Village of Mahomet

WATTS BEYOND WATER

Sustainable Water Infrastructure Plan

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TABLE OF CONTENTS

I. Executive Summary

Energy and water are two critical resources that are highly interrelated. For example, delivery of clean drinking water and adequate sanitation of wastewater depend on reliable energy supplies. The overlap between energy and water resources and their direct relationship with public policy means that collaboration between engineers and policymakers regarding resource management and use is critically important.

The village of Mahomet has been providing a good, reliable, and safe water systems to its citizens for well over seventy years. As the fastest growing community in Central Illinois, the village of Mahomet now faces substantial growth in the near future which will stress the capabilities and performance of both the existing water and energy system. However, like many other small towns, the village lacks the resources to open information on its energy usage or to analyze the interrelation between water and energy. In order to identify capital improvements needed to strengthen the energy efficiency of the existing water system and support future developments, a Sustainable Water Infrastructure Plan has been developed. In this study, an energy model has been developed complementary with the village's existing hydrologic model as part of the Infrastructure Plan and has been used to identify improvements that will increase the transparency and efficiency of the process of decision-making.

Throughout the development of the Sustainable Water Infrastructure Plan, several key discoveries were made which highlighted the current state of energy and water efficiency. With the development of the Infrastructure Plan, the village now has a road map that provides valuable information on the interrelation of water and energy that can aid in the planning process. With the development of the energy model, the village now has an advanced tool that can not only evaluate potential developments but can also be used to explore any number of "what if" scenarios.

II. Purpose of Report

The village of Mahomet published its Master Plan in 2016, identifying infill development as one of the key sustainable strategies for the village. Much of the village's new development is likely to occur in the agricultural areas on the outskirts of the Village (Exhibit 1), which would lead to increased governmental expenditure on new infrastructure and an increasing burden on the existing utility and level of service. Aided by the development of an energy model and its continued use of existing hydrologic models, the village would be able to explore different scenarios in the face of a range of water supply changes. This project focuses on proposed future development and creates corresponding scenarios for evaluation in the models. By studying the interrelation between water and energy and how they are projected to grow in tandem in the future, the village would be able to prioritize important improvements and budget for future water system improvements.

Another purpose of this report is to highlight the importance of the water-energy nexus in local infrastructure system, which provides valuable information for small localities in response to global climate change adaptation. There are three specific aspects of the water-energy nexus that are addressed here: energy-intensive water supply, carbon dioxide and global climate change and partnerships between water and energy professionals.

Energy-Intensive Water Supply

While the primary goal of the city water plan is to use water more efficiently, ancillary benefits include energy savings and the resultant environmental quality benefits. The latter arise because the water supply chain, or the route water follows as it is pumped and/or conveyed from its source; treated to drinking water standards; distributed; used; and treated to wastewater standards, is energy intensive[1]. For example, water treatment facilities incorporate a variety of techniques when processing drinking water. No matter what individual techniques they use, all processes involve a series of pumps and motors to move water from a source (lake, stream, aquifer), through the treatment facility, into storage vessels to the public distribution system. These pumps, blowers, and motors require substantial amounts of energy, which makes them expensive to operate (Figure 1).

[1] Santa Clara Valley Water District. From Watts to Water. 2011

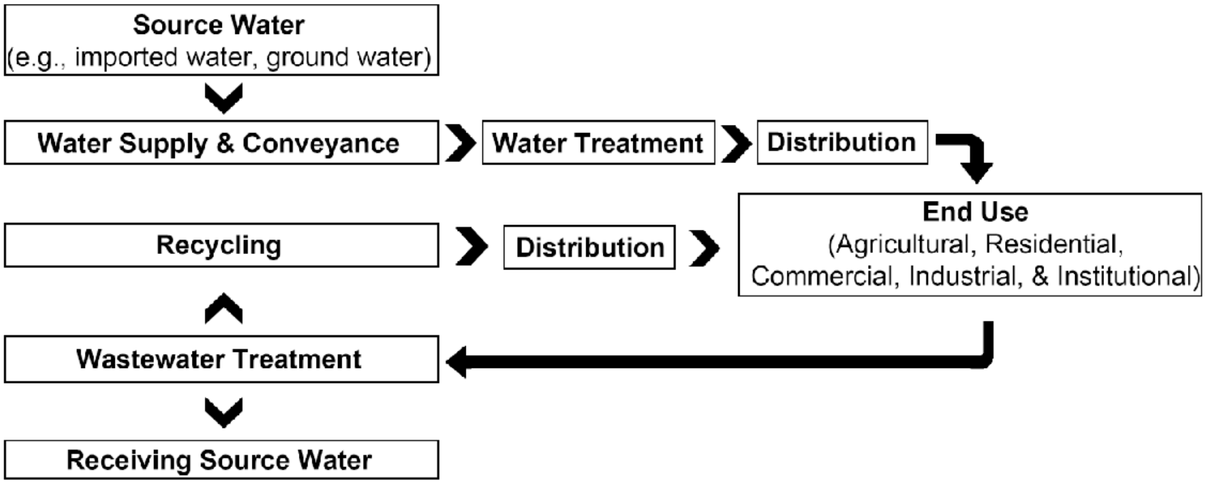


Figure 1 The Water Supply Chain Is Energy Intensive

Carbon Dioxide and Global Climate Change

Carbon dioxide is a greenhouse gas and plays a role in global climate change. Thus, there is a direct connection between water supply and global climate change (Figure 2). Global warming and the climate changes that may occur as a result of global warming present many challenges for water agencies because it is predicted that water supply systems will likely change in the near future with shifting precipitation patterns and increased drought frequency[2]. Cities, especially small localities, have generally committed to responding to these challenges through adaptation (preparing for future changes) and mitigation (reducing the city's role in global warming through more efficient use of resources). Water conservation and water recycling play a large role in these adaptation and mitigation efforts.

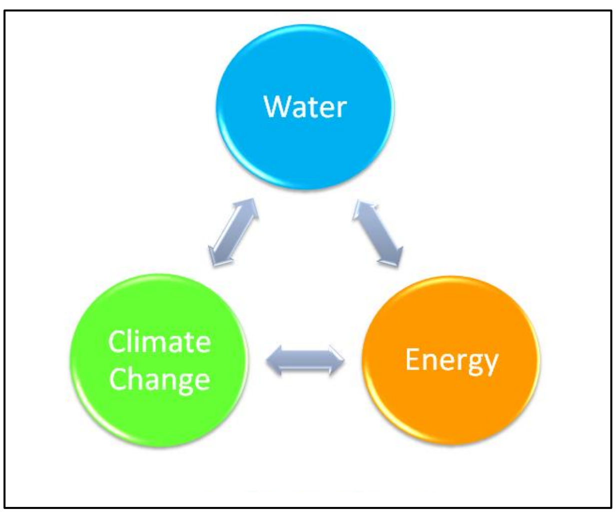


Figure 2 Water-Energy-Climate Change Nexus

[2] United States Environmental Protection Agency. Addressing Climate Change in the Water Sector.

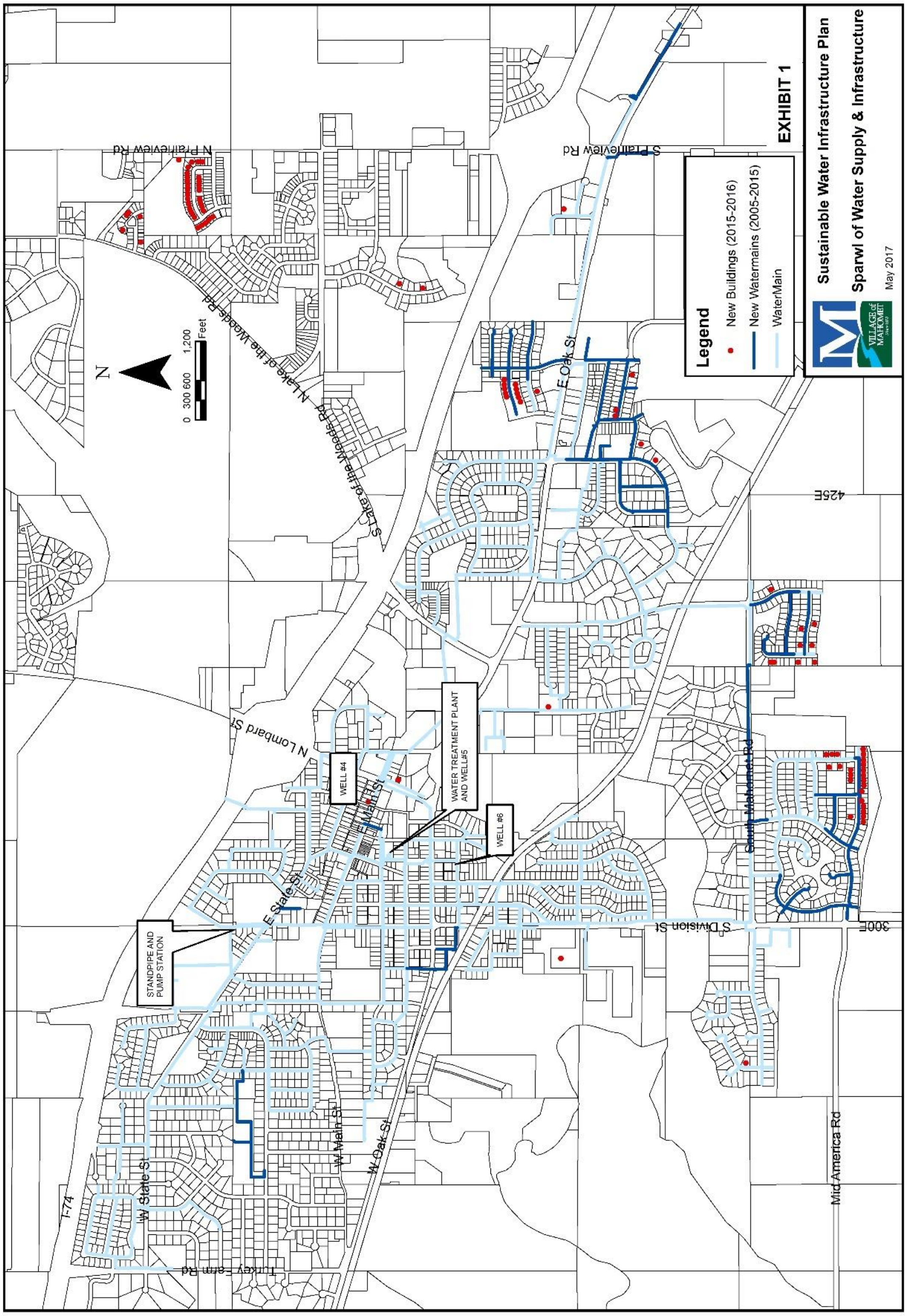
Partnerships Between Water and Energy Professionals

The challenges posed by global climate change have brought together professionals from both the water and energy industries with the shared goal of understanding the connections between water and energy in a city's water supply system[3]. This report demonstrated that water conservation and water recycling offer significant energy savings, recommending that water and energy policymakers consider the energy implications of water policy decisions (Figure 3). The interdependence of energy and water resources overlap with public policy such that a need exists for collaborative efforts between engineers and policymakers regarding resource management and use.

Figure 3 Water and Energy Professionals

[3] Association of Energy Engineers. Certified Water Efficiency Professional.

Exhibit 1 Sparwl of Water Supply & Infrastructure



III. Existing Drinking Water System

For the purpose of analyzing the water-energy nexus, the system boundary of this report consists of five entities that can be tracked in the village's energy bills with addresses. The information of each component of the village's drinking water system are shown in Exhibit III-1 and summarized in Table 1. These components can be classified as source, treatment/supply and storage based on their functions, which offers great insights on how each of them consumes electricity compared to the whole system.

Table 1 Village's Drinking Water System

Service Address	Description
1404 E Heather Dr	0.3 MG Elevated Tank
504 S Center St	Well #6
302 S Vine St	Water Treatment Plant & Well #5
309 N Division St	0.16 MG Standpipe and Booster Pump Station
505 E Franklin St Unit Well	Well #4

A. Source

The village's water source is the Mahomet Aquifer which is pumped by three shallow wells. Well #4, #5, and #6 pump directly to the water treatment. Well No. 4 is located west of Jefferson Street and was drilled by Albrecht Well Drilling, Inc. to a depth of 283 feet in 1988 (Figure 4). This well has a design capacity of 500 gpm at a total pumping head of 225 feet. The motor size is 60 hp/230 volt. Well No. 5 is located west of Elm Street and was drilled by Layne-Western to a depth of 318 feet in 1990. This well has a design capacity of 600 gpm at a total pumping head of 280 feet. The motor size is 60 hp/230 volt. Well No. 6 is located north of Sangamon Street and was drilled by Layne-Western to a depth of 319 feet in 2006. This well has a design capacity of 750 gpm at a total pumping head of 250 feet (Figure 4).

Figure 4 Well #4 & #6

B. Treatment/Supply

The village has one treatment facility – the Brooks Water Plant (Figure 5) and one pump station at the standpipe. The Brooks Water Plant was improved in 2005 and is located northeast of the intersection of Vine Street and Union Street.

Water from Well #4, Well #5, Well #6 is pumped to the water treatment plant where the water enters three package iron removal units. Raw water enters each unit at the top which contains an induced draft blower to aerate the water. Water then flows to the detention tank and is then directed to a four cell sand and anthracite filter which removes the oxidized iron.

The treated water is then pumped by 4 variable speed centrifugal high service pumps to the four 9' diameter ion exchange softeners or 6" bypass line. Pump #1 is the smallest pump and is rated at 600 gpm at 285' Total Dynamic Head. Pumps #2, #3, and #4 are rated at 600 gpm at approximately 330' TDH. It is noted that two pumps operate at approximately at 252' TDH. Individual pump flow cannot exceed 750 gpm as the pump can overload the motor; as a result the pump set point is constantly maintained at 600 gpm. The water treatment plant has a design flowrate of 1,800 gpm (2.59 MGD) with space available to accommodate a future iron removal unit.

Once hardness is removed by the ion exchange softeners, treated water is blended with bypass water and chlorine, fluoride, and polyphosphate are injected into the finished water prior to its exit from the water treatment plant.

The water treatment plant has a Supervisory Control and Data Acquisition (SCADA) system which monitors and controls the entire system. The groundwater wells turn on and off based on automatic set points for the detention tank. Each high service pump is run at variable speed in order to maintain 600 gpm in order to match well and treatment capacity. A lead pump turns on when the elevated tank reaches a level of 26' and turns off when the elevated tank reaches a level of 31.5'. A lag pump turns on when the elevated tank reaches a level of 25' and turns off when the elevated tank reaches a level of 31.5'.

Figure 5 Brooks Water Plant

C. Storage

The village has two storage tanks with a combined storage capacity of 0.46 million gallons.

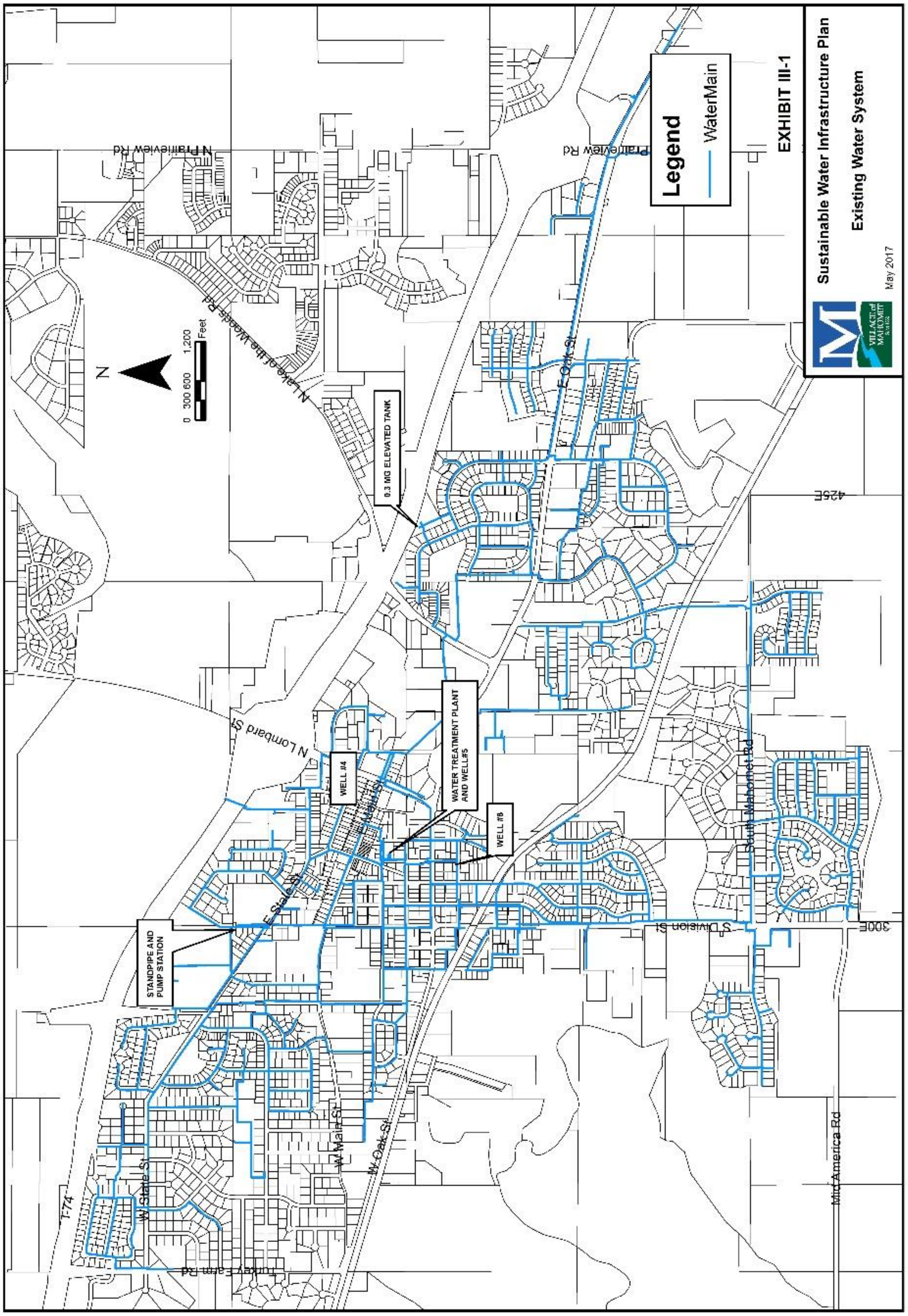
The first tank is an elevated 0.30 million gallon waterspheroid tank constructed in 1997. The elevated storage tank is located near the intersection of Jeffrey Drive and Heather Drive.

The village has one ground storage tank in the distribution system. It is a 0.16 million gallon standpipe located near the intersection of Division Street and State Street constructed in the 1960's.

There is a pump station located next to the standpipe which contains 6" and 8" piping and a single 40 HP variable speed vertical end suction pump that has a design flow of 600 gmp at 170' TDH. Under normal operations, the pump turns on in the morning at 9:00 a.m. and runs at variable speed to maintain approximately 250 to 275 gpm. The pump runs until the standpipe reaches a level of 75' to 80'. The standpipe is filled at night by a control valve which opens at 2:00 a.m. and continues filling until the standpipe reaches a level of 105'. The pump can turn on automatically if low pressure (40 psi) is encountered at the pressure transducer.

Figure 6 0.3-MG Elevated Tank

Exhibit 2 Existing Water System



IV. Historical Water & Energy Data and Projections

A. Existing Water Pumpage Volume

The monthly water pumpage volume was obtained from the village's drinking water treatment and is expressed in units of million gallons. This number is recorded everyday by the facility management and aggregated for each month throughout the year for the purpose of analysis. For the convenience of this study, only the data from 2010-2011 and 2014-2015 was extracted to make comparisons. According to the village, the number also includes unaccounted water and water used for hydrant flushing, firefighting, leakage, backwashing, and construction.

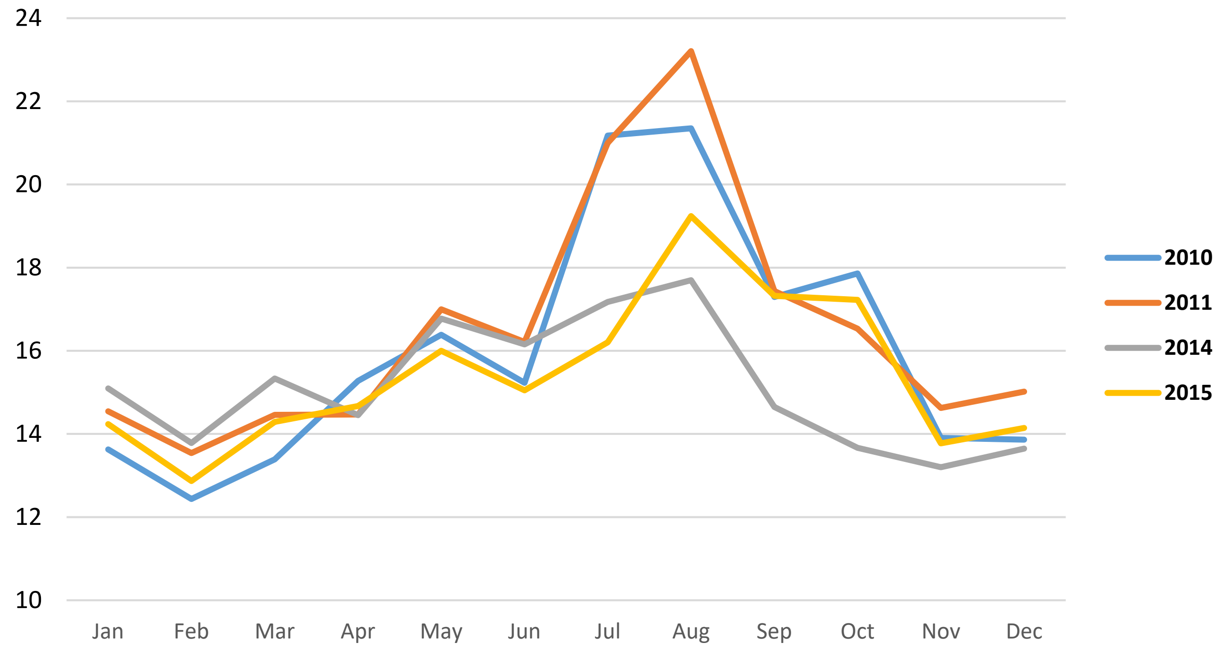
Monthly water pumpage volume presents water usage as constant over the course of the year. However, water usage is dynamic and there are seasonal variations in water use. One would expect more water use on a hot summer day versus a cold winter day. In addition, one would expect less residential water use at 2:00 a.m. versus 6:00 p.m. on any given day. Data on the water treatment volume is useful in evaluating the water system's demand in long-range planning for predictive and sustainable system.

The historical annual and monthly water pumpage based on information obtained from the village's water plant from year 2010-2011 and 2014-2015 is shown in Table 2 and Figure 7.

Table 2 Annual Water Pumpage in Drinking Water Plant

Year	Annual Water Treatment (MG)
2010	191.798
2011	177.042
…	
2014	181.63
2015	185.023

Figure 7 Monthly Water Pumpage (MG)



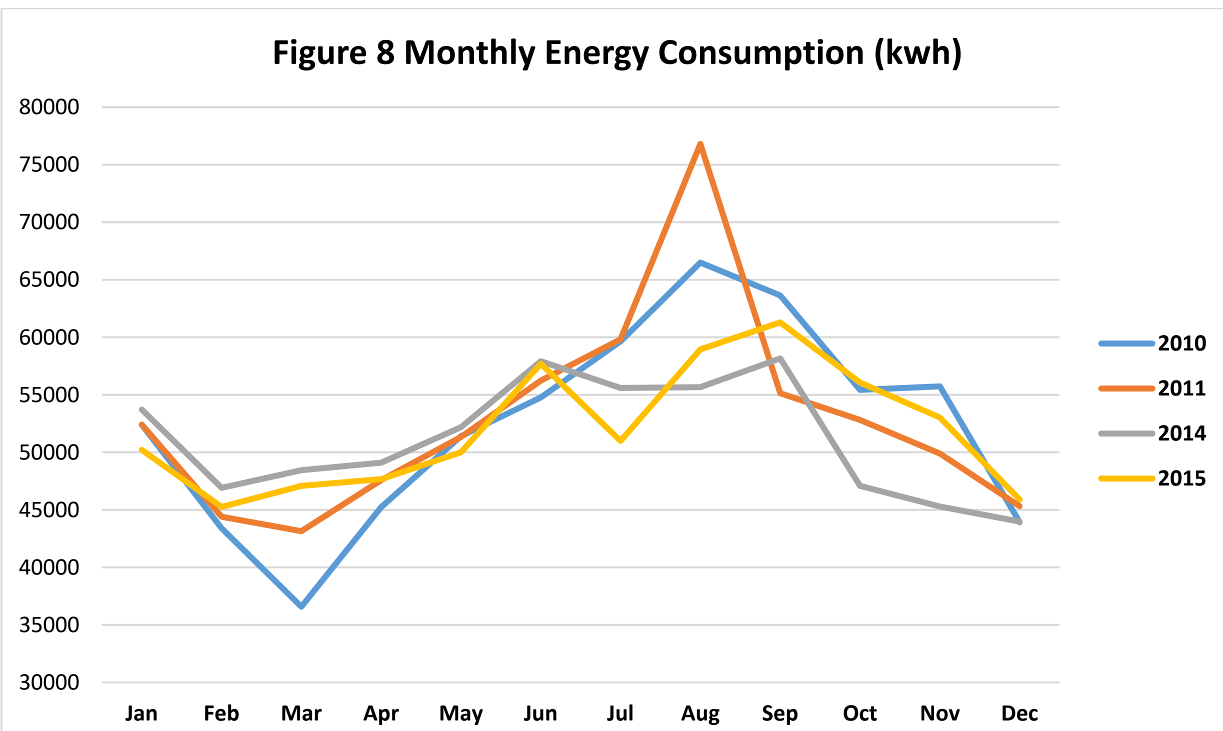
B. Associated Energy Consumption

Similar to the water pumpage volume, the energy bill data from the five addresses was collected in order to compare it with the water treatment. As mentioned above, only the data from 2010-2011 and 2014-2015 was extracted. Like the water pumpage volume, the energy consumption remains constant over the course of the year at around 600,000 kWh, but exhibits seasonal fluctuations, peaking in the summer.

The historical annual and monthly energy consumption associated with water treatment based on information obtained from the village's energy bill from year 2010-2011 and 2014-2015 is shown in Table 3 and Figure 8.

Table 3 Associated Annual Energy Consumption

Year	Total Energy Consumption (kWh)
2010	628,629.00
2011	634,877.00
…	
2014	614,052.63
2015	624,136.00



C. Projected Water Usage

Using the historical data presented above and the relative increase in water customers, increase in water use were projected to the year 2040 based on anticipated future developments.

Future development information for this study was obtained from the Mahomet-Area Population and Employment Projections from the Champaign Urbana Area Transportation Study (CUUATS) by the Champaign County Regional Planning Commission with input from the village. Also, consultation with the village staff provided other information like the potential location and population projections of future developments.

Exhibit 3 shows locations of anticipated future developments and those that will receive village water have been included in the map. Developments that are north of I-74 and west of Route 47 that will receive water from Sangamon Valley Public Water District have not been included.

Water demand for the undeveloped areas were calculated based on one of the following: number of people, number of units, or acreage. The population and water usage were calculated based on the following assumptions by land use[4] (Table 4):

Table 4 Assumptions of Future Land Use Development

Land Use Designation	Assumptions
Residential	2.7 people/unit
Commercial	2 unit/acre, 500 gallons/unit/day
Industrial	2,000 gallons/unit/day
Mixed Use	800 gallons/acre/day

[4] Village of Mahomet. Water Master Plan Report. 2015

For all residential land use designations, average day water usage was assumed to be 100 gallons per person per day. For locations where water demand was based on acreage, a value of 20% was used to account for open space. The remaining 80% was then used along with the assumed density per acre to determine water demand.

Using these assumptions, the annual water demand for the undeveloped parcels was calculated at 128.48 MG. The projected relative addition of residential water users in 2040 is 2,664 people. The resulting 2040 projected annual water demand is 317.92 MG. For the years between the existing annual water demand of 185.02 MG in 2015 and the projected annual water demand in 2014, growth line was assumed to be linear, as shown in Figure 9.

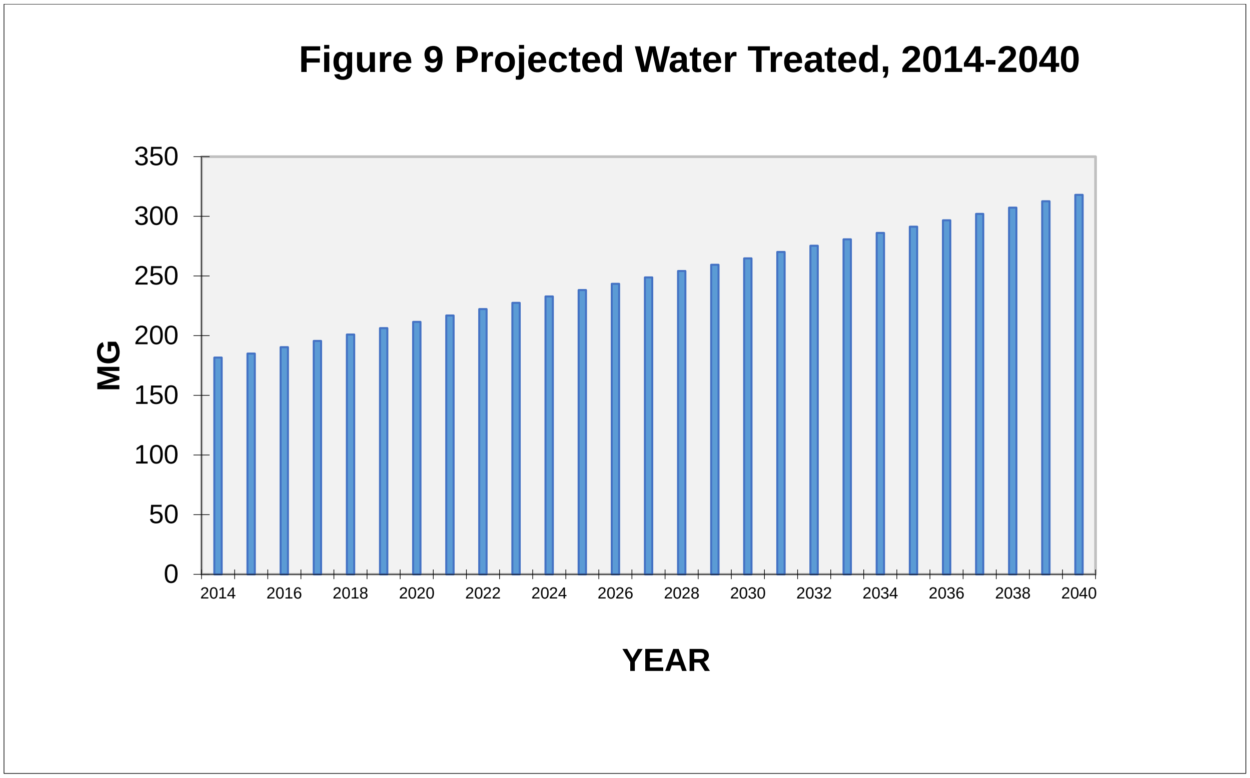
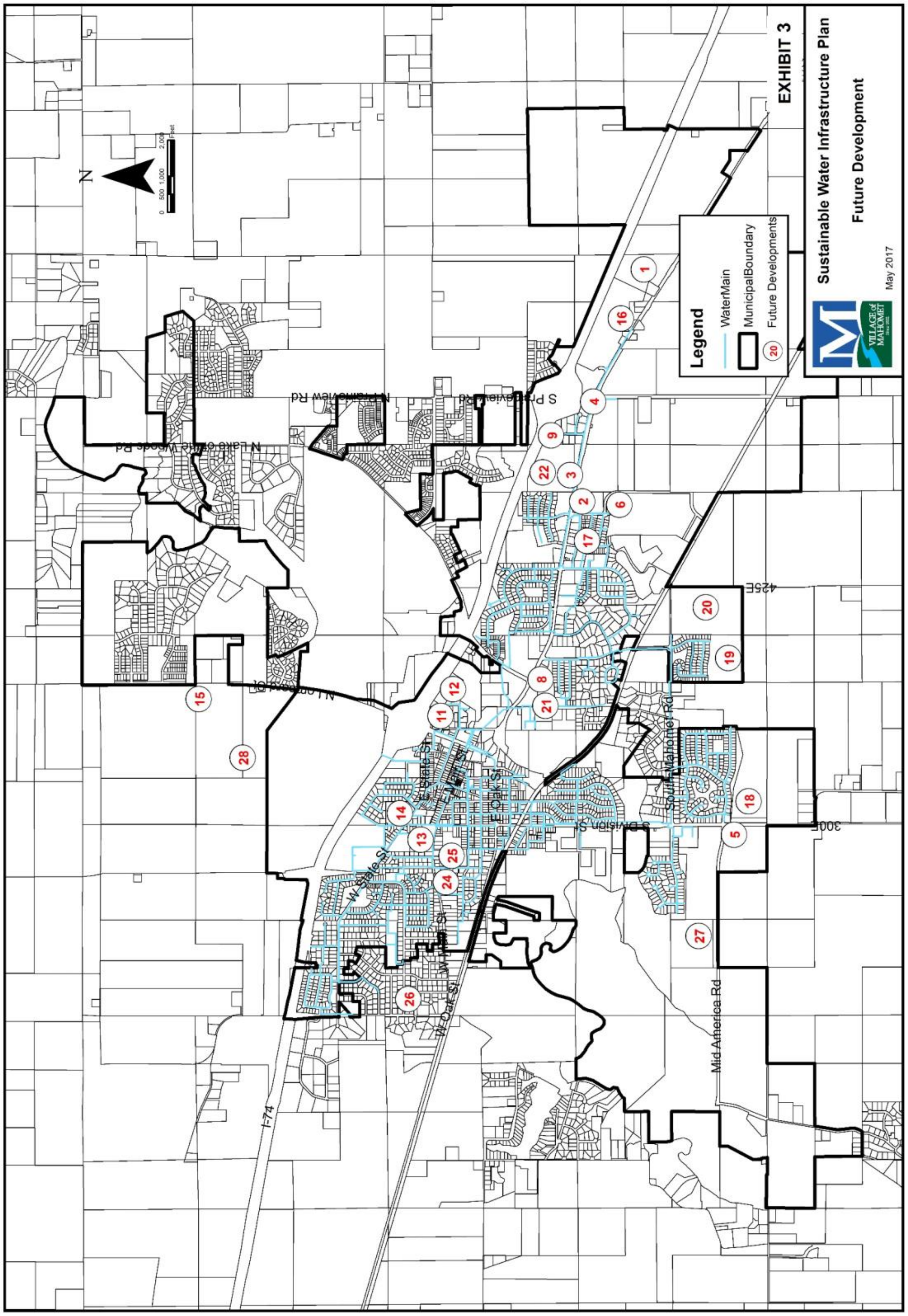


Exhibit 3 Future Developments in 2040



V. Computational Model Development

The energy model of the existing and future water system was developed using EPA's Energy Use Assessment Tool[5]. The Energy Use Assessment Tool serves as a key step in analyzing and ultimately reducing the energy usage at a small or medium sized water system. The Tool helps to create an individual energy and cost baseline which can provide a utility an organized overall look at their facility's current energy usage.

The village of Mahomet has a relatively small water system due to its scale and population, which made this method possible. The following is a listing of each step of using EPA's Energy Use Assessment Tool to build the energy model of the village's water system.

A. Energy Baseline and Data Collection

An energy baseline is developed by measuring and documenting the energy usage and costs at a specific time. To establish a baseline, this study collects utility bills and the operating data of process equipment, HVAC equipment and lighting, for up to five years. Operating data of the facility's equipment was collected to feed into the Energy Use Assessment Tool. In addition, energy load and the operating schedule for major equipment are also collected to determine its energy consumption. To estimate equipment energy consumption, this study collected equipment nameplate data from the village's staff.

The key strategy for this step is to focus on those assets consuming the most energy as it is important to not get lost in the little things when developing the initial baseline. A perfect model of the facility is not the goal of the baseline and the baseline involves working in some generalities, rough numbers, industry averages and rules of thumb. The idea here is to try to achieve quality numbers, but not to chase perfection.

B. Baseline Evaluation and Improvements

The results can sometimes be surprising as assets that are not expected to consume large amounts of energy may be identified as top energy use systems. This may be due to a large number of smaller assets with long operating hours. Examples include lighting or ventilation equipment. These can collectively contribute to a larger than expected percentage of energy usage.

Systems that consume a large percentage of the total energy consumption are those expected to be initially considered as improvement efforts. If a vendor is recommending higher efficiency equipment, the Tool's electrical balance can be utilized to compare and contrast the potential impact to the site. Here are two general strategies for improvements. The first is to prioritize further investigation of opportunities to reduce the energy use. More specifically, with energy evaluations, the first goal is to find the "low hanging fruit", which are the changes to the operations or equipment that are cheap or quick to implement. The second method is to determine operational improvements to reduce energy use. Time is money when it comes to energy consumption and run time is a large factor in the amount of energy an asset uses. Changing operational procedures and schedules could reduce overall costs. Shutting equipment down rather than leaving it idle during

[5] United States Environmental Protection Agency. Energy Efficiency for Water Utilities.

long periods of inactivity is an easy operator or programming change and looking for process equipment that is left on during non-processing periods or lighting and heating that are left on when a building is vacant is another strategy.

C. Modeling Scenarios

Modeling scenarios can be created easily in the energy model to simulate different conditions. Based on the discussion of performance improvements, the model can be simulated in terms of the change in both equipment or operational condition. Inside the model there are five physical parameters that can be simulated as different motor size, efficiency, speed and operational schedule. With the help of the energy model, it would be easy for the village to simulate different physical environment like purchasing new equipment or changing schedule. The following Table 5 provides some possible model scenarios.

Table 5 Suggested Model Scenarios

Scenario	Description	Related Parameters
1	Purchasing New Equipment	Adding new equipment
2	Changing Operational Schedule	Changing Operating Hours
3	Changing Motor Speed According to Seasonal Change in Water Treatment	Changing Average Motor Operating Current (Amps)
4	Emergent Conditions	Shutting down specific equipment
…		

VI. Results and Analysis

A. Overview of Current Baseline Energy Usage

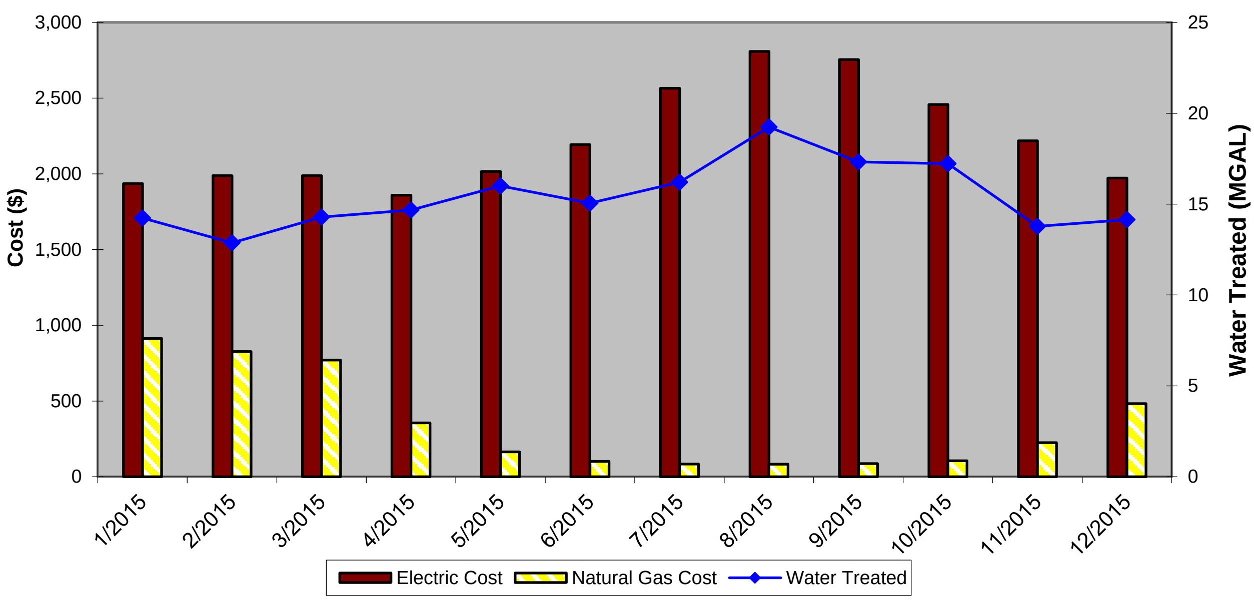
The Baseline Energy Use (Table 6) summarizes each utility's consumption and cost for the last 12 months and the amount of water treated during that period. It calculates the percentage of the total plant utility cost that each utility is generating during the 12 month. After inputting energy bills data and water treatment data from the village's drinking water plant into the energy model, an energy baseline in 2015 is developed by measuring and documenting the energy usage and costs from the water treatment plant. It is noted that most of the energy consumption comes from electricity, comprising 86%, and there is no alternative energy source. The water plant also consumes water treated by itself, such as water used for hydrant flushing, firefighting, leakage, backwashing, and construction. The water consumed by the plant only takes up 0.4% of the total pumpage and every million gallons of water treated by the plant would cost $167.27 in terms of energy. The energy baseline is shown as in Table 6.

Table 6 Energy Baseline in 2015

Utility	Site Utility Use (Common Units)	Site Utility Costs	% of Costs
Electricity	624,136 kWh	$26,751	86%
Natural Gas	4,975 CCF	$4,198	14%
No 2 Fuel Oil	0 CCF	$0	0%
Water & Sewer	671,600 GAL	$0	0%
Total		$30,949	100%
Plant Annual Water Treatment Flow (MGAL/Year)			185
Plant Average Water Treatment Flow (MGAL/Month)			15
Plant Average Energy Cost Per Million Gallons Water Treated ($/MGAL)			$167.27

By combining the utility cost and water treatment, the following graph reveals that there exists an obvious relationship between the treated water and its associated energy cost. The energy costs of the water plant would rise and fall as the volume of water treatment changes in the plant as shown in Figure 10.

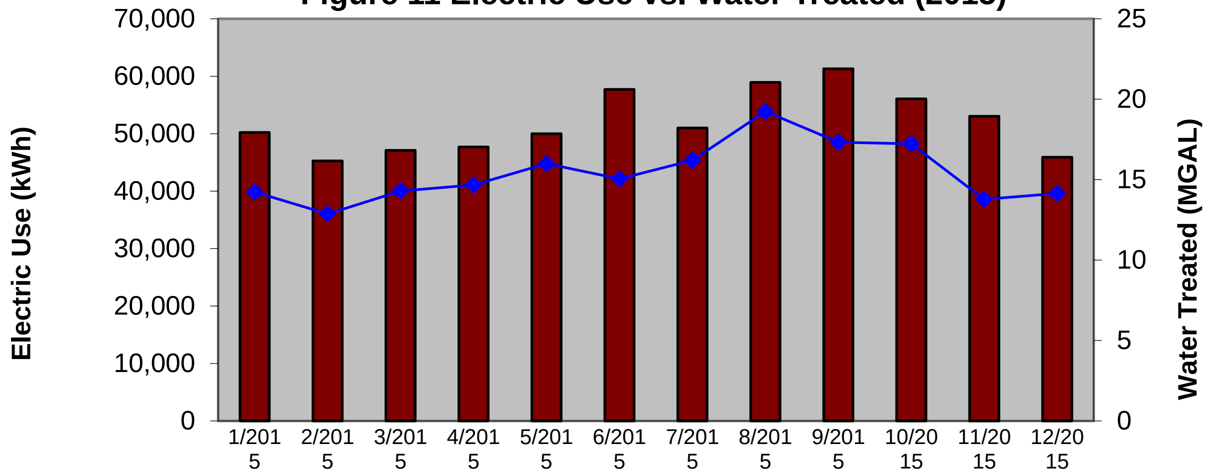
Figure 10 Utility Cost Summary, 2015



B. Electric Energy Utilization

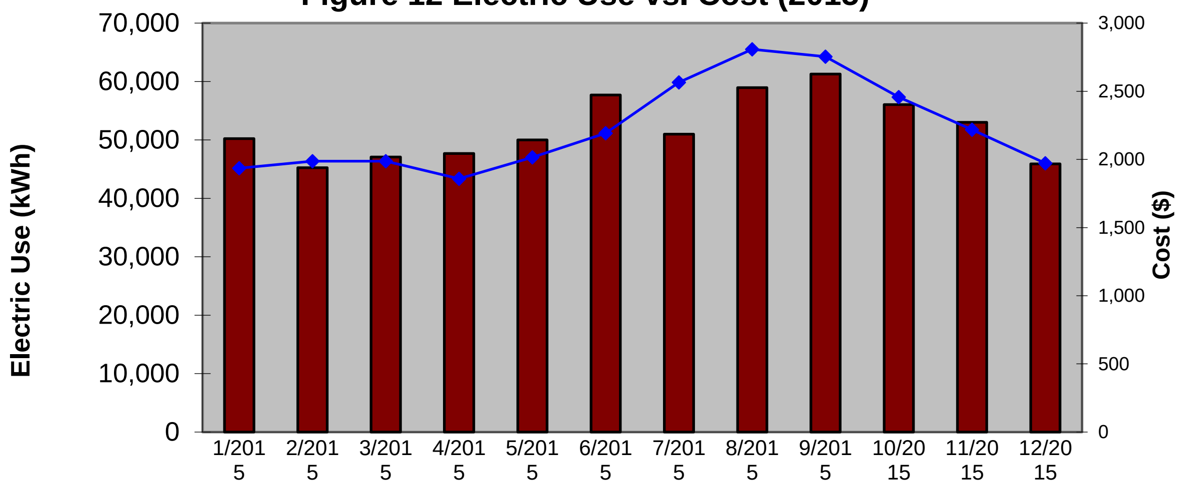
The Electric Use vs. Water Treated graph (Figure 11) compares Electric Use (electric energy consumption) in bar graph form with Water Treated volumes in line graph form. As treatment amounts increase so should electric consumption and vice versa. If that relationship is weak there might be opportunities for energy savings in equipment schedules and in process procedures. The Electric Use vs. Cost graph (Figure 12) shows the Electric Use in bar graph form as compared to Cost in line graph form. That allows the plant to see how energy costs are trending. Reducing peak demand charges can reduce the overall cost without decreasing the consumption. For the village, it should be noted that during the summer the energy utilization fell down compared to other periods, high energy was consumed with low water treated in June and higher energy bill was charged in July.

Figure 11 Electric Use vs. Water Treated (2015)



	1/2015	2/2015	3/2015	4/2015	5/2015	6/2015	7/2015	8/2015	9/2015	10/2015	11/2015	12/2015
Electric Use	50,218	45,250	47,089	47,669	50,002	57,696	50,985	58,941	61,291	56,065	53,024	45,906
Water Treated	14	13	14	15	16	15	16	19	17	17	14	14

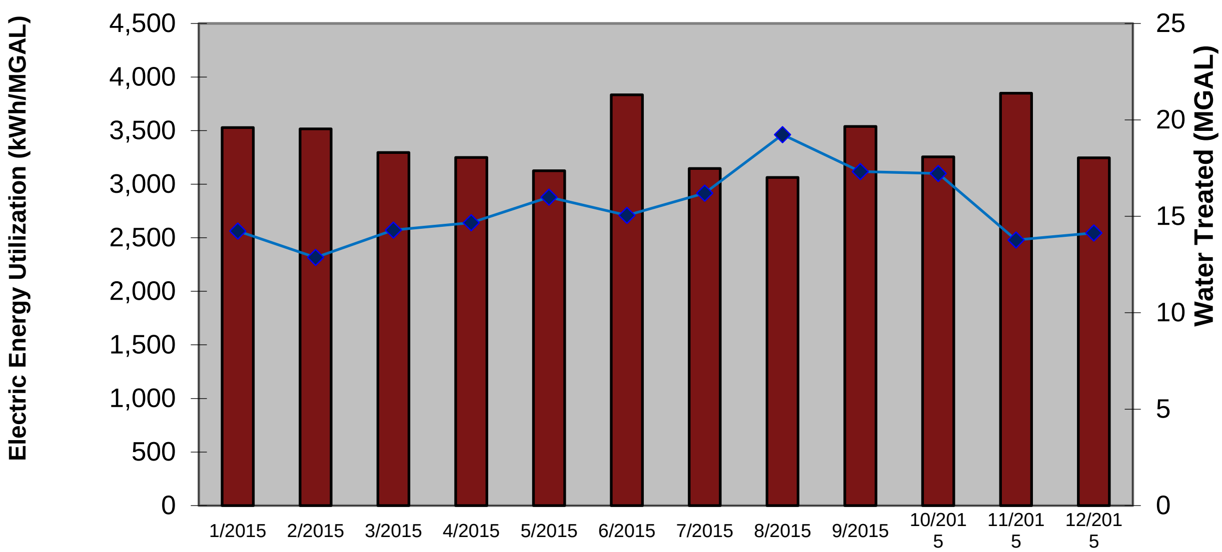
Figure 12 Electric Use vs. Cost (2015)



	1/2015	2/2015	3/2015	4/2015	5/2015	6/2015	7/2015	8/2015	9/2015	10/2015	11/2015	12/2015
Electric Use	50,218	45,250	47,089	47,669	50,002	57,696	50,985	58,941	61,291	56,065	53,024	45,906
Electric Cost	1,935	1,987	1,988	1,859	2,015	2,193	2,565	2,808	2,754	2,458	2,218	1,972

The Electric Utilization vs. Water Treated graph (Figure 13) shows the Electric Energy Utilization (energy consumption per amount of water treated) in bar graph form compared to the amount of Water Treated in line graph form. If electric utilization increases sharply as the amount of water treated decreases there might be opportunities to reduce energy consumption in the non-process, building systems or the treatment process is not designed to efficiently handle varying flows. For the village, the electric energy utilization (kwh/mgal) remained relatively stable throughout the year with a value of about 3307 kwh/mgal. This provides a basis for estimating the energy requirement for projected water demand under specific future development patterns.

Figure 13 Electric Utilization vs. Water Treated (2015)

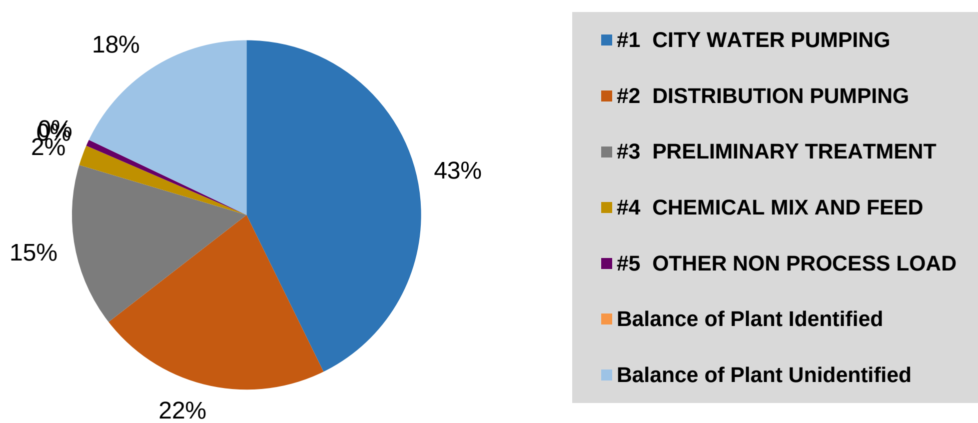


	1/2015	2/2015	3/2015	4/2015	5/2015	6/2015	7/2015	8/2015	9/2015	10/2015	11/2015	12/2015
Electric Energy Utilization	3,528	3,517	3,295	3,249	3,125	3,834	3,146	3,064	3,538	3,255	3,849	3,246
Water Treated	14	13	14	15	16	15	16	19	17	17	14	14

C. Energy Usage Distribution

The summary report also generates a list of the Top 5 Electrical Energy Use Systems at the plant (Figure 14). That breakdown is listed by major system type. Those smaller systems not in the Top 5 will be combined and shown as the Balance of Plant Identified. The electrical energy that has not yet been identified will be shown as Balance of Plant Unidentified. After entering additional site data, the percent of site electrical energy identified moves closer to 100%, and the Balance of Plant Unidentified decreases. Based on the result of the energy model, most of the energy usage comes from the pumping system (Figure 13), which provides valuable information on how to reduce energy costs.

Figure 14 Disdribution of Electrical EnergyUse By Major Process



D. Projected Energy Usage

The 4 Year Electric Use vs. Water Treated graph (Figure 15) shows the annual Electric Use in bar graph form compared to the amount of Water Treated in line graph form. That allows the plant to compare how electric use and water treated is trending from year to year. Contrasts in these comparisons may show opportunity for reductions in equipment in operation or equipment right sizing. From the projection of water use in previous section, the energy projection can be projected as well based on the relation between electricity us and water treatment from the graph. Assuming that the growth between 2014 and 2040 is linear and energy utilization remains the same throughout the time, the water demand and its associated energy consumption are projected as shown in Figure 16. And it is shown that the energy consumption in drinking water system would reach higher than 1,000,000 kWh.

Figure 15 Electric Use vs. Water Treated

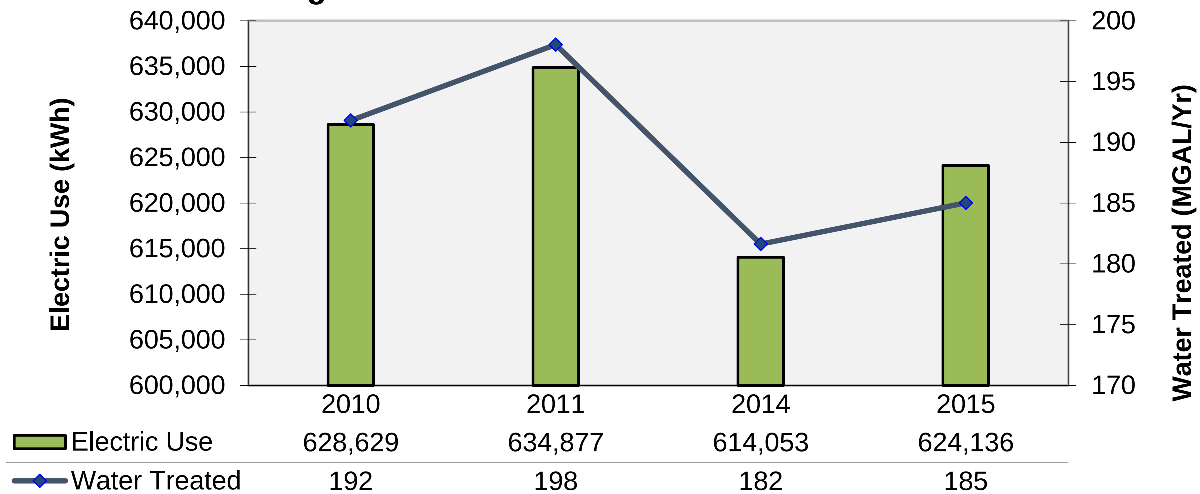
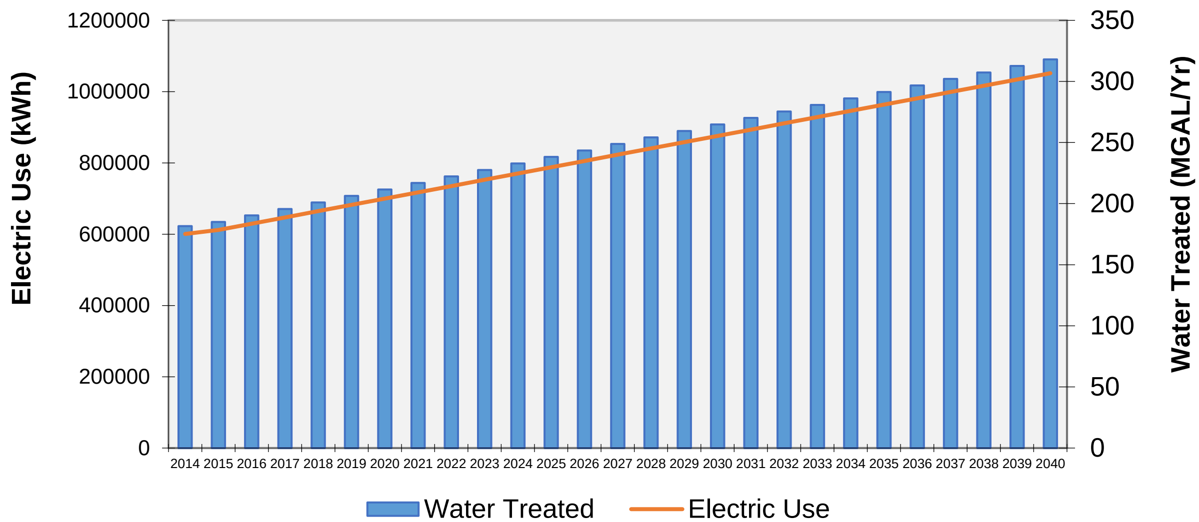


Figure 16 Projected Electric Use (kWh) vs. Water Treated (MG), 2014-2040



VII. Recommendations and Conclusion

Both the demand for water and energy consumption increase significantly based on the projections. In order to continue providing a good, reliable, and safe drinking water to its citizens in the following decades, the village should look for opportunities to build a sustainable water infrastructure system in the face of a range of environmental challenges. There are two ways to realize that goal: (1) improving water efficiency or (2) improving energy efficiency. For strategies to increase water efficiency for the village's water supplier, there have been many existing plans from other jurisdictions addressing the issue of water conservation and recycling already and the most common approach is to reduce operational costs through pipeline optimization in an engineering aspect. On the other hand, promoting infill development would also be a good strategy to increase water efficiency by avoiding sprawl of water supply infrastructure. Based on previous section, most of the water demand comes from the outskirts developments, which requires new construction of water infrastructure as well as more burden on the pipeline, which would contribute to a significant amount of costs from the city.

This report recommends focusing more on the energy efficiency side to address the water-energy nexus improvements and based on two case studies in similar sized localities, there are two actionable strategies for the village to increase energy efficiency for water utilities.

A. Improving Pumping System Performance

Based on the result of the energy model, most of the energy usage comes from the pumping system. Therefore, improving pumping system performance would be a good strategy to reduce energy costs.

It is noted that fan, pump and blower power consumption is equal to the cube of the speed[6]. Two times the speed will consume eight times (2^3) the power. Speed is expensive. The penalty for running a motor faster than necessary is severe. Conversely, one half the speed requires one-eighth (0.5^3) the power to drive a fan, pump or blower (see Table7). This means significant energy savings are available by reducing motor speed.

Table 7 Motor Speed and Required Power

Speed	Flow	Required Power
100%	100%	100%
90%	90%	72.9%
80%	80%	51.2%
70%	70%	34.3%
60%	60%	21.6%
50%	50%	12.5%
40%	40%	6.4%
30%	30%	2.7%

[6] Illinois Sustainable Technology Center. Reducing Energy Usage in Water and Wastewater Treatment Facilities: A Tale of Two Cities. 2009.

A Variable Frequency Drive (VFD), also known as an Adjustable Speed Drive (ASD), is a system that controls the rotational speed of an alternating current (AC) electric motor by controlling the frequency of the electrical power supplied to the motor (**Figure 16**). It converts incoming 60Hz AC power into other desired frequencies, which allows for AC motor speed control. VFDs enhance process control and provide energy savings by matching motor speed with load requirements. Pump, fan and blower applications at water and wastewater facilities are excellent candidates for retrofits because VFDs match motor speeds to fluctuating loads at these facilities, which is more economical than running motors at a constant speed.

Figure 17 Variable Frequency Drive

Scenario 1: 100 HP motor running 24/7 at 100% speed and 75% Flow with mechanical flow control.

Cost of Operating at Fixed Speed= $50,000 per year

Scenario 2: 100 HP motor running 24/7 at 75% speed, 75% Flow, and VFD at 75% speed 24/7.

Cost of Operating with a VFD= $21,094 per year

Annual Savings: $28,906

According to the research conducted by ISTC, the implementation of VFD in the water plant in the City of Greenville, which has similar population with Mahomet, has an annual projected savings of $9,800 and 0.9 projected payback year.

B. Renewable Energy Generation

According to previous discussion, most of the energy consumption is comprised of electricity usage from Ameren Illinois. Therefore, the village could look for renewable energy such as solar and geothermal to supplement existing energy structure and therefore increase its energy efficiency.

Solar cells, also called as solar photovoltaic devices, are gaining more attention in the field of renewable energy technology and commonly seen in many small localities as alternative energy source. Unlike wind energy, solar cells do not affect the rural environment a lot. Cell prices are also predicted to get lower and the efficiency higher in future. Being able to generate emission free energy from irradiation coming from an abundant energy source, from the Sun, solar cells can be considerable technology for electricity generation. Solar energy is converted into electricity using photovoltaic (PV) cells. A group of these cells can be mounted together into a solar panel.

A pilot project of solar energy utilization for groundwater pumping was considered in Tyrnävä, Finland. Tyrnävä is a small municipality[7]. In 2013, the amount of inhabitants in the municipality was around 6600, and this amount is predicted to increase in future. Tyrnävän Vesihuolto is treating and supplying drinking water to the citizens of the municipality. However, the area is offgrid, hence exploring a solar photovoltaic solution for groundwater pumping. Solar PV was considered to be utilized during periods of sufficient solar irradiation, which fits with the water pumpage volume pattern during the year. In an ideal situation, about 50,000 m3 of groundwater could be pumped annually. Table 8 illustrates the economics of solar PV. The calculations made various assumptions, however, the system seems very profitable.

Table 8 Economics of Solar PV in Tyrnävä, Finland

	Value	Unit
Module Price	11,200	€
Pump Price	4,000	€
Capital Cost of the System	15,200	€
Water Price	0.2	€/m3
Water Quantity	49,289	m3
Operation and Maintainance Cost	9,858	€/a
Profit from Pumped Water	3,040	€
Payback Period	2.2	year
Payback Period with Investment Support 30%	1.7	year

[7] THULE Institute. Best Practices in Water Asset Utilization for Renewable Energy Generation in Finland, Norway, Scotland, Northern Ireland and Ireland. 2015.

C. Conclusion

This report identified the highly interrelated energy and water which are two critical resources for the village of Mahomet throughout the development of the Sustainable Water Infrastructure Plan. Aided by the development of an energy model and its continued use of existing hydrologic models, this study helped the village evaluate potential developments in terms of water and energy. Based on the model, 2040 projected annual water demand is 317.92 MG and the associated energy consumption in drinking water system would reach over 1,000,000 kWh.

Municipalities must balance budgets as revenues decline, especially those vulnerable to climate change. Energy is a major component in producing drinking water and in treating wastewater. Reducing energy consumption at treatment facilities makes good business sense while it is reaching relative high level in the near future. Therefore, for the village of Mahomet, besides considering water conservation and recycle, the village’s treatment facilities can save money by upgrading to more energy-efficient motors and looking for renewable energy.

By studying the interrelation between water and energy and how they are projected to grow in tandem in the future, the village would be able to prioritize important improvements and budget for future water system improvements. Also, the importance of the water-energy nexus in local infrastructure system is highlighted, which provides valuable information for small localities in response to global climate change adaptation.

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