities. At issue for protecting Manchester's water supplies is the availability of management techniques to protect a resource that straddles municipal boundaries (Gravelly Pond watershed) as well as strategies that can remedy pre-existing threats (the presence of underground storage tanks within several hundred feet of the Lincoln Street well). Traditional management tools (zoning, subdivision and health regulations) are localized in their applicability and rarely serve to protect regional resources, even small systems such as Gravelly Pond. For example, the failure of Hamilton to adopt regulatory controls commensurate with surface watershed protection for Gravelly Pond would seriously impact Manchester's goal of protecting the Pond from contamination.

To establish an action program that is successful, Manchester's water resource management plan needs a broad approach. To that end, the following regulatory (zoning, subdivision, Board of Health and wetlands), non-regulatory and legislative recommendations have been prepared as part of the Town's Water Resource Protection Study. These alternative should prove useful in a variety of ways.

First, they supplement existing federal and state laws which, although designed to protect water resources, fall far short in protecting public and private drinking supplies from point and non-point contamination.

Second, they will allow Manchester officials to require data from developers in order to evaluate the impact of developments allowable under existing zoning, but which are clearly inappropriate when based upon the unavailability of Town water or the proposed development's impact upon existing water resources.

Third, they will allow Manchester an opportunity to establish several non-regulatory management programs that are atypical for water resource protection in New England. Atypcial not because of their limitations, but rather because New England communities have traditionally relied only on regulatory management techniques such as zoning and subdivision control.

Finally, the adoption of these alternatives will represent a significant step toward public recognition in Manchester that water systems are unavoidably linked to land development patterns and local land use practices. It also represents acceptance of the premise that water resources, up to now considered limitless in quantity, are a precious and finite resource.

Regulatory Tools

Introduction

Any comprehensive plan to protect Manchester's drinking water quality must address land uses throughout the entire contributing area, as many of the contaminant that could influence both the Lincoln Street Well and Gravelly and Round Ponds may originate far from the water supply. Effective water quality protection will require consistency and coordination between various Town boards, departments and committees, as well as among the Town of Hamilton and City of Gloucester. To this end, it is recommended that Manchester adopt a package of regulations including zoning bylaws, subdivision rules and regulations, wetland bylaws and Board of Health regulations. Recommendations for each of these four categories of regulatory tools are discussed in detail below.

Zoning Bylaws

The underlying assumption behind zoning is that there are limits to the amount of growth which a resource can withstand without harm to public health, safety or welfare of the general public. Environmental systems reach their limit or "carrying capacity" when they can no longer assimilate the by-products of land development without significant degradation or impairment. In Massachusetts, local government is empowered through General Laws Chapter 40A to adopt zoning bylaws designed to minimize adverse environmental impacts--ideally to prevent natural resource systems from exceeding their defined "carrying capacity".

Towns have numerous zoning tools available for the protection of water quality. Historically, communities adopted large lot zoning and prohibited various noxious uses in environmentally sensitive areas in an attempt to maintain water quality. More recently, municipal officials have begun to look at more innovative tools including site plan review, transfer of development rights, performance standards and overlay water resource protection districts.

Manchester currently has in place several zoning by-laws designed to protect natural resources; with the exception of an overlay protection district which effectively links the delineation of the recharge area to the Lincoln Street Well and the watershed to Gravelly Pond with specific regulations.

The recommended overlay protection district is presented below:

Recommendation One:

Adopt the following Water Resource Protection Overlay District designed to protect the Lincoln Street Well, Gravelly and Round Pond drinking water supplies as well as the water quality of Manchester Harbor.

Implementation:

The Water Resource Protection Committee and the Planning Board should submit the following Overlay District bylaw to Annual Town Meeting 1990 for adoption.

4.9 Water Resource Protection District

4.9.1 Findings. The Town of Manchester finds that:

1. The groundwater underlying the town is a major source of its existing and future water supply, including drinking water.

2. The aquifer system supplying Manchester with its groundwater supply is integrally connected with numerous surface waters, lakes and streams.

3. The surface water supplies of Gravelly and Round Ponds supplement the Town's groundwater resource, and are similarly considered an indispensable natural resource.

4. Accidental spills and discharges of toxic and hazardous materials have threatened the quality of such water supplies, posing public health and safety hazards.

5. Unless preventive measure are adopted to control the discharge and storage of toxic and hazardous materials within the Town, further spills and discharges of such materials will predictably occur and with greater frequency and degree of hazard by reason of increasing land development, population and vehicular traffic within Manchester.

4.9.2 Purpose: The purpose of this section is to protect the public health, safety and welfare through the preservation of the town's water resources to ensure a future supply of safe and healthful drinking water for the residents and employees of the Town of Manchester and the general public. The designation of the water resource protection districts and careful regulation of development activities within these districts can reduce the potential for ground and surface water contamination.

4.9.3 Water Resource Protection District Maps:

The maps delineating the Water Resource Protection District, dated April, 1990, prepared by Horsley Witten Hegemann, Inc. are incorporated herein and made a part of this Bylaw. These Maps shall be on file and maintained by the Town Clerk's office. Any amendments, additions or deletions to said Maps shall be made only as provided for in MGL Chapter 40A, Section 5.

4.9.3.1 Determination of Location within Water Resource Protection Districts: In determining the location of properties and facilities within the Water Resource Protection District, the following rules shall apply:

(a) Properties located wholly within one (1) zone reflected on the Water Resource Protection District maps shall be governed by the restrictions applicable to that zone.

(b) Properties located such that the site lies within more than one zone as reflected on the Water Resource Protection District maps shall be governed by the restrictions applicable to the zone in which the part of the property is located.

(c) Where a facility, building or accessory thereto including but not limited to sewage disposal systems is overlapped by different zones, the stricter zone shall apply.

(d) Special permits, in accordance with the provisions of this bylaw, Section 7.5 of the Manchester Zoning Bylaw and MGL Chapter 40A, Section 9, may be granted by the Planning Board to exempt a location from the requirements of this bylaw provided that the applicant demonstrates that the Water Resource Protection District maps incorrectly identify the location as being within the Water Resource Protection District. The burden of proof shall rest upon the applicant for a special permit to

demonstrate that the location is not within a delineated district. The applicant shall be required to present detailed hydrogeologic and hydrologic information to the Planning Board indicating that the location is, in fact, not within a Water Resource Protection District. The applicant shall provide funds to the Planning Board to pay for the technical review by the Planning Board's choice of consultant(s) of said hydrogeologic and hydrologic information and shall based its decision, in part, on the report by said consultant(s).

4.9.4 Definitions

"Applicant" means any person filing an application.

"Person" means any agency or political subdivision of the federal government or the Commonwealth, any state, public or private corporation or authority, individual, trust, firm, joint stock company, partnership, association, or other entity, and any officer, employee, or agent or such person, and any group of persons.

"Zone I" means the 400 foot protective radius required around a public water supply well or wellfield.

"Zone II" means that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation). It is bounded by the ground water divides which result from pumping the well and by the contact of the aquifer with less permeable materials such as till or bedrock. In some cases, streams or lakes may act as recharge boundaries. In all cases, Zone II shall extend upgradient to its point of intersection with prevailing hydrogeologic boundaries (a ground water flow divide, a contact with till or bedrock, or a recharge boundary).

"Zone III" means that land area beyond the area of Zone II from which surface water and ground water drain into Zone II. The surface drainage area as determined by topography is commonly coincident with the ground water drainage area and will e used to delineate Zone III. In some locations, where surface and ground water drainage are not coincident, Zone III shall consist of both the surface drainage and the ground water drainage areas.

"Zone WS" means that land area that contributes surface run-off to Gravelly and Round Ponds.

"Regulated Substances" means those substances found in Appendix "A", attached hereto and incorporated herein.

"Spill" means the unpermitted release or escape of a Regulated Substance, irrespective of the quantity thresholds directly or indirectly to soils, surface waters or ground waters.

4.9.5 Restrictions within Water Resource Protection District

4.9.5.1 Zone I

4.9.5.2 Prohibited Uses

(a) The use, handling, production and storage of Regulated Substances except as provided under the General Exemptions provisions of this bylaw.

(b) Any uses with on-site disposal of sewage effluent.

4.9.5.3 Special Permit Uses

(a) The use, handling, production and storage of Regulated Substances.

4.9.5.4 Zone II

4.9.5.5 Prohibited Uses

(a) The use, handling, production and storage of Regulated Substances except as provided under the General Exemptions provisions of this bylaw unless the applicant obtains a special permit.

(b) Residential approval not required land divisions, subdivisions or comprehensive permit developments, pursuant to MGL Chapter 41, Sections 81L, 81P, 81S and 81U and MGL Chapter 40B, Sections 20-23, at a density greater than one dwelling unit per 30,000 square feet unless connected to the municipal sewage treatment facility.

4.9.5.6 Special Permit Uses

(a) The use, handling, production and storage of Regulated Substances.

(b) Residential approval not required land divisions, subdivisions or comprehensive permit developments, pursuant to MGL Chapter 41, Sections 81L, 81P, 81S and 81U and MGL Chapter 40B, Sections 20-23, with on-site disposal of effluent , at a density greater than one dwelling unit per 30,000 square feet provided that the nitrate-nitrogen concentrations described in Section 4.9.6.3 (d) are not exceeded.

(c) Covering with impervious construction more than 20% of the portion of lot area within Zone II.

4.9.5.7 Zone III

4.9.5.8 Prohibited Uses

(a) The use, handling, production and storage of Regulated Substances unless the applicant qualifies for a General Exemption or obtains a special permit.

4.9.5.9 Special Permit Uses

(a) The use, handling, production and storage of Regulated Substances.

(b) Any uses with on-site disposal of sewage effluent exceeding 2,000 gallons per day for the entire project provided that the nitrate-nitrogen concentrations described in Section 4.9.6.3 (d) are not exceeded.

(c) Covering, with impervious construction, more than 40% of the portion of lot area within Zone III.

4.9.5.10 Zone WS

4.9.5.11 Prohibited Uses

All activities within Zone WS which store, handle, produce or use any regulated substance are prohibited unless the applicant qualifies for a General Exemption or obtains a special permit.

4.9.6 Special Permits: This section provides the requirements and procedures for the issuance of Special Permits by the Planning Board as required by this bylaw.

4.9.6.1 Special Permits: The Special Permit Granting Authority (SPGA) under this bylaw shall be the Planning Board. Special permits shall be granted only in conformance with this bylaw, Section 7.5 of the Manchester Zoning Bylaw and MGL Chapter 40A, Section 9.

4.9.6.2 Review by Other Town Agencies: Upon receipt of the special permit application, the SPGA shall transmit one copy to the Director of Public Works, the Executive Secretary, the Building Inspector, the Board of Health, the Conservation Commission, and any other relevant town board/agency or department for their written recommendations. Failure to respond in writing within 30 days shall indicate approval or no desire to comment by said agency. The necessary number of copies of the application shall be furnished by the applicant.

4.9.6.3 Special Permit Criteria and Decision

Special Permits may be approved by the SPGA provided that the SPGA determines, in conjunction with other town agencies as specified in Section 4.9.6.2, that the intent of this bylaw as well as its specific criteria are met. In making such determination, the SPGA shall give consideration to the simplicity, reliability and feasibility of the control measures proposed and the degree of threat to water quality which would result if the control measures failed. It shall then issue a written decision which describes its findings with respect to the following:

(a) meets the intent of this bylaw as well as its specific criteria;

(b) will not, during construction or thereafter, have an adverse impact on Zone I, Zone II, Zone III, or Zone WS;

(c) will not cause the average quality of groundwater recharged on the property to violate Class 1 drinking water standards promulgated by the DEP;

(d) will not cause the average concentration of nitrate-nitrogen in groundwater recharged on the property to exceed five (5) milligrams per liter.

4.9.6.4 Submittals: In applying for a special permit required by this bylaw, the information listed below shall be submitted to the SPGA, where applicable:

(a) A list of all Regulated Substances which are to be stored, handled, used or produced in the activity being proposed.

(b) A detailed description of the activities that involve the storage, handling, use or production of the Regulated Substances indicating the unit quantities in which the substances are contained or manipulated.

(c) Evidence of approval by the Massachusetts Department of Environmental Protection (DEP) of any industrial waste treatment or disposal system or any waste-water treatment systems over 15,000 gallons per day capacity.

(d) A site plan illustrating the location of all operations involving Regulated Substances.

(e) A hydrogeologic assessment of the site which shall address, at a minimum, soil characteristics and ground water levels and direction of ground water flow relative to operating and future planned public water supplies.

4.9.6.5 Design and Operating Guidelines: As a condition(s) of granting a special permit, the SPGA may require adherence to any, or all of the following design and operation guidelines, where in its opinion, such adherence would further the purpose and intent of this bylaw.

(a) Containment of Regulated Substances.
Leak-proof trays under containers, floor curbing or other contaminant systems to provide secondary liquid containment shall be installed. The containment shall be of adequate size to handle all spills, leaks, overflows, and precipitation until appropriate action can be taken. The specific design and selection of materials shall be sufficient to preclude any Regulated Substance loss to the external environment. Containment systems shall be sheltered so that the intrusion of precipitation is effectively prevented. The owner/operator may choose

to provide adequate and appropriate liquid collection methods rather than sheltering only after approval of the design by the SPGA. These requirements shall apply to all areas of use, production, and handling, to all storage areas, to loading and off-loading areas, and to above-ground and underground storage areas.

(b) Emergency Plan.
An emergency plan shall be prepared and filed with the Special Permit application indicating the procedures which will be followed in the event of spillage of a Regulated Substance so as to control and collect all such spilled material in such a manner as to prevent it from reaching any storm or sanitary drains or the ground water.

(c) Inspection.
A responsible person designated by the permittee who stores, handles, uses or produces the Regulated Substances shall check on every day of operation, for breakage or leakage or any container holding the Regulated Substances. Electronic sensing devices may be employed as part of the inspection process, if approved by the SPGA, and provided the sensing system is checked daily for malfunctions. The manner of daily inspection shall not necessarily require physical inspection of each container provided the location of the containers can be inspected to a degree which reasonably assures the SPGA that breakage or leakage can be detected by the inspection. Monitoring records shall be kept daily and made available to the SPGA on a quarterly basis.

(d) Reporting of Spills.
Any spill of a Regulated Substance in excess of the non-aggregate quantity thresholds shall be reported by telephone to the Fire Department and the Department of Public Works within one (1) hour of discovery of the spill. Clean-up shall commence immediately upon discovery of the spill. A full written report including the steps taken to contain and clean up the spill shall be submitted to the Fire Department, Director of Public Works, and Executive Secretary within fifteen (15) days of discovery of the spill.

(e) Monitoring of Regulated Substances in Groundwater Monitoring Wells.
If required by the SPGA, groundwater monitoring well(s) shall be provided at the expense of the permittee in a manner, number and location approved by the SPGA. Except for existing wells found by the SPGA to be adequate for this provision, the required well or wells shall be installed by a water well contractor. Samples shall be analyzed and

analytical reports prepared by a Commonwealth of Massachusetts certified laboratory of the quantity present in each monitoring well of the Regulated Substances.

(f) Alterations and Expansion.
The SPGA shall be notified in writing prior to the expansion, alteration or modification of an activity holding a Special Permit under this bylaw. Such expansion, alteration, or modification may result from increased square footage of production or storage capacity, or increased quantities of Regulated Substances, or changes in types of Regulated Substances beyond those square footages, quantities, and types upon which the permit was issued. Excluded from notification prior to alteration or modification are changes in types of Regulated Substances used in a laboratory or laboratories designated as such in the currently valid permit which do not exceed the non-aggregate limits and which are within the Generic Substances listed in said permit based upon the Generic List attached hereto and incorporated herein as Exhibit A. The introduction of any new Regulated Substance shall not prevent the revocation or revision of any existing Special Permit if, in the opinion of the SPGA, such introduction substantially or materially modifies, alters or affects the conditions upon which the existing Special Permit was granted or the ability to remain qualified as a General Exemption, if applicable, or to continue to satisfy any conditions that have been imposed as part of a Special Permit, if applicable.

4.9.7 General Exemptions

4.9.7.1 Exemptions for Continuous Transit. The transportation of any regulated substance through Zones I, II, III, or WS shall be exempt from the provisions of this bylaw provided the transporting motor vehicle is in continuous transit.

4.9.7.2 Exemptions for Vehicular and Lawn Maintenance Fuel and Lubricant Use. The use in a vehicle or lawn maintenance equipment of any regulated substance solely as fuel in that vehicle or equipment fuel tank or as lubricant in that vehicle or equipment shall be exempt from the provisions of this bylaw.

4.9.7.3 Exemptions for Application of Pesticides, Herbicides, Fertilizers, Fungicides and Rodenticides. The application of those Regulated Substances used as pesticides, herbicides, fertilizers, fungicides, and rodenticides in recreation, agriculture, pest control and aquatic weed control activities shall be exempt from the provisions of this bylaw provided that:

(a) In all zones, the application is in strict conformity with the use requirement as set forth in the substances EPA registries and as indicated on the containers in which the substances are sold.

(b) In all zones, the application of any of the pesticides, herbicides, fertilizers, fungicides, and rodenticides shall be noted in the records of the certified operator. Records shall be kept of the date and amount of these substances applied at each location and said records shall be available for inspection at reasonable times by the Building Inspector and Director of Public Works.

(c) In all zones, the application of pesticides, herbicides, fertilizers, fungicides, and rodenticides for non-residential or non-agricultural purposes shall require a special permit.

4.9.7.4 Exemption for Retail/Wholesale Sales Activities

Except in Zone I, retail/wholesale sales establishments that store or handle Regulated Substances for resale in their original unopened containers shall be exempt from the provisions of this bylaw, provided however, that retail/wholesale sales establishments that store or handle quantities of Regulated Substances exceeding thirty (30) gallons liquid or twenty-five pounds (25) solid shall be prohibited without receipt of a special permit.

4.9.7.5 Exemptions for Office and Commercial Uses

Except in Zone I, office and commercial use of Regulated Substances below the aggregate sum not exceeding thirty (30) gallons where said substance is a liquid or twenty-five (25) pounds where said substance is a solid shall be exempt from the provisions of this bylaw, provided however, that office and commercial uses that store or handle quantities of Regulated Substances exceeding thirty (30) gallons liquid or twenty-five pounds (25) solid shall be prohibited without receipt of a special permit.

4.9.7.6 Exemption for Construction Activities

The activities of constructing, repairing or maintaining any facility or improvement on lands within Zones I, II, III, or WS shall be exempt from the provisions of this bylaw provided that all contractors, subcontractors, laborers, material men and their employees when using, handling, storing or producing Regulated Substances in Zones I, II, III,or WS,use those applicable Best Management Practices set forth in Exhibit B, attached hereto and incorporated herein.

4.9.7.7 Exemption for Household Use

In addition to the exemptions provided for in Section 4.9.7.3, the household use of Regulated Substances below the aggregate sum not exceeding thirty (30) gallons where said substance is a liquid or twenty-five (25) pounds where said substance is a solid shall be exempt from the provisions of this bylaw, provided however, that household uses that store or handle quantities of Regulated Substances exceeding thirty (30) gallons liquid or twenty-five pounds (25) solid shall be prohibited without receipt of a special permit.

4.9.7.8 Exemption for Municipal Use

In addition to the exemptions provided for in Section 4.9.7.3, the municipal use of Regulated Substances in quantities exceeding thirty (30) gallons where said substance is a liquid or twenty-five (25) pounds where said substance is a solid shall be prohibited without receipt of a special permit.

4.9.7.9 Exemption for Underground Storage of Oil(s)

The underground storage of oil(s) used for heating fuel shall be exempt from the provisions of this bylaw provided, however, that the container used for said storage shall be located within an enclosed structure sufficient to preclude leakage of oil to the external environment (e.g. cement-floored basement), and sheltered to prevent the intrusion of precipitation.

4.9.8.0 Severability

The provisions of this bylaw are severable from each other and the invalidity of any provisions or section shall not invalidate any other provision or section thereof.

EXHIBIT A
GENERIC SUBSTANCES LIST

Acid and basic cleaning solutions
Antifreeze and Coolants
Arsenic and arsenic compounds
Bleaches, Peroxides
Brake and transmission fluids
Brine solution
Casting & Foundry chemicals
Caulking agents and sealants
Cleaning solvents
Corrosion and rust prevention solutions
Cutting fluids
Degreasing solvents
Disinfectants
Electroplating solutions
Explosives
Fertilizers
Fire extinguishing chemicals
Food processing wastes
Formaldehyde
Fuels and additives
Gasolines
Glues, adhesives and resins
Greases
Hydraulic fluid
Indicators
Industrial and commercial janitorial supplies
Industrial sludges and stillbottoms
Inks, printing and photocopying chemicals
Laboratory chemicals
Liquid storage batteries
Medical, pharmaceutical, dental, veterinary and hospital solutions
Mercury and mercury compounds
Metals finishing solutions
Oils
Paints, primers, thinners, dyes, stains, wood preservatives, varnishing and cleaning compounds
Painting solvents
PCB's
Pesticides and herbicides
Plastic resins, plasticizers and catalysts
Photo development chemicals
Poisons

EXHIBIT A
GENERIC SUBSTANCES LIST
(Continued)

Polishes
Pool chemicals in concentrated form
Processed dust and particulates
Radioactive sources
Reagents and standards
Refrigerants
Roofing chemicals and sealers
Sanitizers, disinfectants, bactericides and algaecides
Soaps, detergents and surfactants
Solders and fluxes
Stripping compounds
Tanning industry chemicals
Transformer and capacitor oils/fluids
Water and wastewater treatment chemicals

EXHIBIT B
"BEST MANAGEMENT PRACTICES" FOR THE CONSTRUCTION INDUSTRY

A) The general contractor, or if none, the property owner, shall be responsible for assuring that each contractor or subcontractor evaluates each site before construction is initiated to determine if any site conditions may pose particular problems for the handling of any Regulated Substances. For instance, handling Regulated Substances in the proximity of water bodies or wetlands may be improper..

B) If any Regulated Substances are stored on the construction site during the construction process, they shall be stored in a location and manner which will minimize any possible risk of release to the environment. Any storage container of 55 gallons, or 440 pounds, or more, containing Regulated Substances shall have constructed below it an impervious containment system constructed of materials of sufficient thickness, density and composition that will prevent the discharge to the land, ground waters, or surface waters, of any pollutant which may emanate from said storage container or containers. Each containment system shall be able to contain 150% of the contents of all storage containers above the containment system.

C) Each contractor shall familiarize him/herself with the manufacturer's safety data sheet supplied with each material containing a Regulated Substance and shall be familiar with procedures required to contain and clean up any releases of the Regulated Substance. Any tools or equipment necessary to accomplish same shall be available in case of a release.

D) Upon completion of construction, all unused and waste Regulated Substances and containment systems shall be removed from the construction site by the responsible contractor, and shall be disposed of in a proper manner as prescribed by law.

Subdivision Rules and Regulations

Introduction

Subdivision regulations, as provided for in the Commonwealth's enabling legislation, "fine-tune" zoning bylaws in that they focus less on land use and more on engineering concerns such as road construction, utilities and site plan lay-out of individual subdivisions. The protection of coastal water quality via subdivision control is therefore far less effective than through zoning, particularly as is the expressed intent of subdivision control legislation that plans which meet a community's subdivision rules and regulations are to be approved by the planning board. Furthermore, subdivision rules and regulations do not regulate other major developments proposed on single lots.

Nonetheless, several techniques can be incorporated into subdivision rules and regulations to reduce impacts of subdivisions proposed within critical areas. These focus primarily on the environmental impact assessment process, site-plan lay-out, and stormwater and sedimentation controls.

Recommendation One:

Manchester's current Environmental and Community Impact Analysis should be revised to require detailed information on the proposed development's impact on water resources.

Amend Section 6.04 of the Manchester Subdivision Rules and Regulations as follows:

Add new Sections 6.04 ii (1-4) as follows:

1. All sensitive receptors on and adjacent to the site should be clearly identified. These include surface waters, wetlands and ground water supplies (existing and potential public and private wells).

2. Detailed information on the existing condition of each of these water resources should be provided as part of the report. This may entail hydrogeologic investigations, surface and ground water sampling, and hydrologic investigations of surface waters and wetlands.

3. The environmental impact assessment should then focus on impacts on these specific water resources. Pre-and post-development conditions should be compared and quantified, and where possible, linked to performance standards. For example, pre- and post-development nitrate-nitrogen concentrations in ground water should be calculated using approved methodologies, and compared to performance standards. Similarly, drainage calculations should be calculated under pre-and post-development conditions, and compared with established performance standards.

4. If the proposed subdivision cannot meet the applicable performance standards or is found to result in unacceptable impacts on water resources, the environmental impact assessment should specify appropriate mitigation.

Implementation:

The Planning Board should revise the environmental impact requirements of the Subdivision Rules and Regulations to include the above-noted standards.

Recommendation Two:

Manchester's Subdivision Rules and Regulations should be revised to add new section focusing on stormwater run-off and the proposed development's impact on water resources.

Amend Section 6.06 of the Manchester Subdivision Rules and Regulations by adding new Subsection 6.06 (B) as follows:

Add new Sections 6.06 (B) as follows:

6.06 (B) STORMWATER MANAGEMENT PLANS

Stormwater Management: A plan for effective stormwater management shall be prepared detailing how the project will minimize the volume of run-off generated, by limiting the extent of impervious area (where considerations of safety permit) and subsequently enhance overland flow and pre-concentration infiltration by both treating the run-off unavoidably generated and controlling its off-site transport. The plan shall also detail how the "first flush" of storm-generated run-off (which contains the highest pollutant loads) will be treated.

Purpose: Minimum standards are established to prevent the degradation of surface and groundwater quality, to promote the enhancement of water quality in critical resource areas, and to prevent downstream and coastal flood damage resulting from direct and cumulative impacts of development. Minimum standards shall apply to new residential developments of 5 or more residential units or dwellings (including attached units); commercial developments; industrial developments; highway construction, upgrades, or other roadway improvements generating increased run-off volumes and discharges rates, channelization of run-off, or alteration of existing drainage systems.

The Stormwater Management Plan shall include a discussion on the following general guidelines:

1) Stormwater management facilities should be installed and plans reviewed with full consideration given to both water quality enhancement and flood hazard management. Minimum standards for water quality enhancement and flood control may be met (in order of preference) via a combination of site design, and structural and non-structural measures.

2) Site Preparation: Natural drainage patterns and natural flood mitigation capacity should be maintained wherever possible. Watercourses should be left open unless approval to enclose a ditch is granted by the Planning Board, with prior approval by the Conservation Commission.

3) New grades should be established in proper relation to the need to fulfill drainage requirements while ensuring that surface waters do not cause any damage to the developed or undeveloped land downstream or below the proposed development.

4) To the maximum extent feasible and consistent with groundwater protection objectives, stormwater should be treated and recharged on-site or in an approved regional stormwater management facility, rather than discharged to surface waters. In no case should untreated stormwater be discharged to surface waters.

5) Roadway design should to the maximum extent possible aim at removing water from paved surfaces continuously rather than at infrequent catch basins or spillways, using swales and ponding areas in preference to gutters, catch basins, and piped sewerage.

Section 6.06 (B) should be further revised to include the following minimum standards.

The following minimum standards shall be followed, and the Stormwater Management plan shall detail the manner in which these requirements will be met:

6) In the watershed of Gravelly and Round Ponds,and Zones I, II and III as shown on the Water Resource Protection Overlay District, stormwater should be treated to a solids removal efficiency of 85 percent.

7) For purposes of flood hazard mitigation and water quality protection, no increase in the pre-development peak discharge rate for the 2- and 25-year, 24 hour storm events should be permitted. Downstream analysis of the 100-year, 24 hour storm event should be performed and presented. Where downstream impacts of the post development 100-year, 24 hour storm event are deemed to be potentially significant, no increase in the pre-development peak discharge rate should be permitted.

   Exceptions: Where an applicant can prove that downstream flooding is not a concern (e.g., stormwater is discharged to coastal waters or to pre-existing storm drainage systems of sufficient capacity to accommodate the additional volume and peak discharge), minimum flood control requirements may be waived. Calculations presented in support of such a determination should consider the cumulative effect of all proposed development projects within the watershed at full build-out.

8) Where structural methods are necessary, detention basins are recommended to meet minimum standards for flood control. To meet pollutant removal objectives, use of extended detention basins or wet basins designed to achieve the specified solids removal rate is recommended.

Health Regulations

Introduction

Boards of Health have far reaching powers to adopt local regulations designed to protect the health and safety of a community. Issues which fall within their regulatory jurisdiction include the disposal of sanitary sewage, control and registration of hazardous materials, the siting and monitoring of landfills and land developments and the review of all subdivision plans filed under the Subdivision Control Law (MGL, Chapter 41).

Recommendation #1

The Board of Health should adopt the following health regulation governing hazardous materials and tank regulations.

Implementation:

The Board of Health should adopt the following regulation in accordance with the provisions of MGL Chapter 111.

MANCHESTER BOARD OF HEALTH REGULATION

HAZARDOUS MATERIALS AND TANK REGULATIONS

Section 1. Authority

This regulation is adopted by the Manchester Board of Health ("Board") under Massachusetts General Laws, Chapter 111, Section 31, which gives the Board authority to make reasonable health regulations, violations of which are punished by fines up to two hundred ($200.00) dollars.

Section 2. Purpose

This regulation is intended to protect the surface and ground water quality and quantity within Zone I, Zone II, and Zone III of the Lincoln Street well, from contamination with hazardous materials (see Zone Map attached hereto). This regulation is intended to protect the public health and safety relative to the risks and potential risks posed by contamination of said waters.

Section 3. Definitions

"Board" means the Manchester Board of Health.

"Discharge" means the disposal, deposit, injection, dumping, spilling, leaking, incineration, or placing of any hazardous material into or on any land or water so that such hazardous material or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters.

"Hazardous Material" means a product or waste, or combination of substances which because of quantity, concentration, or physical, or chemical, or infectious characteristics, poses in the Board's judgment a substantial present or potential hazard to the human health, safety, while stored, transported, used or disposed of, or otherwise managed. Any substance deemed a hazardous waste in Massachusetts General Laws, Chapter 21C, shall also be deemed a hazardous material for the purpose of this regulation.

"Operator" means any person who occupies and/or is responsible for operation of a site. The term shall not include a person who, without participating in the management of a site, holds indicia of ownership primarily to protect his security interest in said site. In the case of an abandoned site, the term operator means any person who operated such site immediately prior to such abandonment.

"Owner" means any person who has effective control or legal ownership of a site. The term shall not include a person who, without participating in the management of a site, holds indicia of ownership primarily to protect his security interest in said site. For the purpose of this regulation the Board shall be entitled to rely upon the most current list of owners in the records of the Town Board of Assessors as providing sufficient evidence of ownership under this regulation. In the case of an abandoned site, the term owner means any person who owned such site immediately prior to such abandonment.

"Zone I" means the protective radius required around a public water supply well or wellfield.

"Zone II" means that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation). It is bounded by the ground water divides which result from pumping the well and by the contact of the aquifer with less permeable materials such as till or bedrock. In some cases, streams or lakes may act as recharge boundaries. In all cases, Zone II shall extend upgradient to its point of intersection with prevailing hydrogeologic

boundaries (a ground water flow divide, a contact with till or bedrock, or a recharge boundary).

"Zone III" means that land area beyond the area of Zone II from which surface water and ground water drain into Zone II. The surface drainage area as determined by topography is commonly coincident with the ground water drainage area and will be used to delineate Zone III. In some locations, where surface and ground water drainage are not coincident, Zone III shall consist of both the surface drainage and the ground water drainage areas. For purposes of definition herein, the geographical limits of Zone I, II, and III shall be presumed to be those represented on the attached map.

Section 4. Registration

Every owner and operator of a commercial or industrial establishment (including home occupations) storing hazardous materials in quantities totaling more than thirty (30) gallons liquid volume or twenty-five (25) pounds dry weight, shall register with the Board the types, quantities, location, and method of storage of said hazardous materials. Registration required by this provision shall be initially submitted within ninety (90) days of the effective date of these regulations and annually thereafter.

Any owners and operators of commercial or industrial establishments who exceed these thresholds after the effective date of these regulations shall meet the registration requirement within thirty (30) days of exceeding the thresholds.

In addition to registration, owners and operators of commercial or industrial establishments registered in accordance with this section shall maintain on the premises an inventory, reconciled on a monthly basis, of purchase, use, sale, and disposal of hazardous materials. The purposes of this account is to detect any product loss and to provide an ongoing record of all quantities of hazardous materials within the Town over the registration threshold. The Board may at any time request to inspect these inventory records.

Section 5. Hazardous Wastes Generally

All activities involving wastes containing hazardous materials shall be held on the premises in product-tight containers for removal by a licensed carrier and for disposal in accordance with the Massachusetts Hazardous Waste Management Act, MGL, Chapter 21C and its implementing regulations found at 310 CMR 30.00.

Section 6. Right-of-Entry

The Board and its agents may enter upon privately-owned property for the purpose of implementing and enforcing the provisions of this regulation. The Board shall provide no less than 24 hours notice prior to such a visit.

Section 7. Above-ground Storage of Hazardous Wastes

Above-ground tanks of wastes containing hazardous materials shall be stored on a surface that is designed and at all times operated so that it is free of cracks and gaps and is sufficiently impervious to contain discharges and accumulated precipitation until the collected material is detected and removed. The surface or the containment system shall be sloped or otherwise designed, constructed, operated, and maintained to drain and remove liquids resulting from discharges or precipitation. The storage area shall be enclosed by a permanent dike of impermeable construction that shall form a retaining basin not less than the capacity of the largest tank plus 10% of the aggregate capacity of all other tanks within the enclosure. Above-ground containers in the Zone I, Zone II or Zone III shall have secondary containment with interstitial space monitoring consisting of either a double wall, external liner system, or vault system. All above-ground containers shall utilize "state of the art" construction, containment, monitoring and leak detection. Suitable fire control and toxic control facilities shall be maintained at all times.

Section 8. Under-ground Storage (Large Quantity)

The following provisions shall apply to all under-ground liquid hazardous material storage systems with capacities of 55 gallons or greater.

Owners shall register with the Board the size, type, age, and location of each existing tank, and the type of hazardous material stored in each, within ninety (90) days of the effective date of these regulations.. Evidence of date of purchase and installation, including Fire Department permit, if any, shall be included along with a sketch map showing the location of such tanks on the property.

Owners of tanks for which evidence of the installation date is not available shall, at the order of the Board, have such tank and piping systems tested. If either the Board or the Fire Department determines that the tank or piping is not material tight, all material shall be removed from the tank or piping, the tank or piping shall be removed from the ground, and the tank or piping shall be disposed of under the direction of the Board or the Fire Department.

All steel tanks and piping shall be subject to a test for tightness at the owner's expense fifteen (15) years after installation and annually after twenty (20) years, or if evidence of installation is not available. A tank shall be tested by any final or precision test which can accurately and predictably detect leaks, and which has been approved in advance by the Board or the Fire Department. All tests shall be administered by qualified persons, and any such persons shall notify the Board and the Fire Department prior to administering the test. The person performing the test shall promptly supply the owner of the tank, the Board and the Fire Department with certified copies of all test results for the tank and its piping. Any tanks failing the test shall be disposed of under the direction of the Board or the Fire Department.

If a steel tank or piping is unprotected, they shall be retrofitted with cathodic protection by 22 December 1998. Until cathodic protection has been added, an annual test for tightness shall be required. (The testing and reporting procedures are described in the preceding paragraph.) If a tank or piping does not have cathodic protection by 22 December 1998, the owner or operator shall have the tank or piping removed from the ground on or before 22 December 1998. Fuel oil tanks utilized exclusively for consumptive use on the premises and located outside of Zone I, Zone II and Zone III shall be exempt from the requirements of this paragraph.

The owner or operator of every existing tank which does not have an acceptable form of leak detection, and which does not have a spill containment manhole, overfill protection device, and cathodic protection shall have the tank tested for tightness at the owner's or operator's expense on an annual basis until 1998. If the tank does not have leak detection installed by 22 December 1998, the owner or operator shall have the tank removed from the ground on or before 22 December 1999. Fuel oil tanks utilized exclusively for consumptive use on the premises and located outside of the Zone I, Zone II and Zone III shall be exempt from the requirements of this paragraph.

All newly installed tanks shall be designed and constructed to minimize the risk of corrosion and leakage. Tanks shall be protected from internal and external corrosion by utilizing "state-of the-art" type of tanks construction providing proven long-term protection including : double-walled tanks, fiberglass coatings, electrical isolation, cathodic protection, electronic monitoring systems, secondary

containment, or any other approved in advance by the Board and the Fire Department.

Section 9. Under-ground Storage (All Quantities)

The following provisions apply to all under-ground hazardous material storage systems of any capacity.

All leaking tanks must be emptied by the owner or operator with twelve (12) hours of leak detection and removed by the owner and/or operator in a time period to be determined by the Board or the Fire Department.

Tank installations on lots not having a permit prior to adoption of this regulation are not permitted within four (4') feet of maximum high water table, within four (4') feet of bedrock. within one hundred (100') feet of a surface water body or wetland, or within the Zone I or Zone II.

Section 10. Variances

The Board may vary the application of any provision of this regulation, unless otherwise required by regulation or law, in any case when, in its opinion, the applicant has demonstrated hardship and that an equivalent degree of environmental protection required under this regulation will still be achieved. The applicant at his own expense must notify all abutters by certified mail at least ten (10) days before the Board meeting at which the variance request will be considered. The notification shall state the variance sought and the reasons therefore. Any variance granted by the Board shall be in writing. Any denial of a variance shall also be in writing and contain a statement of the reasons for the denial.

Section 11. Enforcement

All discharges of hazardous material within the Town are prohibited.

Any person having knowledge of a discharge of hazardous material shall immediately report the discharge to the Board, and if involving flammable or explosive materials, to the Fire Department.

The Board and its agents may enter upon privately owned property for the purpose of performing their duties under this regulation.

Any person who violates ant provision of this regulation shall be punished by a fine of not more than two hundred ($200.00) dollars for each violation. Each day or portion thereof during which a violation continues shall constitute a separate

offense; if more than one, each condition violated shall constitute separate offense. This regulation may be enforced pursuant to MGL, Chapter 40, Section 21D by a Town police officer or other officer having police powers. Upon request of the Board or the Fire Department, the Board of Selectmen and Town Counsel shall take such legal action as may be necessary to enforce this regulation. Any fine unpaid for a period of 30 days shall give rise to a lien against the property where the violation occurred. The Board of Health may file a notice of such lien with the Registry of Deeds.

Section 12. Fees

Any person registering storage of hazardous materials pursuant to Section 4 shall pay to th Board an annual Registration Fee of ($) dollars for every gallons or fraction thereof of storage capacity. Such fee shall be due on the same date as the annual registration. Failure to pay shall constitute a violation and shall subject the violator to the penalties of Section 10.

The Board may charge for expenses incurred in the enforcement of this regulation.

Recommendation #2

The Board of Health should adopt the following health regulation governing the cleanup of hazardous materials and wastes.

Implementation:

The Board of Health should adopt the following regulation in accordance with the provisions of MGL Chapter 111.

MANCHESTER BOARD OF HEALTH REGULATION

HAZARDOUS WASTE CLEANUP REGULATION

Section 1. Authority

This regulation is adopted by the Manchester Board of Health ("Board") under Massachusetts General Laws, Chapter 111, Section 31, which gives the Board authority to make reasonable health regulations, violations of which are punished by fines up to two hundred ($200.00) dollars. This regulation also is adopted under Massachusetts General Laws, Chapter 111, Section 122, which directs the Board to examine into all nuisances, sources of filth, and causes of sickness within the Town which may be injurious to the public health, to destroy, remove, or prevent them, and to make regulations for the public health and safety relative thereto.

Section 2. Purpose

These regulations are intended to protect the public health and safety relative to risks and potential risks posed by hazardous waste contamination of air, land, surface water, soil, ground water, wetlands, drinking water, the Zone I, Zone II, and Zone III, or other resources. For this purpose, the regulation requires any owner and/or operator of a contaminated site to disclose to the Board the presence of such contamination, to describe assessment, containment, or removal efforts and, if deemed appropriate by the Board, to conduct these response actions prior to sale or other disposition of the site, prior to new construction or alteration of existing structures, or upon other appropriate terms. This regulation supplements federal and state hazardous waste contamination cleanup laws, with requirements tailored to the needs of Manchester to have the Board informed of contaminated sites and to empower the Board to require appropriate cleanups and other actions when there are releases or threats of releases of hazardous wastes.

Section 3. Definitions

"Board" means the Manchester Board of Health.

"Hazardous Waste" means a waste, material, product, substance, or combination thereof, in whatever form, which poses a present or potential threat to human health or safety, welfare, or the environment because of its quantity, concentration, physical, chemical, corrosive, flammable, reactive, toxic, infectious, or radioactive characteristics, either separately or in combination, which has been released to the environment whether intentionally or otherwise. Any waste, material, product, or

substance deemed hazardous under the Massachusetts Hazardous Waste Management Act, Massachusetts General Laws, Chapter 21C, the Massachusetts Superfund Act, Massachusetts General Laws, Chapter 21E, the Resource Conservation and Recovery Act (RCRA), 42 United States Code 6901 et seq., as these statutes may be amended, shall be deemed a hazardous waste for the purpose of this regulation. Hazardous waste shall include oil, which shall mean insoluble or partially soluble oils of any kind or origin or in any form, including, without limitation, waste oils, crude or fuel oils, lube oil or sludge, asphalt, and derivatives of mineral, animal, or vegetable oils.

"Operator" means any person who occupies and/or is responsible for operation of a site. The term shall not include a person who, without participating in the management of a site, holds indicia of ownership primarily to protect his security interest in said site. In the case of an abandoned site, the term operator means any person who operated such immediately prior to such abandonment.

"Owner" means any person who has effective control or legal ownership of a site. The term shall not include a person who, without participating in the management of a site, holds indicia of ownership primarily to protect his security interest in said site. For the purpose of this regulation, the Board shall be entitled to rely upon the most current list of owners in the records of the Town Board of Assessors as providing sufficient evidence of ownership under this regulation. In the case of an abandoned site, the term owner means any person who owned such site immediately prior to such abandonment.

"Person" means any agency or political subdivision of the federal government or the Commonwealth, any state, public or private corporation or authority, individual, trust, firm, joint stock company, partnership, association, or other entity, and any officer, employee, or agent or such person, and any group of persons.

"Release" means any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment. The term shall not include any emissions from the exhaust of an engine; release of source, byproduct, or special nuclear material from a nuclear incident if such release is subject to requirements with respect to financial protection established by the Nuclear Regulatory Commission; the normal application of fertilizer; the application of pesticides consistent with their registrations and labeling; any emissions from a point source of air pollution in compliance with a permit under the Federal Clean Air Act, 42 United States Code 7401 et seq., and the Massachusetts Clean Air Act, Massachusetts General Laws, Chapter 111, Sections 142A - 142H; and any release from a point source of water pollution in compliance with a permit under the Federal Clean Water Act, 33 United States Code 1251, et seq.,

and the Massachusetts Clean Water Act, Massachusetts General Laws, Chapter 21, Section 43, as these statutes may be amended.

"Site" means any real estate, personal property, facility, building, structure, installation, equipment, pipe or pipeline including any pipe into a storm drain, sewer or publicly-owned treatment works, well, pit, pond, lagoon, impoundment, ditch, tank, landfill, storage container, motor vehicle, rolling stock, vessel, or aircraft, or any other place or area to, from, or at which hazardous waste, including oil, has been released. The term shall not include any consumer product in consumer use.

"Threat to Release" means a substantial likelihood of a release.

"Zone II" means that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation). It is bounded by the ground water divides which result from pumping the well and by the contact of the aquifer with less permeable materials such as till or bedrock. In some cases, streams or lakes may act as recharge boundaries. In all cases, Zone II shall extend upgradient to its point of intersection with prevailing hydrogeologic boundaries (a ground water flow divide, a contact with till or bedrock, or a recharge boundary).

"Zone III" means that land area beyond the area of Zone II from which surface water and ground water drain into Zone II. The surface drainage area as determined by topography is commonly coincident with the ground water drainage area and will be used to delineate Zone III. In some locations, where surface and ground water drainage are not coincident, Zone III shall consist of both the surface drainage and the ground water drainage areas. For purposes of definition herein, the geographic limits of Zones I, II, and III shall be presumed to be those represented on the attached map.

Section 4. Notice to Board

Any owner and/or operator of a site, as soon as he has knowledge of a release or threat of release of hazardous waste, including oil, shall immediately notify the Board thereof. Said notice shall be in writing by hand delivery to the office of the Board, its current Agent, the current Chairman, or by Certified mail, Return Receipt Requested.

Any owner and/or operator of a site, as soon as he has received from the Massachusetts Department of Environmental Protection (DEP) any administrative or enforcement order or notice of responsibility under Massachusetts General Laws,

Chapter 21E, compelling assessment, containment, or removal of hazardous waste, including oil, shall immediately notify the Board in the same manner as set forth above.

Any owner and/or operator of a site, as soon as he has received knowledge that the site is listed as a possible or confirmed disposal site on the quarterly list of such sites published by the DEP under MGL, Chapter 21E, Section 3A(b) shall immediately notify the Board thereof in the same manner set forth above. Once such notice has been given, it need not be repeated although such site is listed on subsequent quarterly DEP lists.

Section 5. Board Requirements

For any site for which notice to the Board is required by this regulation, before or after such notice is given, the Board may impose such requirements as it deems appropriate to protect the public health, safety, welfare, and the environment. Such requirements may include, but are not limited to: (a) compelling submittal of real estate site assessment reports; site investigation reports; feasibility studies; remedial action plans; technical reports, copies of correspondence with the United States Environmental Protection Agency (EPA), DEP, or other agency; copies of administrative orders, enforcement orders, violation notices, notices on non-compliance, or penalty assessment notices issued by EPA, DEP, or other agency; copies of permits issued by EPA, DEP, or other agency, plans of the site; and any other document deemed appropriate by the Board for performance of its duties or implementation of its authority under this regulation; (b) ordering any owner and/or operator to perform assessment, containment, or removal activities on or off the site; (c) notifying any owner and/or operator of any violation of this regulation or any order issued thereunder and seeking compliance; and (d) postponing or prohibiting any sale or other disposition of a site, or new construction or alteration of existing structures, prior to assessment, containment, or removal in accordance with the requirements of the Board. Such postponement and/or prohibition may be affected by the filing of a written order with the Registry of Deeds.

Section 6. Variances

The Board may vary the application of any provision of this regulation, unless otherwise required by law, in any case where the Board deems it appropriate, upon a demonstration by the applicant for a variance, in writing, on the public record, that an equivalent or higher degree of protection of the public health and safety, to that required by this regulation, will be achieved. The applicant at his owner expense, shall notify all abutters within three hundred (300') feet of the site by Certified Mail, Return Receipt Requested, at least ten (10) calendar days before the Board meeting at which the variance is sought, the reasons therefor, and where copies of the variance

request may be obtained, without charge. Any variance granted by the Board shall be in the writing and shall include findings of fact and conclusions of law necessary to support the variance. Any denial of a variance by the Board shall be in writing and shall contain a brief statement of the reasons for the denial.

Section 7. Right-of-Entry

The Board and its agents may enter upon privately-owned property for the purpose of implementing and enforcing the provisions of this regulation.

Section 8. Enforcement

The Board may issue administrative orders, enforcement orders, violation notices, requests for compliance, and other documents and correspondence to enforce the provisions of this regulation. The Board may pursue criminal prosecution or civil litigation or both in the courts of the Commonwealth of Massachusetts to enforce the provisions of this regulation. In the event the owner and/or operator fail to promptly comply with an order of the Board, the Board shall be empowered to perform such acts as are necessary to eliminate or reduce the risk to the public health and safety. The reasonable costs of such acts shall be borne by the owner of the property. In the event the costs are not promptly reimbursed, the amount of the costs shall constitute a lien on the property. The Board shall be entitled to file such written notices of lien as may be required in the Registry of Deeds and/or with such other public agencies as may be appropriate.

Section 9. Penalty

Violation of this regulation shall be punished in a criminal prosecution by a fine up to two hundred ($200.00) dollars for each violation. Each day or portion thereof that a violation continues shall be deemed a separate violation.

Section 10. Appeals

Actions of the Board under this regulation may be appealed to the courts of the Commonwealth in a nature of certiorari, pursuant to MGL, Chapter 249, Section 4.

Section 11. Severability

If any provision of this regulation is declared unlawful by a valid judgement or decree of any court of competent jurisdiction, such invalidity shall not affect any of the remaining provisions of this regulation.

Section 12. Effective Date

This regulation shall take effect upon publication in a newspaper published by the Town, on . As required by MGL, Chapter 111, Section 31, an attested copy has been filed with DEP on . The public hearing was conducted on and this regulation was voted by majority of this Board on .

Recommendation #3:

The Board of Health should adopt the following health regulation governing review standards for wetlands, subdivision, zoning and comprehensive permit applications.

Implementation:

The Board of Health should adopt the following regulation in accordance with the provisions of MGL Chapter 111.

MANCHESTER BOARD OF HEALTH REGULATION REVIEW STANDARDS FOR WETLANDS, SUBDIVISION ZONING AND COMPREHENSIVE PERMIT APPLICATIONS

Section 1. Authority

This regulation is adopted by the Manchester Board of Health ("Board") under Massachusetts General Laws, Chapter 111, Section 31, which gives the Board authority to make reasonable health regulations. Acting under this authority, the Board hereby prescribes and establishes "Review Standards for Wetlands, Subdivision and Zoning Applications".

Section 2. Purpose

This regulation is intended to protect the public health and safety relative to risks and potential risks posed by contamination of surface water, ground water, drinking water, wetlands, and soil. The Board's review and decision-making, required by local bylaws and/or state statutes, are clarified and formalized by this regulation. For this purpose, the regulation requires any person seeking state or local permits that require the Board's review and recommendation on water quality and quantity concerns, to file concurrently with the Board said permit application and material, as required pursuant to the pertinent state or local law.

Within Zone I, Zone II and Zone III, any person seeking permits or approvals under the following laws, bylaws or regulations, shall concurrently file all application material with the Board as required by these permit and approval processes:

Any Permit Application to the Manchester Conservation Commission, pursuant to Manchester General Wetlands Bylaw, Article 51, Sections 3 and 6, and MGL, Chapter 131, Section 40, 310 CMR 10.00 et seq.;

Any Approval Not Required, Preliminary Subdivision, or Definitive Subdivision Plan application to the Manchester Planning Board, pursuant to Manchester Subdivision Rules and Regulations, Sections 4, 5 and 6, and MGL, Chapter 41, Section 81P, 81S and 81U;

Any Flood Control District Permit application to the Zoning Board of Appeals, pursuant to Manchester Zoning Bylaw, Section 4.6;

Any Planned Residential Development application to the Planning Board, pursuant to Manchester Zoning Bylaw, Sections 6.8, 6.8.2.2, and 6.8.3.4;

Any Comprehensive Permit application to the Zoning Board of Appeals, pursuant to MGL, Chapter 40B, Sections 20 - 23;

Any Site Plan Review Special Permit application to the Planning Board, pursuant to Manchester Zoning Bylaw, Section 6.9;

Any other Special Permit application to the Board of Selectmen, Zoning Board of Appeals, and Planning Board, pursuant to Manchester Zoning Bylaw, Section 7.8; and

Any other permit or license application to any other Town agency, board, or department, that seeks Board of Health comments and recommendations.

Section 3. Definitions

"Application" means any request, along with required supporting material, for approval, permit, or license from any permit granting agency, board or department, as described in Section 2.

"Applicant" means any person filing an application.

"Person" means any agency or political subdivision of the federal government or the Commonwealth, any state, public or private corporation or authority, individual, trust, firm, joint stock company, partnership, association, or other entity, and any officer, employee, or agent or such person, and any group of persons.

"Zone I" means the protective radius required around a public water supply well or wellfield.

"Zone II" means that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation). It is bounded by the ground water divides which result from pumping the well and by the contact of the aquifer with less permeable materials such as till or bedrock. In some cases, streams or lakes may act as recharge boundaries. In all cases, Zone II shall extend upgradient to its point of intersection with prevailing hydrogeologic boundaries (a ground water flow divide, a contact with till or bedrock, or a recharge boundary).

"Zone III" means that land area beyond the area of Zone II from which surface water and ground water drain into Zone II. The surface drainage area as determined by topography is commonly coincident with the ground water drainage area and will

be used to delineate Zone III. In some locations, where surface and ground water drainage are not coincident, Zone III shall consist of both the surface drainage and the ground water drainage areas. For purposes of definition herein, the geographic limits of Zones I, II, and III shall be presumed to be those represented on the attached map.

Section 4. Procedure

Applications for Board review, comment and recommendation shall be filed with the Board by the applicant at the same time that the application is filed with the Town's pertinent permit granting agency. The Board shall review said application at its next or subsequent regularly scheduled meeting and its recommendation shall be issued at said meeting unless additional review time is granted by the applicant and the pertinent permit granting agency. The applicant shall be notified in advance of the Board's meeting, and is entitled to appear before the Board to present, explain or modify the application.

Section 5. Application Content

The application shall include, at a minimum, the following information, unless waived in writing by the Board:

1) Locus map showing the site and its relationship to Zone I, Zone II, and Zone III.

2) Scaled topographic plans prepared by a registered engineer or surveyor, including site survey of existing conditions, existing and proposed grades, vegetation, and drainage.

3) Except for approval not required, preliminary subdivision or definitive subdivisions, site plan showing building footprint, proposed building use, impermeable surfaces, and any existing or proposed above-nor below-ground storage tanks. This plan should show in tabular form the total amount of building, impermeable surface, and lot coverage.

4) Locations of water bodies or wetland areas that are on-site or that may be affected by the application.

5) Log of the soil profiles and deep observation holes, and location and results of percolation tests.

6) Hydrogeology of the site, including but not limited to (a) maximum ground water elevation, (b) surficial and bedrock geology, (c) ground water flow direction and velocity, (d) nearest surface water and ground water discharge area(s), and (e) location of public and private water supplies.

7) Land uses on abutting properties.

8) Operation and maintenance plans for all proposed on-site activities, for example, storage, and disposal of hazardous or toxic materials; storage of fuel(s); landscaping (application of chemicals, irrigation, clearing); snow clearing and application of de-icing compounds; and, on-site septic systems.

9) All mitigation measures to protect surface water and ground water quality and quantity.

Section 6. Action

Subject to the condition that the Board is provided with the information required above, the Board shall recommend approval of an application to the Town's pertinent permit granting agency unless it finds that the quality and quantity of surface water and ground water flowing within or affecting the Zone I, Zone II, or Zone III will more probably than not be adversely effected by any of the following activities:

1) Direct impacts of construction, site preparation, and alterations of the land and water surface.

2) Excessive coverage by buildings, pavement, and other impervious surfaces.

3) Inappropriate soil types for development.

4) Inadequate storm water drainage and run-off design.

5) Removal of stabilizing vegetation.

6) On-site disposal of sanitary sewage.

7) Storage, use, handling, transport, or disposal of toxic, hazardous, and petroleum materials.

8) Chemical treatment of landscaped and vegetated areas.

9) Removal and treatment of snow and ice.

10) Insufficient on-site monitoring of ground water quality and elevation.

11) Excessive water withdrawal volumes.

Section 7. Recommendation

The Board shall submit its written recommendation to approve, approve with conditions, or disapprove an application to the Town's pertinent permit granting agency. A copy of the recommendation shall be sent concurrently to the applicant. If the Board determines that the activities which are the subject of the application are likely to have an adverse effect upon the surface water and ground water quality and quantity in the Zone I, Zone II, or Zone III, the Board shall recommend approval with conditions or denial of the activities requested. If it recommends approval, the Board shall recommend imposing conditions which the Board deems necessary or desirable to protect those waters, and all activities shall be done in accordance with those conditions.

The Board shall recommend denial of a permit for failure to meet the requirements of this regulation; for failure to submit necessary information and plans requested by the Board; for failure to meet the design specifications, performance standards, and other requirements and regulations of the Board; for failure to avoid or prevent adverse effects upon the waters of the Zone I, Zone II, or Zone III; and/or, where no conditions are adequate to protect those waters. Due consideration shall be given to any demonstrated hardship on the applicant by reason of denial, as presented in the application or at the public meeting.

The Board shall comply with the following time periods, unless granted an extension by the applicant or Town's pertinent permit granting agency, otherwise it shall be deemed that the Board constructively approved the application.

1) Permit applications with the Conservation Commission--14 days from submission of application, the Board shall notify the Conservation Commission.

2) Approval not required plan application with the Planning Board--as soon as possible, not to exceed 21 days after submission of the plan, the Board shall notify the Planning Board.

3) Preliminary subdivision plan application with the Planning Board--within 45 days after submission of the plan, the Board shall notify the applicant.

4) Definitive subdivision plan application with the Planning Board--within 45 days after submission of the plan, the Board shall report to the Planning Board.

5) Flood Control District special permit application with the Board of Appeals--the Board shall report to the Board of Appeals prior to any public hearing by the Board of Appeals, which shall occur within 65 days of filing the application.

6) Planned residential development special permit application with the Planning Board--the Board shall report to the Planning Board (a) within 45 days of the applicant filing formal notice with the Planning Board; and, (b) prior to the public hearing, which shall occur within 65 days of filing with the Planning Board.

7) Comprehensive permit application with the Board of Appeals--the Board shall report to the Board of Appeals prior to the close of the public hearing.

8) Site plan review special permit application with the Planning Board--the Board shall report to the Planning Board prior to or during the Planning Board's public hearing, which shall occur within 45 days of filing of the application.

9) Referrals of special permit applications with the Board of Selectmen, Board of Appeals, and Planning Board--the Board shall report to the respective board within 35 days of the receipt of the referral request.

Section 8. Effective Date

These regulations are approved and adopted by the Board of , after a public hearing held on , published verbatim in the local newspaper on , and filed with the Department of Environmental Protection on , to become effective on the date of advertisement of the public hearing.

Section 9. Appeal

Appeals of recommendations issued by the Board to other town permit granting agencies, pursuant to this regulation and applicable local and state laws, shall be made in accordance with the statutes, bylaws and regulations pertinent to said agencies.

Recommendation #4:

The Board of Health should adopt the following health regulation governing the application of fertilizers and road salts.

Implementation:

The Board of Health should adopt the following regulation in accordance with the provisions of MGL Chapter 111.

MANCHESTER BOARD OF HEALTH REGULATION

REGULATIONS REGARDING THE APPLICATION OF FERTILIZERS AND ROAD SALT

1) The application of fertilizers, pesticides and fungicides within Zone I of the Lincoln Street well is prohibited without receipt of a Special Permit from the Planning Board in accordance with Section 4.9.6 of the Zoning Bylaw.

2) Within Zone II, an annual permit from the Manchester Board of Health ("Board") shall be required for any person applying fertilizers, pesticides and fungicides over an area that exceeds two (2) acres.

   a) The applicant shall submit the following information to the Board prior to its determination of whether to issue a permit for fertilizer, pesticide and fungicide use:

      (1) A description of the proposed type, amount, and frequency of application of the fertilizer, pesticide and fungicide;

      (2) A plan showing the proposed location of the application of the fertilizer, pesticide and fungicide;

      (3) A plan proposed by a Registered Engineer or Landscape Architect showing the location of sensitive environmental resources, such as wetlands, water bodies, water courses, and public and private water wells;

      (4) A description of the direction and rate of ground water flow and the maximum ground water elevation; and

      (5) A proposed ground water quality monitoring plan describing the location of ground water monitoring wells, sampling frequency, reporting, and protocols.

b) Upon review of the submitted information, the Board shall determine whether to grant a permit for the proposed use of fertilizers, pesticides and fungicides. The Board may condition such a permit by limiting the type, amount and location of proposed fertilizer, pesticide and fungicide use.

3) Any person proposing to apply fertilizers, pesticides and fungicides over an area exceeding two (2) acres within the Zone III or the delineated watershed of Gravelly Pond shall, prior to applying the fertilizers, pesticides and fungicides, register such proposed application annually with the Board of Health by submitting a letter describing the type, amount, frequency and location of application of the fertilizer, pesticide and fungicide.

4) Commercial enterprises for the purpose of hydroseeding, fertilizing, and lawn care shall consult with the Soil Conservation Service for a soil analysis, and appropriate fertilizer application rates (if applicable) and shall show certification of consultation to the Board from the Soil Conservation Service before a permit to operate in Manchester will be issued pursuant to paragraphs 2) and 3) above.

5) No fertilizer, pesticide and fungicide shall be stored in quantities or concentrations exceeding the maximum volume or concentration set by law, or such lesser amount recommended by the manufacturer.

6) No fertilizer, pesticide and fungicide shall be applied to any lot in quantities or concentrations exceeding the maximum set by law, or such lesser amount recommended by the manufacturer.

7) The application and storage of road salt (sodium chloride) shall be prohibited within Zone I and Zone II. Mechanical deicing or calcium chloride may be used in Zone I and Zone II.

8) Within Zone III, and the delineated watershed of Gravelly Pond, the application and storage of sodium chloride shall be prohibited. Alternative deicing techniques, such as mixing sodium chloride with sand or calcium chloride, may be used if the sodium chloride concentration does not exceed fifty (50%) percent.

9) Nothing in this regulation should be interpretated or applied in a manner inconsistent with the Massachusetts Pesticide Control Act, as amended.

Recommendation #5:

The Board of Health should adopt the following health regulation governing miscellaneous revisions to the Town's minimum requirements for the subsurface disposal of sanitary sewage.

Implementation:

The Board of Health should adopt the following regulation in accordance with the provisions of MGL Chapter 111.

MANCHESTER BOARD OF HEALTH REGULATION

REVISIONS AND AMENDMENTS TO THE MINIMUM REQUIREMENTS FOR THE SUBSURFACE DISPOSAL OF SANITARY SEWAGE

(Refer to Board of Health Revisions 4 November 1987)

1) Change title in 4 November 1987 to read Title 5 of the State Environmental Code. Add regulatory cite - 310 CMR 15.00 et seq., as amended.

2) Add to §15.02(5): If the site is located within the Zone I or Zone II, the applicant shall first apply for a connection with the municipal sewer system. Where that is not possible due to physical and/or legal constraints, the applicant shall seek approval of a sewage disposal system. The applicant shall submit a locus plan showing the site within the Zone I or Zone II and the location of the nearest sewer line. All water courses and wetlands within 100 feet of the proposed septic system and leaching field shall be shown on the plan. The Board of Health shall determine, after reviewing deep observation holes and percolation tests, whether to permit the siting of a subsurface sanitary sewage disposal system in lieu of requiring a connection to the municipal sewer system.

3) Amend §15.02 (23) to read: "...a geohydrological report prepared by a professional engineer, hydrogeologist, or geologist, experienced in the field shall be required for subsurface disposal of sanitary sewage in Zone I and Zone II and may be required elsewhere as part of the Board of Health permit..."

- correct spelling - "transmissivity"

- add at the end of the paragraph - The applicant shall also refer to the Board of Health review standards for wetlands, subdivision, and zoning applications for additional informational requirements.

4) Add new sections:
§15.02(24) Sale or Transfer of Property Containing Septic Systems

Prior to the sale or transfer of any property within Zone I and II of the Town of Manchester, the subsurface sanitary sewage disposal system on said property shall meet all applicable Title 5 and Board of Health standards or shall be upgraded to meet these standards.

After an inspection by a Registered Professional Engineer or Sanitarian, that Engineer or Sanitarian shall file a Certificate of Compliance and Inspection Form with the Board of Health with copies to the seller, buyer, and Assessor's Office, stating whether the system is in compliance with applicable standards.

If the inspection finds evidence of septic system failure or non-compliance with applicable regulations, the Board of Health shall determine within fourteen (14) days whether or not the system constitutes a danger to the public health and should be repaired or replaced. By the end of the time period, the Board of Health or its Agent shall notify the Owner by certified mail whether and under what conditions the system shall be repaired or replaced.

If it is determined by the Board of Health that the system constitutes a danger to the public health, the Board shall order the Owner to make repairs to or replace the system. If the work is not completed within the time designated by the Board of Health, the Board may impose fines or repair or replace the system at the expense of the Owner. Regulations of the Board of Health shall apply to all repairs or replacements of the system.

Upon completion of any required work, the Board of Health shall inspect and certify in writing that satisfactory repairs have been made. Any system having been installed and having received final inspection approval by the Board of Health or its agent within 24 months shall be exempt from this regulation provided additional living space has not been added to the residence in question.

(25) Inspection Requirements

The Board of Health may require repairs or replacement of all subsurface sewage disposal systems within Zone I, Zone II, or Zone III, or the watershed of Gravelly Pond if it finds that the system constitutes a danger to public health or a threat to existing or potential drinking water supplies. Oversight of any required repair or replacement shall be done pursuant to paragraph (24) above. Subsequent inspection of systems shall occur every three (3) years.

(26) Septic Cleaner Ban

The use of septic cleaners containing 1,1,1-Trichloroethane or any similar solvent is prohibited within Zone I, Zone II, or Zone III, or the watershed of Gravelly Pond.

Wetland Bylaws

Introduction

The Massachusetts Wetlands Protection Act, M.G.L. Chapter 131 Section 40, is administered by Conservation Commissions at the local level and by the Department of Environmental Protection at the state level. This Act and its associated regulations provide for the protection of most wetlands; however, in the case of an appeal of local determinations, the Commonwealth has jurisdiction. To augment the protection of wetlands afforded by the Wetlands Protection Act and to allow for an alternative in the case of an appeal, Manchester, similar to many communities, has adopted a local wetlands bylaw.

It is a well-documented fact that wetlands are a critical component in the protection of both surface and ground water quality. Wetlands absorb and contain flood waters and have been shown to remove significant quantities of pollutants through a combination of physical, chemical and biological processes. Clearly, the first step in protecting water quality is to protect the wetlands themselves, by enforcing both state and local regulations to their fullest extent.

In addition to protecting wetland resources themselves, Conservation Commissions have jurisdiction over activities proposed within 100 feet of wetlands. Thus, the protection of water quality can be greatly enhanced by the judicious regulation of activities proposed within this buffer zone. Specific steps that a Commission can take include: the requirement that a natural, vegetated buffer strip be retained adjacent to wetland areas; stringent controls on surface water discharges to wetlands; restrictions on the use of fertilizers, pesticides and herbicides within close proximity to wetlands; and stringent erosion control requirements during construction activities. Recommendations for each of these are discussed in greater detail below.

> (Note: Manchester's wetlands regulations are considered exceptionally thorough and clearly written. The following commentary is provided to assist the reader to more fully understand the role of the Commission, the regulations governing wetlands protection, and the connection to water quality protection. Specific comments regarding the Manchester Wetlands Bylaw were forwarded to the Conservation Commission in March 1990 under separate cover).

Natural Vegetated Buffers

Vegetated buffer strips are of tremendous value in protecting wetlands and surface waters from a variety of impacts. Buffer strips serve to contain and to allow infiltration of surface run-off and to prevent pollution through the attenuation of nutrients, heavy metals, hydrocarbons and other contaminants. In addition, buffer strips provide critical habitat for a variety of wildlife species. Therefore, we recommend that Conservation Commissions incorporate buffer strip requirements

into their regulations. Appropriate definitions and specifications are provided below:

> A buffer strip is defined as an area of undisturbed natural vegetation (endemic/indigenous species) situated adjacent to and parallel to the boundaries of wetland resource areas protected under 310 CMR 10.00 and the town's Wetland Bylaw. Buffer strips may be omitted for certain resource areas (e.g. Bordering Land Subject to Flooding, Coastal Bank) at the discretion of the Conservation Commission.

Although the Commission does require that natural buffer strips be maintained adjacent to wetland resource areas, we recommend that language and guidelines regarding buffer strips be included within the Town's Wetland Regulations.

A review of recent literature on vegetated buffer strips suggests that optimal buffer strips should range from 40 to over 300 feet in width to adequately protect water quality and wildlife interests (Groffman *et al.*, 1989; Brady and Buchsbaum, 1989; Roman and Good, 1985). In determining the appropriate buffer width for a particular site, the following issues should be considered: sensitivity of the resource area; presence of rare or endangered species; soils, slopes, and existing vegetation within the buffer area; and the type and intensity of the proposed development. Several quantitative buffer delineation models have been developed to determine appropriate buffer strip widths (e.g. Roman and Good, 1985) which could be required by the Commission. Alternatively, a more qualitative approach may be followed, requiring progressively wider buffer strips for areas with sensitive wetland resource areas, steep slopes, soils with low permeabilities, and areas known to contain rare or endangered species.

Based on a review of the literature described above, it is recommended that a minimum buffer strip width of 40 feet be required adjacent to Bordering Vegetated Wetlands, Land Under a Waterbody/Waterway, Salt Marsh, Land Under the Ocean and Land Subject to Tidal Action. A narrower buffer strip may be appropriate for some isolated wetlands, depending on their wildlife value.

Surface Water Discharges

Land development frequently results in increased discharges of surface run-off to wetlands and watercourses,which may cause downstream flooding, severe alterations to wetlands hydrology, and degradation of water quality. The Conservation Commission is in a particularly effective position to regulate these impacts, due to its jurisdiction over all activities proposed within 100 feet of wetland resource areas. We recommend that the Commission prohibit the direct discharge of surface run-off from roads and other paved areas to wetlands and watercourses. Applicants should be encouraged to minimize the extent of paving within buffer zones and to use permeable paving materials where possible. Surface run-off

should be recharged on site, using a combination of vegetated swales, detention basins and similar techniques.

Restrictions on Fertilizers, Pesticides and Fertilizers

Fertilized lawns may contribute substantial levels of nutrients, pesticides and herbicides to surface waters both directly, via surface water run-off, and indirectly, via leaching to ground water. Recent literature suggests that the leaching of fertilizers from lawns to ground water may be less significant than initially proposed (i.e. only 10 to 30% leaches as opposed to 60 to 80%), however, in areas with steep slopes and poorly drained soils, surface run-off may be of concern. Therefore, we recommend that the Conservation Commission restrict the extent, and particularly the location, of lawn areas proposed within the buffer zones to sensitive water resources.

Erosion and Sedimentation Control

The discharge of sediments to wetlands and waterways may have severe consequences, ranging from direct sedimentation of wetland flora and fauna to reduction in water clarity. Furthermore, many contaminants including phosphorus, heavy metals and hydrocarbons are readily adsorbed onto soil particles and are transported effectively through the process of siltation. To prevent direct siltation to wetlands and watercourses, the Commission should specify strict erosion and sedimentation controls for construction activities proposed within the buffer zone. Different types of erosion controls will clearly be required for different slopes, soil conditions and construction activities. Subsequent revegetation requirements should also be specified in Orders of Conditions, to insure long-term site stability.

Two publications are recommended as sources of specific erosion and sedimentation control techniques: Erosion and Sediment Control in Site Development (Volume I); and Vegetative Practices in Site Development (Volume II). These guides are published by the Soil Conservation Service, USDA, and were developed for soil conditions specific to Massachusetts.

Non-Regulatory Recommendations

Introduction

As noted in the Introduction to the Regulatory section, Manchester, similar to most communities in the region, has relied upon so-called traditional tools to protect water quality, mostly in the form of zoning and subdivision regulations. While these tools serve a legitimate purpose, it is clear that regulatory management approaches program a community for development and allow little flexibility if the program is inaccurate, or if better information has been made available since the program was devised.

The presence of petroleum product at 76 Summer Street provides an excellent example. As discussed, the zoning bylaw accurately programmed the gasoline station and the installation of underground storage tanks several years ago. With the limited exception of health regulations, few regulatory tools exist to mitigate the potential impact of the discovered product to the Lincoln Street Well. Non-regulatory mechanisms provide for other, often more creative, options to protect Manchester's water supplies.

Recommendation #1

Monitor and remove the floating product and dissolved hydrocarbon contamination 76 Summer Street.

Implementation:

The floating product at 76 Summer Street should be recovered as quickly as possible to prevent further dispersion of volatile organic compounds into the ground water. A treatment system will then be required to remove the existing dissolved product downgradient of the release.

Recommendation #2

Remove all municipally-operated underground storage tanks within Zone I and Zone II of the Lincoln Street well.

Implementation:

The existing underground storage tanks at the High School and Memorial School are over 30 years old and have a combined storage volume of 45,000 gallons. These tanks are used for the storage of #2 and #4 fuel oil, are located in close proximity to the Lincoln Street well, and pose a distinct hazard to the Town's water supply. At a

minimum, these tanks should be tested and monitored, although the preferable option is to discontinue the use of these tanks, remove them and any discernable product, and use the gas line that runs along Lincoln Street or an above-ground storage facility.

Recommendation #3

The town should re-divert surface road run-off on town-owned roads to protect the Lincoln Street well.

Implementation:

Much of the road run-off within the Zone III discharges to streams which pass within 100 feet of the Lincoln Street well. Where possible, this road run-off should be diverted to other drainage basins. Existing direct discharges may be mitigated through the use of detention/retention basins, leaching catch basins and similar structures.

Recommendation #4

The town should pursue any and all steps possible to acquire conservation restrictions and/or title to property within Zones I, II, III and the watersheds of Gravelly and Round Ponds.

Implementation

The Town should seek to acquire conservation restrictions on land within the above-noted resource areas, particularly the Essex County Club. This recreational facility currently makes up over half of the Zone II to the Lincoln Street well, and provides critical recharge to the aquifer. Although the County Club has not expressed any intention of subdividing or otherwise developing this parcel more intensively, there are no existing deed restrictions on the land which would prevent this in the future.

Recommendation #5

Work with the Massachusetts Department of Public Works to reduce and/or restrict the application of sodium chloride within the Water Resource Protection Districts.

Implementation:

The elevated sodium and chloride levels in the Lincoln Street well appear to be related to road salting practices within the Zone II and Zone III areas. To alleviate

this problem, the Town should identify and designate reduced salt zones on Town roads within Zones II and III, and work with the State DPW to adopt similar zones along Route 127 and 128.

Recommendation #6

The Town should develop an emergency response or contingency plan to protect its water supply in the event of a contamination incident or loss of supply.

Implementation:

The Town, headed by the Water Resources Protection Committee, should commence work on the development of a contingency plan for protecting Manchester's water supply. Contingency planning, referred to by the US EPA as "common sense planning", is the identification of potential threats to the Town's water supplies and the development of procedures to be followed if and when such threats materialize. Manchester does not currently have a contingency plan in place, and while the preparation of one is beyond the scope of this study, several general guidelines for the preparation of a contingency/emergency plan include answers to the following questions:

- What are the most likely threats to the Lincoln Street well and Gravelly and Round Ponds ? (Identified throughout the Water Resources Protection Plan)
- What specific steps must be taken to address these threats (i.e. removal of underground storage tanks at the High School and the Memorial School)
- Who is responsible for each step and how will response actions be coordinated (i.e. the Fire or Police Chief, Director of Public Works)
- Where can replacement water supplies be obtained (i.e. written agreement with Beverly, Gloucester or other neighboring community)
- Where can necessary technical, logistical, and financial resources be obtained (i.e. emergency fund, DEP)

Recommendation #7

Expend as much effort and as many public funds as are necessary to conduct workshops and distribution of relevant educational materials (such as the brochure

found in Plate 3) to ensure that Manchester's residents and visitors understand the sensitivity and vulnerability of the Town's water resource systems.

Implementation:

Despite a great deal of attention given to the issue of water resource protection, it is clear that the general public does not fully understand the complexity of Manchester's water resource systems and their level of susceptibility to contamination. It is critical therefore, that Manchester embark on an aggressive public education program designed to help the public become better educated on issues involving the Town's water resources. Specific recommendations include:

- organizing a series of speakers on water quantity and quality protection
- encouraging news coverage of meetings and special events
- household hazardous waste collection programs
- promoting regional conferences on land use planning and water quality
- distribution of the brochure found in Plate 3

Recommendation #8

Develop a comprehensive ground-water monitoring program to provide an early warning system to protect the Lincoln Street well and downgradient surface water supplies.

Implementation

1. Monitoring Wells: A total of four to nine sets of monitoring wells should be installed for future water quality sampling in the vicinity of the Lincoln Street well and Gravelly Pond. Where geologic conditions dictate, each set should consist of a well cluster containing 2 to 3 small diameter (2-inch) wells, which terminate at different depths within the aquifer. A well cluster should be located down-gradient of the underground storage tanks located at the High School and Memorial School (unless these are removed), and down-gradient of the service station located at the intersection of Lincoln Street and Summer Street. In addition, 1 to 2 well clusters are recommended down-gradient of large areas of golf greens on the Essex County Club property, to the northeast and northwest of the Lincoln Street well (drainfields or

lysimeters located under golf greens and fairways may be considered as an alternative to monitoring wells on the golf course). Another well cluster should be installed down-gradient of the cemetery, to the west of the well. In addition, a well cluster should be installed between the reported hazardous release at 36 Summer Street and the Lincoln Street well. Finally, 1 to 2 well clusters should be installed between the landfills and Gravelly Pond.

These monitoring wells will forewarn of most potential water quality impacts to Manchester's surface and ground water supplies. Wells should be screened both above and below clay layers, where present, to enable sampling at discrete depths within the aquifer, and to determine the vertical stratification of contaminants, if present. Well construction should consist of 2-inch diameter flush-threaded joint PVC with 10-foot, number ten slot, screens. Finished wells should be backfilled with sand and gravel from the borehole or clean quartz sand, sealed with bentonite and capped with a steel security cover that is anchored to a cement base.

2. Sampling and Analysis: During the first two years of operation, monitoring wells should be sampled quarterly (four times per year) for the following parameters: sodium, chloride, nitrate-nitrogen, ammonium-nitrogen, iron and manganese. Wells located down-gradient of existing or potential petroleum releases and landfills should also be tested for volatile organic compounds using EPA Methods 501 and 502. Wells located down-gradient of golf greens and playing fields should be tested for all pesticides (fungicides, insecticides and herbicides).

Recommendation #9

Develop a water conservation plan aimed at reducing the amount of water consumed, lost as a result of aged infrastructure, or otherwise wasted through average and/or peak demand problems.

Implementation:

Conservation of water in Manchester can solve many of the problems identified in this study: excessive consumption, threatened existing supplies and limited new supply sources. As noted earlier, Manchester residents currently use water at a rate double the national average. While this consumption rate is in keeping with many Massachusetts communities, it nevertheless represents a volume many residents believe excessive.

If there existed an abundant supply of water, free from contamination threats or supply disruptions, the consumption statistics would be less alarming. However,

Manchester's water supply is limited and threatened, two facts that increase the necessity of reducing the overall amount of water used and consumed.

While the preparation of a water conservation plan is beyond the scope of this study, it is important to note that many of the most effective conservation measures are easily adopted.

1. The Town should establish a specific water conservation goal that will lead to the solution of the Town's water supply problems (particularly during peak summer demand). For example, average day demand is currently well beyond the national average. A conservation goal of reducing consumption by twenty to twenty-five percent would represent a significant decrease.

2. The Town should explore achieving the conservation goal noted above by reducing the amount of water made available.. Commonly referred to as "supply management", this option simply limits the pumping rates and volume of water withdrawn from the Lincoln Street and Gravelly Pond systems.

3. The Town should explore the cost-effectiveness and impacts of "supply management" programs noted above, including: upgrading of all residential and non-residential water meters, leak detection and repairs, and reduction in overall systems pressure.

4. The Town should explore the possibility of establishing a "full-cost" pricing program that reflects the true cost of providing water to consumers.

5. The Town should consider adopting non-regulatory management programs for water use, particularly during peak demand periods. Historically, Manchester has restricted water consumption during peak summer demands, but only as a reaction to water withdrawal limitations, and not in anticipation of foreseeable problems. As an alternative, Manchester could consider regulating water usage for certain activities throughout the year, anticipating peak summer demand problems. For example, Manchester could:

    - prohibit water use for certain activities (i.e. car washing)
    - restrict the time during which certain water uses are allowed (i.e. limiting lawn watering to early morning or evening hours)
    - require permits for large water users (i.e. consumption of a specified gallon per day usage)

- restrict the overall quantity of water used or consumed
- require the installation of water saving appliances

6. The Town should adopt and implement a water conservation plan, ideally providing answers to the issues noted above. Perhaps the most important element of the plan is educating--informing--the public of the importance of water conservation in Manchester.

Recommendation #10

Design and initiate ground water exploration program to develop additional water supply sources within the Town.

Implementation

An additional supply of water for the Town, while not removing the need for water conservation, would ease problems with peak summer demands. It would also provide a reserve, or insurance supply, if a contamination problem affected either of the Town's other two supplies.

Extensive geologic information exists for the Town, both for the unconsolidated sediments and the underlying bedrock. The design of an exploration program should couple this information with the location of existing open space parcels (see Plate 2) within the Town to choose sites for test well drilling.

Based on HWH's investigation, and an investigation of the past exploration programs, areas of unconsolidated deposits that may warrant further investigation are Cedar and Millets Swamp. Previous drilling in Cedar Swamp by Metcalf and Eddy (1979) has shown that there may be sufficient yields of water in this area, although elevated levels of iron and manganese may require treatment. There has been no drilling in Millets Swamp, west of School Street, although the investigation of this area as part of the Lincoln Street aquifer study has shown that this area may be capable of supplying significant amounts of water. Aside from further exploration in the unconsolidated deposits in Town, exploration of bedrock supplies may also yield an additional source of water. Presently there are numerous bedrock wells throughout the Town used as irrigation wells by residents. Many of these wells are artesian and yield a supply of 20-50 gallons per minute.

A large bedrock well, if sited properly, could yield a significantly larger amount of water. For this to occur, the well would have to be located within a bedrock fracture or within a porous section of rock. The design of a bedrock exploration program

should be based on sound geologic principles and should first explore areas of Town-owned land that may be large enough to site a water supply well.

Recommendation #11

The Town should work with the Town of Hamilton to assess the impacts to Gravelly Pond of the proposed "recycling" project at the Chebacco Road landfill. This assessment is particularly important due to the broad disposal and recycling goals of the applicant. As of this writing (April 1990), the proposed project will include recycling of household hazardous waste, septage and various components of municipal solid waste.

Implementation

Notwithstanding many merits of the recycling program, its location within the watershed of Gravelly Pond raises several serious issues for Manchester to consider, all revolving around the impacts (both short and long term) of the recycling proposal on Gravelly Pond. Manchester officials should request information regarding the proposed application in the following areas:

- plans for monitoring effluent from the facility
- plans for secondary containment of materials within and outside of the facility
- plans for regular inspections by town and state officials
- emergency contingency plans
- plans to utilize "best management practices"

Recommendation #12

The Board of Selectmen should ensure the continuation of the Water Resource Protection Committee to implement the recommendations of this Plan and to address the issue of water resource protection on an aggressive and ongoing basis,

Implementation:

While all town boards, committees and departments are committed to the issue of water resource protection, Manchester has no official liaison among the Town's various boards, committees and departments ensuring that ground and surface supplies are protected from a quantity and quality perspective. And while the

Department of Water and Sewer has done an outstanding job of protecting the supplies to date, they lack the relationship with the Town's regulatory boards and committees to provide for comprehensive water resource protection.

Finally, the Water Resource Protection Committee can serve as a logical negotiator and coordinator between the town's regulatory boards and land developers in Manchester, with specific focus on ground and surface water protection.

Legislative Tools

Introduction

Legislative tools include those created by individual state legislative bodies. As local governments do not possess inherent sovereign power, their jurisdiction rests almost exclusively with state constitutional charters, statutes and regulations. Legislative options are those that states deem appropriate for state-wide or regional land management, and are usually adopted where local management alone is insufficient to protect the resource. The Cape Cod Commission Act and the Canoe River Advisory Committee Act are two examples where the Legislature approved special regional legislation designed to protect regional resources.

Gravelly Pond and to a lesser extent, the Lincoln Street Well (Zone III designation lies partially within the City of Gloucester) provide additional examples of regional resources that rely on two corporate jurisdictions to manage. At issue is whether legislative adoption of a "Gravelly Pond District" or "Lincoln Street Well District" (or language of similar import) is necessary to ensure that the resources are protected.

The answer lies within the communities. Based on the present study, it is clear that Manchester's water resources can be protected from contamination if the variety of regional management tools discussed in this report are implemented. If they are not, then perhaps the Towns of Manchester and Hamilton should be required to do so. While local governments may be concerned that their home rule authority is being usurped, history has proven that critical natural resources cannot always be adequately protected by local government alone.

Summary of Recommendations

The following matrix outlines in summary form the various management options discussed above, the responsible agency or board for overseeing the implementation of the option and the general timing of when each recommendation should commence.

TABLE 15 SUMMARY OF WATER RESOURCE MANAGEMENT TOOLS

TOOL	RESPONSIBLE AGENCY/ BOARD	TIMING	INITIATED*	COMPLETED**
Regulatory				
Water Resource Overlay District	Planning Board, WRPC	ATM 1990		
Environmental Impact Analysis	Planning Board	Spring, 1990		
Stormwater Management	Planning Board	Spring, 1990		
Hazardous Materials Health Bylaw	Board of Health	Spring, 1990		
Hazardous Waste Cleanup Bylaw	Board of Health	Spring, 1990		
Health Review Standards Bylaw	Board of Health	Spring, 1990		
Fertilizer and Road Salt Health Bylaw	Board of Health	Spring, 1990		
Title 5 Health Bylaw	Board of Health	Spring, 1990		
Wetlands Bylaw Revisions	Conservation Commission	Spring, 1990		

WRPC = Water Resource Protection Committee
*Check when management action has been undertaken
**Check when management action has been completed

TABLE 15 SUMMARY OF WATER RESOURCE MANAGEMENT TOOLS (continued)

TOOL	RESPONSIBLE AGENCY/ BOARD	TIMING	INITIATED*	COMPLETED**
Non-Regulatory				
Monitor 36 Summer Street Site	WRPC, DPW	Ongoing		
Remove Zone I, Zone II UST's	WRPC, DPW	Spring, 1990		
Divert Surface Runoff	WRPC, DPW	Spring, 1990		
Acquire Land within Watersheds and Zones of Contribution	WRPC, Conservation Commission, Planning Board	Ongoing		
Reduce Road Salting	WRPC, DPW, Conservation Commission, Planning, Board	Ongoing		
Develop Contingency Plan	WRPC, DPW, Planning Board	Spring, 1990		
Public Education	WRPC, All Board	Ongoing		
Monitor Lincoln Street Well	WRPC, DPW	Ongoing		
Development of Water Conservation Plan	WRPC	Spring, 1990		

WRPC = Water Resource Protection Committee
*Check with management action has been undertaken
**Check with management action has been completed

TABLE 15 SUMMARY OF WATER RESOURCE MANAGEMENT TOOLS (continued)

TOOL	RESPONSIBLE AGENCY/ BOARD	TIMING	INITIATED*	COMPLETED**
Initiate Ground Water Exploration Program	WRPC, DPW	Summer, 1990		
Analyze Recycling Project in Hamilton	WRPC, Planning Board, Conservation Commission	Spring, 1990		
Continue Water Resource Protection Committee	Board of Selectmen	Spring, 1990		

WRPC = Water Resource Protection Committee
*Check when management action has been undertaken
**Check when management action has been completed