Chapter 7

Alternative Analysis

7 Background

All work to this point utilized both engineering analysis and hydraulic modeling to identify deficiencies within the MWU system. A deficiency is defined as a condition that does not meet established Level of Service (LOS) in the system. Alternatives will be developed and analyzed that mitigate deficiencies within the system. A review and evaluation of identified alternatives determine the feasibility and cost effectiveness of mitigation of deficiencies and restore operation of the MWU system to enable it to meet its LOS standards. With growth of the City and projected water system demand increasing over the next 20 years, existing facilities will be optimized together with the addition of new facilities to continue to provide a high level of service to area consumers.

Chapter 7 will provide recommendations to remediate deficiencies and to prepare the system for future growth. Ultimately, the proposed improvements identified were tested within the hydraulic water system model to assure that the improvements will satisfy future water system needs and meet required LOS.

7.1.1 Purpose

Chapter 7 will present a map of potential project improvements in Figure A1 (Appendix 7A) and will be referenced throughout this section. Additionally, the ultimate improvement recommendations are documented in Figure B1 (Appendix 7B). Following identification of system deficiencies, numerous alternatives were identified as possible solutions to the presented deficiencies. Work summarized in this chapter describes the alternatives analysis process and ultimately the selection and modeling of the proposed projects for near term and long term improvement needs. It is the intent of this report to document the merit of each alternative and rank each project so that the most cost effective collection of projects can be assembled. The conclusions and recommendations of this report are outcomes of multiple meetings between SEH and MWU throughout the project.

7.1.2 Approach

7.2.1 Identified Deficiencies

Two design years were selected for water modeling, as discussed in the Chapter 6. The terms “year 2020” and “year 2040” represents what the water needs of the system between the years 2020 and 2030 (near term) and between the years 2030 and 2040 (long term), according to the assumptions in the Chapter 3. The terms “year 2020” and “year 2040” will be used to remain consistent for referencing to the Chapter3. However, the terms may be practically interpreted as “short term” and “long term”.

7.2.1.1 Water Supply

All Regions of the MWU system struggle to meet water supply standards during maximum demand periods. Tables 6-4 to 6-11 itemize the supply deficiencies in each case. The Consequence of Failure Simulations presented in Section 6.7.4 of this report evaluated performance during the maximum 10-Day period. Supply deficiencies were indicated when two wells were off line in Regions A and D.

Three items will be considered to mitigate water supply deficiencies; new supply; water transfer; existing facility enhancement. The total water supply developed by MWU has sufficient capacity to meet projected demands. However, the supply capacity is not in the area of supply need. Cost effectively moving water from an area of surplus to an area of need will be considered prior to development of new supply. Capacity of the water system to move water and the cost of pumping will determine the feasibility of utilizing existing water supply to mitigate identified supply deficiencies.

Existing facilities may have limited supply capacity due to water quality constraints, pumping limitations, and overall system hydraulic capacity. Constructing treatment facilities and improving pump and system capacity may result in additional supply capacity.

7.2.1.2 Interzone Pumping

Tables 6-13 and 6-14 illustrate the results of the interzone pumping analysis. BPS 213 and possibly BPS 129 have been identified as pumping deficiencies. BPS 213 upgrades are necessary to meet fire flow demands in Zone 5. BPS 129 relocation would convert the Felland Road Reservoir into a two zone facility which improves reliability and redundancy in Zone 3.

7.2.1.3 Storage

MWU has provided sufficient storage across the water system. The only deficiency identified was Zone 5 and that will be mitigated with improvement to BPS 213.

7.2.1.4 Water Quality

Water quality concerns are identified as follows:

- Elevated Iron and Manganese concentrations: Wells 8, 17, 19, 24, 27, 28 and 30
- Elevated Radium: Wells 19 and 27
- VOC: Wells 6, 9, 11, 18
- Sodium and Chloride: (Road Salt) Well 14
- PFAS: Well 15
- Storage mixing: The addition of mixers may be considered in Reservoirs 115, 19, 20, and 26

MWU staff itemized water quality projects for consideration in the Master Plan Capital Improvement Program. The focus of the alternative evaluation was hydraulic capacity and water quality projects will be included and prioritized in conjunction with recommended supply and hydraulic improvements. The computer modeling of the system assumed that all wells were available at full capacity and did not consider a reduction in supply capacity. If, adding treatment to a well is determined to be unfeasible, replacement of that well should be considered to sustain long term supply capacity, system reliability, and well redundancy.

7.2.1.5 Facility Condition and Renewal

Facility renewal needs are itemized in Section 6.9.1 in Chapter 6. MWU is developing a comprehensive Asset Management Program that will monitor asset condition and develop a long term asset renewal program for the Utility. Reinvestment costs will be incorporated into the Capital Budget Process to fund infrastructure replacement and renewal. No additional analysis or information will be developed in this Water Master Plan with regard to scheduling facility reinvestment projects.

7.3 Potential Alternatives

The Water Master Plan team developed a comprehensive list of potential alternatives to mitigate identified deficiencies. The list of potential projects to be evaluated includes unbuilt facilities recommended in the previous water master plan as well as new projects developed during this master planning process. Each project was first summarized in relation to function, layout, effectiveness, performance and cost. Projects were analyzed with regard to flexibility and application to multiple deficiencies. Project alternatives were evaluated and scored by MWU engineering staff using the Utility' triple bottom line asset management prioritization process. The project scoring established criticality, scheduling, and determined recommended projects.

The list of improvement alternatives are cataloged in Appendix 7A of this chapter. The characteristics and operational objectives of each alternative are summarized below.

7.3.1 Proposed Project Alternative Development

A short summary of potential projects is provided below and a more thorough description of each is included in Appendix 7A. With each project alternative scored and ranked, specific projects were selected and paired together to address the expected deficiencies in both the short term (2020) and long term (2040) planning periods. Proposed projects represent the selected alternatives deemed to be the best value for addressing future water system needs. The updated water distribution model water was then utilized to "test" the function and operation of the water system with the proposed projects in place while utilizing short term (2020) and long term (2040) water demand projections.

7.3.2 Supply Alternatives

Each alternative option listed below is further summarized in Appendix 7A, which include location maps. A capital improvement project update was developed in 2022/2023, which includes the addition of new potential alternatives, or the combination of existing projects discussed in the summaries below, summarized in Appendix 8. The summaries provide a high-level description of each alternative considered.

Supply alternatives include new wells, refurbishing existing wells, and water transfer options from areas of surplus supply. Installing a new well or refurbishing an existing well may result in difficult permitting challenges, siting issues, or excessive cost. A new source of supply may not be necessary if it is feasible to move water from on Zone to another.

7.3.2.1 East Side Supply Alternatives

7.3.2.1.1 S.E01 - Station 124 (Interzone Transfer)

Deficiency Addressed: East Side Water Supply and West Side Water Supply

Description: Pump water from an area of surplus to an area of need. A booster pumping station located near the Yahara River would move water from west to east across the Isthmus and the Yahara River.

Objective: Construction of BPS 124 would involve siting a water pumping station near the Yahara River to pump water from Zone 6w to Zone 6e. The project would help to address the supply deficit in Region A and Region B.

Flexibility and Other Benefits: BPS 124 would have a PRV installed to transfer water by gravity from 6e to 6w in the event of a deficit on the West side. BPS 124 would utilize existing supply capacity and be more economical than the construction of a new well.

Challenges: Community may not readily accept a new pumping station in the neighborhood. Siting could be difficult and expensive.

Capacity: 2,200 gpm or 3.1 MGD

Cost: Site and Pumping Station $3.3 million; Piping: $1.4 million

7.3.2.1.2 S.E02 – Unit Well 8 – Conversion to a 3 Zone Well (Restoration of Existing Capacity)

Deficiency Addressed: East Side Water Supply and West Side Water Supply

Description: Reconstruct Well 8; configure booster pumps to move water between three pressure zones: Zones 4, 6e and 6w.

Objective: Move water from an area of surplus to an area of need to maximize supply sources

Flexibility and Other Benefits: Combined with project S.E08, a key centrally located municipal well would provide significant operational benefits to the system. Moving water between three zones will delay the need for an additional east side well. With the addition of treatment, Well 8 is returned to full production capacity.

Challenges: Permitting would involve the community, City Parks, and potentially shoreline concerns. Local residents would have concerns about the contamination at the Kipp Corporation site. Significant public outreach would be required.

Capacity: 2,200 gpm or 3.1 MGD

Cost: Site and Pumping Station $3.3 million; Piping: $1.4 million

S.E08 – Unit Well 8 Treatment and Capacity Upgrades (combined with S.E02)

Deficiency Addressed: Facility Renewal and Water Quality Improvement

Description: Reconstruct Well 8; Install iron and manganese filtration, combine with Project S.E02

Objective: Restore lost water production capacity to the system and renew an aging facility.

Flexibility and Other Benefits: Renewal of a key centrally located municipal well will provide significant operational benefits to the MWU supply system. Installing iron and manganese filtration will improve water quality, reduce customer complaints, and lower flushing requirements.

Challenges: See Project S.E02 above. Limited space is available on site, would need to preserve and enhance the sledding hill. Property issues with the Park would need to be resolved.

Capacity: 2,200 gpm or 3.1 MGD filtration capacity

Cost: Facility Reconstruction with Filters $8.2 million;

7.3.2.1.3 S.E03 – Lake Monona Crossing – (Not considered feasible due to cost and permitting)

Deficiency Addressed: East Side Water Supply and West Side Water Supply

Description: Convey water from Zone 6w to Zone 6e to supplement supply

Objective: Move water by gravity from west to east. Project would need to be tied into a pumping system to benefit Zone 6e

Flexibility and Other Benefits: Moves water both ways with pumping. Move supply from area of surplus to an area of need and may delay the need for an addition municipal well.

Challenges: Capacity may be limited; Permitting, difficult construction, environmental opposition. Additional costs required to modify Well 8 or BPS 109 to accommodate pumping requirements. **Not considered feasible.**

Capacity: 1,000 gpm

Cost: $6.6 million plus pump system and piping modifications

7.3.2.1.4 S.E04 – City of Monona Transmission Main - (Not considered feasible due to capital and operating cost)

Deficiency Addressed: East Side Water Supply and West Side Water Supply

Description: Convey water between Zone 6w and Zone 6e to supplement supply

Objective: Move water by gravity from west to east. Project would need to be coordinated with Well 31 and BPS 109 for pumping.

Flexibility and Other Benefits: Moves water between east and west sections of the system benefiting water supply without the addition of a municipal well.

Challenges: Permitting and construction of a long pipeline through a neighboring municipality. Requires the use of two pumping systems to move water from Zone 6w to Zone 6e where it is needed. **Not considered financially and operationally feasible.**

Capacity: 2,100 gpm

Cost: $7.7 million plus pump system and piping modifications

7.3.2.1.5 New East Side Unit Well: Projects 33A; 33B and 33C (New Supply)

S.E05 – New Unit Well 33A

Deficiency Addressed: East Side Water Supply

Description: Construct new well at the Felland Road Reservoir to supplement East side supply.

Objective: Increase east side water supply capacity, redundancy and reliability.

Flexibility and Other Benefits: Takes advantage of an existing facility using the 6.0 million gallon reservoir to provide service to Z 6e and to Z 3 with the addition of BPS 129. Converts the Felland Road Reservoir into a two zone facility. This project will be constructed in an area of no known contamination and near anticipated growth. This site was identified as a preferred location in the ESWS plan.

Challenges: There may be some opposition from the neighborhood to siting a well at Felland. A filter will be required to remove expected iron and manganese in the groundwater supply.

Capacity: 2,100 gpm

Cost: $6.3 million

S.E06 – New Unit Well 33B

Deficiency Addressed: East Side Water Supply

Description: Construct new well south and east of the East Washington Avenue and Stoughton Road intersection to supplement East side supply.

Objective: Increase east side water supply capacity, redundancy and reliability.

Flexibility and Other Benefits: The well site is near large water transmission piping and will benefit from the existing hydraulic capacity. The well will be hydraulically close to both the Bunker Hill Reservoir and the Felland Road Reservoir enabling them to be easily refilled during the night.

Challenges: This project will be constructed in an established neighborhood in Zone 6e. Potential construction and permitting challenges are anticipated due to the proposed location being in the general proximity of the airport, military and MATC. Water quality in the area presents another potential challenge to overcome as groundwater contamination of PFAS has been documented in the surrounding area. A filter will be required to remove expected iron and manganese in the groundwater supply.

Capacity: 2,100 gpm

Cost: $9.5 million

S.E07 – New Unit Well 33C

Deficiency Addressed: East Side Water Supply

Description: Construct new well near the intersection of Buckeye Road and Sprecher Road to supplement East side supply.

Objective: Increase east side water supply capacity, redundancy and reliability. Add redundancy to supply to Zone 3.

Flexibility and Other Benefits: The well site is near large water transmission piping and will benefit from the existing hydraulic capacity. The well will be hydraulically close to both the Bunker Hill Reservoir and the Felland Road Reservoir enabling them to be easily refilled during the night. This project would be constructed in a future development area in Zone 3, which would increase the redundancy in the zone.

Challenges: Well would be remote from other Zone 3 facilities which could drive costs up due to additional piping improvements. A filter will be required to remove expected iron and manganese in the groundwater supply.

Capacity: 2,100 gpm

Cost: $9.9 million

7.3.2.1.6 T.E01 Booster Station 213 Upgrades (Interzone Transfer)

Deficiency Addressed: Zone 5 fire flow capacity and pumping reliability

Description: Upgrade the existing booster pumping station to increase capacity. Addition of a generator to provide needed reliability.

Objective: Provide fire flow capacity to Zone 5 and standby electrical power.

Flexibility and Other Benefits: Relatively low cost improvement that would allow Zone 5 to be expanded.

Challenges: Limited space available. Required piping improvements may be difficult to construct due to a required rural to urban conversion of local streets.

Capacity: Redundant 1,000 gpm pumps

Cost: $1.7 million

7.3.2.1.7 T.E02 – Booster Pump Station 129 Relocation (Interzone Transfer)

Deficiency Addressed: Operational flexibility and additional reliability for Interzone Transfer.

Description: Reconstruct BPS 129 at the Felland Road Reservoir to provide redundant supply to Zone 3.

Objective: Relocate an existing pump station to a location that provides a larger beneficial impact to the system to address the water deficit in Region B.

Flexibility and Other Benefits: Relatively low cost improvement that would improve Zone 3 supply and support development east of the interstate highway on the far east side of the service area. The project converts the Felland Road Reservoir to a two zone facility. With the installation of a PRV, water could move from Zone 3 to Zone 6e.

Challenges: Anticipate some neighborhood opposition to the project. Would be coordinated with development of the area to maximize benefit.

Capacity: Redundant 2,100 gpm pumps

Cost: $1.5 million

7.3.2.1.8 T.E03 – Booster Pump Station 109 (Located at Unit Well 9 – Interzone Transfer)

Deficiency Addressed: Supply Deficiency in Zone 6e

Description: Upgrade transfer capacity from Zone 4 to Zone 6e.

Objective: Provide additional capacity to transfer water from Zone 4 to Zone 6e to reduce the supply deficiency in Zone 6e.

Flexibility and Other Benefits: Relatively low cost improvement that would utilize surplus capacity in Zone 4 to supplement supply in the south end of Zone 6e. With construction of transmission main, BPS 109 may have the capacity to pump directly to Zone 3. Also addition of a PRV will allow water to move from Zone 6e into Zone 4.

Challenges: Limited space available in a fully developed older neighborhood. Additional trunk system pipe capacity would be required to realize full benefit from the pumping station improvement.

Capacity: Redundant 2,100 gpm pumps

Cost: $2.3 million

7.3.2.2 West Side Supply Alternatives

7.3.2.2.1 New West Side Well – Projects S.W01; S.W02; and S.W03 (New Supply)

S.W01 – New Unit Well 32

Deficiency Addressed: Supply Deficiency in Zone 8, 10, and 11

Description: Construct a new well near the intersection of Mineral Point Road and South Point Road in Pressure Zone 10.

Objective: Provide additional supply capacity on the far west side in Zone 10 within a rapidly growing area.

Flexibility and Other Benefits: Unit well would be constructed as a two zone well feeding Zones 8 and 10. Well is in an area of no known contamination and will support development in the area. This site was selected as a part of the 2006 Water Master Plan. Locating a point of supply centrally located in Zone 10 will result in reduced water main size to without impacting fire flow capacity.

Challenges: It is expected that an iron and manganese filter will be required due to typical groundwater quality. Some piping additions will be required to convey water to Zone 8.

Capacity: 2,100 gpm

Cost: $8.5 million

S.W02 – New Unit Well 34

Deficiency Addressed: Supply Deficiency on far west side

Description: Construct a new well near the intersection of Mineral Point Road and South Whitney Way on the border between Pressure Zones 7 and 8.

Objective: Provide additional supply capacity on the far west side to support a rapidly growing area. Provide transfer capacity to pump water from Zone 7 to Zone 8. Note: This location could be a potential well site for a replacement of Well 14.

Flexibility and Other Benefits: Unit well would be constructed as a two zone well feeding Zones 7 and 8. The facility will also serve as a pumping station to transfer water from Zone 7 to Zone 8. Construction of a transmission main on Whitney Way to University Avenue to the north would allow the facility to serve Zone 6w and potentially replace Well 14. This site was selected and purchased by MWU in the 1970's as a potential future well location. The site is identified in the 2006 Water Master Plan.

Challenges: Well is in a fully developed area with known contamination to the southwest. It is expected that an iron and manganese filter will be required due to typical groundwater quality. Due to the proximity of Garner Park, there could be some neighborhood opposition. A storm water pond is located just to the north of the site that would need to be modified.

Capacity: 2,100 gpm

Cost: $8.5 million

S.W03 – New Unit Well 35

Deficiency Addressed: Supply Deficiency on far west side

Description: Construct a new well in the southwest portion of the water system. Well location could supply Zones 7, 8, 9, and 10 with piping installation.

Objective: Provide additional supply capacity on the far west side to support a rapidly growing area.

Flexibility and Other Benefits: Unit well would be constructed as a multiple zone well potentially feeding Zones 7, 8, 9, and 10. Well would be sited in an area of need.

Challenges: It is expected that an iron and manganese filter will be required due to typical groundwater quality.

Capacity: 2,100 gpm

Cost: $8.4 million plus piping improvements

7.3.2.2.2 S.W04 – Isthmus Transmission Line (Interzone Transfer)

Deficiency Addressed: Supply Deficiency in Zone 6w and Zone 6e

Description: Connect Zones 6e and 6w through UW 24 with a transmission main across the Isthmus to include a Yahara River Crossing.

Objective: Provide interzone transfer capacity and operational flexibility across the Isthmus.

Flexibility and Other Benefits: Using UW 24 as a water transfer point would maximize existing facilities and potentially reduce construction costs. The transmission main would discharge water from Zone 6e directly into the UW 24 reservoir and then pump water into the system using existing pumping equipment. The transmission main could also permit pumping water from Zone 6w to Zone 6e using the existing pumping equipment. This configuration has the possibility to save construction costs. Moving water from one area to another may delay the need for new supply.

Challenges: Constructing a large transmission main across the Isthmus would be difficult and possibly very costly. Other piping improvements may also be required and would drive up costs.

Capacity: 3.4 MGD

Cost: $4.6 million

7.3.2.2.3 T.W01 - Booster Pump Station 114 (Interzone Transfer)

Deficiency Addressed: Interzone transfer capacity and supply reliability on the far west side. Supplement supply to the far west side.

Description: Construct a booster pumping station in the general vicinity of UW 14 to transfer water from Zone 6w to Zone 8.

Objective: Provide interzone transfer capacity and operational flexibility to move water from an area of surplus to an area of need.

Flexibility and Other Benefits: Could utilize current Well 14 site if Well 14 is abandoned. Piping could be configured to provide supply/transfer to Zones 7 & 8. Installing a PRV would allow water to transfer from Zones 7 & 8 to Zone 6e or specifically to the UW 14 service area.

Challenges: Distribution system piping is undersized to permit sufficient transfer capacity. Significant transmission capacity would need to be added to the system. Scheduling multiple pipe projects could delay implementation.

Capacity: 3.3 MGD

Cost: $4.9 million

7.3.2.2.4 T.W02 - Booster Pump Station 134 (Interzone Transfer – Part of Well 34 Project)

See the description and objectives of Well 34 above. The booster pumping station could be built as a stand-alone project if the Well 34 project does not move forward.

7.3.2.2.5 T.W03 - BPS 106 Discharge Line (Interzone Transfer)

Deficiency Addressed: Supply Deficiency in Zone 8

Description: Construct a direct connection from the Glenway Reservoir (Res 106) Zone 6w to Zone 8. This would eliminate the need to repump into Zone 8 from Zone 7.

Objective: Provide interzone transfer capacity and operational flexibility to transfer water from Zone 6w to the far west side of the water system.

Flexibility and Other Benefits: Using Reservoir 106 as a water transfer point with direct pumping to Zone 8 would maximize existing facilities and potentially reduce construction costs. The transmission main could also permit moving water from Zone 8 to Zone 6w using. Transferring water from one area to another may delay the need for new supply.

Challenges: Constructing a large transmission main may be difficult to schedule and coordinate with street work. Other piping improvements within Zone 8 may also be required and would drive up costs.

Capacity: 3.3 MGD

Cost: $6.6 million

7.3.2.2.6 T.W04 - BPS at UW 12 (Interzone Transfer – Part of UW 12 Conversion/Rebuild)

This project is part of the UW 12 reconstruction and would not be considered as a separate project.

7.3.2.2.7 T.W05 – Upgrade of Booster Pump Station 128 (Interzone Transfer)

Deficiency Addressed: Supply capacity, reliability, and redundancy to Zone 11.

Description: Upgrade the firm pumping capacity at BPS 128 to 2,100 gpm using either 2 each 2,100 gpm booster pumps or 3 each 1,100 gpm pumps.

Objective: Provide interzone transfer capacity and operational flexibility provide reliable pumping capacity to Zone 11.

Flexibility and Other Benefits: The upgrade would be made at the existing booster pumping station facility resulting in reduced costs. This upgrade would provide supply redundancy to Zone 10 to the south if needed and match the capacity of the booster pumps at Well 26.

Challenges: May present operational challenges on the pump suction and result in low pressures.

Capacity: 3.0 MGD

Cost: $0.8 million

7.3.2.2.8 T.W06 - BPS at Old Well 10 (Interzone Transfer)

Deficiency Addressed: Supply deficiency in the far west side.

Description: Using the former Well 10 site as a booster pumping station to transfer water from Zone 6w to Zone 7 and 8.

Objective: Provide interzone transfer capacity and operational flexibility.

Flexibility and Other Benefits: The use of the Well 10 facility could save siting and construction costs. Neighborhood residents are accustomed to a MWU facility at this location. The high pressure area in the Nakoma Neighborhood would be converted to Zone 6w and used as transmission mains.

Challenges: The available supply is limited to 500 gpm and the need is 2,100 gpm. Additional surplus supply would require significant piping improvements at great cost. This alternative is not considered to be feasible and will not be considered further.

Capacity: 3.0 MGD needed: 0.75 MGD available

Cost: $6.8 million

7.3.2.2.9 T.W07- Revise PZ 8 boundaries - 3 (Interzone Transfer)

Deficiency Addressed: Supply deficiency in the far west side

Description: Using existing pumping facilities, move water from Zone 6w to Zone 7 and then to Zone 9 and construct piping to provide gravity flow to Zone 8. Construction would include 3,100 feet of 16" main, a flow and pressure control station, and automation modifications.

Objective: Provide interzone transfer capacity and operational flexibility to move water from Zone 6w to the far west side.

Flexibility and Other Benefits: The project would use existing booster pumping station facilities resulting in no additional facility requirement. Connecting Zone 9 and Zone 8 would provide an emergency intertie that could delay the construction of a new well on the far west side.

Challenges: Operational coordination and capacity may limit effectiveness of this concept. Currently capacity is limited to 1.5 MGD when 3.1 MGD is needed. No simple means to increase capacity significantly.

Capacity: 1.5 MGD available: 3.0 MGD needed.

Cost: $2.1 million

7.3.2.2.10 T.W08 – BPS 112 at Elver Park (Interzone transfer)

Deficiency Addressed: Supply deficiency in the far west side

Description: Construction of a new booster pumping station in the Elver Park area at the west end of Hammersley Road to pump water from Zone 7 to Zone 8.

Objective: Provide interzone transfer capacity and operational flexibility to move water from Zone 7 to the far west side.

Flexibility and Other Benefits: The project would move water through the existing distribution system to the High Point Road Reservoir (Res 26). This configuration would supplement flow from UW 12 and the proposed BPS 114 providing supply reliability and redundancy. BPS 112 could also enhance the transfer of water from Zone 6w through BPS 118.

Challenges: Could have some siting challenges and may require additional piping to mitigate potential pressure swings.

Capacity: 3.3 MGD

Cost: $2.9 million

7.3.2.2.11 T.W09 –Booster Pump Sta. 106 Discharge to Zone 8 (Interzone Transfer)

This alternative is very similar to Alternative T.W03 and would provide efficient transfer of water from Reservoir 106 to the west side of the water system. The Zone 8 pressure zone boundary would be modified to the east and extended into Zone 7, shortening the length of the dedicated pipe through Zone 7. This configuration would allow for additional pumping units to be installed at the existing Reservoir 106 facility to facilitate the pumping of water from the reservoir to Zone 8.

See Alternative T.W03 above for additional information.

7.3.2.2.12 T.W10 - Arbor Hills WM Upgrade (Piping Modifications)

Deficiency Addressed: Supply deficiency in Zones 7 and 8.

Description: A parallel pipe line from BPS 118 to Zone 7 will be constructed along the Beltline Highway frontage road providing additional hydraulic capacity.

Objective: Improve interzone transfer capacity and operational flexibility at BPS 118 to move water from Zone 6w to Zone 7.

Flexibility and Other Benefits: Improving hydraulics and reducing head loss will manage the pressures around BPS 118 while allowing increased flow up to 2,000 gpm.

Challenges: Construction along the Beltline Highway Frontage Road will be difficult due to existing buried utility conflicts. This could drive cost up significantly.

Capacity: 3.0 MGD

Cost: $3.6 million

7.3.2.2.13 T.W11 - Raymond Road WM Upgrade (Piping Upgrade – Interzone pumping)

Deficiency Addressed: Supply deficiency in Zones 7 and 8.

Description: Replacing and upgrading the pipe in Raymond Road from Verona Road to McKenna Boulevard will provide additional east/west hydraulic capacity providing additional capacity to transfer water between zones.

Objective: Improve interzone transfer capacity and operational flexibility across Zone 7 to improve water transmission to Zone 8 from BPS 118.

Flexibility and Other Benefits: Improving hydraulics in Zone 7 will increase system reliability and operational flexibility while replacing critical infrastructure.

Challenges: Scheduling significant water main replacement projects may delay the project and force use of several phases over multiple years.

Capacity: 3.0 MGD

Cost: $3.6 million

7.3.2.2.14 T.W12 - Arbor Hills Cannon Ball Pipeline Modifications (Pressure Management)

Deficiency Addressed: High pressures and potential limited pump capacity at BPS 118.

Description: This alternative could work in conjunction with other Arbor Hills BPS 118 modifications. The alternative would isolate the Cannon Ball pipeline from the Arbor Hills neighborhood using several PRV's that would lower the pressure to more acceptable levels for consumers. Pressures in the pipeline could be raised with higher flow rates without concern.

Objective: Improve interzone transfer capacity and operational flexibility at BPS 118 to move water from Zone 6w to Zone 7.

Flexibility and Other Benefits: Improving hydraulics and increasing flow from BPS 118 while controlling pressures in Arbor Hills will improve operations, minimize main breaks and reduce system pressures to a manageable level.

Challenges: Lowering the pressure could cause issues with fire protection sprinkler systems.

Capacity: 3.0 MGD

Cost: $2.0 million

7.3.3 Water Quality Alternatives

Water quality alternatives are specifically tailored for existing facilities. It is assumed that any new well proposed would be constructed with the appropriate treatment system to meet MWU LOS standards and Federal and State regulations. It is also assumed that existing facilities will be maintained and there will be no limit on water production due to water quality concerns. If the analysis of a water quality issue at an existing well results in abandonment of that water source, it is assumed that the well will be replaced with a new source of supply. Hydraulic analysis completed in this Master Plan is based on maintaining the existing supply system and having all of the existing wells available and operational.

Water quality mitigation alternatives include wellhead treatment, abandonment of a well with replacement, refurbishing existing wells, and water transfer options from areas of surplus supply. Installing a new well or refurbishing an existing well may result in difficult permitting challenges, siting issues, or excessive cost.

7.3.3.1 Iron and Manganese Treatment Alternatives

Elevated Iron and Manganese concentrations exists at: Wells 8, 17, 19, 24, 27, 28 and 30

Iron and manganese are secondary contaminates and are sometime referred to as nuisance contaminates. Elevated levels of iron and manganese will result in colored water events, staining of plumbing fixtures and laundry, and is not acceptable to area residents. Iron and manganese can be removed using oxidation and filtration techniques relatively easily. MWU has iron and manganese filters in operation at Wells 29, 7, and 31 using pyrolucite media and chlorine oxidation. Iron and manganese filters will reduce the contaminate in the finished water to non-detectable levels.

Retrofitting an existing well with filtration will cost $4 to $5 million, will require additional space for the filters and the backwash facilities, and will increase operations costs due to a small increase in chemicals, higher pumping energy requirements, and backwash water disposal costs.

7.3.3.2 Radium Treatment Alternatives

Elevated Radium: Wells 19 and 27

Radium is regulated by the Safe Drinking Water Act as a primary contaminate. HMO addition and filtration is considered the best available technology for radium reduction and is very similar in many aspects to iron and manganese filtration. 90% removal of the radium is feasible using HMO filtration. The challenge of radium removal is disposal of the waste materials which impacts the efficiency of removal.

Retrofitting an existing well with radium HMO filtration will cost $5 to $6 million, will require additional space for the filters and the backwash facilities, and will increase operations costs due to an increase in chemical costs, higher pumping energy requirements, and backwash water disposal costs.

7.3.3.3 VOC Treatment Alternatives

VOC: Wells 6, 9, 11, 18

Volatile Organic Compounds (VOC) are regulated by the Safe Drinking Water Act as a primary contaminate. Air stripping or granular activated carbon (GAC) filtration are considered the best available technology for VOC reduction. 90% removal of the VOCs is feasible using air stripping or GAC. MWU installed a low profile air stripper at Well 15 in 2013 and has excellent treatment results, lowering VOC levels by more than 90%. One complication with the hardness in the Madison groundwater is the aeration raises the pH of the finished water and reduces the carbonate solubility resulting in wide spread scaling. Acid is added at Well 15 to mitigate this situation which adds to the cost of air stripping treatment.

Retrofitting an existing well to add air strippers or GAC filtration will cost $6 to $6 million, will require additional space for the equipment, and will increase operations costs due to an increase in chemical costs and higher pumping and blower energy requirements.

7.3.3.4 Sodium and Chloride Treatment Alternatives

Sodium and Chloride: (Road Salt) Well 14

Sodium and chloride levels are regulated by the Safe Drinking Water Act. Treatment to remove sodium and chloride from a drinking water source is extremely expensive. The best available technology for sodium and chloride reduction is reverse osmosis or specialized ion exchange. Mixing with other sources to dilute the sodium and chloride and therefore reduce it is also an option.

Road salt has been used for decades to maintain winter roads for safe travel. Tons of salt have been applied and have entered the groundwater environment. Recent efforts to reduce and control the use of salt on roads and parking lots will take decades to reduce its overall impact on the drinking water supply. Due to the cost of constructing and operating a sodium and chloride treatment system it would seem to indicate that the best option would be to abandon the well and replace it with a well not impacted by road salt.

The recommended alternative for Well 14 is to abandon the well and replace the lost capacity with either a new well or with interzone transfer pumping capacity.

7.3.3.5 PFAS/PFOA Treatment Alternatives

PFAS: Well 15

Per- and polyfluoroalkyl substances (PFAS) are an emerging contaminate that has not been regulated by the Safe Drinking Water Act as a primary contaminate. Widely used in industry and known as the forever chemicals, PFAS can be removed by granular activated carbon (GAC) filtration and ion exchange. MWU tested for and found PFAS in several wells with Well 15 having the highest concentration. With no regulatory level established, a treatment system may or may not be required. An alternative to treatment to remove the PFAS would be to abandon the well and site a new well away from any known sources of the contaminate.

Retrofitting an existing well to add GAC filtration or ion exchange will cost $4 to $6 million depending on the capacity, will require additional space for the equipment, and will increase operations costs due to an increase in chemical or media costs and higher pumping energy requirements.

7.3.3.6 Reservoir Mixing Alternatives

Storage mixing: The addition of mixers may be considered in Reservoirs 115, 19, 20, and 26

High water age can result in depleted free chlorine levels raising the risk of biological contamination of a reservoir. Reservoir short circuiting and dead spots within the tank can lead to problems. Static, sometimes referred to as passive mixers, or active mixers can be retrofitted into a reservoir to reduce the risk of chlorine depletion. Configuration of the mixer will vary and cost between $100,000 and $200,000 depending on the configuration and size of the tank.

Adding mixing to a tank can be accomplished during painting when the tank is out of service. It is recommended that mixers be considered for Reservoirs 115, 19, 20, and 26.

7.3.4 Proposed Project Alternative Evaluation & Ranking

During the implementation of the MWU Asset Management Program, MWU developed a process to review and prioritize multiple alternatives. The process followed a Triple Bottom Line (TBL) methodology to evaluate and rank alternatives. The concept of TBL demands that a Utility consider the interests of all stakeholders in the evaluation of a project by considering three general areas; Environmental/Regulatory; Financial; and Social/Community. MWU added a fourth category, Engineering/Construction, to be able to consider unique challenges that individual projects may encounter.

For the analysis, the scoring breakdown was 30% to Environmental/Regulatory; 30% to Financial; 30% to Social/Community; and 10% to Engineering/Construction. This methodology gave equal weight to the TBL components while considering construction and permitting challenges.

Environmental/Regulatory/Level of Service: The environmental/regulatory/LOS bottom line refers to sustainable environmental practices, regulatory practice, and customer service. MWU endeavors to benefit the natural order and minimize environmental impact.

Financial: – The financial bottom line deals with the economic value or impact created by an alternative. The intent is to maximize return on investment, value added to the community, or reduction in core risk by a project. Alternatives are scored on cost efficiency; operational improvement; risk reduction; project coordination and other benefits.

Social/Community: – Social and community equity focuses on public and organizational needs, mission, individual needs, and community issues. The intent is to provide equity for all stakeholders without regard to social or economic status or position. Social equity seeks to provide benefit to many constituencies and not to exploit or endanger any group.

Engineering and Construction: – Engineering and construction focus is on project siting and permitting feasibility, operational complexity, and overall constructability. This scoring seeks to ensure that the alternative can be located, permitted, constructed, and then operated and maintained in a reasonable and efficient manner. Identifying potential roadblocks could avoid project failure during implementation.

7.3.5 Alternative Project Scoring

Table 7-1 below provides a list of the project alternatives being considered and scored based on the TBL methodology noted above. The weighted score will determine the project priority ranked from high to low. This list is not rigid and must be coordinated with MWU financial capacity and needs. The ranking of project alternatives shall be routinely updated. Asset management procedures using core risk and business risk analysis shall be used to determine the most cost effective alternative for the deficiency identified.

Table 7-1 – Alternative Project Scoring

Project #	Alternative	Draft Budgetary Costs	Project Planning Horizon	Weighted Score	Notes
WQE-01 WQE-02 WQE-03	Well 19 Water Treatment Mitigation	Treatment Total: $5.8M Blending $2.0M to $3.0M Replacement $9.7M	2023	78	Critical supply source for the west side and the University of Wisconsin.
SE-01	Well 8 Water Quality Mitigation and Conversion to 3 Zone Facility	Total: $12.6M Several alternatives to consider	2025 to 2030	78	Rebuilds a critical east side supply source in the system. Will transfer water between three pressure zones. Cost will be high due to location. Neighborhood may oppose disruption of the park.
TW-04	UW 12 Upgrade and Conversion to a Two Zone Well	UW 12 Upgrade: $4.5M (Designed in 2018)	2024	76	Project designed and ready for bid in 2018 when funding was cut. Piping connection to Zone 8 is complete. Key transfer point between Z7 & Z8 on the west side.
WQE-04	UW 27 Fe, Mn & Radium Filter	Total: $7.4M	2030	74	Limited space @ Well 27 will require innovative facility design layout to accommodate a filtration system. Well 27 is a seasonal well that would provide year around benefit to the west side.
SE-05 SE-06 SE-07	Upgrade BPS 213	Total: $2.5M	2025	73	Critical project between Z6e and Z5 to provide required fire flow capacity to Zone 5. A generator will be added for reliability.
SW-01	New West Side Well	Total: $9.7M	2025 to 2030	70	The west side of Madison is rapidly growing and needs additional supply to support ongoing and protected growth. Three sites have been identified for a new well.
SW-05	Well 15 PFAS Mitigation	UW 15 Treatment: $4.6M	2025 to 2030	62	Treatment would allow Well 15 to be returned to service. No PFAS regulations. Implementation of regulation will impact scoring. A study of alternatives is recommended for long term viability.
SW-04	Isthmus Transmission Main to Well 24	Total: $4.4M	2032	59	Project is a pipeline that will use an pumps at UW 24 to convey water from east to west. Provides no increase in supply but optimizes existing pumping facilities and could reduce costs.
WQW-04	UW 30 Fe and Mn Filter	Total: $6.3M	2030	59	Iron and manganese filtration will reduce colored water complaints and flushing requirements in the area. The Well 30 property has sufficient area to accommodate an iron and manganese filter.
WQW-06	UW 24 Fe and Mn Filter	Total: $6.3M	2035	56	Iron and manganese filtration will reduce colored water complaints and flushing requirements in the area. UW 24 has limited space and will require innovative facility design layout to add filtration.

Table 7-1 – Alternative Project Scoring					
Project #	Alternative	Draft Budgetary Costs	Project Planning Horizon	Weighted Score	Notes
WQW-07	Booster Pumping Station 124	Total: $4.4 M	2030	55	BPS 124 is an alternative to use existing surplus supply and transfer the water across the Isthmus. Project does not provide an increase in supply which may still be required.
WQW-08	New East Side Well	Total: $5.6M to $9.7M	2035	54	The east side is growing and needs additional supply during the next 20 years. Three sites have been identified for a new well. The Felland Reservoir is the preferred site due to existing reservoir.
WQW-09	UW 28 Fe and Mn Filter	Total: $6.3M	2035	54	Iron and manganese filtration will reduce colored water complaints and flushing requirements in the area. Limited space on the site will require innovative facility configuration.
TW-02	Addition of BPS 134	Total: $5.1M	2030	51	One of several pump station alternatives under consideration to move water from Zone 7 to Zone 8 to supplement Z8 supply. BPS 134 would be incorporated into UW34 if that project proceeds.
WQW-10	Relocate BPS 129	Total: $3.4M	2028	48	The relocation of BPS 129 to the Felland Road Reservoir property significantly increases redundancy of supply to Z3. The project will support development within Zone 3.
TW-10	Raymond Road Water Main Upgrade	Water Main $4.2M	2035	48	Increasing the capacity of the water main on Raymond Road will improve transmission capacity from BPS 118 to a potential pumping station from Z7 to Z8 at Elver Park.
TW-08	BPS 220 @ Elver Park	Total: $3.6M	2035	48	An pumping station alternative to supplement water supply in Z8 from Z7. Transferring water from the east to the west may allow construction of a new well to be delayed.
TE-03	Upgrade/Expansion of BPS 109	Total: $2.9M	2030	47	Upgrading BPS 109 to multiple pumps and increasing capacity will improve Z6e supply redundancy. Ultimate capacity of the pumping system will be dependent upon system piping improvements.
TW-01	Addition of BPS 114	Total: $6.0M	2030	46	BPS 114 will connect Zone 6w with Zone 8 to move excess water from 6w to the far west side of the system and improve supply reliability. An increase in capacity in the distribution system is also required.
TW-03	BPS 106 Transmission Main to Zone 8	Total: $4.5M	2040	46	Using an existing pumping station and a dedicated transmission main to transfer water from Z6w to Z8 through Z7 could be more economical than other alternatives and will use existing facilities.
WQW-11	Well 14 Water Treatment	Total: $10.3M	2030	44	Treating for sodium and chloride is expensive to construct and very expensive to operate. Other options to replace Well 14 or move water from other areas may be a more cost effective solution.
TW-10 TW-12	Arbor Hills Pressure Mitigation	Total: $2.0 to $5.5M	2030	42	Mitigate high pump pressures from BPS 118 and increase capacity to Z7 from Z6w. Two projects considered, a parallel pipeline and PRV installation in the BPS 118 neighborhood.
TE-01	UW 17 Fe and Mn Filter	Total: $6.8M	2030	40	Iron and manganese filtration will reduce colored water complaints and flushing requirements in the area. UW 17 has limited space, lake views, and will require innovative facility design.

Table 7-1 – Alternative Project Scoring					
Project #	Alternative	Draft Budgetary Costs	Project Planning Horizon	Weighted Score	Notes
TE-02	UW 18 Air Stripper	Total: $5.7M	2030	38	VOC concentration at Well 18 is on the watch list and no action is needed at this time. Adding an air stripper or GAC filter at Well 18 will be difficult due to lack of space.
TW-05	BPS 128 Upgrade	Total: $0.7M	2025	37	The upgrade of BPS 128 will improve reliability to Z11 and if necessary provide redundant pumping capacity to Z10.
TW-11	Z9 to Z8 PRV @ Raymond Rd	Total: $2.4M	2030	33	Project provides an interconnection between Z9 and Z8 and will use existing pumping equipment at Well 20 to transfer water and supplement supply to Z8.

7.3.6 Alternative Project Selection

Using the project alternatives TBL prioritization process, the following projects were selected to address near term (2020) and long term (2040) water system deficiencies. Alternatives were categorized by water quality, water supply, hydraulic improvements etc. From this ranking process a suite of Capital Improvement Projects were proposed and tested within the calibrated model using a 10 day MAX demand extended period simulation. Results and a brief description of the chosen alternatives are presented below.

The list below represents the collection of the highest ranking projects that could be combined to mitigate system deficiencies for the short and long term planning periods. Scheduling of these projects will be based on prioritization score and budget feasibility.

7.3.6.1 Near Term System Hydraulic Projects (2020) in no particular order

- UW 12 - Conversion to a Two Zone Well (T.W04)
- Lake View Booster Station 213 Upgrades (T.E01)
- UW8 Reconstruction to a 3 zone well + Filtration + Water main. (S.E02 + S.E08)
- BPS 128 Upgrade (T.W05)
- New West Side Well (UW 32 - Mineral Point Road)

7.3.6.2 Long Term System Hydraulic Projects (2040) in no particular order

- New East Side Well - UW 33A Felland Road (S.E05)
- BPS 129 Relocation (T.E02)
- BPS 109 at UW9 (T.E03)

7.4 Future System Hydraulic Modeling

The water modeling exercises documented below outline a series of modeling scenarios that tested the existing water main system grid with an increase in system demand based on future demand projections. This exercise was intended to stress the water system to reveal areas that may be weak links in the overall water system operation. This operation also tested the water systems ability to meet future demand projections with the proposed near term and long term water system improvements in place.

7.4.1 Future Water System Model

Figure B1 illustrates the water system master plan to meet current and projected water system needs through the 2040 planning period. As mentioned previously, these improvements are intended to correct existing deficiencies as well as meet the needs for future growth and development. To demonstrate the effectiveness of the recommended improvements, additional water system modeling was completed. Now with the water system project recommendations, the water model can be used to verify that the suggested improvements are effective in improving the overall water system operation. Many of the simulations completed on the existing system are completed on the proposed water system and are presented in figures included in Appendix 7B. Figure B20 represents the water system modeled for the 2020 near term planning period while Figure B2040 represents the System Modeled for the 2040 long range planning period.

7.4.1.1 Future Water System Model Development

The water distribution system computer model developed for the existing water system was used as the foundational analysis to identify potential future water system weaknesses. Various improvement alternative packages were then identified to develop an effective and complete water system to serve projected water system demands. The projected build out conditions, developed earlier in this plan were incorporated into the model to define the anticipated magnitude and location of system demands. Finally, proposed water system facilities were built into the model to analyze the effectiveness of the improvements while operating over a Max 10 day extended period simulation.

Two different design years were modeled, Year 2020 representing “near term” improvements and year 2040 representing “long term” water system demand projections. Water model simulations were conducted to evaluate water system performance and determine potential needed adjustments to the recommended system improvement project list. After each model year was operated, engineering judgement was utilized to adjust the improvements built into the model to enhance the performance of the complete system. This iterative process, consisting of calculated adjustments produced an optimized system capable of efficiently serving the future water system demands.

7.4.1.1.1 Future Model Water Main Assumptions

For purposes of future water system planning, three types of future water main improvements have been identified for future water system modeling. Ultimate staging of these water main improvements will depend upon future planning efforts and the circumstances at the time of the improvement are implemented. In general, the approach to each type of water main improvement utilized for this analysis is summarized below.

Facility Related Water Main Improvements: There are select water main improvements that would be required to allow for future supply or transfer facilities to operate as intended. Those particular water main improvements are identified with the corresponding facility improvement. These mains will serve primarily a transmission function with a mutual added benefit of increased hydraulic capacity and fire flow improvement.

Future Water Main Upgrades within Existing Pipe Network: Chapter 3 identified a series of water main deficiencies within the existing water main grid. For purposes of the alternatives analysis modeling effort, a limited number of these pipes were upgraded, namely for the purposes of enhancing proposed water facility operation. Identified mains are illustrated on the model results maps. For the 2040 water system modeling, all recommended water main upgrades were included in the modeling scenario. The primary purpose of these mains is to address fire flow deficiencies and limited hydraulic capacity.

Future Expansion Area Water Main: For purposes of modeling, a series of water main improvements are identified outside of the existing service area and assumed to be constructed as development occurs and road improvements are constructed. Figure B40 presents the proposed preliminary routing of trunk water mains to serve future development areas. Actual main routing will depend on a variety of local factors as individual projects progress. This map should be seen as a recommendation for the general hydraulic capacity of the distribution system as it is extended to serve new development. Generally speaking, the trunk main layout is comprised of a gridded network of 16-inch and 12-inch diameter water mains.

7.4.1.2 Future System Hydraulic Analysis and Evaluations

Future water system hydraulic analysis evaluations were completed for Year 2020 (near term) and Year 2040 (long term) water system configurations in a similar fashion to what was performed on the existing water system. These hydraulic modeling analyses were completed to assure that proposed system improvements are adequate to support reliable water service as growth in the system occurs. These evaluations also work to help verify the proposed schedule for the improvements. The near term improvements were added to the water system model with projected 2020 water system demands to evaluate the ability of these improvements to address the anticipated water system deficiencies. Additional improvements were added to the 2040 (long term) water system model. The year 2040 model also includes additional trunk water main extending beyond the current water service area. These pipes represent those pipes that will be needed to support adequate pressure and fire flow to the future development areas.

Extended period simulations (EPS) were setup in the model to check system operation during several consecutive days of various demand levels. The primary purpose of this simulation was to check for cumulative system imbalances that are not evident in standard simulations. Tower and system supply placement and the sizes of distribution system pipe contribute to imbalances. They also contribute to a reduced storage-replenishment rate and the ability to refill the towers at night during low demand periods.

The goal of the EPS simulations is to utilize the computer water model to check the operation and performance of the water system facilities over an extended period of time. This provides for an understanding in regards to how the system supply and storage facilities will react to future 2020 and 2040 demands.

As part of this EPS evaluation, the system was tested with various wells offline to assure that the water system improvements support reliable operation during potential water supply facility failures. The east side and west side were tested separately. The offline well combinations utilized for the analysis were as follows:

- East Side Analysis:
  - Scenario A: UW 11, UW 13 and UW 25 out of service
  - Scenario B: UW 11, UW 15 and UW 25 out of service
- West Side Analysis:
  - Scenario A : UW 12, UW 14 and UW 28 out of service

Results of the scenarios above are included in Appendix 7C (near term) and Appendix 7D (long term).

In addition steady state fire flow analysis scenarios were generated, each for year 2020 and 2040 and are included in Appendix 7E:

- 2020 Fire Flow – Year 2020 Water System Fire Flow Evaluation with 2020 Max Day Demands
- 2040 Fire Flow – Year 2040 Water System Fire Flow Evaluation with 2040 Max Day Demands

7.4.2 Near Term Hydraulic Analysis

The near term water system, including the proposed improvements was simulated over the maximum 10 day period with a maximum day demand of **51.8 mgd**. This is based on a drought year condition with a prolonged period of no rain. The proposed improvements defined for the 2020 planning period were built into the model for the analysis to test their ability to sustain water supply with three existing water facilities off-line. The purpose of this analysis was to test the overall performance of the updated water system with the proposed improvements. The model was operated to simulate the conditions that would be expected to be experienced over a maximum 10-day period.

7.4.2.1 Near Term Hydraulic Analysis Observations

The distribution system computer model analysis completed for the proposed system improvements revealed generally a favorable performance and adequacy of system components to provide the required level of service with three wells offline. The E20 and W20 map series figures included in Appendix 7C illustrate and document the results of the EPS scenarios. Minimum system pressures and maximum velocities are symbolized for junctions and pipes respectively such that those areas with deficiencies are documented with red symbolism. Additionally, the figures show the system flows, water tank levels, and system pressure for each hour during the day over the 10 day period. These figures provide assurances that the identified water supply deficiencies will be sufficiently addressed with the proposed improvements. Some of the key elements related to this analysis are discussed below.

The combination of taking various water supply sources offline creates specific operational challenges of sustaining the specified level of service. The sections below describe and discuss the assumptions and water system operating conditions required to overcome the challenges of operating with various facilities offline.

7.4.2.1.1 East Side Hydraulic Observations & Challenges

East side operations presented alternatives in scenario A and scenario B where a series of unit wells were taken offline. When Region A is short on water, and two wells are in production in region B (Zone 4), surplus water in Zone 4 must be pumped to Region A to meet projected demands. Given the limited connections between these zones, upgrades to system pumping and transfer system is necessary. The proposed projects of upgrading BPS 109 and converting UW8 to a three zone well provide the capacity necessary to pump from Region B to Region A.

A second observation was when Well 25 is taken offline in Zone 3; the two elevated tanks will lag one another. The supply system in Zone 3 will be maintained under these conditions during maximum demand periods and no adjustment is necessary.

7.4.2.1.2 West Side Hydraulic Observations & Challenges

Initially, water supply shortages can be satisfied through a combination of transfer from the east and the recommended new West side well. New well located in Zone 10 provides significant benefit due to its location. Delivery of water across the pressure zones in a downgradient flow pattern allows the well to operate as a two zone well providing flexibility and long term benefit.

The conversion of UW 12 to a two zone well with booster pumping capabilities between Zones 7 & 8 provides the means to transfer water from lower zones to the far west boundary of the system. Developing this pumping ability has been a long term goal of the Utility. This pumping capacity improves reliability and redundancy in Zone 8 and may reduce the urgency of installing a new well on the far west side.

7.4.3 Critical Hydraulic Improvements and System Performance

For some of the alternatives to function as intended, key water main improvements were assumed to be completed along with the associated proposed facility. The following is a brief summary of operational assumptions and a summary of the effect on system hydraulic performance. Hydraulically critical improvements are identified below as required to mitigate identified deficiencies and enable the MWU system to meet established LOS.

7.5.3.1.1 BPS at UW 12 - Conversion to a Two Zone Well

Conversion and upgrade of UW 12 is a key project because it renews an aging facility and installs a booster pumping system that can function as a multiple use unit to: Provide water from Well 12 supply to either Zone 7 or Zone 8, transfer water from Zone 7 to zone 8; or convey water from Zone 8 to Zone 7. Previous construction projects in the UW 12 area have improved water main connectivity and hydraulic capacity. This will facilitate transfer of water between Zones 7 and 8 and sets up UW 12 to pump to either zone. Modeling the various 2020 scenarios around UW 12 indicated this facility was critical in to the West side supply system during maximum demand periods. Not only is the recommended project important for sustaining the high quality supply from UW 12, it is also critical for West side water system reliability and redundancy.

7.5.3.1.2 Lake View Booster Station 213 Upgrade

The Lake View BPS 213 Upgrade project is considered to be critical to meet required fire flow capacity in Zone 5. While the new Lake View tower is in place to help support reliable system pressure and fire protection capacity, additional supply capacity is needed at the booster station to reduce the required water storage volume in the zone. The proposed project that will increase pumping capacity and provide a standby generator will provide the required system fire capacity reliability. The ultimate expansion of Zone 5 will also benefit from the upgrade of BPS 213. Expansion will result in higher demands in the north end of Zone 5.

BPS 213 is required to operate at designed fire flow capacities of up to 2,000 gpm. Additional trunk main hydraulic capacity is required within Zone 5. For purposes of near term water system modeling, a small section of the recommended water main improvements was assumed to be installed. Ultimately, there is a need for additional pipe upgrades in the vicinity of Zone 5 within Zone 5 and Zone 6e.

7.5.3.1.3 UW8 Reconstruction to a 3 zone well + Filtration + Water main

Unit Well 8 is considered a long term critical supply point in Zone 6e. Due to age, UW 8 is in need of a full reconstruction. The facility has a small well bore hole and a single booster pump, the reservoir is small, and generally the facility layout does not meet current operational and functional criteria. Well 8 is located in a unique geographical position within the MWU system being close to the boundaries of 3 pressure zones. Using some piping improvements and pressure zone boundary adjustments, UW 8 is poised to become a key link in the Madison water supply system.

It is recommended that the full facility be reconstructed and the well re-drilled and brought up to current well construction standards with a seal through the shale layer. The presence of iron and manganese in Well 8 water will require the addition of filtration equipment and due to the proximity of the Kipp Corporation, consideration of the potential of future VOC contamination must be included in the design. The pumping system including the reservoir will be configured to allow pumping to any of the three adjacent pressure zones, 4, 6e and 6w either from one of the other zones or from the well supply. The well, Zones 6e, 6w, and 4 will all be configured to fill the 500,000 gallon reservoir. It is desirable to configure the UW 8 pumping system with two pumping systems. Two pumping systems will allow the facility to simultaneously pump from any source to two pressure zones while drawing from the third pressure zone and the well supply. For example, both Zone 4 and the well could be delivering water to the reservoir and pump system "A" could be pumping to Zone 6e at a variable rate up to 2,100 gpm and pump system "B" could be pumping to Zone 6w at a variable rate up to 2,100 gpm. The other advantage is the pumping system will be configured to allow two pumps to move water, with necessary system piping improvements, to Zone 6e at up to a rate of 4,000 gpm.

Water Supply to Zone 6e: Well supply: UW 8 will primarily supply Zone 6e at a rate of up to 2,100 gpm. Water transfer from Zone 6w: Water will be drawn from the Zone 6w distribution system piping to the reservoir and booster pumps will pump the water from the reservoir to Zone 6e. The 6w Zone Boundary will be adjusted to minimize the need to construct transmission mains. Water main routes identified in Figure B1 support water discharge routes connecting to existing water trunk mains within Zone 6e. When pumping up to 4,000 gpm to Zone 6e, it requires sizable discharge water mains to limit the flow velocities and corresponding discharge pressures. Water transfer from Zone 4: Water will be drawn from the Zone 4 distribution system piping into the reservoir up to a maximum of 1,000 gpm and booster pumps will pump the water from the reservoir to Zone 6e. The Zone 4 Boundary will be adjusted to minimize the need to construct transmission mains to the greatest extent possible.

Water Supply to Zone 6w: Water main improvements needed in this zone are limited by the proposed pressure zone reconfiguration. The extension of Zone 6w into 6e as accommodated by dividing the zone along an existing water main separation due to the presence of railroad tracks. This boundary is a natural choice for a zone boundary since there are limited water main crossings across the railroad tracks. The collection of water main that was previously in Zone 6e and transferred to 6w form a modest grid of main that when combined can support a flow of 3.1 MGD in either direction while providing adequate system pressure.

Well supply: When needed, Well 8 supply can be pumped to Zone 6w at a rate of up to 2,100 gpm. Water transfer from Zone 6e: Water will be drawn from the Zone 6e distribution system piping to the reservoir and booster pumps will pump the water from the reservoir to Zone 6w at up to 2,100 gpm. Water transfer from Zone 4: Water will be drawn from the Zone 4 distribution system piping into the reservoir up to a maximum of 1,000 gpm and booster pumps will pump the water from the reservoir to Zone 6w.

Water Supply to Zone 4: Well supply: If needed, Well 8 supply can be pumped to Zone 4 at a rate of up to 1,000 gpm. Water transfer from Zone 6e: If needed, water will be drawn from the Zone 6e distribution system piping to the reservoir and booster pumps will pump the water from the reservoir to Zone 4 at up to 1,000 gpm. Water transfer from Zone 6w: Water will be drawn from the Zone 6w distribution system piping into the reservoir and booster pumps will pump the water from the reservoir to Zone 4 at up to 1,000 gpm.

7.5.3.1.4 BPS 128 Upgrade

The firm capacity of BPS 128 will be increased to 2,100 gpm. The upgrade of the capacity of BPS 128 to provide the ability to transfer the full capacity of a unit well from Zone 8 to Zone 10 and 11 will improve operational flexibility and reliability of the water supply system.

7.5.3.1.5 New West Side Well

The growing far west portion of the MWU distribution system requires additional sources of supply to meet reliability and redundancy standards during maximum demand periods. Additional supply sources include interzone pumping stations and construction of new wells. Interzone pumping stations are reliant on surplus water from existing wells and the hydraulic capacity to move the water from an area of surplus to an area of need. Given the current and projected water demands on the far west side, the most effective and efficient means of meeting peak demand is the construction of a new well.

Three different sites have been identified as potential west side well locations. These sites have been identified as near the intersection of Mineral Point Road and South Point Road, designated UW 32; the intersection of Mineral Point Road and S. Whitney Way, designated UW 34; and the far southwest corner of the system, designated UW 35. It is recommended that a well siting study be completed to determine the recommended location for a new west side well.

Hydraulically, the UW 32 site provides a central location in Zone 10. The delivery of water from a new water source in Zone 10 will provide benefit to the overall operation of the water system function. There is currently a developing network of trunk water main in the vicinity of proposed UW 32 and connection of the facility to this existing grid, in addition to a connecting feed to Zone 8 will allow UW 32 to function as a multi-zone well. For modeling purposes water from this well was delivered directly to zone 10 and then flowed by gravity to zone 8 as needed through a pressure reducing valve (PRV).

Constructing a new west side well at the identified UW 34 and UW 35 sites will benefit the system in a similar manner. These sites would not have the advantage of a central location or potentially multiple zone supply.

7.5.3.2 General Distribution System Observations

In general the proposed improvements suggested for the near term water system support reliable operation and delivery of a sufficient level of service. The interaction between zones 7 and 8 suggests that Zone 7 has characteristics that result in some distinctive operational anomalies. This appears to be a result of the combination of the reservoir locations and relatively long coverage area and shape. Given the remote location of the floating water reservoir, this configuration can result in pressure fluctuations and short periods of water supply shortages. Under some operating conditions, this can lead to water flowing from Zone 8 to Zone 7 to sustain adequate system pressures even when the primary direction of flow is from 7 to 8 through a transfer function. This “pumping water in circles” is not efficient and will be considered when siting supply facilities.

7.4.4 Long Term Hydraulic Analysis

The long term water system, including all of the proposed improvements was simulated over the maximum 10 day period with a maximum drought day demand of **59.06 mgd**. The proposed improvements defined for the 2040 planning period were built into the model for the analysis to test their ability to sustain water supply with three existing wells off-line. Stressing the system in this way will test the overall performance of the updated water system with the proposed improvements. The model was operated to simulate the conditions that would be expected to be experienced over a maximum 10-day period during an extended drought period.

As with the near term analysis, three operational conditions were selected and 240-hour extended period simulations (EPS) were performed to determine how the water system might react after improvements are added in conjunction with the projected demands. For each scenario, three wells were taken out of service. These outages provide the opportunity to evaluate the ability of the water distribution system to move water from one area to another. The four operational scenarios included:

- East Scenario A : UW 11, UW 13 and UW 25 out of service
- East Scenario B: UW 11, UW 15 and UW 25 out of service
- West Scenario A : UW 12, UW 14 and UW 28 out of service

The E40 and W40 map series figures included in Appendix 7D illustrates the results of the long term (2040) modeling. Pipe improvements for the 2040 Model were based on the long-term improvements from the 2006 Master Plan except where it was recognized that the improvement is no longer needed or conflicts with a new facility development.

Three proposed facility improvements were added to the Year 2040 long term Model; BPS 109 at UW9 (to move water from Zone 4 to Zone 6e), New East Side Well (UW 33A Felland Road) to deliver water to both Zone 6e and Zone 3 and the relocation of BPS 129 to the same site as UW 33A. The Construction of the new unit well is necessary to meet projected water system demand and the other improvements necessary to distribute water across the system. The figures included in Appendix 7E show there are not any areas of major concern in the system and service can be provided in accordance with the standards outlined in the Level of Service Memo. Critical water system storage can be maintained with the three identified wells offline.

7.4.4.1 Long Term Hydraulic Analysis Observations

The model analysis completed for the 2040 water system, consisting of all of the proposed improvements in conjunction with projected 2040 water system demands revealed generally a favorable performance of the overall water system. The analysis supports the assumption that the proposed system components are adequate to sustain the LOS even with three well facilities offline. The figures in in Appendix 7E illustrate and document the results of the EPS scenarios. Minimum system pressures and maximum velocities are symbolized for junctions and pipes respectively such that those areas with deficiencies are documented with red symbolism. Additionally, the figures show the system flows, water tank levels, and system pressure for each hour during the day over the 10 day period. These figures provide assurances that the identified water supply deficiencies will be sufficiently addressed with the proposed improvements. Some of the key elements related to this analysis are discussed below.

7.4.4.1.1 BPS 109 at UW9

The BPS 109 project at UW 9 will pump water from Zone 4 to Zone 6e transferring excess water to an area of need. The first phase of this project is to convert the existing booster pump to a zone transfer pump and revising the zone boundaries. This will permit approximately 1,000 gpm to be transferred between Zones 4 and 6e. This converts UW9 to function as a two zone well.

The BPS 109 project will also allow the abandonment of UW 23. UW 23 has limited capacity and low water quality however its location provided supply advantages to Zone 6e. Pumping water from UW 9 will replace the water lost with the removal and demolition of UW 23.

Future enhancements to BPS 109 would include expansion of the station to install duplex pumps with a firm pumping capacity of 2,100 gpm. Distribution system piping improvements would allow a higher pumping rate and potentially a short transmission main project could deliver water directly to Zone 3 from BPS 109.

7.4.4.1.2 New East Side Well

The hydraulic analysis documented in Chapter 6 indicated a need for additional East side water supply during peak demand periods. As the area continues to develop and grow, additional supply will be required to meet the demand.

Three different sites have been identified as potential east side well locations. These sites have been identified as the Felland Road Reservoir site, designated UW 33A; southeast of the intersection of E. Washington Avenue and Stoughton Road, designated UW 33B; and the intersection of Buckeye Road and Sprecher Road, designated UW 33C. It is recommended that a well siting study be completed to determine the recommended location for a new west side well.

Previous studies have indicated that placement of the proposed well at Felland road will take advantage of existing infrastructure (Supply piping and Reservoir) and deliver water to a growing area of the water system. The location at Felland Road will also allow the well to deliver water directly to either Zone 3 (through BPS 129) or Zone 6e. It would take advantage of existing facilities and reduce overall costs. The model operations revealed this location to be favorable as the system operated well to sustain water reservoir levels through the 10 day model runs.

7.4.4.1.3 BPS 129 Relocation

BPS was located at UW 29 and had limited capacity due to pump size and distribution system piping restrictions. Relocation of BPS 129 to Felland Road has been planned since the Felland Road Reservoir was constructed in 2007. BPS 129 would be sized to provide reliable fire protection capacity and water supply redundancy to Zone 3.

7.5 Alternative Analysis Conclusion

The identified priority projects selected provide supply and transfer capacity to support future water system growth and expansion while maintaining a desired level of service. MWU now has a list of highest priority projects that can be considered as future CIP’s are developed. The previous triple bottom line analysis supports the value justification for each project while the completed hydraulic modeling provides assurances that the selected improvements will function and perform as intended while operating in partnership with the existing water system.

Chapter 8

Water System Improvements

8 Water System Improvements

8.1 Introduction

Chapter 8 will provide recommendations to mitigate current and anticipated deficiencies and to prepare the system for future growth. Multiple water system improvement options and alternatives have been considered and evaluated to determine the efficacy of the alternatives for addressing future water system deficiencies. A map of recommended improvements is shown in Figure 8-1 and will be referenced throughout Chapter 8. Recommended improvements were categorized in terms of Supply, Treatment, Storage, Transfer and Distribution Improvements. These improvements are recommended to support water system operations through the 20-year planning period.

An update to the recommended water systems improvements was developed in 2022/2023 as part of a capital improvement plan. The plan included the re-evaluation of potential project alternatives, and the development of a 10-year project outlay. The Chapter 8 Appendix included in the master plan summarizes the work completed to update and re-evaluate the alternatives in addition to the development of the Capital Improvement Plan.

8.1.1 Water System Planning

Chapter 8 will summarize the results of the MWU long range master plan for the water system required to meet the established level of service for the projected service area and long range 2040 drought year water system demands. Projects have been prioritized by MWU staff for the short term and long term water planning period. Prioritization of the improvements will be reviewed annually during the preparation of the Capital Budget to adapt to actual water use trends and changes in projected growth in Madison as demands continue to change and evolve. The long range 2040 recommended improvements to meet future 2040 water system demand projections and provide guidance in relation to project priority are presented in the following sections.

It should be noted here that the projects identified do not typically include improvements needed to repair, replace or rehabilitate aging infrastructure, except for those projects itemized in this plan that enhance the operation of existing facilities (i.e. Unit Well 8 Expansion, Conversion of UW 12, to a two zone well, relocation of BPS 129 etc.)

The MWU Asset Management Program will implement the a full spectrum of capital expenditures to ensure operations meet required levels of service, minimize core risk, and maximize rate of return. Projects identified and prioritized in the Water Master Plan, the Asset Management Program, and any maintenance or operational capital requirements will be evaluated based on core risk and business risk evaluation.

Financial resources to support the Capital Improvement Program will be considered as required by WUB Policy and the Wisconsin Public Service Commission. Financial planning is beyond the scope of this Plan and it is assumed that MWU will provide the required long term funding to sustain the Utility through the next 20 years by supporting the replacement, upgrade, or addition of recommended facilities and pipe lines.

8.1.2 Cost Estimates

Construction costs are presented in 2019 estimated dollar amounts for budgetary purposes. Estimated costs for construction are based on recent project bidding results for project constructed for MWU.

8.2 Summary of Recommended Improvements

Near Term and Long Term system evaluation provide the basis for alternative recommendations from Year 2020 to Year 2040. These recommended facilities and pipe lines are shown on Figure B1. Below is a summary of the recommended water system improvements through the 2040 Design year.

The improvement summary provided below is a guidance document that details existing conditions and recommendations for the future. The plan is based on future conditions as perceived in 2019/2020. As time progresses, additional information will become available and events will shape the development of the water system. The Water Master Plan must be dynamic in response; it should be studied and used but also adjusted to conform to the changes and projections as they develop. The Water Master Plan shall be reviewed and adjusted to current conditions. This review will take into account but will not be limited to: development pressures, regulations, financial capacity, water conservation, and Asset Management Program recommendations. The timing of the proposed improvements stated here is in accordance with near term and long term growth projections developed in the Water Master Plan with regard to a drought design year. Actual growth rates and development patterns will be driven by the regional economy and the timing of the future improvements and should be adjusted as necessary.

8.2.1 Long Range Plan

The Long Range Plan has developed recommendations to achieve established Levels of Service through 2040. The piping improvements to the distribution system will be added to first address existing deficiencies and then accommodate growth and demand in the water service area. Portions of this report will later define the timing for these projects. The long range master plan of capital improvements for the MWU system are shown in figure B1. Prioritization scoring is presented in Chapter 7 in Table 7-1 and is based on the Triple Bottom Line. **An update of project costs and priorities is included in Appendix 8A as part of the 10-year Capital Improvement Plan Development**

Table 8-1 Summary of Long Term Improvements			
Alt #	Alt Title	Category	Budget Cost
WQ.W01	Well 19 Water Treatment Mitigation – Fe, Mn, and Radium Several options to consider	Water Quality	$3.0M to $10M
S.E03 WQ.E02	Well 8 Conversion to a 3 Zone Supply Well w/piping improvements Well 8 Water Treatment Mitigation – Fe, Mn, and Radium	Supply Water Quality	$12.6M to $14M
T.W04	Well 12 Upgrade and Conversion to Two Zone Well	Interzone Pumping Renewal	$4.5M
WQ.W04	Well 27 Water Treatment Mitigation – Fe, Mn, and Radium Several options to consider	Water Quality	$7.4M
T.E01	BPS 213 (Lake View PS) Upgrade and Generator Addition	Interzone Pumping	$2.5M
S.W01	New West Side Well (Three sites to consider)	Supply	$9.7M
WQ.E05	Well 15 PFAS Mitigation (Treatment vs relocation)	Water Quality	$4.6M to $9.7M
WQ.W04	Well 30 Iron and Manganese Filter	Water Quality	$4.6M

Table 8-1 Summary of Long Term Improvements			
Alt #	Alt Title	Category	Budget Cost
WQ.W06	Well 24 Iron and Manganese Filter	Water Quality	$6.3M
S.E05	New East Side Well (Three sites to consider)	Supply	$5.6M to $9.7M
WQ.W09	Well 28 Iron and Manganese Filter	Water Quality	$6.3M
T.E02	BPS 129 Relocation to Felland Road	Interzone Pumping	$3.4M
T.E03	BPS 109 Capacity Upgrade at UW 9	Interzone Pumping	$2.9M
T.W01	BPS 114 – Transfer from Zone 6W to Zone 8	Interzone Pumping	$6.0M
T.W05	BPS 128 Capacity Upgrade	Interzone Pumping	$0.7M
Pipe	Annual Budget for Pipeline Replacement/Rehab/Improvements Recommend 7.1 miles per year – Total 20 yr investment $194M	Transmission	$9.7M/yr
Note: Not all projects listed in Table 7.1 are included here due to redundancy or feasibility of the project. Further evaluation is required.			

Sections included later in this report will summarize the selected suite of high impact and effective projects. The entirety of the improvements shown on the planning map are assembled to meet future projected water system demands and the established level of service for a drought year through the year 2040. The locations for the proposed pipelines and water system facilities are assumed to be approximate but represent the needed functionality to satisfy future system demands per the previous hydraulic model evaluations. When the time arrives for final facility design, improvements should be more precisely evaluated in the model.

8.2.2 Improvement Phases

As previously described, the proposed water system improvements have been split into near term (2020) and long term (2040) improvement phases. MWU does not have the financial capacity to immediately construct all of the proposed projects; they will be phased in as demand grows and funding permits. A phased long term plan has been developed for the 20 year planning period. Project priorities have been determined according to impact of the prosed project as it related to the previous triple bottom evaluation process.

The near term projects have been scheduled out in the first phase to satisfy the future water system demand through the first 10 years of the planning period while the second group of projects set to accommodate system demands through the long term planning phase (2040). Any project identified beyond the 2040 planning period are considered conceptual (see alternative analysis) and can be considered as a part of future planning efforts.

8.2.2.1 Near Term Improvement Phase (2020)

The near term improvement projects focus on addressing identified deficiencies while accommodating future water system growth and resiliency by both optimizing existing facilities and adding new facilities where necessary. Alternative ranking and prioritization described in Chapter 7 identified those projects which make use of existing supply, specifically as the projects are able to move water between the east and west sides of the water system. The proposed project package represents the recommended alternatives deemed to be the best value for addressing future water system needs. These projects focus on addressing identified water system deficiencies related to water transfer between zones, water quality, storage limitations and transmission. These improvements will enhance the reliability and ability of the water system to deliver water to satisfy projected water system demands. These projected water system deficiencies are addressed with a suite of improvements that requires only one new well on the west side along with improvements and reconstruction of Unit Well 12 and Unit Well 8.

Furthermore additional improvements to BPS 213 and BPS 128 will enhance firefighting abilities. Pressure reducing valve (PRV) stations are recommended for select locations to enhance system pressures and fire flow along select pressure zone boundaries. Finally selected pipelines are recommended to enhance and facilitate the functional operation of some of the proposed facilities. Additional pipe improvements are recommended to enhance the overall hydraulic performance of the water system.

Recommended Near Term Improvement Projects:

- Well 19 Water Treatment Mitigation – Fe, Mn, and Radium
- UW8 Reconstruction to a 3 zone well + Filtration + Watermain. (S.E02 + S.E08)
- UW 12 - Conversion to a Two Zone Well (T.W04)
- Lakeview Booster Station 213 Upgrades (T.E01)
- New West Side Well (UW 32 - Mineral Point Road)
- BPS 128 Upgrade (T.W05)

8.2.2.2 Long Term Improvement Phase (2040)

The long term improvement phase project focus on further adding water system capacity to enhance water system delivery to sustain a desired level of service. Ultimately the combination of the proposed water system improvements would balance regional and zone demand with available supply. Water treatment systems will be constructed at Wells 27, 30, and 24. A PFAS mitigation project for Well 15 will be developed. A new multi zone well (Unit Well 33A) would be constructed at the Felland road reservoir which would be capable of supplying water directly to either Zone 6e or Zone 5. As a part of the east side well project, BPS 129 would be relocated to the Felland Road site to work efficiently with the new Unit Well. The booster pump station at Well 9, BPS 109, would be upgraded to increase capacity and reliability in interzone pumping from Zone 4 and Zone 6e.

Recommended Long Term Improvement Projects

- UW 27 Water Treatment Mitigation – Fe, Mn, and Radium
- UW 15 PFAS Mitigation
- UW 30 Fe and Mn Filtration
- UW 24 Fe and Mn Filtration
- New East Side Well (UW 33A Felland Road)
- BPS 129 Relocation (T.E02)
- BPS 109 at UW9 (T.E03)

8.2.2.3 Extended Planning

Additional water system facilities inventoried in the alternative analysis are available to be added to the water system as needs arise. During the annual project evaluation for the capital budget, existing conditions will reprioritize projects due to current operational conditions. Through the use of hydraulic modeling, additional assessments can be completed to confirm the effectiveness of future alternative improvements. It is recommended that MWU develop system modeling expertise in house to provide timely and economical evaluation of system operation and needs. The projects included in the extended planning period would aid in meeting system demands beyond the 2040 planning period.

8.2.3 Supply

The general assessment of the water system identified the need for only two new unit wells over the 20 year planning period with other supply redundancy coming through transfer of water between regions. Additionally existing well facilities will be improved and optimized to assure that those facilities can provide a quality water supply to the MWU water system well into the future.

During project development and evaluation, a life cycle cost analysis including cost of energy to pump water across the system should be included in the Business Case Evaluation.

8.2.4 Water Quality

Well water quality is a key component in the overall production capacity of a well. A well with lower water quality may not be fully utilized resulting in limited annual production. Installing treatment to mitigate water quality could have a significant impact on well production. Case in point is Wells 8, 15, 17, and 27. These wells have water quality concerns that limit annual production. Constructing treatment at these wells, if feasible and economical, will convert them to year around production.

Well 8 has elevated iron and manganese levels that result in colored water events and requires frequent main flushing. Due to the geographical location of Well 8, it is an excellent candidate to provide supply and water transfer capacity to three pressure zones. During this master planning process, Well 8 reconstruction, treatment addition, and interzone pumping was identified as a critical project for near east side water supply. The multiple benefits of increased production and interzone transfer warrant the investment in this project. The well would go from marginal use to a key supply facility.

Well 15 has been impacted by the emerging contaminate, PFAS, and has been taken out of production. For decades, Well 15 was a critical supply point on the east side. Without the availability of Well 15, the supply system in the NE corner of the distribution system is limited. Treatment of Well 15 or replacement would mitigate the impact of PFAS and bring it back into production.

Well 17 has elevated iron and manganese levels that may be impacting free chlorine residual in the reservoir. Adding treatment to Well 17 would be difficult and costly due to lack of space so it may need to remain a seasonal well. Adding mixing to the reservoir may provide mitigation of chlorine decay in the reservoir.

Well 27 has elevated iron, manganese, and radium levels that result in colored water events and may require frequent main flushing. The radium has been measured at just below the regulatory limit and historic pumping patterns used for Well 27 have resulted in very low annual production. Due to the location of Well 27 and considering it has a standby generator, it is an excellent candidate to provide supply and water transfer capacity from the University area to the near and far west side. A 20” transmission main from Well 27 to Reservoir 106 will provide significant west side transfer capacity. Adding treatment to Well 27 would allow the well would go from marginal use to a key west side supply facility.

8.2.5 Transfer Pumping

The water system assessment identified multiple pumping facilities in need of improvement. These facilities provide water transfer capabilities either through standalone booster pumping facilities or through transfer pumping capabilities added to well supply facilities. The booster stations in need of improvement are listed in Table 7-1.

8.2.6 PRV Transfer

A limited number of PRV stations have been identified to transfer water from higher to lower pressure zones. The locations of these particular PRV stations land along pressure zone boundaries where the neighboring lower pressure zone lacks system pressure or in some cases localized fire flow. The various recommended PRV locations are included in Appendix 7-A.

8.2.7 Storage

The previous hydraulic assessment for water storage revealed that the current storage capacities appear to be adequate through the 2040 planning period. Where limited storage shortfalls exist reserve water system pumping is recommended to be enhanced to deliver water stored in lower pressure zones.

8.2.8 Pipelines

Much of the water systems value and corresponding improvement costs exists in the distribution system pipelines. Strategic location of water system pipelines is necessary to right-size the conduits for efficient water delivery. Two different classes of pipes and therefore implementation strategies have been identified for proposed water system piping. A summary of the proposed piping is included in Appendix 7-A.

8.2.8.1 Transmission

Transmission piping includes larger pipelines that are intended to move large volumes of water across the water system to other areas where water is then distributed 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. Though not considered transmission pipes, smaller 6, 8, and 10 inch diameter water main play a critical role in certain situations and in some cases are included in this piping plan. In an effort to continue with recommendations suggested in previous master plans, the following priorities were identified for future transmission main improvements:

- Connect new or improved water system facilities to the distribution network for more efficient distribution/transmission from the improved facility.
- Supplement or replace undersized water main.
- Increase pipeline capacities in fire flow deficient areas.
- Complete transmission pipelines where current "gaps" exist.
- Extend new pipelines to previously unserved areas as development progresses.

Only those pipelines associated with proposed facilities are provided with a proposed installation schedule. Other pipelines can be phased in as money is available and other infrastructure work may permit.

8.2.8.2 Distribution

When development occurs, smaller pipelines are added to the water system to distribute water to individual customers. In general these mains are 8-inch in size for residential areas and 10-inch in size for Industrial, commercial and institutional users. These mains are to be installed according to the criteria established and required by the MWU. Since the placement of these mains can be highly variable depending on the proposed development, this master plan update will not attempt to predict the location and spacing of future distribution water main. Depending on the layout of the development, developers may be required to incorporate transmission mains within the grid of the smaller water main piping grid. As before, the hydraulics of the water system will need to be evaluated on a case by case basis to make sure the proposed water mains are right sized to serve the local development and appropriately contribute to the overall function of the MWU water system.

8.3 Conclusions and Recommendations

The culmination of this Master plan has produced a package of potential water supply and transfer projects that will assure that MWU has adequate water supply facilities to sustain a high level of service to accommodate future water system growth. The Recommended facilities strike a balance between improving existing facilities while adding a reasonable amount of future system capacity.

A preliminary Capital Improvement Schedule is presented below in Table 8-2. This table presents the highest priority projects as currently rated. As the Asset Management Program develops and "Core Risk" and "Business Risk Exposure" are determined this scheduling will be adjusted. The actual scheduling of projects will be reviewed and adjusted annually during the capital budget process.

Table 8-2 Recommended Capital Improvement Program											
Priority	Project	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1	UW 19		$ 891,000	$6,691,000	$ 81,000						
2	UW 8	$120,000			$ 100,000	$2,000,000	$2,000,000	$7,000,000	$1,500,000		
3	UW 12			$ 300,000	$3,800,000	$ 400,000					
4	UW 27								$ 900,000	$6,500,000	
5	BPS 213				$ 200,000	$1,250,000			$1,000,000		
6	New West Side Well							$ 100,000	$1,100,000	$1,000,000	$7,500,000
7	UW 15	$122,000									
	Pipe Rehab*	$4,166,000	$2,961,000	$2,990,000	$3,033,000	$2,608,000	$4,714,000	$7,000,000	$7,350,000	$7,718,000	$8,104,000
	Totals	$4,408,000	$3,852,000	$9,981,000	$7,214,000	$6,258,000	$6,714,000	$14,100,000	$11,850,000	$15,218,000	$15,604,000

*2021-2026 based on actual budget. 2027 to 2030 Projected and adjusted for Annual Inflation
Current Budget through 2026 not displayed

The approved 2021 City of Madison Water Utility Capital Budget is included below.

Water Utility

Capital Improvement Plan

Project Summary: Executive Budget

	2021	2022	2023	2024	2025	2026
Booster Pump Station #213 Lakeview Reconstruc	-	-	-	188,000	1,161,000	-
Chlorinators & Florinators	31,000	35,000	35,000	40,000	40,000	41,000
Unit Well #15	122,000	-	-	-	-	-
Unit Well #8 Reconstruction	120,000	-	-	88,000	1,778,000	2,292,000
Unit Well 12 Conversion	-	-	263,000	3,754,000	41,000	-
Unit Well Rehab Program	240,000	330,000	247,000	340,000	254,000	350,000
UW#23 Abandonment	50,000	-	-	-	-	-
Water Hydrants Program	350,000	350,000	350,000	350,000	350,000	350,000
Water Mains - New	152,000	159,000	166,000	1,429,000	178,000	185,000
Water Mains - Pavement Mgt	1,208,000	1,586,000	1,286,000	335,000	362,000	378,000
Water Mains - Pipe Lining	1,110,000	983,000	1,111,000	1,036,000	1,077,000	1,419,000
Water Mains- Reconstruct Streets	1,848,000	392,000	593,000	1,662,000	1,169,000	2,917,000
Water Meter & Fixed Network Prg	500,000	513,000	526,000	539,000	552,000	566,000
Water Utility Facility Improvements	417,000	1,167,000	1,152,000	1,119,000	1,153,000	1,187,000
Water Utility Vehicles & Equipment	344,000	521,000	246,000	539,000	256,000	557,000
Water Valve Cut-In Program	16,000	16,000	17,000	18,000	19,000	20,000
Well 14 Mitigation	-	82,000	-	-	-	-
Well 19 Iron and Manganese Filter	-	891,000	6,691,000	81,000	-	-
Total	**$ 6,508,000**	**$ 7,025,000**	**$ 12,683,000**	**$ 11,518,000**	**$ 8,390,000**	**$ 10,262,000**

8.4 2023 CIP Planning Process and Update

In 2022 MWU embarked on an effort to re-evaluate water system priorities considering the updated financial plan, inflationary pressures related to construction costs and emerging issues all of which can impact capital improvement planning. The result of this effort is summarized in the documentation included in the Chapter 8 Appendix. The updated 10-year CIP is included below as well as the 2024 City of Madison Water Utility Capital Budget request. Full summaries of this work is included in the updated Chapter 8 Appendix

MADISON WATER UTILITY

10-YEAR CAPITAL IMPROVEMENT PLAN

Project #	Project Name	Project Type	Year 1 2024	Year 2 2025	Year 3 2026	Year 4 2027	Year 5 2028	Year 6 2029	Year 7 2030	Year 8 2031	Year 9 2032	Year 10 2033	TOTALS
	Beginning Balance (Carryover)		$500,000	$1,700,000	$3,450,000	$2,450,000	$850,000	$600,000	$500,000	$1,750,000	$550,000	$3,620,000	
	Revenues		$18,423,000	$11,150,000	$17,250,000	$17,500,000	$24,000,000	$24,250,000	$24,500,000	$24,750,000	$35,000,000	$35,250,000	**$232,073,000**
	Total Available Fiscal-Year Funds for Capital Projects		**$18,923,000**	**$12,850,000**	**$20,700,000**	**$19,950,000**	**$24,850,000**	**$24,850,000**	**$25,000,000**	**$26,500,000**	**$35,550,000**	**$38,870,000**	**$232,073,000**
(Various)	Water Mains (Funded by Exp. Depreciation)	Water Mains	$5,000,000	$5,000,000	$10,000,000	$10,000,000	$15,000,000	$15,000,000	$15,000,000	$15,000,000	$15,000,000	$15,000,000	$120,000,000
(Various)	Services & Hydrants	Water Mains	$1,250,000	$1,250,000	$2,500,000	$2,500,000	$3,750,000	$3,750,000	$3,750,000	$3,750,000	$3,750,000	$3,750,000	$30,000,000
(Various)	System Planning, Maintenance & Fleet	Maintenance	$3,050,000	$1,750,000	$1,750,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$3,500,000	$3,500,000	$23,550,000
1	Unit Wells 14 & 19 Treatments	Quality/Treatment	$2,788,000	$400,000									$3,188,000
2	Unit Well 15 PFAS Treatment	Quality/Treatment	$5,135,000										$5,135,000
3	New Unit Well Facility and Site	Quantity/Supply						$1,500,000	$2,500,000	$5,200,000	$3,000,000		$12,200,000
12	Unit Well 24 Treatment (Fe and Mn Filter)	Quality/Treatment										$7,000,000	$7,000,000
6	Unit Well 30 Water Treatment Improvements	Quality/Treatment									$3,000,000	$4,000,000	$7,000,000
8	East/West Transfer - Zone 4 to 6W Conn.	Transfer									$3,680,000	$5,520,000	$9,200,000
9	Zone 7/8 Transfer (Unit Well 12)	Transfer		$1,000,000	$4,000,000								$5,000,000
11	Booster Pump Station 128 Upgrades	Transfer				$1,100,000							$1,100,000
13	Unit Well 27 Water Treatment Improvements	Quality/Treatment				$3,500,000	$3,500,000						$7,000,000
14	Upgrade Booster Pump Station 213	Transfer						$2,100,000					$2,100,000
	Total Annual Project Expenditures		$17,223,000	$9,400,000	$18,250,000	$19,100,000	$24,250,000	$24,350,000	$23,250,000	$25,950,000	$31,930,000	$38,770,000	**$232,473,000**
	Total Annual Carryovers		$1,700,000	$3,450,000	$2,450,000	$850,000	$600,000	$500,000	$1,750,000	$550,000	$3,620,000	**$100,000**	

Water Utility 2024 Capital Budget Request

	2024	2025	Rate Increase 2026	2027	Rate Increase 2028	2029
UW 15 PFAS	5,135,000	-	-	-	-	-
UW 19						
Water Mains - New	89,000	1,070,000	1,696,000	3,294,000	3,039,000	3,192,000
Water Mains Replace Rehab Improve	4,459,000	4,970,000	9,491,000	10,000,000	13,855,000	15,000,000
Services & Hydrants associated w/ main projects	1,250,000	1,250,000	2,500,000	2,500,000	3,750,000	3,750,000
John Nolen Drive	30,000	30,000	-	-	-	-
Outer Capitol Loop Southeast	-	-	-	-	-	-
Park Street, South (Olin to RR)	-	-	509,000	-	-	-
Pleasant View Road - Phase 1	-	-	-	-	-	-
Wilson St (MLK to King)	501,000	-	-	-	-	-
High Point/Raymond/MidTown	10,000	-	-	-	1,145,000	-
Unit Well Rehab Program	371,000	382,000	393,000	405,000	417,000	430,000
Water Hydrants Program	412,000	424,000	437,000	450,000	464,000	476,000
Water Meter and Fixed Network Program	539,000	552,000	566,000	580,000	595,000	610,000
Water Utility Facility Improvements	2,248,000	2,316,000	2,385,000	2,457,000	2,530,000	2,606,000
Water Utility Vehicles & Equipment	1,015,000	915,000	875,000	820,000	815,000	795,000
Water Valve Cut-In Program	64,000	66,000	68,000	70,000	72,000	74,000
Chlorinators & Florinators Program	40,000	40,000	50,000	50,000	60,000	60,000
Unit Well #8 Reconstruction	-	-	-	-	-	-
Unit Well 12 Conversion to a Two Zone Well	-	1,000,000	4,000,000	-	-	-
New Water Facility Planning	800,000	-	-	-	-	1,500,000
BPS 128 Upgrade	-	-	-	1,100,000	-	-
Booster Pump Station #213 Lakeview Reconstru	500,000	-	-	-	-	2,100,000
UW 27 Iron & Manganese Mitigation	-	-	-	3,500,000	3,500,000	-
	17,463,000	13,015,000	22,970,000	25,226,000	30,242,000	30,593,000

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