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Witness:	J. S. Young
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MISSOURI PUBLIC SERVICE COMMISSION

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Missouri Public Service Commission

Direct Testimony of

JOHN S. YOUNG

on Behalf of

MISSOURI-AMERICAN WATER COMPANY (MAWC)

NOVEMBER 19, 1999

DIRECT TESTIMONY OF
JOHN S. YOUNG

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MISSOURI-AMERICAN WATER COMPANY
DIRECT TESTIMONY OF
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1. Q. **WHAT IS YOUR NAME AND BUSINESS ADDRESS?**

A. John S. Young, Jr., 1025 Laurel Oak Road, Voorhees, New Jersey, 08043.

2. Q. **BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?**

A. I am employed by American Water Works Service Company, Inc. ("the Service Company") as Vice President - Engineering. I have held my current position since 1992.

3. Q. **PLEASE STATE YOUR EDUCATIONAL BACKGROUND.**

A. I received a B.S. Degree in Civil Engineering from Duke University in 1975 and a M.S. Degree in Environmental Engineering from the University of North Carolina - Chapel Hill in 1977. I am qualified as a registered Professional Engineer.

4. Q. **WHAT ARE YOUR DUTIES AS VICE PRESIDENT - ENGINEERING?**

A. As Vice President - Engineering I am responsible for managing the Engineering function for the American Water System. This includes the preparation of Comprehensive Planning Studies for system operations in 23 states, and the design, design overview and construction management of projects involving water supply, treatment, pumping, distribution and transmission facilities. My responsibilities also include development of engineering standards, project management procedures, and employee development.

5. Q. **WHAT WERE YOUR DUTIES PRIOR TO BEING APPOINTED VICE PRESIDENT - ENGINEERING?**

A. From 1986 to 1992, as Director - Engineering Design, I was responsible for managing the design of water works facilities throughout the American Water

System. My duties included the development of project design concepts, management of detailed design and technical assistance during the construction phase of a project. In this position I was involved with more than 100 water works engineering projects.

In 1984 and 1985 I was employed by the American Water System as Director - Engineering Planning. In this position I was responsible for water works planning throughout the American Water System. These duties included the development of water demand projections, regional water supply plans, evaluation of production and pumping facilities, hydraulic analysis of distribution systems, and development of plans to remedy system deficiencies.

6. Q. HAVE YOU TESTIFIED BEFORE OTHER REGULATORY COMMISSIONS IN PREVIOUS PROCEEDINGS?

A. Yes. I have testified before commissions in Kentucky, Virginia, Pennsylvania, Iowa, Massachusetts and Missouri. In these cases I have addressed the subjects of water quality and production, treatment plant reliability and capacity, and the necessity to implement production and distribution system improvements.

7. Q. WHAT IS THE PURPOSE AND SCOPE OF YOUR TESTIMONY?

A. The purpose of this testimony is to address issues associated with the source of supply and production facility improvements in St. Joseph, Missouri. Additionally, the testimony will describe the intent, scope, rationale and status of the Platte County Water Treatment Plant Improvements, the Platte County Storage Tank, the Warrensburg Additional Source of Supply, the

Warrensburg Sulfide Removal Improvements, and the Mexico Water Treatment Plant Improvements.

8. Q. HOW DOES MISSOURI-AMERICAN WATER COMPANY ("MAWC' OR "COMPANY") FORMALLY IDENTIFY SYSTEM DEFICIENCIES AND ITS CAPITAL PROJECT REQUIREMENTS?

A. MAWC periodically evaluates the adequacy of its facilities through the development of a Comprehensive Planning Study ("CPS"). The most recent CPSs for MAWC were completed in 1994 and 1997.

9. Q. DESCRIBE THE COMPREHENSIVE PLANNING STUDY PROCESS?

A. The Comprehensive Planning Study is an engineering analysis of water demand projections, the potential for regionalization opportunities, source of supply adequacy and characteristics, treatment facilities, pumping facilities, storage facilities and distribution system piping. The purpose of the CPS is to develop a plan which maintains and/or improves the reliability and quality of the water system.

Demand projections are performed to determine the necessary capacity of facilities. Population projection data and an analysis of historic customer and usage trends are utilized to develop a projection of water demands. Maximum day water demand projections are based on a statistical analysis of the maximum day to average day ratios experienced in a specific service area. The effects of water conservation are considered in the demand projections along with the analysis of historic water consumption needs.

Regionalization opportunities are evaluated to determine if a consolidated solution to water supply problems in a particular area is feasible. Regionalization can often provide economies of scale, avoid duplication of facilities, and provide more effective service to customers.

Sources of supply are evaluated to provide a sufficient quantity of water to supply the system's needs. The quality of the raw water is considered to determine the treatment that must be provided to deliver finished water which meets all Federal and State regulations. The reliability of existing source of supply facilities such as raw water intakes, screening equipment and pumping equipment is reviewed to assure a reliable supply of raw water to the treatment process.

Treatment facilities are designed to meet projected maximum day water supply needs. The CPS evaluates the individual treatment plant components to assure they are appropriately sized and functional, with appropriate back-up to allow the plant to be able to meet the maximum day demand and water quality goals under varying operating conditions. Pumping facilities are reviewed to ensure that they can reliably and efficiently deliver finished water into and through the distribution system.

Water storage facilities, both at the treatment plant and in the distribution system, are evaluated to equalize the treatment plant's production rate on the maximum day, provide the effective volume necessary for fire fighting, and provide a reserve volume for emergency use.

The distribution system piping network is evaluated to determine the improvements that are necessary to maintain adequate pressures and flows through the system under peak conditions. Computer modeling of the distribution system piping network is a tool that is used to determine the adequacy of existing facilities and compare alternative improvements.

When system deficiencies are identified, the CPS provides a preliminary evaluation of alternatives which will adequately address the need. Additionally, during the early stages of design of a project, the CPS project scope is further developed when a formal project Design Concept is prepared. Additional detailed evaluation and review of alternatives is performed at this stage of design. This additional review process defines the final design solution for subsequent implementation.

ST. JOSEPH 2000 PROJECT

10. Q. WHAT SPECIFIC DEFICIENCIES WERE IDENTIFIED FOR THE ST. JOSEPH PRODUCTION FACILITIES DURING THE COMPREHENSIVE PLANNING STUDY PROCESS?

A. Capacity, reliability, process control, and safety deficiencies were identified.

11. Q. HAVE THE DETAILS OF THESE DEFICIENCIES BEEN PREVIOUSLY DESCRIBED?

A. Yes. The capacity, reliability, process control and safety deficiencies were presented in the direct testimony of John S. Young, Jr. before the Missouri Public Service Commission in its casesWA-97-46/WF-97-241

12. Q. PLEASE DESCRIBE THE PROPOSED ST. JOSEPH 2000 PROJECT.

A. This title "St. Joseph 2000 Project" has been given to the project that includes construction of alluvial wells adjacent to the Missouri River, dual raw water transmission pipelines, ground water treatment facilities at a remote upland site, and dual finished water transmission pipelines to connect with the existing distribution system. This project scope was selected as the most cost-effective, feasible project to reliably supply the St. Joseph service area.

13. Q. PLEASE DESCRIBE THE PROPOSED SOURCE OF SUPPLY.

A. The proposed source of supply is ground water obtained from Missouri River alluvial sediments. The proposed well field is located north of the Missouri River in Andrew County. Wells withdrawing from the alluvial aquifer will be recharged from induced infiltration from the river, providing a high capacity ground water source of supply.

The natural filtration provided by the stream bed and the alluvial sediments will minimize the potential for transmission of surface water microbiologic contaminants from the river to the wellhead. An exception is viruses which have the potential to travel substantial distances and remain viable. Disinfection for viruses is discussed in a subsequent question concerning the ground water treatment process.

Testing has shown the quality of the ambient ground water quality to be high in hardness (500 to 600 mg/L), iron (greater than 10 mg/L), manganese (0.4 to 1 mg/L), and ammonia. A shift in quality is projected to occur after pumping from the wells is begun and infiltration from the river is induced. With the pumping rates needed to supply St. Joseph, the hardness levels are expected to decline to within 10 to 20 percent above historical hardness levels in the river. Iron and ammonia levels are also expected to gradually decline to steady state levels much lower than in the ambient ground water.

14. Q. PLEASE DESCRIBE THE NUMBER, TYPES AND CAPACITY OF WELLS THAT WERE SELECTED.

A. Seven vertical wells, each rated at 2500 GPM (3.6 MGD), are being constructed. The well screens are 36" in diameter and 25'-30' in length. One horizontal collector well rated at 12,510 GPM (18 MGD) is being constructed. This well consists of seven laterals each 200 feet in length.

15. Q. PLEASE DESCRIBE HOW THE PROPOSED SOURCE OF SUPPLY WAS LOCATED.

A. As part of the comprehensive planning process in the aftermath of the 1993 flood, alternative sources of supply were evaluated. Hydrogeologists familiar with alluvial settings similar to those found in St. Joseph recommended the proposed site as the most promising location for a high capacity ground water supply.

A two phase investigation was implemented to locate and quantify the ground water resources in the area. Several possible sites in the river valley were prioritized according to proximity to existing facilities and potential for adequate capacity. Borings were then performed approximately one mile south of the existing treatment plant site, but revealed inadequate aquifer materials. Next, borings were conducted at the proposed well field site on the protected side of the levee which confirmed desirable subsurface materials. Water quality testing on water obtained from the bore holes showed high hardness, iron, and manganese.

Additional borings were performed on the River side of the levee to better characterize the site. The site characterization was followed by an aquifer pumping test. The pumping test was used to quantify aquifer characteristics such as transmissivity and stream bed permeability. A follow-up hydrogeologic investigation was undertaken to provide data to be used for design and regulatory purposes.

The construction of well field facilities was also considered south of St. Joseph. However, this area was eliminated from consideration due to industrial and commercial activity that could contaminate the ground water, and the difficulty and cost of integrating a production facility at this location into the existing distribution system.

16. Q. BRIEFLY DESCRIBE THE PROPOSED TREATMENT PLANT AND ITS CAPACITY.

A. The treatment plant will provide removal of iron and manganese, disinfection, and corrosion control.

The proposed treatment plant capacity is 30 mgd. The system delivery capacity is approximately 28.5 mgd or five percent less than treatment capacity. This value closely matches the 27.7 mgd demand projection for 2009. The 1.5 mgd difference accounts for filter wash water and in-plant usage.

17. Q. PLEASE DESCRIBE THE TREATMENT PROCESS WHICH HAS BEEN DESIGNED FOR THE PROPOSED PLANT.

A. The treatment process includes oxidation of dissolved iron and manganese, followed by solids contact clarification and dual media filtration. Chlorine will be used for oxidation of the dissolved iron while manganese will be removed through a combination of oxidation by potassium permanganate and adsorption to filter media.

The ground water supply has the potential for viruses to be present and disinfection criteria will be based on virus inactivation using a brief contact time with free chlorine. Corrosion control will be provided by pH adjustment using a combination of hydrated lime and caustic soda. Powdered activated carbon will be provided to remove synthetic organic chemicals such as pesticides which may be present in the ground water in the future. Chloramination (chlorine/ammonia combination) of the filter effluent or plant effluent will limit any increase in disinfection byproducts as the water travels through the distribution system.

The American Water Works Service Company competitively bids chemical supply contracts annually for a number of chemicals, including all chemicals to be used at the plant under construction (except for salt and blanket polymer) and the unit chemical cost ($/lb) used in the workpapers for pro forma chemical adjustments shown on Schedule LJG-2.6, which is attached to the direct testimony of Company witness Linda Gutowski, is based on the chemical bid results for chemical contracts beginning in January, 2000.

The chemical dosages (lb/MG) shown in the workpapers for pro forma chemical adjustments shown on Schedule LJG-2.6 are based on the projected water quality of the ground water supply and the results of pre-design pilot testing. The chlorine dosage is based on the projected iron content and on the ammonia content of the ground water. The potassium permanganate dosage is based on projected manganese concentrations in the ground water. The blanket polymer and ferric chloride dosages are based on pilot testing results to properly operate the solids contact clarifiers. The hydrated lime dosage is based on projected pH adjustment requirements in pretreatment, while the caustic soda dosage is estimated to make final adjustments to the pH of the filtered water prior to distribution. The ammonia dosage is based on *stoichiometric relationship to free chlorine to properly form chloramines* prior to distribution. The salt requirement is for the ion exchange softening of ejector supply water for ammonia feed and for dilution water necessary to feed caustic soda. The fluosilicic acid dosage is based on the difference between natural fluoride concentration and the desired value of approximately 1.0 mg/L in the finished water.

18. Q. WHY IS THIS PROCESS APPROPRIATE FOR THE GROUND WATER SUPPLY?

A. The elevated levels of iron and manganese in the raw water require a clarification step to be provided prior to filtration. Providing effective removal of the iron and, to a lesser extent, the manganese through the solids contact clarifiers allows optimal performance of the filters as a polishing step.

The solids contact clarifiers offer the flexibility for use in a future lime softening process, if required. Lime softening is not currently planned due to the additional capital and operating costs, and the difficulty in disposing of the resulting treatment residual solids.

19. DESCRIBE THE RAW WATER TRANSMISSION MAIN PROJECT WHICH CONNECTS THE PROPOSED GROUND WATER SOURCE OF SUPPLY TO THE TREATMENT PLANT.

A. Dual 36-inch pipelines will relay water from the well field to the proposed water treatment plant. One pipeline consists of approximately 15,000 feet of 36-inch main in a route which begins in the Missouri River bottoms area (well field), crosses Mace Creek parallels the Burlington Northern Railroad right-of-way, crosses the railroad and Waterworks Road onto a private road that becomes County Line Road, and then proceeds under an interstate highway to the treatment plant.

The second pipeline consists of approximately 16,000 feet and begins on the protected side of the levee at the well field, and crosses Mace Creek and the Burlington Northern Railroad. After these crossings, the route proceeds south adjacent to the Burlington Northern Railroad right of way, then east up the Missouri River bluffs. The maximum grade through the bluffs along this route is about 17%. The route follows a series of dirt roads through private property to Interstate 229, crosses the interstate and proceeds through private property until it reaches Amazonia Road where it continues east along County Line Road to the plant site.

20. Q. WHY ARE TWO INDEPENDENT PIPELINES PROPOSED FOR RAW WATER TRANSMISSION?

A. Two separate pipelines were selected in order to insure the reliable delivery of raw water to the treatment plant in the event of a main break or routine maintenance in either of the mains. The pipelines follow differing routes since each of the routes is vulnerable to Missouri River flooding and/or soil slope failures. Repair of pipeline breaks could require more than one day because much of the piping is difficult to access. The use of a single pipeline has significant potential for an interruption of water service to St. Joseph. The use of two raw water pipelines also allows the pipelines to be removed from service and cleaned to maintain hydraulic capacity.

21. Q. HOW WERE THE ANNUAL SEWER FEES ESTIMATED FOR DISPOSAL OF TREATMENT RESIDUALS ?

A. The sewer fees are set by the City of St. Joseph. The three components to the disposal cost are listed in the sewer fee calculation workpapers. There is a monthly service charge, but the major costs are related to the flow charge and the excess solid charge. It is projected that the plant will discharge an average of 201,600 gallons per day of treatment residuals to the sanitary sewer with a Total Suspended Solids (TSS) concentration of 2,000 mg/L.

The treatment residuals result from the removal of precipitated iron and manganese present in the ground water, and from the addition of chemicals such as ferric chloride and polymer used to enhance the removal of iron and manganese. Each solids contribution was estimated based on projected iron and manganese concentrations in the ground water and projected chemical requirements.

The blowdown from the solids contact clarifiers is the primary solids contributor, and the suspended solids concentration of the waste stream is based on the projected solids concentration of the clarifier blowdown. A value of 2,000 mg/L TSS was used in the estimate based on results of a pre-design pilot study and operating experience at facilities where solids contact clarifiers are in operation.

22. Q. WHAT ALTERNATIVES TO SEWER DISPOSAL WERE CONSIDERED?

A. Two major alternatives to sewer disposal were considered. First, direct discharge to the Missouri River was considered. However, current regulatory policies of the Missouri Department of Natural Resources and the Environmental Protection Agency would not allow an operating permit to be issued for direct discharge of iron and manganese treatment residuals. For example, typical NPDES permit requirements limit average discharge TSS to values far below the projected 2,000 mg/L TSS concentration from the treatment process. Other limits typically are placed on iron and manganese concentrations. Direct discharge to the Missouri River is not a feasible alternative.

Secondly, on-site dewatering of iron and manganese residuals was considered. Land requirements were estimated and construction cost estimates prepared for lagoons. The lagoons would require impermeable liners to comply with Missouri Department of Natural Resource design requirements. Filter backwash water would be treated and recycled to the plant influent. Supernatant discharge from the lagoons would be returned to the Missouri River. Operation of the lagoons would require annual removal of partially dewatered iron and manganese solids and disposal in a landfill. Additional costs with the lagoon/landfill alternative are for construction of a septic system on the plant site, for sanitary waste, and a laboratory waste holding tank since laboratory wastes could not be discharged to the septic system.

The projected revenue requirement was similar for both sewer disposal and dewatering by lagoon with disposal of solids to a sanitary landfill. The sanitary sewer alternative was selected since the Water Company would not be responsible for dewatering of the residuals or for limitations on landfilling of treatment residuals. Iron and manganese residuals typically dewater poorly in lagoons, and additional mechanical dewatering may have been needed to adequately prepare the material for acceptance by a landfill. Long-term landfill acceptance of the treatment residuals is an unknown. Discharge of iron and manganese residuals to the sanitary sewer can benefit the sewage treatment process through reduction of hydrogen sulfide and as a clarification aid in the primary settling process.

23. Q. WHAT PROJECT IS REQUIRED TO CONNECT THE PLANT TO THE EXISTING DISTRIBUTION SYSTEM?

A. Finished water transmission pipelines are necessary to connect the treatment plant to the distribution system. Two 36-inch pipelines from the plant to the Huntoon Reservoirs, located approximately one and one-half miles southwest of the plant site are being constructed. Two pipelines are required to insure reliable service in the event of a main break or if maintenance is required on one of the pipelines.

24. Q. WHAT IS THE STATUS OF THE ST. JOSEPH 2000 CONSTRUCTION PROJECT?

A. The raw water transmission main contract has been completed. For the wellfield contract, the seven vertical wells have been installed and are currently pumping to waste. The caisson and laterals for the horizontal collector well have been installed and the pump station construction has commenced.

For the water treatment plant contract, the major structures have been erected and equipment installation has started. Equipment start-up should commence in January, 2000.

Pipeline installation has started for the finished water transmission main.

25. Q. WHEN WILL THE FACILITIES BE PLACED INTO SERVICE ?

A. April, 2000.

26. Q. WHAT IS THE PROJECTED CAPITAL COST OF THE PROJECT?

A. $74,684,000.

27. Q. WHAT IS THE SCOPE AND ESTIMATED COST OF DEMOLITION AT THE EXISTING ST. JOSEPH WATER TREATMENT PLANT?

A. Once the ground water supply and treatment facilities are in operation, the existing water treatment plant site and facilities will be of no benefit to the Company. The scope of the retirement and demolition activities at the existing treatment plant is listed below:

Cut and cap the 30" concrete plant discharge pipeline in Water Works Road

Cut and cap both the 16" and 24" plant discharge pipelines from the existing treatment plant to the Huntoon storage tanks

Remove treatment residuals from all clarifiers and basins

Remove the Emergency Intake, including screen and support piling from the Missouri River, and Raw Water Pump No. 10.

Remove the hydraulic submersible pump at the Main Intake

Remove the traveling screen from the Screen Well, backfill the screen well, and seal the raw water intake piping.

Dispose of unusable treatment chemicals

Remove and dispose of filter media

Demolish steel wash water tank

Plug residual discharge piping to the Missouri River and stabilize the affected areas of the river bank

The retirement and demolition costs are estimated to total $500,000.

PLATTE COUNTY WATER TREATMENT PLANT

28. Q. WHAT WAS THE PURPOSE OF THE PLATTE COUNTY WATER TREATMENT PLANT IMPROVEMENTS?

A. The improvements to the Platte County Water Treatment plant address a number of operational, water quality, safety and chemical system deficiencies. One aspect of the improvements allows the wells, treatment plant and distributive pumps to operate without constant on-site operator intervention and supervision. A primary goal of the automation was to permit the facilities to operate continuously at variable rates instead of an on/off manner, thereby improving water quality and operating reliability. The control system improvements also allow improved monitoring and control of plant performance and water quality.

The treatment plant and distributive pumps had been operating in an on/off manner using the limited automation installed in the plant following the 1993 flood. The treatment facilities and pumping equipment sometimes cycled on and off more than 20 times per day. When the plant was "on", the treatment and pumping rate was often near plant capacity. The frequent cycling had negative impacts on the treatment process, finished water quality and the distribution system pressure.

The solids contact type clarifier at the Platte County Plant can produce high quality effluent at relatively high overflow rates, but it is sensitive to flow rate changes. The on/off operation upset the clarifier to the point that the softening process was difficult to monitor and control. Finished water quality was highly variable, often with elevated turbidity and iron levels. Precipitated softening chemicals and iron that passed the filters tended to accumulate in the distribution system and subsequently resulted in discolored water. Chlorine residual also fluctuated and sometimes led to taste and odor complaints.

The frequent on/off operation also resulted in hydraulic transients (i.e water hammer) that was directly impacting customers plumbing and water service. The transients contributed to water quality complaints by dislodging the softening chemical and iron precipitates in the distribution system.

The improvements also were intended to provide adequate disinfection capacity to address the presence of viruses in the source water and to distribute water with a compatible type of chlorine residual to blend with the water purchased from Kansas City, Missouri.

Chemical system improvements addressed the safety of the chlorine storage and feed by improvements to the chlorination equipment, the ability to neutralize chlorine leaks by provision of a scrubber, and the reliability of the lime softening process by improvements to the lime feed and slaking equipment.

29. Q. WHAT WAS THE SCOPE OF THE PLATTE COUNTY WATER TREATMENT PLANT IMPROVEMENTS?

A. Improvements were made in several areas. First, a computerized distributed control system (DCS) was installed to automate the wells, the treatment plant, and the distributive pumps. A control strategy was implemented to allow the wells, treatment process, chemical systems, and distributive pumps to operate at variable rates instead of an on/off high flow rate. Digital controllers were installed at the wells to operate the pumps remotely. Radio communication with the wells was installed to replace unreliable telephone lines.

The distributive pumping rate is based on water level in the Crooked Road Tank and the time of day. Well flow is controlled to maintain a constant level in the clearwell at the treatment plant. The lime feed and slaking system is controlled based on the lime dosage set by the operator. Pre-chlorine, phosphate, and polymer feed rates are automatically controlled based on the dosages set by the operator. Post-chlorine is controlled automatically through measurement of the residual entering the clearwell. Ammonia feed is controlled through the free chlorine residual entering the clearwell and the distributive pumping flow rate.

The control system improvements included monitoring and recording water quality parameters, including clarifier effluent turbidity, combined filter effluent turbidity, plant effluent turbidity, clarifier effluent pH, plant effluent pH, clearwell influent free chlorine residual, and plant effluent combined chlorine residual. These water quality analyzers allow treatment plant performance to be continuously documented in the absence of an on-site operator. Flow meters were installed to continuously monitor and record the raw water and the finished water flows.

A chlorine storage and feed system was installed to provide adequate capacity for a free chlorine residual and to address safety concerns. A free chlorine residual is needed to ensure disinfection of viruses in the alluvial ground water supply. A room dedicated to the storage of chlorine gas cylinders was constructed separately from a chlorine feed room. A chlorine scrubber was installed to automatically detect, capture and neutralize chlorine leaks.

The single lime feeder and slaker was replaced because the unit was maintenance intensive and unreliable. The replacement unit is a less complex design yet can automatically adjust the feed rate in response to the control system.

Purchased water from Kansas City, Missouri contains chloramines as a disinfectant in the distribution system. An ammonia storage and feed system was installed at Platte County to ensure that the finished water chlorine residual was compatible for blending with the purchased water. Separate storage and feed rooms were installed for the ammonia storage and feed system.

An upgrade of the plant service water system was necessary to provide sufficient flow capacity and pressure to feed chlorine, ammonia and lime. An ion exchange water softening system was necessary to feed ammonia without causing excessive plugging of the feed line and diffuser with carbonate deposits.

Renovation of the space above the chlorine storage room provided adequate space for the control system computer and laboratory testing for process control. Improvements included lighting, heating and air conditioning, cabinets, countertop and a sample sink.

30. Q. WHAT ALTERNATIVES WERE CONSIDERED?

A. The completed improvements were necessary for the Platte County Water Treatment Plant to continue in operation while addressing disinfection, chlorine gas safety, lime feed system reliability and performance, and clarifier/filter performance issues. Alternatives included abandoning the existing plant and either constructing a new water treatment plant or purchasing the entire water supply from Kansas City, Missouri. These alternatives had a higher present worth cost than the completed project.

31. Q. DO THE IMPROVEMENTS PREVENT THE WELLS AND TREATMENT PLANT FROM FLOODING?

A. No. It was determined that the plant could not be protected adequately from the type of flooding that occurred in 1993 due to limited space, structural, safety and cost concerns. Consequently, none of the improvements are directly related to flood proofing the water supply and treatment facilities. However, the interconnections with Kansas City, Missouri provide a reliable supply in case of flooding or other catastrophic conditions. Nevertheless, the plant improvements were designed to quickly return the facilities to service once flood waters recede.

32. Q. WHAT IS THE STATUS OF THE PLATTE COUNTY TREATMENT PLANT IMPROVEMENTS ?

A. *The treatment plant improvements were placed in service in June, 1998.*

33. Q. WHAT WAS THE TOTAL PROJECT COST OF THE PLATTE COUNTY TREATMENT PLANT IMPROVEMENTS?

A. $1,828,535

PLATTE COUNTY WATER STORAGE TANK AND PUMP STATION

34. Q. WHAT IS THE PURPOSE OF THE PLATTE COUNTY STORAGE TANK?

A. The tank will eliminate the existing equalization and total storage deficits in the High Pressure Zone of about 0.2 MG and 0.6 MG, respectively. In addition to providing equalization, the tank will assist in meeting fire flow requirements of the High Pressure Zone. The site for the tank also provides additional gravity storage to the Main Pressure Zone. The combined storage deficit is projected to increase to 0.9 MG by the year 2000 as a result of significant residential development.

35. Q. HOW DID SUBSURFACE CONDITIONS AFFECT THE PROJECT SCOPE?

A. The tank site is located on top of a hill overlooking the Missouri River flood plain near Kansas City. The site consists of an approximately 45 to 55 foot layer of soft to moderately stiff silty clay soil with moderate consolidation potential overlaying intermittent beds of shale and limestone imbedded with shale. Because of the consolidation potential, the net allowable bearing capacity was limited to 3,000 pounds per square foot. This geologic condition, combined with mining in the area, resulted in a sophisticated tank foundation design

36. Q. WHAT IS THE SCOPE OF THE STORAGE TANK PROJECT?

A. The steel tank has an overflow elevation of 1041-feet USGS. The ground elevation for the top of foundation will be set at 1004-feet USGS. With the tank diameter established as 68-feet and a height to overflow of 37-feet, the approximate volume of the tank will be 1,000,000 gallons. The tank overflow is set by the main pressure zone system gradient.

The proposed tank was designed in accordance with AWWA Standard D100-96. The roof will be a self supporting dome having no interior columns. The interior and exterior of the tank will have an epoxy finish. Separate inlet and outlet piping was designed to serve the Main Service Gradient by gravity and to pump to the High Service Gradient.

37. Q. DESCRIBE THE PUMP STATION BUILDING.

A. The building will house the three booster pumps, motor control centers, telemetry equipment, the motorized butterfly control valve, the discharge meter and the standby generator. The building will be constructed of masonry block with split face finish on the outside.

38. Q. HOW ARE THE TANK AND PUMP STATION INTENDED TO OPERATE?

A. The main purpose of the tank is to provide pumped storage capacity to the high service area of the distribution system which operates at a gradient of 1167 feet USGS. The tank will be filled from the Platte County Water Treatment Plant which pumps to a gradient of 1041 feet USGS. When system pressure in the Main Pressure Gradient drops below a set pressure, water from the tank will return to the Main Pressure Gradient by gravity.

Service to the High Service Gradient will rely on the booster pumps. A declining water level in the Platte Woods elevated tank will start the primary 800 gpm pump. If the water level continues to drop, a second 800 gpm pump will start and both pumps will operate to meet system demand. The 800 gpm pumps will cease operation and an emergency 1,750 gpm pump will start if the water level in the Platte Woods elevated tank continues to drop due to a fire or other unusual demand condition. The booster pump(s) will continue to operate until a low-low level is reached in the Platte County Tank.

The tank and pump station will be monitored and controlled from the Platte County Water Treatment Plant through the DCS. The pumping equipment also can be operated locally for maintenance purposes.

39. Q. WHAT IS THE STATUS OF THE TANK AND PUMP STATION?

A. The tank and pump station are under construction and expected to be in service by April, 2000.

40. Q. WHAT IS THE PROJECTED COST OF THE PLATTE COUNTY TANK PROJECT?

A. $2,338,000.

WARRENSBURG SOURCE OF SUPPLY

41. Q. WHAT IS THE INTENT OF THE ADDITIONAL SOURCE OF SUPPLY PROJECT FOR WARRENSBURG?

A. An additional well was constructed to ensure that customer demands could be met with one well out of service. In 1997 the Warrensburg service area had an existing reliable source of supply capacity deficit of about 0.6 mgd. By the year 2000, this deficit was projected to increase by additional 0.6 mgd. The reliable source of supply deficit was projected to increase to 1.67 mgd by 2010. This project and future ground water development were recommended to eliminate these deficits.

The project also quantified and documented regional ground water quality and supply issues to ensure the availability of an adequate supply into the future.

42. Q. WHAT IS THE SCOPE OF THE FACILITIES CONSTRUCTED FOR THE ADDITIONAL SOURCE OF SUPPLY PROJECT?

A. The project included the installation of Well No. 9 and 1,300 feet of 12-inch diameter transmission main to connect the well to the Warrensburg system. Well No. 9 consists of a 16-inch diameter borehole, cased for the upper 350 feet, and with a total depth of 800 feet. The well is equipped with a 75 horsepower submersible pump. The reliable capacity has been determined to be approximately 975 gpm. Electrical service, the pump motor starter, instrumentation and controls, and a flow meter were installed at the well head.

43. Q. WHAT IS THE STATUS OF WELL NO. 9?

A. Well No. 9 was available for use in August, 1998. Well No. 9 is currently used as the baseload production well. With the completion of Well No. 9, the maximum day demand can be met with the largest well out of service. (per MDNR regulations)

44. Q. WHAT IS THE MOST IMPORTANT LONG TERM GROUND WATER SUPPLY ISSUE FOR WARRENSBURG?

A. It has been determined that increasingly mineralized water is present to the west of the Company's wellfield. It also was determined that the mineralized water is moving eastward toward the Company's wellfield. Additional treatment facilities or an alternative source of supply will be needed if the mineralized water reached the baseload production wells. The Company's wellfield was constructed in 1963 following a dramatic increase in Total Dissolved Solids (TDS), or salinity, in the wells located to the south of Warrensburg near Pertle Springs.

45. Q. WHAT STEPS HAS THE COMPANY TAKEN TO ASSESS THE POTENTIAL IMPACT OF THE MINERALIZED GROUND WATER ON CAPITAL INVESTMENT REQUIREMENTS?

A. A hydrogeological study was initiated in 1998 to determine feasible alternatives for locating future wells and to quantify and document the potential impact of the mineralized water in the area. The study determined that ground water is available south and east of the existing wellfield with quality similar to the current supply. Wells can be installed in these rural locations with minimal impact on adjacent water users.

The initial phases of the hydrogeological study consisted of data collection to determine historic and present water quality and hydrogeologic conditions. The third and final phase of the study entailed ground water modeling to determine the future availability and quality of ground water in the region. This study was the basis for locating Well No. 9.

The study adequately identified the location and concentration gradient of the ground water with elevated TDS. The TDS concentration for the existing wellfield has been stable at 350 mg/L since construction in 1963. However, the 500 mg/L TDS isoconcentration line is approximately 1.7 miles west of the westernmost Company production well (Well No. 5).

A series of three monitoring wells were installed to help confirm current and future water quality and water levels. Monitoring Well No. 3 is located between the 500 mg/L TDS isoconcentration line and production Well No. 5, and it serves as a "sentinel" well to be impacted before the production wells. Monitoring Well No. 2 was installed 1.8 miles east of the most easterly well (Well No. 9) in an area that could be used for relocation or expansion of the existing wellfield. Monitoring Well No. 1 was installed approximately 1.5 miles south of Well No. 9.

Ground water flow and quality modeling were performed to determine approximate time frames for ground water movement and to evaluate the effect of various operational and water supply management alternatives. The Company immediately adopted the recommended practice of using the easternmost wells as baseload wells and minimized use of the westerly wells to help slow down the migration of mineralized water.

Using a constant annual water withdrawal based on the projected demand for the year 2020, the modeling projected that TDS concentrations in Monitoring Well No. 3 will begin to rise in 2014 and reach concentrations of 500 mg/L by 2022. The TDS concentration in Well No. 7 is expected to begin increasing around 2020 and reach 500 mg/L by 2044.

The modeling effort also evaluated the impact of installing two baseload wells approximately two miles east of Well No. 9. The benefit of this alternative is an immediate slowing of the migration rate of the elevated TDS interface. For example, the rise of TDS concentrations to 500 mg/L in Monitoring Well No. 3 would be postponed by approximately 20 years compared to the "no construction" alternative. The initial rise in TDS would be postponed and the rate of increase would be reduced by moving the pumping center eastward toward the aquifer recharge area.

The construction of two replacement baseload wells, and a transmission pipeline to deliver water to the existing wellfield piping network has an estimated capital cost of $1,800,000. The Company plans to evaluate the benefit and timing of this project in comparison with other water supply needs in prioritizing the capital investment program. The Company also intends to update the ground water model periodically with additional water level and quality data to verify the validity of model results.

46. Q. WHAT WAS THE COST OF DEVELOPING AND EQUIPPING WELL NO. 9 AND THE ASSOCIATED HYDROGEOLOGIC STUDIES?

A. $950,000.

WARRENSBURG WATER QUALITY IMPROVEMENTS

47. Q. WHAT ARE THE CURRENT WATER QUALITY CONCERNS VOICED BY WARRENSBURG SERVICE AREA CUSTOMERS ?

A. Two aesthetic water quality related issues have been raised by a number of customers: 1) taste and odor and 2) short appliance life due to water hardness and the scaling tendency of the water.

48. Q. WHAT IS THE CAUSE OF THE TASTE AND ODOR PROBLEMS?

A. The presence of hydrogen sulfide in the ground water, and the inadequacy of the current treatment process to remove sufficient sulfide, results in a rotten egg or sulphurous taste and odor in the finished water. The sulfide detracts from the aesthetic palatability of the water, but is not a health concern.

Approximately 0.3 mg/L of hydrogen sulfide is present in the source of supply. Although the current treatment process removes most of the sulfide, the remaining sulfide concentration, after aeration and chlorination, is still objectionable to customers. The aeration process also releases sulfurous odors to the neighborhood atmosphere.

49. Q. WHAT IS THE CAUSE OF THE SCALING PROBLEMS ?

A. The scaling problems and subsequent impact on appliance life are related to the calcium and magnesium content of the water. These constituents are frequently measured as "water hardness". The total hardness of the finished water at Warrensburg is approximately 226 mg/L which falls within the middle range for potable water supplies in Missouri. The treatment process does not remove hardness.

50. Q. WHAT IS THE PURPOSE OF THE WARRENSBURG SULFIDE REMOVAL IMPROVEMENTS ?

A. The Sulfide Removal Improvements well accomplished the following results:

Improve the taste and odor of the finished water by oxidizing sulfide in the raw water with ozone.

Control the growth of the sulfur bacterium "Beggiatoa".

Discontinue the discharge of hydrogen sulfide odors to the neighboring residential areas.

Increase the reliable treatment and distributive pumping capacity to 5.0 mgd.

Improve safety and process control for chlorine storage and feed.

Provide a permanent sequestering agent storage and feed system to control scaling.

Provide for treatment and distributive pumping when purchased power is unavailable.

Provide an instrumentation and control system to control and monitor the treatment and pumping operations with a minimum of operator intervention.

51. Q. WHAT IS THE SCOPE OF THE SULFIDE REMOVAL IMPROVEMENTS ?

A. The project includes an ozonation system for the oxidation of sulfide. The ozonation system includes a liquid oxygen storage tank, liquid oxygen evaporators and pressure reducing valves, two ozone generators each with a capacity of 105 pounds per day of ozone, two generator cooling systems, two ozone gas injection systems, a degasification chamber, two ozone offgas destruction systems and ozone monitoring and control equipment. A masonry structure houses the ozonation facilities.

The project scope includes a chlorine storage and feed system based on the use of 150 pound cylinders. A vacuum feed system is used to withdraw chlorine from the cylinders and distribute the gas under vacuum to minimize the potential for chlorine leaks. Two feeders are provided and are capable of automatic control through the distributed control system (DCS). Chlorine gas detectors and a chlorine gas scrubber is provided to capture and neutralize chlorine gas leaks with a maximum capacity of 150 pounds. Separate rooms are provided to isolate the chlorine cylinders from the feeders.

Since the treatment process does not remove hardness, the project includes a storage and feed system for a sequestering agent to minimize scaling in water heating equipment. The chemical storage and feed system includes a day tank, a transfer pump, two metering pumps, secondary containment to capture chemical leaks or spills, and instrumentation and controls for automatic feed rate adjustments in proportion to plant flow.

The project includes a connection to the sanitary sewer for the office building, floordrains in the ozone/chemical building, process wastes from the ozonation system and potential floatable residuals from the clearwell.

A 350 kW diesel engine generator is included to power Well No. 5, the ozonation system, other chemical systems, the office building, and one or two distributive pumps during interruption of purchased electrical power. The generator is equipped with a self contained double wall fuel tank with 24 hours of storage capacity. The generator replaces a 200 kW unit which was inadequate to supply the increased electrical loads associated with ozone.

The scope includes one additional vertical turbine distributive pump with associated motor starter, check valve and air relief valve. Clearwell and distributive pump wet well improvements include installation of slide gates between the clearwell and the wet well to reduce the headloss caused by the existing valves.

The scope also includes a distributed control system (DCS) to operate, monitor and document the treatment process, raw water supply, distributive pumping and storage tank levels. Control strategies are programmed for the pumping and treatment process equipment along with alarming to notify personnel of the need for operator intervention.

The existing aerator, chlorination system, controls, and some of the yard piping are to be retired.

52. Q. HOW DOES THE USE OF OZONE ELIMINATE SULFIDE FROM THE WATER SUPPLY ?

A. Ozone is the most powerful oxidant used in water treatment. Ozone is created from oxygen subjected to high voltage, and the ozone gas is injected to the raw water. The reaction with sulfide is almost instantaneous to form sulfate. The resulting slight increase in sulfate concentrations above normal background levels has no deleterious aesthetic or health effects. Unlike the use of chlorine to oxidize sulfide, particulate sulfur is not formed. Therefore, there is little or no increase in turbidity.

53. Q. WHAT PRECAUTIONS MUST BE TAKEN WHEN USING OZONE IN WATER TREATMENT ?

A. As with any chemical used in water treatment, safety must be addressed through proper design and operation. The liquid oxygen system, identical to the systems used at most hospitals, requires special precautions such as no smoking and prohibitions on oil or petroleum based greases in piping used in oxygen service. Ozone gas detection equipment is located within the ozone building for automatic operation of ventilation equipment if ozone gas is detected inside. The concentration of ozone gas in the offgas from the degasification chamber is continuously monitored. The ozone in the offgas is converted to oxygen through the ozone destruction system using heat and a catalyst. The exhaust from the destruct units is continuously monitored to ensure adequate performance.

The ozone generation process must be carefully controlled to react effectively with the sulfide. Under dosing would allow objectionable sulfide to remain while gross overdosing could result in excessive formation of bromate. Bromate is formed by the reaction of ozone with naturally occurring bromide in the source water. The Maximum Contaminant Level (MCL) for bromate is 10 parts per billion. Bromate formation studies were performed as part of the design of the ozonation facilities. The studies showed that bromate levels could be maintained below the MCL by adequate process control. For example, the bench scale testing showed that an ozone residual of 0.3 mg/L resulted in bromate levels of 1.5 ppb which is below the MCL. Aqueous ozone residual monitoring equipment is provided to monitor and document ozone residuals. The ozone generators can be controlled by using the feedback from the ozone residual monitors to limit bromate formation.

54. Q. WHAT ALTERNATIVES TO THE USE OF OZONE WERE INVESTIGATED FOR SULFIDE REMOVAL ?

A. A study of sulfide removal alternatives was conducted and documented in a report entitled "*Sulfide Treatment Evaluation for the Warrensburg District Water Treatment Plant*" by CH2M Hill, January 1998. The processes evaluated in that study were oxidation with chlorine (with and without pre-aeration), oxidation with hydrogen peroxide (with and without pre-aeration), Centaur GAC (with and without aeration) and ozonation. Bench and pilot scale evaluations were performed on chlorine, peroxide and Centaur GAC. Ozonation was evaluated through a desktop study. The results of the evaluations showed that chlorine and hydrogen peroxide were incapable of achieving complete sulfide oxidation and formed undesirable colloidal sulfur at some concentrations. Chlorine performed poorly in all taste tests. Short term testing of Centaur GAC provided promising results.

Three primary alternatives were compared on an estimated revenue requirement basis with the assumption that each alternative was effective in removing sulfide. Centaur GAC was the least costly, followed closely by ozonation, with conventional oxidation-coagulation-filtration being the most costly. Because Centaur GAC appeared to be the least costly, the study recommended that GAC be further evaluated through a long term pilot study.

GAC was evaluated through pilot testing over a five-month timeframe. While initial performance was excellent with complete sulfide removal, sulfide appeared in the GAC effluent after just seven weeks of testing. A filamentous biological growth was evident on each of the GAC columns at about the same time. The biological growth was identified as *Beggiatoa*, which is a sulfur based bacteria. Based on the performance demonstrated in the pilot testing, GAC would have to be replaced every 133 days instead of the 730-day (two year bed life) assumption used in the economic analysis. Based on a GAC changeout frequency of every 133 days, ozonation is the least cost process for sulfide removal. Without cost effective control of *Beggiatoa*, GAC is not a realistic or feasible treatment alternative at Warrensburg.

55. Q. HOW WILL OZONATION CONTROL *BEGGIATOA* ?

A. *Beggiatoa* is apparent in the current process as a thin film on the aerator slats and as cottony tufts which are visible in the clearwell. *Beggiatoa* appears to thrive in the environment of the aerator where both oxygen and sulfide are readily available. The elimination of the extensive substrate within the aerator, the addition of ozone as the first treatment step, followed by chlorination is expected to be effective in controlling the *Beggiatoa.*

56. Q. WHAT IS THE ADDITIONAL POWER COST TO OPERATE THE OZONATION FACILITIES?

A. As identified in the workpapers for pro forma Fuel and Power Expense on Schedule LJG-2.5, attached to the direct testimony of Linda Gutowski, there are both fixed costs and variable electric costs associated with operation of the ozonation facilities. The additional fixed annual electric cost has been estimated to be $6,400; the additional variable electric cost has been projected to be $3.10 per million gallons.

The estimated costs are based on Missouri Public Service Energy One Rate Schedule 320 with incremental unit energy costs of $0.0362 per kilowatt-hour (summer rate). Incremental demand charge was estimated using the summer rate of $3.29 per kW.

The fixed energy consumption is a characteristic of equipment such as the sidestream injection pumps, degasification blower, and ozone destruct units that operate at fixed rates whenever the ozone system is in operation. Total fixed energy consumption is estimated at 16 kW.

The ozone generator consumes power proportional to ozone production. Variable energy consumption was estimated using the assumption of a 1.5 mg/L ozone dosage requiring 5 kwh/pound of ozone for an ozone generation electrical requirement of 63 kwh/million gallons and an operating cost of $2.28/million gallons. The variable electrical demand associated with operation of the ozone generator was estimated at approximately 10 kW for a monthly cost of approximately $33 or approximately $0.415 per million gallons. A 15 percent contingency factor was added to account for estimating inaccuracies and items such as ozone transfer efficiency, seasonal rate differences, and miscellaneous equipment electrical consumption. This results in the total of $3.10 per million gallons or $0.0031 per thousand gallons.

57. Q. WHAT ADDITIONAL CHEMICAL COSTS WILL BE INCURRED AS A RESULT OF OZONATION?

A. The only additional chemical to be fed is oxygen, which is needed to form ozone. The oxygen related costs are identified in the workpapers for the pro forma chemical adjustments on Schedule LJG-2.6. The required oxygen dosage is based upon the ozone dosage and sulfide concentration in the ground water. The unit cost of the oxygen ($/lb) was determined after being competitively bid.

58. Q. WHAT IS THE STATUS OF THE SULFIDE REMOVAL IMPROVEMENTS?

A. The project is under construction and will be placed in-service no later than April, 2000.

59. Q. WHAT IS THE PROJECTED CAPITAL COST OF THE PROJECT?

A. $3,950,000

MEXICO TREATMENT PLANT

60. Q. WHAT IS THE PURPOSE OF THE MEXICO WATER TREATMENT PLANT IMPROVEMENTS?

A. The improvements to the Mexico Water Treatment plant are intended to resolve a number of capacity, operational, water quality, safety and chemical system issues. The primary elements are intended to:

Increase the rated capacity of the treatment and distributive pumping facilities from 3.1 mgd to 4.5 mgd to meet projected demands.

Provide effective unit processes such as rapid mixing, flocculation, sedimentation, stabilization and filtration consistent with the lime softening process.

Provide automated chemical feed systems that automatically adjust to varying plant flow.

Provide chemical storage and feed systems that minimize the exposure of Company personnel and neighbors to the chemicals.

61. Q. WHAT IS THE SCOPE OF THE MEXICO WATER TREATMENT PLANT IMPROVEMENTS?

A. A number of improvements were folded into the scope of the project. The most significant improvements are:

Construction of a rapid mixing basin for adequate dispersion of lime and other chemicals.

Construction of two parallel, three-stage, tapered flocculation basins with variable speed vertical turbine mixers to promote calcium carbonate flocculation for efficient settling in the downstream sedimentation basins.

Rehabilitation of the two sedimentation basins with a structural concrete overlay, improved inlet and outlet flow distribution and collection to facilitate parallel operation of the basins and to maximize solids removal prior to filtration.

Construction of a third filter for increased plant capacity and improved reliability in the filtration process. Dual media, consisting of sand and anthracite, is to be installed in each filter to reduce headloss and increase the allowable filtration rate.

Improved filter washing capability with a vertical turbine pump drawing wash water from the clearwell and surface washers in each filter to enhance the cleansing of filter media.

Rehabilitation of piping, valves, and controls for the two existing filters to provide adequate control of filter flows and water levels.

Chlorination improvements including an all-vacuum withdrawal system to minimize the potential for gas leaks.

Installation of chlorine gas feeders with automatic control through the DCS.

Installation of chlorine gas scrubber to capture and neutralize chlorine leaks.

Installation of bulk lime storage to replace the existing bag and hopper system.

Installation of two pebble lime feeders and slakers to replace the single unit which is in poor condition and is unreliable.

Installation of a fourth distributive pump to provide a reliable distributive pumping capacity of 4.5 mgd.

Replacement of an existing distributive pump due to its service life and the unavailability of replacement parts within a reasonable timeframe.

Electrical power distribution improvements to support increased electrical loads for chemical systems, flocculation basin mixers, the filter backwash pump and a fourth distributive pump.

Installation of a replacement radio telemetry system to allow data communication with storage tanks, wells, and automated valves.

Installation of a distributed control system (DCS) to coordinate operation of the supply, treatment and storage facilities with minimal operator intervention.

The DCS controls, monitors, and documents the operation of the wells, treatment processes, distributive pumping, and storage tanks. It operates the facilities in accordance with prescribed control strategies, and it alerts personnel when process parameters are not in accordance with preset parameters. Included in the scope of the DCS is instrumentation to monitor raw water flow, individual filter flows, and finished water flow. Water quality monitors are included to monitor turbidity, chlorine residual and pH at certain locations through the treatment process.

62. Q. WHAT ALTERNATIVES WERE CONSIDERED TO MINIMIZE THE COST OF THE MEXICO WATER TREATMENT PLANT IMPROVEMENTS?

A. A number of alternatives were evaluated prior to commencing design of the project, and additional alternatives were evaluated in the early stages of design. The potential for discontinuing softening and retiring all softening related facilities was considered as an alternative. It was determined that the industrial and commercial customers would strongly object to the unsoftened water which would have a total hardness of approximately 290 mg/L as CaCO3 (calcium carbonate). Currently, finished water hardness is maintained at 180 mg/L which is acceptable to the customers.

Blending of softened water with unsoftened water, in a manner to maintain a final hardness equivalent to the current operation, also was considered as an alternative. The blending could occur either prior to filtration or within the clearwell. Blending after filtration would eliminate the need for additional filtration capacity. Approximately two-thirds of the plant flow would be softened to 125 mg/L of total hardness to achieve 180 mg/L in the blended product. This degree of softening would require an elevated pH treatment scheme to remove magnesium in addition to calcium.

It was estimated that the revenue requirement of the blending alternative was only slightly less (i.e., six percent) than conventional treatment of the entire flow. There were several significant process control and water quality concerns with the post-filtration blending alternative. These concerns include the treatment challenges associated with magnesium removal, such as poorer settling and increased production of treatment residuals, difficulty in controlling plant effluent hardness, and the potential degradation of plant effluent quality due to (untreated) ground water quality. Furthermore, the blending alternative did not address the reliability of the existing filtration process.

As part of the Water Company's requested critique of the Design Concept, the design consultant recommended that carbon dioxide be injected as a solution rather than a gas. In addition to more efficient chemical transfer, this alternative method of carbon dioxide addition does not require a contact basin. Following a pilot study and discussions with Missouri Department of Natural Resources, this cost-saving alternative was implemented in the design.

The design consultant also recommended that helical flow type solids contact type clarifiers be constructed. These clarifiers would not require construction of upstream flocculation facilities or rehabilitation of the sedimentation basins. Although this type of clarifier is widely used for lime softening, it was rejected for this project because of the depth required for the clarifier (i.e., 30 feet) and the resulting need for extensive excavation and earthwork, limited construction space, the need to maintain existing facilities in operation during construction, and the limited service life of the proposed buried steel shell. It was estimated that construction of helical flow clarifiers actually would result in higher costs.

The Company also investigated the potential for other types of solids contact clarifiers with decreased depth requirements, but the cost of tankage and internal mechanisms made this alternative more costly.

63. WHAT IS THE PROJECTED INCREASE IN CHEMICAL EXPENSE FOLLOWING COMPLETION OF THE IMPROVEMENTS?

A. The additional chemical expense is identified in the workpapers supporting Schedule LJG-2.6, which is attached to the direct testimony of Company witness Linda Gutowski. The unit cost of the pebble lime used in the softening process will decrease following installation of the bulk storage facility. The bulk pebble lime contract for 2000 was competitively bid.

The plant improvements will provide bulk storage for carbon dioxide, which will be used to stabilize the water being applied to the filters with respect to calcium carbonate solubility. The dosage of carbon dioxide was determined through a full scale pilot study. The unit cost for carbon dioxide ($/lb) will be determined through a competitive bidding process.

64. Q. WHY WAS IT NECESSARY TO CONSTRUCT IMPROVEMENTS TO INCREASE PLANT CAPACITY ?

A. Demand projections were developed as part of the American Water System comprehensive planning process and are presented in the Mexico District Comprehensive Planning Study, dated July 1997. The projections indicate that the appropriate maximum day demand for planning of facilities (as described below) is 4.45 mgd in 2010. Current plant capacity, as defined by filter area and the approved filtration rate, is 3.1 mgd. Other capacity limiting unit processes include the ground water supply, flocculation, and distributive pumping facilities.

65. Q. WHAT ROLE DID THE SANITARY INSPECTIONS BY THE MISSOURI DEPARTMENT OF NATURAL RESOURCES (MDNR) PLAY IN THE COMPANY'S DECISION TO PROCEED WITH THE MEXICO WATER TREATMENT PLANT IMPROVEMENTS?

A. The MDNR had been performing sanitary surveys for the Mexico facilities November 17, 1999on an annual basis, and the tone of the surveys was critical. For example, the June 3, 1998 report listed 32 unsatisfactory features of the wells, treatment plant, distribution system and administration. The Company made considerable effort in rectifying the noted items before initiating the Mexico Water Treatment Plant Improvements. However, a number of the noted items were deficiencies in the facilities that could only be corrected with a major construction project.

The Mexico Water Treatment Plant Improvement project is primarily the result of the comprehensive planning process, although the MDNR sanitary surveys helped to bring attention to the facility deficiencies during the planning process. The Company's comprehensive planning process, completed in July 1997 for the Mexico District, evaluated the facilities, identified deficiencies, evaluated alternatives and recommended the appropriate improvements.

66. Q. WHAT IS THE STATUS OF MEXICO WATER TREATMENT PLANT IMPROVEMENTS ?

A. The project is under construction and will be placed in-service no later than April, 2000.

67. Q. WHAT IS THE PROJECTED CAPITAL COST OF THE PROJECT?

A. $5,050,000.

JOPLIN SOURCE OF SUPPLY IMPROVEMENTS

68. Q. WHAT IS THE PURPOSE OF THE GRAND FALLS DAM IMPROVEMENTS?

A. Grand Falls Dam (a.k.a. Shoal Creek Dam), which is located in the Joplin District, is a low head, concrete gravity wall dam built around 1892 by the Empire District Electric Company to provide hydroelectric power. It was purchased by the Joplin Water Company in the 1950s to ensure reliability for the raw water intake when hydroelectric power generation became uneconomical, and the future of the Dam became questionable.

The Dam consists of three sections: the turbine structure with concrete gravity wall, the spillway, and the east wall and curb. The abandoned hydroelectric turbine structure is located at the west abutment. Two (2) 8-foot diameter conduits were used to convey water from the impounded Shoal Creek to the hydroelectric turbines. A concrete gravity wall extends from the turbine structure in a northeast direction towards the spillway. A single buttress support is located at midlength.

The second section is an arched spillway extending from the gravity wall to the east abutment wall. The length of the spillway is approximately 195 feet. Pipe sleeves are embedded in the top of the spillway to support the flashboard posts. During periods of low flow, flashboards are installed above the spillway to increase the impounded water level. The spillway was overlaid with concrete in 1961 and is in generally good condition.

The third section is a concrete gravity wall from the spillway to the east abutment. In 1971, a concrete curb was installed from the wall to the road. When the flashboards are used, water flows over the curb and the exposed chert bedrock back to Shoal Creek.

Improvements to the dam focused on the two abutments since deterioration, caused by leakage at both abutments, threatens the integrity of the dam. Failure of either abutment would result in an uncontrolled release of the impounded water which is critical to the reliable operation of the Shoal Creek intake.

69. Q. WHAT IMPROVEMENTS ARE BEING DONE TO THE EAST WALL?

A. The east abutment is a concrete wall with exposed large gray limestone aggregate. Cold joints give the appearance of placed block. The wall is severely deteriorated with loss of section, disintegrated cement paste, seepage, and open cracks with tree roots growing through the wall. The length of this wall is approximately 42 feet. One end abuts the spillway; the other was poured against the outcrop of bedrock. The wall is stepped into two ledges of bedrock.

The east abutment wall will be replaced in its entirety from the spillway to the bedrock ledges. The wall will be a concrete cantilever wall with a top elevation matching the existing curb elevation. It shall be similar in dimension to the existing wall, except high strength steel anchor rods will be doweled into the bedrock base to provide resistance to overturning and sliding resulting from an additional water flow over the wall. The additional water flow over the wall of about four feet is based on possible flood events. The wall will be poured directly against the spillway using a polyurethane type swelling water stop. Dowels will be drilled into the spillway and secured by epoxy adhesive to provide shear support for the wall. A cofferdam must be built from the spillway to the east bank to construct the wall. This will be accomplished by either sand bagging across the channel, by sheet piling or by use of inflatable dams.

70. Q. WHAT IMPROVEMENTS ARE BEING DONE TO THE WEST ABUTMENT?

A. The turbine support structure is a concrete structure poured against the bedrock face of the west abutment. Seepage through the interface of the concrete and bedrock is due to weathering of the rock and through the conduit gates. Work at this abutment is intended to stop seepage in both locations.

Each conduit will be cleaned of mud and debris and water blasted to a sound base. Two small holes will be cored from the top of the structure down to each conduit for a distance of about seven feet. One hole will be used to pump controlled low strength concrete (flowable fill) into the conduit and the other will be used to vent air.

The face of this structure is severely scaled with large spalls. This surface will be water blasted clean, and an 8-inch cast-in-place concrete face will be applied to the surface. A key will be cut into the limestone bedrock adjacent to the existing wall, and a reinforced concrete layer will be applied from the key across the deteriorated face of the concrete structure to extend over and seal the conduits. Dowels will be inserted into the face of the structure to provide shear transfer from the existing structure to the overlay.

In 1961, the three original buttresses in the center of the west wall were combined into one large buttress. This combined buttress exhibits medium vertical full height cracks and some spalling and exposed reinforcing. To prevent further deterioration of the buttress, the vertical cracks will be injected with an epoxy grout. The spalls will be repaired with a modified polymer cement grout.

71. Q. WHAT ALTERNATIVES WERE CONSIDERED?

A. Repair of the existing east wall was considered instead of replacement, but the severely deteriorated condition of the concrete precluded any possibility of repair.

Low slump concrete initially was specified to fill the conduits. However, internal value engineering suggested the use of flowable fill material instead. This flowable fill marginally reduced the total project cost.

72. Q. WHAT IS THE STATUS OF THE GRAND FALLS DAM IMPROVEMENT CONSTRUCTION?

A. This project will completed by December 31, 1999.

73. Q. WHAT IS THE PROJECTED COST OF THE PROJECT?

A. The initial budget for this project was $650,000, which was based on a cursory inspection of the dam. After completing detailed investigations, design, and competitive bidding, the current project cost has been reduced to $225,000.

74. Q. DOES THIS CONCLUDE YOUR TESTIMONY AT THIS TIME?

A. Yes.

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