

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

INTEROFFICE COMMUNICATION

TO: File

FROM: Izabel Hartman

DATE: February 20, 2015

SUBJECT: Drinking Water Revolving Fund Project No. 7407-01
City of Grand Rapids (Livingston Discharge Line; Eastside CSO Contract No. 27
Water Main; Franklin Street PS Improvements)
Green Project Reserve (GPR) Funding Cost Calculation

The purpose of this memo is to document the cost calculations for the green project reserve funding for the city of Grand Rapids, DWRP Project No. 7407-01. The total loan amount is \$10,000,000. The portion of the project that qualifies as green is the Franklin Street Pump Station Improvements (\$1,023,000). Therefore, the total cost of construction for the green portion of the project is \$1,023,000. The total construction cost for the entire DWRP project is \$8,704,496. In order to determine the percentage of non-construction costs associated with the green portion of the project, a proration was applied, as shown below:

$$1,023,000 / 8,704,496 = 0.1175$$

$$10,000,000 \times 0.1175 = 1,175,000$$

The total amount of green project reserve funding for this project comes to \$1,175,000.

The principal forgiveness amount is at 25 percent of GPR associated costs.

$$1,175,000 \times 0.25 = 293,750$$

The total principal forgiveness amount for the project would be \$293,750. However, the total eligible GPR was limited to the amount estimated on the Project Priority List, which was \$259,250.

RECEIVED

MAY - 1 2014

DEQ-RMD
RLS



April 30, 2014
Project No. G140304

Ms. Izabel Hartman
Project Manager
MDEQ - Office of Drinking Water and Municipal Assistance – Revolving Loan Section
Constitution Hall - 4th Floor South
525 West Allegan
Lansing, MI 48933

Re: City of Grand Rapids Drinking Water Revolving Fund (DWRf) Fiscal Year (FY) 2015
Green Project Reserve Letter

Dear Ms. Hartman:

This letter is in response to your request for Green Project Reserve letters for DWRf projects scheduled for FY 2015. The City of Grand Rapids has four scheduled projects for FY 2014; one has been identified as a green project: the Franklin Street Pump Station Improvements.

The Franklin Street Pump Station and Reservoir are located on the east side of the distribution system and were designed to serve two purposes:

- Supply “high pressure” water at an average hydraulic grade line of 927 feet for the East High Pressure District (EHPD) and Cambridge Elevated Storage Tank; and East Grand Rapids (EGR) and the EGR Elevated Storage Tank.
- Supply “low pressure” water at an average hydraulic grade line of 837 feet to 855 feet through the dedicated transmission main to the East Paris Ground Level Reservoir and Pump Station.

Variable Frequency Drives (VFDs)

The Franklin Street Pump Station has nine constant speed pumps, six high pressure pumps (Pumps 1 through 6) and three low pressure pumps (Pumps 7 through 9) as listed in the table below.

Table 1 - Franklin Pumps

Pump	Capacity (mgd)	Head (feet)	HP	Motor	Year Installed
1	10	200	450	440V, 3 phase, induction	1956
2	14	220	700	440V, 3 phase, synchronous	1940
3	6	175	250	440/480V, 3 phase, induction	1956
4	12	200	600	460V, 3 phase, induction	1982
4 alt	16	200	600	Diesel	1982
5	8	220	450	460V, 3 phase, induction, premium efficiency	1995
6	12	220	600	460V, 3 phase, induction, premium efficiency	1995
7, 8, and 9	11.5	75	200	460V, 3 phase, induction, premium efficiency	1995

mgd million gallons per day
HP horsepower
V volt



VFDs are recommended for Pumps 5, 6, 7, and 8 (possibly shared with 9) to increase efficiency at the pump station. The pumps are single speed, so there are flow ranges that a combination of pumps cannot achieve. The station needs increased flexibility to achieve the list of pump station functions discussed in the project plan. One of the critical operational challenges with the existing single speed pumps is that when the Cambridge Tank is full, the operators have two choices:

- Take off a pump, which can result in a rapid emptying of Cambridge Elevated Tank followed by the need to turn another pump back on, which results in an electrical inrush and peak usage charges.
- The typical operation, which is to change the low pressure Southeast Transmission Main to high pressure, and dump the excess water to the East Paris Reservoir.

While dumping the water maintains system operation, it wastes energy. East Paris Reservoir is ideally filled with the low pressure Pumps 7, 8, and 9 that are 200 HP pumps operating at 75 feet of head. However, when water is dumped, the East Paris Reservoir is filled by 250 to 700 HP pumps, operating at 175 to 200 feet of head.

There is a large financial penalty from Consumers Energy (up to \$11.00 per kilowatt hour [kWh]) for turning on a pump during peak hours (11 a.m. to 7 p.m). In order to minimize this financial penalty, the operators use the Southeast Transmission Main to dump excess high pressure water. From reviewing operating data, there is a pattern for how often high pressure water is dumped to East Paris for summer and non-summer operation as summarized in the following table, and presented in more detail on the attached Basis of Design. The Southeast Transmission Main is being used to dump excess high pressure water 50% of the time (61 days/year) during the summer and almost 95% of the time (230 days/year) during the remainder of the year.

Table 2 - Franklin Pump Station Operation for Southeast Transmission Main

Item	Unit	Summer	Non-Summer	Energy Use (kWh/year)
Operating Time per Year	days	122	243	
High Pressure Operation (Pumps 1-6)	(%)	50.0%	94.7%	1,308,144
Low Pressure Operation with One Pump (7-9)	(%)	23.0%	5.0%	144,803
Low Pressure Operation with Two Pumps (7-9)	(%)	27.0%	0.3%	214,482
Total Energy Use for SE Transmission Main				1,667,429

As shown in the table above, the primary operation of the Southeast Transmission Main is as a high pressure line and accounts for 78% of the energy use when pumping water to the East Paris Service Center. By adding VFDs to the high pressure pumps (Pumps 5 and 6) as presented in the project plan, the operators have the flexibility to slow down or speed up a pump instead of turning a pump on and off. Also, if the operators need to bring a pump on-line, with a VFD, Pumps 5 and 6 will no longer have a high starting amp draw. The VFDs allow the operators to more closely match demands in the EHPD and control the rate at which the Cambridge Tank fills and empties. And more importantly, the VFDs allow the Southeast Transmission Main to be operated as a low pressure water main, which results in substantial energy savings as summarized in Table 3 and the attached Basis of Design.



Table 3 - Franklin Pump Station Proposed Operation for Southeast Transmission Main

Item	Unit	Summer	Non-Summer	Energy Use (kWh/year)
Operating Time per Year	days	122	243	
High Pressure Operation (Pumps 1 through 6)*	(%)	0%	0%	0
Low Pressure Operation with One Pump (7 through 9)*	(%)	73.0%	99.7%	746,613
Low Pressure Operation with Two Pumps (7 through 9)	(%)	27.0%	0.3%	214,482
Total Energy Use for SE Transmission Main				961,095
Total Energy Savings				706,334
Percent Energy Savings for SE Trans Main				42%
* Because the High Pressure Operation averages 7 mgd, it was replaced with a single Low Pressure Pump that would also be operated with a VFD.				

In reviewing the electric bills for the Franklin Pump station, a total yearly energy consumption of 3,630,000 kWh was used from 1/24/2013 to 1/24/2014 with a total cost of \$366,000. This energy usage includes the pumping to the East Paris Service Center through the Southeast Transmission Main, as discussed above, as well as pumping to the EHPD and East Grand Rapids. Overall, the energy cost was \$0.10 per kWh, and the average monthly cost was \$30,500. The energy savings for the Southeast Transmission Main shown in Table 3 would be a reduction of roughly 19% of the total electric power used at the Franklin Pump Station. As a simple energy cost of \$0.10 per kWh, reducing the yearly energy consumption by 706,334 kWh (19%) would be a savings of \$70,600 per year.

However, in reviewing electric bills for the Franklin Pump Station, on average, 23% of the electric bill is due to "On-Peak Billing Demand". For this same period of 1/24/2013 to 1/24/2014, the City was billed for an average 648 kWh of On-Peak Billing Demand per month at \$11.00 per kWh for a cost of \$7,128 per month. In other words, this peak usage that accounts for only 0.2% of the monthly use is 23% of the monthly cost. When the energy use in a facility is evaluated, the total energy used and the total energy reduction is evaluated, but the reduction in peak usage and high amp draws for starting large motors is also important for the power company for the efficiency of their distribution system. Hence, the reason the power company uses monetary disincentives to reduce peak energy use. Therefore, if On-Peak Billing Demand is decreased, further savings may be realized.

Just as VFDs are proposed for the high pressure Pumps 5 and 6 to control the filling and emptying of the Cambridge Elevated Storage Tank, low pressure Pumps 7, 8, and 9 also need VFDs to control the filling and emptying of the East Paris Service Center Reservoir. As shown in the attached Basis of Design, on average, the high pressure pumps are delivering 7 mgd to the East Paris Service Center. The low pressure pumps are rated for 11.5 mgd at constant speed. VFDs are needed to match the pump operation with demand and optimize operation. Further, should a pump need to be turned on, with a VFD there will not be the same high amp draw on starting.



Ms. Izabel Hartman
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Flow Meters

Flow meters are proposed for the three discharge lines leaving the Franklin Pumps Station:

1. Southeast Transmission Main to the East Paris Service Center.
2. Discharge to East High Pressure District and Cambridge Elevated Tank.
3. Discharge to East Grand Rapids and the East Grand Rapids Elevated Tank.

The DWRP discusses the fact that the East Grand Rapids meter is located in a vault in Franklin Street with confined space entry, traffic control, and safety concerns for entering the vault and reading the meters. There are currently two meters in the vault: one 8-inch and one 12-inch. The 24-inch water main supplying East Grand Rapids reduces in size down to 8 inches, causing a constriction in the water main and increasing velocity nine-fold and hence, increasing headloss. The smaller meter is used during the non-summer months when the average flow is 1.3 mgd, so that low flows can be accurately measured. However, during summer months when the average flow is 2.5 mgd, the 12-inch meter is supposed to be open to reduce headloss during higher flows. However, due to the difficulty of entering the vault, often the 12-inch meter is not opened and hence, the 8-inch meter can easily have 10 feet of headloss, which is not energy efficient. By moving the EGR meters into the Franklin Street Pump Station, the safety concerns are eliminated and the larger meter can be used during high flows. There is currently a 14-inch magnetic flow meter in the Franklin Pump Station that can be used at higher flows, so the Project Plan only calls for a single, smaller magnetic flow meter to replace the existing 8-inch meter.

The Southeast Transmission Main and the East High Pressure District Water Main both have insertion meters that are greater than 20 years old. New meters are needed to properly control and optimize operation of the pump station. As the VFDs are utilized to control the rate that the tanks fill and empty, the energy use per million gallons pumped can also be tracked and used to optimize the operation of the Pump Station and realize further energy savings.

Summary

Operating the Franklin Street Pump Station with VFDs on Pumps 5 and 6 to control the filling and emptying of Cambridge Tank while operating the Southeast Transmission Main at low pressure with VFDs of Pumps 7, 8, and 9 reduces the yearly energy consumption by 19%, saving 706,334 kWh per year, and \$70,600 per year. Based on a 20-year present worth analysis with a discount rate of 4.375%, the annual savings of \$70,600 has a present worth of \$928,000. If an energy escalation of 3% is assumed, then the present worth is \$1,197,000.

As presented in the DWRP Project Plan, the estimated project cost is \$1,037,000, which includes the four VFDs and three meters plus piping, valves, electrical, and instrumentation. The proposed energy savings over a twenty-year planning period accounts for 100% of the capital investment.



Ms. Izabel Hartman
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If you have any questions or require additional information, please contact me at 616-464-3848 or ccirving@ftch.com.

Sincerely,

A handwritten signature in black ink, appearing to read "Cynthia C. Irving". The signature is fluid and cursive, with a large initial "C" and a stylized "I".

Cynthia C. Irving, P.E.

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Attachment

By e-mail and Fed Ex

cc: Mr. Michael Bolf, P.E. - MDEQ
Mr. Scott Hayden - City of Grand Rapids
Mr. Wayne Jernberg, P.E. - City of Grand Rapids
Mr. Jeff McCaul, P.E. - City of Grand Rapids
Mr. Arden Postma, P.E. - City of Grand Rapids
Mr. David P. Bratt, P.E. - FTCH



Basis of Design

Green Project Reserve – Energy Savings Calculations

Southeast Transmission Main = Supply to East Paris Service Center

	Existing Operation		Proposed Operation	
	Summer	Non-Summer	Summer	Non-Summer
Operating Time (Days Per Year)	122	243	122	243
East Paris Service Center (EPSC) Hydraulic Grade Line at High Water Level (feet)	775	775	775	775
Franklin Reservoir Hydraulic Grade Line at High Water Level (HWL) (feet)	760	760	760	760
Assume Average Pump Efficiency (%)	85%	85%	85%	85%
Assume Average Motor Efficiency (%)	95%	95%	95%	95%
High Pressure Pumps 1-6				
Percent of Time Supplying EPSC (%)	50%	94.7%	0%	0%
Flow (million gallons per day [mgd])	7.1	6.8	0	0
Head (feet)	166.4	168.9		
Hydraulic Grade Line at Discharge (feet)	926	929		
Motor Horsepower (HP)	256.6	249.5		
Energy Use per Year (kilowatt per year [kWh/year])	280,222	1,027,922	0	0
One Low Pressure Pump 7, 8, or 9				
Percent of Time Supplying EPSC (%)	23%	5%	73%	99.7%
Flow (mgd)	12.0	11.9	8.64	7.05
Head (feet)	77.5	77.5	77.5	77.5
Hydraulic Grade Line at Discharge (feet)	837	837	837	837
Motor Horsepower (HP)	201.9	200.2	145.4	118.7
Energy Use per Year (kWh/year)	101,426	43,377	231,883	514,730
Two Low Pressure Pumps 7 and 8 or 9				
Percent of Time Supplying EPSC (%)	27%	0.3%		
Flow (mgd)	17.1	17.1	17.1	17.1
Head (feet)	96.0	96.0	96.0	96.0
Hydraulic Grade Line at Discharge (feet)	856	856	856	856
Motor Horsepower (HP)	356.3	356.3	356.3	356.3
Energy Use per Year (kWh/year)	210,141	4,341	210,141	4,341
SUMMARY				
Total Flow to East Paris per year (million gallons per year [MG/year])	1,333.09	1,720.46	1,333.09	1,720.46
Total Energy Use Per Year (kWh/year)	591,789	1,075,640	442,025	519,070
Total Current Operation versus Proposed variable frequency drives (VFDs)	1,667,429		961,095	
Energy Saved per Year			706,334	
Percent Savings Current Operation Versus Proposed VFDs			42%	
Money Saved per Year @ \$0.10 per kWh			\$70,633	
Estimated Simple Pay Back (years)			15*	

* Based on Total Project Cost of \$1,037,000

Note – Total Current Energy Use for the entire station is 3,630,000 kWh/year; 46% of this energy is currently used by the Southeast Transmission Main Operation. The energy savings of 706,334 kWh/year from the VFDs would be a total station savings of 19%.

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

INTEROFFICE COMMUNICATION

TO: Izabel Hartman, Environmental Quality Analyst
Revolving Loan Section, Office of Drinking Water and Municipal Assistance

FROM: Michael Bolf, P.E.
Field Operations Section, Office of Drinking Water and Municipal Assistance
Grand Rapids District Office

DATE: May 28, 2013

SUBJECT: City of Grand Rapids – Fiscal Year 2015 – Franklin Pump Station Upgrades
Qualification for Green Project Reserve Funding

The purpose of this memo is to confirm the basis for determining whether or not portions of the city of Grand Rapids DWRP Project No. 7407-99 qualify for the green project reserve funding under Public Law 111-88. The portion of the project for which the city is applying for GPR funding consists of the installation of variable speed drives (VFDs) on Pumps 5, 6, 7, and 8 at the Franklin Street Pump Station. The city's consultant submitted an April 30, 2014 letter outlining the energy savings that could be realized through the implementation of these improvements.

I concur with the explanation provided by the city's consultant which details how the use of VFDs will enhance efficiency. Energy efficiency will be gained by virtue of being able to reduce the frequency of constant speed pump startups and by reducing the energy required to start a pump. In addition, energy efficiency will be gained by reducing the need for the high pressure pumps to dump excess water to the East Paris Reservoir. This reservoir can be more efficiently filled by using the low pressure pumps. The proposed VFDs will enable these operational changes, which are not currently possible.

I concur with the business case estimate that an annual energy savings of 19% can be gained with these improvements. Therefore, I recommend approval for green project reserve funds.

The costs, if any, that qualify for green project reserve will be determined after bids are received and the amount of the loan established. At that point, the percentage of this loan that is provided by Public Law 111-88 can be applied to the total amount spent on this portion of the project to determine the green project reserve.

Hartman, Izabel (DEQ)

From: Bolf, Michael (DEQ)
Sent: Friday, May 30, 2014 9:27 AM
To: Hartman, Izabel (DEQ)
Subject: RE: GR GPR Approval Memo

Good question - I probably should have commented on that in the memo.

Replacing old meters with new meters will gain them efficiency by enhancing their ability to monitor flow rates. There are several pump discharge locations from Franklin, requiring multiple meters. Currently, they are not able to accurately meter the outgoing flow. For example, accurate metering might allow them to find an ideal VFD setting that will reduce the number of energy intensive pump start ups or reduce the amount of flow to the East Paris reservoir, which represents a loss of energy.

In other words, they likely would not be able to operate as energy efficiently with the VFD upgrades and the existing meters as they could with VFDs and new meters. So the meters are, as I think Cindy is arguing, necessary to realize the full benefit of the VFDs. Therefore, in this application, the meters should also be considered green.

Finally, what Cindy doesn't mention, is the new master meters at Franklin will also enhance the city's ability to measure water loss by comparing the proposed master meters with customer meters. Any reduction of water loss made possible by the ability to better measure flows would also be considered green.

Michael Bolf, P.E.
District Engineer - Grand Rapids
MDEQ – Office of Drinking Water and Municipal Assistance
(616) 307-0501

From: Hartman, Izabel (DEQ)
Sent: Friday, May 30, 2014 8:30 AM
To: Bolf, Michael (DEQ)
Subject: RE: GR GPR Approval Memo

Great, thanks Mike! I do have one question – is the whole project (meters included) considered green? I wasn't sure if it was all tied together. Cindy's business case indicates the whole project (\$1,037,000) is green.

Thanks,

Izabel Hartman
DEQ
517.284.5408

From: Bolf, Michael (DEQ)
Sent: Wednesday, May 28, 2014 4:12 PM
To: Hartman, Izabel (DEQ)
Subject: GR GPR Approval Memo

Izabel,

I reviewed Cindy Irving's GPR request and concur with her analysis. See attached.

Let me know if you need anything more.