Raineri Mutual Water Company Slow Sand Filter Water Treatment Plant

Operations Plan

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Raineri Mutual Water Company

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1.0 Description

Water supply to the plant is from Moody Creek via 3,800 feet of 2-inch pipe. The water quality from Moody Creek is good, but filtration followed by chlorination is necessary to remove turbidity and bacteriological contaminants.

The original slow sand filter plant with four filters was constructed in 2013. Two additional filters were added in 2018/2019 along with two Harmsco WaterBetter Cartridge "Roughing" filters on the raw water supply line to take some of the turbidity load off the slow sand filters.

Flow and Control Diagrams for the plant are shown in Figures 1 and 2. Design Criteria summarized in Table 1. A general description of the slow sand filter process is included in Appendix A.

Table 1
Design Criteria

Parameter	Value
Maximum Design Flow, gpm	30
Number of Cartridge Filters	2
Size of Cartridges, inches	7x30
Membrane Size, microns	1-25
Design Flow per Cartridge, gpm	100
Number of slow sand filters	6
Nominal Diameter and height of each filter, feet	8 x 7.5
Loading rate of each filter, gpm/sq ft	0.1
Sand depth each filter, inches @ size, mm	36 @ 0.3
Gravel support bed depth, inches	12
Balance tank, diameter x height, feet	6 x 4
Balance tank, net volume, gallons	150
Transfer pump, gpm x TDH	30 @ 40'
Gardia removal in slow sand filters, log	2.0
Cryptosporidium removal in slow sand filters, log	2.0 (a)
Giardia log removal in disinfection	1
CT required at 5C, pH 8.5, chlorine residual @ 1.5	92
CT in 20,000 gallon tank, 62% full, 30 gpm, T/T10 of 0.1, chlorine residual of 2.2	92
Total water storage in system, gallons, excluding 20,000 gallons tank	80,000

(a) Crypto removal achieved by slow sand filter effluent of less than 1.0 NTU.

Flow enters the plant through a flow meter and normally closed solenoid control valve, then to two Harmsco roughing filters that can be operated either in series or parallel, then to six slow sand filters operating in parallel. High level in the chlorine contact tank will close the solenoid valve as will a power failure and high turbidity.

Each pair of filters had a control tank with an internal float valve to maintain a minimum level in the filters, and a flow control valve on the outlet which is used to adjust the flow through that pair of filters. A flow restricting valve on the inlet line to each filter limits the maximum flow to 5 gpm.

Filtered water from the three control tanks will flow by gravity to a small balance tank, from which it will be pumped up to the chlorine contact tank. Chlorine is injected into the discharge line from the pump whenever the pump is running.

The following conditions stop the transfer and close the raw water solenoid valve:

- Low chlorine residual going to the chlorine contact tank;
- High turbidity in either the raw water or the filtered water;
- Power failure.

A float valve on the line to the balance tank keeps the tank from overflowing. High raw water turbidity will also close the solenoid valve on the plant supply line.

The outlet line on the chlorine contact tank maintains a minimum level in the tank. If the plant flow rate, as set by the flow control valves on the control tank outlets is set higher than the daily demand, the float in the chlorine contact tank will close the solenoid valve on the inlet, which will gradually reduce then stop the flow through the slow sand filters. It would be preferable to keep the plant running continuously by adjusting the flow seasonably and perhaps on a weekly or even daily basis so that equalization storage occurred in the distribution tank (s) rather than the upper level of the chlorine contact tank, where volume is limited.

An exception to this would be if significant precipitation was anticipated in the Moody Creek watershed, which could cause the raw water turbidity to spike. Closing the solenoid valve would probably be preferable to having the plant automatically shut off due to high raw water turbidity.

2.0 Startup

The following assumes the plant has been shut down for a relatively short period. Some of the following steps may have already been done during normal operations.

1. Check to see that the chlorine tank is full.

2. Start flow through the raw water line by opening the angle valve on the plant inlet and checking the turbidity to make sure it is not excessive.

3. Close the angle valve and open the solenoid valve by putting the HOA switch on is valve control panel in the hand position.

4. Check the positioning of the valves of the roughing filters. Depending of raw water turbidities and actual operating experience, parallel operation during periods of low raw water turbidities will probably result in longer filter runs, whereas during periods of elevated raw water turbidities it make be necessary to operate the filters in series to reduce the turbidity load to the slow sand filters.

5. Adjust the flow control valves on each filter inlet line so that the maximum flow does not exceed 5 gpm.

6. After flow starts through the three control tanks, adjust the flow control valves on the tank outlets to the desired plant flow rate, but not more than 30 gpm total.

7. Put the HOA switches on the pump control panel in the hand position. Note: The level switch will still control the pump.

8. When the transfer pump starts, make sure the chlorine feed pumps starts and the chlorine dose is adequate for the flow, temperature and pH conditions.

9. As soon as all readings are normal and the flow has stabilized, put all HOA switches in the auto position.

10. If a filter has been drained or cleaned, it may be necessary to connect a hose to the drain/sample valve on the filter's outlet and run the filter to waste until the turbidity drops below 1 NTU. If it doesn't within an hour or so, throw ¼ cup of granular alum into the top of the filter.

3.0 Shutdown

The following assumes the plant will only be shut down for a short period.

1. Put all switches in the valve control panel and pump control panel in the off position.

2. If an individual filter has to be taken off-line for repair or cleaning, close the manual shut off valves on that filters inlet and outlet lines, and drain it as necessary through the drain/sample valve on the outlet, or through the harrowing valve if the filter is being cleaned.

4.0 Filter Cleaning

1. The Harmsco cartridges will have to be cleaned as the flow is restricted through them due to clogging of the cartridges. During periods of high raw water turbidity, this may be as often as two or three times a week. Follow the procedures recommended in the Harmsco instructions.

2. All of the slow sand filters will have to be periodically cleaned by harrowing as the head loss builds up across the media. Follow the procedures recommended by Blue Future Filters in Appendix A.

5.0 Bi-Weekly Plant Checks

Fill out the plant daily operating log as the following steps are completed.

1. Check levels in both tanks, and adjust plant flow rate if necessary.

2. Check residual chlorine level going to chlorine contact tank.

3. Manually measure chlorine contact tank outlet and complete CT.

Table 2 shows the preliminary format for the log.

Table 2
Daily Operating Log

Date	
Time	
Operator	
Tank Levels, feet	
Cl2 Contact	
Distribution	
Meter Reading	
Raw, gpm	
Daily Total, gallons	
Treated, gpm	
Daily Total, gallons	
Disinfection	
Chlorine Concentration, mg/L	
Tank Inlet	
Tank Outlet	
pH	
Temp °F	
Turbidity, NTU	
Raw	
Combined Filtered	
Filter 1	
Filter 2	
Filter 3	
Filter 4	
Filter 5	
Filter 6	
Headloss, inches	
Filter 1	
Filter 2	
Filter 3	
Filter 4	
Filter 5	
Filter 6	

Table 3 is a spread sheet which will automatically compute CT.

Table 3
CT Compliance for Giardia Lamblia Cysts by Free Chlorine

Input Parameters:		
Water System Name:	**Raineri MWC**	
Number of Service Connections:		
System Number:	**3100040**	
Month and Year:		
Clearwell(s) - Volume per Foot:		Gallons/Ft
Short-Circuiting Factor for Clearwell(s):	**0.10**	t_{10}/T
Required Log Inactivation of Giardia Cyst:	**1.0**	Log

	Clearwell Data for Peak Hourly Flow[1]							CT Results				
Date	Flow Rate, gpm	Lowest Level, ft	Effective Volume, gal	Effective Contact Time, minutes	Temperature, °C	pH	Chlorine Residual, mg/L	Required CT	Calculated CT_{10}	CT Ratio (CT_{calc}/CT_{req})	Inactivation Ratio ($CT_{calc}/CT_{99.9}$)	Calculated Log Inactivation
1			-	-				-	-	-	-	-
2			-	-				-	-	-	-	-
3			-	-				-	-	-	-	-
4			-	-				-	-	-	-	-
5			-	-				-	-	-	-	-
6			-	-				-	-	-	-	-
7			-	-				-	-	-	-	-
8			-	-				-	-	-	-	-
9			-	-				-	-	-	-	-
10			-	-				-	-	-	-	-
11			-	-				-	-	-	-	-
12			-	-				-	-	-	-	-
13			-	-				-	-	-	-	-
14			-	-				-	-	-	-	-
15			-	-				-	-	-	-	-
16			-	-				-	-	-	-	-
17			-	-				-	-	-	-	-
18			-	-				-	-	-	-	-
19			-	-				-	-	-	-	-
20			-	-				-	-	-	-	-
21			-	-				-	-	-	-	-
22			-	-				-	-	-	-	-
23			-	-				-	-	-	-	-
24			-	-				-	-	-	-	-
25			-	-				-	-	-	-	-
26			-	-				-	-	-	-	-
27			-	-				-	-	-	-	-
28			-	-				-	-	-	-	-
29			-	-				-	-	-	-	-
30			-	-				-	-	-	-	-
31			-	-				-	-	-	-	-
									Average:	-	-	-

4. Check turbidity level in raw water and filtered water. If filtered water turbidity is creeping up, manually check effluent turbidity of each filter.

5. Check headloss of each filter. Schedule cleaning of filters as necessary.

6. Check raw and filtered flow meter readings, and calculate daily production.

6.0 Weekly Plant Checks

1. Check and order plant supplies such as reagents for analytical equipment and sodium hypochlorite.
2. Perform general housekeeping.
3. Check chlorine residual in distribution system.
4. Confirm accuracy of the turbidimeters.

7.0 Monthly Plant Checks

1. Check all equipment for proper operation, leaks, noise, etc.
2. Collect sample for BacT from distribution system in accordance with the Site Sampling Plan in Appendix B.
3. Check all distribution system tanks.
4. Read residential meters.
5. Submit Monthly Report to the Division of Drinking Water in a format that is acceptable to them.

8.0 Quarterly Plant Checks

1. Calibrate turbidimeters.
2. Make sure all analytical tests required by the Health Department are scheduled.

9.0 Yearly Plant Checks

1. Inspect media in all six filters. Add media if necessary.
2. Make sure all analytical tests have been completed.
3. Exercise all valves in the distribution system.
4. Prepare and mail out the Consumer Confidence Report (CCR).

10.0 Supplies

1. Sodium hypochlorite is purchased from _____. Make sure there is a two week supply on hand.
2. Reagents for the chlorine residual analyzer shall be purchased from the manufacturer.

3. Replacement cartridges for the Harmsco filters can be purchased from Filtration Technology in Boise Idaho, (208) 336-6611.

11.0 Emergency Disinfection

A chlorine residual must be maintained throughout the distribution system. If the chlorine residual is below 0.5 mg/L, check the hypochlorite pump for proper operation, and increase the pumping rate as necessary. If there is no measurable chlorine in the distribution system, add chlorine to all distribution storage tanks manually.

If contamination in the distribution is suspected but not confirmed, a boil water alert should be issued. If contamination is confirmed, the Health Department should be notified and a boil water notice issued until Bac T samples are negative. Note: If contamination is suspected, flush the distribution system until there are chlorine residuals throughout the system.

12.0 Emergency Notification

In the event of an emergency, the following people or agencies should be notified.

1. Manager of the Raineri MWC.
2. President of the Raineri MWC.
3. State Water Resources Control Board, Division of Drinking Water.
4. County Health Department.

See the Water Quality Emergency Notification Plan in Appendix C for additional information.

13.0 Operating Staff

The system is operated under contract by Gary MacKenzie (831) 682-1848

Water quality analyses are provided by Soil Control Labs, Watsonville, CA (831) 724-5422..

Engineering services are provided by Fred Fahlen, Hydros-Engineering, (530) 559-7999.

14.0 Complaint Procedures

When a complaint is received, the following steps should be followed:

1. Make a written record of the time and nature of the complaint.
2. Call the person complaining to get complete information on the complaint. Be courteous.
3. If necessary, visit the site, collect samples, call for additional assistance if necessary.
4. Investigate any water quality complaints.

5. Flushing the distribution system in the vicinity of the complaint may be necessary.

6. Check the operation of the treatment facilities.

7. If it is a leak, try to isolate or repair it without depressurizing the entire distribution system, and make arrangements to repair the leak.

8. If someone if sick and they believe it is due to the water, immediately check with other residents in the park or marina, and call the County and/or State Health Departments for instructions.

9. Make a written report summarizing the complaint and how it was resolved.

15.0 Contaminate Monitoring

Table 4 below reflects the current California Code of Regulations, Title 22, Chapter 15. Samples for the various contaminants should be collected and delivered to Soil Control Labs, or arrangements made for them to collect the samples. It should be noted that some of these tests are very expensive, and the need for them should be confirmed with the Division of Drinking Water. It should also be noted that the Domestic Water Supply Permit for Raineri may require additional analyses not listed in Table 4.

Table 4
Monitoring: Current California Code of Regulations, Title 22, Chapter 15

Contaminate	Monitoring Frequency
Coliform Bacteria [b]	Once every month
Organic Chemicals	Once every three years [a]
Inorganic Chemicals	Once every year [a]
Nitrate	Once every year
Nitrite	Once every three years
Perchlorate	Twice per year [a]
Radionuclides	Once every four to nine years
Secondary Standards	Once every three years [a]
Lead and Copper	Once every three years (June – September)
Disinfection By-products	One sample per year at the warmest temperature at a site representing the longest residence time. Obtain field test for alkalinity, pH and chlorine at the same time. [a]
Consumer Confidence Report	Once every year by July 1 for the previous calendar year data

(a) Frequency may be reduced.
(b) See the Sampling Site Plan Appendix A for additional details.

N

1" = 6' ±

From Moody Creek

Sample line to turbidimeter

Control Room

Existing Clearwell 20,000 Gallons Tank 1.

Sample line To Cl2 Res. Analyzer

2" PVC

To upper services

2" Inlet to top of tank

Cl2 inj

Sample line to Turbidimeter

Height controls min. level in tank

2"

Tank 1

2"

12' ±

1" Solenoid Control Valve

2" PVC & 2" Conduit w/ 3 #8 wires

2"

To upper services

Existing Distribution storage tank 40,000 gal Tank 2

Harmsco cartridge filters

1" Inlet w/ control valve & meter (Typ)

8' ϕ SSF (Typ) #4

30" ϕ Control Tank (Typ) #3

#2

Harrowing Valves (Typ)

#1

2½" PVC

#6 Control Tank

8' ϕ SSF #5

2½" PVC

1" Vertical air vent

1" Outlet w/ control valve, meter & anti syphon (Typ)

2"

2"

Transfer Pump 30gpm @ 40'

1½"

Note: Physical arrangment on site may differ slightly.

Raineri MWC Piping Plan Feb 2019 Figure 1

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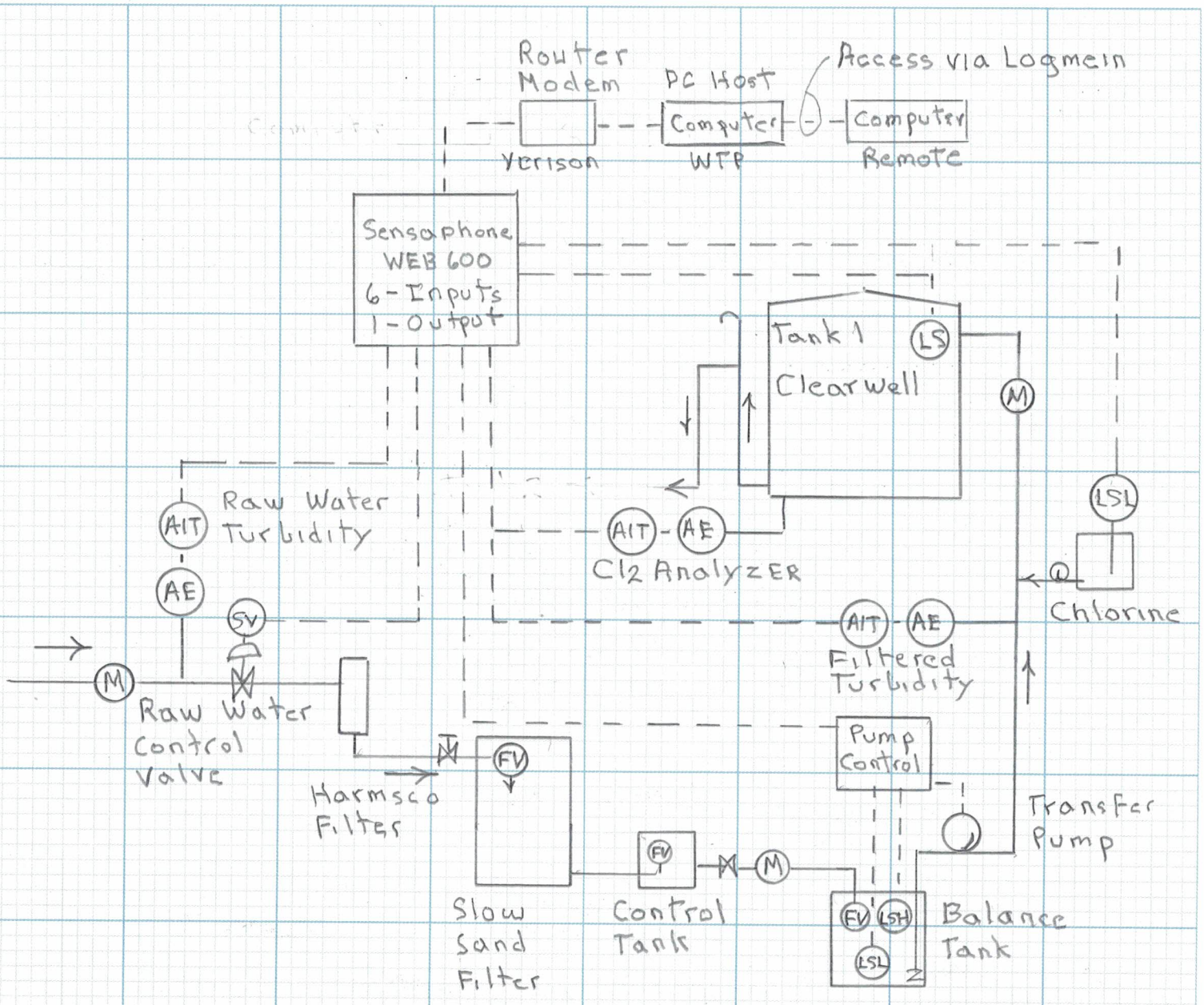
PROJECT	Rainer, MWC	JOB NO.	BY FJF	DATE 5/30/2018
SUBJECT	Filter Addition		CHECKED	PG OF



AE Sensor
AIT Indicator/Transmitter
LSL Level Switch Low
LSH Level Switch High
FV Float Valve
M Flow Meter
SV Solenoid Valve
LS Level Switch
Control Valve

Figure 2 Control Diagram Existing

Appendix A Blue Future Filters Guide

Appendix B Site Sampling Plan

Appendix C Water Quality Emergency Notification Plan