# SECTION 6.0 –
# DESIGN CRITERIA, LAYOUTS, & HYDRAULICS

This project focused on evaluating conventional ozone and Peroxone for meeting the Zone 7 T&O destruction goals. “Conventional ozone” refers to a standard design of an ozone contactor where ozone is added to the first or second chamber of a multi-chamber contactor having an overall contact time of at least 10 minutes. This type of contactor provides sufficient ozone contact time to meet T&O destruction goals, as well as *Giardia* disinfection goals. “Peroxone” refers to an Advanced Oxidation Process (AOP) in which hydrogen peroxide is added with ozone to form hydroxyl radicals, which are stronger oxidants than ozone. A Peroxone process is typically designed for destruction of T&O chemicals, but is not suitable for meeting disinfection requirements because of its short contact time and fast-decaying ozone residual. A Peroxone contactor is smaller than a conventional ozone contactor, with an overall contact time of 3 minutes. Section 5 presented the results of the pilot testing effort. Based on the study results, the following conclusions and recommendations were made:

1. *Both the conventional ozone process and the Peroxone process should continue to be considered for either plant*
2. *Either process should only be applied on the raw water, and not on settled or filtered water.*

This Section addresses three issues for the application of either process at each plant:

1. Process design criteria
2. Site layouts
3. Hydraulic constraints

This Section describes the implementation of both processes at both plants in sufficient detail such that cost estimates can be developed. Once cost information is generated for each option, the project team will evaluate the water quality, operational, and cost impacts of each ozone-based option, and make a final recommendation regarding the preferred option for both plants.

## 6.1 GENERAL PROCESS IMPLEMENTATION REQUIREMENTS

### 6.1.1 General Plant Modifications Required

In order to incorporate either conventional ozone or Peroxone into each plant, specific modifications will need to be implemented. These modifications can be classified under four primary categories:

A. Acid addition for bromate control
B. New chlorine CT contactor for primary disinfection
C. New backwash water system
D. New chemical addition points

Table 6.1 below summarizes these modifications and describes which modifications are needed for each the two T&O treatment options.

**Table 6.1 – Summary of General Plant Modifications Needed to Accommodate Each of the two Technologies at Either Plant**

| Category | Conventional Ozone | Peroxone |
|---|---|---|
| A. Acid addition for bromate control | $CO_2$ addition will be used to lower the pH for bromate control, stabilize the process, and lower the ozone dose needed for disinfection | No acid addition is necessary since the process will be operated only intermittently |
| B. New chlorine CT contactor for primary disinfection | No new chlorine CT contactor will be necessary since primary disinfection will be achieved with ozone | A new chlorine CT contactor will be needed downstream of the filters since they will no longer be used for disinfection |
| C. New backwash water supply tank and associated pumps and valving | An unchlorinated backwash water supply tank will be required to provide backwash water for the biofilters | An unchlorinated backwash water supply tank will be required to provide backwash water for the biofilters |
| D. New chemical addition points | A number of chemical addition points will be eliminated, relocated, or added to accommodate the need for bromate control, promoting biofiltration, and intermittent chlorination of the filter backwash water supply | A number of chemical addition points will be eliminated, relocated, or added to accommodate the need for bromate control, promoting biofiltration, achieving CT with a new chlorine contactor, and intermittent chlorination of the filter backwash water supply |

The Peroxone process is designed to meet the T&O destruction goals. However, it will not achieve the plants' disinfection goals. The process will be operated only when required by T&O occurrence in the raw water. This is similar to the manner in which powdered activated carbon (PAC) is currently used at both plants. In some years, the T&O period may extend from June through October. In other years, a T&O event may not occur at all. The following issues are associated with the use of the Peroxone process at both plants:

1. pH reduction is not necessary. Since the Peroxone process is operated intermittently, bromate formation will be sufficiently controlled with prechloramine addition such that pH reduction is not necessary. Pilot testing results showed that the bromate level formed with prechloramine addition at ambient pH ranged from 4 to 11 µg/L, even with high raw water bromide concentrations. Since the bromate levels will be "zero" when the Peroxone process is off-line, then each plant should be able to maintain the annual average bromate at or below the MCL of 10 µg/L, or the Zone 7 goal of 8 µg/L. Therefore, pH suppression of the raw water is not recommended.

2. Biological filtration is needed. With the Peroxone process, primary disinfection at each treatment plant (0.5-log *Giardia* inactivation and 2-log virus inactivation) will continue to be met with free chlorine. Currently, chlorine is added at the filter influent at each conventional plant thus utilizing the contact time through the filters to meet the disinfection CT requirements. With the use of Peroxone, though intermittently, it is desirable that the assimilable organic carbon (AOC) formed be removed with biological filtration. This means

that the chlorine addition point will need to be delayed to a point downstream of the media filters. This action would take away the chlorine contact time through the filters, and thus eliminate the ability of each plant to meet its minimum CT requirements. To compensate for the loss of disinfection contact time, additional free chlorine contact time must be provided downstream of media filtration at conventional each plant. It should be noted that at the PPWTP, only one of the two trains is capable of biofiltration (the conventional train). Water passing through the UF train will have elevated levels of AOC due to the Peroxone process. This high-AOC water will be blended with the low-AOC water produced by the conventional train.

3. Unchlorinated backwash water supply is needed. Biologically active filters should be backwashed with water that does not contain chlorine or chloramine in order to maintain biological growth on the media. Therefore, a separate backwash water storage tank should be provided to store unchlorinated backwash water, and pumps and valving must be provided to fill this tank. However, occasionally, chlorine needs to be added to the backwash water to control excess bacterial growth in the biofilters. An additional chlorine feed system should be provided to inject chlorine directly into the water used to backwash the media filters whenever it is deemed necessary by the operators. Along with unchlorinated backwash water, the biological filters should be equipped with an air scour system to improve the backwash efficiency.

It should be noted that the on/off operation of a Peroxone system, while economically sound, may have potential negative impacts in two main areas: First, even in the absence of MIB and geosmin, there is a particular taste to SBA water. The use of Peroxone will likely change this taste. When the Peroxone process is turned on and off, the taste of the water will change, which may be falsely viewed by some customers as a water quality concern. Second, the required doses of coagulants and chlorine will change when Peroxone is turned on or off. This will require the operators to make adjustments to compensate. If these issues become problematic for Zone 7, the Peroxone process could be operated year-round.

The ozone process achieves the T&O destruction goals. In addition, it also has the long hydraulic detention time needed to meet the primary disinfection goals of 0.5-log *Giardia* and 2-log virus inactivation. As a primary disinfection process, it will have to be operated continuously with no interruptions. The following issues associated with the use of ozone at both plants will be addressed in this Section:

1. pH suppression is needed. Since the ozone process is operated year-round, compliance with the bromate MCL will require that both pH depression and prechloramination be implemented for bromate control. Carbon dioxide ($CO_2$) gas will be injected into the raw water to lower the pH to a range of 7.0 to 7.5, followed by chlorine and ammonia, all upstream of the ozone contactor. Further, the lowering of the pH lowers the ozone dose needed to meet the disinfection requirements. And finally, due to the significant diurnal variations in raw water pH in the SBA, stabilization of the pH is needed for good control of the ozonation process.

2. Biological filtration is needed. This will require that the chlorine addition point upstream of the filters be abandoned and moved to a location downstream of the filters. Since primary disinfection is achieved with the ozone process, no significant free chlorine contact time is required, and therefore, no additional chlorine CT contactor is needed at either plant. A short contact time (1 to 3 minutes) should be maintained between chlorine and ammonia addition points to adequately inactivate the HPC bacteria in the effluent of the biofilters. It

should be noted that at the PPWTP, only one of the two trains is capable of biofiltration (the conventional train). Water passing through the UF train will have elevated levels of AOC due to the ozone process. This high-AOC water will be blended with the low-AOC water produced by the conventional train.

3. Unchlorinated backwash water supply is needed. Biologically active filters should be backwashed with water that does not contain chlorine or chloramine. Occasionally, chlorine should be present in the backwash water to help control excess bacterial growth in the biofilters. Therefore, a separate backwash water storage tank should be provided to store unchlorinated backwash water supply, and an additional chlorine feed system should be provided to inject chlorine directly into the backwash water used to backwash the media filters whenever it is deemed necessary by the operators. Along with unchlorinated backwash water, the biological filters should be equipped with an air scour system to improve the backwash efficiency.

### 6.1.2 Del Valle Water Treatment Plant

To implement either ozone or Peroxone at the Del Valle Water Treatment Plant (DVWTP), various modifications will need to be made. Figure 6.1 shows a three-part schematic of the process-flow diagrams (PFDs) of the Del Valle WTP in (A) its current configuration, (B) with Peroxone addition, and (C) with ozone addition. In its current configuration (Figure 6.1-A), DVWTP includes two parallel pretreatment trains, each with its own rapid-mix system: 1) the Superpulsators® train and 2) the Dissolved Air Flotation (DAF) train. The clarified waters from the two trains then combine and pass through a set of eight (8) media filters, followed by clearwell storage. This analysis assumes that the pipeline from the raw water pump station currently feeding the Superpulsator® train will be abandoned and a new pipeline will be installed from the new DAF trash screen to feed the Superpulsators®.

#### *6.1.2.1 DVWTP with Peroxone*

Figure 6.1-B shows the anticipated PFD with Peroxone implementation. Currently each pretreatment train includes its own mechanical screen upstream of the clarification process, and this functionality will be preserved. The screens are needed to prevent plugging of the orifices in the Superpulsator® distribution laterals and the ports in the DAF basin. Since the DAF screen was designed to handle the entire plant flow, it was decided to supply the Superpulsator® train with a new line from the DAF screen, parallel to the line supplying the DAF basins. This will involve constructing a new flash mix unit (hydraulic pump-injection system similar to that used for the DAF train) for the Superpulsator® train, and abandoning the existing Superpulsator® supply line, flash mix, and screen.

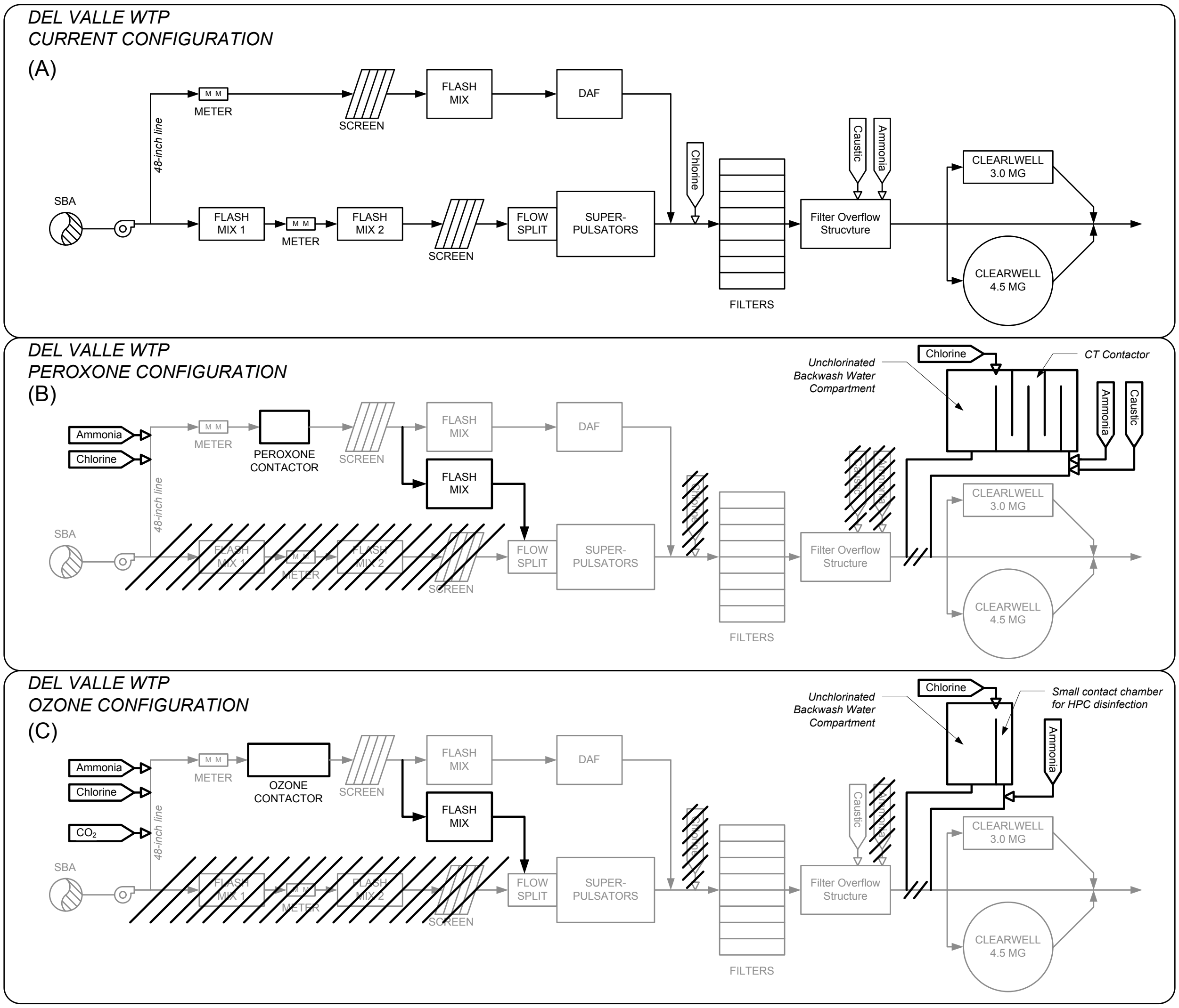



**Figure 6.1 – Process Flow Diagrams for Current & Modified Del Valle WTP**

Figure 6.1-B also shows that chlorine addition upstream of the media filters will be abandoned. This will allow the filters to become biologically active. However, this modification will eliminate the free chlorine contact time through the filters and a new disinfection contactor will be required. There are two available options: either convert one of the clearwells to a chlorine contactor, or construct a new CT contactor between the filter overflow structure and the clearwells. Preservation of the existing storage and operational flexibility provided by the clearwells is necessary. Therefore, Figure 6.1-B shows the latter option. A new two-compartment contactor will be constructed. Filtered water will flow into the first compartment, which will supply the unchlorinated backwash water to the backwash pumps. Chorine will be added at the inlet to the second compartment, which will serve as the CT contactor. The contactor is planned to have a serpentine flow pattern in order to ensure a high hydraulic efficiency. Ammonia and caustic will be added at the effluent of the chlorine contactor before the water flows into the existing clearwells. The online free and total chlorine residual analyzers and pH analyzer will need to be relocated and the control system adjusted accordingly.

Although not shown in the schematic, provisions should be made for chlorine to be added to the backwash water flow to the filters on an as-needed basis. This is commonly practiced in biological filtration plants in order to prevent excessive bacterial growth in the filters.

Finally, Figure 6.1-B shows that chlorine and ammonia will be added upstream of the Peroxone process as-needed for bromate control.

#### *6.1.2.2 DVWTP with Ozone*

Figure 6.1-C shows the PFD for the DVWTP with conventional ozone. Similar to the Peroxone process, the ozone process will be located on the feed line to the DAF train upstream of the DAF trash screen. This mechanical screen will then supply both clarification trains, and a new flash mix for the Superpulsator train will be added. The existing line supplying the Superpulsators, along with the corresponding flash mix and mechanical screen, will be abandoned.

The chlorine addition point upstream of the filters will be eliminated to allow the filters to operate in biological mode. Since the filters will be biologically active, a new two-chamber tank will need to be constructed to store unchlorinated filtered water for backwashing. With this modification, the existing backwash pumps will be used to backwash the biofilters with unchlorinated filtered water from the first chamber. The regular chlorine addition point will be relocated to the second chamber of the new filtered water tank, and the ammonia addition point will be moved to the effluent of this tank. This will allow for a 1 to 3 minute free-chlorine contact time before ammonia is added to form chloramine. The caustic feed point will remain in its current location. Unlike the Peroxone process, no new CT contactor will be required since primary disinfection will be achieved with the ozone process. Although not shown in the schematic, provisions should be made for chlorine to be added to the backwash water flow to the filters on an as-needed basis.

Figure 6.1-C also shows that $CO_2$, chlorine, and ammonia will be added upstream of the ozone process for bromate control. The $CO_2$ feed system will be used to maintain the raw water pH between 7.0 and 7.5. The lower pH, along with the prechloramine addition, will be needed to maintain bromate below the MCL of 10 μg/L. Also, the $CO_2$ feed will allow for stabilization of the raw water pH, which in turn will stabilize the ozone residual.

### 6.1.3 Patterson Pass Water Treatment Plant

To implement either ozone or Peroxone at the Patterson Pass Water Treatment Plant (PPWTP), various modifications will need to be implemented. Figure 6.2 shows a three-part schematic of the PFDs of the Patterson Pass WTP in (A) its current configuration, (B) with Peroxone addition, and (C) with ozone addition.

#### *6.1.3.1 PPWTP with Peroxone*

In its current configuration (Figure 6.2-A), the PPWTP includes two parallel trains: An ultrafiltration (UF) membrane train and a conventional media filtration train. The two filtered waters then combine in a 2.0 MG clearwell. Each train includes its own flash mix, flowmeter, and upflow clarifier. Therefore, the Peroxone process should be located upstream of the flow split between the two trains. Figure 6.2-B shows the anticipated PFD with Peroxone implementation at PPWTP. As discussed later in this Section, the plant flow rate and required contact time of the Peroxone process allows for the use of a pipeline contactor in lieu of a rectangular basin.

The plant receives its water from the Patterson Pass Reservoir, but also has a direct SBA connection in order to maintain operation when the reservoir is off line. To maintain this functionality, the Peroxone process should be located downstream of the direct SBA connection point as shown in Figure 6.2-B.

Figure 6.2-B also shows that chlorine addition upstream of the media filters will be abandoned and moved to a point downstream of the filters. This will allow the media filters to become biologically active (note that biofiltration is not possible in the UF train). However, this modification will eliminate the disinfection contact time through the filters and a new disinfection contactor will be required. Similar to the discussion for the DVWTP, two options were considered: 1) install a new chlorine contact chamber or 2) modify the existing clearwell to serve as a chlorine contact chamber. Modifying the clearwell to function as a contact chamber will decrease operational flexibility. Therefore, a new contact chamber will be added. This option will not require any changes to the existing service water and potable water pumps. The online free and total chlorine analyzers will need to be relocated and the control system reprogrammed for this new disinfection strategy.

Each train in the PPWTP already has its own backwash water supply tank. The tank providing backwash water to the UF membranes will continue to operate under its current configuration, although it will no longer be needed to meet the disinfection CT requirements. The backwash water storage tank for the conventional train currently receives chloraminated water from the 2.0 MG clearwell. Since the biologically active filters will require backwashing with unchlorinated water, Figure 6.2-B shows that the backwash water will now be drawn from the filtered water line upstream of chlorine addition. Provisions should be made for chlorine to be added to the backwash water flow to the filters on an as-needed basis. This is commonly practiced in biological filtration plants in order to prevent excessive bacterial growth in the filters.

Finally, Figure 6.2-B shows that chlorine and ammonia will be added upstream of the Peroxone process, as needed, for bromate control.

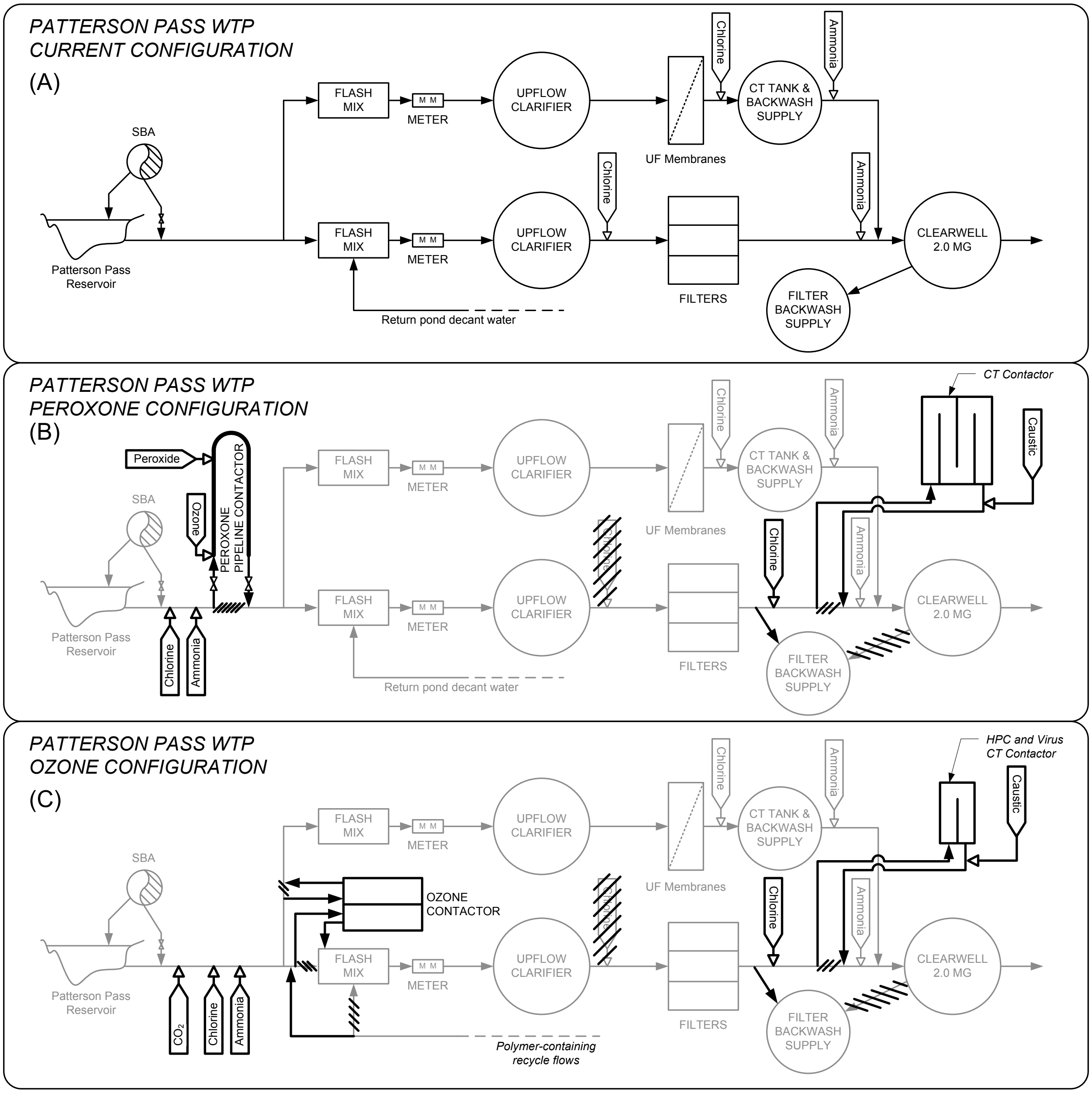



**Figure 6.2 – Process Flow Diagrams for Current & Modified Patterson Pass WTP**

### *6.1.3.2 PPWTP with Ozone*

Figure 6.2-C shows the PFD for the PPWTP with conventional ozone. Similar to the Peroxone process, the ozone process will be located downstream of the direct SBA connection point, and upstream of the flow split to the two treatment trains. Similar to the discussion regarding Peroxone, the chlorine addition point upstream of the filters will be eliminated to allow the filters to operate in a biological mode (biofiltration is not possible for the UF train). The chlorine addition point will be relocated to a point downstream of the media filters and upstream of the ammonia addition point. No modifications to the 2.0 MG clearwell will be necessary since primary disinfection for will be achieved with the ozone process. However, a small chlorine

contact chamber is still necessary downstream of filtration because high counts of HPC bacteria are expected in the effluent of the biofilters, and a short contact time of 1 to 3 minutes of free chlorine is recommended to inactivate them.

Similar to the application of the Peroxone process, the tank providing backwash water to the UF membranes will continue to operate under its current configuration. The backwash water storage tank for the conventional train currently receives chloraminated water from the 2.0 MG clearwell. Since the biologically active filters will require backwashing with unchlorinated water, Figure 6.2-C shows that the existing backwash water pump will be plumbed to draw water from the filtered water line upstream of chlorine addition. Provisions should be made for chlorine to be added to the backwash water flow from the backwash water tank to the filters on an as-needed basis. Figure 6.2-C shows that $CO_2$, chlorine, and ammonia will be added upstream of the ozone process for bromate control. The $CO_2$ feed system will be used to maintain the raw water pH between 7.0 and 7.5. The lower pH, along with the prechloramine addition, will be needed to maintain bromate below the MCL of 10 µg/L and stabilize the ozonation process.

The implementation of ozone at PPWTP encounters a unique complication. Under the current PPWTP configuration, the decant water from the ponds is returned to the flash mix of the conventional train, and not the UF train. The reason is that the return water contains residual polymer from the sludge de-watering operation, and polymers are not compatible with the UF membranes at the plant. This practice needs to continue after ozone or peroxone implementation. However, under the ozone option, the ozone process, which is located upstream of the rapid mix points of both trains, will become the primary disinfection process at the plant. Any water returned to the rapid mix locations will not receive the required disinfection, and that is not acceptable. Therefore, the polymer-containing return decant water must be returned upstream of the ozone process. Since the use of polymers in the conventional train is necessary, and since the polymer-containing return water cannot be applied upstream of the UF train, a single ozone system upstream of the flow split between the two trains is not possible. At PPWTP, two parallel ozone contactors will be configured where one contactor will serve the conventional train and one contactor will serve the UF train. The influent to each contactor will be drawn from the raw water pipes after the flow split between the two trains. The polymer-containing decant washwater will then be returned to the influent of the conventional ozone contactor. This will allow for the proper disinfection of the return stream without exposing the UF train to residual polymers.

## 6.2 PROCESS DESIGN CRITERIA

The pilot testing results provided information on a number of important design parameters for either ozone or Peroxone. This section presents the design criteria for the new unit processes to be added under the ozone or Peroxone alternative at the Del Valle & Patterson Pass Water Treatment Plants. Design criteria are provided for the following components:

- Carbon dioxide storage & feed system (only for the ozone alternative)
- Ozone or Peroxone contactor
- Ozone generation building
- Hydrogen peroxide storage & feed system (only for the Peroxone alternative)
- Liquid oxygen (LOX) storage & feed system
- Prechloramination chemical feed rates (chlorine and ammonia)
- Disinfection CT contactor (only for the Peroxone alternative)

It is noted that the design flowrate through DVWTP was assumed at 44 MGD, which includes 40 MGD of raw water flow plus an estimated 4 MGD of recycled water flows. Similarly, the design flowrate through PPWTP was assumed at 24.5 MGD, which includes 22 MGD of raw water flow plus an estimated 2.5 MGD of recycled water flows.

### 6.2.1 Del Valle Water Treatment Plant

Tables 6.2, 6.3, and 6.4 present the design criteria for the various added components under the ozone and Peroxone alternatives for the DVWTP. Table 6.2 presents the criteria for the ozone and Peroxone processes and their components (contactor, generators, and generator building). Since the size of the Peroxone contactor is only 30% of the ozone contactor size, the Peroxone contactor is projected to be 28 ft long by 27 ft wide compared to a 50 x 50 $ft^2$ ozone contactor. The ozone contactor includes two parallel trains, each containing five chambers, with a 13-ft wide gallery between the two trains. The gallery is required to access monitoring stations along the length of the contactor and to locate various online instrumentation required for the operation of the ozone system. On the other hand, the Peroxone contactor is a single train process with three chambers in series. The water depth in the ozone contactor is set at 22 ft because ozone will be fed through porous diffusers in the first chamber, which will require this depth to achieve high ozone transfer efficiency. For the Peroxone process, the ozone will be injected in the pipe before the water enters the contactor. Therefore, the 22-ft depth is not necessary. The water depth in the Peroxone contactor was assumed at only 16 ft.

While the average ozone dose applied in a Peroxone process is lower than the average dose applied in a conventional ozone process, pilot testing showed that, at times, the dose required for both processes is the same. Therefore, for the purpose of design, the maximum ozone dose for both processes was set at 3.0 mg/L. This translates into a maximum ozone production of 1,100 lbs/day. Since the ozone process will be designed to meet the disinfection requirements, it is assumed that the system will include two duty generators and one stand-by generator. However, for the Peroxone process, no standby generator is necessary since the process will not be relied upon for meeting the disinfection requirements. For this reason, although the two processes will be designed for the same maximum ozone dose, the ozone process will require three 550 lbs/day generators, while the Peroxone process will require only two 550 lbs/day generators.

Liquid Oxygen (LOX) will be used to supply oxygen to the ozone generators. Assuming that the ozone content in the generator outlet will be 8% by wt., the plant will consume about 14,000 lbs of oxygen per day when the maximum ozone dose is applied to the maximum water flowrate through the plant. Assuming a target storage capacity of 15 days at maximum demand, approximately 22,000 gallons of LOX should be stored onsite. This can be accommodated in a vertical 14-ft diameter tank with an approximate height of 25 ft. A standard thermal/catalytic off gas destruct system, cooling water system, and nitrogen-boost/supplemental air system are assumed to be included with both the ozone and Peroxone options.

**Table 6.2 – Design Criteria for the Ozone & Peroxone Systems at the Del Valle WTP**

| Process & Parameter | Design Value Ozone | Design Value Peroxone | Unit | Basis/Comment |
|---|---|---|---|---|
| Plant Design Flow Rate | 44 | 44 | MGD | 40 MGD + 4 MGD of Recycle Flow |
| ***Ozone or Peroxone Contactor*** | | | | |
| Hydraulic Retention Time | 10 | 3 | minute | |
| No. of Contactors in Parallel | 2 | 1 | | |
| Volume of Contactor | 305,536 | 91,661 | gallons | |
| Volume of Each Contactor | 152,768 | 91,661 | gallons | |
| Water Depth | 22 | 16 | ft | Assumed |
| Area of Each Contactor | 928 | 766 | $ft^2$ | |
| Contactor Length | 50 | 28 | ft | |
| Contactor Width (each) | 19 | 27 | ft | |
| Total Contactor Width | 50 | 27 | ft | Includes 13-ft wide Gallery for ozone contactor only |
| ***Ozone Generation & Feed System*** | | | | |
| Max. Ozone Dose | 3.0 | 3.0 | mg/L | Based on pilot testing results |
| Max. Ozone Production Rate | 1,101 | 1,101 | lbs/day | |
| Ozone dose during T&O season | 2.5 | 2.5 | mg/L | |
| Ozone dose during non-T&O season | 1.5 | 0 | mg/L | |
| Number of Duty Generators | 2 | 2 | | |
| No. of Standby Generators | 1 | 0 | | |
| Total Number of Generators | 3 | 2 | | |
| Capacity per Generator | 550 | 550 | lbs/day | |
| Installed Capacity | 1,650 | 1,100 | lbs/day | |
| Feed Gas Type | LOX | LOX | | |
| % Ozone in Generator Outlet | 8% | 8% | % | |
| LOX Storage Requirement | 15 | 15 | days | Based on max dosage |
| LOX Usage Rate | 13,761 | 13,761 | lbs/day | Based on max dosage |
| LOX Tank Capacity | 206,415 | 206,415 | lbs | |
| LOX Volumetric Usage Rate | 1,446 | 1,446 | gal/day | LOX S.G. = 1.141 |
| Volume of LOX Tank | 21,691 | 21,691 | gallons | Minimum storage volume |
| Approx. LOX Tank Diameter | 14 | 14 | ft | |
| Approximate LOX Tank Height | 25 | 25 | ft | Includes 6 ft for freeboard & underside clearance |
| ***Ozone Generation Building*** | | | | |
| Ozone Building Area | 6,110 | 4,073 | $ft^2$ | 3.7 $ft^2$/lb of Capacity(1) |

(1). Langlais et al., 1991

Langlais et al. (1991) provide an estimate of the size of the ozone building required to house the ozone generators and their electrical components. Based on the factors provided by Langlais et al. (1991), the ozone generator building under the ozone option is projected to have a floor area of approximately 6,000 $ft^2$ while that under the Peroxone option is projected to require a floor area of approximately 4,000 $ft^2$. While both options will experience the same ozone consumption at maximum dose and flowrate, the ozone option has one extra standby generator that the Peroxone option does not. This is why the building under the ozone option is larger than that under the Peroxone option.

Table 6.3 presents the design criteria for the chemical addition systems required in conjunction with either ozone or Peroxone implementation at DVWTP. A hydrogen peroxide storage and feed system will be required for the Peroxone process. With a maximum design Peroxone ratio of 1:1 (mg $H_2O_2$-to-mg ozone), the maximum hydrogen peroxide dose is projected at 3.0 mg/L. At this dose, the maximum hydrogen peroxide usage rate is projected at 334 gallons/day to be fed by two duty and one standby pumps. With a desired storage capacity of 15 days under maximum usage conditions, a minimum operating volume of 5,000 gallons is required. For the purpose of this project, it is assumed that either plant will have a permanent $H_2O_2$ storage and feed system, similar to any other chemical at that plant. Alternatively, Zone 7 may chose to lease a system on an as-needed basis.

Table 6.3 presents the design criteria for the $CO_2$ feed system required under the ozone option only. The projected maximum $CO_2$ dose is 45 mg/L, which would reduce the pH of the raw water from a high of 9.5 to approximately 7.0. This dose was determined assuming an alkalinity of 150 mg/L as $CaCO_3$. Under maximum dose and flow conditions, approximately 1,900 gallons of liquid $CO_2$ will be consumed per day of operation. A 30,000 gallon tank would satisfy this consumption rate over a 15-day period. This is the same size as the $CO_2$ tank currently installed at ACWD's WTP2.

Finally, Table 6.3 lists the feed requirements for chlorine and ammonia to the raw water required to control bromate with pre-chloramination. DVWTP already has chlorine and ammonia storage and feed facilities. Therefore, the information in Table 6.3 is limited to sizing new feed pumps required to pump sodium hypochlorite and ammonia from the existing tanks to the raw water line. Under maximum flow conditions and a projected prechloramine dose of 1.0 mg/L, a total of 352 gallons of 12.5% hypochlorite and 62 gallons/day of 19% ammonia will be consumed each day. Since the prechloramine dose is not anticipated to vary greatly, only one duty and one standby pumps are required for each chemical. The turn-down ratio on one pump should be sufficient to accommodate changes in chemical feed rate with changing flow rate through the plant. Note that Zone 7 currently uses ammonia gas (anhydrous ammonia) and will continue to do so until the planned conversion to aqua ammonia.

**Table 6.3 – Design Criteria for the Chemical Feed Systems Associated with the Implementation of Ozone or Peroxone at the Del Valle WTP**

| Process & Parameter | Design Value | | Unit | Basis/Comment |
|---|---|---|---|---|
| | Ozone | Peroxone | | |
| ***Hydrogen Peroxide Feed System*** | | | | |
| Maximum $H_2O_2$ Dose | -- | 3.0 | mg/L | Peroxone Ratio of 1:1 |
| Average $H_2O_2$ Dose | -- | 0.65 | mg/L | Peroxone Ratio of 0.5:1 |
| Peroxide Strength | -- | 35 | % | % active by weight |
| Peroxide Stock Concentration | -- | 3.3 | lbs/gal | S.G. = 1.13 |
| Max Feed Rate at Max Dose | -- | 1,101 | lbs/day | |
| Max Feed Rate at Max Dose | -- | 334 | gal/day | |
| Pumping Capacity | -- | 13.9 | gal/hr | |
| Number of Duty Pumps | -- | 2 | | 1 @ 4.5 gph & 1 @ 9.5 gph |
| Number of Standby Pumps | -- | 1 | | 1 @ 4.5 gph |
| Total Number of Pumps | -- | 3 | | |
| Capacity per Pump | -- | 4.6 | gal/hr | |
| Storage Capacity at Max Dose | -- | 15 | days | |
| Min. Tank Operating Volume | -- | 5,006 | gallons | |
| Approx. Tank Diameter | -- | 12 | ft | |
| Approx. Solution Height in Tank | -- | 5.9 | ft | |
| Approx. Total Tank Height | -- | 12 | ft | |
| ***Carbon Dioxide Feed System*** | | | | |
| Maximum $CO_2$ Dose | 45 | -- | mg/L | Lower pH from 9.5 to 7.0 |
| Average $CO_2$ Dose | 16 | -- | mg/L | |
| $CO_2$ Gas Usage Rate | 16,513 | -- | lbs/day | |
| Liquid $CO_2$ Usage Rate | 1,922 | -- | gal/day | Liquid $CO_2$ S.G. = 1.03 |
| Storage Capacity at Max Dose | 15 | -- | days | |
| Minimum Storage Volume | 30,000 | -- | gallons | |
| ***Pre-Chlorine Feed Rate*** | | | | |
| Chlorine Dose | 1.0 | 1.0 | mg/L | |
| Hypochlorite Strength | 12.5 | 12.5 | % | percent active by wt. |
| Hypochlorite Strength | 1.04 | 1.04 | lbs/gal | S.G. = 1.0 |
| Hypochlorite Usage Rate | 367 | 367 | lbs/day | |
| Hypochlorite Used from Tank | 352 | 352 | gal/day | |
| Number of Pumps on Duty | 1 | 1 | | |
| Number of Pumps on Standby | 1 | 1 | | |
| Total Number of Pumps | 2 | 2 | | |
| Capacity of each pump | 7.3 | 7.3 | gal/hr | |
| ***Pre-Ammonia Feed Rate*** | | | | |
| Ammonia Dose | 0.25 | 0.25 | mg/L | |
| Ammonia Strength | 19.0 | 19.0 | % | percent active by wt. |
| Ammonia Strength | 1.5 | 1.5 | lbs/gal | S.G. = 0.93 |
| Ammonia Usage Rate | 92 | 92 | lbs/day | |
| Ammonia Used from Tank | 62 | 62 | gal/day | |
| Number of Pumps on Duty | 1 | 1 | | |
| Number of Pumps on Standby | 1 | 1 | | |
| Total Number of Pumps | 2 | 2 | | |
| Capacity of each pump | 1.3 | 1.3 | gal/hr | |

The implementation of the ozone or Peroxone alternative at DVWTP will require the addition of an unchlorinated backwash water storage tank and a chlorine disinfection contactor. Instead of building two separate contactors, the two functions will be combined inside a single tank to be constructed between the filters and the existing clearwells. The design criteria for the two tanks under the two options are listed in Table 6.4, and their configurations are illustrated in Figures 6.3-A and 6.3-B. Under each option, the tank will be divided into two compartments. The first compartment will serve as a source of un-chlorinated water for filter backwashes, and the second compartment will serve as a chlorine contactor. Water will flow over a weir from the first compartment to the second compartment and the water level in the first compartment will be 21 ft compared to 20 ft in the second compartment. Chlorine will be added at the weir between the first and second compartment. Under the Peroxone option, the contactor portion of the tank will be comprised of four serpentine flow channels (see Figure 6.3-A). Each channel will have a length of 180 ft and a width of 19 ft. The unchlorinated water compartment will comprise the first 93 ft of the first channel. The disinfection CT compartment will comprise the entire remaining volume of the overall contactor. Under the ozone alternative, the tank will be comprised of only two serpentine channels. Each channel will have a length of 93 ft and a width of 19 ft. The first channel will serve as the unchlorinated water storage compartment, while the second channel will serve as the disinfection contactor. Water will flow over a weir between the first compartment and the second, and chlorine will be added at the weir. The disinfection compartment will only be sized to achieve sufficient inactivation of HPC bacteria that may slough off the biofilters.

Under the Peroxone alternative, the disinfection compartment will be sized to meet the disinfection CT requirements of the Surface Water Treatment Rule for *Giardia* and viruses. The sizing requirements of the two compartments of this contactor are presented in Table 6.4. The unchlorinated water compartment will be sized to store two filter washes plus a 25% contingency volume. This translates into a total volume of 279,000 gallons. For the disinfection compartment, the volume required under the ozone alternative is set at 259,000 gallons, while that required under the Peroxone alternative is set at 1,781,000 gallons. The volume of the CT contactor is based on conservative assumptions of chlorine residual (1.5 mg/L), pH (8.0), and temperature (8 $^{o}$C), at maximum flowrate. Under these conditions, the chlorine CT contactor will meet the minimum *Giardia* inactivation requirements (0.5 logs) with a 33% safety factor.

In addition, the filters should be retrofitted with an air scour system that improves backwashing efficiency, which is recommended for biologically active filters. Using a standard design criterion of 3 scfm/ft$^2$, a minimum air flow of 2,000 scfm is required. This can be achieved with only one blower.

**Table 6.4 – Design Criteria for the New Filtered Water Tank and the Air-Scour System at the Del Valle WTP**

| Process & Parameter | Design Value | | Unit | Basis/Comment |
|---|---|---|---|---|
| | Ozone | Peroxone | | |
| Overall Length | 93 | 180 | ft | |
| Number of serpentine channels | 2 | 4 | | |
| Width of each channel | 19 | 19 | ft | |
| Overall Width | 38 | 76 | ft | |
| | | | | |
| ***Unchlorinated Backwash Water Storage Compartment (1st compartment of overall tank)*** | | | | |
| Unit Filter Backwash Volume | 165 | 165 | gal/ft$^2$ | Estimated |
| Area per Filter | 676 | 676 | ft$^2$ | |
| Vol. of Backwash Water per filter | 111,540 | 111,540 | gallons | |
| Number of Backwashes Stored | 2 | 2 | | |
| Volume of Washwater Required | 223,080 | 223,080 | gallons | |
| Volume Provided | 278,850 | 278,850 | gallons | 125% of required vol. |
| Water Height in Compartment | 21 | 21 | ft | Assumed |
| Compartment Width | 19 | 19 | ft | |
| Compartment Length | 93 | 93 | ft | |
| ***Chlorine Disinfection CT Contactor (2nd compartment of overall tank)*** | | | | |
| Length of water path | 93 | 627 | ft | serpentine contactor |
| Width of water path | 19 | 19 | ft | |
| Water depth | 20 | 20 | ft | |
| Length of each reach | 93 | 180 | ft | |
| Volume | 34,570 | 238,096 | cu-ft | |
| Volume | 259,000 | 1,781,000 | gallons | |
| HRT at Design Flow | 8.5 | 58 | minutes | |
| Hydraulic Efficiency ($T_{10}$/HRT) | 0.3 | 0.5 | | Baffled Contactor |
| $T_{10}$ at Maximum Flow | -- | 29 | minutes | |
| Minimum Chlorine Residual | -- | 1.5 | mg/L | |
| Minimum CT | -- | 43.7 | mg-min/L | |
| Minimum Water Temperature | -- | 8.0 | $^{o}$C | |
| Maximum Water pH | -- | 8.0 | | |
| Min. Log *Giardia* Achieved | -- | 0.67 | logs | |
| Log *Giardia* Required | -- | 0.5 | logs | |
| Min. CT Ratio | -- | 1.33 | | (goal is Ratio > 1.0) |
| ***Air Scour System*** | | | | |
| Design Air Scour Rate | 3.0 | 3.0 | scfm/ft$^2$ | |
| Minimum total Air Flow | 2,000 | 2,000 | scfm | |
| Number of blowers | 1 | 1 | | |

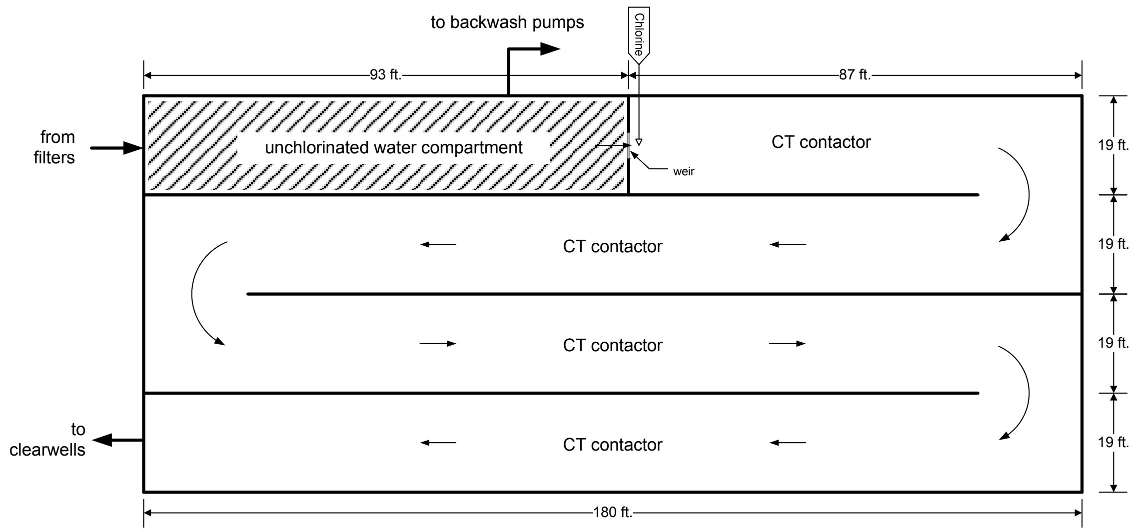



**Figure 6.3-A – Potential Configuration (Plan View) of the New Filtered Water Tank under the Peroxone Option at DVWTP**

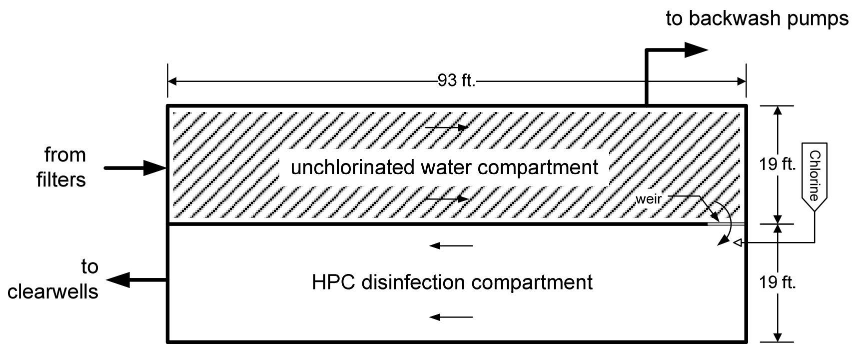



**Figure 6.3-B – Potential Configuration (Plan View) of the New Filtered Water Tank under the Ozone Option at DVWTP**

### 6.2.2 Patterson Pass Water Treatment Plant

Tables 6.5 and 6.6 present the design criteria for the additions and modifications required at the Patterson Pass Water Treatment Plant under the ozone and Peroxone options. The design treated water flowrate through the plant is 24.5 MGD, which includes 22.5 MGD of water production plus 2 MGD of return water flow. Table 6.5 presents the criteria for the ozone and Peroxone processes and their components (contactors, generators, and generator building). With a flow rate of only 24.5 MGD and a required contact time of 3 minutes, it was possible to utilize a pipeline Peroxone contactor for PPWTP. Specifically, 543 ft of 48-inch diameter pipe would provide the necessary contact time at the design flow. For the ozone option, two parallel over-under contactors would be used. Each train contains five chambers, with a 13-ft wide gallery between the two trains. Each contactor will be sized to provide 10 minute hydraulic retention time (HRT) at a flowrate of 15 MGD. This is the flowrate through the conventional train (13.5 MGD) plus 1.5 MGD of return flow to the conventional train. The gallery between the two contactors is required to access monitoring stations along the length of the contactors and to locate various online instrumentation required for the operation of the ozone system. The water depth in the ozone contactor is set at 22 ft.

**Table 6.5 – Design Criteria for the Ozone & Peroxone Systems at the Patterson Pass WTP**

| Process & Parameter | Design Value | | Unit | Basis/Comment |
|---|---|---|---|---|
| | **Ozone** | **Peroxone** | | |
| Plant Design Flow Rate | 24.5 | 24.5 | MGD | 22.5 MGD + 2 MGD of recycle flow |
| Conv. Train Capacity | 15.0 | | MGD | 13.5 MGD + 1.5 MGD of recycle flow |
| ***Ozone or Peroxone Contactor*** | | | | |
| Hydraulic Retention Time | 10(1) | 3 | minute | 10-min HRT per contactor |
| Contactor Type | Basin | Pipeline | | |
| Number of Contactors in Parallel | 2(1) | 1 | | |
| Volume of Contactor | 208,320 | 51,042 | gallons | |
| Volume of Each Contactor | 104,160 | 51,042 | gallons | |
| Water Depth | 22 | -- | ft | Assumed |
| Area of Each Contactor | 633 | -- | $ft^2$ | |
| Contactor Length | 40 | -- | ft | |
| Contactor Width (each) | 16 | -- | ft | |
| Total Contactor Width | 45 | -- | ft | includes 13-ft wide Gallery |
| Peroxone Pipeline Diameter | -- | 48 | inches | |
| Peroxone Pipeline Length | -- | 543 | ft | |
| ***Ozone Generation & Feed System*** | | | | |
| Max. Ozone Dose | 3.0 | 3.0 | mg/L | Based on pilot testing results |
| Ozone Dose during T&O season | 2.5 | 2.5 | mg/L | |
| Ozone Dose during non-T&O season | 1.5 | 0 | mg/L | |
| Max. Ozone Production Rate | 613 | 613 | lbs/day | |
| Number of Duty Generators | 2 | 2 | | |
| Number of Standby Generators | 1 | 0 | | |
| Total Number of Generators | 3 | 2 | | |
| Capacity per Generator | 306 | 306 | lbs/day | |
| Total installed capacity | 918 | 612 | lbs/day | |
| Feed Gas Type | LOX | LOX | | |
| % Ozone in Generator Outlet | 8% | 8% | | |
| LOX Storage Requirement | 15 | 15 | days | |
| LOX Usage Rate | 7,660 | 7,660 | lbs/day | |
| LOX Tank Capacity | 115,000 | 115,000 | lbs | |
| LOX Volumetric Usage Rate | 805 | 805 | gallons | LOX S.G. = 1.141 |
| Volume of LOX Tank | 12,000 | 12,000 | gallons | |
| Approximate LOX Tank Diameter | 14 | 14 | ft | |
| Approximate LOX Tank Height | 16 | 16 | ft | Includes 6 ft for freeboard & underside clearance |
| ***Ozone Generation Building*** | | | | |
| Ozone Building Area | 3,800 | 2,500 | $ft^2$ | 4.1 $ft^2$/lb of Capacity(2) |

(2). Each contactor is sized for 10-min HRT for the conventional train (15.0 MGD)
(2). Langlais et al., 1991

**Table 6.6 – Design Criteria for the Chemical Feed Systems Associated with the Implementation of Ozone or Peroxone at the Patterson Pass WTP**

| Process & Parameter | Design Value | | Unit | Basis/Comment |
|---|---|---|---|---|
| | Ozone | Peroxone | | |
| ***Hydrogen Peroxide Feed System*** | | | | |
| Maximum $H_2O_2$ Dose | -- | 3.0 | mg/L | Peroxone Ratio of 1:1 |
| Average $H_2O_2$ Dose | -- | 0.65 | mg/L | Peroxone Ratio 0.5:1 |
| Peroxide Strength | -- | 35 | % | % active by weight |
| Peroxide Stock Concentration | -- | 3.3 | lbs/gal | S.G. = 1.13 |
| Max Feed Rate at Max Dose | -- | 613 | lbs/day | |
| Max Feed Rate at Max Dose | -- | 186 | gal/day | |
| Pumping Capacity | -- | 7.7 | gal/hr | |
| Number of Duty Pumps | -- | 2 | | One at 2.7 gph & one at 5.0 gph |
| Number of Standby Pumps | -- | 1 | | @ 2.7 gph |
| Storage Capacity at Max Dose | -- | 15 | days | |
| Min. Tank Operating Volume | -- | 3,000 | gallons | |
| ***Carbon Dioxide Feed System*** | | | | |
| Maximum $CO_2$ Dose | 45 | -- | mg/L | Based on ACWD Design |
| Average $CO_2$ Dose | 16 | -- | mg/L | Based on ACWD Design |
| $CO_2$ Gas Usage Rate | 9,195 | -- | lbs/day | |
| Liquid $CO_2$ Usage Rate | 1,100 | -- | gal/day | Liquid CO2 S.G. = 1.03 |
| Storage Capacity at Max Dose | 15 | -- | days | |
| Minimum Storage Volume | 16,000 | -- | gallons | |
| ***Pre-Chlorine Feed Rate*** | | | | |
| Chlorine Dose | 1.0 | 1.0 | mg/L | |
| Hypochlorite Strength | 0.8 | 0.8 | % | percent active by wt. |
| Hypochlorite Strength | 0.07 | 0.07 | lbs/gal | S.G. = 1 |
| Hypochlorite Usage Rate | 367 | 367 | lbs/day | |
| Hypochlorite Used from Tank | 5,500 | 5,500 | gal/day | |
| Number of Pumps on Duty | 1 | 1 | | |
| Number of Pumps on Standby | 1 | 1 | | |
| Capacity of each pump | 114.6 | 114.6 | gal/hr | |
| ***Pre-Ammonia Feed Rate*** | | | | |
| Ammonia Dose | 0.25 | 0.25 | mg/L as N | |
| Ammonia Strength | 19.0 | 19.0 | % | percent active by wt. |
| Ammonia Strength | 1.47 | 1.47 | lbs/gal | S.G. = 0.93 |
| Ammonia Usage Rate | 51 | 51 | lbs/day | |
| Ammonia Used from Tank | 35 | 35 | gal/day | |
| Number of Pumps on Duty | 1 | 1 | | |
| Number of Pumps on Standby | 1 | 1 | | |
| Capacity of each pump | 0.7 | 0.7 | gal/hr | |

The ozone dose anticipated at the PPWTP is the same as that planned for DVWTP. Based on the pilot testing results, a design maximum applied ozone dose of 3.0 mg/L was selected for the ozone or Peroxone alternative. This translates into an ozone production of 613 lbs/day (at maximum water flowrate). Since the ozone process will be designed to meet the disinfection requirements, it is assumed that the system will include two duty generators and one stand-by generator. However, for the Peroxone process, no standby generator is necessary since the process will not be relied upon for meeting the disinfection requirements. For this reason, although the two processes will be designed for the same ozone dose, the ozone process will require three 306 lbs/day generators, while the Peroxone process will require only two 306 lbs/day generators.

Liquid Oxygen (LOX) will be used to supply oxygen to the ozone generators. Assuming that the ozone content in the generator outlet will be 8% by wt., the plant will consume about 7,660 lbs of oxygen per day when the maximum ozone dose is applied to the maximum water flowrate through the plant. Assuming a target storage capacity of 15 days at maximum demand, approximately 12,000 gallons of LOX should be stored onsite. This can be accommodated in a vertical 14-ft diameter tank with an approximate height of 16 ft. A standard thermal/catalytic off gas destruct system, cooling water system, and nitrogen-boost/supplemental air system are assumed to be included with both the ozone and Peroxone options.

Finally, based on the factors provided by Langlais et al. (1991), the ozone generator building under the ozone option is projected to require a floor area of approximately 3,800 $ft^2$ while that under the Peroxone option is projected to require a floor area of approximately 2,500 $ft^2$.

Table 6.6 presents the design criteria for the chemical addition systems required in conjunction with either ozone or Peroxone implementation at PPWTP. A hydrogen peroxide storage and feed system will be required for the Peroxone process. As indicated earlier for the DVWTP, Zone 7 may choose to lease a $H_2O_2$ feed system on an as-needed basis. With a maximum design Peroxone ratio of 1:1 (mg $H_2O_2$-to-mg ozone), the maximum hydrogen peroxide dose is projected at 3.0 mg/L. At this dose, the maximum hydrogen peroxide usage rate is calculated at 186 gallons/day to be fed by two duty pumps and one standby pump. With a desired storage capacity of 15 days under maximum usage conditions, a minimum storage volume of approximately 3,000 gallons is required. During design, a larger size may be selected in order to allow for full truck deliveries.

Table 6.6 also presents the design criteria for the $CO_2$ feed system required under the ozone option only. The projected maximum $CO_2$ dose is 45 mg/L, which would reduce the pH of the raw water from a high of 9.5 to approximately 7.0. This calculation was conducted assuming a high alkalinity of 150 mg/L as $CaCO_3$. Under maximum dose and flow conditions, approximately 1,100 gallons of liquid $CO_2$ will be consumed per day of operation. A 16,000 gallon tank would satisfy this consumption rate over a 15-day period.

Table 6.6 lists the feed requirements for chlorine and ammonia to the raw water required to control bromate with pre-chloramination. PPWTP already has chlorine and ammonia storage and feed facilities. Therefore, the information in Table 6.6 is limited to sizing new feed pumps required to pump sodium hypochlorite and ammonia from the existing tanks to the raw water line. It should be noted that PPWTP utilizes an on-site hypochlorite generation system that produces 0.8% hypochlorite solution (by wt.). In addition, Zone 7 plans to convert the existing anhydrous ammonia system to an aqua ammonia storage and feed system as part of the larger T&O project. Therefore, the design criteria quantities are shown for aqua ammonia. Under maximum flow conditions and a projected prechloramine dose of 1.0 mg/L, a total of

5,500 gallons of 0.8% hypochlorite and 35 gallons/day of 19% ammonia will be consumed each day. Since the prechloramine dose is not anticipated to vary greatly, only one duty and one standby pump is required for each chemical. The turn-down ratio on one pump should be sufficient to accommodate changes in chemical feed rate with changing flow rate through the plant.

Table 6.7 presents the design criteria for the new chlorine contactor and the air-scour system for the conventional filters. As discussed earlier, the contactor is added to the conventional plant filtered water before it blends with the treated water from the UF plant. Under the ozone option, the chlorine contactor is 30 ft long and 20 ft wide with a side water depth of 20 ft. The contactor is comprised of two 10-ft wide serpentine channels. At the design flowrate of 13.5 MGD through the conventional train, this contactor will have an average hydraulic retention time of 9.6 minutes which is sufficient for HPC bacteria inactivation. In addition, assuming a baffling factor of 0.3, this contactor will have an effective disinfection time, $T_{10}$, of 2.9 minutes at maximum flowrate. Combined with the conservative assumptions for temperature (8.0 $^{o}$C) and chlorine residual (1.5 mg/L), this contactor will meet the minimum virus inactivation requirement of 2-logs as stipulated by the Surface Water Treatment Rule, and provide for a safety factor of 27%.

Under the Peroxone option, the chlorine contactor is 100 ft long and 40 ft wide with a side water depth of 20 ft. The contactor is comprised of four 10-ft wide serpentine channels. At the design flowrate of 13.5 MGD through the conventional train, this contactor will have an average hydraulic retention time of 63.8 minutes. Assuming a baffling factor of 0.5, this contactor will have an effective disinfection time, $T_{10}$, of 31.9 minutes at maximum flowrate. Combined with the conservative assumptions for pH (8.0), temperature (8.0 $^{o}$C) and chlorine residual (1.5 mg/L), this contactor will meet the minimum disinfection requirements of 0.5-logs *Giardia* and 2-logs virus inactivation, along with a safety factor of 46%.

Table 6.7 projects the minimum air flow rate required to incorporate air-scour at the PPWTP. Air scour is recommended to improve filter backwashing, especially with the conversion of the filters to a biological filtration mode. Based on a filter surface area of 675 ft$^2$ and a standard air-scour rate of 3.0 scfm/ft$^2$, the minimum air flow required is estimated at 2,000 scfm.

**Table 6.7 – Design Criteria for the New Chlorine Contactor and Air-Scour System at the Patterson Pass WTP**

| Process & Parameter | Design Value | | Unit | Basis/Comment |
|---|---|---|---|---|
| | Ozone | Peroxone | | |
| Overall Length | 30 | 100 | ft | |
| Number of serpentine channels | 2 | 4 | | |
| Width of each channel | 10 | 10 | ft | |
| Overall Width | 20 | 40 | ft | |
| Water depth | 20 | 20 | ft | |
| Length of each reach | 93 | 180 | ft | |
| Volume | 12,000 | 80,000 | cu-ft | |
| Volume | 89,760 | 598,400 | gallons | |
| Design Flowrate | 13.5 | 13.5 | MGD | Conventional train |
| HRT at Design Flow | 9.6 | 63.8 | minutes | |
| Hydraulic Efficiency ($T_{10}$/HRT) | 0.3 | 0.5 | | assumed |
| $T_{10}$ at Maximum Flow | 2.9 | 31.9 | minutes | |
| Minimum Chlorine Residual | 1.5 | 1.5 | mg/L | |
| Minimum CT | 4.3 | 47.8 | mg-min/L | |
| Minimum Water Temperature | 8.0 | 8.0 | $^{o}$C | |
| Maximum Water pH | 8.0 | 8.0 | | |
| Min. Log virus or *Giardia* Achieved | 2.53 | 0.73 | logs | Virus for Ozone option & *Giardia* for Peroxone option |
| Min. Log virus or *Giardia* Required for a Conventional Filtration Plant | 2.0 | 0.5 | logs | Virus for Ozone option & *Giardia* for Peroxone option |
| Min. CT Ratio | 1.27 | 1.46 | | (goal is Ratio > 1.0) |
| ***Air Scour System*** | | | | |
| Design Air Scour Rate | 3.0 | 3.0 | scfm/ft$^2$ | |
| Minimum total Air Flow | 2,000 | 2,000 | scfm | |
| Number of blowers | 1 | 1 | | |

## 6.3 SITE CONSTRAINTS & PROCESS LAYOUT

Each of the two plants has specific site constraints that should be taken into consideration. While a detailed site layout and piping plan is outside the scope of this effort, it is important to evaluate how either technology may fit within the boundaries of each site. The location of the unit process will also impact the plant hydraulics, and the potential need to make other modifications at the plants to accommodate the new processes. All these factors ultimately impact the overall cost of implementation of either technology.

### 6.3.1 Del Valle Water Treatment Plant

Figure 6.4 shows a workable layout of the primary facilities with ozone implementation (Figure 6.4-A) or Peroxone implementation (Figure 6.4-B) at the Del Valle WTP. In siting the various components at the noted locations, the following factors were considered:

1. As discussed in subsequent sections in this Section, the hydraulic gradeline between the raw water pumps and the water surface elevation in the DAF unit or the splitter box to the Superpulsators® is limited. Therefore, minor hydraulic losses from elbows and tee's should be minimized.
2. The mechanical screen for the DAF train will be maintained, and the screen for the Superpulsator® train will be abandoned. The screen is needed for both of the clarification units, but not for the ozone contactor. Therefore, the ozone contactor can be located upstream of the screen.
3. A new flash mix unit for the Superpulsator® train will be needed. This unit can be installed adjacent to the existing flash mix unit for the DAF train immediately downstream of the mechanical screen.
4. Because of the off-gassing concerns when using hydrogen peroxide, it is important that the chemical line runs between the $H_2O_2$ tank and application point are as short as possible. Therefore, a site had to be selected where the $H_2O_2$ tank could be located adjacent to the Peroxone contactor.
5. No above-grade facilities can be located underneath the PG&E high-voltage power lines that cross over the site, as well as within five feet on either side.
6. The new solar panel project will be installed soon, and the layout must not encroach into the area to be used by this project.

With the above factors in mind, Figures 6.4-A & 6.4-B show potential locations for the ozone contactor, Peroxone contactor, ozone generation building, LOX tank and evaporators, $CO_2$ tank (for the ozone option) and hydrogen peroxide tank (for the Peroxone option). As indicated in Section 1.0, the entire plant will be fed through the 48-inch line added as part of the DAF design project. Immediately downstream of the raw water pumps and flowmeter, the water flow be diverted from the 48-inch line into the ozone or Peroxone contactor as shown in Figures 6.4-A and 6.4-B. The ozone building as well as the LOX tank and evaporators, will be located east of the pump building. The $CO_2$ tank and control panel (under the ozone option), or the $H_2O_2$ tank and feed system (under the Peroxone option) will be located next to the ozone or Peroxone contactor, respectively. It is noted that the sizes of the contactors and ozone building shown in Figures 6.4-A and 6.4-B are based on the process design criteria presented earlier in this Section. However, additional modifications could be made during preliminary design to further reduce the sizes of the facilities, especially the ozone building.

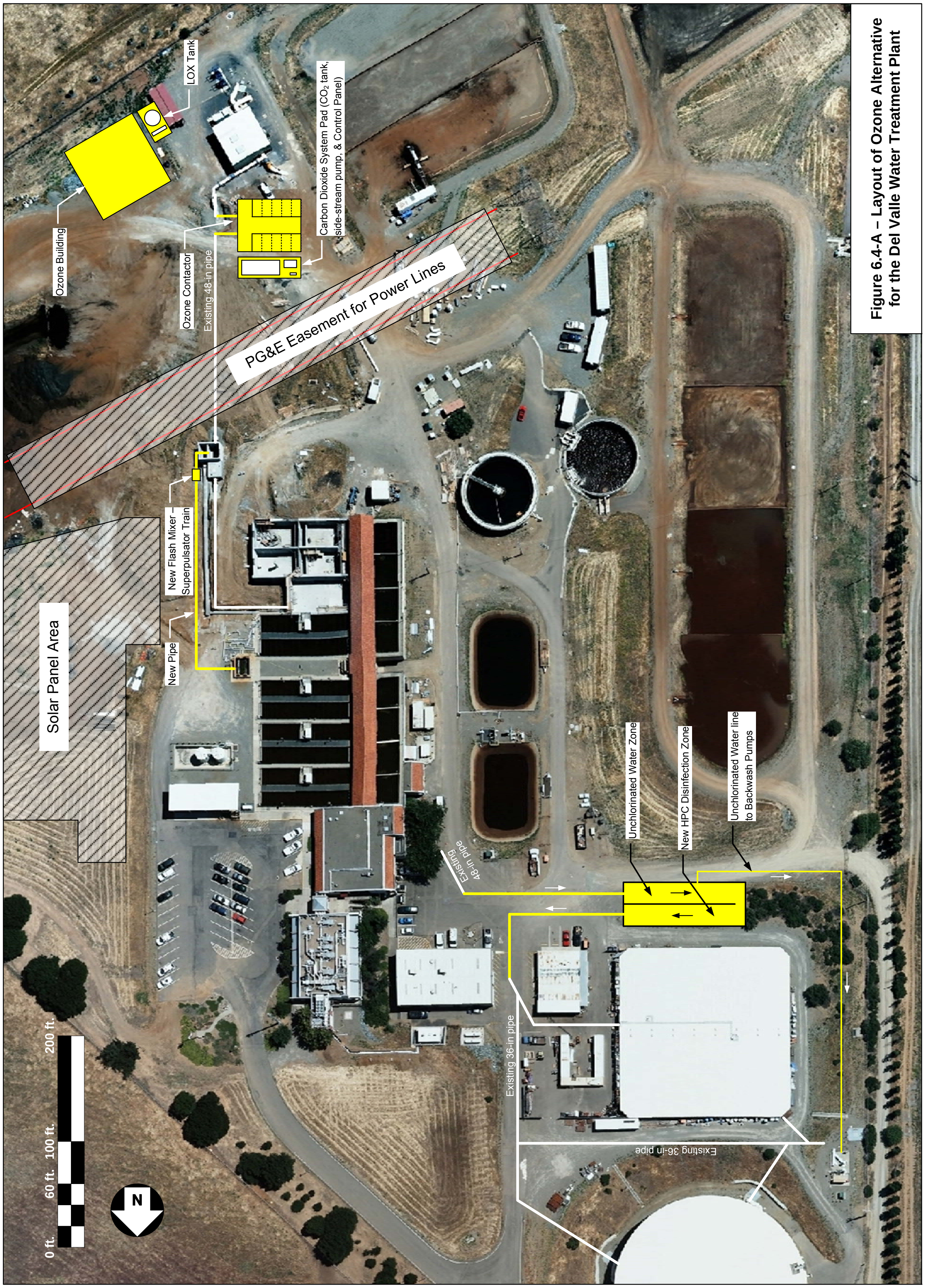



**Figure 6.4-A – Layout of Ozone Alternative for the Del Valle Water Treatment Plant**

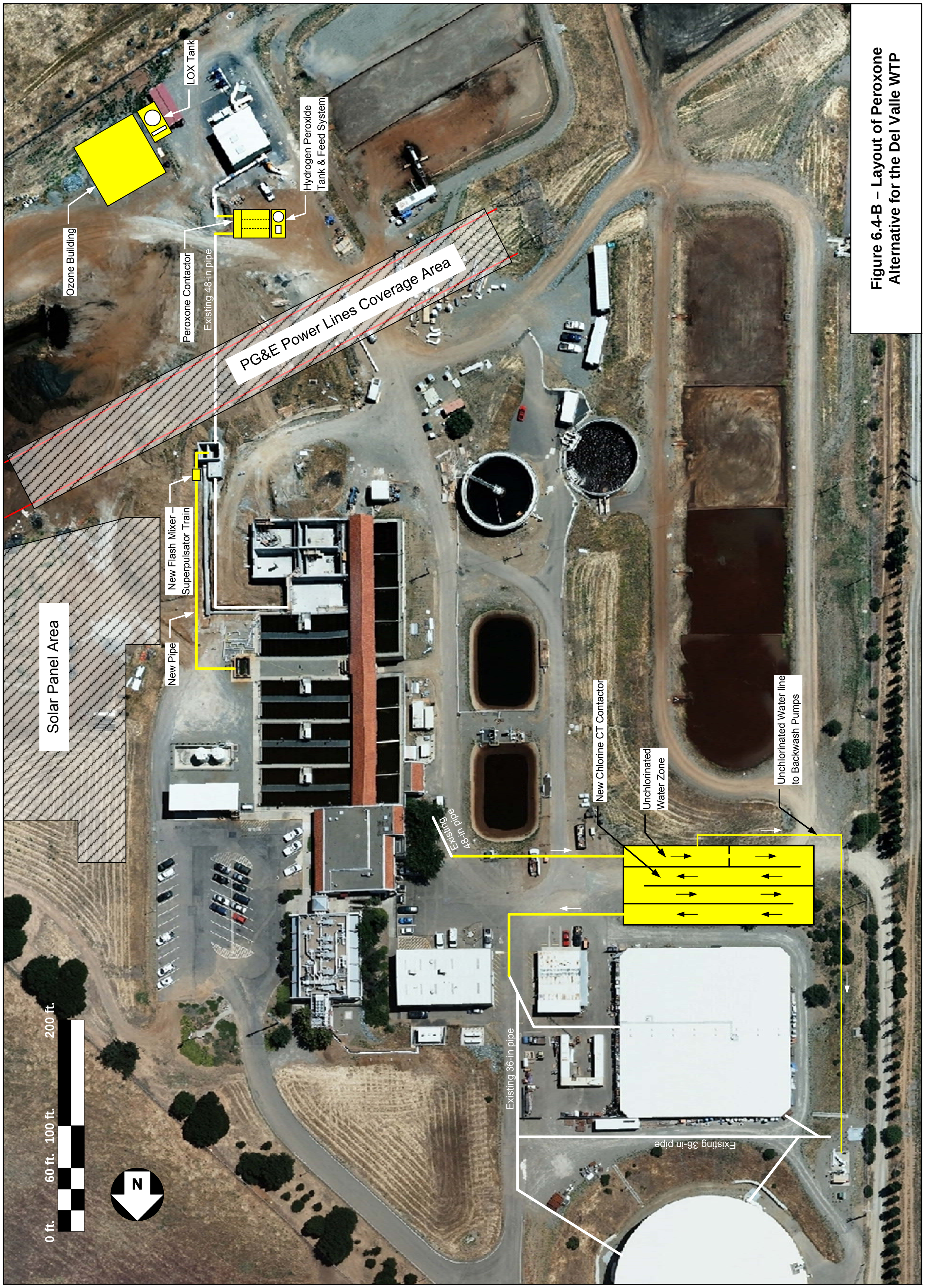



**Figure 6.4-B – Layout of Peroxone Alternative for the Del Valle WTP**

A new pipe will be constructed between the mechanical screen well and the flow splitter box for the Superpulsators. This line will also include a pumped jet flash mixer to allow for different chemical treatment scenarios for the Superpulsators and the DAF process.

The current piping configuration at the raw water pumps includes an above-ground 50-ft section of 30-inch line before it increases to the 48-inch line. This section includes the flow meter to the DAF train. The pipe diameter was set at 30 inches because of the need to maintain a high-enough velocity through the pipe as it feeds the 10 MGD DAF units. Zone 7's plan was to increase the diameter of this pipe to 48-inches as the entire plant capacity of 40 MGD is fed through that line. Therefore, under the modifications outlined in this Section, this pipe will be replaced with a 48-inch pipe. However, it is recommended that the flowmeter not be installed at that location, but rather install two flow meters on the two pipes downstream of the mechanical screen and flash mixers. This approach would provide for a separate flow measurement for each train.

Figure 6.4-A shows a potential location of the new filtered water tank under the ozone option and the associated piping required to bring filtered water to the tank and then return it to the inlet of the clearwells. The tank is 93 ft long and 38 ft wide. Figure 6.4-B shows the size and configuration of the tank under the Peroxone option (180 ft long and 76 ft wide). The backwash pumps will be re-plumbed to draw unchlorinated water from the first compartment of the new tank and utilize it to backwash the biofilters. This approach maintains the backwash pumps and piping configuration after conversion to biological filtration.

### 6.3.2 Patterson Pass Water Treatment Plant

Figures 6.5-A and 6.5-B show potential layouts of the new facilities under the ozone alternative and the Peroxone alternative, respectively. All the facilities were located on the north edge of the Zone 7 property in close proximity to the raw water line. It is noted that the UF train raw water supply take-off and vault are located immediately inside the property line. Therefore, the diversion of the water from the raw water line to the ozone or Peroxone contactor may have to take place within the DWR right-of-way, and then connect to the ozone or Peroxone contactor on the Zone 7 property. This will require permission from DWR. The Peroxone-treated water will then be returned to the raw water pipeline immediately upstream of the flow split between the two trains. The piping configuration for the ozone train is complicated since each of the two contactors must be fed from a location downstream of flow split, but upstream of the flash mix of each train. The decant from the washwater ponds will then be returned to the influent of the ozone contactor on the conventional train. The configurations of the ozone and Peroxone processes are shown in Figures 6.5-A and 6.5-B.

Figure 6.5-A shows the potential layout of the ozone contactor, ozone building, and LOX tank at the north edge of the Zone 7 property. Figure 6.5-A also shows the potential location of the $CO_2$ tank and control panel on the south side of the membrane building. The siting of this tank is not critical and may be moved to any other preferred location. The system will use filtered water to inject the $CO_2$ and the "carbonated water" will need to be piped to the raw water line upstream of the ozone or Peroxone contactor. This suggests that locating this facility closer to the north side of the plant would be desirable.


Figure 6.5-A – Potential Layout of the Ozone Alternative for the Patterson Pass WTP


**Figure 6.5-B – Layout of Peroxone Alternative for the Patterson Pass Water Treatment Plant**

Figure 6.5-B shows the potential layout of the Peroxone pipeline contactor, the ozone building, the LOX tank, and the $H_2O_2$ tank. The pipeline contactor is 543 ft of 48-inch diameter pipe. Ozone will be injected at the entrance to the contactor, and $H_2O_2$ will be injected approximately 100 ft downstream of the ozone injection point. During the detailed design of this system, close attention should be given to designing a reliable off-gassing system that minimizes the amount of gas bubbles that make it all the way to the clarifiers. Figure 6.5-B shows a small structure over the pipeline contactor after the water flow turns around and back to the head of the plant. This structure is intended to serve as a location for allowing the off-gas to be removed from the water. Ozone destruct units would be located at that location to destroy the any remaining ozone from the gas before it is discharged into the atmosphere.

The layouts shown in Figures 6.5-A and 6.5-B involve loss of some of the existing roadway on the site. Specifically, the looped access road around the back of the membrane building and membrane clarifier would be lost. However, vehicle access to these buildings will still be preserved, just not in a looped fashion. If a vehicle loop is desired, particularly for truck deliveries to the membrane building, then the access road around the back of the sludge drying beds can be evaluated and improved if necessary to allow for such looped access.

Figures 6.5-A and 6.5-B also show potential locations for the filtered water disinfection contactor. Under the ozone option, the contactor is small enough that it could fit next to the clearwell as shown in Figure 6.5-A. However, under the Peroxone option, the contactor is significantly larger (100ft x 40ft). One option is to locate this contactor to the east of the clearwell. The clearwell is shown to overlap some facilities. If these facilities are essential and cannot be removed, then the contactor could be moved further south.

## 6.4 HYDRAULIC CONSTRAINTS

Adding an ozone or Peroxone contactor in the raw water line of either plant is expected to increase the headloss between the source and the plant. This section includes a preliminary analysis of the anticipated headloss through each of the two alternatives at each plant and compares it to the available head. Three types of headloss estimates were made:

1. Friction losses through straight pipe runs were estimated using the Hazen-Williams equation with a Hazen-Williams C factor of 130.

2. Minor losses through various pipe fittings, as well as entrance and exit losses into and out of open basins. These estimates were slightly conservative in that the K factor used was that for smaller pipes (18 to 24 inches). Fittings for larger pipe diameters have lower K value than those for smaller pipe diameters.

3. Loss through a multi-chamber ozone or Peroxone contactor. This value was set at 1.0 ft for a 10-minute multi-chamber ozone contactor, and at 0.5 ft for a 3-minute Peroxone contactor. These values are also conservative, and were assumed based on ozone designs at ACWD and SCVWD.

Information on available head at each plant was obtained from previous work conducted by other engineering firms for Zone 7 and provided to WQTS by Zone 7 staff.

### 6.4.1 Del Valle Water Treatment Plant

Table 6.8 summarizes the estimated Hydraulic Gradeline (HGL) level at a number of critical points along the water path from the raw water pumps to the flow splitter box on the Superpulsator train. During the DAF design project, MWH estimated the water level in the flow splitter box at 658.96 ft with a flowrate of 36 MGD through the Superpulsator® train. This level was used in this analysis. With 34 MGD through the Superpulsator® train, the water level downstream of the mechanical screen was projected at 659.82 ft. With a flow of 44 MGD through the screen, the headloss through the screen was estimated at 0.26 ft (3.12 inches) based on the MWH DAF design report. With 44 MGD through the 48-inch pipe from the ozone/peroxone contactor to the mechanical screen, the water level at the end of the ozone/peroxone contactor was projected at 661.33 ft. Since a headloss of 1.0 ft was assumed for the 10-minute ozone contactor and a headloss of 0.5 ft was assumed for the 3-minute Peroxone contactor, the water level at the start of the ozone contactor was projected at 662.33 ft, while the water level at the start of the Peroxone contactor was projected at 661.83 ft. Finally, hydraulic calculations project the HGL level at the discharge of the raw water pumps required to push 44 MGD through the plant at 664.06 ft under the ozone alternative, and 663.56 ft under the Peroxone alternative.

**Table 6.8 – Estimated HGL Levels (ft) Across the DVWTP Under the Ozone & Peroxone Alternatives**

| Component | Ozone Alt. | Peroxone Alt. |
|---|---|---|
| HGL at Raw Water Pump discharge | 664.06 | 663.56 |
| Water Level at Start of Ozone or Peroxone Contactor | 662.33 | 661.83 |
| Water Level at end of Ozone or Peroxone Contactor | 661.33 | 661.33 |
| Water Level before Mechanical Screen | 660.07 | 660.07 |
| Water Level after Mechanical Screen | 659.82 | 659.82 |
| Water Level in Superpulsator® Flow Splitter Box | 658.96 | 658.96 |

The MWH DAF design report shows the HGL at the pump discharge at 666 ft. However, this assumed maximum water level in the SBA. Based on the Preliminary Design Report for Del Valle WTP Booster Pump Station (1999) prepared by CDM, fluctuating water level in the SBA would result in pump discharge HGL levels ranging from 663.0 ft to 666.0 ft. The projected required HGL level of 664.06 ft under the ozone alternative and 663.56 ft under the Peroxone alternative at 44 MGD is in the middle of the available range based on the existing pumps. This analysis shows that the maximum HGL required is only 1.06 ft above the current available HGL. Based on comments from Zone 7, planned SBA modifications downstream of the DVWTP will increase the water level in the SBA at DVWTP. In addition, Zone 7 staff indicated that minor changes in the operation of the pump VFDs could also increase the pump discharge pressures. Based on these two comments, it can be assumed that no significant modifications will be required to the raw water pumps at DVWTP to accommodate the implementation of either ozone or Peroxone on the raw water side. It should be emphasized that the hydraulic calculations made herein are based on the recommended modifications noted in Section 3. For example, it is assumed that the 36-inch diameter pipe spool on the pump discharge side will be replaced with a 48-inch diameter pipe.

### 6.4.2 Patterson Pass Water Treatment Plant

Table 6.9 summarizes the estimated headloss from the Patterson Pass reservoir to the flow split between the two trains (UF and conventional). During the design of the UF train, CDM developed a hydraulic gradeline showing that the HGL level at the point of takeoff for the new UF train is 700.1 ft when the overall flow is 20 MGD. Unfortunately, there is no indication of what the HGL level would be at 24.5 MGD. Based on hydraulic estimates, a flow increase from 20 MGD to 24.5 MGD would increase the friction and minor losses by approximately 50%. Based on the water levels in the clarifiers, it is estimated that the HGL at the point of takeoff of the UF train could increase from 700.1 ft at 20 MGD to 701.45 ft at 24.5 MGD. This level was set in the analysis presented herein. Based on the hydraulic calculations conducted and summarized in Table 6.9, the minimum required water level in the Patterson Pass Reservoir is projected at 705.43 ft under the ozone alternative, and 703.82 ft under the Peroxone alternative.

**Table 6.9 – Estimated HGL Levels (ft) Across the PPWTP Under the Ozone & Peroxone Alternatives**

| Component | Ozone Alt. | Peroxone Alt. |
|---|---|---|
| Required Minimum Water Level in PP Reservoir | 705.43 | 703.82 |
| HGL Level at Start of Ozone or Peroxone Contactor | 703.53 | 702.45 |
| HGL Level at end of Ozone or Peroxone Contactor | 702.53 | 702.05 |
| HGL Level at Flow Split between Two Trains | 701.45 | 701.45 |

In the 2003 CDM design report, the minimum water surface elevation in Patterson Pass reservoir is presented at approximately 703 ft. However, Zone 7 staff indicated that DWR and Zone 7 are currently making modifications to the SBA and PP Reservoirs that will result in an additional three feet of head in the Reservoir. With this improvement, the water level in Patterson Pass reservoir would increase to 706 ft, which would be sufficient to provide 24.5 MGD of flow to the PPWTP under either the ozone alternative or the Peroxone alternative as shown in Table 6.9.

## 6.5 Summary of Required Modifications

As presented in this Section, implementing either ozone or Peroxone at the DVWTP or the PPWTP will require specific modifications and additions to each plant. For each plant, some modifications will need to be implemented with either technology, while some modifications are specific to one of the two technologies. This section summarizes these required modifications.

### 6.5.1 Required Modifications at the Del Valle Water Treatment Plant

The following modifications are required for the implementation of <u>either ozone or Peroxone</u> at the DVWTP:

1. Eliminate raw water pipe currently used to feed the Superpulsator® train, and feed the entire plant through the 48-inch diameter pipe currently feeding the DAF train. The existing influent meter station/vault will also be eliminated.
2. Retain the mechanical screen on the 48-inch diameter line.
3. Construct a new 48-inch line from the mechanical screen to the Superpulsator flow splitter box, and add a new flash mix on this line to allow for independent chemical treatment of the Superpulsator® train and the DAF Train.
4. Install new flowmeters on the DAF and Superpulsator train feed pipes downstream of the mechanical screen.
5. Replace the existing 36-inch line between the raw water pumps and the 48-inch pipe with a 48-inch section.
6. Eliminate chlorine feed to the settled water and allow the filters to operate in a biological mode.
7. Add a two-compartment tank in between the filtered water overflow structure and the clearwells.
    a. The first compartment will hold 223,000 gallons of unchlorinated water for backwashing
    b. The size of the second compartment will vary depending on which option is selected (2.8 MG for the Peroxone option, 259,000 for the ozone option).
8. Add a chlorine addition point at the effluent of the first compartment of the two-compartment tank.
9. Add an intermittent chlorine addition point to the backwash water line.
10. Add a chlorine addition point and an ammonia addition point immediately downstream of the raw water pumps.
11. Add a 22,000 gallon LOX storage and feed system.
12. Re-plumb the existing backwash water pumps to draw from the first chamber of the two-chamber tank
13. Add an air-scour system to supplement the water backwash system for the biofilters.

The following required modifications are <u>specific to the implementation of ozone</u> at DVWTP:

1. Add a $CO_2$ storage and feed system for raw water pH suppression.
2. Construct a 50 ft x 50 ft multi-chamber ozone contactor
3. Construct a 5,400-ft$^2$ ozone generation building containing three 550 lbs/day ozone generators and their ancillary equipment.

The following required modifications are <u>specific to the implementation of Peroxone</u> at DVWTP:

1. Construct a 27 ft x 28 ft Peroxone contactor
2. Construct a 4,000-ft$^2$ ozone generation building containing two 550 lbs/day ozone generators and their ancillary equipment.
3. Add a hydrogen peroxide ($H_2O_2$) storage and feed system with a minimum operating volume of 5,000 gallons.

### 6.5.2 Required Modifications at the Patterson Pass Water Treatment Plant

The following modifications are required for the implementation of either ozone or Peroxone at the PPWTP:

1. Re-route the return washwater line (return flows without residual polymer) to a point in the raw water pipe upstream of the ozone or Peroxone process.
2. Eliminate chlorine feed to the settled water and allow the filters to operate in a biological mode.
3. Add a chlorine addition point downstream of the filters and upstream of ammonia addition.
4. Add a chlorine addition point to the feed backwash water line.
5. Add a chlorine addition point and an ammonia addition point immediately downstream of the DWR meter and upstream of the new ozone or Peroxone process.
6. Add a LOX storage and feed system with a minimum operating storage volume of 12,078 gallons.
7. Add an air-scour system to supplement the water backwash system for the biofilters.
8. Re-plumb existing backwash water pump to draw from un-chlorinated filtered water to fill backwash water supply tank.
9. Possible add new potable water supply, as it currently comes from backwash tank supply line.

The following required modifications are specific to the implementation of ozone at PPWTP:

1. Add a 16,000-gallon liquid $CO_2$ storage and feed system for raw water pH suppression.
2. Construct a 40 ft x 45 ft multi-chamber dual-train ozone contactor with each train configured to serve the UF plant and one train configured to serve the conventional train.
3. Relocate the rapid mix of the UF train to a new location between the ozone contactor and the UF clarifier.
4. Relocate the return line of the pond decant to a location upstream of the conventional train ozone contactor.
5. Construct a 3,800-$ft^2$ ozone generation building containing three 306 lbs/day ozone generators and their ancillary equipment.

The following required modifications are specific to the implementation of Peroxone at PPWTP:

1. Construct a Peroxone pipeline contactor with a 48-diameter and a length of 543 ft.
2. Construct a 2,500-$ft^2$ ozone generation building containing two 306 lbs/day ozone generators and their ancillary equipment.
3. Add a hydrogen peroxide ($H_2O_2$) storage and feed system with a minimum operating volume of 3,000 gallons.

# SECTION 7.0 – COST ESTIMATE

This Section presents WQTS' opinion of the probable capital and annual O&M cost for implementing either the ozone or Peroxone alternative at the Del Valle Water Treatment Plant (DVWTP) and the Patterson Pass Water Treatment Plant (PPWTP). Section 6 discussed the details of the modifications required under each treatment alternative. Table 7.1 summarizes the primary modifications to be implemented at each plant under each alternative.

**Table 7.1 – Summary of Primary Modifications at Each Plant under Each Alternative**

| Ozone Alternative | Peroxone Alternative |
|---|---|
| Ozone contactor | Peroxone contactor |
| Ozone generation equipment & bldg | Ozone generation equipment & bldg |
| Carbon dioxide storage & feed system | Hydrogen peroxide storage & feed system |
| Air scour system | Air scour system |
| Small chlorine contactor | Chlorine CT contactor |

## 7.1 CAPITAL COST

In developing the opinion of probable capital cost, a planning level budgeting approach was utilized. In this approach, costs of basic components are projected based on unit cost values, and specific percent markups are added for various project components such as general conditions, site work & yard piping, electrical, instrumentation & control, contingency, and engineering. This planning level approach is projected to have an uncertainty range of ±30%.

Tables 7.2 through 7.5 present the breakdown of the probable capital costs for ozone or Peroxone implementation at DVWTP and PPWTP. The footnotes at the bottom of each table explain the basis for the unit cost factors used. Unit costs for the ozone contactor, LOX system, ozone generation system and building, hydrogen peroxide feed system, and air scour addition were based on unit cost equations developed by McGivney & Kawamura (2008).[6] The specific equations used are summarized in Table 6.

A few items should be noted regarding the capital cost breakdowns presented and the equations used:

1. McGivney & Kawamura (2008) does not have a specific equation for a $H_2O_2$ feed system. Therefore, the equation for a ferric chloride feed system was used as a substitute.

2. McGivney & Kawamura's equations were developed based on an ENR CCI of 8889. Therefore, the cost values generated by these equations were adjusted to ENR CCI 9755, which is the February 2009 ENR CCI for San Francisco.

[6] McGivney & Kawamura, 2008. *Cost Estimating Manual for Water Treatment Facilities*, John Wiley & Sons, Hoboken, NJ.

**Table 7.2 – Probable Capital Cost for Implementing Ozone at DVWTP**

| ***Capital Cost:*** | | | | |
|---|---|---|---|---|
| **Item** | **Level** | **Unit** | **Note** | **Cost** |
| Ozone Contactor | 306,000 | gallons | (1) | $335,000 |
| Ozone system & building | 1,650 | lbs/day | (1) | $4,124,000 |
| Carbon Dioxide System | | | (2) | $675,000 |
| Air Scour System | 5,360 | $ft^2$ | (1) | $587,000 |
| Chlorine Contactor | 520,000 | gallons | (3) | $780,000 |
| | | | Subtotal "A" = | $6,500,000 |
| General Conditions | 15% | of "A" | | $975,000 |
| Site work & Yard Piping | 40% | of "A" | | $2,600,000 |
| Electrical, Instrumentation & Control | 40% | of "A" | | $2,600,000 |
| | | | Subtotal "B" = | $6,175,000 |
| Construction Contingency | 30% | of "A+B" | | $3,803,000 |
| Engineering, Legal, & Admin. | 25% | of "A+B+Contingency" | | $4,120,000 |
| **Probable 2009 Capital Cost (±30%)** | | | | **$20,600,000** |

(1) McGivney & Kawamura (2008) adjusted to ENR CCI 9755 for San Francisco (S.F. ENR)
(2) TOMCO Budgetary Quote
(3) Estimated based on a unit cost of $1.5/gal of clearwell volume (for volumes less than 1.0 MG)

**Table 7.3 – Probable Capital Cost for Implementing Peroxone at DVWTP**

| ***Capital Cost:*** | | | | |
|---|---|---|---|---|
| **Item** | **Level** | **Unit** | **Note** | **Cost** |
| Ozone Contactor | 92,000 | gallons | (1) | $154,000 |
| Ozone system & building | 1,100 | lbs/day | (1) | $3,171,000 |
| Hydrogen Peroxide System | 334 | gal/day | (1) | $239,000 |
| Air Scour System | 5,360 | $ft^2$ | (1) | $587,000 |
| Chlorine Contactor | 2,140,000 | gallons | (2) | $2,140,000 |
| | | | Subtotal "A" = | $6,300,000 |
| General Conditions | 15% | of "A" | | $945,000 |
| Site work & Yard Piping | 40% | of "A" | | $2,520,000 |
| Electrical, Instrumentation & Control | 40% | of "A" | | $2,520,000 |
| | | | Subtotal "B" = | $6,000,000 |
| Construction Contingency | 30% | of "A+B" | | $3,690,000 |
| Engineering, Legal, & Admin. | 25% | of "A+B+Contingency" | | $3,998,000 |
| **Total Probable Capital Cost (±30%)** | | | | **$20,000,000** |

(1) McGivney & Kawamura (2008) adjusted to S.F. ENR CCI 9755
(2) Estimated based on a unit cost of $1.0/gal of clearwell volume (for volumes greater than 1.0 MG)

### Table 7.4 – Probable Capital Cost for Implementing Ozone at PPWTP

| ***Capital Cost:*** | | | | | |
|---|---|---|---|---|---|
| **Item** | **Level** | **Unit** | **Note** | | **Cost** |
| Ozone Contactor | 208,320 | gallons | (1) | | $261,000 |
| Ozone system & building | 919 | lbs/day | (1) | | $2,823,000 |
| Carbon Dioxide System | | | (2) | | $570,000 |
| Air Scour System | 2,000 | $ft^2$ | (1) | | $402,000 |
| Chlorine Contactor | 100,000 | gallons | (3) | | $150,000 |
| | | | | Subtotal "A" = | $4,200,000 |
| General Conditions | 15% | of "A" | | | $630,000 |
| Site work & Yard Piping | 40% | of "A" | | | $1,680,000 |
| Electrical, Instrumentation & Control | 40% | of "A" | | | $1,680,000 |
| | | | | Subtotal "B" = | $3,990,000 |
| Construction Contingency | 30% | of "A+B" | | | $2,457,000 |
| Engineering, Legal, & Admin. | 25% | of "A+B+Contingency" | | | $2,662,000 |
| **Probable 2009 Capital Cost (±30%)** | | | | | **$13,300,000** |

(1) McGivney & Kawamura (2008) adjusted to S.F. ENR CCI 9755
(2) TOMCO Budgetary Quote
(3) Estimated based on a unit cost of $1.5/gal of clearwell volume (for volumes less than 1.0 MG)

### Table 7.5 – Probable Capital Cost for Implementing Peroxone at PPWTP

| ***Capital Cost:*** | | | | | |
|---|---|---|---|---|---|
| **Item** | **Level** | **Unit** | **Note** | | **Cost** |
| Ozone Pipeline Contactor | 543 | ft | (1) | | $260,000 |
| Ozone system & building | 613 | lbs/day | (2) | | $2,172,000 |
| Hydrogen Peroxide System | 186 | gal/day | (2) | | $199,000 |
| Air Scour System | 2,000 | $ft^2$ | (2) | | $402,000 |
| Chlorine Contactor | 600,000 | gallons | (3) | | $900,000 |
| | | | | Subtotal "A" = | $3,900,000 |
| General Conditions | 15% | of "A" | | | $585,000 |
| Site work & Yard Piping | 40% | of "A" | | | $1,560,000 |
| Electrical, Instrumentation & Control | 40% | of "A" | | | $1,560,000 |
| | | | | Subtotal "B" = | $3,705,000 |
| Construction Contingency | 30% | of "A+B" | | | $2,282,000 |
| Engineering, Legal, & Admin. | 25% | of "A+B+Contingency" | | | $2,472,000 |
| **Probable 2009 Capital Cost (±30%)** | | | | | **$12,400,000** |

(1) $480/ft of 48-inch pipe based on B&V's cost estimate for AWTP
(2) McGivney & Kawamura (2008) adjusted to S.F.ENR CCI 9755
(3) Estimated based on a unit cost of $1.5/gal of clearwell volume (for volumes less than 1.0 MG)

**Table 7.6 – Unit Cost Equations**

| Item | Unit Cost Equations (CCI = 8889) | Variable |
|---|---|---|
| Ozone Contactor | Cost = $89.217 \times X^{0.6442}$ | X = Volume of contactor, gallons |
| Ozone System & Building | Cost = $31{,}015 \times X^{0.6475}$ | X = ozone capacity, lbs/day |
| $H_2O_2$ Feed System | Cost = $34{,}153 \times X^{0.3190}$ | X = chemical feed rate, gal/day |
| Air Scour | Cost = $50.157 \times X + 266{,}176$ | X = filter surface area, ft |

Table 7.7 summarizes the probable 2009 capital costs for implementing ozone or Peroxone at the DVWTP and PPWTP presented in Tables 7.2 through 7.5. For DVWTP, the probable capital cost for ozone was estimated at $20.6M, while that for Peroxone was estimated at $20.0 M. These values are within 1.5% of the average of $20.3M, which is well within the minimum accuracy of the capital costs developed (±30%). The same observation is made for the PPWTP where the cost of ozone or Peroxone is only within 3.9% of the average probable capital cost of $12.9M. Therefore, for all practical purposes, the probable capital cost of either ozone or Peroxone is approximately $20.3M for DVWTP and $12.9M for PPWTP, for a combined total probable cost of $33.2M for both plants.

**Table 7.7 – Summary of Opinion of Probable 2009 Capital Cost**

| Plant | Ozone | Peroxone | Average | Relative Range |
|---|---|---|---|---|
| Del Valle WTP | $20.6 M | $20.0 M | $20.3 M | ±1.5% |
| Patterson Pass WTP | $13.3 M | $12.4 M | $12.9 M | ±3.5% |
| **Total 2009 Capital Cost** | **$33.9 M** | **$32.4 M** | **$33.2 M** | **±2.4%** |

## 7.2 ANNUAL OPERATING & MAINTENANCE COST

The annual operating and maintenance (O&M) cost was developed for implementing ozone or Peroxone at both plants. The operating cost covered includes energy, chemicals, and labor costs. The development of the annual chemical usage rate required specific assumptions about the T&O duration and the anticipated ozone dose during the T&O season compared to the rest of the year. These are important assumptions because the ozone system will be in operation full-time under the ozone option, but only during the T&O season under the Peroxone option. Therefore, the following assumptions and estimations were made to develop the annual operation cost of each option:

1. Based on discussion with Zone 7 staff, while the duration and specific period of T&O season may vary from year to year, the typical T&O season was assumed to extend from June through November (6 months).

2. Based on the production data from 2006, 2007, and 2008 provided by Zone 7 staff, the average annual water production was calculated at 24 MGD for DVWTP and 11 MGD for PPWTP. These values were used for the development of the annual operating cost under the ozone option.
3. Based on the production data from 2006, 2007, and 2008 provided by Zone 7 staff, the average water production during the T&O season of June through November was estimated at 31 MGD for DVWTP and 13 MGD for PPWTP. These values were used for the development of the annual operating cost under the Peroxone option.
4. The ozone dose during the T&O season was assumed to be 2.5 mg/L under both options. During the non-T&O season (December through May), the ozone dose under the ozone option was assumed to be 1.5 mg/L. This is a typical ozone dose used by other SBA users for disinfection purposes.
5. A general annual maintenance cost is estimated at 1% of the capital cost. This estimate covers miscellaneous ozone-related maintenance items such as:
    a. Replacement dielectric cells (1/5$^{th}$ of total per year)
    b. One complete set of fuses every three years
    c. Specialized contractor for maintenance of cooling water system
    d. Replacement parts for water-phase and gas-phase ozone analyzers
    e. Complete set of gaskets for diffusers, every two years
    f. Complete set of gaskets for generators, every year
6. For labor cost, the addition of either technology was assumed to require 0.5 Full-Time-Equivalent (FTE) of each of the following: operator, mechanic, instrumentation technician, and electrician. The burdened labor rates were obtained from Zone for 2008.
7. The addition of chlorine and ammonia upstream of the ozone or Peroxone contactor was assumed to be implemented only six (6) months each year when bromide levels in SBA water are elevated enough to require a bromate control strategy.

The detailed breakdowns of the probable annual operating costs for the Ozone and Peroxone options at DVWTP and PPWTP are presented in Tables 7.8 through 7.11. The tables also include unit costs for chemicals that are based on information gathered from Zone 7 and other Northern California water agencies. It is also noted that individual line items in Tables 7.8 through 7.11 are rounded to the nearest $1000/yr, while the total is rounded to the nearest $100,000/yr.

**Table 7.8 – Probable 2009 Operating Cost for Implementing Ozone at DVWTP**

| ***Annual O&M Cost:*** | **Note** | | | **Value** | **Unit** | |
|---|---|---|---|---|---|---|
| Annual Average Flow Rate | (1) | | | 24 | MGD | |
| Days of Operation | | | | 365 | days | |
| Average Ozone Dose | (2) | | | 2.0 | mg/L | |
| | **Value** | **Unit** | **Unit Cost** | **Unit** | | **Cost** |
| Energy Cost | 8.0 | kW-hr/lb | $0.16 | /kW-hr | | $187,000 |
| LOX Cost | 12.5 | lb $O_2$/lb $O_3$ | $0.25 | /lb $O_2$ | | $457,000 |
| $CO_2$ Cost | 20 | mg/L | $0.09 | /lb | | $137,000 |
| Chlorine Cost (6 months only) | 0.75 | mg/L | $0.94 | /lb | | $26,000 |
| Ammonia Cost (6 months only) | 0.19 | mg/L | $0.72 | /lb | | $5,000 |
| Total Consumables Cost | | | | | | $812,000 |
| General Maintenance Cost | 1.0 | % of Capital | | | | $206,000 |
| Labor Cost (Operator) | 0.5 | FTE | $239,034 | /yr | | $120,000 |
| Labor Cost (Mechanic) | 0.5 | FTE | $226,138 | /yr | | $113,000 |
| Labor Cost (Instrument Tech.) | 0.5 | FTE | $253,261 | /yr | | $127,000 |
| Labor Cost (Electrician) | 0.5 | FTE | $253,885 | /yr | | $127,000 |
| Total Labor Cost | | | | | | $487,000 |
| **Probable Annual Operating Cost (2009 Dollars)** | | | | | | **$1,500,000** |

(1) Based on average day flow between January 2006 and December 2008
(2) Assuming 2.5 mg/L during 6-month T&O season & 1.5 mg/L during rest of year

**Table 7.9 – Probable 2009 Operating Cost for Implementing Peroxone at DVWTP**

| ***Annual O&M Cost:*** | **Note** | | | **Value** | **Unit** | |
|---|---|---|---|---|---|---|
| Average Flow Rate during T&O season | (1) | | | 31 | MGD | |
| T&O season | (2) | | | 180 | days | |
| Average Ozone Dose during T&O season | (3) | | | 2.5 | mg/L | |
| | **Value** | **Unit** | **Unit Cost** | **Unit** | | **Cost** |
| Energy Cost | 8.0 | kW-hr/lb | $0.16 | /kW-hr | | $149,000 |
| LOX Cost | 12.5 | lb $O_2$/lb $O_3$ | $0.25 | /lb $O_2$ | | $364,000 |
| $H_2O_2$ Cost | 1.25 | mg/L | $0.54 | /lb | | $31,000 |
| Chlorine Cost | 0.75 | mg/L | $0.94 | /lb | | $33,000 |
| Ammonia Cost | 0.19 | mg/L | $0.72 | /lb | | $6,000 |
| Total Consumables Cost | | | | | | $583,000 |
| General Maintenance Cost | 1.0 | % of Capital | | | | $200,000 |
| Labor Cost (Operator) | 0.5 | FTE | $239,034 | /yr | | $120,000 |
| Labor Cost (Mechanic) | 0.5 | FTE | $226,138 | /yr | | $113,000 |
| Labor Cost (Instrument Tech) | 0.5 | FTE | $253,261 | /yr | | $127,000 |
| Labor Cost (Electrician) | 0.5 | FTE | $253,885 | /yr | | $127,000 |
| Total Labor Cost | | | | | | $487,000 |
| **Probable Annual Operating Cost (2009 Dollars)** | | | | | | **$1,300,000** |

(1) Based on average day flow during June – November of 2006, 2007, and 2008
(2) Assuming T&O season from June through November
(3) Assuming 2.5 mg/L during T&O season

### Table 7.10 – Probable 2009 Operating Cost for Implementing Ozone at PPWTP

| ***Annual O&M Cost:*** | **Note** | | **Value** | **Unit** | |
|---|---|---|---|---|---|
| Annual Average Flow Rate | (1) | | 11 | MGD | |
| Days of Operation | | | 365 | days | |
| Average Ozone Dose | (2) | | 2.0 | mg/L | |

| | **Value** | **Unit** | **Unit Cost** | **Unit** | **Cost** |
|---|---|---|---|---|---|
| Energy Cost | 8.0 | kW-hr/lb | $0.16 | /kW-hr | $86,000 |
| LOX Cost | 12.5 | lb $O_2$/lb $O_3$ | $0.25 | /lb $O_2$ | $209,000 |
| $CO_2$ Cost | 20 | mg/L | $0.09 | /lb | $63,000 |
| Chlorine Cost (6 months only) | 0.75 | mg/L | $0.94 | /lb | $12,000 |
| Ammonia Cost (6 months only) | 0.19 | mg/L | $0.72 | /lb | $2,000 |
| Total Consumables Cost | | | | | $372,000 |
| General Maintenance Cost | 1.0 | % of Capital | | | $133,000 |
| Labor Cost (Operator) | 0.5 | FTE | $239,034 | /yr | $120,000 |
| Labor Cost (Mechanic) | 0.5 | FTE | $226,138 | /yr | $113,000 |
| Labor Cost (Instrument Tech) | 0.5 | FTE | $253,261 | /yr | $127,000 |
| Labor Cost (Electrician) | 0.5 | FTE | $253,885 | /yr | $127,000 |
| Total Labor Cost | | | | | $487,000 |
| **Probable Annual Operating Cost (2009 Dollars)** | | | | | **$1,000,000** |

(1) Based on average day flow between January 2006 and December 2008
(2) Assuming 2.5 mg/L during 6-month T&O season & 1.5 mg/L during rest of year

### Table 7.11 – Probable 2009 Operating Cost for Implementing Peroxone at PPWTP

| ***Annual O&M Cost:*** | **Note** | | **Value** | **Unit** | |
|---|---|---|---|---|---|
| Average Flow Rate during T&O season | (1) | | 13 | MGD | |
| T&O season | (2) | | 180 | days | |
| Average Ozone Dose during T&O season | (3) | | 2.5 | mg/L | |

| | **Value** | **Unit** | **Unit Cost** | **Unit** | **Cost** |
|---|---|---|---|---|---|
| Energy Cost | 8.0 | kW-hr/lb | $0.16 | /kW-hr | $62,000 |
| LOX Cost | 12.5 | lb $O_2$/lb $O_3$ | $0.25 | /lb $O_2$ | $152,000 |
| $H_2O_2$ Cost | 1.25 | mg/L | $0.54 | /lb | $13,000 |
| Chlorine Cost | 0.75 | mg/L | $0.94 | /lb | $14,000 |
| Ammonia Cost | 0.19 | mg/L | $0.72 | /lb | $3,000 |
| Total Consumables Cost | | | | | $244,000 |
| General Maintenance | 1.0 | % of Capital | | | $124,000 |
| Labor Cost (Operator) | 0.5 | FTE | $239,034 | /yr | $120,000 |
| Labor Cost (Mechanic) | 0.5 | FTE | $226,138 | /yr | $113,000 |
| Labor Cost (Instrument Tech) | 0.5 | FTE | $253,261 | /yr | $127,000 |
| Labor Cost (Electrician) | 0.5 | FTE | $253,885 | /yr | $127,000 |
| Total Labor Cost | | | | | $487,000 |
| **Probable Annual Operating Cost (2009 Dollars)** | | | | | **$900,000** |

(1) Based on average day flow during June – November of 2006, 2007, and 2008
(2) Assuming T&O season from June through November
(3) Assuming 2.5 mg/L during T&O season

Table 7.12 presents a summary of the probable 2009 annual operating costs for the ozone or Peroxone option at each plant. The annual operating cost of the Peroxone system is projected to be slightly lower than that of the ozone system at either plant. The primary driver behind the difference is the fact that the Peroxone system is operated only 6 months per year, while the ozone system is operated full time. The 2009 operating cost for the ozone option at DVWTP is projected at $1.5M/yr, while that of the Peroxone option is projected at $1.3M/yr. Similarly, for the PPWTP, the 2009 operating cost for the ozone option is projected at $1.0M/yr, while that of the Peroxone option is projected at $0.9M/yr. If the ozone option is implemented at both plants, the 2009 annual operating cost is projected at $2.5M/yr compared to $2.2M/yr if the Peroxone process is implemented at both plants.

**Table 7.12 – Summary of Opinion of Probable Annual O&M Cost (2009 Dollars)**

| Plant | Ozone | Peroxone |
|---|---|---|
| Del Valle WTP | $1.5 M/yr | $1.3 M /yr |
| Patterson Pass WTP | $1.0 M/yr | $0.9 M/yr |
| **Total Annual O&M Cost (2009)** | **$2.5 M/yr** | **$2.2 M/yr** |

Unlike the development of the capital costs, the development of the annual operating costs is based on current pricing for chemicals and energy, as well as on the results of the pilot study and the operational information gathered from other water agencies using the same source water. Therefore, there is much less uncertainty in them compared to the capital cost estimates.

## 7.3 TOTAL ANNUAL COST

The total cost of implementing ozone or Peroxone includes the sum of the annual debt payment on the capital investment and the annual O&M cost. The debt payment was calculated based on an amortization rate of 6% and a debt-payment period of 20 years. The amortized capital cost was then added to the annual O&M cost to determine the total annual cost. It is important to emphasize that these costs are based on 2009 dollars since there is no current schedule for implementing this project at DVWTP or PPWTP. Tables 7.13 and 7.14 present the calculated total probable annual costs for implementing ozone or Peroxone at DVWTP and PPWTP, respectively. The total values are rounded to the nearest $100,000/yr.

**Table 7.13 – Total Probable Annual Cost for Implementing Ozone or Peroxone at DVWTP**

| Item | Ozone | Peroxone |
|---|---|---|
| Capital Cost | $20,600,000 | $20,000,000 |
| Annualized Capital Cost (6%, 20 yrs) | $1,796,000 | $1,744,000 |
| Annual O&M Cost | $1,500,000 | $1,300,000 |
| **Probable Total Annual Cost** | **$3,300,000** | **$3,000,000** |

**Table 7.14 – Total Probable Annual Cost for Implementing Ozone or Peroxone at PPWTP**

| Item | Ozone | Peroxone |
|---|---|---|
| Capital Cost | $13,300,000 | $12,400,000 |
| Annualized Capital Cost (6%, 20 yrs) | $1,160,000 | $1,081,000 |
| Annual O&M Cost | $1,000,000 | $900,000 |
| **Probable Total Annual Cost** | **$2,200,000** | **$2,000,000** |

Table 7.15 summarizes the total annualiz costs for implementing ozone or Peroxone at DVWTP and PPWTP. Due to the difference in the annual operating cost, the cost of implementing the Peroxone process is projected to be slightly lower than that of implementing the ozone process. For example, implementing the Peroxone process at DVWTP is projected to be $300,000/yr less costly than that of implementing the ozone process at the plant, which is ±5% from the average cost of $3.2M/yr. This is significantly lower than the minimum uncertainty of ±30% in the probable capital cost which makes up more than half of the total probable annual cost. For this reason, it is appropriate to assume that the difference in the probable annual cost between the two options is not significant, and that the average total probable annual costs listed in Table 7.15 should be assumed for either option.

**Table 7.15 – Summary of Opinion of Probable Total 2009 Annual Cost**

| Plant | Ozone | Peroxone | Average | Relative Range |
|---|---|---|---|---|
| Del Valle WTP | $3.3 M/yr | $3.0 M/yr | $3.2 M/yr | ±5% |
| Patterson Pass WTP | $2.2 M/yr | $2.0 M/yr | $2.1 M/yr | ±5% |
| **Total Annual Cost (2009)** | **$5.5 M/yr** | **$5.0 M/yr** | **$5.3 M/yr** | **±5%** |

## 7.4 SUMMARY

The cost analysis presented in this Section demonstrated that the probable costs of implementing ozone and Peroxone at either plant are well within the accuracy of the cost projection. A summary of the cost information developed in this Section is presented in Table 7.16. The total probable capital cost of implementing an ozone-based T&O control strategy at Zone 7's two treatment plants is projected at $33.2M, with the probable annual operating cost projected at $2.3 M/yr (both are in 2009 dollars). Table 7.16 also includes an estimate of the impact of implementing ozone and/or Peroxone at either or both plants on the total water cost to Zone 7. This was determined by dividing the annual cost under each option by the 2008 total water production of 45,216 AF. Using this approach, the water cost impact of implementing either technology at both plants is projected at $116/AF of total water produced by Zone 7.

**Table 7.16 – Summary of Projected Probable Costs (2009 Dollars) of Implementing Ozone or Peroxone at DVWTP and PPWTP**

| Item | Del Valle WTP | | | Patterson Pass WTP | | | Probable Total |
|---|---|---|---|---|---|---|---|
| | **Ozone** | **Peroxone** | **Average** | **Ozone** | **Peroxone** | **Average** | |
| Capital Cost | $20.6 M | $20.0 M | $20.3 M | $13.3 M | $12.4 M | $12.9 M | **$33.2 M** |
| Amortized Capital Cost | $1.8 M/yr | $1.7 M/yr | $1.8 M/yr | $1.2 M/yr | $1.1 M/yr | $1.2 M/yr | **$3.0 M/yr** |
| Annual Operating Cost | $1.5 M/yr | $1.3 M/yr | $1.4 M/yr | $1.0 M/yr | $0.9 M/yr | $0.9 M/yr | **$2.3 M/yr** |
| Total Annual Cost | $3.3 M/yr | $3.0 M/yr | $3.2 M/yr | $2.2 M/yr | $2.0M/yr | $2.1 M/yr | **$5.3 M/yr** |
| Water Cost(1) | $73 /AF | $66 /AF | $70 /AF | $49 /AF | $44 /AF | $46 /AF | **$116 /AF** |

(1) Based on 2008 water production of 45,216 AF.

# SECTION 8.0 – PERMITTING & SCHEDULE

This Section provides a summary of the necessary permits that Zone 7 must obtain in order to implement the project and a summary of the anticipated project bidding and construction schedule.

## 8.1 PERMITS

### 8.1.1 California Department of Public Health

Public water systems must have an operating permit issued by California Department of Public Health (CDPH), and this permit must be amended any time there is “any addition or change in treatment”. Zone 7 has an existing permit covering the operation of all facilities (treatment plants, wells, and distribution system components). In order to incorporate the new facilities, the permit will need to be amended. Application for a permit amendment must be made to CDPH, and the amendment must be approved prior to implementation of the change. For this project, CDPH staff representatives have been present at various meetings of the Technical Review Committee and are familiar with the proposed changes. We do not anticipate any obstacles to obtaining a permit amendment provided all the necessary documentation is submitted to CDPH in a timely fashion. Currently, CDPH requires that the complete permit amendment package be submitted at least four (4) months prior to startup.

Implementation of either Peroxone or ozone technologies at both plants will require a change in the way the plants demonstrate compliance with the disinfection requirements of the surface water treatment rules. Both plants must demonstrate adequate treatment of three classes of pathogen: *Giardia*, viruses, and *cryptosporidium*. Overall, the plants must demonstrate reductions of 3-log, 4-log, and 2-log, respectively, for these three groups of microorganisms. Zone 7 has completed the required source water monitoring under the Long-Term 2 Enhanced Surface Water Treatment Rule, and the water source is classified as being in “Bin 1” which means that no additional treatment for *cryptosporidium* is required beyond the standard level of treatment.

Compliance with the microbial reduction can be achieved by either physical removal or inactivation, or a combination of the two. For conventional filtration plants operated in conformance with the prevailing turbidity standards, the following levels of physical removal are credited: 2.5 logs of *Giardia*, 2 logs of viruses, and 3 logs of *cryptosporidium*. The difference between the overall required reduction for each pathogen and the removal credit must be achieved by disinfection. Table 8.1 summarizes the requirements and removal credits for a well-operated conventional water treatment plant. As detailed in the 2003 amendment to the operating permit, for the ultrafiltration train at the PPWTP, a removal credit of 4-log *Giardia*, 4-log *cryptosporidium* and 4-log viruses has been granted to the membrane process. In addition, in order to ensure a multi-barrier treatment approach, the clarification process must be operated at all times and 2-log virus disinfection must be achieved. If the clarification process is bypassed, then the level of disinfection that must be achieved increases to 0.5-log *Giardia*.

**Table 8.1 – Summary of Disinfection Credits and Requirements**

| | Overall Reduction Required | Removal Credit for Treatment | Balance Needed via Disinfection |
|---|---|---|---|
| *Del Valle WTP and Patterson Pass Conventional WTP* | | | |
| *Giardia* | 3-log | 2.5-log | 0.5-log |
| Viruses | 4-log | 2-log | 2-log |
| *Cryptosporidium* | 2-log | 3-log | None |
| *Patterson Pass UF Train* | | | |
| *Giardia* | 3-log | 4-log | None[1] |
| Viruses | 4-log | 4-log | 2-log[2] |
| *Cryptosporidium* | 2-log | 4-log | None |

[1]If the clarification process is bypassed, then an additional 0.5-log *Giardia* inactivation must be achieved.
[2]Although the entire virus reduction credit is met via removal through the membranes, an additional 2-log inactivation is required by CDPH.

At both the DVWTP and the PP conventional plant, disinfection is currently achieved with free chlorine through the sand/anthracite filters. At the PP UF plant, disinfection is accomplished with free chlorine in the post-membrane chlorine contactor. For implementation of either ozone or Peroxone, the filters will be operated biologically, which means that no chlorine will be added upstream of the filters. Under this condition, disinfection must be achieved somewhere else in the treatment process and thus a change in each plants' disinfection strategy is needed.

If ozone is implemented, it will be designed and operated to meet the overall disinfection requirements for both plants (0.5-log *Giardia* and 2-log virus). For ozone at the DVWTP, the process is straightforward: the two parallel ozone contactors will be operated to meet the disinfection requirements, and the water leaving these contactors can be fed to either or both of the downstream clarification processes (Superpulsators or DAF). For ozone at the PPWTP, there is a minor complication. Because the UF membranes at the PPWTP cannot tolerate any residual polymers, the polymer-containing recycled water flows from the dewatering process must be returned to the conventional train only. Since there will be two parallel ozone contactors, one will be dedicated for each train, and the polymer-containing recycle flows will be returned to the head of the conventional-train ozone contactor. This means that the two ozone contactors must be operated independently, similar to the manner in which the two flash mix systems are currently operated. The water flows will be different and thus the contact times and required ozone doses will be different between the two trains. Each train's level of disinfection will be calculated independently.

For implementation of Peroxone at either plant, disinfection will be accomplished with free chlorine. Since the sand/anthracite filters will not be chlorinated, new post-filter chlorine contact basins will be added. These basins will be sized to allow for adequate contact time to satisfy the 0.5-log *Giardia* inactivation requirements. For both plants, there will be only one raw water Peroxone contactor. At Del Valle, the recycled water will be returned upstream of the Peroxone process. However, as noted above in the discussion about ozone, the recycled water flows containing polymer residuals cannot be introduced into the UF train at the Patterson Pass plant. Therefore, the recycled water must be introduced downstream of the Peroxone process at the head of the conventional train (which is its current location).

Although recycled water flows are generally returned to the head of the plant upstream of all processes, the proposed recycled water injection point at Patterson will be downstream of one process (Peroxone). Since the Peroxone process is used only intermittently for T&O control and not for disinfection, this recycled water injection point should be acceptable to CDPH. According to the Federal Filter Backwash Water Recycle Rule:

> *"Any system that recycles spent filter backwash water, thickener supernatant, or liquids from dewatering processes must return these flows through the processes of a system's existing conventional or direct filtration system as defined in § 141.2 or at an alternate location approved by the State"*

The referenced Section 141.2 includes the definition of the conventional filtration system (coagulation, flocculation, sedimentation, and filtration). The proposed recycle location meets this federal requirement. The California version of the filter backwash rule is slightly different, as follows:

> *"A supplier that uses conventional filtration or direct filtration and recycles spent filter backwash water, thickener supernatant, or liquids from dewatering processes shall…return all recycle flows to the headworks of the treatment plant or an alternative location approved by the Department."*

Since the Peroxone process is designed for T&O control only, is not part of the filtration or disinfection processes, and may be operated only seasonally, CDPH should not object to introducing the recycled water stream at a point downstream of Peroxone but upstream of all other processes. There are no specific requirements (e.g. studies) needed to request permission for this type of recycle practice; the request would be made to the Department via the standard permit amendment process.

The ozone generation system will likely have a single-pass cooling water system. The water from this system will be combined with the water from the water management basins and recycled to the head of the plants along with the other recycled water flow streams. This operation must be described in the request for the amended permit.

Along with the application for an amended permit, Zone 7 will need to submit an updated Operations Plan. This updated plan will include the details of how the systems will be monitored and operated, and how the various treatment requirements will be met.

No impact is expected on the level of certification needed for the new facilities. The Chief Operator is already required to hold a T5 certification, and shift operators must hold at least a T3. The new facilities will not require a higher certification level.

Implementation of either ozone or Peroxone is not expected to impact any other drinking water regulatory compliance issues. All remaining CDPH requirements, such as monitoring for various inorganic and organic chemicals, radionuclides, etc., will remain the same, and the new processes are not expected to impact the levels of these constituents in the finished water. With regard to disinfection byproducts, in the case of the ozonation option the levels of THMs and HAAs in the finished water are expected to be significantly lower. Regular monitoring for bromate will need to be conducted.

### 8.1.2 Alameda County Department of Environmental Health

The Alameda County Department of Environmental Health (ACDEH) Certified Unified Program Agency (CUPA) is the administrative agency that coordinates and enforces numerous local, state, and federal hazardous materials management and environmental protection programs in the county. The CUPA administers the Hazardous Materials Business Plan Program. Chapter 6.95 of the Health and Safety Code establishes minimum statewide standards for Hazardous Materials Business Plans (HMBP's). HMBP's contain basic information on the location, type, quantity, and health risks of hazardous materials. Each business must prepare a HMBP if that business uses, handles, or stores a hazardous material and/or waste or an extremely hazardous material in quantities greater than or equal to the following:

- 55 gallons for a liquid
- 500 pounds of a solid
- 200 cubic feet for any compressed gas
- Threshold planning quantities of an extremely hazardous substance

Zone 7 already has HMBPs for both sites. These HMBPs will need to be amended for implementation of either ozone or Peroxone. The storage and feed systems for hydrogen peroxide, oxygen, carbon dioxide, and ozone must be described. Inventory information regarding the chemicals to be used, such as average and maximum quantities stored, chemical properties, chemical forms (e.g. gas, liquid, solid) must be provided, along with a Facility Site Plan and Storage Map. The HMBP also includes an Emergency Response Plan (ERP) /Contingency Plan (CP), and these must be updated to incorporate the new chemical and facilities. An updated Training Plan must also be included.

Businesses that handle extremely hazardous substances (EHS) equal to or greater than the threshold planning quantities (TPQ) listed in Appendix A, Part 355, Title 40, of the Code of Federal Regulations, are additionally subject to the Federal Emergency Planning and Community Right-to-Know Act (EPCRA). This program is implemented in California by the California Accidental Release Prevention Program (Cal ARP). Hydrogen peroxide and ozone are both on the list. However, when stored in strengths of less than 52%, hydrogen peroxide is not subject to these additional requirements. The TPQ for ozone is 100 pounds. Since ozone will be generated and used continuously and not stored, the amount of ozone on hand at any time is much less than this quantity. Therefore, it is expected that the Right-to-Know Act requirements for the facilities will not change with the implementation of either ozone or Peroxone.

The California Office of Emergency Services (OES) has merged with the Office of Homeland Security (OHS) to become the Emergency Management Agency (EMA). This agency handles the statewide emergency response programs. Zone 7's Emergency Response Plan will need to be updated to incorporate the new facilities and this plan must be submitted to EMA.

Specific elements will be included in the design to ensure acceptance of the HMBP. Where allowed by the 2007 California Fire code and the 2007 California Building code, chemical feed equipment will be housed inside of buildings to protect them from the elements and facilitate maintenance. Chemical piping will be designed with spill containment systems from the points of chemical delivery through the metering pump systems and to the feed points. The containment systems will consist of tank secondary containment, chemical duct banks or double-contained pipes. The chemical duct banks consist of chemical feed piping routed in conduit, compatible with the chemical being transmitted, and then encased in concrete. The tank secondary containment will be designed consistent with requirements of UFC Article 80 and all other applicable regulations. Emergency eyewash fixtures and showers will be provided in the chemical building, as well as at the truck unloading stations. A natural gas-fired water heater with a mixing valve will be provided in the cold water supply to the emergency shower/eyewash fixtures to maintain the temperature of water to be supplied to the fixtures in the range of 60°F to 90°F.

Ozone will be generated on-site using oxygen as the source. In addition, under the ozone option, carbon dioxide will be used for pH suppression. Both oxygen and carbon dioxide will be delivered as liquids by pressurized trucks and stored onsite in bulk tanks as liquids. Both liquids will be converted to gases through the use of ambient vaporizers. The pressure of the oxygen storage tank will provide the driving force for the flow of oxygen out of the tanks, through the vaporizers, to the ozone generators, and into the ozone contactor. Similarly, under the ozone option, the pressure in the carbon dioxide tank will provide the driving force for the flow of carbon dioxide through the vaporizer and into the carrier water stream.

### 8.1.3 California Regional Water Quality Control Board

The Water Boards regulate wastewater discharges to both surface water (rivers, ocean, etc.) and to groundwater (via land), and also storm water discharges from construction, industrial, and municipal activities; discharges from irrigated agriculture; dredge and fill activities; the alteration of any federal water body, and several other activities with practices that could degrade water quality. Zone 7 is under the jurisdiction of the San Francisco Bay Regional Water Quality Control Board (RWQCB).

Discharges from Zone 7's Del Valle WTP and Patterson Pass WTP are covered under the Region-wide NPDES permit for Discharges from Surface Water Treatment Facilities for Potable Supply (NPDES No. CAG382001, Order No. R2-2003-0062), which is administered by the San Francisco Bay RWQCB. Implementation of either ozone or Peroxone is not expected to impact these permits since they only regulate the pH, chlorine residual, and total suspended solids (TSS) of the periodic wastewater (storm water) discharges and these parameters are not anticipated to be impacted by the new processes.

Neither site is connected to a sanitary sewer system, so there are no pre-treatment permits. At both plants, the domestic discharges from the buildings and the laboratory are sent to a septic tank system. Septic tanks in the area are regulated by Zone 7. No impact is expected to the septic tank systems from either the ozone or Peroxone process. A Report of Waste Discharge (ROWD) will be needed for the construction period. No impacts to waterways are expected, and there are no known wetlands on either site. It is likely that the construction will involve more than one acre of disturbance, therefore coverage under the General Construction Permit will need to be obtained. This program is administered by the State Water Resources Control Board.

### 8.1.4 Bay Area Air Quality Management District (BAAQMD)

The Bay Area Air Quality Management District's Regulation 2, Rule 1, describes the permit requirements for sources of air pollution. In general, any equipment or operation that emits pollutants into the atmosphere, and any pollution control equipment associated with that source, require a Permit to Operate unless it is specifically exempted. The ozone off-gas treatment system will require a Permit to Operate from the BAAQMD. It is expected that the off-gas treatment system will be designed in the standard fashion whereby the concentration of ozone in the vent gas (downstream of the ozone destruct units) is continuously monitored and if the level exceeds a particular amount, the ozone generation system will be automatically shut down.

Ozone is on the Toxic Air Contaminants List and as such, emission calculations are required (annual, maximum daily, and maximum 1-hour amounts). None of the other air program requirements such as Offsets, Prevention of Significant Deterioration (PSD), or modeling are expected to apply, since the expected levels of ozone discharged to the atmosphere from the off-gas treatment system will be very low. Since Zone 7 intends to install and continuously operate a treatment system, a request for operation without such a treatment system will not be made.

### 8.1.5 Alameda County Fire Code Compliance

Fire suppression and emergency hazardous materials response services are provided by the Alameda County Fire Department (ACFD). A wet-pipe fire protection system should be incorporated in the design to meet the requirements of NFPA for each structure where required by applicable code and by the local fire department. If required by Alameda County Fire, the pumps should be located in a dedicated room. The fire protection system should have one main backflow preventer located in the same room as the pumps. A fire distribution line should be provided to each of the buildings and fire hydrants located on this line.

Both project sites are located outside city limits in unincorporated Alameda County. Strictly speaking, no building permit is required from the County for the proposed ozone building at each treatment plant site. Zone 7 is exempt from the building permit requirements for any treatment process and related facilities. However, based on the review process for other recent Zone 7 projects, (e.g. Chain of Lakes Wells 1 & 2) ACDEH's staff requested that Zone 7 "satisfy" ACFD requirements on chemicals being used (and quantity being stored) for each new process. ACFD normally conducts its reviews under the Alameda County Building permit process. Therefore, although Zone 7 is exempt from an Alameda County Building permit, the County Building official, per recommendations of their County Counsel, provided a "courtesy" review of building plans to help expedite the review by ACFD.

### 8.1.6 California Building Code Compliance

No changes in the access roads to either site are anticipated with the implementation of either ozone or Peroxone at either plant. Therefore, no specific permission is needed from the Alameda County Road Planning and Design Division.

The new buildings should be designed to conform to the California Building Code (2007), and California Title 24 Energy Code. Each building should be categorized by the building's functional occupancy, and a basic code study is recommended for each one. The materials, colors and textures used in the design and construction should be selected to blend with the existing materials on the site. Windows and skylights should be utilized to provide natural lighting where appropriate. The PG&E Savings-By-Design Program should be implemented on this project. This program will be considered in coordination with Title 24 Energy Conservation Requirements for all buildings.

Mechanical design must conform to the latest editions of all applicable standards and codes such as the following:

- National Fire Protection Association Recommended Practices (NFPA) and Manuals
- Council of American Building Officials (CABO) Model Energy Code
- American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) handbooks and standards
- American Society of Plumbing Engineers (ASPE) handbooks
- Sheet Metal and Air Conditioning Contractors National Association (SMACNA) handbooks
- Part 4, California Mechanical Code (CMC), based on the Uniform Mechanical Code (UMC)
- Part 5, California Plumbing Code (CPC), based on the Uniform Plumbing Code (UPC) (including backflow protection devices)
- State of California, Title 24, Part 4 Mechanical Systems
- Occupational Safety and Health Act (OSHA) Standards Manual
- 8.2.1 Title 24 and Savings-By-Design Compliance
- Electrical Code

### 8.1.7 United States Fish and Wildlife Services (USFWS) and California Department of Fish and Game (CDFG)

No permits are required from either of these two agencies. The projects will be constructed within the existing developed sites and will have no impact on fish, wildlife, or game in the area.

### 8.1.8 California Department of Water Resources (DWR)

The California Department of Water Resources (DWR) owns and operates the South Bay Aqueduct, which is the source of water for both treatment plants. The ozone or Peroxone project will not involve any change in the quantity of water to be treated through the plants, and therefore no specific permission is needed from DWR. However, in the case of the Patterson Pass site, there may be encroachment onto DWR property needed in order to place all of the necessary facilities. In this case, an easement or some other form of permission must be acquired. DWR staff has indicated that locating underground facilities in close proximity to the property line is not likely to be a problem. However, DWR needs to retain access to the site to store sediment material periodically dredged from the bottom of Patterson Reservoir.

### 8.1.9 California Environmental Quality Act (CEQA) / National Environmental Policy Act (NEPA) Requirements

The addition of a new treatment process to an existing water treatment plant is generally assumed to qualify for a Negative Declaration or Mitigated Negative Declaration rather than requiring an Environmental Impact Report. A Negative Declaration is prepared when the proposed project will not have a significant impact on the environment. A Mitigated Negative Declaration is prepared when the proposed project potentially has a significant impact on the environment but can be mitigated to a less than significant level and there is no substantial evidence that the proposed project may have a significant effect on the environment. As the

Lead Agency, Zone 7 will need to prepare an Initial Study to determine the appropriate CEQA document necessary for the ozone or Peroxone installations.

NEPA requirements do not apply because there is no federal nexus between the proposed project and the federal government.

#### 8.1.10 California Division of Occupational Safety and Health (Cal/OSHA)

According to the California Occupational Safety and Health Act, Zone 7 must have a written, effective Injury and Illness Prevention (IIP) Program. The IIP Program will need to be updated to include the new chemicals and facilities and it must be made available to the Division of Occupational Safety and Health (A.k.a. Cal/OSHA) upon request. The IIP and its updates are also available on Zone 7's web site. In particular, there may be new confined spaces associated with the new facilities, and an update of the respiratory protection component of the Program may be needed to address hazards associated with the ozone systems.

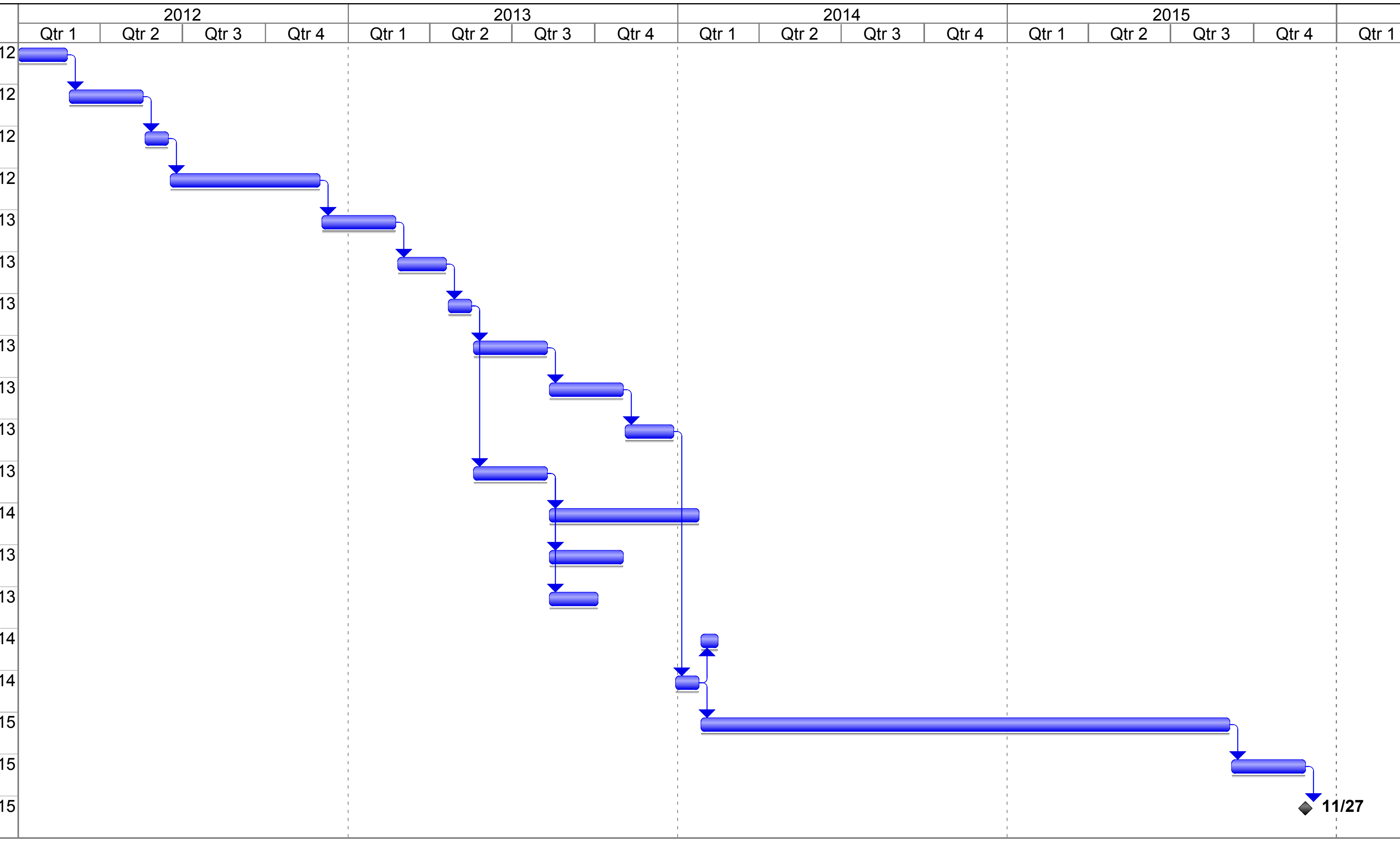
#### 8.1.11 Alameda County Building Department

Both project sites are located outside the city limits and in unincorporated Alameda County. No building permit is required from this Department for the proposed Ozone building at each treatment plant site. Zone 7 is exempt from a building permit for any treatment process and related facilities, such as the Ozone building. See Section 1.5 above for information about the relationship between the building permit process and the fire code compliance process.

### 8.2 PROJECT SCHEDULE

Figure 8.1 includes the major tasks associated with the planning, design, construction, and startup of the new facilities. The exact start date is not known at this time, but for purposes of schedule development an arbitrary date of January 1, 2012 was used. From this date, it is expected to take 24 months to contract with an engineering design firm, complete the design, advertise and award the construction contract per Alameda County procedures for public bids, and issue a Notice to Proceed. Construction and startup are expected to take 24 months, such that the project would be in service by late 2015. This puts the overall schedule from the decision to issue a design RFP to having fully operational ozone or Peroxone plants at four (4) years.

| ID | | Task Name | Duration | Start | Finish |
|---|---|---|---|---|---|
| 1 | | Develop RFP for Engineering Design | 40 days | Mon 1/2/12 | Fri 2/24/12 |
| 2 | | Advertise, Evaluate Proposals, Interview, Select Engineering Firm | 60 days | Mon 2/27/12 | Fri 5/18/12 |
| 3 | | Negotiate Design Engineering Contract | 20 days | Mon 5/21/12 | Fri 6/15/12 |
| 4 | | Level 1 Design Submittal (30% complete) | 120 days | Mon 6/18/12 | Fri 11/30/12 |
| 5 | | Level 2 Design Submittal (50% complete) | 60 days | Mon 12/3/12 | Fri 2/22/13 |
| 6 | | Level 3 Design Submittal (90% complete) | 40 days | Mon 2/25/13 | Fri 4/19/13 |
| 7 | | Finalize Design | 20 days | Mon 4/22/13 | Fri 5/17/13 |
| 8 | | Advertise Construction Contract | 60 days | Mon 5/20/13 | Fri 8/9/13 |
| 9 | | Evaluate Proposals, Interview, Select Construction Contractor | 60 days | Mon 8/12/13 | Fri 11/1/13 |
| 10 | | Negotiate Construction Contract | 40 days | Mon 11/4/13 | Fri 12/27/13 |
| 11 | | File Negative Declaration | 60 days | Mon 5/20/13 | Fri 8/9/13 |
| 12 | | Request DPH Permit Amendment | 120 days | Mon 8/12/13 | Fri 1/24/14 |
| 13 | | Request ACDEH HMBP Update | 60 days | Mon 8/12/13 | Fri 11/1/13 |
| 14 | | File for BAAQMD Operating Permit | 40 days | Mon 8/12/13 | Fri 10/4/13 |
| 15 | | PG&E Relocations/Connections | 15 days | Mon 1/27/14 | Fri 2/14/14 |
| 16 | | Construct Temporary Facilities | 20 days | Mon 12/30/13 | Fri 1/24/14 |
| 17 | | Construction | 420 days | Mon 1/27/14 | Fri 9/4/15 |
| 18 | | Startup Period | 60 days | Mon 9/7/15 | Fri 11/27/15 |
| 19 | | Project Completion | 0 days | Fri 11/27/15 | Fri 11/27/15 |




Project: WQ Enhancement Project
Date: Thu 10/15/09

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone



**Figure 8.1 - Potential Project Schedule**

# SECTION 9.0 – OPERATIONAL IMPACTS

Either ozone or Peroxone will be implemented in the raw water for the Del Valle and Patterson Pass Water Treatment Plants. The new process will have an impact on the performance of the existing plants as well as on the level of operation and maintenance resources needed. This section has two objectives:

1. Identify the expected changes in plant performance,
2. Recommend changes to the current Operations & Maintenance (O&M) practices, procedures, and documentation necessitated by the new facilities.

## 9.1 EXPECTED CHANGES TO TREATMENT PLANT PERFORMANCE

### 9.1.1 Particle Removal (coagulation, clarification, filtration)

At both existing plants, no pre-oxidant is used under normal operating conditions. The addition of ozone or Peroxone ahead of the coagulation process is expected to result in lower ferric chloride dosages, lower filtered water turbidity and particle counts, and a corresponding decrease in sludge volume. Further, since the ferric chloride dose will be lower, the amount of caustic needed to restore the pH before delivery to the distribution system is expected to be lower. Precise quantification of the expected reduction in ferric dose is beyond the scope of this project.

Whether ozone or Peroxone is selected for implementation, the granular media filters at each plant will be operated biologically. This means that chlorine will no longer be applied to the filter influent, but will be moved downstream (to the filter effluent). When filters are operated biologically, particular care must be taken when dosing the filter aid polymer. Both SCVWD and ACWD report that their biologically-active filters are very sensitive to small changes in filter aid polymer, particularly during cold weather. Both agencies report that low filtered water turbidity and particle count values are achievable, but that the filter performance is highly dependent on proper dosing of the filter aid polymer. Both DVWTP and PPWTP already have filter aid polymer storage and feed systems in place and these are currently used for feeding cationic polymer. Therefore, no new facilities are anticipated for filter aid polymers.

Finally, biologically active filters can develop excess attached microbial growth that can adversely impact filter performance by increasing the rate of headloss buildup. Both ACWD and MWDSC report that periodic addition of chlorine to the backwash water is necessary to remove this excess growth and restore performance. During the summer months, these agencies add several milligrams per liter of chlorine to the backwash water every few backwash cycles to control excess growth. Their data indicate that this intermittent application of chlorine does not impede the ability of the filters to remove biodegradable organic material, but it does slow the rate of headloss buildup during the filter runs, thus lengthening the filter run times.

### 9.1.2 Disinfection

The new ozone system would be operated to achieve the minimum disinfection requirements of 0.5-log reduction of *Giardia* and 2-log reduction of viruses plus some reasonable margin of safety. While the minimum required level of disinfection will not change, the actual level of disinfection achieved at Zone 7's plants may decrease if ozone is used as the primary disinfectant, with chloramines used for maintenance of a distribution system residual. This is because the chlorine dose currently added to the settled water is determined by two parameters: 1) the disinfection requirements, and 2) maintenance of a chlorine residual in the distribution system. The higher of these two values controls the chlorine dose. Therefore, even when the chlorine dose needed for disinfection is low, a higher dose may be needed to ensure that the residual in the distribution system is sufficient. The net result is that the level of disinfection achieved is sometimes much higher than the minimum requirement. Ammonia is added to the chlorinated water after filtration, forming chloramines, which are a much weaker disinfectant compared to free chlorine. For an ozone system, the operational goal would be disinfection only, not residual maintenance. Chlorine and ammonia would be added only to the filter effluent, with a very short free-chlorine contact time. Therefore, the actual level of disinfection is likely to be less than the historical levels and closer to the required levels.

Table 9.1 includes the monthly average CT ratios for the DVWTP and PPWTP. These data are based on the minimum CT ratio calculated each day; then the average of these minimum daily values was calculated for each month of calendar year 2008. The CT ratio is calculated as follows:

$$CT_{ratio} = \frac{CT_{achieved}}{CT_{required}}$$

Where $CT_{achieved}$ is based on the actual measured chlorine residual and contact time through the filters, and $CT_{required}$ is the required value from the regulations for the given water quality conditions. This ratio must be at least 1.0 in order to satisfy the disinfection requirements. In general, treatment plants target a CT ratio of 1.2 to 1.4 in order to ensure continuous compliance with the requirements. As shown in Table 9.1, the ratio for Zone 7's plants is often significantly higher than the minimum requirement. It is expected that for an ozone disinfection system, these ratios would be closer to 1.0.

Under the Peroxone option, disinfection will continue to be achieved with free chlorine. The same operational strategy will be used in that the higher of the two chlorine doses will be added (disinfection vs. residual maintenance). The result is that the disinfection profile for the Peroxone process will likely be similar to the historical values shown in Table 9.1.

**Table 9.1 – Monthly Average CT Ratios for DVWTP and PPWTP During 2008**

| Month | Del Valle WTP | Patterson Pass Conventional WTP | Patterson Pass UF WTP |
|---|---|---|---|
| January | 2.6 | 1.7 | out of service |
| February | 2.0 | 2.1 | out of service |
| March | 2.3 | 2.1 | out of service |
| April | 1.8 | 2.3 | 2.3 |
| May | 2.8 | 2.8 | 2.5 |
| June | 2.8 | 2.9 | 6.2 |
| July | 3.1 | 3.4 | 6.7 |
| August | 3.3 | 3.4 | 7.2 |
| September | 3.3 | 2.9 | 8.6 |
| October | 2.9 | 2.1 | 6.6 |
| November | 2.4 | 2.7 | out of service |
| December | 2.0 | out of service | out of service |
| **Minimum** | **1.8** | **1.7** | **2.3** |
| **Maximum** | **3.3** | **3.4** | **8.6** |

### 9.1.3 Enhanced Coagulation (TOC Removal) and DBP formation

Both plants currently meet the Step 1 TOC removal requirements of the Stage 1 Disinfectants/Disinfection Byproduct Rule. No significant change is expected in TOC removal as a result of either ozone or Peroxone implementation, although there may be slight improvement due to the biofilters. In the case of ozone implementation, it is expected that the levels of THMs and HAAs formed will be significantly lower, since there will be much less contact time with free chlorine. For example, the typical THM concentrations in the finished water at ACWD's WTP2 range from 5 to 10 ppb. In the case of Peroxone implementation, THM and HAA levels are expected to be higher than those with ozone, but lower than the current levels. Tests conducted during the pilot study showed that a reduction in THMs and HAAs of approximately 20% can be expected as a result of just raw water ozone or Peroxone. Additional removal of DBP precursors is expected to result from the biological filtration process.

### 9.1.4 Aesthetics (Taste, Odor, and Color)

Implementation of either ozone or Peroxone will result in improved taste and odor of the water. It is expected that the current practice of monitoring of the raw water for MIB and geosmin will continue to be done on a weekly basis during the T&O season, and the ozone or Peroxone doses will be adjusted accordingly to ensure that the MIB and geosmin goals are met.

Aside from MIB and geosmin, there are other naturally-occurring compounds in the SBA water that impart taste, odor, and/or color to the water. Ozone and bio-filtration have been demonstrated to improve the overall taste and appearance of the water. As an example, Figure 9.1 shows two samples of the raw SBA water collected during the pilot study. The bottle on the left is the untreated water, while the bottle on the right was ozonated but not filtered or otherwise treated. This figure shows the color removal performance of the ozonation process.


**Figure 9.1 – Raw and Ozonated Water, Del Valle WTP, August 2008**

When the taste, odor, or color of the water changes, customer complaints often result. This occurs regardless of whether or not a particular compound is present; merely a change in the aesthetics of the water can be a cause for concern. The on/off operation of the Peroxone system is likely to result in periodic changes to the taste, odor, or color of the water. Therefore customer complaints may result each time the system is turned on or off, even when MIB and/or geosmin is not present (as was the case when the photo in Figure 9.1 was taken), other organic compounds in the water may change the appearance and flavor of the water.

There is a potential for manganese release from the media filter after implementation of ozone or Peroxone and conversion of the filters to biological mode. Manganese is known to be contained in ferric chloride, and this manganese can accumulate on the media from historical use of ferric chloride, as well as manganese captured from the raw water. This manganese will remain bound to the filter media as long as a chlorine residual is present in the water passing through the media. Once that chlorine is removed, the manganese may slough off the media into the filtered water, potentially causing turbidity spikes and aesthetic concerns. This issue should be carefully evaluated during design. The evaluation may determine that the filter media will need to be replaced with new media before implementation of either ozone or peroxone.

## 9.2 DOCUMENTATION NEEDS

Implementation of either ozone or Peroxone will require an amendment to the existing operating permit from the California Department of Public Health (CDPH). In both cases, a new (updated) Operations Plan will be needed as part of the permit amendment process. Per Zone 7's current practice, the Standard Operating Procedures (SOPs) pertaining to the various components of the ozone or Peroxone systems will be included in the updated Operations Plan. New SOPs will need to be developed for processes such as startup and shutdown of the system, chemical ordering and delivery, and monitoring and controlling the processes. Existing SOPs such as filter backwashing will need to be updated to reflect the changes in operation.

The manner in which disinfection is demonstrated will change and a new disinfection calculation methodology will be needed. The new disinfectant sampling plan and calculation methods will be included in the updated Operations Plan, and a new monthly report format will be required.

Updated plant drawings per standard Zone 7 practices will be needed. All new equipment will need to be included in the computerized maintenance management system (CMMS) system along with the corresponding manufacturer's manuals. An inventory of spare parts associated with the ozone or Peroxone system will be needed as well as routine maintenance tasks for each piece of equipment.

## 9.3 Additional Water Quality Monitoring

Because the biofiltration process is new, it should be monitored carefully to ensure that it is working correctly. In addition to the regular plant monitoring (turbidity profiles, headloss curves, chlorine residuals, pH, etc.) samples should be taken for heterotrophic plate count (HPC) bacteria across the plant. This will provide an indication of the level of biological activity in the filters. Additionally, it would be helpful to monitor for indicators of the removal of biodegradable organic matter (BOM) such as aldehydes or Assimilable Organic Carbon (AOC) upstream and downstream of the biofilters.

Because both ozone and Peroxone will create bromate, it will be important to monitor this regulated parameter closely. When using ozone, monthly monitoring for bromate is required, and the MCL is based on a rolling 12-month average of these monthly values. Higher-frequency monitoring, such as once per week, is recommended at least for the first year of operation to ensure that adjustments are made as needed. For example, the addition of chloramine to the contactor inlet has been shown to be effective in suppressing bromate formation, but is not necessary when the raw water bromide level is low (below approximately 80 - 100 ppb).

## 9.4 Additional On-Line Analyzers and Specialized Equipment

In the case of ozone, it is best to monitor the ozone residual in the water continuously (similar to the chlorine residual under the current operation). The online water-phase analyzers should be verified by periodic grab samples. Older ozone analyzers were problematic, but recent models have shown much improvement in reliability. Two or more ozone analyzers per contactor are recommended to allow for precise calculation of disinfection.

Ozone in the gas phase must also be monitored continuously. Typically, three locations are monitored: the ozone concentration in the feed gas, the off-gas, and the vent gas after the ozone destruct system. Additionally, ambient ozone monitors are needed in enclosed areas to ensure that personnel are not exposed to dangerous level of ozone resulting from leaks.

For the Peroxone option, pH control is not needed. The raw water ambient pH will continue to fluctuate between approximately 7 and 9 as is does under current operation. Therefore, no new pH analyzers will be needed. However for ozone, the pH should be stabilized at a moderate level such as 7.3 units by the addition of carbon dioxide. This will have more than one benefit: it will stabilize the ozone residual, reduce the amount of ozone needed to achieve the disinfection goals, and improve TOC removal with the downstream processes. For ozone implementation, additional pH analyzers will be needed to monitor and control the carbon dioxide feed system.

## 9.5 EXPECTED IMPACT ON STAFFING LEVELS

Currently, both the DVWTP and PPWTP are staffed continuously (24 hours per day, 7 days per week) in three shifts: day, swing, and graveyard. Only one operator is present at each site during the swing and graveyard shifts, while multiple operators are present during day shifts. There are 20 operators, and these operators share responsibility for operating the Del Valle WTP, the conventional and UF plants at Patterson Pass, the well fields, distribution system, and the new demineralization plant. Maintenance is centralized, with one lead mechanic, four mechanics, one laborer, two electricians, and four instrument technicians to cover all facilities. Several tasks are contracted out such as solids dewatering, certain instrumentation maintenance, and PLC/PC system maintenance.

It is likely that the ozone or Peroxone process can be implemented without adding any new operators, although existing schedules may need to be adjusted. Some plants using ozone in the SF Bay area (SCVWD and ACWD) employ double coverage: two operators on shift at all times, while others (CCWD) have only one operator at night. It is difficult to generalize, since some plant operators monitor solids handling processes, some control distribution systems, and some operate other remote facilities in addition to on-site plant operational duties. However, it is reasonable to assume that an ozone or Peroxone process could be added to each plant, and assuming that the design incorporated modern automated control features, these processes could be operated with existing staff. Ozonation is expected to be fairly continuous and stable, particularly with pH adjustment. Further, there are good online instruments to measure and trend the ozone residual as well as other performance parameters. This means that reliable automation is possible, similar to that used for chlorine feed or caustic feed. In the case of the Peroxone process, operation would be simpler since it would be run at a constant dose. Once the system is in place and running, the operator must monitor it in a similar fashion to the existing chlorination or caustic feed systems. It should be emphasized that this operator staffing assumption is dependent on the quality of the ozone system design: gas flows must be able to be controlled by the PC/PLC system, online analyzers must be properly located and accurate, and the computer control system must be well thought out an operator-friendly. If the system is not well designed, more operator attention will be needed. Based on discussions with Zone 7 staff, an additional operator, split equally between the two plants, will be needed due to the additional workload associated with other duties such as operating of the distribution system and the new demineralization plant.

Maintenance staff will need to be increased to handle the new equipment. The new LOX storage and feed systems, ozone generation and control systems, off-gas destruct systems, and either hydrogen peroxide or carbon dioxide storage and feed systems will require mechanical, electrical, and instrumentation support. At least one additional full-time mechanic, one new control system/instrumentation technician, and one new electrician will be needed to maintain the equipment for both sites (0.5 FTE per trade per site).

There are examples of local surface water treatment plants in which ozone was added to an existing plant. WQTS contacted three agencies regarding the impact of ozone implementation on the level of operations and maintenance staff needed. The following are summaries of the feedback received:

*East Bay Municipal Utility District:* Settled water ozone was added to both the Upper San Leandro WTP and Sobrante WTP in 1991. No new operators were hired, but operator trainees were added. Maintenance staff size was increased. Maintenance was centralized at the time, which makes it difficult to determine the impact of the ozonation system on the maintenance needs. However, at least two new mechanics, two electricians, and three instrument technicians were added. It should be noted that these projects also included other significant changes to the plants, aside from ozone, such as new chemical handling facilities and changes in backwash water recycle systems.

*Santa Clara Valley Water District*: Settled water ozone was added to the Penitencia WTP in 2006 and to the Santa Teresa WTP in 2005. The plants had been operated in single shifts at night, but a few years before ozone was added, the District changed to double shifts at all plants (two operators per shift at all times). This was done partly in anticipation of ozone addition, but also to deal with the new washwater clarification facilities and for safety and workforce/continuity concerns. The Rinconada plant (which has no ozone) also employs double coverage for all shifts. For the addition of ozone, the District added one new control technician at each plant, plus one new electrician and one new mechanic for the combined facilities. It should be noted that the distance between SCVWD's plants is significant; consideration of travel time was part of the decision to station a dedicated control tech and each site.

*Contra Costa Water District*: Settled water ozone was added to the Bollman WTP in 1999. There is single operator coverage during the night shift, with double coverage during most day shifts. No new operators were added specifically for the implementation of ozone as the existing staff at the Bollman plant incorporated the new duties into normal operations. CCWD estimates that ozone requires 3 – 4 hours of operator attention per 24 hour day, but that this is highly dependent on the quality of the operator interface with the PLC. Programming flaws such as common alarms that do not inform the operator of the source of a problem or shutdown have resulted in unnecessary resources being expended to determine the cause of the problem and conduct needed repairs.