REPORT ON WATER SYSTEM

SOUTHBOROUGH, MASSACHUSETTS

1972

WHITMAN & HOWARD, INC.
ENGINEERS AND ARCHITECTS
89 Broad Street
Boston, Mass.

J.N. 70-076

NOVEMBER, 1972

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November 13, 1972

Board of Water Commissioners
Southborough, Massachusetts 01772

Gentlemen:

In accordance with the terms of our contract with you dated July 28, 1970, we are pleased to submit the following report on the water system of the Town of Southborough. This report includes recommendations for improvements to the existing system to supply water to all parts of the Town of Southborough.

Respectfully submitted,

WHITMAN & HOWARD, INC.

By _____
George A. Howland III, P.E.
Associate

COMMONWEALTH OF MASSACHUSETTS
GEORGE A. HOWLAND III
REGISTERED PROFESSIONAL ENGINEER

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PURPOSE OF REPORT

The purpose of this report is to present the results of an engineering study of the water system of the Town of Southborough, Massachusetts as regards its capability of meeting the needs of the Town through the year 2000. This report is to be used as a guide for improving existing facilities, adding to pumping and storage capacity and for expanding the distribution system to include all sections of the Town. The population of the Town has risen steadily over the past thirty years and, with the communities closer to the core cities, such as Boston and Worcester, filling in, Southborough will continue to grow, probably more rapidly in the future than in the past. The Town therefore should have a completely planned water system capable of meeting the needs of the Town as this growth occurs.

SCOPE OF REPORT

This report includes the following information:

1. An analysis of past records enabling us to prject the population and probable water needs of the Town through the year 2000.

2. The results of fire flow tests conducted throughout the Town for the purpose of determining the existing water system's capabilities.

3. Preliminary design of additions to the water system to include distribution mains, storage facilities and pumping station. The distribution system has been expanded to cover all parts of the Town.

4. Plans showing the existing water distribution system, storage facilities and pumping station together with proposed improvements and additions.

5. Estimates of construction costs for proposed work together with recommendations for phasing this work.

POPULATION

As previously discussed in our April, 1959 report entitled "Report on Improvements to the Water System of the Town of Southborough, Mass.", the Town can expect a marked increase in population over the next thirty years. Southborough is ideally located with respect to both Boston and Worcester and has easy access to the Massachusetts Turnpike and Route 495, and still has much residential and industrial land yet to be developed.

A population projection curve, Appendix A, has been prepared based on population records from 1940 through 1970, and the April, 1968 report of the Metropolitan Area Planning Council entitled "The Population of Cities and Towns in Metropolitan Boston Projected to 1990". Southborough is considered part of Metropolitan Boston, for planning purposes, by the Massachusetts Department of Commerce and Development. The population of Southborough projected to the year 2000 is 16,000 people.

It should be noted that the above population projection has been based on current trends in zoning, land availability and economic activity. Any changes in these variables could cause the population projections to differ either slightly or substantially from those indicated on the graph. As long as the Town continues to grow, as it has during the past several years, and large industrial developments to help broaden the tax base locate in Southborough, the projected population can be expected to be reached well within the time

indicated or even sooner. The design of a water system to cover the whole Town is based more on what is to be expected rather than the precise year the growth is recorded.

The responsible Town officials have wisely allowed the development of industrial complexes which have and will help to broaden the tax base. For a Town to be able to finance the necessary expansion of its utilities such as water and sewers it is mandatory to provide areas for industrial development and to promote developments that will fit in with existing land use. This is being done along Route 9 which obviously is not conducive to residential development.

REQUIRED QUANTITY OF WATER

The required quantity of water needed by the Town over the next thirty years has been based on the projected population for the year 2000 and the average of the maximum day water demands actually experienced to date. It is necessary to use maximum day water demands because the pumping stations can only furnish water at a certain fixed rate regardless of the demand on the system.

The average of the maximum day water demands is 200 gallons per capita per day and with a projected population of 16,000 people, the quantity of water needed for the maximum day in the year 2000, therefore, is 3,200,000 gallons. This represents the required quantity of water on which the design of water system improvements and additions has been based.

WATER SUPPLY SOURCE

The Town presently obtains its water from the Metropolitan District Commission's grade line pressure aqueduct off Ward Road in the northwesterly section of Town. The pumping station at this site has the maximum capability of supplying water at the rate of 1000 gallons per minute.

The above pumping station is presently the only source of good quality water available to the Town. This pumping station alone would not be capable of furnishing a sufficient quantity of water to meet the needs of the Town over the next thirty years without extensive alterations to pumping equipment and piping. This would not be advisable since it would be analogous to putting all of ones eggs in one basket. Any serious problem with this station because of mechanical failure or natural disaster could mean that the Town would be without a source of water. It is therefore recommended that a new pumping station be constructed with a maximum capacity of 1000 gallons per munite. This new station along with the present one would then be capable of meeting the water supply needs of the Town over the next thirty years.

It is proposed to locate this new pumping station at Shaft No. 3 of the Metropolitan District Commission's Hultman Pressure Aqueduct as shown on the attached plans. When the Metropolitan District Commission originally constructed Shaft No. 3, a 20 inch connection was left for the future use of the Town of Southborough.

Since it was suggested that the new pumping station be located at MDC Shaft No. 4, the MDC was consulted regarding this possibility. It was learned that there are no existing provisions at Shaft No. 4 for a pumping station. It would be necessary to tap the aqueduct in a similar manner to that used at your existing pumping station. It would cost an estimated $20,000 more to construct the new pumping station at Shaft No. 4 than at Shaft No. 3. The MDC indicated that they would definitely consider allowing Southborough to make a connection to Shaft No. 4 if an application was presented. The M.D.C. is aware that their holdings in Southborough are large and that they have an obligation to co-operate with the Town in any way they can.

The prime reason for recommending the use of Shaft No. 3 as the site for the new pumping station is its location relative to the distribution system, expecially the standpipes, as the pumping station will be designed to fill all the standpipes on the system.

WATER DISTRIBUTION SYSTEM

A field investigation as to the present condition of the Town's water distribution system was made during March and April, 1971. Flow tests were conducted throughout the Town as indicated on the attached plans. The results of these tests are included in the Appendix and show that many sections of the Town do not meet the minimum standards set by the New England Fire Rating Association.

Along with the above flow tests, a pipe coefficient test was conducted for the 10 inch pipe in Oak Hill Road. The Hazen-Williams "C" value (constant accounting for the surface roughness of pipe) was computed to be about 52 for the stretch of pipe between the Oak Hill Tank and Route 9. This low "C" value (C=about 130 for new pipe) indicates that there is a large head loss in this pipe for a given flow compared to a new pipe of the same size and given flow. Records indicate that other pipes in this general area (Fayville section of Town) may be in the same condition as the pipe tested. This indicates an inefficient distribution system for this area. It would therefore be advisable to either replace these pipes or have them cleaned and lined. We recommend that replacement with new pipe would be the best move.

The design of improvements to the water system were based on correcting the above mentioned inadequacies as well as extending an adequate distribution system to all sections of Town. A preliminary design and distribution system lay out,

including added storage, was made to accomplish the aforementioned goal. This proposed system was then analyzed by a computer to check the adequacy of design. The design was found to be quite adequate for meeting the Town's needs through the year 2000. A copy of the computer findings is included in the Appendix. The proposed system need not be constructed immediately, but should be accomplished in accordance with our phasing recommendations and the Town's financial capability.

The sizes of pipe shown for the proposed improvements and extensions to the water distribution system are those required to provide a minimum fire flow of 4000 gallons per minute throughout all sections of the Town except the northeast section where the pipe is sized to provide a minimum fire flow of 2000 gallons per minute. These fire flows are quite adequate in meeting the minimum requirements of the New England Fire Rating Association. In all cases, allowances have been made for maintaining the domestic flow with at least 20 pounds per square inch in the mains in the vicinity of the hydrants meeting the required fire flow.

The proposed water mains vary in size as shown on the plans so as to give the above recommended flow and are to be laid in trenches with four and one half feet of cover over the pipe. The design calls for using 150 pound class water pipe together with all necessary fittings. The work proposed herein provides for installing about 35 miles of water mains.

In order to secure the maximum benefit for individual insurance rates, it is necessary that the insured building be within 500 feet of a hydrant. We therefore recommend that fire hydrants be installed on all water main extensions in such a manner as to give as many property owners as possible the full advantage of this reduction. We therefore have based our cost estimates on providing the proper number of hydrants. We have also provided for the installation of a sufficient number of gate valves in order that various sections of the water system, including all hydrant branches, may be shut off without interferring with the remainder of the system. It is also proposed, on all water main extensions and improvements, to install the usual house services of copper pipe together with a corporation cock where the service enters the water main, a curb cock at the back of the sidewalk or close to the property line, and a shut off valve and meter in the basement or other appropriate location of the water taker's building. The cost estimates do not include the cost of the service pipe in private property or the cost of the shut-off valve in the basement of the buildings as it is usual for the owner to pay for these. Where existing house services are found during system improvement or replacement work, a new copper house service from the main in the street to the curb cock will be installed.

WATER STORAGE

Water storage for the Town is now provided by two standpipes, one reservoir, and one elevated tank. The standpipes are on Oak Hill, with a capacity of 275,000 gallons, and on Clear Hill, with a capacity of 460,000 gallons; the reservoir is on Tara Road and has a capacity of 1,300,000 gallons. The elevated tank, with a capacity of 150,000 gallons, is located on Atwood Street. The design for the proposed expansion of the water system for the Town was based on the elevated tank on Atwood Street being abandoned when the proposed reservoir on Fairview Hill is constructed and the reinforcement of the distribution system to the portion of the Town that lies south of the Massachusetts Turnpike has been completed. The capacity of the Atwood Street elevated tank is not sufficient enough to warrant keeping it in the system. The available fire flows in this area with this elevated tank on line are very misleading as there is not enough water in the tank to fight a fire of several hours duration.

The total capacity of existing storage facilities is 2,185,000 gallons of which about 54 per cent is considered to be available for fire protection. Fifty-four percent of 2,185,000 gallons is 1,180,000. The maximum fire demand today is 3000 gallons per minute. To determine storage requirements it is necessary to supply the above fire demand of 3000 gallons per minute for a period of ten hours plus the domestic demand during the same period. The fire demand for 10 hours would be 1,800,000 gallons and the domestic demand for the same period would be 500,000 gallons for a total demand of 2,300,000 gallons. It has already been determined that 1,180,000 gallons are available

in storage and the pumping station during the same period can deliver 600,000 gallons for a total of 1,780,000 gallons. This total is 520,000 gallons less than the required amount, therefore it is not enough to meet present day needs. For the period covered by this study, that is to the year 2000, additional storage will be required to meet the needs of the Town as it grows. We have used a fire demand of 4000 gallons per minute to determine future storage requirements. A fire demand of 4000 gallons per minute for 10 hours is equal to 2,400,000 gallons and the projected population during the same 10 hours will consume 1,333,000 gallons of water for a total requirement of 3,733,000 gallons in the year 2000. Discounting the elevated tank on Atwood Street, the existing storage facilities plus the proposed 2,000,000 million gallon reservoir on Fairview Hill and the proposed 1,000,000 gallon standpipe on Pine Hill, will have a combined capacity of 5,035,000 gallons. Of this, 54 percent (2,700,000 gallons) will be assumed to be available. With the construction of the second pumping station proposed herein there will be available for a 10 hour period 1,200,000 gallons, thus storage and pumping will be able to provide 3,900,000 gallons against a design requirement of 3,733,000 gallons.

It is recommended that the Town construct, in the near future, a 2,000,000 gallon reservoir on Fairview Hill south

of Route 9 and west of Parkerville Road. It is further recommended to construct a 1,000,000 gallon standpipe on Pine Hill, west of Pine Hill Road, as this area develops.

The construction of these storage facilities will not only take care of the fire demand but will also provide storage for peak periods of demand when the consumption is greater than the capacity of the pumping stations.

HYDRAULIC GRADIENT

The overflow elevations of the water storage tanks, except for the reservoir on Tara Road, are about 493 feet above mean sea level. The Tara Road tank overflow is at an elevation of 515 feet above mean sea level.

In our report dated April 1959 it was proposed to build the Tara Road tank with a higher overflow elevation than the other tanks so that the higher ground around Tara Road could be adequately served as that area developed. Water would be boosted into the tank thus forming a high service area.

We have recommended this plan in the course of this current study with an eye to possibly raising the hydraulic gradient throughout the Town. The static pressures at the various test points for flow tests, as tabulated in column one on the fire flow tests in the appendix, indicate satisfactory static pressures throughout most of the Town. There are some high points that could benefit by putting the whole town on a higher hydraulic gradient but in our opinion there is not enough of a problem to warrant a change.

We realize it is difficult to discourage development on these high elevations but an attempt should be made to limit such development.

It is our opinion, that except for the area to be covered by the Tara Road tank, the present hydraulic gradient should be maintained.

RECOMMENDATIONS AND CONSTRUCTION COST ESTIMATES

The following construction cost estimates are based on constructing water supply, storage and distribution facilities within the designated study area for this report. These estimates are further based on doing the work by usual contract methods after receiving competitive bids. Costs for land, rights-of-way and possible legal fees are not included.

The cost estimates included herein reflect current prices and should be reviewed and brought up-to-date, if necessary, prior to starting any phase of construction. This price adjustment may be readily made by use of the "Engineering News Record Construction Cost Index Curve" which provides a factor by which construction cost estimates may be updated.

A. Water Supply Facility

It is proposed to construct a pumping station with a capacity of 1000 gallons per minute at Shaft No. 3 along the M.D.C. Hultman Pressure Adequate. The cost estimate for this pumping station is.....$125,000.

B. Water Storage Facilities

Two water storage facilities are proposed one with a capacity of 1,000,000 gallons to be located on Pine Hill in the northeast section of Town, the other, with a capacity of 2,000,000 gallons to be located on Fairview Hill which is south of Route 9 and west of Parkerville Road.

The cost estimate for the Pine Hill tank is $ 185,000

The cost estimate for the Fairview Hill tank is $ 275,000

These construction cost estimates include the painting of the tanks.

C. Water Distribution Facilities

The following improvements to the water distribution system are recommended. All of the water main locations are designated either by street names or point numbers and are shown on the plans accompanying this report.

1. Chestnut Hill Road -

560' of 12" pipe from the pumping station to Fisher Road $ 10,200
4400' of 8" pipe from Fisher Road to Main Street $ 65,200

2. Northboro Road -

3120' of 8" pipe from Chestnut Hill Road to Main Street $ 46,200

3. Fisher Road -

9920' of 12" pipe from Chestnut Hill Road to the Southborough-Marlborough line, then parallel with the Town Line to Sears Road $173,500

4. Sears Road -

6560' of 12" pipe from Main Street to Pt.23 $113,800
1360' of 8" pipe from Pt.23 to Marlboro Road $ 20,600

5. Marlboro Road -

6000' of 12" pipe from Main Street to Framingham Road $104,400
1760' of 8" pipe from Acre Bridge Road north $ 26,300

6. Cross Street -

480' of 8" pipe from Marlboro Road to Newton Street — $ 7,800

7. School Street -

1840' of 8" pipe south from Marlboro Road — $ 28,600

8. Bagley Road -

3600' of 8" pipe between Route 9 and Boston Road — $ 54,700

9. Cordaville Road -

6320' of 8" pipe between Mt. Vickery Road and Main Street — $ 93,900

10. Route 9 -

2960' of 8" pipe between Middle Road and Bagley Road — $ 44,000

13,520' of 12" pipe between the Westborough and Framingham lines — $235,500

11. Middle Road -

8560' of 8" pipe between Mt. Vickery Road and Main Street — $127,800

12. Parkerville Road -

4640' of 8" pipe from Knox Street to Main Street — $ 69,700

3840' of 12" pipe from Southville Road to Gilmore Road — $ 67,000

13. Clifford Street -

2720' of 8" pipe from Deerfoot Road to Parkerville Road — $ 40,500

14. Deerfoot Road -

2160' of 8" pipe from Route 9 to Clifford Street — $ 32,300

15. Woodland Road -

4000' of 8" pipe between Richards Road and Cordaville Road and between Pt.61 and Route 9 — $ 89,200

16. Breakneck Road -

4000' of 8" pipe from Woodland Road to Mt. Vickery Road — $ 59,200

17. Mt. Vickery Road -

2560' of 8" pipe from Middle Road to Cordaville Road — $ 39,200

18. East Main Street -

2240' of 12" pipe from Newton Street to Framingham Road — $ 39,300

19. Framingham Road -

1760' of 12" pipe north from Boston Road — $ 30,900

20. Boston Road -

11,120' of 12" pipe from Bagley Road to Pt. 97 — $194,900

21. Southville Road -

8400' of 12" pipe from Parkerville Road to the Ashland line — $145,500

22. Edgewood Road -

5200' of 12" pipe from Oregon Road to Southville Road — $ 90,500

23. Walnut Drive and Oregon Road -

6100' of 12" pipe from Oak Hill Drive to Woodland Road — $105,800

24. Old Mill Road, Route 9 and Willow Street -

4200' of 12" pipe from the Oak Hill tank to Boston Road — $ 75,000

25. Gilmore Road -

4960' of 12" pipe from Parkerville Road to Pt. 5	$ 86,300

26. Fairview Drive -

2320' of 12" pipe between Pt.4 and Pt. 5	$ 40,700

27. Pt. 5 to Pt. 6 -

3520' of 12" pipe	$ 61,300

28. Pt. 78 to Pt. 79 -

2480' of 12" pipe from Boston Road to new pumping station at MDC Shaft #3	$ 43,300

29. Old Mill Road Extension -

3040' of 8" pipe from Pt. 6 to Pt. 61	$ 45,200
560' of 12" pipe from Walnut Drive to Oak Hill Drive	$ 10,200

30. Pt. 97 to Pt. 98 -

1440' of 8" pipe	$ 21,700

31. Pt. 97 to Pt. 104 -

4800' of 12" pipe	$ 84,500

32. Pt. 98 to Pt. 99 -

1760' of 8" pipe	$ 26,400

33. Pt. 98 to Pt. 100 -

2880' of 8" pipe	$ 42,900

34. Pt. 100 to Pt. 102 -

2960' of 12" pipe	$ 52,200

35. Pt. 100 to Pt. 106 -

8080' of 8" pipe	$119,200

36. Pt. 104 to Pt. 105 -

2800' of 8" pipe	$ 42,700

37. Pt. 104 to Pt. 106 -

3760' of 8" pipe	$ 55,800

38. Pt. 105 to Pt. 106 -

2880' of 8" pipe	$ 42,700

39. Pipe for Proposed Tank on Pine Hill -

1360' of 12" pipe from Pt. 101 to Pt. 103	$ 24,000

40. Pipe for Proposed Tank on Fairview Hill -

1200' of 12" pipe from Pt. 1 to Pt. 2	$ 21,200
1200' of 12" pipe from Pt. 1 to Pt. 7	$ 21,200

If all of the above cited work were to be undertaken at one time, the total construction cost estimate would amount to about $ 3,658,000. It is recommended, however, that this work be performed in phases, starting with that portion of the work most beneficial to the Town as a whole. Recommended phasing of the work to be done is the subject of the next section of this report.

RECOMMENDED CONSTRUCTION PHASING

The work outlined in the previous section of this report is required to adequately supply and convey water throughout the Town. This work should be accomplished in phases beginning with that work providing immediate and noticeable benefits to the water system and the Town as a whole. Two construction phases accomplishing this purpose are outlined below and it is recommended that the Town proceed immediately to accomplish the work outlined.

PHASE I WORK

1. Acquire the land and rights-of-way necessary for the construction of the two water storage facilities proposed in this report. We recommend that a sum of $ 25,000 be appropriated for real estate plan preparation and land acquisition.

2. Install the sleeves across Route 9 necessary for future water main crossings. This should be done prior to the re-surfacing of Route 9 by the Commonwealth of Massachusetts. A sum of $40,000 is recommended to be appropriated for this work.

3. Certain water mains, as listed below, should be installed for the purpose of eliminating some of the dead-ends, which will eliminate some bad water problems and substantially increase the volume of water available, especially with relation to fire protection, with a minimum of cost. A budget amount should be used for appropriation purposes and should include at least the following:

a. A 12-inch water main in Marlboro Road from the end of the existing 6-inch to the existing 12-inch at Cross Street.

b. An 8-inch water main to connect the existing 8-inch water main in Overlook Road to the Clear Hill tank.

c. A 12-inch water main in Framingham Road from Boston Road to the existing 10-inch in Framingham Road. Also a 12-inch water main in East Main Street from Framingham Road to the existing 8-inch.

d. An 8-inch water main in Bagley Road from Route 9 to Partridge Hill and also an 8-inch water main from Latisquama Road to the existing 6-inch on Bagley Road.

e. A 12-inch water main on Woodland Road from Cordaville Road to Richards Road.

f. A 12-inch water main from the Oak Hill tank to the intersection of Valley Road and Boston Road to be located in Old Mill Road, Route 9 and Willow Street.

g. A 12-inch water main from the new pumping station site to Boston Road and then a 12-inch water main in Boston Road from Central Street to Framingham Road.

The construction cost of this work is estimated to be about $ 265,000.

4. Construct the new pumping station along with pumping equipment, at MDC Shaft No. 3. We estimate the construction cost of this new pumping station to be about $ 125,000.

PHASE II WORK

Water mains should be installed at the following locations:

1. A 12-inch water main in Boston Road from "A" St. to Willow Street.

2. An 8-inch water main in Parkerville Road from Main Street to Knox Street.

3. A 12-inch water main to be installed along the north side of Route 9 from Parkerville Road to connect to the existing 12-inch main.

4. Replace the existing 6-inch water main on Bagley Road from Boston Road to the railroad tracks with an 8-inch water main.

5. A 12-inch water main on Old Mill Road Extension, Walnut Drive and Oregon Road to be installed from Pt. 70 at Oak Hill Drive to Pt. 59 at Edgewood Road.

6. An 8-inch water main on Middle Road from Route 9 south to the existing 8-inch main on Middle Road.

7. A 12-inch water main on Marlboro Road from Main Street to the existing 6-inch main at School Street. Also an 8-inch main on School Street from Marlboro Road to the existing 8-inch main on School Street.

8. An 8-inch water main on Woodland Road from Route 9 south to the existing 8-inch water main near Old Mill Road Extension.

9. An 8-inch water main on Deerfoot Road from Route 9 north to Clifford Street.

The construction cost of this Phase II Work is estimated to be about $ 512,000.

The total construction cost for Phase I Work is about $ 455,000. This amount, borrowed for a period of ten years at 6 percent interest, would result in equal yearly payments for principal and interest of about $ 62,000 which would amount to about a $1.50 increase in the tax rate.

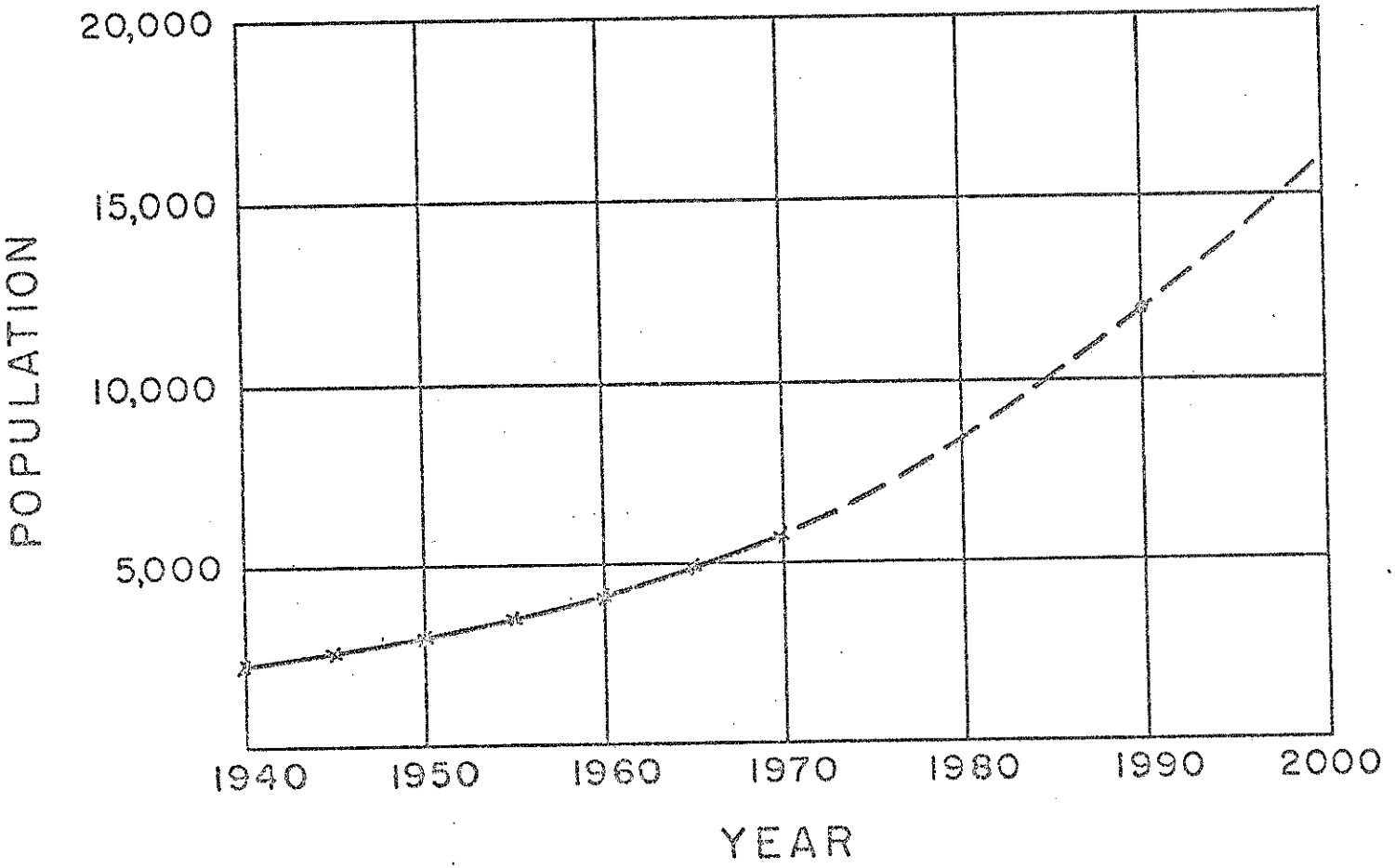
The total construction cost for both Phase I Work and Phase II Work is about $ 967,000. If this amount were borrowed for ten years at 6 percent interest, equal yearly payments of principal and interest would amount to about $ 131,500 which would increase the tax rate by about $ 3.25.

An outline of the construction phasing for the remaining work to be done should be established after Phase II Work has begun. This to enable us to better assess which of the remaining work to carry out first. When and if water mains are required to be installed prior to normal construction scheduling due to housing developments, new industry, etc., water mains of the sizes shown on the attached plans and indicated within this report should be installed.

In conclusion, it is suggested that this report be used as a master plan for the future development of the water system in the interest of maintaining an efficient and reliable water system for the Town of Southborough.

APPENDIX A

POPULATION PROJECTION CURVE



POPULATION PROJECTION

SOUTHBOROUGH MASS.

MARCH 1971

APPENDIX A

APPENDIX B

HYDRAULIC SURVEY

HYDRAULIC SURVEY

An extensive hydraulic survey was conducted as a part of the study being reported herein.

Flow tests were made in twenty-two locations. The results of these tests are contained herein and shown on the accompanying map of the existing water system. Under that portion of this report entitled "Water Storage" the future abandoning of the Atwood Street elevated tank was discussed. A review of tests 6 and 6-A; 20 and 20-A; 21 and 21-A and 22 and 22-A indicate the wide difference in available water with the Atwood Street tank on or off. With the tank on line the results were very high, but with only 150,000 gallons available, the tank would quickly empty in the event of a prolonged fire.

In addition to the flow test results the following is also included in conjunction with this hydraulic survey:

1. System operation data during tests and reproductions of recording charts during the period of the tests.
2. Water levels at each storage facility and estimated hydraulic grade lines established for each flow test location.
3. Fire flow computations and analysis of 1971 test results and Whitman & Howard 1969 test results.
4. Coefficient test results for Oak Hill Road.
5. Statistical data for distribution storage facilities.

The overall results of the tests confirm the necessity of reinforcing the Southborough water system not only for future growth but to meet current needs.

Fire Flow Tests
Southboro, Massachusetts
Hydrant Flow Tests

District	No.	Location	Hydrant Pressures 1	2	Discharge Gallons per Minute (see footnotes) 3	4	5
Ind.	1	Refrigerator Plant off of Willow Street	101	42	1560	1850	3000
"	1A	" " " " " "	101	68	1140	1850	3000
"	1B	" " " " " "	101	43	1580	1890	3000
Comm.	2	Oak Hill and Worcester Road (Rt. #9)	78	50	1480	2190	3000
Warehouse	3	R. E. Jarvis Co. @ Worcester Road	78	25	780	820	3000
Res.	4	Oak Hill Road and Mitchell Street	97	69	990	1710	1000
Res.	5	Woodland Road near Oregon Road	71	21	760	770	1000
Res. & Ind.	6	Woodland Road and Southville Road	102	92	1040	3250	3000
" " "	6A	" " " " "	102	32	1160	1260	3000
Res.	7	Marlboro Road near School Street	73	21	630	635	1000
Res.	8	Marlboro Road at dead end near Sears Road	95	45	810	1010	1000
Res.	9	Flagg Road near Love Lane	68	57	3210	7100	1000
Res.	10	Ward Street and Bigelow Road	85	74	1680	4390	1000
Res.	11	Main Street and Deerfoot Road	97	56	3460	4870	1000
Res.	11A	" " " " "	96	67	1520	2560	1000
Comm. & School	12	Main St. between Marlboro Rd. & School St.	70	28	2780	3050	4000
Res. & Comm.	13	Parkerville Road and Knox Street	89	38	1300	1530	1500
Res.	14	Parkerville and Middle Roads	72	48	1400	2120	1000
M.M. &							

Church	15	Parkerville and Southville Roads	96	80	1260	2920	1500
Ind.	16	Worcester Road @ Crandall Hicks Co.	70	38	740	940	3500
School	17	School Street @ St. Mark's School	77	26	1220	1300	4500
Res.	18	Newton and Cross Sts.	88	50	1480	2020	1000
Res.	19	White Bagley & Crestview Roads	98	29	1340	1440	1000
Res. & Truck Ter,	20	Breakneck Hill & Mt. Vickery Roads	93	37	1370	1580	3000
" " "	20A	" " " " "	93	23	1120	1150	3000
Res. & School	21	Richards and Parkerville Roads	83	70	1340	3150	1000
" "	21A	" " " "	83	18	1030	1010	1000
Res.	22	Richards and Cordaville Roads	93	76	1600	3520	1000
Res.	22A	" " " "	93	29	1170	1260	1000

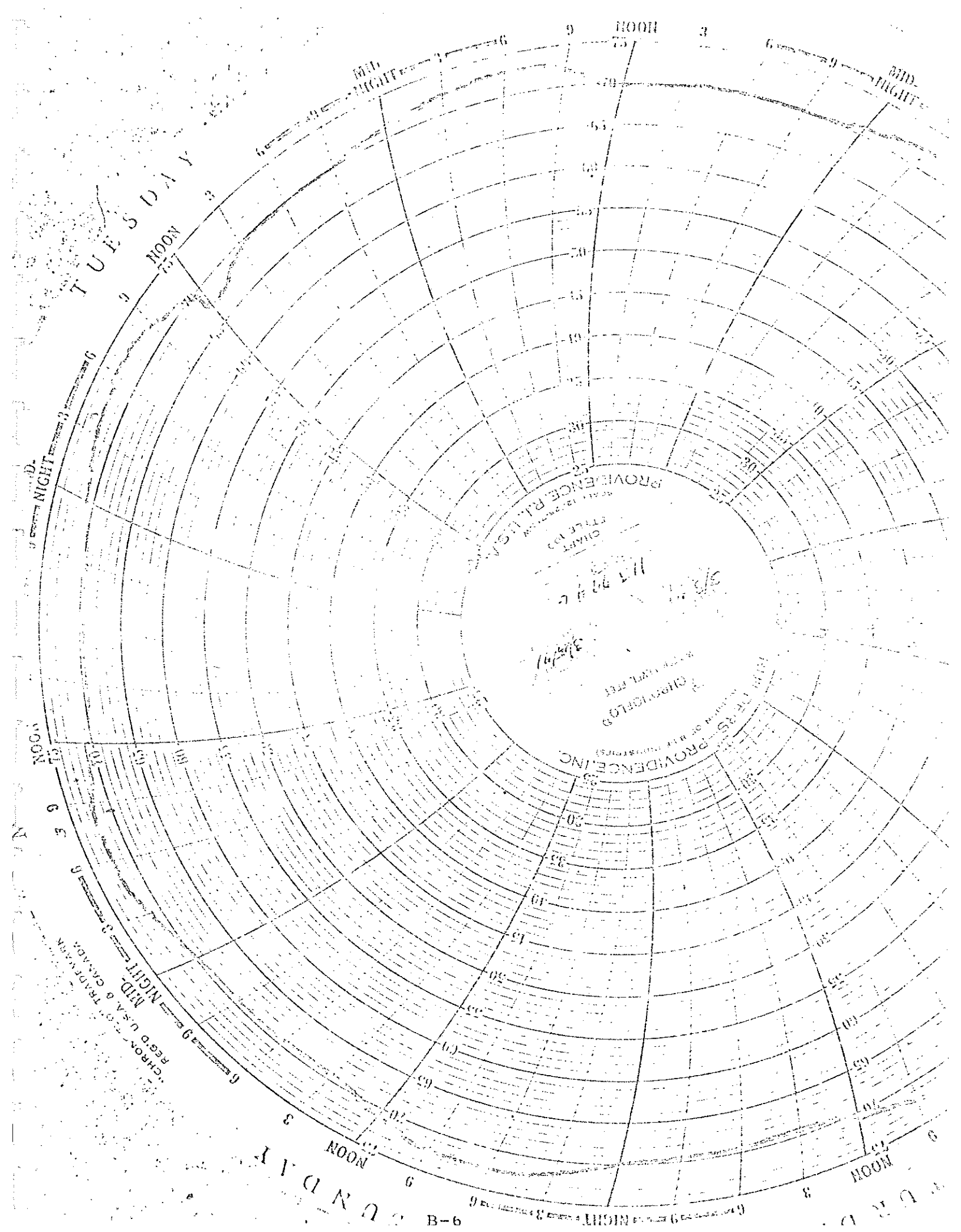
Note: Column 1. Static pressure, hydrants closed.
" 2. Residual pressure, hydrants flowing.
" 3. Discharge obtained with residual pressure shown in Column 2.
" 4. Discharge estimated for engine supply at residual pressure of 20 psi.
" 5. Required fire flow at residual pressure of 20 psi.

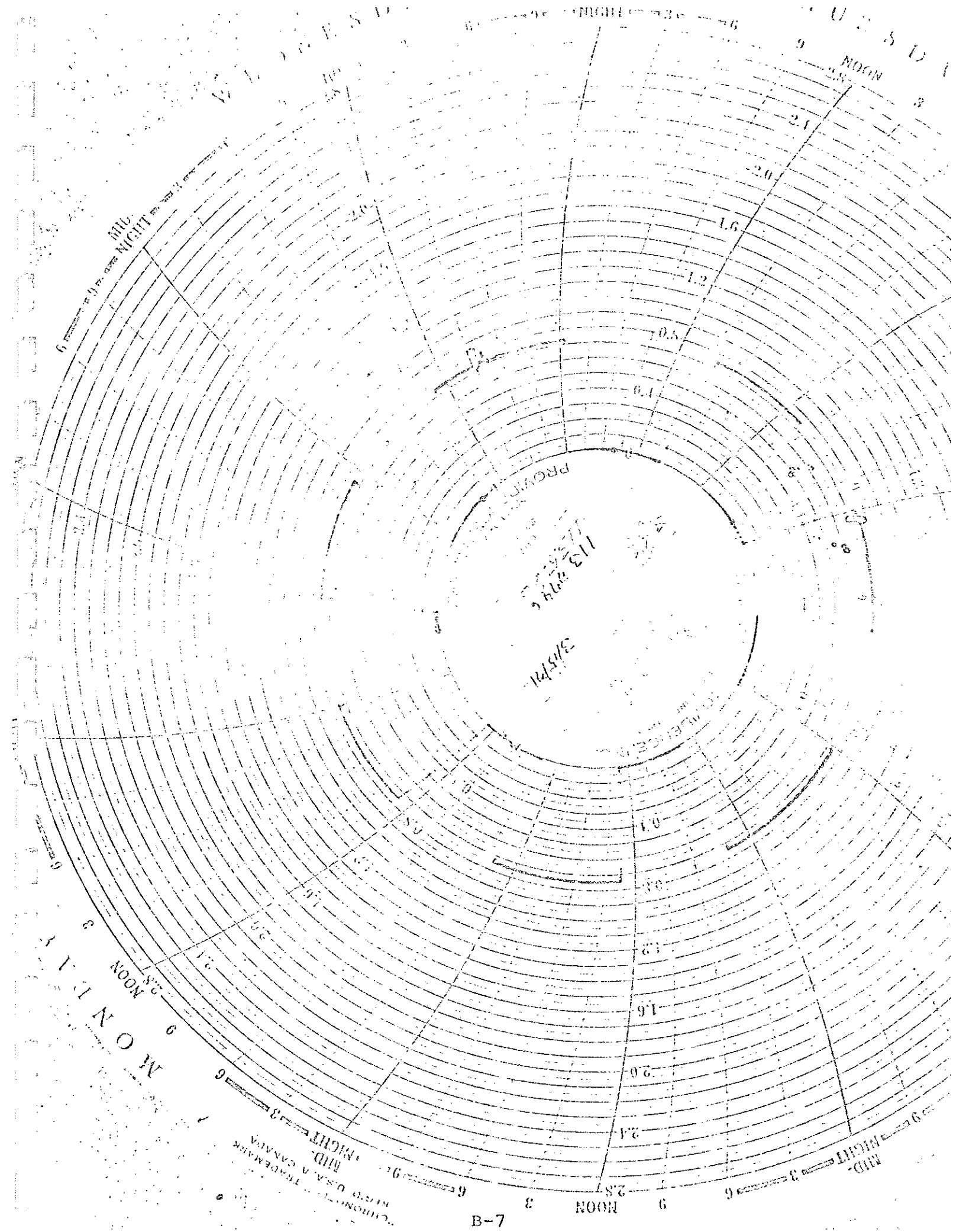
Test #1A conducted with one (1) outlet discharging.
Test #11A conducted with gate valve on Main Street near Wyndemere Drive closed.
Tests #6A, 20A, 21A and 22A conducted with the Atwood St. elevated tank shut off from system.

Res. denotes Residential Area
Ind. denotes Industrial Area
Comm. denotes Commercial Area
M.M. denotes Minor Mercantile Area

SUBJECT: System Operations During Flow Tests

Test No.	Date	Time	Pump Capacity	Storage Water Level 71' Telemeter
1	3/9/71	10:30 A.		
1A	4/22/71	4:15 P.	0.75 mgd	69' "
1B	4/22/71	4:30 P.	0.75 mgd	69' "
2	4/23/71	10:20 A.		
3	3/9/71	11:10 A.	0.75 mgd	69' "
4	3/9/71	11:35 A.	0.75 mgd	67½' "
5	3/9/71	11:55 A.	0.75 mgd	67½ "
6	3/9/71	2:45 P.	0.75 mgd	69' "
6A	3/9/71	3:40 P.	0.75 mgd	70' "
7	3/10/71	11:35 A.	0.75 mgd	70' "
8	3/10/71	11:55 A.	0.75 mgd	70' "
9	4/22/71	10:50 A.		71' "
10	3/10/71	2:40 P.	0.75 mgd	70' "
11	4/22/71	10:20 A.		71' "
11A	4/22/71	10:10 A.		71' "
12	3/10/71	3:30 P.	0.85 mgd	70' "
13	3/10/71	3:55 P.	0.85 mgd	70' "
14	3/10/71	4:15 P.	0.85 mgd	70' "
15	3/10/71	4:30 P.	0.80 mgd	70' "
16	4/22/71	11:10 A.		70' "
17	4/22/71	11:35 A.	0.75 mgd	70' "
18	4/22/71	2:25 P.	0.75 mgd	69½' "
19	4/22/71	2:45 P.	0.75 mgd	69½ "
20	4/22/71	3:00 P.	0.75 mgd	69' "
20A	4/22/71	3:45 P.	0.75 mgd	69' "
21	4/22/71	3:15 P.	0.75 mgd	69' "
21A	4/22/71	3:30 P.	0.75 mgd	69' "
22	4/23/71	12:50 P.		
22A	4/23/71	3:15 P.		


MID-NIGHT
NOON
TUESDAY
PROVIDENCE R.I.
PROVIDENCE, INC.
MID-NIGHT
NOON
MONDAY


NOON
MID-NIGHT
NOON
MID-NIGHT
NOON
MID-NIGHT
NOON
MID-NIGHT
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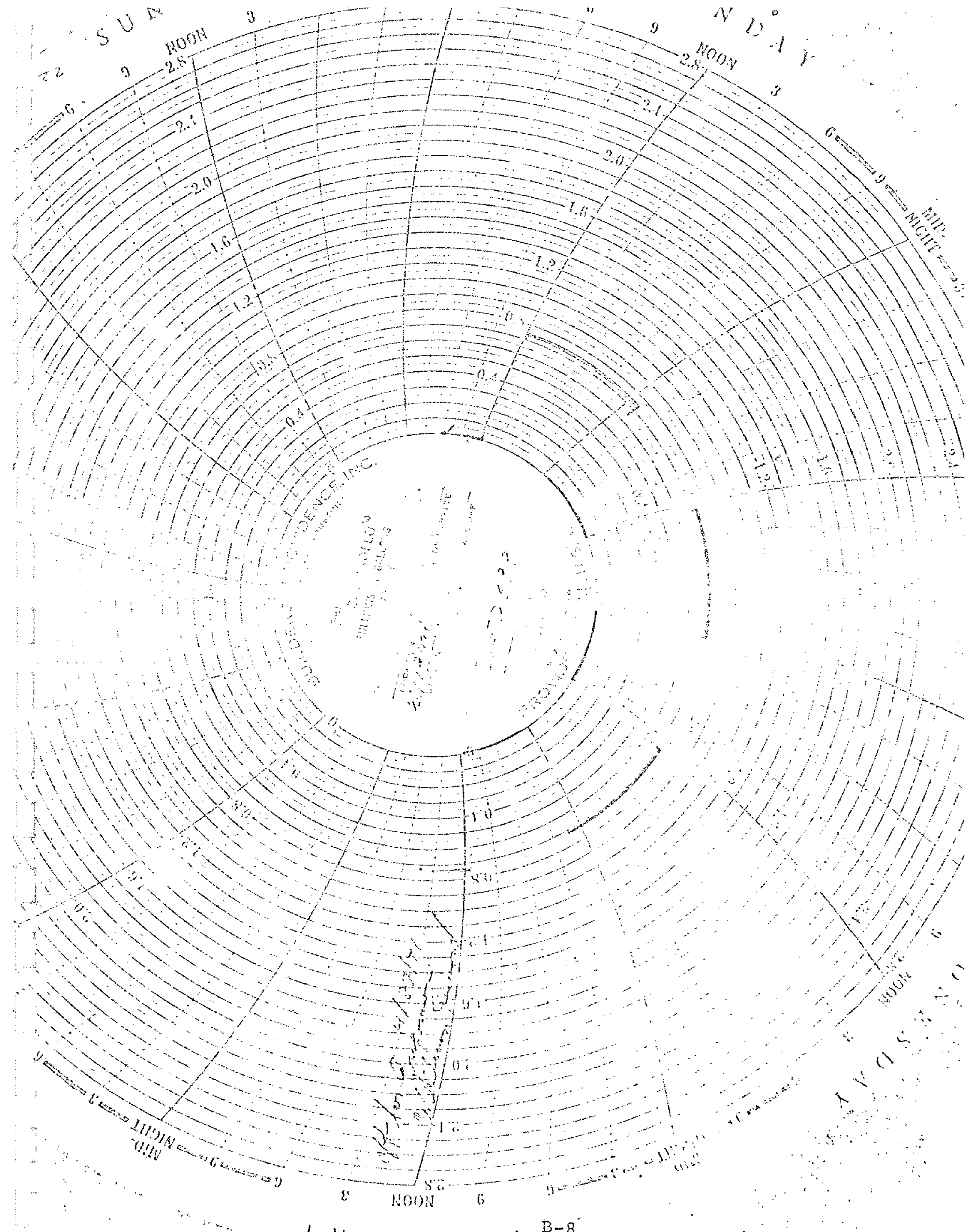
2.4
2.0
1.6
1.2
0.8
0.4
0.1
0.4
0.8
1.2
1.6
2.0
2.4
2.8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MID-NIGHT
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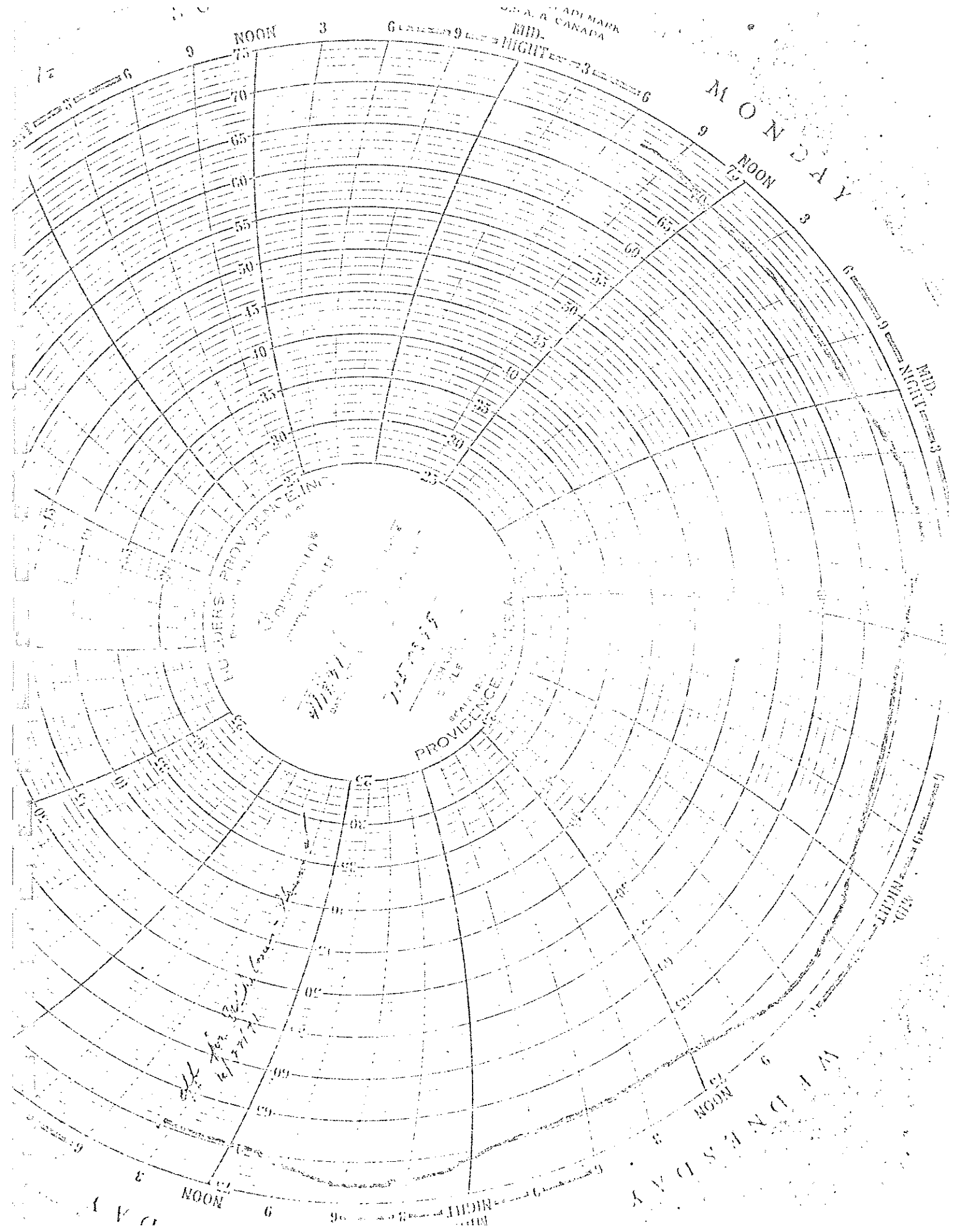
2.4
2.0
1.6
1.2
0.8
0.4


MONDAY
NOON
MID-NIGHT
PROVIDENCE

SUBJECT: Gradients Observed During Flow Tests

NOTE: Elevations Obtained from U.S. Geological Topographic Maps - Datum USGS

Test No.	Elevation	Static - ft. ±	Gradient - USGS
1	260	233	493
1A	260	233	493
1B	260	233	493
2	310	180	490
3	305	180	485
4	265	224	489
5	320	164	484
6	250	235	485
6A	250	235	485
7	315	169	484
8	265	220	485
9	335	157	492
10	290	197	487
11	270	224	494
11A	270	222	494
12	325	164	489
13	290	206	496
14	325	166	491
15	265	222	487
16	320	162	482
17	310	179	489
18	290	204	494
19	260	226	486
20	276	215	491
20A	276	215	491
21	301	192	492
21A	301	192	492
22	271	215	486
22A	271	215	486

COEFFICIENT TEST SHEETS

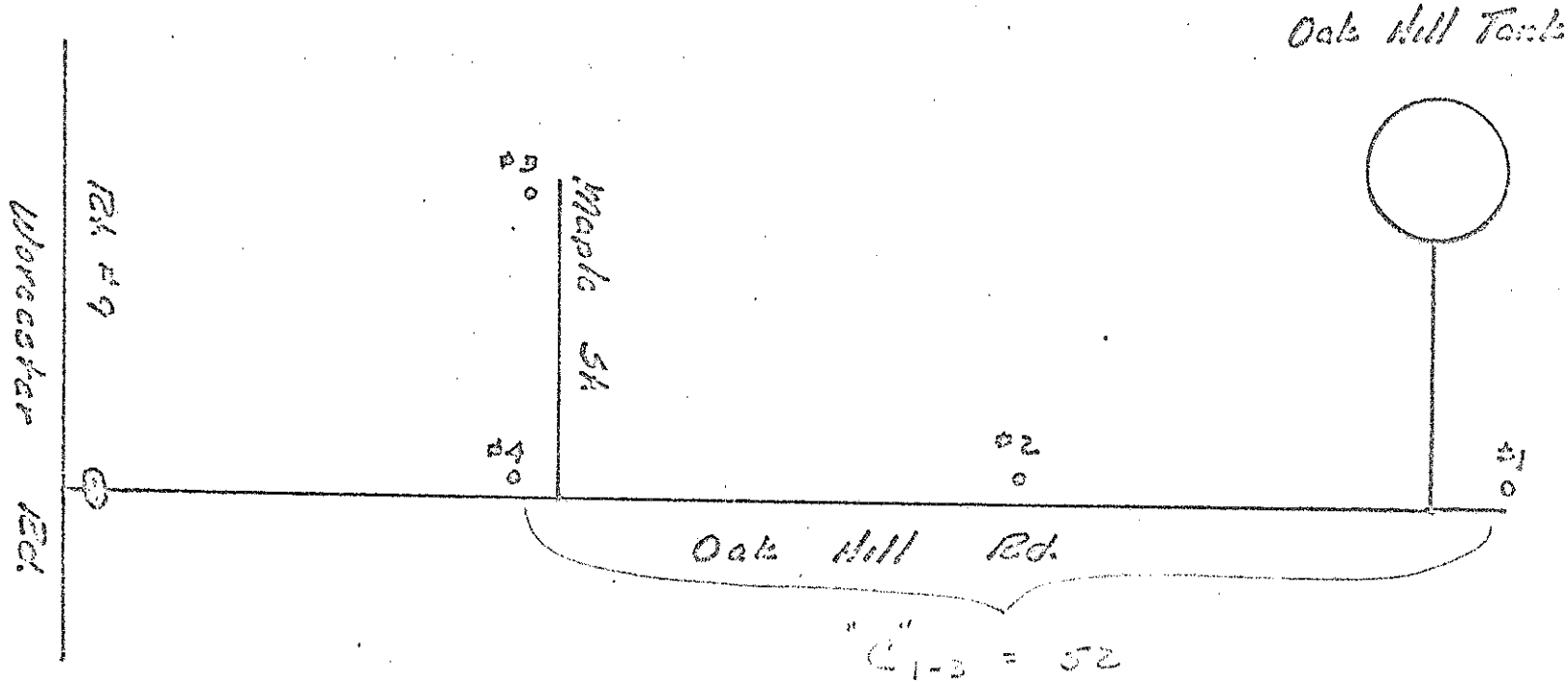
City/Town Of: Southboro State: Mass. Date: 9/29/71 Time: 11:15 AM By:

Const. of Main: CI Size: 10" Date Installed: Location: Oak Hill Rd.

Hydrant No.	Elevation	Pressures		Distances		Flows				
		Static	Residual	Hydrants No.	Length	Hydrant No.	No. Outlets	Size	Pitot	GPM
1	143.89	26	19½	1-2	521'	1	2	2½	11	530
2	119.63	36½	19	2-3	427'			2½	11	530
3	100.00	45	22	Total	948'			Total		1060

* Static press. used as relative elev.

Sketch



R-11

FIRE FLOW COMPUTATION AND ANALYSIS

City _____ State _____ Date _____

Test No. 1959	Test No. 1971	Location	Statics 1959	Statics 1971	Diff.	Q @ 20# 1959	Q @ 20# 1971	Reqd @ 20# 1959	Reqd @ 20# 1971	% Deficient 1959	% Deficient 1971
1	12	Main near Newton	77	70	-7	2930	3050	1500	4000	-	24
2	6	Woodland and Southville Roads	92	102	+10	3080	3250	1500	3000	-	-
3	15	Parkerville and Southville Roads	93	96	+6	2890	2920	1500	1500	-	-
4	21	Parkerville and Richards Roads	80	83	+3	1720	3150	1000	1000	-	-
5	8	Marlboro near Sears Road at end	91	95	+4	1830	1010	1000	500	-	-
7	2	Oak Hill Road and Worcester Road	74	78	+4	3480	2190	1500	3000	-	27
11	5	Woodland Road near Oregon Road	74	71	-3	930	770	1000	1000	7	23
12	7	Marlboro Road near School Street	72	73	+1	1650	635	1500	500	-	-
13	13	Parkerville Road and Knox Street	82	89	+7	1540	1530	1000	1500	-	-
14	11	Main Street and Deerfoot Road	88	97	+9	2080	4870	1000	1000	-	-

Storage Facilities:

4 in No. - 2 S.P., 1 Res., 1 elev. tank (to be abandoned).

Oak Hill Standpipe:

25' dia. x 75' ht. cap. = .275 mg @ elev. 492.73' ± USGS

Clear Hill Standpipe:

40' dia. x 42.5' ht. cap. = .460 mg @ elev. 493.32 USGS

Tara Road Reservoir:

67' dia. x 48' ht. cap. = 1.3 mg @ elev. 515' ± USGS

Oak Hill S.P. is lead tank equipped with telemeter to pump station. Other storage facilities are not equipped with water level control devices.

Telemeter controls auto. pump operations:

Pump #1 starts @ 69' stops @ 71' - 72')
Pump #2 starts @ 65' stops @ 71' - 72') high water level

Determining Water Levels in Storage:

On 3/10/71 telemeter recorder indicated Oak Hill S.P. water level was 69'.

Oak Hill S.P.
Gauge @ S.P. base read 29.75# = 69'. Telemeter checked. 11:15 A.M. 3/10/71.

Clear Hill S.P.
Gauge 6' below base read 18# = 41.5' - 6' = 35.5' of water 11:05 A.M. 3/10/71.

Tara Road Res.
Gauge 15' ± below base read 14.75# = 34' - 15' = 19' of water 10:20 A.M. 3/10/71.

Name	Oak Hill S.P.	Clear Hill S.P.	Tara Road Res.	Totals
Dia. - ft.	25	40	67	
Ht. - ft.	75	42.5	48	
Cap. - mg	.275	.46	1.30	1.975 mg
Overflow Elev. - USGS	493±	493±	515±	
Base Elev.	418'	451'	467'	
High Water	72	est. 38.5	est. 22	
H.W.L. Cap. - mg	.264	.362	.595	1.221 mg 62%
Water level - ft. @ 69' - telemeter	69	35.5	19	
Gradient Maintained	487' ±	486.6' ±	486.7' ±	
Available Cap. - mg	.253	.334	.515	1.102 mg 56%
Normal daily min. in stg. - ft. (est.)	est. 62 ±	28.5	12	
N.D.M. Cap. - mg	.227	.268	.325	.820 mg 41.5%
Cap./ft. of stg. mg	.0036 +		.027 +	

APPENDIX C

WATER SYSTEM ANALYSIS USING COMPUTER TECHNIQUES

WATER SYSTEM ANALYSIS USING COMPUTER TECHNIQUES

General

In order to fully evaluate the proposed water system improvements, a digital computer was used to simulate flow in the pipes and from the pumps. The computer uses the Hardy-Cross method for flow analysis in a pipe network. This method has been in use for many years, and although accurate, the technique consists of a trial and error procedure which is lengthy and time consuming. The digital computer provides an excellent tool in evaluating a network using this procedure.

Before the computer could be used on the network, a number of factors had to be defined; among these being the pipe locations and diameters, the coefficient of roughness of the pipe, i.e., how well the pipe transmits water, the demands at different points in the system, and the sources of supply along with the characteristics of the pumps.

First the proposed distribution system was skeletionized to include only those pipes that transmitted significant quantities of water to the consumers. Once the system had been skeletionized, the next step was to determine the coefficient of friction of the pipes in the system. This was done by assigning a coefficient to each pipe by noting the type of pipe and its age. This was based on our experience resulting from actual coefficient tests on similar pipes of equal age and transporting water having the same or nearly the same quality as that used in Southborough. The next step was to determine the quantity of water consumption. Once the water consumption had been determined, it was applied to the net-

work at representative locations. In the final analysis the system that was used on the computer simulated the actual system that is proposed to be in service in the Town of Southborough by the year 2000.

System Demands

The determination of the maximum day water demand for the Town of Southborough for the year 2000 has been described in a separate section.

A schematic diagram of the proposed water distribution system is included in the attached plans. The circles represent nodes. A node is located on the plan at a significant point of water consumption or where the pipe changes in diameter or C-value. Once a maximum day water demand had been determined, a portion of that demand was assigned to each node based on the population density in the areas of the node.

Maximum Day System Analysis

The computer balanced flows in the proposed distribution system using the maximum day water demands for the year 2000. The results can be seen in the following tables. The pressures, flows and velocities throughout the proposed pipe network are quite adequate, providing all sections of the Town with an ample supply of water at reasonable pressures.

Fire Flow Analysis

For a distribution system to be considered completely adequate, it must carry not only average and maximum flows, but fire flows as well. The proposed system was therefore subjected to fire demands at selected locations throughout the entire Town. The results of these fire flow analyses are also included in the following tables.

A fire demand of 4000 gallons per minute was superimposed on domestic demands at selected nodes in all sections of the Town except the northeast section where a 2000 gallon per minute fire demand was superimposed. The results from the balanced distribution system in all cases show that both domestic and fire demands can be easily handled simultaneously by the proposed system with the pressure in the mains in the vicinity of the fire remaining at or above 20 psi, and the pressure in other sections of Town remaining quite reasonable.

Water Supply Source and Storage Analysis

The results of the computer analyses in all cases indicate that the two M.D.C. water supplies of 1000 gallons per minute each will be quite adequate to furnish the Town with water through the year 2000. The results also indicate that the proposed storage facilities provide adequate fire protection for the Town and maintain a gradient throughout the Town that should be quite acceptable.

```
 JOB ID= SOUTHB ----  PIPES=182,LOOPS= 66,INDEX= 451,NODES=121
IT'NS=  40,DELTA= 1.0,BASE NODE    1 AT EL  462.0 W/  53.0 FT HEAD

ENTER DATA TYPE FOR PRINTOUT,(OR 'NONE')=NODES

NODE DATA FOR JOB SOUTHB
ID ELEV'N DRAWOFF GRAD'T    PSI
ID=ALL
   1  462.0 -1161.4  515.0   22.9
   2  325.0    19.0  513.2   81.5
   3  325.0    19.0  508.2   79.3
   4  425.0    19.0  508.2   36.0
   5  350.0    19.0  509.0   68.9
   6  355.0    19.0  513.8   68.8
   7  363.0    19.0  514.3   65.5
   8  296.0    16.0  504.4   90.2
   9  345.0    16.0  513.9   73.1
  10  295.0    16.0  513.9   94.8
  11  305.0    16.0  514.0   90.5
  12  320.0    16.0  514.1   84.1
  13  346.0    16.0  514.6   73.0
  14  335.0    16.0  515.4   78.1
  15  337.0    16.0  515.1   77.1
  16  468.0  -229.3  515.0   20.4
  17  283.0    16.0  516.7  101.2
  18  275.0    16.0  517.8  105.1
  19  272.0    16.0  518.9  106.9
  20  270.0    16.0  507.1  102.7
  21  295.0    16.0  516.5   95.9
  22  275.0    16.0  516.7  104.6
  23  295.0    16.0  504.4   90.7
  24  277.0    16.0  504.3   98.4
  25  270.0    16.0  514.0  105.6
  26  312.0    16.0  514.0   87.5
  27  266.0    16.0  504.0  103.0
  28  285.0    16.0  504.0   94.8
  29  285.0    16.0  504.1   94.9
  30  290.0    16.0  503.8   92.6
  31  266.0    16.0  504.0  103.1
  32  262.0    19.0  504.1  104.8
  33  306.0    19.0  504.1   85.8
  34  324.0    19.0  505.4   78.6
  35  305.0    19.0  504.1   86.2
  36  295.0    15.0  502.9   90.0
  37  264.0    15.0  501.0  102.6
  38  300.0    15.0  498.7   86.0
  39  380.0   575.0  493.0   48.9
  40  370.0    15.0  498.8   55.7
  41  368.0    15.0  499.3   56.8
  42  340.0    15.0  499.5   69.1
  43  310.0    15.0  499.5   82.1
  44  287.0    15.0  497.3   91.0
  45  300.0    15.0  499.6   86.4
  46  315.0    15.0  499.5   79.9
```

NODE DATA FOR JOB SOUTHB

ID	ELEV'N	DRAWOFF	GRAD'T	PSI
47	318.0	15.0	499.6	78.6
48	271.0	15.0	497.6	98.1
49	262.0	15.0	497.6	102.0
50	255.0	15.0	500.1	106.1
51	255.0	15.0	500.1	106.1
52	255.0	15.0	500.2	106.2
53	268.0	15.0	500.1	100.5
54	265.0	15.0	500.1	101.8
55	257.0	15.0	500.3	105.4
56	285.0	15.0	497.6	92.1
57	305.0	15.0	497.6	83.4
58	320.0	15.0	494.2	75.4
59	345.0	15.0	494.2	64.6
60	415.0	19.0	494.2	34.3
61	340.0	19.0	495.0	67.1
62	320.0	19.0	494.9	75.7
63	276.0	19.0	500.8	97.3
64	259.0	19.0	500.2	104.5
65	293.0	19.0	501.3	90.2
66	262.0	19.0	501.3	103.6
67	270.0	19.0	498.0	98.7
68	277.0	19.0	498.0	95.7
69	310.0	19.0	498.0	81.4
70	410.0	19.0	494.2	36.5
71	410.0	214.3	493.0	35.9
72	295.0	19.0	498.1	87.9
73	280.0	19.0	498.1	94.4
74	250.0	19.0	500.2	108.3
75	285.0	19.0	500.0	93.1
76	295.0	19.0	499.6	88.6
77	225.0	19.0	506.4	121.8
78	260.0	19.0	505.5	106.3
79	260.0	-1000.0	513.0	109.5
80	270.0	-1000.0	519.8	108.2
81	282.0	35.0	500.8	94.7
82	265.0	35.0	499.3	101.4
83	310.0	35.0	499.0	81.8
84	300.0	35.0	498.5	86.0
85	330.0	35.0	498.6	73.0
86	325.0	35.0	498.6	75.2
87	325.0	35.0	498.6	75.2
88	287.0	35.0	499.4	92.0
89	443.0	990.1	493.0	21.7
90	330.0	35.0	495.2	71.5
91	285.0	35.0	498.8	92.6
92	275.0	35.0	499.1	97.1
93	295.0	35.0	499.1	88.4
94	335.0	35.0	499.2	71.1
95	306.0	35.0	500.9	84.4
96	310.0	35.0	501.7	83.0
97	245.0	20.0	511.0	115.2
98	267.0	20.0	511.6	105.9
99	257.0	20.0	511.7	110.3
100	259.0	20.0	513.0	110.0

NODE DATA FOR JOB SOUTHB

ID	ELEV'N	DRAWOFF	GRAD'T	PSI
101	330.0	20.0	513.2	79.3
102	283.0	20.0	512.6	99.4
103	451.0	-627.7	515.0	27.7
104	275.0	20.0	512.6	102.9
105	351.0	20.0	512.6	70.0
106	305.0	20.0	512.6	89.9
107	410.0	19.0	494.2	36.5
108	370.0	15.0	494.6	54.0
109	290.0	16.0	504.3	92.8
110	325.0	35.0	498.7	75.2
111	305.0	19.0	498.0	83.6
112	270.0	19.0	498.1	98.7
113	270.0	19.0	501.2	100.1
114	260.0	15.0	500.2	104.0
115	270.0	15.0	501.0	100.0
116	262.0	16.0	504.1	104.8
117	296.0	19.0	504.7	90.4
118	338.0	16.0	514.8	76.6
119	295.0	16.0	515.9	95.6
120	320.0	35.0	499.0	77.5
121	220.0	15.0	493.9	118.6

ENTER DATA TYPE FOR PRINTOUT,(OR 'NONE')=PIPES

PIPE DATA FOR JOB SOUTHB

ID (#)	FROM I	TO J	D (IN)	L (FT)	P (#)	C	FLOW (GPM)	V (FPS)	LOSS /100'	HD-LOSS (FT)	DH/DQ (FT/GPM)
ID=ALL											
1	1	2	12.000	1100	0	120.0	731.1	2.07	0.16	1.81	0.46E-02
2	1	7	12.000	1100	0	120.0	430.3	1.22	0.06	0.66	0.29E-02
3	2	3	8.000	1550	0	100.0	301.6	1.92	0.32	5.02	0.31E-01
4	2	117	8.000	1500	0	100.0	410.5	2.61	0.57	8.53	0.38E-01
5	3	4	10.000	1760	0	120.0	-66.8	-0.27	-0.00	-0.07	0.22E-02
6	3	34	8.000	650	0	100.0	349.4	2.22	0.42	2.76	0.15E-01
7	4	5	12.000	2250	0	120.0	-85.8	-0.24	-0.00	-0.06	0.14E-02
8	5	6	12.000	4400	0	120.0	-583.6	-1.65	-0.11	-4.76	0.15E-01
9	5	35	12.000	4960	0	120.0	478.8	1.35	0.08	3.72	0.14E-01
10	6	16	12.000	3200	0	120.0	-331.3	-0.94	-0.04	-1.22	0.68E-02
11	6	9	12.000	4400	0	120.0	-44.2	-0.13	-0.00	-0.06	0.20E-02
12	6	7	12.000	4800	0	120.0	-170.1	-0.48	-0.01	-0.53	0.58E-02
13	7	117	12.000	1350	0	120.0	241.2	0.68	0.02	0.28	0.22E-02
14	8	9	12.000	1900	0	120.0	54.9	0.16	0.00	0.04	0.10E-02
15	8	117	8.000	100	0	100.0	-263.4	-1.68	-0.27	-0.27	0.18E-02
16	8	109	8.000	200	0	100.0	111.4	0.71	0.05	0.10	0.17E-02
17	8	116	8.000	1300	0	120.0	81.1	0.52	0.02	0.29	0.63E-02
18	9	10	8.000	2080	0	120.0	-5.4	-0.03	-0.00	-0.00	0.11E-02
19	10	11	8.000	1120	0	100.0	-44.3	-0.28	-0.01	-0.12	0.46E-02
20	10	109	8.000	2800	0	120.0	22.9	0.15	0.00	0.07	0.49E-02
21	11	12	8.000	650	0	100.0	-53.4	-0.34	-0.01	-0.08	0.29E-02
22	11	26	8.000	1120	0	100.0	-6.9	-0.04	-0.00	-0.00	0.12E-02
23	12	26	8.000	2080	0	120.0	31.2	0.20	0.00	0.07	0.43E-02
24	12	13	8.000	1200	0	100.0	-100.7	-0.64	-0.04	-0.51	0.93E-02
25	13	14	8.000	1360	0	100.0	-116.7	-0.74	-0.06	-0.76	0.12E-01
26	14	15	8.000	300	0	120.0	191.0	1.22	0.10	0.30	0.29E-02
27	14	17	12.000	3600	0	120.0	-323.6	-0.92	-0.04	-1.31	0.75E-02
28	15	16	12.000	2400	0	120.0	102.0	0.29	0.00	0.10	0.19E-02

PIPE DATA FOR JOB SOUTHB

ID (#)	FROM I	TO J	D (IN)	L (FT)	P (#)	C	FLOW (GPM)	V (FPS)	LOSS /100'	HD-LOSS (FT)	DH/DQ (FT/GPM)
29	15	118	8.000	1200	0	100.0	73.0	0.46	0.02	0.29	0.72E-02
30	17	18	12.000	1920	0	120.0	-418.4	-1.18	-0.06	-1.12	0.50E-02
31	17	22	12.000	2200	0	120.0	78.8	0.22	0.00	0.06	0.14E-02
32	18	19	12.000	1680	0	120.0	-434.4	-1.23	-0.06	-1.05	0.45E-02
33	19	80	12.000	800	0	120.0	-607.9	-1.72	-0.12	-0.93	0.28E-02
34	19	22	8.000	3200	0	120.0	157.5	1.00	0.07	2.26	0.26E-01
35	20	80	8.000	550	0	120.0	-392.1	-2.50	-0.37	-2.05	0.97E-02
36	20	21	8.000	4320	0	120.0	99.2	0.63	0.03	1.25	0.23E-01
37	20	23	12.000	10000	0	120.0	276.8	0.78	0.03	2.71	0.18E-01
38	21	22	12.000	750	0	120.0	-220.3	-0.62	-0.02	-0.13	0.11E-02
39	21	119	12.000	2000	0	120.0	303.5	0.86	0.03	0.64	0.39E-02
40	23	24	12.000	6400	0	120.0	37.9	0.11	0.00	0.05	0.22E-02
41	23	92	8.000	4000	0	120.0	222.9	1.42	0.13	5.23	0.43E-01
42	24	119	10.000	850	0	100.0	-287.5	-1.17	-0.10	-0.84	0.54E-02
43	24	25	10.000	850	0	100.0	309.4	1.26	0.11	0.96	0.58E-02
44	25	26	8.000	2080	0	100.0	-8.4	-0.05	-0.00	-0.00	0.13E-02
45	25	27	10.000	400	0	100.0	301.8	1.23	0.11	0.43	0.26E-02
46	27	96	10.000	2400	0	100.0	296.7	1.21	0.10	2.49	0.16E-01
47	27	28	8.000	4400	0	120.0	-10.9	-0.07	-0.00	-0.03	0.46E-02
48	28	29	8.000	500	0	120.0	-70.2	-0.45	-0.02	-0.08	0.21E-02
49	28	30	8.000	1450	0	120.0	43.3	0.28	0.00	0.10	0.41E-02
50	29	109	8.000	450	0	120.0	-118.3	-0.75	-0.04	-0.19	0.29E-02
51	29	31	8.000	1400	0	120.0	32.1	0.20	0.00	0.07	0.33E-02
52	30	31	8.000	400	0	120.0	-107.1	-0.68	-0.04	-0.15	0.24E-02
53	30	96	8.000	4800	0	120.0	134.4	0.86	0.05	2.55	0.35E-01
54	31	116	8.000	400	0	120.0	-91.0	-0.58	-0.03	-0.11	0.21E-02
55	32	116	8.000	100	0	120.0	25.9	0.16	0.00	0.00	0.15E-03
56	32	33	8.000	2960	0	120.0	39.0	0.25	0.00	0.15	0.73E-02
57	32	117	12.000	1200	0	120.0	-369.3	-1.04	-0.05	-0.56	0.28E-02
58	32	66	8.000	1350	0	120.0	285.5	1.82	0.21	2.80	0.18E-01
59	33	34	8.000	1440	0	120.0	-182.3	-1.16	-0.09	-1.30	0.13E-01
60	33	65	8.000	2560	0	120.0	202.3	1.29	0.11	2.80	0.26E-01
61	34	35	8.000	1520	0	100.0	148.1	0.94	0.09	1.33	0.16E-01
62	35	36	12.000	1050	0	120.0	607.9	1.72	0.12	1.22	0.37E-02
63	36	115	12.000	2600	0	120.0	311.6	0.88	0.03	0.88	0.52E-02
64	36	47	8.000	1680	0	120.0	281.3	1.79	0.20	3.42	0.22E-01
65	37	115	12.000	100	0	120.0	-123.9	-0.35	-0.00	-0.00	0.92E-04
66	37	114	12.000	3100	0	120.0	108.9	0.31	0.00	0.15	0.26E-02
67	38	115	8.000	2000	0	100.0	-172.7	-1.10	-0.11	-2.29	0.25E-01
68	38	108	8.000	1120	0	100.0	324.6	2.07	0.37	4.12	0.24E-01
69	38	54	8.000	1300	0	100.0	-166.9	-1.06	-0.11	-1.40	0.16E-01
70	39	108	8.000	150	0	100.0	-575.0	-3.66	-1.06	-1.60	0.51E-02
71	40	108	6.000	400	0	100.0	265.4	3.00	1.04	4.15	0.29E-01
72	40	41	8.000	300	0	100.0	-214.2	-1.36	-0.17	-0.51	0.44E-02
73	40	47	6.000	1000	0	100.0	-66.1	-0.75	-0.08	-0.81	0.22E-01
74	41	42	8.000	300	0	100.0	-131.7	-0.84	-0.07	-0.21	0.29E-02
75	41	46	8.000	1000	0	100.0	-97.5	-0.62	-0.03	-0.28	0.64E-02
76	42	43	8.000	300	0	100.0	-72.2	-0.46	-0.02	-0.07	0.18E-02
77	42	45	8.000	950	0	100.0	-74.5	-0.47	-0.02	-0.15	0.47E-02
78	43	44	8.000	850	0	100.0	-87.2	-0.56	-0.03	-0.28	0.58E-02
79	44	48	8.000	1000	0	120.0	-104.1	-0.66	-0.04	-0.36	0.60E-02
80	44	45	8.000	300	0	100.0	1.9	0.01	0.00	0.00	0.30E-03
81	45	46	8.000	300	0	100.0	-87.6	-0.56	-0.03	-0.08	0.19E-02
82	46	47	8.000	300	0	100.0	-200.2	-1.27	-0.14	-0.42	0.40E-02

PIPE DATA FOR JOB SOUTHB

ID (#)	FROM I	TO J	D (IN)	L (FT)	P (#)	C	FLOW (GPM)	V (FPS)	LOSS /100'	HD-LOSS (FT)	DH/DQ (FT/GPM)
83	48	49	8.000	1400	0	100.0	15.4	0.10	0.00	0.02	0.22E-02
84	48	65	8.000	4240	0	100.0	-148.4	-0.94	-0.09	-3.68	0.46E-01
85	48	57	8.000	1300	0	100.0	13.9	0.09	0.00	0.01	0.19E-02
86	49	50	8.000	800	0	100.0	25.4	0.16	0.00	0.03	0.19E-02
87	49	56	8.000	1250	0	120.0	-25.0	-0.16	-0.00	-0.04	0.24E-02
88	50	51	8.000	250	0	100.0	4.8	0.03	-0.00	-0.00	0.21E-03
89	50	53	8.000	650	0	120.0	5.6	0.04	0.00	0.00	0.31E-03
90	51	53	8.000	400	0	100.0	38.9	0.25	0.00	0.01	0.89E-03
91	51	52	8.000	250	0	100.0	-49.1	-0.31	-0.02	-0.04	0.13E-02
92	52	55	12.000	1600	0	120.0	-122.6	-0.35	-0.00	-0.10	0.14E-02
93	52	114	12.000	400	0	120.0	58.5	0.17	0.00	0.00	0.19E-03
94	53	54	8.000	300	0	100.0	29.5	0.19	0.00	0.01	0.82E-03
95	54	114	8.000	150	0	120.0	-152.3	-0.97	-0.08	-0.12	0.13E-02
96	55	56	8.000	2400	0	120.0	-38.4	-0.24	0.00	0.00	0.45E-04
97	55	121	12.000	3280	0	120.0	-99.2	-0.28	-0.00	-0.13	0.25E-02
98	56	57	8.000	750	0	120.0	-78.4	-0.50	-0.00	-0.04	0.19E-02
99	57	58	8.000	2100	0	120.0	-79.4	-0.51	-0.00	-0.12	0.54E-02
100	58	59	12.000	960	0	120.0	73.5	0.21	0.00	0.01	0.44E-03
101	58	62	8.000	350	0	100.0	-167.9	-1.07	-0.09	-0.31	0.38E-02
102	59	60	12.000	5280	0	120.0	-55.7	-0.16	-0.00	-0.07	0.24E-02
103	59	121	12.000	5200	0	120.0	114.2	0.32	0.00	0.27	0.44E-02
104	60	61	8.000	3120	0	120.0	-70.7	-0.45	-0.02	-0.76	0.16E-01
105	60	70	12.000	600	0	120.0	-4.0	-0.01	-0.00	-0.00	0.27E-04
106	61	62	8.000	1360	0	100.0	45.2	0.29	0.00	0.05	0.34E-02
107	61	67	8.000	4160	0	120.0	-134.9	-0.86	-0.05	-2.16	0.30E-01
108	62	63	8.000	4800	0	120.0	-141.6	-0.90	-0.06	-2.71	0.35E-01
109	63	64	8.000	650	0	100.0	-89.0	-0.57	-0.04	-0.26	0.49E-02
110	63	65	8.000	2400	0	100.0	-71.6	-0.46	-0.02	-0.54	0.14E-01
111	64	66	8.000	1550	0	120.0	-158.6	-1.01	-0.07	-1.08	0.13E-01
112	64	67	8.000	3450	0	100.0	112.6	0.72	0.05	1.79	0.29E-01
113	64	82	8.000	2160	0	120.0	-62.0	-0.39	-0.01	-0.27	0.80E-02
114	65	113	8.000	850	0	100.0	-36.8	-0.23	-0.00	-0.06	0.28E-02
115	66	113	8.000	1060	0	120.0	55.8	0.35	0.01	0.11	0.36E-02
116	66	95	8.000	5200	0	120.0	52.1	0.33	0.00	0.46	0.16E-01
117	67	68	8.000	250	0	60.0	-41.4	-0.26	-0.02	-0.05	0.23E-02
118	68	75	6.000	1200	0	60.0	-59.3	-0.67	-0.16	-1.95	0.61E-01
119	68	69	8.000	650	0	60.0	-1.1	-0.00	-0.00	-0.00	0.28E-03
120	69	76	8.000	850	0	100.0	-219.6	-1.40	-0.18	-1.53	0.13E-01
121	69	72	6.000	550	0	60.0	-5.0	-0.06	-0.00	-0.01	0.40E-02
122	69	111	12.000	275	0	120.0	-51.9	-0.15	-0.00	-0.00	0.12E-03
123	69	107	10.000	1850	0	60.0	256.4	1.04	0.21	3.81	0.28E-01
124	70	107	10.000	200	0	60.0	-23.0	-0.09	-0.00	-0.00	0.38E-03
125	71	107	10.000	800	0	60.0	-214.3	-0.87	-0.15	-1.23	0.10E-01
126	72	76	6.000	1280	0	60.0	-52.0	-0.59	-0.12	-1.52	0.57E-01
127	72	73	6.000	1300	0	60.0	-3.5	-0.04	-0.00	-0.03	0.94E-02
128	72	112	12.000	650	0	120.0	-39.4	-0.11	-0.00	-0.00	0.22E-03
129	72	111	12.000	275	0	120.0	70.9	0.20	0.00	0.00	0.16E-03
130	73	74	6.000	800	0	60.0	-80.9	-0.92	-0.29	-2.33	0.54E-01
131	73	112	12.000	650	0	120.0	58.4	0.17	0.00	0.00	0.31E-03
132	74	75	10.000	2560	0	120.0	90.3	0.37	0.00	0.23	0.45E-02
133	74	77	6.000	500	0	60.0	-190.2	-2.15	-1.42	-7.12	0.69E-01
134	75	78	8.000	2320	0	100.0	-278.6	-1.77	-0.27	-6.31	0.42E-01
135	75	76	8.000	150	0	100.0	290.6	1.85	0.30	0.45	0.29E-02
136	77	78	12.000	4320	0	120.0	238.5	0.67	0.02	0.89	0.69E-02

PIPE DATA FOR JOB SOUTHB

ID (#)	FROM I	TO J	D (IN)	L (FT)	P (#)	C	FLOW (GPM)	V (FPS)	LOSS /100'	HD-LOSS (FT)	DH/DQ (FT/GPM)
137	77	97	12.000	5280	0	120.0	-447.7	-1.27	-0.07	-3.46	0.14E-01
138	78	79	12.000	2560	0	120.0	-1000.0	-2.83	-0.29	-7.49	0.00
139	78	81	12.000	1800	0	120.0	941.0	2.66	0.26	4.71	0.93E-02
140	81	82	8.000	2800	0	120.0	138.4	0.88	0.05	1.53	0.20E-01
141	81	88	12.000	1200	0	120.0	603.9	1.71	0.12	1.38	0.42E-02
142	81	110	8.000	2000	0	100.0	163.6	1.04	0.11	2.12	0.24E-01
143	82	83	8.000	3520	0	100.0	41.4	0.26	0.00	0.29	0.13E-01
144	83	84	10.000	600	0	100.0	255.2	1.04	0.08	0.46	0.34E-02
145	83	95	10.000	1050	0	100.0	-227.1	-0.93	-0.06	-0.68	0.55E-02
146	83	120	10.000	2080	0	100.0	-21.7	-0.09	-0.00	-0.02	0.14E-02
147	84	90	10.000	2880	0	100.0	318.0	1.30	0.12	3.36	0.20E-01
148	84	86	12.000	800	0	120.0	-8.7	-0.02	-0.00	-0.00	0.70E-04
149	84	110	8.000	450	0	100.0	-89.1	-0.57	-0.03	-0.15	0.32E-02
150	85	110	6.000	450	0	100.0	-39.5	-0.45	-0.03	-0.15	0.66E-02
151	85	86	6.000	300	0	100.0	4.5	0.05	0.00	0.00	0.89E-03
152	86	87	12.000	550	0	120.0	-39.2	-0.11	-0.00	-0.00	0.18E-03
153	87	88	12.000	800	0	120.0	-568.9	-1.61	-0.10	-0.83	0.27E-02
154	87	89	10.000	2880	0	120.0	494.8	2.02	0.19	5.58	0.21E-01
155	89	90	10.000	800	0	100.0	-495.4	-2.02	-0.27	-2.17	0.81E-02
156	90	91	8.000	2160	0	100.0	-212.3	-1.35	-0.17	-3.61	0.32E-01
157	91	92	8.000	1120	0	100.0	-86.8	-0.55	-0.03	-0.36	0.76E-02
158	91	93	8.000	450	0	120.0	-160.6	-1.02	-0.07	-0.31	0.37E-02
159	92	93	12.000	800	0	120.0	101.2	0.29	0.00	0.03	0.61E-03
160	93	94	12.000	1550	0	120.0	-94.4	-0.27	-0.00	-0.06	0.11E-02
161	94	95	12.000	3680	0	120.0	-186.0	-0.53	-0.01	-0.47	0.47E-02
162	94	120	8.000	1700	0	120.0	56.7	0.36	0.00	0.17	0.56E-02
163	95	96	10.000	450	0	100.0	-396.1	-1.61	-0.18	-0.81	0.38E-02
164	97	98	8.000	1520	0	120.0	-120.4	-0.77	-0.04	-0.64	0.98E-02
165	97	99	12.000	1600	0	120.0	-347.3	-0.98	-0.04	-0.65	0.35E-02
166	98	99	8.000	1760	0	120.0	-15.2	-0.10	-0.00	-0.02	0.20E-02
167	98	100	8.000	2960	0	120.0	-125.3	-0.80	-0.04	-1.33	0.20E-01
168	99	102	12.000	2000	0	120.0	-382.5	-1.08	-0.05	-0.99	0.48E-02
169	100	101	12.000	2080	0	120.0	-179.4	-0.51	-0.01	-0.25	0.26E-02
170	100	106	8.000	8160	0	120.0	34.2	0.22	0.00	0.33	0.18E-01
171	101	102	12.000	960	0	120.0	428.3	1.21	0.06	0.59	0.25E-02
172	101	103	12.000	1440	0	120.0	-627.7	-1.78	-0.12	-1.77	0.52E-02
173	102	104	12.000	1200	0	120.0	25.8	0.07	0.00	0.00	0.29E-03
174	104	105	8.000	2720	0	120.0	9.6	0.06	0.00	0.01	0.20E-02
175	104	106	8.000	3840	0	120.0	-3.8	-0.02	-0.00	-0.00	0.13E-02
176	105	106	8.000	2900	0	120.0	-10.4	-0.07	-0.00	-0.01	0.23E-02
177	6	118	6.000	1600	0	100.0	-57.0	-0.64	-0.06	-1.01	0.32E-01
178	1	16	0.000	0	0	0.0	0.0	0.00	0.00	0.00	0.00
179	1	39	0.000	0	0	0.0	0.0	0.00	0.00	22.00	0.00
180	1	71	0.000	0	0	0.0	0.0	0.00	0.00	22.00	0.00
181	1	89	0.000	0	0	0.0	0.0	0.00	0.00	22.00	0.00
182	1	103	0.000	0	0	0.0	0.0	0.00	0.00	0.00	0.00

ENTER DATA TYPE FOR PRINTOUT,(OR 'NONE')=NONE

Southborough Water System

Fire Demand at Node 6

ID	Elev'n	Drawoff	Grad't	PSI
6	355.0	4019.0	493.2	59.8
16	468.0	-1986.9	515.0	20.4
118	338.0	16.0	509.5	74.3
9	345.0	16.0	502.0	68.0
7	363.0	19.0	507.0	62.4
5	350.0	19.0	495.3	62.9
1	462.0	-2660.1	515.0	22.9
39	380.0	221.0	493.0	48.9
71	410.0	38.4	493.0	35.9
89	443.0	806.4	493.0	21.7
103	451.0	- 657.9	515.0	27.7

Fire Demand at Node 11

ID	Elev'n	Drawoff	Grad't	PSI
11	305.0	4016.0	370.9	28.5
12	320.0	16.0	402.5	35.7
26	312.0	16.0	404.1	39.9
10	295.0	16.0	459.6	71.3
1	462.0	-2462.2	515.0	22.9
16	468.0	-2043.8	515.0	20.4
39	380.0	314.2	493.0	48.9

Southborough Water System

Fire Demand at Node 11 (continued)

ID	Elev'n	Drawoff	Grad't	PSI
71	410.0	263.7	493.0	35.9
89	443.0	356.7	493.0	21.7
103	451.0	- 667.6	515.0	27.7

Fire Demand at Node 18

ID	Elev'n	Drawoff	Grad't	PSI
18	275.0	4016.0	436.4	69.9
17	283.0	16.0	459.2	76.3
19	272.0	16.0	452.3	78.1
1	462.0	-2127.4	515.0	22.9
16	468.0	-2304.7	515.0	20.4
39	380.0	333.0	493.0	48.9
71	410.0	298.4	493.0	35.9
89	443.0	292.2	493.0	21.7
103	451.0	- 730.6	515.0	27.7

Fire Demand at Node 37

ID	Elev'n	Drawoff	Grad't	PSI
37	264.0	4015.0	443.1	77.6
115	270.0	15.0	444.7	75.6
38	300.0	15.0	466.0	71.9

Southborough Water System

Fire Demand at Node 37 (continued)

ID	Elev'n	Drawoff	Grad't	PSI
36	295.0	15.0	471.4	76.4
114	260.0	15.0	463.7	88.2
54	265.0	15.0	464.4	86.3
1	462.0	-1801.5	515.0	22.9
16	468.0	- 585.5	515.0	20.4
39	380.0	-1222.3	493.0	48.9
71	410.0	- 515.2	493.0	35.9
89	443.0	609.3	493.0	21.7
103	451.0	- 723.7	515.0	27.7

Fire Demand at Node 65

ID	Elev'n	Drawoff	Grad't	PSI
65	293.0	4019.0	410.2	50.7
113	270.0	19.0	442.5	74.7
63	276.0	19.0	473.1	85.3
48	271.0	15.0	483.4	92.0
33	306.0	19.0	478.3	74.6
1	462.0	-1921.5	515.0	22.9
16	468.0	- 645.4	515.0	20.4
39	380.0	- 279.9	493.0	48.9
71	410.0	- 571.8	493.0	35.9
89	443.0	- 36.0	493.0	21.7

Southborough Water System

Fire Demand at Node 65 (continued)

ID	Elev'n	Drawoff	Grad't	PSI
103	451.0	- 784.4	515.0	27.7

Fire Demand at Node 69

ID	Elev'n	Drawoff	Grad't	PSI
69	310.0	4019.0	381.0	30.8
68	277.0	19.0	426.2	64.6
76	295.0	19.0	411.9	50.6
72	295.0	19.0	381.5	37.4
111	305.0	19.0	381.3	33.0
107	410.0	19.0	468.9	25.5
1	462.0	-1453.9	515.0	22.9
16	468.0	- 354.4	515.0	20.4
39	380.0	- 133.6	493.0	48.9
71	410.0	-1091.0	493.0	35.9
89	443.0	- 211.4	493.0	21.7
103	451.0	- 994.8	515.0	27.7

Fire Demand at Node 84

ID	Elev'n	Drawoff	Grad't	PSI
84	300.0	4035.0	469.3	73.3
90	330.0	35.0	486.6	67.8

Southborough Water System

Fire Demand at Node 84 (continued)

ID	Elev'n	Drawoff	Grad't	PSI
83	310.0	35.0	478.8	73.1
110	325.0	35.0	472.8	64.0
86	325.0	35.0	474.3	64.7
1	462.0	-1425.5	515.0	22.9
16	468.0	- 451.1	515.0	20.4
39	380.0	483.1	493.0	48.9
71	410.0	- 261.8	493.0	35.9
89	443.0	-1716.2	493.0	21.7
103	451.0	- 867.5	515.0	27.7

Fire Demand at Node 105

ID	Elev'n	Drawoff	Grad't	PSI
105	351.0	2020.0	414.7	27.6
106	305.0	20.0	464.2	68.9
104	275.0	20.0	486.4	91.5
1	462.0	-1256.2	515.0	22.9
16	468.0	- 297.0	515.0	20.4
39	380.0	553.9	493.0	48.9
71	410.0	33.2	493.0	35.9
89	443.0	697.9	493.0	21.7
103	451.0	-1970.8	515.0	27.7

Southborough Water System

Fire Demand at Node 121

ID	Elev'n	Drawoff	Grad't	PSI
121	220.0	4015.0	398.9	77.5
55	257.0	15.0	453.2	84.9
59	345.0	15.0	450.4	45.6
1	462.0	-1428.6	515.0	22.9
16	468.0	- 217.7	515.0	20.4
39	380.0	- 976.0	493.0	48.9
71	410.0	- 864.4	493.0	35.9
89	443.0	45.0	493.0	21.7
103	451.0	- 797.3	515.0	27.7

Fire Demand at Node 92

ID	Elev'n	Drawoff	Grad't	PSI
92	275.0	4035.0	414.4	60.3
23	295.0	16.0	480.6	80.4
93	295.0	35.0	427.5	57.4
91	285.0	35.0	428.4	62.1
1	462.0	-1529.3	515.0	22.9
16	468.0	- 794.7	515.0	20.4
39	380.0	487.6	493.0	48.9
71	410.0	- 222.1	493.0	35.9
89	443.0	-1458.0	493.0	21.7
103	451.0	- 722.4	515.0	27.7

APPENDIX D

PLANS OF THE SOUTHBOROUGH WATER SYSTEM

Plan I - Existing Southborough Water System plus Flow Test Results

Plan II - Proposed Improvements to the Southborough Water System

Plan III - Schematic Computer Diagram for Analysis of the Southborough Water System

MARLBOROUGH

WESTBOROUGH

HOPKINTON

ASHLAND

FRAMINGHAM

SUDBURY

RESERVOIR

Transmission Line

Pressure Tunnel

Sudbury River

Crystal Pond

PUMPING STATION
CAPACITY 1,000 G.P.M.

1,300,000 GALLON RESERVOIR
OVERFLOW ELEVATION 515.00

460,000 GAL. STANDPIPE
OVERFLOW ELEV. 493.32

150,000 GALLON ELEVATED TANK
OVERFLOW ELEV. 493.04

275,000 GALLON STANDPIPE
OVERFLOW ELEVATION 492.73

FAYVILLE DAM

INTERSTATE ROUTE 495

NORTHBORO RD.
JACKSON HILL RD.
FISHER RD.
BIGELOW RD.
WARD RD.
BRIGHAM RD.
CHESTNUT HILL RD.
LYNBROOK RD.
LOVE LANE
WYNDEMERE DR.
MAIN ST.
BLACKTHORN DR.
DAVIS RD.
TARA RD.
BANTRY RD.
FLAGG RD.
RED GATE LA.
HICKORY RD.
STRAWBERRY RD.
ROCKRIDGE RD.
PEACH TREE LA.
ORCHARD RD.
DEERFOOT RD.
CLIFFORD ST.
PARKERVILLE RD.
KNOX ST.
MATTHEW ST.
STUB TOE LANE
MIDDLE RD.
PRIVATE WAY
ACRE BRIDGE RD.
CROSS ST.
MAPLECREST RD.
PINECONE RD.
MARLBORO RD.
SCHOOL ST.
NEWTON ST.
LYMAN ST.
HILLSIDE RD.
MDC OVERLOOK RD.
FRAMINGHAM RD.
EAST MAIN ST.
WINCHESTER RD.
UPLAND RD.
LOCKER RD.
BOSTON RD.
FOLEY DR.
LATISQUAMA RD.
McNEIL DR.
BAGLEY RD.
PARTRIDGE HILL
CRESTVIEW RD.
MITCHELL ST.
JOHN ST.
SUMMER ST.
GROVE ST.
WINTER ST.
PLEASANT ST.
WILLOW ST.
BROCK RD.
VALLEY RD.
MAPLE ST.
OLD MILL RD.
HILL DR.
OAK ST.
WALNUT DR.
BREAKNECK RD.
WOODLAND RD.
VIEWHILL RD.
MT. VICKERY RD.
CORDAVILLE RD.
ROCK POINT RD.
GILMORE RD.
RIDGE RD.
FAIRVIEW DR.
SUMMIT RD.
MASSACHUSETTS TURNPIKE (Toll Road)
RICHARDS RD.
LEONARD DR.
BRITTEN RD.
MOULTON RD.
HARRIS DR.
ATWOOD ST.
PRENTISS ST.
PEARL ST.
HIGHLAND ST.
WOOD ST.
SOUTHVILLE RD.
HAMMOND ST.
PARKER ST.
NORTH ST.
WOODBURY RD.
YALE TERR.
CARLOLYN LA.
TED LANE
BROOKSIDE RD.
OREGON RD.
EDGEWOOD RD.

Location No.	Static Pressure psi	Flow (gpm) at 20 psi Residual Pressure
1	101	1860
2	78	2190
3	78	820
4	97	1710
5	71	770
6	102	3250
6A	102	1260
7	73	635
8	95	1010
9	68	7100
10	85	4390
11	97	4870
11A	96	2560
12	70	3050
13	89	1530
14	72	2120
15	96	2920
16	70	940
17	77	1300
18	88	2020
19	98	1440
20	93	1580
20A	93	1150
21	83	3150
21A	83	1010
22	93	3520
22A	93	1260

MARCH 1971
FLOW TEST RESULTS

Note:
6A, 20A, 21A, 22A, conducted with Atwood Street Elevated Tank shut off
11A conducted with gate valve on Main Street near Wyndemere closed

WATER SYSTEM
SOUTHBOROUGH, MASS.
- 1970 -

1000 0 1000 2000 3000 4000 5000
SCALE IN FEET

WHITMAN & HOWARD, INC.
ENGINEERS AND ARCHITECTS
BOSTON, MASS.

PLAN

MARLBOROUGH

WESTBOROUGH

HOPKINTON

SUDBURY

FRAMINGHAM

ASHLAND

RESERVOIR

PUMPING STATION
CAPACITY 1,000 G.P.M.

1,300,000 GALLON RESERVOIR
OVERFLOW ELEVATION 515.00

PROPOSED 2,000,000 Gal.
Standpipe Overflow El. 517.00

460,000 GAL.
STANDPIPE
OVERFLOW ELEV.
493.32

PROPOSED 1,000,000 Gal.
Standpipe Overflow El. 515.00

PROPOSED PUMPING STATION
SHAFT #3 SOUTHBOROUGH TUNNEL

150,000 GALLON ELEVATED
TANK
OVERFLOW ELEV. 493.04

275,000 GALLON STANDPIPE
OVERFLOW ELEVATION 492.73

FAYVILLE
DAM

Crystal
Pond

Sudbury
River

NORTHBORO RD.
BIGELOW RD.
Transmission Line
WARD RD.
BRIGHAM RD.
ROUTE 495
NORTHBORO RD.
CHERRY HILL RD.
FISHER RD.
CHESTNUT HILL RD.
WYNDEMERE DR.
LYNBROOK RD.
INTERSTATE
LANE
LOVE
MAIN ST.
BLACKTH RD.
DAVIS RD.
TARA LA.
BARTRY RD.
FLAGG RD.
HICKORY RD.
RED GATE LA.
STRAWBERRY RD.
ROCKBRIDGE RD.
PEACH TREE LA.
ORCHARD RD.
DEERFOOT RD.
CLIFFORD RD.
PARKERVILLE RD.
KNOX ST.
MATTHEW ST.
STUB TOE LANE
PRIVATE WAY
WOODS RD.
TURNPIKE
RIDGE RD.
SUMMIT RD.
FAIRVIEW DR.
MIDDLE RD.
MT. VICKERY RD.
GILMORE RD.
ROCK POINT RD.
CORDAVILLE RD.
MASSACHUSETTS
(Toll Road)
RICHARDS
PRENTISS ST.
SOUTHVILLE RD.
PEARL ST.
HIGHLAND ST.
WOOD ST.
LEONARD DR.
EDMUND RD.
MOULTON RD.
HARRIS DR.
ALFRED
HAMMOND ST.
PARKER ST.
NURSE ST.
WOODBURY RD.
YALE TERR.
SOUTHVILLE RD.
WOODLAND RD.
BRECKNECK RD.
FERRY LANE
BROOKSIDE RD.
OREGON RD.
EDGEWOOD RD.
ACRE BRIDGE RD.
SEARS RD.
Pressure Tunnel
MAIN ST.
MARLBORO
SCHOOL ST.
NEWTON ST.
LYMAN ST.
HILLSIDE RD.
EAST MAIN ST.
WINCHESTER RD.
UPLAND RD.
LOCKER
PARK ST.
FOLEY DR.
BAGLEY RD.
McNEIL DR.
LATISQUAMA RD.
PARTRIDGE HILL
CRESTVIEW
BOSTON RD.
MITCHELL ST.
JOHN ST.
VALLEY RD.
SUMMER
GROVE
WINTER
PLEASANT
WALNUT
BROCK LA.
MAPLE ST.
OLD MILL RD.
OAK HILL DR.
WALNUT DR.
MAPLECREST RD.
PINECONE RD.
OVERLOOK RD.
FRAMINGHAM
VIEWHILL RD.
Transmission Line

LEGEND

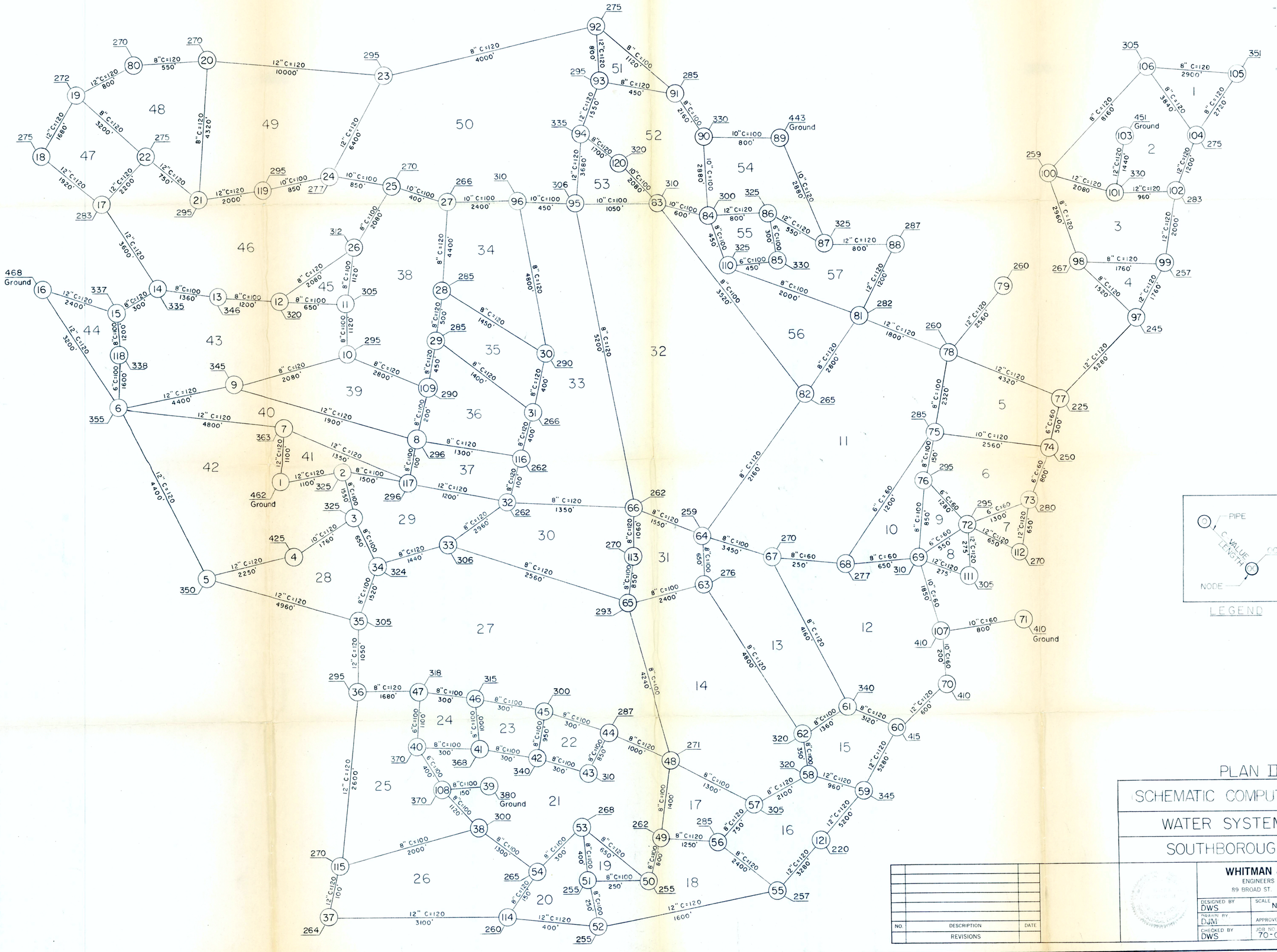
Existing Water Mains
Proposed Water Mains

PROPOSED
WATER SYSTEM
SOUTHBOROUGH, MASS.
- 1972 -

1000 0 1000 2000 3000 4000 5000
SCALE IN FEET

WHITMAN & HOWARD, INC.
ENGINEERS AND ARCHITECTS
BOSTON, MASS.

PLA



PLAN III

SCHEMATIC COMPUTER DIAGRAM

WATER SYSTEM STUDY

SOUTHBOROUGH , MASS.

NO.	DESCRIPTION	DATE
	REVISIONS	

WHITMAN & HOWARD INC.
ENGINEERS AND ARCHITECTS
89 BROAD ST. BOSTON, MASS.

DESIGNED BY DWS	SCALE NO SCALE	DATE APR 1971
DRAWN BY DJM	APPROVED	
CHECKED BY DWS	JOB NO. 70-076	SHEET 1 OF 1 SHEETS