Preliminary Engineering Survey and Report

on the

Feasibility of Establishing a Municipal Water System

for the Town of

Plaistow

New Hampshire

June 1973

Fenton G. Keyes Associates

Architects - Engineers

321 South Main St., Providence, R. I.

PRELIMINARY ENGINEERING STUDY AND REPORT

on the

FEASIBILITY OF ESTABLISHING

a

MUNICIPAL WATER SYSTEM

in the

TOWN OF PLAISTOW, NEW HAMPSHIRE

* * * * *

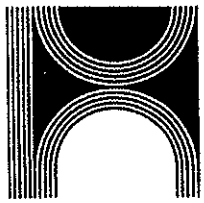
JUNE 1973

* * * * *

FENTON G. KEYES ASSOCIATES
CONSULTING ARCHITECT-ENGINEERS

Nashua, N. H. Waltham, Mass. Providence, R. I. Wethersfield, Conn.

FENTON G. KEYES ASSOCIATES
CONSULTING ARCHITECT — ENGINEERS TEL. 401/861-2900
321 SOUTH MAIN STREET PROVIDENCE, RHODE ISLAND 02903



June 14, 1973
"Our Twenty Second Year"

Board of Selectmen
Town of Plaistow
Selectmen's Office
Town Hall
Plaistow, New Hampshire 03865

Subject: Preliminary Engineering Study & Report on the Feasibility of Establishing a Municipal Water System for the Town of Plaistow, New Hampshire

Gentlemen:

In accordance with our contract we are pleased to present the following Preliminary Engineering Study and Report dealing with the Feasibility of Establishing a Municipal Water System in the Town of Plaistow.

Our studies find that a municipal water system in Plaistow is feasible both from an engineering and an economic standpoint; however, due to termination of federal construction grant programs for water systems, the cost to the individual customer will be somewhat higher than normally expected for water systems in this general size category which have been federally-aided. The recommended water supply system is gravel-packed wells. It is anticipated the capacity of each of these wells will range between 700 and 1000 gallons per minute. The geophysical survey performed as a part of these studies located several areas within the town which give strong indication of being able to support relatively high-capacity wells. These several areas are presently being explored and tested.

The recommended scope of the initial distribution system is shown on Sheets Nos. 2, 3 and 4 bound in Appendix A. With reasonable participation in the system by abutting landowners this general scope of distribution system is financially feasible. We have anticipated that 75 percent of all possible users of the system will connect in the beginning.

The initial storage facility for the system will be a 1,500,000 gallon steel standpipe located on Sweet Hill. This sized tank will provide adequate storage and meet the necessary fire flow demands for a substantial period in the future. The system has been designed to have a maximum static pressure of 115 p.s.i. and a minimum flowing pressure under extreme fire flow demands of 23 p.s.i. These pressures represent the extremes in the system under these conditions.

The estimated cost of the recommended system including engineering fees and incidental costs is $3,520,786.00. Three plans for financing the system have been developed and are presented in detail in Section 16 of the report. All three plans are on the same basis in that they provide for financing in three forms; a minimal annual water bill, a one-time assessment and a minimal increase in the general tax rate. As an example, Charge Plan "C" calls for a minimum annual water bill of $60.00, a one-time benefit assessment of $400.00 and a general tax increase of $2.00 per $1,000.00 of assessed valuation. These charges, together with other miscellaneous income, such as excess water use and hydrant rental, are sufficient to construct, operate and maintain the proposed water system.

We wish to express our appreciation for having been selected to execute this work, and are prepared to spend whatever time may be necessary to aid in reviewing any aspect of the survey and report and in its presentation to the townspeople. At such time as the town is prepared to proceed with the recommended project, we would be pleased to aid the town in the preparation of the work.

Very truly yours,

FENTON G. KEYES ASSOCIATES

Raymond C. Murphy

Raymond C. Murphy

RCM:map

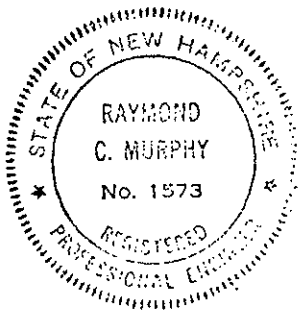


TABLE OF CONTENTS

Table of Contents cont.

List of Tables

List of Drawings

The following sheets are bound in Appendix A at the rear of the report.

THE REPORT

1. PURPOSE OF THE FEASIBILITY STUDY AND REPORT

The need for establishing a municipally-owned water supply and distribution system to serve the Town of Plaistow has long been recognized by town officials and responsible resident citizens. The preparation of this feasibility study and report was undertaken to determine if the rapidly-growing town of Plaistow can financially support the construction and maintenance of a municipally-owned and operated water supply, storage and distribution facility. This report provides the basic planning necessary to determine the most feasible and economic water supply source, the amount of storage required to meet the demands of domestic, commercial and industrial water usage and fire flows, and to layout, on a schematic basis, a water system that will serve the areas of the town in immediate need and provide for expansion as required by the growth of the Town.

2. SCOPE OF THE STUDY AND REPORT

This study and report encompasses the entire Town of Plaistow. The town has already reached the stage where development has extended to all general areas and more intense development is rapidly expanding to the presently less populated areas. In the development of the studies and preparation of the report, water supply sources, the character of the town, population and population trends, anticipated future growth patterns, domestic, commercial and industrial water usage and planning and zoning were developed, investigated and studied and these several items, together with others, were used to develop a water supply, storage and

distribution system which will meet present and future needs of the town in the most feasible manner, both from an engineering and economic standpoint. The distribution system is designed to serve the greatest number of people and still be self-supporting. Those streets or areas which presently cannot be economically justified have been reserved for future development.

3. DESCRIPTION OF THE STUDY AREA

The Town of Plaistow is located in Rockingham County in the southern portion of New Hampshire and immediately north of the Massachusetts state line. The town has a total area of approximately nine square miles and a documented 1970 population of 4417 persons. The estimated 1972 population is 4700 persons.

Plaistow, as shown on Plate R-1, is bordered on the south and east by the City of Haverhill, Massachusetts, on the north by the Towns of Newton and Kingston, on the west by the Town of Hempstead and on the southwest by the Town of Atkinson. The town is primarily rural residential in character; however, in recent years due to substantial commercial and industrial development in the southern portion this character is becoming more suburban and more highly developed. This type of development can and will be controlled as required by the town's zoning ordinance. The present zoning of the town is shown graphically on Plate R-2.

The town is provided freight transportation facilities by the Boston and Maine Railroad and is served by principal highway Route Nos. 125, 121A and 108. These highways provide easy access to major highway Route Nos. 495, 3 and 93. State and town highways

are well maintained and the town has a well-developed general street system.

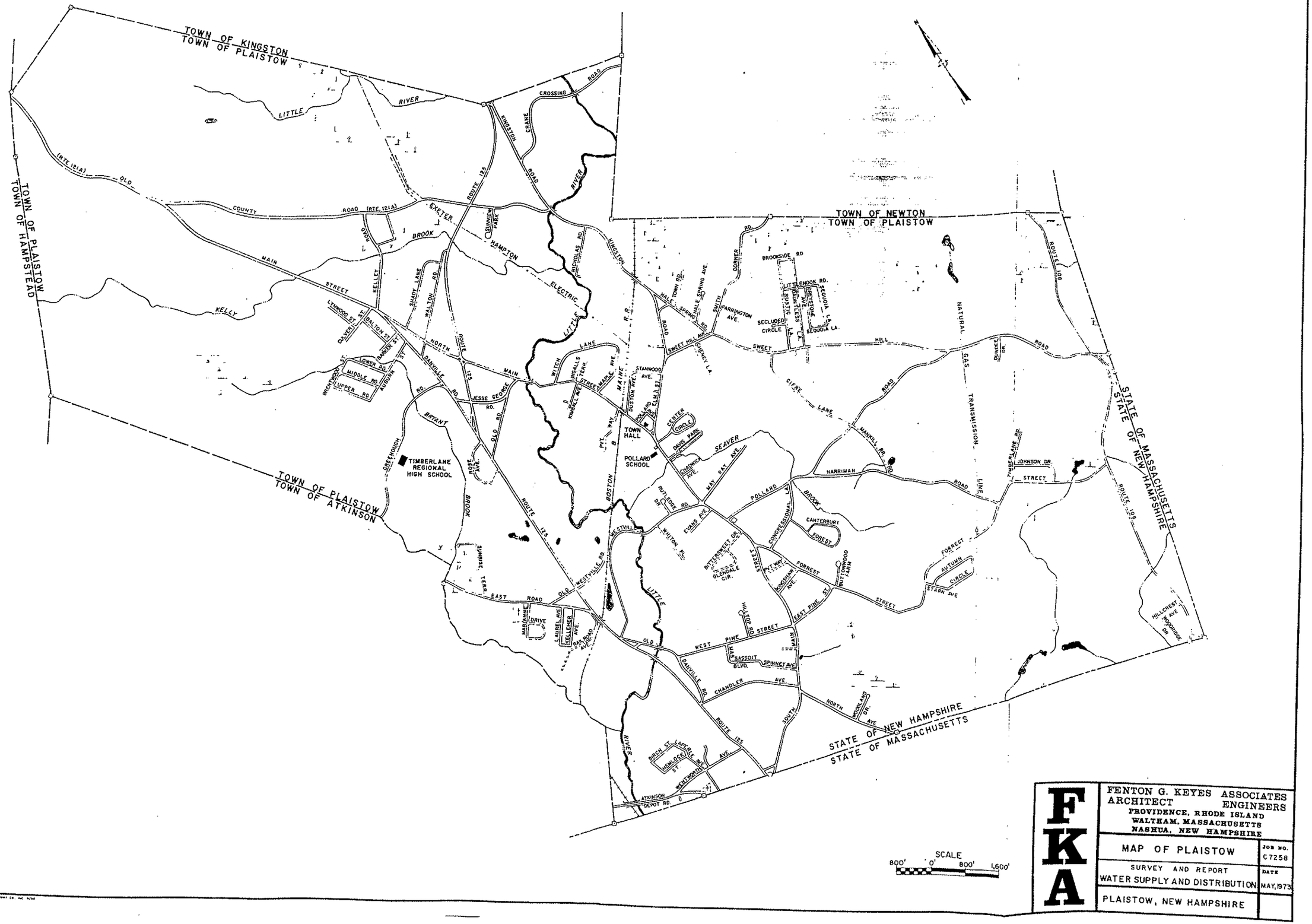
The Little River runs southward through almost the geographical center of the town and provides its principal valley. Major streams tributary to the Little River are Kelly Brook, Bryant Brook and Seaver Brook. Plaistow is unique for a New Hampshire community inasmuch as it does not contain a natural pond, however, there are numerous swampy areas in the wet seasons.

The topography of the town is considered to be gently rolling with virtually no sharp changes in grade and no monumental topographic features. The lowest elevation in town is 50' above mean sea level (m.s.l.) adjacent to the Little River at the southern boundary. The highest land is at Mt. Misery in the northwest corner which has an elevation of 354' above m.s.l. The average elevation of land is in the range of 100' and 125' above m.s.l.

Plaistow is completely lacking in public utilities in the form of either sewerage collection or water distribution systems. There are, however, several privately-owned water systems in addition to the limited town-owned fire protection system. Consideration of incorporating these limited facilities into the proposed municipal water system is discussed in a later section of this report. The general characteristics of the town are shown on Plates R-1 and R-2.

4. THE NEED FOR ESTABLISHING A WATER SUPPLY, STORAGE AND DISTRIBUTION SYSTEM IN THE TOWN

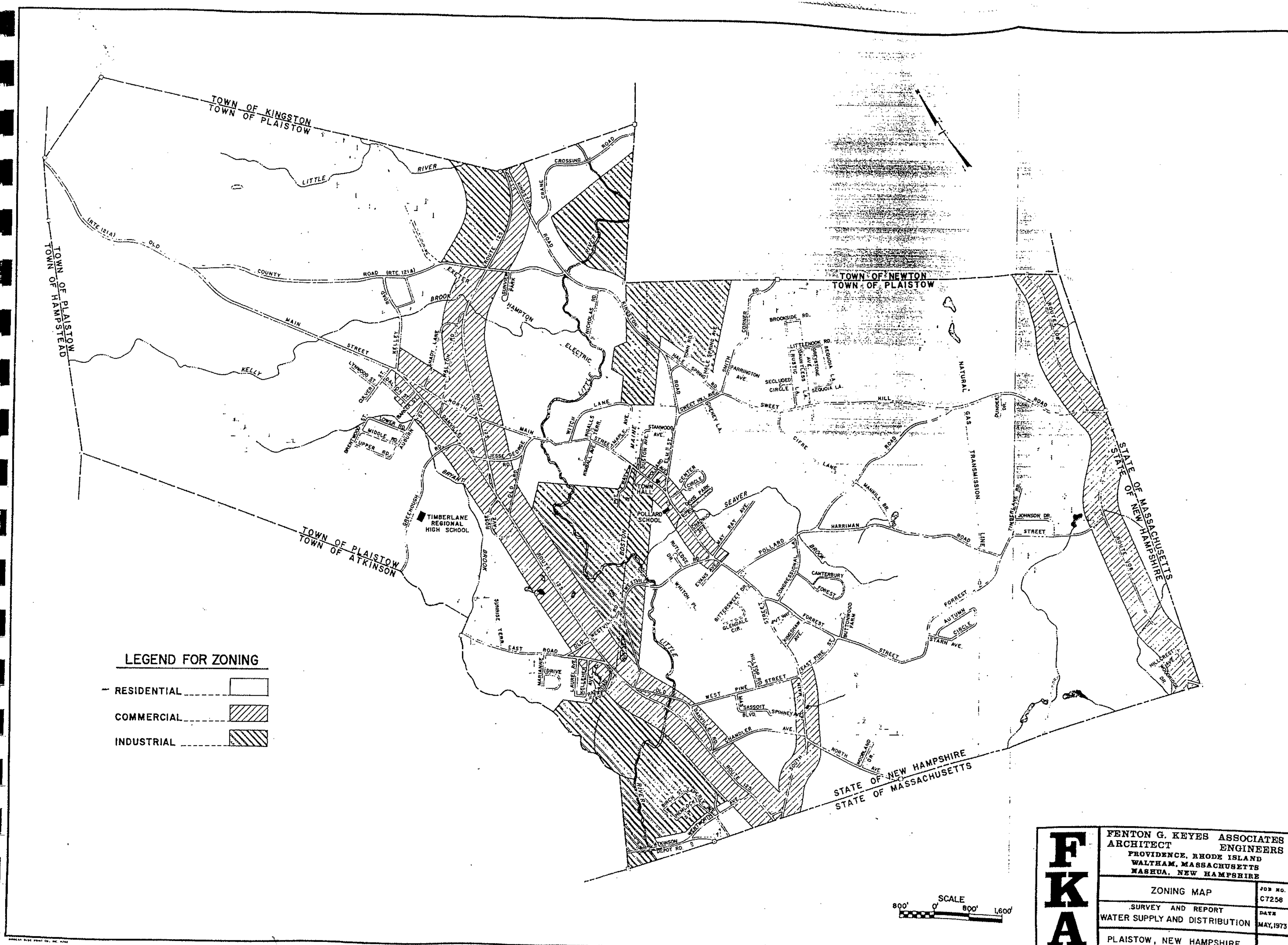
While Plaistow is a rapidly growing community, businesses, industry and homeowners have apparently experienced only minor, if



FKA

FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE

MAP OF PLAISTOW	JOB NO. C7258
SURVEY AND REPORT WATER SUPPLY AND DISTRIBUTION	DATE MAY, 1973
PLAISTOW, NEW HAMPSHIRE	


TOWN OF KINGSTON
TOWN OF PLAISTOW
TOWN OF PLAISTOW
TOWN OF HAMPSTEAD
TOWN OF NEWTON
TOWN OF PLAISTOW
TOWN OF PLAISTOW
TOWN OF ATKINSON
STATE OF MASSACHUSETTS
STATE OF NEW HAMPSHIRE
STATE OF NEW HAMPSHIRE
STATE OF MASSACHUSETTS
LITTLE RIVER
OLD COUNTY ROAD (RTE. 121A)
MAIN STREET
KELLY BROOK
EXETER
HAMPTON ELECTRIC
TIMBERLANE REGIONAL HIGH SCHOOL
TOWN HALL
POLLARD SCHOOL
NATURAL GAS TRANSMISSION LINE
SWEET HILL ROAD
HARRIMAN ROAD
FORREST STREET
WEST PINE STREET
EAST ROAD
ROUTE 125
ROUTE 108
LEGEND FOR ZONING
RESIDENTIAL
COMMERCIAL
INDUSTRIAL
SCALE
800'
0'
800'
1,600'
FKA
FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE
ZONING MAP
SURVEY AND REPORT
WATER SUPPLY AND DISTRIBUTION
PLAISTOW, NEW HAMPSHIRE
JOB NO.
C7258
DATE
MAY, 1973

any, difficulties in obtaining adequate quantities of water from individual wells for their limited requirements. However, with increased development more and more of these individual well supplies may become polluted as a result of increased sewage discharge to the ground. In addition, as more individual wells are developed the incidence of failure of these supplies will naturally increase. It is probable during extended periods of low rainfall that some of these existing wells go dry or experience decreased production. It is interesting to note from the Annual Town Report of 1965 the following: "The Town acquired the Hale Spring and land and a road was built to the Spring which was used as good advantage this year due to the drought."

The development of a public water system is essential to attract industrial and commercial growth to any community. Property valuations in Plaistow have increased from $5,737,651 in 1962 to $15,333,179 in 1971 which represents an increase of 268 percent. All but $2,368,819 of this increase in valuation was due to new construction. During the same period taxes have risen from $52.00 to $89.50, per $1,000 of valuation, primarily due to the increased cost of education. Quoting from the annual town report of 1967, "For the past three years our tax rate has steadily increased in spite of more dollars of building and our additional valuations have not been great enough to keep up with the increase in educational costs.....and we are also getting closer to a need for a water and sewerage system. The only way these services can be accomplished is by an increase in non-expense income from commercial and industrial enterprises." There is no question the

town sorely needs a broader industrial and commercial tax base. A town lacking the basic utility facilities cannot expect to be competitive with communities providing these facilities, regardless of the tax rate.

Plaistow has a dedicated fire department with modern fire fighting equipment but it lacks the essential tool it must have, a municipal water system. The basic fire protection system now offered to the three principal existing industries should be made available to all of the developed areas of the town. Fire insurance rates would be reduced and the assurance of having a hydrant within a reasonable distance from the home would be realized.

5. DISCUSSION OF GENERAL PROBLEMS

The primary concern in the development of a municipal water system to serve the Town of Plaistow is locating an adequate and dependable source of supply. A study undertaken in this regard indicated that a ground water source was the most feasible. To that end a geophysical survey consisting of seismic and resistivity investigations was performed. The results of this survey indicates that a substantial potential for the development of an adequate well water supply exists within the Town of Plaistow. The detailed results of this survey are reported in a later section of the report. In addition, as a result of this geophysical work, an exploratory and test well program to develop ground water supplies has begun.

The lack of knowing the exact location of the final water supply wells presents some technical difficulty in the final

detailed layout of the distribution system. This becomes a relatively minor problem, however, due to the fact that the more productive areas for the location of well supplies are located within or immediately adjacent to the proposed distribution system. A basically standard cost can therefore be used for each of the required well water supplies.

The general street pattern within the town has developed well and it generally covers the developable areas. This greatly simplifies the overall layout of the distribution system by permitting the design of service loops in existing streets which will serve future adjacent development areas. No large undeveloped sections of the town into which major distribution systems would have to be extended at a future time actually remain.

The final financing of the water system has been seriously complicated by the elimination of all federal grant programs covering the construction of basic water facilities. Under prior federal programs and regulations the Town of Plaistow would have most probably been eligible for an outright construction grant of up to 50 percent of the construction cost of the proposed water systems. This construction grant would have come either from the Farmers Home Administration of the Department of Agriculture or from the Community Facilities Branch of the Department of Housing and Urban Development. As of January 1st of this year all construction grants, for water and sewer facilities, from either of these federal agencies were eliminated. As the situation now stands, there are no construction grants for water facilities and construction grants for sewers are being

handled, in total, by the Environmental Protection Agency. It is our understanding that a "Community Facilities Bill" is presently pending in Congress. This bill, if passed, would provide general grants to communities for needed projects and would cover all categories of public works from municipal water systems to urban redevelopment. The only possible assistance from the Federal Government, presently available to the town, appears to be low-interest long-term loans from the Farmers Home Administration. This report, by necessity, envisions full financing of the proposed water system by the town. Should federal money again become available in the future the proposed rates and charges recommended herein can be substantially reduced.

6. HYDROLOGIC DATA

Climatology. The climate of the Town of Plaistow is typical of central New England. In general, periods of extreme heat or cold are of short duration due to the moderating influence of the Atlantic Ocean. Climatological records of the weather stations at Haverhill, Massachusetts and Windham, New Hampshire are available and indicate that the annual mean temperature of Plaistow is 49.2°F. July is the warmest month with a mean temperature, over the period of record, of 73.8°F. and January is the coldest with a mean temperature of 27.9°F. Haverhill recorded a record high temperature of 105°F. in 1949 and record low of -19°F. in 1917 with corresponding temperatures recorded by Windham of 103°F. and -27°F.

Similar to most of New England, Plaistow has no "rainy season".

Precipitation is spread fairly evenly throughout the year. The difference in normal totals between the driest month (February) and the wettest month (March) is less than one inch. The average annual precipitation over the period of record is 40.47 inches. The greatest single day precipitation amounted to 7.06 inches. The average seasonal snowfall is 53.6 inches. Extremes of record are 15.0 inches in the winter of 1936-37 and 102.4 inches in 1947-48. In January, 1923, 49.5 inches of snow were recorded during the month.

More than half the 41 inches of average annual precipitation evaporates directly from the land surface or is transpired by vegetation. The remainder (about 19 inches) travels rapidly over the land surface into the Merrimack River and its tributaries or percolates down to the water table and thence moves laterally to the streams. The part that reaches the water table and subsequently discharges into the streams is estimated to be about 8 inches per year - an average ground water discharge of 0.4 million gallons per day per square mile of drainage area.

During the winter months frozen ground impedes the movement of water downward through the soil and is therefore an important factor in determining the groundwater recharge regimen. Normally the ground freezes in November and remains frozen in part until March. The thickness of the frozen layer varies from about one-half to five feet or more depending on the topographic setting, vegetation and snow cover, climatic conditions, the type of material, and soil-moisture condition. Where the snow accumulates to a thickness of two feet or more, especially under forest cover,

the frozen layer may thin and even disappear entirely under the snow.

7. SURFICIAL GEOLOGY

The lowland in the eastern part of the county is made up of fairly smooth planes interspersed with smooth rounded hills that generally have mild slopes.

The bedrock that underlies Rockingham County is mainly granite and mica interspersed with other materials. Along the coast the mica schist is finer textured than elsewhere and is similar to phyllite in characteristics.

The area was once covered by the glacier of the Wisconsin age. When the glacier receded it left two main types of deposits - non-stratified, unsorted glacial till and stratified, water sorted, gravelly glacial outwash. Hilly, stratified deposits, known as kames, occupy a much smaller area than the till and glacial outwash.

The till is generally stony and has characteristics similar to those of the underlying rock. It varies in depth, but in most places it is 4 to 5 feet deep. In a large part of the area, the till is shallow and outcrops are common.

The glacial outwash is less extensive than the till. It was deposited by the water from the melting ice of the glacier. As the glacier melted, deposits of marine clay were laid down along the coastal areas. The land was depressed by the weight of the ice so that several miles inland from the coast the deposits of marine clay were interfingered with deposits of till and glacial outwash. This caused the soil pattern to be complex.

Ground water occurs in both the consolidated and unconsolidated rocks in Rockingham County, In the unconsolidated rocks, or bedrock formations, it occurs only in the cracks or fissures. In the unconsolidated deposits, as glacial drift, marine sediments, and glaciol aclustrine and glacioflurial deposits, ground water is in the voids or pore spaces between the individual particles making up the deposits.

Plaistow has a terrain which is a result of glacial action on a structure which originally consisted of highlands to the northwest, a major valley (Little River) running in a general north-south direction through the center of Town and additional highlands to the southwest.

The evidence is quite convincing that the Little River valley is pre-glacial and was filled in by coarser materials from the highlands and glacial outwash initially. These would generally tend to be coarse sands and gravels. During later glacial stages, the valley became a dammed up glacial lake and finer silts and clays were deposited which formed the present surface layers of the valley. The hills to the northeast and southwest have some cover of glacial sands and gravels and tills, but much of this gravel lies above its present day water table and are not suitable for water supplies.

The most likely areas to develop a suitable public water supply well, would be in the deeper lying sands underlying the Little River; sands and gravels in the northwest highlands, if they extend deep enough, and some of the smaller valleys to the southwest, if they are deep enough.

8. POPULATION STUDY

In the development of a comprehensive water supply and distribution system to serve a community, a rational prediction of the future population must be made. For purposes of this feasibility study the future permanent population is based on consideration of past minimum, maximum, and median rates of growth experienced in Plaistow since 1900, the number of new dwellings constructed since 1961, and other factors which affect population such as zoning and availability of land.

U. S. Census - Table No. 1 lists the U. S. Census population figures for Plaistow from 1900 through 1970. This table indicates that Plaistow has experienced a steady increase in population throughout the period, except for the decade between 1920 and 1930 when a decline in population took place. The minimum rate of growth in the period since 1930 was a 3.5% increase which occurred from 1930 to 1940 while the maximum rate of growth (61.6% increase) occurred in the past decade from 1960 to 1970. The median rate of growth computes to be 32.5 percent.

Table No. 1
Population of Plaistow - 1900 thru 1970

Year	Population	Numerical Increase	Percent Increase
1900	1027		
1910	1173	146	14.2
1920	1368	192	16.6
1930	1366	-2	-
1940	1414	48	3.5
1950	2082	668	47.2
1960	2915	833	40.0
1970	4712	1797	61.6

New Dwelling Construction - The construction of new dwellings has been fairly consistent since 1961 with the exception of the dip that occurred in 1967 and 1968 in Plaistow and elsewhere. However, home building recovered in 1969 and has sustained a steady rate through 1972. The following tabulation on construction of new dwelling units was obtained from the building inspector's annual reports.

Table No. 2
New Dwelling Construction, Plaistow, N. H.

Year Permit Issued	No. of Dwelling Units	Estimated Construction Value of All Permits Issued
1962	35	$ 500,500.00
1963	33	316,800.00
1964	49	873,396.00
1965	43	2,528,924.00
1966	54	1,197,800.00
1967	29	1,037,244.00
1968	14	410,589.00
1969	46	1,234,497.00
1970	45	1,104,180.00
1971	109	1,966,970.00
1972*	41	1,246,765.00
10 Year Totals	457	$11,166,900.00
Yearly Average	46	1,115,700.00

*Through the month of October

The 1970 census shows the number of persons per dwelling unit to be 3.5. As a part of this study a street by street count of dwelling units in Plaistow was made late in 1972. This count produced a total of 1463 existing dwelling units housing a computed population of 5,120 persons.

Available Land - As shown on Plate R-2 the present zoning in Plaistow is divided into three broad categories, residential, commercial, and industrial. Of particular interest is the

residential zoning area which totals about 4360 acres. Presuming an average lot size to be 40,000 square feet, the estimated total number of dwelling units which could be built in Plaistow would total about 4522 with proper allowance for roads, recreation areas, open spaces and unfavorable terrain. Using the present unit population figure of 3.5 persons per dwelling unit the estimated ultimate population of this residentially-zoned area would be 15,830 persons. In addition, there are 363 dwelling units presently situated in the industrially and commercially zoned areas which house an estimated population of about 1270 persons. Based on this analysis the estimated ultimate population of the Town of Plaistow, using the present zoning ordinance becomes about 17,100 persons.

Population Projection - Plate R-3 depicts the population trends based on both a growth projection and a dwelling unit criteria. The selected growth curve was based on the dwelling unit criteria which was established by assuming a 50 dwelling unit per year growth and applying the 3.5 person per dwelling unit factor. Table 3 lists the estimated future population for Plaistow.

Table No. 3
Projected Population of Plaistow, N. H.

Year	Est. No. of Dwelling Units	Estimated Population
1972	1463	5,120
1982	1963	6,870
1987	2213	7,745
1992	2463	8,620
2002	2963	10,370
2012	3463	12,120
2022	3963	13,870

As will be seen from Plate R-3, the dwelling unit population projection lies closer to the maximum growth projection line than the median growth projection line. This is not unreasonable considering that the Town of Plaistow borders the City of Haverhill, Massachusetts which is very densely populated. From all signs such as new shopping facilities and commercial establishments, and new residential construction, it appears that Plaistow is experiencing an overflow of population from Haverhill. A comparison of the 50 year estimated population of about 13,100 persons and the estimated ultimate population of 17,400 persons, reveals that the 50 year projected population would be about 75 percent of the estimated ultimate population which again appears to be reasonable.

9. ESTIMATED WATER CONSUMPTION

General Use - In a community with the character of Plaistow without a substantial wet process industry and without a public sewerage system the present average per capita usage per day can be expected not to exceed 75 gallons. This per capita consumption figure will increase in the future and for purposes of this report this per capita usage has been increased as shown on Table 4.

Table No. 4
Estimated Water Consumption

Year	Population	Per Capita Consumption	Avg. Daily Use	Peak Daily Use
Present	5,000	75	375,000 Gals.	562,500 Gals.
1980	6,500	80	520,000 "	780,000 "
1995	8,500	90	765,000 "	1,147,500 "
2000	9,500	100	950,000 "	1,425,000 "
2020	13,000	110	1,430,000 "	2,145,000 "
2030	17,400	120	2,088,000 "	3,132,000 "

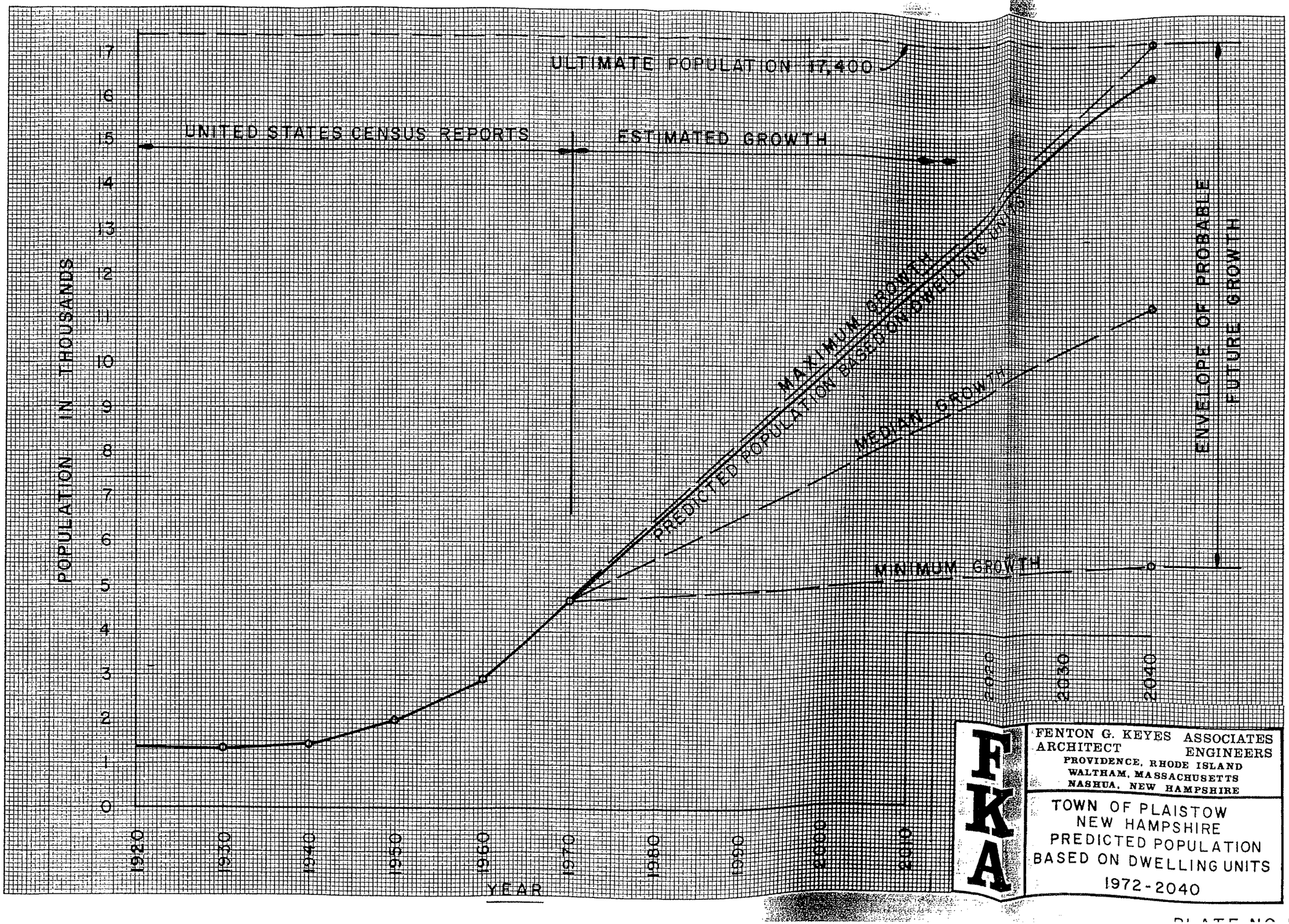

ULTIMATE POPULATION 17,400
UNITED STATES CENSUS REPORTS
ESTIMATED GROWTH
POPULATION IN THOUSANDS
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
YEAR
MAXIMUM GROWTH
POPULATION BASED ON DWELLING UNITS
PREDICTED POPULATION
MEDIAN GROWTH
MINIMUM GROWTH
ENVELOPE OF PROBABLE FUTURE GROWTH
2000
2020
2040
FKA
FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE
TOWN OF PLAISTOW
NEW HAMPSHIRE
PREDICTED POPULATION
BASED ON DWELLING UNITS
1972-2040

PLATE NO. P-7

As indicated on Table No. 4, the average daily use would be 375,000 gallons with a peak daily usage of 562,500 gallons. By the year 2030, it is estimated that the daily usage would be 2,088,000 gallons with a peak usage of 3,132,000 gallons per day.

On the basis of the water supply source being gravel packed wells and pumping not over a total of 16 hours per day the wells and pumping equipment should initially provide a capacity of 1000 gallons per minute and would ultimately have the capability of producing a minimum of 3500 gallons per minute.

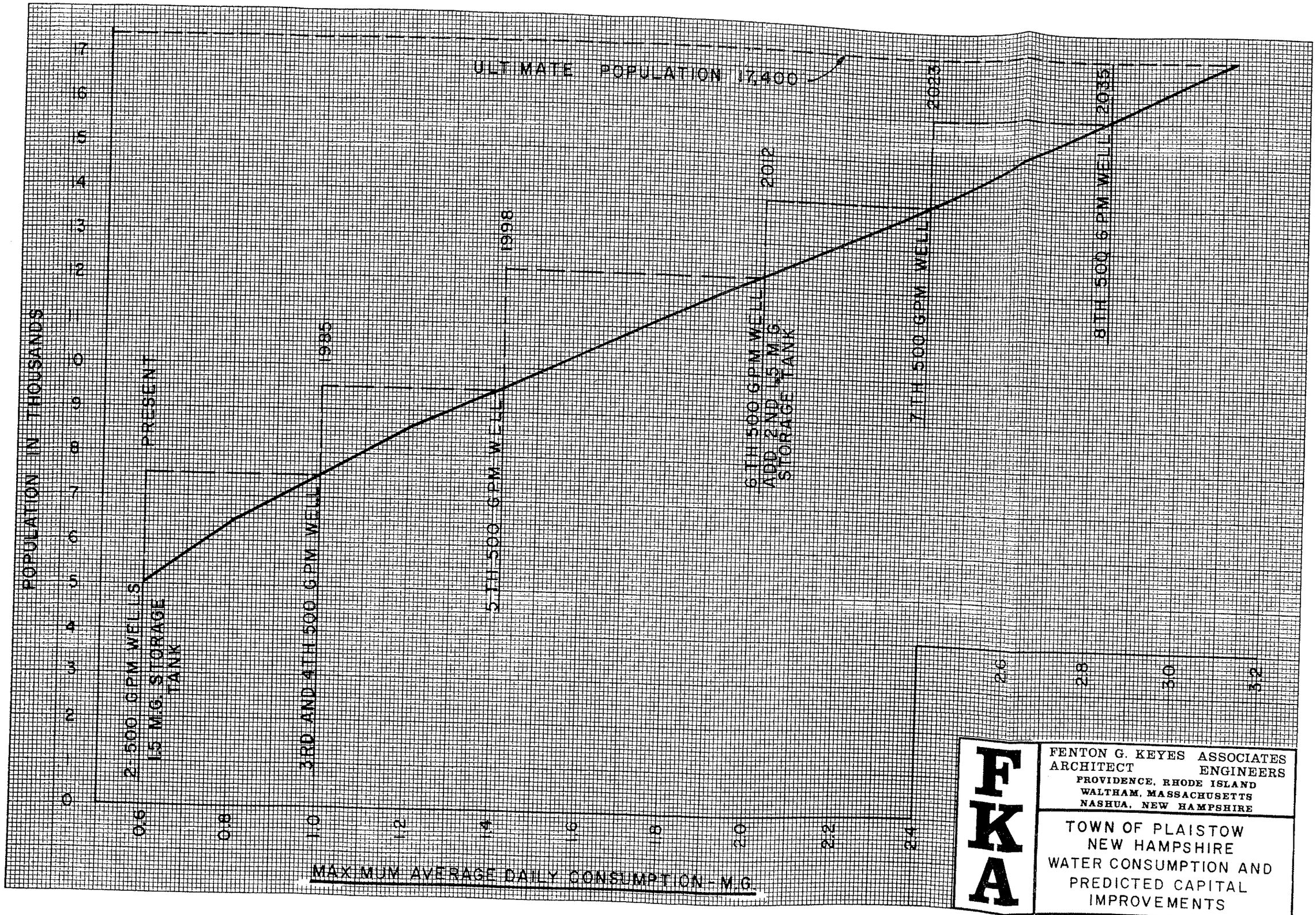
Fire Flow Requirements - A storage facility will be required in the system to maintain adequate pressures and to provide water for fire protection purposes. Water to be used for fire fighting purposes represents an essentially uncontrolled draw on the available water in the system. It becomes prudent then to provide storage for a sufficient quantity of water to fight any fire to the fullest extent necessary and at the same time maintain full service for domestic, commercial and industrial uses. For fire fighting purposes an initial flow of 1,500 gallons per minute for a four hour period is considered to be adequate for Plaistow. However, as the population in Plaistow increases, the fire flow requirements would ultimately reach 3000 gallons per minute for a seven hour period.

The capacity of the storage facility should be sufficient to meet this fire flow demand during a peak day use with all supply pumps running and not deplete the storage capacity by more than one-third. An initial peak day use has been determined to be 562,500 gallons or about 585 gallons per minute based on a 16 hour

period of usage. During a period of maximum fire flow usage the total draw on the system would be 2,085 gallons per minute. Input to the system based on a 1,000 gallon per minute supply would be 1,000 gallons per minute resulting in a net draw from storage of 1,085 gallons per minute or a total draw for the four hour fire flow period of 260,000 gallons. A storage tank with a capacity of 750,000 gallons would be required to meet the criteria outlined above, however, to provide for the projected growth in the system and to avoid the necessity of having to add a second small storage facility in a relatively short time in the future it is recommended that the size of the initial storage facility be made 1,500,000 gallons.

Ultimately, the peak day's use has been determined to be 3,132,000 gallons or about 3,260 gallons per minute based on a 16 hour period of usage. During a period of maximum fire flow usage the total draw on the system would be 6,260 gallons per minute. Input to the system based on 4,000 gallons per minute supply would be 4,000 gallons per minute resulting in a net draw from storage of 2,260 gallons per minute or a total draw for the seven hour fire flow period of 950,000. An additional 1,500,000 gallon storage tank resulting in a total capacity of 3,000,000 gallons will, therefore, be required to meet the ultimate demands of Plaistow.

Fire hydrants have been located throughout the proposed system to provide the greatest possible amount of protection to all customers of the system. The New England Insurance Rating Association, the agency which establishes basic fire insurance rates, has the following regulations concerning fire hydrants. A hydrant must be



FKA

FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE

TOWN OF PLAISTOW
NEW HAMPSHIRE
WATER CONSUMPTION AND
PREDICTED CAPITAL
IMPROVEMENTS

PLATE NO.

under pressure; must be connected to a 6 inch main, minimum, by a 6 inch connection; must be available to a public fire company; must have standard 2-1/2 inch hose connections and must deliver a minimum of 250 gallons per minute at a residual pressure of 20 pounds per square inch. Areas so protected are placed in a "Protected" or "D" classification. Without these facilities the area would be considered to be in an "Unprotected" or "E" classification. In addition the best insurance rate is obtained when the building is located within 500 feet of a fire hydrant. In the layout of the system and the location of hydrants every attempt has been made to place the hydrants so that each customer will be within a radius of 500 feet.

Plate R-4 presents a graphic representation of the capital improvements, in the form of wells and storage facilities, which will be required with the growth of the system and increased water consumption.

10. EXISTING WATER SUPPLIES

There are no known quasi-public or privately-operated water systems within Plaistow which are of any appreciable size or serve a substantial number of customers. A town owned limited fire protection system was completed in 1971. This system serves one hydrant on North Main Street and 5 hydrants in the Westville area in addition to private hydrants at Process Engineering, Pennsylvania Box & Lumber and the Westville Homes Corporation. No general service or domestic connections are permitted to this fire system. This project was a cooperative effort shared by the Town with Process

Engineering, Westville Homes and the Economic Development Agency of the federal government. Portions of this system can be incorporated in a town-owned municipal system.

It is worthy of note that the three above-named firms employed 70 percent of the total number of industrial employees employed in Plaistow in 1972. It is doubtful that these firms could afford to stay in Plaistow if adequate fire protection had not been made available. This would seem to be a positive indication that more industry would be attracted to Plaistow if a public water system were to become a reality.

It is understood, but not confirmed, that some of the commercial establishments adjacent to the Haverhill city line are obtaining water from the Haverhill system. This is another strong indication of the value of the availability of a public water system.

All other establishments and residences in Plaistow obtain their water from privately owned shallow or rock wells. It is known that some rock wells extend as deep as 600 feet and that at Canterbury Forest, adjacent to Seaver Brook, individual wells are about 65 feet deep and are good producers.

11. WATER SUPPLY SOURCES

The water supply sources generally available to a town such as Plaistow are:

1. Ground Water
2. Surface Water and,
3. Purchased Water

Ground Water - Bedrock and glacial till are sources of small or limited supplies of ground water almost everywhere in the area, but stratified glacial drift (ice-contact and outwash deposits) is a much more favorable source for larger supplies. The most favorable areas for development of substantial large-scale ground-water supplies are those underlain by relatively thick ice-contact or outwash deposits, especially those adjacent to streams or large bodies of surface water from which flow can be induced to replace water withdrawn from the deposits. These deposits generally are less than 50 feet thick in the lower Merrimack River valley, but in places may be more than 100 feet thick, Where saturated, these deposits are groundwater reservoirs storing about one and one-half billion gallons of water per square mile for each 20 feet of saturated thickness. This reservoir of water can be used as a backlog in seasonal dry periods and in time of drought, when ground-water recharge is insufficient, to supply water to wells and maintain streamflow.

Bedrock wells generally yield less than 10 or 15 gpm in most of the lower Merrimack River valley, but there is a unique area in Salem, Pelham and Atkinson where bedrock wells locally, and perhaps generally, yield more than 40 gpm and reportedly as much as 150 gpm (Rockingham Race Track). This area appears to be relatively narrow, extending southwestward through Pelham and northwestward through Atkinson, parallel to the major faults and the regional bedrock structure.

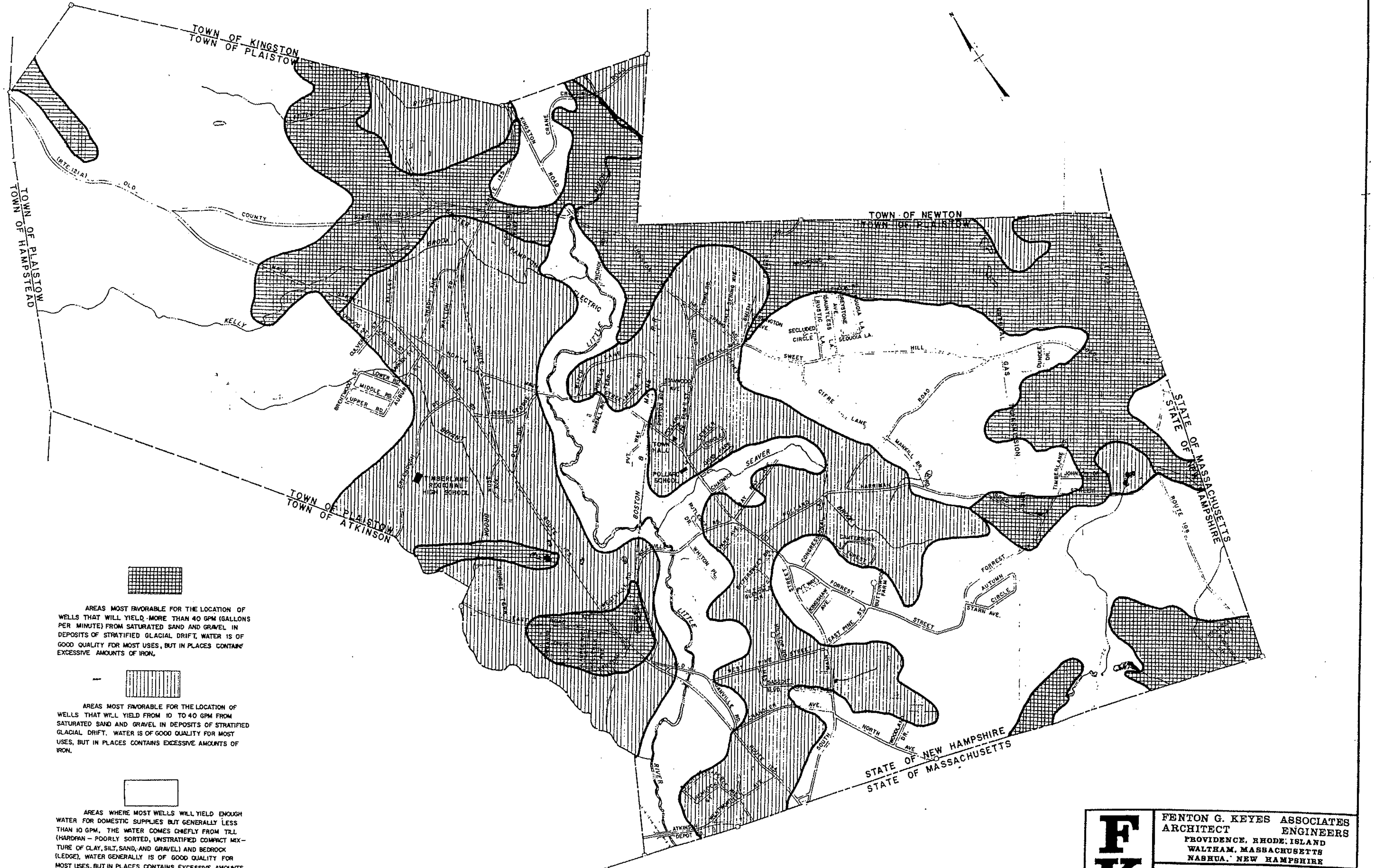
In Plaistow, the ground water table fluctuates in an annual cycle, generally rising during the winter and spring and declining

during the summer and fall. The range of water-level fluctuation is less in well-sorted sand and gravel than in till and bedrock. This is because the porosities of bedrock and till are less than those of ice-contact and outwash materials, and, therefore, a given amount of recharge or discharge saturates or dewaters a correspondingly greater thickness of bedrock or till.

The annual water-table rise normally begins in autumn, but commonly is interrupted in winter when the ground freezes and when potential recharge is temporarily withheld as snow at the land surface. After subsequent thaws the rise generally continues to a maximum in late March or April, then declines through the growing season. Water-table fluctuations indicate changes in ground-water storage resulting from changes in the balance between recharge and discharge. During the growing season much water is lost by evaporation and transpiration in addition to ground-water discharge to streams. Hence, ground-water storage decreases through the growing season even though precipitation continues at the same average monthly rate during that period.

Plate R-5 is a "Ground-Water Favorability Map" of the Plaistow area prepared by James M. Weigle, 1968, of the U. S. Geological Survey and issued in cooperation with the State of New Hampshire Water Resources Board. Explanatory notes accompanying the above referenced map are, as follows:

> "This map shows the relative favorability of areas for exploration for ground-water supplies in the Plaistow area, New Hampshire. It also indicates the magnitudes of the ground-water yields most likely obtainable from properly located (as by test drilling) and properly constructed wells in those areas. The limits shown are estimates based



AREAS MOST FAVORABLE FOR THE LOCATION OF WELLS THAT WILL YIELD MORE THAN 40 GPM (GALLONS PER MINUTE) FROM SATURATED SAND AND GRAVEL IN DEPOSITS OF STRATIFIED GLACIAL DRIFT. WATER IS OF GOOD QUALITY FOR MOST USES, BUT IN PLACES CONTAINS EXCESSIVE AMOUNTS OF IRON.

AREAS MOST FAVORABLE FOR THE LOCATION OF WELLS THAT WILL YIELD FROM 10 TO 40 GPM FROM SATURATED SAND AND GRAVEL IN DEPOSITS OF STRATIFIED GLACIAL DRIFT. WATER IS OF GOOD QUALITY FOR MOST USES, BUT IN PLACES CONTAINS EXCESSIVE AMOUNTS OF IRON.

AREAS WHERE MOST WELLS WILL YIELD ENOUGH WATER FOR DOMESTIC SUPPLIES BUT GENERALLY LESS THAN 10 GPM. THE WATER COMES CHIEFLY FROM TILL (HARDPAN – POORLY SORTED, UNSTRATIFIED COMPACT MIXTURE OF CLAY, SILT, SAND, AND GRAVEL) AND BEDROCK (LEDGE). WATER GENERALLY IS OF GOOD QUALITY FOR MOST USES, BUT IN PLACES CONTAINS EXCESSIVE AMOUNTS OF IRON. WATER FROM WELLS IN BEDROCK IS EXCESSIVELY HARD.

FKA

FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE

GROUND-WATER FAVORABILITY — JOB NO. C7258

SURVEY AND REPORT
WATER SUPPLY AND DISTRIBUTION — DATE MAY, 1973

PLAISTOW, NEW HAMPSHIRE

on the best hydrologic and geologic data available.

It is emphasized that this map represents an interpretation of observed data, and is generalized. It does not eliminate the need for detailed exploration, but does provide a logical basis for directing such exploration."

There is very little substantiated related published matter on well water supplies in the town of Plaistow. In 1962 the U. S. Geological Survey in cooperation with the State of New Hampshire Water Resources Board prepared and issued the publication entitled, "New Hampshire Basic-Data Report No. 1 Ground-Water Series Southeastern Area by Edward Bradley and Richard G. Petersen".

This publication gives the logs of selected wells and test holes, also very rough approximate locations. Seven wells are tabulated for Plaistow. The logs of these seven wells are summarized below. The numbers of the wells are those utilized by the U. S. Geological Survey.

Table No. 5
Brief Logs of Selected Wells, Plaistow, N. H.

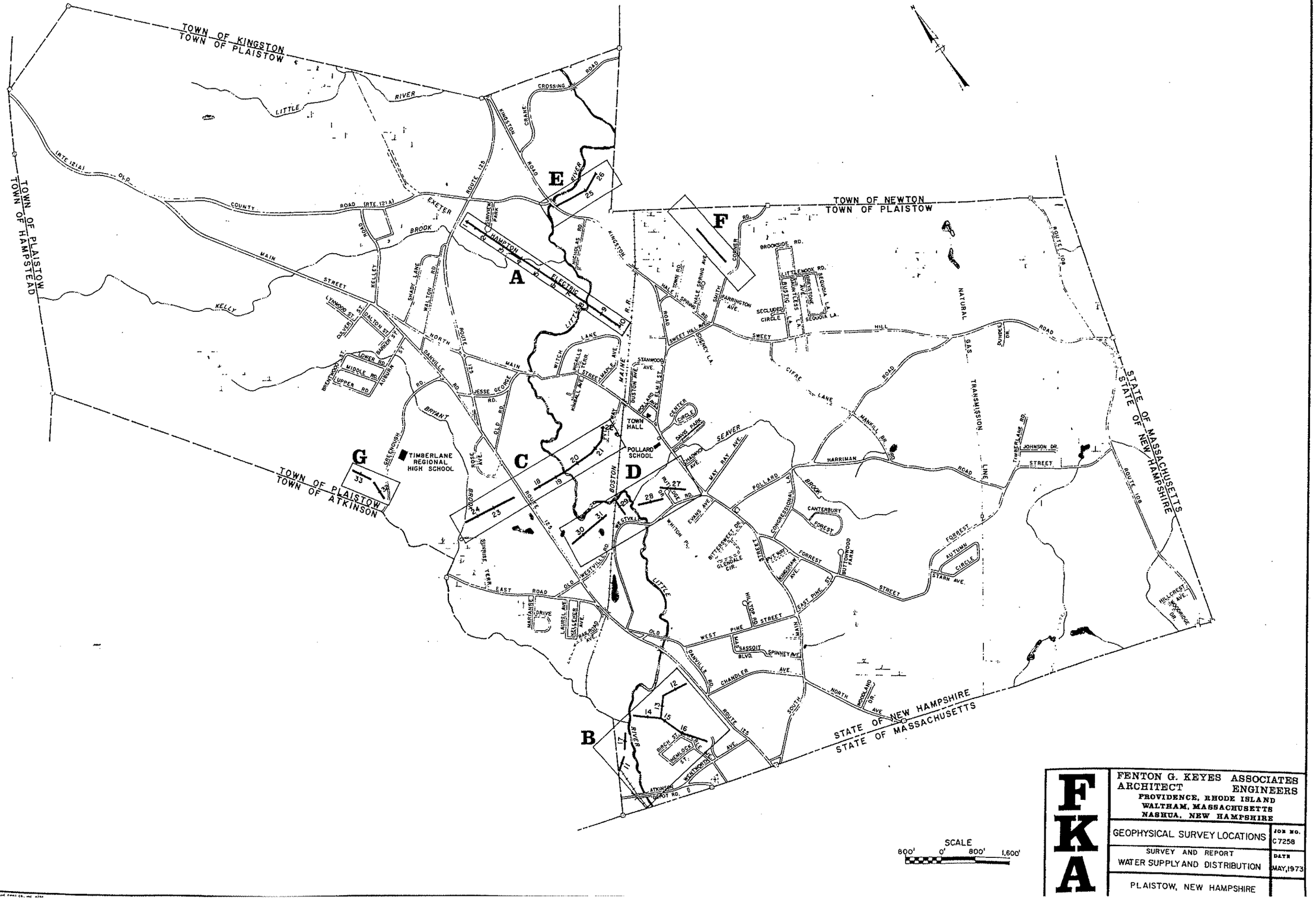
Well No.	Type of Material Encountered	Refusal Depth
7	80' till, bedrock 95'	
10	4.5' outwash, 0.5' fill	5.0'
11	Silt, fine sand, clay & till	27.5'
12	Fine sand, silt & clay	40.0'
13	Fine to medium sand, medium to very coarse sand, mixed with mineral & mica grains. Bottom 13' silt & clay	40.0'
14	Clay, sand, gravel, hardpan	38.9'
15	Clay, sand & gravel	25.0'

The logs of these seven wells do not indicate material or depth conducive to large capacity wells. There is no follow-up information offered such as static water level or yield. From the

evidence of the kind of material encountered it is doubtful if any of these wells will produce more than 10 to 15 gpm. The background information on these wells is somewhat significant, all wells but the rock well are in the Little River valley and in all wells, except at the surface there is a lack of outwash material.

Included in the above referenced publication is the daily log of the water level in Well No. 3 in Plaistow from December 5, 1955 to November 12, 1957. The highest water level was registered on January 13, 1956, the lowest on November 2, 1957, these water levels being 13.65' and 23.18' respectively below the level of land surface for a minimum drop in water level 9.53 feet. No details of Well No. 3 are given. The foregoing data and information is minimal and should not be utilized to any degree beyond being a very general guide.

Exploratory work to determine possible locations for a permanent well water supply was not included as a part of this study and report. We have, however, studied all available literature published by the United States Geological Survey which has done extensive research work on ground water resources in the State in addition to the usual on-site observations, and also have conducted a geophysical survey of Plaistow so as to locate the best potential ground water sources. Plate R-6 shows the locations that were tested by seismic and resistivity investigations. The purpose of the survey is to obtain information on the subsurface geology of the area which can be used to direct the exploratory and test drilling to locate productive well sites. Specifically the hope is that the geophysical measurements will be able to detect, in



FKA

FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE

GEOPHYSICAL SURVEY LOCATIONS	JOB NO. C7258
SURVEY AND REPORT WATER SUPPLY AND DISTRIBUTION	DATE MAY, 1973
PLAISTOW, NEW HAMPSHIRE	

the area surveyed, where the stream alluvium or glacial material extends to the greatest depth and where it is the cleanest. The seismic information is generally more reliable for depth information, the resistivity more reliable in defining the nature of the material.

The general results of the geophysical survey are as follows. The complete geophysical survey report is contained in Appendix B.

Site "A" - A geophysical line was run following the power lines, crossing part of the north-west pattern and the Little River Valley. Resistivity and seismic data confirmed the existance of relatively deep lying sands and gravel deposits at several locations. Recharge to the area is available from Kelly and Little Rivers, access to the area is reasonably good. Test wells are recommended at resistivity stations 8 and 4.

Site "B" - This is a swampy basin near the south end of town and from the geophysical data, appears to be out of the main valley. Bedrock is shallow and the basin is primarily clay filled. There is some indication of a thin, shallow sand and gravel deposit on the south edge of the basin, which would appear to be too close to existing housing for development. Stations 11 and 17 are close to the river and would have good recharge, but appear to be shallow. There is a possibility that just above bedrock, a sand and gravel area exists and an exploratory well could be driven, if necessary.

Site "C" - The survey profile crosses the main valley and part of the north-west highland, near the center of town. The survey indicates shallow sand and gravel to the north-west, but

adjacent to the river at Station 20, sand and gravel appears to be thicker. Access to the area is quite difficult, due to the swamps, but the recharge potential, is excellent. An exploratory well at Station 20 is recommended.

Site "D" - This survey line crosses the Little River Valley just below the center of town and also indicates good material at reasonable depth near Station 29. The site is accessible and the recharge potential good. An exploratory well is recommended at Station 29.

Site "E" - This profile runs along a glacial Esker, which has been mined of its surface sand and gravel. The survey indicates that the sand and gravel extended below ground to a limited depth. Since the recharge potential at the site is excellent and access is good, this might prove a satisfactory site despite its shallowness. An exploratory well should be driven at Station 26.

Site "F" - A profile of four resistivity stations was attempted along the same Esker as "E", but farther south. Coarse, loose, dry gravel on its surface prevented the taking of satisfactory readings. We believe the area would still be worth drilling on speculation toward the end of the program.

Site "G" - This profile is in the north-west highland, across the street from the Regional High School and the results show a deep lying sand and gravel layer. Adequate recharge should be available from Bryant Brook and access is good. An exploratory well at Station 32 and 33 is recommended.

Summary and Recommendations - As a result of the Geophysical Survey there is adequate evidence to state that a number of

potentially productive well sites exist within the Town of Plaistow. This survey should be followed by a full exploratory and test well program carried out in accordance with the schedule as set forth in the report of the geophysical work. Table No. 6 below lists this recommended schedule.

Table No. 6
Schedule of Exploratory Drilling Based on the Geophysical Survey

Profile Designation	Line Stations	Priority
A	7 & 8	1
A	4	2
G	32 & 33	3
C	20	4
D	29	5
E	26	6
F	Convenient Location	7
B	11 & 17	8

The results of the geophysical survey and these recommendations were presented to Town Officials, in preliminary form, early in 1973 and shortly thereafter $19,500 was appropriated by the Town for the recommended exploratory and test well program. A test program of this type is handled in two phases, the exploratory phase and the test phase.

The exploratory wells are 2-1/2 inches in diameter and are driven into the ground to refusal (bedrock). The various materials penetrated and the static level of the ground water is carefully noted. If the material penetrated appears promising an observation well is driven nearby and the original well is pumped at the highest rate possible, usually between 50 and 125 gallons per minute in a successful location. If possible several such locations will be developed and tested on an exploratory basis.

The several locations will then be evaluated and the most promising sites further tested by means of eight inch test wells.

These eight inch test wells are also drilled to bedrock. The casing is then pulled back, the screen is set in the most promising strata and the well is naturally developed. To measure the zone of influence of the well and to obtain data on the aquifer a series of 2-1/2 inch observation wells are driven at strategic locations surrounding the main test well. The pump is then set and the pumping test is begun. A desirable pumping rate to be obtained is between 300 and 500 gallons per minute and the pumping test is run continuously for a period of 92 to 168 hours. During a successful pumping test stabilization is normally reached, that is, the level of water in the immediately adjacent observation well holds steady at a given pumping rate. Stabilization is normally attempted at the highest possible pumping rate. Careful observation and recordings of the water levels in the several observation wells and the main well are frequently made, usually hourly. At the end of the test the recovery of the ground water level to, or nearly to, its original elevation is carefully observed. From the mass of data obtained during the pumping test a ground water geologist can determine with considerable accuracy the quantity of water which a properly constructed gravel packed well will produce on a long term basis.

Samples of the water pumped are taken several times during the test and analyzed chemically to determine such characteristics as color, turbidity, solids, chlorides, hardness, alkalinity, iron,

manganese and pH. These chemical analyses will indicate if treatment of any kind will be required.

Because of a rapid change in the lithology of deposits and variation in the chemical constituents in various wells throughout the town the use of an eight inch test well at each promising test location is most desirable. The eight inch well assures setting the screen in the most productive strata and the long, high capacity pumping test will indicate, almost conclusively, the presence of undersirable minerals and whether their content is increasing or decreasing with continuous pumping. It is anticipated at this time that two eight inch test wells will initially be needed.

Surface Water - Generally speaking communities the size of Plaistow cannot afford the development of a surface water supply. The cost of acquiring water rights and protecting against pollution is usually excessive and surface water supplies usually require a complete treatment system which is expensive both to build and to operate. The topography of Plaistow does not lend itself to a deep water reservoir with relatively small surface area per million gallons of water stored. This means that a large surface area would be created with the resultant increase of loss by evaporation. Even if this latter type of storage was acceptable there simply isn't sufficient area within the town to support the reservoir area that would be required and protect its watershed. Dams of this type to develop a large shallow reservoir are generally expensive.

A surface supply within Plaistow would necessitate the use of Little River. This could be accomplished by a small catchment dam in the stream with pumping to a remote reservoir where storage and treatment would take place prior to distribution. Here again this represents an expensive solution to obtaining a water supply and should be resorted to only if an adequate ground water supply is not available. Due to the obvious differences in first cost between well supplies and a surface supply only cursory study of the safe yield of the Little River was made. The river has a drainage area upstream of Plaistow of about 11 square miles and this brief study indicates the safe yield to be borderline for Plaistow's future needs.

Purchased Water - The third possible water supply source is purchased water from the City of Haverhill, Massachusetts. Haverhill presently takes its water supply from three sources; Kenoza Lake, Crystal Lake, and Johnson Pond. The quantity of water available from thse sources is adequate to supply the increased demand of Plaistow, however, the quality of water from these sources requires treatment to meet present State standards. Apparently the cost of this treatment will be fairly expensive because Haverhill is considering additional water supply from ground water sources with a view towards phasing out the present surface supply system.

If Plaistow took water from Haverhill, the proposed 8 inch main along North Avenue would have to be increased to 12 inches; about 3,000 feet of 8-inch main along North Avenue in Haverhill

would have to be increased to 12 inches; and probably a booster pump added to this system to supply the proposed Plaistow system. In addition to the above capital improvements, Plaistow would be charged at the present wholesale water rate of $0.17 per 100 cubic feet of water and also be required to allow Haverhill to tap Plaistow's ground water supply to serve both communities in the event the combined system was faced with a water shortage.

Recommendation - In view of the capital costs involved together with substantial difficulties inherent in developing an adequate surface supply this source of water supply is not recommended at this time. Similarly, because of existing supply problems in the Haverhill system coupled with substantial main strengthening to deliver the water to Plaistow this source of supply is also not recommended. In addition the Haverhill wholesale water rate of $227.80 per million gallons is considered high for basically raw water.

A ground water supply of course, must be developed and until this is done there must be some concern that it exists in sufficient quantity. The geophysical work indicates a good potential for the development of reasonably high capacity wells and on this basis wells are recommended as the source of water supply.

A ground water supply is substantially less expensive to develop and to operate and generally does not require treatment beyond chlorination. In some instances removal of minerals may become necessary. This initial cost factor makes a well water supply much more attractive and practical to a developing small water system.

12. THE OVERALL PLAN OF WATER DISTRIBUTION

The Distribution System - The recommended initial water distribution system is shown schematically on Plate R-7 and in greater detail on Sheets Nos. 2, 3 and 4 bound as Appendix A at the rear of the report. This initial system has been designed to serve the presently developed and developing areas of the town. Some areas have been intentionally bypassed at this time due to their general elevation in relation to the system service elevation or because present development in some areas does not economically justify water distribution at this time. Those areas recommended for later construction are as follows:

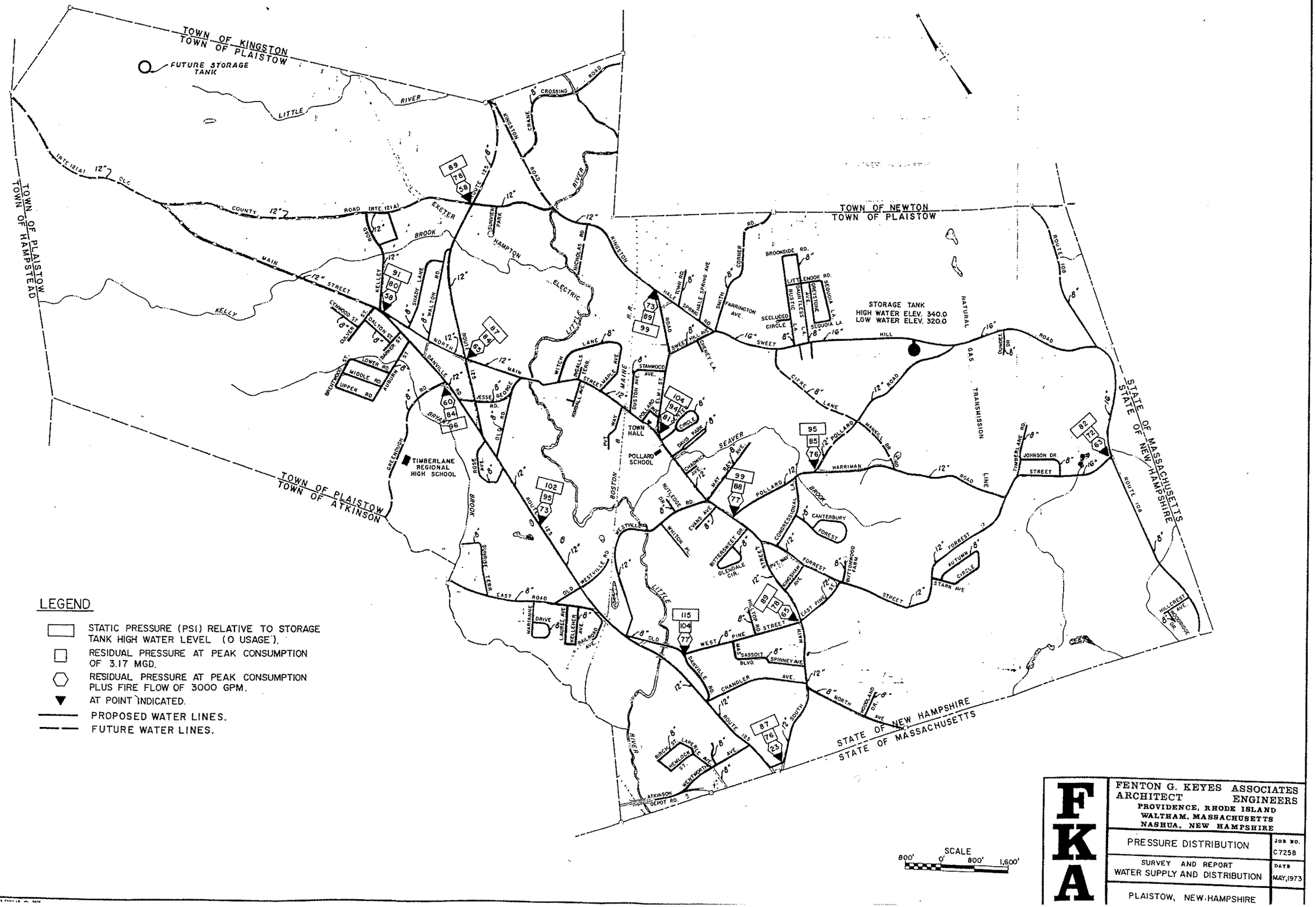
Old County Road (west of Kelley Road)
Main Street (west of Kelley Road)
Old County Road (west of Rte. 125)
Route 125 (north of Old County Road
Kingston Road (north of Old County Road)
Crane Crossing Road
Nicholas Road
Smith Corner Road (northern portion)
Cifre Lane
Mankill Brook Road
Pollard Road (west of Cifre Lane)
Greenough Road

The initial distribution system as proposed herein would provide service to approximately 1372 customers which constitutes 94 percent of the dwelling units in Plaistow. The main outer loop feed system from the proposed standpipe located on Sweet Hill consists of a 16-inch water main along Sweet Hill Road to Route 108; a 16-inch main along Route 108 to Forest Street, thence in Forest Street to Harriman Road where the main loop changes to 12-inch main in Forest Street to East Pine Street. The 12-inch main

continues in East Pine Street to South Main Street, in South Main Street to Route No. 125, thence northerly in Route 125 to Danville Road. The 12-inch main continues in Danville Road to North Main Street then easterly in this street back to Route No. 125 where it runs northerly to Old County Road. In Old County Road the 12-inch main runs easterly to Kingston Road, in Kingston Road to Hale Spring Road then in Hale Spring Road to Sweet Hill Road where the main again increases to 16 inches in size completing the loop back to the standpipe.

Subsidiary mains consisting of 8-inch and 12-inch piping feed the internal areas of this main water supply loop and are sized to assure sufficient residual pressure within the system with a proper allowance for reduced pressures which could occur during a major fire. Plate R-7 indicates the residual water pressures as determined by a "Hardy Cross" analysis at selected locations in the water system which may be expected during conditions of: 1.) zero usage conditions; 2.) residual pressures expected during peak usage periods; and 3.) residual pressures expected during a fire coincident with peak usage periods. All main water piping has been sized with a view towards supplying the future ultimate population of Plaistow, thus precluding the need for increasing the pipe sizes or installing relief mains at a future date.

Fire hydrants as shown on Sheets Nos. 2, 3, and 4 have been placed so as to provide the greatest degree of fire protection possible to the buildings which will be connected to the proposed distribution system. These hydrants' locations will satisfy all criteria established by the New England Insurance Rating Association,



FKA

FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE

PRESSURE DISTRIBUTION	JOB NO. C7258
SURVEY AND REPORT WATER SUPPLY AND DISTRIBUTION	DATE MAY, 1973
PLAISTOW, NEW HAMPSHIRE	

which have been set forth at length previously in this report.

Storage Facilities - In addition to maintenance of proper system pressures and provision of continuous service for a reasonable period of time in the event of a supply system failure, storage facilities provide a supply of water for use during fire emergencies. During these times water is used at a much increased rate to fight the fire. Much criteria has been developed as to how much water should be in storage as fire reserve and at what rate of flow and for how long a period water should be available to meet the emergency. In residential areas containing one and two story single family dwellings, widely spaced, and in semi-commercial areas a fire flow of 1500 gallons per minute for a four hour period is considered adequate. However, as residential and commercial areas become more intensely developed, an increased fire flow of up to 3,000 gallons per minute for a seven hour period could be expected in Plaistow.

These fire flows must be met during a peak day use with all supply pumps running and not deplete the total storage capacity by more than one third. The estimated fire flow, of course, governs the quantity of storage necessary. Initially a 1,500,000 gallon storage tank will satisfy these requirements and provide adequate storage. Beginning peak daily flow is estimated to be 562,500 gallons or 585 gallons per minute based on a 16 hour period of usage. With a fire flow of 1500 gallons per minute the total draw on the system would be 2085 gallons per minute. At the same time the well supply pumps would be in service providing an inflow to the system of 1000 gallons per minute resulting in a net draw

from storage of 1085 gallons per minute. Over a four hour period the total draw from storage would be 260,000 gallons or about 17 percent of the total tank capacity. From this analysis it can be seen that the proposed initial storage facility has sufficient capacity to provide for some reasonable growth in the system.

The proposed storage tank would be a steel standpipe located on Sweet Hill on the southerly side of Sweet Hill-Road. The tank would be approximately 61 feet in diameter with a full side water depth of 70 feet. The base of the tank would be set at elevation 270.0±.

This base elevation and a full tank of water would provide a maximum static pressure of 115 psi and a minimum residual pressure during peak consumption and a fire, of 23 psi. The system was investigated for pressure drops under different conditions of flow at various locations and the results are illustrated on Plate No. R-7.

The rise and fall of water in this tank will control the operation of the pumps at the wells. The tank will be equipped with a telemetering transmitter which will read the water level in the tank. These signals will be transmitted by means of leased telephone wires to the pumping stations. At a predetermined level of water in the tank a signal will be sent to start one well pump. If the tank level continues to drop the second well pump will start and both pumps will run until the tank is refilled. On the next cycle the operation of the pumps will be reversed. This initial system, can and will eventually serve all developable areas of the town below elevation 245.0. Within this service area static water

pressure will range from a low of about 40 pounds per square inch to a high of 115 pounds per square inch. Individual pressure reducing valves may be required in some residences located in the lower elevation areas.

The topography of the town is such that as development moves in a northeasterly direction higher elevations are encountered resulting in the necessity for a high level system which would serve all areas of the town above elevation 245.0. These higher areas would also be served by the basic water supply system and water would be delivered to the system by booster pumps taking suction on the primary distribution system. Storage facilities would be installed in the high level system as required by development. Emergency connections between the two systems utilizing check valves and by-passes with pressure reducing valves would be established to assure complete flexibility if the need for a reverse transfer of water arose. It is very probable that the need for the high level system will not occur for some time in the future.

Materials - The water mains will be either class 150 asbestos-cement pipe with cast iron fittings or class 150 cement-lined cast iron pipe with rubber ring type gaskets. It is recommended that both types of pipe be specified with the final choice being made on the basis of cost. House connections will be type K copper tubing with brass corporation stops and brass curb cocks at the property line with cast iron curb boxes. All system shut-off gate valves will be cast iron body with bronze discs complying with the latest American Water Works Association standards and with cast

iron adjustable-stem gate boxes. Fire hydrants will be of the improved A.W.W.A. type with 2-2½" nozzles and a steamer connections conforming to American Water Works Association specifications. Steel standpipe type water storage tanks will also conform to American Water Works Association standards.

13. USE OF EXISTING SYSTEMS

The Town of Plaistow presently owns a limited fire protection system which was completed in 1971. This system consisting of a single 12-inch pipe serves one hydrant on North Main Street and 5 hydrants in the Westville area in addition to private hydrants at Process Engineering, Pennsylvania Box & Lumber and Westville Homes Corporation. No general service or domestic connections are permitted to this fire system. At the present, it is intended to sanitize and incorporate this 12-inch water main into the proposed water distribution system. It is expected that the present elevated tank with its own source of supply would be utilized as a secondary fire protection system for Process Engineering and the Pennsylvania Box & Lumber companies. During the final design stage consideration will be given to possibly utilizing this tank as an emergency storage facility for the municipal system.

14. FUTURE CAPITAL IMPROVEMENTS

In addition to the periodic installation of water mains as growth requires, which will be self-liquidating, certain storage and supply capital improvements will be necessary. These capital improvements are shown graphically on Plate No. R-4 Initially,

the major facilities required, beyond the basic distribution system, will be the two wells with a combined production of 1000 gallons per minute and a 1,500,000 gallon capacity storage tank. As the system expands and the population served increases additions to these major facilities will be necessary. The curve of predicted capital improvements as shown on Plate No. R-5 is essentially based on peak water consumption figures and population figures. The population figures represent permanent town population and are approximate only.

By 1985 when the peak daily consumption of water reaches 1,000,000 gallons, which will probably occur most frequently in the summer, an additional well or wells with a capacity of 1000 gallons per minute should be installed. At this point in the growth of the system the original wells will be operating in excess of 16 hours on peak days and the installation of this additional well will prevent too much overpumping. At the same time this addition to the supply system will improve the storage capacity insofar as fire flows are concerned. The peak daily flow at this time will be 1,000,000 gallons or 1041 gallons per minute if pumped over 16 hours. With an increase in the fire flow in the commercial area to 2000 gallons per minute the total draw on the system would be 3041 gallons per minute. This draw would be offset by an inflow of 2000 gallons per minute from the supply pumps resulting in a net draw from storage of 1041 gallons per minute; a total draw in a four hour period of 249,840 gallons or 16 percent of available storage.

By the year 1998 the peak daily consumption will reach a figure of about 1,425,000 gallons and the need for an additional 500 g.p.m. well will become apparent once again. At this point in the growth of the system the four existing wells will be operating in excess of 16 hours on a peak day and the required storage for fire flows will be approaching one-third of the actual storage available. With a peak daily flow of 1,425,000 gallons or 1,480 gallons per minute, if pumped over 16 hours, and an increase in the required fire flow to 2,500 gallons per minute, the total draw on the system would be 3,980 gallons per minute. This draw would be offset by an inflow of 2,500 gallons per minute from the five supply pumps resulting in a net draw from storage of 1480 gallons per minute; a total draw in 4 hours of 355,200 gallons or 23 percent of available storage.

By the year 2012, when the peak daily consumption of water reaches a figure of 2,020,000 gallons, the original storage tank of 1.5 million gallons capacity has now become too small. It will no longer provide at least one day's storage of water based on peak daily use and the depletion of storage as a result of fire flows will not equal one third of available storage. At this point in the growth of the system the five existing wells will be over-pumping and the need for an additional 500 gallon per minute well will become apparent. The peak daily flow will be 2,020,000 gallons or 2104 gallons per minute if pumped over a 16 hour period and the required fire flow at this time will be 2500 gallons per minute over a five hour period. The total draw on the system would then be 4604 gallons per minute and this draw would be offset by an

inflow of 3000 gallons per minute from the six supply pumps, resulting in a net draw from storage of 1604 gallons per minute; a total draw in a five hour period of 481,200 gallons or 16 percent of available storage.

By the year 2023 the peak daily consumption will reach a figure of 2,400,000 gallons and the need for an additional 500 gallon per minute well will become apparent once again. At this point in time the six existing wells will be operating in excess of 16 hours on a peak day and the required storage for fire flow will be over one-third the available storage. With a peak daily flow of 2,400,000 gallons or 2510 gallons per minute if pumped over 16 hours and a required fire flow of 3000 gallons per minute for six hours, the total draw on the system would be 5510 gallons per minute. This draw would be offset by an inflow of 3,500 gallons per minute from the seven supply pumps resulting in a net draw from storage of 2,010 gallons per minute; a total draw in six hours of 723,600 gallons or 24 percent of available storage.

By the year 2035, when the peak daily consumption of water reaches 2,840,000, the seven existing wells will be operating in excess of 16 hours on a peak day and the required storage for fire flow will be over one-third of the available storage. With a peak daily flow of 2,840,000 or 2958 gallons per minute if pumped over 16 hours and a required fire flow of 3000 gallons for seven hours, the total draw on the system would be 5958 gallons per minute. This draw would be offset by an inflow of 4,000 gallons per minute from the eight supply pumps, resulting in a net draw from storage of 1985 gallons per minute; a total draw in seven hours of

833,700 gallons or 28% of available storage.

The addition of the eighth 500 gallons per minute well will complete the program for future capital improvements. With a combined storage of 3,000,000 gallons and a combined supply of 4,000 gallons per minute the system will support Plaistow's ultimate population of 17,400 persons while providing adequate storage with depletion not exceeding 33 percent during fires and adequate supply pumping for a period not exceeding 16 hours.

15. ESTIMATE OF COST

The following cost estimates have been based on bid prices for similar work recently constructed in New England. The prices shown include the contractor's overhead and profit and an amount has been added to the construction cost to cover contingencies. Land acquisition, engineering and legal fees and administrative costs have been included. The prices include all items of construction including repaving of streets. The cost of ledge removal has been included where it is expected ledge will be encountered. The scale of the drawings makes a clear indication of sectionalizing and street valves difficult, however, they have been located and are included in the following estimate.

The project for which the following estimate is made is considered to be the most comprehensive, that is, it will serve the greatest number of customers on a self-sustaining basis at an annual rate which is considered reasonable. The first layout of the system included approximately 8,400 lineal feet of additional mains which, it was found on careful analysis, could not be

considered reasonably self-supporting at this time. These streets were therefore deleted from the initial system until such time as additional development warranted their inclusion. In the interest of brevity the following estimate has been condensed from a street by street detailed estimate.

Construction Cost Estimate

Item No.	Item	Quantity	Unit Cost	Total Cost
1	16" Pipe	14,900 L.F.	$12.00/L.F.	$178,800.00
2	12" Pipe	74,500 L.F.	$ 9.00/L.F.	670,500.00
3	8" Pipe	111,250 L.F.	$ 7.50/L.F.	834,375.00
4	16" Gate Valves	13	$1600/ea.	20,800.00
5	12" Gate Valves	71	$ 390/ea.	27,690.00
6	8" Gate Valves	101	$ 170/ea.	17,170.00
7	Hydrants	220	$ 520/ea.	114,400.00
8	C.I. Fittings	40.40 Tons	$ 900/Ton	36,396.00
9	Thrust Blocks	122.5 C.Y.	$ 55/C.Y.	6,737.00
10	Saw Cut Pavement	194,350 L.F.	$ 1.00/L.F.	194,350.00
11	Rock Excavation	10,032 C.Y.	$12.00/C.Y.	120,390.00
12	Town Road Pave.	163,850 L.F.	$ 1.30/L.F.	213,005.00
13	State Road Pave.	30,500 L.F.	$ 1.70/L.F.	51,850.00
14	R.R. Crossings	8	$5,000/ea.	40,000.00
15	Service Connections	1,460	$ 100/ea.	146,000.00
	Total Estimated Construction Cost of Distribution System			$2,672,463.00
16	Storage Tank (1,500,000 Gals.)	L.S.		$200,000.00
17	500 G.P.M. Wells	2	$20,000/ea.	40,000.00
18	500 G.P.M. Pumps	2	$15,000/ea.	30,000.00
19	Pump Stations	2	$50,000/ea.	100,000.00
20	Supply Piping	5,280 L.F.	$ 10.00/L.F.	52,800.00
21	Access Roads		L.S.	10,000.00
	Total Estimated Construction Cost of Storage & Supply System			$432,800.00
	Total Estimated Construction Cost of System			$3,105,263.00
	Contingencies & Other Costs @ 5%			155,523.00
	Engineering Services (Eng. Fees, Surveys & Borings)			260,000.00
	Total Estimated Project Cost			$3,520,786.00

The proposed initial distribution system will incorporate 200,650 lineal feet or 38 miles of 8,12 and 16 inch pipe and 220 fire hydrants. A total of 1460 service connections to existing buildings can be made from this initial system. The cost per connection based on existing development therefore becomes $2,411.50.

16. FINANCING THE WATER SYSTEM

General - Under prior federal programs and regulations the Town of Plaistow would have most probably been eligible for an outright construction grant of up to 50 percent of the construction cost of the proposed water system. This construction grant would have come either from the Farmers Home Administration of the Department of Agriculture or from the Community Facilities Branch of the Department of Housing and Urban Development. As of January 1st of this year all construction grants, for water and sewer facilities, from either of these federal agencies were eliminated. As the situation now stands, there are no construction grants for water facilities and construction grants for sewers are being handled, in total, by the Environmental Protection Agency. It is our understanding that a "Community Facilities Bill" is presently pending in Congress. This bill, if passed, would provide general grants to communities for needed projects and would cover all categories of public works from municipal water systems to urban redevelopment. The only possible assistance from the Federal Government, presently available to the town, appears to be low-interest long-term loans from the Farmers Home Administration.

In view of the foregoing the following financial schedules call for full financial support of the project by the town by means of assessments, selected taxation and the issuance of general obligation bonds carrying 5% interest for amortization in thirty years with principal payments in 28 equal annual payments, the first principal payment to be made in the third year of operation. General obligation bonds are recommended inasmuch as they would be backed by the credit of the Town of Plaistow and this type of bond is more attractive to investors than would be revenue bonds which probably would carry 1% or 1½% higher annual interest rate. The reason for deferring principal payments on bond amortization for two years is that in a project of this type the revenue derived from water customers during the first few years of operations is lower than at any time thereafter and at the same time bond retirement costs are at their highest level. Deferrment of the principal payment provides time for the system to grow, gain strength and improve its annual income situation. Public water systems under most circumstances develop the capability to pay their own way, although in recent history they have been materially aided in gaining this status by federal construction grants. The following sets forth the suggested minimum charges, selected taxation and assessments, the estimated number of water customers and the method of arriving at these various figures which are the basis of financing the system.

This provides the basic data used in estimating total income to be derived annually for the first thirty years or the life of the bonds. Based on the preceding Estimate of Cost the total

amount to be financed will be $3,520,786. For simplicity of calculations a figure of $3,520,000 has been used.

Number of Customers - The total number of potential customers that can be immediately served by the proposed systems as of 1972, is approximately 1463. From past experience it is unlikely that more than 75% or 1095 of the potential customers will become water customers during the first year of operation. The remaining 25% or 368 can be expected to connect to the system during the first 10 years of operation. Spread equally over 9 years this would mean an addition of 41 customers per year. From the town Building Inspector's records it was determined that for the 10 years preceding 1972 an average of 46 new homes were constructed per year. When a water system is installed the rate of new construction can be expected to accelerate for at least a 10 year period, accordingly we have included 87 new customers for a period of 10 years and 47 new customers per year thereafter.

Charges - The following proposed charges are considered to be the minimum necessary to adequately operate, maintain and finance the water system. Three finance schemes have been developed using various combinations of charges for the annual water bill, basic assessment and tax rate increases. Alternate "A" (Tables Nos. 8, 9 and 10) list income, expense and cumulative balance for building and operating the system according to the following minimal charges:

1. A minimum annual water bill of $85.00 (40,000 gallons of water per connection).
2. A one-time assessment against all customers served of $500.00. This overall assessment could be divided into

a benefit charge of $300 and a connection charge of $200.00.

3. An increase in the general tax rate of all property owners in the town regardless of availability of water of $1.00 per $1,000.

Alternate "B" (Tables Nos. 11, 12 and 13) shows the effect of a larger tax increase and reducing the annual water bill and assessment rate. In a town such as Plaistow where the proposed water system is relatively extensive, support by tax revenue may be a favorable alternate. The following minimum charges were used for Alternate"B":

1. A minimum annual water bill of $75.00
2. A one-time assessment of $300.00
3. A tax increase of $2.00 per $1,000.

In Alternate "C" (Tables Nos. 14, 15 and 16) the effect of lowering the annual water bill to a minimum resulted in the following minimal charges:

1. A minimum annual water bill of $60.00
2. A one-time assessment of $400.00
3. A tax increase of $2.00 per $1,000

In addition to the above charges excess water would be charged at the rate of $0.75 per 1,000 gallons and a hydrant rental of $100.00 per unit would be charged to the Town.

The Benefit and Connection Charges would be paid either in a lump sum or paid periodically over a period not to exceed two years. Unpaid balances would draw interest at the rate of 6% per annum. All connections at the main installed subsequent

to original construction will be at the property owners expense at actual cost or at a predetermined flat charge. All property owners will pay all costs for installation of service piping from the curb stop to the structure to be served, including connections to meter and customer's piping.

Operating Costs - Table No. 7 below lists the anticipated annual operating costs for the overall water supply and distribution system. The major expenses will be the salaries of operating personnel and the cost of power. Table No. 7 shows the costs for the first year.

Table No. 7
Estimated Operating Costs - First Year

Expense Item	Estimated Cost
Salaries	
Superintendent	$ 8,000.00
Clerk (Part-time)	3,000.00
Meter Reading	500.00
Fringe Benefits	1,000.00
System Maintenance	1,000.00
Truck Maintenance & Depreciation	1,000.00
Heat, Light & Telephone	500.00
Printing & Mailing	500.00
Electric Power	5,000.00
Chemicals	500.00
Estimated Total First Year Operating Cost	$21,000.00

It is anticipated these costs will drop slightly following the first year of operation and then steadily increase as the unit costs of the expense items naturally increase and the number of customers served grows. An additional first-year startup charge of $2,500.00 has been added to the above estimated operating cost in the following finanial tables.

New Residential Developments - Developers will pay all costs for extending the system to their property and all charges for installing piping, valves, hydrants, and service connections within the property being developed. All piping, valve arrangement, hydrant spacing, testing, and other facilities shall be approved by the Water Department of the Town of Plaistow. After acceptance the approved system shall be deeded by the developer to the Water Department. Some variations or modifications to the above might be made to developers if the addition requires the installation of a large supply main in principal thoroughfares to serve the area to be developed.

TABLE NO. 8 PLAISTOW WATER DEPARTMENT - ALTERNATE ''A''- EXPENSES

YEAR	OPERATING COST	PRINCIPAL PAYMENT	BALANCE DUE	INTEREST CHARGE	BOND REPAYMENT	TOTAL EXPENSES
1	23500.00	0.00	3520000.00	176000.00	176000.00	199500.00
2	21000.00	0.00	3520000.00	176000.00	176000.00	197000.00
3	21500.00	125714.28	3520000.00	176000.00	301714.28	323214.28
4	31500.00	125714.28	3394285.71	169714.28	295428.57	326928.57
5	32000.00	125714.28	3268571.43	163428.57	289142.85	321142.85
6	32500.00	125714.28	3142857.14	157142.85	282857.14	315357.14
7	33000.00	125714.28	3017142.86	150857.14	276571.42	309571.42
8	33500.00	125714.28	2891428.57	144571.42	270285.71	303785.71
9	34000.00	125714.28	2765714.29	138285.71	264000.00	298000.00
10	37500.00	125714.28	2640000.00	132000.00	257714.28	295214.28
11	38000.00	125714.28	2514285.72	125714.28	251428.57	289428.57
12	38500.00	125714.28	2388571.43	119428.57	245142.85	283642.85
13	39000.00	125714.28	2262857.15	113142.85	238857.14	277857.14
14	39500.00	125714.28	2137142.86	106857.14	232571.42	272071.42
15	40000.00	125714.28	2011428.57	100571.42	226285.71	266285.71
16	40500.00	125714.28	1885714.29	94285.71	220000.00	260500.00
17	44000.00	125714.28	1760000.00	88000.00	213714.28	257714.28
18	44500.00	125714.28	1634285.72	81714.28	207428.57	251928.57
19	45000.00	125714.28	1508571.43	75428.57	201142.85	246142.85
20	46000.00	125714.28	1382857.15	69142.85	194857.14	240857.14
21	46500.00	125714.28	1257142.86	62857.14	188571.42	235071.42
22	47000.00	125714.28	1131428.58	56571.42	182285.71	229285.71
23	47500.00	125714.28	1005714.29	50285.71	176000.00	223500.00
24	48000.00	125714.28	880000.01	44000.00	169714.28	217714.28
25	49000.00	125714.28	754285.72	37714.28	163428.57	212428.57
26	49500.00	125714.28	628571.44	31428.57	157142.85	206642.85
27	50000.00	125714.28	502857.15	25142.85	150857.14	200857.14
28	50500.00	125714.28	377142.86	18857.14	144571.42	195071.42
29	51000.00	125714.28	251428.58	12571.42	138285.71	189285.71
30	52000.00	125714.28	125714.29	6285.71	132000.00	184000.00

YEAR 1 TERM 30 PRINCIPAL= 3520000.00 INTEREST RATE = 5.00 PERCENT

PAY BACK IN 28 INSTALLMENTS

TABLE NO. 9 PLAISTOW WATER DEPARTMENT - ALTERNATE "A" - INCOME

YEAR	CUSTOMERS	WATER REVENUE	EXCESS WATER	HYDRANT RENTAL	TAX REVENUE	ASSESSMENT REVENUE	TOTAL INCOME
1	1095	93075.00	0.00	21900.00	40000.00	547500.00	702475.00
2	1182	100470.00	600.00	22000.00	42000.00	43500.00	207870.00
3	1269	107865.00	729.75	22100.00	44100.00	43500.00	218065.00
4	1356	115260.00	859.50	22200.00	46305.00	43500.00	227894.75
5	1443	122655.00	989.25	22300.00	48620.25	43500.00	237834.75
6	1530	130050.00	1119.00	22400.00	51051.26	43500.00	247890.51
7	1617	137445.00	1248.75	22500.00	53603.82	43500.00	258067.82
8	1704	144840.00	1378.50	22600.00	56284.01	43500.00	268372.76
9	1791	152235.00	1508.25	22700.00	59098.21	43500.00	278811.71
10	1878	159630.00	1638.00	22800.00	62053.12	43500.00	289391.37
11	1924	163540.00	1767.75	22900.00	65155.78	23000.00	276133.78
12	1970	167450.00	1897.50	23000.00	68413.57	23000.00	283531.32
13	2016	171360.00	2027.25	23100.00	71834.25	23000.00	291091.75
14	2067	175695.00	2157.00	23200.00	75425.96	25500.00	301748.21
15	2108	179180.00	2286.75	23300.00	79197.26	20500.00	304234.26
16	2154	183090.00	2415.00	23400.00	83157.12	23000.00	314833.87
17	2200	187000.00	2546.25	23500.00	87314.98	23000.00	323129.98
18	2246	190910.00	2676.00	23600.00	91680.73	23000.00	331636.98
19	2292	194820.00	2805.75	23700.00	96264.76	23000.00	340360.76
20	2338	198730.00	2935.50	23800.00	101078.00	23000.00	349313.75
21	2384	202640.00	3065.25	23900.00	106131.90	23000.00	358507.40
22	2430	206550.00	3195.00	24000.00	111438.50	23000.00	367953.75
23	2476	210460.00	3324.75	24100.00	117010.42	23000.00	377665.42
24	2522	214370.00	3454.50	24200.00	122860.94	23000.00	387655.70
25	2568	218280.00	3584.25	24300.00	129003.99	23000.00	397938.49
26	2614	222190.00	3714.00	24400.00	135454.19	23000.00	408528.44
27	2660	226100.00	3843.75	24500.00	142226.90	23000.00	419440.90
28	2706	230010.00	3973.50	24600.00	149338.25	23000.00	430692.00
29	2752	233920.00	4103.25	24700.00	156805.16	23000.00	442298.66
30	2798	237830.00	4233.00	24800.00	164645.42	23000.00	454278.67

ANNUAL WATER BILL = 85.00 ASSESSMENT = 500.00 TAX LEVY 1.00/$1,000.00

HYDRANT RENTAL= 100.00/UNIT EXCESS WATER USE 0.75

TABLE NO.10 PLAISTOW WATER DEPARTMENT - ALTERNATE "A" - INCOME vs. EXPENSES

YEAR	INCOME	EXPENSES	DIFFERENCE	CUMULATIVE BALANCE
1	702475.00	199500.00	502975.00	502975.00
2	207870.00	197000.00	10870.00	513845.00
3	218065.00	323214.28	-105149.28	408695.71
4	227894.75	326928.57	-99033.82	309661.89
5	237834.75	321142.85	-83308.10	226353.78
6	247890.51	315357.14	-67466.63	158887.15
7	258067.82	309571.42	-51503.60	107383.55
8	268372.76	303785.71	-35412.94	71970.60
9	278811.71	298000.00	-19188.28	52782.32
10	289391.37	295214.28	-5822.90	46959.41
11	276133.78	289428.57	-13294.78	33664.62
12	283531.32	283642.85	-111.53	33553.09
13	291091.75	277857.14	13234.60	46787.70
14	301748.21	272071.42	29676.78	76464.49
15	304234.26	266285.71	37948.54	114413.04
16	314833.87	260500.00	54333.87	168746.91
17	323129.98	257714.28	65415.69	234162.61
18	331636.98	251928.57	79708.41	313871.02
19	340360.76	246142.85	94217.91	408088.93
20	349313.75	240857.14	108456.61	516545.55
21	358507.40	235071.42	123435.97	639981.53
22	367953.75	229285.71	138668.03	778649.56
23	377665.42	223500.00	154165.42	932814.99
24	387655.70	217714.28	169941.41	1102756.40
25	397938.49	212428.57	185509.92	1288266.33
26	408528.44	206642.85	201885.58	1490151.92
27	419440.90	200857.14	218583.76	1708735.68
28	430692.00	195071.42	235620.57	1944356.25
29	442298.66	189285.71	253012.94	2197369.20
30	454278.67	184000.00	270278.67	2467647.87

TABLE NO. 11 PLAISTOW WATER DEPARTMENT - ALTERNATE "B" - EXPENSES

YEAR	OPERATING COST	PRINCIPAL PAYMENT	BALANCE DUE	INTEREST CHARGE	BOND REPAYMENT	TOTAL EXPENSES
1	23500.00	0.00	3520000.00	176000.00	176000.00	199500.00
2	21000.00	0.00	3520000.00	176000.00	176000.00	197000.00
3	21500.00	125714.28	3520000.00	176000.00	301714.28	323214.28
4	31500.00	125714.28	3394285.71	169714.28	295428.57	326928.57
5	32000.00	125714.28	3268571.43	163428.57	289142.85	321142.85
6	32500.00	125714.28	3142857.14	157142.85	282857.14	315357.14
7	33000.00	125714.28	3017142.86	150857.14	276571.42	309571.42
8	33500.00	125714.28	2891428.57	144571.42	270285.71	303785.71
9	34000.00	125714.28	2765714.29	138285.71	264000.00	298000.00
10	37500.00	125714.28	2640000.00	132000.00	257714.28	295214.28
11	38000.00	125714.28	2514285.72	125714.28	251428.57	289428.57
12	38500.00	125714.28	2388571.43	119428.57	245142.85	283642.85
13	39000.00	125714.28	2262857.15	113142.85	238857.14	277857.14
14	39500.00	125714.28	2137142.86	106857.14	232571.42	272071.42
15	40000.00	125714.28	2011428.57	100571.42	226285.71	266285.71
16	40500.00	125714.28	1885714.29	94285.71	220000.00	260500.00
17	44000.00	125714.28	1760000.00	88000.00	213714.28	257714.28
18	44500.00	125714.28	1634285.72	81714.28	207428.57	251928.57
19	45000.00	125714.28	1508571.43	75428.57	201142.85	246142.85
20	46000.00	125714.28	1382857.15	69142.85	194857.14	240857.14
21	46500.00	125714.28	1257142.86	62857.14	188571.42	235071.42
22	47000.00	125714.28	1131428.58	56571.42	182285.71	229285.71
23	47500.00	125714.28	1005714.29	50285.71	176000.00	223500.00
24	48000.00	125714.28	880000.01	44000.00	169714.28	217714.28
25	49000.00	125714.28	754285.72	37714.28	163428.57	212428.57
26	49500.00	125714.28	628571.44	31428.57	157142.85	206642.85
27	50000.00	125714.28	502857.15	25142.85	150857.14	200857.14
28	50500.00	125714.28	377142.86	18857.14	144571.42	195071.42
29	51000.00	125714.28	251428.58	12571.42	138285.71	189285.71
30	52000.00	125714.28	125714.29	6285.71	132000.00	184000.00

YEAR 1 TERM 30 PRINCIPAL= 3520000.00 INTEREST RATE = 5.00 PERCENT

PAY BACK IN 28 INSTALLMENTS

TABLE NO. 12 PLAISTOW WATER DEPARTMENT - ALTERNATE "B" - INCOME

YEAR	CUSTOMERS	WATER REVENUE	EXCESS WATER	HYDRANT RENTAL	TAX REVENUE	ASSESSMENT REVENUE	TOTAL INCOME
1	1095	82125.00	0.00	21900.00	80000.00	328500.00	512525.00
2	1182	88650.00	600.00	22000.00	84000.00	26100.00	220650.00
3	1269	95175.00	729.75	22100.00	88200.00	26100.00	232075.00
4	1356	101700.00	859.50	22200.00	92610.00	26100.00	243239.75
5	1443	108225.00	989.25	22300.00	97240.50	26100.00	254625.00
6	1530	114750.00	1119.00	22400.00	102102.52	26100.00	266241.77
7	1617	121275.00	1248.75	22500.00	107207.65	26100.00	278101.65
8	1704	127800.00	1378.50	22600.00	112568.03	26100.00	290216.78
9	1791	134325.00	1508.25	22700.00	118196.43	26100.00	302599.93
10	1878	140850.00	1638.00	22800.00	124106.25	26100.00	315264.50
11	1924	144300.00	1767.75	22900.00	130311.57	13800.00	312849.57
12	1970	147750.00	1897.50	23000.00	136827.14	13800.00	323044.89
13	2016	151200.00	2027.25	23100.00	143668.50	13800.00	333566.00
14	2067	155025.00	2157.00	23200.00	150851.93	15300.00	346304.18
15	2108	158100.00	2286.75	23300.00	158394.52	12300.00	354151.52
16	2154	161550.00	2415.00	23400.00	166314.25	13800.00	367251.00
17	2200	165000.00	2546.25	23500.00	174629.96	13800.00	379244.96
18	2246	168450.00	2676.00	23600.00	183361.46	13800.00	391657.71
19	2292	171900.00	2805.75	23700.00	192529.53	13800.00	404505.53
20	2338	175350.00	2935.50	23800.00	202156.01	13800.00	417811.76
21	2384	178800.00	3065.25	23900.00	212263.81	13800.00	431599.31
22	2430	182250.00	3195.00	24000.00	222877.00	13800.00	445892.25
23	2476	185700.00	3324.75	24100.00	234020.85	13800.00	460715.85
24	2522	189150.00	3454.50	24200.00	245721.89	13800.00	476096.64
25	2568	192600.00	3584.25	24300.00	258007.99	13800.00	492062.49
26	2614	196050.00	3714.00	24400.00	270908.39	13800.00	508642.64
27	2660	199500.00	3843.75	24500.00	284453.81	13800.00	525867.81
28	2706	202950.00	3973.50	24600.00	298676.50	13800.00	543770.25
29	2752	206400.00	4103.25	24700.00	313610.32	13800.00	562383.82
30	2798	209850.00	4233.00	24800.00	329290.84	13800.00	581744.09

ANNUAL WATER BILL = 75.00 ASSESSMENT = 300.00 TAX LEVY 2.00/$1,000.00

HYDRANT RENTAL= 100.00/UNIT EXCESS WATER USE 0.75

TABLE NO. 13 PLAISTOW WATER DEPARTMENT - ALTERNATE "B" - INCOME vs. EXPENSES

YEAR	INCOME	EXPENSES	DIFFERENCE	CUMULATIVE BALANCE
1	512525.00	199500.00	313025.00	313025.00
2	220650.00	197000.00	23650.00	336675.00
3	232075.00	323214.28	-91139.28	245535.71
4	243239.75	326928.57	-83688.82	161846.89
5	254625.00	321142.85	-66517.85	95329.03
6	266241.77	315357.14	-49115.36	46213.66
7	278101.65	309571.42	-31469.77	14743.89
8	290216.78	303785.71	-13568.93	1174.95
9	302599.93	298000.00	4599.93	5774.89
10	315264.50	295214.28	20050.22	25825.11
11	312849.57	289428.57	23420.99	49246.11
12	323044.89	283642.85	39402.04	88648.15
13	333566.00	277857.14	55708.86	144357.01
14	346304.18	272071.42	74232.75	218589.77
15	354151.52	266285.71	87865.81	306455.58
16	367251.00	260500.00	106751.00	413206.58
17	379244.96	257714.28	121530.68	534737.26
18	391657.71	251928.57	139729.14	674466.41
19	404505.53	246142.85	158362.68	832829.09
20	417811.76	240857.14	176954.62	1009783.71
21	431599.31	235071.42	196527.88	1206311.60
22	445892.25	229285.71	216606.54	1422918.14
23	460715.85	223500.00	237215.85	1660133.99
24	476096.64	217714.28	258382.36	1918516.36
25	492062.49	212428.57	279633.92	2198150.28
26	508642.64	206642.85	301999.78	2500150.06
27	525867.81	200857.14	325010.67	2825160.73
28	543770.25	195071.42	348698.82	3173859.56
29	562383.82	189285.71	373098.11	3546957.67
30	581744.09	184000.00	397744.09	3944701.77

TABLE NO. 14 PLAISTOW WATER DEPARTMENT - ALTERNATE "C" - EXPENSES

YEAR	OPERATING COST	PRINCIPAL PAYMENT	BALANCE DUE	INTEREST CHARGE	BOND REPAYMENT	TOTAL EXPENSES
1	23500.00	0.00	3520000.00	176000.00	176000.00	199500.00
2	21000.00	0.00	3520000.00	176000.00	176000.00	197000.00
3	21500.00	125714.28	3520000.00	176000.00	301714.28	323214.28
4	31500.00	125714.28	3394285.71	169714.28	295428.57	326928.57
5	32000.00	125714.28	3268571.43	163428.57	289142.85	321142.85
6	32500.00	125714.28	3142857.14	157142.85	282857.14	315357.14
7	33000.00	125714.28	3017142.86	150857.14	276571.42	309571.42
8	33500.00	125714.28	2891428.57	144571.42	270285.71	303785.71
9	34000.00	125714.28	2765714.29	138285.71	264000.00	298000.00
10	37500.00	125714.28	2640000.00	132000.00	257714.28	295214.28
11	38000.00	125714.28	2514285.72	125714.28	251428.57	289428.57
12	38500.00	125714.28	2388571.43	119428.57	245142.85	283642.85
13	39000.00	125714.28	2262857.15	113142.85	238857.14	277857.14
14	39500.00	125714.28	2137142.86	106857.14	232571.42	272071.42
15	40000.00	125714.28	2011428.57	100571.42	226285.71	266285.71
16	40500.00	125714.28	1885714.29	94285.71	220000.00	260500.00
17	44000.00	125714.28	1760000.00	88000.00	213714.28	257714.28
18	44500.00	125714.28	1634285.72	81714.28	207428.57	251928.57
19	45000.00	125714.28	1508571.43	75428.57	201142.85	246142.85
20	46000.00	125714.28	1382857.15	69142.85	194857.14	240857.14
21	46500.00	125714.28	1257142.86	62857.14	188571.42	235071.42
22	47000.00	125714.28	1131428.58	56571.42	182285.71	229285.71
23	47500.00	125714.28	1005714.29	50285.71	176000.00	223500.00
24	48000.00	125714.28	880000.01	44000.00	169714.28	217714.28
25	49000.00	125714.28	754285.72	37714.28	163428.57	212428.57
26	49500.00	125714.28	628571.44	31428.57	157142.85	206642.85
27	50000.00	125714.28	502857.15	25142.85	150857.14	200857.14
28	50500.00	125714.28	377142.86	18857.14	144571.42	195071.42
29	51000.00	125714.28	251428.58	12571.42	138285.71	189285.71
30	52000.00	125714.28	125714.29	6285.71	132000.00	184000.00

YEAR 1 TERM 30 PRINCIPAL= 3520000.00 INTEREST RATE = 5.00 PERCENT

PAY BACK IN 28 INSTALLMENTS

TABLE NO.15 PLAISTOW WATER DEPARTMENT - ALTERNATE "C" - INCOME

YEAR	CUSTOMERS	WATER REVENUE	EXCESS WATER	HYDRANT RENTAL	TAX REVENUE	ASSESSMENT REVENUE	TOTAL INCOME
1	1095	65700.00	0.00	21900.00	80000.00	438000.00	605600.00
2	1182	70920.00	600.00	22000.00	84000.00	34800.00	211620.00
3	1269	76140.00	729.75	22100.00	88200.00	34800.00	221740.00
4	1356	81360.00	859.50	22200.00	92610.00	34800.00	231599.75
5	1443	86580.00	989.25	22300.00	97240.50	34800.00	241680.00
6	1530	91800.00	1119.00	22400.00	102102.52	34800.00	251991.77
7	1617	97020.00	1248.75	22500.00	107207.65	34800.00	262546.65
8	1704	102240.00	1378.50	22600.00	112568.03	34800.00	273356.78
9	1791	107460.00	1508.25	22700.00	118196.43	34800.00	284434.93
10	1878	112680.00	1638.00	22800.00	124106.25	34800.00	295794.50
11	1924	115440.00	1767.75	22900.00	130311.57	18400.00	288589.57
12	1970	118200.00	1897.50	23000.00	136827.14	18400.00	298094.89
13	2016	120960.00	2027.25	23100.00	143668.50	18400.00	307926.00
14	2067	124020.00	2157.00	23200.00	150851.93	20400.00	320399.18
15	2108	126480.00	2286.75	23300.00	158394.52	16400.00	326631.52
16	2154	129240.00	2415.00	23400.00	166314.25	18400.00	339541.00
17	2200	132000.00	2546.25	23500.00	174629.96	18400.00	350844.96
18	2246	134760.00	2676.00	23600.00	183361.46	18400.00	362567.71
19	2292	137520.00	2805.75	23700.00	192529.53	18400.00	374725.53
20	2338	140280.00	2935.50	23800.00	202156.01	18400.00	387341.76
21	2384	143040.00	3065.25	23900.00	212263.81	18400.00	400439.31
22	2430	145800.00	3195.00	24000.00	222877.00	18400.00	414042.25
23	2476	148560.00	3324.75	24100.00	234020.85	18400.00	428175.85
24	2522	151320.00	3454.50	24200.00	245721.89	18400.00	442866.64
25	2568	154080.00	3584.25	24300.00	258007.99	18400.00	458142.49
26	2614	156840.00	3714.00	24400.00	270908.39	18400.00	474032.64
27	2660	159600.00	3843.75	24500.00	284453.81	18400.00	490567.81
28	2706	162360.00	3973.50	24600.00	298676.50	18400.00	507780.25
29	2752	165120.00	4103.25	24700.00	313610.32	18400.00	525703.82
30	2798	167880.00	4233.00	24800.00	329290.84	18400.00	544374.09

ANNUAL WATER BILL = 60.00 ASSESSMENT = 400.00 TAX LEVY 2.00/$1,000.00

HYDRANT RENTAL= 100.00/UNIT EXCESS WATER USE 0.75

TABLE NO. 16 PLAISTOW WATER DEPARTMENT - ALTERNATE "C" - INCOME vs. EXPENSES

YEAR	INCOME	EXPENSES	DIFFERENCE	CUMULATIVE BALANCE
1	605600.00	199500.00	406100.00	406100.00
2	211620.00	197000.00	14620.00	420720.00
3	221740.00	323214.28	-101474.28	319245.71
4	231599.75	326928.57	-95328.82	223916.89
5	241680.00	321142.85	-79462.85	144454.03
6	251991.77	315357.14	-63365.36	81088.66
7	262546.65	309571.42	-47024.77	34063.89
8	273356.78	303785.71	-30428.93	3634.95
9	284434.93	298000.00	-13565.06	-9930.10
10	295794.50	295214.28	580.22	-9349.88
11	288589.57	289428.57	-839.00	-10188.88
12	298094.89	283642.85	14452.04	4263.15
13	307926.00	277857.14	30068.86	34332.01
14	320399.18	272071.42	48327.75	82659.77
15	326631.52	266285.71	60345.81	143005.58
16	339541.00	260500.00	79041.00	222046.58
17	350844.96	257714.28	93130.68	315177.26
18	362567.71	251928.57	110639.14	425816.41
19	374725.53	246142.85	128582.68	554399.09
20	387341.76	240857.14	146484.62	700883.71
21	400439.31	235071.42	165367.88	866251.60
22	414042.25	229285.71	184756.54	1051008.14
23	428175.85	223500.00	204675.85	1255683.99
24	442866.64	217714.28	225152.36	1480836.36
25	458142.49	212428.57	245713.92	1726550.28
26	474032.64	206642.85	267389.78	1993940.06
27	490567.81	200857.14	289710.67	2283650.73
28	507780.25	195071.42	312708.82	2596359.56
29	525703.82	189285.71	336418.11	2932777.67
30	544374.09	184000.00	360374.09	3293151.76

17. FINANCING OF FUTURE ADDITIONS

As the system grows to serve areas not proposed for the initial construction, additional supply piping and eventually an additional water supply and storage tank will be needed. The location for these facilities will depend largely on the direction of future growth development. A water system, once in operation, will probably be the greatest single factor affecting the direction of future growth. In the case of new developments, it is recommended that the developer be required to install water mains and all appurtenances in the streets at entirely his cost and in accordance with strict regulations established by the Town Water Department. It is generally understood that the utility supplying water is obligated in most cases to provide the principal supply main, providing the proposed project will generate sufficient revenue.

This financing, if exceeding the existing reserve fund, can be arranged by means of short term borrowing. A minimum balance should be kept in the reserve fund for capital improvements and replacement of physical facilities. It is not recommended that the reserve fund be dissipated by reducing the minimum charge until at least all water supply and storage problems have been resolved and satisfied. The proposed charges presented herein are reasonable for new water system developments in towns comparable to Plaistow. It is not fair to compare water rates for newly constructed systems with rates in cities or towns where systems were constructed 10 or more years ago and where large industrial

users pay a considerable percentage of the costs.

18. MANAGEMENT OF THE SYSTEM

The proposed water supply and distribution system should be administered by a water authority or board and operated by a water superintendent and his personnel. In the early stages of the project the needed personnel will consist of the superintendent and one part time helper as operating personnel and a clerk to do the necessary record keeping and billing. As the system expands additional personnel in the form of maintenance men and meter readers will have to be hired. Generally, the superintendent and his work force will be responsible for the maintenance of the overall system. When the size of the work force permits, they will make all new connections, repair breaks and leaks, maintain fire hydrants, oversee new construction, maintain the pumping stations and the storage tanks, answer complaints and perform the many other tasks involved in the operation of the system.

The water authority or board would be directly responsible to the Board of Selectmen and generally responsible for establishing broad administrative policy, establishing rules and regulations, rates and charges, approving extensions and connections, planning for the future, dealing with adjacent communities, maintaining good customer relations, and administering the finances of the system. All of these things are accomplished in concert with the superintendent. In addition, there are many other functions which must be performed in the proper operation of a water utility;

preparation of yearly budgets, cost accounting, purchasing of supplies and parts, planning for capital improvements and the keeping of accurate records and reports.

19. CONCLUSIONS AND RECOMMENDATIONS

Conclusions. The establishment of a municipal water supply, storage and distribution system within the Town of Plaistow, New Hampshire is feasible, from an engineering standpoint. The basic construction cost of the proposed water system is realistic and compares favorably with similar systems installed in other communities. The cost estimates do, of course, reflect the increases in cost which have occurred in recent years. At this point the economic feasibility of the system must be considered. Perhaps this factor should be referred to more accurately as economic acceptability. The system can be built and can be operated, however, the resulting charges to be made against the customer will be higher than normal. The reason for this situation is the discontinuance of federal grants for the construction of water systems by both HUD and FHA. Most water systems of this size and scope, built recently, have been aided, usually to the extent of 50 percent of the cost, by these federal grants. Without such grants the total financial responsibility for construction of the system falls on the customer and to some minor extent onto the town, as a whole. Schematic layouts of the proposed water supply mains and distribution piping have been made and from these cost estimates and financial studies were developed. These studies show that, with the predicted conservative rate of growth, the

water system as developed in the Overall Plan is economically possible and will be self-supporting. It should be understood, however, that if the proposed system is to be self-liquidating in its initial years, it must be wanted and supported by the majority, at least 75% of the present residents of the areas to be served who can physically connect to the system. These residents under existing legislation cannot be required to connect, they will, however, be assessed whether they connect or not. The "free" service connection from the main to the curb shut-off during the construction period should serve as an inducement to most residents.

Future homeowners and developers will, without question, desire to connect to the system. The basic rate charge, connection charges at cost, hydrant rentals and assessments presented in this report are considered to be minimum, but are flexible. If it becomes desirable or necessary to have additional revenue at the outset, these charges can be increased. Depending upon such factors as: final construction cost, yearly income, rate of growth and long-range operating costs, some short-term borrowing, either from the Town or by bond issue, may be necessary to install some of the required capital improvements at the proper time.

The proposed improvement will be of benefit to the Town of Plaistow as a whole. The needed municipal water system within the Town will provide the stimulus for increased growth resulting in increased tax revenue to the Town. The direct benefits to be derived from the proposed project, to the present and future residents of the area are obvious: freedom from concern for health hazards resulting from polluted wells, pure water at proper pressure,

adequate water for fire protection, uninterrupted service, reduced first costs and lower long-term operating costs and an increase in the value of land and real estate. In addition to the foregoing, the installation of a public water system with fire hydrants will reduce the fire insurance on properties by an average amount of at least $10.00 per year.

Recommendations: As a result of the several studies carried out in the formulation of this survey and report the following recommendations, regarding the establishment of a water supply and distribution system within the Town of Plaistow, are made.

1. The actual implementation of a municipal water system is a difficult and time-consuming task. It is therefore recommended that for these purposes the Board of Selectmen appoint a Board of Water Commissioners consisting of not less than five nor more than seven qualified citizens of the Town of Plaistow. The initial responsibility of this Board will be to administer the design and construction of the proposed water system. Once the operation of the system has begun the Board's duties will largely become those outlined in a previous section of this report.
2. One of the first duties of the Water Board will be to determine the interest of the townspeople in the development of the proposed municipal water system. This can best be accomplished by holding one or more public meetings at which all the details of the system, its financing and the charge plans would be fully explained.

3. Assuming it is found that the people have a definite interest in the establishment of a municipal water system then the necessary item for bonding should be placed before the next town meeting.

4. The cost of the proposed municipal water system should be paid for by the sale of general obligation bonds backed by the credit of the town, but repaid from Water Department revenues.

5. Assuming approval of the necessary bond issue by the town meeting the Board of Water Commissioners should then immediately proceed with the final design of the system. At this time the future availability of Federal funds for construction grant assistance should be thoroughly investigated.

6. During the design of the system it is recommended that the Board of Water Commissioners undertake a street-by-street survey of the community to accurately ascertain the actual number of customers who plan to connect to and use the water system.

7. During the design of the water system the Board of Water Commissioners should "finalize" and assessment, taxation and charge procedures and formulate a set of Water Department rules and regulations.

8. During the design of the water system the Board of Water Commissioners should interview and hire a Water Superintendent so that he becomes available for employment at the start of construction of the system.

The following brief specific recommendations regarding the system itself are also made.

1. The geophysical work accomplished as a part of this study and report indicates several areas in the town which have potential as a ground water supply source. These areas are presently being tested. Assuming reasonable success in this exploratory and test well program, it is recommended that the supply source for the proposed water system be gravel-packed wells.
2. It is recommended that the initial scope of the distribution system be as shown on Sheets Nos. 2, 3 and 4 bound in Appendix A. Street-by-street variations in this scope would be made by the Board of Water Commissioners.
3. It is recommended that the initial storage facility be a steel standpipe located on Sweet Hill.
4. It is recommended that meters be installed in all commercial and industrial buildings and in all permanently occupied dwelling units.

In the final analysis, it should be understood, for the proposed system to be self-supporting and successful, virtually all residents within the service areas who can reasonably connect to the system must partake of the service. This is not intended to be arbitrary only from an economic standpoint, but it should be impressed upon the people that the development and full use of the proposed facility is necessary for the general welfare and public health of the community.

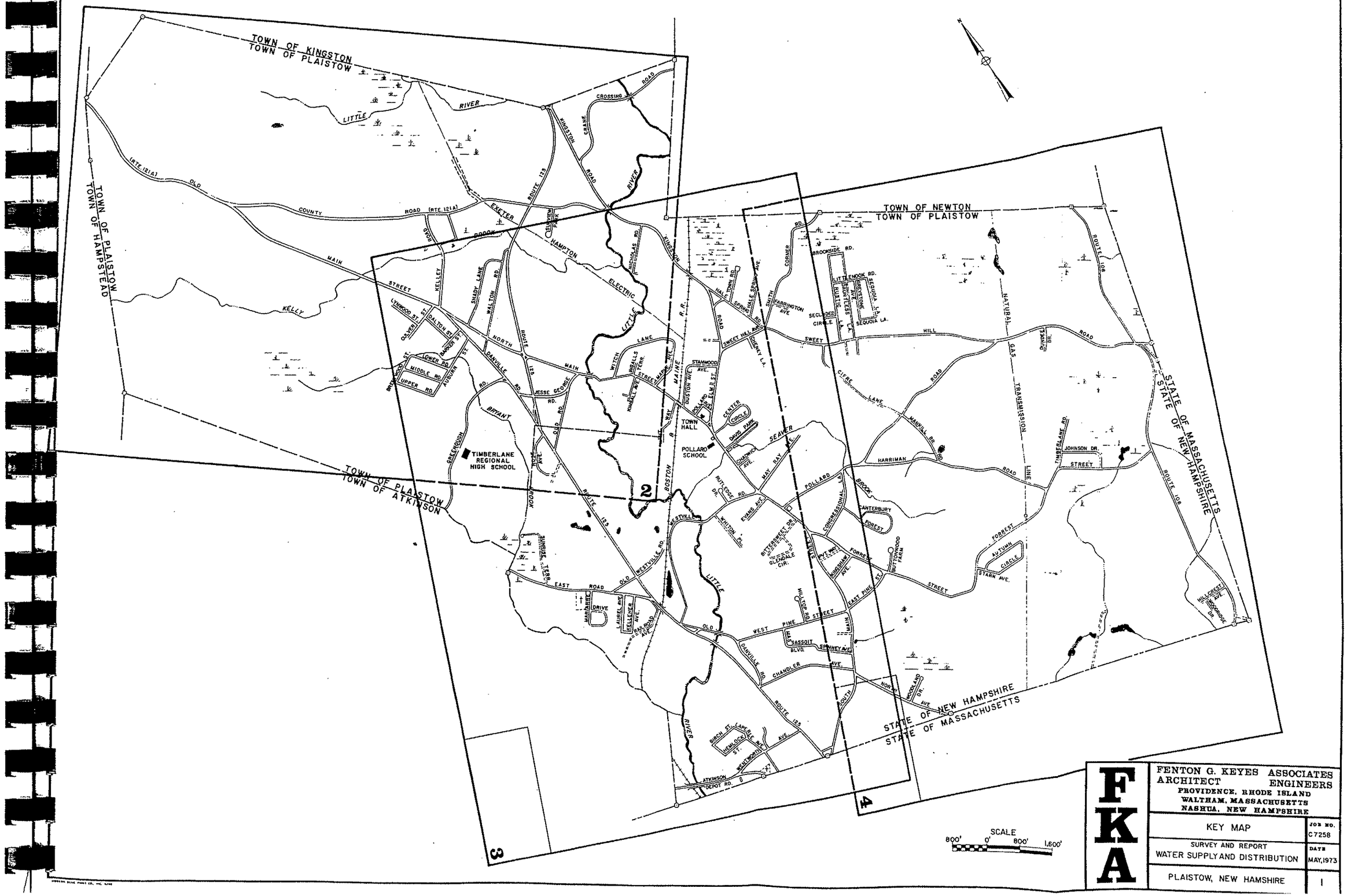
ACKNOWLEDGEMENTS

We wish to gratefully acknowledge the assistance rendered us in the preparation of this study and report by the members of the Plaistow Board of Selectmen and the Plaistow Planning Board. These gentlemen were always most pleasant to meet with and their advice regarding certain aspects of the report was very valuable.

We wish to particularly acknowledge the assistance of Mr. Thomas Cullen who gave freely of his time and rendered essential assistance every time a representative of this firm was in town.

APPENDIX A

Sheets Nos. 1 thru 4



FKA

FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE

KEY MAP

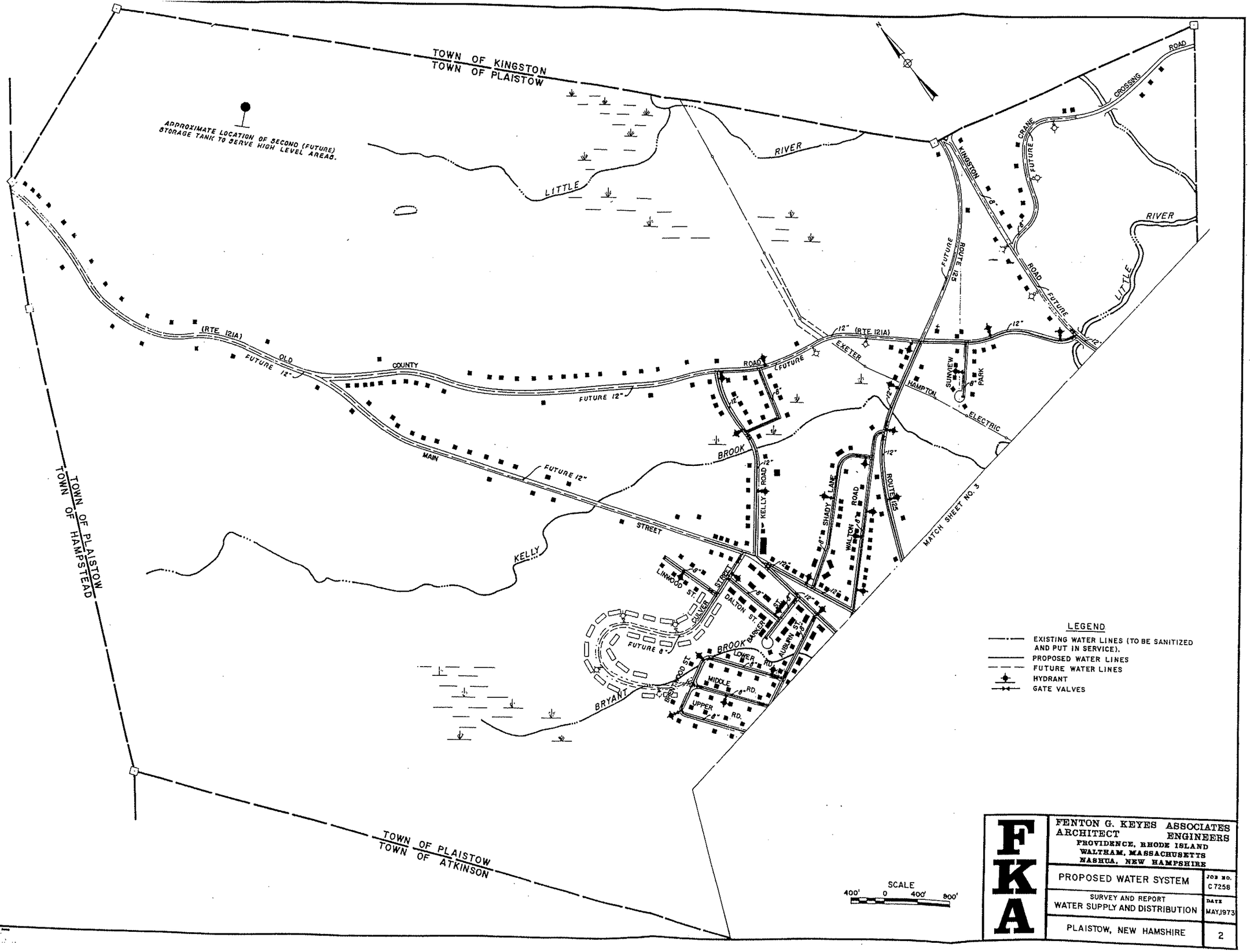
JOB NO. C7258

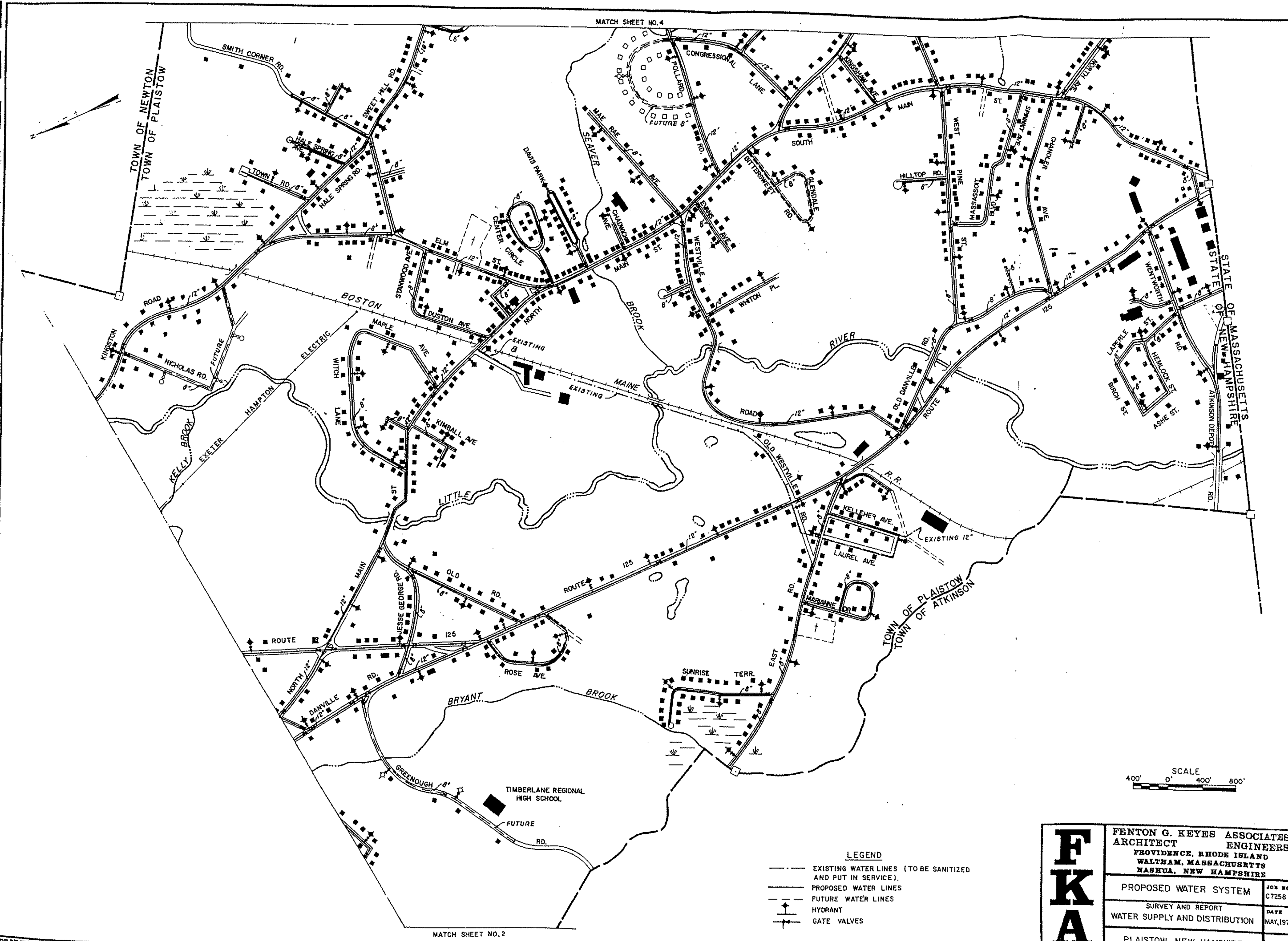
SURVEY AND REPORT
WATER SUPPLY AND DISTRIBUTION

DATE MAY, 1973

PLAISTOW, NEW HAMSHIRE

1


TOWN OF KINGSTON
TOWN OF PLAISTOW
APPROXIMATE LOCATION OF SECOND (FUTURE) STORAGE TANK TO SERVE HIGH LEVEL AREAS.
LITTLE
RIVER
(RTE 121A)
OLD
COUNTY
ROAD
FUTURE 12"
MAIN
STREET
KELLY
BROOK
BRYANT
EXETER
HAMPTON
ELECTRIC
SUNVIEW
PARK
KINGSTON
ROUTE 125
CRANE
CROSSING
ROAD
KELLY ROAD
SHADY LANE
WALTON ROAD
LINWOOD ST.
CULVER
DALTON ST.
BARKER
AUBURN ST.
LOWER RD.
MIDDLE RD.
UPPER RD.
FUTURE 8"
MATCH SHEET NO. 3
TOWN OF PLAISTOW
TOWN OF HAMPSTEAD
TOWN OF PLAISTOW
TOWN OF ATKINSON
LEGEND
EXISTING WATER LINES (TO BE SANITIZED AND PUT IN SERVICE).
PROPOSED WATER LINES
FUTURE WATER LINES
HYDRANT
GATE VALVES
SCALE
400' 0 400' 800'
FKA
FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE
PROPOSED WATER SYSTEM
JOB NO. C7258
SURVEY AND REPORT
WATER SUPPLY AND DISTRIBUTION
DATE MAY,1973
PLAISTOW, NEW HAMSHIRE
2



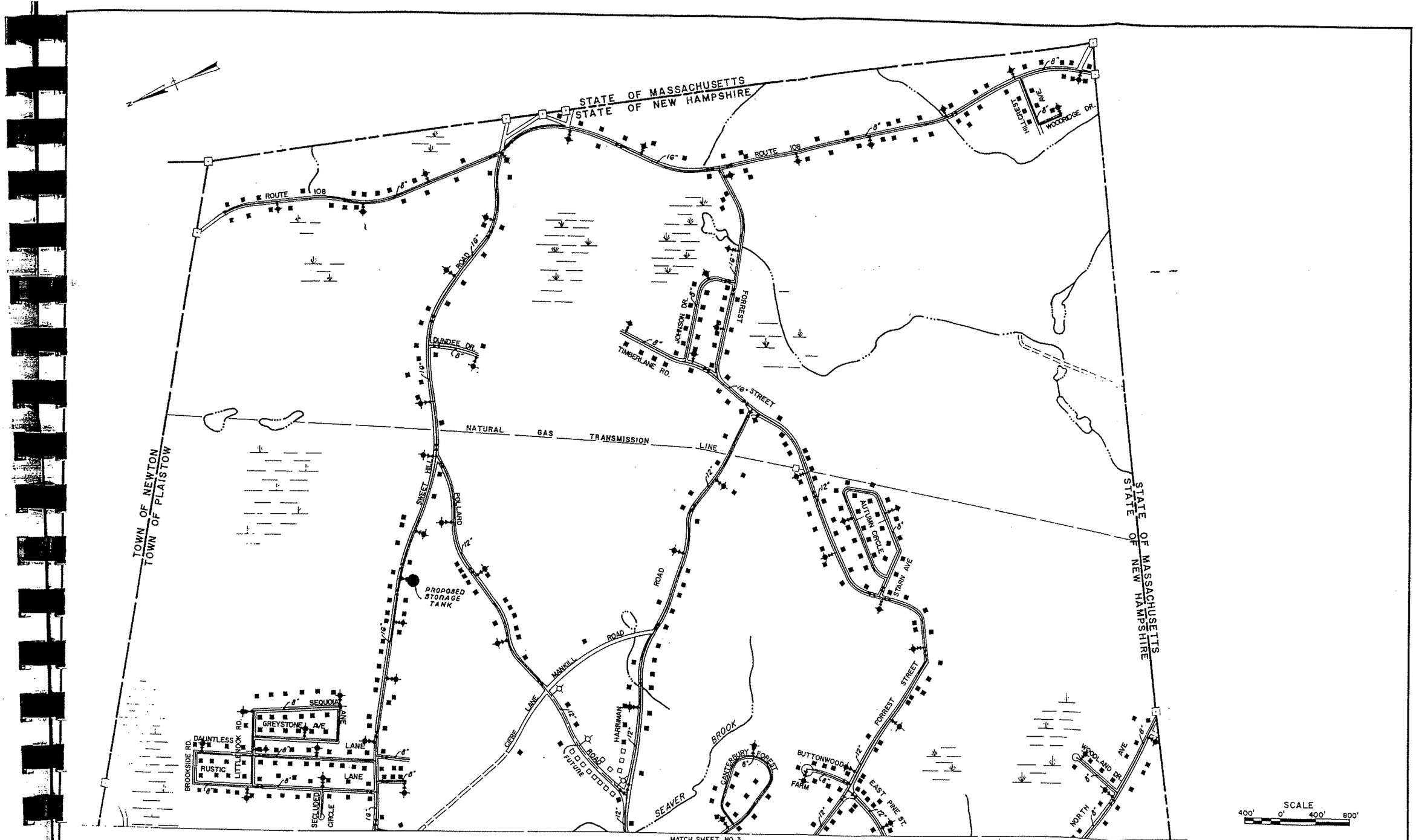
LEGEND

- EXISTING WATER LINES (TO BE SANITIZED AND PUT IN SERVICE).
- PROPOSED WATER LINES
- FUTURE WATER LINES
- HYDRANT
- GATE VALVES

FKA

FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE

PROPOSED WATER SYSTEM	JOB NO. C7258
SURVEY AND REPORT WATER SUPPLY AND DISTRIBUTION	DATE MAY, 1973
PLAISTOW, NEW HAMSHIRE	3



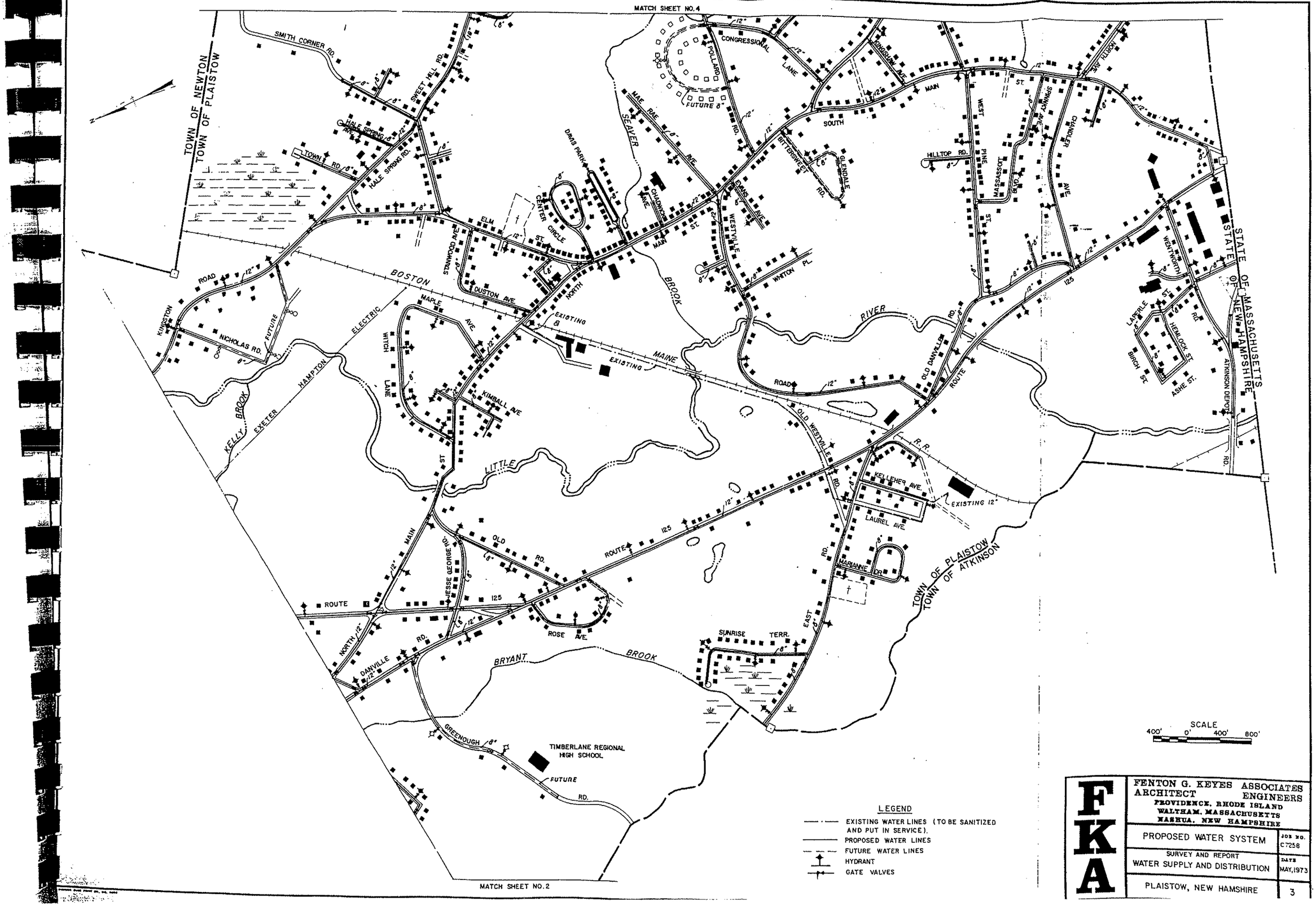
LEGEND

- EXISTING WATER LINES (TO BE SANITIZED AND PUT IN SERVICE).
- PROPOSED WATER LINES
- FUTURE WATER LINES
- HYDRANT
- GATE VALVES

FKA

FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE

PROPOSED WATER SYSTEM	JOB NO. C7258
SURVEY AND REPORT WATER SUPPLY AND DISTRIBUTION	DATE MAY, 1973
PLAISTOW, NEW HAMPSHIRE	4



FKA

FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE

PROPOSED WATER SYSTEM

JOB NO. C7258

SURVEY AND REPORT
WATER SUPPLY AND DISTRIBUTION

DATE MAY, 1973

PLAISTOW, NEW HAMSHIRE

3

APPENDIX B

Copy of Geophysical Report

TOWN OF PLAISTOW, NEW HAMPSHIRE

GEOPHYSICAL SURVEY

NOVEMBER 1972

for
FENTON G. KEYES ASSOCIATES
ARCHITECTS AND ENGINEERS
PROVIDENCE, RHODE ISLAND-NASHUA, N.H.

by
LAYNE NEW ENGLAND COMPANY
15 RYDER STREET
ARLINGTON, MASSACHUSETTS

GEOPHYSICAL SURVEY

Layne New England Company personnel have recently completed a Geophysical Survey at the above location. The following is the analysis and interpretation of the data.

The purpose of the survey is to obtain information on the subsurface geology of the area which can be used to direct the test drilling for a new permanent water well. Specifically the hope is that the geophysical measurements will be able to detect, in the area surveyed, where the stream alluvium or glacial material extends to the greatest depth and where it is the cleanest. The seismic information is generally more reliable for depth information, the resistivity more reliable in defining the nature of the material.

It should be pointed out that the use of the survey in no way eliminates the need for test drilling. Rather, we feel it reduces the number of test wells needed to completely explore a given area, by guiding the drill to the most promising areas.

This report will present the data obtained in the field and an interpretation will be given. Additionally, necessary background information on both the electrical method of prospecting for ground water and the general geology of the area will be included. The report will conclude with the recommendation of sites to be tested by the drill.

SEISMIC INVESTIGATION

The basic seismic refraction principle is based on the fact that seismic waves travel through different materials (sand, gravel, clay, rock, etc.) at characteristic velocities. The velocity varies from slow in loose materials to fast in dense materials. If one can measure seismic wave velocity, then the general nature and depth of materials can be determined.

Seismic waves are created by hammer blows on the ground surface, starting 10 feet from a geophone. Hammering continues outward from the geophone at 10 foot intervals. At 10 and 20 feet, seismic waves near ground surface are first to reach the geophone. As hammering continues at greater distances, waves traveling through denser material below are the first to reach the geophone, if the material below increases in density with depth. Seismic waves which travel through denser material travel faster and consequently reach the geophone first. It should be born in mind, however, that loose, lower velocity materials overlain by denser, high velocity material will not show up, but rather the velocity of the denser material will be read for the entire thickness of material underlying it, until a still more dense material is encountered. A plot of the time elapsed from the origin of the shock to receipt of the echo at the geophone is plotted against distance from the geophone to the hammer and depth and velocity information read from this. Profiles using the depth and velocity data and other geological and geophysical are then constructed.

THE ELECTRICAL METHOD OF PROSPECTING FOR GROUND WATER

The electrical, or resistivity method has proven useful in exploring for ground water because of the characteristic range of resistivity values exhibited by the various types of earth materials. For example, sand and/or gravel is highly resistive. Clay on the other hand is low resistive. It follows then, if we map the resistivity values in a given area, we should be able to generalize on the type of materials in the area.

The method used to measure the earth's resistivity consists of four electrodes are planted in the ground, in a straight line with equal spacing between adjacent electrodes. Electrical current is then sent between the two outer electrodes and the resulting potential drop measured across the two inner electrodes. Then, knowing the value of the current used, the potential drop and the electrode spacing, one can compute a quantity called the apparent resistivity. This is in the form of a weighted average of all the material from the surface down to a depth equal to approximately the electrode spacing. By making measurements with varying electrode spacings, information on the manner in which the resistivity varies over broad depth intervals can be obtained.

In the course of the survey, at each station six separate readings were taken, varying the electrode spacing. From these data the apparent resistivity values were computed and curves of apparent resistivity versus electrode spacing prepared. While the apparent resistivity values are quite informative in themselves, they are in the form of weighted averages, more to

the point would be a knowledge of the true resistivity for a specific depth interval. To this data a correction based upon theoretical considerations has been applied, resulting in a new set of values which more correctly portrays the true depth-resistivity relationship.

An alternate method of interpretation is also performed as follows:

Curves for an almost infinite number of subsurface conditions have been computed from potential theory. By matching the apparent resistivity curves obtained in the field with the best fit "type curve" information on the depth and resistivity of the various strata can be obtained.

The two interpretations of the data are then evaluated in the light of the known geology and other geophysical data and the information used to construct profiles, or contour maps. These charts are included at the end of the report. From this information then, an evaluation of the relative merits of each site can be weighted and the best potential location in each site selected. This provides a basis for selecting the number and sequence of sites to be test drilled.

GENERAL GEOLOGY

Plaistow has a terrain which is a result of glacial action on a structure which originally consisted of highlands to the north-west, a major valley (Little River) running in a general north-south direction through the center of Town and additional highlands to the south-west.

The evidence is quite convincing that the Little River valley if pre-glacial and was filled in by coarser materials from the highlands and glacial outwash initially. These would generally tend to be coarse sands and gravels. During later glacial stages, the valley became a dammed up glacial lake and finer silts and clays were deposited which formed the present surface layers of the valley. The hills to the north-east and south-west have some cover of glacial sands and gravels and tills, but much of this gravel lies above its present day water table and are not suitable for water supplies.

The most likely areas to develop a suitable public water supply well, would be in the deeper lying sands underlying the Little River; sands and gravels in the north-west highlands, if they extend deep enough, and some of the sma-ler valleys to the south-west, if they are deep enough.

The purpose of the survey then, is to locate sites in each of these regions where there is sufficiently coarse sand and gravel deposits, with sufficient recharge, at sufficient depth, to develop high capacity water wells.

DETAILED ANALYSIS (SEE MAPS, PAGES 1 THROUGH 6)

SITE "A"
A geophysical line following the power lines, crosses part of the north-west pattern and the Little River valley. Resistivity and siesmic data confirmed the existance of relative deep lying sands and gravel deposits at several locations. Recharge to the area is available from Kelly and Little Rivers, access to the area is reasonably good. Test wells are recommended at resistivity stations 8 and 4.

SITE "B"
This is a swampy basin near the south end of Town and from the geophysical data, appears to be out of the main valley. Bedrock is shallow and the basin is primarily clay filled. There is some indication of a thin, shallow sand and gravel deposit on the south edge of the basin, which would appear to be too close to existing housing for development. Stations 11 and 17 are close to the river and would have good recharge, but appear to be shallow. There is a possibility that just above bedrock, a sand and gravel area exists and a test well could be driven, if necessary.

SITE "C"
The geophysical profile crosses the main valley and part of

the north-west highland, near the center of Town. The survey indicates shallow sand and gravel to the north-west, but adjacent to the river at Station 20, sand and gravel appears to be thicker. Access to the area is quite difficult, due to the swamps, but the recharge potential, is excellent. A test well at Station 20 is recommended.

SITE "D"
The survey line crosses the Little River valley just below the center of Town and also indicates good material at reasonable depth near Station 29. The site is accessible and recharge potential, good. A test well is recommended at Station 29.

SITE "E"
The profile runs along a glacial Esker, which has been mined of its surface sand and gravel. The survey indicates that the sand and gravel extended below ground to a limited depth. Since the recharge potential at the site is excellent and access is good, this might prove a satisfactory site despite its shallowness. A test well should be tried at Station 26.

SITE "F"
A profile of four resistivity stations was attempted along the same Esker as "E", but farther south. Coarse, loose, dry gravel on its surface prevented the taking of satisfactory readings. We believe the area would still be worth drilling as a speculation.

SITE "G"
Is in the north-west highland, across the street from the Regional High School and tests show a deep lying sand and gravel layer. Adequate recharge should be available from Bryant Brook and access is good. A test well at Station 32 or 33 is recommended.

SUMMARY AND RECOMMENDATIONS
We believe there is adequate evidence from the geophysical survey that good potential sites exist for the development of a Municipal water supply from wells in sands and gravels above bedrock.

We recommend a test well program be conducted at the following locations. We have listed these sites on a priority basis, solely on geological and geophysical considerations. We realize there may be other factors which may effect the actual sequence of drilling and may necessitate the elimination of some of the sites.

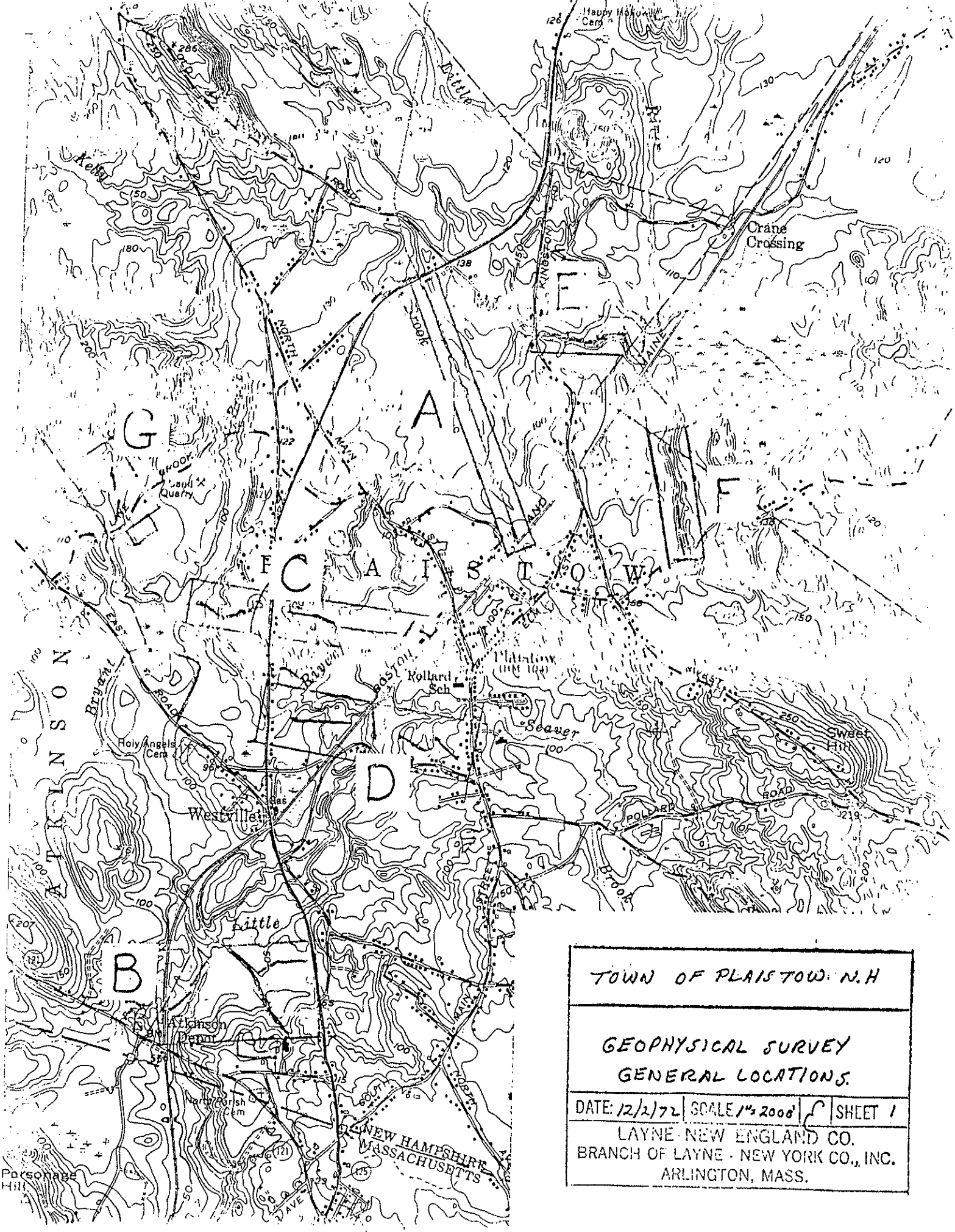
PRIORITY	AREA	STATION
1.	A	7-8
2.	A	4
3.	G	32-33
4.	C	20
5.	D	29
6.	E	26
7.	F	Convenient spot
8.	B	11-17

We trust you will find the report satisfactory. Needless to say, if you have further comments or questions, we would be pleased to review the data with you in further detail.

Respectfully submitted,

David M. Erickson
Registered Geologist

DME/mbh

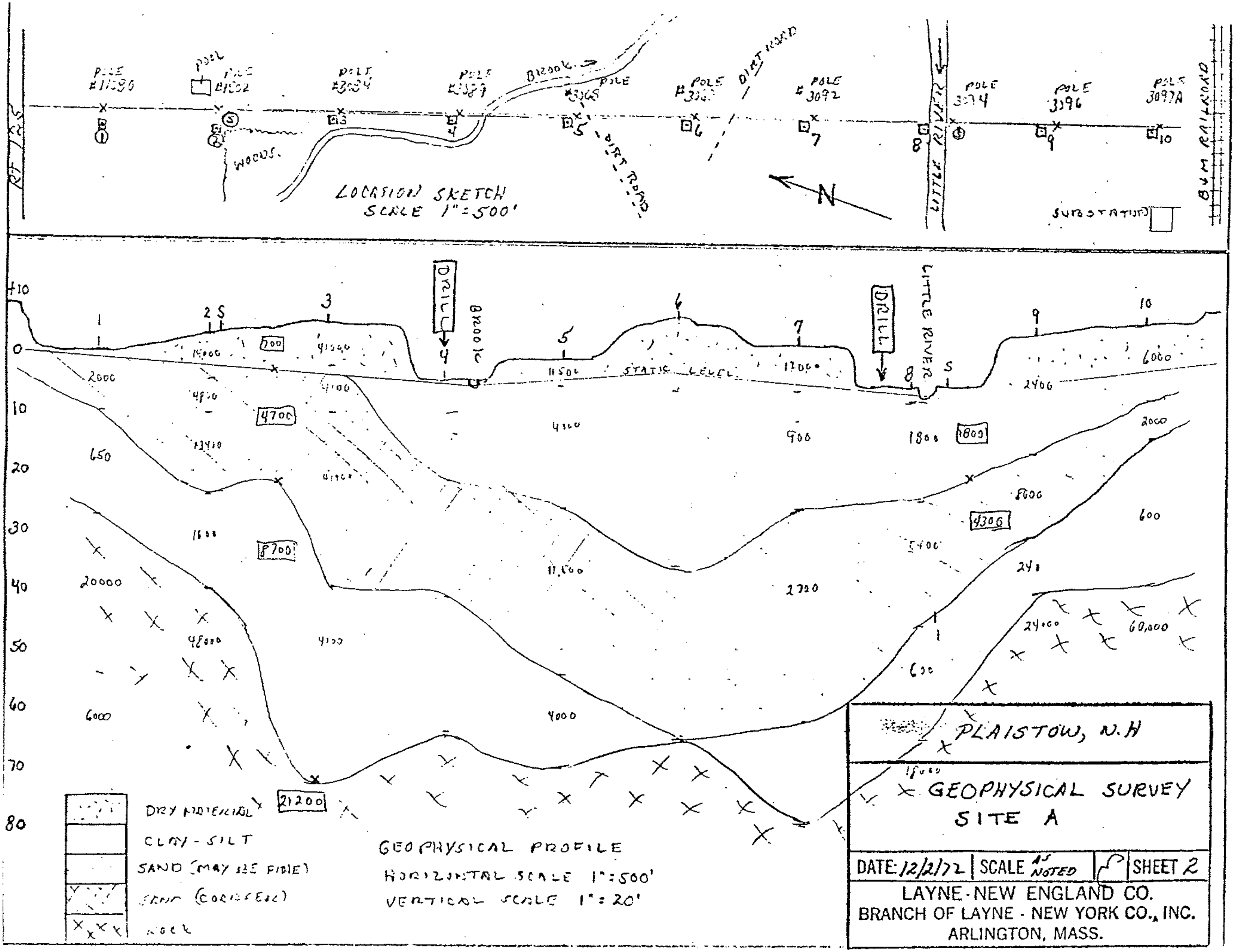


TOWN OF PLAISTOW, N.H

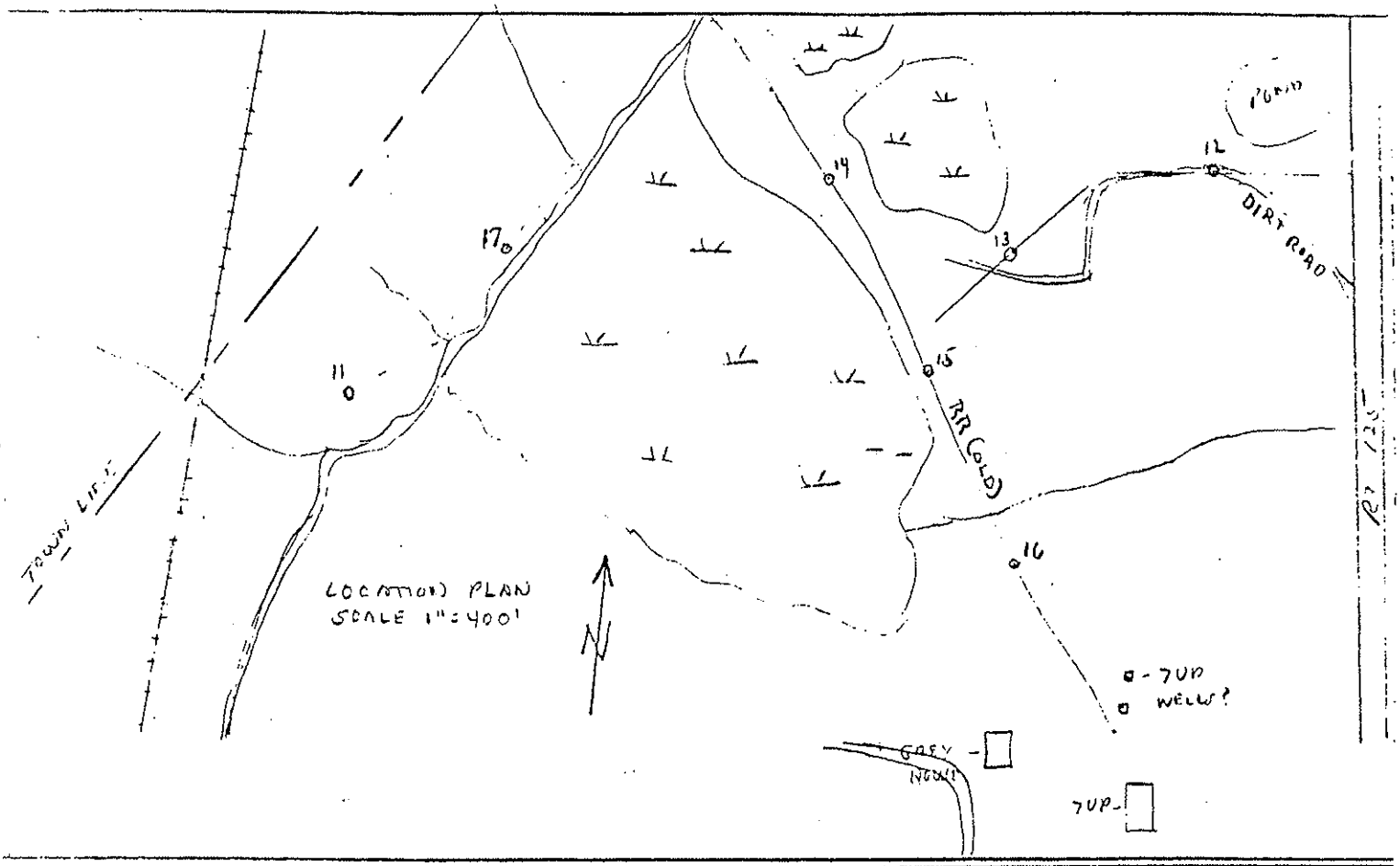
GEOPHYSICAL SURVEY
GENERAL LOCATIONS

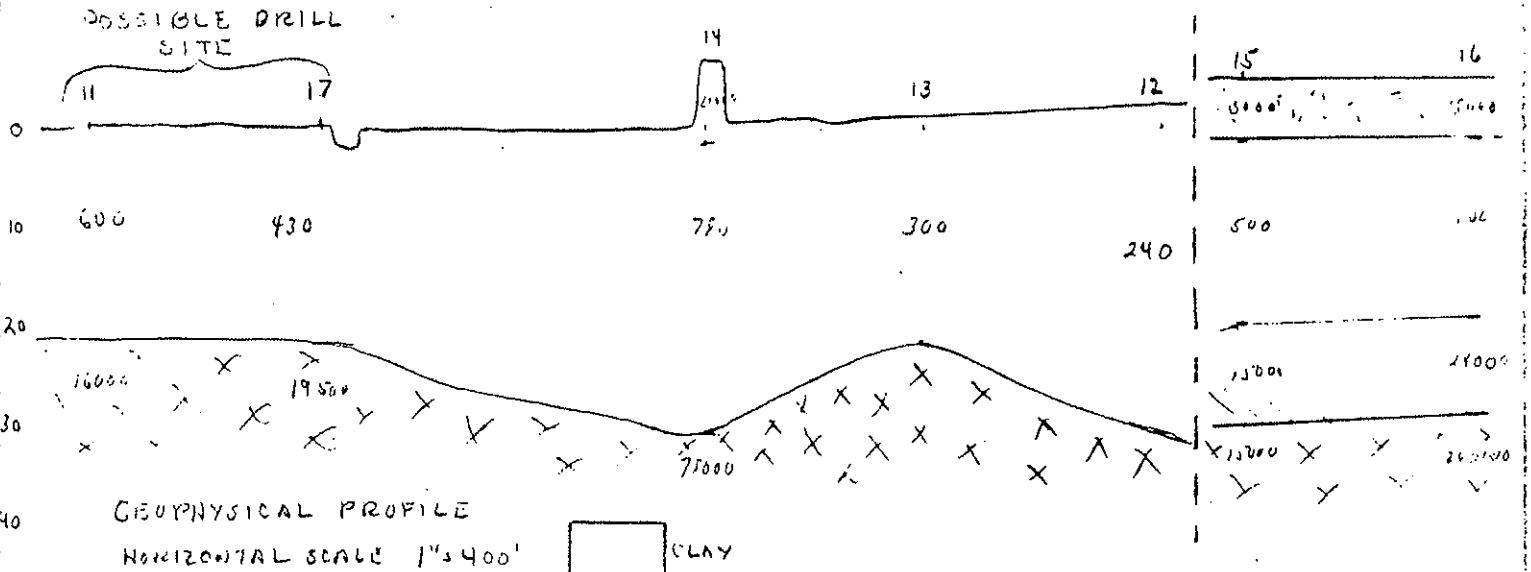
DATE: 12/2/72	SCALE 1" = 2000'	C	SHEET 1

LAYNE-NEW ENGLAND CO.
BRANCH OF LAYNE - NEW YORK CO., INC.
ARLINGTON, MASS.



RT 125
POLE #11590
POLE
POLE #11502
POLE #3084
POLE #3587
BROOK
POLE #3365
DIRT ROAD
POLE 3363
DIRT ROAD
POLE 3092
LITTLE RIVER
POLE 3074
POLE 3096
POLE 3097A
B&M RAILROAD
WOODS.
LOCATION SKETCH
SCALE 1"=500'
N
SUBSTATION
DRILL
BROOK
DRILL
LITTLE RIVER
STATIC LEVEL
DRY MATERIAL
CLAY - SILT
SAND (MAY BE FINE)
SAND (COARSER)
ROCK
GEOPHYSICAL PROFILE
HORIZONTAL SCALE 1"=500'
VERTICAL SCALE 1"=20'
PLAISTOW, N.H
GEOPHYSICAL SURVEY
SITE A
DATE: 12/2/72
SCALE AS NOTED
SHEET 2
LAYNE-NEW ENGLAND CO.
BRANCH OF LAYNE - NEW YORK CO., INC.
ARLINGTON, MASS.



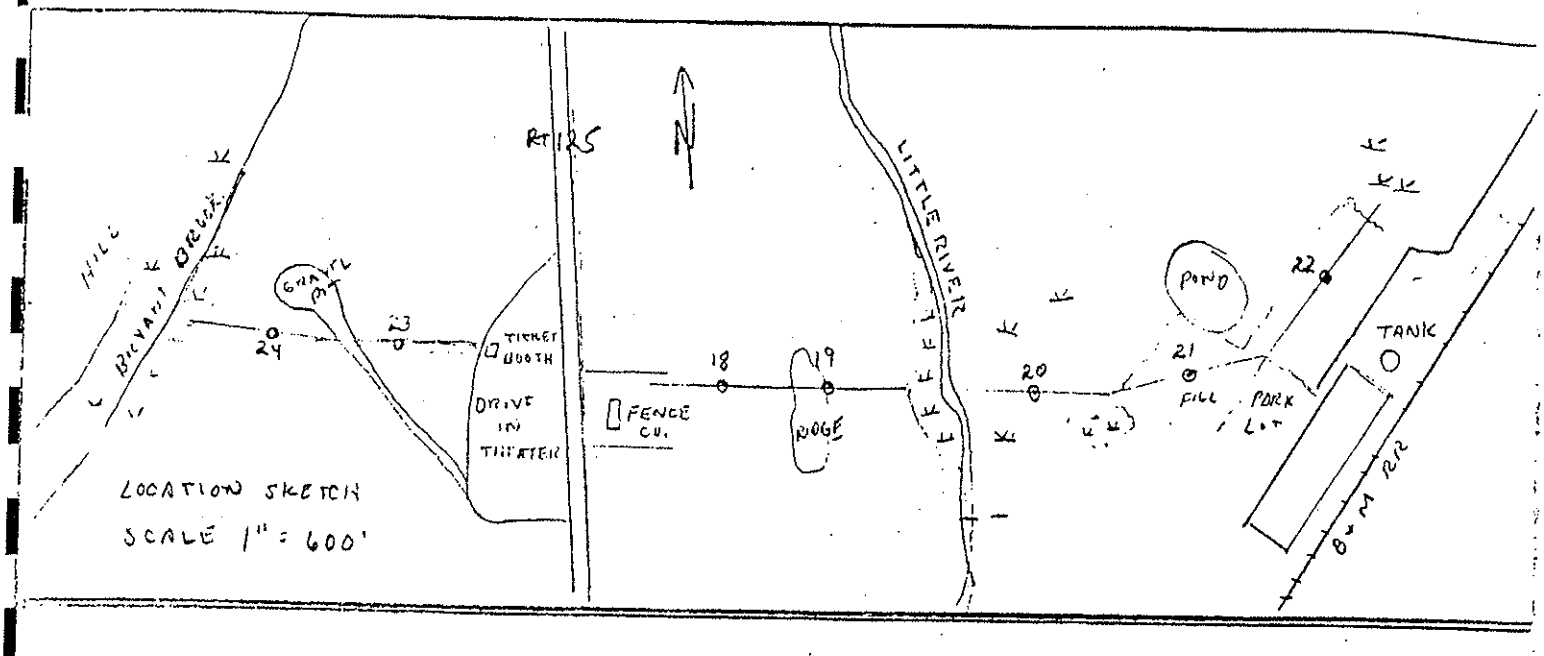


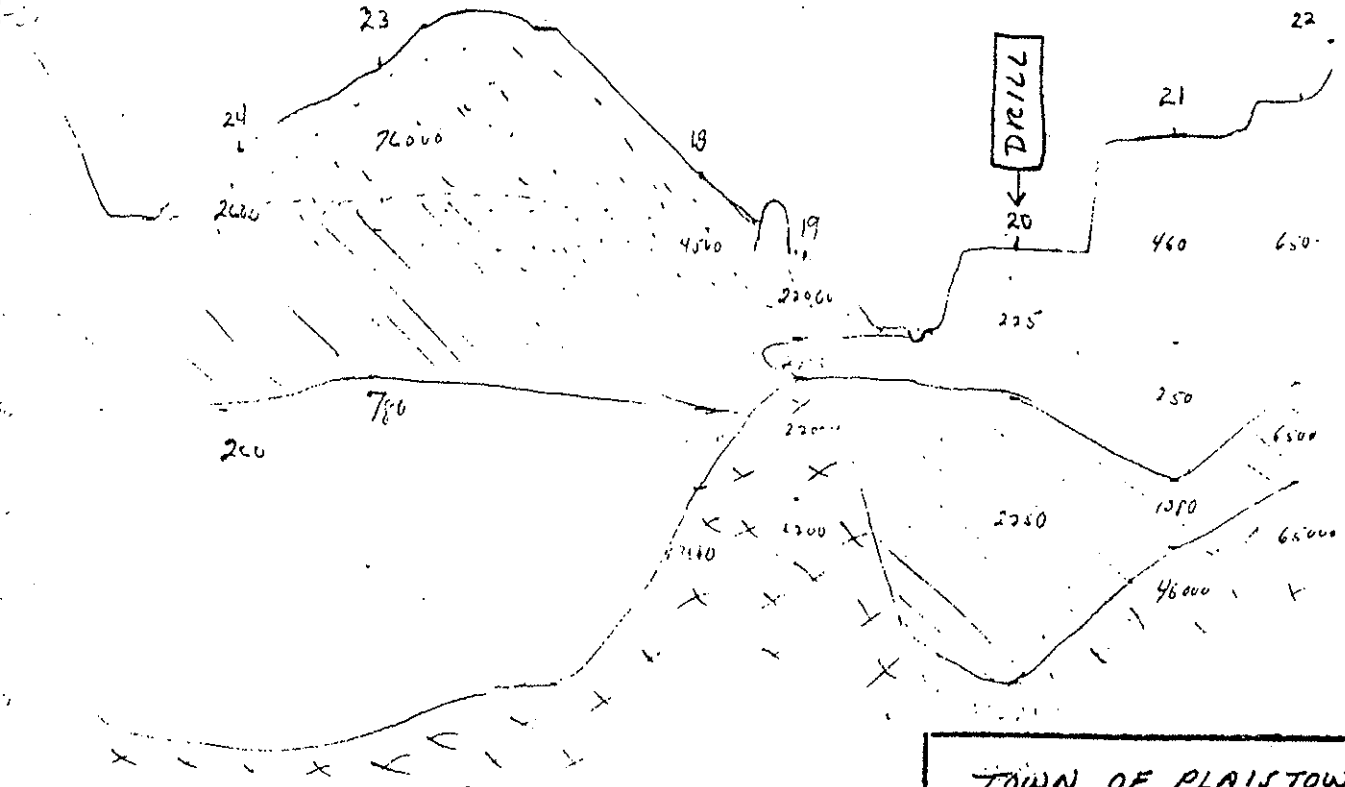
TOWN OF PLAISTOW, N.H.

GEOPHYSICAL SURVEY
SITE B

DATE: 12/2/72 | SCALE AS NOTED | SHEET 3

LAYNE-NEW ENGLAND CO.
BRANCH OF LAYNE - NEW YORK CO., INC.
ARLINGTON, MASS.





CLAY
SATURATED SAND
ROCK
DRY SAND

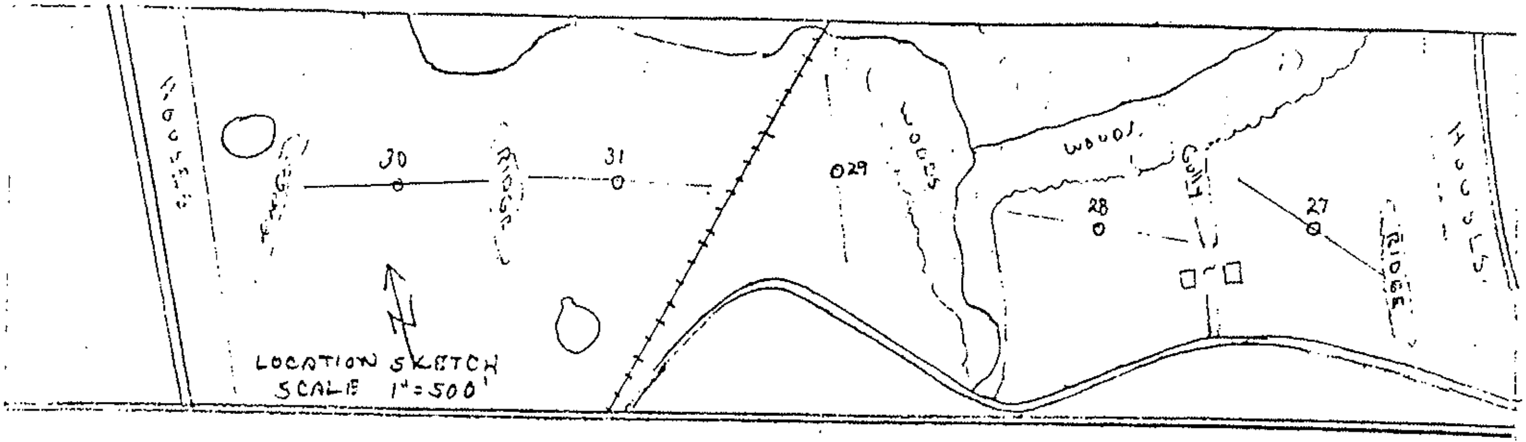
GEOPHYSICAL PROFILE
SCALE HORIZ. 1" = 600'
VERT. 1" = 20'

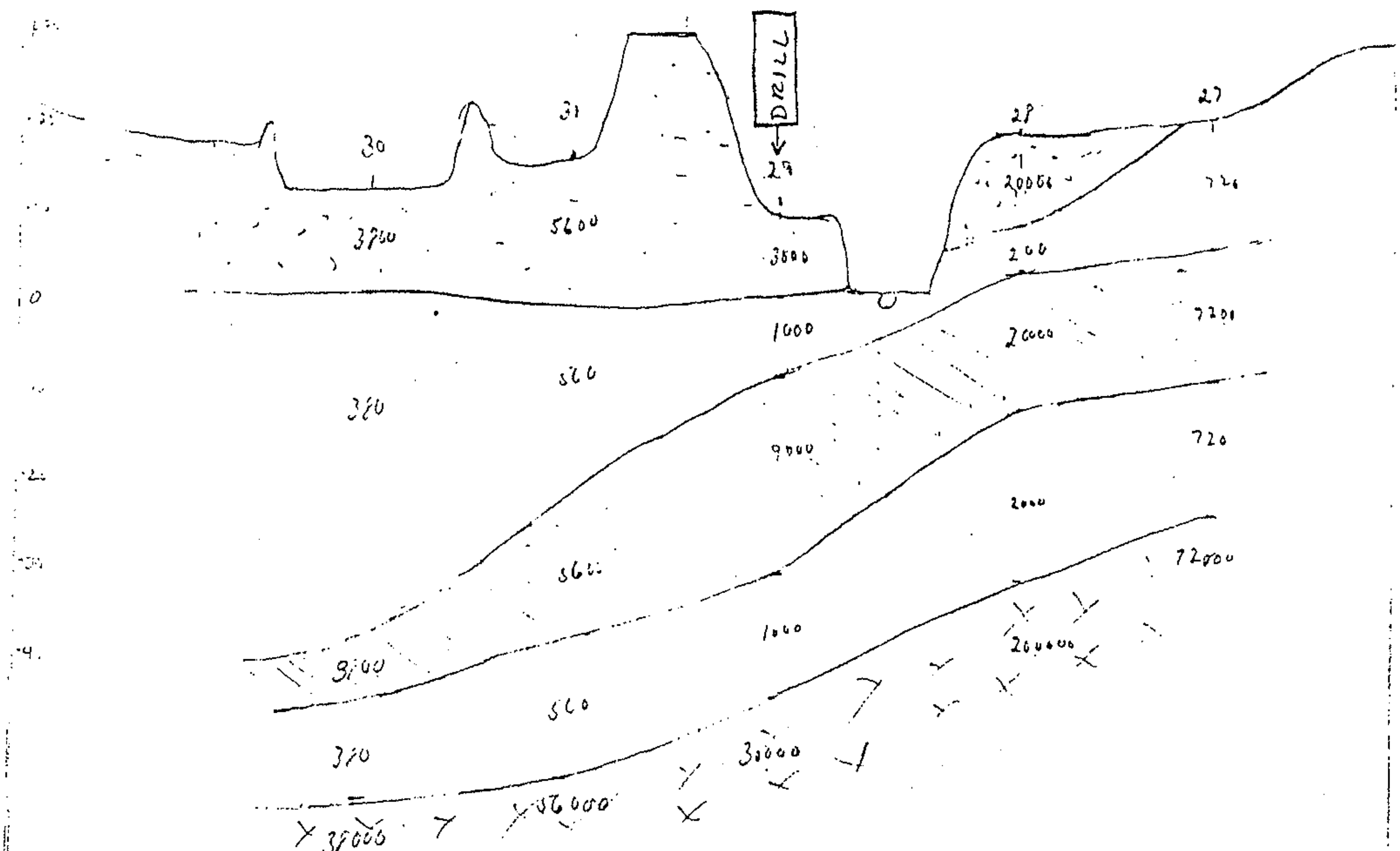
TOWN OF PLAISTOW, N.H.

GEOPHYSICAL SURVEY
SITE C

DATE: 12/2/72 | SCALE AS NOTED | SHEET 4

LAYNE-NEW ENGLAND CO.
BRANCH OF LAYNE - NEW YORK CO., INC.
ARLINGTON, MASS.





GEOPHYSICAL PROFILE
SCALE HORIZ 1"=500'
VERT 1": 20'

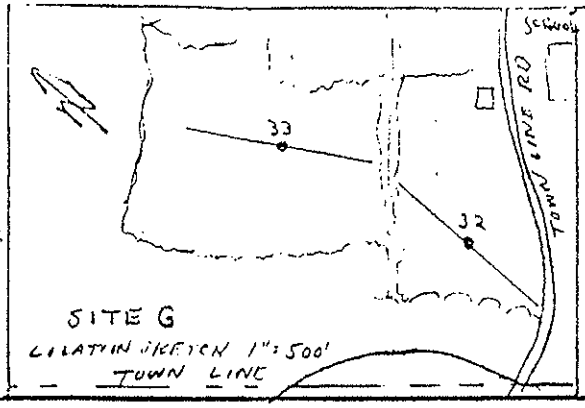
. . .	DRY SAND
	SILT; CLAY
.	SAND
x x	ROCK

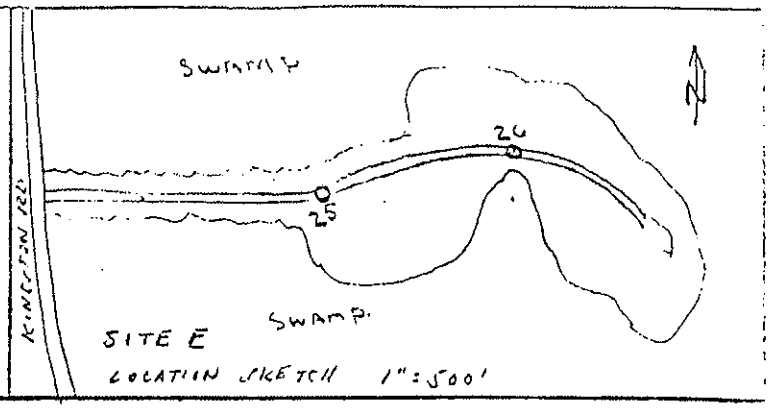
TOWN OF PLAISTOW, N.H.

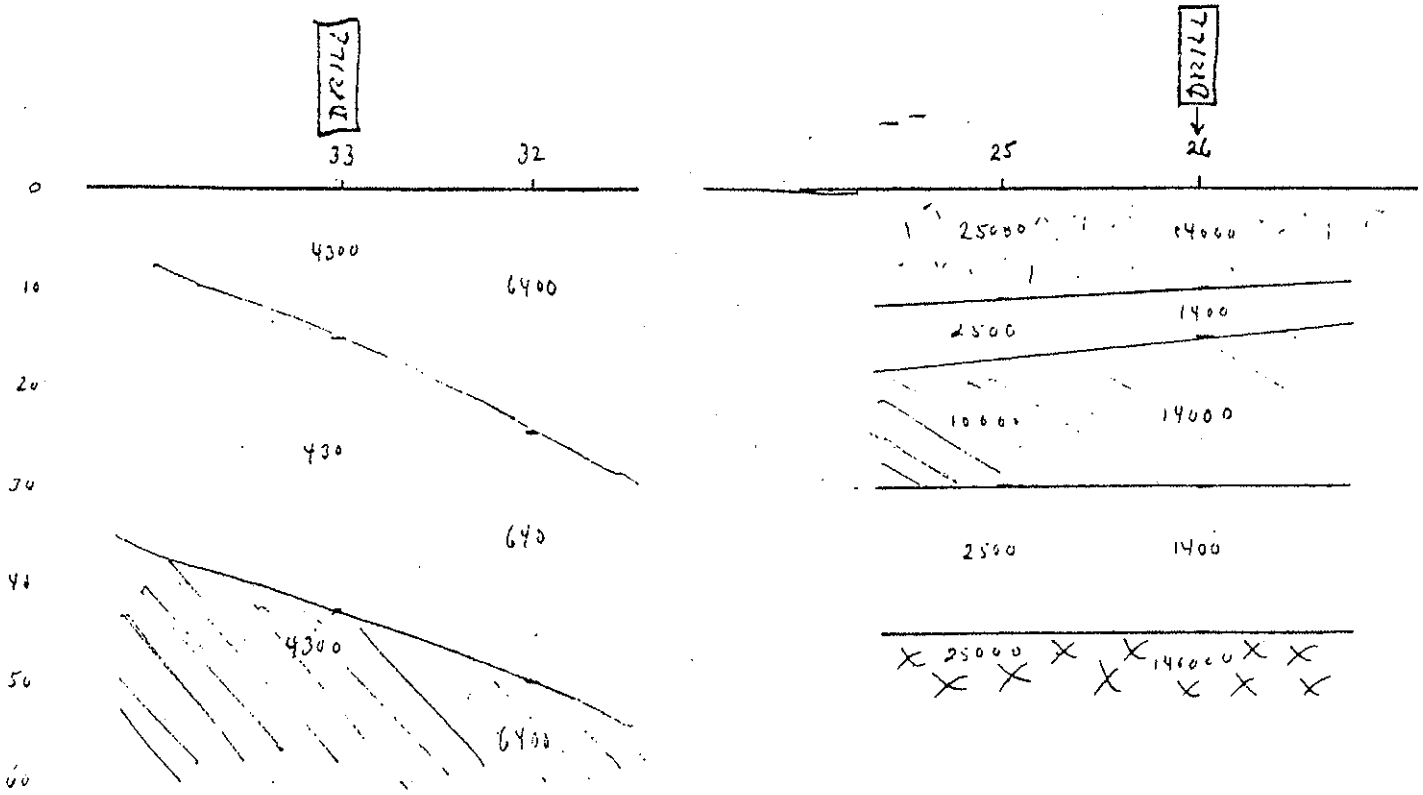
GEOPHYSICAL SURVEY
SITE D

DATE: 12/2/72	SCALE AS NOTED		SHEET 5

LAYNE-NEW ENGLAND CO.
BRANCH OF LAYNE - NEW YORK CO., INC.
ARLINGTON, MASS.







SITE G GEOPHYSICAL PROFILES SITE E.

SCALE HORIZ: 1"=500'

VERTICAL 1"=20

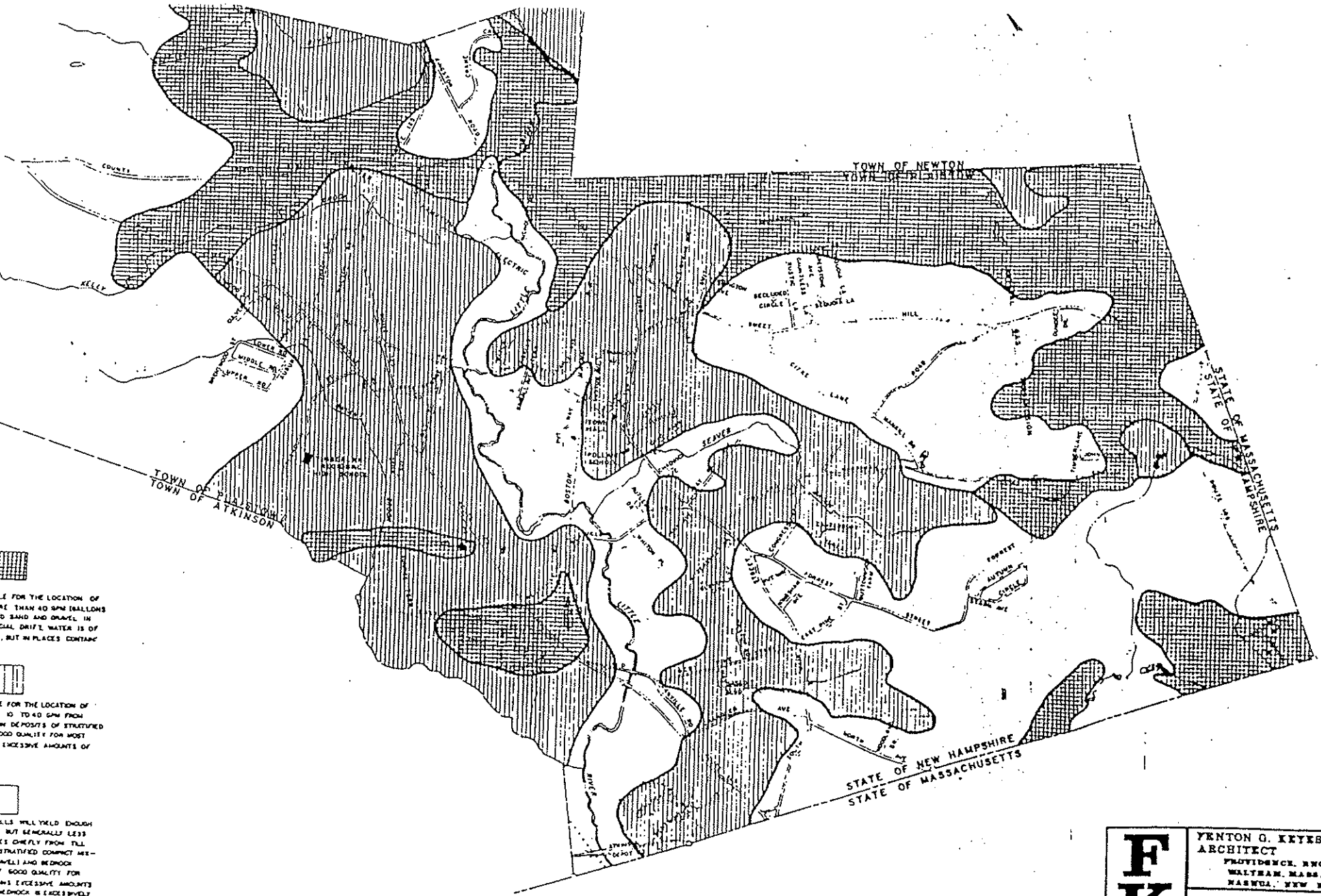
	DRY SAND
	CLAY; SILT
	SAND
	Rock

TOWN OF PLAISTOW, N.H.

GEOPHYSICAL SURVEY
SITES E AND G

DATE: 12/2/72 | SCALE AS NOTED | SHEET 6

LAYNE-NEW ENGLAND CO.
BRANCH OF LAYNE-NEW YORK CO., INC.
ARLINGTON, MASS.



FOR THE LOCATION OF
THAN 40 GPM (GALLONS
SAND AND GRAVEL IN
GLACIAL DRIFT, WATER IS OF
, BUT IN PLACES CONTAIN

FOR THE LOCATION OF
10 TO 40 GPM FROM
DEPOSITS OF STRATIFIED
GOOD QUALITY FOR MOST
EXCESSIVE AMOUNTS OF

WELLS WILL YIELD ENOUGH
BUT GENERALLY LESS
CHIEFLY FROM TILL
STRATIFIED COMPACT MIX-
GRAVEL AND BEDROCK
GOOD QUALITY FOR
EXCESSIVE AMOUNTS
BEDROCK IS EXCESSIVELY

FKA

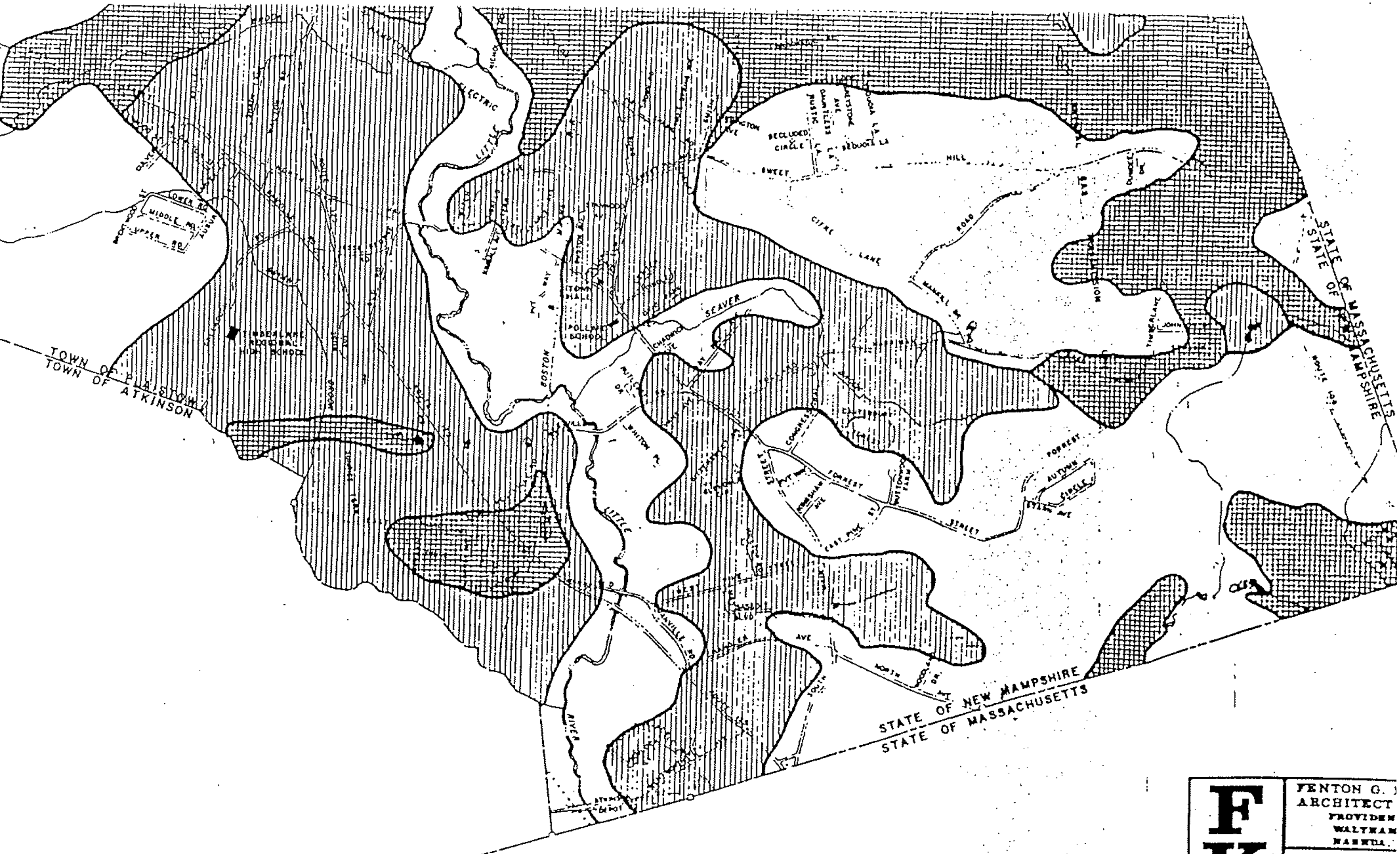
KENTON G. KEYES ASSOCIAT
ARCHITECT ENGINEE
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE

GROUND-WATER FAVORABILITY

SURVEY AND REPORT
WATER SUPPLY AND DISTRIBUTION

PLAISTOW, NEW HAMPSHIRE

PLATE

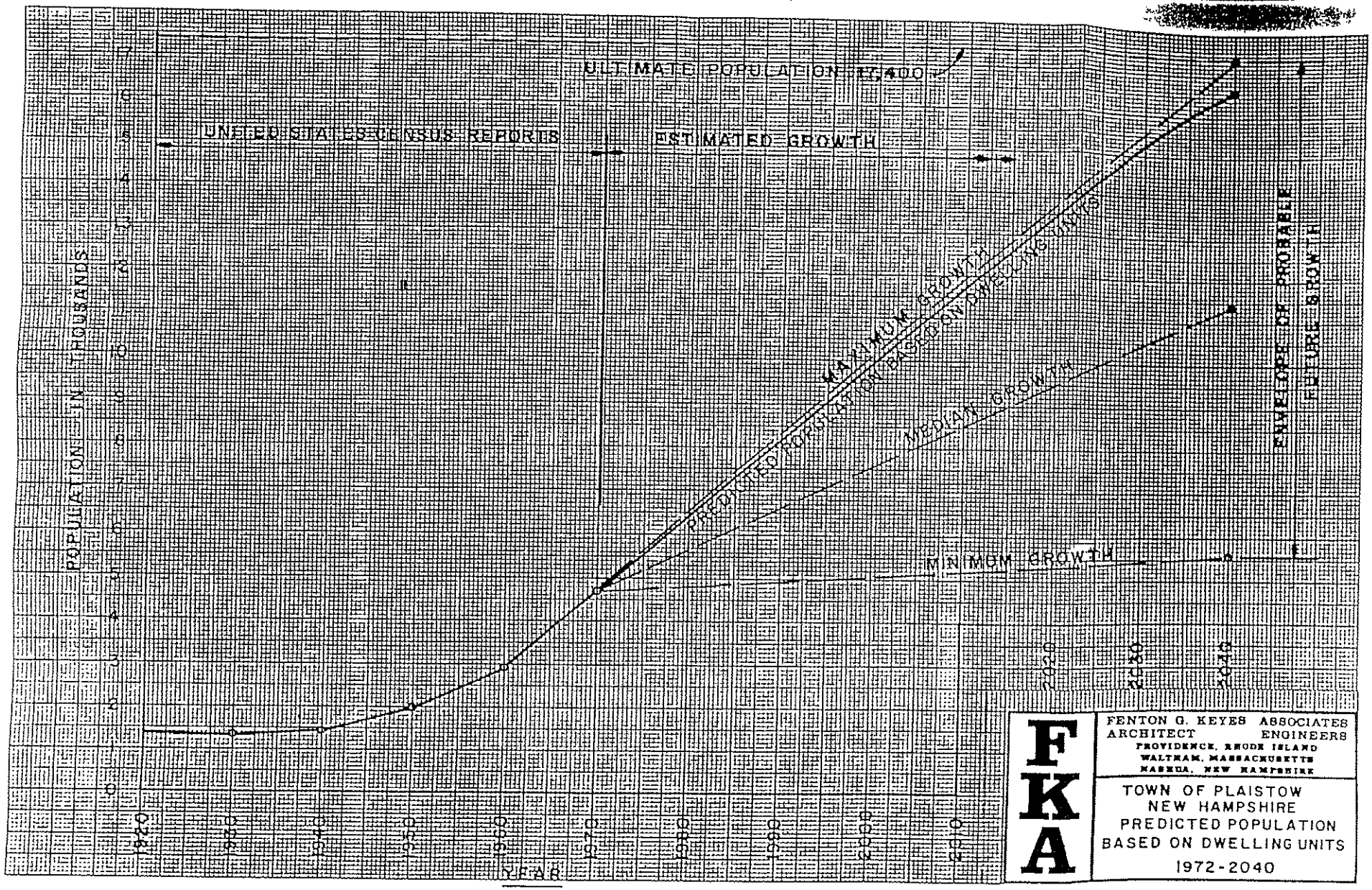


FENTON G. [illegible]
ARCHITECT [illegible]
PROVIDEN[illegible]
WALTHAM
NASHUA,

GROUND-WATE[illegible]

SURVEY A[illegible]
WATER SUPPLY A[illegible]

PLAISTOW, N[illegible]

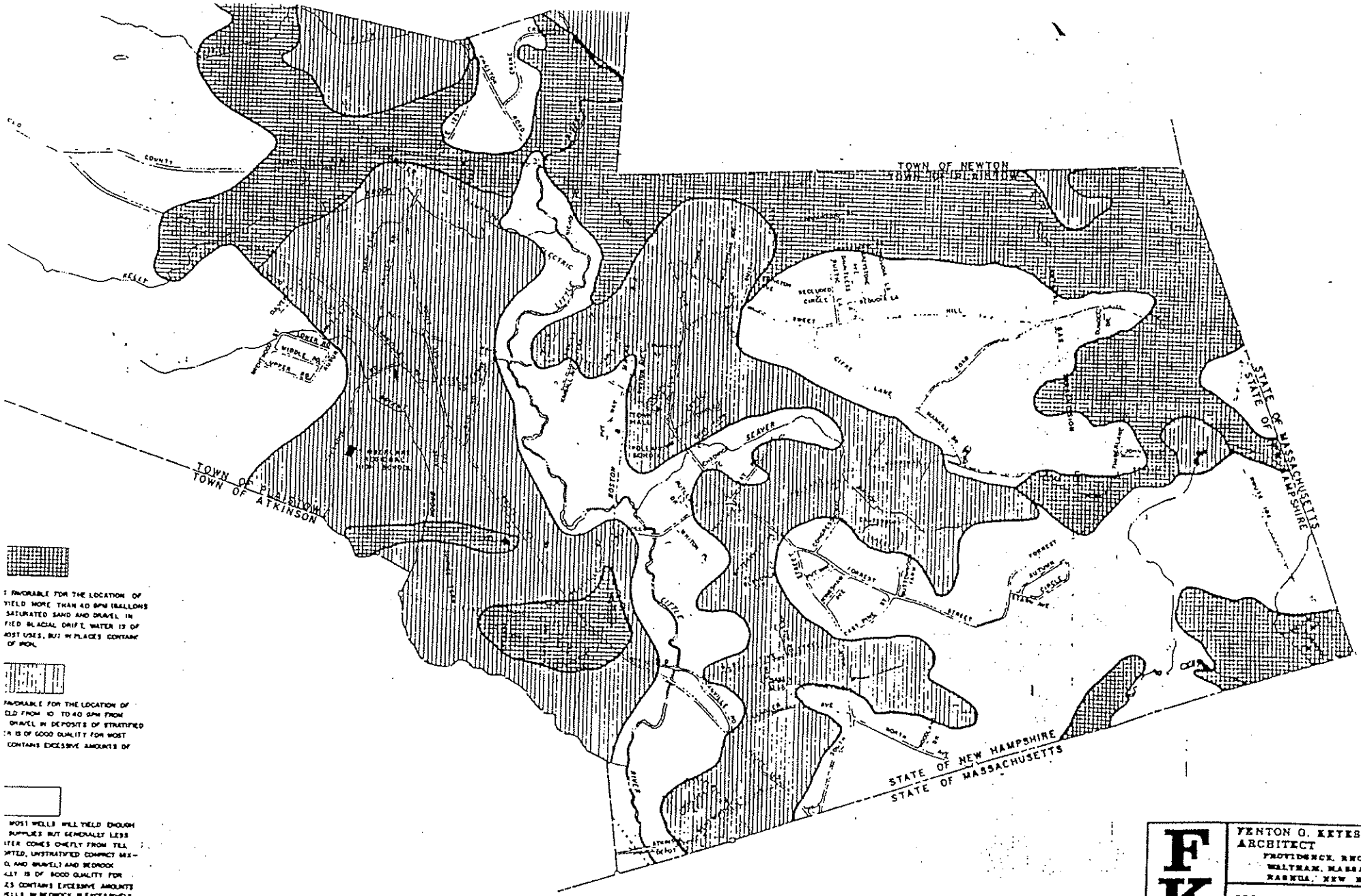


FKA

FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE

TOWN OF PLAISTOW
NEW HAMPSHIRE
PREDICTED POPULATION
BASED ON DWELLING UNITS
1972-2040

PLATE NO. R-3



FAVORABLE FOR THE LOCATION OF
YIELD MORE THAN 40 GPM (GALLONS
SATURATED SAND AND GRAVEL IN
FIED GLACIAL DRIFT. WATER IS OF
OST USES, BUT IN PLACES CONTAINS
OF IRON.

FAVORABLE FOR THE LOCATION OF
ELD FROM 10 TO 40 GPM FROM
GRAVEL IN DEPOSITS OF STRATIFIED
R IS OF GOOD QUALITY FOR MOST
CONTAINS EXCESSIVE AMOUNTS OF

MOST WELLS WILL YIELD ENOUGH
SUPPLIES BUT GENERALLY LESS
TER COMES CHIEFLY FROM TILL
MIXED, UNSTRATIFIED COMPACT MIX-
D, AND GRAVEL) AND BEDROCK
LITY IS OF GOOD QUALITY FOR
ES CONTAINS EXCESSIVE AMOUNTS
WELLS IN BEDROCK IS ERRATIC AND

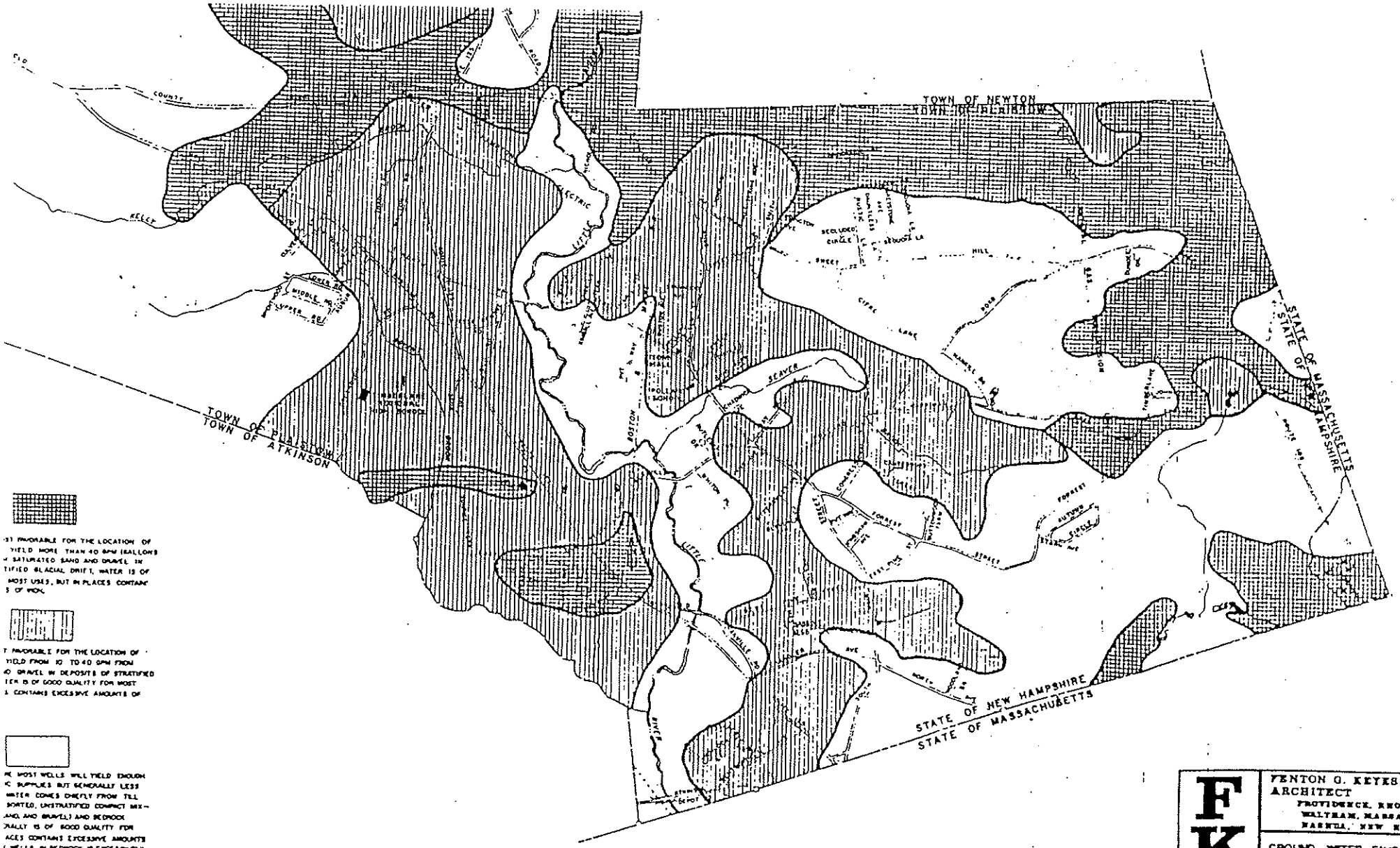
FKA

FENTON G. KEYES ASSO
ARCHITECT ENGI
PROVIDENCE, RHODE ISL
WALTHAM, MASSACHUSE
NASHUA, NEW HAMPSH

GROUND-WATER FAVORABILIT

SURVEY AND REPORT
WATER SUPPLY AND DISTRIBUTION

PLAISTOW, NEW HAMPSHIRE



...33 FAVORABLE FOR THE LOCATION OF ... YIELD MORE THAN 40 GPM (GALLONS ... SATURATED SAND AND GRAVEL IN ... TIFIED GLACIAL DRIFT. WATER IS OF ... MOST USES, BUT IN PLACES CONTAIN ... S OF IRON.

...T FAVORABLE FOR THE LOCATION OF ... YIELD FROM 10 TO 40 GPM FROM ...O GRAVEL IN DEPOSITS OF STRATIFIED ...TER IS OF GOOD QUALITY FOR MOST ... CONTAINS EXCESSIVE AMOUNTS OF

...E MOST WELLS WILL YIELD ENOUGH ...IC SUPPLIES BUT GENERALLY LESS ...WATER COMES CHIEFLY FROM TILL ...SORTED, UNSTRATIFIED COMPACT MIX... ...AND, AND GRAVEL) AND BEDROCK ...ERALLY IS OF GOOD QUALITY FOR ...ACES CONTAINS EXCESSIVE AMOUNTS ...WELLS IN BEDROCK IS EXCESSIVELY

FKA

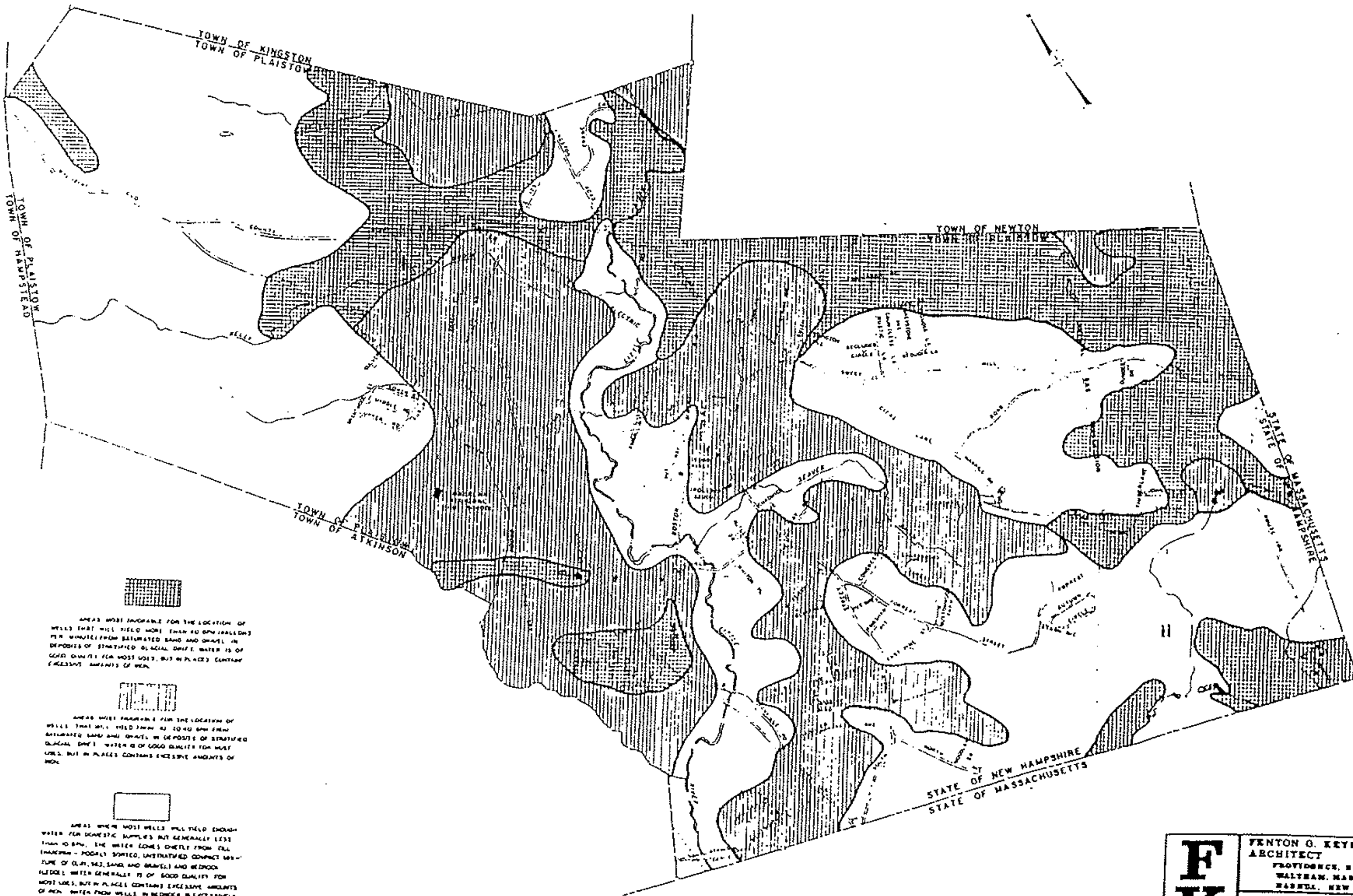
FENTON G. KEYES AS...
ARCHITECT ...
PROVIDENCE, RHODE ...
WALTHAM, MASSACHUS...
MANCHESTER, NEW HAMP...

GROUND-WATER FAVORABIL...

SURVEY AND REPORT
WATER SUPPLY AND DISTRIBUT...

PLAISTOW, NEW HAMPSHIR...

TOWN OF PLAISTOW
TOWN OF HAMPSTEAD
TOWN OF ATKINSON
TOWN OF KINGSTON
STATE OF NEW HAMPSHIRE
STATE OF MASSACHUSETTS
TOWN OF NEWTON
STATE OF MASSACHUSETTS
STATE OF NEW HAMPSHIRE
FENTON O. KEYES ASSOCIATES
ENGINEERS
ARCHITECT
PORTSMOUTH, RYE, DURHAM, EXETER
NASHUA, MANCHESTER
CONCORD, NEW HAMPSHIRE
GROUND-WATER FAVORABILITY
SURVEY AND REPORT
WATER SUPPLY AND DISTRIBUTION
PLAISTOW, NEW HAMPSHIRE



AREAS MOST FAVORABLE FOR THE LOCATION OF WELLS THAT WILL YIELD MORE THAN 40 GPM (GALLONS PER MINUTE) FROM SATURATED SAND AND GRAVEL IN DEPOSITS OF STRATIFIED GLACIAL DRIFT. WATER IS OF GOOD QUALITY FOR MOST USES, BUT IN PLACES CONTAINS EXCESSIVE AMOUNTS OF IRON.

AREAS MOST FAVORABLE FOR THE LOCATION OF WELLS THAT WILL YIELD FROM 10 TO 40 GPM FROM SATURATED SAND AND GRAVEL IN DEPOSITS OF STRATIFIED GLACIAL DRIFT. WATER IS OF GOOD QUALITY FOR MOST USES, BUT IN PLACES CONTAINS EXCESSIVE AMOUNTS OF IRON.

AREAS WHERE MOST WELLS WILL YIELD ENOUGH WATER FOR DOMESTIC SUPPLIES BUT GENERALLY LESS THAN 10 GPM. THE WATER COMES CHIEFLY FROM TILL (HARDPAN - POORLY SORTED, UNSTRATIFIED COMPACT MIXTURE OF CLAY, SILT, SAND, AND GRAVEL) AND BEDROCK (LEDGE). WATER GENERALLY IS OF GOOD QUALITY FOR MOST USES, BUT IN PLACES CONTAINS EXCESSIVE AMOUNTS OF IRON. WATER FROM WELLS IN BEDROCK IS EXCESSIVELY HARD.

FKA

FENTON G. KEYES ASSOCIATES
ARCHITECT ENGINEERS
PROVIDENCE, RHODE ISLAND
WALTHAM, MASSACHUSETTS
NASHUA, NEW HAMPSHIRE

GROUND-WATER FAVORABILITY

SURVEY AND REPORT
WATER SUPPLY AND DISTRIBUTION

PLAISTOW, NEW HAMPSHIRE

PLATE NO. R-3