APPENDIX E

FACILITY INVENTORY REPORT

Appendix E Water Treatment Plant and Storage Inventories

1. Water Treatment Plant Inventories

Each water treatment plant in the service area with greater than 0.5 MGD capacity was inventoried and an assessment was made of potential needs. The following is a description and evaluation of each plant and a schematic flow diagram is also included. The plants are list in alphabetical order.

City of Abilene

The city of Abilene currently operates three water treatment plants and a fourth is under construction. The Grimes and Northeast treatment plants currently provide most of the city's treated water. The Abilene plant on the south side of town is currently not in service due to the low level of Lake Abilene that provides raw water to the plant. This plant operates when water is available from the lake. The Hargesheimer treatment plant located south on U.S. Highway 84 is under construction and will treat water from O.H. Ivie Reservoir.

The Abilene treatment plant was constructed in the 1920s and has been through various stages of renovation in 1940 and again in 1982. Capacity of this plant is limited to 1.8 MGD due to hydraulic limitations. Existing pumping capacities at the Abilene Plant exceed current firm treatment capacity. Raw water flows by gravity from Lake Abilene to the Abilene Water Treatment Plant through a 12-mile line, which was installed in the early 1920s. This system has a delivery capacity of 3 MGD. In 1982, the plant was rehabilitated with the construction of a new 3.0 MGD solids contact clarifier and the filters were also refurbished. The plant has a 600,000 gallon clearwell. Alum and Cationic polymer are added for coagulation. Caustic is added for pH adjustment. Disinfection is accomplished using chlorine dioxide and chloramines. Backwash water is discharged to holding ponds and left to evaporate and sludge from the clarification unit is also discharged into the holding ponds.

The Grimes Water Treatment Plant was constructed in the 1940s and has been expanded and rehabilitated several times. The last rehabilitation project in 1980 converted two of the gravity flow clarifiers into upflow solids contact clarifiers and upgraded eight filters. The plant has a treatment capacity of 23.5 MGD. The plant has updated instrumentation and a computer control system for automatic system functions and record keeping. This water treatment plant receives water from Lake Fort Phantom Hill and Hubbard Creek Reservoir. The plant has a high

service pumping capacity of 30 MGD, with five pumps. This treatment plant has two solids contact clarifiers, each being 125 feet in diameter and 15 feet in depth. This treatment plant has 8 existing dual media filters, 13.5 feet by 27 feet each. The plant has a 5,000,000 gallon and two 500,000 gallon clearwells. The total clearwell volume is 6,000,000 gallons. Alum and Cationic polymer are added at the influent line for coagulation. Chlorine dioxide is used for primary disinfection and is added in the raw waterline. Chlorine/ammonia (chloramines) is used for secondary disinfection and is added at the hydraulic rapid mix and at the inlet to the clearwells. Caustic is added for pH adjustment. Backwash water from the filters and sludge blowdown from the solids contact clarifiers are deposited in earthen holding ponds.

The Northeast Water Treatment Plant was placed in service in 1971 and was upgraded in 1983 and 1998. The treatment plant has a firm capacity of 21.3 MGD. The plant has updated instrumentation and a computer control system for automatic system functions and record keeping. This water treatment plant receives water from Lake Fort Phantom Hill and Hubbard Creek Reservoir. This treatment plant has high service pumping capacity of 29.0 MGD, with 4 (6?) pumps. Alum and Cationic polymers are added at the rapid mix box for coagulation. This treatment plant has three solids contact clarifiers, each 80 feet in diameter and 15.5 feet deep. This treatment plant has seven dual media filters, each 13.75 feet by 41.25 feet. This treatment plant has two 5,000,000 gallon clearwells for a combined total of 10,000,000 gallons storage. Chlorine dioxide is used for primary disinfection and is added in the raw waterline. Chlorine/ammonia (chloramines) is used for secondary disinfection and is added at the hydraulic rapid mix and at the inlet to the clearwells. Caustic is added for pH adjustment. Solids removed from the water during clarification are pumped as sludge to the existing sludge lagoons.

The Hargesheimer water treatment plant receives water from Lake Ivie through a 51 mile 36-inch RCCP raw waterline with a capacity of 24 MGD. The Lake Ivie Intake Pump Station has two pumps, one 10 MGD fixed speed and one 16 MGD variable speed. The Booster Station, southeast of Winters and north of Highway 67, has a 6 MG ground storage tank and two pumps, the same size as the Intake. The Intake and Booster Station both have provisions for the future addition of an 18 MGD fixed speed pump. There is a 10 MG ground storage tank on the 36-inch raw waterline located in Ovalo, Texas. This water treatment plant has been designed to use membrane microfiltration followed by membrane reverse osmosis. There are six microfiltration skids proposed with room in the facility to add three more. There are two reverse osmosis skids

proposed with room to add one more in the future. This treatment plant has a 5,000,000 gallon clearwell, with provisions being made for adding an additional 5,000,000 gallon clearwell in the future. Provisions are being made in the treatment plant design for the addition of chlorine, sodium hydroxide, ferric sulfate, ammonia sulfate, sulfuric acid, and fluoride at various points in the treatment process. Chloramines will be used for final disinfection. The design of this water treatment plant includes four proposed reverse osmosis lagoons for evaporation of reject. The surface area of these lagoons is approximately 50 acres. A backwash recovery system is in the design. This treatment plant will have a high service pumping capacity of 12 MGD, with three pumps. There are provisions being made to add two more pumps in the future. This water treatment plant is designed to treat 8 MGD with expansion capability to 12 MGD. The plant will have instrumentation and a computer control system for automatic system functions and record keeping. Construction of this treatment plant is projected to be complete in June 2003.

There are no capacity issues at any of the Abilene treatment plants. However, meeting new requirements for Total Organic Carbon (TOC) has proven to be problematic. The older plants, particularly the Abilene WTP, will likely have problems meeting these requirements as well as upcoming turbidity requirements. The city has procured an engineering firm to perform a study regarding the removal of TOC. The purpose of the study will be to make recommendations as to the types of improvements needed at the plants to meet current and upcoming requirements.

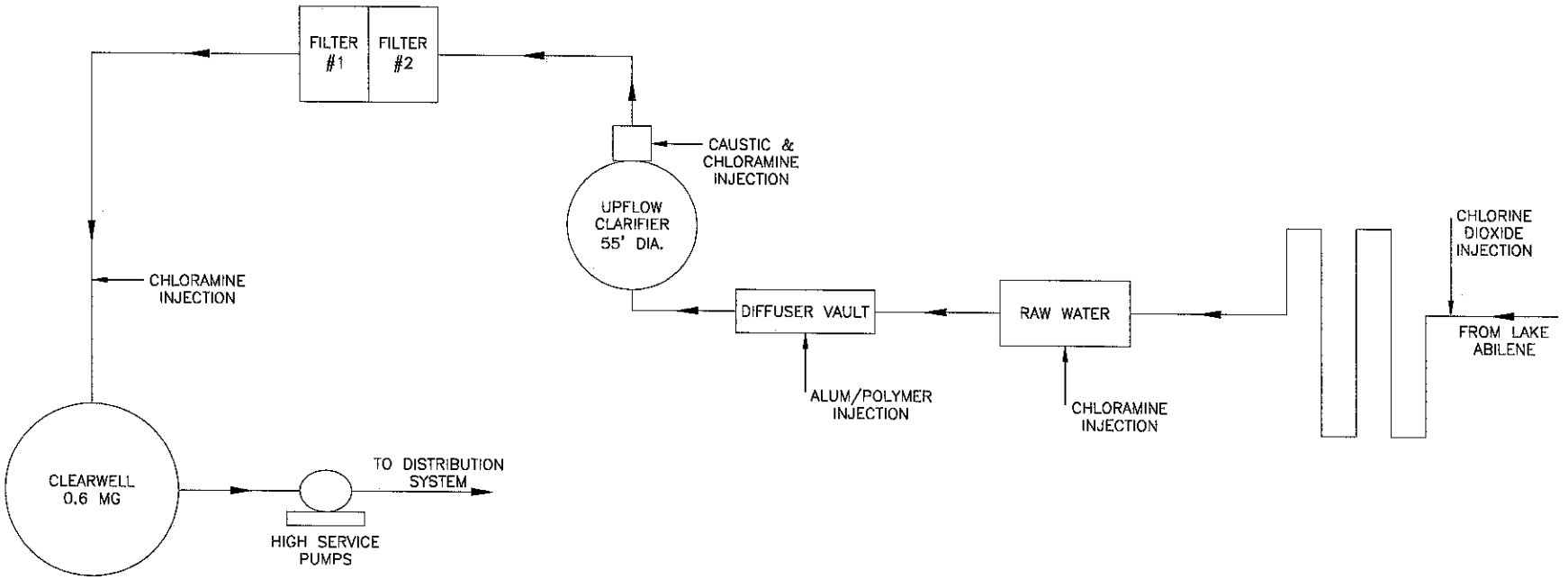

FIGURE E.1

CITY OF ABILENE, TEXAS
ABILENE WATER TREATMENT PLANT
SCHEMATIC

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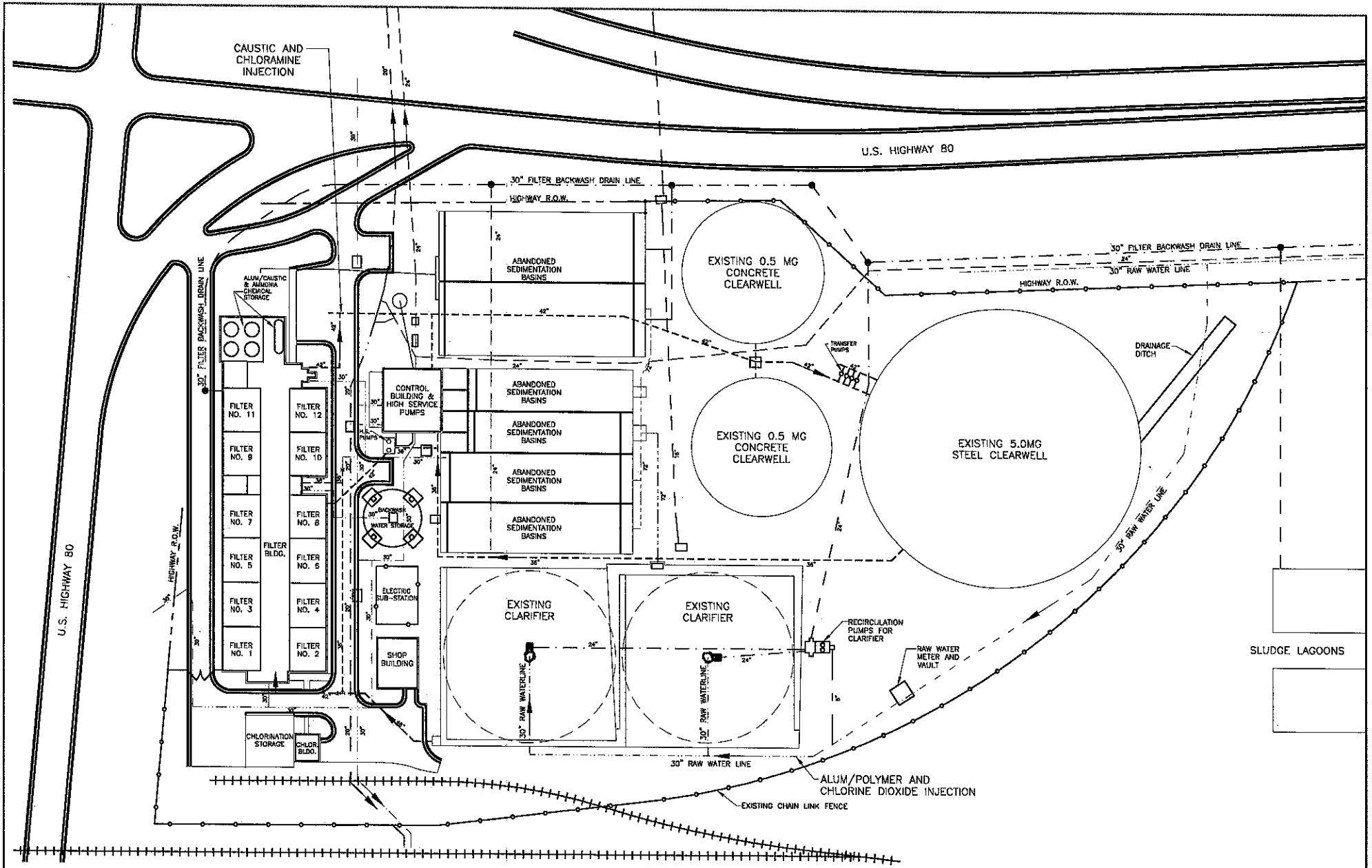

FIGURE E.2

CITY OF ABILENE, TEXAS
GRIMES WATER TREATMENT PLANT
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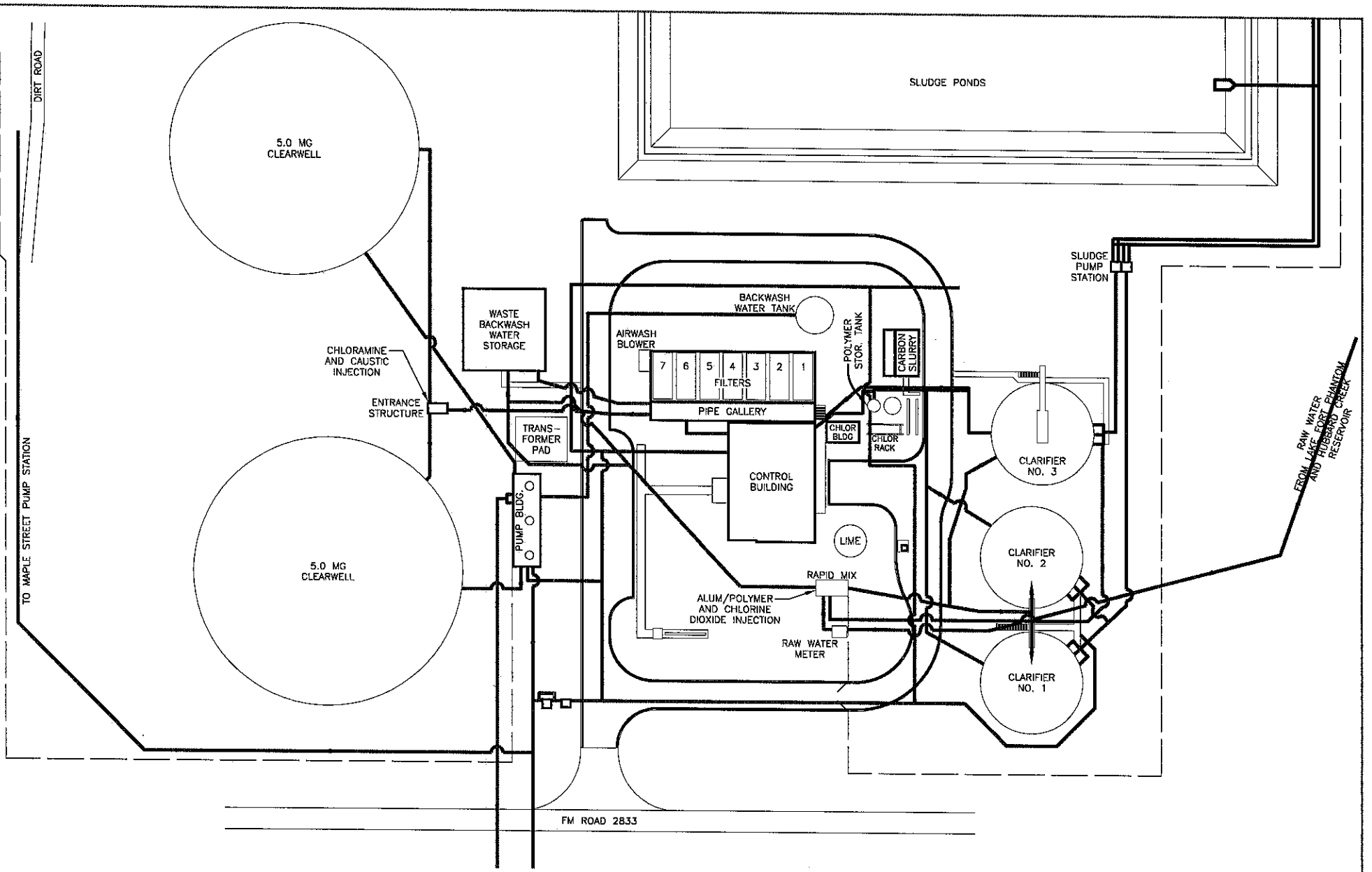

FIGURE E.3

CITY OF ABILENE, TEXAS
NORTHEAST WATER TREATMENT PLANT
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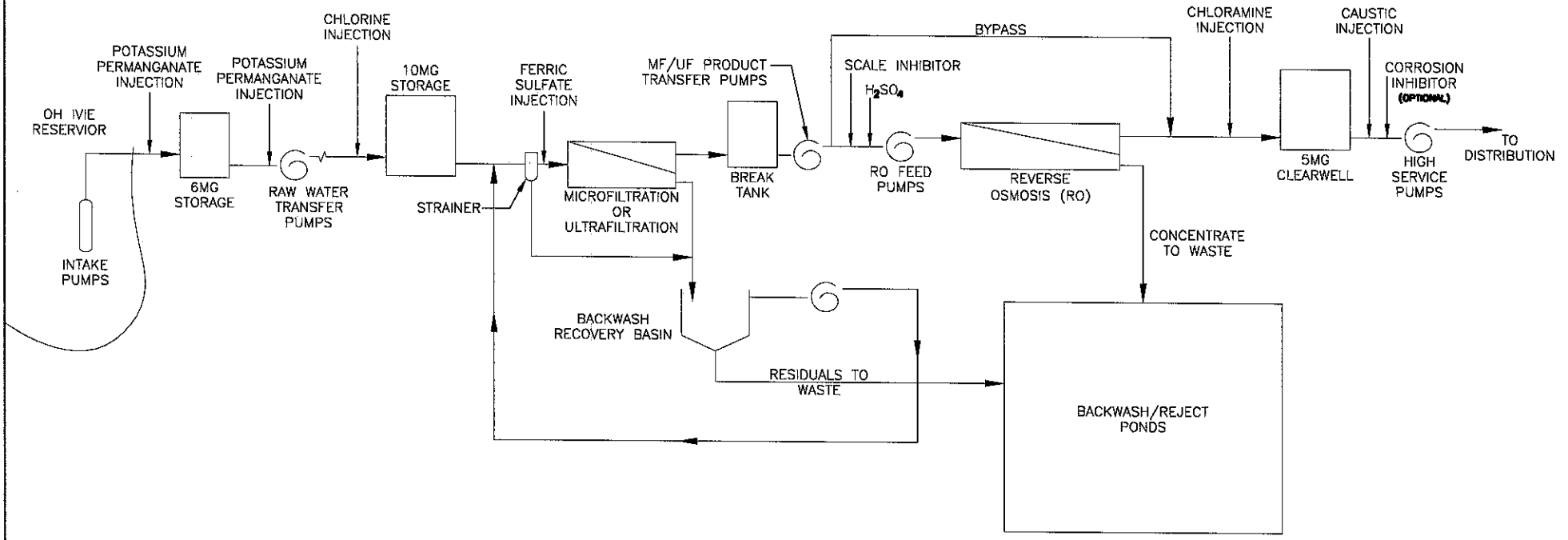

FIGURE E.4

CITY OF ABILENE, TEXAS
SOUTHSIDE WATER TREATMENT PLANT
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City of Albany

The Albany Water Treatment Plant is of conventional design and was built in 1953. The plant has 1.7 MGD capacity as rated by TCEQ. There is room remaining at the current site for some further expansion. The plant was upgraded in 1999 with a new turbidity monitor and in 1998 with rehabilitation of filters #1 and #2. In 1997 filters #3 and #4 were overhauled. In 1986 tube settlers, a track vac and high/low alarms were installed. Lake McCarty and Hubbard Creek Lake provide raw water for the city. Hubbard Creek Lake provided 231 MG in 2001 due to low water levels in Lake McCarty. Lake McCarty has high turbidity and is located 7 miles south of the city. Raw water gravity feeds from Lake McCarty to the WTP through a 12-inch pipeline. Hubbard Creek Lake, which provides water to Albany through the 36-inch West Central Texas Municipal Water District (WCTMWD) pipeline, is located 14 miles east of Albany. The water is transferred to the city through the WCTMWD's raw water pump station. Water moves through the plant by gravity flow. After water enters the WTP it is treated with chlorine and alum in the pipe before it flows into the flash mix tank. Flocculation and sedimentation take place in a rectangular 200,000-gallon sedimentation basin, which is capable of processing 1.7 MGD. The water follows a "U" shaped course through the basin. The sedimentation basin capacity limits the total WTP output to 1.7 MGD. The plant has four indoor multi-media rectangular filters. Two measure 9 feet x 9 feet (81 square feet each), and two measure 10.5 feet x 13.5 feet (142 square feet each), providing a total filtration area of 446 square feet. Finished water is stored in a 100,000-gallon clearwell at the plant. There is also a 200,000-gallon ground storage tank on site, which is considered part of the distribution system. Disinfection and odor control is by free chlorine injected into the raw water line, and pH adjustment is by 50 percent sodium hydroxide stored in outdoor poly-tanks. Three earthen backwash ponds are in use at the plant: one large, one medium and one small, having a total capacity of 250,000 gallons. Finished water exits the clearwell through three high service pumps with capacities of 800, 1,300, and 1,400 GPM. A 200,000-gallon ground storage tank at the WTP feeds a 1.0 MG ground storage tank on high terrain 3/4 mile southwest of the plant. There is an 8 foot perimeter fence with three strands of barbed wire on top and additional security is provided by City of Albany Police who patrol the site.

The city's plant is very old. However, recent upgrades should allow the city to maintain compliance with current regulations. The plant may not be adequate to maintain the more restrictive surface water drinking standards that are expected to be implemented over the next decade. The City will have to comply with the upcoming disinfection by-product rules effective in January, 2004 and improvements will have to be made for this purpose. Also, the surface water at Hubbard Creek Reservoir is not typically over the limit for dissolved solids. The City is investigating another source, Possum Kingdom Reservoir, which is high in dissolved solids. More advanced treatment such as reverse osmosis would have to be added to the plant if this source is used or use of the new supply would have to be curtailed with blending. The plant is also operating very near capacity. The plant capacity is 1.7 MGD and the City has seen demands very close to this on a few occasions. The city will be required to expand the plant or construct a new one unless the demand on the plant changes. The city's highest use customer, Shackelford WSC, is investigating an alternate source and may elect not to buy water from the city in the future. If so, the current plant would be of sufficient capacity. The city has made application for funding to construct a new water treatment plant near Lake McCarty. The proposed plant would be of conventional design with a solids contact clarifier and dual media filters. The current proposal is to build a 2.5 MGD plant, which would be capable of meeting the needs of both the city and Shackelford WSC.

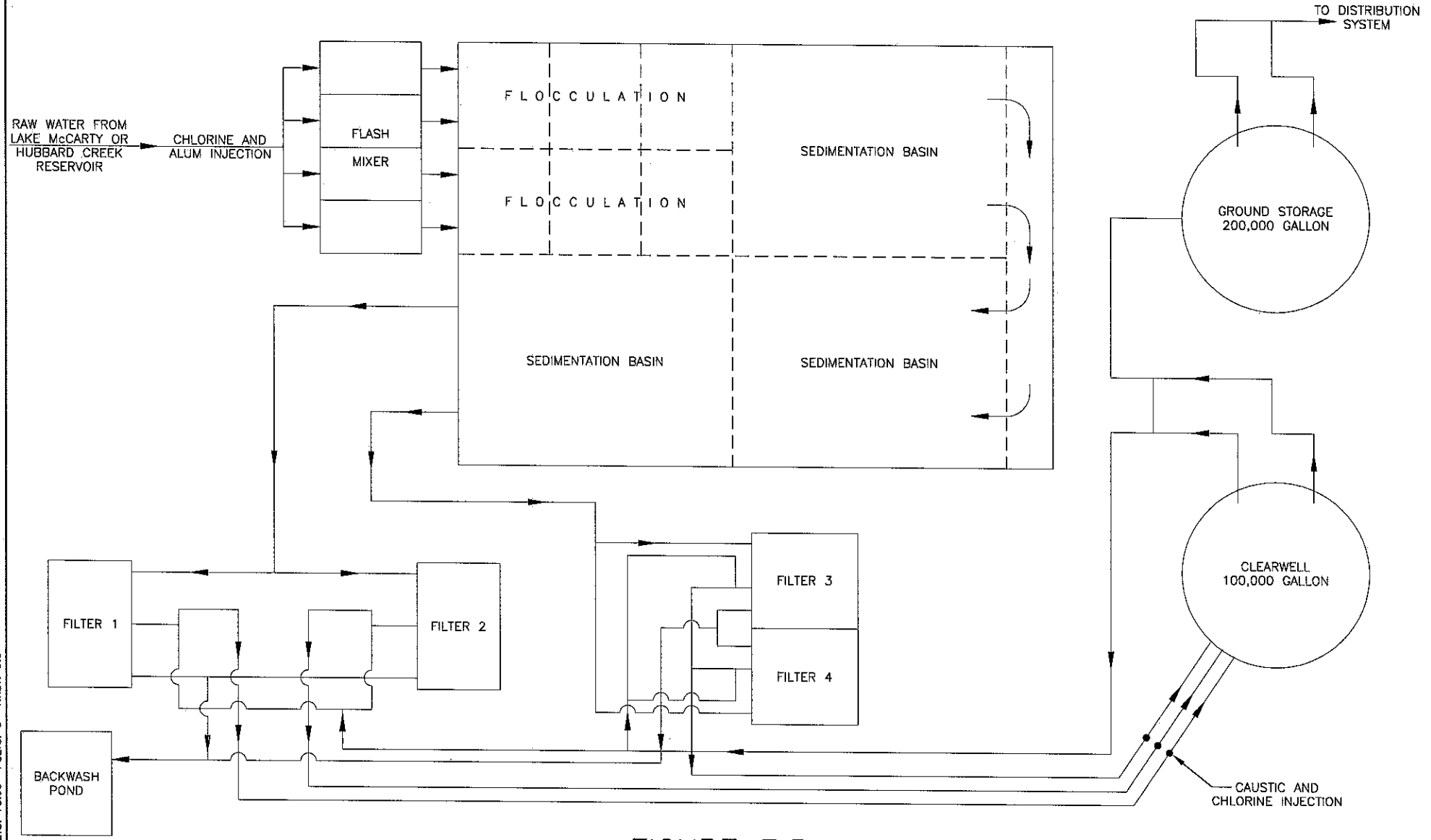

FIGURE E.5

CITY OF ALBANY, TEXAS
WATER TREATMENT PLANT
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City of Anson

The City of Anson's current water treatment plant was constructed in 1964 and was upgraded in 1991 and 1998. The city owns additional land around the facility, which could be used for expansion. West Central Texas Municipal Water District (WCTMWD) supplies water to the WTP through a 14-inch line from a booster pump station located on the WCTMWD/Abilene line. The water is received into a 0.5 MG ground storage tank and is then gravity fed to the WTP. Disinfection and coagulants are added in the following order: Alum and chlorine are added before the claricone clarifier. Chlorine is added again after the filters as well as caustic for final pH adjustment. Anson is adding alum just before the raw water enters the claricone for sedimentation. The claircone is rated at 2.0 MGD and measures 47 feet in diameter and has a 31 feet-10 inch water depth. The plant has three (3) multimedia filters that measure 11 feet x11 feet. The backwash is provided by a standpipe, which is 50 feet tall and 20 feet in diameter. The WTP has three 100,000 gallon concrete clearwells, each of which is 47 feet in diameter. The finished water leaves the plant and is pumped into the city's distribution network using two vertical turbine pumps, each rated at 600 gpm @ 219 feet TDH. The WTP and all related facilities are surrounded by 6 feet chain link fences with 3 strands of barbwire above. The WTP is manned 16 hours a day and has an alarm system for dialing the operator in the event of a plant problem.

The WTP has been upgraded recently and the water quality is generally good. Therefore, it is expected that the WTP should have no problems meeting current regulations. However, meeting upcoming standards may prove difficult. The city will have to comply with disinfection by-product rules coming into effect in January 2004 and capital improvements will be necessary to accomplish this. The city has applied for funding to install a new chloramine disinfection system along with other plant improvements which will be designed to help meet new turbidity requirements.

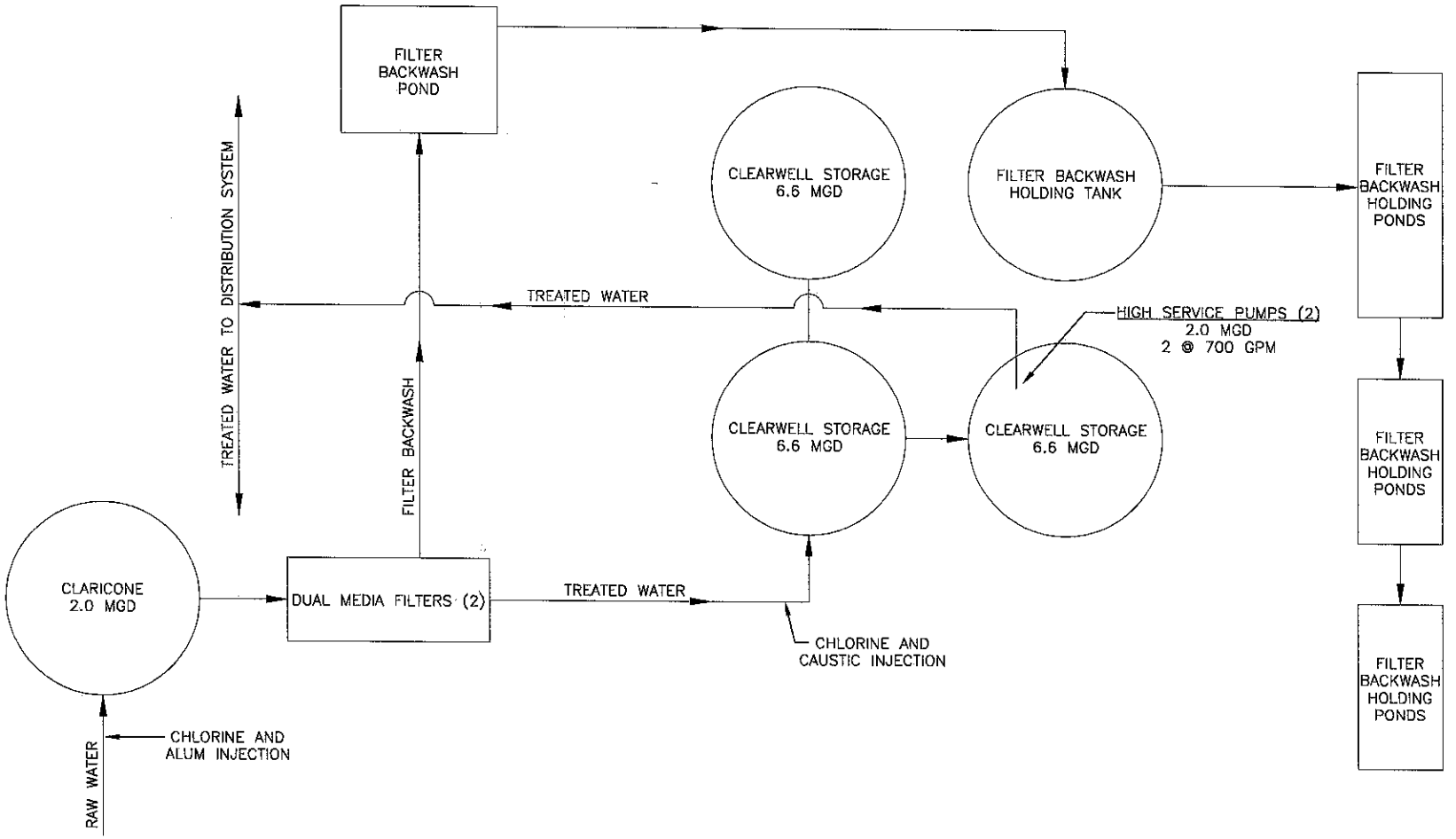

FIGURE E.6

CITY OF ANSON, TEXAS
WATER TREATMENT PLANT
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City of Baird

The City of Baird Water Treatment Plant is of conventional design and was originally built around 1950. The capacity of the plant is 0.455 MGD. The WTP was last updated in 2001 when the filter media was changed to multi-media (sand, gravel & anthracite) and rate-of-flow controllers were added. Baird Lake provides raw water for the city. The estimated yield for Baird Lake is between 400 and 500 acre feet per year. The lake is located approximately 12 miles southeast of the city and has a 23.5 square mile watershed. The intake has two 8-inch valves and the raw water line has an 8-inch diameter. Water is conveyed to the plant through two raw water pumps. One is rated for 500 gpm @ 125 feet TDH and the other is rated for 270 gpm @ 125 feet TDH. After water enters the plant, it flows into the 112,500 gallon circular sedimentation basin. The basin has a diameter of 40 feet and is 12 feet deep. The plant has 4 multi-media (sand/gravel/anthracite coal) 0.83 MGD filters, each of which is 10 feet-3 inches x 7 feet-1 inch

Finished water is stored in a 46,500 gallon below grade concrete clearwell. Disinfection is by free chlorine injected into the raw water line ahead of the sedimentation basin and again in the clearwell. Alum is injected ahead of the sedimentation basin to aid in coagulation. Caustic is used for pH control. Waste from the filters and clarifier are gravity fed to two lagoons (0.5 MG total). The settled water can be returned to the head of the plant through the raw water line. The backwash is returned with a floating pump rated at 150 gpm @ 60 feet TDH. Finished water exits the treatment plant through two pumps with a total capacity of 560 gpm. These pumps transfer potable water to storage tanks that are elevated on either side of the Interstate and feed back through the entire distribution system. Each pump is rated at 350 gpm @ 105 feet TDH. The entire plant is secured by an intruder resistant chain link fence with stranded barbed wire around the top.

The existing clarifier is at capacity and a new clarifier is needed which could almost double the capacity of the plant. The city must also meet the upcoming disinfection by-products rules that will require modifying the existing disinfection system. The city is planning to apply for funding to install a new claricone style solids contact clarifier as well as a new chloramine disinfection system. The upgrades to the disinfection system may also include some other form of treatment for initial disinfection such as chlorine dioxide.

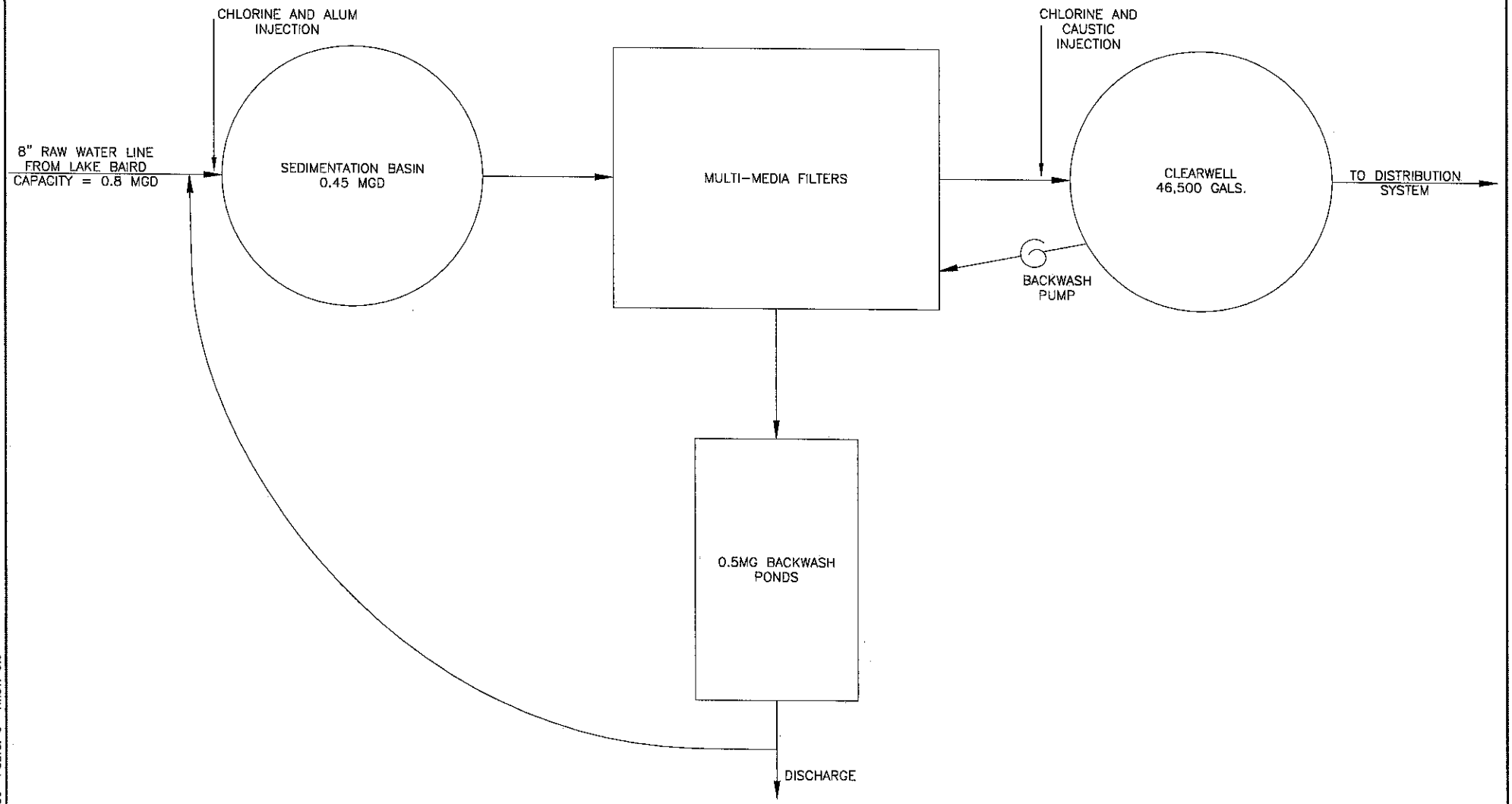

FIGURE E.7

CITY OF BAIRD, TEXAS
WATER TREATMENT PLANT
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Brown County Water Improvement District

Brown County Water Improvement District owns and operates two water treatment plants. The treatment facilities consist of a rated 8 MGD "East" Water Treatment Plant that was originally constructed in 1938, and expanded in 1942 and 1966. Modifications and improvements to the chemical and disinfection system and improvements to the high service pumping facilities were also made to the East Plant in 1985 when the West Plant was under construction. The East Plant is currently only operated in periods when the West Plant is off-line for maintenance repair.

The "West" WTP was constructed in 1985 and is rated for 10 MGD by TCEQ. The facilities consist of a terminal storage reservoir for pre-settling, a rapid mix unit for chemical mixing, two-stage flocculation with variable speed drive units, sedimentation basin with tube settlers for enhanced settling, variable declining rate filters with air assisted backwash, multiple disinfection zones and baffled clearwells for enhanced disinfection contact time. The West Plant currently operates at 80 percent of capacity in the summer months, producing 8 MGD. Winter usage averages 40 percent of capacity producing 4 MGD.

Raw water is obtained from Lake Brownwood, located in Pecan Bayou watershed, approximately eight miles north of the City of Brownwood in Brown County, Texas. The raw water supply system consists of a pump station and pipeline that delivers water from Lake Brownwood to the water treatment plant (WTP) terminal storage reservoir. The pump station boosts flows as demand increases beyond the capacity of gravity flow. The pipeline consists of 34,650 feet of 42-inch pipe and 21,000 feet of 36-inch pipe. Capacity under gravity flow varies with the level of the lake. Maximum capacity is approximately 10.6 MGD with water at elevation of 1425.0 feet (spillway level). When demand exceeds gravity flow capacity at any lake level, the pump station can be placed in operation. The pump station is equipped with four pumps. Pump 1 operates as a stand-alone pump providing a design capacity of approximately 18.0 MGD. Pumps 2, 3, and 4 are identical, designed for 10.7 MGD at 83 feet head. These pumps must be operated with either 2 or 3 in parallel. The auxiliary system consists of a pump station in the City Park on Pecan Bayou and 17,700 feet of 30-inch diameter pipeline from the pump station to the terminal storage reservoir at the WTP. The pump station is equipped with two pumps, each providing a capacity of 8MGD at 135 feet total dynamic head. Water first

enters an earthen reservoir located adjacent to the treatment facilities. The reservoir has an approximate surface area of 7.3 acres, effective depth of 5 feet, and volume of 12 million gallons.

Raw water enters the East Water Treatment Plant from the terminal storage reservoir through a 30-inch cast iron line into a rapid mix chamber (6.5 feet long, 15.0 feet wide, and 9.0 feet side water deep) where Alum is introduced along with a polymer solution, Chlorine, and ammonia to produce chloramines. The existing rapid mixer was renovated in 1985 and has a mechanical mixer. No pH adjustment is required. From the East Plant's rapid mix chamber, the water then passes through two flocculation basins (23-feet long, 23-feet wide, and 10.7-feet deep) for the formation of floc. The flocculators were modified in 1985. Flocculation is accomplished by static mixing through redwood baffling. The flow then enters into four rectangular sedimentation basins (148.5-feet long, 52-feet wide, and 10.5-feet deep) for clarification. The East Plant's sedimentation basins do not have mechanical sludge removal equipment, adequate weir length at the outlet and have severe structural deterioration. The East Plant has eight conventional gravity filters, each with the following dimensions: 16 feet long, 25.5 feet wide, and 6.5 feet side water deep. The filters utilize sand and gravel on a cast iron underdrain system with a surface-loading rate of 2gpm per square foot at the rated flow of 8 MGD. The East clearwell is a below-ground concrete structure 50 feet x 50 feet with a side water depth of 12.1 feet. The East clearwell has a storage capacity of 177,700 gallons. The East Plant's HSPS consists of two 6 MGD pumps installed at the plant's clearwell. Pump #6 is a high service, vertical turbine pump, rated at 4000 gpm, with a 250 horsepower, 2300 (medium voltage) motor. Pump #7 is a high service vertical turbine pump, rated at 4200 gpm, with 300 horsepower, and a 2300-volt motor. The East Plant's HSPS supplements the West Plant's HSPS to meet peak demands on the systems and to provide a reliable backup to the West Plant HSPS.

Raw water enters the West Water Treatment Plant from the terminal storage reservoir into a rapid mix chamber (10-feet long, 10-feet wide, and 12-feet side water deep) where Alum is introduced along with a polymer solution, Chlorine, and Ammonia to produce chloramines. No pH adjustment is required. From West Plant's rapid mix chamber, the water then passes through a two-stage flocculation basin (32-feet long, 60-feet wide, and 13-feet deep) for the formation of floc. The flocculators have been equipped with variable speed drive units. The flow then enters into the sedimentation basin (60 feet long, 60-feet wide, and 15-feet deep) equipped with tube

settlers for enhanced clarification. With the addition of the tube settlers, the sedimentation basin detention time has been reduced from six hours to two hours. The West Plant's sedimentation basin is equipped with mechanical sludge collection in the first half of the basin where the majority of solids are initially deposited. The West Plant employs four variable declining rate filters, each with the following dimensions: 25 feet long, 14.1 feet wide, and 3 feet side water deep. Each filter employs dual media (anthracite coal and sand) with air-assisted backwash. As water passes through the West Plant filters, three vertical turbine pumps with capacity of 4200 gpm at 43 feet total dynamic head move the flow to an above ground steel clearwell. The West clearwell is an above ground 72 foot diameter steel storage tank with 12.2 feet side water depth. The West clearwell capacity is 385,000 gallons. Treated water exits the clearwell facilities through the high service pump station (HSPS) at the West Plant. The West Plant HSPS consist of two 2,800 gpm and two 3,900 gpm HSPS. Total pumping capacity is approximately 19 MGD. The West Plant HSPS routinely meets base demands of the District's water system A looped 30-inch diameter pipeline connects all HSPS, which pumps to two-one million gallon storage tanks on White Mines Mountain. Each of the White Mine Mountain Tanks is steel with 30 feet of water depth and 75 feet diameter. The storage tanks contain five baffles varying in length from 40 feet to 60 feet in the circular tanks. Personnel are on duty at the WTP 24 hours a day and there is a 6 foot chain link perimeter fence with three strands of barbed wire on top. There is also an automatic security gate. The capacity of the raw water delivery system has been reduced by an estimated 15 percent over the past 19 years due primarily to infestation of Asian clams which have adhered to the inside of the raw water pipeline. The District is planning to clean the main pipeline of Asian clams. In addition to the capacity reduction, the peak summer time irrigation usage and the peak summer municipal usage exceed the current system capacity. Plans are under consideration to add a third pump to the auxiliary pump station to supply irrigation water while providing adequate capacity to meet the maximum summer demands. Improvements are needed in the sedimentation basins at the East Plant as previously mentioned. The West WTP is rapidly approaching its rated capacity of 10 MGD. The District will consider an uprating study to petition TCEQ to uprate the plant to 12 MGD based on demonstrated performance.

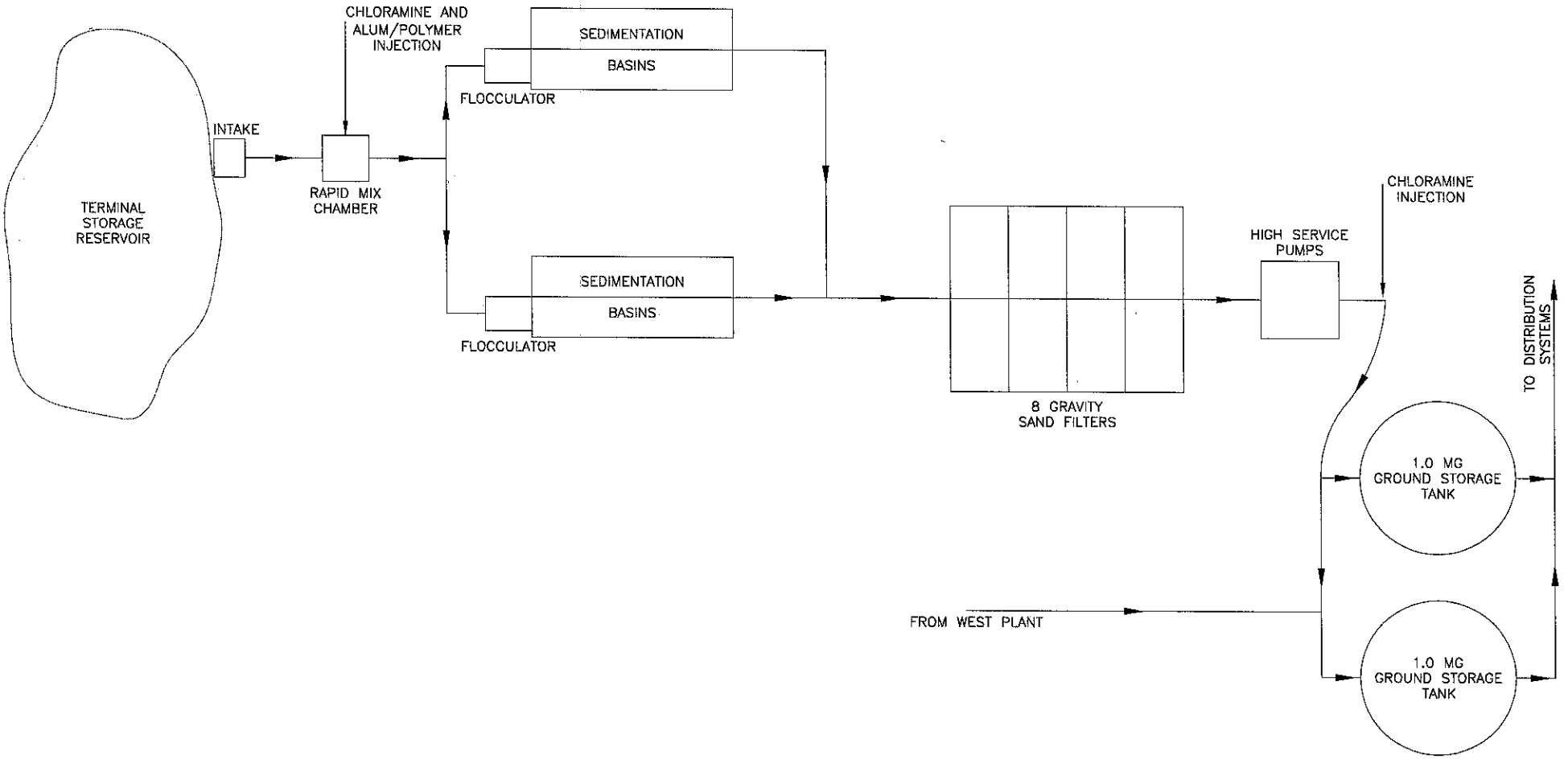

FIGURE E.8

BCWID
EAST WATER TREATMENT PLANT
SCHEMATIC

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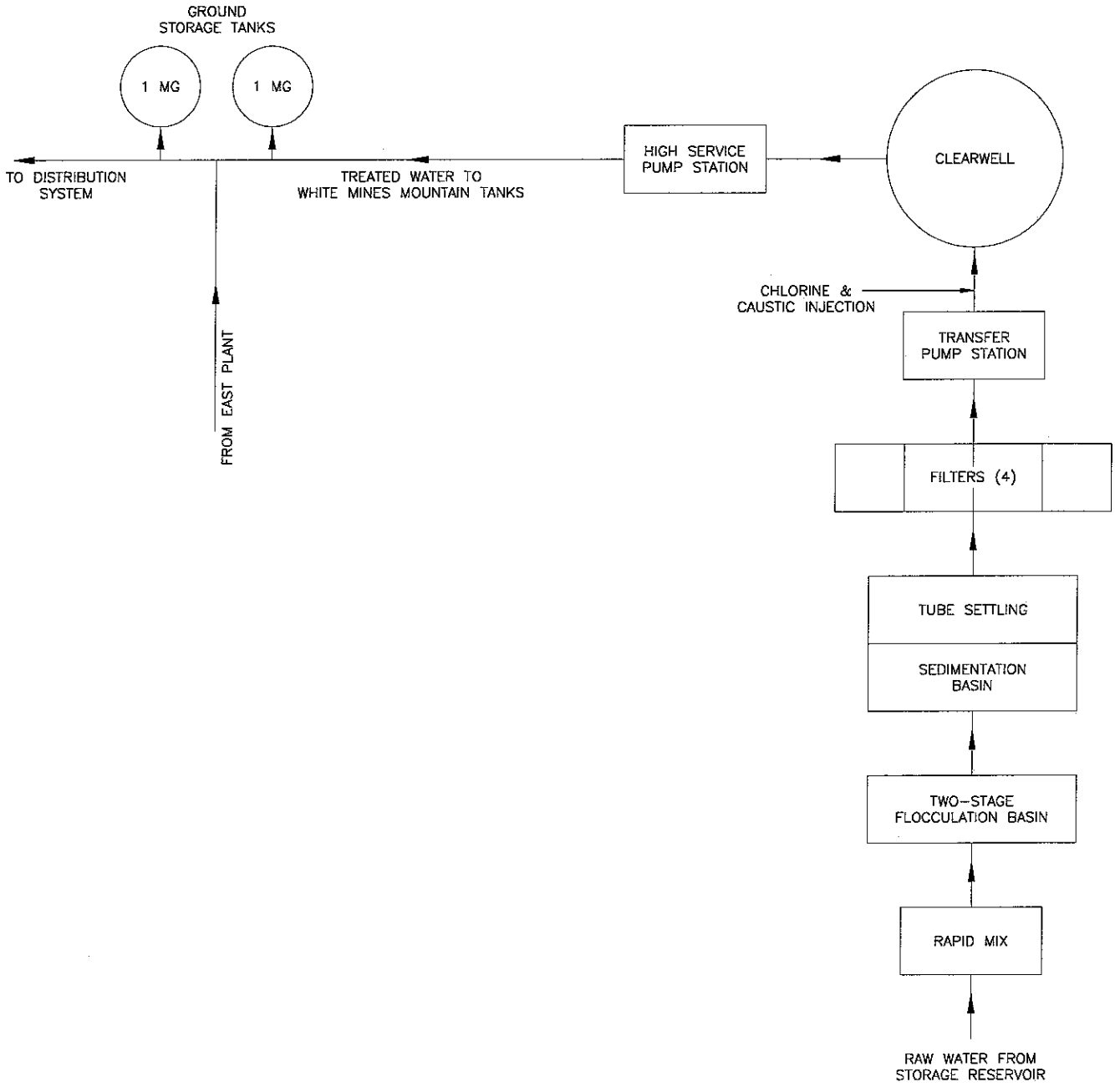

FIGURE E.9

BCWID
WEST WATER TREATMENT PLANT
SCHEMATIC

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City of Breckenridge

The Breckenridge Water Treatment Plant is of conventional design and was originally constructed in 1975. It is currently rated at 3.4 MGD. The facility does have room for expansion on the site to the south of the facility. Some of the land surrounding the plant is undeveloped and probably could be acquired if needed. The current configuration does allow for easy expansion. The capacity of the plant is currently limited by the rapid mix chambers. Water is taken out of Hubbard Creek Reservoir and sent through a 14-inch line to the water treatment plant. Water can also be drawn from Lake Daniel and transported to the treatment plant through a 14-inch line. Disinfections and coagulants are added in the following order: A polymer/alum blend and chlorine is fed at the rapid mix units. Chlorine is injected again before the filters and in the clearwell. Sodium hydroxide is injected in the rapid mix chamber for pH control. The City injects a polymer/alum blend before the rapid mix basins to aid in sedimentation. The flow enters a series of two rapid mix basins each 8 feet x 4 feet x 9.6 feet deep. The rapid mix capacity is 3.4 MGD. The flow splits between two 65-foot diameter 1.7 MGD up flow clarifiers each of which is 18 feet deep. Sludge is blown off to a tanker fill station. The plant has two (2) multi-media filters that measure 12 feet x 24 feet each, and are all in service. The filters are equipped with a surface wash system to aid during backwash of the filters. The filter capacity is 4.1 MGD. The plant has a 64,640-gallon concrete underground clearwell 32.5 feet long x 15 feet wide x 18.25 feet deep. There is also a 1,000,000 gallon ground storage tank 68 feet in diameter and 37 feet tall. A backwash pond located directly east of the plant serves to hold backwash, which can be returned to the plant through a return lift station. There is an 8 foot perimeter fence with barb wire surrounding the physical plant and each of the city's facilities. The plant is manned 24 hours a day year round.

The most urgent need at the plant is the expansion of the rapid mix basins to make it possible to utilize the full capacity of the rest of the plant. The city must also make modifications in order to meet the upcoming disinfection by-product rules effective in January 2004. The city is planning to install a chloramine disinfection system by the end of 2003. The city is also exploring the possibility of either selling the plant to the Brazos River Authority or constructing a reverse osmosis plant to accommodate raw water from Possum Kingdom Reservoir.

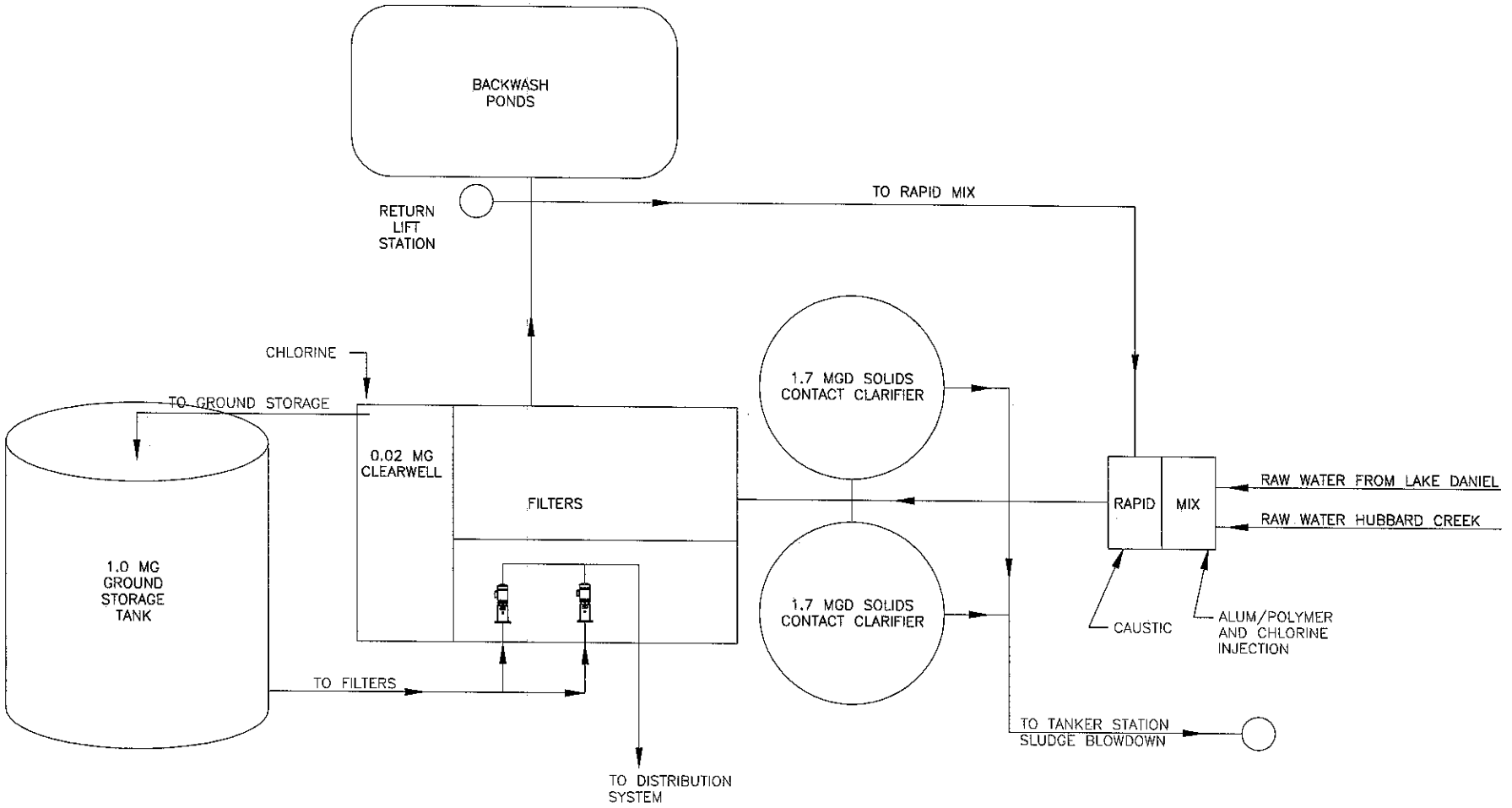


FIGURE E.10

CITY OF BRECKENRIDGE, TEXAS
WATER TREATMENT PLANT
SCHEMATIC

[BRA02372]N:\WR\JM-REPORT\BRASTUDY\CITYOFBRECKENRIDGE.DWG LAYOUT: Layout1
JUL 21, 2004 7:30:29 A.M. LTS: 20.00 PSLTS: 1 TWIST: 0.0, 0.0

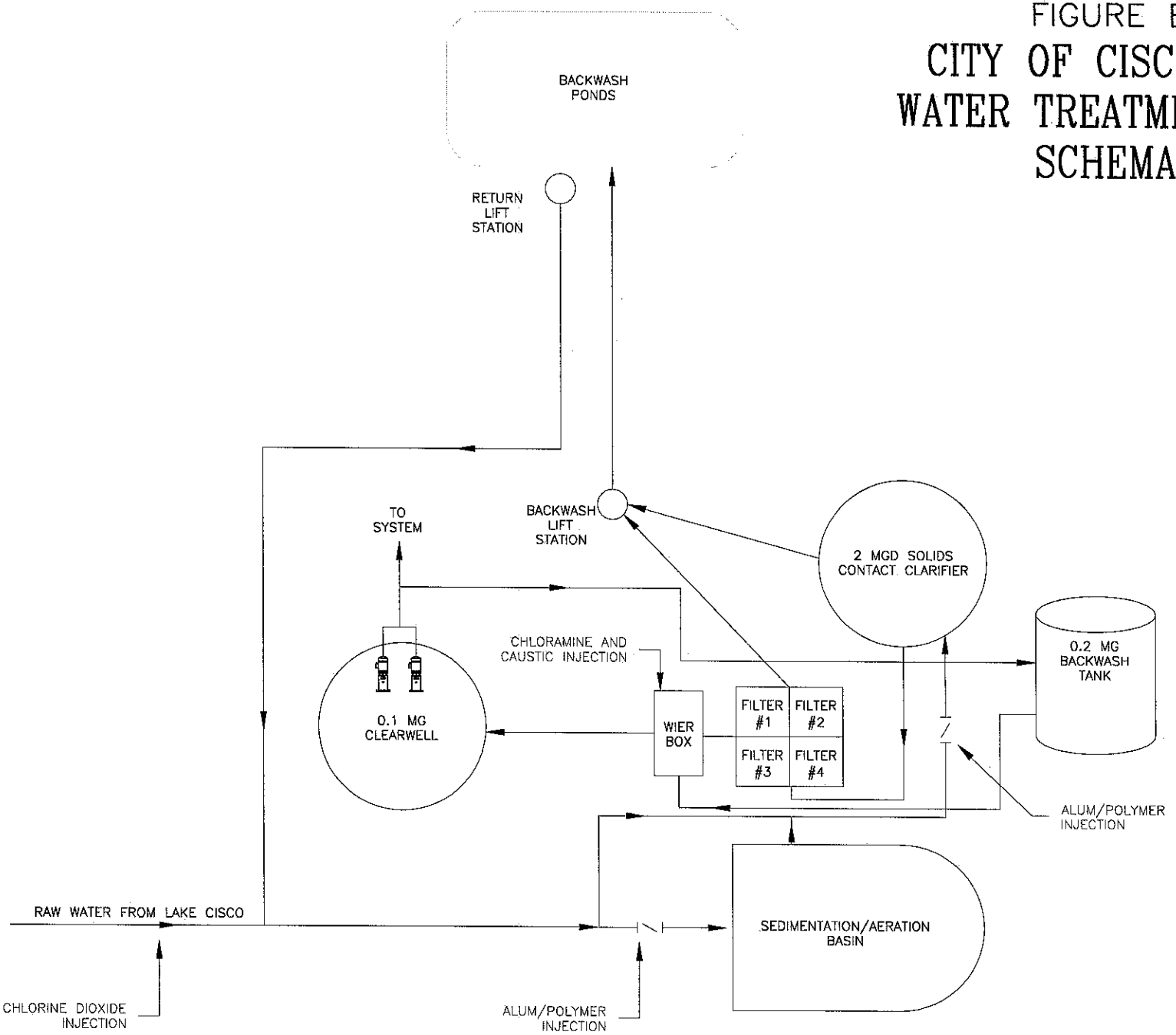
City of Cisco

The Cisco Water Treatment Plant is of conventional design and was originally constructed in 19. The plant has seen expansions in the 1980s as well as in 2002. It is currently rated at 2.1 MGD. The facility does have room for expansion on the site south of the facility. The land surrounding the plant is undeveloped and much of it is owned by the city. The current configuration does not allow for easy expansion. The filters are of common-wall design. The water treatment plant is located downstream of Lake Cisco which provides all of the city's raw water supply. The raw water intake is built into the hollow-core dam and consists of four 18-inch gates, 18-inch interconnecting piping and four 18-inch intake valves. The 18-inch raw water line conveys water to the plant and the flow is controlled by an 18-inch inlet valve. Disinfections and coagulants are added in the following order: Chlorine Dioxide is generated at the WTP and is injected into the raw water line ahead of the inlet valve. A polymer/alum blend is injected into the raw water line just prior to the tee between the aeration/sedimentation basin and solids contact clarifier. After the filters, chloramines are injected into the water upon entering the clearwells and caustic can be injected to adjust pH if needed. The city injects a polymer/alum blend before the sedimentation basin and clarifier to aid in settling prior to the filters in the plant. After the injection point, the raw water line splits and goes to the sedimentation basin, clarifier, or both in series. There is an in-line static mixer before each unit. The plant has four (4) multi-media filters that measure 14 feet x 14 feet each, and are all in service. The filters are equipped with a surface wash system to aid during backwash of the filters. The plant has a 100,000-gallon concrete underground clearwell and a 200,000 gallon welded steel ground storage tank. There is an additional 0.5 MG storage tank at the city's College Hill pump station. There are two on-site, 40 feet x 75 feet backwash ponds with a capacity of 100,000-gallons each, which can be returned to the plant through a return lift station to the head of the WTP for additional water recovery. Water is pumped into the distribution system through two vertical turbine high service pumps. Each pump is rated for 1,350 gpm at 280 feet of head. There is an 8 foot high perimeter fence with barb wire surrounding the physical plant. The plant is manned 24 hours a day year round.

The existing plant will likely have problems meeting new turbidity requirements expected to be implemented within the next ten years. The filter backwash system needs

modifications to alleviate turbidity spikes during backwash. A current project is underway to alleviate the backwash issue and resolve other minor issues at the plant. More extensive improvements will be required in the future to meet the new regulations.

FIGURE E.11
CITY OF CISCO, TEXAS
WATER TREATMENT PLANT
SCHEMATIC



ACAD Rel 15.06s (LMS Tech) User: CAM
[BRA02372]N:\WR\JM-REPORT\BRASTUDY\CITYOFCISCO.DWG LAYOUT: Layout1
FEB 10, 2004 8:09:22 A.M. LTS: 20.00 PSLTS: 1 TWIST: 0.0, 0.0

City of Clyde

Clyde operates a 2 MGD conventional plant. Improvements to the treatment plant were made in1988. The City of Clyde receives raw water from Lake Clyde. Lake Clyde is located approximately 4 miles south of the city. The current estimated safe yield for the lake is approximately 595 acre-feet per year. Water is fed to the plant through a 10-inch raw waterline. The intake consists of two The City of Clyde has a water line that is shared with the City of Baird to take treated water from the City of Abilene. Free chlorine is injected at the head of the plant and carries the residual throughout the system until it leave the plant. After the raw water is pumped into a head tank, it is injected with polymer and chlorine and pumped up to the claricone clarifier. The solids are drawn to the bottom and the waste is taken to the backwash ponds. The clarified water is then transferred to the filters. The plant has four multi-media/declining rate filter cells. Clarified water is settled through the four filters. Potable water from the clearwell is used to backwash the filters. The waste from the filters is transported to the backwash ponds to settle out. Transfer pumps transport the filtered potable water to the clearwell. The City of Clyde has two 300,000gallon clearwell storage tanks. Waste from the plant is fed to two ponds. The wastewater is settled out and the effluent from these ponds is pumped back to the head of the plant. Finished water exits the plant through two 1,200 gpm high service pumps. One pump transfers treated water from the clearwell to two 0.30 MG ground storage tanks and the other pumps water to the 0.25 MG elevated storage tank and to the distribution system. The entire plant is secured by an intruder resistant chain link fence with barbed wire around the top.

The city may have to meet upcoming disinfection by-product rules with some combination of chloramines and chlorine dioxide, ozone or ultraviolet disinfection. No other major modifications will be needed at the plant in the near future. Modifications will likely be necessary when more stringent turbidity requirements are put in place.

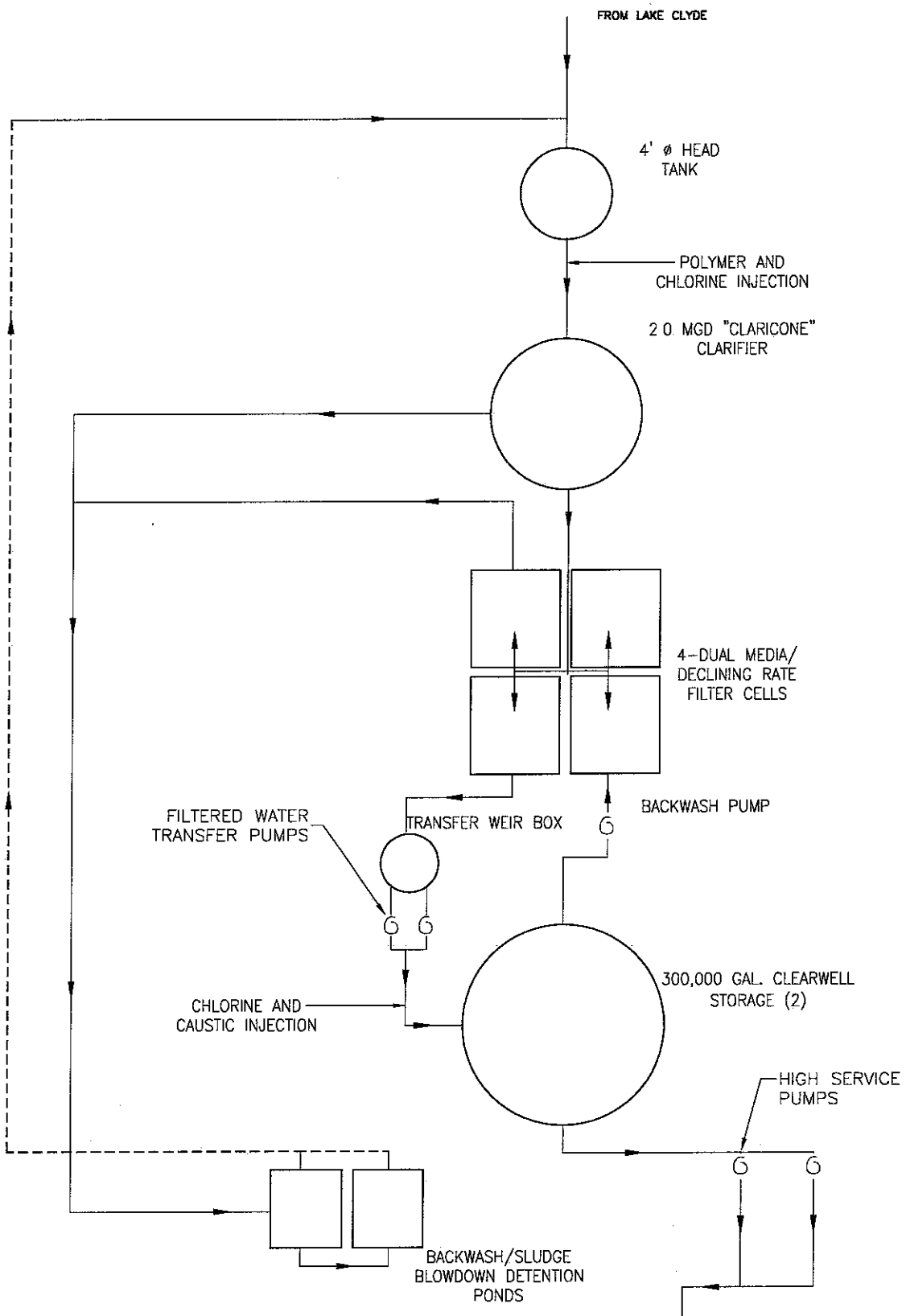


FIGURE E.12

CITY OF CLYDE, TEXAS WATER TREATMENT PLANT SCHEMATIC

ACAD Rel 15.06s (LMS Tech) User: CAM
[BRA02372]N:\WR\JM-REPORT\BRASTUDY\CLYDEWTP.DWG LAYOUT: Layout1
FEB 10, 2004 8:10:54 A.M. LTS: 40 PSLTS: 0 TWIST: 0

City of Early

The current water treatment plant for the City of Early was constructed in 1985 and was upgraded in 1987 and 1990. The facility does not have room for much expansion at the current location without acquiring more property to the south of the plant. Lake Brownwood supplies water to the WTP from a line off of the Brown County Water Improvement District raw water line. The water is received into a holding lagoon at the plant. A floating pump at the facility is then used to boost the water to the raw water pump house which houses two horizontal type pumps rated at 800 GPM @ 55 TDH, 1200 RPM. The floating pump is rated at 1400 GPM with a 100 TDH. Disinfections and coagulants are added in the following order: Polymer is added, followed by alum and finally chlorine between the raw water pump and the claricone clarifier. Chlorine is added again after the filters as well as caustic for final pH adjustment. Early is adding polymer and alum just before the raw water enters the claricone for sedimentation. The claricone is rated at 2.0 MGD and measures 47 feet in diameter and has a 31 feet-10 inch water depth. The plant has three (3) multimedia filters that measure 11feetX11feet. The horizontal backwash pump is rated at 1,800 GPM @ 44 TDH, 1200 RPM. The WTP has a 0.350 MG welded steel tank that serves as finished water storage. The tank has a 45 foot diameter and is 25 feet tall. A 0.5 MG elevated tank provides distribution pressure to the city. The four high service pumps are all horizontal split case pumping units and are rated at 700GPM @ 250feet THD. The WTP and all related facilities are surrounded by 6foot chain link fences with 3 strands of barbwire above. The WTP is manned 16 hours a day and has an alarm system for dialing the operator in the event of a plant problem.

The plant is currently very near capacity. The city sells treated water to Zephyr WSC, which accounts for approximately 33 percent of the plant demand. Zephyr WSC is investigating a replacement source that would eliminate the need for Early to make plant upgrades. The City has also invested purchasing treated water directly from Brown County Water Improvement District. In the meantime, the City is planning to install a chlorine dioxide and a chloramine feed system to meet upcoming disinfection by-product rules.

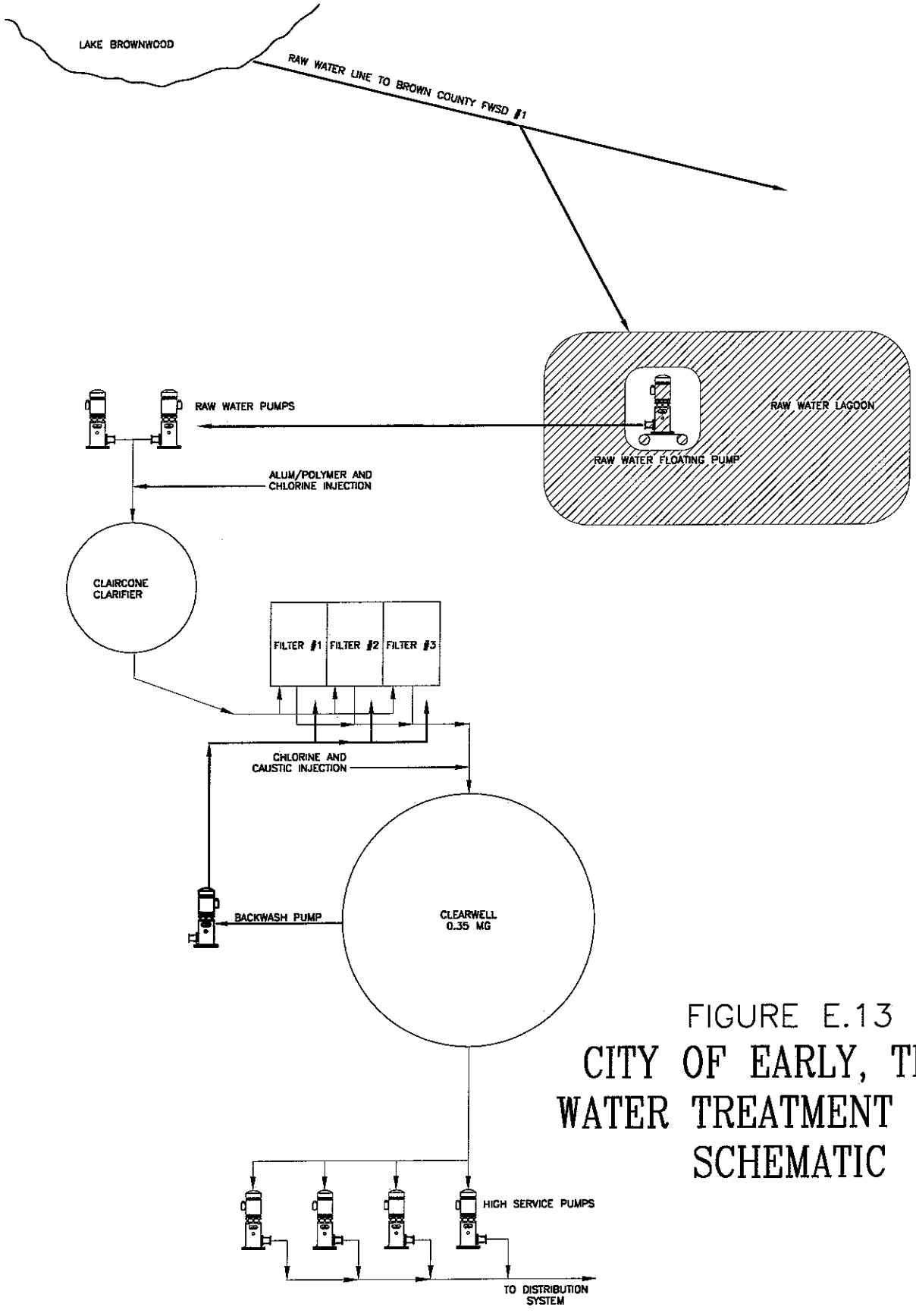


FIGURE E.13

CITY OF EARLY, TEXAS WATER TREATMENT PLANT SCHEMATIC

ACAD Rel 15.0&s (LMS Tech) User: CAM
[BRA02372]N:\WR\JM-REPORT\BRASTUDY\EARLYWTPSCHEMATIC2003.DWG LAYOUT: Layout1
FEB 10, 2004 8:11:11 A.M. LTS: 1.00 PSLTS: 1 TWIST: 0.0

Eastland County Water Supply District

The Eastland County WTP is of conventional design and was originally constructed in 1952. The Eastland County Plant has seen expansions in 1992-93 as well as 2000-01. It is currently rated at 6.0 MGD. The facility does have room for expansion on the site south of the facility. The land surrounding the plant is undeveloped and probably could be acquired if needed. The current configuration does allow for easy expansion or pump upgrades. Two of the filters have had media replacement in 1996 and the third filter is currently under contract for media replacement. The in-line raw water booster pump station was constructed in 1992-93 and has seen less than 100 hours of operation. Lake Leon Reservoir is 4.5 miles south of the WTP and provides all raw water for the District. Lake Leon is controlled by the District and encompasses 1,590 surface acres at the spillway and impounds 27,290 acre-feet of water. Spillway elevation is 1375.0 MSL. Water passes through an intake structure and a 24-inch concrete intake line, which is then boosted through an 18-inch concrete cylinder pipeline by up to four raw water pumps with the capacities as listed below;

a.) Three (3) 125 HP horizontal pumps rated at 2080 GPM @ 157 TDH, 1750 RPM.

b.) One (1) 75 HP horizontal pump rated at 1000 GPM @ 100 TDH, 1750 RPM.

An inline raw water booster pump station is located approximately 2.0 miles from the lake which, has two (2) 250HP vertical turbine pumps rated at 4200 GPM @ 173 TDH, 1750 RPM. One mile downstream from the inline booster is a 16feet in diameter by 100feet tall surge tower for pressure relief. The raw water line from the surge tower to the plant is a 16-inch diameter concrete cylinder pipeline. Disinfection and coagulants are added in the following order: GAC is added when needed at the raw water pump station, followed by chlorine gas added 250 feet after the raw water pump station. Chlorine dioxide is generated at the WTP and is injected along with a polymer/alum blend approximately 150 feet prior to the 4.0 MGD upflow clarifier and the two 1.0 MGD contact clarifiers. The finished water is chlorinated after the filters upon entering the clearwells and caustic can be injected to adjust pH if needed. Chlorine and caustic can be added as needed at the Eastland pump station to adjust disinfection residual

and pH level. The District also has the capability to use chloramines for final disinfection at the WTP and at the Eastland pump station. The District injects a polymer/alum blend before the clarifiers to aid in the sedimentation prior to the filters in the plant. The blend is injected in front of a static mixer at the head of the plant. The plant splits the flow between a 72' diameter 4.0 MGD up flow clarifier and two 50foot diameter contact clarifiers. The plant has three (3) multi-media filters that measure 15 feet x 24 feet each, and are all in service. The filters are equipped with a surface wash system to aid during backwash of the filters. The plant has a 75,000-gallon and 240,000-gallon concrete underground clearwells. There is also located a 230,000-gallon backwash standpipe, which may be dumped into the clearwell for emergency purposes if required. There is an additional 1.0 MG storage tank at the Eastland pump station. There is an on-site, 50 feet x 165 feet backwash pond with a capacity of 762,000 gallons which can be returned to the head of the plant through a return lift station. There is an 8 feet high perimeter fence with barb wire surrounding the physical plant and each of the District's facilities. The District is considering upgrading the fence to encompass the backwash standpipe and the backwash lagoon in the near future. The Plant is manned 24 hours a day year round and the District's Superintendent has a house on site for additional backup when needed.

Eastland County Water Supply District is currently bidding a project to rehabilitate one filter. Aging controls will also be upgraded in the near future. Other needs are replacement of the raw water line and other maintenance improvements at the plant. The District expects to be able to comply with the upcoming turbidity limit changes.

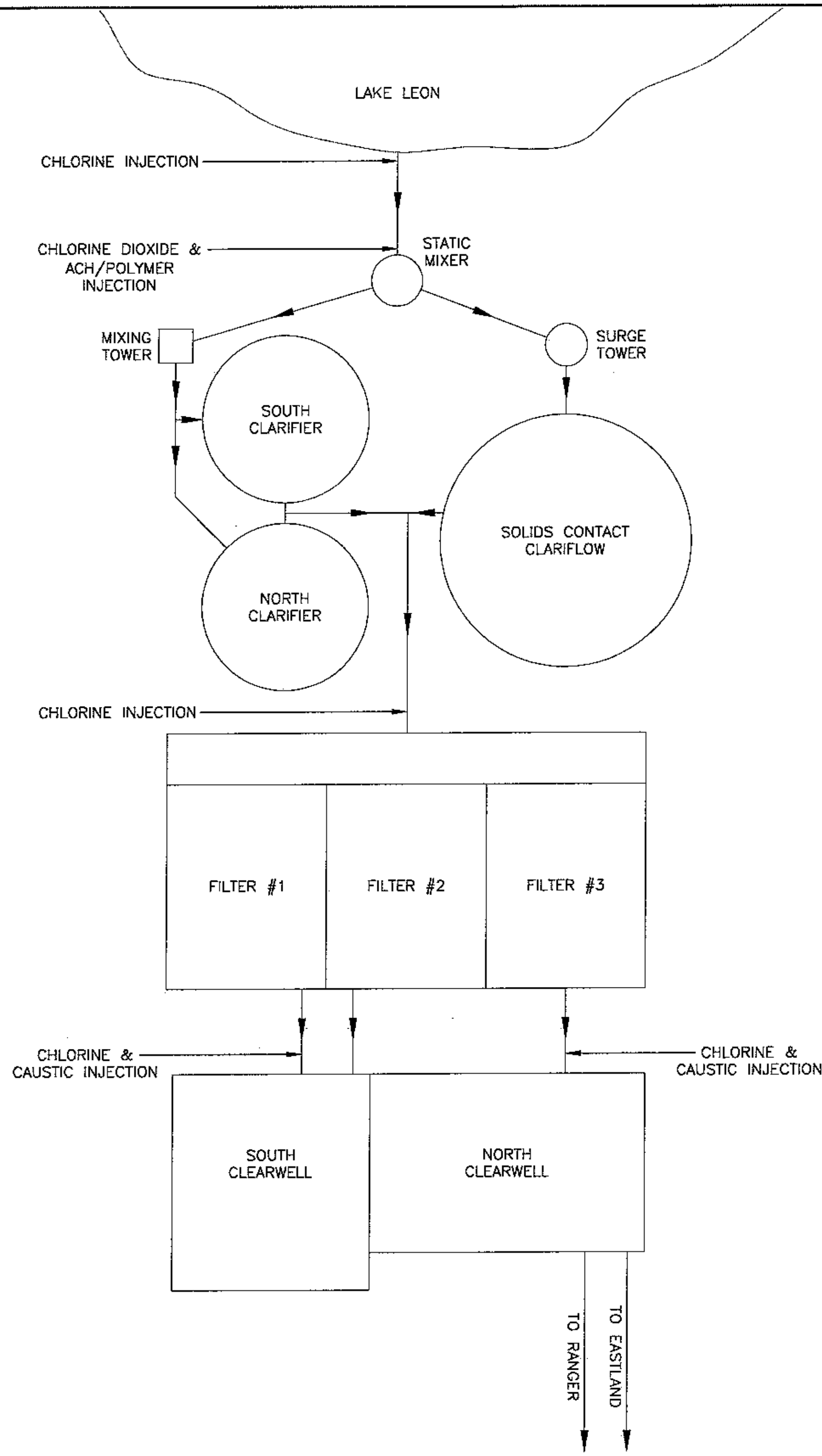


FIGURE E.14

EASTLAND COUNTY WATER SUPPLY DISTRICT
LAKE LEON WATER TREATMENT PLANT
SCHEMATIC

[BRA02372]N:\WR\JM-REPORT\BRASTUDY\ECWSDLAKELEONWTP.DWG LAYOUT: 8.5x11
FEB 10, 2004 8:11:34 A.M. LTS: 75.00 PSLTS: 0 TWIST: 0.0

City of Gordon

The City of Gordon operates the WTP that is located at Lake Gordon. The WTP was originally constructed in 1976 and is rated at 0.8 MGD. The WTP receives water from three lakes: Lake C. B. Long, Lake Gordon, and Lake Thurber. The facility has had several upgrades since its original construction. The latest improvement was the construction of a 0.30 MG ground storage tank in 1999 that serves as an elevated tank for the city of Gordon. Lake Gordon has a floating pump rated at 300 GPM from the lake into the clarifier. The raw water line from Lake C.B. Long passes through an intake structure and then is pumped by up to two 40 HP pumps rated at 330 GPM and 340 GPM through 15,000 feet of 6-inch and 8-inch water line down to the WTP. The raw water line from Lake Thurber passes through an intake structure and pumps are set when the water is needed and pumped through a 3-inch and 4-inch line to the WTP. Disinfection and coagulants are added in the following order:

- Polymer, alum, and caustic are injected followed by free chlorine at the head of the clarifier.
- Chlorine is again injected in the filters and is adjusted at the high service pumps heading into the elevated storage tank.
- The city injects polymer and alum for coagulation and Caustic for pH adjustment directly in front of the claircone clarifier.

The 1.0 MGD rated clarifier measures 36feet in diameter and is 15 feet tall. The plant has two multimedia filters, one which is 10 feet in diameter and the other that measures 5 feet x 10 feet rectangular. The filters are equipped with surface wash to aid in cleaning the filters. The backwash pump is rated at 1300 GPM and is a 10 HP horizontal pump. The treatment plant has three cylindrical clearwells, varying in size and configuration for a total 35,000 gallons of clearwell capacity. The city has a 0.30 MG galvanized bolted ground storage tank constructed in 2000 that provides the elevated water storage for the city. Finished water leaves the clearwell through one of two 250 GPM horizontal pumps that are rated 20 HP and 25 HP. The line from the plant to the elevated storage is 10-inch PVC. All of the facilities controlled by the City have a 6foot chain link fence around their perimeters.

The city has applied for funding to construct one new dual-media, gravity filter, install new valves and controls on all of the filters, construct a new clearwell and install a chlorine dioxide feed system. All of these improvements are necessary to meet TCEQ regulations. The city plans to install a chloramine feed system as well as to meet upcoming disinfection by-product rules. It is unlikely that the plant will meet upcoming turbidity requirements without further improvements.

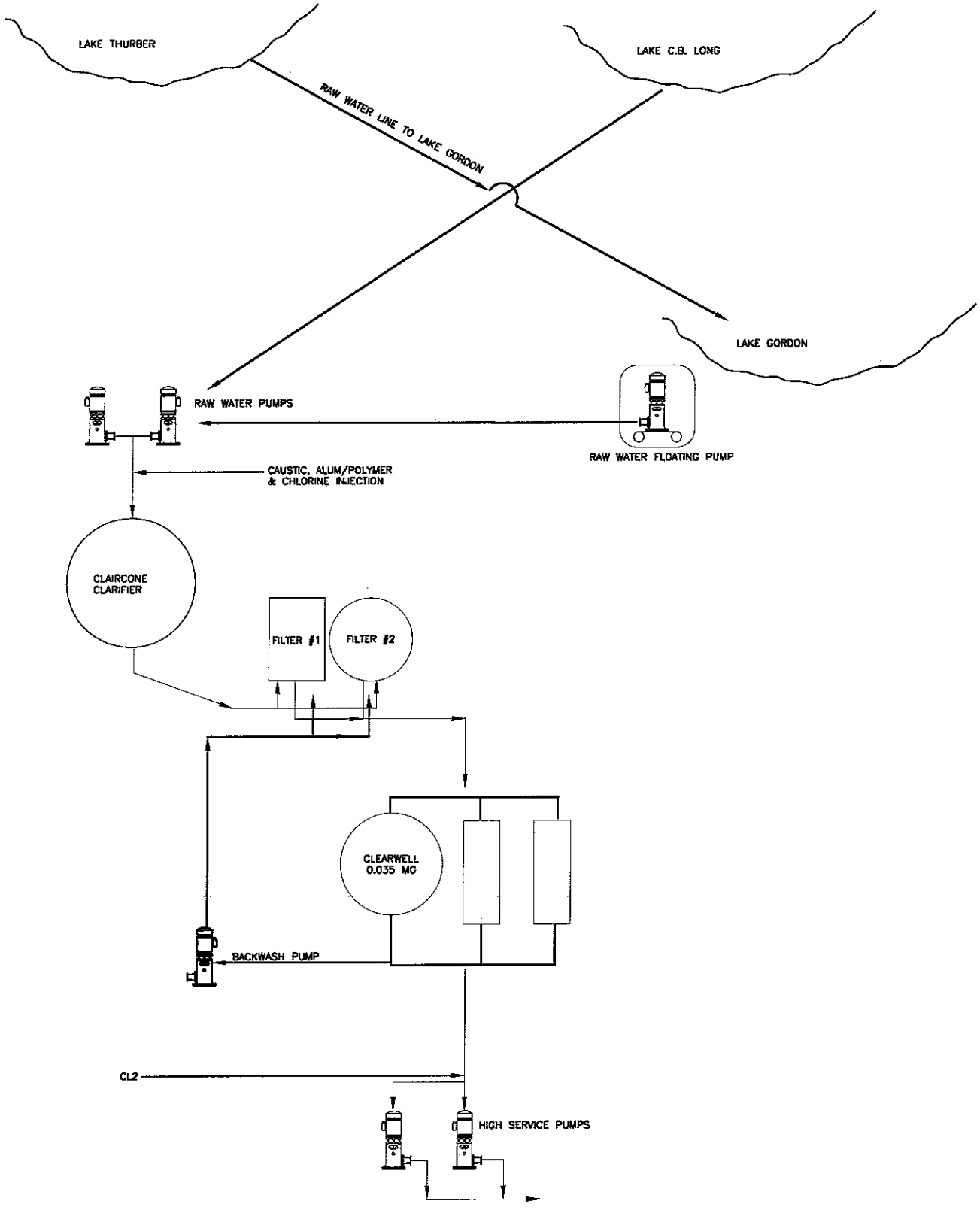


FIGURE E.15

CITY OF GORDON, TEXAS
WATER TREATMENT PLANT
SCHEMATIC

ACAD Rel 15.0ds (LMS Tech) User: LAM
[BRA02372]N:\WR\JM-REPORT\BRASTUDY\GORDONWTPSCHEMATIC2003.DWG LAYOUT: Layout1
FEB 10, 2004 8:11:48 A.M. LTS: 1.00 PSLTS: 1 TWIST: 0.0

City of Graham

The Graham Water Treatment Plant was built in 1984 and a fluoridation system was added in 1988. The plant is currently rated by TCEQ at 6.1 MGD with an emergency capacity of 8.0 MGD. The plant is currently operating at 21 percent of capacity, producing 1.3 MGD. During the summer of 2000 the plant produced 6 MGD on a few occasions. Raw water is obtained from Lake Eddleman, adjacent to the WTP (currently at 60 percent of capacity and 7.5feet below the spillway). Lake Eddleman also serves as a cooling water source for the nearby electric power plant, which keeps any stratification of the temperature and oxygen layers to a minimum and eliminates the need for odor control in the finished water. Raw water enters the plant through a 24-inch line fed by a 50 HP and/or a 150 HP intake pump. The smaller pump is rated at 6 MGD. Water first enters a rapid mix tank where aluminum sulfate (liquid alum) is added and then flows into two identical redundant water treatment facilities. This arrangement permits half of the system to be shut down for maintenance. Water enters two parallel flocculation tanks then four sedimentation basins, the first two with sludge removal paddles on the bottom. The capacity of the sedimentation basins is 400,000 gallons, with the whole assembly measuring 180feet 3 inches x 46feet x 15feet deep. Filtration occurs in six approximately 14feet x 14feet (1,200 total square feet) sand, gravel and anthracite coal aggregate multi-media filter tanks. Disinfection is by chlorine injected at the bottom of the filters. Twenty-two percent caustic sodium hydroxide stored in a steel tank serves to adjust pH. The caustic is purchased at a 50 percent concentration and diluted on site with tap water to 22 percent to prevent gelling. Finished water is stored in a 1 MG reinforced concrete clearwell southeast of the filter basin. Two trapezoidal earthen lagoons are in use on site as backwash ponds.

Finished water exits the clearwell through three 2,200-gpm high service pumps located in a pump house adjacent to the clearwell. Three ground storage tanks in the city receive the finished water. The Twin Mountain ground storage tank and Woodland ground storage tank (which has a booster and backup pump) each hold 1.0 MG, while the Hexcel ground storage tank has a 0.5 MG capacity. Personnel are on duty at the water treatment plant 24-hours a day and there is an excellent perimeter fence which also encircles the power plant that enhances plant security.

Plans are on file with TCEQ to double the plant size, and some of the preliminary rock blasting and removal has been accomplished at a site adjacent to the present water treatment plant. There is ample acreage available for additional plant expansion. A liquid ammonium sulfate system is currently being installed at the rapid mix tank and will be in operation by May 2003. Removal of total organic carbons (TOCs) stands at 35 percent and a search for a better system to perform this function is now underway. The city pays for rights to 1 MGD from Possum Kingdom Lake (13 miles SE), but no pipeline exists to use this water yet. There are no other new potential sources of raw water being considered.

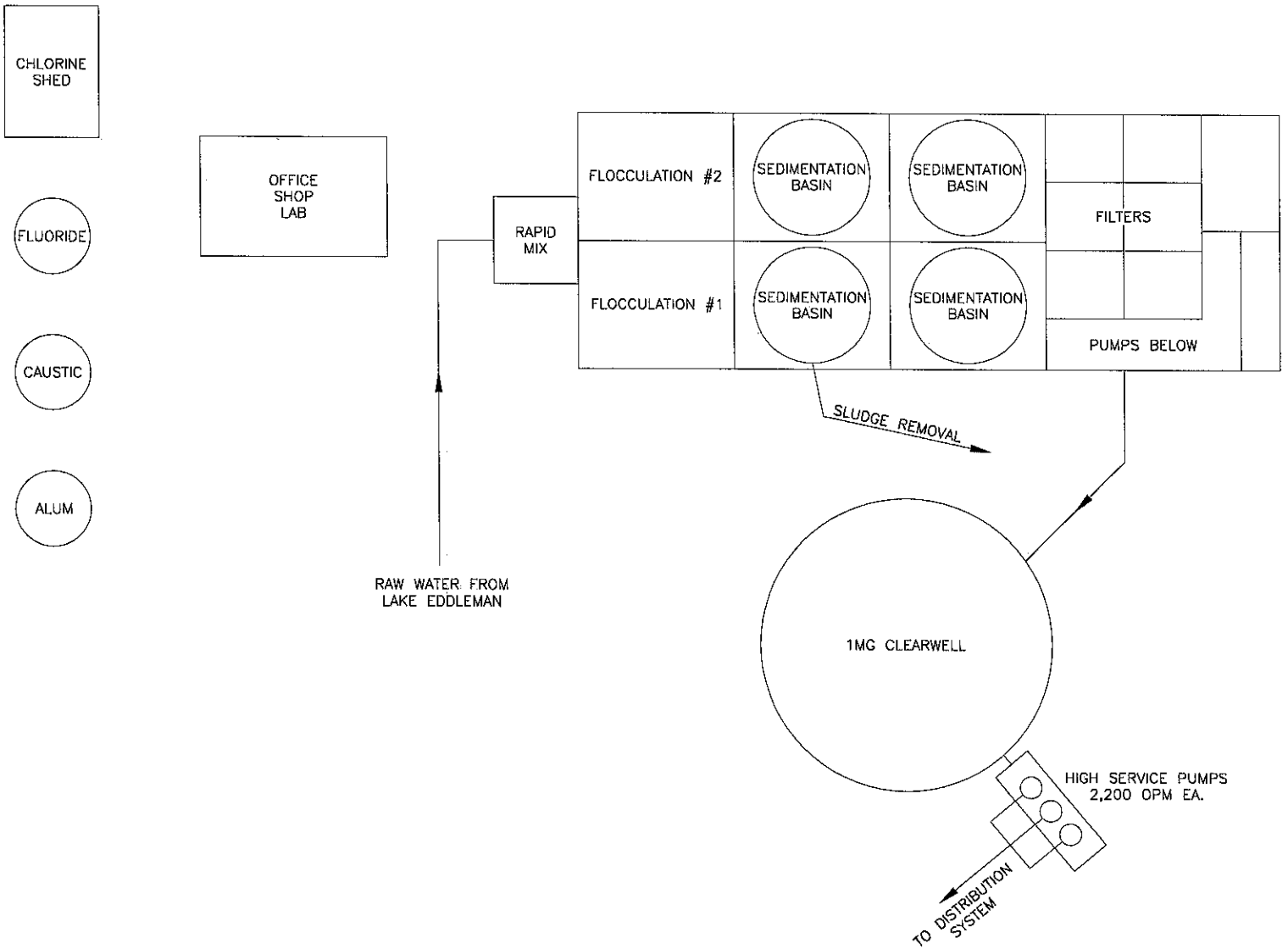


FIGURE E.16

CITY OF GRAHAM, TEXAS WATER TREATMENT PLANT SCHEMATIC

ACAD Rel 15.06s (LMS Tech) User: CAM
[BRA02372]N:\WR\JM-REPORT\BRASTUDY\GRAHAMWTP.DWG LAYOUT: 8.5x11
FEB 10, 2004 8:12:03 A.M. LTS: 75.00 PSLTS: 0 TWIST: 0.0

City of Mineral Wells

The Mineral Wells Hill Top Water Treatment Plant was built in 1962. The plant is rated by TECQ at 8.0 MGD. The plant is currently operating at 31 percent of capacity, producing 2.5 MGD. During the summer of 1999 and 2000 the plant produced 8 MGD on numerous occasions. The plant was upgraded in 1978 with new instrumentation. In 1980 the plant was upgraded further with a new chemical building, 2 new sedimentation basins, 2 new filters, an additional clearwell, an additional high service pump, and a recycle basin. In 1994 the chemical bulk storage area was rehabilitated. In 2003 the filter basins were overhauled, the SCADA was upgraded, backwash lagoons were improved, and the electrical and bulk storage facilities were updated. There is acreage available for additional plant expansion and improvement. Raw water is obtained from Lake Palo Pinto, 12 mile west of the WTP (currently at 80 % of its 28,000 acre feet capacity and 2.5' below the spillway). Raw water flows from the lake by gravity to a diversion dam where it is pushed by three 450 HP, (4.5 MGD each) pumps through a 24-inch line to the Hill Top Water Treatment Plant, 7 miles south of the city on Hwy 281. Water first enters a 133 surface acre (1,172 acre feet) pre-sedimentation reservoir just west of the WTP, and then an alum polymer blend is injected into the water before it flows into 4 flocculation/sedimentation basins consisting of 2 0.5 MG circular tanks and 2 1.0 MG rectangular basins.. The water then flows into four 24 feet x 24 feet (784 square feet) filtration tanks utilizing sand and anthracite coal aggregate dual-media filter tanks. Finished water is stored in three reinforced concrete clearwells having capacities of 0.5, 1.0, and 2.0 MG. Disinfection and odor control is by chlorine dioxide injected into the raw water line. D3 disinfection is with free chlorine, while D4 disinfection is with ammonia chlorine chloramines. Caustic sodium hydroxide stored in composite outdoor tanks is used for pH adjustment. The warm weather concentration is 50 percent while during the cool seasons a 25 percent concentration is used to prevent gelling. Fluoride is also added to the finished water. Finished water exits the clearwell through four high service pumps with the following ratings: 40 HP, 125 HP, a constant speed 500 HP, and a variable speed/variable frequency 500 HP unit. Personnel are on duty at the water treatment plant 24 hours a day and there is a perimeter fence.

The city is searching for other new potential sources of raw water. One plan being considered is to use the old 24-inch line from the Hilltop Water Treatment Plant to the city as a

raw water line to carry water from Lake Mineral Wells south to the Hilltop Water Treatment Plant (a new 36-inch treated line carries water from the plant to the city). One concern is that if the water level of Lake Mineral Wells is reduced too far, it will have a negative impact on tourism at the state park adjacent to the lake. Another plan calls for pulling water from the Brazos River, but there is currently insufficient flow at the proposed pick up point and elevated chlorides concentration would require reverse osmosis treatment.

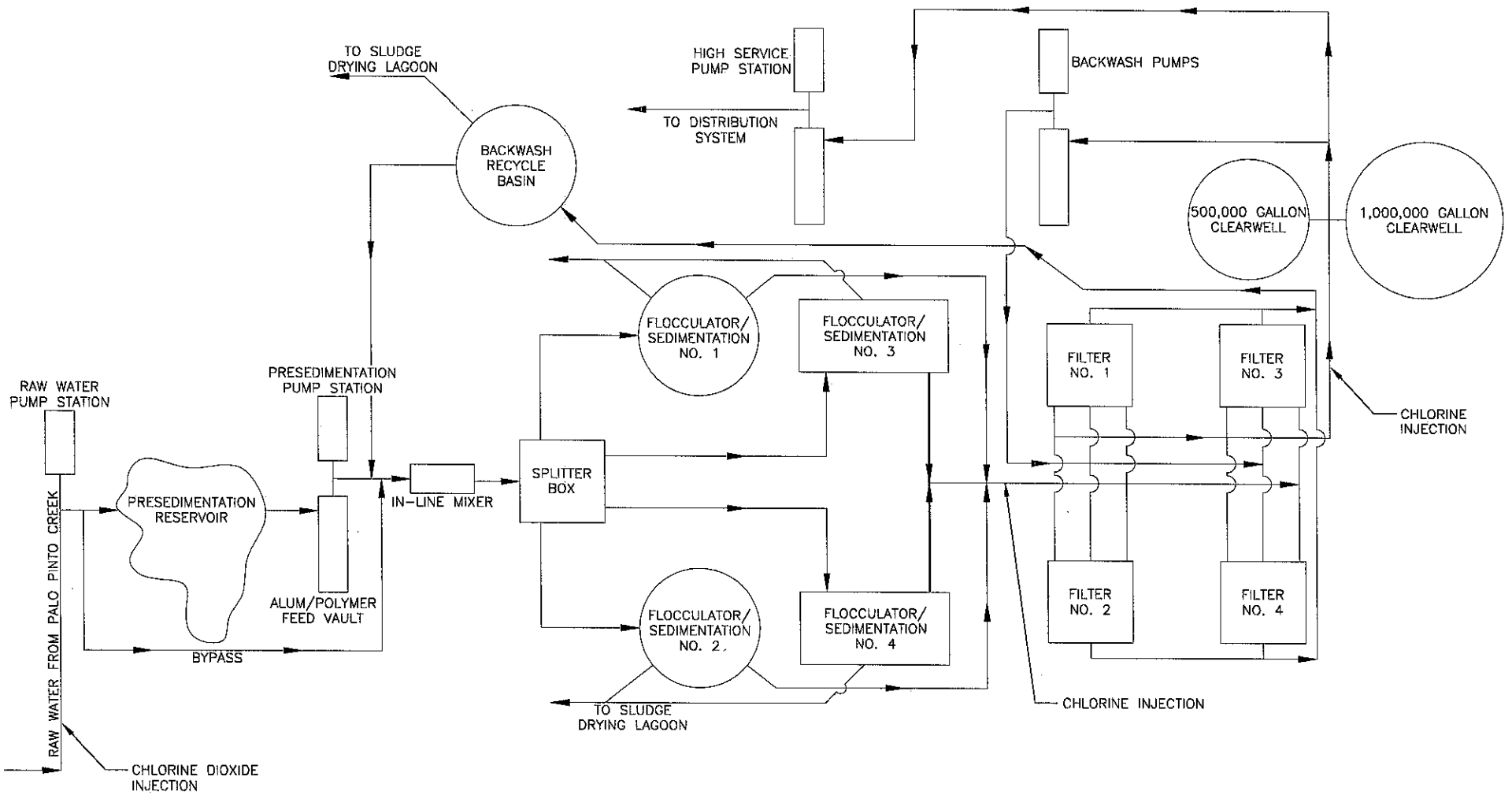


FIGURE E.17

CITY OF MINERAL WELLS, TEXAS
WATER TREATMENT PLANT
SCHEMATIC

ACAD Rel 15.06s (LMS Tech) User: CAM
[BRA02372]N:\WR\JM-REPORT\BRASTUDY\MINERALWELLSWATERSYSTEMFACILITYINVENTORY.DWG LAYOUT: Layout1
FEB 10, 2004 8:12:21 A.M. LTS: 75.00 PSLTS: 0 TWIST: 0.0

North Central Texas Municipal Water Authority

The North Central Texas Water Treatment Plant was originally constructed in 1972-74, with periodic updates to stay up with regulations. The plant is rated at 4.0 MGD. The facility does have room for expansion on the existing site. The land surrounding the plant site is undeveloped pastureland. The current configuration of the facility meets current TCEQ standards. The facility would require extensive modifications to add additional pumps or to change the process flow. The two filters have had media replacement in 2001. The Water Authority installed a complete new SCADA system in 2001 and added additional automation equipment and valve operators. Millers Creek Reservoir provides all water to the plant and is located less than one mile from the plant. Raw water is supplied through an intake structure to a pair of vertical turbine pumps on shore. These pumps supply the WTP through a 16-inch concrete cylinder pipeline. The two pumps are rated at 2,800 GPM @ 60 TDH and 1200 RPM motors. Disinfection and coagulants are added in the following order:

- Potassium permanganate is added at the raw water pumps for taste and odor control.
- Chlorine is added just ahead of the plant along with a polymer/ alum blend for coagulation.
- Chlorine, if required, is again added after both the clarifiers and the filters.
- Chlorine is also injected at each of the following pump stations: Munday, Goree, Knox City, and Haskell.
- Fluoride is injected into the finished water at the clearwell.
- A polymer/alum blend is injected in front of the two up flow clarifiers.

The clarifiers are 100 feet in diameter and rated at 2.0 MGD each. Raw water flow is split between the two clarifiers. The plant has two multi-media filters that measure 11 feet x 33 feet each and are currently in service. The filters are equipped with a surface wash system to aid during backwash of the filters. The backwash pump is rated at 6,800 GPM @ 40 THD, 900 RPM. The WTP has a concrete clearwell, which holds 403,000 gallons, 1.0 MG storage at Munday Terminal, 84,000 gallons at Goree Pump Station (PS), 210,000 gallons at Knox City PS, and 420,000 gallons at the Haskell PS. Finished water leaves the plant and is delivered to the

terminal one mile south of Munday, through an 18-inch concrete cylinder pipeline 13.5 miles from the WTP. The two supply pumps are rated at 2,100 GPM @ 280 TDH and are VFD motors with a max speed of 1750 RPM.

There are at least 6 foot chain link fences around all of the Water Authority pump stations and the water treatment plant. The WTP is manned 24 hours a day, 7 days a week. The Water Authority currently has employees that live in Munday, Goree, and Haskell. In the event of an emergency these employees can be dispatched from their homes.

The District is planning to install chlorine dioxide and chloramine feed systems to meet disinfection by-product regulations by the end of 2003. It is not likely that the expected new turbidity requirements will result in non-compliance. The District has been investigating alternate sources of water including diversion of Lake Creek and groundwater. Either source would supplement the Miller's Creek supply.

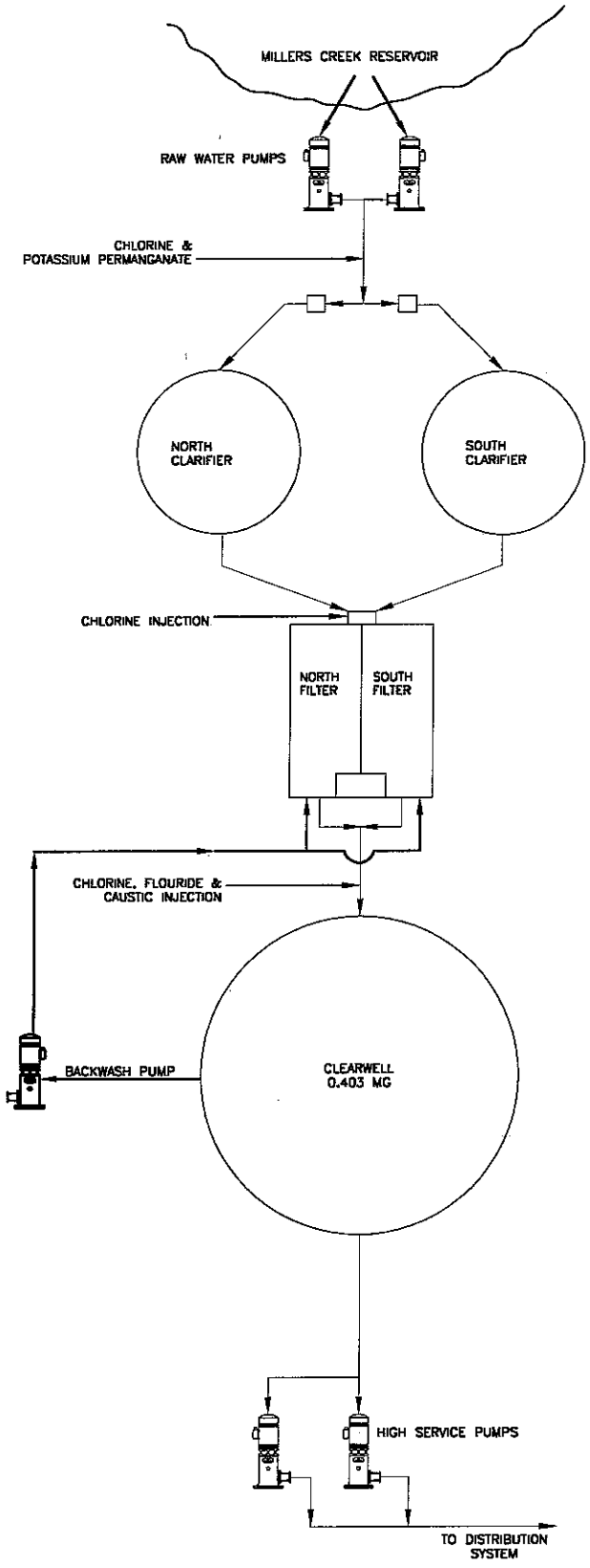


FIGURE E.18

NCTMWA
WATER TREATMENT PLANT
SCHEMATIC

AcAD Rel 15.06s (LMS Tech) User: LAM
[BRA02372]N:\WR\JM-REPORT\BRASTUDY\NCTMWAWATERWTPSCHEMATIC2002.DWG LAYOUT: Layout1
FEB 10, 2004 8:12:38 A.M. LTS: 1.00 PSLTS: 1 TWIST: 0.0

City of Olney

The City of Olney WTP was built in 1934 and received upgrades in 1954, 1975, 1987, and 1991. In 1989 TNRCC inspected the plant and determined the daily capacity was 1.861 MGD. The plant is currently operating at 22 percent of capacity at 400,000 gpd. During the summer of 2001 the plant produced 1.8 mgd on a few occasions. Upgrades to the pipe gallery, air scour, electrical and pneumatic systems are underway in 2003. There is ample acreage available for additional plant expansion. In 1994, the ability to take water from Lake Kickapoo (20 miles north of the WTP) was put into operation with the capability to pump 700 gpm for up to 1.0 MGD. This system included the 4.0 MG holding reservoir 1/4 mile from the WTP, which features a 40 mil poly liner to eliminate water loss through seepage. Raw water is obtained from Lake Cooper (which also receives water from adjacent Lake Olney through a spillway) or from Lake Kickapoo (20 mi north). Raw water enters the plant through a 14-inch line fed by two 1,600 GPM pumps. Water first enters a flash mix tank and is then pumped into three rectangular 14 feet x 100 feet x 12 feet sedimentation basins with a capacity of 350,087 gallons. Next the water enters three 14 feet x 14 feet (588 total sq ft) sand/coal aggregate filter tanks. Finished water is stored in two clearwells of 100,000 and 236,000-gallon capacity each. Disinfection is by chlorine prior to the rapid mix chamber, and pH adjustment is made with caustic sodium hydroxide. Polymers are added for coagulation. Three earthen reservoirs are in use on site, two as backwash ponds and one as a sludge pit. Finished water leaves the plant through two 1,350 gpm high service pumps feeding a 10-inch cast iron and a 10-inch AC line. An operator who resides in a city owned house on site provides plant security. There is also a chain link security fence around the plant.

There is ample acreage available for additional plant expansion. Modification of the disinfection system will be required prior to January 2004. It is intended to install a chloramine feed system to meet new regulations and utilize the existing treated water lines for CT credit.

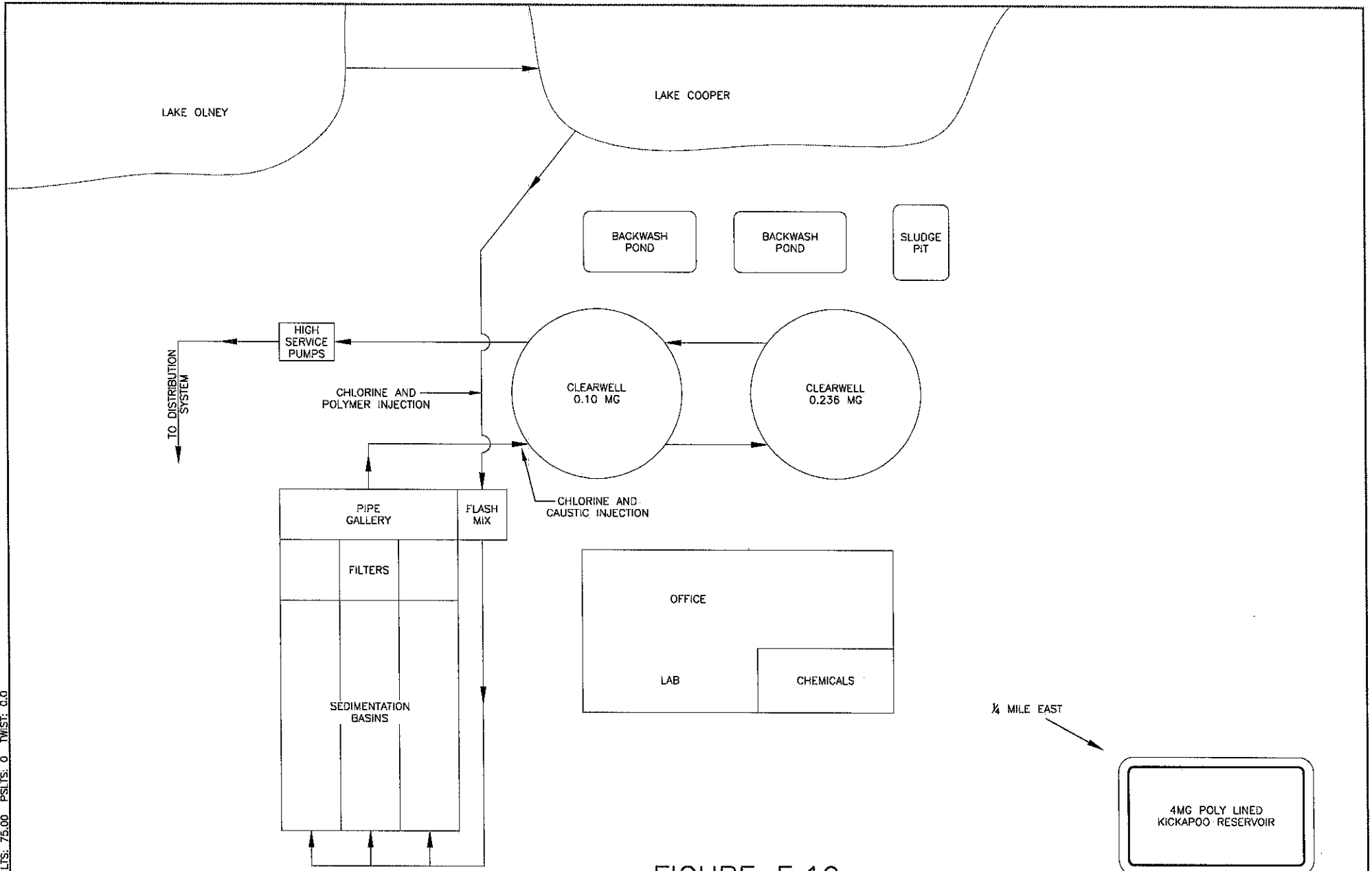


FIGURE E.19

CITY OF OLNEY, TEXAS WATER TREATMENT PLANT SCHEMATIC

PLOTTED: FEB 10, 2004 8:12:54 A.M. BY: USER
[BRA02372]N:\WR\JM-REPORT\BRASTUDY\OLNEYWTP.DWG LAYOUT: 8.5x11
LTS: 75.00 PSLTS: 0 TWIST: 0.0

City of Snyder

The City of Snyder's old WTP was built in 1951 and is currently rated by TCEQ at 4 MGD. The new plant was built on the north boundary of the property and is entirely above ground level. It is rated at 5 MGD and has a projected life of 25 years. During the winter months, when water consumption is low, the old plant is kept in operation, and the new plant is put in standby status. There is little room remaining at the current site for any further expansion. The old plant was upgraded in 1988 with a new rapid mix tank and rehabilitated Neptune micro-flock 8-stage multimedia filters. These filters were predicted to have a 35-year life. In 1999 and 2000, the plants were upgraded further with new SCADA controls and instrumentation. A contract to receive 204,000 acre-feet per year of raw water is in effect with the Colorado River Municipal Water District. The District can obtain water from Lake J.B.Thomas, 19 miles to the southwest, which is currently at 9.7 percent of capacity, Lake E.V.Spence that is at 7.4 percent of capacity, or Lake Ivie, which is at 37.3 percent of capacity. A well field, which contains 12 wells but operates 6 wells, is also capable of supplying 9 MGD. Raw water flows by gravity from a holding reservoir 5 miles southwest of the WTP through a 24-inch line. Water enters the new WTP at a screened flash mix tank where an alum polymer blend is injected. The water next enters a variable speed flocculator with six sets of twin 4 foot paddles. It then enters a 10 feet x 40 feet sludge collection box before flowing into a 40 feet x 54 feet angle tube sedimentation basin. At the old plant a rapid mix tank and an up-flow clarifier are used. At the new plant water flows into three 12 feet x 20 feet filtration tanks utilizing sand and anthracite coal aggregate dual-media filters. At the old plant there are two 24 feet by 36 feet multimedia sand, gravel and anthracite coal aggregate filter tanks. These will be converted to dual media the next time they are overhauled. Finished water is stored in three clearwells at the plant, two with capacities of 1.0 MG and one holding 0.3 MG. Initial disinfection and odor control is by chlorine dioxide injected into the raw water line at the flash mix tank. After sedimentation, the water is treated with gaseous ammonia and chlorine to form chloramines. Caustic sodium hydroxide stored in outdoor poly-tanks is used for pH adjustment. Two concrete lined backwash ponds with capacities of 172,000 and 193,000 gallons are situated on the south boundary of the WTP. Finished water exits the clearwell through three high service pumps with ratings of: 4, 6, and 1.5 MGD. A 1 MGD automotive six cylinder gasoline powered pump is available for use during

power outages. There is an 8 foot perimeter fence and additional security is provided by frequent patrols of city and county police officers transiting to and from the Law Enforcement Center one-half mile north of the WTP.

According to the operators, the current WTP will be able to comply with all anticipated future water quality standards. Nitrates are currently at 5 to 10 ppm and arsenic can be reduced below the 10 ppb standard by 2006.

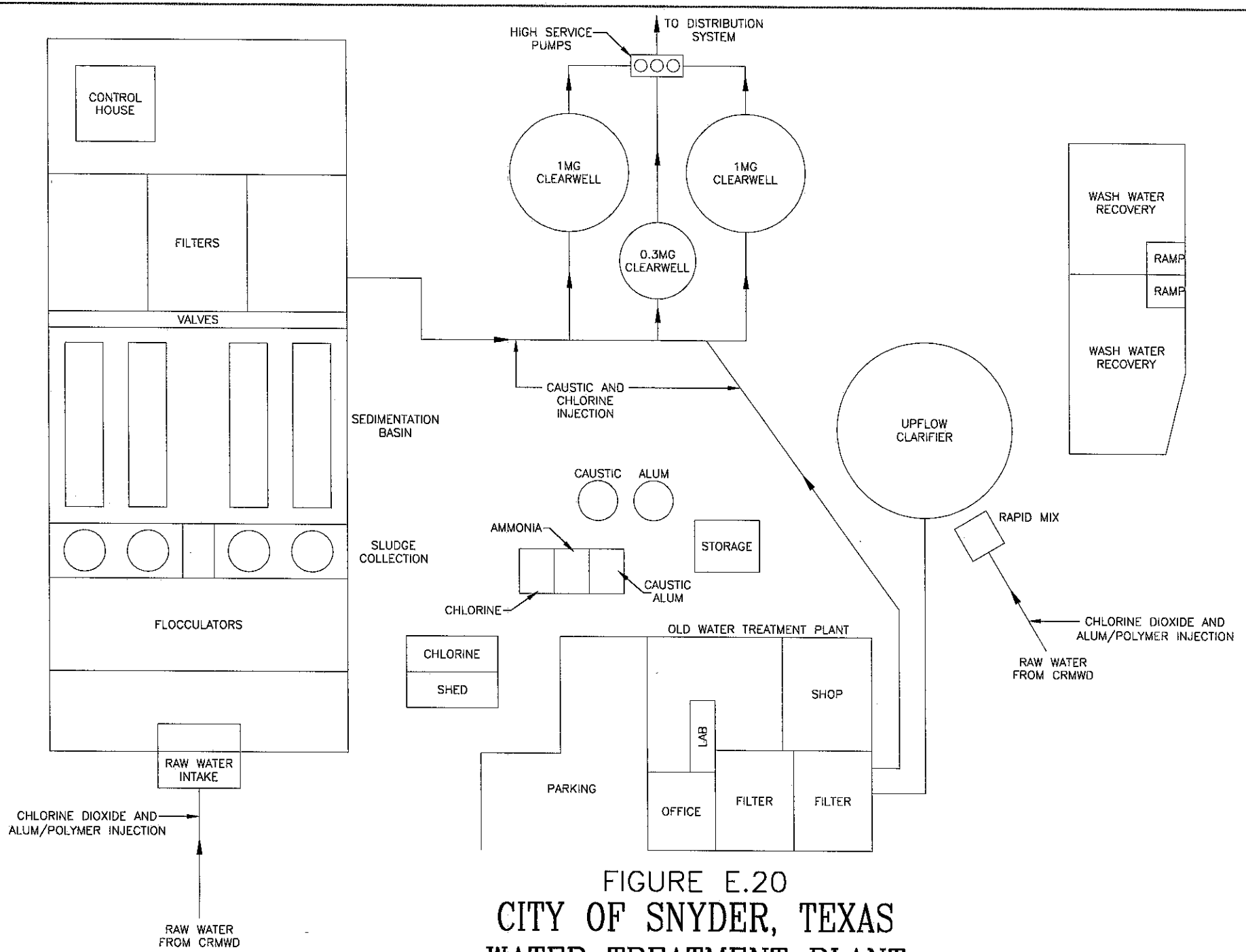


FIGURE E.20

CITY OF SNYDER, TEXAS
WATER TREATMENT PLANT SCHEMATIC

[ERA02372]N:\WR\JM-REPORT\BRASTUDY\SNYDERWTP.DWG LAYOUT: 8.5x11
FEB 10, 2004 8:13:09 A.M. LTS: 75.00 PSLTS: 0 TWIST: 0.0

City of Stamford

The Stamford WTP was completed in 1953 and has received numerous upgrades from 1980 to the present. In 1995 computer controls were installed as well as updates to the lab. In 2001, the TNRCC inspected the plant and determined that the daily capacity was 2.603 MGD. The plant is currently operating at about 23 percent of capacity at 600,000 GPD. There is ample acreage available for additional plant expansion. Raw water is obtained from Lake Stamford eight miles northeast of the WTP. Raw water is pumped through a 32-inch line fed by two 150 HP (1,300 gpm each) pumps and one 300 HP 2,000 gpm intake pump to a 1.0 MG ground storage tank on high terrain just east of the WTP. Water flows by gravity through the plant without the use of additional pumps. Raw water receives Aqualume, a blend of alum and polymer, for coagulation that is injected into the feed pipe prior to entering a flocculation chamber immediately south of the lab and north of the sedimentation basin. After the flocculation chamber, water flows south into a rectangular 0.8 MG capacity sedimentation basin (46.5 feet x 130.5 feet x 20 feet). The water continues south and enters two 23.5 feet x 21.5 feet (1,010.5 total sq ft) sand/coal aggregate filter tanks. The water receives gaseous chlorine disinfection at the inlet pipe to the flocculation chamber. Secondary gaseous chlorine disinfection and a dosing with caustic sodium hydroxide for pH control occurs prior to the finished water leaving the plant. Additional odor control is occasionally initiated with activated carbon when sulfur dioxide residuals are present. Finished water is stored in three clearwells with a total 0.6 MG capacity. Finished water leaves the clearwells through two 75 HP (900-1,000gpm) high service pumps, which can fill a 0.45 MG elevated tank 1 mile southwest of the WTP. Two additional high service pumps of 75 and 150 HP are available, but are not in use at this time. A double 8-foot chain link fence enhances plant security. One fence is around the perimeter of the entire site and an inner fence is around the only the WTP building. The Stamford Police Department is often on the property because they share some of the site facilities. The plant is manned 24 hours a day.

The plant is operating well under capacity. Improvements will be necessary to meet disinfection by-product rules and will likely consist of chlorine dioxide and chloramines. It is unlikely that the plant will meet future turbidity requirements without significant modifications.

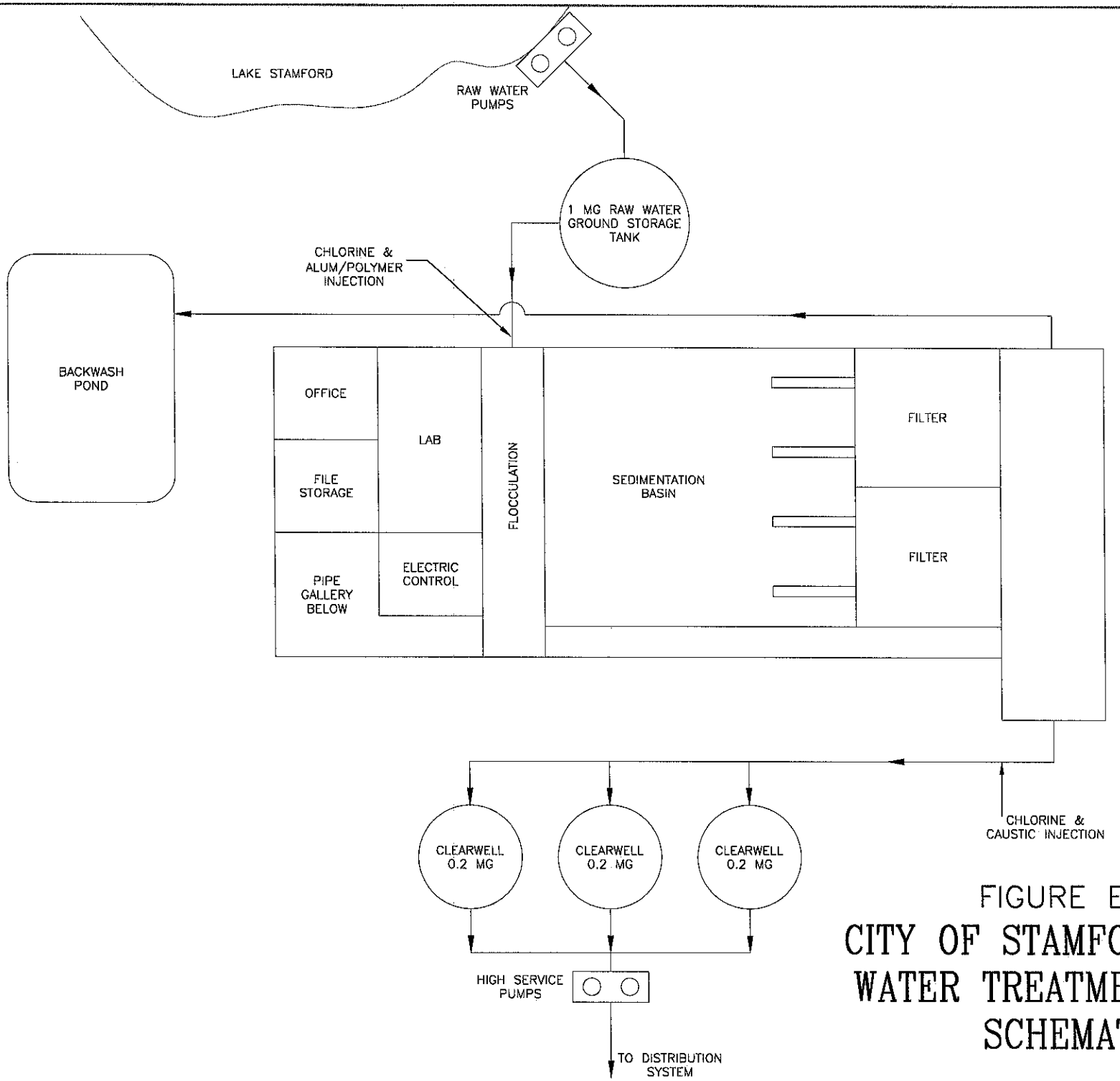


FIGURE E.21

CITY OF STAMFORD, TEXAS WATER TREATMENT PLANT SCHEMATIC

[BRA02372]N:\WR\JM-REPORT\BRASTUDY\STAMFORDWTP.DWG LAYOUT: 8.5x11
FEB 10, 2004 8:13:26 A.M. LTS: 75.00 PSLTS: 0 TWIST: 0.0

City of Strawn

The Strawn WTP is of conventional design and was built in 1984. It is currently rated by the TCEQ at 0.576 MGD. Due to steep terrain and the railroad tracks north of the site, there is little room remaining at the current site for any further expansion without occupying land outside the fence east of the plant. The plant was upgraded in 1999 with three new ground storage tanks, a new clarifier, and an extra filter tank. A standpipe was built in 1998. Lake Tucker provides raw water for the city. The lake is 3 miles west of the WTP and water is moved through a 6-inch line by a 10 HP 250 GPM pump to the WTP. Water moves through the plant by gravity flow. After water enters the WTP it is treated with free chlorine and polymer before it flows into two circular 54,000-gallon clarifiers. The plant has three multi-media (sand/gravel/anthracite coal) 3,000 gallon cylindrical filters. Only two of the three filters are currently in use. Finished water is stored in five clearwells at the plant, two with capacities of 10,000 gallons and three with 15,000-gallon capacities. Disinfection and odor control is by free chlorine injected into the raw water line. Caustic sodium hydroxide stored in outdoor poly-tanks is used for pH adjustment. A 75 feet x 75 feet earthen backwash pond is in use west of the plant. Finished water exits the clearwell through two 30 HP / 450 GPM high service pumps. A standpipe on 1,000 feet MSL high terrain west southwest of the plant stores 152,000 gallons of water for the City of Strawn. There is an excellent 8 foot high perimeter fence and additional security is provided by the operator who can stay at the facility when necessary in a travel trailer provided by the city.

According to the operator, the TOC program is not yet in compliance, and a program to use ammonia to reduce chloromines will be initiated. The current 6-inch raw water line will be replaced with an 8-inch or 10-inch pipe hooked to two 250 GPM submersible pumps. It is not likely that the plant will be able to maintain compliance with upcoming turbidity requirements. Current turbidity limits are difficult to maintain with conventional filters and the limits will likely be reduced further in the future.

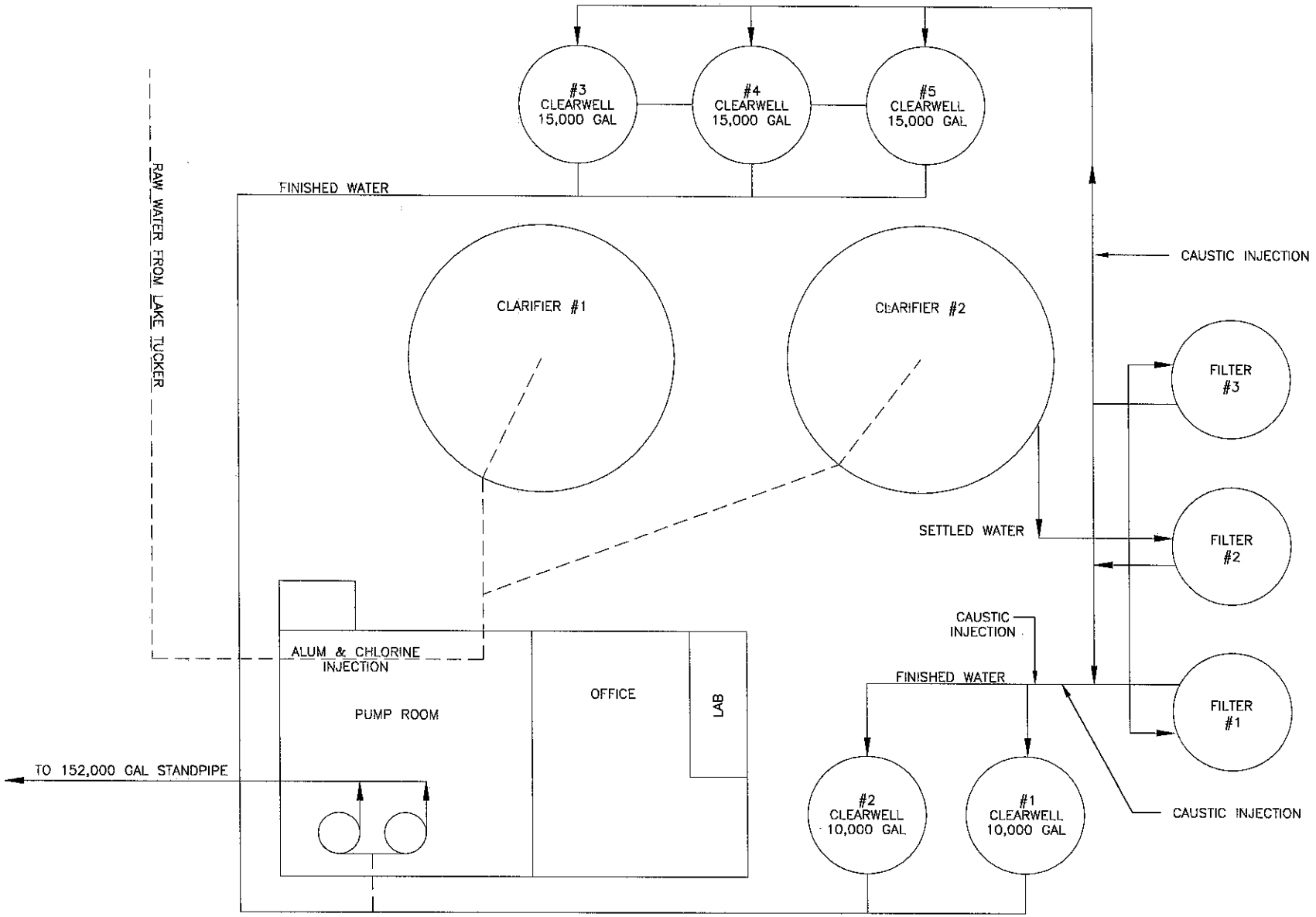


FIGURE E.22

CITY OF STRAWN, TEXAS
WATER TREATMENT PLANT
SCHEMATIC

ACAD Rel 15.06s (LMS Tech) User: CAM
[BRA02372]N:\WR\JM-REPORT\BRASTUDY\CITYOFSTRAWNWATERTREATMENTPLANT.DWG LAYOUT: Layout1
FEB 10, 2004 8:10:04 A.M. LTS: 75.00 PSLTS: 0 TWIST: 0.0

City of Sweetwater

The City of Sweetwater is currently constructing a new ultrafiltration water treatment plant. This plant will replace the existing treatment plant that is not currently used. The existing plant has been out of operation since the city began using well water and stopped using surface water approximately two years ago. Lake Sweetwater, Lake Trammel (12 mi. south) and Oak Creek Lake (28 mi. south.) previously provided raw water for the city. Due to low water levels in these lakes, 100 percent of the city's needs are now met with groundwater. Sweetwater utilizes 34 wells of 250 feet average depth in a municipal well field located 20 miles southwest of the city. Water is pumped from the well field by a pair of 1,000 GPM pumps through an 18-inch line to a booster station 15 miles west of the water plant where a 5.5 MGD pump station boosts the pressure to the WTP. Initial disinfection is achieved with chlorine dioxide that is injected at the head of the plant. Coagulation is enhanced using aluminum chlorohydrate. Chloramines will be used for residual disinfection and will be injected prior to the clearwell. Sodium hydroxide stored in outdoor poly-tanks is used for pH adjustment. Supplemental fluoride is added to the finished water. After water enters the WTP it will enter a blending tank. The water will pass through a mechanical screen and static mixer where aluminum chlorohydrate will be injected. The water will then pass through a flocculation basin and the submersed ultrafiltration units. Finished water is stored in a 1.7 MG clearwell at the plant. A 1.5 MG and a 0.2 MG ground storage tank will follow the clearwell. Finished water exits the storage tanks through three small high service pumps, each having a capacity of 1.5 MGD at a TDH of 200 feet, and two large high service pumps having a capacity of 4 MGD at a TDH of 215 feet. There is a perimeter fence and additional security is provided by city police who patrol the site and must enter to obtain fuel from the city fuel island inside the gates.

The ultrafiltration technology results in very high quality water and new disinfection requirements will be met with chloramines. With this type of treatment plant, the City should be able to meet any foreseeable water quality requirements.

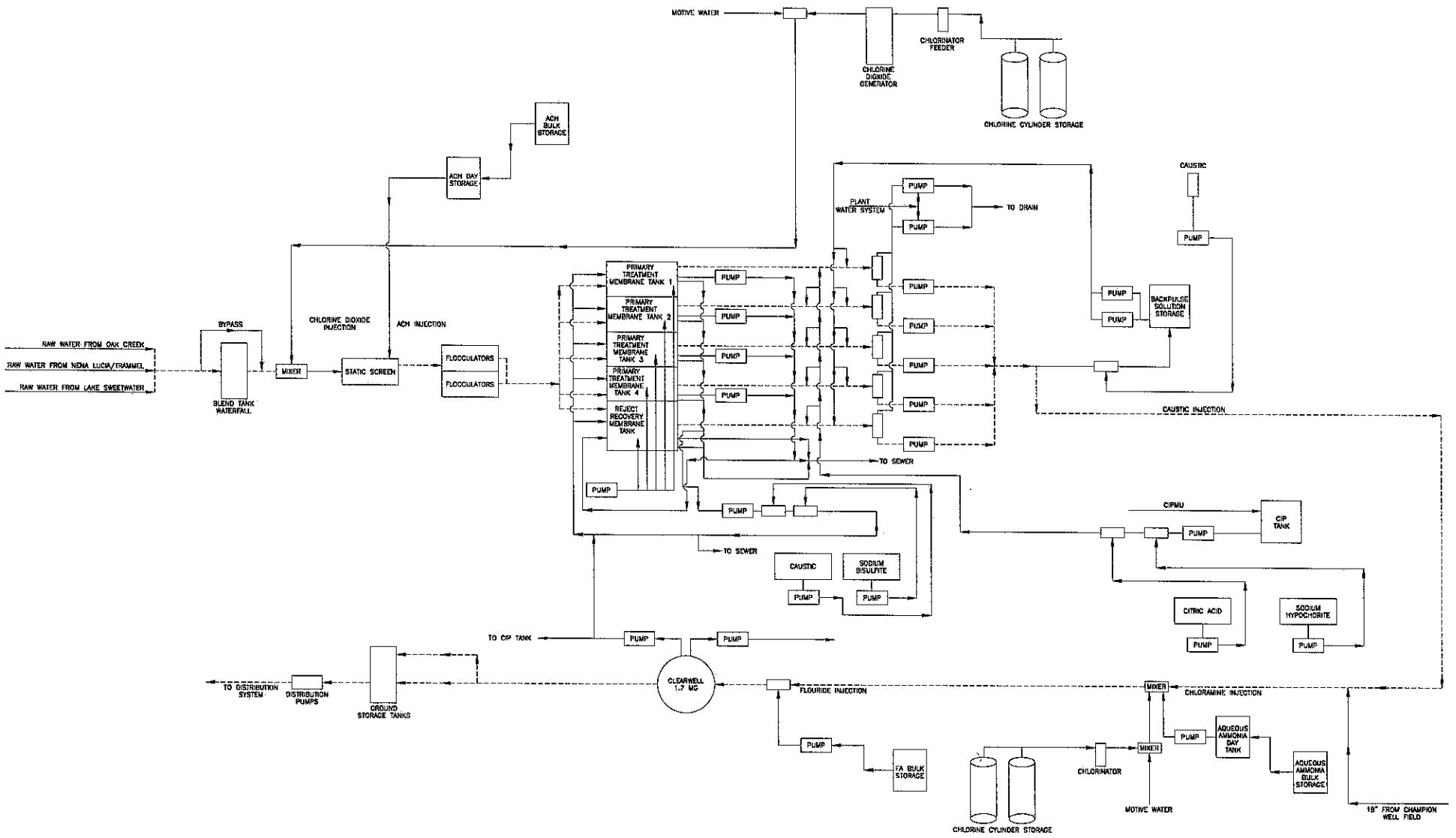


FIGURE E.23

CITY OF SWEETWATER, TEXAS
WATER TREATMENT PLANT
SCHEMATIC

ACAD Rel 15.05s (LMS Tech) User: CAM
[BRA02372]N:\WR\JM-REPORT\BRASTUDY\CITYOFSWEETWATER.DWG LAYOUT: Layout1
FEB 10, 2004 8:10:20 A.M. LTS: 50.00 PSLTS: 0 TWIST: 0.0

City of Throckmorton

The current WTP for the city of Throckmorton was constructed in 1984. The City owns additional land around the facility that could be used for expansion. The City takes its water supply from an intake in Lake Throckmorton. Raw water is pumped to the WTP through an 8-inch line from the intake. The intake consists of three 8-inch intake pipes and gate valves. There are two horizontal split-case pumps rated at 500 gpm @ 55 feet TDH. Disinfection and coagulants are added in the following order: Alum and chlorine are added before the claricone clarifier. Chlorine is added again after the filters as well as caustic for final pH adjustment. Throckmorton is adding alum just before the raw water enters the claricone for sedimentation. The claricone is rated at 0.7 MGD and measures 30 feet in diameter and has a 26 feet-10 inch water depth. The plant has two (2) multimedia filters that measure 10 feet-6 inches bottom diameter. The horizontal centrifugal backwash pump is rated at 1550 gpm @ 32 feet TDH. Two backwash ponds exist but are not in operation. The backwash is currently discharged into the sanitary sewer system. The WTP has one 87,000 gallon concrete clearwell. The clearwell is 48 feet-7 inches x 19 feet x 12 feet-7 inches deep. The finished water leaves the plant and is pumped into the city's distribution network using three horizontal split-case pumps, two of which are rated at 375 gpm @ 160 feet TDH and the other rated at 500 gpm @ 180 feet TDH. The WTP and all related facilities are surrounded by 6 foot chain link fences with 3 strands of barbwire above. The WTP is manned 16 hours a day and has an alarm system for dialing the operator in the event of a plant problem.

The City has applied for funding to install a chloramine disinfection system at the plant to comply with upcoming by-product regulations. Other maintenance items are included in the grant application as well. The ability of the plant to comply with the expected 0.1 NTU turbidity requirement is marginal and additional improvements may be necessary.

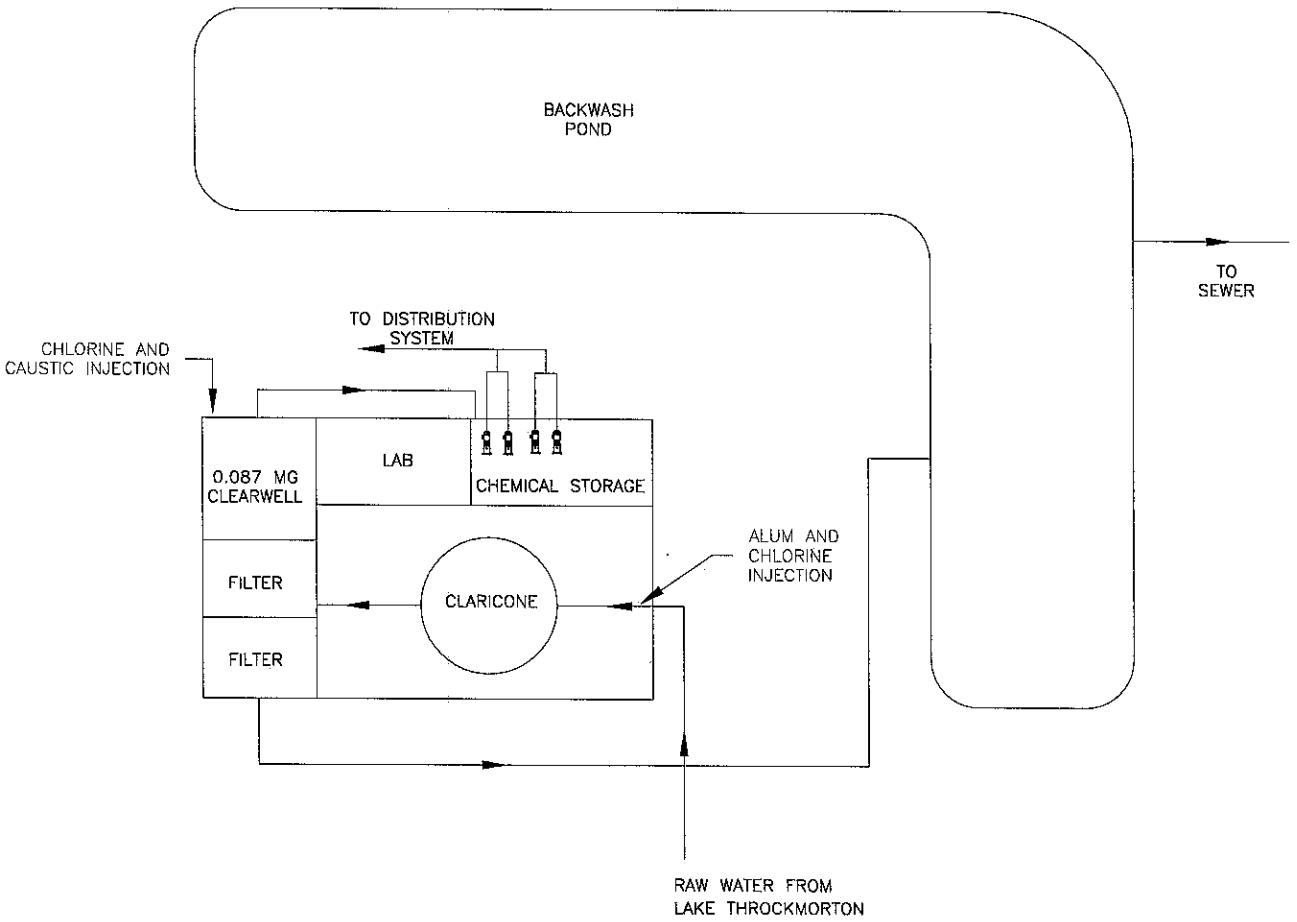


FIGURE E.24

CITY OF THROCKMORTON, TEXAS
WATER TREATMENT PLANT
SCHEMATIC

ACAD Rel 15.06s (LMS Tech) User: CAM
[BRA02372]N:\WR\JM-REPORT\BRASTUDY\CITYOFTHROCKMORTON.DWG LAYOUT: Layout1
FEB 10, 2004 8:10:37 A.M. LTS: 20.00 PSLTS: 1 TWIST: 0.0, 0.0, 0.0

Upper Leon Municipal Water District

The WTP was built in 1969 and is rated by TCEQ at 7.2 MGD. The plant is currently operating at 25 percent of capacity, producing 1.8 MGD. The maximum past production was 3.4 MGD. The plant was upgraded in 1978 with a new 4 MGD clarifier. In 1986 the plant was upgraded further with new controls and instrumentation. In 1995 new transfer pumps and controls for the up-flow clarifier were added. Current ongoing upgrades include filter and control improvements. There is acreage available for additional plant expansion and improvement. Raw water is obtained from Lake Proctor adjacent to the WTP. Raw water is pumped from the lake by four intake pumps with capacities of 1,225 GPM, 2,450 GPM, 3,200 GPM and 3,675 GPM through an 18-inch line to the WTP, northeast of the City of Comanche. Water first enters the WTP at a flash mix tank where an alum polymer blend (which is custom tailored on site) is added. After flowing through two splitter boxes, sedimentation occurs in either a 1 MGD (694 gpm) cross-flow rectangular sedimentation basin, a 4 MGD (2778 gpm) radial flow sedimentation basin, or a 4 MGD (2778 gpm) up-flow, solids-contact clarifier. The water flows into two 14.5 feet x 42.5 feet (1,233 total sq ft) filtration tanks utilizing sand and anthracite coal aggregate dual-media. Air scour is currently being added to the underdrain system. Finished water is stored in two clearwells at the plant, with capacities of 50,000 gallons and 1.0 MG. Initial disinfection and odor control is by chlorine dioxide injected into the raw water line at the intake pump discharge. The chlorine dioxide is currently undergoing a trial period, which began 11/20/2002. Secondary disinfection occurs just prior to the flash mix with chlorine, and a third injection point is located prior to the 50,000-gallon clearwell. Caustic sodium hydroxide stored in outdoor tanks is used for pH adjustment. One large earthen backwash pond exists adjacent to the WTP. Finished water exits the clearwell through six high service pumps with the ratings ranging from 350 to 2,800 gpm. Ground storage tanks store system water at three locations:

- West of De Leon on Hwy 6, 0.1 MG
  Two booster pumps, 350 and 450 gpm
- Gorman, 0.1 MG
  Three booster pumps, 2 of 350 gpm and one of 600 gpm.
- Erath/Comanche County line on Hwy 67/377, 0.6 MG
  Six booster pumps rated at 350 to 1,400 gpm

Personnel are not on duty at the WTP 24 hours a day but there is a perimeter fence and additional security due to the proximity of the US Corps of Engineers Office. The plant is equipped with alarms to alert operators of problems at the plant.

The District has a project underway to modify the control system at the plant. Filter modifications were recently completed. A change in the raw water pick up point to a down stream location versus the current lakeshore location is planned as soon as funding can be secured. Also planned are one or two new filters and a 1 MG ground storage tank. Plant personnel believe that the current WTP will be able to comply with all anticipated water quality standards.

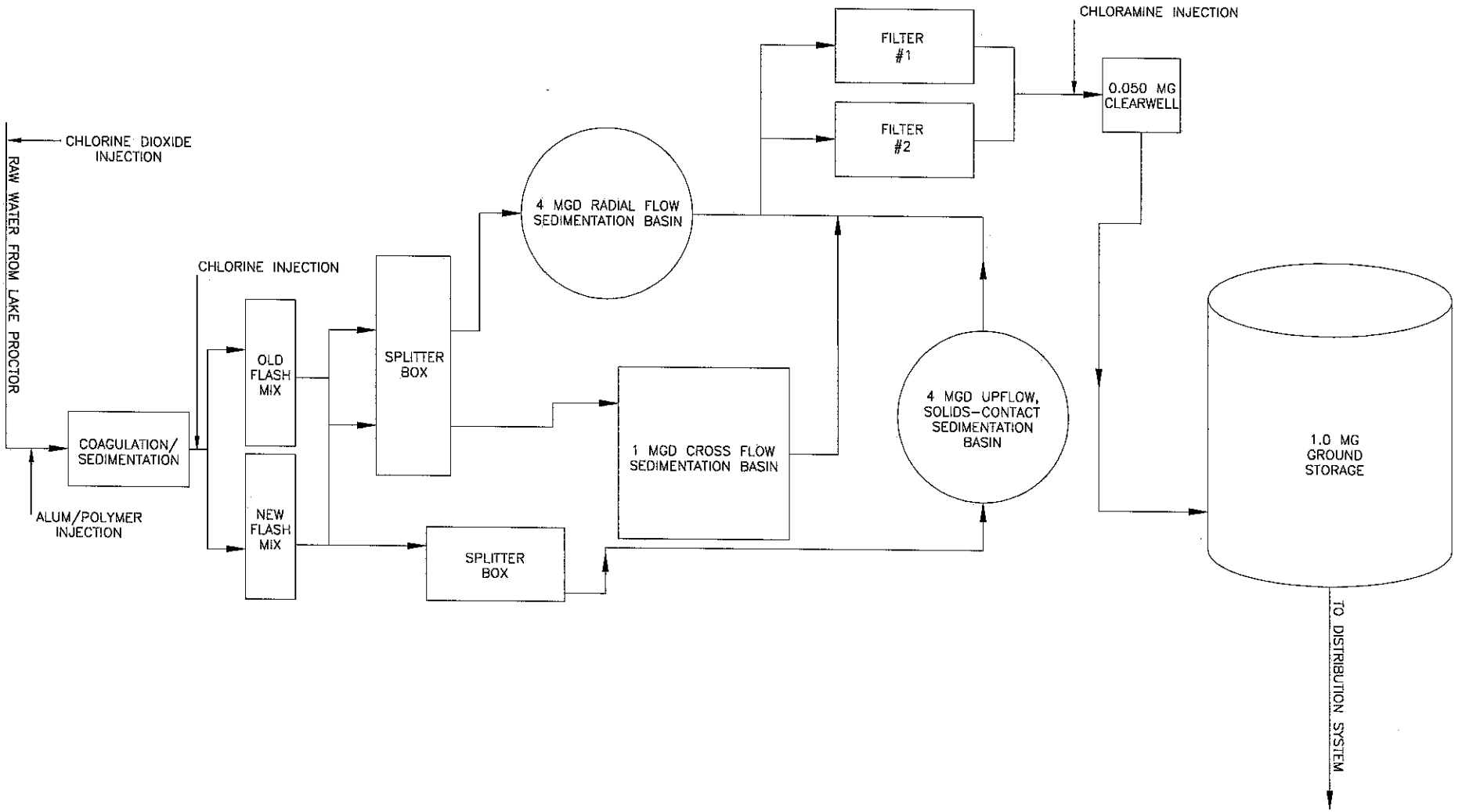


FIGURE E.25

UPPER LEON MUNICIPAL WATER DISTRICT WATER TREATMENT PLANT SCHEMATIC

[BRA02372]N:\WR\JM-REPORT\BRASTUDY\UPPERLEONRIVERMUNICIPALWATERDISTRICT.DWG LAYOUT: Layout1
FEB 10, 2004 8:13:45 A.M. LTS: 1.00 PSLTS: 1 TWIST: 0.0, 0.0

2. Storage Inventory and Assessment

The existing ground storage and elevated storage for each system in the study area was obtained from representatives or through the Texas Commission on Environmental Quality (TCEQ) web site for public water systems. The available storage was compared to the minimum TCEQ requirements based on the current number of customers. These requirements are discussed in Section 2.1, along with other capacity requirements for water systems. It was determined whether each system was in compliance with respect to storage requirements and how much excess storage was available in the study area. Tables E-1 and E-2 list the findings of the study. None of the systems in the study were found to be out of compliance although some of the systems meet requirements through additional pumping capacity and pressure storage in lieu of elevated storage. It was also found that throughout the study area there was a surplus storage capacity of 56.79 million gallons, however, this surplus is confined to the larger communities.

2.1 Summary of TCEQ 290.45. Minimum Water System Capacity Requirements

The Texas Commission on Environmental Quality (TCEQ) governs water systems in Texas. Chapter 290 of the TCEQ's regulations lay out the requirements for water system design and operation and Subchapter D, Section 290.45 specifically deals with minimum water system capacity requirements. This section is divided into requirements for community water systems and non-community water systems each broken down into groundwater and surface water. The groundwater sections are further broken down by size. Tables E-3 and E-4 provide summaries of the rules that are applicable to this study.

Table E-1

Storage Inventory for Municipalities in the West Central Brazos Study Area

City	Current # of Customers	Ground Storage	Stand Pipe		Elevated Storage	Required Storage		Deficient?		Surplus Storage
			Ground	Elevated		Total	Elevated	Total	Elevated	
		MG	MG	MG	MG	MG	MG	Yes/No	Yes/No	MG
City of Abilene	37,294	23.100			5.750	7.459	3.729	no	no	21.391
City of Albany	1,073	1.250			0.250	0.215	0.107	no	no	1.285
City of Anson	1,150	0.330			0.250	0.230	0.115	no	no	0.350
City of Aspermont	576	1.580			0.100	0.115	0.058	no	no	1.565
City of Baird	845				0.630	0.169	0.085	no	no	0.461
City of Bangs	830	0.420			0.200	0.166	0.083	no	no	0.454
City of Benjamin	155	0.380			0.050	0.031	0.016	no	no	0.399
City of Breckenridge	2,645	1.000			0.650	0.529	0.265	no	no	1.121
City of Brownwood	7,400	2.500			3.200	1.480	0.740	no	no	4.220
City of Cisco	1,675	0.500			0.500	0.335	0.168	no	no	0.665
City of Clyde	1,480	0.600			0.250	0.296	0.148	no	no	0.554
City of Comanche	1,930	1.000			0.500	0.386	0.193	no	no	1.114
City of Cross Plains	580	0.215			0.100	0.116	0.058	no	no	0.199
City of De Leon	1,066	0.160			0.125	0.213	0.107	no	no	0.072
City of Early	950	0.250			0.500	0.190	0.095	no	no	0.560
City of Eastland	1,731	1.575	0.817	0.204		0.346	0.173	no	*	2.250
City of Gorman	550	0.100			0.075	0.110	0.055	no	no	0.065
City of Graford	275	0.300			0.050	0.055	0.028	no	no	0.295
City of Graham	4,150				1.500	0.830	0.415	no	no	0.670
City of Hamlin	1,250				0.250	0.250	0.125	no	no	0.000
City of Haskell	1,716	0.450			0.750	0.343	0.172	no	no	0.857
City of Jayton	300	0.100			0.050	0.060	0.030	no	no	0.090
City of Knox City	609		0.043	0.024	0.040	0.122	0.061	*	*	-0.015
City of Merkel	1,200	0.050			0.500	0.240	0.120	no	no	0.310
City of Mineral Wells	6,220	1.500			2.550	1.244	0.622	no	no	2.806
City of Munday	648	0.109			0.050	0.130	0.065	no	yes	0.029
City of Newcastle	264	0.050			0.076	0.053	0.026	no	no	0.073
City of Olney	1,730	0.855			0.350	0.346	0.173	no	no	0.859
City of Ranger	1,011	0.000			0.500	0.202	0.101	no	no	0.298
City of Rising Star	325	0.100			0.075	0.065	0.033	no	no	0.110
City of Roby	436	0.490				0.087	0.044	no	yes	0.403
City of Roscoe	546	0.180	0.12	0.09	0.050	0.109	0.055	no	yes	0.331

Table E-1 (continued)

City	Current # of Customers	Ground Storage	Stand Pipe		Elevated Storage	Required Storage		Deficient?		Surplus Storage
			Ground	Elevated		Total	Elevated	Total	Elevated	
		MG	MG	MG	MG	MG	MG	Yes/No	Yes/No	MG
City of Rotan	930	1.000			0.200	0.186	0.093	no	no	1.014
City of Rule	341	0.200			0.050	0.068	0.034	no	no	0.182
City of Snyder	6,061	3.050			1.200	1.212	0.606	no	no	3.038
City of Stamford	1,872				0.600	0.374	0.187	no	no	0.226
City of Strawn	230	0.067			0.152	0.046	0.023	no	no	0.173
City of Sweetwater	4,787	0.700	0.292	0.084	0.750	0.957	0.479	no	no	0.869
City of Throckmorton	537	0.272			0.104	0.107	0.054	no	no	0.269
City of Tye	541				0.150	0.108	0.054	no	no	0.042
TOTALS	**97,909**	**44.43**	**1.27**	**0.40**	**23.13**	**19.58**	**9.79**			**49.65**

*Utilizes supplier's storage to meet requirements.

Table E-2

Storage Inventory of Rural Water Systems

Water System	Current # of Customers	Ground Storage	Stand Pipe		Elevated Storage	Required Storage		Deficient?		Surplus
			Ground	Elevated		Total	Elevated	Total	Elevated	Storage
		MG	MG	MG	MG	MG	MG	Yes/No	Yes/No	MG
Bitter Creek WSC	598	0.036			0.236	0.120	0.060	no	no	0.152
Brookesmith SUD	2,530	2.250			0.750	0.506	0.253	no	no	2.494
Brown County WID 1					2.000	n/a	n/a	n/a	n/a	n/a
Callahan County WSC	762	0.048	0.12	0.03		0.152	0.076	no	**	0.046
Coleman County WSC	2,085	0.485			0.520	0.417	0.209	no	no	0.588
Comanche County WSC	190	0.120				0.038	0.019	no	**	0.082
Eastland County WSD						n/a	n/a	n/a	n/a	n/a
Eula WSC	914	0.242	0.279	0.068		0.183	0.091	no	**	0.406
Fort Belknap WSC	1,747	0.360			0.200	0.349	0.175	no	no	0.211
Hawley WSC	690	0.470			0.080	0.138	0.069	no	no	0.412
North Central Texas MWD		2.215				n/a	n/a	n/a	n/a	n/a
North Rural WSC	903	0.252			0.200	0.181	0.090	no	no	0.271
Palo Pinto County MWD 1		0.040			0.050	n/a	n/a	n/a	n/a	n/a
Possum Kingdom WSC		0.786	0.467	0.0943		0.000	0.000	no	no	1.347
Potosi WSC	1,271	0.200			0.250	0.254	0.127	no	no	0.196
Shackelford WSC	960	0.362			0.100	0.192	0.096	no	**	0.270
Steamboat Mountain WSC	1,158	0.275			0.120	0.232	0.116	no	no	0.163
Stephens County Rural WSC (& Woodson)	1,205	0.322	0.054	0.036	0.100	0.241	0.121	no	**	0.271
Taylor County FWSD 1 Tuscola	375	0.150			0.075	0.075	0.038	no	no	0.150
Upper Leon River MWD		1.980				n/a	n/a	n/a	n/a	n/a
West Central Texas MWD		16.000				n/a	n/a	n/a	n/a	n/a
Westbound WSC	566	0.040			0.100	0.113	0.057	no	no	0.027
Zephyr WSC	1,123	0.276				0.225	0.112	no	**	0.051
TOTALS	**17,077**	**26.91**	**0.92**	**0.23**	**4.78**	**3.42**	**1.71**			**7.14**

*Utilizes supplier's storage to meet requirements.

** Utilizes pump capacity in lieu of elevated storage

A community water system is defined as one that has a potential to serve at least 15 residential service connections on a year-round basis or serves at least 25 residents on a year-round basis. Each of the entities included in this study fall under this category; therefore, non-community water systems will not be discussed here. The rules for groundwater systems vary depending on the size of the system. The classifications are as follows:

1. Systems with fewer than 50 connections without ground storage
2. Systems with fewer than 50 connections with ground storage
3. Systems with 50 to 250 connections
4. Systems with more than 250 connections
5. Mobile home parks with a density of 8 or more units per acre and apartment complexes which supply fewer than 100 connections without ground storage
6. Mobile home parks and apartment complexes which supply 100 or more connections, or fewer than 100 connections and utilize ground storage

Groundwater systems serving fewer than 50 connections without ground storage must have a well capacity of 1.5 gpm per connection and a pressure tank capacity of at least 50 gallons per connection. Groundwater systems serving fewer than 50 connections with ground storage must have a well capacity of 0.6 gpm per connection, a total storage capacity of 200 gallons per connection, two or service pumps with a total capacity of 2.0 gallons per minute and a pressure tank capacity of 20 gallons per connection. Systems with 50 to 250 connections must meet the same requirements. In addition, the system may provide 100 gallons per connection of elevated storage in lieu of pressure storage and, if the system provides at least 200 gallons per connection of elevated storage, the service pump capacity is reduced to 0.6 gpm per connection. For systems of this size and larger, the pumping and pressure/elevated storage requirement apply to each pressure plane. The rules are the same for systems serving more than 250 connections, except that two or more wells must be provided and emergency power provisions must be made if elevated storage requirements are not met.

All surface water suppliers must provide a raw water pumping, treatment plant and transfer pump capacity of 0.6 gpm per connection. Clearwell storage of 50 gallons per connection or, for systems serving more than 250 connections, 5.0 percent of the daily plant capacity must be provided. The total storage capacity requirement is 200 gallons per connection. The system must provide two or more high service pumps with a total capacity of 2.0 gpm per

connection or a total capacity of at least 1,000 gpm and the ability to meet peak hourly demands with the largest pump out of service, whichever is less. Systems providing 200 gallons per connection of elevated storage need only provide 0.6 gpm per connection high service pumping capacity. Pressure storage of 20 gallons per connection or elevated storage of 100 gallons per connection must be provided as well. Emergency storage is required for systems serving more than 250 connections and not meeting elevated storage requirements.

Table E-3

Groundwater Systems

			Pressure Maintenance		High Service Pumps	
Category	**Well Capacity (gpm)**	**Total Storage**	**Pressure Storage**	**Elevated Storage**	**w/o 200 gal Elevated Storage**	**with 200 gal Elevated Storage**
1	1.5		50		2.0	
2	0.6	200 gallons	20		2.0	
3	0.6	200 gallons	20	100	2.0	0.6
4	2 or more at 0.6	200 gallons	20	100	2.0	0.6
5	1.0		50			
6	0.6*	200 gallons	20		2.0	

*Systems serving more than 250 connections must have two wells.

Table E-4

Surface Water Systems

System Component	Less Than 250 Connections	More Than 250 Connections
Raw Water Pumps	0.6 gpm per connection*	0.6 gpm per connection*
Treatment Plant	0.6 gpm per connection	0.6 gpm per connection
Transfer Pumps	0.6 gpm per connection*	0.6 gpm per connection*
Clearwell	50 Gallons per Connection	Same or 5% of Daily WTP Capacity
Total Storage	200 Gallons per Connection	200 Gallons per Connection
High Service Pumps w/o Elevated Storage	2.0 gpm per Connection	2.0 gpm per Connection
High Service Pumps with 200 Gallons Elevated Storage	0.6 gpm per connection	0.6 gpm per connection
Pressure Storage	20 Gallons per Connection	20 Gallons per Connection
Elevated Storage in Lieu of Pressure Storage	100 Gallon per Connection	100 Gallon per Connection
Emergency Power		Capable of 0.35 Gallons per Connection

* With largest out of service