

City of Rigby, Forsgren & Sons
1995 Water improvements
P.W.D. Doug Nelson March 3, 2004

CHAPTER 2.0 GENERAL SYSTEM DESCRIPTION

2.1 INTRODUCTION

In order to provide proper operation and maintenance for the water system it is helpful to have an understanding of the history and previous conditions of the system as well as information regarding new components. The purpose of this chapter is to provide an overall view of the improvements to the water system, individual components of the new system, and how the changes relate to the older facilities.

The purpose of the recent improvements to the water system was to 1) provide for better water supply; 2) increase water pressures; and 3) increase storage capacity for both seasonal demand and fire flows. A general overall view of improvements made during the recent project improvements is shown on the Record Drawings.

The recent improvements made to the distribution system have removed many flow restrictions. New 12-inch, 10-inch, and 8-inch lines were constructed to eliminate several deadend lines, improve pressure and delivery to the northeast and northwest portions of town, and to provide a more efficient network for the remainder of the system.

An important change made to the water system was the abandonment of the elevated 250,000 gallon storage reservoir new City Hall. Prior to the recent improvements, the elevation of the tank provided for a constant 50-55 psi pressure to the City, and pumps were operated as needed to keep the tank reasonably full. The well located under the elevated tank was operated according to the level of water in the tank while the other two wells near the National Guard Armory and near the Harwood School were manually turned on and off according to seasonal fluctuations in demand.

The City's system is now operated by a pump controller that turns on wells and booster pumps as necessary to maintain system pressure in response to varying water demands. Pressure in the system is maintained by two variable frequency drive booster pumps housed in a new pump station at 550 N 2nd W. The well near the National Guard Armory and the well under the old elevated tank are activated by the controller as conditions require. Additionally, a fire booster pump at the new pump station is automatically called for during brief periods of critical demand.

A new well was drilled as a part of this project. This well was designed to pump only from a deep qualifier (700 ft) to guarantee long-term, high quality groundwater free of possible surface contamination. The new well supplies water only to the reservoir and does not pump directly into the system.

The new storage reservoir was constructed directly east of the new pump station. This partially buried concrete structure has a capacity of 1,000,000 gallons. Water from the tank is pumped into the system by the booster pumps since the storage reservoir itself is not pressurized.

12	"There is a booster pump failure alarm from well #3"
13	"There is chlorine alarm from well #3"
14	"There is well #2 failure alarm"
15	"There is an AC power failure alarm at the Zeetron for well #2"
16	"There is the Zeetron communication failure alarm for well #1"

The presence of an alarm signal also activates an alarm light on the corresponding control panel. The above voice message describing the alarm condition is broadcast over the City's radio frequency and is repeated three times every 30 minutes until the alarm condition has been rectified. The cause of each type of alarm and the corrective actions to be taken by the operator are described in detail in Chapter 5.0.

2.2 DESIGN CRITERIA

Population	3,835	(Year 2015)
Average Daily Flow (gpm)	2,135	
Peak Hourly Flow (gpm)	4,700	
Peak Daily Flow (gpm)	2,775	
Available Fire Flow (gpm)	2,000	
Normal Pressure (psi)	60-70	
Minimum Fire Pressure (psi)	20+	
Storage Capacity (gallons)	1,000,000	

2.3 DISTRIBUTION SYSTEM

The distribution system is comprised of 4, 6, 8, 10, and 12-inch diameter waterlines with associated valves, hydrants, and fittings. The distribution system is generally constructed on a looped layout wherein water at any given point in the system is available from at least two directions. This greatly improves water delivery and reduces problems from freezing and stagnant water.

For the most part, the system is in good condition and major maintenance problems occur only infrequently. However, it is possible that several small leaks exist that have not yet been identified. The City has been engaged in a program to gradually identify and replace older lines as funding permits.

Recent improvements made to the water system were performed after computer analysis of the existing system was performed by Forsgren Associates. The computer data showed that the existing system was unable to provide adequate pressures in a fire flow situation for outlying areas (i.e. High School).

Another computer modeling analysis of the distribution system was performed after adding the improvements. This showed that a residual pressure of at least 20 psi will be available at all points in the system during a fire flow event.

2.4 WELLS AND PUMPS

2.4.1 Previous Numbering System: Prior to the recent improvements, the City of Rigby's wells were labeled as follows:

abandoned → **Well #1:** Located in the basement of City Hall. This well was drilled in approximately 1920. This well had not been used since it was last tested in 1989 and was abandoned as a portion of this improvement project.

Well #2: Located directly west of City Hall under the elevated tank and is approximately 50 years old. This well is 196 feet deep and was served by a 150 horsepower pump that delivered approximately 2200 gpm. In the past, this well was

the transfer switch can also be tested by opening the main circuit breaker to the booster station building.

Under the routine exercise cycle, the transfer switch can be configured to simply run the generator or start the generator and transfer the electrical load to the generator. There are advantages to each method of operation. If the generator is operated without transferring the electrical load there is no interruption of electrical power to the pump controller or the booster pumps. However, exercising the generator with a load allows the generator to come to full operating temperature as recommended by the manufacturer. In this mode, there is a momentary loss of power to the pump controller and booster pumps while the power transfer is taking place. This temporary loss of power can result in a low pressure situation and will likely trigger several alarms. In any case the generating set should be operated under full load at least four times per year to verify that it is in proper working condition. At present the generator is set up to exercise without a load.

Fuel for the generator is supplied by a 1000 gallon tank located directly south of the pump station. The level of fuel in the tank should be checked periodically and should be filled with No. 2 diesel fuel when it is below half full. A low generator fuel alarm will sound if the tank is not filled.

A separate 25 gallon day tank is provided in the generator room and supplies fuel directly to the generator. This day tank is fitted with a small transfer pump that periodically transfers fuel from the 1000 gallon tank to the day tank as needed. This day tank is equipped with an alarm system to detect fuel leakage, low fuel, or a fuel overfill condition. The 1000 gallon tank is also equipped with an automatic leak detection system.

3.4 ALARM MONITORING SYSTEM

In addition to the pump and reservoir controls as mentioned in previous sections, each monitoring device also reports its condition to the pump controller at Well #3 or to the central alarm system. Alarm conditions reported over the City's radio frequency are:

TABLE 3-2 SYSTEM ALARMS	
Alarm #	Alarm Message
1	"This is the well #1 failure alarm"
2	"This is a control failure from well #3"
3	"There is a low pressure alarm from well #3"
4	"There is a high pressure alarm from well #3"
5	"There is a power failure at the generator"
6	"There is a high tank level alarm from well #3"
7	"There is a low tank level alarm from well #3"
8	"There is a generator failure alarm from well #3"
9	"There is a generator low diesel fuel alarm for well #3"
10	"There is a diesel fuel leak from well #3"
11	"There is well #3 failure alarm"

the City's main well that ran throughout the year according to the water level in the elevated tank. This well was upgraded during this project.

abandoned →

Well #3: Located near the Harwood Elementary School and was served by a 60 horsepower pump. This well was last measured at 1,243 gpm. This well was 165 feet deep and had experienced continuous problems with pumping sand. As a portion of this improvement project, this well was also abandoned.

Well #4: This well is located near the National Guard Armory and was drilled in 1990 to a depth of 487 feet. This well supplies water to the system by means of a 100 horsepower pump. This pump works on a variable frequency drive and acted as a backup to Well #2. This well has often been operated manually due to problems occurring with the variable frequency drive.

2.4.2 New Well Numbering: The new arrangement of wells that will be used throughout this manual is as follows:

Well #1:	Old Well #2 located under the elevated tank
Well #2:	Old Well #4 located near the National Guard Armory
Well #3:	New well drilled in 1996 at 550 North 2nd West

The pump controller at the new pump station and the alarm system both refer to the City's wells by the numbers listed above.

2.4.3 Well #1: This well is located in an existing block building on Fremont Avenue. The pump level is set at 110 feet. The pump has a 150 horsepower motor and is capable of pumping 2100 gallons per minute at a head of 216 feet. The pump is a Verti-line model 14RM and has been equipped with three stages. Well #1 pumps directly into the City main on Fremont Avenue. This pump is normally controlled by the pump controller at Well #3.

2.4.4 Well #2: This well has a 100 horsepower motor and is located in the existing building west of the Rigby National Guard Armory. Well #2 is capable of pumping approximately 1150 gallons per minute under normal operation. This pump discharges directly into the City mains located on 2nd South.

This pump can be operated in one of three modes; hand mode where the speed of the motor is controlled by the operator, local automatic control where the VFD drive responds to changing pressures at the well and adjusts the speed accordingly to maintain a preset pressure, and remote automatic mode where the pump controller at Well #3 controls the functioning of the well. In the remote automatic mode the pressure set point should be set high enough that the well runs at full speed to deliver maximum flow. The local automatic mode has been provided for a backup in case of a system controller failure.

2.4.5 Well #3: This well is located in the new pump station at 550 North 2nd West. This well is approximately 720 feet deep. The pump level is set at 220 feet. The well column is housed in a 16-inch casing. The pump is a 125 horsepower pump capable of pumping 2050 gallons per minute at a head of 180 feet. The pump is a Verti-line model 12FHM equipped with five stages. This well pumps directly into the new 1,000,000 gallon storage reservoir

3.2.3 Reservoir Levels: Control of the water level in the storage reservoir is accomplished by a Miltronics Hydroranger acoustic level sensing device. This Hydroranger monitors the water level in the tank and turns Well #3 on when the level falls below 12.0 feet and turns it off when the level reaches 14.3 feet. If the level of the tank exceeds 14.5 feet, a high tank alarm is sent over the radio system. Additionally, if the water level falls below 5 feet a low level alarm is sent over the radio system, and if it falls below 1 foot the well controller automatically cuts out the three booster pumps as previously discussed.

This operation of the system helps to provide water to the storage reservoir and keep it as full as possible for maximum storage in case of emergency, yet still not allowing for excessive pump operation. It is important to remember that Well #3 is not directly controlled by the D620i pump controller.

3.2.4 Manual Operation of Pumps: Each well and pump in the system can be operated automatically as designed or can be operated in "hand" mode. The two VFD booster pumps at the new pump station can be operated manually with manual speed control or can be operated to bypass the speed control equipment and immediately run at full speed in the "bypass" mode.

Well #1 at City Hall can be operated in automatic mode or can be operated by hand. This well does not have a variable frequency drive and will always operate at 1780 rpm. Well #2 can be operated in one of three modes; hand mode with manual speed control, remote automatic control, and local automatic control. The normal setting will be the remote automatic control wherein the pump is controlled by the pump controller at Well #3 and runs only when called for. In this mode the motor always runs at full speed. This is done by setting the pump's setpoint to 80 psi. In local automatic mode the pump runs continuously and changes speed in response to locally sensed pressures. This method of operation would typically be used as a backup in case of a controller failure at the new pump station. When operating as backup, the pressure set point for this pump should be set at 70 psi.

3.3 STANDBY GENERATOR SYSTEM

The new pump station has been equipped with a 400 kW Onan standby generator system. This generator is capable of supplying electrical power to all four pumps located in the new pump station. An automatic transfer switch located in the pump station detects a loss of electrical power and brings the generator on-line within a few seconds. When electrical power is restored and remains constant for one minute, the transfer switch retransfers the load back to normal utility power.

The automatic transfer switch is equipped with an exercise clock that runs the generator for half an hour every Monday at noon. Regular exercising keeps engine parts lubricated, prevents oxidation of electrical contacts, and helps provide reliable engine starting. The generator can be tested with a load by manually turning the keyed switch on the transfer switch panel to the "test" position. Power can be transferred back to the electrical service by turning this switch to "retransfer" and then returning it to the "normal" position. Proper functioning of the generator and

and pumps at a constant rate. This pump is controlled by the liquid level of the storage reservoir.

2.5 STORAGE FACILITIES

A new 1.0 million gallon partially buried concrete storage reservoir was constructed as part of this project to provide better water supply for fire protection and peak summer demands. The reservoir is 105 feet in diameter and 16 feet high with an 8-inch thick floor slab, a 12-inch thick wall, and an 8-inch thick roof slab supported on sixteen 18-inch diameter columns. The circular walls of the tank have steel reinforcement on both faces and have been provided with a continuous PVC waterstop at the top and bottom of the wall to prevent leakage and/or contamination. The tank has been mostly buried to protect it from deterioration and to provide some insulation during periods of cold weather.

Access to the new tank is through a hatch opening on the roof located at the north end of the storage reservoir. A ladder extends from the roof to the floor of the reservoir. Venting of the reservoir is accomplished through two galvanized pipe roof vents with insect screens to prevent entrance of contaminants. This vents are located on the east and west sides of the tank. A 12-inch line supplies water to the east end of the reservoir from the booster station. Water leaves the tank at the west end through a 16-inch line that supplies the booster pumps inside the booster station. An overflow for the reservoir is provided to allow gravity drainage to an overflow structure located north of the reservoir.

An acoustic water level sensing device is mounted near the main hatch entrance and provides information to the Miltronics Hydromanager controller that operates Well #3.

2.6 BOOSTER PUMPING FACILITY

A new booster pumping facility was also constructed as a part of the recent upgrades. It is housed in a new cinder block building which is situated directly west of the storage reservoir. The facility consists of three "can" type pumps and one deep well located within the building.

The booster pumps are two 60 horsepower VFD drives and one constant speed 100 horsepower motor. The 60 horsepower drives are operated by a pump controller and vary their speed according to the pressure demands of the system. The remaining fixed speed 100 horsepower fire booster is controlled by the pump controller in response to extreme flow demands.

The two 60 horsepower VFD drives are Verti-line model 12RL pumps with four stages and are each capable of producing 1050 gpm at a head of 180 feet. The operation curves are presented in the manufacturers' information. The 100 horsepower fire booster is a Verti-line pump model 14RL with three stages. This pump is capable of producing 1700 gpm at a head of 180 feet.

Controls for operation of the booster pumping facilities are located inside the pump building and receive information from several monitoring points. This controller will be discussed in Chapter 5.0 of this manual. Additionally, a standby power generator has been installed in the booster pumping facility. The generator can power the deep well and the three boosters simultaneously.

controller will automatically detect the failure of a VFD booster pump to start when called for, and if necessary will replace the failed booster with Well #2. Once repairs to the pump are complete the system controller will need to be reset by the operator to notify it that the pump is ready to operate again. This is done by scrolling through the displays on the D620i controller by pressing the up or down arrow until the booster reset screen is found. Then move the cursor over the failed pump with the right or left arrow, as required. When the failed pump is highlighted press [enter]. The pump will now be put back into service.

Another backup procedure built into the pump controller concerns the functioning of Stage 5. Stages 0-4 operate in sequential order. If the system is operating in Stage 1 and flow demands suddenly increase, the controller will normally step through Stage 2 and then Stage 3, etc. until the demands are satisfied. As each stage can take up to one minute to activate, this may result in inadequate fire flows for several seconds and a low pressure condition. To remedy this situation, Stage 5 will become active anytime the system pressure falls below 50 psi for more than 45 seconds. When this happens the fire booster will supplement flows until the other wells in the system become active.

The system operator should be aware that if Well #1 or Well #2 is inoperable and if summer daytime water use is high the system pressure may decrease enough to call the fire booster at the new pump station on-line. When this occurs the well at the booster station will be unable to keep up with the three booster pumps; thus causing the water level in the reservoir to fall. A low level tank alarm will be sent over the radio system when the water level falls to 5 feet. If the level continues to fall to 1 foot, the pump controller will automatically shut off all three booster pumps to prevent them from pumping dry and damaging the pumps. The pumps will remain off until the water level rises above 2 feet. **CAUTION: If the booster pumps shutoff due to a low tank level, it is likely that the City will be left with no water at all for several minutes.**

The flow rates shown in Table 3-1 have been programmed in the controller and represent the rates at which switching of the pumps should occur to keep pressure changes to a minimum and maximize the efficiency of the booster pumps. However, these flow rates are user definable values and can be quickly changed at anytime using the programmable controller input routines.

Electrical controls for the individual pumps and wells include meters to record the hours of operation, a hand-off-auto switch which allows for manual or automatic operation of the pump, and pump running and pump failure lights to monitor the operating conditions. The pump control circuits are also protected by a device sensing phase loss, phase reversal, low voltage, high voltage, and high amperage as well as having lightning arresters for surge protection.

Incorporated in the main control panel are digital readouts for the total system flow rate, flow rate from each flow meter, total system flows, totalizing flows for each flow meter, system pressure, pressure set point, and any active alarm conditions. Alarm conditions are monitored for each pump in the system and broadcast over the City radio frequency in case of operational failures.

Automatic ventilation louvers have been installed in the walls of the building to provide proper cooling in the summertime and adequate ventilation when the standby power generator is activated.

2.7 FLOW METERING STATION

Two new flow metering stations have been installed. This first is located in the new pump station building on the discharge line from the three booster pumps. This meter is a 12-inch Neptune high performance turbo meter. The meter vault is located directly inside the main doors. Access to the vault is through a standard 24-inch floor hatch. A totalizer for this meter is installed on the door of the pressure transducer unit located on the east wall of the building near the wall exhauster. Instantaneous flow from this meter can be read directly from the pump controller.

An 8-inch Sensus meter was also installed on the discharge line from Well #1. The electronic readout for this meter is located on the west wall of the building at Well #1 and the digital flow signal is transmitted via the radio system to Well #3 where it is used by the pump controller to determine total system flow.

The flow signal from an existing flow meter at Well #2 is also transmitted via the radio system to the pump controller at Well #3. A new digital readout was also installed at this well.

2.8 CHLORINATION FACILITIES

No chlorination facilities existed prior to this improvement project. Presently no chlorination takes place at the new pump station. However, a room has been constructed to house chlorination equipment and a chlorination line has been stubbed out from the Well #3 discharge line to the chlorine room. If in the future it becomes necessary to chlorinate, the necessary equipment can be easily installed at Well #3. No provisions have been made for chlorinating Well #1 or Well #2.

In the unlikely event that more than 5500 gpm is needed, flows will increase until the two VFD booster pumps are operating at maximum speed. If the demand for water continues to increase, the system pressure will gradually fall as the pumps are no longer able to maintain the preset value. When the pressure at the new pump station falls below 50 psi, the pump controller will activate the 100 horsepower fire booster. With all three booster pumps, Well #1, and Well #2 in operation the maximum system capacity at 70 psi is over 7000 gpm. This is approximately 2500 gpm more than the anticipated peak hourly demand at the design year of 2015.

With the fire booster in operation, Well #3 at the new pump station will not be able to keep up with the three booster pumps and the level in the tank will gradually drop. With all three boosters operating at full design capacity there will be a minimum reserve of 5-6 hours in the new storage reservoir.

When demands begin to fall, the pump controller will detect the decreasing flow rates and will turn off pumps accordingly so that the two VFD pumps in the new pumps station can maintain the preset pressure set point. For clarification, Table 3-1 illustrates which pumps are in operation at various flow rates.

TABLE 3-1 BOOSTER PUMP OPERATION MATRIX						
Total Flow (gpm)	1st 60 Hp VFD Booster	2nd 60 Hp VFD Booster	Well #1	Well #2	Fire Booster	Corresponding Stage
0-900	on	off	off	off	off	0
900-1100	on	on or off	off	off	off	transition
1100-1850	on	on	off	off	off	1
1850-2200	on	on	off	on or off	off	transition
2200-2800	on	on	off	on	off	2
2800-3300	on	on	on or off	on or off	off	transition
3300-4000	on	on	on	off	off	3
4000-4300	on	on	on	on or off	off	transition
4300-5500	on	on	on	on	off	4
5500+	on	on	on	on	on	5

There are two backup devices built into the pump controller that need to be understood by the system operator. Both backup modes address the problem of maintaining system pressure and fire flow protection when one or more pumps are off-line for service or repair. A potential problem arises when one or more of the pumps that normally operate in the lower stages is not functioning.

To illustrate this point, consider the following scenario. If one of the 60 horsepower boosters is down for repairs it would be impossible for the remaining VFD drive to develop the total flow of 2200 gpm required to call Well #2 on. To remedy this problem, the pump

3.0 THEORY OF OPERATION

Source: City of Rigby Public
Works Dept.
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CHAPTER 3.0 THEORY OF OPERATION

3.1 GENERAL

The basic operational theory behind Rigby's new water supply system is to supply water to the distribution system through the operation of Well #1, Well #2, and the new booster pump station. Through the use of electric power these pumps provide pressure to the system as if an elevated storage facility were in use but on a more economical basis over the life of the facility.

The improvements to the supply system allow for delivery of greater pressure through the distribution system and provide adequate storage to meet peak summer demands and fire flow requirements.

3.2 CONTROLS

3.2.1 Well Pumps: Under normal operation, the D620i pump controller located at the new pump station controls all the various wells and pumps in the City's water supply system. Information produced at several locations is collected by the pump controller to determine which pumps should be operating at any given time.

In general, the cumulative flow from the flow meters is used to determine which pumps should be operating. Pressure control is maintained by adjusting the speed of the two 60 horsepower VFD booster pumps.

3.2.2 Booster Pumping Facilities: At low flows only one booster pump is required. The speed of this pump adjusts automatically to compensate for changes in system demand. One booster pump is capable of maintaining 70 psi at flows up to approximately 1150 gpm. When the pump controller detects that flows have exceeded 1100 gpm it brings an additional booster pump on-line. The speed of both pumps is then adjusted by the pump controller to maintain the system at the preset pressure set point. With both booster pumps operating the system is able to maintain 70 psi up to approximately 2300 gpm. When flows exceed 2200 gpm, the system calls for the 100 horsepower booster pump at Well #2 to come on-line. As this well speeds up and starts to produce water, the two VFD booster pumps at the new booster station automatically decrease their speed to maintain the pressure set point.

When flows increase to 3300 gpm the controller sends a signal to Well #1 to turn on and to Well #2 to turn off. The larger pumping capacity of Well #1 together with the two VFD booster pumps have a combined capacity of approximately 4300 gpm. If flow demands exceed this value then the system will call for Well #2 to reactivate. With Well #1, Well #2, and both booster pumps the system has a total capacity of approximately 5400 gpm. Again, the booster pumps adjust their speed automatically to maintain the pressure set point.