# 8 Distribution

The master plan for Detroit's water distribution system is based on the findings of technical evaluations and input from the retail customer outreach program. The technical evaluations included a review of DWSD's past and current practice for water main rehabilitation, review of current and emerging practice in other cities, and discussions with DWSD Field Services Group and City of Detroit representatives. The retail customer outreach program included Retail Steering Committee and a series of neighborhood meetings conducted over the term of the master planning study.

With the anticipated completion of institutional arrangements by the end of January 2016, the new Great Lakes Water Authority will take responsibility for the regional water system and the City of Detroit will take responsibility for its retail water system within the city limits. The schedule for preparation of this Water Master Plan Update only allowed a limited opportunity to discuss the planning concepts with representatives of the City of Detroit. The planning team welcomes further discussion with City of Detroit representatives to refine this plan and incorporate new ideas.

This chapter covers the following topics:

- Customer Service
- Rehabilitation and Rehabilitation
- System Consolidation
- Lead Pipe Services
- Proposed Capital Improvement Plan

Findings and recommendations on nonrevenue water and metering, both retail and wholesale, are discussed in Chapter 9.

## 8.1 Retail Customer Service

The customer outreach program for this planning project included the formation of a Retail Customer Steering Committee and the participation of Detroit residents at a series of neighborhood meetings. Technical Memorandum 1 in the appendix describes the objectives, scope, and results from the retail customer outreach program. The program was constructive in identifying the following retail service priorities from the standpoint of citizens:

- Affordable water rates
- Assurance that customer service questions and requests are understood and will be addressed
- Responsiveness to water leak reports, particularly flooded basements in vacant buildings
- Maintain high standards for water quality and water distribution infrastructure

Retail customers regularly expressed concern regarding the high cost of the sewer service portion of their water bills. At the same time, most customers believe that the portion of the bill for water is reasonable and affordable.

DWSD has initiated a series of retail customer service initiatives over the last two years.

- Automated Meter Reading Program
- Fire Hydrant Winterization
- Assistance with Water Bill Payments
- Leak Detection and Repair Contracting
- Customer Service Center
- On-line Water Bill Payment
- Shut-off Program
- Budget Billing Program
- Water Main Break Repair Contracting

The water service shut-off program was the subject of intense public discussion in 2014. Updates to the program were made in the second half of 2014 and there have been significant improvements in retail water bill collection through 2014 and 2015.

Formation of the new DWSD-Retail organization is focusing attention on the needs and methods for continuing improvement in customer service. A responsive customer service program is an essential element of financial sustainability for retail water service.

DWSD has made improvements in its response to water main breaks and leaks. In FY2014, there were approximately 1,920 breaks compared to an average of 1,446 breaks in preceding years. The winter of FY2014 was extremely cold, and DWSD retained contractors to augment its own forces in break repair.

DWSD's goal is to respond to reports of water leaks and make repairs within 4 days. During FY2014, 56 percent of reported leaks were fixed in 1 day, 22 percent within 2 days, and 12 percent within 3 days. The remaining 10 percent were completed within 4 or more days.

## 8.2 Rehabilitation and Replacement of Distribution Mains

Rehabilitation and replacement of water distribution mains in the City has benefits for customer service, reduction of nonrevenue water, and supporting redevelopment of the City and property owners. Over the next 5 years, the new DWSD-Retail organization can develop a strategy for its new mission focused on the City of Detroit, and a key part of that new mission is rehabilitation and replacement of aging water mains in the city. A framework for such a strategy is presented below.

### 8.2.1 Recent Rates of Water Distribution Main Replacement

DWSD has generally allocated $10 million annually for water distribution main rehabilitation in its annual capital improvement programs. Generally, water main rehabilitation is performed by replacing old water mains with new ductile iron pipe. During the fiscal years 2002 to 2008, approximately 140 miles of water transmission and distribution mains were re-constructed in the City. From July 2008 to June 2014, less than 45 miles of distribution main were reconstructed. In Fiscal Year 2015, DWSD's distribution system rehabilitation program was restructured. Several new projects were initiated: WS-648A, WS-685, WS-686, WS-691 and WS-693 totaling approximately $35 million and including approximately 20 miles of water main replacement. In the restructuring of the water distribution main replacement program, DWSD discontinued its traditional practice of furnishing water main and appurtenances for water main contracts. Contractors are now responsible for furnishing water mains and appurtenances in conformance with DWSD specifications.

Over the last 20 years, funding for distribution main replacement in Detroit has allowed for the replacement of less than 10 miles per year, or approximately 0.3 percent of the system annually. In the last 5 years, the replacement rate has been significantly less than this. DWSD's records indicate a total of 2,700 miles of water distribution main in the City of Detroit. Therefore, the recent rate of replacement is low relative to the expected service life of distribution pipeline.

### 8.2.2 Water Distribution Main Renewal Alternatives

In Phase 2 of this planning study, the project team conducted technical investigations of alternative technologies for pipe rehabilitation and replacement. A series of meetings were held with DWSD Field Services Group representatives to discuss current practices in Detroit and practices in other cities in the United States and Canada.

The technologies reviewed included:

- Ductile Iron Pipe
- Cleaning and Cement Mortar Epoxy Lining
- PVC Pipe
- HDPE Pipe
- Pipe Bursting
- Slip-Lining
- Tight-Fit Lining
- Cured-in Place Lining
- Polymeric Lining
- Horizontal Directional Drilling

DWSD is currently spending $250 to $300 per foot for construction of new ductile iron water mains. Alternatives technologies were investigated for applicability to reduce water main renewal cost to $150 to $200 per foot.

A three year pilot program is recommended for DWSD to determine the optimal application of the following technologies:

- Ductile Iron Pipe
- PVC Pipe
- HDPE Pipe
- Pipe Bursting
- Slip-Lining

The pilot program would include the development of specifications, standard installation details, construction inspection protocols, and evaluation criteria testing completed construction. The outcome of the pilot program would be guidelines regarding which technologies are most cost-effective in which locations. The pilot program is described in more detail later in this chapter.

A review of potential new pipe materials and construction techniques that were considered and discussed with DWSD is presented below.

#### 8.2.2.1 Ductile Iron Pipe

Ductile iron is the strongest and most durable of pipe materials considered in this comparison. Ductile iron has a higher yield stress; the minimum yield stress for ductile iron is 42,000 psi, this is approximately 6 times the tensile strength of PVC, and 24 times the tensile strength of HDPE material. Since the wall thickness required for DI pipe to resist internal pressure is substantially smaller than either PVC or HDPE pipe, DI pipe has a larger a flow cross-sectional area than either the PVC or HDPE pipe product. For instance, the ID of an 8" diameter class 350 ductile iron pipe (8.43 inches) is comparable to the ID of a 10" dia SDR 11 HDPE pipe (8.8 inches). The Hazen-Williams flow coefficient for DI pipe is close to that of PVC and HDPE pipe, with a typical "C" value of 140 for design of new pipe.

The strength of DI pipe is not affected by temperature variations during installation and operation. Both PVC and HDPE are thermoplastic materials, pipe produced from these materials are rated for a design temperature of 73.4 °F, and are derated for water system operating temperatures greater than 80°F. While all pipe products are subject to thermal effects, expansion and contraction with change in temperature, these effects are moderate for DI pipe. PVC has a thermal expansion coefficient 4.5 times that of ductile iron; HDPE has a thermal expansion coefficient 18 times greater than ductile iron.

DI pipe will resist 4 times the hydrostatic burst pressure of PVC pipe, and up to 6.1 times the hydrostatic burst pressure of HDPE pipe. DI pipe is not affected by long-term stress from internal pressure. There is no measurable relationship between applied tensile stress (applied hoop stress) and time to failure.



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DI pipe is more resistant to possible damage during handling, shipping and installation. DI pipe has more than 13 times the impact strength of PVC pipe, and up to 12 times more impact strength than HDPE pipe. For PVC and HDPE pipe, nicks or gouges that have a depth greater than 10 percent of the pipe wall thickness significantly reduce the performance life of the product. DI pipe has higher pipe stiffness than PVC or HDPE pipe. DIP will resist up to 8 times the crushing load of PVC pipe, and up to 82 times greater than HDPE pipe.

For service connections that are 1-1/2 inches and smaller, DI pipe may be directly tapped with a corporation stop unlike PVC that requires a tapping saddle, or HDPE pipe which requires a fusion coupling.

Ductile iron is typically 2 to 3 times the material and installation cost compared with PVC and HDPE. DI pipe is metallic, and is subject to potential corrosion due to stray currents and dissimilar metals. DI pipe must be protected when installed in potentially corrosive environments that include:

- Soils that are poorly drained or have high moisture content;
- Soils with low measured resistivity;
- Soils with low pH;
- Soils with low or negative oxidation-reduction potential; and

With available laying lengths of 18- to 20-feet, a water distribution system using DI pipe will have numerous pipe joints, and a greater potential for leakage if the pipe joints are not installed correctly. Joint leakage is minimized by adhering to the manufacturer's recommended installation instructions, performing industry standard construction oversight procedures, and implementation of pressure testing procedures on all completed piping systems.

#### 8.2.2.2 Cleaning and Cement Mortar/Epoxy Lining

Conventional cement mortar lining provides a cement liner to the internal wall of the pipe after the pipe has been cleaned by removing tuberculation and some of the graphitization that has occurred on the inside of the pipe. A thorough cleaning of the pipe is required before the lining can be applied using an electric or air-powered rotating head, or a drag-line cleaning head. However, it should be noted that the completed cement mortar linings do not require adherence to the pipe wall. Cleaning and cement mortar lining does not provide a quantifiable structural improvement. Cleaning and cement mortar lining is typically utilized when the existing pipe is in good structural condition and does not require structural rehabilitation. Cleaning and cement mortar lining will typically improve hydraulic capacity in the existing pipe and arrest internal pipe corrosion, extending the life of the existing pipe.

Epoxy lining is another non-structural material that is applied to the internal surface of the pipe. The epoxy is sprayed onto the surface after a thorough cleaning. Epoxy lining is typically thinner that cement, maintaining more of the pipe's nominal inside diameter.

Cleaning and cement mortar/epoxy lining are AWWA M28 Class I non-structural liners.

In general, cleaning and cement mortar lining or epoxy lining are not considered applicable to most of DWSD's water distribution mains due to the age of the mains. This technology may be applicable to certain larger diameter transmission mains within the city.

#### 8.2.2.3 PVC Pipe

For the 6-inch through 12-inch pipe sizes the applicable industry standard for PVC pipe is AWWA C900. PVC pipe manufactured under this standard is a blend of PVC resin and filler materials that meet or exceed the cell classification 12454B as defined in ASTM D1784. AWWA C900 designates three diameter to wall thickness ratios (DR's) and pressure classifications or maximum working pressures as shown in **Table 8-1**. A surge pressure allowance based on an instantaneous velocity change of 2 fps is included in the pressure classification.

**Table 8-1: Dimension Ratios, Pressure Class, and Surge Allowance for AWWA C900 PVC Pipe**

| Dimension Ratio (DR) | Pressure Class/ Maximum Working Pressure (psi) at 73.4°F | Surge Pressure Allowance (psi) |
|---|---|---|
| 25 | 100 | 30 |
| 18 | 150 | 35 |
| 14 | 200 | 40 |

PVC pipe has been used successfully in many water distribution systems for several years, without and significant material issues. PVC pipe is thermoplastic material, resistant to corrosion, and is unaffected by aggressive soil conditions. Due to the pipe wall thickness required to resist internal pressure, PVC pipe has a flow cross-section area that is smaller than DI pipe, but greater than HDPE pipe. To offset the reduced flow area, PVC pipe has a higher Hazen-Williams flow coefficient, with typical "C" value of 150 used for design of new pipe.

The material cost for PVC pipe is comparable to that of HDPE pipe, and is lower than DI pipe.

Some water utilities have reported PVC pipe failures including joint leakage to catastrophic failure during tapping operations. Damage to PVC pipe from impact by construction equipment usually propagates in a spiral direction along the length of the pipe, and often requires the entire pipe segment to be removed and replaced.

The maximum working pressures are for water at a service temperature of 73.4°F. For water at service temperatures greater than 80°F, the pressure classes of pipe must be reduced by appropriate pressure rating reduction coefficient listed in AWWA C900. Since water temperatures in the distribution system are seldom above 70°F, this does not appear to be an issue for PVC pipe in this project.

#### 8.2.2.4 HDPE Pipe

The industry standard ASNSI/AWWA C906-99 describes three material code designations for polyethylene (PE) material, PE 2406, PE 3406, and PE 3408. The three PE material codes provide two series of pressure class or working pressure ratings that describe the hydrostatic design basis (HDB) for PE pipe and fittings. The PE 2406 and PE 3406 materials use an HDB of 1250 psi and PE 3408 uses an HDB of 1600 psi. Pipe products within the two series of pressure classes are further classified into

10 standard dimensional ratios with diameters ranging from 3- through 54-inches. Pipe and fittings manufactured from PE 3408 materials cover a broader range of working pressures from 51 psi through 254 psi. HDPE pipe is available with ductile iron pipe size (DIPS), iron pipe size (IPS), or ISO pipe sizing systems.

HDPE pipe is chemically inert, resistant to corrosion, and will remain unaffected when installed in aggressive soils, or soils conditions such as cyclic wetting and drying that promote corrosion of metallic pipeline materials such as ductile iron. Unlike DI or PVC pipe, HDPE pipe is unaffected by freezing temperatures. Water can be frozen solid in HDPE pipe without damaging the pipe.

Since individual HDPE pipe segments, fittings, and service connections can be connected by butt fusion or electrofusion joints, the portions of the water distribution system that are constructed from HDPE pipe and fittings offer an essentially "leak free" system independent of pipeline valves and appurtenances. The potential for leakage remains where HDPE transitions to DI pipe or fittings (HDPE/mechanical joints at valves, and at flanged HDPE/HDPE connections). However, by reducing the overall number of pipe joints in the water system, use of the HDPE Pipe offers significant savings by reducing unaccounted losses from the water distribution system.

HDPE pipe is a tough, lightweight, flexible, and resilient material. Although installation of HDPE pipe requires use of specialized equipment for the butt fusion joints, HDPE pipe can be installed in narrower trench, using the same types of excavation equipment as DI or PVC pipe. Additionally, the fusion-bonded segments of HDPE pipe can be bent to closely follow curved roads, without the need for additional special bends or deflected pipe joints required for DI or PVC pipe.

HDPE pipe segments installed with fusion joints essentially become one fully restrained length of HDPE pipe. HDPE pipe has a flow cross-sectional area smaller than either DI or PVC pipe, due to the wall thickness required to resist internal pressure. To compensate for this, HDPE pipe has a higher Hazen-Williams flow coefficient, with a typical "C" value for design of 155 for new pipe.

HDPE pipe is resistant to ultraviolet radiation and thermal degradation during storage prior to construction, two environmental factors responsible for brittle failure of PVC pipe.

There are several methods available to effect either temporary or permanent repairs of damaged HDPE Pipe. Temporary repairs can be performed while the line is under pressure by covering the damaged section of pipe with a service saddle or a dresser type coupling. The damaged section of HDPE pipe may be permanently repaired by first removing the damaged section of pipe, and then installing a new section of pipe using butt fusion joints, electro-fusion couplings, or a combination of both.

HDPE pipe has a thermal expansion coefficient that is significantly higher than DI or PVC. While the heat fusion joints will produce one fully restrained length of HDPE pipe, temperature changes in the pipe may overcome the friction resistance of the soil and have adverse effects on pipeline valves, fittings, and appurtenances. One solution to this potential problem is the installation of concrete thrust anchors at intervals along the length of the pipeline. Construction of the thrust anchor involves first excavating an area perpendicular to the pipeline, then heat welding an HDPE collar (with an integral webbed ridge) to the pipeline, and finally embedding the HDPE collar in low strength concrete poured against undisturbed soil.

For HDPE pipe, the pressure class/maximum working pressure rating is based on maximum water temperatures of up to 80°F. Above this temperature, the pressure class is derated by the appropriate temperature compensation multiplier. Again, since water temperatures in the distribution system are seldom above 70°F, this does not appear to be an issue for use of HDPE pipe in this project.

HDPE pipe is difficult to repair due to the complexity in performing the fusion welding process in inclement weather (i.e. rain, snow, freezing temperatures). It is very difficult, often impossible, to perform the fusion welding process in a trench filled with water, which is often the case during pipe repairs.

#### 8.2.2.5 Pipe Bursting

Pipe Bursting is a method of pipe replacement of gas, water and sewer mains usually from excavations 20-600 feet apart. Typically, two pits (a receiving pit and launching pit) are constructed. Then, an expanding device which, may be either pneumatic or hydraulic, is introduced into the defective pipeline, shattering the pipe and pulling in the new line behind it. Insertion of short lengths may be made from pits but this involves jointing of the pipeline within the pit. Two methods are commonly used as outlined below.

- Static Bursting: The hydraulic burster is positioned in the excavation and the rods individually connected and pushed into the old pipe. Each rod is unscrewed and removed, or in the case of two-way bursting, fed directly into the of pipe, on reaching the hydraulic burster the tooling is disconnected from the new pipe and removed

- Pneumatic Bursting- the pipe to be replaced is exposed and cut out at two points, a winch cable is pulled into the old pipe with a flexible rod. Using the flexible rodding, the air supply hoses are pulled through the new pipe to be installed and connected to the compressor and the rear of the pipe bursting head. The new pipe is secured to the rear of the pipe bursting head, which is in turn connected to the winch cable and drawn into the launch pit and the air supply turned on.

#### 8.2.2.6 Pipe Splitting

Pipe splitting is similar in technique to pipe bursting but is used on non-fragmental pipes such as steel, ductile iron or polyethylene. The process of pipe splitting involves pulling a bladed cutting wheel through an existing pipeline, and cutting the pipe along the crown and invert as a new, typically larger pipe, is being drawn through the space where the existing pipeline was. The bladed wheels actually split the host pipe instead of ripping or tearing it like single fin-type static systems. The bladed wheel system is a very "clean" process that requires less power than other static systems and helps prevent potential damage to the product pipe. An attached expander spreads and displaces the split pipe into the surrounding soil while simultaneously pulling in the new pipe. This method avoids sizable surface damage and costly restoration required for open trenching methods. HDPE or fusible PVC can be the new pipe material to be pulled.

Pipe splitting is preferable in situations when a reduction in pipe diameter is undesirable or when it is necessary to increase the pipe diameter. It is also preferable that there are few lateral connections on the pipeline.

### 8.2.2.7 Pre-chlorinated Pipe Bursting

Pre-chlorination pipe-bursting is a specialized technique for potable water lines in which the HDPE pipe is bacteriologically disinfected and pressure tested above grade prior to installation, allowing it to be placed into service immediately after installation.

The method of pre-chlorinated pipe bursting has a history that extends many decades as the process was first adapted by water companies in the U.K. It has become a preferred method of replacement in Europe, with over 100 million feet replaced to date. The method utilizes HDPE pipe and entails the pre-assembly and testing of approximately 300 to 600 foot lengths of pipe above grade at a nearby staging location. This work is completed in advance of pipe bursting operations. Once the pipe string is proven to be sound by the testing and disinfection procedures, bursting operations can begin. In the area of water main being replaced, a series of small excavations are made and the new pipe is pulled into place by pipe bursting the existing main. A post-chlorination and flushing of the main is then performed and the new line is connected into the distribution system.

Ultimately, all services are connected into the new main and the surface area is backfilled to preconstruction grade. The entire process is completed within, 6 to 8 hours, thereby minimizing the disruption to area residents.

### 8.2.2.8 Slip Lining

Slip lining is the insertion of a new pipe into an existing host pipe, with the outside diameter of the new pipe being smaller than the inside diameter of the existing host pipe. This method allows the lining to fit inside of the existing pipe without excavating or removing the pipeline. The decrease in diameter of the new pipe will depend on the thickness of the lining and the standard pipe sizes available. Common materials used for slip lining include steel, fiberglass mortar pipe (FMP), high density polyethylene (HDPE) and fusible poly-vinyl chloride (FPVC), a material that is increasing in popularity. Following the insertion of the new liner, the annular space left between the host pipe and the new pipe would typically be filled with a grout. Following grouting, the newly installed liner pipe has full structural strength like the host pipe, but does not rely on the host pipe.

Although slip lining does not require an open-cut trench for the entire length of pipe, access pits are required for inserting and receiving the pipe as well as for changes in alignment or connections to branch mains. Curved sections of pipe are of particular concern and may also require an open cut, unless a flexible pipe material such as HDPE or PVC is used to maneuver through the curves. The minimum bending radius for flexible slip liners varies depending on the pipe material and diameter. For example the minimum bending radius for HDPE is significantly smaller than that of FPVC, which would allow the HDPE to navigate much tighter curves.

In addition to the ability of HDPE and FPVC to maneuver through curved sections of existing pipe, these types of liners can also be disinfected and pressure tested before installation and can be fused together in long sections. The fusion process results in strong joints which are equal in strength to that of the actual pipe. The length of pipe to be fused is based on the conditions of the existing pipe including slope, bends, and other considerations which go into locating access points, as well as the available lay down area nearby.

Slip lining is considered a structural solution because the liner acts as a pipe within a pipe and is capable of serving without the host pipe, if necessary. Slip lining is typically used when the existing pipe is in poor structural condition and a structural repair is necessary. Slip lining will eliminate internal and external pipe corrosion on the slip liner and extend the life of the existing main by arresting internal corrosion by the placement of grout. A factor when considering slip lining is that it typically reduces the internal cross sectional area of the existing pipe, reducing overall hydraulic capacity. If hydraulic capacity cannot be reduced, then slip lining may not be the appropriate method to select. However, sometimes the low friction material of the slip liner can make it hydraulically comparable to a tuberculated pipe of larger nominal diameter.

The design considerations for slip lining projects include selection of a pipe diameter, determination of required wall thickness, analysis of flow capacity, and locating access points. The pipe diameter of the liner is typically 10 percent less than the diameter of the existing host pipe. The liner diameter depends on available sizes and the size and condition of the existing host pipe. The wall thickness of the new pipe depends on the estimated internal pressure that the pipe will be exposed to. The new pipe is also sized so that it is capable of withstanding all external forces including soil, groundwater and static water pressure loads.

As mentioned above, for HDPE and FPVC liners, the lengths that can be pulled through each access point will depend on the available lay down area, the physical variations in the existing pipe, the tensile strength of the new pipe material and the total pipe weight that can be pulled by the Contractor's equipment. The size of access pits are determined primarily by the pipe depth and the features of the location such as traffic and topography. Other factors include the soil conditions and size of pipe.

#### 8.2.2.9 Tight Fit Lining

This technology and approach consists of an HDPE pipe (4" to 60") that is inserted into the host pipe. Tension on the HDPE pipe, in conjunction with rollers will create a temporary reduction in the HDPE pipe diameter to allow it to be inserted into the host pipe.

The host pipe must be thoroughly cleaned and then inspected with CCTV cameras. Before the pipe is installed a "proofing pig" that is the same outside diameter as the diameter of the HDPE liner pipe is pulled through the host pipe. The proofing pig assures the new HPDE liner pipe can be installed. In addition, the surface of the pig can be inspected for damage to determine if internal corrective work is required in the host pipe.

Once the towing head exits the host pipe at the receiving or pulling pit, the pulling cable is disconnected and the pipe is able to return to its original size creating a tight-formed fit pipe within a pipe. It takes 1 to 3 days for the pipe to completely relax before any connections can be made. Depending on the liner thickness, the liner can be semi- or fully structural. The insertion lengths for a single pull can be up to several thousand feet long.

This technology is nearly identical to slip-lining with HDPE as discussed above with a few key differences including:

- It is tight fitting and does not need grouting

- The pipe requires more extensive pipe cleaning / pigging and proofing that the proposed pipe can be pulled through the pipeline.

#### 8.2.2.10 Cured in Place Pressure Pipe Liner (CIPP)

This method consists of an epoxy resin impregnated, glass or carbon fiber reinforced, flexible felt tube that is inserted through an inversion process utilizing water pressure to force the liner to travel through the host pipe and stay against the host pipe wall. The pressurized water is then heated to cure the thermosetting epoxy resin against the host pipe. It is considered a tight fitting liner with no grouting required between the liner and the host pipe. The CIPP has an internal polyethylene layer in contact with the water that is NSF 61 approved.

CIPP is considered a semi-structural liner for the diameter and pressure in this application, acting as a pipe within a pipe, but relying on the host pipe for a measure of overall structural support. CIPP is installed as a continuous liner without joints; therefore it is able to repair holes, gaps, and leaks in the existing pipe. CIPP is also capable of navigating through modest vertical and horizontal bends in the existing pipe, likely reducing the number of necessary access pits. CIPP will improve existing pipe hydraulics, is a non-corrosive material and will extend the life of the existing main by arresting internal corrosion. A CIPP liner is an AWWA M28 Class III semi-structural liner.

DWSD has successfully used CIPP as a technology for lining sewers, however this technology is not considered applicable to most water distribution mains. This technology may be applicable to certain larger diameter transmission mains within the city.

#### 8.2.2.11 Polymeric Liner

This lining is a rapid-setting polymeric material that is centrifugally sprayed onto the host pipe's interior after a thorough cleaning of the pipe has been performed. Certain products include a polyurea blend that restores pipe width while increasing water flow rates and minimizing water loss throughout the system. The thermoset coating is essentially an inert plastic that is resistant to corrosive environments. With its rapid curing time, pipes are ready to be put back into service on the same day of the application. The pipe must be dewatered to apply a polymeric liner. A polymeric liner is considered semi-structural, able to span small holes in the host pipe. It is not a class IV structural rating but rather relies on the host pipe strength and provides a barrier to prevent or eliminate future internal corrosion of the metallic pipe wall.

This spray-on lining system has been developed for installation for pipe sizes up to12-inch diameter, however this technology is not considered applicable to most water distribution mains due to the age and structural condition of many distribution mains.

#### 8.2.2.12 Horizontal Directional Drilling

Horizontal directional drilling is commonly used to minimize construction impacts relative to open cut construction within urban settings, or within environmentally sensitive areas. It is an applicable trenchless construction technique in appropriate situations for installation of Fusible PVC, HDPE, and in some situations ductile iron pipe.

This technique is often used to replace failing water mains while leaving the existing pipe in service while the construction of the parallel water main is installed. After the construction is complete, any valves, taps and services are reinstated on the new pipeline.

First a pilot hole is drilled to a predetermined depth and exit point. A reamer is then attached to the pilot drill and the water main is attached to the reamer. The water main is then pulled back through the reamed-out pilot hole.

The head of the drill contains a transmitter which enables the crew to track its location and make adjustments in the direction needed. Some variation in horizontal and vertical alignment can be expected, but the possible deviation is within the tolerance of the drill.

Except for the construction of the entry and exit pits on each side of the river, which will occupy relatively small area, minimal environmental impact to the surrounding area is anticipated. With the HDD and protection of the work areas, sensitive environmental receptors in and around the river will not be disturbed.

### 8.2.3 Asset Management Prioritization of Water Distribution Renewal Projects

Many older water distribution systems face the same challenges as Detroit relative to the expense of replacing or rehabilitating water distribution mains within a service life of 100 years. That is why rehabilitation and replacement is increasingly implemented on a risk-based asset management approach to identify those mains most at risk of leaking, breaking and internal or external corrosion. The approach to evaluating risk in a rehabilitation and replacement program considers the severity of the impact of a water main failure and the probability that the failure will occur. The level of service goal, in conjunction with field data and leak and break history is used to quantify severity of risk.

Asset condition ratings, such as Excellent, Good, Fair, Poor, or more precise numerical ratings, are assigned to each city block of water main. Lower asset condition ratings imply higher risk hazards, which are defined as potential negative events that will reduce performance and level of service. Assets with low condition ratings have greater probability that a failure will occur. As a result, for two assets in equally poor condition, the probability of “failure” is the same but the risk to the utility is greater for the more critical asset. The level of risk reflects both the severity of impact and the probability of occurrence. By using the risk assessment approach that is linked to the level of service targets, future risk levels can be predicted and a plan for prioritizing rehabilitation and replacement for each City block can be assigned.

DWSD uses the following criteria that are similar to a risk based approach:

- Age
- Material
- Number of Breaks
- Population Density



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- Coordination with other roadway improvement or redevelopment projects by others

The data that DWSD has collected on break repair and pipeline condition within its GIS system and record books should be migrated to an asset management software application for ongoing use to assess the highest risk water mains and rehabilitation or replacement needs.

The criteria for population density reflects the situation that certain areas of the city have lost population and some streets have no active water users, or only a limited number of residential or commercial customers. DWSD has typically not replaced or rehabilitated water mains on vacant or low residency streets. However, these old mains and their service connections could be a significant source of water loss. The following section on 'System Consolidation' addresses distribution mains in these locations with a proposed program of water main retirement.

## 8.3 System Consolidation

While rehabilitation and replacement is needed in at least 70 percent of the City, 30 percent of the City includes areas where the population is less than 2 persons per acre, or is projected to reach that population density in the next ten years. In these areas, consolidation of the distribution system is proposed to reduce the number of miles of active water mains.

Consolidation is achieved by retiring water mains. In the simplest situation, where all properties on both sides of the street are vacant, a main can be retired by shutting the gate valves at each end, and then cutting and capping both ends. The retired main can be left in place, if it is structurally sound. If corrosion is suspected, then flowable fill should be injected for structural support.

A preliminary estimate of the cost of retiring water mains was prepared. The estimated cost is $40,000 per mile, and it is based on the use of DWSD field crews and equipment. It is estimated that three crews would be required to complete the retirement of 1 mile of main within one week. Locations for main retirement would be planned in advance.

Before retiring a main, an evaluation needs to be done to assure that the main is not providing a transmission or redundancy function for another main. Also the ability to provide fire protection needs to be assessed by considering distance to surrounding fire hydrants and fire hose length analysis. A general outcome of this would be for the Fire Department to be equipped with longer 1,000 foot 4-inch diameter fire hoses, instead of the standard 100- to 300-foot hoses. Additional training for Fire Department personnel would be required.

DTE established a natural gas main consolidation program in Southeast Michigan in 2011. A total of 160 miles of gas main has been retired, and 76 miles is planned in 2014. Within the City of Detroit, 15 miles were retired in 2013, and another 15 miles is planned for retirement in 2015. DTE has a methodology to select mains for retirement based on numbers of properties abandoned. In some cases, where one or two properties remain customers in mid-block, the gas main is retired, but service is replaced with a new smaller diameter and shorter pipe in an easement through one or more vacant lots from a nearby active main.

**Figure 8-1** shows the location of DTE gas main retirements since 2012.

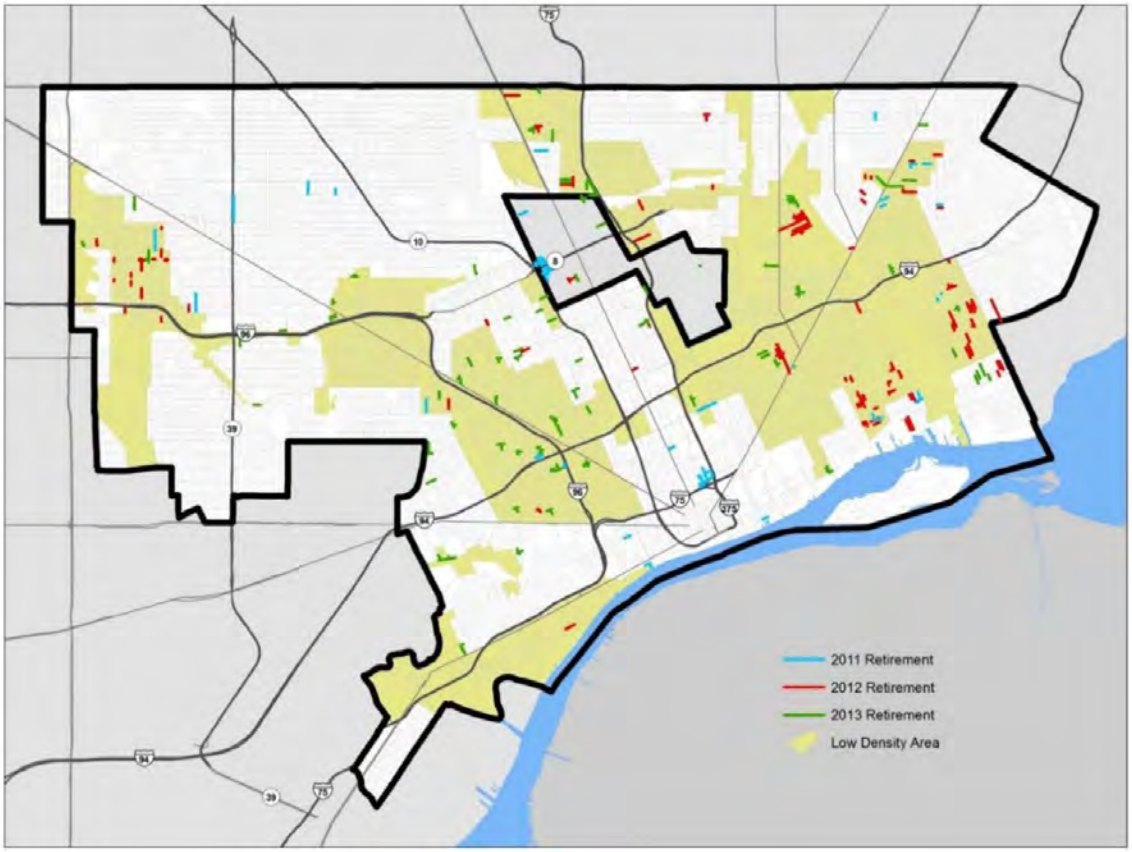


**Figure 8-1: DTE Gas Main Retirement Program 2011 to 2013**

The experience of DTE provides a viable model for DWSD to use in identifying potential locations for retiring water mains.

It is proposed that DWSD retire at least 3 to 5 miles of water main in the next two years, based on the locations where DTE has retired mains. After basic procedures are established, then it is proposed that DWSD prepare an annual plan for water main retirement in coordination with other City departments and DTE. Annual planning should have a goal consistent with the City's framework for consolidation of services. It is anticipated that this goal would be in the range of 10 to 15 miles per year for the next 5 years, and then goals should be reassessed in 2020.

## 8.4 Lead Pipe Services

DWSD estimates that 95 percent of properties in the city have lead pipe service connections. When DWSD replaces water mains, the portion of the service connection in the street right of way is changed to copper pipe. However, the portion of the service connection on the property is only changed if the property owner makes the change.

The City of Detroit should evaluate options for replacing lead service pipes. AWWA provides guidance documents on options for lead service pipe replacement. As long as DWSD (or GLWA) are in compliance with the Lead and Copper Rule, and long as Detroit's lead service lines have stabilized with phosphate or other chemical coating, there is no driver to replace the lead services lines in the near future. However, some utilities want to eliminate phosphate in their drinking water and wastewater. These utilities are considering full lead service line replacement (both in the right of way and on private properties). Madison, Wisconsin is taking this approach. Partial lead service line replacement (only in the right of way) is not recommended due to leaching of lead in contact with a dissimilar metal interface and potential disturbance to the lead service lines. Some utilities, such as Chicago, are replacing lead service lines all the way to the customer meter during water main replacement projects. This approach is relatively low cost, because it replaces lead services that have already been exposed during water main replacement.

The proposed 20-year CIP does not explicitly include funding for lead service elimination in Detroit. As stated earlier, chemical addition is being performed at the water treatment plants in compliance with the Lead and Copper Rule to protect public health from lead pipe and fittings. However, DWSD-Retail should develop a long term strategy to eliminate lead service pipes outside of the public right-of-way.

## 8.5 Proposed Capital Improvement Plan

Accompanying this master plan report in TM-17 is a 20-year Capital Improvement Plan (CIP) spreadsheet that lists approximately 330 CIP projects. These projects are organized by specific programs. There are three programs pertaining to the Detroit water distribution system:

- Program for Piloting New Water Main Renewal Technologies
- Program for Water Main Renewal
- Program for Water Main Retirement

Each program is described below.

### 8.5.1 Program for Piloting New Water Main Renewal Technologies

This program should start with a review of DWSD's mapping and GIS data for water distribution mains within the city limits. The review should produce an updated GIS system of water distribution mains that will be under the jurisdiction of the City of Detroit as of July 2015. The updated GIS data should be structured to produce an inventory of water main locations, lengths, diameter, and material. Field inspections and internal reviews should determine if certain older mains, such as those constructed on Historic Fort Wayne, are owned by the City or have been transferred to the property owner, and therefore no longer in the City's inventory of water mains. The objective of the inventory and GIS is to refine the reported estimate of 2,700 miles of water distribution main in the city.

After completion of the inventory, the pilot program for new technologies for water main renewal should be conducted. A three year pilot program is recommended for DWSD to determine the optimal application of the following technologies:

- Traditional ductile iron pipe
- PVC pipe
- HDPE pipe

- Pipe Bursting
- Slip-lining

The pilot program would include the development of specifications, standard installation details, construction inspection protocols, and evaluation criteria testing completed construction. The outcome of the pilot program would be guidelines regarding which technologies are most cost-effective and constructible in which type of street, public right-of-way, and development density situation.

This program should start by 2017 and finish in 2020. When results of this program are complete, then scheduling of new water main renewal projects can proceed using the most cost-effective technologies for each location.

### 8.5.2 Program for Water Main Renewal

In the spring of 2015, DWSD was underway with 7 new contracts for water distribution and smaller transmission replacement. These contracts total approximately 45 miles of new main.

The preliminary CIP spreadsheet includes water main renewal projects currently in the FY2016 approved CIP plus approximately 80 future renewal projects. These future renewal projects extend from 2020 to 2035, and each project include 5 miles of water main renewal. Past practice by DWSD has found that 5-mile lengths for water main renewal provide competitive prices and can be completed within one or two construction seasons.

### 8.5.3 Program for Water Main Retirement

The preliminary CIP spreadsheet includes a series of water main retirement projects that are scheduled from 2016 to 2035. The first years of the retirement program can follow the approximately 45 miles of streets where DTE has already retired gas mains. In order to proceed beyond the streets where DTE has completed its work, the City should convene an annual meeting of all service departments to coordinate planning and level of service for streets that could be candidates for water main retirement. Input from the Fire Department is especially critical. An update to the Fire Department's master plan should be considered. Water main retirements will impact the distance to hydrants. Options for fire protection include longer hose lengths and tanker trucks. Costs for new fire protection strategies need to weigh against the cost of replacing water mains on vacant streets, or the cost of water loss through a leaking water main that is left in service.

The City's Green Infrastructure Program would also be closely coordinated with the water main retirement program. The Green Infrastructure Program will be identifying new open space areas which could benefit from water main retirements in the green infrastructure project area.

# 9 Metering and Non-Revenue Water

## 9.1 Trends in Nonrevenue Water

Nonrevenue water is the difference between the volume of water produced and the volume of authorized water used. Water utilities generally have water production that exceeds water sales. This is due to meter inaccuracies, losses of water through leaks and breaks, and authorized unmetered public use of water for firefighting, water main construction and other purposes.

DWSD's rate setting process includes detailed reporting to wholesale and retail customers on revenues, prior period expenditures and proposed budgets for capital improvements, financing, and operation and maintenance. The information presented in the rates process documents the estimated volume of nonrevenue. In the last ten years, nonrevenue water has been increasing in volume and as a percentage of total water production, as shown in **Table 9-1**.

**Table 9-1: Trends in Nonrevenue Water**

| Period | Annual Volume of Nonrevenue Water (MGD) | Percentage of Total Water Production |
|---|---|---|
| July 2004 to June 2005 | 108.0 | 18.6 |
| July 2005 to June 2006 | 106.2 | 17.7 |
| July 2006 to June 2007 | 101.9 | 17.7 |
| July 2007 to June 2008 | 139.2 | 23.2 |
| July 2008 to June 2009 | 125.0 | 22.7 |
| July 2009 to June 2010 | 113.6 | 22.0 |
| July 2010 to June 2011 | 127.1 | 23.4 |
| July 2011 to June 2012 | 145.5 | 26.2 |
| July 2012 to June 2013 | 152.3 | 27.7 |
| July 2013 to June 2014 | 164.1 | 30.0 |

## 9.2 Preliminary Water Balance for FY 2012

The American Water Works Association (AWWA) has established terminology and procedures for analyzing and managing nonrevenue water. DWSD performed its first water audits in accordance with the AWWA procedures in 2006 and completed a second audit in 2014. The purpose of these water audits is to analyze nonrevenue water and develop estimates for leakage, meter inaccuracy, and authorized, but un-metered public uses and develop strategies to reduce the nonrevenue water volume.

The first step in management of nonrevenue water is to establish best estimates of apparent causes of water loss. **Table 9-2** shows preliminary estimates prepared for this Phase 1 Interim Report based on results from DWSD's water audit program and its rate setting methodology.

**Table 9-2: Preliminary Water Balance for FY 2012**

| Category | Estimated Volume (Million Gallons) | Approximate Percent of Total Production | Basis |
|---|---|---|---|
| Total Production | 203,600 | | FY2012 recorded water production |
| Over-Registration at WTPs | 10,000 to 20,000 | 5 to 10% | DWSD water audit 2006 pump tests and rate setting methodology |
| Net Production | 183,600 to 193,600 | | |
| Water Sold to Suburbs | 121,200 | | Actual sales to wholesale customers |
| Allowance for Transmission and Wholesale Meter Loss | 10,000 to 20,000 | 5 to 10% | DWSD water audits and rate setting methodology |
| Water Sold to Dearborn | 4,500 | | Actual sale to Dearborn |
| Allowance for NRW in Dearborn | 800 | | DWSD water audit and rate setting methodology |
| Water Sold in Detroit | 29,200 | | Meter readings and estimated billings |
| Allowance for NRW in Detroit | 20,000 to 30,000 | 10 to 15% | Rate setting methodology |
| Total Production | 203,600 | | |
| Total Sales | 150,400 | | |
| Nonrevenue Water (Total Production – Total Sales) | 53,200 | 26.2% | Annual financial report |

Source: CS 1396 2006 Draft Report; Sept 2013 BOWC Finance Committee Water Supply System Revenue Analysis; and Water Rate Methodology Table 14 *Allocation of Non-Revenue Water.*

## 9.3 Goals for Nonrevenue Water

Many water utilities operate with nonrevenue water of less than 10 percent. For example, Orlando, Florida, and Singapore, maintain nonrevenue water at 5 percent or less. Note that these utilities have limited supplies of potable water. In the United States, northern water utilities with abundant supply may economically operate with 10 to 15 percent, or higher, nonrevenue water.

A goal of 15 percent nonrevenue water in the year 2035 is proposed by this Master Plan Update. The goal of 15 percent was selected because it is representative of nonrevenue water for larger water utilities serving older northern cities in the United States. Setting a target is important for several reasons:

- Nonrevenue water has been growing over the last 10 years.
- Nonrevenue water is an increasing component of retail and wholesale water rate setting.
- More accurate information on actual water production and pumping rates is important to new initiatives proposed for electrical demand management.

- Management of nonrevenue water leverages DWSD's previous investments in wholesale customer and retail customer metering.

# 9.4 Current Practice for Metering and Water Audits

## 9.4.1 Production Metering

Production is currently estimated at four plants based on pump curves and discharge pressures measured at regular time intervals. Depending on the number of pumps running and throttling conditions, pressure is measured at either the discharge header or at the individual pump casing. For variable speed pumps running at reduced speed, the plant operators use additional information on pump speed to calculate flow rates. At Lake Huron, water production is reported by totalizing individual filter effluent flow meter readings. All pressures and estimated production rates are manually recorded.

All of DWSD's water treatment plants were initially constructed with differential pressure meters to measure water production. With the exception of Lake Huron, Venturi meters were installed at all plants. The Lake Huron meter was an Annubar type, which has multiple ports for measuring differential pressures across the full cross section of flow.

The meters themselves are highly accurate, require little maintenance, and have a long service life. However, the original instrumentation and recording systems were older hydraulic analog technology, difficult to maintain, and produced inconsistent results. Consequently, DWSD has been using pump curve data for at least 20 years.

Flow measurement using pump curve data is generally used to estimate accuracy of actual flow meters. Over the long term, the accuracy of pump curves degrades as wetted parts of pumps wear and corrode. Also, because pressure and flow measurements are recorded hourly, actual flow variations may be missed, and the manual recording process is subject to human error. Human error is minimized by having flow and pressure recorded in the Ovation system, so that the information can be retrieved and checked.

DWSD recently completed an assessment of the Venturi meters to determine the feasibility and practicality of restoring the Venturi meters versus replacing them with new meters. Findings are summarized in **Table 9-3.** DWSD is proceeding in 2015 with a new project to design the rehabilitation of the Venturi meters at Southwest, Northeast, and Water Works Park.

**Table 9-3: Characteristics of Existing WTP Meters**

| Plant | Existing Meters | Installation Date | Condition and Configuration |
|---|---|---|---|
| Lake Huron | 1-Annubar meter | 1970 circa | ▪ Abandoned |
| Water Works Park | 14-Venturi meters | Unknown; believed to be prior to 1915 | ▪ Limited access, full inspection not yet performed due to inability to operate yard piping.<br>▪ Vaults in satisfactory condition, but small.<br>▪ External condition of two meters is satisfactory; others expected to be satisfactory. |
| Springwells | 6-Venturi meters<br>1-Venturi meter | 1931<br>1958 | ▪ Vaults in excellent condition and adequate size.<br>▪ Access into four vaults is adequate; access into three vaults should be improved<br>▪ External condition of four meters is satisfactory to excellent. External condition of three meters is poor or unknown.<br>▪ Internal condition of Meter 5 is satisfactory, others are expected to be satisfactory. |
| Southwest | 5-Venturi | 1961 | ▪ Vaults in excellent condition and adequate size.<br>▪ Access into vaults for employees and for removal of Venturi throats is satisfactory.<br>▪ External condition of all meters is very good.<br>▪ Internal condition of one meter is excellent; others expected to be the same. |
| Northeast | 6-Venturi | 1956 | ▪ Vaults in satisfactory condition and adequate size.<br>▪ Access into vaults for employees and for removal of Venturi throats needs improvement.<br>▪ External conditions of Venturi meters are satisfactory.<br>▪ Internal condition of one meter is satisfactory; others expected to be same. |

### 9.4.2 Water Audits

DWSD performed its first comprehensive water audit in 2006. In addition to the audit, the work included a leak survey for portions of the distribution system, assessing the water plant metering, an assessment of water loss in both the City of Detroit and the suburban system, and recommendations to improve metering, improve the recording of non-metered beneficial uses, and reduce real losses.

Pump testing at three of the water plants (Water Works Park, Southwest, and Northeast) was conducted as part of the water loss work. The purpose of the work was to improve the recording of plant flows into the system until the permanent solution of upgrading the existing plant meters was completed.

DWSD completed another water audit for the system based on year 2012 data. This second audit provides for a categorical evaluation between the two audits to assist the Department in assessing how the volume of water loss has changed and what recommendations can be implemented to reduce real and apparent losses.

In addition to the updated water audit, DWSD is continuing with the leak survey and investigating new technologies that would assist in reducing real losses. The new technologies are in the process of being piloted to evaluate their effectiveness within the Detroit system. Two of these include helium injection and sounding technology that is fixed to the distribution system.

Finally, an investigation is being performed to assess water loss associated with theft. To evaluate this, billing accounts will be overlaid in GIS with parcels to identify parcels without water accounts. A sample set will be identified and investigated to determine if any of the homes on these parcels are still using water. Based on the results, recommendations will be made to investigate the other sites.

## 9.5 Techniques for Managing Nonrevenue Water

The AWWA Manual of Practice 36 Water Audits and Loss Control Programs outlines a wide range of operational and management approaches to controlling water loss. The following four techniques have been selected based on their success in other large water utilities.

### 9.5.1 Plant Metering

DWSD is moving forward with a project to re-institute metering at its water treatment plants. Previous investigations by DWSD has shown that rehabilitation of Venturi meters and replacement of the associated instrumentation systems is cost-effective and can be completed in the shortest time and least cost.

### 9.5.2 District Metered Area Approach to Leak Detection and Management

DWSD currently performs leak detection within the City of Detroit using a combination of its own forces and contract crews. This program generally measures leakage on each street every two years. Measurements are made with acoustic devices, and new technologies, such as helium and sounding pods have recently been used. DWSD also practices active leak management and pressure management to reduce leakage. When leaks are detected, work orders are issued for leak repair.

The District Meter Area (DMA) approach proposed below would supplement DWSD's existing leak detection efforts by providing geographic focus with specific areas of up to 3,000 customer accounts. The DMA approach is described below.

Some large water utilities use DMAs to allow for sub-dividing the system for monitoring leakage and other types of actual water loss. In the United Kingdom, DMAs are generally used. DMAs are typically established for groups of 2,000 to 3,000 customer accounts. Where beneficial for managing pressure and reducing real water loss due to high pressure, the DMA district can be used for pressure management.

Depending on location and other factors, leakage testing would be performed on a biennial or triennial basis for approximately a 1-week duration. During test events, most valves to the DMA would be closed. Test events would be scheduled during the night hours when water use is at a minimum. Valves are closed except for two or more locations where flow into the area, or out of the area, is measured. Flow is measured with temporary pitot tube or insertion magnetic flow meter. A high level of accuracy is not needed, because the flow measurements are intended to find large water leaks. Flow into the area is compared to calculated water use for the area. If the flow into the DMA is larger than what is calculated for the area, then street by street investigation with leak detection monitoring is scheduled. DMAs are typically measured every two or three years to monitor long term progress in leak reduction.

There is a new body of knowledge and technologies being developed around the world to utilize DMA information. Several companies are currently using computer algorithms and advanced statistical analysis to use DMA data to “pinpoint” leaks and breaks within DMA areas in a more accurate way. DMAs have some other advantages: they facilitate model calibration and improve water security by facilitating isolation of areas during contamination events.

The City of Detroit has a land area of approximately 140 square miles, and most of the area is within one large pressure district. The City of Dearborn has 42 unmetered connections with Detroit, and Dearborn spans 25 square miles. Highland Park adds another 3 square miles. So, in total there are approximately 168 square miles and approximately 300,000 residential, commercial and industrial water accounts without the master metering or the ability to measure leakage systematically in the area.

The DMA concept proposed for Detroit would be to generally have valves open during non-test events. Larger DMA areas can be established initially, and these sub-divided in later years as the leak detection program matures. The DMA is established by assuring that valves are operable around the group of customers.

**Figures 9-1 and 9-2** show concepts for DMAs in Detroit. Figure 9-1 is a proposed DMA in northwest Detroit for the area generally bounded by McNichols, Greenfield, Grand River, and Southfield Expressway. Figure 9-2 is a proposed DMA on the east side of Detroit for the area generally bounded by the Detroit River, Grosse Pointe Park, Mack Avenue and the Water Works Park water treatment plant. This DMA is designed to directly overlay a collection system metering district. In this situation, leakage from the water system can be directly correlated with infiltration/inflow in the wastewater collection system.

The colors for valves in Figures 9-1 and 9-2 depict the following:

- Green is an existing valve location
- Yellow is a proposed new valve
- Red is a valve that would be closed during the DMA test.

A preliminary cost estimate was prepared for establishing DMAs at the two sites. The McNichols/Grand River area is estimated to be $150,000. The East Jefferson area is estimated to be $250,000. These estimates do not include the replacement of 24-inch manhole rims and covers which provide access to the gate valves.

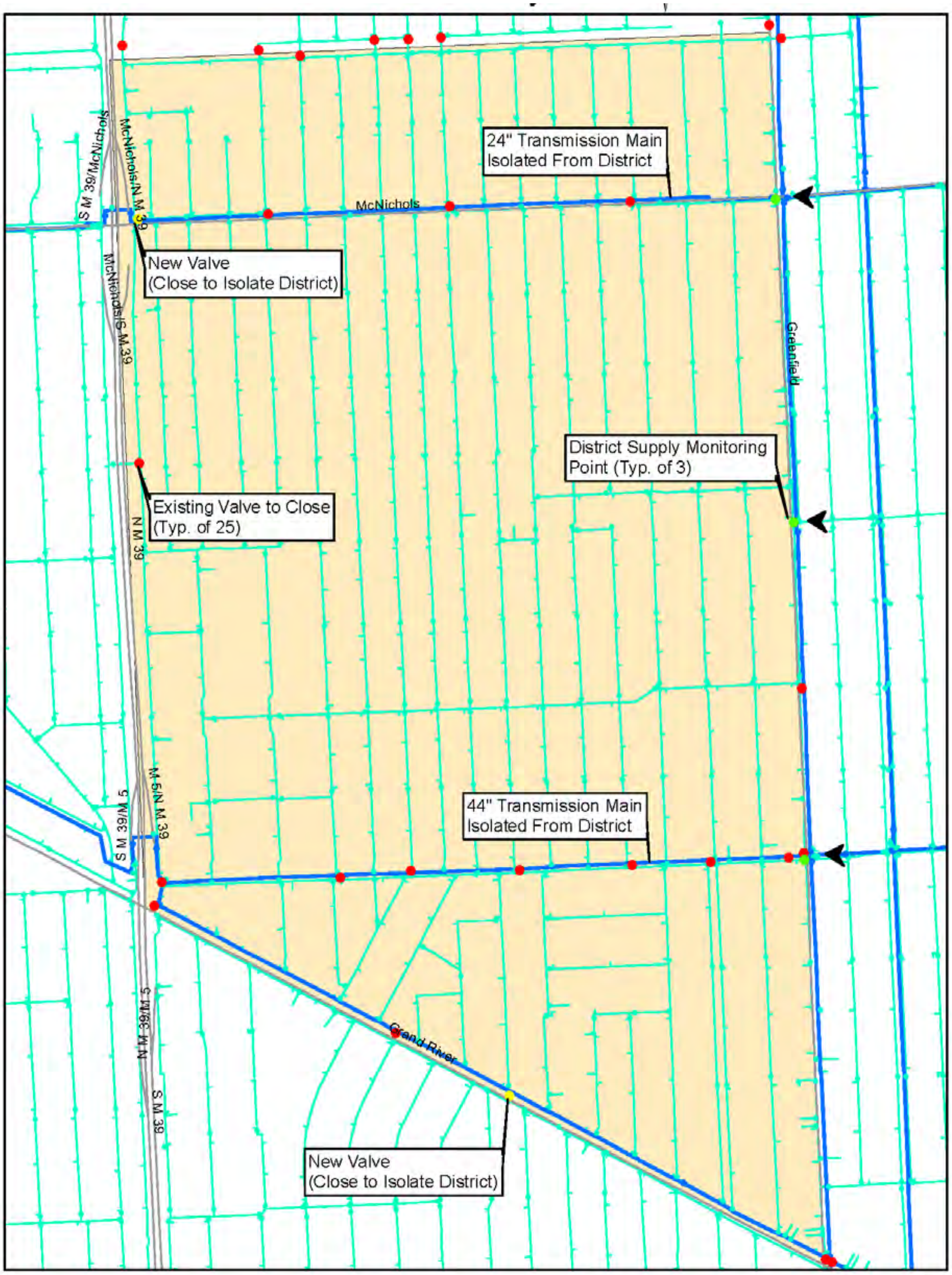


**Figure 9-1: McNichols-Greenfield-Grand River-Southfield Survey Area**

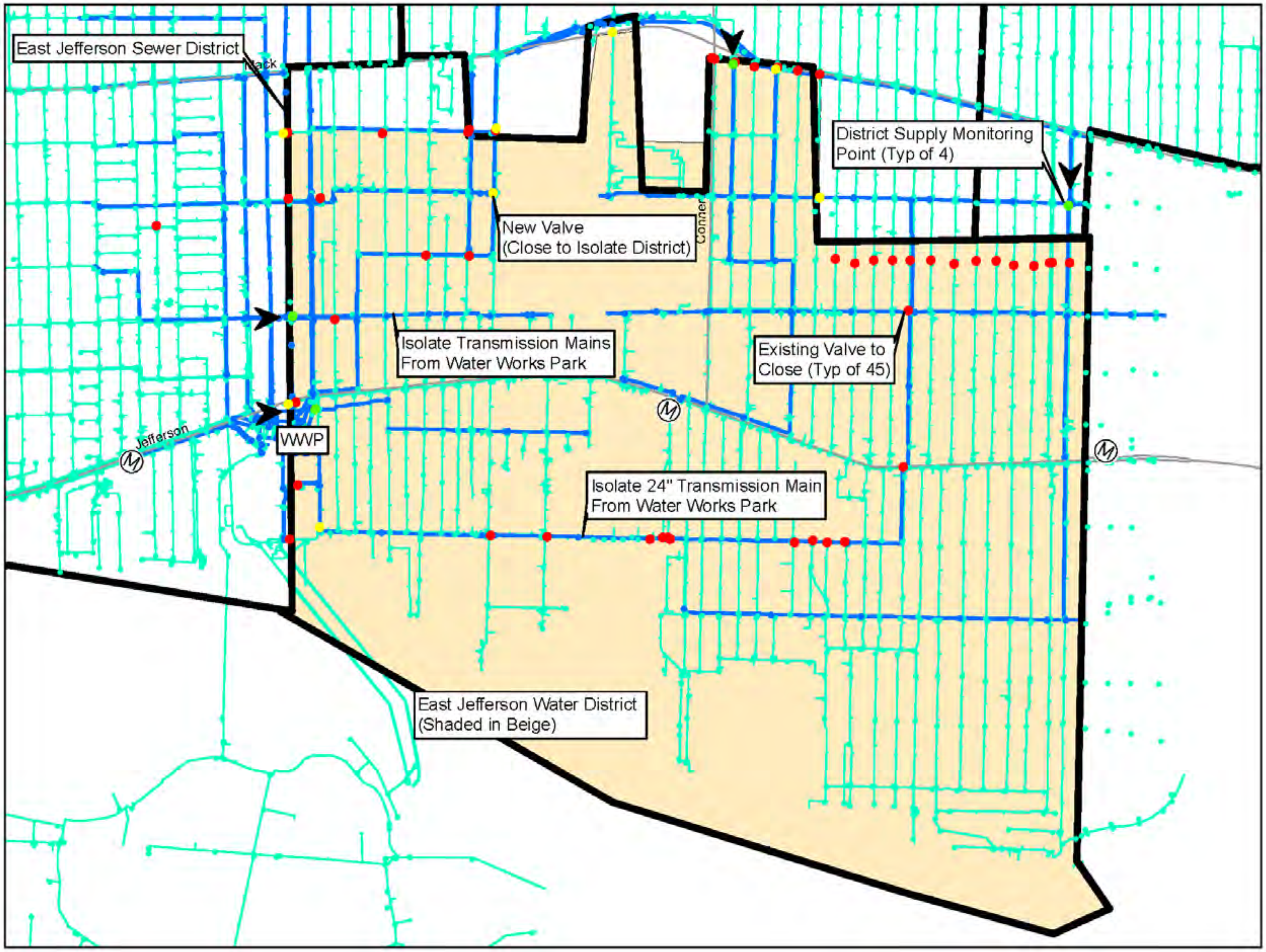


**Figure 9-2: East Jefferson Survey Area**

DMAs would be established with the following general criteria:

1. Boundaries of areas of the distribution system where inspection, rehabilitation and replacement is scheduled in the first 10 years of the planning period.

2. Boundaries of areas where mains may be shut-off due to low residential population and changing land use. See Chapter 8.

3. Boundaries for potential future permanent pressure districts or master metering districts in the City.

4. Highland Park's distribution system could be configured as one DMA.

5. Boundaries of the master meters on the wastewater collection system that were established in the last 15 years to monitor infiltration and inflow. Overlaying the distribution system leakage monitoring districts with the collection system Infiltration/inflow monitoring districts provides benefits for managing both volumes of water.

A distribution system gate valve upgrade program is the highest cost of establishing DMAs. Gate valves must be in good working condition and be able to close completely. For the two proposed DMAs shown in Figures 9-1 and 9-2, the total number of new or replacement valves is approximately 75, and it is assumed that 80 percent of the existing valves need to be replaced or rehabilitated. Beyond the benefit of creating the DMA, there are other benefits of operable valves, such as for flushing mains, main inspection, ongoing repair and replacement programs, and potentially to manage the district at a reduced pressure.

The DMA program would be conducted for 20 to 40 years, and would be phased out as new wholesale meters between the GLWA regional system and the City of Detroit retail system are put in place. A plan for wholesale meters for Detroit is presented in Section 9.7.

### 9.5.3 Distribution System Inspection, Rehabilitation and Replacement

The programs for water main inspection, renewal and retirement will reduce water loss as the pipeline infrastructure is replaced. The renewal and retirement programs should be sequenced in alignment with the district meter areas, so that water loss reduction can be documented, and then resources for leak detection can be moved to other district meter areas. .

Previously in Chapter 8, a plan was presented to retire underutilized water main in Detroit over the next 20 years. Mains could be retired in vacant streets in areas of the City where population is less than approximately 2 persons per acre. The retirements would be planned annually in coordination with other gas, electric, and cable utilities, as well as with the Fire Department, and Department of Transportation and other city services. In planning these shut-offs, existing rates of leakage would be considered in prioritizing shut-off locations. A major benefit of reducing the number of active mains is that leakage will also be reduced.

## 9.6 Wholesale Metering for Dearborn and Highland Park

DWSD provides water service to Dearborn and Highland Park through unmetered delivery points. Dearborn has traditionally been an un-metered customer due to the configuration of its system and its many connections to the DWSD transmission system. There are currently 42 water delivery connections from DWSD to Dearborn.

The City of Dearborn recently completed a water distribution master plan. That plan evaluated the supply connections to the DWSD system and determined that it would be feasible to reduce the connections to 18 delivery points.

It is proposed that DWSD and Dearborn develop a plan for metering, and complete the installation of wholesale meters during the 20-year planning period. The metering plan should be prepared by 2020.

**Figure 9-3** shows a preliminary proposal of two locations where the first two wholesale meters could potentially be installed. These locations represent the two largest supply points for Dearborn. Based on a preliminary estimate, these two locations could provide about 20 percent of Dearborn's daily water demand.

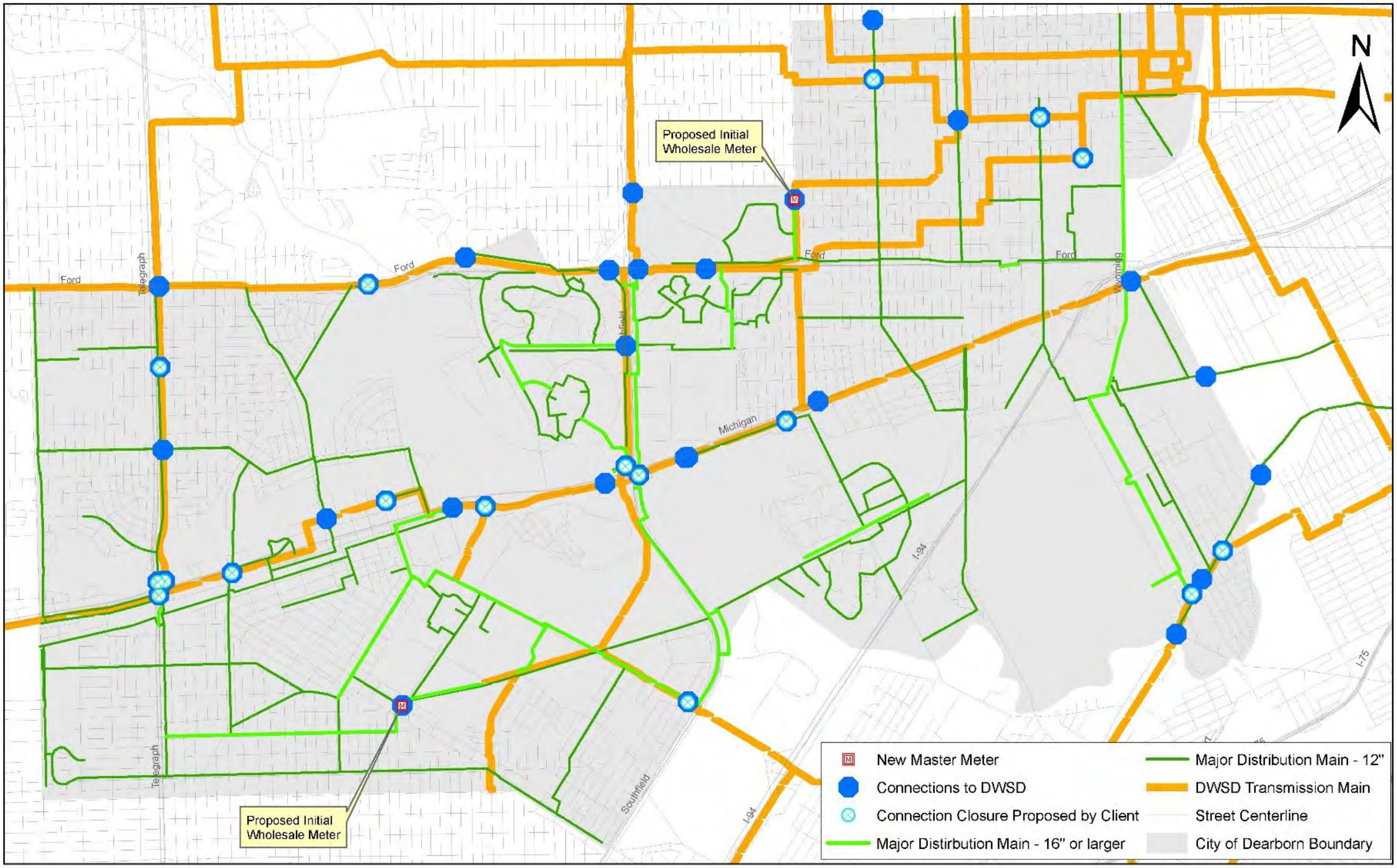


**Figure 9-3: DWSD Wholesale Meters Installation for the City of Dearborn**

Highland Park provided its own water supply prior to 2012. DWSD began retail service to Highland Park in 2012 under an emergency supply agreement. The City of Highland Park is less than 3 square miles in area. It is proposed that DWSD establish a district metering area, as discussed in Section 9.5.2 to monitor water consumption and nonrevenue water for Highland Park. In the future, permanent meters for Highland Park could be installed that would be “deduct meters” for water sold by GLWA to Detroit.

## 9.7 Wholesale Metering for Detroit

The installation of new wholesale meters between the GLWA transmission system and the Detroit retail system can be accomplished cost-effectively in conjunction with water distribution renewal projects in Detroit and transmission improvements by GLWA. **Figures 9-4 and 9-5** show two example areas for new wholesale meters on the east side of the City of Detroit. The estimated construction cost for a typical wholesale meter in Detroit is $250,000, inclusive of a magnetic flow meter, automated cone valve to reduce pressure at night, bypass piping and underground vault. The concept plans shown on Figures 9-4 and 9-5 would require 9 meters and would cost approximately $2,900,000 inclusive of engineering and contingencies. These 9 meters would measure approximately 15 percent of Detroit’s average daily demand.

The proposed 20-year CIP includes allowances to complete 50 percent of wholesale metering for the City of Detroit by the year 2035. See Section 9.9.3.

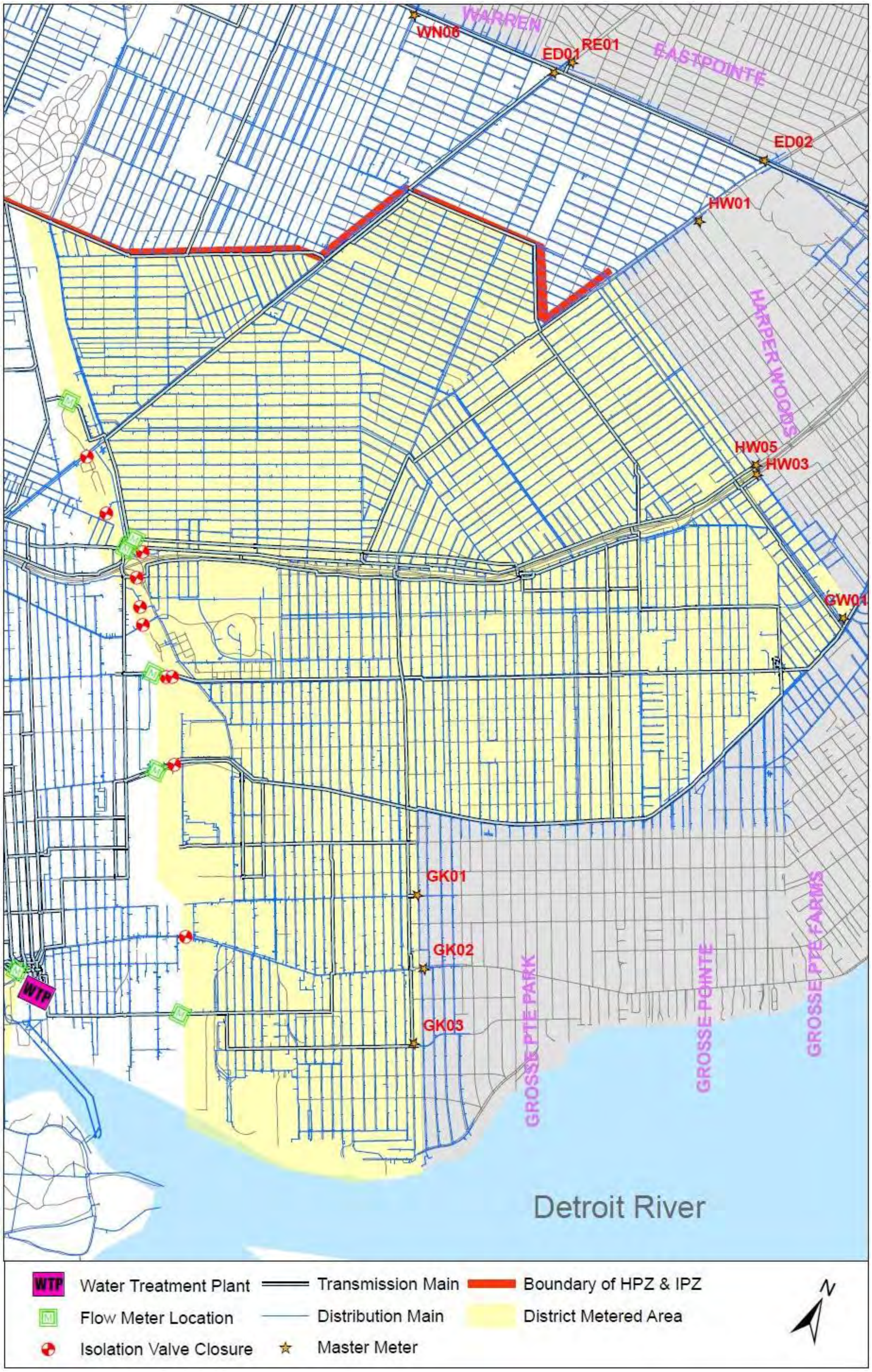


**Figure 9-4: District Metered Area Example 1– WWP Intermediate-Low Pressure Zone Map for Flow Meter Installation & Valve Closure Locations**

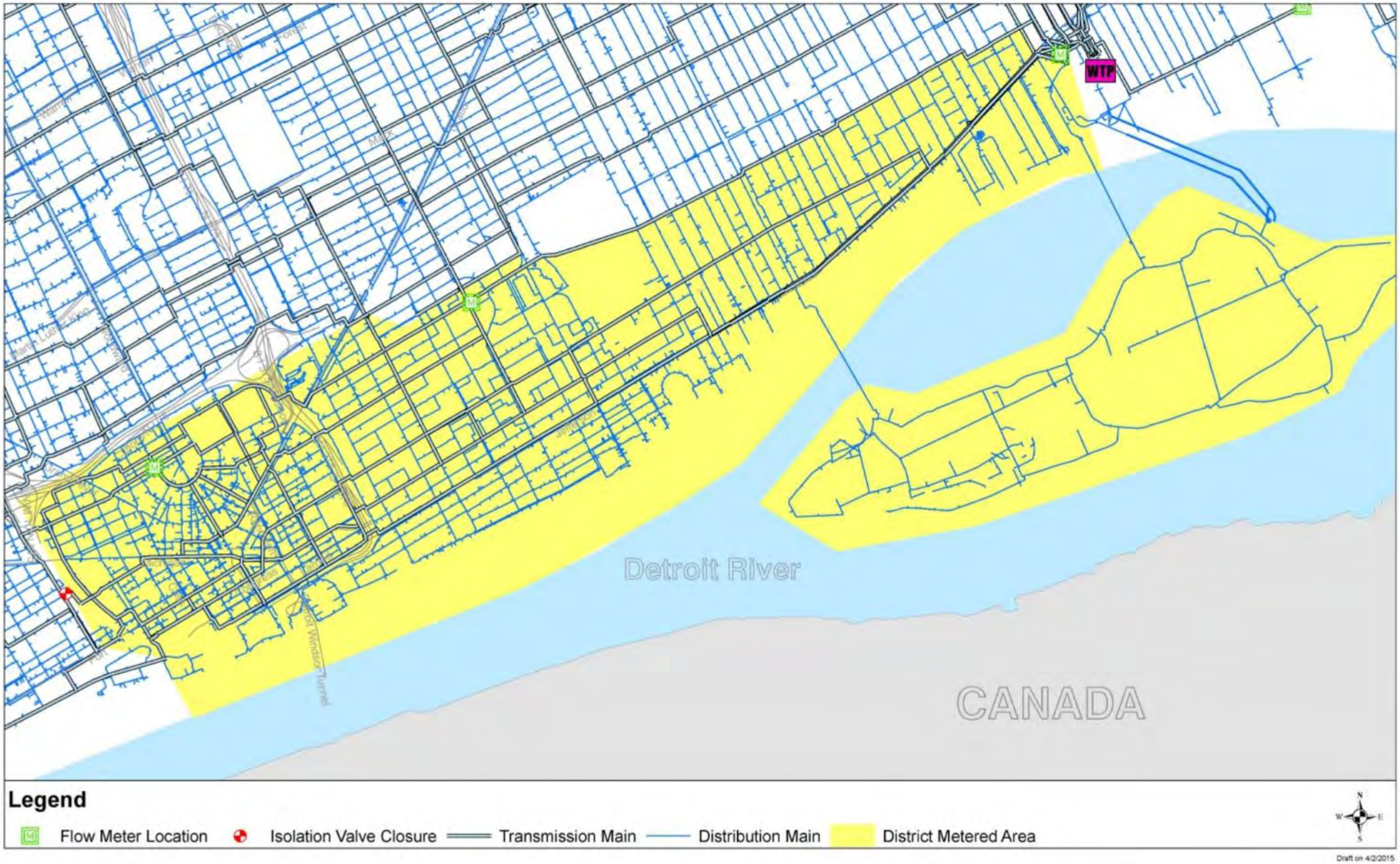


**Figure 9-5: District Metered Area Example 2– WWP Intermediate-Low Pressure Zone Map for Flow Meter Installation & Valve Closure Locations**

## 9.8 Retail Customer Metering in Detroit

DWSD began the installation of water meters with radio transmitters in 2007. The new technology, called Automated Meter Reading (AMR), reduces the cost of collecting meter readings and improves the accuracy of the data. The detailed time series data that is collected can be retrieved for analysis and verification.

The current status of retail account metering is shown in **Table 9-4.**

**Table 9-4: Status of Retail Metering (January 2014)**

| Type of Metering | Number of Accounts |
|---|---|
| AMR | 188,543 |
| Non-AMR | 44,239 |
| Transitional Properties(1) | 24,000 |
| Total Accounts | 256,782 |

(1) "Transitional properties" refer to properties that have water service, but water bills have been returned to DWSD for at least two months. After two months, DWSD performs an investigation and then based on results, may perform a water service shut-off. Properties that are declared abandoned are removed from the list of accounts.

From January 2014, to February 2015, DWSD installed an additional 8,217 AMR meters. The current CIP project for AMR meter installations calls for 10,000 new AMR meters starting in July 2015.

A preliminary estimate of the cost to add new 5/8-inch AMR meters in remaining properties is $400 per meter. The total cost to complete metering in Detroit is approximately $20 million.

## 9.9 Proposed Capital Improvement Plan

Accompanying this master plan report is a 20-year Capital Improvement Plan (CIP) spreadsheet that lists approximately 330 CIP projects. These projects are organized by specific programs. There are four programs pertaining to the Detroit water distribution system:

- Program for Plant Production Metering
- Program for Nonrevenue Water Reduction
- Program for New Wholesale Metering
- Program for Completion of AMR Metering in Detroit

Each program is described below.

### 9.9.1 Program for Plant Production Metering

This program includes the current CIP project for rehabilitation of Venturi meters at Northeast, Water Works Park and Southwest, plus future projects for production metering at Lake Huron and Springwells.

### 9.9.2 Program for Nonrevenue Water Reduction

The program for nonrevenue water reduction includes ongoing water audit projects and other operational initiatives. It is proposed that both GLWA and the City of Detroit conduct their respective programs for nonrevenue water reduction.

### 9.9.3 Program for New Wholesale Metering

The program for new wholesale metering includes the installation of new wholesale meters for Dearborn, Highland Park and Detroit. Also included in this program are scheduled replacements and improvements to existing wholesale customer meter pits and meters. The proposed CIP includes allowances to complete the wholesale metering of the City of Dearborn by 2035, and to complete 50 percent of the City of Detroit in the same time period.

### 9.9.4 Program for Completion of AMR Metering in Detroit

The program for completion of AMR metering in Detroit includes the current CIP project for FY2016 and subsequent annual projects to complete the remaining 44,000 non-AMR accounts.

GLWA and DWSD-Retail should perform annual water audits to provide current information that will guide the four capital improvement projects discussed above, and to provide key performance indicators relative to overall progress on reducing nonrevenue water. Chapter 11 includes a discussion of future implementation policies, including policy for water audits, which should form the basis for designing the annual water audit process.

# 10 Financial Analysis

## 10.1 Introduction

The Water Master Plan Update proposes a 20-year capital improvement program with total capital expenditures in excess of $3 billion. The recommendations of the Water Master Plan Update are consistent with the current direction of DWSD to optimize operations, therefore there are no major anticipated increases in annual costs for operations and maintenance costs. Anticipated savings in operation and maintenance costs through optimization could partially mitigate future costs of price inflation.

Concurrent with preparation of the Water Master Plan Update, independent forecasts of long-term DWSD financial performance are being prepared by others. The projections in those forecasts are intended to facilitate evaluation of the establishment of independent wholesale and retail utilities, as envisioned by the Great Lakes Water Authority, to support refinancing a portion of the current DWSD debt portfolio, and to support issuance of bonds to finance capital improvements envisioned by the Master Plan Update. This Water Master Plan Update provided key data and assumptions to those projections. Specifically, the independent projections utilized the projected 20-year capital improvement program and referenced the Water Master Plan Update's assumptions regarding future water sales and demands. The results of the independent projections support an overall strategy of gradually employing more revenue (and less debt) financing for capital, and indicate that financing the proposed capital improvement program can be supported within the four percent annual revenue requirement increases envisioned by the Memorandum of Understanding for establishing the Great Lakes Water Authority.

Also concurrent with preparation of the Water Master Plan Update, DWSD has recently made changes to its wholesale water rate structure, increasing the portion of revenue recovered via fixed monthly charges to 60 percent (from 40 percent) and decreasing the portion recovered from commodity charges to 40 percent (from 60 percent). In recent years, wholesale water sales have been below customer projections, therefore rates did not sufficiently recover the total revenue requirements of the system, which are largely fixed in nature. In the last two years, projections were 8 percent higher than actual sales. Approximately 90 percent of DWSD's costs are fixed costs. The FY 2016 wholesale water charges reflect an increase of approximately 11 percent, relative to FY2015, to eliminate these recent revenue shortfalls.

Given the ongoing efforts by others, this chapter includes the following sections:

- Recent Financial Performance of DWSD
- Key Performance Indicators Relative to Peer Utilities
- Recent Organizational Initiatives to Improve Performance
- Review of 20-Year Capital Improvement Program

## 10.2 Recent Financial Performance

DWSD has experienced significant impacts in governance, finance, customer base, and operations in the last decade which have impacted financial performance.

For the period of time from Fiscal Year 2001 through Fiscal Year 2007, sales remained relatively stable. The recession, which began in 2007, hit the Detroit area particularly hard, and led to the decline in population and decline in water sales. From 2007 to 2015 sales declined nearly 30 percent, as shown in **Table 10-1**.

**Table 10-1: DWSD Water Sales from 2001 to 2015**

| | Reported | Water Sales | | | Non-Revenue Water | |
|---|---|---|---|---|---|---|
| Fiscal Year | Production | Wholesale | Retail | Total | Amount | Percent of |
| | *Mcf* | *Mcf* | *Mcf* | *Mcf* | *Mcf* | Production |
| | | | | | | |
| 2001 | 31,965,700 | 20,297,200 | 6,046,900 | 26,344,100 | 5,621,600 | 17.6% |
| 2002 | 30,223,800 | 19,289,500 | 5,799,600 | 25,089,100 | 5,134,700 | 17.0% |
| 2003 | 32,253,100 | 19,543,800 | 5,374,400 | 24,918,200 | 7,334,900 | 22.7% |
| 2004 | 31,902,900 | 20,197,000 | 4,997,000 | 25,194,000 | 6,708,900 | 21.0% |
| 2005 | 29,643,700 | 19,195,700 | 5,405,000 | 24,600,700 | 5,043,000 | 17.0% |
| 2006 | 28,367,300 | 19,372,200 | 4,850,800 | 24,223,000 | 4,144,300 | 14.6% |
| 2007 | 29,266,700 | 19,156,300 | 4,672,800 | 23,829,100 | 5,437,600 | 18.6% |
| 2008 | 28,063,000 | 18,417,900 | 4,927,000 | 23,344,900 | 4,718,100 | 16.8% |
| 2009 | 29,360,700 | 18,405,500 | 4,145,500 | 22,551,000 | 6,809,700 | 23.2% |
| 2010 | 25,142,700 | 15,676,300 | 3,924,000 | 19,600,300 | 5,542,400 | 22.0% |
| 2011 | 26,513,000 | 16,094,700 | 4,217,500 | 20,312,200 | 6,200,800 | 23.4% |
| 2012 | 27,219,500 | 16,280,300 | 3,903,100 | 20,183,400 | 7,036,100 | 25.8% |
| 2013 | 26,832,800 | 15,687,900 | 3,660,300 | 19,348,200 | 7,484,600 | 27.9% |
| 2014 | 26,088,800 | 14,778,500 | 3,410,600 | 18,189,100 | 7,899,700 | 30.3% |
| 2015 | 23,237,700 | 13,547,100 | 3,153,300 | 16,700,400 | 6,537,300 | 28.1% |

The wholesale water charge reforms mentioned above are designed to reflect the declining water demands and stabilize financial performance.

In April 2014, DWSD's largest wholesale customer, the City of Flint, formally notified DWSD that it would immediately be terminating service. Flint represented approximately 3% of total system revenue, and ceased purchasing water in May 2014. Genesee County, which was formerly served by DWSD through Flint, continues to purchase water, but has also notified DWSD that it is constructing its own facilities to supply water to its customers and will discontinue purchases from DWSD once those facilities are in service. DWSD estimates that service to Genesee County will be discontinued as of July 1, 2017. This represents an additional loss of 4% total system revenue to DWSD.

Over this same time period, DWSD has experienced an increase in non-revenue water. Non-revenue water is the difference between the amount of water treated at the plant and the amount of water billed to the customer. Nonrevenue water rose from approximately 17.6 percent in FY2001 to approximately 28.1 percent for FY2015. DWSD has undertaken a number of initiatives to mitigate this loss, as described in previous sections of this report, and these initiatives, plus recommendations of this Water Master Plan Update are designed to reduce nonrevenue water below 15 percent by 2035.

## 10.3 Key Performance Indicators Relative to Peer Utilities

Many utilities like to get a sense of performance relative to their peers. One way is through evaluation of Key Performance Indicators (KPIs). KPIs are measures to assess operational performance and help provide context for future targets and improvement. Periodically, the American Water Works Association (AWWA) collects information on KPIs for a cross-section of utilities throughout the Country. Results of the most recent survey, Performance Indicators for Water and Wastewater Utilities: Survey Data and Analysis Report (2012), was used to compare DWSD performance against an aggregate representation of DWSD peers. While each utility operates under a unique set of circumstances and in a unique environment, it is often helpful to compare KPIs against a broad cross-section of peers. Table 10.1 shows DWSD data are for FY2014, except where information from the August 2014 refinancing was used for comparison to the Benchmarking Report.

The AWWA Benchmarking Survey collects information from a cross-section of utilities and represents those utilities that provide only water service to its customers, as well as utilities which provide both water and wastewater service to its customers. These are distinguished by "water only operations" and "combined operations" respectively. The survey compiles the results into an aggregate average for all participants, and then groups the metrics into quartiles indicating performance respective to the measure. So, for example, the top quartile for operation and maintenance cost indicates poorer performance than the bottom quartile, while the top quartile for cash reserves indicates better performance than the bottom quartile. Each quartile should be interpreted specifically for the metric.

**Table 10-2: Comparison of Key Performance Indicators to AWWA Benchmark Survey (published 2014, 2012 data)**

| | Detroit Water and Sewerage | Water Only Operations | | | Combined Water & Sewer Operations | | |
|---|---|---|---|---|---|---|---|
| | | Top Quartile | Median Quartile | Bottom Quartile | Top Quartile | Median Quartile | Bottom Quartile |
| Debt Ratio (Total Liabilities/Total Assets*100%) – measure of utility indebtedness | 102% | 18.0% | 34.0% | 53.0% | 21.0% | 37.0% | 53.0% |
| Cash Reserves (DAYS) – measure of financial liquidity – number of days of available cash reserves | 246 | 474 | 265 | 159 | 391 | 225 | 118 |
| O&M Cost Ratios | | | | | | | |
| O&M Cost/Customer Account | $626 | $330 | $395 | $557 | $281 | $408 | $608 |
| O&M Cost/MGD | $782 | $1,853 | $2,425 | $3,313 | $1,873 | $2,565 | $3,406 |
| Return on Assets – measure of estimate of financial effectiveness | 0.28% | 3.10% | 2.20% | 1.00% | 2.60% | 1.7% | 0.50% |
| Staff Efficiency Ratios – measure of overall staff efficiency relative to operations | | | | | | | |
| MGD Water Produced/Employee | 0.38 | 0.32 | 0.21 | 0.16 | 0.35 | 0.24 | 0.16 |
| Disruption of Service | | | | | | | |
| *Planned outages/1,000 customers* | | | | | | | |
| Outage less than 4 hours | | | | | | | |
| Outage between 4 and 12 hours | 0 | 0.52 | 1.27 | 3.07 | 0.14 | 0.77 | 4.56 |
| Outage greater than 12 hours | 0 | 0.08 | 0.44 | 1.12 | 0 | 0.15 | 0.68 |
| | 0 | 0 | 0 | 0.01 | 0 | 0 | 0.01 |
| *Unplanned Outages* | | | | | | | |
| Outage less than 4 hours | 0 | 0.38 | 2.23 | 3.9 | 0 | 0.75 | 3.39 |
| Outage between 4 and 12 hours | 0 | 0.18 | 0.75 | 1.57 | 0 | 0.09 | 0.57 |
| Drinking Water Compliance Percentage (100% * # of days in full compliance / 365) | 98% | 100% | 100% | 100% | 100% | 100% | 100% |

In comparing KPIs to benchmarks it is important to recognize the unique configuration and customer composition of the DWSD system. Very few utilities in the United States are comprised of significantly more wholesale customers than retail customers (measured by population served), which is reflected in the performance of DWSD relative to peers.

Cash reserves for the utility compared to combined utility operations ranks between the top and median quartiles indicating solid financial liquidity. For O&M Cost ratio comparisons, a more effective measure of O&M costs for DWSD is the O&M cost/MGD treated. This measure is more reflective of the cost of delivering water to DWSD customers.

Difficult financial circumstances are reflected in several of the financial KPIs: Debt Ratio and return on assets. However the utility has taken a number of steps to move these KPIs from the bottom quartile. Recent staff restructuring efforts have resulted in improvement in the staff efficiency ratios and puts DWSD in the top quartile relative to combined water and sewer utility survey participants.



CDM Smith

Water quality percentage in FY2014 was impacted by MCL incidents in the Trenton, MI wholesale customer system in August and September, 2013. There were no other violations in the system for the year. Following September 2013, there have been no violations in the Trenton, MI wholesale customer system.

## 10.4 Organizational Initiatives to Improve Performance

DWSD has taken a number of actions since 2012 to address the recent history of adverse financial impacts.

### 10.4.1 Regional Perspective and GLWA

DWSD management has taken a leadership role in the formation and transition to the Great Lakes Water Authority. The large percentage of sales from wholesale accounts was a primary financial driver for the transition to the Great Lakes Water Authority (GLWA).

DWSD actively leads efforts in reorganization transition activities for GLWA, and it provides financial analysis and monitoring for start-up in mid-2015 for GLWA and the redefined City of Detroit retail service provider arrangement. These activities involve implementing systems and reporting mechanisms that support bond indentures and a "credit positive" objective for the GLWA and City of Detroit. The DWSD Water Rates working group together with Board of Water Commissioners and Great Lakes Water Authority have been meeting to address the issues with revenue forecasting.

The goal in creating the GLWA, along with a new retail organization for the City of Detroit's distribution system is to enable long-term financial sustainability of the system.

### 10.4.2 DWSD's Internal Strategic Initiatives

In addition to its leadership in the formation of GLWA and City of Detroit retail water operations, DWSD is performing a wide range of strategic initiatives for performance optimization and improvement. Key initiatives are described below:

***Enhanced Information Technology***

1. Completion of Enterprise network transformation and implementation of managed datacenter and disaster recovery services.
2. Implementation and enhancement of core systems including ERP, GIS, Work and Asset Management, Enterprise Content Management and Reporting
3. Delivery of year 2 of IT transformation of staff to match organizations needs and structure

***Water Operations***

1. Investigate energy contract, equipment use, and energy rebate initiatives to further reduce energy consumption and expense.
2. Maintain 100% compliance – the delivery of pure safe drinking water is an essential element of DWSD's mission.
3. Investigate new programs around efficiency in utilities and chemicals and evaluate the investment versus return on investment for each of the programs.

***Field Services***

1. Focus on Water Loss Prevention through the use of Detroit Delivers and Click Fix, together with improved, coordinated, and timely response (48 hours to abandoned building running water reports, repair of main breaks within 4 days, will help reduce unaccounted for water loss within the system. This will result in improved customer experience as well as reduce system expense.

2. Address reports of running water within abandoned buildings within 48 hours

3. Valve and gate assessment project

4. Hydrant assessment time frame implementation (minor=4 days, major=7 days)

***Customer Service***

1. Update interim collection policy and procedure

2. Retail customer portal and app development and launch

***Organizational Development***

1. Complete placement of all positions in new classifications

2. Move to implementation of enterprise resource planning through cross-functional collaboration. Will result in improved decision making for stakeholders, efficient operations and effective internal controls.

3. DWSD will continue the staff optimization project started in Fiscal Year 2012. Staffing goals will be based on forecasted investment in technology to ensure changes will not affect levels of service.

***Financial***

1. Implement Phase 2 of Finance Transformation – Move from addressing backlog and first layer of business process redesign and staff re-deployment to building best financial management practices state to result in operational efficiency and deployment of cost-effective strategies.

2. Improved monthly financial reporting and cash flow analysis for stakeholders. Will result in improved financial management and decision making.

3. Establish Performance Benchmarks of +/- 2% of actual sales to projected sales revenue net of bad debt expense. It is anticipated that operating within this benchmark will improve financial performance, bond ratings, less reliance on debt to finance capital improvements, and a resultant lower cost of borrowing over time.

4. Reduction of lower variable operations and maintenance costs. The continuation of staffing optimization efforts has resulted in a decrease of 37 percent of the positions at DWSD since the beginning of FY2012 and savings in personnel related costs.

5. Annual debt service coverage is set forth in accordance with Board policy which establishes coverage targets at least 15 percentage points higher than bond ordinance covenant requirements. The most recent official statement indicates that DWSD has consistently ensured sufficient revenue to meet these requirements.

## 10.5 Review of FY 2016 Budget and Capital Improvement Plan

### 10.5.1 20 Year Capital Improvement Plan

The 20-year Capital Improvement Plan is presented in Technical Memorandum 17 in an appendix to this report. A summary of the CIP is presented in **Table 10-3**. The proposed CIP identifies significant capital improvements to the regional water system of the new GLWA and the distribution system of the City of Detroit over the next 20 years. While all known variables have been taken into account as part of this plan, over such a long time span there will be many unknown variables which can impact the need for capital improvements for the system.

**Table 10-3: Summary of Proposed 20-Year Capital Improvement Program[3]**

| Asset Group | Program | GLWA | City of Detroit | Total |
|---|---|---|---|---|
| Treatment | Repurpose the Northeast Plant | $ 230,860,000 | $ - | $ 30,860,000 |
| | Regulatory Compliance | $ 117,909,000 | $ - | $ 17,909,000 |
| | Treatment Renewal, Reliability and Energy Management | $ 1,019,996,601 | $ - | $ 1,019,996,601 |
| Transmission | Decommission Certain Booster Stations | $ 23,337,253 | $ - | $ 23,337,253 |
| | Optimize Service Delivery | $ 165,443,550 | $ - | $ 165,443,550 |
| | Improve Transmission Redundancy | $ 82,947,000 | $ - | $ 82,947,000 |
| | Transmission and Reservoir Renewal and Reliability | $ 927,846,205 | $ - | $ 927,846,205 |
| Distribution | Piloting New Water Main Renewal Technologies | $ 13,500,000 | $ - | $ 13,500,000 |
| | Water Main Renewal | $ - | $ 448,798,000 | $ 448,798,000 |
| | Water Main Retirement | $ - | $ 13,770,000 | $ 13,770,000 |
| Metering | Plant Production Metering | $ 21,000,000 | $ - | $ 21,000,000 |
| | Wholesale Customer Metering | $ 47,250,000 | $ - | $ 47,250,000 |
| | Completion of Detroit AMR Metering | $ - | $ 20,000,000 | $ 20,000,000 |
| **Total** | | **$ 2,650,089,610** | **$ 482,568,000** | **$ 3,132,657,610** |

[3] The total cost of the CIP shown in the table includes several alternative projects. Depending on which alternatives are chosen, the total cost of the CIP ranges from approximately $2.8 billion to $3.0 billion.

In anticipation of this variability, the Water Master Plan Update evaluated four scenarios for water sales over the 20 year planning period.

1. Most Probable – this scenario provides neither an overly optimistic nor overly pessimistic forecast of water sales.
2. Best Case – this scenario provides the most optimistic view of water sales.
3. Worst Case – this scenario provides a moderately pessimistic view of water sales.
4. Worst-worst case – this scenario builds upon worst case and considers possible further impacts to the worst case.

**Table 10-4** shows in detail the inputs as classified by each of the scenarios.

**Table 10-4: Detailed inputs as classified by each of the scenarios**

| Scenario | Population | Domestic Per Capital Water Consumption | Commercial and Industrial Water Consumption | Real Water Loss for Wholesale Customers | Real Water Loss for Detroit |
|---|---|---|---|---|---|
| Most Probable | SEMCOG forecast updated by wholesale customers | Decrease 5% by 2035 | GPED decreases 5% by 2035 | Decrease 0.5% per year | Decrease 0.5% per year |
| Best Case | 4% higher than Most Probable | Stays at current level | Stays at current level | Stays at current level | Decrease 1% per year |
| Worst Case | 4% lower than Most Probable | Decrease 10% by 2035 | GPED decreases 10% by 2035 | Decrease 1% per year | Stays at current level |
| Worst Worst Case | 10% lower than Most Probable | Decrease 10% by 2035 | GPED decreases 10% by 2035 | Decrease 1% per year | Stays at current level |

**Figure 10-1** shows the projections of water sales and **Table 10-5** shows the projections for each scenario.

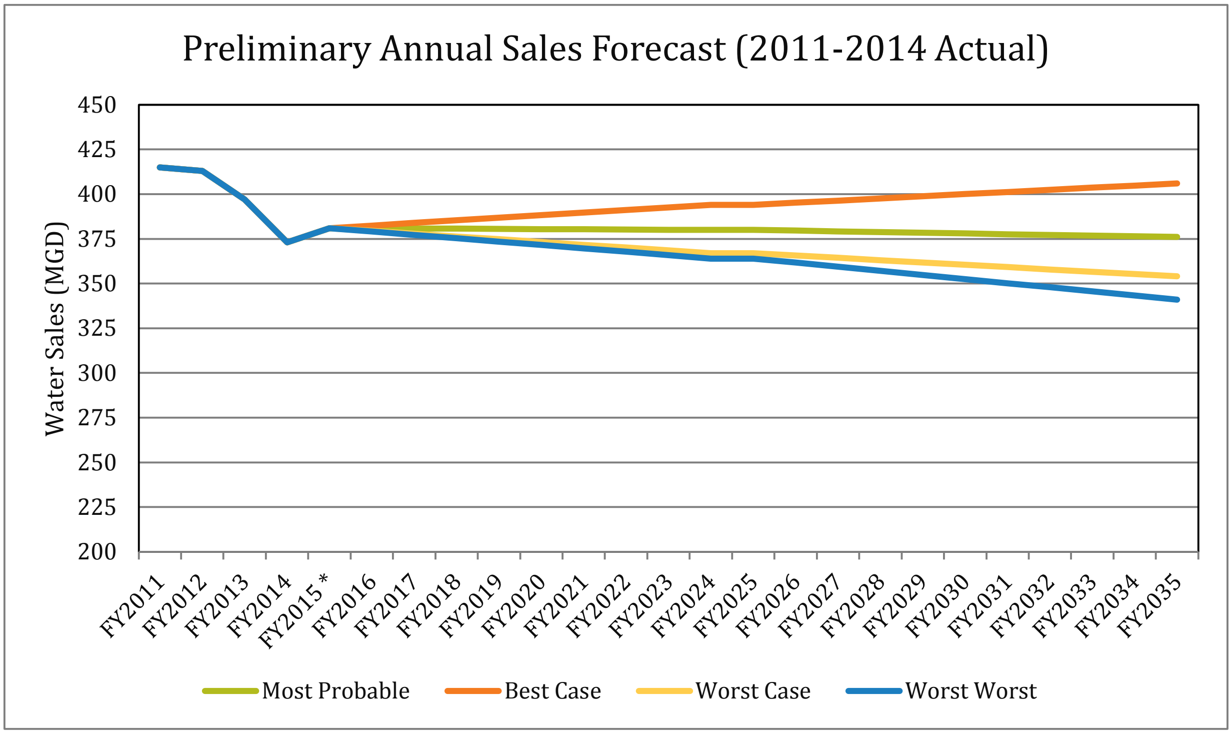


**Figure 10-1: Projections of Water Sales under Different Growth Scenarios**

**Table 10-5. Preliminary Forecast of Water Sales**

| Year | Most Probable | Best Case | Worst Case | Worst Worst |
|---|---|---|---|---|
| FY2011 | 415 | 415 | 415 | 415 |
| FY2012 | 413 | 413 | 413 | 413 |
| FY2013 | 397 | 397 | 397 | 397 |
| FY2014 | 373 | 373 | 373 | 373 |
| FY2015* | 381 | 381 | 381 | 381 |
| FY2016 | 381 | 381 | 381 | 381 |
| FY2017 | 381 | 381 | 381 | 381 |
| FY2018 | 381 | 381 | 381 | 381 |
| FY2019 | 381 | 381 | 381 | 381 |
| FY2020 | 381 | 381 | 381 | 381 |
| FY2021 | 381 | 381 | 381 | 381 |
| FY2022 | 381 | 381 | 381 | 381 |
| FY2023 | 381 | 381 | 381 | 381 |
| FY2024 | 381 | 381 | 381 | 381 |
| FY2025 | 380 | 394 | 367 | 364 |
| FY2026 | 380 | 394 | 367 | 364 |
| FY2027 | 380 | 394 | 367 | 364 |
| FY2028 | 380 | 394 | 367 | 364 |
| FY2029 | 380 | 394 | 367 | 364 |
| FY2030 | 380 | 394 | 367 | 364 |
| FY2031 | 380 | 394 | 367 | 364 |
| FY2032 | 380 | 394 | 367 | 364 |
| FY2033 | 380 | 394 | 367 | 364 |
| FY2034 | 380 | 394 | 367 | 364 |
| FY2035 | 376 | 406 | 354 | 341 |

*FY2015 values were estimated based on a weighted average of FY2013 and FY2014 values.

As noted in the opening of this Financial Analysis, there are independent forecasts of long-term DWSD financial performance are being prepared by others. The projections in those forecasts are intended to facilitate evaluation of the establishment of independent wholesale and retail utilities, as envisioned by the Great Lakes Water Authority, and to support refinancing a portion of the current DWSD debt portfolio. The independent projections utilized the projected 20-year capital improvement program and referenced the Water Master Plan Update's assumptions regarding future water sales and demands. The results of the independent projections support an overall strategy of gradually employing more revenue (and less debt) financing for capital, and indicate that financing the proposed capital improvement program can be supported within the four percent annual revenue requirement increases envisioned by the Memorandum of Understanding for establishing the Great Lakes Water Authority.

# 11 Implementation

## 11.1 Introduction

This chapter recommends early activities for implementing the recommendations of the Water Master Plan Update. It includes:

1. Policies to Implement the Water Master Plan Update
2. Project Initiation Activities
3. CIP Execution Management

## 11.2 Policies to Implement the Master Plan

It is anticipated that GLWA and DWSD-Retail will develop a wide range of policies and procedures to direct their respective organizational missions. New or updated policies are anticipated for finance, budgeting, procurement, document management, design, construction, customer service, human resources, and other business areas. Policies will be important tools for communication from the GLWA and the City of Detroit to their staff, customers, and stakeholders. Policy communications will provide organizational alignment for staff, and will communicate priorities and values to customers and stakeholders.

Certain policies will be important to the successful implementation of this Water Master Plan Update. These policies cover the following areas:

- Planning Processes
- Water Rates
- Water Audits
- Wholesale Customer Service
- Asset Management

In the sections below, key questions and issues to be addressed by new policy are listed. These questions and issues are based on discussion of a preliminary framework of policy ideas among DWSD staff and retail and wholesale customer representatives. It is recommended that GLWA convene a Technical Advisory Committee Policy Work Group in the fourth quarter of 2015 to develop policy statements, procedures, measures of effectiveness, and the process to update policies in the future. Similarly, DWSD-Retail would convene a working group to develop policies and procedures to successfully implement its new mission in water distribution for the City.

### 11.2.1 Planning Processes

Both GLWA and Detroit should develop policies for water supply planning. DWSD had a strong planning group which guided system expansion from the 1940s to decades thereafter. Going forward, planning must strike a balance between the economic development and sustainability goals of the region. Recently, the City of Detroit hired a new City Planner who will address the full range of city services and redevelopment, including those for water, sewer, and green infrastructure issues. There is discussion within GLWA regarding the formation of a planning group. New planning policy should address the following questions and issues:

#### *Who will be responsible for planning?*

- Role and responsibilities of dedicated groups for GLWA and DWSD-Retail.
- The relationship between planning and development of 5-year annual capital improvement plans

#### *What processes will be used?*

- How to integrate information from the recently introduced new process of 5-year wholesale contract negotiations into planning forecasts
- How to integrate information from the annual Lease Renewal process
- Processes for data collection, regional forecasts, condition assessment, and protocols to update planning projections every 5 years, or other designated frequency
- Sharing of data between GLWA and wholesale customers, such as: water sales data, hydraulic modeling tools and results, technology
- Tracking progress on execution of the CIP and updated needs assessments
- Processes for the City of Detroit to create geographic alignment of multiple programs for home ownership, redevelopment, new infrastructure, and retirement of infrastructure that has reached it service life

#### *How will planning be coordinated and communicated?*

- Sharing of data with SEMCOG, MDOT, DTE and others
- Annual planning conference
- Information technology applications for reporting progress on projects and assessing new needs to be addressed through planning

### 11.2.2 Water Rates

There are ongoing initiatives related to water rates, including rate simplification and reallocation for fixed costs and water purchase costs. Energy is a major factor in the cost of delivering wholesale water supply. Across the USA, one third of all electrical energy is used for moving water or wastewater. For DWSD, energy represents 25 percent of the water operations budget and 40 percent of its pumping and treatment budget.  DWSD is one of a relatively few regional water utilities in the United States that provides peak hour water supply to wholesale customers.

To build on the accomplishments of the Technical Advisory Committee Water Rates Work Group, and to recognize the impact of energy costs of water rates, new policies for GLWA should address the following questions and issues:

***How will rates take into consideration the repurposing of one or more water treatment plants in the elevation and distance formula?***

- Review applicability of elevation and distance formula for water rates

***Should rates consider more directly the cost of energy to serve customer pressure requirements?***

- Evaluate whether to align water rates to pressure, volume and location of actual metered water use, rather than meter size and location.

- Evaluate surcharges for water supplied at the highest grade line for customers who have multiple meters.

- Evaluate requests for higher volume and pressure by particular customers.

***How can the use of energy be made more immediate to GLWA operators and wholesale customers?***

- Establish real time measurement and reporting of energy use at all pumping stations

- Provide additional training to System Control Operators on methods to reduce demand charges

- Establish annual goals for energy use, renewable energy supply, and sustainability indicators.

**What additional information should be considered in the process of setting water rates?**

- Consider financial performance and key performance indicators (KPI) in Table 10-2 with quarterly KPI updates.

### 11.2.3. Water Audits

DWSD's own work, and confirmed by this Water Master Plan Update, have demonstrated the magnitude of nonrevenue water and the need to reduce this operating metric.  Water supply is abundant, but nonrevenue water diminishes operating efficiency, distracts management focus, and clouds capital planning decisions.  DWSD has performed water audits since 2006 in accordance with standards of the AWWA.  Continuing water audits conforming to AWWA standards are recommended in the future, coupled with greater participation by wholesale customer representatives in the audit processes.  This Master Plan Update recommends production metering at all treatment plants, new wholesale metering for Detroit, Dearborn, and Highland Park and continuing investment in upgrade and improvement of existing wholesale customer meters.  This Master Plan Update also recommends new methods for leak detection and pressure management, with district metering areas, to supplement existing techniques for water loss reduction within the City of Detroit

New policy for GLWA should address the following questions and issues:

***What goals and schedules should be established?***

- Schedule to complete production metering improvements
- Time period to address identified wholesale metering problems when they arise
- Schedule for metering Dearborn, Detroit and Highland Park

***How can water audit and leak detection and correction processes be made more effective?***

- Regular auditing of wholesale meters and creation of a task force analogous to the Wastewater Flow Metering Task Force
- Testing program for meters
- Implement information technology "dashboard" that displays goals and results

***What leak detection and metering programs will the City of Detroit prioritize?***

- Completion of AMR meters.
- Procedures for non-AMR customers and estimated bills.
- Goals and benchmarks for improving collections over the planning period.
- District Meter Areas as a temporary approach while wholesale metering is being implemented.

### 11.2.4 Wholesale Customer Service

DWSD has conducted ambitious and effective customer outreach and involvement programs for its water customers since 2003. Similar programs for wastewater customers were started in the 1990's. It is understood that both GLWA and City of Detroit plan to continue customer involvement as a key tool for management of their operations as well as to assure effective customer service.

New policies should be based on the practices that have been most effective in the past, and what new emphasis is needed in the future. Every aspect of wholesale customer service should be considered, from marketing to potential new customers, to water service contracts, and programs to involve customers in working groups. New policies should address the following questions and issues:

***Should marketing and new forms of water service be offered?***

- Process for marketing, incentivizing, identifying and facilitating new wholesale customers who seek water service.
- Identify new forms of water service– low pressure (delivered at 35-PSI and new customer boosts its own pressure), raw water, and seasonal service.
- Different water rate structure for a different type water service?
- Re-evaluate the current Growth Pays for Growth policy; consider business case issues and benefits for the system for each situation.

### *How can water service contracting procedures be improved?*

- Procedure for updating existing water service contracts, when needed.

- Procedures and timelines for handling expiring contracts.

### *How can regional water quality services be extended?*

- Provide regional information and messaging in the annual Consumer Confidence Reports (CCR) for each wholesale customer

- Market regional water quality testing and compliance reporting services to wholesale customers

### *How can emergency response notification and communications be improved?*

- Re-set emergency response objectives and notification processes

- Use **Figure 11-1** as a point for discussion with wholesale customers.

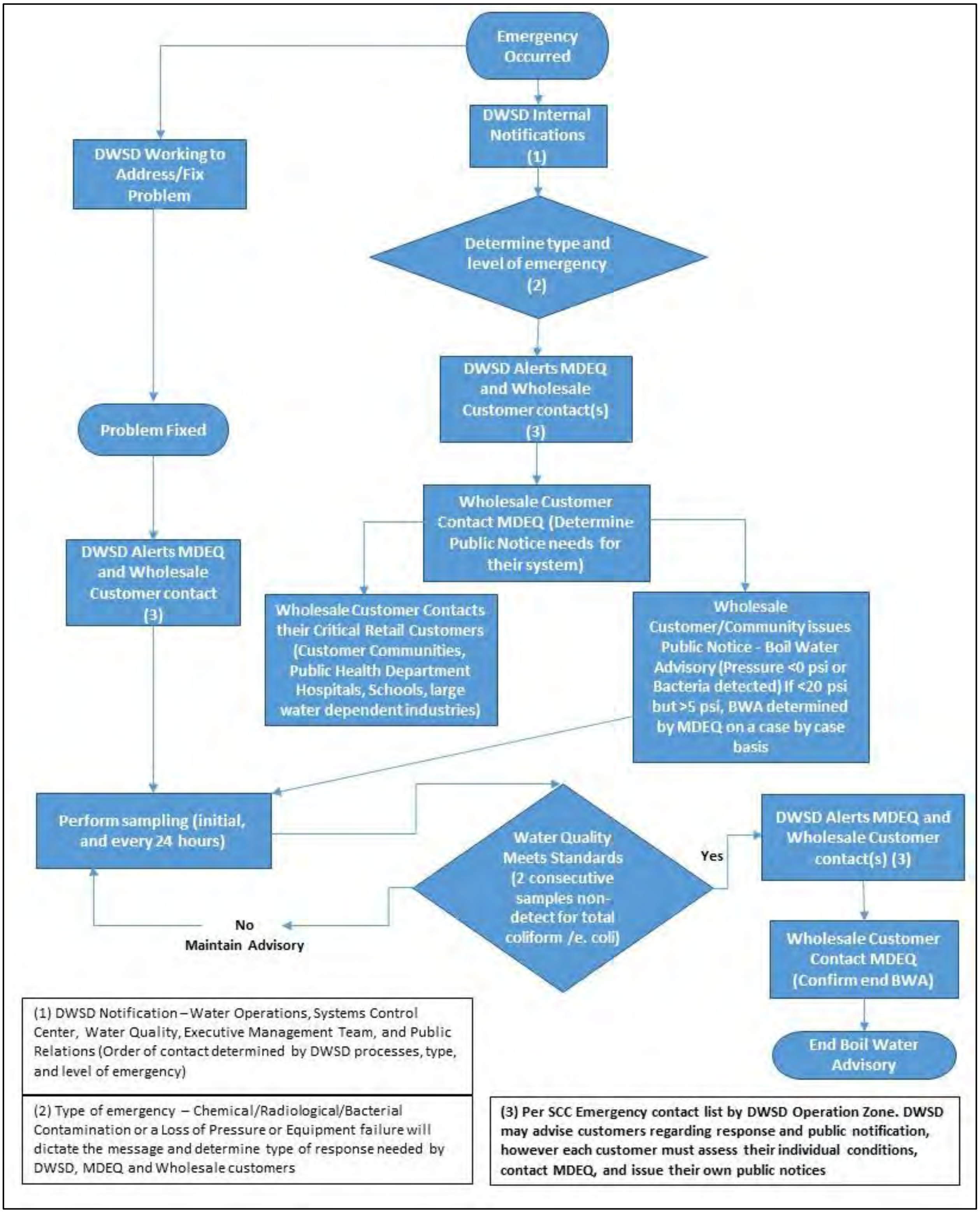


**Figure 11-1: Preliminary Emergency Response Notification Flow Chart**

This preliminary flow chart captures a simplified representation of the current notification process between DWSD, Wholesale customers, MDEQ, and the public (via issuance of Public Notices). The first line of defense for preventing an emergency situation or handling a minor emergency before it becomes a notification situation are the immediate actions of the trained water treatment plant operators and system control center operators. When the system conditions or emergency occurrence is beyond a readily correctable condition, then the DWSD internal notification process begins.

For situations that originate at a water treatment plant, notification goes from the operator or chemist to their team leader then the plant manager. The plant manager notifies the Water Operations Director. The Water Operations Director notifies all the other parties within DWSD who need to be involved. This may include the Executive Management Team and Public Affairs. If it is a water quality emergency that will include notification to the Water Quality manager. For situations that originate from a loss of pressure or transmission main break, the System Control Center (SCC) is typically the first group to be aware of the emergency. The SCC manager will notify the Water Operations Group manager and then determine who will contact the Executive Management Team and Public Affairs.

As indicated by the flow chart, DWSD (typically the Water Quality manager) will notify both MDEQ and the affected wholesale customer(s). DWSD will work with MDEQ and customer(s) to inform them of the Water Supply Conditions: Bacteriological, chemical, radiological maximum contaminant level (MCL) violation, treatment technique (TT) violation, Loss of Pressure (<20 psi) or other water quality events and advise them on determining system conditions, contacting MDEQ, and any other next steps. The direction that DWSD has received from MDEQ is that each community/customer is responsible for issuing public notices for boil water advisories based on MDEQ protocols and the individual community's internal protocols for notifications.

In parallel to these notifications the various group managers are working with operators and staff to address the emergency situation to restore service and maintain water quality. Site-specific Emergency Response plans are also available at each WTP and should be followed.

DWSD will notify MDEQ and the customer(s) when the problem is fixed. Sampling is required for at least 24 hours after the pressure is restored, until bacteria is below detection in two consecutive samples. The Customer should stay in contact with MDEQ regarding the determination to lift the boil water advisory.

The process described above will change in some respects with the transition to the GLWA.

### 11.2.5 Asset Management

Asset management is a systematic approach to monitoring, maintaining, and replacing the regional water infrastructure. At this scale, the regional DWSD water system has 500,000 to 1,000,000 or more individual components of equipment and infrastructure, depending on how these pieces are counted. Within the City of Detroit, there are additional water assets that exceed 400,000 when counting customer meters, pipe line by the block, hydrants, and valves. The annual volume of maintenance work orders on these facilities exceeds 25,000 per year.

Computerized systems for asset management, work order management, and maintenance management allow for data to be collected and reported on age, frequency of maintenance and condition. Much of DWSD's system was built for historically larger manufacturing water use and a larger population, therefore there are now excess assets in some locations.

Policy should address the following questions and issues:

***How should asset management data be utilized for GLWA and DWSD-Retail planning and reporting?***

- Role and responsibility of an Asset Management Group
- Objectives for asset management and reporting on assets.
- Improving Asset Management capabilities so that the system can provide a preliminary report on capital replacement needs, and this report would then be reviewed and vetted by a committee knowledgeable of the operating and capital needs.
- Role of an advisory group of staff, customers and consultants to continuously review the quality of asset management data.

***What new procedures are needed for asset ownership and costs?***

- Procedures to transfer ownership of water facilities, either from wholesale customers to the regional utility, or from the regional utility to wholesale customers.
- How the system is reimbursed for assets that transfer, to assure that parties remain financially whole; consideration of who is impacted by the transfer of an asset.
- Handling of stranded assets, and handling of excess assets.
- Consider adding a new provision in the Water Service Contract for stranded asset, similar to that in the Wastewater Service Contract.
- Ownership and responsibility for pressure reducing valves at wholesale customer metering points.
- Removal of PRVs that are no longer needed.

## 11.3 Project Initiation

It is anticipated that after GLWA begins operational responsibilities, it will implement the regional capital improvements and operations, and City of Detroit will implement projects for its retail system. DWSD is expected to have a transitional implementation role as requested by either GLWA or City of Detroit, depending on the timing when the new organizations are fully authorized.

The 20-year capital improvement program provided in TM-17 identifies projects for GLWA and for City of Detroit. Approximately 30 percent of the projects are for implementation by the City of Detroit, and approximately 70 percent by the GLWA.

The 20-year capital improvement program identifies for each project a ‘project type’. Major project types include:

- Study
- Design/Construction

- Design-Build
- Program Management
- Small Capital

The approach to initiating a project varies by project type.

Study Projects: Approximately 10 percent of the projects are of the study type. These projects would include collection and review of new information, development of criteria for evaluation or design, evaluation of alternatives, and development of recommendations.

Most study projects would lead to subsequent design projects.

Small Capital Projects: The Small Capital Program has an upper limit of $2,000,000 per project, which includes engineering and construction. These projects are typically executed by DWSD staff and on-call suppliers, or by as-needed engineering services providers.

Design Projects: Approximately 90 percent of the projects are design followed by bidding for construction, design-build, or the Small Capital Program. Where a project type indicates Design/Construction, it is implied that design would proceed directly from this Water Master Plan Update. Design should include the three major tasks shown in Table 11-1. In the Preliminary Design task, the work includes review of the information in the Water Master Plan Update and other previous applicable studies, collection and review of new information, development of design criteria, evaluation of alternatives where appropriate, and development of a recommended alternative for final design.

**Table 11-1: Standard Design Tasks**

| Task Name | Purpose | Key Milestones | End Product |
|---|---|---|---|
| Preliminary Design | ▪ Review master plan recommendations<br>▪ Add project specific criteria and new information<br>▪ Provide for value engineering, where needed | ▪ Workshop on data sources and design criteria<br>▪ Workshop on alternatives<br>▪ Workshop on recommended design<br>▪ Value Engineering, if applicable | ▪ Basis of Design Report (30% design)<br>▪ Updated Cost Estimate |
| Design Development | ▪ Initiate permitting<br>▪ Final coordination with other utilities, projects | ▪ 60 percent design<br>▪ Specifications<br>▪ 60 percent design<br>▪ List of permits | ▪ Design Development Report, Drawings, Materials and Equipment Specifications |
| Final Design | ▪ Finish permitting<br>▪ Procure Construction | ▪ 90 percent<br>▪ 100 percent<br>▪ Construction contract documents | ▪ Contract Documents ready for bid |

Program Management: DWSD has used program management to execute multiple projects that are related by location or by type of facility. Initiating new projects under a program management approach is applicable when there is sufficient information about the scope, costs, and risk management issues for the projects to be executed. Program management can be an effect method for project execution where cost, schedule, and risk can be reduced.

## 11.4 CIP Execution Management

The proposed 20-year capital improvement plan includes over 330 projects. Certain projects need to be completed within the first five years of the planning period in order to provide the greatest benefit for operating cost savings and avoidance of costs for new equipment in excess facilities. Certain projects are related to potential future regulatory requirements, which may, or may not take effect during the planning period. Other projects, such as transmission main condition assessment, have discretionary staring dates, but should be initiated in the first half of the planning period.

The projects in the 20-year CIP have been organized into a series of programs which group projects by specific objectives of the Master Plan Update. See Table 11-2. Each program should be led by a senior project manager, and major responsibilities should include:

- Manage the implementation process in accordance with the recommended schedule and estimated cost.
- Make additions and changes to the recommended projects based on new information in the future.

- Manage related annual operational initiatives that augment the capital projects and measure results achieved.
- Provide quarterly progress reporting to management relative to the approved CIP schedule and budget.

The first five year programs would sunset when the objectives are complete, anticipated to be the year 2020.

**Table 11-2. Proposed Programs for Managing the Execution of the 20-Year CIP**

| Time Frame | Treatment | Transmission | Distribution | Metering & NRW |
|---|---|---|---|---|
| First Five Years | Repurposing Northeast WTP | High Lift Pumping Station Optimization | | Production Metering |
| Full Planning Period | Regulatory Compliance | Renewal and Replacement | Renewal and Replacement | Wholesale Customer Metering |
| | Renewal | Booster Pumping Station Optimization | Lead Service Connections | Water Loss Reduction |
| | | Service Optimization | AMR Metering | |

The Northeast Repurposing Program should be completed within the first five years. A preliminary schedule for execution of this program is shown in **Figure 11-2**. The schedule is based on the following criteria:

- Accurate condition assessment of existing infrastructure before design for rehabilitation.
- Increase the reliability and serviceability of the 96-inch main by installation of new isolation gates
- Minimize risk by scheduling the use of the existing Garland main during fall-winter-spring (not summer).
- Minimize the number of years that Northeast plant would remain in operation.
- Discuss the anticipated pressure changes shown in **Table 7-11** with Madison Heights, Troy, Sterling Heights, and Warren.

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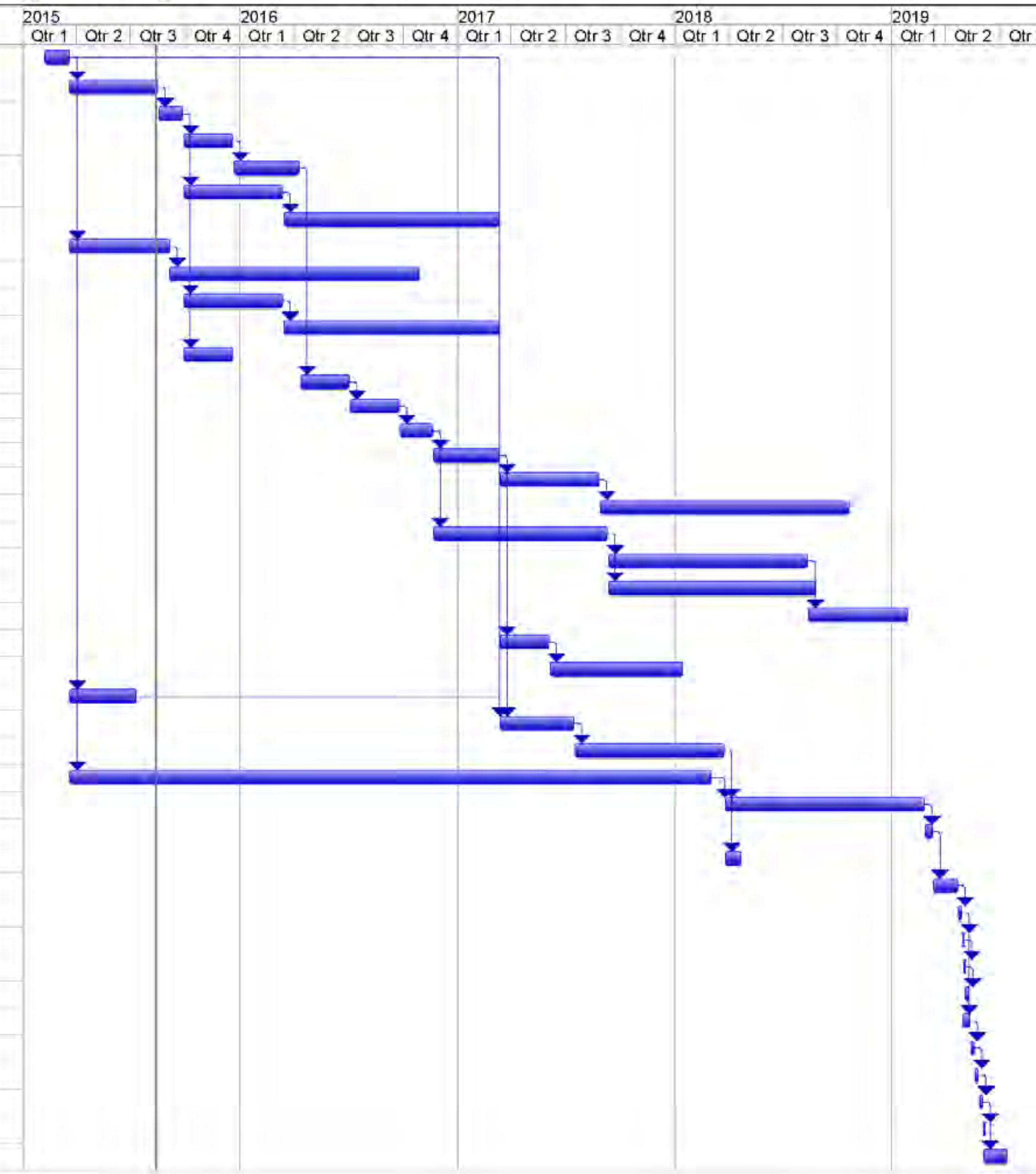
# Conceptual Fast Track Schedule for Repurposing the Northeast WTP

| ID | Task Name | Duration | Start | Finish | Predecessors | Resource Names |
|---|---|---|---|---|---|---|
| 1 | 2016 CIP Approval | 30 days | Fri 2/6/15 | Thu 3/19/15 | | |
| 2 | Complete Water Master Plan Update | 106 days | Fri 3/20/15 | Fri 8/14/15 | 1 | |
| 3 | GLWA and BOWC Approval of Water Master Plan Update | 30 days | Mon 8/17/15 | Fri 9/25/15 | 2 | |
| 4 | Prepare procurement strategy and requests for proposals | 60 days | Mon 9/28/15 | Fri 12/18/15 | 3 | |
| 5 | Design Procurement Period 1 | 80 days | Mon 12/21/15 | Fri 4/8/16 | 4 | |
| 6 | Design State Fair Valve and yard piping updates at the Northeast plant | 120 days | Mon 9/28/15 | Fri 3/11/16 | 3 | |
| 7 | Construct State Fair Valve and yard piping updates at Northeast plant | 260 days | Mon 3/14/16 | Fri 3/10/17 | 6 | |
| 8 | Design Repair to Northeast Raw Water Tunnel | 120 days | Fri 3/20/15 | Thu 9/3/15 | 1 | |
| 9 | Construct Repair to Northeast Raw Water Tunnel | 300 days | Fri 9/4/15 | Thu 10/27/16 | 8 | |
| 10 | Design new Isolation Gates for 96-inch Main | 120 days | Mon 9/28/15 | Fri 3/11/16 | 3 | |
| 11 | Construct new Isolation Gates for 96-inch Main | 260 days | Mon 3/14/16 | Fri 3/10/17 | 10 | |
| 12 | Plan and test North Service Center isolation valve changes | 60 days | Mon 9/28/15 | Fri 12/18/15 | 3 | |
| 13 | Perform Garland Main Record Plan Review and Leak Survey | 60 days | Mon 4/11/16 | Fri 7/1/16 | 5 | |
| 14 | Perform Garland Main Photographic/Acoustic Internal Inspection | 60 days | Mon 7/4/16 | Fri 9/23/16 | 13 | |
| 15 | Review WW-536 and Create Phased Implementation | 40 days | Mon 9/26/16 | Fri 11/18/16 | 14 | |
| 16 | Design Procurement Period 2 | 80 days | Mon 11/21/16 | Fri 3/10/17 | 15 | |
| 17 | Design Improvements to WWP High Lift PS | 120 days | Mon 3/13/17 | Fri 8/25/17 | 16 | |
| 18 | Construct Improvements to WWP High Lift PS | 300 days | Mon 8/28/17 | Fri 10/19/18 | 17 | |
| 19 | Design WW-536 Phase 1: New 72-inch Main from High Lift to Forest and Pennsylv | 210 days | Mon 11/21/16 | Fri 9/8/17 | 15 | |
| 20 | Design WW-536 Phase 2: Venturi Meter Rehabilitation | 240 days | Mon 9/11/17 | Fri 8/10/18 | 19 | |
| 21 | Construct WW-536 Phase 1: New 72-inch Main from High Lift to Forest and Penns | 250 days | Mon 9/11/17 | Fri 8/24/18 | 19 | |
| 22 | Construct WW-536 Phase 2: Venturi Meter Rehabilitation | 120 days | Mon 8/13/18 | Fri 1/25/19 | 20 | |
| 23 | Design Garland Main Rehabiliation | 60 days | Mon 3/13/17 | Fri 6/2/17 | 16 | |
| 24 | Construct Garland Main Rehabilitation | 160 days | Mon 6/5/17 | Fri 1/12/18 | 23 | |
| 25 | Complete Inspection of Raw Water Tunnel | 80 days | Fri 3/20/15 | Thu 7/9/15 | 1 | |
| 26 | Prepare Basis of Design for NE Raw Water Tunnel to Finished Water | 90 days | Mon 3/13/17 | Fri 7/14/17 | 16,1,25 | |
| 27 | Design NE Raw Water Tunnel Liner | 180 days | Mon 7/17/17 | Fri 3/23/18 | 26 | |
| 28 | Complete work on Springwells Filter Rehabilitation SP-563 | 770 days | Fri 3/20/15 | Thu 3/1/18 | 1 | |
| 29 | Construct Tunnel Liner | 240 days | Mon 3/26/18 | Fri 2/22/19 | 28,27 | |
| 30 | Test/Commission new transmission systems from WWP and LH to NE | 10 days | Mon 2/25/19 | Fri 3/8/19 | 29 | |
| 31 | Prepare decommissioning plan for NE WTP treatment processes | 20 days | Mon 3/26/18 | Fri 4/20/18 | 27 | |
| 32 | Plan work steps with System Control, Security, Water Quality,Safety | 30 days | Mon 3/11/19 | Fri 4/19/19 | 30 | |
| 33 | Start decommissioning after September 15; full reservoirs at NEWTP. | 5 days | Mon 4/22/19 | Fri 4/26/19 | 32 | |
| 34 | Shut down and lock out the low lift pumps, remove filters from service. | 2 days | Mon 4/29/19 | Tue 4/30/19 | 33 | |
| 35 | Cease operation of all chemical feed systems. | 2 days | Wed 5/1/19 | Thu 5/2/19 | 34 | |
| 36 | Open the State Fair valve and initiate valve operations at NSC. | 5 days | Fri 5/3/19 | Thu 5/9/19 | 35 | |
| 37 | Dewater and close influent gates to the treatment units. | 10 days | Mon 4/29/19 | Fri 5/10/19 | 33 | |
| 38 | Dewater the north and south applied water conduits. | 5 days | Mon 5/13/19 | Fri 5/17/19 | 37 | |
| 39 | Remove chemicals and clean chemical storage tanks. | 5 days | Mon 5/20/19 | Fri 5/24/19 | 38 | |
| 40 | Drain the raw water conduits from the low lift to the filter building. | 5 days | Mon 5/27/19 | Fri 5/31/19 | 39 | |
| 41 | Turn-off high voltage electrical service to the treatment units. | 2 days | Mon 6/3/19 | Tue 6/4/19 | 40 | |
| 42 | Install bulkhead at filter effluent tunnel. | 30 days | Mon 6/3/19 | Fri 7/12/19 | 40 | |




Project: Schedule for NE Repurposing
Date: Thu 8/13/15

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Progress | Deadline

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