Section 4: Treatment Processes

This section presents the recycled water treatment processes. The wastewater pumping, storage, and distribution systems are discussed in Section 5.

4.1 Title 22 Requirements

In order to meet Title 22 regulations, disinfection and tertiary treatment is required for irrigation use in schoolyards and parks as well as for structural fire fighting purposes. Accordingly the existing WWTP must be modified to include these treatment processes.

Tertiary treatment consists of coagulation/flocculation, sedimentation, filtration, and disinfection. A number of tertiary filtration systems are available; systems that should be evaluated in more detail in the preliminary design report include the Parkson Dynasand and the Aqua-Aerobic Aquadisk. The Parkson Dynasand system is reliable and provides continuous backwash. The Aqua-Aerobic Aquadisk is relatively small in size, a benefit when space is limited. In addition, the modular US Filter Memcor ultrafiltration system or competing Zenon system could be considered. For a 0.5 MGD tertiary treatment capacity, these systems would have an estimated capital cost of $1 to $3 million (in 2002 dollars) and meet Title 22 regulations. Only water required for recycled water use would need to be treated to tertiary levels, which may save on operation and maintenance costs.

CCSD may also consider the use of a membrane bio-reactor (MBR) instead of tertiary filtration. A MBR is a variation on the activated sludge process, currently practiced at the WWTP. The significant difference is eliminating the need for secondary clarifiers, return activated sludge, and tertiary filters. The MBR process consists of applying a vacuum to hollow core, long strand membranes to filter the mixed liquor directly from the aeration basin. Benefits of a MBR include, superior filter removal to typical wastewater tertiary filters and the ability to operate at mixed liquor suspended solids concentrations of 10,000 milligrams per liter. The primary limitation of an MBR system is the flux rate of effluent through the membranes. Accordingly, the facility should be designed with adequate capacity to meet peak hydraulic flows, detention time, and solids retention time. Additionally, to keep the solids from ultimately plugging the microfilter membranes, each membrane module has a compressed air connection. The air scours the long-stranded membranes, keeping them in constant motion. For in-place backwashing, a hypochlorite solution, diluted with the high quality MBR effluent, may be periodically back pulsed through the membrane. The backwash material is absorbed into the mixed liquor with no impact on the activated sludge organisms. Several manufacturers, including Zenon, U.S. Filter, and Enviroquip, produce MBR systems which have been approved for Title 22 recycled water use. Unlike a tertiary filtration, a MBR system would treat the entire influent flow, which may lead to increased operational costs. A MBR system has an estimated capital cost of $5 to $6 million (in 2002 dollars), assuming no other treatment upgrades are required (e.g., additional grit screening to prevent membrane clogging).

4.2 Potential Additional Processes

Due to emerging concerns regarding nitrate, total dissolved solids (TDS), NDMA formation, and trace pharmaceuticals, CCSD had Kennedy/Jenks consider implementing additional processes that would treat WWTP effluent beyond current regulatory requirements. Additional processes to be considered include dentrification, nanofiltration (a low pressure reverse osmosis process) and advanced oxidation using hydrogen peroxide with ultraviolet light irradiation. This approach would also ensure there is no potential degradation to groundwater or surface water in the vicinity of any larger landscape irrigators using recycled water.

4.2.1 Dentrification

Although not required under Title 22 regulations, a dentrification process would aide in addressing concerns regarding impacts of increasing nitrate concentrations on habitat and water quality within the watershed. Dentrification would be achieved by adding an anoxic zone upstream from the MBR, microfiltration, or tertiary filtration. This would be done by the addition of baffling to the aeration basin, creating oxic and anoxic zones. Although the existing aeration facilities have the necessary provisions for baffle insertion, modifications to the aeration control may be required.

4.2.2 Nanofiltration (low pressure reverse osmosis)

Due to recent modifications to the WDR Order issued by the RWQCB, the need for additional salt management has emerged. To ensure levels of TDS are kept at or below background levels, further demineralization of the recycled water could be achieved by the including a nanofiltration (low pressure reverse osmosis [RO]) membrane system downstream of filtration. A low-pressure RO membrane could significantly reduce TDS and salt concentrations and thus reduce concerns regarding impacts to water quality resulting from the use of recycled water. Because the TDS concentration is much lower in recycled water than in seawater, the amount of energy needed to reverse the osmotic force is also much lower. Additionally, nanofiltration membranes have less hydraulic head loss than typical seawater membranes adding further energy savings.

A 0.5 MGD low-pressure reverse osmosis system would have an additional capital cost of $2 to $3 million (in 2002 dollars), not including the cost for brine disposal. Concerns for increased TDS and salt loading may also be addressed by the proposed Seawater Desalination facility. The Seawater Desalination facility would provide high-pressure RO treated seawater for potable use. This would eliminate the need for in-home softening units as well as reduce the overall TDS concentrations in the WWTP influent, thereby reducing the salt loadings in the WWTP effluent. The Seawater Desalination facility is further discussed in the Task 4 report.

4.2.3 Advanced Oxidation (hydrogen peroxide and ultraviolet light irradiation)

The combination of hydrogen peroxide and ultra-violet light irradiation has been developed as a means to oxidize and destroy organic molecules. Trace pharmaceuticals and NDMA are examples of organic molecules that are not currently regulated, that could be destroyed using advanced oxidation. Although neither of these is known to exist in the WWTP effluent, for cost estimating purposes, the use of advanced oxidation is being assumed.

Although, CCSD can reliable meet Title 22 requirements for disinfection utilizing their existing sodium hypochlorite facilities, CCSD may further benefit from the use of Ultraviolet (UV) light irradiation as the primary disinfectant. UV light irradiation would provide an efficient disinfection, minimize hazardous chemical storage and handling, and utilize a smaller size facility than chlorination. Sodium hypochlorite would still be used to maintain a disinfection residual in the storage tank and distribution system. Although, UV light lamps need to be periodically cleaned to maintain their efficiency, operational costs would decrease due to the reduction in sodium hypochlorite usage.

There are two main configurations available: (1) open channel, and (2) in-pipe. With the open channel option, the UV lamps are installed in an open channel. The wastewater flows over the lamps and is disinfected. With the in-pipe option, the lamps are installed inside a pipe.

The open channel option is more common and allows for more direct inspection, removal, and cleaning of the lamps. Also, there are more manufacturers for the open channel option than the in-pipe option. However, it does require installing an open channel, which will take up more space and is more costly than the in-pipe option. Therefore, the in-pipe option is the preferred configuration. However, currently there are no in-pipe manufacturers certified to meet the DHS's requirements for Title 22. One manufacturer, Aquionics, expects to receive their certification within the next several months. Several other manufacturers, including Wedeco, Trojan, and Suntec, are certified by the DHS for open-channel UV. The capital cost for a 1.0 MGD UV disinfection system is approximately $1 million (in 2002 dollars).