Water Supply for
City of Moscow

WATER SUPPLY STUDY

for

CITY OF MOSCOW

by

CITY OF MOSCOW

ENGINEERING DEPARTMENT

JOHN SIATH
PROJECT ENGINEER
APRIL 16, 1973

TABLE OF CONTENTS

INTRODUCTION

At the present time, the Moscow City Council is evaluating a proposal for treatment of wells No. 2 and 3 for the removal of Iron and Manganese. This treatment facility will require a monetary commitment of approximately three hundred thousand dollars. (page 22 Water Treatment an Alternative Analysis by Stevens, Thompson, Runyan Inc., April, 1972) The principle source of funds will be general revenue bonds.

Before making a determination on treating this proven source of water to improve its esthetic quality, the Council requested a review of the City's Water supply status.

The objective of this report is to evaluate the present and near future water requirements of the City.

POPULATION & WATER DATA

Forecasts of future water demands are commonly based on population estimates and per capita consumption. Population projections for the combined population of the City of Moscow and University of Idaho and for the City of Moscow only were made by Stevens, Thompson, and Runyan Inc., Consulting Engineers in their reports references 1, 2 and 3. These reports attempt to differentiate between the student population of the University of Idaho and the City of Moscow as each operates a separate water system. Considerable confusion and inconsistencies arise from this division of population and subsequent assignment of per capita consumption rates due to one-third to one-half of the student population residing off campus and living within the City of Moscow.

The per capita consumption for the year 1970 was estimated at 170 gpd (gallons per day) with a projected demand of 180 gpd by 1980. (2) Actual records for the City of Moscow show that a consumption rate of 200 gpcd was experienced in 1970. This is one inconsistency. The report also projects an average of 1.28 mgd while the actual average daily consumption for 1970 was 1.50 mgd. (2)

For the purpose of this report, future water demands are projected to 1980 based on the acutal increases experienced since 1960.

Table I shows the water usage records for the City of Moscow from 1965 to 1972.

TABLE I
WATER USAGE 1965-1972

YEAR	DAILY AVE. mg*	MAXIMUM DAY mg	RATION MAX. DAY TO AVE. DAY
1965	1.20	3.38	2.82
66	1.38	4.14	3.00
67	1.48	3.89	2.62
68	1.45	3.93	2.71
69	1.40	3.79	2.70
70	1.50	4.40	2.95
71	1.55	3.23	2.11
72	1.60	4.21	2.65

*million gallons

The projected annual daily demand is shown as a linear function in Figure I.

The ratio of annual daily average to maximum day demand has been 3.0 which supports the findings of the Pullman-Moscow Resources Committee Report. (1)

Table II contains the projected average daily demand and the maximum daily demands to the year 1980.

SHEET NO. .... OF ....
JOB NO. ....
BY .... DATE ....

FIGURE I

Projection of Annual Average Day Consumption

YEAR	CONSUMPTION (MG)
1972	1.60
73	1.66
74	1.71
75	1.77
76	1.83
77	1.88
78	1.94
79	2.00
80	2.06

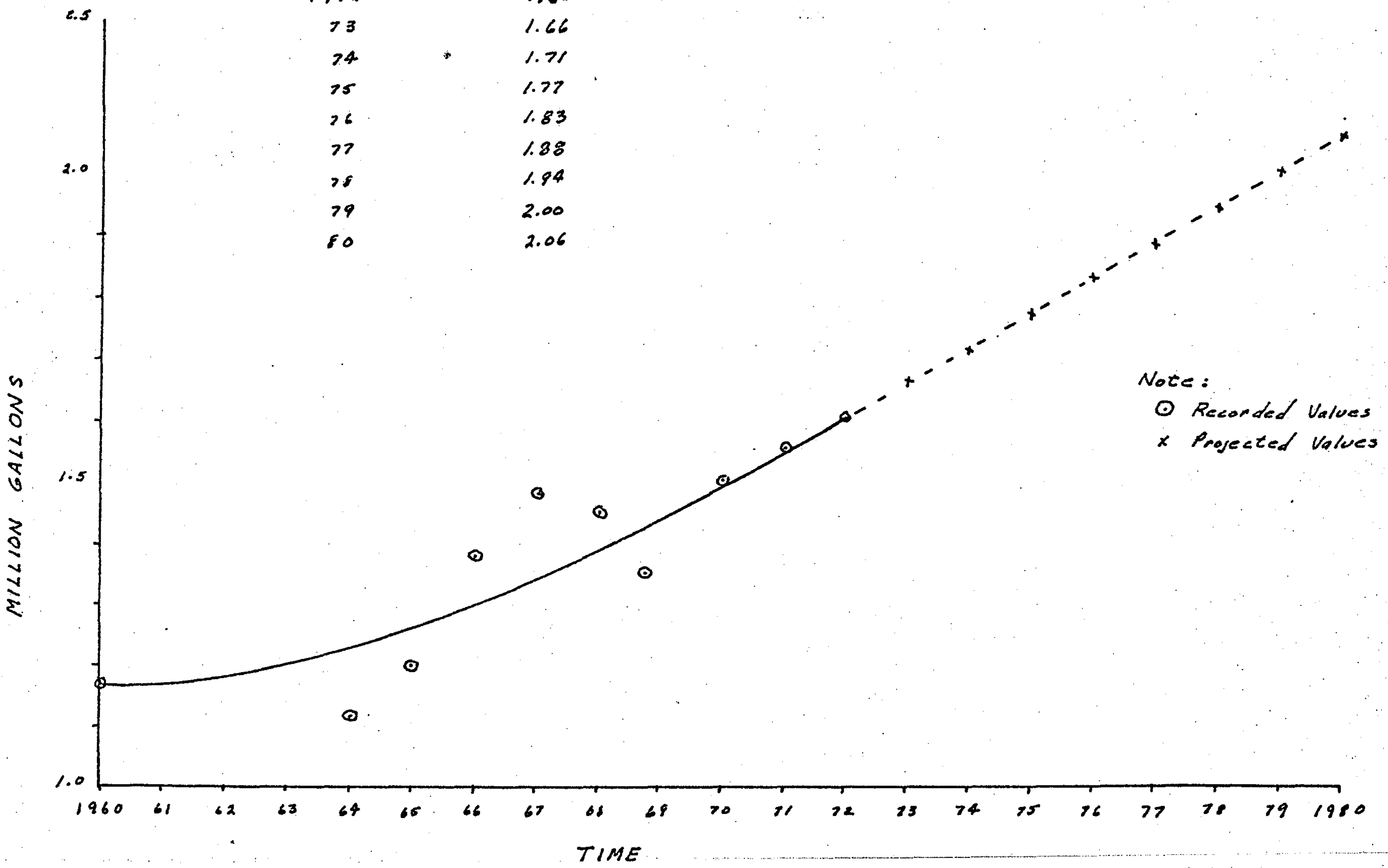


TABLE II
PROJECTED DEMANDS

YEAR	DAILY AVE. mg	MAX. AVE. mg
1973	1.657	4.971
74	1.714	5.142
75	1.771	5.313
76	1.828	5.484
77	1.885	5.655
78	1.942	5.826
79	1.999	5.997
1980	2.056	6.168

Fire flow requirements have been established by the National Board of Fire Underwriters in "Standard Schedule for Grading Cities and Towns of the United States," 1956. The recommended flows of ten hour duration are:

POPULATION	FLOW gpm*	REQUIRED STORAGE for 10 hrs (mg)
6,000	2,500	1.5
10,000	3,000	1.8
13,000	3,500	2.1
17,000	4,000	2.4

* gallons per minute

The following tabulation indicates the total projected flows to the year 1980. Water needs for the University of Idaho were not included in these projections. If the City were to furnish water to the University, which is possible with the present interlocking systems, the maximum day demands would increase from 40 to 50 per cent.

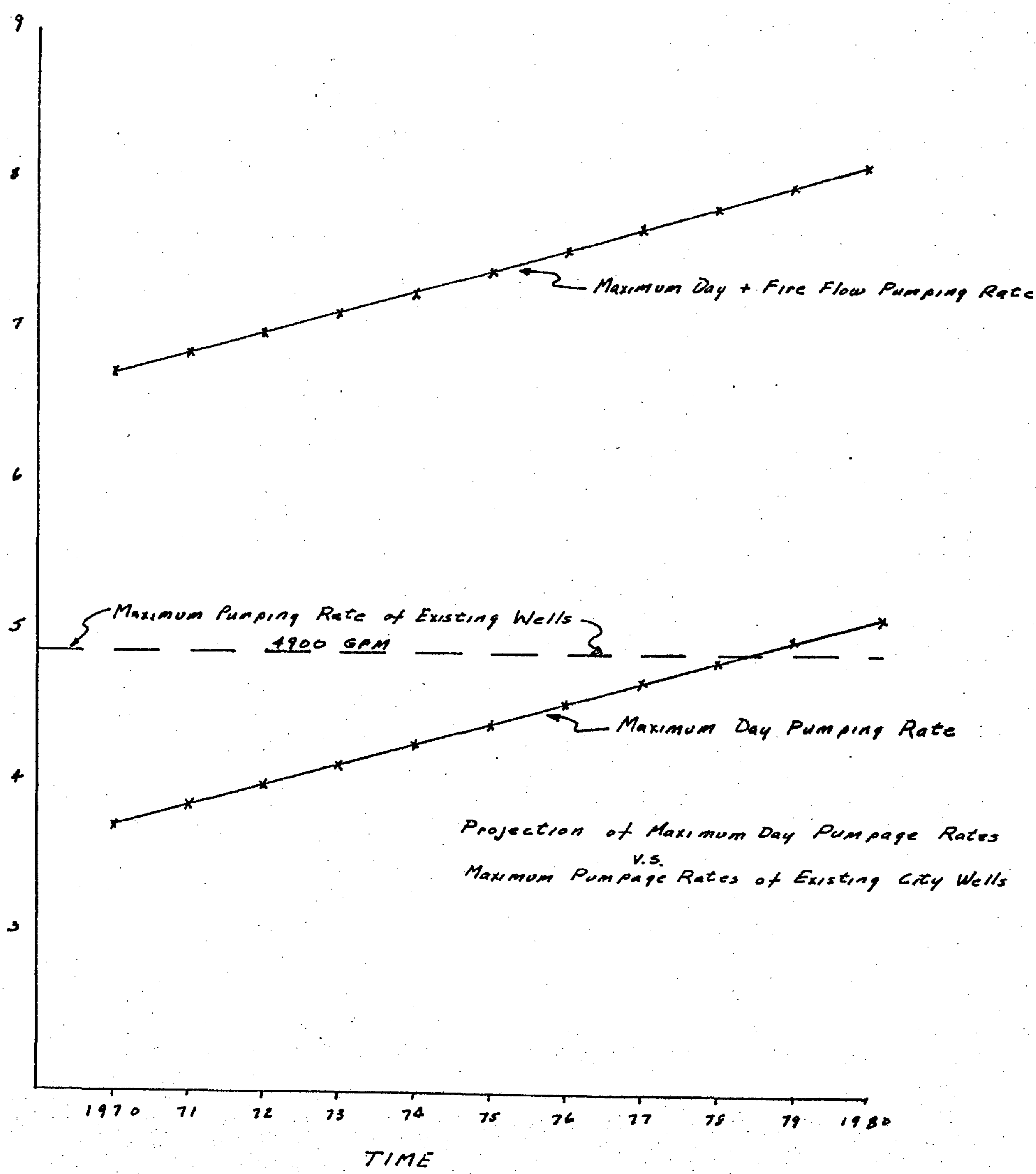
Table III summarizes the projected flows for the City through 1980.

TABLE III

TOTAL PROJECTED FLOWS CITY OF MOSCOW

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Average Day (mg)	1.50	1.55	1.60	1.66	1.71	1.77	1.83	1.88	1.94	2.00	2.06
Peak Day (mg)	4.50	4.65	4.80	4.97	5.14	5.31	5.48	5.66	5.83	6.00	6.17
Fire Flow (10 hr) mg	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80
Peak Day (gpm)	3750	3875	4000	4142	4283	4425	4567	4717	4858	5000	5142
Peak Day & Fire (10 hr) gpm	6750	6875	7000	7142	7283	7425	7567	7717	7858	8000	8142

FIGURE II


9
8
7
6
5
4
3
Maximum Day + Fire Flow Pumping Rate
Maximum Pumping Rate of Existing Wells
4900 GPM
Maximum Day Pumping Rate
Projection of Maximum Day Pumpage Rates
V.S.
Maximum Pumpage Rates of Existing City Wells
1970
71
72
73
74
75
76
77
78
79
1980
TIME

EXISTING CITY FACILITIES

The pumping capacity for the City of Moscow is shown in Table IV.

TABLE IV

PUMPING CAPACITIES OF CITY WELLS

WELL NO.		PUMPING RATE GPM
2		1,200
3		1,300
6		1,300
8		1,100
	TOTAL	4,900

To augment this supply the City has 2.8 million gallons of elevated storage facilities. They consist of 300,000 gallon N.W. tank, 500,000 gallon N.E. tank and a 2 million gallon S.E. reservoir. These facilities serve a dual role in that the stored water is used to meet the variations in demands and provide a reserve for contingencies, such as fire.

WATER REQUIREMENTS

The projected maximum day demand for the City of Moscow in the year 1978 is 5.83 million gallons which is to be supplied at a rate of 4900 gpm. To meet this demand maximum pumpage from the City's four wells is necessary. (Fig. II) The fire requirements of 1.8 mg supplied at a rate of 3000 gpm, in addition to the maximum day demand must be made available. Utilizing the system analysis done in 1962 by Stevens Thompson and Runyan and incorporating the additional loadings and storage of the S.E. reservoir, the N.E. tank was emptied in seven hours. This falls short of the minimum requirement of ten hours by NBRU standards.

Conducting a similiar analysis for the year 1980, the results show 95% storage deplection with the N.E. tank emptied in four hours. The high loss in storage is partially related to the maximum day demand which cannot be met by the city's existing facilities.

CONCLUSIONS & RECOMMENDATIONS

The City's current water supply obligation is threefold; domestic requirements, irrigation and fire reserve.

There is no immediate problem in meeting the domestic requirements.

Irrigation is the demand which when combined with domestic consumption dictates an additional well in operation before 1978. The 2.8 million gallon storage capability of the City is currently utilized in supplying peak irrigational demands placed on the system. At the present time, the 4900 gpm pumping capability of the City wells will not satisfy the peak demand which is known to exceed 6000 gpm and probably reaches 10,000 gpm. Every attempt is made to replentish these reservoirs during the early morning hours.

It should be recognized that pumping 4900 gpm from twelve midnight until 8 A.M. amounts to 2.35 mg and during this time period, there is a consumptive demand on the system. When the City approaches a time period of 24 hour pumpage to satisfy the irrigational and domestic demand, total recovery of the reservoirs will not be possible.

For several years the City has not satisfied the requirements of the National Board of Fire Underwriters on peak demand days. This situation will continue to deteriorate until either additional storage or a new well is provided or the combination of both.

Considering that averages were used in this report to project water demand, it is reasonable to assume the possibility of an unusually dry year at which time water rationing would be required.

With the possibility of drilling a "dry hole" and other delays, it is recommended that well nine be started late this year or early 1974 with completion and production scheduled for mid 1976. It is further recommended that above ground storage be seriously reviewed in terms of providing both fire flow and a reserve for peak demand draw down.

The alternative to this is to regulate irragation during peak demand periods.

REFERENCES

1. Master Plan for Water Distribution System, Moscow, Idaho, by Stevens & Thompson, December, 1962.

2. Water Treatment, An Alternative Analysis by Stevens, Thompson & Runyan Inc., April, 1972.

3. Water Supply Study, by Stevens, Thompson and Runyan, Inc., August, 1970.

ADDENDA TO WATER SUPPLY
STUDY OF APRIL 16, 1973

by

CITY OF MOSCOW

ENGINEERING DEPARTMENT

TABLE OF CONTENTS

INTRODUCTION

To ananlyze a water system such as ours, the first problem is to identify the demand. This can be done by determining (1) a population growth, (2) per capita per day average consumption, and (3) peak day to average day ratio. With this method the projected demand for any period in time is a direct function of population. A second and simpler method is to project growth in demand on past experience. This is the approach used in our report submitted April 16, 1973. The reason this method was selected is the amount of confusion existing on the percentage of the population attributable to the University of Idaho that is supplied by the City system. In simple terms, our April 16 report projected demand on a straight line function based on the weighted average of the previous 10 year's growth. Normally growth is a log function following a parabolic curve, however, for a short time period, such as the 7 years involved here, it was felt that an adequate and rational projection could be achieved with a straight line function. This projection will probably prove to be conservative. No exception is taken with this projected demand in this addenda.

Once demand is established, the question is satisfying this demand. This involves three components of the system, (1) supply (2) distribution and (3) storage. In order to limit the scope of analysis, water line distribution system has been arbitrarily deleted from both studies. This leaves supply (wells) and storage.

Considerable time and effort went into analyzing the interaction of these two water supply components prior to drafting our April 16 report. To evaluate the unknowns within these two components of our system, we feel a need first to define what the known facts are.

ANALYSIS OF EXISTING SYSTEM

From previous report, the City's pumps have a rated capacity of 4,900 gpm and the City has a storage capacity of 2.8 mg. These four pumps are activated automatically by monitors in the storage units. It is known that this off/on procedure results in approximately 20 hours of effective pumping or an efficiency rate of 83 percent. This percent is supported by City records.

The next fact is that we should be maintaining 1.8 mg of fire reserve based on our present population. This leaves 1 mg of our 2.8 mg storage as useful storage.

In summary these four facts are:

1. Total pumping capability = 4,900 gpm
2. Effective pumping capability = 4,067 gpm (equals 83% x 4900)
3. Total storage = 2.8 mg
4. Required fire reserve = 1.8 mg

EVALUATION OF EXISTING SYSTEM

The obvious conclusion to be drawn from the known facts is that pumping 24 hours per day at 4,067 gpm, the four City wells can supply 5.8 mg per day, which will satisfy our domestic needs until 1978. This calcualtion is simple enough and should be the answer. This was presented in Figure II of the report submitted April 16, 1973.

To confuse the issue, we have used almost our entire storage including fire reserve to meet the demand placed on the system during a single day. How can this happen? Simply, the water is not consumed evenly over the entire 24 hour period. It is used during the daylight and evening hours in varying quantities of demand.

This phenomenon has been known and documented for some time and is the reason for our dissatisfaction in the report presented April 16.

We had not evolved the methodology for a rational approach to presenting this particular problem, that the majority of the water supply is consumed in something less than 24 hours.

At the recent AWPA convention in Bozeman, Montana, Mr. David Husby, senior partner, Reike, Carroll, Muller & Associates of Minneapolis, Minnesota presented the following during his discussion of Water & Sewer Planning.

1. Daily consumption occurs during a 16 hour period, (probably from 6 A.M. to 10 P.M.)

2. This demand has to be supplied during this 16 hours by pumpage plus excess storage over fire reserve

3. Relationship of storage to supply is a function of the recovery pumpage capability during the remaining 8 hour period of the day.

Figure I was developed applying this criteria to the City of Moscow. The maximum pumpage from the City's four wells at 83% efficient during 16 hours is 3.92 mg. This is 1.05 mg short of supplying the projected peak day demand during 1973. This also indicates that the fire reserve has to be utilized to meet the total peak day demand during this coming summer. From 1973 on, this situation continues to deteriorate.

The pumping capability during the remaining eight hours is 1.92 mg which is adequate to replenish the storage.

ANALYSIS OF FUTURE DEMANDS

Figure II and Figure III have been prepared to show the relative effects of adding an additional 1,200 gpm well and a 1 mg storage reservoir.

It is necessary to consider additions of a well before adding a storage reservoir due to the requirement of recouping the storage capacity during the eight hour period from 10 P.M. until 6 o'clock in the morning. Five wells will give a combined total output of 6,100 gpm or an effective 5,063 gpm. This 5,063 gpm will recover 2.43 mg in storage. Assuming a population growth warranting 2.1 mg in fire reserve, this equates to 4.5 mg of total storage.

Figure II shows the effect of adding an additional well at 1,200 gpm. This would satisfy the demand requirements until 1978 when additional storage is required.

Figure III shows the combined effect of additional storage and the additional well.

RECOMMENDATIONS & CONCLUSIONS

The City can meet the domestic and irrigational demands on its system until 1978 only by utilizing its fire reserve. During 1978 additional storage, or a new well will be required or serious consideration will have to be given to controlling irrigation.

To meet the fire reserve requirements set by the National Board of Fire Underwriters, an additional well or storage is necessary now. As pointed out in discussion, a well is recommended due to inability of our present system to recover additional storage. In addition to maintain this fire reserve capability, a combination of both a well and additional storage will be required before 1978.

This report does not include similar problems existing with the University of Idaho system, nor does it consider the present problem with our distribution system.

VC DATE 5/3/73 SUBJECT EXISTING CONDITION SHEET NO. 1 OF 3
BY JCS DATE JOB NO.

ELEVATED STORAGE

TABLE

YEAR		MAX. DAY DEMAND (m.g.)
1970	=	4.50
1971	=	4.65
1972	=	4.80
1973	=	4.97
1974	=	5.14
1975	=	5.31
1976	=	5.48
1977	=	5.66
1978	=	5.83
1979	=	6.00
1980	=	6.17

LEGEND

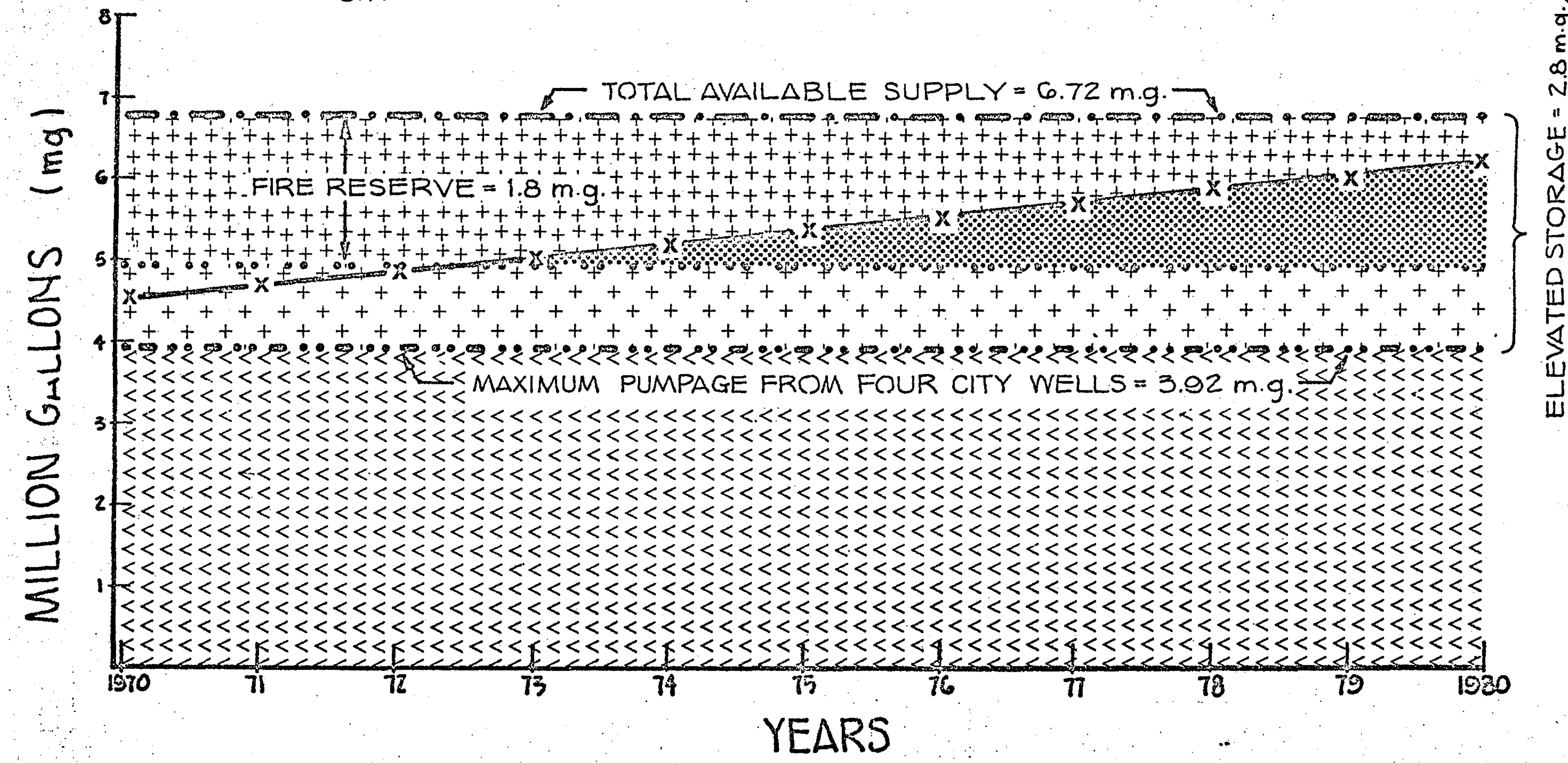
X = PROJECTED MAX. DAY DEMAND

(+ + +) = FIRE RESERVE

(shaded) = FIRE RESERVE DEPLETION

(+ +) = ELEVATED STORAGE

(> > >) = MAX. QUANTITY AVAILABLE



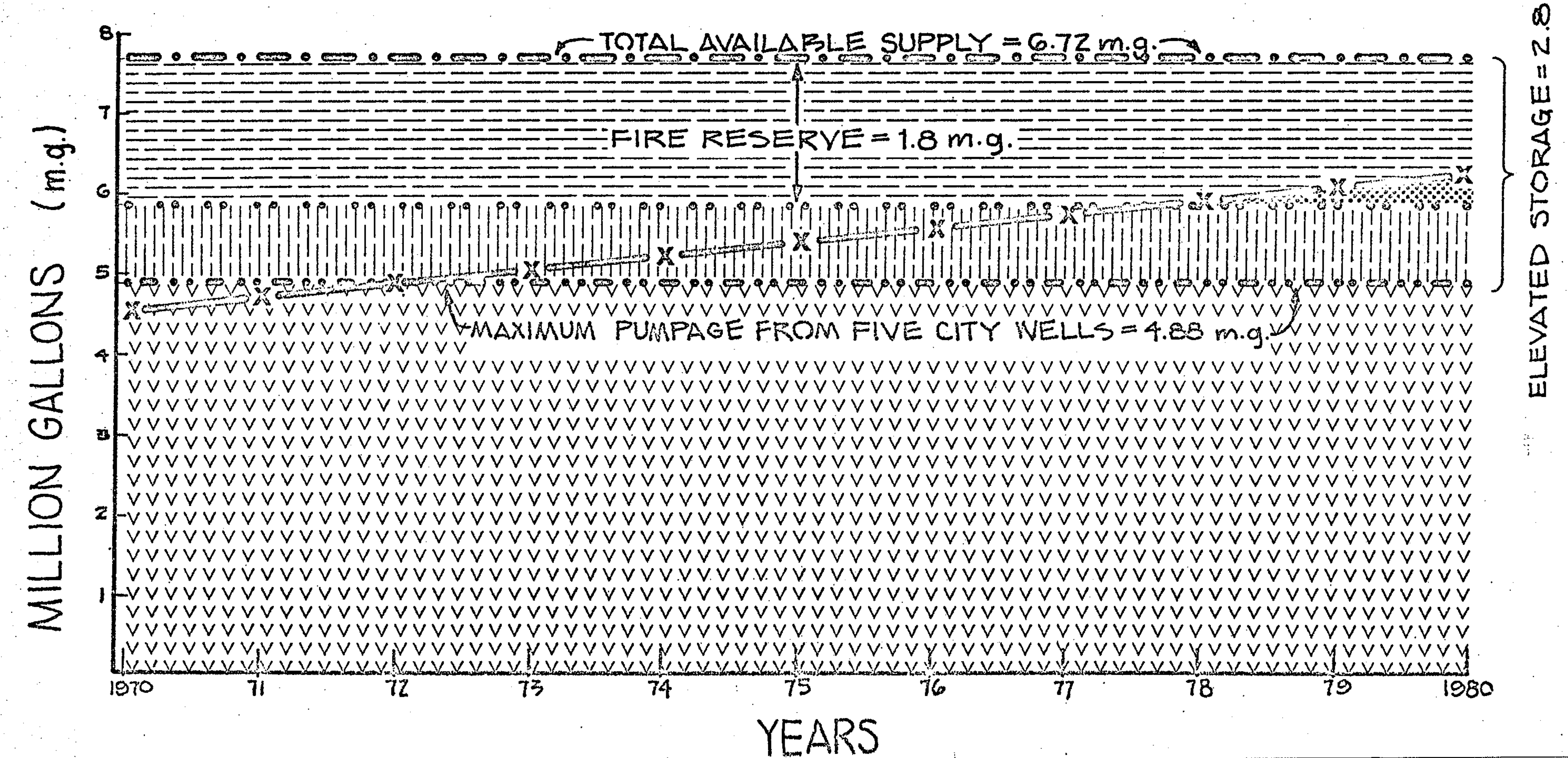
ELEVATED STORAGE

TABLE

YEAR		MAX. DAY DEMAND (m.g)
1970	=	4.50
1971	=	4.65
1972	=	4.80
1973	=	4.97
1974	=	5.14
1975	=	5.31
1976	=	5.48
1977	=	5.66
1978	=	5.83
1979	=	6.00
1980	=	6.17

LEGEND

X = PROJECTED MAX. DAY DEMAND
= FIRE RESERVE
= FIRE RESERVE DEPLETION
= ELEVATED STORAGE
= MAX. QUANTITY AVAILABLE



MAXIMUM DAY DEMAND and FIRE RESERVE vs ELEVATED STORAGE

TABLE

YEAR		MAX. DAY DEMAND (m.g.)
1970	=	4.50
1971	=	4.65
1972	=	4.80
1973	=	4.97
1974	=	5.14
1975	=	5.31
1976	=	5.48
1977	=	5.66
1978	=	5.83
1979	=	6.00
1980	=	6.17

LEGEND

- X = PROJECTED MAX. DAY DEMAND
- = FIRE RESERVE
- = FIRE RESERVE DEPLETION
- = ELEVATED STORAGE
- = MAX. QUANTITY AVAILABLE