# 6.0 Capital Improvements Program

## 6.1 General

Previous chapters of this report present the progressive development of the long-range water master plan for the Madison area. The previous chapters:

- Describe the factors that influence water supply planning.
- Project future water requirements.
- Define the existing water system and assess its capacity to serve current demand.
- Formulate and prove with hydraulic computer modeling a future system of components needed to correct current deficiencies and serve future demand.
- Define improvements to the existing system that would transform the existing system into the future system.

This chapter presents the long-range master plan for water works required to serve the needs of the Study Area at buildout development, and identifies a phased capital improvements program (CIP) for the necessary improvements during the last nineteen years of the 20-year study period, from Year 2007 through 2025. The timing of the phased improvements is keyed to the projected growth rates and development patterns defined in the 2005 City of Madison Comprehensive Plan. Actual growth rates and development patterns, along with resulting demand and system performance, should be monitored regularly and the timing of future improvements either confirmed or adjusted to fit future conditions.

Improvements identified for installation after year 2025 are conceptual in nature. They are presented primarily to provide long-term facility site guidance, and to give context to the improvements defined for the study period. The improvements identified for installation after Year 2025 have not been proven by hydraulic modeling for buildout conditions, and should be assessed and proven in future master plan updates.

Except for a few instances specifically identified, the improvements identified in this report do not include improvements needed to repair, rehabilitate or replace deteriorated existing facilities. Those improvements are defined in the 2005 Infrastructure Management Plan.

## 6.2 Cost Estimates

In every engineering study that develops a capital improvements program it is necessary to make estimates of the capital costs required to implement the program. To that end, basic cost data must be obtained or developed for each type of construction and system components laid out in sufficient detail to permit determination of approximate project capital costs. Cost data used in this report for most facilities and all pipelines were derived from the costs stated in the 2005 Infrastructure Management Plan. Costs for PRV stations were derived from conceptual quantities and from unit prices found in recognized cost estimating manuals.

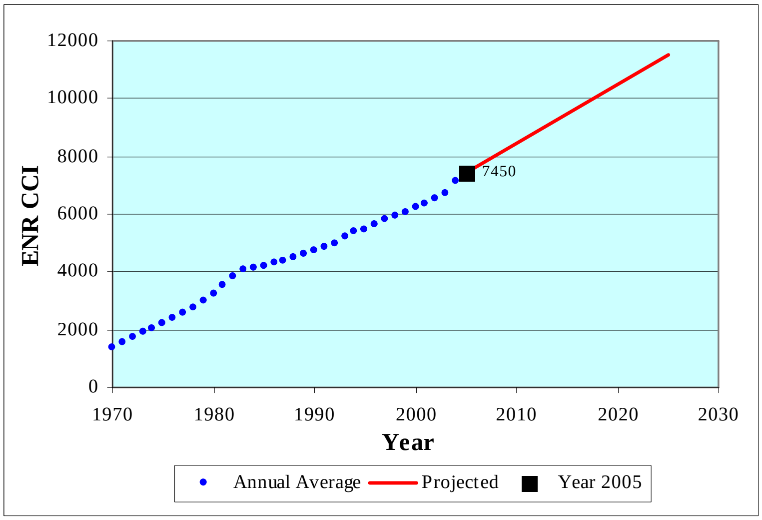
### *6.2.1 Precision of Cost Estimates*

The precision of a cost estimate is a function of the detail to which the system components have been developed and the techniques used in preparing the estimate. An order-of-magnitude estimate, as defined by the American Association of Cost Engineers, is appropriate for the level of detail that is common in planning level studies and alternatives comparisons. An order-of-magnitude estimate is made with little or no detailed engineering data. Techniques such as cost capacity curves, scale-up or scale-down factors and ratios are used in developing such estimates. An order-of-magnitude cost estimate has an expected accuracy of +30 percent to -30 percent. All estimates of capital cost presented in this report are order-of-magnitude estimates that are sufficient for overall program budgeting. While preparing for each project, capital cost should be refined using more detailed information generated during preliminary design and each next-year capital budget processes.

### *6.2.2 Basis of Costs*

In considering the estimates presented in this report, it is important to realize that they are reported in year 2005 dollars, and that future changes in the cost of materials, equipment and labor will cause comparable changes in project costs. A good indicator of changes in construction costs is the Engineering News-Record (ENR) Construction Cost Index (CCI), which is computed from prices of construction material and labor, and based on a value of 100 in the year 1913. Figure 6-1 shows the increasing trend in construction costs averaged for 20 major U.S. cities.

**Figure 6-1 Engineering News Record – Construction Cost Index**




Cost data in this report are based on an ENR CCI (20-city average) of 7450, which is the average value for year 2005. Cost data presented in this report can be adjusted to any time in the past or future by factoring it by the ratio of the then-prevailing ENR CCI (20-city average) divided by 7450.

### *6.2.3 Capital Cost*

The total capital cost necessary to complete a project consists of expenditures for land acquisition, construction, all necessary engineering services, contingencies, and such overhead items as legal, administrative and financing services. The various components of capital costs are considered in the following sections.

#### *6.2.3.1 Land Acquisition*

For a variety of reasons, the cost of land acquisition is not included in the capital costs presented in this report. In most cases, the construction of pipelines will not require purchase of private property or acquisition of easements. Pipeline routes, insofar as possible, follow public streets and roads. In cases where sites will be needed for supply, pumping and storage works, some sites have already been secured by the MWU, and the cost of the remaining sites would be difficult to define because their locations are somewhat flexible. Although land acquisition is a significant activity that determines whether a project occurs, the cost of land acquisition is generally a small portion of the overall program cost. An assessment of additional land that will be needed for the recommended CIP projects should be conducted by MWU staff, assisted as necessary by a competent local appraiser, to determine a land acquisition budget.

#### *6.2.3.2 Construction Costs*

Construction costs cover the material, equipment, labor and services necessary to build the proposed project. Prices used in this study were obtained from a review of previous reports and pertinent sources of construction cost information. Construction costs used in this report are not intended to represent the lowest prices which may be achieved but rather are intended to represent a median of competitive prices submitted by responsible bidders.

#### *6.2.3.3 Engineering, Overhead and Contingencies*

Engineering services may include all of the following: preliminary investigations and reports, site and route surveys, foundation explorations, preparation of design drawings and specifications, engineering services during construction, construction observation, construction surveying, sampling and testing, start-up services, and preparation of operation and maintenance manuals. The cost of engineering depends on the nature and size of the project and can be expected to range from approximately 12 to 20 percent of the project construction cost. For this report, engineering costs were assumed to be 15 percent of the construction cost.

Overhead charges cover such items as legal fees, financing fees, and administrative costs. The cost of these items can vary, but for the purpose of this study it was assumed that overhead charges will be about 5 percent of the construction cost.

It is also appropriate to allow for the uncertainties unavoidably associated with preliminary layout of projects. Such factors as unexpected construction conditions, the need for unforeseen mechanical and electrical equipment, and variations in final quantities are a few examples of items that that can add to planning level estimates of project cost. To cover such contingencies, an allowance of 20 percent of the construction cost has been included.

When applied together, the cost of all necessary engineering services, overhead expenses, and contingencies was estimated to be 40 percent of construction costs.

#### *6.2.3.4 Total Unit Capital Costs*

Total unit capital costs were developed for each of the system components that will be added in the future. The total unit capital costs used in this study are equal to 140 percent of the unit construction costs. Unit prices were developed for the component categories of supply, pumping, PRV stations, storage and pipelines.

#### *6.2.3.4.1 Supply*

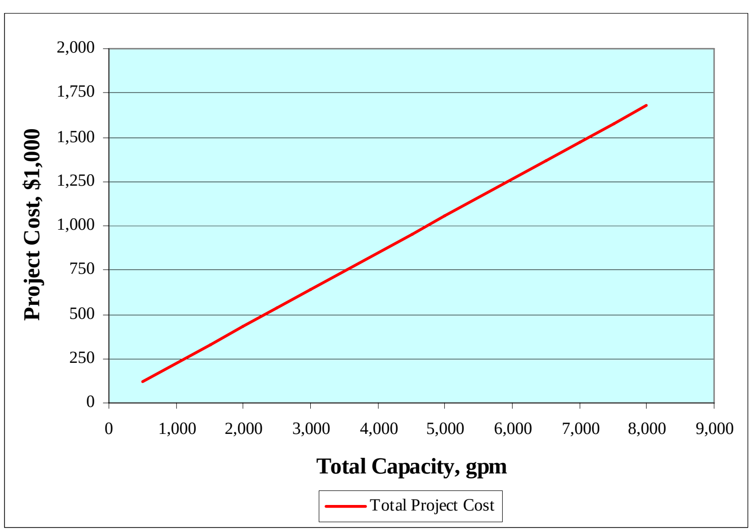
Additional supply will be provided from groundwater. Most new facilities will be unit wells that consist of a 3-mgd well and well pump, a 0.4 MG ground storage reservoir, and a 3,000 gpm booster pumping station. The total unit capital cost for a standard unit well is estimated to be $3,000,000. A breakdown of this cost is presented in Table A6-1 in Appendix 6.

In a few cases, supply will be added by constructing only the 3-mgd well and well pump portion of a unit well adjacent to an existing ground storage reservoir and booster pumping station. The total unit capital cost for a standard well is estimated to be $1,300,000. A breakdown of this cost is presented in Table A6-2 in Appendix 6.

#### *6.2.3.4.2 Pumping*

Booster pumping stations will be used to transfer water from a lower service zone to the next higher service zone. Booster pumping station costs vary considerably, depending on such factors as architectural and mechanical features, pumping head, and total pumping capacity. Because future station features and pumping head will likely be similar to a generally standardized design adopted by MWU, the estimated cost for future booster pumping stations can be presented as a function of capacity. The estimated total unit capital costs for distribution system booster stations ranging from 500 to 8,000 gpm is presented in Table A6-3 in Appendix 6, and shown graphically in Figure 6-2.

**Figure 6-2 Capital Cost Curve – Booster Stations**



The cost data are based on enclosed stations having architectural and landscaping treatment suitable for residential areas and similar to recent MWU designs, including site work, building foundation, building superstructure, site piping, equipment, electrical and instrumentation, and miscellaneous appurtenances. The costs are based on total pumping capacity including one standby pump, but do not include engine drivers or standby power generators.

#### *6.2.3.4.3 PRV Stations*

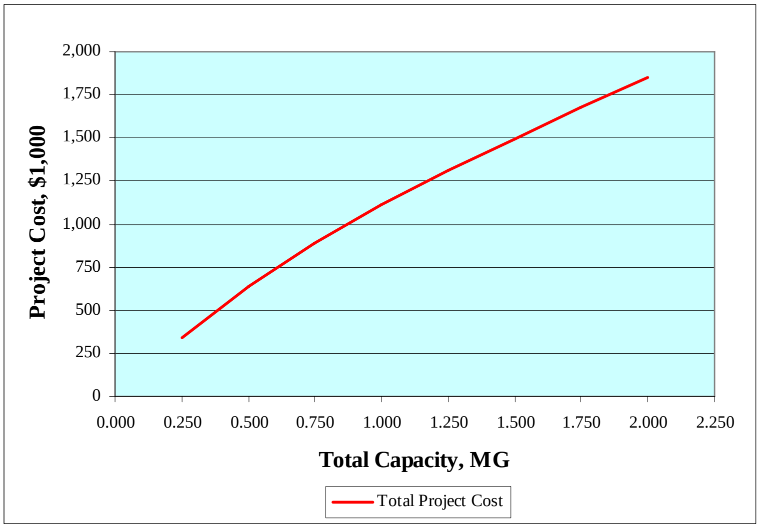
Pressure reducing valve (PRV) stations will be used to transfer water from a higher service zone to the next lower service zone. For most PRV stations the piping, valves, electrical and instrumentation components will be housed in one of the booster pumping stations. At a few locations they will be housed in an above-grade prefabricated utility structure. The total unit capital cost for each PRV station would be approximately $30,000 in booster pumping stations, and about $75,000 in utility structures. The capital costs for PRV stations are presented in more detail in Tables A6-4 and A6-5 in Appendix 6.

#### *6.2.3.4.4 Storage*

The capital cost for distribution system storage varies considerably, depending on such factors as type, material, capacity and support system. Estimated total unit capital costs were developed for four combinations of these features to represent storage systems that are currently in service and will likely be added in the future. The estimated total unit capital costs include site work, tank foundation, the tank, site piping, controls and miscellaneous appurtenances. In each case the total unit capital cost can be presented as a function of capacity because the other three variables are common to all tanks represented.

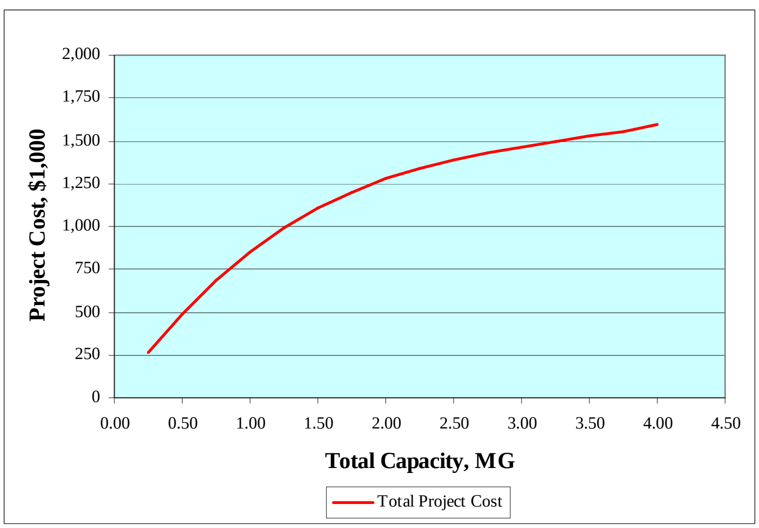
Reinforced concrete ground-level tanks would be used primarily for storage at unit wells, where the tank must be partially or completely buried, and for distribution storage tanks having capacities up to 1.0 million gallons (MG). The estimated total unit capital costs for reinforced concrete ground-level tanks ranging from 0.25 to 2.0 million gallons (MG) is presented in Table A6-6 in Appendix 6, and shown graphically in Figure 6-3.

**Figure 6-3 Capital Cost Curve – Reinforced Concrete Reservoirs**



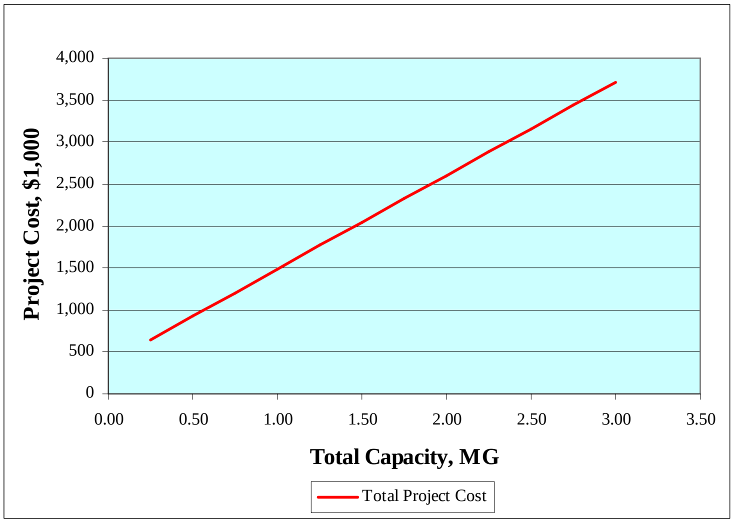

Steel or pre-stressed concrete ground level tanks would be used primarily for exposed tanks having capacities over 1.0 MG. The estimated total unit capital costs for steel or pre-stressed concrete ground-level tanks ranging from 0.25 to 4.0 MG is presented in Table A6-7 in Appendix 6, and shown graphically in Figure 6-4.

**Figure 6-4 Capital Cost Curve – Steel or Pre-stressed Concrete Reservoirs**



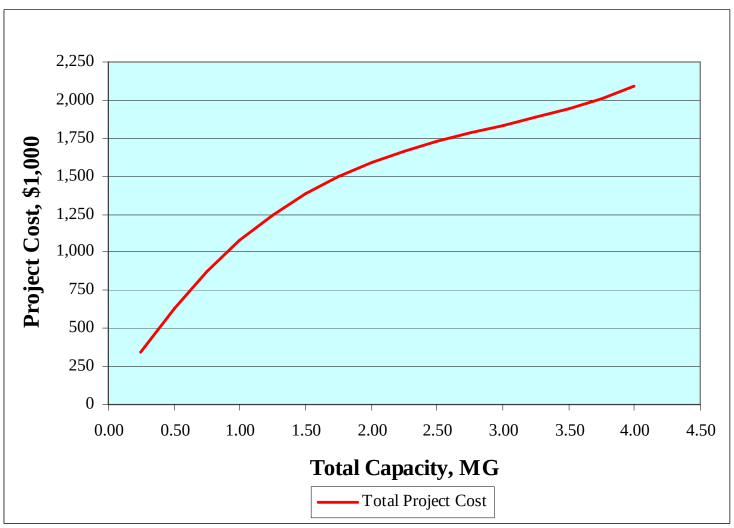

Elevated tanks would be used for situations where structural support of the tank is necessary to raise the storage up to the desired hydraulic grade because no nearby ground is high enough to support a ground-level tank at that elevation. The estimated total unit capital costs for elevated tanks ranging from 0.25 to 3.0 MG is presented in Table A6-8 in Appendix 6, and shown graphically in Figure 6-5.

**Figure 6-5 Capital Cost Curve – Elevated Tanks**




Steel standpipes would be used for situations where the storage height above ground is intermediate, not warranting an elevated tank, but also requiring an abnormally high side-water depth for a ground-level tank.  The estimated total unit capital costs for steel standpipes ranging from 0.25 to 4.0 MG is presented in Table A6-9 in Appendix 6, and shown graphically in Figure 6-6.

**Figure 6-6 Capital Cost Curve – Steel Standpipes**




### *6.2.3.4.5 Pipelines*

The capital cost for transmission and distribution pipelines varies considerably, depending on such factors as pipe diameter, material, bury depth, and the type of trench and surface restoration. Water transmission and distribution pipelines ranging in size from 8 inches to 20 inches in diameter will be needed for future system improvements. Estimated total unit capital costs were developed for pipelines based on providing cement mortar lined ductile iron pipe, a 6-foot burial depth, and trench backfill and surface restoration for road right-of-way conditions. Pipeline costs cover preparation of the right-of-way, trench excavation, placing and joining the pipe, installation of valves and fittings, placement of imported and initial backfill, and placement of subsequent backfill for a trench depth of 6 feet plus one pipe diameter. The subsequent backfill was assumed to be imported or select material for streets. Allowance was made for valves, fittings and surface restoration common to urban distribution system layout. Allowance was not made for project-variable features, such as special fittings, crossings, and structures.

The total unit capital cost can be presented as a function of pipe diameter because the other three variables are common to all pipeline sizes and the condition assumed typical for this report. The estimated total unit capital costs for transmission and distribution pipelines ranging from 8 to 20 inches in diameter are presented in Table 6-1.

**Table 6-1**
**Unit Capital Cost - Pipelines**

| Pipeline Diameter, inches | Unit Cost, $/LF |
|---|---|
| 8 | 112 |
| 10 | 140 |
| 12 | 168 |
| 16 | 224 |
| 20 | 280 |

A breakdown of these unit costs is presented in Table A6-10 in Appendix 6

## 6.3 Long-Range Plan

This section describes the waterworks recommended to serve the water needs of the Madison area at build-out development. The improvements to the existing distribution system necessary to complete the buildout water works system will be added as needed to first alleviate current deficiencies and then to satisfy growth in demand and service area. Later sections will define the timing of these improvements.

The long-range master plan for capital improvements to the MWU water system are shown on Figure 6-7, Water System Master Plan, bound at the end of this Chapter. The information in Figure 6-7 is subdivided and enlarged to show more detail in Figures A6-1.1 through A6-1.8 in Appendix 6. The cost to complete each category of the improvements is presented in Table 6-2.

**Table 6-2**
**Total Capital Cost – Long-Range Master Plan**

| Improvement Category | Capital Cost, $1,000 |
|---|---|
| Wells | 1,300 |
| Unit Wells | 50,850 |
| Booster Stations | 7,900 |
| PRV Stations (at booster station) | 750 |
| PRV Stations (at utility vault) | 150 |
| Storage | 10,500 |
| Pipelines | 93,225 |
| Demolition | 100 |
| **Total** | **164,775** |

Later sections will subdivide the categories of improvements shown in Table 6-2 into system components that in the future can be combined to form projects.

The entire improvements shown are conceptual and have been generally assessed to be necessary to meet projected water demands for buildout conditions. A more thorough evaluation was completed to define the portion of these improvements that will be necessary to provide the required capacity and reliability to meet water demands projected for Year 2025, the end of the study period and CIP defined in this report. Later sections will identify these improvements.

It should be recognized that the locations shown for new facilities and pipelines are approximate but accurate enough to convey layout concept and complete reliable hydraulic evaluation. Specific facility locations and pipeline route alignments will have to be determined as part of preliminary design for each project. The locations of system improvements may need to be adjusted to conform to actual development patterns, to utilize available property and right-of-way, to coordinate with and/or take economic advantage of other improvement projects, to satisfy other MWU commitments, and to avoid interference with other utilities.

## 6.4 Improvement Phases

It is not necessary to immediately construct all of the improvements described in the previous section of this Chapter. A phased, long-term plan for adding the necessary improvements at the appropriate time over the last nineteen years of the 20-year study period, from 2007 through 2025, has been prepared to guide the MWU. Priorities have been set for the improvements according to importance and immediacy of need. The high-priority improvements are those required to meet current fire flows and system needs. The improvements needed to meet future growth are of lower priority and should be implemented as growth occurs. The high priority improvements should be implemented as much as possible during the first five years of the capital improvements program.

A short-term plan, identified as Phase I, has been prepared to define construction projects for each year from 2007 through 2010, years 2 through 5 of the study period. The remainder of the long-term plan, identified as Phase II, has been prepared to define construction projects for each five-year period from 2011 through 2025. The improvements scheduled for construction after year 2025, collectively identified as Phase III, are conceptual in nature and should be reassessed in future master plan updates to confirm or modify them before firm installation commitments are made. Later sections will identify improvements within each phase of the long-term plan.

### *6.4.1 Phase I*

Phase I projects focus on correcting current deficiencies in raw water quality, transfer capacity between service zones, and fire storage and transmission capacity. The improvements will significantly improve current capability to serve peak hour demand, fire demand, and emergency supply. Phase I projects will also enhance existing system capability to deliver projected demand for year 2010.

Two new wells (Well 31 and Unit Well 33) will be constructed to serve increasing West Campus demand, to replace capacity lost to reduced use of Unit Wells 3 and 10 that currently produce unacceptable water quality, and to increase fire flow capacity in service zone 4. Unit Well 3 will be offline, and Unit Well 10 will be converted to reserve capacity.

Existing booster stations BS106, BS113, BS115, BS120, and BS129 will be either upgraded, rebuilt or replaced to increase transfer capacity from a lower service zone to a higher service zone. A new booster station BS118 will be constructed. These improvements will make it possible to utilize temporary excess supply and/or storage capacity in the central service zones 4, 6West, 6East, and effectively postpone some supply and/or storage improvements in the higher zones.

Pressure reducing valve (PRV) stations will be added at strategic locations to increase transfer capacity from a higher service zone to a lower service zone. These improvements will make it possible to use in lower service zones temporary excess supply and/or storage capacity in the higher service zones, and effectively postpone some supply, storage and/or pipeline improvements in the lower service zones. Not intended for routine use, these PRVs would be used during abnormal demand and operating conditions.

Distribution storage will be added to correct current deficiencies in flow equalization and fire storage capacity. One ground level tank (Felland Road reservoir RES129) is currently under construction to serve service zone 6East, and two elevated tanks (Raymond Road tower TWR216 and Blackhawk tower TWR228) will be constructed to serve the upper service zones 9 and 11.

Pipelines will be added to connect the facilities described previously in this section to the existing system. These pipeline improvements will also initiate a systematic long-term enhancement and completion of the partially undersized and disconnected transmission network that the existing pipeline system provides. Completion of an adequately sized and fully connected transmission network will occur as Phase II pipeline improvements.

### *6.4.2 Phase II*

Phase II projects focus on strategically adding supply capacity, transfer capacity between service zones, storage capacity, and transmission pipelines. The improvements would eliminate a few lingering current deficiencies, begin balancing service zone supply with projected service zone peak demand (thereby reducing cross-system and interzone transfers during high demand), add booster stations to increase system reliability and system capacity to transfer central well water into outer service areas, and add PRV stations to increase system reliability and flexibility.

During the first two years of Phase II (years 2011 and 2012) lingering supply, pumping and storage deficiencies will be addressed. A new Unit Well 45 will be constructed in 2011 to replace Unit Well 3 that currently produces unacceptable water quality. Unit Well3 will be abandoned. A new booster station BS216 will be constructed to increase transfer capacity into service zones 9 and 10 and provide backup to sole-source booster stations BS120 and BS128. Elevated tanks TWR137 and TWR213 will be constructed to correct deficiencies in equalization and fire storage capacity in service zones 10 and 5. A new ground-level tank RES113, perhaps as a combined structure with TWR213, will be constructed to correct fire flow deficiencies in service zone 6E in the vicinity of service zone 5.

During the remaining 132 years of Phase II additional supply, pumping, PRV, and storage projects will be constructed primarily to satisfy demand growth. Phase II pipeline improvements will connect new facilities to the transmission network and systematically enhance and complete the partially undersized and non-continuous existing transmission network to produce an adequately sized and fully connected transmission network. Phase II projects will provide system capacity to deliver projected demand for year 2025.

### *6.4.3 Phase III*

Phase III improvements identified in this report are conceptual, presented primarily to provide long-term facility site guidance, and to give context to the Phase I and Phase II improvements. After hydraulic modeling and assessment to confirm and/or modify them in future master plan updates, Phase III improvements would provide system capacity to deliver projected demand after Year 2025 and up to buildout conditions.

## 6.5 Supply

The general assessment of the water system facilities that was presented in Chapter 5 identified two existing unit wells that need to be retired, two more that should be converted to reserve capacity, and additional wells for supply capacity to meet future growth in demand and provide additional reserve capacity. This will be accomplished with 16 additional unit wells and one well. Each well and unit well that needs to be improved or added is identified by facility ID number and presented in numerical order in Table 6-3.

**Table 6-3**
**Supply Improvements**

| Unit Well | Year Installed | Purpose |
|---|---|---|
| UW 3 | 2011 | Abandon |
| UW 7 | 2023 | Convert to Reserve Capacity |
| UW 8 | 2021 | Convert to Reserve Capacity |
| UW10 | 2023 | Abandon |
| UW12 | 2012 | Add VFD for supply to 2 Zones w/ 30' HGL difference |
| UW25 | 2009 | Change pumps; increase head to serve Zone 123 |
| Well31 | 2007 | West Campus demand / Supplement UW10 |
| UW32 | >2025 | Meet Buildout demand |
| UW33 | 2009 | Replace UW8 |
| UW34 | 2013 | Dual zone supply |
| UW35 | 2015 | Meet Year 2015 demand |
| UW36 | >2025 | Meet Buildout demand |
| UW37 | 2019 | Meet Year 2020 demand |
| UW38 | >2025 | Meet Buildout demand |
| UW39 | 2023 | Meet 2025 Demand |
| UW40 | >2025 | Meet Buildout demand |
| UW41 | 2017 | Meet Year 2020 demand |
| UW42 | 2025 | Reserve Capacity |
| UW43 | >2025 | Meet Buildout demand |
| UW44 | >2025 | Meet Buildout demand |
| UW45 | 2011 | Replace UW3 |
| UW46 | >2025 | Meet Buildout demand |
| UW47 | 2021 | Reserve Capacity |

The information in Table 6-3 above identifies the recommended construction year for each well and unit well and provides a brief description of the need for each improvement.

## 6.6 Pumping

The general assessment of the water system facilities that was presented in Chapter 5 identified six existing booster stations that need to be either upgraded, rebuilt or replaced, and nine additional booster stations to increase transfer capacity from a lower service zone to a higher service zone. All booster stations that need improvements are identified by facility ID number and presented in numerical order in Table 6-4.

| Table 6-4<br>Pumping Improvements | | |
|---|---|---|
| Booster Station | Year Installed | Purpose |
| BS9 | >2025 | Change / add pumps to deliver to both Zones 4 and 6E |
| BS106 | 2007 | Demolish aging facility / build new BS to increase capacity |
| BS113 | 2007 | Change / add pumps and building space to increase capacity |
| BS114 | 2014 | Utilize existing supply / postpone new supply (Zone 8); Maximize use of central wells |
| BS115 | 2009 | Change existing 1,400 gpm pump; increase head for delivery to Zone 123 |
| BS118 | 2009 | Utilize existing supply / postpone new supply; Maximize use of central wells |
| BS120 | 2008 | Change / add pumps and building space to increase capacity |
| BS129 | 2011 | Glacier Heights; Demolish existing PS |
| BS129 | 2010 | Felland Road; Replace existing BS129; Provide pumps for fire storage in lower zone |
| BS132 | >2025 | Backup BS128; manage water quality |
| BS114 | 2024 | Utilize existing supply / postpone new supply(Zone 7); Maximize use of central wells |
| BS143 | >2025 | Backup BS143; manage water quality |
| BS144 | 2022 | Create Zone 12 |
| BS216 | 2012 | Utilize existing supply /postpone new supply. Backup BS120 and BS128 |
| BS237 | >2025 | Backup BS120; manage water quality |

The information in Table 6-4 above identifies the recommended construction year for each booster station and provides a brief description of the need for each improvement.

## 6.7 PRV Transfer

The general assessment of the water system facilities that was presented in Chapter 5 identified twenty seven new PRV stations that would substantially improve controlled transfer capability from a higher service zone to a lower service zone, thereby providing maximum operational flexibility and reliability. All but two of the PRV stations would be located inside an existing or new unit well booster station or interzone booster station. Two would be located inside new utility structures. All PRV stations are identified by facility ID number and presented in Table 6-5.

| Table 6-5<br>PRV Transfer Improvements | | |
|---|---|---|
| **Service Zone Transfer** | **Year Installed** | **PRV Station Description** |
| 123 to 4 | 2025 | @ UW42 |
| 123 to 6E | 2015 | @ UW35 |
| 123 to 6E | 2009 | @ BS115 |
| 123 to 6E | 2011 | @ BS125 |
| 123 to 6E | 2010 | @ BS129 |
| 123 to 6E | 2011 | @ BS215 |
| 6E to 4 | 2009 | @ UW33 |
| 6E to 4 | 2007 | @ Vondron Rd (utility structure) |
| 6E to 4 | >2025 | @ BS9 |
| 7 to 6W | 2007 | @ BS106 |
| 7 to 6W | 2009 | @ BS118 |
| 7 to 6W | 2024 | @ BS134 |
| 8 to 6W | 2014 | @ BS114 |
| 8 to 7 | 2007 | @ Gammon Rd (utility structure) |
| 8 to 7 | 2012 | @ UW12 |
| 8 to 7 | 2013 | @ UW34 |
| 9 to 7 | 2008 | @ BS120 |
| 9 to 7 | >2025 | @ UW36 |
| 9 to 8 | 2021 | @ UW47 |
| 9 to 8 | 2012 | @ BS216 |
| 9 to 8 | >2025 | @ BS237 |
| 10 to 8 | >2025 | @ UW32 |
| 10 to 8 | 2019 | @ UW37 |
| 10 to 8 | 2009 | @ BS126 |
| 10 to 8 | 2012 | @ BS216 |
| 11 to 8 | 2019 | @ BS128 |
| 11 to 8 | >2025 | @ BS132 |

The information in Table 6-5 above identifies the recommended construction year for each PRV station, and the service zone interface that is bridged by the improvement.

## 6.8 Storage

### *6.8.1 Equalization and Fire*

The general assessment of the water system facilities that was presented in Chapter 5 identified one elevated storage tank that needs to be demolished and replaced, and three additional ground-level storage tanks and five additional elevated storage tanks that need to be constructed to increase storage capacity dedicated to diurnal equalization and fire reserve. All equalization and fire storage improvements are identified by facility ID number and presented in numerical order in Table 6-6.

**Table 6-6**
**Equalization and Fire Storage Improvements**

| Storage Facility | Year Installed | Purpose |
|---|---|---|
| Ex Lake View TWR113 | 2012 | Demolish undersized aging facility |
| New Lake View TWR213 | 2012 | Replace existing undersized tank |
| Lake View RES113 | 2012 | Sustain system pressures during fire |
| Felland Rd RES 129 | 2006 | Eliminate current storage deficiency |
| TWR137 | 2011 | Eliminate current storage deficiency |
| TWR140 | >2025 | Meet buildout storage need |
| RES144 | 2022 | Meet Year 2025 storage need |
| Raymond RdTWR216 | 2008 | Eliminate current storage deficiency |
| Blackhawk TWR 228 | 2010 | Eliminate current storage deficiency |

The information in Table 6-6 above identifies the recommended construction year and provides a brief description of the need for each improvement.

### *6.8.2 Emergency*

Additional storage capacity to satisfy the need for additional emergency reserve is provided with each of the sixteen new unit wells described in a previous section of this Chapter. Based on incrementally increasing total emergency storage to provide a volume at buildout equal to 12 hours of average day demand, each additional unit well would include a 0.4 million-gallon (MG) ground-level storage tank that would cost about $520,000. This is the amount included in the base cost for the unit wells presented in this report.

The MWU may wish to consider a larger emergency reserve. For example, to incrementally increase the emergency reserve with each additional unit well and reach an equivalent of 16 hours of maximum day demand at buildout, a 2.5 MG storage tank costing about $1,400,000 would be needed at each unit well. Table A6-11 in Appendix 6 presents for further consideration alternative unit well tank volumes and their associated capital costs for other combinations of emergency duration and demand during the emergency. If the MWU chooses to increase the emergency reserve above that presented in this report as the base alternative, the capital cost for each unit well would need to be increased accordingly.

## 6.9 Pipelines

In that pipelines normally comprise about 70 percent of the total water system value, defining and strategically implementing a hydraulically efficient pipeline network is crucial to achieving greatest value in water master plan improvements. A separate implementation strategy has been developed for the two pipeline categories, transmission pipelines and distribution pipelines.

### *6.9.1 Transmission*

The transmission network consists of those larger pipelines that serve to move large volumes across the service area to sub-areas where smaller pipelines distribute the water to customers. The transmission pipelines identified in this master plan for the MWU system generally consist of all pipelines 12-inches in diameter and larger, and most 10-inches in diameter whose service is not limited to localized distribution within an area of industrial/commercial/institutional (ICI) land use. Although not normally considered transmission pipelines, a few 6-inch and several 8-inch diameter pipelines are have been included in this pipeline master plan because each would strategically supplement deficient nearby existing transmission capacity at an economical cost.

The existing transmission network is discontinuous or undersized at several locations, resulting in localized flow restrictions and low pressures during peak demand periods, limited ability to move water continuously across the system, and areas sub-areas served by an individual pipeline with no backup looping. The implementation plan for adding transmission pipelines to the MWU presented in this study was developed following a general priority as follows:

- Connect new facilities to the existing transmission network.
- Supplement or replace undersized pipelines that connect existing facilities to the transmission network.
- Increase transmission capacity into areas of deficient fire flow capacity.
- Replace needed transmission capacity lost when a sub-area is transferred from one service zone to another.
- Add transmission pipelines at gaps or undersized pipelines in the existing transmission network to complete a continuous transmission framework
- Extend new pipelines to previously unserved areas as development progresses

The total quantity of transmission pipeline improvements identified in this study is presented for each pipe diameter in Table 6-7.

**Table 6-7**
**Pipeline Improvements**

| Pipeline Diameter, inches | Pipeline Length, linear feet | | |
|---|---|---|---|
| | 2007 thru 2025 | After 2025 | Total |
| 6 | 261 | 0 | 261 |
| 8 | 59,041 | 1,855 | 60,896 |
| 10 | 117,694 | 47,610 | 165,304 |
| 12 | 451,646 | 123,911 | 575,557 |
| 16 | 135,419 | 11,072 | 146,491 |
| 20 | 8,917 | 5,813 | 14,730 |
| **Total** | **772,978** | **190,261** | **963,239** |

The quantities shown in Table 6-7 above are the aggregate of all transmission pipeline segments identified by pipe ID number and presented in numerical order in Table A6-12 in Appendix 6. The information in Table A6-12 identifies the year in which construction for each pipeline is recommended to occur, from which the implementation phase can be determined. The location and implementation phases for the pipeline improvements are presented in the phased implementation plan described in the next section of this chapter.

### *6.9.2 Distribution*

As development progresses, smaller pipelines must be added to the system to distribute water to customers. These distribution pipelines would generally be 8-inches in diameter for residential areas, and 10-inches in diameter for areas of ICI development. These pipelines would be installed by developers according to criteria established by the MWU. Because these distribution pipelines will not contribute significantly to transmission network capacity, and because the timing, layout and quantity of distribution pipeline installation will be dictated by and costs incurred by developers, no attempt has been made in this study to quantify future distribution pipelines.

As previously unserved areas develop, developers will be required to extend transmission pipelines and add necessary distribution pipelines. The hydraulics of the system will have to be monitored to ensure that these improvements progress in a manner that does not create temporary hydraulic problems due to missing sections of transmission pipeline.

## 6.10 Implementation Plan

The phased implementation plan for capital improvements to the MWU water system is shown on Figure 6-8, Improvements Implementation Plan, bound at the end of this Chapter. The information in Figure 6-8 is subdivided and enlarged to show more detail in Figures A6-2.1 through A6-2.8 in Appendix 6. The improvements shown on Figure 6-8 are described in Table A6-13 in Appendix 6. In Table A6-13, the improvements are subdivided by individual system component, organized by year of installation, and listed with their associated capital costs. The yearly categorized quantities for pipeline improvements shown in Table A6-13 are subdivided into the pipeline segments defined by the distribution system model and presented with pipe ID number and capital cost in Table A6-14 in Appendix 6.

## 6.11 Summary of Costs

A summary of annual capital costs for Phase I, Years 2007 through 2010, are shown in Table 6-8.

**Table 6-8**
**Summary of CIP Capital Costs - Phase I**

| Improvement Category | Capital Cost, $1,000 | | | | | |
|---|---|---|---|---|---|---|
| | **2006** | **2007** | **2008** | **2009** | **2010** | **Total** |
| Wells | | 1,300 | 0 | 0 | 0 | 1,300 |
| Unit Wells | | 2,400 | 0 | 3,200 | 0 | 5,600 |
| Booster Stations | | 1,050 | 320 | 740 | 1,200 | 3,310 |
| PRV Stations (at booster station) | | 30 | 30 | 120 | 30 | 210 |
| PRV Stations (at utility structure) | | 150 | 0 | 0 | 0 | 150 |
| Storage | | 0 | 1,500 | 0 | 1,200 | 2,700 |
| Pipelines | | 2,159 | 5,552 | 3,630 | 5,378 | 16,719 |
| Demolition | | 0 | 0 | 0 | 0 | 0 |
| **Total** | Projects In Progress | **7,089** | **7,402** | **7,690** | **7,808** | **29,989** |

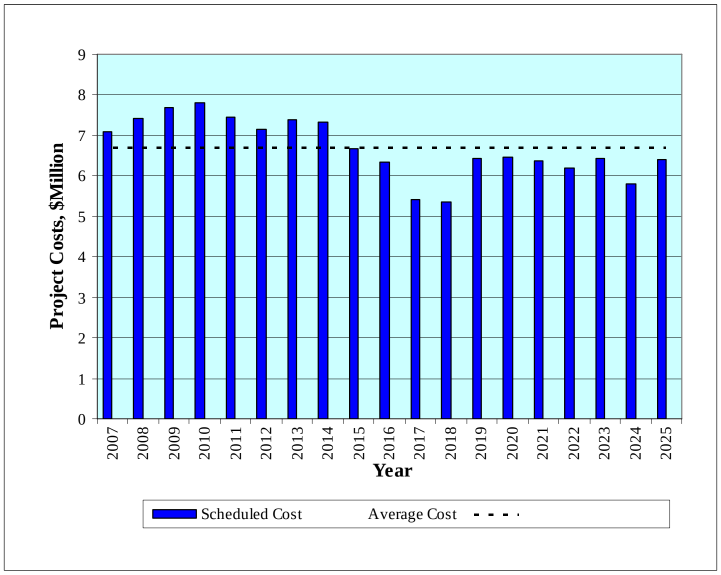
A summary of capital costs for Phase II, Years 2011 through 2025, aggregated into five-year sub-phases, are shown in Table 6-9.

**Table 6-9**
**Summary of CIP Capital Costs - Phase II**

| Improvement Category | Capital Cost, $1,000 | | | |
|---|---|---|---|---|
| | **2011-15** | **2016-20** | **2021-25** | **Total** |
| Wells | 0 | 0 | 0 | 0 |
| Unit Wells | 9,100 | 6,000 | 9,150 | 24,250 |
| Booster Stations | 1,590 | 0 | 1,160 | 2,750 |
| PRV Stations (at booster station) | 240 | 60 | 90 | 390 |
| PRV Stations (at utility structures) | 0 | 0 | 0 | 0 |
| Storage | 2,800 | 0 | 1,300 | 4,100 |
| Pipelines | 22,145 | 23,922 | 19,520 | 65,587 |
| Demolition | 100 | 0 | 0 | 100 |
| **Total** | **35,975** | **29,982** | **31,220** | **97,177** |
| **Average Annual** | **7,195** | **5,996** | **6,244** | **6,478** |

The yearly scheduled capital costs presented in Table A6-13 in Appendix 6 for Phases I and II, the study period for this report, are shown graphically in Figure 6-9.

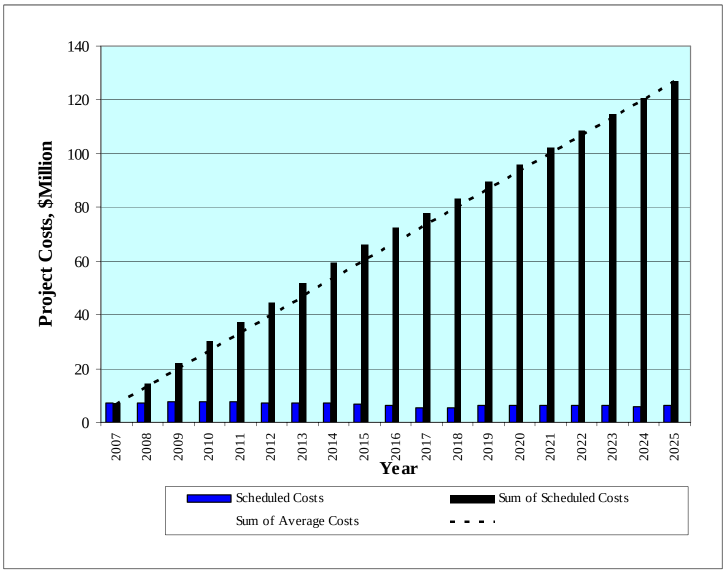
**Figure 6-9 Yearly Capital Costs**



Over the study period the scheduled capital costs for the CIP range from about $5.4 to $7.8 million per year. The yearly costs are generally uniform because for those pipelines for which the year of installation is flexible, projects have been strategically timed. By monitoring future system performance and performing predictive hydraulic modeling, the MWU may be able to further adjust the installation year of some pipeline improvements to attenuate year-to-year capital costs closer to the average cost shown in Figure 6-9.

The accumulation of yearly scheduled capital costs presented in Table A6-13 in Appendix 6 for Phases I and II are shown graphically in Figure 6-10.

**Figure 6-10 Cumulative Capital Costs**




The trend of capital costs shown in Figure 6-10 indicates that to construct approximately $127 million dollars in capital improvements over the last nineteen years of the twenty-year study period will require an average of about $6.7 million per year.

A summary of capital costs for Phase III improvements, which would occur after Year 2025, is shown in Table 6-10.

| Table 6-10<br>Summary of CIP Capital Costs - Phase III | |
|---|---|
| **Improvement Category** | **Capital Cost, $1,000** |
| Wells | 0 |
| Unit Wells | 21,000 |
| Booster Stations | 1,840 |
| PRV Stations (at booster station) | 150 |
| PRV Stations (at utility structure) | 0 |
| Storage | 3,700 |
| Pipelines | 10,920 |
| Demolition | 0 |
| **Total** | **37,610** |

## 6.12 Five-Year Capital Improvements Program

A summary of annual capital costs for Phase I, Years 2007 through 2010, plus the first year of Phase II, Year 2011, are shown in Table 6-11 to represent a Five-Year CIP.

| Table 6-11<br>Five-Year Capital Improvement Program | | |
|---|---|---|
| **Description** | **Purpose** | **Capital Cost, $[1]** |
| **Year 2007 Improvements** | | |
| **Wells** | | |
| Well31: New deep well | Serve West Campus demand; Replace UW10 capacity (reduced use) | 1,300,000 |
| **Unit Wells** | | |
| UW29: Treatment or replace | Provide treatment or replace well at new location | 2,400,000 |
| **Booster Stations** | | |
| BS106: Demolish & rebuild | Replace aging facility; Increase capacity and reliability; transfer normal supply to postpone supply expansion in Zone 7; transfer emergency supply until unit wells are built. | 850,000 |
| BS113: Change / add pumps | Improve fire supply capacity until fire storage is built in year 2012. Transfer normal and emergency supplies. | 200,000 |
| **PRV Stations (booster station)** | | |
| @ BS106 | Improve RES106 refill ability; Improve reliability | 30,000 |
| **PRV Stations (above-grade structure)** | | |
| @ Vondron Rd | Improve fire flow capacity in Zone 4; Improve reliability | 75,000 |
| @ Gammon Rd | Provide emergency supply transfer capability; Improve reliability | 75,000 |
| **Pipelines** | | 2,160,000 |
| | **Year 2007 Subtotal** | **7,090,000** |

| **Table 6-11** (continued)<br>**Five-Year Capital Improvement Program** | | |
|---|---|---|
| **Description** | **Purpose** | **Capital Cost, $(1)** |
| **Year 2008 Improvements** | | |
| **Booster Stations** | | |
| BS120: Change / add pumps | Increase capacity/reliability; transfer normal supply to postpone supply expansion; transfer emergency supply until wells are built | 320,000 |
| **PRV Stations (booster station)** | | |
| @ UW120 | Improve reliability; supply transfer during abnormal conditions | 30,000 |
| **Storage** | | |
| TWR216 (Raymond Road) – New 1.0 MG elevated tank | Eliminate current storage deficiency in Zone 9 | 1,500,000 |
| **Pipelines** | | 5,550,000 |
| | **Year 2008 Subtotal** | **7,400,000** |
| **Year 2009 Improvements** | | |
| **Unit Wells** | | |
| UW25: Change pumps | Provide head to deliver to Zone 123; First Zone 123 unit well | 200,000 |
| UW33: New unit well | Increase Zone 4 fire flow capacity; Reliability via dual zone supply | 3,000,000 |
| **Booster Stations** | | |
| BS115: Change pump, add VFD | Improve pressure near RES 115; transfer normal supply to postpone supply expansion; transfer emergency supply until wells are built | 100,000 |
| BS118: New booster station | Transfer normal supply to replace capacity lost by reduced use of Unit Well 10 and to postpone supply expansion in Zone 7 | 640,000 |
| **PRV Stations (booster station)** | | |
| @ UW33 | Improve reliability; supply transfer during abnormal conditions | 30,000 |
| @ BS115 | Improve reliability; supply transfer during abnormal conditions | 30,000 |
| @ BS118 | Improve reliability; supply transfer during abnormal conditions | 30,000 |
| @ BS126 | Improve reliability; supply transfer during abnormal conditions | 30,000 |
| **Pipelines** | | 3,630,000 |
| | **Year 2009 Subtotal** | **7,690,000** |
| **Year 2010 Improvements** | | |
| **Booster Stations** | | |
| BS129 (Felland Road): New | Replace BS129 Glacier Hts; Provide fire flow transfer from Zone 6E | 1,200,000 |
| **PRV Stations (booster station)** | | |
| @ BS129 | Improve reliability; supply transfer during abnormal conditions | 30,000 |
| **Storage** | | |
| TWR228 (Blackhawk) – New 0.75 MG elevated tank | Eliminate current storage deficiency in Zone 11 | 1,200,000 |
| **Pipelines** | | 5,380,000 |
| | **Year 2010 Subtotal** | **7,810,000** |
| **Year 2011 Improvements** | | |
| **Unit Wells** | | |
| UW3: Abandon | Groundwater contamination renders well unusable | 50,000 |
| UW45: New unit well | Replace UW3. Maintain Zone 6W supply capacity | 3,000,000 |
| **PRV Stations (booster station)** | | |
| @ BS125 | Improve reliability; supply transfer during abnormal conditions | 30,000 |
| @ BS215 | Improve reliability; supply transfer during abnormal conditions | 30,000 |
| **Storage** | | |
| TWR137: New 1.0 MG elevated tank | Eliminate current storage deficiency in Zone 10 | 1,500,000 |
| **Pipelines** | | 2,790,000 |
| **Demolition** | | |
| BS129 (Glacier Heights) | Obsolete facility replaced by BS129 (Felland Road) | 50,000 |
| | **Year 2011 Subtotal** | **7,450,000** |

(1) All capital costs reported in 2005 dollars for consistency with 2005 Infrastructure Management Plan

## 6.13 Current System Challenges Addressed by the Five-Year CIP

In addition to providing new facilities and pipelines for community growth, the MWU has faced a number of challenges serving current customers. Three primary challenges are related to low system pressure on the east side of Service Zone 6; low fire flow capacity in several areas; and unacceptable water quality from a few wells. These challenges are addressed by the Five-Year CIP improvements.

- **Low east-side pressure.** Low service pressures currently occur on the east side of existing Service Zone 6, in an area west of and within 2,000 to 4,000 feet of Interstate 39/90, south of Lien Road, and north of E. Buckeye Road. This land lies above elevation 988 feet above sea level, the upper limit that Service Zone 6E could reliably provide water pressure that meets service standards. Adjacent to existing Service Zones 2 and 3, this area will become part of the new Service Zone 123, as described in Section 5.2.1. Improvements that consolidate this area with Service Zones 1, 2 and 3 include:

    - Transmission pipelines that connect existing pipelines in these areas.
    - Selected valve closures that isolate the new Service Zone 123 from Zone 6E.
    - Transmission pipeline enhancements along the east edge of Zone 6E that replace the north-south transmission capacity that is converted to Zone 123 service.
    - Supply dedicated to Service Zone 123 by converting existing UW25 pumps.
    - Increased transfer capacity from Zone 6E to 123 by converting one pump at BS115 and by constructing new BS129 on Felland Road.

- **Low fire flow capacity.** Most of the fire flow deficiency identified by distribution modeling is in pockets throughout the Service Area and will be corrected over time as storage is constructed and transmission network capacity is enhanced. The first projects targeting improved fire flow capacity relate to areas of greatest capacity deficit and risk, and to widespread areas that can be corrected with modest improvements. The Five-Year CIP improvements that will improve fire flow capacity include:

    - For the Arbor Hills area, a transmission pipeline placed along the south side of Highway 14/151/18, which with BS118 will be used to transfer supply from Service Zone 6W to Service Zone 7.

- For Service Zone 123, fire storage will be located in RES129, and transferred by BS115 and BS129.
- For Service Zone 4, a transmission pipeline will enhance the connection between RES9/BS9 and existing transmission pipelines, and UW33 will provide additional supply.
- For Service Zone 5, increased pumping capacity at BS113 as an interim measure until RES113 can be built in 2012, and transmission pipeline enhancements.
- For Service Zone 9, fire storage in TWR216.
- For Service Zone 10, fire storage in TWR137.
- For Service Zone 11, fire storage in TWR228.

- **Water quality.** Three existing wells produce water with elevated manganese concentrations, and one well has produced detectable levels of carbon tetrachloride. The location and capacity of these wells are considered in the strategy of new well addition to achieve timely replacement or limited future use. Described in more detail in Section 5.2.2 of this Chapter, the Five-Year CIP includes system improvements that allows management of these wells for improved water quality as follows:

  - UW3 is currently offline and will be abandoned in 2011 when UW45 is constructed.
  - UW8 will remain in service until 2021 when it will be converted to reserve capacity.
  - UW10 will provide reserve capacity until 2023 when it will be replaced.
  - UW29 will provide reserve capacity until either treatment is provided for it's water, or it is replaced. Although assessment and selection of the preferred approach is outside the scope of this study, an allowance of $2,400,000 is included in the CIP to implement the selected approach.