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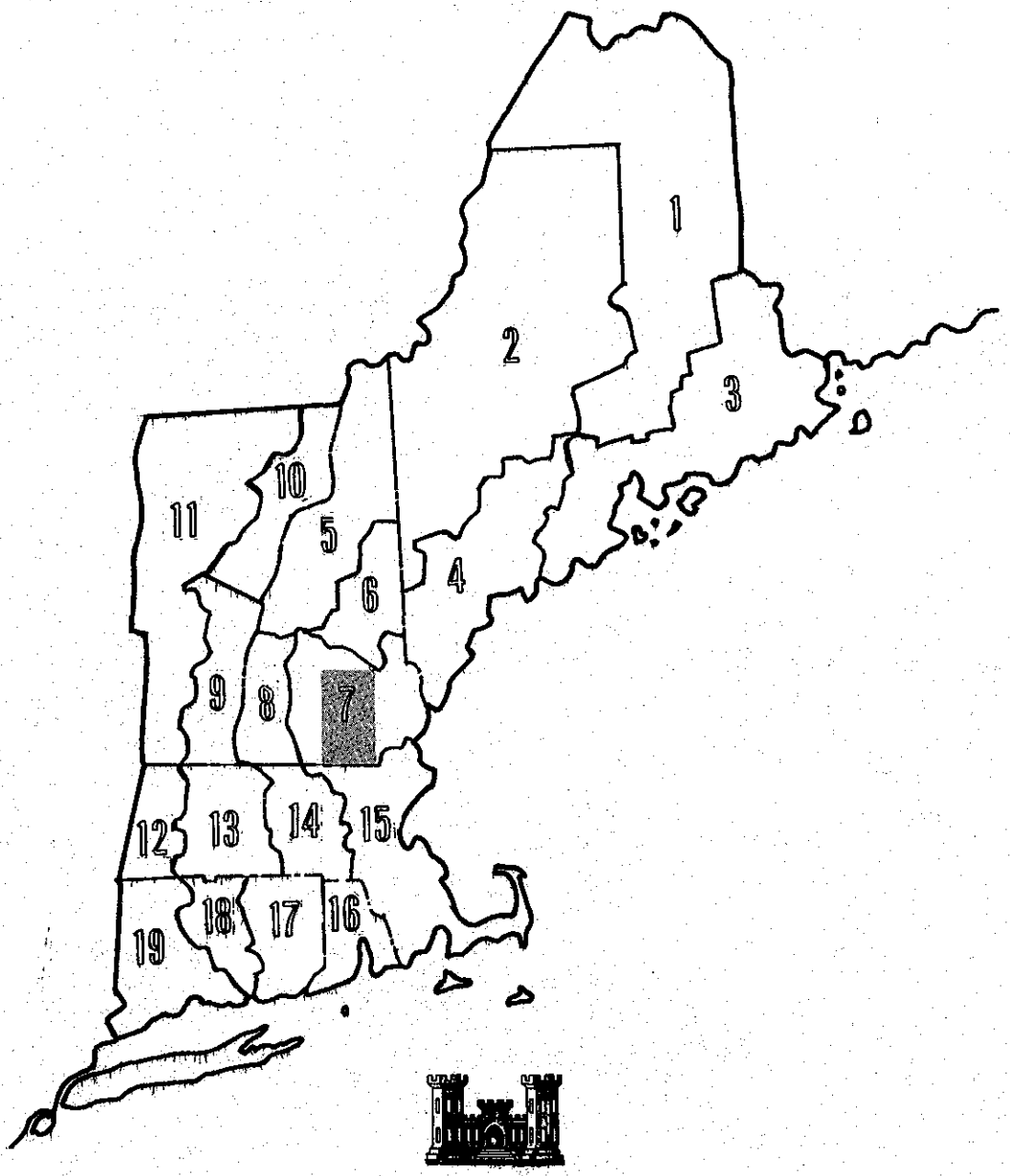
NORTHEASTERN UNITED STATES WATER SUPPLY STUDY

SOUTHERN NEW HAMPSHIRE TRI-CITY AREA

(PART OF OBE SUB-REGION 7)

INTERIM MEMORANDUM NO.4



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

AUGUST 1968

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NORTHEASTERN UNITED STATES WATER SUPPLY STUDY

INTERIM MEMO NO. 4

SOUTHERN NEW HAMPSHIRE TRI-CITY AREA
(Part of OBE Sub-region No. 7)

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

August 1968

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Southern New Hampshire Tri-City Area
(Part of OBE Sub-Region No. 7)
Interim Memorandum No. 4

1. PURPOSE OF REPORT

This Interim Memo is being submitted in accordance with scope of work detailed in Memorandum dated 21 November 1967, as part of this Division's participation in the Northeast Water Supply Study for the New England Area. It presents a report on the Tri-City area of southern New Hampshire, outlining present population, water supply and demand along with projections made for water supply needs through the year 2020. Sources of water which could be developed to meet the needs through 2020 are evaluated and possible solutions are discussed.

2. SCOPE OF STUDIES

a. General Information. Preliminary studies and investigations of reconnaissance scope have been made to determine water supply requirements for the Tri-City area of Southern New Hampshire. Findings are based upon personal contact with the water departments of Concord, Manchester and Nashua, and a study of reports prepared by their consulting engineers; personal interviews with members of the Southern New Hampshire Planning Commission, and a study of their reports; discussions with U.S.G.S.; and a review of the publications of HEW, U.S.G.S., and other agencies.

The findings of this report are based upon municipally-owned systems now suppliers of domestic needs, including those of industrial customers having small or moderate requirements. One exception is the Nashua system, which is supplied by a privately-owned water company. In general, most of the larger users of process water use the Merrimack River as their supply, but those users who need a high quality water tend to rely upon local public water supplies. An example is the proposed construction of a new Anhaeuser-Busch Company plant, to be located in the town of Merrimack, contiguous to the city of Nashua and adjacent to the Merrimack River. Their initial water supply requirement is reported as 3.3 MGD, to be supplied either by the Nashua or Manchester water companies. There is also a possibility that Anhaeuser-Busch Company might develop their own supply.

b. Topographic Surveys. Topographic information was obtained from U.S. Geological Survey maps, the Water Departments of Concord, Manchester and Nashua, and from reports prepared by their consulting engineers.

c. Geologic and Subsurface Information. Subsurface data was obtained from U.S. Geological Survey publications, and from discussions with U.S.G.S. representatives in Concord, New Hampshire.

d. Office Studies. Office studies consisted of projecting present water demands and supplies, and determining the deficiencies for the three major metropolitan centers of Concord, Manchester and Nashua.

e. Field Reconnaissance. Field reconnaissances, consisted of cursory vehicular inspections in specific areas, of those sites of various potential improvements, and/or new facilities.

3. PRIOR REPORTS

The NENYIAC study of 1954 contains information that is generally applicable to NEWS in such areas as topography and geology, surface and groundwater availability, pollution, and recreation.

4. DESCRIPTION OF AREA

a. General. The study area is composed of bedrock hills and ridges with varying elevations 600-800 feet msl, and several peaks exceeding 1,000 ft. msl. Terrain is substantially wooded, with many small streams and ponds, and several larger rivers and lakes (see Plate #1). The Merrimack River Basin has a total drainage area of 5,010 square miles, of which 3,800 square miles are in New Hampshire and 1,210 square miles are in Massachusetts. The drainage areas above each of the cities in the Tri-City area are as follows:

Concord - 2,427 square miles (at Garvins Falls Dam)
Manchester - 2,854 square miles (at Amoskeag Dam)
Nashua - 3,982 square miles (at the Nashua - Hudson Bridge

The major river tributaries to the Merrimack River in the respective cities of the Tri-City area are:

Concord

Contoocook River - D.A. of 766 sq. mi.
Soucook River - D.A. of 90 sq. mi.

Concord-Manchester

Suncook River - D.A. of 252 sq. mi.

Manchester

Piscataquog River - D.A. of 214 sq. mi.

Nashua

Souhegan River - D.A. of 225 sq. mi.
Nashua River - D.A. of 516 sq. mi.

The larger ponds located near the three cities are:

1. Penacook Lake - 3 miles N.W. of Concord having a S. A. of 365 acres and a D.A. of 3.9 sq. mi.

2. Turkey Pond - 3 miles West of Concord having a S.A. of 190 ± acres and a D.A. of approximately 25 sq. mi.

3. Massabesic Lake - 2 miles East of Manchester, having a S. A. of 2560 acres, and a D.A. of 47 sq. mi.

4. "The Pennichuck Ponds" - 2 miles N.W. of Nashua with a S. A. of 231 acres, and a D.A. of 25 sq. mi.

The ponds near the large cities have, through legislation and regulation, been protected from pollution. Those further away have been developed as resort areas having large summer populations located along their shore. Some of the tributaries of the Merrimack River such as the Contoocook, are relatively clean, while others are somewhat more polluted. The Merrimack itself is polluted, especially with nutrients (such as phosphates from detergents). These conditions contribute in part to the fact that the three major cities are using local lakes for their present surface water sources. Discussion with officials of these communities indicate they plan to go to tributaries of the Merrimack River Basin to meet future water needs in excess of their present sources, rather than use of the Merrimack River.

b. Sources of Supply. The major source of water in the Tri-City area has been and is expected to continue to be surface water. Although ground water sources have been developed in Concord and Nashua, and are now being used, future plans are to use tributary streams and rivers. The city of Nashua plans to install a few more gravel packed wells (yielding between 1 and $1\frac{1}{2}$ MGD at each location) in addition to their surface system.

c. Geology and Topography. Information supplied by U.S.G.S. describes the bedrock as consisting generally of granite, granite gneiss and schist. It varies considerably in contour, being as much as 200 feet below the surface but in some places rising steeply several hundred feet above the surface. The bedrock is covered by glacial till composed of variable, unstratified, silty, gravelly sand and clays with cobbles and boulders. The cover is usually thin on the hilltops and steep slopes, and deep in the valleys. On some of the steep rock slopes the till may be missing, and in the valleys is usually buried under various types of glacial deposits. In the Concord area the steep hills rise to several hundred feet msl, while below Manchester the steep hills gradually give way to rolling hills of 300-400 ft, msl elevation, and are composed mostly of glacial till, kames, and outwash. The Merrimack River flows southerly through a narrow valley, at a low gradient. The elevation of the river in the Concord area is about 200 feet msl, dropping to about 100 ft. msl elevation in the Nashua area, some 32 miles downstream. Below Manchester and beyond Nashua the valley gradually widens to become a part of the rolling hills typical of the area.

d. Maps. Topography of southern New Hampshire is shown on the U.S. Department of the Interior Geological Survey maps at a scale of 1:62,500, 15 minute series, with 20-foot contour intervals. Included in this series are the cities of Concord, Manchester, and the northern two-thirds of Nashua. Beginning at 42° - 45' and extending South, the scale of the Geological Survey maps changes so that the southern one-third of Nashua and the downstream part of the Merrimack River is shown at a scale of 1:24,000, $7\frac{1}{2}$ minute series, with 10-foot contour intervals.

5. WATER SUPPLY HISTORY

Concord. The City of Concord, which is the capital of the State of New Hampshire, possesses population characteristics which vary from urban to rural. It has been said that "the business of

Concord is government," and this is demonstrated by the fact that the urban area of the city is largely residential except for the area used for city and state office buildings. Manufacturing is not yet a major influence in Concord, but farming is still important in the area. Population growth is not as great as other industrial cities in the state are experiencing. The city's water supply began in 1872 when it purchased the stock of the Torrent Aqueduct Association. This purchase provided the city the right to draw upon 1 MGD from Long Pond, which was being utilized at that time for power purposes. The adjacent Forge Pond, at the northeast end of Long Pond, was later connected to Long Pond, to form the resulting body now referred to as Penacook Lake. In 1891 a study was made to determine the feasibility of developing a water supply from Walker Pond in nearby Boscawen. The study concluded the supply from Penacook Lake to be more advantageous. On this basis the city purchased the water power privileges of Long Pond and Forge Pond, in order to expand the prior withdrawal limitation of 1 MGD. The water supply demand continued to increase until in 1926 the average draft of 2.7 MGD was met. In January 1927 the average daily consumption was 3.05 MGD. Since Penacook Lake has a safe yield of only 2.8 MGD (per A&E report), it became apparent that an increase in water supply was necessary.

The Pembroke Well Field, about 3 miles east of Concord and across the Merrimack River, was developed. It consisted of 150-$2\frac{1}{2}$ inch diameter wells, which could provide 1.1 MGD. In 1950 the original well screens had deteriorated, and new wells were driven. When the same problem occurred in 1962, it was decided to replace the 150-$2\frac{1}{2}$ inch wells with 4-18 inch wells. These were installed in 1963, and in 1964 provided a total of 400 MG to the city, an average of 1.1 MGD, similar to the yield as provided in the earlier well field.

Manchester. Manchester, about 15 miles below Concord, and the largest city in New Hampshire, lies astride the Merrimack River some 22 miles north of the New Hampshire-Massachusetts state line. Covering an area of about 35 square miles, Manchester is a large shopping and commercial center serving the central part of the state. When the remainder of the interstate highway system is completed, the city will be served by excellent arterial highways providing access in all directions. Already industry is increasing in the area, due in part to the proximity to the Boston market over modern highways.

In 1874 the first municipal water supply service was installed. Water was pumped from Massabesic Lake into the new distribution system, which included 23 miles of wrought iron pipelines and a new distribution reservoir. In 1886, the pumping capacity at the low pressure station was increased from 5 MGD to 10 MGD by the addition of new pumping units. Several years later, in 1893, residential growth on the higher elevations in the city necessitated the addition of a high pressure system, which consisted of a new pumping station, new mains, and a new distribution reservoir. In 1903, and again in 1906, increased demands for water required the installation of additional pumping capacity at both the high and low pressure stations. At the present time the pumping equipment at the high pressure station consists of two pumps with a combined capacity of 10.5 MGD, and a 13 MGD standby unit. At the low pressure station are a 10 MGD unit and a standby pump of 8.5 MGD capacity. Also at the low pressure station is small hydroelectric unit. Water in excess of that required to meet the water supply needs is used to generate electric power at the low pressure station. The amount of power produced is enough to operate the pumping units at either the low or the high pressure stations, but not both.

Massabesic Lake continues to meet the requirements of Manchester and the parts of five adjacent towns, namely: Londonderry, Bedford, Goffstown, Hooksett, and Auburn, which are served by the Manchester Water Works. The average demand in 1939 was 6.2 MGD. This increased to 9.2 MGD in 1949 and in 1959 was up to 11.5 MGD. The present demand is about 14 MGD. The safe yield of Massabesic Lake is 20 MGD and can be raised to 27 MGD by lowering the intake to the low pressure pumping station.

Nashua. The Pennichuck Water Works was started in 1852 to serve the city of Nashua. It was then and still is now an investor-owned company, and by franchise continues to serve only Nashua. The source of supply is Pennichuck Brook, 2 miles N. W. of the city. The company has controlled and modified the brook by a series of 4 dams. The resulting impoundments produced a series of contiguous small ponds. Further upstream, the brook is generally in its natural state. The drainage area of the brook is about 25 square miles. Under the extreme conditions of the recent drought, the safe yield of the watershed is rated as 6 mgd.

The supply of Pennichuck Brook has been supplemented by pumping from the Souhegan River when necessary. Land was purchased

at the so-called Iron Bridge on the Souhegan, about 8 miles N. W. of Nashua. A pumping station was built on this land, and about $1\frac{1}{2}$ miles of 16" pipe laid along Route 122 to a point where the pipe reaches the Pennichuck Brook Watershed. There the water flows freely along the surface to the brook and the downstream impoundments. The watershed of the Souhegan above this diversion point is 156 square miles. The lowest flow ever recorded at the nearby gaging station at Wildcat Falls for a one-day period was 10.2 MGD. No treatment other than 15 ppm chlorine is currently necessary. In addition to these surface water sources, the company has 3 gravel packed wells on Roy Street, on the Salmon Brook watershed, in Nashua, affording a safe yield of 2 MGD.

The water demand has been increasing steadily since 1950. For the preceding 20 year period 1930-1949, the demand was nearly steady at around 3 MGD. Since 1950 it has more than doubled to the present level of approximately 6-7 MGD.

6. PRESENT WATER SUPPLY SITUATION

Concord. The existing sources of water supply currently being utilized by Concord are:

Name	Location	Safe Yield
Penacook Lake	3 mi. N. W. of Concord	2.8 MGD
Pembroke Well Field	3 mi. E. of Concord	1.6 MGD
Turkey River (temp. diversion)	2 mi. W. of Concord	*

*The city is allowed to pump up to 3 MGD into Penacook Lake, subject to other rights.

The first two sources had been adequate to meet the demand until the cumulative effects of the successive years of the recent drought began to literally dry up Penacook Lake. In March, 1964, the officials of St. Paul's School agreed to let the city pump from the pool created by their dam on the Turkey River when such river flow was spilling over their dam. This original contract expired 30 June 1965. During that period, the level in Penacook Lake was maintained at a level $5\frac{1}{2}$ feet above what it would have been without the diversion, thereby preventing a critical supply situation which could otherwise have occurred.

The original contract for the Turkey River Diversion was extended, and pumping continued during the allowable 6 months periods in 1965 and 1966. During 1967, the drought then being over, pumping was required for only a short period to maintain Penacook Lake at a full level. At the present time (July 1968), the lake is full, and no diversions were required this past year.

Manchester. The present source of water supply for Manchester is Lake Massabesic. It has a safe yield of 20 MGD and a present demand of about 14 MGD. The supply was adequate to meet demand, including the recent drought period. Manchester and those towns it now serves are considered as being adequately supplied by Lake Massabesic.

Nashua. The present sources of water for Nashua are both surface and ground. The surface source at Pennichuck Brook provided 6 MGD during the recent drought. The ground water sources are the 3 gravel packed wells on Roy Street, in the Salmon Brook watershed, which provide a total safe yield of 2 MGD. The company has never had to restrict water use, and does not anticipate having to do so in the forseeable future, since they pump from the Souhegan River as necessary to meet peak demand. Existing supply sources are considered adequate to meet the present demand of 6-7 MGD.

7. PROJECTED FUTURE WATER REQUIREMENTS.

Concord. According to an engineering reported dated April 1965, the population and the per capita consumption are expected to increase for several decades. While the GPCD will increase at a rate comparable to other urban areas, the population increase will be slower. Reasons for a lower rate of increase of population were given as follows:

(a) Concord has not experienced the development of a major manufacturing industry, and is not expected to do so.

(b) It has been and still is the center of a prosperous farming country.

(c) Even though only 17 miles from Manchester (the state's most populous city), it is not a part of the metropolitan area of that city, and

(d) it has the highest percentage of persons over 65 years of age and the smallest percentage of persons under 18 years of age among all the urban areas of the state that were studied and reported (1960 Federal Census). The projections for population, per capita consumption and average daily demand are estimated as follows:

Year	Population	GPCD	MGD
1960	28,991	134	3.9
1970	31,800	155	4.9
1980	33,500	164	5.5
1990	35,000	172	6.1
2000	36,800	180	6.7
2010	38,600	186	7.2
2020	40,200	193	7.8

Concord is at the limit of the safe yield of their present sources of supply, namely Penacook Lake and the Pembroke well field. Short term demand could be met either by continued diversion from Turkey River to Penacook Lake and/or additional wells at the Pembroke field. However, future needs will be high enough to require a more reliable source than the present installation for the temporary diversion from the Turkey River.

Manchester. According to an engineering report dated November 1960, the population, per capita consumption and total demand will continue to increase for the next 50 years, projected as follows:

Year	Population	GPCD	MGD
1960	95,000	127	12.1
1970	108,000	137	14.8
1980	122,000	148	18.1
1990	135,000	162	21.9
2000	148,000	174	25.8
2010	165,000	182	30.0
2020*	180,000	190	34.2

*Projection by NED

Projections reveal that sometime between 1980 and 1990, the demand will exceed the supply of Lake Massabesic as the system is presently installed.

Nashua. The projected demand for Nashua should not be based entirely upon population projections. For example, Anhaeuser-Busch will build a brewery just north of Nashua in the Town of Merrimack, along the Merrimack River. This installation is reported to have an initial demand of 3.3 MGD. The Coca-Cola Company is expected to install a plant in the same general area to have an initial demand of 0.5 MGD. The close proximity of Nashua to the large Metropolitan Boston area makes it particularly attractive for major corporations of the kind noted to locate in the Nashua area. The Pennichuck management had an A&E firm study their supply capabilities in 1958. Their projections have been updated by NED, using the Arthur D. Little 1964-1965 "Projective Economic Studies of New England" as a basis for the population projections, along with the Manchester GPCD figures to arrive at following MGD figures:

Year	Population	GPCD	MGD
1960	39,100	127	4.97
1970	46,000	137	6.30
1980	56,000	148	8.29
1990	68,000	162	11.02
2000	82,000	174	14.27
2010	99,000	182	18.02
2020	114,000	190	21.66

The figure of 4.97 MGD for 1960 is substantially correct, but as a result of the drought, the demand actually reached 7 MGD in 1966. However, it has dropped slightly since that time, and does indicate the weakness of population projections times per capita consumption. Since the existing water supply sources, along with rights for added diversion from the Souhegan are capable of a safe yield of 20 MGD, the city should have a reasonable supply to about 2010. However, if large water users such as Anhaeuser-Busch and Coca-Cola continue to locate in the area, the demand will exceed the safe yield well ahead of the timing as presented by these projections. The demand for such large users is not included in the above Nashua projections owing to difficulty in anticipating these large water users. The Anhaeuser-Busch Company has decided to build, but negotiations are still going on with the Coca-Cola Company. The Anhaeuser-Busch Company plans to supply as much of their needs as possible from wells dug on their 300-acre tract, but request the Pennichuck Company to supply the rest. If this occurs, both the Town of Merrimack and the State Public Utilities Commission would perhaps agree to a change in the Pennichuck franchise to allow this service.

8. POSSIBLE SOURCES OF WATER FOR FUTURE DEVELOPMENT

Concord. The Pembroke well field could become contaminated with iron and manganese if pumped beyond 1.6 mgd[1]. Based on test well work performed by others there is also little likelihood of finding another ground water source that would provide a sufficient supply to meet Concord's future requirements. Because of the large storage volume of Penacook Lake in relation to its natural watershed, it lends itself well to diversion of water from another watershed. Diversion of surface water from a suitable source, such as the Contoocook River, into Penacook Lake to supplement its yield as required is an attractive possibility.

There are several possible sources of surface water in the immediate vicinity of the city, but high development cost eliminates most of them from practical consideration. The most economical means of increasing the water supply is considered to be a diversion into Penacook Lake either from the Turkey River, or the Contoocook River. Diversion from the Merrimack River would cost about 50% more than either of these two alternatives. Impoundments, conveyances, treatment, etc. of other surface sources would cost appreciably more based upon back-up data on costs as provided by a recent engineering study[2]. The present arrangement for the Turkey River Diversion should be adequate until the year 1980, at which time further work would be necessary to provide supplies that would carry Concord through to the year 2020.

The Contoocook River could provide a relatively large supply of water (the lowest recorded flow for one day was 50 mgd at the proposed point of diversion at Riverhill). This water also is of higher quality than that of the Turkey River. A pumping station could be built at Riverhill together with 6,000 feet of 18 inch pipe laid, emptying into a stream which naturally flows into Penacook Lake. The flow in Turkey River between 1 June and 1 December is insufficient to allow diversion, but pumping could be permitted year-round from the Contoocook River. At present, it appears that the city will select the Contoocook diversion, rather than extensively modifying the temporary diversion system as now installed at Turkey River.

Manchester. Prior investigations have indicated that ground water supplies are inadequate to meet needs of the magnitude that will be required by 2020 (an additional 20 mgd). Various surface water sources in the area have been studied, and appear capable of

[1] Camp, Dresser & McKee Report, April 1965; page 20.
[2] Ibid, pages 49-55

providing the required quantities of water for well beyond the 2020 time frame. An initial step toward increasing the supply should take place in the early 1980's. It could consist of lowering the present intakes at Lake Massabesic by some 4 feet and would increase the safe yield of 20 MGD to 27 MGD. This is estimated to cost (in 1968 dollars) about $220,000. The projections indicate the added yield would satisfy Manchester's requirements until the decade 2000-2010. Two other developments could follow as necessary. The first would utilize the North Branch of the Lamprey River. Here, an impoundment, a pumping station and 12,000 feet of 18" C.I. would be laid to empty into the Massabesic watershed. This will provide 7 MGD at an estimated cost of about $1,400,000 (1968 dollars). The second improvement would provide an impoundment on the Black Brook to effect an 11 MGD yield at a cost (1968 dollars) of $4,800,000. Cost estimates are based upon data provided by recent engineering studies.[1] These two opportunities would supply Manchester to beyond the year 2020.

Nashua. Diversions from the Souhegan into Pennichuck Brook watershed, plus flow from the Pennichuck Brook watershed, could provide a minimum safe yield of 16 MGD. The safe yield from the Roy Street Wells (2 MGD) and future wells off Route 111 in southwestern Nashua of 2 MGD should result in a minimum safe yield of 20 MGD. This supply could be supplemented when necessary (say after 2010) by withdrawals from the Merrimack River, assuming that by that time the river will be of a more acceptable quality. Another alternative would be to improve the yield of Pennichuck Brook by improving the existing impoundment system. For example, a dam and impoundment at each of two locations, Dunklee Pond and Witch Brook, would increase the yield of the Pennichuck Brook watershed by a total of 3 MGD from the present 6 MGD to 9 MGD. The yield could be further increased from 9 MGD to 11 MGD by repairing the two 60-inch gates at Harris Dam and also by raising the level of the existing Harris Dam. A total of 5 mgd is now being lost because the cost of performing the work is reported as being beyond the means of the private water company now serving Nashua.

The anticipated sequence of improvements is:

a. the new wells in southwestern Nashua (the "Jensen" wells).

[1] Whitman & Howard, Inc., August 1967; and Edward S. Brown, Hanover, N. H., November, 1960

b. increase the capacity of the Souhegan River diversion to 10 MGD.

c. improve the yield of the Pennichuck Brook watershed, by the Dunklee and Witch Brook impoundments, and the Harris Dam improvements.

In addition to increasing the supply, the "Jensen" wells will also assist in the distribution since they are on the opposite side of the city from the main pumping station. The Souhegan diversion is considered as the next logical improvement because it will cost less per MGD capacity than the Pennichuck Brook improvements.

9. FINDINGS

Each of the three cities is, to a considerable extent, economically independent of the other two. Relative to water supply they are independent of each other and have adequate opportunities for future supply. Further, the three cities have as added insurance the main stem of the Merrimack River. For these reasons there has not been in the past any requirement or investigations for a regional water supply system. Each city relies upon its own supply capability. Local sources of supply should provide Concord with water for many decades to come, as well as handle Manchester's increasing residential and commercial demand for several decades. The city of Nashua can be provided with a supply adequate until at least 2020 by increasing the Souhegan River diversion, and by improving the existing impoundment system on Pennichuck Brook. Assuming that these sources were fully developed and the demand equals or exceeds their safe yield (assumed as sometime after 2020) the Merrimack River could be used as a supply source. In the vicinity of the Tri-City area, the Merrimack River is estimated to have a safe yield well in excess of 1,000 MGD.

Although there has not been in the past a serious consideration of a regional supply, there is evidence that as the Tri-City area grows there may be more sentiment for a few large supply sources rather than a number of smaller systems. Examples are the expressed willingness of Concord to supply water to any customer, industrial or municipal, that may request service. Manchester also has plans to expand service not only to the remainder of the 5 adjacent towns it now serves, but also to any other town or industrial customer willing to purchase their water. In fact, they were competing with the Pennichuck Water Works to serve the Anhaeuser-Busch plant in Merrimack.

The Pennichuck Company is desirous of extending its franchise to include the town of Merrimack, and will consider supplying other adjacent towns. Since the three major cities are only 15 miles apart, their systems could in the future years become contiguous. Those various towns without a public supply or with only a limited public supply may wish to connect to these larger systems which could also lead to interconnections between the three major systems.

The Tri-Cityarea is rapidly becoming a major population and industrial complex. The population of the 3 major cities in aggregate will pass the 250,000 mark in the 1990's. If the population from the surrounding communities were served by the three existing water systems this would effect a 250,000 gross population by the 1970's. These communities are, however, adequately meeting their own supply through private wells and small impoundments. Industry that might have located in Massachusetts 20 years ago is now building in the Nashua area, which is but 40 miles from Boston or less than 1-hour travel over improved interstate routes. While Manchester is considered less of a "suburb" of Boston than Nashua, the economic spillover from Massachusetts does have effect on Manchester. This spread is a major factor in the continuing growth of southern New Hampshire, and will likely continue as long as conditions there continue to attract commerce, industry and people.

10. RECOMMENDATIONS

By 1970 the cities of Concord, Manchester and Nashua, New Hampshire will have a combined water demand of about 26 mgd and a population of nearly 200,000. The 1980 projections reveal the population will be nearing the quarter-million mark, and the water demand will exceed 32 mgd. It is also anticipated that both the Pennichuck (Nashua) and the Manchester water systems will have expanded to service adjacent communities. There will be an increasing interdependency in the area with Nashua viewed as the key city for growth. Assistance under the NEWS program is considered justified, with following recommendations for implementation before 1980:

a. In the city of Nashua; install the "Jensen" wells, estimated to cost $160,000; followed by the Souhegan diversion, estimated to cost $60,000.

b. In the city of Manchester; lower the intakes to Lake Massabesic; estimated to cost $220,000. These are construction costs and do not include project design, supervision, and administration cost.

c. In the city of Concord, the present temporary diversion is expected to provide enough water to meet the demand until the early 1980's. No action is believed necessary until 1980, other than further study to determine the timing and scope of later improvements such as the diversion of the Contoocook River.

The improvements noted will take care of the anticipated water demand of the 1980's, as well as initial demands of newer industries such as the Anhaueser-Busch Company and the Coca-Cola Company. More specific timing of these developments would be determined during subsequent phases of the NEWS studies if deemed necessary.

11. CONCLUSIONS

The combined water supply systems of Concord, Manchester and Nashua represent a regional-sized unit considered large enough to comply with NEWS criteria. The three water supply systems are not at this time interconnected so as to result in a truly regional supply system. The cities and their respective suburbs probably should be, therefore, considered separately, and on such a basis, there arises the question of NEWS applicability.

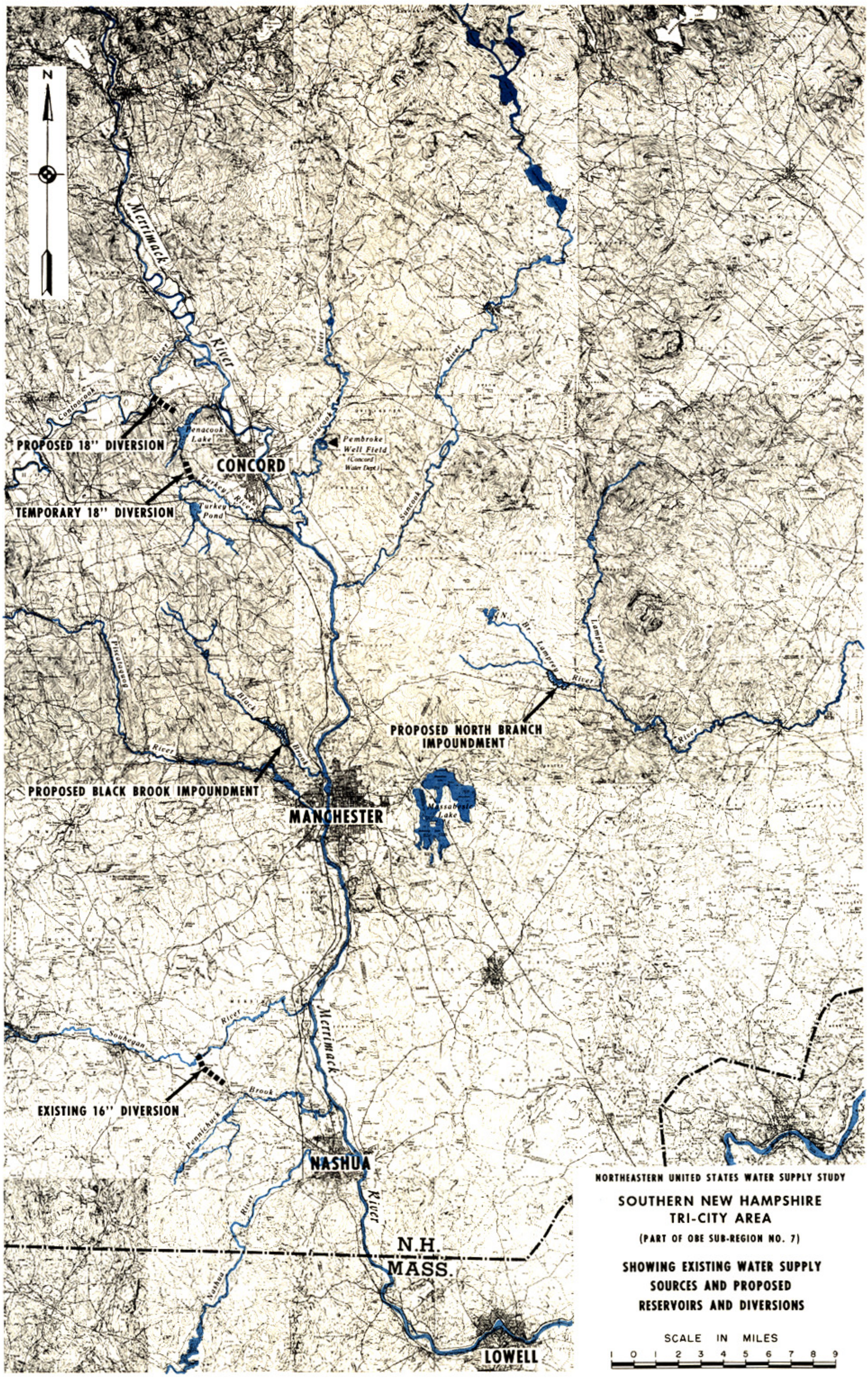
In the case of the Concord system and the proposed diversion of the Contoocook River, and again depending upon the size of the diversion and at the appropriate time, it could be argued that it does or does not qualify as a NEWS undertaking.

Manchester already represents the largest city in New Hampshire, and is surrounded by rapidly growing suburbs. The Manchester system could be improved by modification of their intake and this is programed for the early 1980's. Although no new reservoirs will be required at this time, additional impoundments on Black Brook and the North Branch of the Lamprey River are recommended for installation after the year 2000.

The Nashua system could be expanded by installation of a well field, to be followed by a diversion of 10 mgd from the Souhegan River as well as impoundments of 5 mgd on Pennichuck Brook. We

believe the size of such developments do fall under the NEWS criteria, but these conditions are not expected to apply until after 1980.

A determination by the NEWS study group regarding the above conclusions would be helpful.



NORTHEASTERN UNITED STATES WATER SUPPLY STUDY

SOUTHERN NEW HAMPSHIRE
TRI-CITY AREA

(PART OF OBE SUB-REGION NO. 7)

SHOWING EXISTING WATER SUPPLY
SOURCES AND PROPOSED
RESERVOIRS AND DIVERSIONS

SCALE IN MILES
1 0 1 2 3 4 5 6 7 8 9

PLATE NO. 1