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Packaged Surface Water Treatment Plant for Campgrounds And Other Very Small Water Systems

Packaged Surface Water Treatment Plant for Campgrounds And Other Very Small Water Systems

Brenda Land
Sanitary Engineer

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San Dimas Technology &
Development Center
San Dimas, CA

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INTRODUCTION

This report presents a brief history of the partnerships involved in the development of a packaged water treatment plant. Now marketed as the MIOX P3 Packaged Water Treatment Plant (P3 WTP) (figure 1), this system satisfies the current Environmental Protection Agency (EPA) regulations for a surface water treatment plant. The major components and requirements for installing a P3 WTP are discussed.

Figure 1—MIOX P3 Surface Water Treatment Plant.

The Safe Drinking Water Act (SDWA), passed by Congress in 1974, authorizes the EPA to develop regulations to ensure drinking water safety. It is the principal law governing public drinking water safety in the United States. To ensure drinking water meets safety standards, the EPA also issued the Surface Water Treatment Rule (SWTR) in 1989. The SWTR requires that the following system types provide disinfection, turbidity monitoring, and disinfection residual monitoring.

- Systems using a surface water source, such as a lake, stream, or river.

- A ground water source under the direct influence of surface water, such as shallow well, spring, or infiltration gallery.

It also requires most systems to provide filtration. The EPA delegates the authority to enforce the drinking water regulations to the States. United States Department of Agriculture (USDA) Forest Service water systems must comply with all Federal and State regulations for public water systems. Failure to comply with these regulations can result in civil or criminal liability.

The SWTR has a major impact on USDA Forest Service sites that use a surface water source or ground water source under the direct influence of surface water. The monitoring requirements are difficult to achieve at sites without a full-time staff. For instance, remote recreational areas without grid electricity have limited choices of equipment for treatment and monitoring. Due to the expense and difficulty of meeting the requirements of the SWTR, some of these campgrounds must be closed and their water systems shut off. Several USDA Forest Service water systems are under State consent order to bring their water system into SWTR compliance.

HISTORY

San Dimas Technology and Development Center (SDTDC) was tasked to find a solution to keep these campground water systems open and in compliance with regulations. Without success, SDTDC researched options for pre-engineered packaged water treatment systems. The SDTDC researched systems that would work under campground water use patterns; solar power; and meet the monitoring, recording, and control requirements of the SWTR. Then SDTDC began researching alternatives to have private industry develop a custom system.

SDTDC developed design criteria and specifications for a packaged treatment plant that would meet EPA's SWTR requirements and operate at remote campgrounds. The packaged treatment plant must:

- Treat 1,000 gallons per day.
- Work on solar or grid electrical power.
- Transport from site to site easily.
- Operate with ease.
- Operate up to 1 month unattended.
- Meet the filtration and disinfection requirements of the SWTR.
- Monitor and record turbidity and chlorine residual.
- Shut the water off if it was not treated to standards.

A request for quotations (RFQ) was issued for the design, fabrication, and installation of a test package water treatment plant. Los Alamos Technical Associates, Inc. (LATA) responded and in September 1994, a cooperative agreement was established. LATA agreed to design, build, and install the test unit, and SDTDC would perform tests in order to get the unit accepted by the California State Department of Health Services (DHS).

When the water treatment branch of LATA split, the MIOX Corporation was formed. As the MIOX Corporation continued to work on the packaged treatment plant, SDTDC aided during the design phase.

The Alpha

In 1995, the first prototype unit, the Alpha (figure 2), was installed for testing and evaluation at Lime-Kiln Creek State Campground, CA. California DHS, Drinking Water Division helped SDTDC develop an Alternative Technology Demonstration Test Protocol for the package plant. This test protocol is required for any new surface water treatment system. In accordance with the test protocol, SDTDC conducted particle counter testing of the filters. The UF Strainrite bag filters (model SP 5/1 S30S HA 10 um pre-filter and model GBP 1-30 SB SS 1 um post-filter) supplied with the Alpha unit, did not meet the requirements of the SWTR for alternative filtration.

Figure 2—The Alpha.

In 1996, SDTDC searched for a filter that would meet the requirements for alternative filtration. After several attempts, particle count studies on filters in the field environment had failed. Researchers found that mountain stream water is normally too clean to conduct the studies without artificially increasing (spiking) the turbidity. This method is difficult to conduct on very small water treatment systems.

SDTDC worked with California DHS in writing a testing protocol, allowing particle counter testing of filters to be conducted at the facility in San Dimas (figure 3). The test facility was designed to simulate natural stream conditions. To find a suitable filter, several different filter brands were tested under this protocol. Testing of the 3M-cartridge filter in an RP housing was completed in 1997, and approved as an alternative filtration technology by the California DHS in 1998.

Figure 3—Particle counters and turbidimeters used for filter testing.

In addition to the filter, some other problems were identified during the initial testing at Lime-Kiln State Campground. Not only was it difficult to retrieve data from the data logger but the chlorine generator was subject to scale buildup. Researchers also discovered that a resin-based water softener was not adequate to prevent the scale build-up. As a result, SDTDC and the MIOX Corporation worked together to redesign the unit.

The Beta

In 1996, after researchers gathered the results from the Alpha testing, a redesigned unit called the Beta (figure 4) was constructed.

Figure 4—The Beta installed at SDTDC for Life Cycle/Cost Evaluation.

In 1997, SDTDC and EPA, Small Drinking Water Division agreed to test the mixed oxidant generated by the MIOX electrolytic cell. The EPA tested the Beta unit and determined that for regulatory purposes, the electrolytic cell was an on-site chlorine generator, with no chlorine dioxide or other measurable disinfectants produced.

After testing the first Beta unit met the requirements of the SWTR for remote, unattended campgrounds. As a result, 12 Beta units, identified as MIOX P3 Beta Packaged Water Treatment Plants (P3 Beta), were purchased and installed in USDA Forest Service campgrounds throughout the country for additional testing under field conditions. This included two under consent order. Installation of these P3 Beta units began in 1998.

As the P3 Beta units were being installed, the first Beta was returned to SDTDC for life cycle/cost evaluation (figure 5). The unit, installed at SDTDC in May 1998, was configured in order to put the most wear and tear on it in the shortest amount of time. It was setup to cycle about once per hour with the flow rate restricted to 4 gallons per minute. The chlorine dose was set very high at 4.0 parts per million. This configuration put the equivalent of 24 days of normal operational wear and tear on all moving parts per day (based on a design system treating 1,000-gallons per day, at 16-gallons per minute flow rate, operating 1 hour per day).

During life cycle testing, water was pumped from a 50,000-gallon reservoir tank, through the P3 Beta, into a 150-gallon chlorine contact tank (figure 6). A level switch installed in the 150-gallon contact tank controlled the cycle. A chlorine monitor sample line was gravity fed from the contact tank to the chlorine monitor. A 1-horsepower pump and pressure tank supplied flow and pressure through the system. Water was gravity forced from the contact tank back into the reservoir.

Figure 5—End view of the first Beta installed at SDTDC for Life Cycle/Cost Evaluation.

Figure 6—A 150-gallon stock watering tank was used as a chlorine contact tank during life cycle testing.

The unit ran in this configuration from May 1998 through January 2000 with 433 actual days of operation.

Operation and Maintenance During Life Cycle/ Cost Evaluation

The following operation and maintenance information was obtained during the Life Cycle/Cost Evaluation.

- Approximately 3 bags (150 pounds) of salt were added each week. It took less than 5 minutes to add salt. Salt used for the design system was about 1 pound per 1,000 gallons of treated water at 1.0-parts per million dose.

- The brine filter required cleaning approximately every 10 bags (500 pounds) of salt. Failure to clean the brine filter resulted in a low cell amp fault. It took approximately 10 minutes to clean and replace the brine filter. The brine tank was cleaned every 3 months, taking approximately half an hour, including cleaning the brine filter.

- The chlorine monitor reagent required replacement every 45 days. Cost of reagent is approximately $10. Failure to replace the reagent resulted in low chlorine fault. It took less than 10 minutes to replace the reagent.

- The chlorine monitor cell was cleaned every 3 months. It took 10 to 15 minutes to clean the cell and check the calibration after each cleaning.

- The turbidity monitors were cleaned and the calibration checked every 3 months. It took approximately 1 hour.

- The metering pump was returned to MIOX to be rebuilt after 10 months or 8,814 unit hours (equivalent to 8,814 days of operation for the design system). It took approximately 1 hour to remove and replace the metering pump.

P3 Beta Field Installations

Table 1 shows the 1998 and 1999 USDA Forest Service installation sites, installation date, and water system information. Since the P3 Beta is designed to operate in a wide range of applications, the test sites selected were as varied as possible. The selected installation sites range from a seasonal system treating 300 gallons per day to a year-round system treating 8,000 gallons per day. The P3 Beta is flexible enough to install in most existing systems with very few modifications (figure 7).

Table 1—USDA Forest Service installation sites for the MIOX P3 Beta Packaged Water Treatment Plant.

P3 Beta Installation Site						
Location	Installation Date	Source Water	Power Source	Water Supply	Storage Tank (gallons)	Average Use Per day (gallons per day)
Osprey Campground, Idaho Pan Handle N.F., ID	April 1998	Lake	Grid power	Pump/ pressure tank	600	300
Bog Springs Campground, Coronado N.F., AZ	October 1998	Spring	Grid power	Pump/ pressure tank	20,000	2,000
Clear Creek Campground, Angeles N.F., CA	September 1998	Spring	Grid power	Pump/ pressure tank	350,000	8,000
Kirk Creek Campground, Los Padres N.F., CA	May 1999	Stream	Solar power	Gravity	1,000	2,000
Bridge Campground, Lassen N.F., CA	March 1999	Stream	Grid power	Pump/ pressure tank	560	800
Juanita Lake Campground, Klamath N.F., CA	June 1998	Stream	Solar power	Gravity	500	800
Wish Poosh Campground, Wenatchee N.F., WA	May 1998	Well	Grid power	Pump/ pressure tank	1,000	1,500
Ice Cap Campground, Willamette N.F.,OR	August 1998	Stream	Solar generator	Gravity	3,000	1,500
Elizabeth Furnace C.G., Edinburg, VA	April 1998	Stream	Grid power	Pump	1,000	2,000
Gladie Visitor Center, Daniel Boone N.F., KY	September 1999	Spring	Grid power	Gravity	560	2,000
El Verde Field Station, Rio Grande, Puerto Rico	October 1999	Stream	Grid power generator	Gravity	1000	1,500

Figure 7—Dave Graham and Lisa Anheluk with their P3 Beta installed at Ice Cap Campground.

Several problems were identified with the earliest installations.

- A pressure tank was necessary between the supply pump and the unit.
- An unpressurized tank was preferred after the unit.
- A secure building prevents unauthorized access and tampering.

To start the monitors before starting the unit, the controllers were also modified to eliminate a first recorded chlorine residual value of zero. It takes up to 5 minutes for the chlorine monitor to take its first reading.

In addition, the 3M Company withdrew their filter from the potable water market. Rosedale's Rigid Bag filter and Rosedale's filter vessel were selected to replace 3M's filter (figure 8). California DHS and several other States have approved the Rosedale filter for alternative filtration. Rosedale filter vessels replaced the RP filter vessels on all of the P3 WTPs. Information on approval status may be obtained by contacting Rosedale, Inc. at (559) 683-6854 or your State Agency.

The identified installation and operational problems discovered during the Beta testing have been corrected and most of the installations have operated trouble free during 2000. The P3 Beta testing demonstrated that this is a viable option for treating surface water to safe drinking water standards.

Figure 8—Rosedale filter vessel retrofitted on a P3 Beta.

THE MIOX P3 PACKAGED WATER TREATMENT PLANT

The P3 WTP is designed to treat a surface water source or a ground water source under the direct influence of surface water to SWTR standards of potable water. It is not designed to treat brackish water or water with unacceptable levels of chemical or mineral contamination.

The P3 WTP filters and disinfects water. It continually monitors influent and effluent water turbidity, treated water chlorine residual, and records these values for State reporting requirements (table 2). It also records electrolytic chlorine generator cell voltage and amperage. It will shut water flow off and activate an alarm circuit if it is not able to treat the water to drinking water standards.

In the year 2000, the P3 WTP cost $28,000, plus delivery and installation. Operating costs varied, depending on source water quality and the amount of water treated. The Rosedale filter used in the PSWTP costs approximately $180 and needed to be replaced once per season or once per month, depending on flow and water

Table 2–Data from Juanita Lake Campground

Cell Amps	Cell Volts	Chlorine	Turb. In	Turb. Out	Date	Time
6.9	11.5	1.41	0.01	0.16	05/30/2000	15:36
6.7	10.8	1.42	0.03	0.01	05/30/2000	15:40
6.4	10.8	1.42	0.02	0.01	05/30/2000	15:44
5.8	10.6	1.41	0.02	0.16	05/30/2000	19:59
6.1	10.6	1.36	0.01	0.01	05/30/2000	20:03
6.1	10.6	1.35	0.02	0.01	05/30/2000	20:07
5.3	10.6	1.42	0.03	0.16	05/31/2000	0:32
5.9	10.6	1.40	0.02	0.01	05/31/2000	0:36
5.8	10.6	1.40	0.03	0.01	05/31/2000	0:40
5.0	10.6	1.48	0.01	0.17	05/31/2000	5:08
5.7	11.4	1.33	0.02	0.16	05/31/2000	9:39
5.9	11.1	1.34	0.01	0.01	05/31/2000	9:43
6.0	11.1	1.32	0.02	0.01	05/31/2000	9:47

quality. The cost of salt ranged from 6 to 8 cents per pound and chlorine monitor reagent costs approximately $10 and needed to be replaced once per season or once per month, depending on flow.

The P3 WTP is a portable, skid-mounted unit that weighs 280 pounds (110 kilograms). The skid has four handles for lifting and handling. It is 34-inches (.86 meters) wide by 54-inches (1.37 meters) long and it will fit in the bed of most pick-up trucks and through a 36-inch (.91 meters) doorway (figure 9). It is available in two models, depending on electricity source.

Figure 9—Delivering the P3 WTP.

For optimal performance, the following are included in the P3 WTP unit.

- One Rosedale filter housing and gardia filter for filtration
- On-site chlorine generator for disinfection
- Two on-line turbidimeters to measure turbidity
- On-line chlorine monitor
- System controller
- Data logger
- Tank level switch.

Filtration

Filtration is provided by Rosedale's GLR-825 rigid bag filter encased, in a Rosedale housing. It filters influent water for a 2-log gardia removal credit. The filter is NSF approved and recognized by several States for surface water filtration. Unless the source water is low in turbidity (<0.2 NTU), installation of a prefilter or roughing filter is recommended (figure 10). A filter available from a local hardware store is sufficient.

Figure 10—Prefilter installed at Ice Cap Campground.

Disinfection

The disinfection components of the P3 WTP include a MIOX chlorine generator, brine tank, proportional pump, and optional Kenetico water softener. The chlorine generator, an electrolytic cell developed by LATA, generates sodium hypochlorite from a brine solution. This solution is made by adding granular water softener salt to the brine tank. A proportional pump then mixes water with the concentrated brine solution and pumps it through the electrolytic cell. The water softener is only needed for very hard water, to extend the life of the electrolytic cell, and will only soften the side stream of water feeding the electrolytic cell. This to prevents scale build-up in the cell. The EPA has approved electrolytic on-site chlorine generators for providing disinfection of potable water.

Turbidity

The P3 WTP includes two Hach on-line turbidity monitors (figure 11) that send data to the controller. The first monitor is located on the influent side and the second turbidity monitor is located on the effluent side of the filter. Operators are able to program the high turbidity alarm values on-site.

Figure 11—Back side of P3 WTP showing new turbidity monitors, Rosedale filter housing, and water softener. The three pipe connections at the bottom of the skid are the incoming water connection, treated water connection, and drain line connection.

Chlorine Monitor

A Hach on-line chlorine monitor is used to measure chlorine residual. A sample line is installed between the storage tank outlet, or distribution line, back to the chlorine monitor on the P3 WTP. High and low chlorine residual values are set on the monitor. The low chlorine alarm setting may be increased if necessary, to keep a chlorine residual in the distribution system, but should never be set below 0.20 milligrams per liter. The chlorine monitor displays the last residual reading and sends the information to the controller.

Controller

The controller is a main component of the P3 WTP. It controls the entire operation of the unit. It receives the data sent by the monitors, processes the data, and stores the data to the data logger (figure 12).

Figure 12—Inside the controller.

- The controller receives a signal from the storage tank water level float switch. If the water level falls to the low float switch, the controller will start the system, allowing treated water to fill the tank. When the water level reaches the high float switch, it will stop the water flow and go to a stand-by condition.

- Influent water pressure is monitored by the controller. Water pressure less that 15 pounds per square inch (psi) will cause the P3 WTP to shut down until the pressure returns to above 15 psi. The P3 WTP should not be installed on systems with less than 25 psi available water pressure.

- Differential pressure across the Rosedale filter is monitored by the controller. When the differential pressure reaches the set point, it shuts off water flow and activates an alarm circuit.

- The controller receives the data from the chlorine monitor. If the chlorine residual is below the high set point, it starts the chlorine generator. If it is

above the high set point, it stops the chlorine generator, but continues to filter water. If it falls below the required chlorine residual of 0.20 milligrams per liter, it will put the unit into a hard fault condition, stop water flow, and activate an alarm circuit. It then sends the chlorine residual value to the data logger.

- Turbidity monitors send data to the controller. If either turbidity monitor transmits an alarm value, it stops water flow. High turbidity alarms may be adjusted to meet State requirements. The turbidity values are then sent to the data logger.

- Ambient air temperature is also monitored by the controller. If ambient air temperature in the building drops below 35 degrees Fahrenheit (1.7 degrees Celsius), the controller will shut down the P3 WTP and purge system plumbing, to prevent freeze damage to the unit. However, pipes outside of the unit are not drained, so an operator should winterize the entire water system if freezing weather is expected.

Because of the controller, the P3 WTP meets the EPA requirements for unattended operation. The controller continually monitors influent and effluent water turbidity and treated water chlorine residual. The values are consistently recorded for State reporting requirements. The controller shuts water flow off if it is not able to meet turbidity and chlorine standards.

Data Logger

The date, time, chlorine residual, and turbidity are recorded on the data logger approximately every 5 minutes during operation. The data is stored on computer chips until an operator downloads the information to a computer, or until the memory is full (approximately 3 months). When the memory is full, the data logger begins recording over previous data. The data logger may be downloaded on-site using a laptop computer, or remotely over an internal phone modem, if phone service is available.

Alarm

The P3 WTP controller will activate an alarm circuit in case of a hard system fault. The type of alarm and alarm installation are at the discretion of the system owner. At forest campgrounds with a host, a flashing light outside the building may be adequate. One forest is using an alarm that sends a signal over a USDA Forest Service radio frequency. A phone modem installed in the P3 WTP may be used if phone service is available.

Requirements

Before installing the P3 WTP or any other water treatment equipment on a public water system, the State Primacy Agency must be informed and approval in writing obtained. Schematic drawings, specifications, and diagrams of the P3 WTP are available from the MIOX Corporation for submission to the State.

The P3 WTP requires an adequate water supply, a power supply, treated water storage, a building or protected location, and an operator.

Water Supply

Source water must be approved by the State Primacy Agency as a drinking water supply. It must be free of excess chemical or mineral contaminants (or pretreated to remove excess chemical or mineral contaminants). Water may be supplied to the P3 WTP by gravity, or by pump/pressure tank combination (figure 13). To eliminate a pressure surge when the pump starts, a pressure tank is necessary between a pump and the P3 WTP. This prevents the pump from operating dead-headed (pumping against a closed valve), and prevents the P3 controller from causing a fault due to low water pressure. The desired water delivery pressure is 50 to 60 psi, with a minimum water pressure of 25 psi. Water pressure more than 100 psi requires the installation of a pressure-reducing valve.

Figure 13—Pump/pressure tank installation at Osprey Campground.

The P3 WTP is equipped with flow control valves to prevent exceeding the maximum flow of 16 gallons per minute. The maximum daily treated volume is 24,000 gallons, with a chlorine dose of 1.0 parts per million. The minimum preferred flow rate is 8 gallons per minute, although lower flows rates are possible. On systems operating with solar power, additional solar panels and storage batteries are needed at lower flow rates, due to longer operational time for the same volume of water treated.

Power Supply

The P3 WTP uses approximately 200 watts of direct current (dc) power per hour of operation. Solar panels, batteries, and charge controller are available with the solar powered P3 WTP (figure 14) option. Wind or water generated power may also be used to supply electricity to the dc model. The alternating current (ac) powered P3 WTP model includes a converter and power cord that plugs into a standard 110/120 volt wall outlet supplied by grid electricity or a generator.

Figure 14—Solar Array at Juanita Lake Campground.

The P3 WTP uses 12 volts dc for operation. It operates on almost any electrical power supply between 12 volts dc and 120 volts single phase alternating current (vac) (power supply must be known at time of purchase). A charge controller in the P3 WTP allows a variable dc power supply to be used to charge the batteries. A converter will change 110/120 vac to 12 volts dc power. To protect the converter, a surge protector is recommended (not included) when generator power is used.

Water Storage Tank

A water storage tank, clear well, or chlorine contact tank is required to allow adequate chlorine contact time. The size of the tank depends on water use patterns, tank configuration, chlorine residual, required fire protection, and required chlorine contact time. Consideration should be given to providing separate storage and distribution for fire protection, using untreated water, when possible. Three days of reserve storage capacity allows for uninterrupted water supply in case of power outages, equipment breakdowns, or other unforeseen events. The USDA Forest Service Handbook (FSH 7409.11) may be used to determine water storage requirements. A pressure tank should not be installed directly after the P3 WTP. If a pressure tank is required for distribution system pressure, a pump/pressure tank combination should be placed after a clear well/contact tank.

The P3 WTP operates on a demand basis. When the water level in the storage tank falls below the lower float switch, the unit will start. It will continue to treat water until the water level in the storage tank reaches the upper float switch. The volume of water between the high and low float switches, and water flow rate should be adjusted so the P3 WTP will operate for approximately 1 hour on each start. Short, frequent water treatment cycles cause multiple problems with the unit.

Building

The P3 WTP should be installed in a secure, insulated building for weather protection, vandal protection, and to prevent unauthorized persons from tampering with settings (figure 15). The recommended building size of 8 feet by 10 feet with 8-foot ceiling allows easy access for maintenance and storage room for spare filters, tools, spare parts, and salt.

Figure 15—Building at Elizabeth Furnace Campground.

Operator

Every surface water or ground water under the direct influence of surface water used for drinking water requires a State certified water treatment plant operator. With proper supervision of a certified operator, some States allow an uncertified operator to do routine operation and maintenance. The MIOX Corporation will provide the system operator training on the operation and maintenance of the P3 WTP (figure 16). This training does not take the place of State certification. It is recommended that at least two people be trained on the P3 WTP operation. This provides an alternate operator, familiar with the unit, if the primary operator is not available. In addition to holding a State water treatment plant certificate, the operator should have a general knowledge of plumbing, electrical, and mechanical systems. The operator must also have access to a laptop computer (needed 1 day per month to download data), unless the unit is accessible by phone.

Figure 16—Forrest Baker from MIOX Corporation training Juan Vissepo, El Verde Field Station.

Operation and Maintenance

The P3 WTP was designed to operate unattended for up to 1 month, if treating less than 1,000 gallons per day. However, it should be checked weekly to ensure it is operating properly. Maintenance is required weekly or more often when the unit treats more than a 1,000 gallons per day. Routine operation and maintenance is very easy and usually takes 15 minutes to 1 hour.

- Fill the salt reservoir with salt as needed.
- Check and clean the brine tank filter as needed.
- Replace the water filters as needed.
- Replace the chlorine monitor reagent as needed.
- Download the data collector once per month of operation.
- Keep an operator log recording salt use, filter, and reagent replacement.
- Check flow through the electrolytic cell. Clean orifice if needed.

Start-up or quarterly procedures are more complex and usually takes 1 to 2 hours.

- Clean and check calibration of on-line instruments.
- Check water flow rate and water pressure.
- Check all electrical connections and tighten as needed.
- Check for leaks.
- Replace electrolytic cell if needed (indicated by low cell amp displayed on the control panel).

The P3 WTP is designed to stop water flow if it cannot treat the water to drinking water standards. It will go to a soft fault, a condition where the system continues to test and reset itself if the following conditions cease to exist.

- Low water pressure.
- Loss of power.
- Low power shutdown.
- High temperature in the control box.

The P3 WTP will go into a hard fault, a condition that requires an operator to reset, if the following conditions exist.

- Minimum chlorine residual is not maintained.
- Filter requires changing.
- Filtered water turbidity is too high.
- Voltage or amperage across the electrolytic cell is too low or if the cell amperage is too high.

The P3 WTP Operations and Maintenance Manual includes an easy to use troubleshooting guide. However, finding some problems may be very challenging, especially when the problems are the result of a conflict between the water system component controls and the P3 WTP controls. The personnel at the MIOX Corporation have been very responsive and can usually help an operator locate the problem over the phone.

CONCLUSIONS

The SWTR had a major impact on remote USDA Forest Service water systems that used surface water sources. Many USDA Forest Service campground water systems were not able to meet the treatment and monitoring requirements required by the SWTR. As a result some of these systems were shut down and some areas were closed. As States continue to evaluate ground water sources, more USDA Forest Service recreational water systems are being defined as being under the direct influence of surface water.

The P3 WTP is designed to treat a surface water source or a ground water source under the direct influence of surface water to SWTR standards for potable water. The P3 WTP filters and disinfects water to provide a safe drinking water. It continually monitors turbidity and chlorine residual and records these values for State reporting requirements. It will shut water flow off if it is not able to meet the SWTR requirements for safe drinking water.

The P3 WTP has demonstrated an ability to function in a wide range of applications throughout the country. The identified installation and operational problems discovered during the Alpha and Beta testing have been corrected and most installations have operated trouble free during 2000. The P3 WTP is a viable surface water treatment plant in locations where clean ground water is not available.

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National Primary Drinking Water Regulations, 40 CFR Part 141.

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