SHOULD GENESEE COUNTY CONTINUE TO RELY SOLEY ON A SINGLE 72" DIAMETER WATER MAIN TO SUPPLY ITS WATER SYSTEM OR SHOULD IT PURSUE AN ALTERNATIVE IN ORDER TO INSURE A SAFE RELIABLE SUPPLY

by

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OVERVIEW

The intent of this paper is to examine the current method for supplying a potable backup water supply for the Genesee County water distribution system in the event that the Detroit Water and Sewerage Department's (DWSD) single 72" diameter transmission main fails. This main feeds the entire County and City of Flint's water distribution systems. It will then propose and evaluate feasible alternatives of operation in the event of main failure. The best alternative will then be selected, and an analysis of how such a project would be financed by the County will conclude the paper.

Concisely, the paper will address the following question:

> "Should the County continue to rely solely on the single 72" diameter transmission line as the only supply of water with the possibility of the City's treatment plant as a backup, or should it pursue an alternative to serve the area in the event of the 72" diameter line failing?"

Currently the City and County receive their water supply via a single 72" diameter supply line extended from one of DWSD's booster pumping stations near Imlay City. The raw source of water for the system is Lake Huron, with processing at DWSD's main treatment plant in Port Huron. The average daily demand for the combined City and County systems is approximately 30 million gallons.

If this pipeline were ruptured or had to be taken offline for repairs for an extended period of time, the only other current operational alternative available to the County would be to utilize treated water from the existing City of Flint treatment plant. This plant was originally designed to process approximately 24 million gallons per day of Flint River water at the quality capable of meeting the Environmental Protection Agencies (EPA) standards

for clean water.

However, even with current capital improvements completed on the plant, it is the consensus of those directly related in the water service supply sector that it may not be currently in an adequate state of operation to supply sustained required demands and meet the required water quality in case the 72" diameter main failed or had to be taken out of service.

As a result, the City of Flint and Genesee County water supplies are in jeopardy if there is any disruption in service of the 72" diameter transmission main. In order to fully analyze this situation and the possible consequences, the paper will separate the issue into the following major topical areas:

1. Background on the County water supply system.
2. Current configuration of the County water system.
3. Presentation of the current method of operation of the County water system. This section will also include the benefits, risks, and direct costs of utilizing the 72" diameter main as the backup supply of water.
4. Presentation of viable alternatives to the current method of backup operation to reduce or eliminate the effects of the 72" diameter main failing. This section will also present the benefits, risks, and costs associated with each of the proposed alternatives.
5. Implementing and/or financing the selected best method or alternative of water system operation.

I. BACKGROUND

The Genesee County Drain Commissioner was created under Act 342 of 1939 which gave authorization to establish and provide connecting water, sewer, sewerage disposal services, and their improvements within or between cities, villages, townships, and township improvement districts as well as any authorized and established combinations thereof within

or crossing inter-county boundaries. It also gave authorization to establish and provide solid waste collection and disposal facilities and services for these units of government.

The Act also confers the authority to provide methods for obtaining funds for these purposes, and to provide for the loan of funds to the individual units of government for the above purposes. It also provides the authority for securing money from federal and state sources for major public projects. Repayment of these loans is provided by the ability of the County agency to charge sewer and water user rates, assessments, and tap in fees to new and existing users of the public systems.

More specifically, the Division of Water and Waste Services (WWS), was formed as a County agency under the above mentioned Drain Commissioner's Law as Act 40 of the Michigan Public Acts of 1956. The Act established the ability for WWS to acquire; construct; own; maintain and/or operate; water mains, water pumping stations, water meter pits, water purification plants, sewers, sewerage interceptors, sewage pumping stations, sewage disposal plants, and sewage meter pits within Genesee County. There are also instances where WWS has extended public services into Livingston and Shiawassee Counties, of which, the authority to do so is outlined under Act 342's franchise agreements between counties. Thus, WWS is the responsible agency for insuring the safe and efficient delivery of potable water to county wide customers excluding the City and other municipalities that still operate their own well systems.

The legislation which WWS must adhere to in providing this service is the State of Michigan Safe Drinking Water Act 399 P.A. 1976 and its administrative rules. This Act was created to protect the public health; to provide for supervision and control over public water

supplies; to prescribe the powers and duties of the department of public health; to provide for the submission of plans and specifications for waterworks systems and the issuance of construction permits therefor; to provide for the classification of public water supplies and the examination, certification, and regulation of persons operating those systems; to provide for continuous, adequate operation of privately owned, public water supplies; to authorize the promulgation of rules to carry out the intent of the Act; and to provide penalties.(1) The agency assigned the responsibility of carrying out Act 399 is the Michigan Department of Public Health (MDPH).

Originally, the only public water distribution system in the County was developed and owned by the City of Flint beginning in 1903 when they took over a private water distribution system.(2) This was due to the fact that, at the time, there was not a need for any municipal water system outside of the City due to a lack of development.

The City's first water treatment facilities were completed in 1917 at their present site on Dort Highway adjacent to the Flint River, which was the primary source of water.(3) This original plant, called Plant No. 1, was expanded in 1938, and a second treatment plant called Plant No. 2, which was constructed on the same site as the first, was completed in 1954.(4) Please see Appendix E beginning on page 97 for a map showing the location of the two plants on the site. As a result, the expanded original plant had a capacity of 35 million gallons per day (mgd), with the second plant providing an additional capacity of 24 mgd. Both plants were designed to soften and treat Flint River water by chemical coagulation, gravity clarification, and sand filtration.

By the mid-1960's the demands of the Flint water system were beginning to approach

the reliable yield of the Flint river. Also, deteriorating water quality and the need to maintain a minimum river basin flow for sewage treatment effluent dilution were causes for concern. Thus, in December 1965, Flint negotiated a wholesale water purchase agreement with the City of Detroit to buy treated Lake Huron water from their new treatment plant north of Port Huron.

Of the over 200 customer water supplies in the lower peninsula of Michigan, the DWSD provides water to approximately 120 of them. Their system operates and maintains 20 pumping stations and reservoirs as well as 5 treatment plants utilizing three different raw water intakes.

Service was provided in December 1967 through a single 72" diameter pipeline extended from one of DWSD's pumping stations near Imlay City to the treatment plant site on Dort Highway. This pipeline is capable of delivering 120 mgd to the City and County when DWSD utilizes their pumping capacity available at their pumping facility near Imlay City.

After service from the DWSD was initiated, both Flint treatment plants were retained as stand-by sources of supply in the event a failure was to occur in the 72" diameter transmission main. The plants were originally operated once or twice a year to keep them in working condition and to keep plant personnel familiar with the equipment and operational procedures. Detroit's master plan, at the time, was to provide a second pipeline by about 1980, which would allow the City to permanently retire the treatment facilities.

To date, the second pipeline from Detroit has not been constructed and it does not appear that it will be in the foreseeable future. In the years since 1967, the condition of

Flint's treatment plants have deteriorated to the point where their original 35 mgd treatment facility, Plant No. 1, is no longer operational and is scheduled to be demolished.

The newer 24 mgd treatment facility, Plant No. 2, has had extensive capital improvements over the past five years, and could be expected to meet the average day demand of 30 mgd required by the combined water systems of the City and County. Whether or not the plant could provide this flow cannot be confirmed, because the plant is started only four times a year, never in the summer, and run for five days at a time which never allows for operation at full capacity. As additional years pass, the plant will become less and less capable of meeting the required City and County demands due to further deterioration. Thus, the City and consequently the County are presented with a remedial solution to alleviate the failure of the 72" transmission main.

The County has been operating as part of this single feed main situation since 1967, when they began to buy wholesale water from the City of Flint. At that time, the County's distribution system was a fraction of the size of the City's and the only way to get good quality water at an affordable price was to connect to the City system. As a result, the County, as a contracted customer of the City, was locked into whatever means Flint made to secure water for the distribution systems. Under this arrangement, which still holds today, water is sold to the Genesee County Drain Commissioner's Division of WWS, which provides wholesale and retail service to municipalities and townships in the County.

Prior to 1987, about 85 percent of the volume sold to the County was conveyed through the City's own distribution system to master meter locations on the west side of the City, where the County operated two separate pressure service areas.(5) Please see

Appendix A beginning on page 81, which shows a map of the complete County water system.

The northern service area, generally along and north of Pierson Road, was supplied by the Carpenter Road and Pierson Road master meters, and operated at a lower pressure than the southern service area. The southern area included Flint Township, Swartz Creek, and other areas generally south of Pierson Road, and was supplied by the Donaldson master meter and emergency connections at Beecher Road and Van Slyke Road.

Over the years, though, the demands of the County water distribution system demands steadily increased to a point where it was increasingly difficult for the City system to supply the County's maximum day demand. A significant crisis developed in June of 1983 when some of the County's storage reservoirs were nearly exhausted, and water had to be rationed in some areas.

This condition led to the City and County contracting with a consulting firm in 1985 to study both of the distribution systems. The study consisted of five basic parts as follows:

1. Estimate future average and peak water use in the City of Flint and the County.
2. Develop a computer model of the combined distribution systems.
3. Calibrate the combined distribution systems model using flow and pressure data from June of 1983.
4. Analyze various methods and system improvements to best serve the County's west side customers.
5. Present conclusions and recommendations in their report.(6)

The improvements ultimately recommended by this study called for capital and operational improvements to both the City and County systems. However, this report still proposed to leave both the City and County systems as combined distribution systems, which meant that the County would still receive their water from the City's master meter locations.

This method of operation was becoming increasingly unacceptable for the County and, as a result, they began to analyze other solutions for supplying City water to their customers. This action was felt necessary if the County was to meet the current and future water demands that would be imposed on the system as it expanded.

The solution settled upon was for the County to construct their own feed points off of the 72" diameter transmission main before it terminated at the City's water treatment facility. This, in essence, provided the County their own supply of water and would separate them from the City system. However, the County would still remain a direct customer of the City by buying the water from them. Thus, the master meter configuration of water supply to the County from the City sources would be closed, and the County would have its own operationally independent water distribution system, fed directly from the DWSD's 72" diameter main. This project became known as the south water loop and construction began in 1987.

The major factors that propelled the County to opt for establishing their own separate water system were as follows:

1. Continued economic growth in the County.
2. The ever increasing demand for County supplied water and the continued lack of ability for the combined system to supply water to the County at the required flow and pressure.
3. The need for the County to have more control in supplying water to their own customers.

Factor one meant that, as economic growth in the County increased, a power shift, in terms of economic strength, was taking place. The County was benefitting from the trend for families and industry to relocate in the County and away from the City. In addition,

there was also considerable interest in major commercial, industrial, and residential development in the southern part of the County, namely Grand Blanc and Fenton Townships, by interests inside and outside of the County.

Also, the population in the County had a higher average per capita income than City residents. This larger economic base ultimately provided the County with the necessary monetary backing to improve their distribution system, and, as a result, they were able to provide a distribution system independent of Flint that would better serve their customers.

Factor two was the direct result of factor one in that, as more and more customers came into the County system, the demand for water was increasing to where the combined distribution system could not supply it. This condition, if left unresolved, could have resulted in a lack of development in the County due to the inability to meet the required demands.

Factor three was a direct result of the County system evolving to where it was now a major water supplier in terms of demands and customer base, and, like any organization seeking organizational efficiency for the product they supply, it sought to assume control of its own operation. This could not have been achieved had they stayed a combined system with the City because of the limited flow and pressure capability of their system.

Even though, as a result of the south water loop, the County would now be operationally independent from the City system, it would not be contractually independent. The County had/has a direct contract with the City of Flint for their water supply, and the City of Flint has a direct contract with the DWSD to receive both water systems entire water supply through the 72" diameter transmission main. The current contract between the City

and the DWSD is set to expire in the year 2000.

The current physical water supply feed configuration to the City and County exists because the City built and paid for the construction of the 72" diameter main from the DWSD's 72" diameter main at Baxter Road and Potter Road on the east side of the County to the City's treatment plant site.

Due to the contractual situation between the City and the DWSD, the County essentially has no direct say in any of the DWSD's operating or rate making decisions pertaining to the delivery of water to Flint. The County must direct any formal problems or questions directly to the City, who would then convey the problem to the DWSD.

The current water contract between the County and the City was created June 28, 1973. This contract was for the City to supply and sell water exclusively to the County Agent, the Drain Commissioner, for a period of 40 years. The City's contract with the DWSD was created December 20, 1965.

The City/County contract was amended in March 9, 1981 pursuant to judgement by the State of Michigan Circuit Court to settle a water rate dispute between the City and County. It was the County's position that water being taken directly off of the 72" diameter line should be charged at a lower rate than water being taken directly off of the City system, and the court agreed. The contractual life of 40 years in the original contract and everything else essentially remained the same.

On March 31, 1988 the City and County agreed to a supplemental agreement and amendment to the original contract. In this amendment, the following ten issues were addressed:

1. Approval by the City for the County to construct the South Water Loop.
2. Easements by the County to the city for the construction of a new East/West line by the City to connect to a new North/South DWSD line.
3. The number and locations of County connections to the proposed North/South DWSD line.
4. Rate amendments to the 1981 amendment for the County upon connection of the new North/South DWSD line.
5. Minimum usage of County taking water off of the existing 72" diameter and the new DWSD line.
6. Utility basis of rate making between the City and County.
7. Extension of water agreement between the City and County.
8. Amendments to the Detroit contract.
9. Easements from the City to the County for water main construction purposes.
10. Assistance and consultation for land application of sanitary operations sludge from the City.(7)

Item one dealt with the City approving the County's plans for constructing the south waterloop. This would enable the County to take water directly off of the 72" diameter supply line, and, thus, separate the two systems.

Item two dealt with the City constructing a second East/West supply line to connect to the proposed DWSD's North/South line. These projects would supply the City and County with a second supply source of water from DWSD should the existing 72" line fail. This item also provided the agreement that the County would grant the City any necessary easements to construct any portions of the East/West line through County land.

Item three dealt with the County connecting to this new East/West line. The City secured at least three connection points from the DWSD for the County to connect to.

Item four dealt with the structure of the water rates charged by the City to the County for taking water off of the proposed line. These rates were to be the same as the

rates charged in the 1981 amended contract.

Item five addressed the locations that the County would take water off of the two supply lines. That is, until the County's average day consumption became more than 10 million gallons, they would be required to take water only off of the existing 72" diameter line.

Item six dealt with section 123.141 of the Michigan compiled laws that requires water rates be determined on the basis of actual cost of service as determined under the utility basis of rate making. This section basically provided the verbiage that the City and County would agree to abide by these laws in establishing water rates for the County.

Item seven dealt with the extension of the contract between the City and County. The revised contract called for termination of the current contract under the following conditions:

1. December 31 of the year 2020 or
2. December 31 of the year the final payment would be due on the bonds issued by the City to finance the construction of the proposed East/West line and the demolition of its existing water treatment plant, but not before the year 2013.(8)

Option two has not been exercised since the East/West line still has not been built and the treatment plant demolished.

Item eight dealt with the City agreeing to bargain for the County in good faith with the DWSD to obtain for the County, the exclusive right to sell water obtained from the DWSD through the City to areas outside the County.

Item nine dealt with the City granting the County an easement on a piece of land that it would need for building water main for this project.

Item ten dealt with the County agreeing to provide the City with reasonable consulting and assistance to enable the City to operate its own sanitary sewer sludge land application program.

The major accomplishments of this agreement were the approval of the County to build the south waterloop, which would separate the two systems, and that the City and DWSD proposed to build the second supply line to feed the City and County. However, while the south water loop was built by the County, the City's East/West line and DWSD's North/South line were not.

II. CURRENT COUNTY WATER CONFIGURATION

The current County system has grown to serve the following municipalities and townships listed in Table 1 below.

Table 1

City's and Townships Served by the County Water System

CITY	TOWNSHIP
1. Burton	1. Davison
2. Flushing	2. Flushing
3. Montrose	3. Montrose
4. Clio	4. Vienna
5. Swartz Creek	5. Mundy
6. Mt. Morris	6. Mt. Morris
	7. Flint
	8. Genesee
	9. Grand Blanc
	10. Clayton
	11. Gaines

It should be noted that not every commercial and domestic entity is connected to the distribution system even though the community is part of the system. There are a lot of

areas that the public water system simply does not extend into at this time. Table 2 below, current to July 1992, shows the number of metered water customers for each community in the County system.

Table 2

Metered Water Customers Per Community

MUNICIPALITIES	SERVICE CONNECTIONS
Clayton Township	353
Davison Township	887
Flint Township	4,969
Flushing Township	1,068
Gaines Township	283
Genesee Township	1,338
Grand Blanc Township	1,652
Montrose Township	74
Mt. Morris Township	2,334
Mundy Township	210
Vienna Township	251
City of Burton	4,915
City of Clio	850
City of Flushing	3,439
City of Montrose	592
City of Mt. Morris	1,120
City of Swartz Creek	1,512
TOTAL:	25,847

* Source- Genesee County Division of Water & Waste Services Account Database, July 1992

It must be noted that a metered water customer represents a domestic household or business and not an individual.

In order to supply these communities with water, the County has constructed, the following approximate quantities of water main listed in Table 3 on page 15.

Table 3

Quantities and Sizes of County Water Main

72":	44,502 lineal feet or 8.43 miles
36":	488 lineal feet or 0.09 miles
30":	76,768 lineal feet or 14.5 miles
24":	63,980 lineal feet or 12.1 miles
20":	28,948 lineal feet or 5.48 miles
16":	161,115 lineal feet or 30.5 miles
12":	600,760 lineal feet or 113.8 miles
10":	49,499 lineal feet or 9.37 miles
8":	99,907 lineal feet or 18.9 miles
6":	undetermined

* Source- Genesee County Division of Water & Waste Services hydraulic water model data, July 1992

The vast majority of this water main is ductile iron with the exception of the 72" and the 36" water main, which is prestressed concrete cylinder pipe (PCCP).

The County also has several combined reservoir and pumping facilities. The purpose of water storage is to equalize pumping rates, to equalize supply and demand over periods of high consumption, and to furnish extraordinary volumes during emergencies. The purpose of pumping is to get water from point A to point B and to boost the pressure of the system. Please see Appendix A beginning on page 81.

In order of importance, the storage and pumping facilities are the Center Road Reservoir and Pumping Facility, which is located off Maple Avenue on Manor Drive in the City of Burton. The installation was completed as part of the south loop in 1990 and consists of four, 400 horsepower motors with single stage centrifugal pumps. At the present time, the electrical configuration of the station allows for the operation of only two pumps. However, with only two pumps running, the station is capable of a rated capacity of

approximately 15 mgd.

The reservoir consists of a single 5 million gallon prestressed concrete ground storage tank, which was also completed in 1990. This station is the lead facility in forcing water through the system from the east side of the county to the west and north side of the County.

The Houran Street Reservoir and Pumping Facility which is located off Beecher Road on Houran Street in Flint Township was constructed in 1970. The installation consists of two 125 horsepower, two 150 horsepower, and one 75 horsepower motors with single stage centrifugal pumps. Considering just the four larger pumps, the stations rated pumping capacity is approximately 10 mgd.

The reservoir consists of two steel ground storage tanks each capable of holding 2 million gallons each. This facility was the County's major facility prior to the Center Road facility being constructed. It is now used primarily during the high demand months of summer.

The Orgould Avenue Pumping Station and Reservoir is on Orgould Avenue north of Pierson Road in Mt. Morris Township. The installation consists of four 100 horsepower motors with single stage centrifugal pumps. The stations rated pumping capacity is approximately 7 mgd.

The reservoir consists of one steel 0.5 million gallon ground storage tank. This facility was utilized mainly when the County was a combined system with the City of Flint. It provided water to the west side of the County. It is now only used during extreme water shortage situations. In fact, the last time this facility was utilized was in 1988 during what

was one of the hottest summers on record.

The system also has two in-line booster pumping facilities designed to increase flow and pressure to needed areas. They are the Clio Booster Pumping Station and the Van Slyke Pumping Station. The Clio station is located on Clio Road north of Coldwater Road in Mt. Morris Township. It takes suction from a 12" main and discharges to the cities of Clio and Mt. Morris. It has two 20 horsepower motors with single stage centrifugal pumps. The operation of the Station is based on the level of the Clio Road elevated storage tank which will be discussed later. Since the County has separated their system from the City, this station has essentially been mothballed because the level of the Clio Road elevated storage tank never reaches the turn on point of the pumps.

The Van Slyke Booster Pumping Station is located at the northwest corner of the intersection of Bristol Road and Van Slyke Road in Flint Township. It takes suction from a 24" main and discharges to the southwest area of the County. It has two 7.5 and one 30 horsepower motors with single stage centrifugal pumps. This station has also been placed in stand-by since the County separated their system from the City. It is a direct connection to the City system and was used manually when the pressure and flow dropped below a certain level in the southwest part of the County.

The County also operates several elevated storage tanks. They are, in order of importance, the Beecher Road elevated storage tank located at on the northeast corner of Beecher Road and Elms Road in Flint Township. The storage consists of 1.0 million gallons. The County's Center Road and Houran Street pumping stations and reservoir facility's pumping controls are based on the elevations in the tank.

The Clio Road elevated storage tank is located on Clio Road just North of Stanley Road in Mt. Morris Township. It is also an 1.0 million gallon storage facility. This tank is controlled by the system pressure and flows created by the Center Road pumping station and reservoir facility.

The Clio Plaza Shopping Center Elevated Storage Tank is located off M-57 near the east City limits of Clio. It is a 100,000 gallon storage facility. It is controlled by the system pressure and flows created by the Center Road pumping station and facility.

The McKinley Road Elevated Storage Tank is located on McKinley Road north of Farrand Road near the City of Montrose. It is the most northern tank and has a 500,000 gallon storage capacity. The tank levels are also controlled off of the Center Road facility.

The last major type of storage facility operated by the County is the Noble Avenue Standpipe which is a 4.0 million gallon steel cylindrical standpipe. It is located on Noble Avenue south of Corunna Road in Flint Township. The tank is 166 feet tall, but only the top 30 feet of the tank can be utilized because there is no pumping facility connected to it. The level of the tank is controlled by the Center Road facility.

There are also several communities operating their own storage tanks. They are Grand Blanc Township, City of Flushing, and the City of Swartz Creek. Grand Blanc Township has two 500,000 gallon elevated storage tanks and one 500,000 gallon ground storage tank in their system.

The City of Flushing has their Pierson Road pumping and storage reservoir facility which is located on Commerce Drive off of Pierson Road in Mt. Morris Township. This facility has a 1.0 million gallon ground storage tank and three single stage centrifugal pumps.

The County recently negotiated with the City of Flushing and received the title to this facility from them. In addition, the City also operates a 500,000 gallon elevated storage tank in the City.

The City of Swartz Creek operates a 100,000 elevated storage tank located on the south side of Miller Road just west of downtown.

Based on the storage tank capacity information, Table 4 shows the tabulated storage capacities of the County, the individual municipalities, and all storage facilities combined.

Table 4

Storage Capacity of County Water System

COUNTY	MUNICIPALITIES	COMBINED
16,100,000 Gallons	3,100,000 Gallons	19,200,000 Gallons

The combined storage capacity may seem like a large number, but due to the current system configuration, not all of the storage is accessible. One major area where full storage access is not possible is the Noble Avenue Standpipe. Of the potential 4.0 million gallons of storage, only about 20 percent is accessible without a pumping facility, which does not currently exist. Thus, a revised combined current available storage capacity would total approximately 16,000,000 gallons.

To fully evaluate the effect of this available storage on the County system, current and projected water demands must be analyzed. This is because storage as well as the water distribution system pipes must be designed to handle any existing as well as future projected design demands. In addition, fire flows must also be taken into consideration.

The current average day demand for County water is approximately 10,500,000

gallons and maximum flow conditions have reached as high as 25,000,000 gallons.(9) Guidelines on calculating storage capacity in a system generally require that storage capacity comprise 15 to 30 percent of the maximum daily use.(10) This would represent a range of 3,750,000 gallons to 7,500,000 gallons at todays rate. Therefore, in terms of existing guidelines, the County currently has ample average day storage capacity.

The future demands are based on a selected design period. Typically, this period would be taken as 25 years. In predicting the County's future average day demand, the population projection and usage patterns of the area must be taken into consideration. The population projection studies utilized by the County in designing their facilities were projected to the year 2025.

Table 5 below, prepared by the Committee Planning the development of a second pipe line from the Detroit Water Supply System to Genesee County in 1986, lists the actual 1985 County population and projects the population from 1990-2025.

Table 5

Population Projections from 1990-2025

YEAR	POPULATION
* 1985	293,395
1990	294,236
1995	301,080
2000	305,099
2005	304,956
2010	302,057
2020	297,808
2025	295,727

* Indicates actual demand data from the Division of Water & Waste Services

It must be pointed out, though, that very rarely do any two population projection studies result in identical numbers. To illustrate this Table 6, below, has population projections for the County through the year 2010 based on Michigan Employment Security Commission (MESC) data.

Table 6

MESC Population Projections from 1990-2010

YEAR	POPULATION
* 1990	289,352
1995	293,022
2000	293,555
2005	291,440
2010	287,622

* Indicates actual study data

As can be seen from this data, the MESC projections are smaller than the Committee's for the second water supply. In fact, actual 1990 MESC data indicates an actual population of 289,352 compared with the projected 1990 population by the Committee of 294,236. This is a difference of 4,884 people or an actual over projection of 1.6%.

However, in this type of population projection to determine future water demands, the 1.6% over projection could be considered a reasonable factor that allows for over estimation of the population so that calculated water demands would not be under estimated. In other words, it represents a factor of safety or over capacity which is necessary in the design of long-term capital projects such as the water distribution system.

Once the projected population has been calculated, the next step is to calculate the

estimated population that will be served by the water system. Table 7, prepared by the Committee Planning the Development of a second pipe line from the Detroit Water Supply System to Genesee County, shows the projected population to be served by the County through the year 2025.

Table 7

Projected Service Population from 1985-2025

YEAR	POPULATION SERVED
* 1985	48,224
1990	63,597
1995	75,794
2000	91,418
2005	117,613
2010	145,503
2020	163,400
2025	176,105

* Indicates actual study data

The population to be served is then utilized to calculate a theoretical system demand. In project planning, a minimum of about 165 gallons per capita-day (gcpd) should be considered.(11) This 165 gcpd is a total of all demands, excluding fire fighting, which consists of residential, commercial & industrial, public, loss, and waste. Table 8, on page 23, approved by the Committee Planning the development of a second pipe line from the Detroit water supply System to Genesee County, illustrates these calculated demands.

Thus, according to the demand projections and the guidelines for system storage capacity, the County average day storage should remain adequate until approximately the year 2020 without addressing the Noble Avenue storage situation previously discussed.

In addition, the current County system still maintains its interconnections to the City

Table 8

Projected County Demands from 1985-2025

YEAR	DEMAND (Average Gallons per Day)
* 1985	6,751,000
** 1990	8,904,000
1995	10,611,000
2000	12,799,000
2005	16,466,000
2010	20,370,000
2020	22,876,000
2025	24,654,000

* Indicates actual County data
** Actual 1990 average day demand was only 7,500,000 gallons which indicates that the system was not growing as fast as the Committee had planned

system. In an emergency, the County could open these interconnections to help alleviate the situation and vice versa. This scenario would be as a last resort, however, and would probably represent a major system failure within the County system or the 72" diameter main.

III. EVALUATING THE CURRENT METHOD OF OPERATING THE COUNTY WATER SYSTEM UTILIZING THE 72" SUPPLY LINE AS THE BACKUP SOURCE OF WATER

The current County water system is operationally independent of the City system because the interconnections between the City and County are closed and water is taken into the County system before it reaches the City. The reader is again referred to Appendix A beginning on page 81 for a map showing the entire County water distribution system.

The County water feed points consist of taking water from the 72" diameter water main at the following locations:

1. Potter Road and State Road in Davison Township. This interconnection consists of a 12" diameter outlet for the County. The interconnection is contained in a meterpit. This interconnection is currently closed except for a 12" line to the north that terminates at Richfield Road
2. Potter Road and Irish Road in Davison Township. This interconnection consists of a 20" diameter outlet for the County. The interconnection is contained in a meterpit. This interconnection is currently in service and provides the County with an average day flow of approximately 1.3 million gallons. This interconnection provides water for Davison Township
3. Potter Road and Belsay Road in City of Burton. This interconnection consists of a 12" diameter outlet for the County. The interconnection is contained in a meterpit. This interconnection is currently closed
4. Approximately 100 feet south of the south east corner of Potter Road and Genesee Road in Genesee Township. The interconnection consists of a 36" diameter main off of the 72" diameter main which then runs to a meterpit. Here it is reduced to 30" diameter main where it then proceeds south as part of the south water loop. This is the County's major feed point with flows for an average day of approximately 9.0 million gallons.
5. Approximately 1000 feet north of the north west corner of Potter Road and Genesee Road in Genesee Township. The interconnection consists of a 12" diameter outlet for the County. The interconnection is contained in a meter pit. This feed point provides flow for the northern portion of the County and will ultimately be the main feed point for the north loop which has not been constructed yet. The current average day flow through this installation is approximately 0.3 million gallons

The south loop consists of transporting water from the County's main interconnection site south to the Center Road pumping and reservoir facility. This facility then pumps the water south via a 30" diameter water main to Maple Avenue and Center Road then east to Dye Road where it becomes 24" diameter water main. From here, it flows north to where

it is interconnected with existing 16" diameter water main at Dye Road and Lennon Road in Flint Township.

The south loop begins again as 24" diameter water main at the north east corner of Beecher Road and Elms Road in Flint Township. It then proceeds north to the intersection of Mt. Morris Road and Elms Road in Flushing Township.

The loop provides direct interconnections for the Cities of Burton, Swartz Creek, and Flushing and the townships of Grand Blanc, Mundy, Flint, Flushing, and Mt. Morris.

The Center Road pumping and storage facility is the County's lead storage and pumping facility. All the rest of the systems water main and storage tanks are supplied from this facility. Its pumps are controlled by the elevation of the Beecher Road elevated storage tank. If the Center Road pumps could not maintain the required levels, the Houran Street reservoir and pumping facility would come on line. This would be a high demand situation and currently only occurs during summer months.

The major advantage with the County operating independently of the City pertains to the organization of the agency assigned to carry out the various water system supply operations. The Division of WWS is a centralized zealot type of organization, in that, it is a specialized operation with one of their sole operations being to build and maintain a water supply system for County and outlying customers. The other major operation of the organization is to do the same for sanitary sewer. Thus, WWS can be viewed more as an utility, with a specific purpose, than a governmental organization.

The Division of WWS can be accurately described as a classic example of an organization utilizing the four accepted administrative principles in Herbet A. Simmon's

book titled, "Administrative Behavior- A Study of Decision-Making Processes in Administration Organization." The four principles are

1. Administrative efficiency is increased by a specialization of the task among the group.
2. Administrative efficiency is increased by arranging the members of the group in a determinate hierarchy of authority.
3. Administrative efficiency is increased by limiting the span of control at any point in the hierarchy to a small number.
4. Administrative efficiency is increased by grouping the workers, for purposes of control, according to (a) purpose, (b) process, (c) clientele, or (d) place.(12)

In terms of specialization, WWS is described better in terms of its function than its place. This is because WWS was created specifically to address the sewer and water needs of the population outside of the City. That is, its function is to build and maintain sewer and water facilities as well as finance these projects throughout the County.

WWS's administrative hierarchy is arranged in a determinate hierarchy of order which is intended to preserve "unity of command". In this hierarchy, WWS has a Director that answers only to the Drain Commissioner. Directly under the Director is the Assistant Director who answers to both the Director and Drain Commissioner. These are appointed positions. Under the Assistant Director are the various section Chiefs. These Chiefs are in charge of their individual section and report only to the Director. Personnel in the sections report only to their respective section Chief.

WWS's span of control meets criteria three in that there are, in no cases, more than six subordinates that report directly to any one section Chief. The Director has six people reporting to him and each section Chief has only one person reporting to him with the

exception of the Chief of Operations and Maintenance who has six. Thus, in the classic sense, administrative efficiency is enhanced by keeping the number of organizational levels through which a design, water, sewer, financial, or construction matter must pass to a minimum.

In terms of organization by purpose, process, clientele, and place, WWS best reflects the modified definition of organizing on the basis of process or function within the major sections. According to Herbert Simon, if specialization by clientele and area are forms of functionalization, then, to be successful they must satisfy the conditions of effective functionalization:

1. it must be technologically feasible to split the work activity, along functional lines;
2. these segregated work activities must not affect, to a substantial degree, values extraneous to the specified functions.(13)

WWS satisfies these criteria, in that, each section has its own diverse set of personnel to complete tasks assigned to it. As a result, there is very little overlap between the departments. For example, the Operations and Maintenance Section has its own water, sewer, and treatment plant superintendents; engineers; clerical staff; and computer staff. The segregated work activities cannot effectively affect extraneous values to the specified function because WWS is an inter-jurisdictional entity with the sole responsibility of making sure that water and sewer are available to their customers 24 hours a day every day.

However, even with all of the County's ability to deliver and administer water to its customers, it is still dependent on the original source supply delivered by the 72" diameter supply line from the DWSD. As a result, the only means the County currently has of

weathering the effects of a 72" diameter water main failure without opening the City/County interconnections and utilizing the City's treatment plant water, would be to maximize the life of its existing storage capacity.

Upon examining the County's storage situation, though, it becomes apparent that even if the 72" diameter water main were taken off-line during ideal conditions, which would include having the storage tanks full, the system demand at its lowest, and no fires, the system would only have enough water to last approximately 2.5-3 days. If this supply were stretched further by a mandatory water conservation program, invoked by the County, that strictly limited the consumption of water in the system, the storage, under these ideal conditions, could possibly be stretched to 5 days. This is purely speculative, though, because there is not any hard data available to predict how the service population would cooperate with a mandatory water conservation program.

At this point, the County would have no choice but to open the existing interconnections from the City of Flint water system and take in what water their treatment plant could supply. Under this method of operation, the County would be exposing itself to the following unknowns:

1. What flows could the County expect to receive from the City, and what water quality would the treatment plant deliver to the system?
2. If little or no flow from the City were available, what would the consequences be for the County in terms of fire protection, lost production, and the general health of the population?

The first issue can be broken down into two major categories which are: (a) What flows is the City contractually responsible to deliver to the County, and (b) What flows and

with what quality would the City physically be able to deliver to the County.

The issue of contractually expected flows from the City could be a matter of concern for the County. Upon examination of the original contract of 1973, two specific sections would indicate that the City would not contractually be required to supply the County with water in the event of an emergency. The first is Section 5 Item (b) titled, "Term of Contract and Termination". It states, "That no failure or delay in the performance of this agreement by either party shall be deemed to be a breach thereof when such failure or delay is occasioned by or due to any act of God, strikes, wars, riots, epidemics, explosions, sabotage, **breakage or accident to machinery lines or pipes,** the binding order of any court or governmental authority any other cause, whether of the kind herein enumerated or otherwise, not within the control of either party involved, however, that no cause or contingency shall relieve the County agent of his obligation to make payment for water delivered by the City."(14)

The second is Section 6 Item (c) titled, "Construction, Ownership, and use of Facilities". It states, "The supply of water may be temporarily discontinued to the County system and/or regulated whenever, it is necessary to do so to insure proper operation of the water system of the City, except that under emergency conditions, the Flint department of Public works may take immediate steps to regulate or discontinue flows to the County system. No claims for damages for such discontinuance or decreases in flow may be made by the County Agent or his customers against the City. Any restrictions upon water use imposed on the users in the City shall also be imposed on the users of the County system. The County Agent and his surety shall hold the City harmless from any and all claims,

actions and causes of action which arise with reference to such regulations, limitations, or discontinuance."(15)

Further, the supplemental agreement to this contract in 1988 concerned itself with only the ten issues discussed earlier. This means that the original language of the contract still applies in such circumstances. However, it is generally understood and agreed upon by City and County officials, that the City would provide the County with as much water as possible in such an emergency. This "gentlemen's agreement", though, still leaves a possibility that under certain circumstances, the City could fall back on its legal position and not provide the County with water from the treatment plant.

It appears, though, that the real areas of concern to the County pertaining to the City not delivering water to their system during an emergency, would be that they were not physically and/or politically able to do so, which is outlined in category (b) above. The physical issue will be addressed first. It pertains to the question of whether or not the City's treatment plant would be able to provide the necessary flow and pressure of water at the required quality to satisfy both systems even under a water rationing program.

As mentioned earlier, the current capacity of the treatment plant is approximately 24 mgd. However, according to information obtained in an interview with the City of Flint's water treatment plant superintendent, John Weisenberger, capital and operational improvements have pushed the theoretical yield of the plant to approximately 35 mgd. This new flow rate or even the old one of 24 mgd have not been substantiated, though, because the plant has never been run at its full capacity during the quarterly start-ups.

The major factor determining the amount of water that could be treated at the plant

would be the quality of the source water, which is the Flint River. If the quality is high such as low turbidity, near normal hardness or softness, or low pollution, the water could be treated with much less effort and, thus, more would be processed. If the water is of low quality, the treatment process would be more complicated and thus take longer, which would result in a lower flow output.

Based on data from Mr. Weisenberger, Table 9 below has been created to illustrate the quality of water currently provided by the plant compared to the DWSD water.

Table 9

Comparison of Water Quality Between the
City of Flint Treatment Plant and the DWSD

	DETROIT WATER	FLINT WATER
Hardness	100 mg/l	270 mg/l
Alkalinity	75 mg/l	166 mg/l
Non Carbonate	23 mg/l	104 mg/l
Ph	7.3	7.2
Magnesium	6 mg/l	22 mg/l
Calcium	29 mg/l	72 mg/l

* mg/l= Milligrams per Liter

Of course, this comparative analysis does not address the most important quality issue, which is the bacteriological properties of the water. The DWSD water can be assured of meeting the required bacteriological quality, while the Flint plant water quality would not be known until 24 to 48 hours after startup. This is when the bacteriological sample results on the treated water would be available. Thus, a boil water notice may have to be given

until these results are in to insure that the water would be safe to drink.

In a letter from the MDPH to the City of Flint on August 12, 1991, the MDPH addressed their concern that the standby water treatment plant could not provide a sufficient quantity of water of acceptable quality at all times.

Another factor would be the reliability of the treatment plants machinery. Since the plant has not been operated at full capacity, it is not known whether or not the plants pumps, motors, valves, feed systems, etc. would be able to operate at this capacity without failing.

In a letter sent to the City of Flint by the MDPH on February 8, 1991, the MDPH addressed its concern with what they considered to be serious problems with the flocculation basins and equipment, filters, high service pumps, electrical switchgear, and other areas of the treatment plant.

Another factor affecting the treatment plants output would be the physical and mental condition of the plant personnel. According to Mr. Weisenberger, every time the plant is brought on line, the personnel have to work an average of 16 hour days to keep it running. This problem is compounded, according to him, because the plant is not a fully automated operational system, personnel numbers are kept low in order to reduce budget requirements for operations.

Thus, during an emergency situation, it would be up to this skeletonized crew to keep the plant up and running. This, according to him, would be nearly impossible during emergencies calling for the plant to be run for extended periods of time. He feels that anything over a week and a half, without some kind of personnel relief, would begin to

jeopardize the plant operation.

These issues concerning the ample delivery of safe water to the County system is cause for concern. According to Mr. Weisenberger, the water quality, at least at the beginning of the emergency, would depend on how much prior notice he received. The longer the period of prior notice, the sooner the plant could be started and the treatment process fine tuned to meet mandated quality. However, the amount of water delivered to the systems would still depend on the source available from the Flint river at the time of the emergency.

Of course, when the City and County will need plant water also depends on the amount of water in their storage tanks at the time of the 72" diameter line failure. If the line failed when County tanks were near full, it is speculated that storage could be stretched as far as 5 days before it would become necessary to take on plant water from the City. Thus, under these ideal conditions, the City will have had ample time to fine tune their plant operation in order to meet required water quality.

If, however, the City and County are caught with no prior warning of line failure and low storage tanks, then a boil water notice may have to be given, for human consumption, until the plant operation can be fine tuned and all of the potentially contaminated water purged from the system.

The other circumstance under which the City may provide little or no flow to the County in such an emergency would most likely have to do with political considerations. That is, would the City be willing to compromise its own citizens and industries water supply to supply the County with water in such an emergency? Especially with customers the size

of General Motors applying pressure to keep their factories running.

Of course, it is assumed that the City would not exercise this option unless the treatment plant were not physically able to provide adequate volumes of water. In which case, it would be highly likely that the County would receive a reduced flow from the City that would fall short of its demand. However, for the City to exercise political discretion and not provide any flow to the County for any other reason than physical limitations, would most certainly insure legal and political ramifications between the City and County. These ramifications may include such things as law suits or any other legal means the County would have at their disposal to seek reparation.

However, assuming that there would be a supply of treatment plant water and that the emergency condition has exhausted all of the County storage, the second issue concerns the consequences of operating the County system under this condition in the areas of fire protection, the health of the affected population, and business and production. Required fire flow is the rate of water flow, at a residual pressure of 20 pounds per square inch (PSI) and for a specified duration, that is necessary to control a major fire in a specific structure.(16) These issues will be considered under the worst scenario. That is, with only a limited flow available and a boil water notice issued.

Under these conditions, the County would impose conservation measures such as: a lawn sprinkling ban, no washing of cars or other vehicles, reducing system pressure where possible and other measures to try and save as much water as possible for fire protection, hospitals, and general usage purposes such as showers and other hygiene requirements.

Fire protection, hospitals, and population hygiene would be allocated the highest

priority for receiving water because of their direct effect on the populations welfare and health. Business and industry, under these circumstances would be considered compromisable and would be asked to limit usage particularly during peak demand periods.

Even with the boiling notice, the County would strongly advise that customers not use the water for consumption, to further stretch water supplies, and to buy bottled water for cooking and drinking. This would result in greater water supplies for the vital areas and substantially reduce any possible health threats imposed by consuming potentially contaminated water.

It is hoped that with such conservation measures and the prioritization of necessities, that the risks to the service population would be minimized. However, if these measures were not enough, then the County would be forced to make mandatory provisions for the conservation of water. This would result in all water being conserved for fire protection and critical hospital usage with little left for the basic needs pertaining to consumption and hygiene. Industry would be required to procure their own water from other sources or be cut off from the supply until the emergency was over.

If, however, there is no available supply of water from the City of Flint, the County would be faced with a disaster of possible cataclysmic consequences. The major concern would be no water for fire protection which would place existing structures under a very dangerous predicament. Water for health, consumption, and hygiene uses, under this condition, would have to be procured by using bottled or trucked in water from other sources. In addition, a program that delivered or made potable water available for people dependent on the public water supply, such as the homeless or poor, would have to be

implemented during the emergency.

There is currently no direct cost to the County in terms of the City maintaining its current method of backup water supply. That is, the County pays no direct fee to the City for the maintenance of its water treatment plant. However, while the County pays no direct cost fee to the City, it must be pointed out that these costs are apportioned between the City and County via the rate structures.

According to Mr. Weisenberger, it costs the City approximately $1.6 million per year for staffing and operations for the plant, $1.5 million per year for capital improvements and maintenance to the plant, and an additional $500,000 for operating and maintaining a dam system on the Flint River to keep the water levels sufficient for the plant to operate. This is a total of $3.6 million per year just to keep the plant operating in a standby mode.

All of the above is based on the assumption that the 72" diameter line is taken out of service for an extended, one week or greater, period of time. However, just what is the likelihood of the 72" failing or being damaged, and how long could repairs be expected to take in such circumstances?

A "Report on Alternate Water Supply Study for Flint, Michigan" in 1983 made the following observations concerning the possibility of the 72" diameter main failing:

1. It is a relatively high pressure main. This means that there is a greater chance for the pipe to rupture compared to a lower pressure water main.
2. The main is susceptible to hydraulic transients. This means that the water main is subject to pressure fluctuations that put additional stress on the pipe.
3. Air release valves have failed in the 96" diameter pipeline between Imlay City and the DWSD's treatment plant.
4. There is presently a minor leak in the 72" diameter

main between Imlay City and Flint.(17)

Based on these observations, it can be concluded that the 72" diameter main will fail sometime during its' useful service life.

In fact, according to records kept by the City of Flint, the 72" diameter line has been taken out of service several times since its completion in 1965. However, in only one instance in the early seventies was the flow disrupted long enough that the City treatment plant had to be brought on-line to serve customers. There have also been several close calls, one being as recent as 1990 when repair work was being done to the 72" diameter line. During this repair the City and County storage reserves were depleted to within a couple hours of being critical. After this period, the systems would have had to be supplied by available treatment plant water. This was a planned repair and the treatment plant was on-line for its duration.

These planned repair situations provide the City with the necessary lead time to fire up their treatment facility and prepare for distribution in case of an unforeseen emergency. It is the possibility of unexpected failures that have officials concerned. Mr. Weisenberger says that his biggest fear is that a 72" diameter line failure will be caused by a construction accident in the field. He feels that construction of other utilities, near or, in some cases, on top of the existing 72" diameter line, pose the biggest threat to its integrity.

He does not feel that failure at this point in time would be due to manufacturers or installation defects, since they would have shown up by now. However, he is quick to point out, that if the line does fail on its own, it will be an extensive problem which could take weeks to repair. This is mainly due to the long lead time required to get pipe and fittings

in the 72" size that would be required for the repair.

Another type of failure could simply be attributed to the age of the pipe and the length of time that it has been installed. Generally prestressed concrete cylinder pipe can be hoped to have an effective life of at least 75 years depending on the environment it is constructed in and the quality of materials and installation. However, there is still the chance that line failure could be caused by one of its components simply wearing out mechanically or chemically. Mechanically, a valve, pipe segment, interconnection, or other appurtenance could fail. Chemically, elements in the soil such as acid could eat away at the concrete of the pipe causing a hole and, thus, a failure.

The last concern for failure would be due to system operations. For example, the DWSD could have something go wrong at their plant that could pressurize the line to the point where it would rupture. Or a valve could be closed fast enough to cause severe water hammer, which could rupture the pipe. Water hammer is an increase in pressure in a pipe caused by a sudden velocity decrease, such as a valve closing.(18)

Based on the fact that the 72" diameter line has had to be taken off-line previously and the multitude of different types of failure discussed above, I believe that, while the County may be saving money presently in terms of providing a safe reliable secondary source of water, it is operating on borrowed time. All it will really take is one failure to place the entire distribution system in jeopardy. Thus, it is imperative that the County evaluate alternatives to supply a second safe reliable source to the system in the event of 72" diameter line failure. The next section will address these issues.

IV. EVALUATING THE ALTERNATIVES TO OPERATING THE COUNTY WATER SUPPLY SYSTEM WITH A SINGLE 72" SUPPLY LINE

This section will evaluate the current viable proposed alternatives to insure a safe reliable secondary source of water for the County in the event of a disruption in service of the 72" diameter transmission main. It must be pointed out, though, that the direct cost and construction of any of the proposed alternatives would be undertaken by the City since the County is under contract to receive water from them. Most likely the City would be reimbursed by the County for the County's share of such costs in terms of water rate increases to the County. The alternatives to be analyzed in this section are as follows:

1. A second pipeline connected to the DWSD's system to the south. This alternative will loop the County and City system with the DWSD system. Thus, in the event of a 72" diameter line failure, the second line would supply the area with water.
2. A project by the City to completely or partially refurbish the City water treatment plant to insure that in the case of line failure, there would be a safe reliable source of water during the emergency.
3. The construction of a secondary pipeline to connect to the Saginaw water distribution system.
4. The feasibility of developing a secondary source of water from area groundwater.
5. The County and City forming an authority which would involve completely refurbishing the City treatment plant and running a new line to Lake Huron to supply the plant with raw water. This alternative would sever system connections with the DWSD system.

Alternative 1 is the only alternative that would continue to provide the County with operational autonomy from the City. This is a very important consideration for the County given the current political, operational, and economic relationship between the City and County. These factors will be addressed as the paper progresses.

Alternative 1 involves the construction of a second transmission pipeline from DWSD's transmission network near Pontiac to the City and County systems. This project would provide the following major benefits to the County and City water supply systems:

1. An emergency supply of water of the quality of the the 72" diameter main.
2. A loop for the City and County water supply system. In particular, this loop would especially benefit the County system because of the interconnections that would be made to the DWSD main on the southern side of the County. These interconnections would boost the service capability to the County's southern and western service area and would reduce the amount of pumping necessary to these areas. Thus, the second supply line would become another feed point for the system as well as a backup supply.

Nine possible routes for a pipeline connecting the DWSD's 42" diameter main at Walton and Giddings, in Pontiac, with the Potter Road 72" diameter main were developed in 1987. Please see Figure No. 1 in Appendix B beginning on page 82 which shows a map of the existing DWSD northern transmission mains and service area. Also see Figures No. 3-11 in Appendix C beginning on page 84 which show maps of the proposed routes of the alternatives.

The evaluation of these routes were partially based on a set of weighted criteria. Please see Appendix D beginning on page 94 for a detailed description of the criteria. These criteria and their weights are listed in Table 10 on page 41.

For each alternative, a score ranging from 1 to 10, with 10 representing the best rating, was assigned for each criterion. This criterion was then multiplied by the criterion weight and the resulted weighted scores summed. The Study Report that this table came from did not list the ratings for each of these criteria pertaining to the alternative being

Table 10

Water Main Route Evaluation Criteria
and Assigned Weights

CRITERION	WEIGHT
Acceptability (Local Communities)	5
Access of Maintenance	5
Benefit	7
Capital Cost	9
Institutional Requirements	7
Operation & Maintenance Cost	5
Public Agency Review	3
Right-of-Way Availability	8
Schedules/Time Frame	4

* Source- " Study Report Second Flint Water Supply Line", January 1988

Table 11

"Guessed" Ratings for Evaluating Weighted Score for Route 1

CRITERION	RATING
Acceptability (Local Communities)	3
Access of Maintenance	10
Benefit	7
Capital Cost	8
Institutional Requirements	3
Operation & Maintenance Cost	7
Public Agency Review	3
Right-of-Way Availability	10
Schedules/Time Frame	4

considered. However, an example of how the weighted score for Alternative 1 could have been calculated will be illustrated by utilizing "guessed" ratings. The reader is referred to page 45 for a description of Route 1. Table 11 above shows these "guessed" ratings

pertaining to their desirability in evaluating Route 1. These "guessed" ratings are purely for illustrative purposes, and in no way should be interpreted as actual committee ratings.

The procedure for calculating a weighted score for Alternative 1 would be to take the weight for Acceptability (Local Communities) and multiply it by the rating for Acceptability (local Communities) which is 5x3 = 15. The same would be done for the rest of the criterion, which result in scores of 50, 49, 72, 21, 35, 9, 80, and 16. These scores would then be summed up to provide a weighted score for Alternative 1. The summation would be 15+50+49+72+21+35+9+80+16=247. It must be noted that the criterion weight stays the same for all of the Alternative calculations and that only the rating of desirability/feasibility for each alternative varies.

A preliminary evaluation of alternatives 1 through 8 was made by Flint and the DWSD. This preliminary evaluation was presented and discussed at a technical committee meeting on July 14, 1987. Results of this evaluation are contained in Table 12 on page 43.

Alternative 8 was not evaluated because it provided only a second feed to Flint and was, therefore, not comparable to the other alternatives. This is because the DWSD was trying to provide for a loop to their northern water transmission system as well as provide a second supply of water to the City and County.

In addition to the rankings shown above, discussion at the July 14, 1987 meeting developed the following additional parameters governing the project:

1. Genesee County asked that no construction be proposed in either Genesee Roads or Center Roads because of potential conflicts with other proposed facilities which would become part of the south water loop
2. In lieu of routes deleted by the rankings above, the County proposed an additional alternative route, which

would become route 9. This alternative would follow the route of alternative 5 to the intersection of McCandlish Road and Gale Road, then follow McCandlish, road, Vassar Road, Perry Road, and Belsay Road to a connection with Flint's 72" diameter transmission main at Potter Road

3. Routes in or along the C&O Railroad right-of-way would be withdrawn from further consideration because of extreme right-of-way acquisition problems and excessive construction impediments.(19)

Table 12

Evaluation of Water Main Route Alternatives

ALTERNATIVE NUMBER	DWSD EVALUATION Weighted Score	Rank	FLINT EVALUATION Weighted Score	Rank
1	347	1	420	1
2	314	3	281	2
3	248	6	277	4
4	274	4	272	5
5	330	2	281	2
6	274	4	272	5
7	218	7	263	7
8	Not Evaluated		Not Evaluated	

* Source- "Study Report Second Flint Water Supply Line", January 1988

The result of this screening was that Routes 3, 4, 5, 6, and 7 were eliminated from further consideration. Route 2 was also eliminated because of expected right-of-way acquisition problems. However, Route 9, proposed by the County, was then evaluated utilizing the same procedure as the others and the following ranking, listed in Table 13 on page 44, was determined.

Based on the rankings between Route 1 and 9, Route 1 was selected as the preferred route by both Flint and the DWSD. Route 1 provides for a second supply of DWSD water

Table 13

Evaluation of Proposed County Water Main Route

ALTERNATIVE NUMBER	DWSD EVALUATION Weighted Score	Rank	FLINT EVALUATION Score	Rank
9	322	2	277	2

* Source- "Study Report Second Flint Water Supply Line", January 1988

at the location of the existing connection of the Flint and the DWSD systems, and also provides a loop of the northern DWSD water transmission system. Route 1 also included provisions for a second line paralleling Flint's existing 72" diameter transmission main from the DWSD's mains to the Flint Water Plant site. The cost of paralleling the 72" line is not included in the construction cost estimate that follows for this route.

The County essentially had no choice, but to accept the selection made by Flint and the DWSD unless it wanted to develop and pay for their own secondary supply of water. It must be pointed out again, though, that the County has never had a direct contract with the DWSD to supply water to the County. The contract consists of an agreement between the City and the County for water supply to the County. Thus, the County was merely an invited observer to these meetings with limited or no input capability.

However, in Item 3 of the supplemental agreement to the contract in 1988, it is noted that the City consulted with and received permission from the DWSD to obtain a maximum of three connections to the proposed North/South DWSD water line at such points as shall be selected by the County. As a result, the County would still be assured of their operational independence from the City system if the second pipeline were built. Thus, the

County would have to analyze their system to determine the best locations for interconnection to the proposed DWSD main.

Route number 1 begins at DWSD's 42" diameter transmission main in Walton Boulevard at Giddings Road and runs westerly 0.2 miles in Walton Boulevard, northerly 0.1 mile in Cameron Road, westerly 0.2 miles in Northfield Road, northerly 0.4 mile in Stirling Road, westerly 2 miles in Collier Road, and northerly 2.6 miles in Baldwin Road to Maybee Road. This stretch of main is proposed to be 48" diameter.(20)

From Maybee Road, the route continues northerly in Baldwin Road 2.6 miles to Clarkston Road. This stretch of main is proposed to be 96" diameter.(21)

From Clarkston Road, the route continues northerly in Baldwin Road 2.9 miles, then runs westerly 1.2 miles in Stanton Road northerly 0.5 mile in Dartmouth Road, westerly 3.6 miles in Seymour Lake Road, and northwesterly 5.7 miles in Highway M-15 to the Oakland/Genesee County line. This stretch of main is proposed to be 60" diameter.(22)

This alternative route contains 2.6 miles of 96" diameter main, 27.8 miles of 60" diameter main, and 5.5 miles of 48" diameter main.

The construction cost of Route 1 was broken down to be shared by the DWSD and the City. It is again assumed that the City would have negotiated with the County to pay for their share of the project either through indirect water rate increases to the County or by direct participation in the City's financing plan. The cost of the project in 1988 dollars is listed in Table 14 on page 47.

Utilizing the concept of future worth and the formula $F=P(1+i)EEn$ it is possible to calculate the proposed cost of this project today.(24) Where n= the number of years into

the future which, in this case is 4; i= interest rate (assumed to be 4% in this and future calculation); P= the construction amount in today's dollars which is $104,300,000; and F= the future worth of the construction project.

The interest rate of 4% reflects a conservative approach due to the current state of construction in the Genesee County area. This area in the early 1980's and the early 1990's has and is experiencing a recession, which is resulting in contractor's bids on projects such as these to be artificially low. For example, bid prices taken from bid tabs at WWS in 1983 show that the low bidder submitted a price of $30.00 per lineal foot to construct 12" sanitary sewer pipe. This price included all labor, overhead, construction materials, and equipment to do the job. Sanitary sewer was chosen as the reference because of the availability of data back to 1983, which is when the some of the alternatives were proposed. In 1988, during a state of growth in the economy, bid tabs from WWS show that on average, contractors were bidding to construct 12" sanitary sewer pipe at $42.00 per lineal foot. This represents a 28.6% percent increase over just five years before.

However, when a recession began again in 1990, the bid tabs from WWS show that, on average, contractors were bidding to construct 12" sanitary sewer pipe at $39.00 per lineal foot. This reflects a 23.1% increase from 1983 and a 7.1% decrease from 1988. Thus, choosing an interest rate that accurately reflects this regions economic condition is very difficult. If one were to chose a rate reflective of the growth period, 1988, compared to 1991, based on this data, then the cost of the project would actually decrease. However, this is not true because the cost of other phases of the project have increased. An example of this would be the rising cost of land acquisition because of increased property values.

Table 14

Breakdown of Project Costs for Treatment Plant Alternative

DWSD PORTION OF PROJECT

96" water main, 13,900 l.f.	$ 8,100,000	
60" water main, 146,700 l.f.	39,100,000	
48" water main, 28,800 l.f.	6,700,000	
80 mgd pumping station, 2 ea.	11,200,000	
40 mgd pumping station, 1 ea.	4,000,000	
Estimated Construction Cost	$ 69,000,000	
Engineering, Inspection, Legal	17,200,000	
Contingencies, etc.		
Property (fee purchases)	100,000	
Easements (fees)	1,000,000	
Total DWSD Portion	$ 87,300,000	87,300,000

FLINT PORTION OF PROJECT

42" water main, 19,600 l.f.	$ 4,500,000	
36" water main, 26,000 l.f.	6,400,000	
30" water main, 9,300 l.f.	2,100,000	
Meter and PRV facilities f.f.	500,000	
Estimated Construction Cost	$ 13,500,000	
Engineering, Inspection, Legal,		
Contingencies, etc.	3,400,000	
Easements	100,000	
Total Flint Portion	$ 17,000,000	17,000,000
TOTAL ESTIMATED PROJECT COST		$104,300,000(23)

* l.f.- Lineal Feet
** ea.- each
*** PRV- Pressure Regulating Valve
**** Source- "Study Report Second Flint Water Supply Line", Jan. 1988

Therefore, I am choosing an interest rate of 4%, which is reflective of the consumer price indexes rate of inflation for the economy as a whole for 1991. This would be a very

conservative interest rate in the construction industry because of the way it is affected by upswings and downswings in the economy. Thus, this essentially becomes a calculation to standardize all of the alternatives in terms of 1992 dollars based on an average rate of inflation of 4%. This is because, as mentioned above, the alternatives being evaluated were not all proposed in the same year. If they were not standardized in some way, they could not be accurately compared in terms of project cost.

The calculation becomes F= 104,300,000(1+.04)EE4 which equals $122,016,248. This shows that, at only a 4% interest rate, the cost of the project increases by $17,716,248 or 14.5% from 1983 to 1992. Thus, it becomes apparent, that the longer this project is postponed, the more expensive and, as a result, possibly less and less feasible it may become. The cost of the Flint portion of the project, in todays dollars, is $19,887,596.

Alternative 2 involves analyzing the complete restoration of all facilities at the City's treatment plant site and/or the alternative of only partial restoration of the facilities in order to meet the required emergency demand. Complete rehabilitation of both treatment plants would provide a capacity of 59 mgd, which was the original design capacity of the two plants. A map showing the existing treatment plant site is shown in Appendix E beginning on page 97.

The project would provide the following major benefit to the City and County:

1. An emergency supply of water that would not necessarily be of the quality of the water supplied by the 72" the 72" diameter main.

The sole purpose of this alternative would be to insure that, if the 72" diameter main failed, there would be a secondary source of safe water available. The plant would only be

utilized in case of such an emergency and would not be used in day-to-day operations.

This alternative does not provide the County with operational independence during such an emergency because the source of the water would be from the treatment plant. Thus, all of the old interconnections between the City and County would have to opened during this condition. This situation, though, may be a tolerable one for the County during the emergency condition and should be considered.

Based on the emergency water demand design criteria of 35 mgd, which would be approximately the demand of both the City and County systems on an average day, it was determined that rehabilitating the treatment plants to provide the full 59 mgd demand would be excessive financially and operationally on the City.

Full site rehabilitation would only be considered if the City intended to return to full time treatment when their contract with the DWSD expired in the year 2000. However, this type of operation was what the City had originally abandoned by signing a contract with the DWSD in 1965 because of the questionable future permanent raw water supplies available from the Flint River.

Thus, the alternative becomes one of assessing partial rehabilitation of the existing treatment plant facilities. Since Plant No. 1 was the older plant, it was determined that Plant No. 2 would be rehabilitated to treat and pump the required 35 mgd emergency flow at the legally mandated water quality.

In order to accomplish partial rehabilitation, it was concluded that the most feasible alternative would be to include improvements to pumping station No. 4, Reservoir No. 3, and Plant No. 2. Utilization of the existing chlorine contact chamber at the south end of

Plant No. 1 or the construction of a new chlorine chamber would be required. The auxiliary power generators and its system controls would be relocated to Plant No. 2. A new heating system would be provided in Plant No. 2 and separate heating would be provided in Pumping Station No. 4. This phase of the alternative is known as Permanent Treatment Rehabilitation.(25) Please see the map showing these facilities in Appendix E beginning on page 97.

In addition to the Permanent Treatment Rehabilitation phase, there are two other phases that need to be evaluated to complete the analysis of alternative two. They are Permanent Improvements to Maintain the DWSD Supply, and Demolition of unnecessary facilities at the City treatment plant site.

The Permanent Improvements to Maintain the DWSD Supply phase includes permanent improvements related to the existing 72" diameter DWSD pipeline, Dort Reservoir, high service pumping, and auxiliary power and control systems associated with the DWSD water supply to the Flint and County systems. Demolition consists of tearing down the old Plant No. 1 and everything else that would not be required for this project. The cost of this proposed alternative for the City, in 1983 dollars, is listed in Table 15 on page 51.

Once again, utilizing the concept of present worth, the cost of this project in todays dollars would be; taking n=9, P=7,900,000, and i=4%; F= 7,900,000(1+.04)EE9, which equals $11,244,163.

Risks associated with this solution include the potential of the City not continuing to maintain this facility once rehabilitation is completed, which would, once again, place the

TABLE 15

Breakdown of Project Costs for
Treatment Plant Alternative

1. Permanent Improvements to Maintain the DWSD Supply	$ 900,000
2. Permanent Treatment Rehabilitation	5,600,000
3. Demolition	1,400,000
TOTAL REHABILITATION COSTS	$7,900,000(26)

* Source- "Report on Alternate Water Supply Study for Flint, MI", 1983

alternative water supply at risk. This is because annual operation and maintenance costs would be high compared with little or no return on this investment. Therefore, during budget cutting processes to balance the City budget, the facility would provide a nice target because of the assumed reliability and resulting complacency by officials that the 72" diameter main provides.

Another risk involves the commitment of City water plant administration and personnel to provide the necessary maintenance, training, and supplies in order to safely and effectively start-up and run the facility in an emergency situation.

Other factors to be considered in evaluating this alternative are as follows:

1. There would be little chance for financial participation by the DWSD or County.
2. County officials have expressed concern over the possibility of a partial, continuing supply of raw water from the Flint River. This could impact on current and future relations with the County in terms of an alternative water supply solution.
3. This alternative would provide some incentive to the DWSD to initiate construction of a second pipeline

which is discussed under alternative one. This is because the City and, as a result, the County may utilize this scheme to separate from the DWSD system.

Alternative 3 involves the construction of a secondary pipeline to connect the City system, at the City treatment plant site, to the City of Saginaw system. This would involve the construction of approximately 30 miles of pipeline and four booster pumping stations to get the water to the City plant.

Discussions were held with the Director of Public Works in Saginaw in 1983 to determine the City's willingness and ability to provide an emergency supply of water to Flint. The Director indicated a willingness to consider the possibility of providing a back-up supply to Flint and provided planning and operating data pertaining to the Saginaw system.

Based on information provided by the Director, it was concluded that any analysis of pipeline costs would have to assume that the pipeline to Flint would originate at the Rust Park Treatment Plant in southern Saginaw. The Saginaw distribution system could not be expected to convey the additional 35 mgd required by the City and County in an emergency without significant improvements. Some expansion of the high service pumping station would also most likely be required. Please see the map showing this alternative in Appendix F beginning on page 99.

Capacity at the Rust Park Treatment Plant is approximately 50 mgd.(27) Since during an emergency, the City and County would require approximately 35 mgd, this would only leave 15 mgd for the City of Saginaw to utilize for their own customers. Saginaw's average day demand is currently around 26 mgd. It is therefore concluded that some additional treatment plant capacity improvements to Saginaw's plant would be required. A

less costly alternative would be to impose use restrictions on Saginaw customers during an emergency condition at the City and County. However, depending on the time of the year, this could be a severe imposition on Saginaw customers, and would have to be negotiated in any emergency supply contract between the two cities. Therefore, this would not be considered a viable option.

The construction costs of the pipeline to the Flint treatment plant, which were based on conveying 35 mgd, was estimated in 1983 dollars to be $28,000,000.(29) This cost is based on 30 miles of 36" diameter pipeline and four 35 mgd booster pumping stations. Utilizing the present worth formula; with n=9, P=28,000,000, and i=4%; the cost of this project, in todays dollars, is $39,852,731. In addition, there are no hard figures available to establish a cost for additional treatment capacity or high service pumping capacity at the Rust Park Plant. However, a conservative estimate of the cost of this phase of the project would be approximately $20,000,000 in todays dollars. Thus, the total cost of the proposed project would be $59,852,731.

The project would provide the following major benefit to the City:

1. An emergency supply of water that would essentially be of the quality of the water supplied by the 72" diameter main.

The sole purpose of this alternative, once again, would be to insure that if the 72" diameter main failed, there would be a secondary source of safe water available. The secondary line would only be utilized in case of such an emergency and would not be used in day-to-day operations.

This alternative does not provide the County with operational independence during

such an emergency because the source of the water for the County would be from the treatment plant. Thus, all of the old interconnections between the City and County would have to opened during this condition. This situation would also be tolerable for the County during the emergency condition and should be considered.

Risks associated with this alternative include the potential of the City's of Flint and Saginaw not continuing to maintain the booster pumping facilities and water main once they are on-line. The facility would not be used except in an emergency situation. Thus, all that is accomplished between this alternative and alternative two, is that instead of the City paying to operate and maintain its own treatment plant, it would be paying to operate and maintain this system in a stand-by mode.

The transmission main between Flint and Saginaw could rupture or one or more of the booster pumping stations could fail during the emergency, which would leave Flint and the County without a secondary supply of water. With only periodic operation of the main and stations the chances of failure are increased.

Therefore, to maintain a facility of this magnitude, which would cost hundreds of thousands of dollars each year, with the possibility that it may never be operated, could pose a nice target during budget cutting in order to balance the City's budgets'.

Other additional concerns to be addressed in evaluating this alternative include the following:

1. The inter-connecting pipeline would provide very little benefit to the Saginaw system.
2. There would be little chance of financial participation by the DWSD or the County. This is because the DWSD would not benefit from this solution, and the County would not consider it a permanent solution.

Alternative 4 involves the feasibility of developing underlying groundwater aquifers within or near the City. A portion of this water would then be fed through the existing interconnections with the County to supply them in case of an emergency. Thus, once again the County would lose operational independence of its system. However, during such an emergency, this situation would be tolerable for the County and should be investigated.

The sole purpose of this alternative would be to insure that if the 72" diameter main failed, there would be a secondary source of safe water available. The alternate groundwater supply would only be utilized in case of such an emergency and would not be used in day-to-day operations.

There are two major sources of groundwater in the Flint area. They are the Saginaw bedrock formation and the overlying glacial drift aquifers.(30) The Saginaw bedrock formation is the uppermost bedrock formation in the area. The water produced is generally moderately hard to hard and commonly contains objectionable amounts of chloride. As a result, the quality of the water limits its development for water supply.

The water produced from the overlying glacial drift aquifer is hard or very hard and commonly contains objectionable amounts of iron. The two aquifers are interconnected and considerable flow of water occurs between the two.

There are municipalities, in the County, that currently rely on these aquifers for their water supply. One of these communities, the Beecher Metropolitan District, lies very close to Flint and supplies about 5000 customers. Their first wells were developed in the Saginaw formation. The capacity of these wells were low and water quality was quite hard. Wells since the 1950's have been developed in the glacial drift formation. These wells have much

greater capacity, up to 1.4 mgd and the quality is much better.

The City of Burton also utilized glacial drift water to serve their customers in the south part of the city until 1990. This was when the south part of the City was connected to the County's south water loop and the wells were disconnected. During their production, the wells developed in the glacial drift supplied up to 1.4 mgd of treatable water for the system.

Based on this information, it appears that the best possibility of developing a groundwater alternate supply within Flint lies in tapping the glacial drift formations. It is felt that a series of wells with an average capacity of about 1.4 mgd could be developed in this formation.(31) At this anticipated flow rate, it would be necessary to develop 25 wells in order to handle the 35 mgd emergency demand of the City and County. The wells would have to be approximately 30" in diameter each in order to handle this demand.
The cost for such a project in 1983 dollars, is listed in Table 16 on page 57.

Converting this figure to todays dollars utilizing the present worth formula with $n=9$, $P=13{,}376{,}000$, $i=4\%$ we get an updated cost for the project of $19,038,219. In addition, operation and maintenance costs to maintain facilities of this magnitude would cost the City additional thousands of dollars each year to keep these wells on-line for an emergency situation.

The project would provide the following major benefit to the City:

1. An emergency supply of water that would not be of the quality of the water supplied by the 72" diameter main.

Table 16

Breakdown of Project Costs for Constructing
Wells Alternative

1. Exploration	$	500,000
2. Twenty-five wells, complete with pumps, gas engines, and controls, housings, connecting pipe, and land		6,076,000
3. Total for Construction		5,400,000
4. Contingencies, Engineering, Legal, etc.		1,400,000
PROJECT COST	$	13,376,000(32)

* Source- "Report on Alternate Water Supply Study for Flint, MI", 1983

There are several potential problems associated with utilizing groundwater as a backup water supply. They are:

1. Water quality will be significantly poorer than the City's customers are used to with the Lake Huron supply. Hardness and chloride levels will be high. The potential for even higher chloride content increases with increased rate well withdrawal. Several industries indicated that they could not tolerate significantly increased chloride concentrations. It must be pointed out that if this alternative was utilized, this condition may exist for weeks.
2. There is always potential for future contamination of the groundwater supply, which would render the aquifers and the new wells essentially useless, unless further treatment was provided for.
3. Minute amounts of radioactivity have been found in a few private wells in the area. The Michigan Department of Public Health (MDPH) believes the radioactivity to be naturally occurring and, at the levels found, should

not pose health problems.

4. There is also a known site of potential contamination at the Berlin & Ferro Waste incineration site in Gaines Township south of Swartz Creek.
5. Because the rate of withdrawal from the existing aquifers will be more than double what has previously ever been pumped, the impact on the water level and the chloride content is not known for certain. Thus, the potential for damage to existing wells due to over drafting and/or saltwater intrusion requires further consideration.(33)

Alternative 5 involves the City and County forming an authority. Under this authority, the City and County would jointly pay for a new water line to Lake Huron, which would bring raw water to the City's treatment plant. The treatment plant, under this option, would be completely rehabilitated to process this raw water. As a result, the City and County would sever ties with the DWSD in the year 2000 and begin to operate their own independent system. The result would be a centralized water authority that only overlapped in the delivery of water from the City treatment plant. After the water was delivered to the County interconnections, the County would be responsible for delivering it to its customers.

Benefits associated with this arrangement would be that the City and County would be, as a combined system, operationally independent of the DWSD system. This could result in reduced water rates for City and County water customers because they would not be locked into the DWSD's rate structuring agenda, which includes their whole system in terms of capital and operational improvements.

This alternative is currently being studied by an engineering firm for the City. Therefore, there are no hard numbers available to evaluate the cost of this project. However, a reasonable estimate of the cost of this project can be predicted on the basis of

existing construction costs, cost data developed within this paper, and by preliminary information supplied by Mr. Weisenberger. The project breakdown and associated costs according to Weisenberger are listed in Table 17 on page 60.

There are several issues that need to be considered under this alternative. The first is that this alternative only severs City and County ties with the DWSD. There would be a single 60" diameter line feeding the City and County instead of a 72" diameter line. Therefore, unless a contract could be worked out with the DWSD for them to maintain the existing supply line to the City and County as a backup source of water, there would be essentially nothing gained in terms of system reliability. The City and County systems would still need to secure a secondary water supply in case of the 60" diameter main failing. This source would most likely be from the Flint River because the treatment plant is on the river, which takes us back to the original water quality and quantity issues of the river as a source of water.

Second, this alternative poses interesting operational and political questions concerning the formation of an authority between the City and County. From the County's standpoint, there would be considerable concern over their position in this arrangement.

From an operational standpoint, the City would regain control of the supply of water to the County by processing the raw lake water at their plant. Under this scenario, it would appear that the interconnections between the City and County would have to be reopened and, as a result, the County would lose some of its operational independence.

Therefore, for the new "quasi-centralized" arrangement to be mutually beneficial, the City and County would have to somehow be incorporated into the day to day water supply

operations of each other in order to insure that the combined system was operating efficiently and that both parties were getting the water they needed. One alternative would be to form a joint operations and maintenance department that would transcend the normal political boundaries. Thus, in essence, the water supply systems would be centralized into a super water supply system with both parties having equal control.

TABLE 17

Breakdown of Project Costs for the City and County Constructing Their Own Water Main & Utilizing the City Treatment Plant Alternative

1. Construction of 57 miles of 60" diameter main at a cost of $1.3 million per mile.	$ 74,100,000
2. Construction of an inlet in Lake Huron at an estimated cost of $10 million.	10,000,000
3. Construction of 2 booster pumping stations to convey the water from Lake Huron to the Flint treatment plant at an estimated cost of $10 million.	10,000,000
4. Complete rehabilitation of the existing treatment plant to handle at least 40 mgd of raw Lake Huron water at an estimated cost of $5 million.	1,000,000
Total Projected Project Cost	$ 99,100,000

However, with the County developing the south water loop and severing operational dependence from the City, they are demonstrating the intention to head completely in the opposite direction. Thus, the super water supply system is highly unlikely given the current

political and financial environment between the two administrations.

The County views itself as the newly emerging power in the area due to economic growth outside of the City. The County also has an organization, Water and Waste Services (WWS), that is totally devoted to concerns of the water system. With WWS, it can totally concentrate on the day to day costs associated with expanding and operating its water system and is not faced with general fund obligations as is the City. The system is currently growing to accommodate more and more water customers.

On the other hand, the City has many other non water system budget issues with which to contend with. Of which, many actually draw money away from the water department. Thus, they are not as free to concern themselves with the sole operation of their facilities as is the County. In addition, the City distribution system is fully developed and, in some cases, is getting old and will have to be rehabilitated. Therefore, issues pertaining to who would pay for these improvements between the City and County would have to be resolved. Further, their customer base is actually shrinking, resulting in less and less revenue available to operate and maintain their water supply system.

In a letter from the MDPH to the City of Flint on June 19, 1990, they addressed a concern over budget problems having delayed rehabilitation of filters and flocculation basins at the City treatment plant. In the same letter, they mention the dire financial outlook that the City's budget director expressed in resolving this and other operational problems. Further, in a report of the minutes of a meeting between the City and the MDPH on May 1, 1991, it was reported that the City's current water/sewer rate structure is not providing sufficient revenues to do everything that needs to be done and also have all

rehabilitation/upgrade work done on the treatment plant.

The result of the City's financial situation could cause difficulties between the two organizations in terms of running a combined system. At this time, it is the general consensus of the County administration, that they do not want to inherit these perceived and real problems associated with the City. Thus, it appears that this alternative would not have a great deal of attraction to the County. Table 18, on page 63, summarizes the costs of the alternatives presented in this section in today's dollars.

Choosing the best alternative, in this case, does not necessarily involve choosing the cheapest one. If that were the case, alternative two would be selected. Further, a benefit/cost ratio can not be accurately calculated because of the abstract nature of assessing the benefits from these alternatives. Therefore, with costs known, the alternatives must be analyzed to assess the benefits associated with it. Beginning with Alternative 1, this is the only one that not only provides an emergency supply of water at the same quality that was originally in the City and County system, but it also provides a loop that can be continually operated that would greatly benefit the County system as well as the City system. In addition, operation and maintenance of this alternative by the City and County would be minimal because it consists mainly of pipe buried in the ground.

Alternative 1 would also still leave the County with operational independence. This is because the County would be interconnected at strategically selected points along the proposed North/South route before it reaches the City system. Thus, the County will have taken the water it needed from this source before it reaches the City. This alternative would actually strengthen the County system and, as a result, provide the necessary

capability for expanding the County water system outside of the County, which would ultimately increase the customer base and, thus, revenue.

Table 18

Summary of Project Costs Associated
with the Proposed Alternatives

1.	Alternative (1), City Portion	$19,887,596
2.	Alternative (2)	$11,244,163
3.	Alternative (3)	$59,852,731
4.	Alternative (4)	$19,038,219
5.	Alternative (5)	$99,100,000

Alternative 2 would only provide water for emergency backup purposes that would generally be of a lower quality than the water originally in the City and County system. This would mean that, once the emergency was over, the County system would most likely have to be purged of all of the alternate source of water in order to insure the quality of the original supply when it came back on-line. In addition, there is no guarantee that sustained flow can be delivered by the plant to the County.

The County would also lose operational independence during this emergency, under this alternative, which could potentially place their system at risk if the City did not supply it with the necessary amount of water.

This alternative is also a maintenance and operational intensive solution for the City. It is highly expensive and inefficient to maintain a treatment plant for the sole purpose of supplying an emergency backup water supply.

Alternative 3 would only provide water for emergency backup purposes that would

generally be of comparable quality to the original supply in the City and County system. There may be taste and odor differences between the two, though. However, once the emergency was over, it would be unlikely that the County system would have to be purged of this water to insure the quality of the original supply when it came back on-line. The County would also lose operational independence during this emergency, which could potentially place their system at risk if the City was not able to supply it with the necessary amount of water. There would also be the risk of the main from Saginaw rupturing or a booster pumping station failing during the emergency condition, thus, eliminating the City's and County's emergency backup supply. This alternative is also a maintenance and operational intensive solution for the City. It is highly expensive and inefficient to maintain booster pumping stations and transmission main for the sole purpose of supplying an emergency backup water supply.

Alternative 4 would only provide water for emergency backup purposes that would be of a lower quality than the water originally in the City and County system. This would mean that, once the emergency was over, the County system would most likely have to be purged of all of the alternate source of water in order to insure the quality of the original supply when it came back on-line.

The County would also lose operational independence during this emergency, which could potentially place their system at risk if the City did not supply it with their required flow of water. This alternative is also a maintenance and operational intensive solution for the City. It is highly expensive and inefficient to operate and maintain a well system as large and complex as the one proposed to supply water in an emergency situation for the

sole purpose of supplying an emergency backup water supply. In addition, if the water being drawn was not of suitable quality, then further treatment would be required. Preparing for this situation, the City would have to operate and maintain some kind of emergency treatment facility for this supply, which would continue to involve the treatment plant and its associated costs. Another potential problem would be that the wells would not be able to provide the design rated flow. In which case, the City and County would be faced with major shortages. This is a highly expensive option to have that kind of risk looming overhead.

Alternative 5 would not solve the problem of a secondary emergency supply because the combined system would still be reliant on a single 60" diameter transmission main unless the DWSD agreed to operate and maintain their 72" diameter main as a backup supply. This type of backup service, by the DWSD, could cost a substantial premium and would have to be absorbed by City and County water operations, which would then be passed on to their respective customers in the form of rate increases.

In addition, it does not appear, at this time, that the County administration would be willing to consolidate with the City and absorb their problems. Operationally and politically, it is not the most feasible solution.

Therefore, based on all that has been evaluated in this section, it appears that the optimum solution for a secondary emergency supply of water for the County as well as the City would be to incorporate Alternative 1. The projected cost of the non-DWSD portion of the project is $23,128,312.

It can also be assumed that the City of Flint would finance the cost of this project

and then charge the County for their share of the project by increased water rates until it was paid for. However, if the method of financing used by the City were to be based strictly on their water supply operation revenues, then they would most likely finance this project the same way the County would. Thus, in keeping the context of this paper in the County's perspective, the next section on financing this project will be approached from the County's point of view.

V. FINANCING THE CHOSEN ALTERNATIVE

It must be pointed out that for the foreseeable future the secondary supply line will generate very few new customers for the County. This line will, however, strengthen the southern half of the County and even provide additional resources for the County to expand their system into other Counties, such as Livingston or northern Oakland, that currently have no public supply system. This would generate new customers and, thus increase revenue for the County.

However, for initial budgeting and financing purposes, the County would not include revenues from an expanded customer base as a source to finance this project. Thus, the two basic sources of revenues that would be available to the County would be operating revenues and nonoperating revenues. Operating revenues include sales of water to general customers and other services that would be provided under their standard rate schedules, such as providing the municipality with a billing service. Non operating revenues include gains or losses from the sale of County property, rental of nonoperating property, interest income, and any other item not directly related to the provision of water service.

It is the intent of this section to develop the following:

1. Define Strategic Financial Planning (SFP) and present its various components.
2. Examine financing alternatives available to the County.

One means of determining what it will take, in terms of financing this project, would be to utilize the SFP technique. This method would utilize the County's already developed budget scheme with its defined funds for the water supply system portion of the County operation.

The County utilizes a general fund which is comprised of four different funds. Two of these funds, which are called the interceptor and treatment funds and sanitary sewer districts #3 and #7, are for sanitary sewer operations and will not be addressed. The third type of fund is the water supply system fund. The fourth type of general fund is for miscellaneous expenditures.

The water supply system fund accounts for all revenues generated within the County by user fees from water use. The fund accounts for the entire water supply system. This fund amounted to approximately $3,960,000 in 1991.

The miscellaneous fund consists basically of monies received from investments within each of the four general funds. The nature and amount of the type of investment varies. An example of this would be surplus money from the water supply system fund that is invested to earn interest while not being utilized by the water supply system budget.

Another fund source for the County, has been from State and Federal government in the form of State and Federal grants and/or aid. This money would be used explicitly for the financing of a particular project if it qualified. However, most grants in this area have been for the study and development of wastewater facilities for the County and not

potable water supplies.

Thus, with the amount of revenue known for the water supply fund its associated routine and non-routine costs, a budget is established for the fiscal years water system operation. From this, the County can develop a financing plan that will meet the cash requirements of the water supply system budget. There are a number of alternative financing sources available to publicly owned water utilities that can be used to achieve this goal. The County management has the responsibility to utilize these financing sources so that, over the long run, the cost of money to the County will be minimized.

SFP involves comparing projections of all County water supply system revenue sources for a two- to five-year planning period. This is done in an effort to determine the need for additional sources of funding and alternative financing, which will minimize effects on County finances and potential charges to served water customers. Projections for periods longer than five years are highly speculative even when utilizing the estimated population studies mentioned earlier.

The major step in the planning process is to forecast revenue and revenue requirements. The major source of revenue for the County water supply fund comes from water sales to its customers. Revenue requirements mainly consist of Operation and Maintenance (O&M) expenditures and other capital costs expressed on a cash or utility basis or both. The National Association of Regulatory Utility Commissioners' uniform system of accounts classifies O&M expenditures by the following expense categories:

1. Source of supply of water
2. Pumping
3. Water treatment
4. Transmission and distribution

5. Customer accounts
6. Administrative and general.(34)

Capital costs consist of payments for existing debt service and routine capital projects, which are normally financed from the appropriated budget.

Once projections of the various components of revenue and revenue requirements have been completed, a cash-flow forecast and analysis can be made to compare annual revenue and revenue requirements for the planning period. The planning period for this project would most likely be a 20 year period. This is the typical length of time that the County would utilize to finance long-term debt, which a project of this magnitude would create. If it is determined that a cash shortfall could be incurred by this project, options such as increasing water rates to customers could be considered.

Once the initial financing plan is developed, alternative long-term debt financing methods must be analyzed. Long-term debt financing is generally used for infrequent major capital projects to spread the cost of the project over a number of years. This is done to keep annual revenue requirements low and to insure that future users of the system help to pay for the project.

The two major types of long-term debt financing available to the County are general obligation bonds and revenue bonds. General obligation bonds are debt instruments backed by the full faith and credit of the County. The bonds are secured by an unconditioned pledge by the County to levy unlimited rate increases, if necessary, to retire the bonds. This type of bond is generally regarded by investors and the rating agencies as the strongest form of bond security, and thus generally represents the lowest cost of financing available to the County.

General obligation bonds are the most traditional, well-known form of tax-exempt borrowing. This type of bond benefits the County in a variety of ways. First, due to strong security features, the interest rates of general-obligation bonds are generally the lowest available and can result in considerable interest savings. Costs of issuance are generally lower than those associated with revenue-bond, examined next, not only because it costs less to market a bond with wide market acceptance, but because the documentation associated with general obligation issuance is less complex than that required revenue bond financing.

There are also certain drawbacks with this form of financing. One of the most significant is that new water rates to support new general obligation debt must be authorized ultimately by the customers. In addition to obtaining customer approval for new bonds, issuance of general obligation debt is also limited by County debt ceilings and interest rate ceilings.

Revenue bonds, though, are used almost exclusively by the County to finance these types of projects because it would be part of a self sustaining operation and would ultimately be used to generate additional revenue for the water supply operation. Principal and interest on the bonds are secured by and payable exclusively from revenues received from system operations or from the project being financed. Generally no water rate increases would have to be pledged as a backup. Revenue bond debt service payments would almost certainly come from charges paid by customers on the water system.

Revenue bonds are attractive in that they provide initial financing that can pay for themselves over the projects useful life or at least for the duration of the bond. The market acceptance of this type of bond will be highly dependent on the perceived value of the

service provided by the project and the issuing agency which is the County. This is because these bonds present a greater risk for the investor than general obligation bonds, since repayment of debt depends on timely completion of the project, an adequate water charge structure, and sound County management of the operation. However, revenue bonds usually command higher interest rates than general obligation bonds because of the greater risk perception.

To provide investors and rating agencies with financial assurances that enhance marketability, the County could be required to provide the following security elements:

1. A revenue pledge that all revenues will be used first to pay all O&M costs and then all debt service due, reserve fund requirements, and any costs associated with system repair or replacement;
2. A rate covenant by which the issuer agrees to enact water rates to meet costs and that indicates the number of times current net revenues must cover debt and other costs;
3. An additional bonds test in which both a historical and a projected revenue test may be used to avoid the dilution of coverage below established levels on outstanding debt; and
4. A reserve fund specifying the amount, usually expressed in terms of average or maximum debt in any future year, required to be held as a cash reserve for annual debt service payment to the benefit of the bondholders.(35)

The revenue bond form of financing offers important benefits to the County in that its issuance doesn't always require water user approval. However, their right to petition for a referendum is, however, generally available. They also avoid possible and unnecessary dilution of the County's full faith and credit pledge, since the bonds would be included in the County's debt limit. One disadvantage in using these bonds would be paying the higher interest rate on the borrowed money.

It appears that attempting to finance all or even part of this project utilizing a Federal or State grant is not feasible now or for the foreseeable future because of reduced spending. The few grants available from various Federal and State sources are for rural or economically depressed areas. The Farmers Home Administration (FmHA) provides grants and loans for rural water and sewer systems and communities with populations less than 25,000. Economically depressed areas have received help through programs administered by the Economic Development Administration (EDA), the Department of Housing and Urban Development (HUD), and the Appalachian Regional Commission (ARC). At the State level Wyoming, Colorado, New Jersey, Oklahoma, Pennsylvania, and North Carolina, provide grants or loans in some limited instance.

VI. CONCLUSIONS

Sometime in the future, the County can expect the 72" diameter main to fail. The result of this would probably be the loss of the primary water supply for at least two weeks. This would mean that, under the current method of operation, both the City and County would have to rely on the City's treatment plant as a backup source. Because of the costs and risks associated with operating the treatment plant in a stand-by capacity, this is not considered to be an efficient and reliable long term solution to this condition.

Thus, through the examination of this issue, in this paper, it has been determined that the most economically, operational, long term, and safe way to provide a secondary backup source of water is to build a North/South water main that connects to the DWSD's northern system near Pontiac.

The best way to finance this project, if the County were to do so, would be to issue

Revenue bonds. These bonds are the most conducive type of financing instruments available to a revenue generating organization such as the County's Division of WWS.

The concept for the secondary water main is not new. It was originally proposed when the connection was made by Flint to the DWSD system in 1965. That was over 25 years ago. In that time, the 72" diameter pipeline has aged and the potential for a failure is increasing. Therefore, it is the intent of this paper to provide new insight into this complex issue and to hopefully be a contributing factor in the realization of the construction of the secondary main to supply the City and County in the event of a failure of the 72" diameter supply main.

ENDNOTES

ENDNOTES

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3. Ibid., pg. 1

4. Ibid., pg. 1

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11. Ibid., pg. 7-16

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21. Ibid., pg. 7.

22. Ibid., pg. 7.

23. Ibid., pg. 17

24. Op. cit., pg. 2-2 from reference 10 above.

25. Op. cit., pg. 23 from reference 2 above.

26. Ibid., pg. 6.

27. Ibid., pg. 40.

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29. Ibid., pg. 6.

30. Ibid., pg. 42.

31. Ibid., pg. 43.

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35. Ibid., pg. 17.

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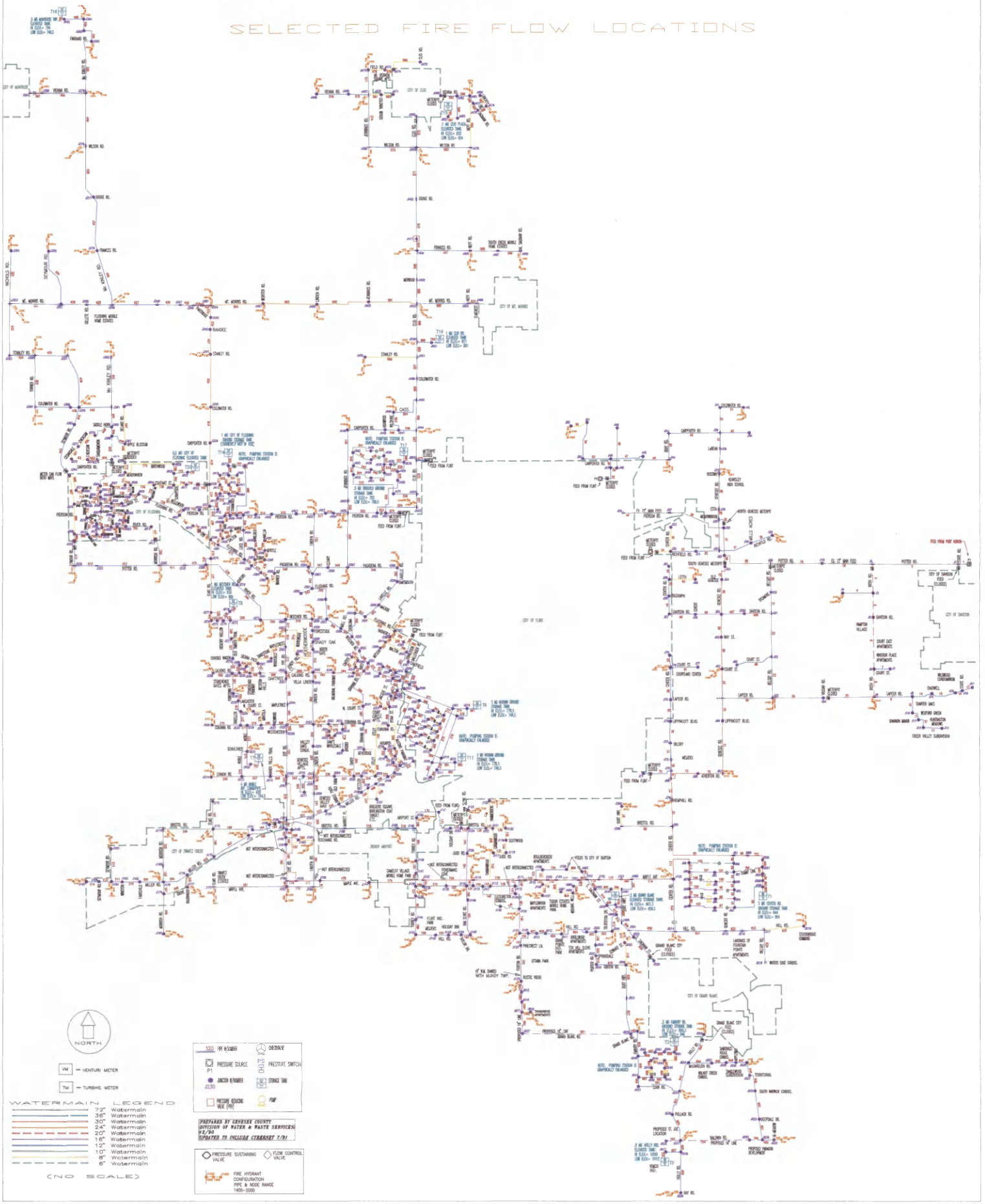
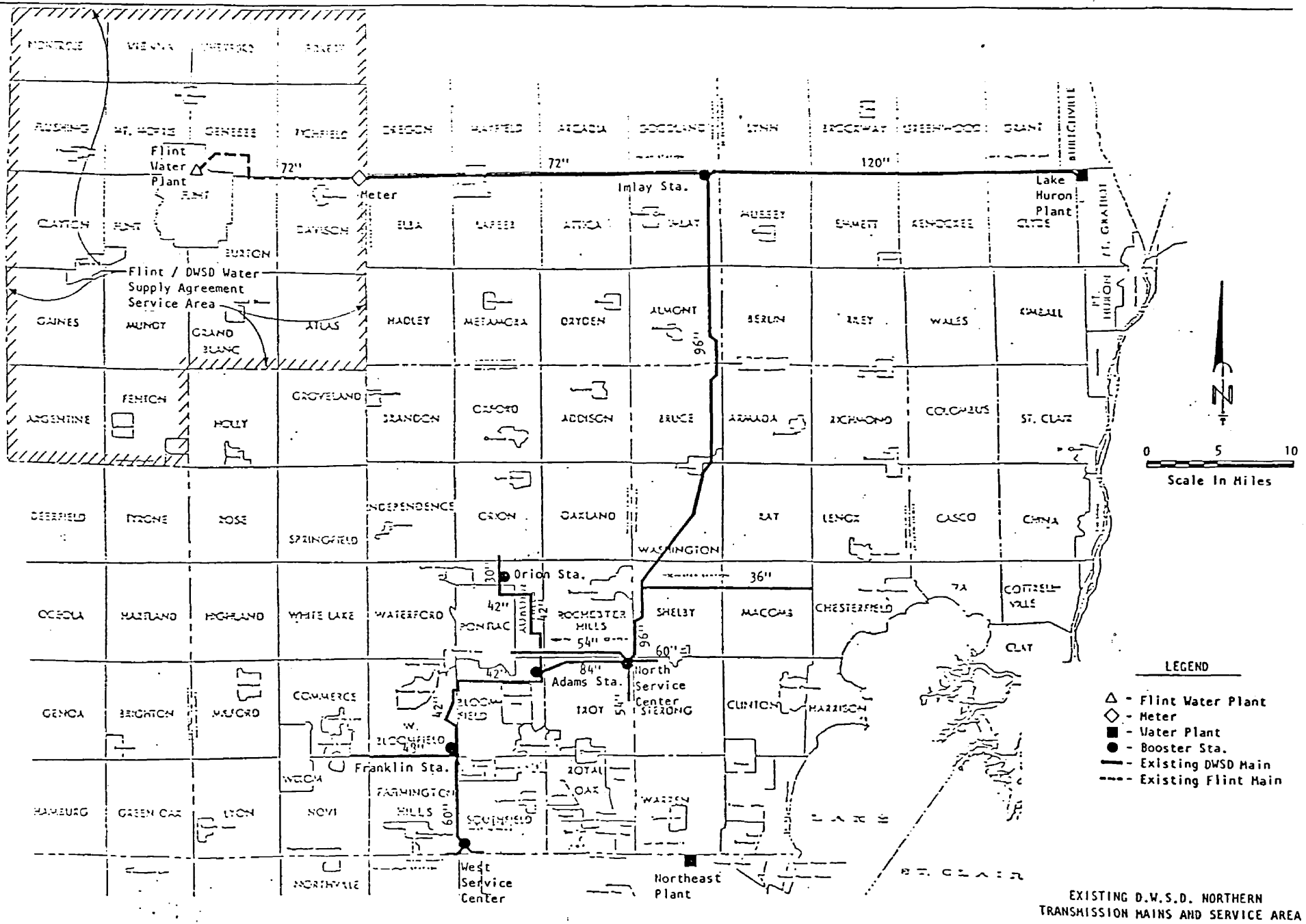
APPENDIX A

GENESEE COUNTY WATER SUPPLY SYSTEM

SELECTED FIRE FLOW LOCATIONS



APPENDIX B

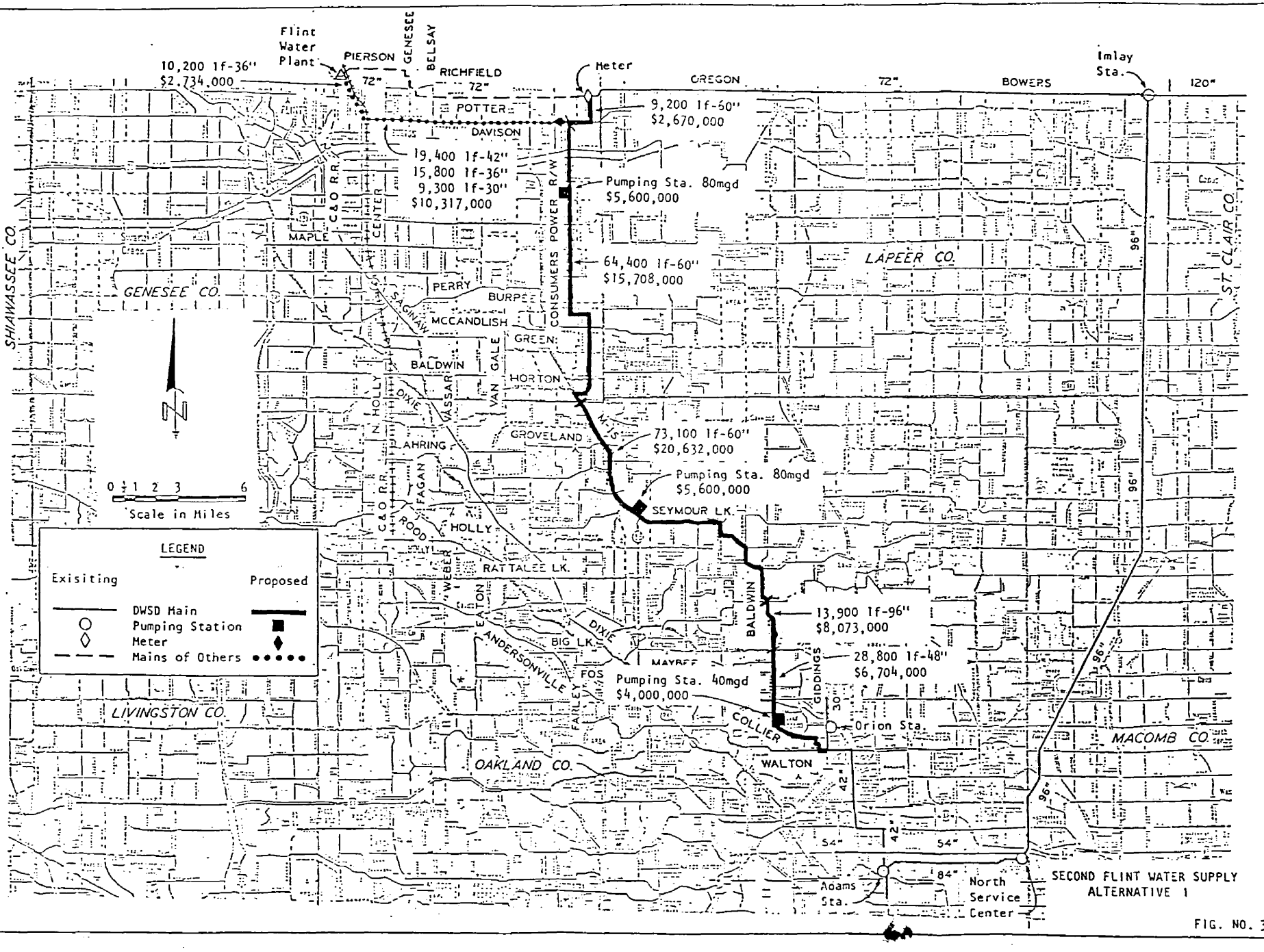


EXISTING D.W.S.D. NORTHERN TRANSMISSION MAINS AND SERVICE AREA

FIG. NO.1

REV 10-87 GJS3

APPENDIX C



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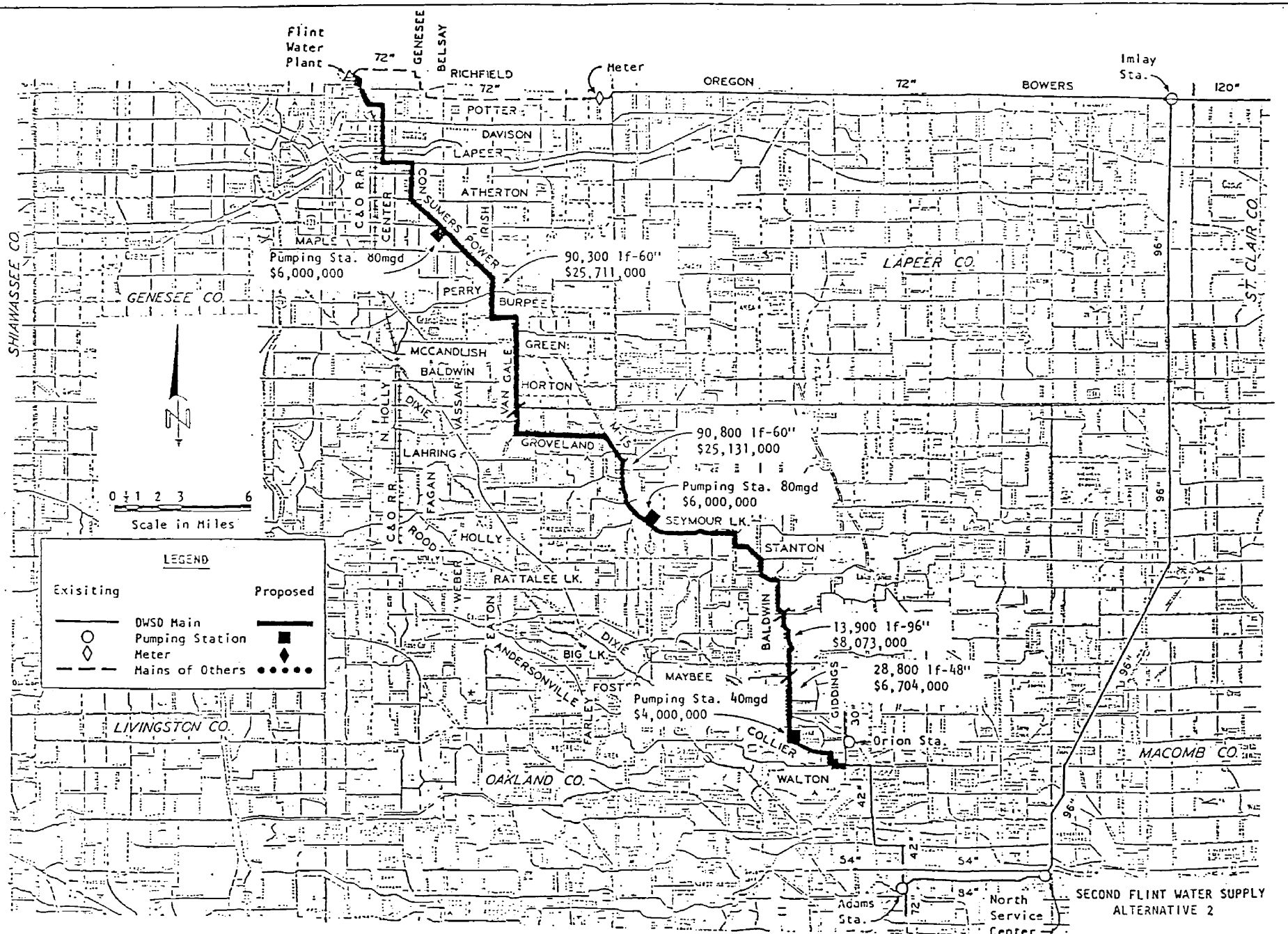
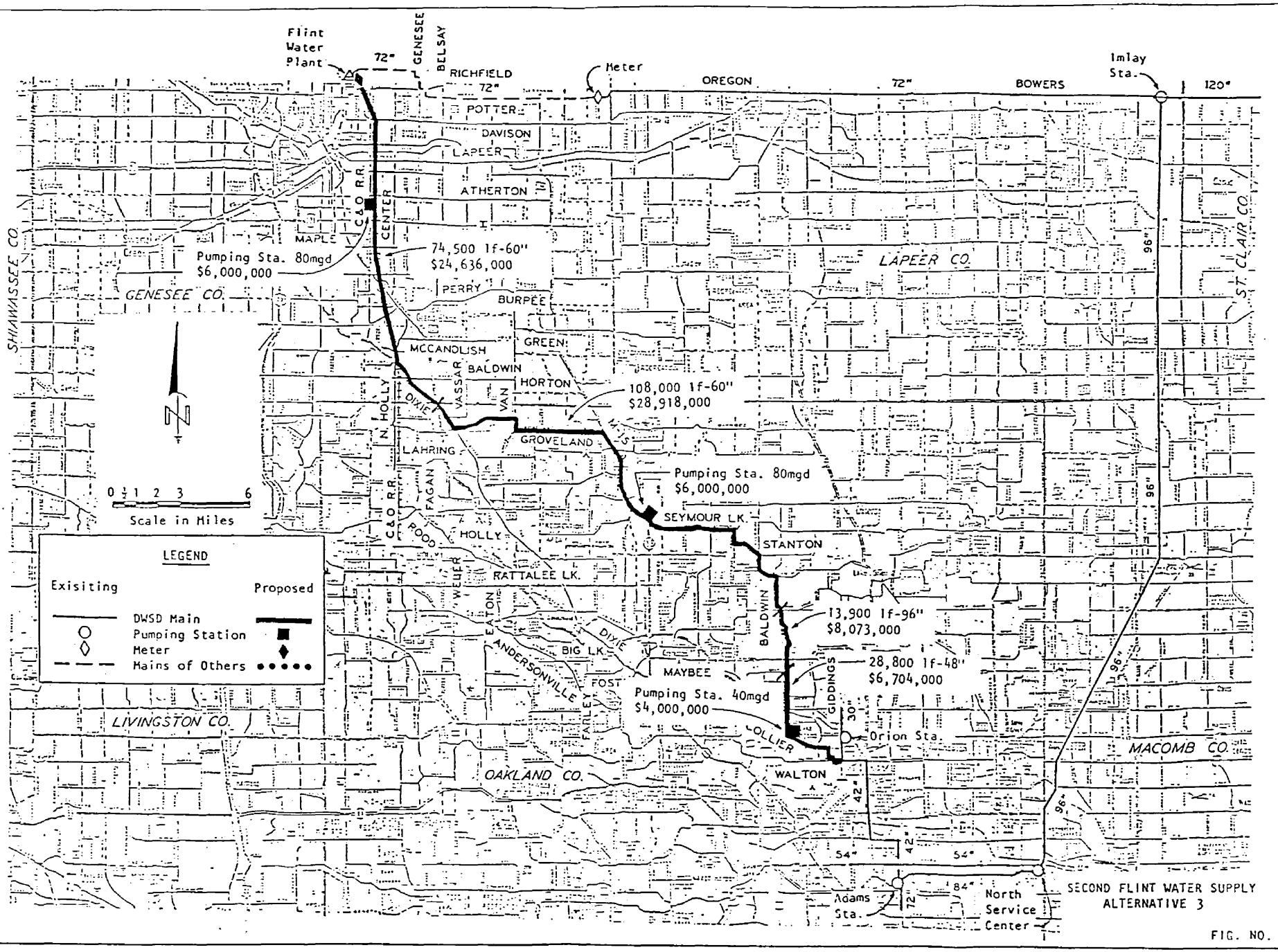


SECOND FLINT WATER SUPPLY
ALTERNATIVE 2

FIG. NO. 4

REV. 10-87 GJS3



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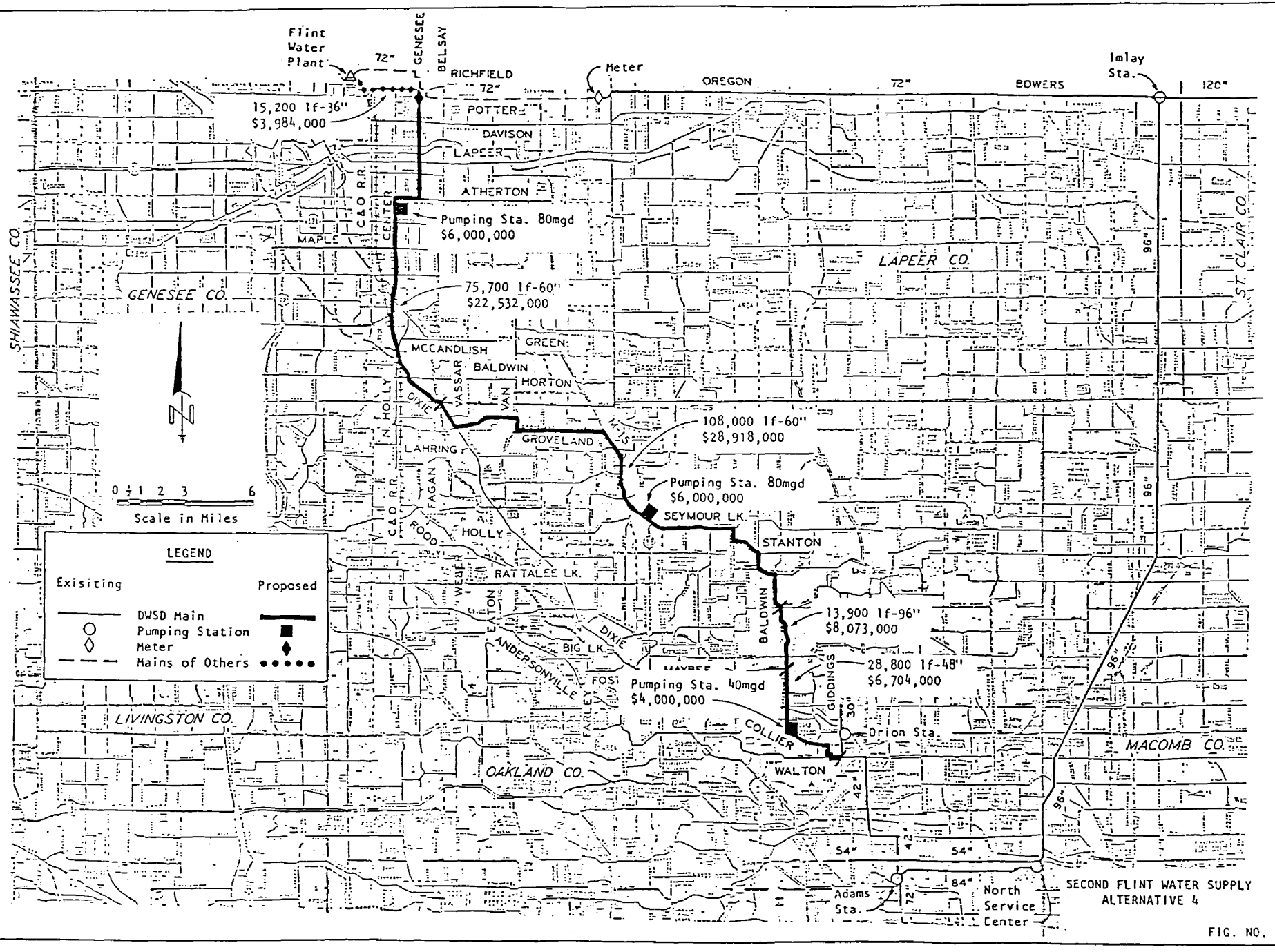

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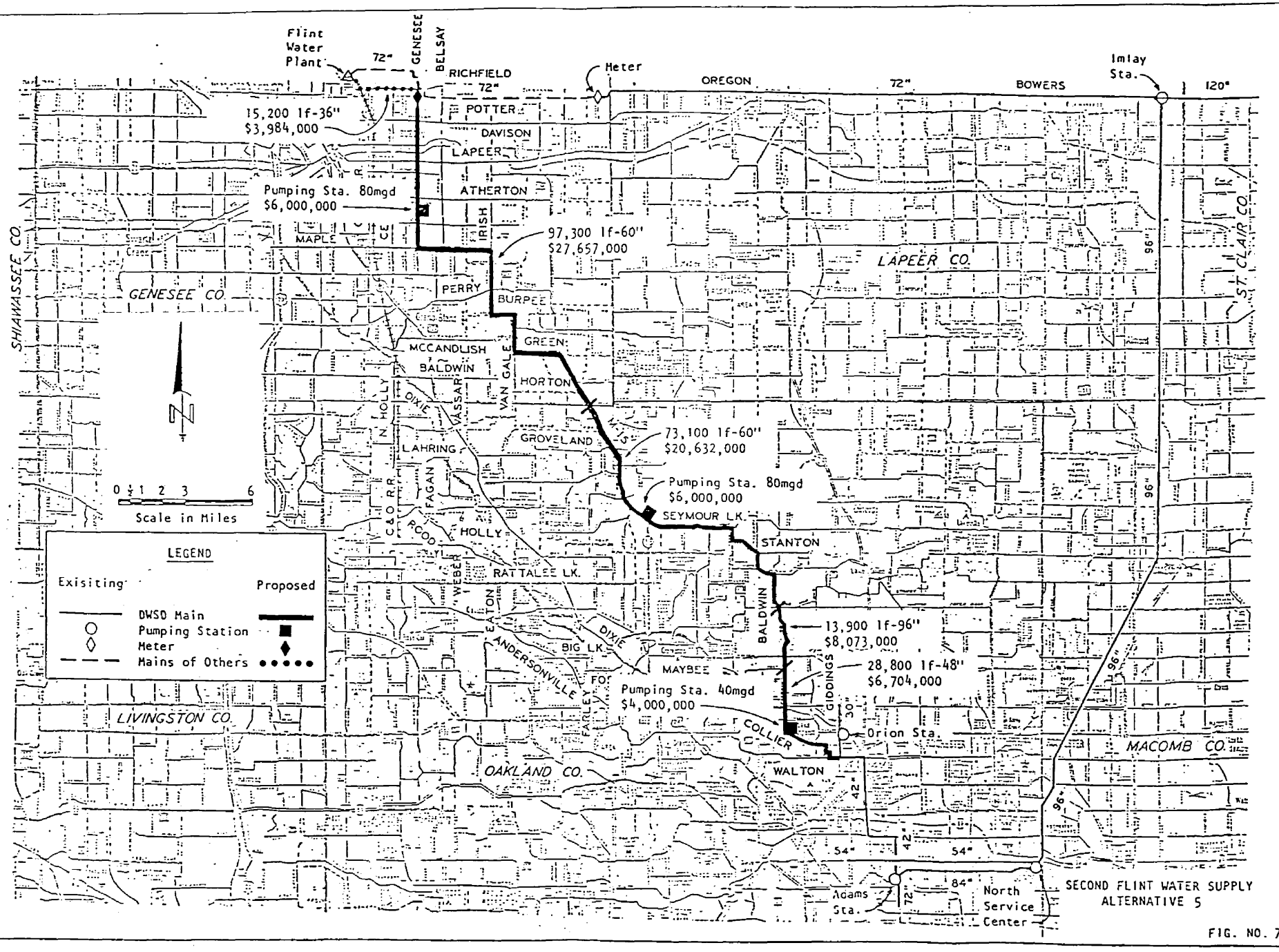
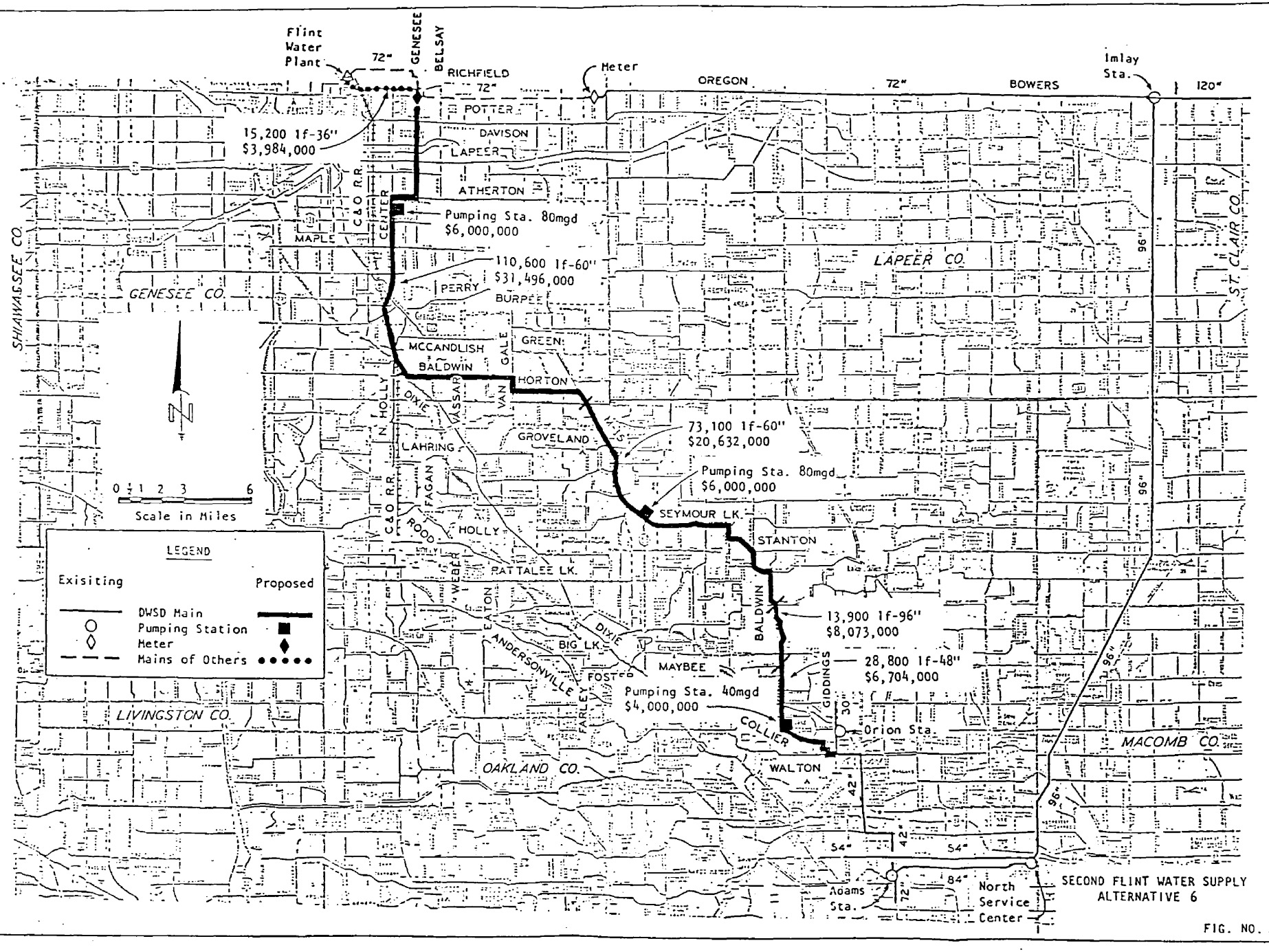


SECOND FLINT WATER SUPPLY
ALTERNATIVE 5

FIG. NO. 7

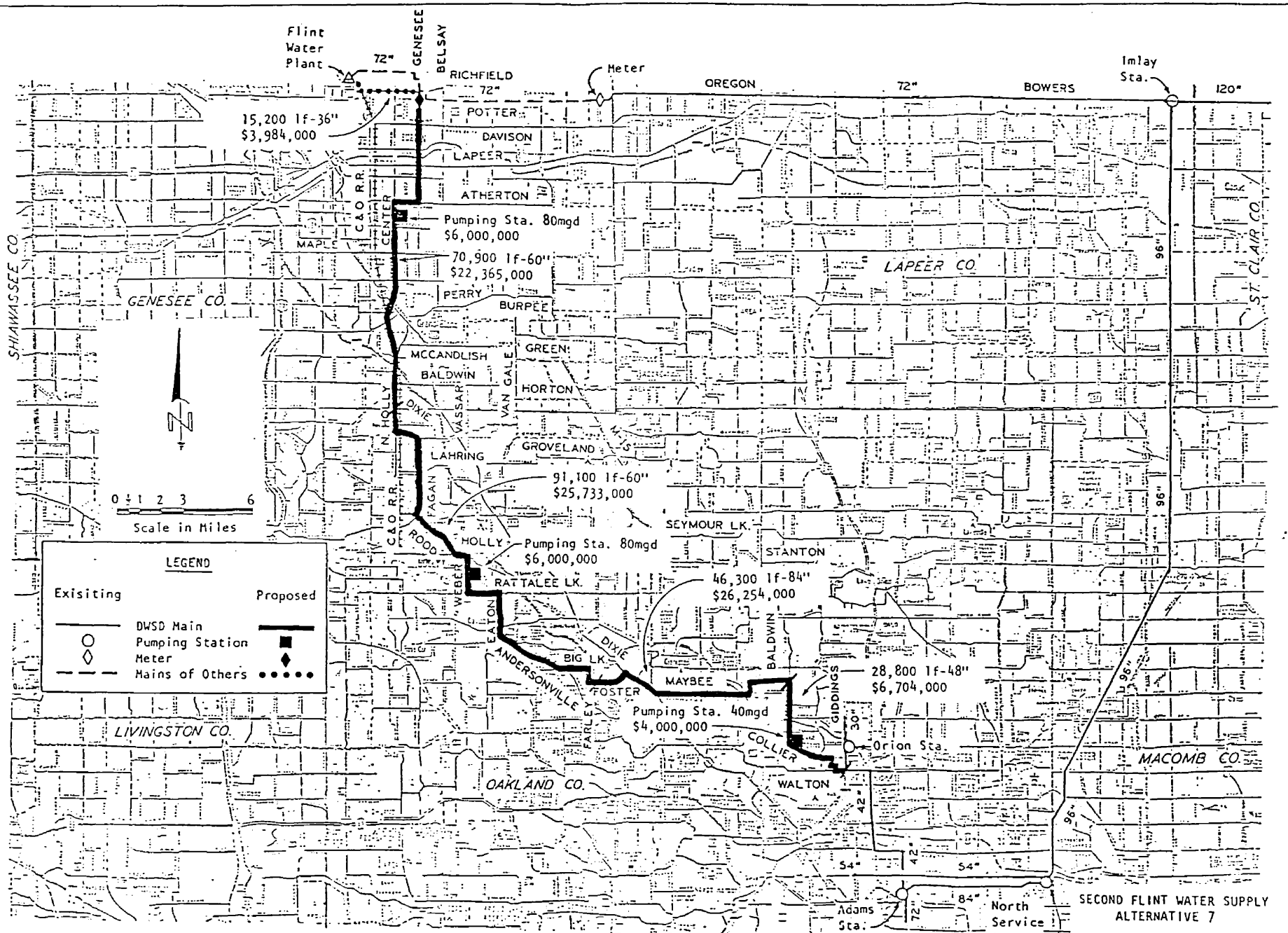
JLM 10/14/87



SECOND FLINT WATER SUPPLY
ALTERNATIVE 6

FIG. NO. 8

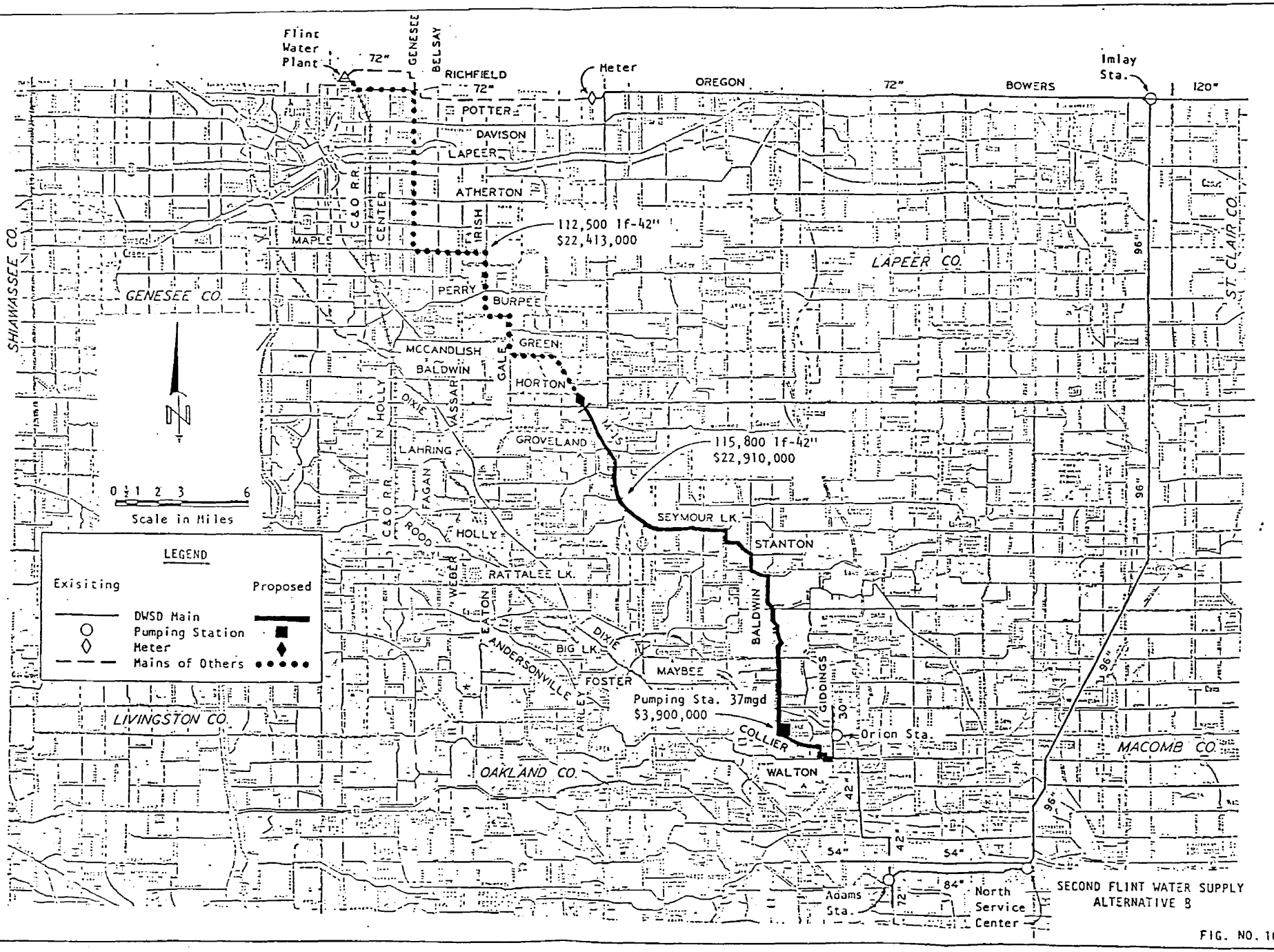
REV. 10-87 GJS3



SECOND FLINT WATER SUPPLY ALTERNATIVE 7

FIG. NO. 9

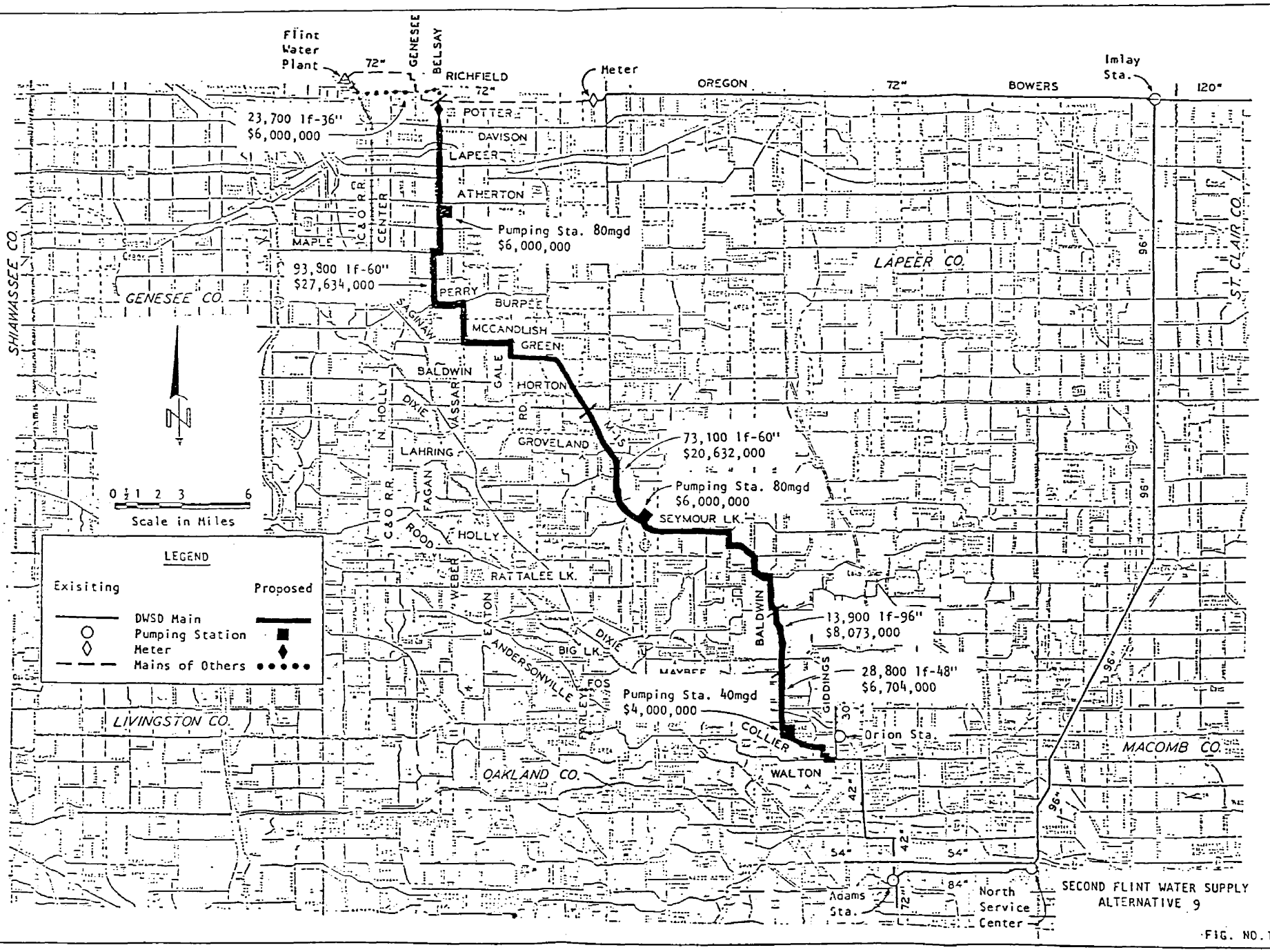
REV 10-87 GJS3



SECOND FLINT WATER SUPPLY
ALTERNATIVE 8

FIG. NO. 10

JLM 10/14/87



SECOND FLINT WATER SUPPLY
ALTERNATIVE 9

FIG. NO. 11

REV 10-87 GJSJ

APPENDIX D

DESCRIPTION OF ROUTE CRITERIA

The evaluation criteria and their weights described in this Appendix were developed, by the technical committee, for this project.

Acceptability

The relative degree of acceptance by any political entity impacted by the project, both as to utility and impact on quality of life, both temporary and permanent. This criterion has been assigned a weight of 5.

Access to Route for Maintenance

The relative degree of ease of entry of personnel and equipment to the location of the facility. Generally, access is easiest in public right-of-ways, somewhat more difficult in public utility corridors, and most difficult in private property easements. Relatively level ground surface is preferred over steep slopes or sharp river valleys. This criterion has been assigned a weight of 5.

Benefits Accruing to Current & Future Customers

The relative worth of any proposed facility to users, either current or future, and the ease with which the facility can later be extended to serve those not now users. This criterion was assigned a weight of 7.

Capital Costs

All costs incurred in development and construction of a facility. Cost of studies, design, construction, right-of-way acquisition, legal actions, bond sales, and interest on borrowed money are all part of capital costs. Generally, these are costs or obligations incurred prior to placing the facility in service. This criterion has been assigned a weight of 9.

Institutional Requirements

The perceived complexity of inter-party negotiations and political, legal, and contractual arrangements. This criterion was assigned a weight of 7.

Operating and Maintenance Costs

Annual cost of labor, power, supplies, tools, and replacement equipment required to keep the facility functioning properly. Other than bond payments, this is generally all costs incurred for a facility after it is placed in operation. This criterion was assigned a weight 5.

Public Agency Reviews and Approvals Required

Time and effort required to obtain necessary project approvals from environmental, public utility, and public health agencies. These reviews could apply to both stream crossings and construction i protected lands. This criterion has been assigned a weight of 3.

Right-of-Way Availability

Perceived relative difficulty of obtaining adequate right-of-way for construction and for operation and maintenance of a facility. This criterion has been assigned a weight of 8.

Schedules and Time Frames Involved

Relative lengths of time required to carry a project through to completion and operation. (Primary delays would be political considerations and right-of-way acquisition.) This criterion has been assigned a weight of 4.

Scoring on some of these criteria was partly subjective, because in depth analyses of all criteria were not done. Capital and Operation and Maintenance costs ranking were the most objective, followed by maintenance access, right-of-way availability, acceptability, and benefits.

APPENDIX E

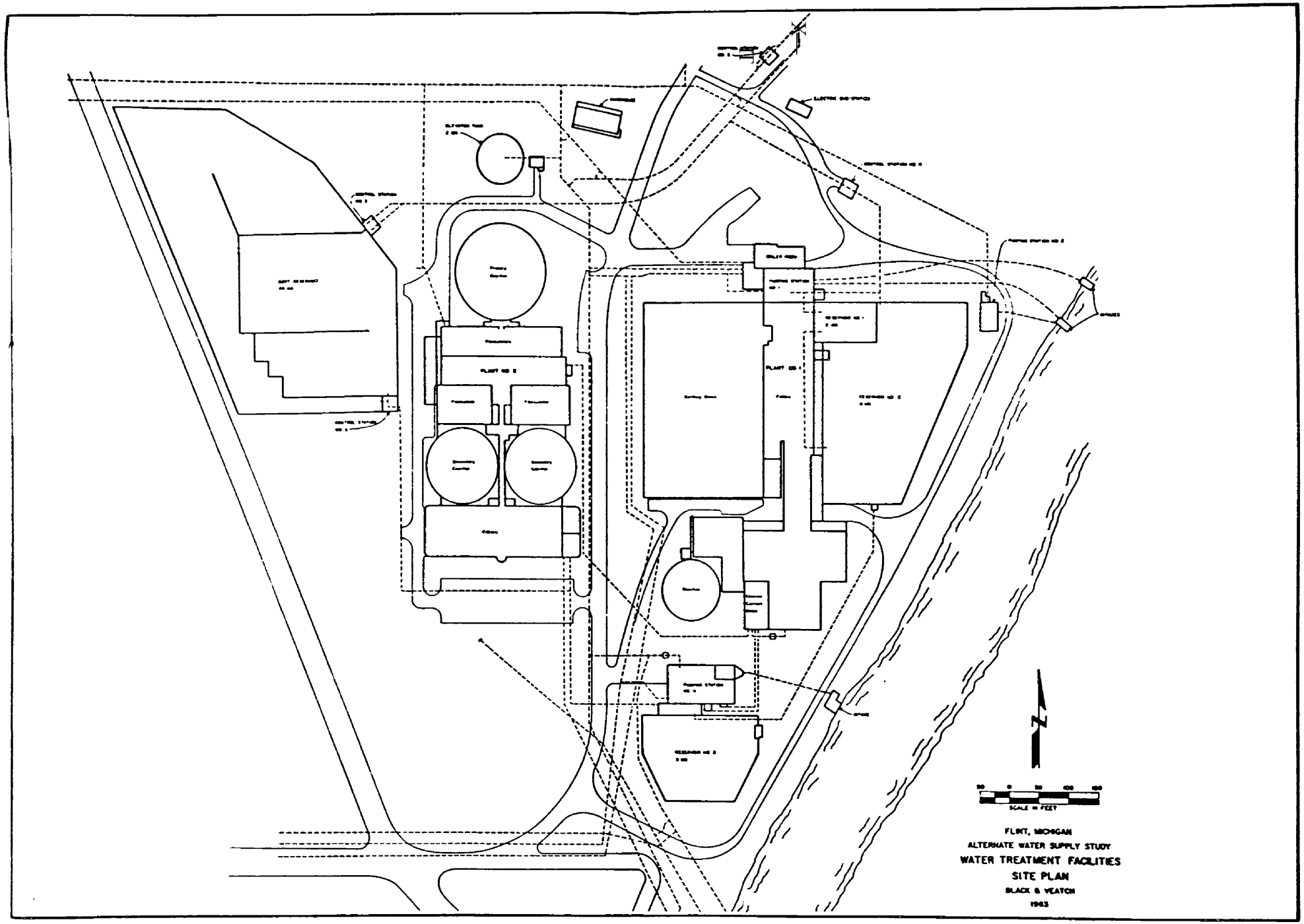

FLINT, MICHIGAN
ALTERNATE WATER SUPPLY STUDY
WATER TREATMENT FACILITIES
SITE PLAN
BLACK & VEATCH
1963

FIGURE 4

APPENDIX F

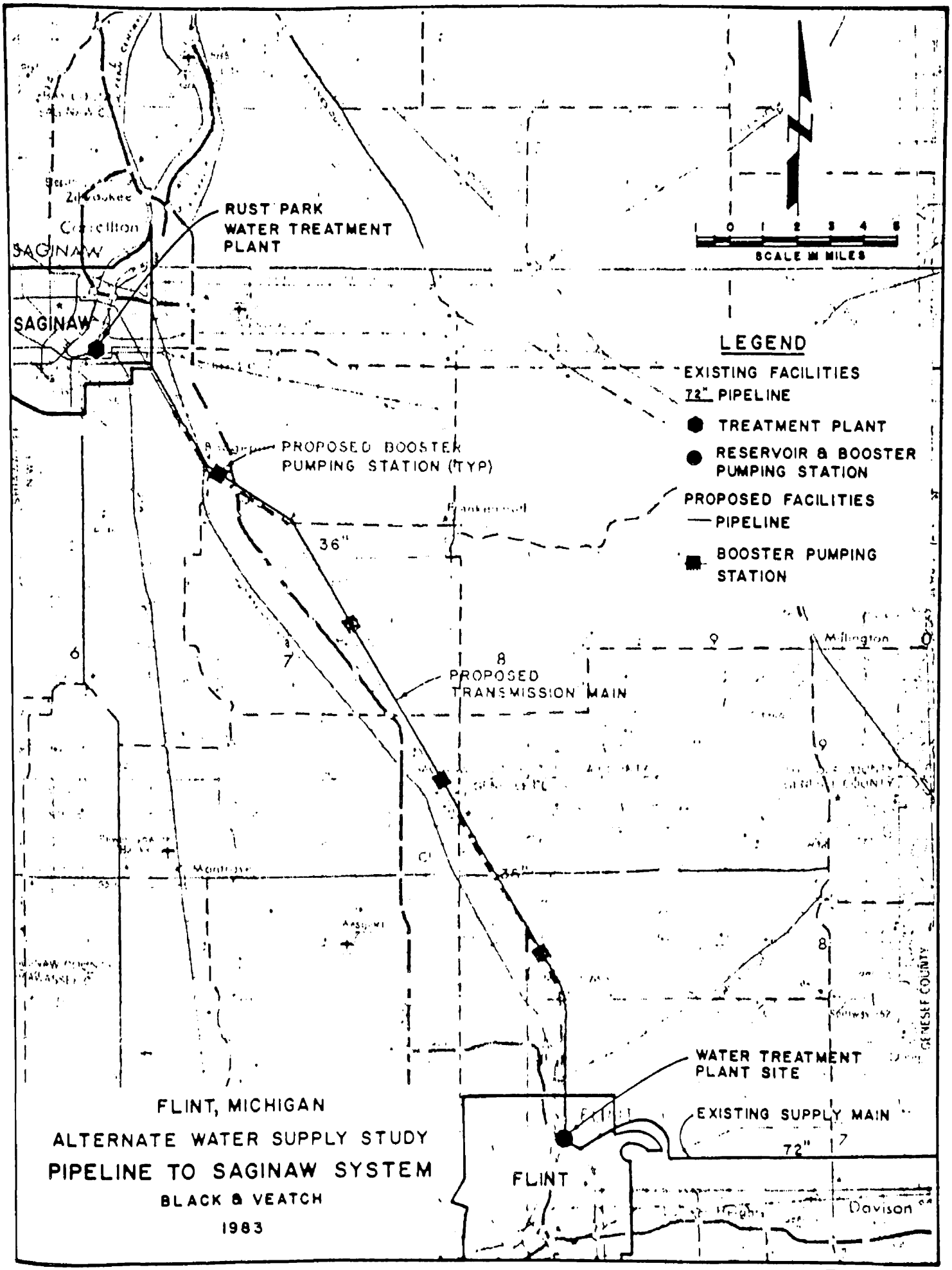

RUST PARK
WATER TREATMENT
PLANT
SAGINAW
SAGINAW
SCALE IN MILES
LEGEND
EXISTING FACILITIES
72" PIPELINE
TREATMENT PLANT
RESERVOIR & BOOSTER
PUMPING STATION
PROPOSED FACILITIES
PIPELINE
BOOSTER PUMPING
STATION
PROPOSED BOOSTER
PUMPING STATION (TYP)
36"
PROPOSED
TRANSMISSION MAIN
WATER TREATMENT
PLANT SITE
EXISTING SUPPLY MAIN
72"
FLINT
Davison
GENESEE COUNTY
FLINT, MICHIGAN
ALTERNATE WATER SUPPLY STUDY
PIPELINE TO SAGINAW SYSTEM
BLACK & VEATCH
1983

FIGURE 5