MEMORANDUM

TO: ROB HAYES, DPS DIRECTOR/CITY ENGINEER

FROM: TIM KUHNS, WATER AND SEWER SENIOR ENGINEER TDK

SUBJECT: ADVANCED METERING INFRASTRUCTURE (AMI) SYSTEM

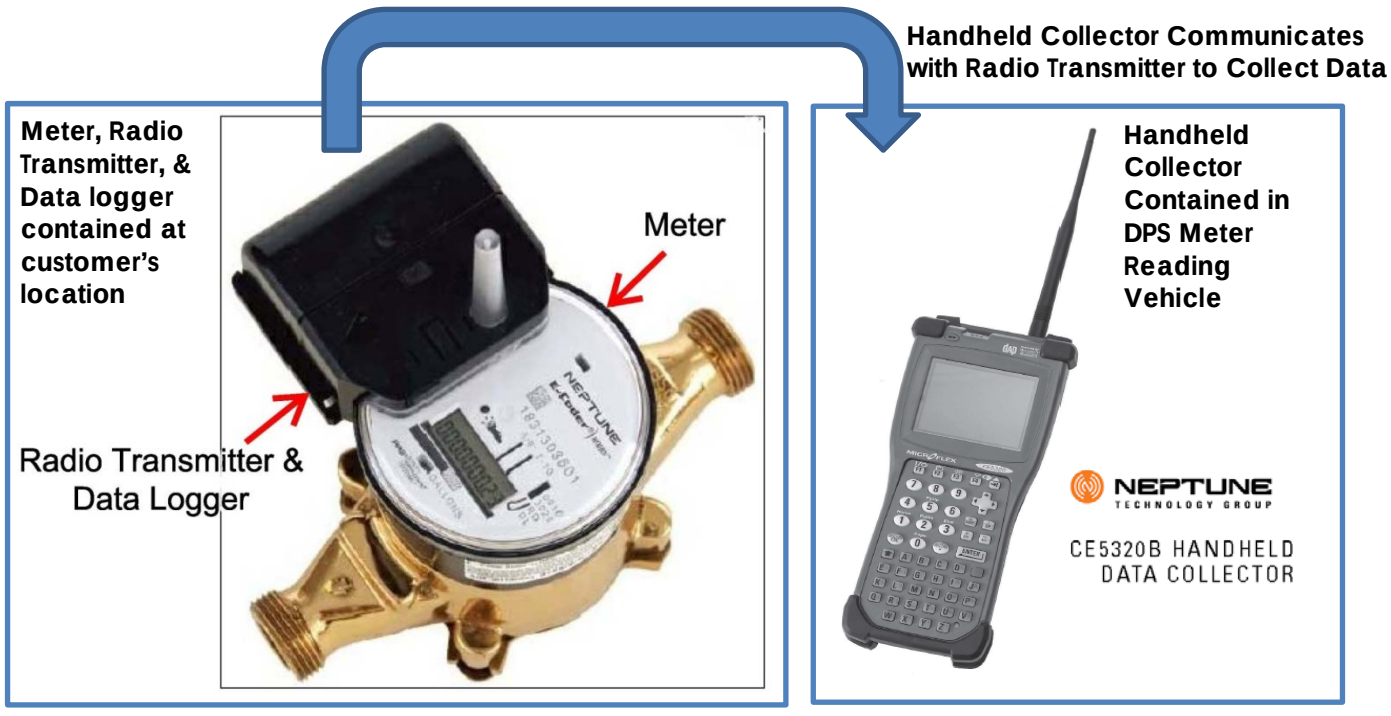
DATE: APRIL 24, 2015

Advanced metering infrastructure (AMI) is a rapidly developing technology that allows water utility providers to remotely obtain hourly reports (by radio or cellular communications) on consumption, leakage, tamper, and backflow conditions for every user in the system without having to do drive-by or walk-by meter reading. The AMI technology is important as the data allows water utility managers to provide better service to customers by proactively identifying issues such as leakage within a customer's building, which results in excessive billing to the customer or water loss within the system and lost revenue to the water utility. This memorandum provides an overview of the existing meter reading system used by the City, a summary of the features of two types of AMI systems, and a recommendation for moving forward.

Current Automated Meter Reading (AMR) System

In order to collect water usage data from over 14,000 water system customer accounts throughout the City of Novi, the Department of Public Services' Water and Sewer Division deploys staff to perform "drive-by" meter reads, using an AMR system, by which the radio transmitter on the meter within a customer's building transmits readings to a mobile data collector. The current system consists of a billing meter, radio transmitter, and handheld data collector as shown in Figure 1.

Figure 1: Current Drive-By Meter Reading System

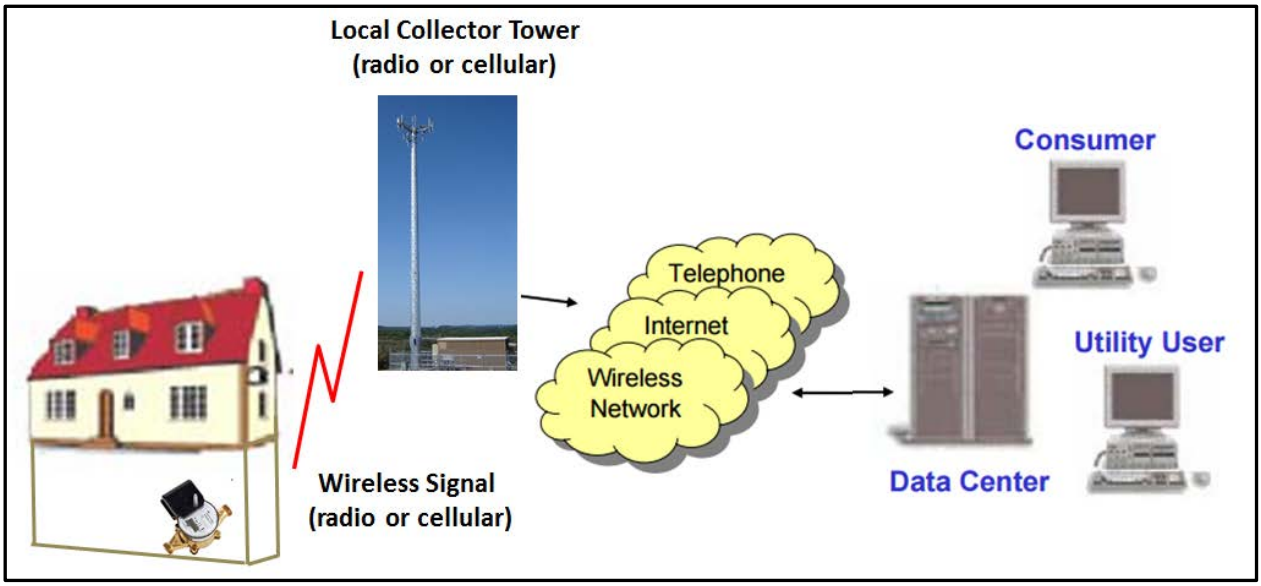


The drive-by meter reads are performed on a monthly basis and usually take 3 days to complete. The meter read data is then used to bill customers on a quarterly basis, except for the top 100 users, who are billed on a monthly basis. Even though most users are billed on a quarterly basis, the meters are still read on a monthly basis as it provides the ability to identify high water usage complaints (leaks), meter tampering, or meter malfunction on a monthly basis such that these issues do not persist for the full quarterly billing period. If these issues were to persist for the full quarterly billing period, it would result in lost revenue for the City in cases of meter malfunction/tampering; and in cases of high water usage complaints where leaks persist, it would result in excessively high water bills that cause undue burden on the customer.

Overview of Proposed Advanced Metering Infrastructure (AMI) System

Recent advances in technology have allowed water utilities to efficiently deploy advanced metering infrastructure (AMI) systems to collect data from the water billing meters on a continuous 5 minute or hourly basis through direct cellular or radio communications and transmit this data directly to a data center, which would make the data available to both utility managers and customers. Figure 2 provides a graphical depiction of a typical AMI system.

Figure 2 – Graphical Depiction of AMI System



In the City's case, the data center would be a server located at the Department of Public Service's Water and Sewer Division such that data is readily available to system operators.

When evaluating options for AMI deployment, it is important to note that 10,912 meters out of 14,310 (76%) of all billing meters are 10 years old or older. The typical service life on positive displacement (PD) meters such as the ones used for the City of Novi system is 10 years. After 10 years, the PD meters typically under-record, resulting in lost revenue from water sales. For this reason, the options for AMI deployment assume an allowance for a wholesale meter replacement program. Currently, there are two main types of

AMI systems, which vary based on how the meters communicate the data back to the central data repository. The two technologies are summarized as follows:

1. Radio-Read AMI System with Replacement of End-User Equipment
   The City's current AMR system uses drive-by radio communications with Neptune R900 meters, data loggers, and radio transmitters at each customer's location. In order to upgrade to a radio read AMI system, local collector towers would need to be deployed throughout the City to serve as intermediate transmission points to communicate the data back to the data center. The collector system consists of a radio frequency antenna, a monopole tower to provide a high-elevation mounting location (assumed to be 75 feet in height for this application), and a Gateway data collector, which transmits the data to the main data repository through cellular communications. A radio propagation study was performed by Neptune Technology Group to evaluate the number of collectors need to provide full radio read coverage across the City. It is important to perform a radio propagation study as radio transmissions can be blocked by terrain, tree cover, and various manmade features. As such, the radio propagation study accounts for these types of obstructions to verify that unobstructed line-of-sight is provided between transmission points to ensure a reliable communications network. The radio propagation study indicated that 13 Gateway data collectors are needed to provide marginal to good coverage for 99.9% of system users, while 24 Gateway data collectors would be needed to provide good coverage to almost 100% of the users. (A copy of the radio propagation study is provided as an attachment to this memo.) For the purposes of evaluating costs of this option, it was assumed that 24 collectors would be needed with the inclusion of an additional 12 collectors as a contingency to provide coverage for the difficult-to-reach user accounts. As mentioned previously, it was also assumed that wholesale replacement of the Neptune metering equipment was included in the costs for this option as most of the billing meters are past the intended service life. The costs for wholesale meter replacement for this option are summarized in Table 1:

Table 1: Breakdown of Wholesale Replacement of Meters for Radio Read Option

Billing Meter Size	Quantity	R900 Encoder Meter & Data Logger	External Radio	Per Site Cost	Total Cost
5/8" Unit	7,188	$94.82	$86.93	$182	$1,306,419
1"	2,464	$165.81	$86.93	$253	$622,751
1.5"	525	$346.17	$86.93	$433	$227,378
2"	649	$459.40	$86.93	$546	$354,568
3"	49	$1,873.22	$86.93	$1,960	$96,047
4"	30	$2,533.37	$86.93	$2,620	$78,609
6"	5	$3,843.39	$86.93	$3,930	$19,652
				Grand Total	**$2,705,424**

Table 2 provides a summary of the total costs for the Radio Read AMI deployment, which includes Collector System Installations and software upgrades.

Table 2: Radio Read AMI Deployment Costs

Description	Cost
Collector System Installation	$561,000
Wholesale Meter/Register/Radio Replacement	$2,705,424
Collector System Replacement	$77,271
Software Upgrade	$7,000
Web Portal and Data Storage N_SIGHT IQ	$156,375
Total Cost	**$3,393,244**

The analysis of costs is based on the following assumptions:

- Collector system project costs of $15,600 per site, which includes a 30% contingency.
- Wholesale replacement of existing meters, registers, and radios. Replacement costs are based on wholesale rates provided by Neptune.
- Collector panels and antennas will have to be replaced after 10 years to estimate the 20 year present worth cost

2. Cellular-Read AMI System with Replacement of End-Use Equipment

This option includes wholesale replacement of the billing meters with Metron Farnier metering equipment and Verizon cellular registers. The Metron Farnier equipment is presented as part of this option as it is compatible with the cellular register equipment. The cellular registers communicate directly through the Verizon network and transmit the high resolution data to the central data repository. This option does not require intermediate collector sites as the existing Verizon cellular towers in and around Novi would serve as the collector sites. The costs for wholesale meter replacement for this option are summarized in Table 3.

Table 3: Breakdown of Wholesale Replacement of Meters for Cellular Option

Billing Meter Size	Quantity	Metron Farnier System	Per Site Cost	Total Cost
5/8" Unit	7188	$340.00	$340	$2,443,920
1"	2464	$535.00	$535	$1,318,240
1.5"	525	$800.00	$800	$420,000
2"	649	$1,085.00	$1,085	$704,165
3"	49	$1,890.00	$1,890	$92,610
4"	30	$2,990.00	$2,990	$89,700
6"	5	$3,890.00	$3,890	$19,450
			Grand Total	**$5,088,085**

The total cost for this option would be equal to the replacement cost of the billing meters as the cellular registers serve to transmit the data directly to the central data repository. The estimate contained in Table 3 indicates the total cost is approximately $5.1 million.

The analysis of cost is based on the following assumptions:

- No intermediate collectors required for this option.
- Wholesale replacement of existing meters, registers, and radios based on "off-the-shelf" rates provided by Metron-Farnier.

The cost analysis indicates that the Radio-Read AMI system is much less expensive than the Cellular-Read AMI system, however, it should be noted that the Radio-Read System replacement costs are based on as-bid wholesale prices, whereas the Cellular-Read System replacement costs are based on "off-the-shelf" costs. The discount provided by Neptune for bulk purchases was approximately 75% of the off-the-shelf costs. Metron-Farnier has indicated that they would be able to provide a wholesale discount on meter purchases. If a similar discount were provided through Metron-Farnier, the total cost of AMI implementation with the Cellular-Read system ***would be approximately $3.9 million***, which is within the range of costs of the Radio-Read AMI system.

Advantages and Disadvantages of a Proposed AMI System

The ability to efficiently collect and transmit data at a high resolution allows system operators the following key advantages:

1. Fully automated daily meter reading through a fixed network, using cellular or radio communications, would eliminate the need for drive-by meter reading and would allow for collection of high resolution consumption data.
2. High resolution meter reads could be used to support monitoring of time-of-day usage restrictions. Water and Sewer Division staff would no longer be required to patrol the City to enforce lawn sprinkling restrictions. The high resolution data could be used to identify water sprinkling ordinance violations.
3. High water bill issues could be identified on a daily basis rather than a monthly basis; thus significantly reducing the potential for excessively high water bills due to leaks.
4. High resolution meter readings could help address high usage inquiries from customers. Furthermore, the AMI System could include a customer web portal whereby the customer can monitor their usage at any time. If the customer better understands their water usage patterns, they could better manage their usage and resulting quarterly bill.
5. High resolution meter readings would allow City staff to identify meter tamper and malfunction. A meter that is not recording usage represents lost revenue to the City.
6. High resolution meter readings allow system operators to identify backflow conditions in the City. Backflow conditions represent a cross connection contamination hazard to the water system.
7. High resolution meter readings will allow system operators to provide better system management. For example, high resolution meter readings will allow

system operators to identify areas of high water loss by comparing the aggregation of meter readings to key distribution system meters.

While there are many key advantages to an AMI system, there are also some disadvantages when considering a system of this type:

1. DTE Energy has deployed a system of this type for use in remotely reading energy consumption at utility meters. For this application, there have been a small number of customers who have refused installation of the AMI system in their residence/building due to perceptions that the radio emissions from the AMI meter may be harmful to their health. If the City were to deploy an AMI system, a policy would need to be developed to accommodate users who do not want the AMI meter in their home.
2. In the case of the radio-communications-based AMI system, new radio collector towers would be required to complete the wireless transmission of data. Initial analysis indicates that over approximately 24, 75-foot tall radio collector towers may be needed to deploy the radio-communications-based AMI system. The radio collector towers may pose an aesthetics issue to neighboring property owners.

Cost-Benefit Analysis of AMI System Implementation

If AMI System implementation were not considered, the cost to the City to maintain the status quo billing meters would be the meter replacement costs in Table 1, which total $2.7 million. Given that the costs of the Radio-Read and Cellular-Read AMI systems are estimated to be $3.4 million and $3.9 million, respectively, the incremental cost of implementing a given AMI system would range from $700,000 to $1.2 million. It is important to consider the benefits of such a system and make sure that these benefits are commensurate with the anticipated costs of $700,000 to $1.2 million. Table 4 summarizes the apparent benefits and associated cost savings of implementing an AMI system.

Table 4: Cost-Related Benefits of AMI system

Description	Present Worth Value
Eliminates Need for Drive-By Collection	$91,155
Minimizes No Read Meters	$85,457
Minimizes High Read Meters	$71,214
Minimizes Lawn Sprinkling Patrols during Summer Months	$56,972
Improved Customer Service on Usage Questions	N/A
Minimizes Service Calls and final meter reads	$30,385
Minimizes Notice of Violation for Sprinkling Ordinance	$56,972
Reduction in Water Loss	$59,345
Minimizes meter tamper	NA
Better System Management	NA
Better Backflow Detection	NA
Grand Total Value of Benefits:	**$451,500**

Many of the benefits of the AMI system are a reduction in labor hours related to meter reading on a manual basis. If these labor hours were reduced as a result of the proposed AMI system, this would allow the Water and Sewer Division to allocate more labor resources to other critical Water and Sewer Division Programs such as the Capacity Management, Maintenance, and Operations (CMOM) Program, which provides for preventative maintenance of the sanitary collection system to reduce the number of sewer back-ups.

The analysis of cost benefits is based on the following assumptions:

- All present worth analysis based on a 10 year planning period with a discount rate of 4.5%. This discount rate was used as it is the rate currently stated in the Michigan Department of Environmental Quality (MDEQ) project planning guidelines.
- Drive-by collection includes a three day collection period per month at $40/labor hour (with fringe benefits).
- Assumes 12 no read meters per month with average residential usage loss in revenue of $75/month.
- Assumes 5 high read meter complaints per month with high usage charges to customer of $150/month.
- Lawn sprinkling patrols include 20 days a month at 3 hours a day at $40/labor hour during 3 month summer period.
- Service calls and final reads include three day collection period per month at $40/labor hour.
- Notice of violation notifications include 20 days a month at 3 hours a day at $40/labor hour during 3 month summer period.
- Water loss savings includes a 2.5% reduction in annual water loss costs of $300,000 over 10 year period.

The evaluation of cost benefits indicates that the City could gain about $450,000 in cost savings through implementation of an AMI System, which is less than the apparent cost of $700,000 to $1.2 million to implement the system; however, these cost savings do not include the non-monetary benefits of improved customer service; minimization of meter tamper; better system management; better backflow detection; and better monitoring to enforce time of day use restriction. The cost analysis also does not account for the opportunity cost of being able to allocate more labor resources to other critical programs, such as the CMOM program. Given the non-monetary benefits, an AMI system implementation looks to be worthwhile.

Next Steps and Recommendation

Based on the cost-benefit analysis, it appears that the AMI System benefits outweigh the costs for the status quo Radio-Read AMR system. Staff's recommendation is that the City should implement a pilot program to test the radio read AMI system. Since the radio read AMI system can use the existing R900 metering equipment, a pilot program would involve temporary deployment in an AMI System radio collector tower. Initial analysis indicates that deployment of a pilot program in the area of the Island Lake Pressure District may be suitable to test the system. The local vendor for the radio read

AMI system indicated that a pilot program could be implemented for the Island Lake Pressure District system at almost no cost to the City.

Please let me know if you have any questions or comments regarding this memorandum.

cc: Pete Auger, City Manager
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Carl Johnson, Finance Director
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