Appendix 8 - Cost of Service Study – Flint Water Treatment Plant

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Technical Memorandum
Cost of Service Study
Flint Water Treatment Plant

I. Introduction

This Technical Memorandum describes the proposed improvements needed at the Flint Water Plant to treat Flint River water on a continuous basis. The primary foundations for this evaluation were the "Water Treatment Plant Rehabilitation – Phase II" report dated December 2003 and the "Preliminary Engineering Report, Lake Huron Water Supply, Karegnondi Water Authority" dated September 2009. The findings, as presented in the following sections, address the improvements required for the water plant to produce finished water in conformance with the current federal and state drinking water regulations. In addition, operation and maintenance costs for continuous operation have been evaluated and included in order to determine the total cost associated with using the Flint River as a source of water.

Improvements, as proposed in this evaluation, along with those previously made during the Phase I improvements program, will produce a finished water quality equal to the current water quality as received from the DWSD. The design parameters are as follows:

1) Minimum Day Demand – 10-mgd
   Average Day Demand – 15-mgd (14-mgd in 2010 increasing to 15-mgd in 2050)
   Maximum Day Demand – 28-mgd

2) Turbidity – 0.20 NTU

3) Hardness – 80 to 100 mg/l as $CaCO_3$

4) Cryptosporidium – 3-Log Inactivation

5) Giardia – >3-Log Inactivation

6) Viruses – >4-Log Inactivation

7) Taste and Odor – Eliminated with pre-ozonation

8) Trihalomethanes – Less than 80 µg/l

9) HAA5 – Less than 60 µg/l

As part of this investigation, an inspection of the Flint Water Plant was performed on May 3, 2011. The purpose of this inspection was to determine if the recommendations in the Phase II report, as referenced above, needed to be revised due to changed conditions or water supply needs. Based on findings from this meeting, the major adjustment to be made is the reduction of average day demand from 20-mgd to 14-mgd and maximum day demand being reduced from 36-mgd to 28-mgd. Required improvements as recommended in this study have taken these new demands into account. The conceptual design of these new facilities would allow cost effective expansion to 36-mgd, as needed, to meet future demands.

II. Required Capital Improvements

The following describes the required improvements as required for the Flint Water Plant to operate on a continual basis using the Flint River as a water source. Most of these improvements are more fully described in the Phase II report and are not repeated to avoid duplicative effort.

A. Lime Sludge Disposal

Lime sludge is proposed to be pumped from the east and west softening basins to two new 42-ft diameter thickeners (25-ft SWD) located adjacent to the plate settling building. Decant from the thickener will flow by gravity to the primary clarifier influent channel. Thickened sludge (12% solids) will be pumped to a new plate-and-frame filter press located at the north end of the WTP 1 primary settling basin. A new two-story building would be constructed at that location to house the pumping facilities and presses. Each press, located on the second floor, will have a 225-cf per hour capacity and will drop the dewatered sludge into a first floor bunker area. The dewatered cake will be transferred to a lime storage concrete bunker located approximately 60 feet north of the sludge press building. The storage bunker (100-ft x 192-ft) will have the capacity to store three to four months of dewatered lime sludge cake. About every three months, contract haulers will remove the lime sludge and place on agricultural lands that are permitted for final disposal.

The capacities of these facilities are based on average day flow of 15-mgd, maximum day demand of 28-mgd and water quality softening requirements. Based on raw water quality data provided by the City of Flint, a lime dosage of 209 mg/l, soda ash dosage of 47 mg/l and carbon dioxide dosage of 37 mg/l were used to estimate lime sludge quantities and flows.

Opinion of Probable Cost:

Site and Access:			
Site Demolition	$ 129,000		
Roadway Improvements	$ 385,000		
Partial Settling Basin Demolition	$ 129,000		
On-site Truck Scale	$ 257,000		
	Subtotal Construction:	$	900,000
	Construction Contingencies (15%):	$	135,000
	Design Contingencies (5%):	$	45,000
	Engineering, Legal, Bonds & Administration (17%):	$	153,000
	Opinion of Probable Cost:	**$**	**1,233,000**

Thickener Basins - 42 ft Diameter:			
Two Thickener Mechanisms	$ 310,000		
Two Concrete Basins (25 ft SWD)	$ 513,000		
Two Geodesic Dome Covers	$ 180,000		
Install Equipment	$ 257,000		
Site Work	$ 97,000		
Utilities, Piping and Process	$ 193,000		
	Subtotal Construction:	$	1,550,000
	Construction Contingencies (15%):	$	232,500
	Design Contingencies (5%):	$	77,500
	Engineering, Legal, Bonds & Administration (17%):	$	263,500
	Opinion of Probable Cost:	**$**	**2,124,000**

Filter Presses and Building:			
Two-225 cf Plate & Frame Press	$	1,650,000	
Building (70 ft x 60 ft)	$	3,331,000	
MEP	$	1,089,000	
Site Utilities	$	129,000	
	Subtotal Construction:	$	6,199,000
	Construction Contingencies (15%):	$	929,850
	Design Contingencies (5%):	$	309,950
	Engineering, Legal, Bonds & Administration (17%):	$	1,053,830
	Opinion of Probable Cost:	**$**	**8,493,000**

Lime Storage Bunker and Site Work:			
12 ft Concrete Walls and Slab	$	833,000	
Frame and Fabric Building Cover	$	325,000	
Site Improvements	$	385,000	
Front End Loader (5 cyd)	$	308,000	
Site Utilities	$	513,000	
	Subtotal Construction:	$	2,364,000
	Construction Contingencies (15%):	$	354,600
	Design Contingencies (5%):	$	118,200
	Engineering, Legal, Bonds & Administration (17%):	$	401,880
	Opinion of Probable Cost:	**$**	**3,239,000**

Total for Lime Disposal : $ 15,089,000

B. Soda Ash Feed System

In order to remove the non-carbonate hardness, soda ash will be needed to meet the finished water hardness concentrations. Two new 800 #/hour feeders will be needed to meet the dosage requirements. Each of these feeders will be connected to the existing silos.

Opinion of Probable Cost:

Demolition of Existing Feeders	$	20,000	
Two 800 #/hr Feeders	$	112,000	
MEP	$	109,000	
Chemical	$	77,000	
New Pneumatic Fill System	$	58,000	
	Subtotal Construction:	$	376,000
	Construction Contingencies (15%):	$	56,400
	Design Contingencies (5%):	$	18,800
	Engineering, Legal, Bonds & Administration (17%):	$	63,920
	Opinion of Probable Cost:	**$**	**516,000**

C. Additional Chemical Storage

During the Phase I improvements, the MDEQ did not mandate 30-day chemical bulk storage requirements since the plant was a redundant water supply to the DWSD. However, if the facility becomes a continuously operated treatment plant, then additional chemical storage must be added to meet the minimum storage volume requirements. To comply with the regulations, new oxygen, nitrogen and carbon dioxide storage facilities must be provided as follows.

Liquid Carbon Dioxide:
- Capacity – 34 tons
- Vaporizer – 750 #/hour @ 300 psig
- Piping – Schedule 80 Carbon Steel and Schedule 40 - 304L Stainless Steel

Liquid Oxygen
- Capacity – 9000 gallons
- Operating pressure – 75 psi
- Feed Rate – 175 scfm
- Piping – Type K Copper

Liquid Nitrogen
- Capacity – 540 gallons
- Operating pressure – 100 psi
- Feed Rate – 1 scfm
- Piping – Type K Copper

Opinion of Probable Cost:

Carbon Dioxide Storage Facilities	$	328,000	
MEP	$	103,000	
Oxygen & Nitrogen Storage Facilities	$	961,000	
MEP	$	109,000	
	Subtotal Construction:	$	1,501,000
	Construction Contingencies (15%):	$	225,150
	Design Contingencies (5%):	$	75,050
	Engineering, Legal, Bonds & Administration (17%):	$	255,170
	Opinion of Probable Cost:	**$**	**2,057,000**

D. Electrical and SCADA Improvements

Section 9, relating to power and controls, of the Phase II study was prepared by Dmytryka Jacobs Engineers (DJE). The scope of the Phase II work did not include detailed investigations of the water plant site-wide power distribution nor the secondary power distribution within each of the facility structures. However, a number of observations and basic recommendations were presented in Section 9 by DJE.

The Flint Water Plant currently uses 2400V as primary power throughout the facility. All of the power feeders in the plant site are 5kV rated and it appears the existing switchgear is also rated at 5kV. Most of the major electrical improvements installed during Phase I were dual voltage (2400/4160) equipment in anticipation of the plant power being changed to 4160V in the near future. This change would allow the existing network of power feeders to handle approximately twice the power and would eliminate running new feeders to various portions of the plant.

The current sub-station has two 2.5MVA transformers running in parallel for a total capacity 5 MVA. These old transformers are not equipped with cooling fans. The full connected load to these transformers is estimated to be 6.97 MVA while the estimated power load at 36 MGD is 4.22MVA. Based on these estimates there is sufficient power for the plant with both sub-station transformers in service. Even though the transformers are owned by Consumers Energy, it could take weeks to replace one of these main transformers in the event of a unit failure, which will result in reduced treatment and pumping capacity. The sub-station switchgear was installed in 1960 and is antiquated and difficult to maintain.

The two existing Fairbanks Morse generators are currently inoperable and would cost approximately $1M to rehabilitate. The DJE team recommended installing two new emergency generators in lieu of re-building the existing units.

Section 9 of the Phase II report provides sufficient detail for the purposes of this report, but a detailed electric system evaluation of the entire plant should be performed prior to any major improvements to this facility.

While LAN did not perform a detailed review of the WTP electrical system during our site visit, it appears that all of the DJE findings are still pertinent. We, therefore, concur with the improvements as recommended by DJE in the Phase I report.

Opinion of Probable Cost:

Substation Upgrade	$ 961,000	
Standby Power Generation	$ 2,242,000	
Pump Station No. 4 Upgrade	$ 1,365,000	
Filter Press Building Feeder	$ 87,000	
WTP SCADA, Equipment & Programming	$ 720,000	
Telemetry System Equipment & Programming	$ 103,000	
Computers, Software & Training	$ 155,000	
Filter Transfer PS Power Feeders	$ 135,000	
Emergency PS Power Feeders	$ 145,000	
Subtotal Construction:		$ 5,913,000
Construction Contingencies (15%):		$ 886,950
Design Contingencies (5%):		$ 295,650
Engineering, Legal, Bonds & Administration (17%):		$ 1,005,210
Opinion of Probable Cost:		**$ 8,101,000**

E. Post-Chlorination and Zebra Mussel Control

The previous report recommended changing the disinfection system from gaseous chlorine to sodium hypochlorite due to the potential for hazardous gas release and the requirements imposed by new federal regulations. Previous treatability studies have not addressed the potential impact of re-growth in the system due to ozonation by-products. These impacts should be addressed prior to proceeding with final plans for using river water.

The Flint River is known to be infested with Zebra mussels and mitigation measures will have to be implemented if the plant is placed into continuous operation. A sodium permanganate feed system is proposed to address these concerns.

Opinion of Probable Cost:

Demolition of Existing Equipment	$	39,000	
Storage Tanks	$	9,000	
Metering Pumps and Tables	$	11,000	
Piping, Valves & Tables	$	9,000	
Containment	$	59,000	
Installation	$	108,000	
	Subtotal Construction:	$	235,000
	Construction Contingencies (15%):	$	35,250
	Design Contingencies (5%):	$	11,750
	Engineering, Legal, Bonds & Administration (17%):	$	39,950
	Opinion of Probable Cost:	**$**	**322,000**

F. Security Issues

For water plant security issues, please refer to City of Flint Vulnerability Assessment. Details are omitted in this report due to confidentiality.

Not available at the time of the previous report, a source water monitoring system is included in the study due to recent advancements in technology. The proposed system design is based on Hach Model SC1000, equipped with UVAS, NH4D, pH, ORP, turbidity and DO probes.

Opinion of Probable Cost:

Security Improvements	$	145,000	
Source Water Monitoring System	$	95,000	
	Subtotal Construction:	$	240,000
	Construction Contingencies (15%):	$	36,000
	Design Contingencies (5%):	$	12,000
	Engineering, Legal, Bonds & Administration (17%):	$	40,800
	Opinion of Probable Cost:	**$**	**329,000**

G. PS No. 4 - Low and High Service Pumps

Section 7 of the Phase II report included recommendations to replace two of the low lift pumps and two of the high lift pumps along with various other improvements. During the site visit, it was apparent the condition of this facility has continued to deteriorate. Furthermore, with the reduction in water system demands, the various pump capacities are no longer properly sized to efficiently meet the new plant flow ranges. The pumps and motors are oversized and are operating outside their best efficiency ranges and should be replaced due to age, condition and cost to operate.

Additionally, some of these pumps cannot be operated due to excessive vibrations in the shaft and steady bearings. Existing vibration monitors are functioning as designed and are shutting the power off to the motors to avoid damage.

For low lift service, it is proposed to install two 10-mgd and two 15-mgd (nominal ratings) vertically mounted pumps equipped with low voltage inverter duty motors. The motors would be powered by low

voltage variable frequency drives. This will provide a firm rated capacity of approximately 35-mgd in low lift capacity.

For high lift service, it is proposed to install one 10-mgd, two 15-mgd and one 20-mgd (nominal ratings) pumps equipped with medium voltage inverter duty motors. These motors will be power by medium voltage variable frequency drives. This combination of pumps will provide a firm rated capacity of 40-mgd.

Opinion of Probable Cost:

Demolition of Existing Equipment	$	135,000	
Install Two (2) 10 MGD @ 40 ft of TDH Vertically Mounted Pumps with 125 HP, 480 V Inverter Duty Motor With 20 ft of Shaft & Steady Bearings	$	473,000	
Install Two (2) 15 MGD @ 40 ft of TDH Vertically Mounted Pumps with 150 HP, 480 V Inverter Duty Motor with 20 ft of Shaft & Steady Bearings	$	495,000	
Install One (1) 10 MGD @ 190 ft of TDH Vertically Mounted Pump with 450 HP, 4160 V Inverter Duty Motor with 20 ft of Shaft & Steady Bearings	$	245,000	
Install Two (2) 15 MGD @ 190 ft of TDH Vertically Mounted Pumps with 700 HP, 4160 V Inverter Duty Motor with 20 ft of Shaft & Steady Bearings	$	520,000	
Install One (1) 20 MGD @ 190 ft of TDH Vertically Mounted Pump with 800 HP, 4160 V Inverter Duty Motor with 20 ft of Shaft & Steady Bearings	$	285,000	
Piping, Valves, Supports & Bearings	$	480,000	
Intermediate Platforms, Ladders & Stairs	$	360,000	
Ventilation & Boiler Systems	$	340,000	
Install Three (3) Low Voltage VFD Units	$	85,000	
Install Four (4) Medium Voltage VFD Units	$	2,250,000	
Subtotal Construction:	$	5,668,000	
Construction Contingencies (15%):	$	850,200	
Design Contingencies (5%):	$	283,400	
Engineering, Legal, Bonds & Administration (17%):	$	963,560	
Opinion of Probable Cost:	**$**	**7,766,000**	

H. Filter Transfer Station to Dort Reservoir and UV Inactivation

Under the requirements as outlined in the USEPA drinking water regulations addressing potential microbial contaminants, additional treatment technologies and enhancement of existing processes must be implemented to comply with these regulations.

As required under the enhanced surface water treatment rules, it is essential for water utilities to address giardia, cryptosporidium, viruses and bacteria in finished water. The level of treatment is dependent on

the source water classification. The City of Flint will need to perform a two-year source water study to determine the bin placement for the Flint River. For the purposes of this report, a Bin 4 placement was selected due to the nature of the watershed and, therefore, it is assumed enhanced Ct and UV inactivation will be required.

Reservoir No. 3 does not provide sufficient Ct to meet the current regulations, therefore, Dort Reservoir will need to be placed into the process train. Since Dort Reservoir does not match the hydraulic profile of the plant, an intermediate pump station will be required. This new facility will also include a UV inactivation system to comply with the enhanced water quality regulations.

This proposed facility, located west of the filters and south of Dort Reservoir, will house three 14-mgd (nominal rating) variable speed pumps with inverter duty, low voltage motors for a firm rated capacity of 28-mgd. Housed in a separate part of this same structure will be the UV system that will be equipped with three 12" medium pressure units with a rated capacity of 28-mgd.

Opinion of Probable Cost:

Site Work & Utilities	$ 77,000	
Building (80 ft x 60 ft)	$ 1,440,000	
Three (3) 14 MGD @ 40 ft of TDH, Vertically Mounted Pumps with 150 HP, 480 V Inverter Duty Motor	$ 535,000	
MEP	$ 940,000	
Valves and Controls	$ 205,000	
Install Three (3) 12" MP UV Units	$ 590,000	
UV Piping & Controls	$ 368,000	
Ventilation & Boiler Systems	$ 165,000	
Install Three (3) Low Voltage VFD Units	$ 85,000	
Piping Connections	$ 125,000	
200 ft of 30" Water Main	$ 200,000	
600 ft of 36" Water Main	$ 420,000	
Subtotal Construction:		$ 5,150,000
Construction Contingencies (15%):		$ 772,500
Design Contingencies (5%):		$ 257,500
Engineering, Legal, Bonds & Administration (17%):		$ 875,500
Opinion of Probable Cost:		**$ 7,056,000**

1. Emergency Interconnect Pumping Station

The City of Flint and Genesee County DWWS have entered into an agreement to provide 8-mgd of back-up service to each other under emergency conditions. There are several alternatives for pumping station locations and configurations to accomplish this interconnect. For the purposes of this report, a station located west of the filter building was selected as the most practical from and operational cost perspective. While the opinions of cost presented below indicate that these pumps will be housed in their own structure, it is feasible to house the pumps in the filter transfer station for potential savings.

Preliminary design for this pumping station include two constant speed 8-mgd pumps equipped with soft starts and medium voltage motors. A reverse flow control station will be included within the same structure to allow for flow from the DWWS to assist the City of Flint. Approximately three miles of 24-inch pipeline will be needed to connect the two systems.
Opinion of Probable Cost:

Site Work & Utilities	$ 90,000	
Building (32 ft x 24 ft)	$ 245,000	
Install Two (2) 8 MGD @ 290 ft of TDH, Vertically Mounted Pumps with 600 HP, 4160V Motor	$ 380,000	
MEP	$ 335,000	
Valves and Controls	$ 128,000	
Reverse Flow Control Station	$ 110,000	
Ventilation Systems	$ 35,000	
16000 ft of 24" Water Main	$ 4,992,000	
Subtotal Construction:		$ 6,315,000
Construction Contingencies (15%):		$ 947,250
Design Contingencies (5%):		$ 315,750
Engineering, Legal, Bonds & Administration (17%):		$ 1,073,550
Opinion of Probable Cost:		**$ 8,652,000**

The opinions of capital cost presented in the preceding sections are tied to an ENR Index of 8688 to match the September 2009 Lake Huron Water Supply Report. Furthermore, the contingency percentages included with each opinion of cost are the same as in the September 2009 report. The total opinion of probable project cost of these proposed improvements is as follows:

Lime Sludge Disposal	$ 15,089,000
Soda Ash Feed System	$ 516,000
Additional Chemical Storage	$ 2,057,000
Electrical and SCADA Improvements	$ 8,101,000
Post-Chlorination and Zebra Mussel Control	$ 322,000
Security Issues	$ 329,000
PS No. 4 - Low & High Service Pumps	$ 7,766,000
Filter Transfer Pumping Station & UV	$ 7,056,000
Emergency Interconnect Pumping Station	$ 8,652,000
Total Opinion of Probable Project Cost:	**$ 49,888,000**

III. Cost of Additional Operation

The City of Flint currently operates the water treatment plant periodically during the year to maintain the systems and to meet regulatory requirements. The water treatment plant is staffed with various classifications of employees to operate and maintain the facility for these minimal operations.

As part of this work, and to develop all costs of providing water service from the Flint River, it is necessary to determine the probable cost for operating and maintaining this facility for continuous operation. Water quality differences between the Flint River and Lake Huron are significant and require different treatment chemicals and dosages. Most noticeable is the fact that Lake Huron water does not require softening which negates the need for softening process and the associated lime sludge disposal.

The primary cost parameters that are included in this difference are labor, chemicals, residual disposal and electrical power. Each will be discussed in the following sections. These costs were projected through the year 2050.

A. Labor

Additional staffing was discussed and developed with representatives from the City of Flint to provide full time coverage on a 24/7/365 schedule, plus provide staff for residual management and operations of the various dams. Hourly rates and fringe benefits were based on current budget figures and inflated at a rate of 3% for future costs. The following table outlines the proposed staffing a cost for this operational element.

Classification	Number	Cost/Hr	Hrs/Year	Total	Fringe (%)	Total
Operators	12	$ 20.00	2080	$ 499,200	90.40%	$ 950,477
Maintenance	4	$ 25.00	2080	$ 208,000	90.40%	$ 396,032
Laboratory QA/QC	2	$ 24.00	2080	$ 99,840	90.40%	$ 190,095
Laboratory SDWA	2	$ 20.00	2080	$ 83,200	90.40%	$ 158,413
Planned Overtime	NA	MIXED	8320	$ 178,048	90.40%	$ 339,003

This estimate represents approximately $2,034,000 per year of additional labor.

B. Chemicals

Chemical costs are based on the projected average day water demand of 14-mgd and the average dose for each of the chemicals based on the raw water quality information and other operational records. Further, data from the previous treatability work performed during the Phase I improvements was also incorporated into these estimates. Chemical suppliers and other water utilities were contacted to obtain current chemical purchase costs which were adjusted by the ENR ratio back to an index of 8688. Where necessary, transportation costs to the Flint, MI area were included. The following summarizes the chemical costs associated with treating the Flint River water.

Chemical	Dose(mg/l)	Cost/#	Cost/ MGD
Ferric	44.50	$0.24	$89.07
Lime	209.00	$0.10	$174.31
Soda Ash	47.00	$0.29	$113.67
CO_2	37.00	$0.10	$30.86
Cl_2	3.00	$0.34	$8.51
Fluoride	1.00	$0.33	$2.75
Phosphate*	1.00	$0.51	$4.25
		Cost per MGD	$423.42

*Costs range from $0.51 to $0.96 per pound

In addition to the above, the cost of ozone will need to be added which is approximately $20.08 per million gallons per day per mg/l dose. This cost includes oxygen, nitrogen and power costs.

C. Residual Disposal

This category is divided into two groups: clarifier sludge collected in the plate settling basins and lime sludge from the softening process. The clarifier sludge is pumped from the clarifier basins by zone (six zones per train, three trains, total of 18 zones) to the plant main drain. As part of the Phase I work, the main drain was connected to a new wastewater pumping station located south of the filter gallery building. This pump station discharges the collected residuals to the city's sanitary sewer system. Nearly all of the filter wash water is recirculated back to the head of the ozone facility for re-use.

The cost to treat clarified sludge discharged into the sanitary sewer system is calculated as follows:

Plate Clarifier Sludge	
Flow (MGD)	14
SS (mg/l)	75
Primary Sludge (#/d	13,435
% Solids	2%
Sludge (gals/day)	80,500
Sludge (cf/day)	10,762

Based on the City of Flint's current wastewater charges of $1.00 per 100 cf, the annual cost would be $39,200 per year.

Lime/Soda Ash softening generates large quantities of residual wastes that have high disposal costs. The treatment proposed in this study involves pumping the sludge, at about 4% concentration, from the softening basins to two gravity thickeners, where it will concentrate to about 12% solids. After thickening, sludge will be pumped to the filter presses to be dewatered to approximately 55% solids. The filter presses will drop the cake into a lower bunker where it will be removed by an end loader to the main storage bunker. About every three months, the sludge will be loaded onto trucks and applied to agricultural land.

The volume of sludge is estimated as follows:

Sludge Production from Clarifier			
Reaction	meq/l	meq/l as $CaCO_3$	meq/l as $Mg(OH)_2$
CO_2	0.25	0.25	0
$Ca(HCO_3)_2$	4.65	9.30	0
$Mg(HCO_3)_2$	0.30	0.60	0.30
$MgSO_4$	0.89	0.89	0.89
Excess Lime	1.25	1.25	0
Total meq/l		12.28	1.19
Less Practical Limits meg/l		0.60	0.20
Precipitate Produced meq/l		11.68	0.99
Precipitate Produced mg/l		584	49
Precipitate Produced #/MG		4872	412
Total #/MG		5284	

WTP Flow (MGD)	14	27		
Dry Sludge Production in #/day	73,983	142,681		
@ 4% Solids (gals/day)	221,771	427,701		
@ 12% Solids (gals/day)	73,924	142,567		
@ 12% Solids (gals/week)	517,466	997,970		
Dry Sludge Production (tons/week)	259		SG $CaCO_3$	2.71
Number of Hours per Week to Press	48		SG $Mg(OH)_2$	2.36
Dry Sludge Processed (#/hr)	10,789		SG solids	2.68
@ 55% Solids Sludge Processed (#/hr)	19,617			
55% Solids Sludge (#/cy)	2571		Sludge Solids =	55% as $CaCO_3$
@ 55% Solids Sludge Processed (cf/hr)	206		Sludge Unit Wt. =	95.22 pcf

Based on the preceding, 471 tons of softening sludge at 55% solids will be handled each week based on average flow and chemical dosage. Several Michigan water facilities were contacted to obtain lime sludge hauling and disposal costs. From this data a rate of $18.50 per wet ton was selected as a reasonable rate for disposal cost. This rate will result in an annual cost of $453,000.

D. Power

Practically all of the additional power costs are associated with low lift, intermediate transfer and high service pumping. Additional power costs will be used for process and handling of the softening sludge. The City of Flint is currently paying $0.07 per kwhr for service at the water plant. Power costs are calculated as follows:

TDH (ft) - High	190
TDH (ft) - Filter Transfer	40
TDH (ft) - Low	40
TDH Total (ft)	270
Pump Eff. (W to W)	80.00%
$/kwhr	$0.070
Pumping Cost Per MGD	$99.51
Solids Handling per MGD	$4.98
Total Power Cost per MGD	$104.49

Annual costs associated with the operation and maintenance of the Flint Water Plant are summarized in the attached tables following this section.

IV. Project Implementation Schedule

There are a number of issues that will impact the implementation schedule for this work. The source water studies to define bin number associated with cryptosporidium and giardia will take approximately two years. Part of these studies can be performed concurrently with design, but sufficient work will need to be performed to avoid impacting design schedule or work. A planning period of one year should be allowed for preliminary water quality and regulatory evaluations prior to initiating design work. Design of this project will require 10 to 12 months, with an additional three months required for permitting. After permits are received, allow three months for bidding and contract execution. Major equipment procurement and construction will take from 24 to 30 months. Plant commissioning will take about 2 months.

Total time required from notice to proceed to project completion 52 months to 60 months. This time frame does not include financing issues.

City of Flint uses Flint River as Water Source with Service in 2014
Phase II Project

Flint uses Flint River Water Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1. Volumn of Water Treated (Mcf)					683,155	685,107	687,059	689,011	690,963	692,914	694,866	696,818	698,770	700,722
Average Annual Day (MGD)					14.000	14.040	14.080	14.120	14.160	14.200	14.240	14.280	14.320	14.360
2. Additional WTP Operation and and Maintenance Costs (3% inflation)														
Labor	Flint Water Treatment Plant Under Design and Construction for Phase II Improvements				$2,034,020	$2,095,041	$2,157,892	$2,222,629	$2,289,308	$2,357,987	$2,428,727	$2,501,588	$2,576,636	$2,653,935
Power					$533,928	$549,946	$566,444	$583,438	$600,941	$618,969	$637,538	$656,664	$676,364	$696,655
Ozone					$207,517	$213,743	$220,155	$226,760	$233,562	$240,569	$247,786	$255,220	$262,876	$270,763
Chemicals & Sludge Disposal					$2,655,967	$2,735,646	$2,817,715	$2,902,247	$2,989,314	$3,078,993	$3,171,363	$3,266,504	$3,364,499	$3,465,434
Maintenance					$1,357,858	$1,398,594	$1,440,552	$1,483,768	$1,528,281	$1,574,130	$1,621,354	$1,669,994	$1,720,094	$1,771,697
Total Additional O&M Cost					$6,789,291	$6,992,969	$7,202,758	$7,418,641	$7,641,406	$7,870,649	$8,106,768	$8,349,971	$8,600,470	$8,858,484
Additional WTP Cost per Mcf					$9.94	$10.21	$10.48	$10.77	$11.06	$11.36	$11.67	$11.98	$12.31	$12.64
3. Regulatory Cost Impacts														
Source Water Protection	$250,000	$250,000	$10,000	$10,300	$10,609	$10,927	$11,255	$11,593	$11,941	$12,299	$12,668	$13,048	$13,439	$13,842
SDWA Impact Costs	$100,000	$100,000	$25,000	$25,750	$26,523	$27,318	$28,138	$28,982	$29,851	$30,747	$31,669	$32,619	$33,598	$34,606
Lead & Copper, IESWTR, CCR														
LT2ESWTR, DDBP2, Cyrpto														
4. WTP Phase II Upgrade														
$49.886 Million @ 8.0% for 25 Years	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575
5. Total Additional Cost of Treated Water					$10,728,997	$10,933,789	$11,144,726	$11,361,990	$11,585,773	$11,816,269	$12,053,680	$12,298,213	$12,550,082	$12,809,507
Total Additional Cost of Treated Water per Mcf					$15.71	$15.96	$16.22	$16.49	$16.77	$17.05	$17.35	$17.65	$17.96	$18.28

City of Flint uses Flint River as Water Source with Service In 2014
Phase II Project

Flint uses Flint River Water Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
1. Volumn of Water Treated (Mcf)	702,674	704,626	706,578	708,529	710,481	712,433	714,385	716,337	718,289	720,241	722,192	724,144	726,096	728,048
Average Annual Day (MGD)	14.400	14.440	14.480	14.520	14.560	14.600	14.640	14.680	14.720	14.760	14.800	14.840	14.880	14.920
2. Additional WTP Operation and and Maintenance Costs (3% Inflation)														
Labor	$2,733,553	$2,815,560	$2,900,027	$2,987,027	$3,076,638	$3,168,937	$3,264,006	$3,361,926	$3,462,783	$3,566,667	$3,673,667	$3,783,877	$3,897,393	$4,014,315
Power	$717,555	$739,082	$761,254	$784,092	$807,614	$831,843	$856,798	$882,502	$908,977	$936,246	$964,334	$993,264	$1,023,062	$1,053,754
Ozone	$278,886	$287,252	$295,670	$304,746	$313,888	$323,305	$333,004	$342,994	$353,284	$363,882	$374,799	$386,043	$397,624	$409,553
Chemicals & Sludge Disposal	$3,569,397	$3,676,479	$3,786,774	$3,900,377	$4,017,388	$4,137,910	$4,262,047	$4,389,908	$4,521,606	$4,657,254	$4,796,972	$4,940,881	$5,089,107	$5,241,780
Maintenance	$1,824,848	$1,879,593	$1,935,981	$1,994,060	$2,053,882	$2,115,499	$2,176,964	$2,244,333	$2,311,663	$2,381,012	$2,452,443	$2,526,016	$2,601,797	$2,679,850
Total Additional O&M Cost	$9,124,239	$9,397,966	$9,679,905	$9,970,302	$10,269,411	$10,577,494	$10,894,818	$11,221,663	$11,558,313	$11,905,062	$12,262,214	$12,630,080	$13,008,983	$13,399,252
Additional WTP Cost per Mcf	$12.99	$13.34	$13.70	$14.07	$14.45	$14.85	$15.25	$15.67	$16.09	$16.53	$16.98	$17.44	$17.92	$18.40
3. Regulatory Cost Impacts														
Source Water Protection	$14,258	$14,685	$15,126	$15,580	$16,047	$16,528	$17,024	$17,535	$18,061	$18,603	$19,161	$19,736	$20,328	$20,938
SDWA Impact Costs	$35,644	$36,713	$37,815	$38,949	$40,118	$41,321	$42,561	$43,836	$45,153	$46,507	$47,903	$49,340	$50,820	$52,344
Lead & Copper, IESWTR, CCR LT2ESWTR, DDBP2, Cyrpto														
4. WTP Phase II Upgrade														
$49.888 Million @ 6.0% for 25 Years	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575	$3,902,575			
5. Total Additional Cost of Treated Water	$13,076,715	$13,351,939	$13,635,420	$13,927,406	$14,228,150	$14,537,918	$14,856,978	$15,185,610	$15,524,101	$15,872,747	$16,231,852	$12,699,156	$13,080,131	$13,472,535
Total Additional Cost of Treated Water per Mcf	$18.81	$18.95	$19.30	$19.66	$20.03	$20.41	$20.80	$21.20	$21.61	$22.04	$22.48	$17.54	$18.01	$18.51

City of Flint uses Flint River as Water Source with Service in 2014
Phase II Project

Flint uses Flint River Water Year	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
1. Volumn of Water Treated (Mcf)	730,000	731,952	731,952	731,952	731,952	731,952	731,952	731,952	731,952	731,952	731,952	731,952	731,952
Average Annual Day (MGD)	14.960	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
2. Additional WTP Operation and and Maintenance Costs (3% inflation)													
Labor	$4,134,745	$4,258,787	$4,386,551	$4,518,147	$4,653,691	$4,793,302	$4,937,101	$5,085,214	$5,237,771	$5,394,904	$5,556,751	$5,723,453	$5,895,157
Power	$1,085,366	$1,117,927	$1,151,465	$1,186,009	$1,221,589	$1,258,237	$1,295,984	$1,334,863	$1,374,909	$1,416,157	$1,458,641	$1,502,401	$1,547,473
Ozone	$421,840	$434,495	$447,530	$460,955	$474,784	$489,028	$503,698	$518,809	$534,374	$550,405	$566,917	$583,925	$601,442
Chemicals & Sludge Disposal	$5,399,034	$5,561,005	$5,727,835	$5,899,670	$6,076,660	$6,258,960	$6,446,729	$6,640,130	$6,839,334	$7,044,514	$7,255,850	$7,473,525	$7,697,731
Maintenance	$2,760,246	$2,843,053	$2,928,345	$3,016,195	$3,106,681	$3,199,882	$3,295,878	$3,394,754	$3,496,597	$3,601,495	$3,709,540	$3,820,826	$3,935,451
Total Additional O&M Cost	$13,801,230	$14,215,267	$14,641,725	$15,080,977	$15,533,406	$15,999,408	$16,479,390	$16,973,772	$17,482,985	$18,007,475	$18,547,699	$19,104,130	$19,677,254
Additional WTP Cost per Mcf	$18.91	$19.42	$20.00	$20.60	$21.22	$21.86	$22.51	$23.19	$23.89	$24.60	$25.34	$26.10	$26.86
3. Regulatory Cost Impacts													
Source Water Protection	$21,566	$22,213	$22,879	$23,566	$24,273	$25,001	$25,751	$26,523	$27,319	$28,139	$28,983	$29,852	$30,748
SDWA Impact Costs	$53,915	$55,532	$57,198	$58,914	$60,682	$62,502	$64,377	$66,308	$68,298	$70,347	$72,457	$74,631	$76,870
Lead & Copper, IESWTR, CCR													
LT2ESWTR, DDBP2, Cyrpto													
4. WTP Phase II Upgrade													
$49.888 Million @ 8.0% for 25 Years													
5. Total Additional Cost of Treated Water	$13,876,711	$14,293,012	$14,721,802	$15,163,456	$15,618,360	$16,086,911	$16,569,518	$17,066,604	$17,578,602	$18,105,960	$18,649,139	$19,208,613	$19,784,871
Total Additional Cost of Treated Water per Mcf	$19.01	$19.53	$20.11	$20.72	$21.34	$21.98	$22.64	$23.32	$24.02	$24.74	$25.48	$26.24	$27.03