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California Department of Corrections and Rehabilitation
Deuel Vocational Institute

Third Party Evaluation of Operation and Maintenance of Wastewater Treatment Facility

June 2016

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Third Party Evaluation of Operation and Maintenance of Wastewater Treatment Facility

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Section 1

Executive Summary

The Deuel Vocational Institute (DVI) is located outside of Tracy, California. DVI provides domestic and non-potable water for use within the facility as well as wastewater treatment for the facility and discharges treated effluent to the Deuel Drain. The DVI Wastewater Treatment Facility (WWTF) serves a population of approximately 3,132 inmates plus 1,066 staff. The WWTF began discharging on September 22, 2010.

The Central Valley Regional Water Quality Control Board (CVRWQCB) required the California Department of Corrections and Rehabilitation (CDCR) to conduct an independent third party evaluation of operations and maintenance of the DVI WWTF. The third party evaluation identified factors which cause or contribute to discharge permit non-compliance and identified corrective actions to operate and maintain the WWTF in compliance with discharge permit limitations. Results of the independent evaluation are summarized in this report.

The evaluation of operations staffing levels determined that the four authorized operations staff positions for the WWTF are adequate to perform all necessary functions. Currently only two of the four full time positions are filled. CDCR has hired additional contract operators on a temporary basis to supplement permanent staff positions and maintain adequate operations staffing levels until the full time positions are filled. CDCR also hires temporary staff when the full time operators are absent due to illness, vacations, during off-site training, testing, and certification activities, or other personal activities.

The current preventive maintenance work order backlog is manageable. The annual budget and standard procurement processes for scheduled preventive maintenance appear to be adequate to reliably maintain continuous operation and compliance with discharge permit limits. For critical items, the replacement and repair components can be approved on an expedited basis. When the WWTF can use redundant equipment to continue operation in compliance with discharge permit limits, replacement or repair of non-critical components or equipment may be deferred until approved through the annual budget and standard procurement process.

The DVI WWTF generally produces high quality effluent which complies with California Title 22 reuse regulations. The DVI WWTF has adequate capacity and redundancy to maintain continuous operation and compliance with stringent discharge permit limits. Violations of discharge permit limits have been caused infrequently by WWTF mechanical equipment failures, but most violations were caused by off specification operation by the drinking water facility or by changes in water use and waste management practices within the institution.

Several potential modifications to enhance redundancy and reliability were recommended for consideration by CDCR including:

- New mechanical screen with narrow bar spacing when the the existing screen is replaced
- Replace the existing manual bar screen with new mechanical screen with narrow bar spacing
- Install overflow sensor and alarm signal on each fine screen

- Divert the fine screen overflow to the influent wet well for re-screening
- Modify existing fine screens to prevent debris from damaging the MBR membranes
- Reuse abandoned oxidation ditch or secondary clarifier as flow equalization basins to:
    - Enhance MBR system operation
    - Reduce cooling tower peak loads and enhance evaporative cooling
- Reuse abandoned secondary clarifier for sludge storage
- Convert existing sludge storage tank into a third aeration basin to increase redundancy and operational flexibility
- Test capability to achieve disinfection requirements by the MBR system alone and seek approval to bypass UV disinfection to reduce operation and maintenance costs

Section 2

Wastewater Treatment Facility Operations and Maintenance

The DVI WWTF has a liquid design flow of 0.70 million gallons per day (mgd) average day average month (ADAM). The facility permit limits the average dry weather flow effluent discharge rate to 0.62 mgd. Compliance with the average dry weather flow effluent limitations is determined annually based on the average daily flow over three consecutive dry weather months (e.g., July, August, and September).

DESCRIPTION OF EXISTING SYSTEM

The DVI WWTF consists of preliminary treatment, alkalinity addition, nitrifying activated sludge secondary treatment with de-nitrification, membrane bioreactor (MBR) system using hollow fiber membranes, ultraviolet (UV) disinfection, effluent cooling, aerobic digestion, sludge thickening, and dewatering.

The design organic loading capacity of the treatment plant is 240 mg/L of 5-day biochemical oxygen demand (BOD5). The design solids loading capacity of the treatment plant is 230 milligrams per liter (mg/L) of total suspended solids (TSS). The activated sludge process design allows for an aerobic solids retention time (SRT) of 10 days at average day maximum month (ADMM) to achieve full nitrification.

Table 2.1 – Hydraulic and Organic Loading Design Criteria for DVI WWTF

Parameter	Flow, mgd	Influent BOD5	Influent TSS	Influent Ammonia	Total Dissolved Solids
Average Day Average Month (ADAM)	0.70				
Concentration, mg/L		240	230		
Mass Loading, ppd		1,401	1,343		
Average Dry Weather Flow (ADWF)					
Concentration, mg/L				40	350
Mass Loading, ppd				3,870	
Average Day Maximum Month (ADMM)	0.84				
Maximum Daily Flow	1.05				
Peak Wet Weather	2.10				

WASTEWATER TREATMENT PERFORMANCE

Wastewater Flows

Wastewater flows for year 2014, shown on Figure 2.1, average 0.459 and 0.496 mgd for the influent and effluent, respectively. Wastewater flows for year 2015, shown on Figure 2.2, average 0.378 and 0.423 mgd for the influent and effluent, respectively. The 2015 influent and effluent flows were 18 and 15 percent lower than the 2014 flows, respectively. The reduction in flows during 2015 reflects water conservation measures within the institution.

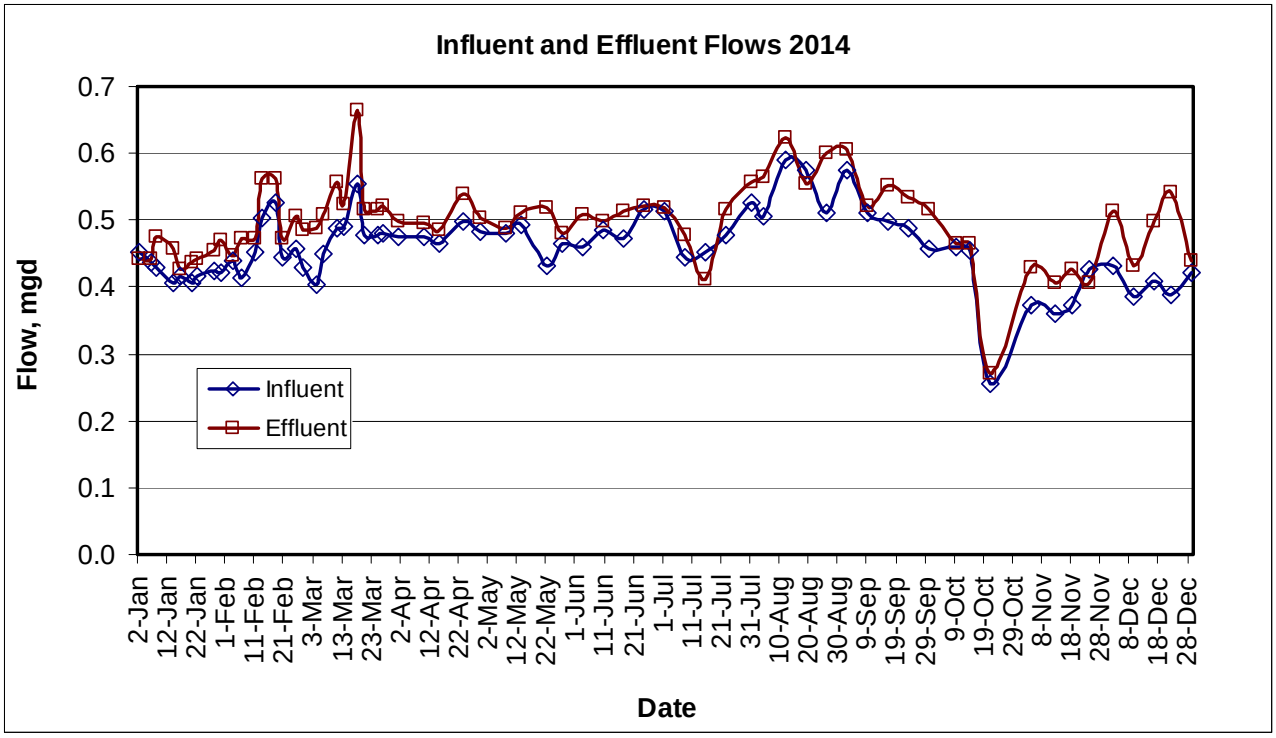

Figure 2.1 – Wastewater Influent and Effluent Flows During 2014

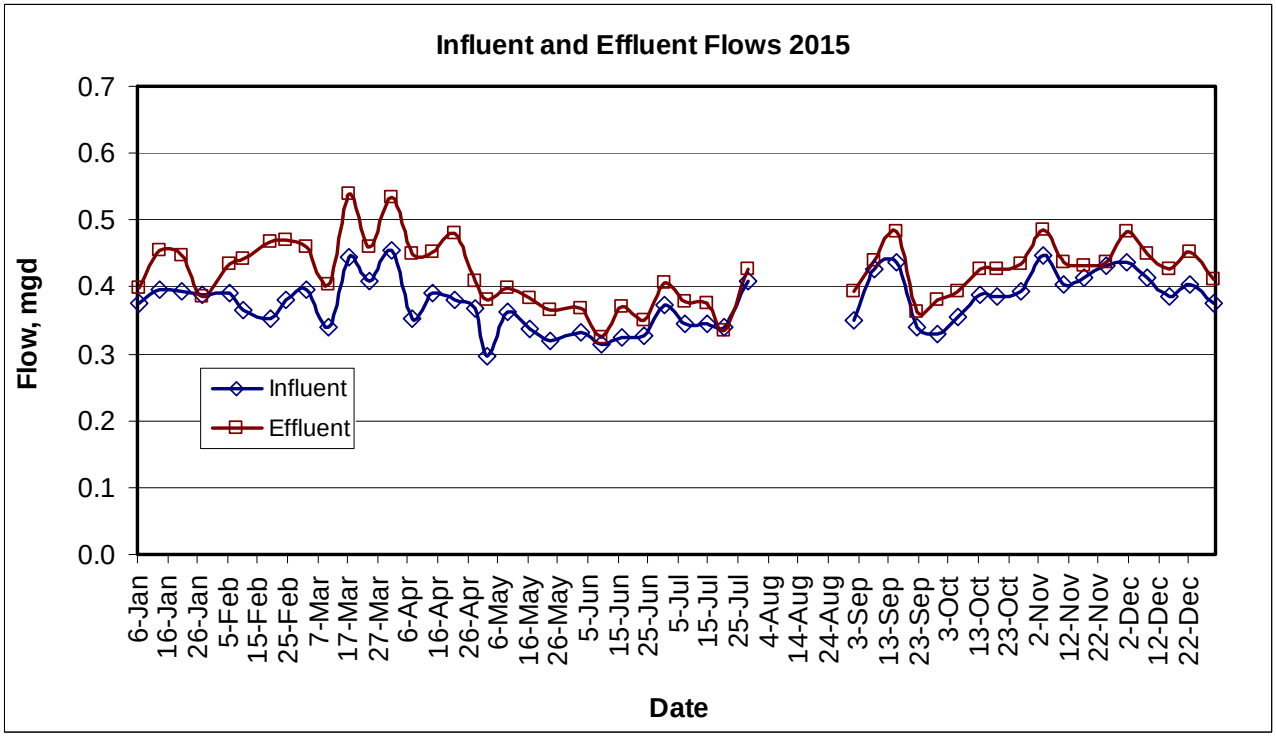

Figure 2.2 – Wastewater Influent and Effluent Flows During 2015

Annual average effluent flow exceeded influent flow by 8 percent in 2014 and by 12 percent in 2015. The higher effluent flows may reflect groundwater infiltration into the collection system.

Influent BOD5 and TSS

During 2014, influent BOD5 and TSS concentrations averaged 175 and 296 mg/L, respectively. Influent BOD5 and TSS average concentrations increased to 324 and 888 mg/L, respectively during year 2015. High TSS concentrations over 1,000 mg/L were recorded each month during 2015 through March 2016. The large increase in influent BOD5 and TSS concentrations during 2015 was caused largely by garbage disposals that were re-installed in the Main Culinary area of the institution in October 2014. Excessive use of these garbage disposal units greatly increased the quantities of food waste discharged into the sewage system. The decrease in influent flows during 2015 also contributed to the increase in influent BOD5 and TSS concentrations.

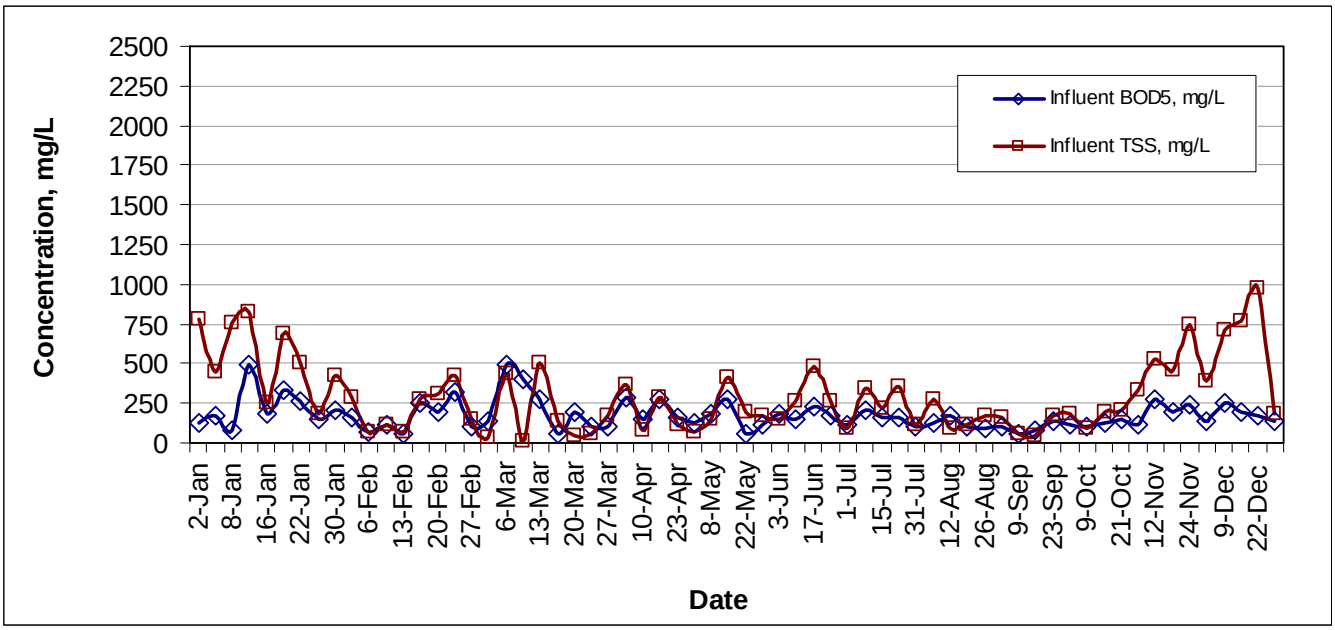

Figure 2.3 – Influent BOD5 and TSS Concentrations During 2014

Effluent BOD5 and TSS

The membrane bioreactors at the DVI WWTF reduced effluent BOD5 and TSS to annual average concentrations of 0.59 and 0.80 mg/L during year 2015. The very low effluent concentrations of BOD5 and TSS are attributed to the effectiveness of the membrane bioreactor (MBR) treatment process.

Effluent Ammonia

Effluent ammonia concentrations are frequently below detection limits and averaged 0.08 mg/L during year 2014 and 2015. The very low effluent ammonia concentrations are attributed to the long sludge age in the membrane bioreactor (MBR) treatment process.

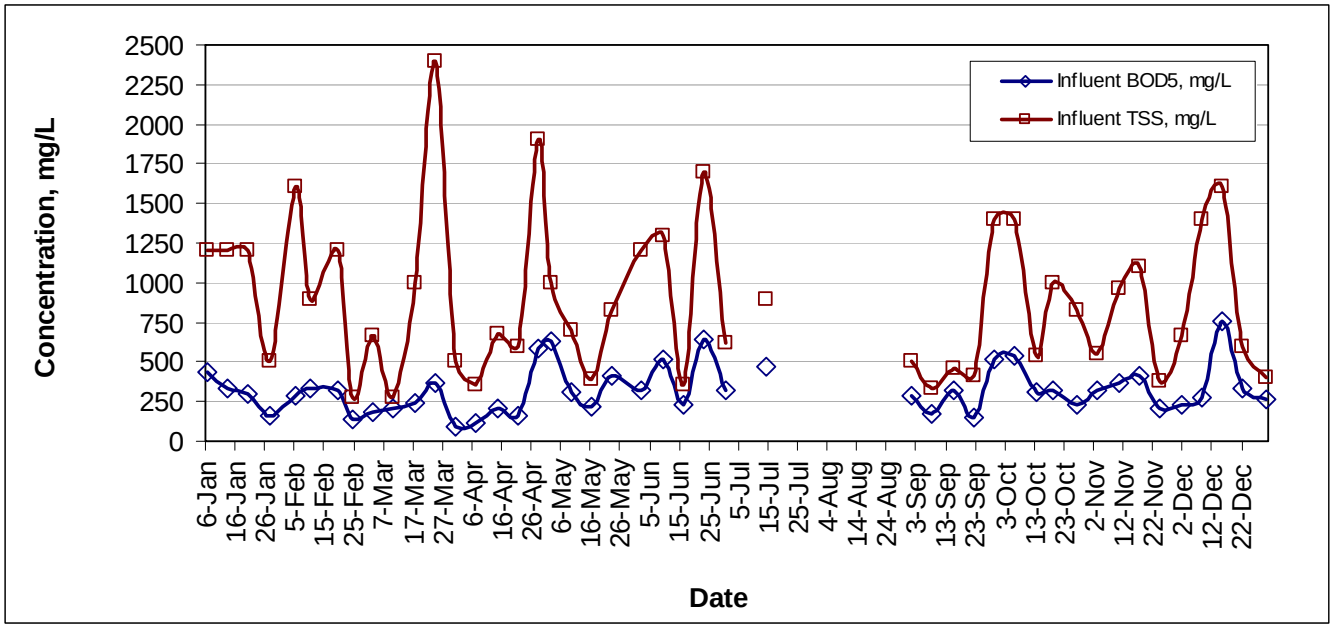

Figure 2.4 – Influent BOD5 and TSS Concentrations During 2015

Effluent Nitrate

Average effluent nitrate concentrations are usually very low. However, the WWTF exceeded the monthly average effluent limitations for total nitrate nitrogen on four occasions during 2013 and 2014. These nitrate violations were attributed to mechanical failure of mixers in the anoxic zones of the activated sludge process. CDCR installed two new mixers to restore denitrification capacity. No further nitrate violations have occurred since the new mixers were installed.

Effluent Chronic Toxicity

The WWTF effluent exhibited chronic toxicity for *Selenastrum capricomutum* in 2012 and for *Ceriodaphnia dubia* in 2013 and 2014. Toxicity Reduction Evaluations for these events concluded that high concentrations of total dissolved solids (TDS) (reflected by high electrical conductivity) were the probable cause of chronic toxicity. High TDS concentrations (from the brackish groundwater source) cause chronic toxicity in the WWTF effluent when the reverse osmosis (RO) system and brine concentrator system (BCS) which supply drinking water are out of service. The drinking water facility must operate continuously to maintain compliance with the WWTF discharge limitations.

EVALUATION OF TREATMENT SYSTEMS

Septage

Septage from CDCR transfer buses is added upstream of the headworks. Domestic septage has a high solids and BOD content which can create high peak loads in the WWTP influent.

Influent Coarse Screens

Raw wastewater is conveyed to the headworks by gravity. The influent wastewater flows into either of two channels which contain a mechanical climber screen in one channel and a manual bar screen in the

second channel. Screenings from the coarse screen are dewatered and compacted in screw conveyor/compactor and are deposited in a dumpster for disposal.

The bar rack of the mechanical screen has a relatively wide 1-inch bar spacing which allows significant amounts of debris to flow to the fine screens. Coarse screen performance could be enhanced by reducing the bar spacing to 0.5-inches or less. However, modifications to the existing screen would be impractical. When the existing mechanical screen reaches the end of its' useful life, it should be replaced with a new screen with narrower bar spacing.

In addition, the existing manual bar screen could be replaced with a new mechanical screen narrower bar spacing which could serve as the primary coarse screen. The existing mechanical climber screen could then serve as the bypass screen in place of the manual screen.

Influent Pumps

Coarse screened wastewater flows into the influent wet well. Three submersible non-clogging pumps convey coarse screened influent from the wet well to two rotary drum fine screens. The influent umps have a capacity of 870 gpm each at a total dynamic head of 50 feet.

Fine Screens

Two rotary drum fine screens with 2 millimeter orifices remove additional trash and debris from the wastewater. The rotating drum screens have internal and external spray nozzles that periodically clean the interior and exterior surfaces of the screen to prevent the accumulation of solids and grease which could blind the screen orifices. Screenings captured by the fine screen discharge into a compactor and hopper for disposal.

The fine screens remove fibrous material and small debris that would otherwise be trapped between the hollow fiber membranes in the MBR system. Accumulation of debris between the hollow fibers decreases scouring and reduces removal of the filter cake from the membrane surface. Abrasion by trash and debris trapped within the fiber modules damages or punctures the membrane surface which decreases membrane life, increases trans-membrane pressure (TMP), increases chemical cleaning frequency, and increases operator maintenance.

During 2012, trash and debris in the fine screen overflow passed through the aeration basins and subsequently into the MBR tanks. Trash, debris, and sludge were trapped between the MBR hollow fibers and in the scouring aeration header jets (Siemens, 2013). The accumulated solids reduced the membrane permeability and damaged the hollow fibers membranes. The existing fine screens do not have overflow alarms.

After the fine screen overflow impacts were observed, the internal and external spray nozzles were operated more frequently to prevent blinding of the screen orifices by solids and grease. In addition, baskets made of perforated plate with 0.25-inch orifices were fabricated and installed to at the fine screen overflow points to intercept trash and debris from the overflow. These overflow baskets reduce the amount of trash and debris which reaches the MBR tanks, but debris in the overflow will adversely affect MBR performance.

The fine screen overflow should be separated from the screened flow and be returned to the influent wet well for re-screening. The overflow should also be equipped with a sensor and alarm signal to alert the operator that an overflow has occurred.

Grit Removal

Fine screened effluent flows by gravity through the vortex grit removal system. Grit settled out in the vortex grit chamber flows is pumped to a cyclone grit classifier where the grit is washed and cleaned grit is deposited in a dumpster for disposal.

Table 2.2 – Headworks Equipment

Treatment Units	Quantity	Capacity		Type
		Each, gpm	Total, mgd	
Coarse screen (Infilco Degremont)	1		2.1	Climber, 1-inch bar spacing
Coarse screen, manual	1		2.1	1.5-inch bar spacing
Influent pumps (ABS)	2 + 1 standby	870	2.1	Submersible, 17.4 hp, 870 gpm
Fine screens (Waste Tech)	2	1,750	5.0	Rotary drum, 2 mm orifices
Grit separator (Eimco)	1		2.6	Vortex, 8 ft diameter
Grit separator & classifier (Eimco)	1	250		cyclonic w/ inclined screw

Sodium Bicarbonate Metering System

The DVI WWTF has a sodium bicarbonate metering system to adjust the pH of the wastewater and satisfy the alkalinity requirement for nitrification. Biological nitrification requires inorganic bicarbonate (at a stoichiometric ratio of 7.14 $CaCO3^-$: 1 NH3-N) as the carbon source required for growth of autotrophic microorganisms. Biological denitrification restores approximately half of the bicarbonate consumed by nitrification. Therefore, the alkalinity in the influent wastewater needs to be approximately 150 mg/L (as $CaCO3^-$) or more. Sufficient effluent alkalinity is also required for pH control and buffering capacity.

The target alkalinity in the drinking water is 60 mg/L as calcium carbonate (Carollo Engineers, 2009). The influent wastewater contains higher mineral content than the drinking water due to minerals and chemicals added during domestic use of the water. In addition, groundwater infiltration into the collection system increases alkalinity in the influent wastewater.

Under most conditions, the influent alkalinity is adequate for complete nitrification and addition of sodium bicarbonate is not necessary. When the alkalinity in the influent wastewater is insufficient to achieve complete nitrification, sodium bicarbonate is added.

DVI WWTF effluent exhibits consistently low ammonia concentrations which indicate that the WWTF has sufficient alkalinity to sustain complete nitrification. Bicarbonate addition allows the WWTF to maintain compliance with effluent ammonia, nitrate, and acute and chronic toxicity limitations whenever the influent alkalinity would otherwise be insufficient.

Aeration Tanks

Effluent flows by gravity from the vortex grit removal system into the aeration tank splitter box where it combines with return activated sludge (RAS) from the MBR system. Blended influent and RAS (mixed liquor) flows into Aeration Tanks 1 and 2. Each aeration tank has two anoxic zones with submerged mechanical mixers. In the second anoxic zone, the wastewater flows underneath and over concrete baffle walls, and into the aerobic zone. The aerobic zone has submerged membrane disk diffusers to aerate the wastewater.

Figure 2.5 – Aeration Basins

Hydraulic Retention Time

With two aeration basins in service, the hydraulic retention time (HRT = V/Q) is 13.4 hours at average day maximum month flow (0.84 mgd). With only one aeration basin in service, the hydraulic retention time would decrease to 6.7 hours at average day maximum month flow (0.84 mgd). With two aeration basins in service operating with a design mixed liquor suspended solids concentration of 8,500 mg/L and with membrane bioreactors for solids separation, the HRT is adequate to reliably achieve compliance with the permitted discharge limits.

Table 2.3 – Aeration Basin Equipment

Treatment Units	Capacity, Each	Notes
Aeration basins, quantity	2	
Dimensions, each, L x W x SWD, ft	90.25 x 20 x 17.6	
Volume, total gallons per train	236,000	
Anoxic zones, quantity per train	2	
Dimensions, each, L x W x SWD, ft	13.6 x 20 x 17.6	
Anoxic volume, gallons per train	72,000	
Aeration zones per train	1	
Dimensions, each, L x W x SWD, ft	63 x 20 x 17.6	
Aerobic volume, gallons per train	164,000	
Aeration blowers, quantity	2 + 1 standby	Rotary lobe, 60 hp
Blower capacity, each, scfm	1,093	2,186 scfm maximum air
Diffusers per basin, quantity	407	Membrane, 9-inch diameter
Mixed liquor suspended solids, mg/L	8,540	
Hydraulic retention time		
One train in service at ADMM, hours	6.7	
Two trains in service at ADMM, hours	13.4	
Solids retention time, days	10.3	
Mixed liquor suspended solids at ADMM, mg/L	8,540	
Aerated sludge storage tank, gallons	236,000	

Membrane Bioreactors (MBRs)

The membrane bioreactor (MBR) system consists of hollow fiber membranes installed in four steel tanks. Each MBR tank contains 6 racks of 16 B40N modules per rack. Aeration tank effluent flows to the MBR wet well. Four submersible pumps convey the mixed liquor from the wet well to the four MBR tanks. The hollow fiber ultra-filtration membranes have a nominal pore size of 0.04 microns. Permeate is drawn through the membranes by a partial vacuum applied using a rotary lobe permeate pump.

The number of membrane tanks in service varies to match the total permeate flow to a running average of the plant influent flow. The level in the ML feed pump wet wells also controls the speed of the MBR filtrate pumps to maintain the level in the wet well between the low and high level set points. When a membrane tank is required to start, the membrane tank that has been off-line for the longest period is called to run.

The MBR system can accommodate a membrane influent flow range from 0.07 mgd to a maximum sustained flow of 1.98 mgd. At the maximum sustained flow, each membrane tank receives an influent flow of 344 gpm and operates at a maximum membrane flux of 12.75 gpd/sf. With all four membrane tanks in service, the MBR system can accommodate a sustained peak flow of 2.8 times the average plant capacity of 0.7 mgd. With three membrane tanks in service (one tank out of service), the MBR system can accommodate a sustained peak flow of 2.1 times the average plant capacity. These operating parameters are conservative for MBR system design.

Table 2.4 – Membrane Bioreactor Equipment

Equipment	Value	Notes
Membrane bioreactor (MBR) system		Submerged hollow fiber
Membrane tanks, quantity	4	
Basin dimensions, each, L x W x SWD, ft	23 x 10 x 10	
Membrane basin volume, gallons each	17,200	
Membrane modules, model number	B40N	Manufacturer: Memcor (Evoqua)
Membrane material	PVDF	
Membrane pore size, microns	0.04	
Membrane modules per tank (6 x 16)	96	
Racks per tank/modules per rack	6/16	
Membrane area per module, sf	404.75	
Membrane area per tank, sf	38,836	
Total system membrane area, sf	155,424	
Membrane flux at max sustained flow, gpd/sf	12.75	Max sustained flow = 344 gpm/tank
Membrane suction pressure range, psi	0.5 to 7.5	
Membrane minimum permeability, gfd/psi	3.3	Initiates alarm, CIP required
MBR Feed pumps, quantity	4	ABS submersible, 33.5 hp
Capacity, gpm each	640	
Permeate discharge pumps	4 + 1	Rotary lobe
Capacity, gpm each	512	
Membrane scour blowers, quantity	3	
Capacity, scfm each	1,710	4.3 psi discharge pressure
Clean in Place (CIP) Tank, quantity	1	
CIP tank volume, gallons each	20,500	
Hypochlorite transfer pump		
Capacity, gph each	144	
Citric acid transfer pump		
Capacity, gph each	484	

Internal Recirculation

Mixed liquor recycle containing a high nitrate concentration flows by gravity from the membrane tanks to the aeration tanks at a rate of up to 500 percent of influent flow. Nitrate in the mixed liquor recycle is converted to nitrogen gas in the anoxic zones of the aeration tanks.

The mixed liquor recycle rate is controlled by the MBR feed pumps which operate based on the permeate flow times an operator adjustable recirculation set point plus one (i.e., 4Q + Q). The internal recycle rate was initially set with an influent flow multiplier of 6.5. The recirculation rate was later modified to a target of 3,200 gpm. For an average permeate flow of 0.6 mgd (417 gpm), the mixed liquor recycle rate is 7.7Q. The high internal recycle rate achieves low effluent nitrate concentrations.

Table 2.5 – Membrane Bioreactor Hydraulic Loading

MBR Tanks on line, quantity	Minimum Flow		Minimum Membrane flux, gpd/sf	Maximum Sustained Flow		Maximum Membrane flux, gpd/sf
	gpm	mgd		gpm	mgd	
1	51	0.073	1.89	344	0.495	12.74
2	102	0.147	1.89	689	0.991	12.76
3	154	0.222	1.90	1,033	1.486	12.76
4	205	0.295	1.90	1,377	1.981	12.75

The MBR system can operate at maximum sustained flow (344 gpm) on a continuous basis with no time limit. Maximum flow is 512 gpm per MBR tank for short periods. If flow exceeds 512 gpm per MBR tank, the plant is outside allowable operational limits.

Figure 2.6 – Membrane Bioreactor Tanks

MBR Air Scour Blowers

The membrane air scour blowers provide continuous scouring of the membrane surface during filtration and relaxation operational modes. Air scouring is intermittent during CIP or standby operational modes.

The blower system consists of 3 blowers, 2 Duty and 1 standby. Each blower discharges into a common manifold, flows through a single air flow meter, and splits four ways to the membrane tanks. All blowers operating at the same time run at the same speed.

Table 2.6 shows the recommended range of scour air flow for the blowers at different filtrate flow rates. The average air flow is used for all permeate flows at or below 344 gpm per tank. Peak air flows are used for permeate flows above 344 gpm per tank.

Table 2.6 – Membrane Tank Air Scour Blower Operation

MBR Tanks in Service	Blowers in operation	Average Air Scour Flow, scfm		Maximum Air Scour Flow, scfm	
		Each tank	Total system	Each tank	Total system
1	1	442	442	588	588
2	1	442	884	588	1,176
3	2	442	1,326	588	1,764
4	2	442	1,768	588	2,352

Replacement of Damaged MBR Modules

During 2012, the MBR membranes exhibited high trans-membrane pressure and reduced permeability. An inspection of the membrane tanks and modules on January 22-24, 2013 found trash, debris, and sludge trapped between the MBR hollow fibers and in the aeration header jets (Siemens, 2013). The accumulated solids had reduced the membrane permeability in two of the MBR tanks to approximately 2.7 gfd/psi, well below the minimum design permeability of 3.3 gfd/psi.

The trash and debris had passed through the overflow from the fine screens into the aeration basins and subsequently into the MBR tanks. In addition to reducing permeability, the trash and debris entangled in the MBR hollow fibers damaged the membranes. The membranes were manually cleaned to remove the trash, debris, and sludge and then were chemically cleaned prior to being returned to service. Subsequently, the irreversible membrane fouling reduced the maximum membrane flux to approximately 40 percent (120 gpm per MBR tank) of the original MBR system capacity.

The inspection report concluded that the membranes had reached the end of their useful life and needed to be replaced. However, the manual removal of debris and chemical cleaning of the existing membranes allowed the system to continue to operate until new modules could be procured and installed at site. The original MBR membrane modules were replaced on May 24 through May 26, 2016.

Long term irreversible fouling requires MBR membranes to be replaced about once every eight to ten years. A comprehensive analysis of membrane life at 250 sites over a 15 year period (1996 – 2011) showed that the aggregate membrane life for all ZeeWeed MBR systems was 8 years since their commercial introduction. This analysis also showed that membrane life should exceed 10 years for the current generation ZeeWeed 500D product (Cote, Alam, and Penny, 2012).

Flow Control

The MBR control system selects the number of membrane tanks in service (and in filtrate standby) by matching the total filtrate flow to a running average of the plant influent flow. The speed of the MBR feed pumps and the filtrate pumps is also adjusted to maintain the level in the MBR feed pump wet well between low (11 feet) and high (17 feet) set points. lf the wet well level drops below the low level set point with the filtrate pumps running at minimum speeds, the filtrate pumps will turn off and the MBR tanks will remain in standby until the level rises above the low level set point. If the plant influent flow remains below the single tank influent flow low level set point, only one membrane tank will remain in service and will alternate between filtrate mode and standby based on the level in the wet well.

Low Flow MBR Operation

Currently, one of the aeration basins is used for low flow storage. This basin operates with variable water surface level ranging from approximately 12 to 16 feet deep. Peak flows fill this aeration basin during the day and the stored volume is pumped out to the membrane tanks during low flows at night. This mode of operation allows the MBR system to run at a constant rate and eliminates the need for the membrane tanks to alternate between filtrate mode and standby during low flows at night. Operating the MBR system at a constant rate minimizes wear on the membranes, pumps, control valves, and other equipment.

The aeration basin volume used for low flow storage is approximately 54,000 gallons which equates to 11.5 percent of the total aeration basin volume. Low flow storage reduces the hydraulic retention time (HRT) in the two aeration basins from 13.4 hours to 11.9 hours at average day maximum month flow (0.84 mgd). However, operating at the authorized permit limit with an average plant discharge rate of 0.62 mgd, the two aeration basins operating with low flow storage would provide 16.2 hours of HRT which would be longer than the design HRT at maximum month flow. Low flow storage benefits operation of the MBR system without compromising performance of the biological system or effluent quality.

Flow Equalization

Although the MBR system can accommodate peak sustained flows up to 1.98 mgd, operating at high flows increases stress on the membranes. To maximize membrane life, flow equalization could be implemented to allow the MBR system to operate at a constant flow rate approximately equal to the average plant influent flow.

Reuse of Oxidation Ditch and Clarifier Basins. Prior to construction of the MBR system, DVI operated an oxidation ditch system which was abandoned after startup of the MBR system. The oxidation ditch and a secondary clarifier are located adjacent to the MBR site and these concrete basins remain in good structural condition. One or both of these basins could be reused as flow equalization basins for the MBR system.

To implement this concept, a two-way pipeline between the MBR site and the old basins would be needed. Peak flows above the average flow could be conveyed from the MBR site to the flow equalization basins by gravity. New mixers or aerators would be needed in the flow equalization basins to keep suspended solids from settling. New pumps would be needed to return the stored wastewater through the two-way pipeline to the MBR system during low flows.

The existing oxidation ditch and secondary clarifier are located in the 100-year flood plain which would require them to be drained and not used during a major flood or to be protected from flooding by earthen embankments around these structures.

UV Disinfection

MBR permeate is conveyed to the UV disinfection system which consists of three parallel UV trains each containing two UV reactors in series. The three disinfection trains are designated as two duty trains and one standby train. Each UV reactor contains twelve high intensity medium pressure lamps.

Each train was designed to provide a UV dose of 110 mJ/cm^2 at a maximum flow rate of 1 mgd and minimum 65 percent UV transmittance.

Figure 2.7 – UV Disinfection System

Table 2.7 – UV Disinfection Equipment

Equipment	Value	Notes
UV reactors, quantity	6	3 trains, 2 reactors/train (Aquionics)
Capacity per train, mgd	1.362	
Lamp type		Medium pressure, high output
Lamps per reactor	12	
Minimum UV Transmittance, %	65	Manufacturer: Memcor (Evoqua)
Effective dosage, mJ/cm2	80	110 mJ/cm^2 maximum

The discharge permit requires the UV disinfection system to be equivalent to Title 22 Disinfected Tertiary Recycled Water (i.e., 2 NTU and 2.2 MPN total coliform). The UV reactor must be operated at a minimum hourly average UV dose in the 80 millijoules per square centimeter (mJ/cm2) to achieve virus inactivation and the minimum hourly average UV transmittance (at 254 nanometers) in the wastewater from the MBR system must be greater than or equal to 65 percent.

MBR Disinfection Capabilities. Several test programs and some full scale systems have demonstrated that MBR facilities can achieve compliance with disinfection requirements for surface water discharge without an additional disinfection step. MBR systems remove protozoa completely and frequently have no detectable coliform bacteria in the permeate. Substantial virus removal (0.5-log to 6-log removal) also occurs depending on membrane pore sizes and operating conditions. Complete removal of bacteria and protozoa by the membranes reduces the operational cost of post membrane UV or chemical disinfection. Despite complete retention of bacteria by the membrane, bacteria may grow inside permeate pipe lines which may cause detection of low concentrations of microorganisms in MBR permeate.

MBR Disinfection Tests at Henderson, Nevada. Full-scale tests of an 8-mgd MBR at the Southwest Water Reclamation Facility (SWRF) in Henderson, Nevada demonstrated complete removal of coliform bacteria and reduced viruses to very low levels (in most cases to non-detect levels) without further disinfection. The study demonstrated that the MBR alone achieved compliance with disinfection requirements of the reuse permit (Erdal and Vorheis, 2015).

Based on the SWRF virus study, the State of Nevada approved disinfection credits for the MBR and approved bypassing the UV disinfection system under normal operating conditions. By eliminating UV disinfection with a design dose of 80 mJ/cm2 at UV transmittance of 65 percent to achieve 5-log inactivation of poliovirus, the City of Henderson reduced power consumption by 1.2 million kWh per year (Erdal and Vorheis, 2015) and achieved estimated cost savings of $93,000 (Katz, 2015) for power and UV lamp replacement.

Potential UV Disinfection Bypass at DVI. Based on the demonstrated MBR disinfection capabilities at Henderson, Nevada and other sites, DVI could conduct performance tests to demonstrate that the MBR system alone achieves compliance with disinfection requirements. If such tests were successful, DVI might be permitted to bypass the UV disinfection system which would reduce operation and maintenance costs.

Non-Potable Water

Disinfected effluent is conveyed to a standpipe which supplies non-potable plant water. The standpipe provides sufficient static pressure for MBR backpulse cleanings and gravity flow through the effluent cooling towers. The WWTF has chlorination equipment which could be used to provide a residual disinfectant for the non-potable plant water. However, residual disinfection of the non-potable plant water has not been practiced since the effluent meets Title 22 reuse requirements.

Effluent Cooling Towers

The WWTF has cooling towers which reduce the effluent temperature. Effluent flows by gravity through the evaporative cooling towers. A two-speed fan in each cooling tower draws air through the cooling tower media to maximize the evaporation rate. A fraction of the effluent evaporates and the remaining effluent that has not been evaporated trickles down through the cooling tower media, collects in the cooled water basin, and discharges through a Parshall flume into the Deuel Drain.

The cooling towers normally operate at all times, but can be bypassed if they are inoperative or the temperature of the effluent upstream of the cooling towers is satisfactory for discharge. During normal peak operation, two cooling towers operate and one unit is in standby. One unit is routinely out of

service at all times to avoid algae growth. The cooling towers must cycle out of service weekly to prevent algae and biofilm growth.

Table 2.8 – Cooling Tower Equipment

Equipment	Value	Notes
Cooling towers, type	Evaporation	Cross-flow open circuit, gravity water distribution
Cooling towers, quantity	2 + 1 standby	
Capacity, each, gpm	700	

The cooling towers must reduce the effluent temperature to no more than 4º F above the receiving stream ambient temperature. However, the cooling towers reduce the effluent temperature by a maximum of 20° F. When the effluent temperature exceeds the receiving stream temperature by more the 24° F, the cooling towers cannot remove enough heat from the water to achieve compliance with the 4° F difference limitation.

Figure 2.8 – Cooling Towers

The temperature decrease of the effluent flowing through the cooling towers is directly related to the quantity of water that can be evaporated. Performance of the cooling tower depends on effluent temperature, air temperature, and relative humidity. During rainy, foggy, humid, or high air temperature conditions, the cooling towers can cool the water only to within 5° F of the ambient wet bulb temperature even with all 3 towers in operation at maximum fan speed.

If influent or effluent flow equalization were implemented, peak cooling loads on the cooling towers could be reduced which would enhance the capability to meet effluent temperature limits. In addition, flow equalization would reduce heat in the wastewater by convection and evaporation from the water surface during storage under adverse weather conditions when cooling tower capacity is limited.

The effluent temperature limits protect wildlife species in the San Joaquin River below the confluence with the Deuel Drain. The Deuel Drain is an agricultural ditch which has intermittent flows and does not support any protected wildlife species. Effluent discharged into the Deuel Drain continues to cool as it flows through the ditch to the confluence with the San Joaquin River, especially during cool weather seasons and when blending with agricultural drainage. If the water temperature at the confluence of the Deuel Drain with the San Joaquin River meets the temperature limits currently applied at the discharge into the Deuel Drain, the effluent temperature limits could potentially be waived. CDCR could conduct an environmental study to support a request to waive the effluent temperature limits. A waiver from effluent temperature limits would reduce operation and maintenance costs for the cooling towers and would eliminate or mitigate a current permit compliance liability.

Effluent Flow Meter

The final effluent flows by gravity from the cooling towers or standpipe through a Parshall flume and 14-inch diameter outfall pipe into Deuel Drain, which is a tributary to Paradise Cut and the San Joaquin River.

Sludge Thickening and Dewatering

The DVI WWTF has two belt filter presses (BFPs) which can be operated as either gravity belt thickeners (GBTs) or dewatering belt filter presses (BFPs). Waste activated sludge (WAS) from the sludge storage tank can be thickened from two percent to five percent solids. During thickening mode, thickened sludge from the GBT is pumped back to the sludge storage tank by two progressive cavity pumps. During dewatering, the BFP produces dewatered cake with a solids concentration to 13 to 14 percent solids. The dewatered cake is conveyed to roll-off bins for disposal off site.

Table 2.9 – Sludge Thickening and Dewatering Equipment

Treatment Units	Quantity	Capacity, Each	Notes
Belt filter press	1 + 1 standby		Ashbrook
Belt width, meters	1		Polyester fabric
GBT maximum liquid feed rate, gpm		500	
GBT maximum solids feed rate, pph		1,250	
BFP maximum liquid feed rate, gpm		160	
BFP Maximum solids feed rate, pph		1,000	
Dewatered cake solids, percent		13 - 14	
Feed pumps	2		Progressive cavity
Capacity, gpm		70	
Sludge screw conveyors	2 in series		1 Horizontal, 1 inclined
Manufacturer			Waste-Tech
Capacity, wet tons/hour		1	
Diameter, inches		14	

Installation of garbage disposals in the Main Culinary area of the institution in October 2014 resulted in much larger quantities of food waste being discharged into the sewage system. The additional food waste was reflected in large increases in influent BOD5 and TSS concentrations during 2015.

Operation of the sludge thickening and dewatering equipment was adversely affected by the large increases in the influent BOD5 and TSS concentrations during 2015. Due to the increased influent loading, the solids concentrations of the dewatered cake from the BFP decreased to levels that were sometimes unacceptable for landfill disposal. When the dewatered cake solids concentrations were too low, the cake was temporarily stored in existing sludge drying beds at the old oxidation ditch site to further concentrate the solids by air drying (D. Mullins, 2016).

When the WWTF operators suspected that the garbage disposal units were of causing the high influent loading, staff in the Main Culinary area were instructed to resume disposal of the majority of solid food waste to garbage bins instead of to the garbage disposal units and sanitary drains. Diversion of most of

the food waste to garbage bins reduced the influent loading in 2016 and restored normal operation of the sludge thickening and dewatering systems.

To dispose of dewatered cake to a landfill, the solids concentration must be greater than 15 percent. When the solids concentration is less than 15 percent minimum, the operators must temporarily store the dewatered cake in existing sludge storage bins located at the old oxidation ditch site. Temporary storage of the dewatered cake is limited to the dry weather season. The stored material must be removed and disposed to landfill prior to wet weather. Prior to disposal, stored cake with a low solids concentration must be blended with a drier material to produce a mixture with the 15 percent minimum solids concentration. Temporary storage, subsequent blending, and reloading of dewatered cake increases the operator workload and increases operating costs.

When the organic and suspended loads discharged from the institution are within normal range, the WWTF produces dewatered cake with 16 to 18 percent solids concentrations that can be disposed to a landfill. Dewatered cake solids concentrations less than 15 percent occur when high organic and suspended loads are discharged from the institution to the WWTF. To restore adequate dewatering for disposal and maintain the normal operator workload, the food waste discharged from the culinary unit of the institution must be managed to moderate the organic and suspended solids waste discharged to the WWTF.

Sludge Storage Tank

The sludge storage tank provides additional stabilization and storage of the waste solids from the MBR prior to thickening and dewatering. The sludge storage tank is mixed by membrane diffusers. The sludge storage tank operates with a mixed liquor suspended solids concentration of 15,000 mg/L.

Potential Reuse of Existing Clarifier for Sludge Storage. The existing sludge storage tank was designed with the same dimensions as one of the aeration basins so that it could be converted into a third aeration basin if needed in the future. The existing sludge storage tank could be converted into a third aeration basin or into a flow equalization basin (or both) by reusing the abandoned secondary clarifier as a sludge storage tank. This potential modification would increase redundancy and operational flexibility of the DVI WWTF.

The unused concrete clarifier basin located adjacent to the MBR site is in good structural condition and could be reused for sludge storage with minimal modifications. New aerators would be needed in the basin to provide oxygen for sludge stabilization and mixing. Sludge could be conveyed to the clarifier basin by gravity. New pumps and a pipeline would be needed to return the stored sludge to the MBR site for thickening and/or dewatering.

The secondary clarifier is located in the 100-year flood plain which would require it to be drained and not used during a major flood or to be protected from flooding by earthen embankments around the structure.

Standby Generator

The DVI WWTF has a 1,000-kilowatt standby generator manufactured by Caterpillar. The standby power system can run the entire DVI WWTF to during a power failure. The standby generator system has a turbo-charged intercooled diesel fueled internal combustion engine. The standby generator system

has an automatic transfer switch to start the generator during a power utility outage. Critical equipment operating in automatic mode will automatically restart and continue operation at previous setpoints after the standby generator starts. The standby generator system has a 2000-gallon main fuel storage tank and a 115-gallon fuel day tank. The standby generator system appears adequate to maintain continuous operation of the DVI WWTF.

Section 3

Operations and Maintenance Staffing Evaluation

CDCR operates 22 institutions which own water or wastewater treatment systems. Fifteen CDCR institutions operate a WWTF. As shown in Table 3.1, these institutions serve populations from 2,800 to 8,500 and treat average daily wastewater flows ranging from 0.4 to 1.5 mgd. The CDCR wastewater systems have an average staffing level of 0.91 (range of 0.2 to 1.98) certified operators per 1,000 population served. The average staffing level is 3.94 certified wastewater operators per million gallons of wastewater treated per day.

Table 3.1 – Water and Wastewater Operations Staff Positions at CDCR Institutions

Institution	Total Inmate + CDCR staff	Daily Flow, mgd			Certification Level Required		Number of Operators			WW Operators	
		Average	Maximum	Design	Water	Wastewater	Water	Wastewater	Total Authorized	Per 1000 people	Per mgd
CMC	4668	1.2			Grade III	Grade IV	4	5	9	1.07	4.17
CIM	4728	0.9		2.0	Grade III	Grade II	4	3	7	0.63	3.33
HDSP/CCC	8333	1.4	2.1	4.2	Grade II	Grade II	4	2	6	0.24	1.43
CCI	4414	1.1			Grade II	Grade IV	1	3	4	0.68	2.73
KVSP	3910	0.8	1.5	2.3	Grade II	Grade III	2	3	5	0.77	3.90
DVI	2580	0.7	0.8	1.1	Grade II	Grade III	6	4	10	1.55	5.71
PBSP	3032	0.8			N/A	Grade IV		6	6	1.98	8.00
SCC	4774	0.6		1.2	Grade III	Grade III	3	3	6	0.63	5.00
CEN	3433	1.0		1.0	Grade III	Grade II	2	2	4	0.58	2.08
CCWF	3513	1.5			Grade I	Grade III	1	3	4	0.85	2.06
CVSP	2641	1.4	1.5	2.7	Grade III	Grade III	3	4	7	1.51	2.94
WSP	4997	1.1			Grade II	Grade II	1	1	2	0.20	0.91
COR	4445	1.5		2.0	N/A	Grade III		3	3	0.67	2.04
MCSP	2807	0.4			N/A	Grade II		4	4	1.43	10.0
PVSP	3533	0.6	0.8	1.0	N/A	Grade I		3	3	0.85	4.76
SOL	3890				Grade III	N/A	4		4		
SVSP	3657				Grade III	N/A	3		3		
CRC	3487				N/A	N/A	1		1		
CTF	5231				Grade II	N/A	4		4		
FSP	2895				Grade II	N/A	4		4		
CAL	3883				Grade II	N/A	3		3		
LAC	3600				N/A	N/A	1		1		
Total	88,451						51	49	100	0.91	3.94

Source: Total Inmate + CDCR staff from http://www.cdcr.ca.gov/Reports_Research/Offender Information_Services_Branch/Population Reports.html, December 31, 2015.

California regulations and the Office of Operator Certification (OOC) do not specify staffing levels for wastewater treatment plants. WWTF staffing levels are based on size and operator certification level. The wastewater systems are classified by their required certification level ranging from Grade I to IV, with IV having the most experience.

Table 3.2 – Operators by Certification Level

Certification Level Required	Average Number of Operators	
	Per WWTF	Per 1,000 population
II	2.4	0.2
III	3.3	1.0
IV	4.7	1.2

DVI WWTF requires a Grade III certification to operate. As shown in Table 3.2, the average number of personnel required for each plant increases at successively higher levels of required certification. Based on the data in Table 3.2, the DVI WWTF requires 1.0 level III certified operator per 1,000 population served.

The DVI WWTF currently has four operations staff positions but currently only two full time positions are filled. CDCR hires additional operators on a temporary basis to supplement permanent staff positions and to perform all necessary functions during the absence of an operator and when the WWTF must be operated manually.

The CDCR WWTFs most similar to DVI based on average flow treated and similar certification requirements are Kern Valley State Prison (KSVP) and Sierra Conservation Center (SCC). Total authorized personnel for these two facilities are estimated to be three per WWTF. Of the fifteen facilities, the California Men's Colony (CMC) treatment train is most similar to DVI as it includes tertiary filtration and solids dewatering. Total authorize personnel for CMC is estimated at five. Comparing system size and required certification level among the CDCR facilities provides a range of between three to five operators required at each WWTF. Seven WWTFs treat less than 1 mgd, serve an average population of 3,600, and have approximately 3.7 operators on average per facility.

ESTIMATED O&M STAFF BY USEPA METHOD

A method for estimating staffing requirements for WWTFs with capacities ranging from 0.5 to 25 mgd was developed by the U.S. Environmental Protection Agency (Estimating Staffing for Municipal Wastewater Treatment Facilities, March 1973). The procedure was incorporated into a computerized work sheet which includes baseline staffing based on plant design capacity, the specific treatment processes at a facility, and adjustments for local conditions.

Using the USEPA method, the DVI WWTF requires an estimated staff of 3.72 operators and operator labor of 5,580 hours per year. The 4 authorized operator positions for DVI WWTF satisfy the staffing requirement estimated by the USEPA method. The estimated operator labor required for each process area and labor category are summarized in Table 3.3. The 3.72 operators required for DVI WWTF by the USEPA method agrees very closely with the average of 3.7 operators per facility for the seven CDCR WWTFs which treat less than 1 mgd each.

Table 3.3 – DVI WWTF Estimated O&M Staff per USEPA

Project Name:	Deuel Vocational Institution WWTP	Hours/Day of Sludge Dewatering Operation	3.00				Date:	27-May-16
Design Flow (mgd): Average Day Maximum Month	0.84	Productive Hours/Worker/Year	1,500					
Adjustment for Local Conditions								
CATEGORY	**NOTES**	**LOCAL CONDITION**	**ADJUSTMENT**					
			Operation	Maintenance	Supervisory	Clerical	Laboratory	Yardwork
Plant layout	500' x 200' Site Area (New Plant - Sept 2010)	Average	0%	0%				0%
Unit processes	MBR	Non-Standard Equipment	10%	10%				
Level of treatment	Tertirary Treatment	Advanced	10%	-20%	2%	2%	2%	10%
Type of waste removal requirement	Table 4 WDR R5-2014-0014 (NPDES CA0078093)	Effluent Concentration	5%				10%	
Industrial waste	None	None or Constant	0%				0%	
Productivity of labor	Periodic permit violations	Low	15%	15%				
Climate	Moderate	Moderate Winters		0%				
Training	No Continuing Education Required in CA	Certification & No Continuing Ed.	0%		0%			
Automatic monitoring	SCADA	Monitoring With Feedback	-5%	5%				
Automatic sampling	Influent and Effluent Composite Samplers	Influent & Effluent	-5%				-5%	
Off-plant laboratory work	Modified Adjustment - Sample Collection Required	Entire Plant					-75%	
Age and condition of equipment	Deferred maintenance due to budget limits	Relatively old & poorly cared for		10%				
Total			30%	20%	2%	2%	-68%	10%
Annual Manhours								
Unit Process/Category		Exists at Plant?	Operation	Maintenance	Supervisory	Clerical	Laboratory	Yardwork
Supervisory & Administrative					460			
Clerical						40		
Laboratory							540	
Yardwork								410
Raw Sewage Pumping at Plant	18" PVC Gravity Sewer	Yes		320				
Screening & Grinding	Mech Climber and Manual Bar Screens	Yes	40	20				
Grit Removal	Vortex Grit System with Cyclone and Classifier	Yes	190	20				
Primary Clarification		No	0	0				
Aeration	Basins, Anoxic and Aeration Zones, Blower	Yes	510	400				
Secondary Clarification for Activated Sludge	MBR Incorporated versus Secondary Clarification	Yes	130	220				
Chlorination	UV Disinfection System	Yes	120	190				
Mixed Media Filtration	MBR Specific Requirements	Yes	250	170				
Anaerobic Digestion		No	0	0				
Aerobic Digestion	Biological Treatment	Yes	70	10				
Gravity Thickening	Gravity Belt Thickener/Belt Filter Press	Yes	90	110				
Flotation Thickening		No	0	0				
Sludge Drying Beds		No	0					
Sludge Dewatering	Gravity Belt Thickener/Belt Filter Press	Yes	330	220				
Sludge Lagoons		No	0					
Effluent Cooling Towers	Added, Estimate	Yes	50	100				
Subtotal			1,780	1,780	460	40	540	410
Subtotal Adjusted For Local Conditions			2,310	2,140	470	40	170	450
Number of Workers			1.37	1.25	0.31	0.03	0.11	0.30
Total Labor Hours/Year		**5,580**						
Total Number of Workers		**3.72**						

Source: Estimating Staffing for Municipal Wastewater Treatment Facilities (USEPA, 1973). WWTPStaffing.xls, Version 1.01, 8/16/2006.

ESTIMATED O&M STAFF BY NEIWPCC METHOD

To account for new treatment technologies and more stringent discharge limits in operator staffing estimates, "The Northeast Guide for Estimating Staffing at Publically and Privately Owned Wastewater Treatment Plants" was published in 2008 (New England Interstate Water Pollution Control Commission (NEIWPCC)). Similar to the USEPA 1973 manual, the NEIWPCC guide defined the number of staff hours required to complete a range of tasks. The NEIWPCC guide also incorporated new treatment technologies, such as the MBR process, which did not exist when the 1973 USEPA manual was developed. The NEIWPCC procedure was incorporated into a computerized work sheet which is available on the internet (www.neiwpcc.org/technicalguides.asp).

Table 3.4 – DVI WWTF Estimated O&M Staff per NEIWPCC

Plant Name: Deuel Vocational Institution WWTP	
Design Flow: 0.5-1.0 mgd	Actual Flow: 0.84
Chart #	**Annual Hours**
Chart 1 – Basic and Advanced Operations and Processes	2405.00
Chart 2 – Maintenance	1699.00
Chart 3 – Laboratory Operations	760.00
Chart 4 – Biosolids/Sludge Handling	1235.00
Chart 5 – Yardwork	285.00
Estimated Operation and Maintenance Hours	6384.00
Estimated Operation and Maintenance Staff	4.26
Estimated Additional Staff from Chart 7	0.00
TOTAL STAFFING ESTIMATE	**4.26**
Note: The Total Staff estimate from Charts 1-5 will not be the final amount of staff necessary to run the facility. Please review Chart 7 for additional staffing needs.	
Chart 6 - Automation/SCADA E-mail, Local Area Network (LAN), Supervisory Control and Data Acquisition (SCADA), Telemetry	
Chart 7 - Considerations for Additional Plant Staffing *Note: The user should attach supporting information to justify additional staffing needs from Chart 7.* No additional staff needs were identified from Chart 7.	

Source: *The Northeast Guide for Estimating Staffing at Publically and Privately Owned Wastewater Treatment Plants* (One Shift) (NEIWPCC, 2008). (www.neiwpcc.org/technicalguides.asp).

Using the NEIWPCC work sheet, the DVI WWTF requires an estimated staff of 4.26 operators and 6,384 hours of operator labor per year. The estimated operator labor requirements are summarized in Table 3.4. NEIWPCC work sheets with detailed labor requirements for each process area and labor category are provided in Appendix B. The estimate of 4.26 operators required for DVI WWTF by the NEIWPCC procedure is 15 percent higher than the number of operators estimated using the USEPA method. The 4 operator positions authorized for DVI WWTF provide approximately 9 percent lower staffing than the requirement estimated by the NEIWPCC procedure.

When the DVI operator work load exceeds the capacity of the 4 operators, CDCR hires additional operators on a temporary basis to perform all necessary functions.

The operator staffing level estimates developed using both the USEPA and NEIWPCC were based on the assumptions shown in Table 3.5.

Table 3.5 – Assumptions for DVI WWTF O&M Staffing Estimates

Criteria	Assumptions
Labor productivity	6.5 hours per day productive work per operator = 1,500 hours per year
WWTF design flow	0.70 MGD, average day, average month
Treatment processes	Based on DVI Wastewater Treatment Plant O&M Manual (September 2010)
Non-standard equipment	MBR process with advanced treatment (tertiary)
Laboratory analysis	Operators collect samples, contract laboratory performs analysis
WWTF site work	Average plant layout, minimum yard work
Maintenance	Deferred maintenance due to budget limits
Sludge dewatering	Approximately 3 hours per day

OPERATOR STAFFING FOR ALARM CONDITIONS

During the day when operators are on site, response to alarm conditions takes priority over routine tasks. At least one operator is on call at all times to respond to alarm conditions which might occur during unattended operation. In addition, DVI operators at the drinking water treatment plant have been cross-trained to assist with emergency responses at the DVI WWTF.

The DVI WWTF has adequate treatment capacity and standby equipment to maintain operation during equipment failures. Abnormal operating conditions which require corrective actions occur infrequently. Abnormal operating conditions at the DVI WWTF are most often caused by unexpected changes in wastewater quality from waste loads within the correctional facility, or from treatment process upsets in the drinking water treatment plant.

WORK ORDER BACKLOG FOR CORRECTIVE AND PREVENTIVE MAINTENANCE

The current work order backlog for maintenance is summarized in Table 3.6. Scheduled preventive maintenance is planned sufficiently in advance of the work that replacement and repair components and equipment can be ordered and delivered through the annual budget and standard procurement process.

Corrective maintenance or emergency repairs for unexpected equipment failures may require replacement and repair components and equipment which have not been approved through the annual budget process. For critical items, the replacement and repair components can be approved on an expedited basis. When the WWTF can use redundant equipment to continue operation and maintain compliance with discharge permit limits, replacement or repair of non-critical components or equipment may be deferred until approved through the annual budget and standard procurement process.

Table 3.6 – Current Work Order Backlog for Preventive Maintenance for DVI WWTF

Item	Equipment or System	Part Required	Preventive Maintenance Replacement	Parts in Stock	Parts on Order	Schedule
1	MBR tanks 1 - 4	B40N membrane modules	Yes	NA	NA	Complete 5/26/16
2	MBR tanks 3, 4	Service switches	Yes	No	No	TBD
3	MBR tanks 3, 4	Auma valves	Yes	No	No	TBD
4	MBR tanks 1 - 4	Bridge crane	No, new	No	No	Quotes requested
5	Aeration Blower 1	Motor	Yes	No	No	bid package needed
6	Drumscreen 2	Motor	Yes	No	Yes	Delivery by 6/30/16
7	UV Trains 1, 2	Service switches	Yes	No	No	TBD
8	Belt Filter Press	Sludge feed pump	Yes	No	Yes	TBD
9	Storm 2 Pump 3	Motor	Yes	Yes	NA	TBD
10	Cooling tower 2 (fan does not start in Auto)	HOA switch for fan	Yes	No	No	TBD

Source: Mullins, D., personal communication, May 25, 2016.

Currently, DVI is proactively exploring modifications to the existing rotary drum fine screens to prevent debris from damaging the new MBR filters installed during May 2016.

Section 4

Summary and Recommendations

SUMMARY

The DVI WWTF generally produces high quality effluent which complies with California Title 22 reuse regulations. The DVI WWTF has adequate capacity and redundancy to maintain continuous operation and compliance with stringent discharge permit limits. Violations of discharge permit limits have been caused infrequently by WWTF mechanical equipment failures, but most violations were caused by off specification operation by the drinking water facility or by changes in water use and waste management practices within the institution.

Operations Staffing Levels. The evaluation of operator work load confirms that the 4 operator positions authorized for the DVI WWTF are generally sufficient to operate the facility and are consistent with operations staffing levels at other CDCR institutions with wastewater treatment systems. Operations staffing levels estimated by both the USEPA method and the NEIWPCC procedure are also consistent with operations staffing levels at the DVI WWTF.

Work Order Backlog. The current work order backlog is manageable. The annual budget and standard procurement processes for scheduled preventive maintenance appear to be adequate to reliably maintain continuous operation and compliance with discharge permit limits.

Drinking Water Treatment Plant Impacts on DVI WWTF. The WWTF effluent exhibited chronic toxicity for green algae (Selenastrum capricomutum) in 2012 and for water fleas (Ceriodaphnia dubia) in 2013 and 2014. Toxicity Reduction Evaluations for these events concluded that high concentrations of total dissolved solids (TDS) (reflected by high electrical conductivity) were the probable cause of chronic toxicity. High TDS concentrations (from the brackish groundwater source) cause chronic toxicity in the WWTF effluent when the reverse osmosis (RO) system and brine concentrator system (BCS) which supply drinking water are out of service. The drinking water facility must operate continuously to maintain compliance with the WWTF discharge limitations.

RECOMMENDATIONS

The DVI WWTF has adequate capacity and redundancy to maintain continuous operation and compliance with discharge permit limits. Potential modifications to enhance redundancy and reliability include:

- Install a new mechanical screen with narrower bar spacing when the useful life of the existing mechanical screen is exhausted
- Consider replacing the existing manual bar screen with a new mechanical screen with narrower bar spacing
- Install overflow sensor and alarm signal on each fine screen

- Separate the fine screen overflow from the screened flow and return it to the influent wet well for re-screening
- Explore modifications to the existing rotary drum fine screens to prevent debris from damaging the new MBR membranes.
- Consider reuse of the abandoned oxidation ditch or secondary clarifier as flow equalization basins to enhance MBR system operation
- Consider reuse of the abandoned oxidation ditch or secondary clarifier as flow equalization basins to reduce cooling tower peak loads and enhance evaporative cooling
- Consider reuse of the abandoned secondary clarifier for sludge storage and convert the existing sludge storage tank into a third aeration basin to increase redundancy and operational flexibility
- Consider testing MBR system capability to achieve disinfection requirements and seek approval to bypass UV disinfection to reduce operation and maintenance costs

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Appendix A

DVI WWTF Influent and Effluent Data

Table A.1 - Influent & Effluent Data 2014

	Flow, mgd		BOD5, mg/L		TSS, mg/L		Ammonia, Total (as N), mg/L	Nitrate, Total (as N), mg/L
Date	Influent	Effluent	Influent	Effluent	Influent	Effluent	Effluent	Effluent
2-Jan	0.453	0.441	130	0	780	0		
6-Jan	0.437	0.442	170	2.8	450	0	0.14	
8-Jan	0.429	0.475	76	0	760	2.6		
14-Jan	0.406	0.456	490	0	830	0.8	0.26	
16-Jan	0.417	0.427	180	2	250	0.8		
20-Jan	0.407	0.438	330	2	690	0	0.28	
22-Jan	0.417	0.441	260	0	510	1.4		
28-Jan	0.424	0.454	150	0	180	0	0.10	
30-Jan	0.421	0.470	210	0	430	10		
3-Feb	0.440	0.448	160	0	290	4.6	0.21	
6-Feb	0.415	0.473	68	0	70	0		
11-Feb	0.453	0.473	120	0	120	0	0.14	
13-Feb	0.503	0.562	56	0	66	0.8		
18-Feb	0.526	0.562	250	0	270	0	0.10	
20-Feb	0.444	0.472	190	0	310	0.6		
25-Feb	0.458	0.506	320	0	420	5.1	0.18	
27-Feb	0.430	0.485	100	0	150	0		
4-Mar	0.404	0.487	140	0	36	0	0.14	
6-Mar	0.450	0.508	490	0	440	0		
11-Mar	0.489	0.557	400	0	14	2	0.07	
13-Mar	0.490	0.525	270	0	500	3.8		
18-Mar	0.556	0.664	56	0	140	1.4	0.07	
20-Mar	0.477	0.516	200	0	43	1.6		
25-Mar	0.477	0.515	99	0	62	0.8	0.10	
27-Mar	0.481	0.522	100	0	170	0		
1-Apr	0.476	0.499	290	0	370	0	0.14	
10-Apr	0.475	0.496	150	0	86	0	0.14	
15-Apr	0.464	0.484	280	0	290	1	0.21	
23-Apr	0.498	0.538	160	0	120	0.3	0.14	
29-Apr	0.483	0.503	130	0	71	0.7	0.18	
8-May	0.480	0.488	180	0	150	0	0.21	
13-May	0.492	0.512	270	0	410	0	0.10	
22-May	0.433	0.519	59	0	190	0	0.18	
27-May	0.466	0.481	110	3.0	170	1.0	0.18	
3-Jun	0.459	0.508	180	2.6	150	0	0.10	
10-Jun	0.485	0.498	150	2.2	260	0	0.24	
17-Jun	0.473	0.513	230	0.0	480	0	0.00	
24-Jun	0.515	0.521	170	0.0	260	0	0.32	
1-Jul	0.512	0.518	120	0	89	4.5	0.1	
8-Jul	0.446	0.478	210	2	340	0	0	
15-Jul	0.452	0.412	160	0	220	0	0	
22-Jul	0.477	0.517	160	0	350	0	0	
31-Jul	0.526	0.557	98	0	110	2.7	0	
4-Aug	0.506	0.565	130	0	270	0	0	

12-Aug	0.591	0.623	170	0	97	1.8	0	
19-Aug	0.574	0.556	100	0	110	1.1	0	
26-Aug	0.512	0.601	87	0	170	0	0	
2-Sep	0.574	0.606	100	0	160	1.7	0	
9-Sep	0.512	0.522	63	0	58	0	0	
16-Sep	0.499	0.552	80	0	51	0	0	
23-Sep	0.488	0.534	140	0	170	0	0	
30-Sep	0.456	0.516	120	0	180	0	0	
9-Oct	0.460	0.465	100	0	92	0	0	
14-Oct	0.456	0.465	130	0	190	0	0	
21-Oct	0.255	0.271	150	0	210	0	0	
4-Nov	0.374	0.428	110	0	330	1.4	0	
12-Nov	0.359	0.407	280	0	530	1.8	0	
18-Nov	0.373	0.427	200	0	460	1.2	0	
24-Nov	0.426	0.407	240	0	750	1.2	0	
2-Dec	0.433	0.514	140	0	390	1.3	0	
9-Dec	0.385	0.432	250	0	710	0	0	
16-Dec	0.408	0.498	200	0	770	1.1	0	
22-Dec	0.390	0.543	170	0	980	0	0	
29-Dec	0.421	0.439	140	0	180	0	0	
Average	**0.459**	**0.496**	**175**	**0.26**	**296**	**0.92**	**0.079**	

Table A.2 - Influent & Effluent Data 2015

	Flow, mgd		BOD5, mg/L		TSS, mg/L		Ammonia, Total (as N), mg/L	Nitrate, Total (as N), mg/L	Temp Rise (deg F)
Date	Influent	Effluent	Influent	Effluent	Influent	Effluent	Effluent	Effluent	Effluent
6-Jan	0.375	0.400	440	3.4	1200	0	0.00		
13-Jan	0.396	0.456	330	0	1200	0	0.18		5.0
20-Jan	0.393	0.446	300	0	1200	0	0.00		
27-Jan	0.388	0.385	160	0	500	1.2	0.00		
5-Feb	0.391	0.433	290	14.4	1600	0	0.00		4.0
10-Feb	0.366	0.441	330	0	890	0	0.00		
19-Feb	0.352	0.468	320	0	1200	1.2	0.00		
24-Feb	0.380	0.469	140	0	280	0	0.00		
3-Mar	0.397	0.461	180	0	670	1.4	0.00		
10-Mar	0.341	0.404	210	0	280	1.1	0.00		4.0
17-Mar	0.444	0.538	240	0	1000	1.3	0.00		
24-Mar	0.409	0.459	370	0	2400	0	0.00		
31-Mar	0.455	0.535	97	0	500	1.8	0.00		
7-Apr	0.351	0.450	120	0	350	2.1	0.00		
14-Apr	0.391	0.452	210	0	680	1.1	0.00		-3.5
21-Apr	0.381	0.481	160	0	600	0	0.00		
28-Apr	0.367	0.408	580	2.8	1900	0	0.00		
2-May	0.297	0.382	630	0	1000	1.5	0.00		-4.6
9-May	0.362	0.397	310	0	700	0	0.00		
16-May	0.338	0.383	220	0	390	0	0.00		
23-May	0.320	0.366	410	0	820	0	0.00		

2-Jun	0.332	0.367	320	2.0	1200	0	0.00		
9-Jun	0.313	0.324	520	0	1300	0	0.00		1.0
16-Jun	0.324	0.370	230	0	350	0	0.00		
23-Jun	0.328	0.349	640	0	1700	0	0.00		
30-Jun	0.373	0.405	320	0	620	0	0.00		
7-Jul	0.345	0.379		0		1.2	0.00		
14-Jul	0.345	0.375	470	0	900	1.0	0.00		-6.8
20-Jul	0.340	0.333							
28-Jul	0.409	0.426							
4-Aug									
11-Aug									
18-Aug									
25-Aug									
1-Sep	0.350	0.393	290	4.4	510	1.3	0.00		
8-Sep	0.426	0.440	170	0	330	0	0.00		
15-Sep	0.437	0.483	320	0	460	0	0.00		
22-Sep	0.341	0.364	150	0	410	0	0.00		
29-Sep	0.330	0.380	520	0	1400	0	0.00		
6-Oct	0.354	0.394	540	0	1400	1.3	0.00		-1.2
13-Oct	0.389	0.427	310	0	540	0	0.00		
19-Oct	0.387	0.426	320	0	1000	0	3.50		
27-Oct	0.393	0.433	230	0	830	0	0.00		
3-Nov	0.448	0.484	320	0	550	0	0.00		
10-Nov	0.405	0.436	370	0	960	0	0.00		
17-Nov	0.414	0.432	410	0	1100	0	0.00		-0.3
24-Nov	0.432	0.438	210	0	380	0	0.00		
1-Dec	0.436	0.482	230	0	670	0	0.00		
8-Dec	0.413	0.451	280	0	1400	0	0.00		
15-Dec	0.386	0.427	760	0	1600	0	0.00		-2.0
22-Dec	0.404	0.452	330	0	600	0	0.00		
30-Dec	0.377	0.411	260	0	400	0	0.00		
Average	**0.378**	**0.423**	**324**	**0.59**	**888**	**0.4**	**0.08**		**-0.4**

Table A.3 - Influent & Effluent Data 2016

	Flow, mgd		BOD5, mg/L		TSS, mg/L		Ammonia, Total (as N), mg/L	Nitrate, Total (as N), mg/L	Temp Rise (deg F)
Date	Influent	Effluent	Influent	Effluent	Influent	Effluent	Effluent	Effluent	Effluent
5-Jan	0.380	0.425	200	0	340	0	0.0		
12-Jan	0.360	0.410	280	0	820	0	0.0		0.0
19-Jan	0.451	0.521	250	0	490	0	0.0		
26-Jan	0.406	0.444	130	0	1200	0	0.0		
2-Feb	0.402	0.437	280	0	560	0	0.0		
9-Feb	0.374	0.417	280	0	1800	0	0.0		0.5
16-Feb	0.393	0.425	340	0	1400	0	0.0		
23-Feb	0.374	0.415	400	0	1000	0	0.0		
Average	**0.392**	**0.437**	**270**	**0.0**	**951**	**0.0**	**0.0**		**0.25**

Appendix B

DVI WWTF Estimated O&M Staff per NEIWPCC

DVI WWTF Estimated O&M Staff

THE NORTHEAST GUIDE FOR ESTIMATING STAFFING AT PUBLICLY AND PRIVATELY OWNED WASTEWATER TREATMENT PLANTS (One Shift)	
Plant Name: Deuel Vocational Institution WWTP	
Design Flow: 0.5-1.0 mgd	**Actual Flow: 0.84**
FINAL ESTIMATES	
Chart #	**Annual Hours**
Chart 1 – Basic and Advanced Operations and Processes	2405.00
Chart 2 – Maintenance	1699.00
Chart 3 – Laboratory Operations	760.00
Chart 4 – Biosolids/Sludge Handling	1235.00
Chart 5 – Yardwork	285.00
Estimated Operation and Maintenance Hours	6384.00
Estimated Operation and Maintenance Staff	4.26
Estimated Additional Staff from Chart 7	**0.00**
TOTAL STAFFING ESTIMATE	**4.26**
Note: The Total Staff estimate from Charts 1-5 will not be the final amount of staff necessary to run the facility. Please review Chart 7 for additional staffing needs.	
Chart 6 - Automation/SCADA	
E-mail Local Area Network (LAN) Supervisory Control and Data Acquisition (SCADA) Telemetry	
Chart 7 - Considerations for Additional Plant Staffing	
Note: The user should attach supporting information to justify additional staffing needs from Chart 7.	
Final Comments:	

Data Notes	# of Units	Begin Chart 1 – Basic and Advanced Operations and Processes Process	Hours	Calculated	Subtotal
	1	Preliminary Treatment	0.50	130.00	
# of units		Primary Clarification	0.50	0.00	
		Activated Sludge	4.00	0.00	
		Activated Sludge w/BNR	6.00	0.00	
Choose Range		Rotating Biological Contactor	**2.25**	0.00	
# of tanks		Sequencing Batch Reactor	1.00	0.00	
		Extended Aeration (w/o primary)	5.00	0.00	
	1	Extended Aeration w/BNR	7.00	1820.00	
		Pure Oxygen Facility	*X*		
		Pure Oxygen Facility w/BNR	*X*		
		Trickling Filter	1.00	0.00	
		Oxidation Ditch (w/o primary)	5.00	0.00	
		Oxidation Ditch w/BNR	7.00	0.00	
		Aeration Lagoon	1.50	0.00	
		Stabilization Pond	1.00	0.00	
		Innovative Alternative Technologies	3.00	0.00	
	1	Nitrification	0.25	65.00	
	1	Denitrification	0.25	65.00	
		Phosphorus Removal (Biological)	0.25	0.00	
		Phosphorus Removal (Chemical/Physical)	0.50	0.00	
	1	Membrane Processes	0.25	65.00	
		Cloth Filtration	0.25	0.00	
		Granular Media Filters (Carbon, sand, anthracite, garnet)	1.00	0.00	
		Water Reuse	0.25	0.00	
		Plant Reuse Water	0.10	0.00	
		Chlorination	0.50	0.00	

		Dechlorination	0.50	0.00	
	1	Ultraviolet Disinfection	0.50	130.00	
# of units		Wet Odor Control	0.50	0.00	
# of units		Dry Odor Control	0.25	0.00	
	1	Septage Handling	0.50	130.00	
		End of Chart 1 – Basic and Advanced Operations and Processes SUBTOTAL:			**2405.00**

-		**Begin Chart 2 – Maintenance**			
Unit Descriptons	**# of Units**	**Activity/Flow**	**Hours**	**Calculated**	**Subtotal**
# of screens	1	Manually Cleaned Screens	0.25	65.00	
# of screens		Mechanically Cleaned Screens	0.25	0.00	
# of screens	3	Mechanically Cleaned Screens with grinders/washer/ compactors	0.50	390.00	
# of units		Comminutor/Macerator	0.25	0.00	
# of chambers		Aerated Grit Chambers	0.10	0.00	
# of units	1	Vortex Grit Removal	0.10	26.00	
# of units		Gravity Grit Removal	0.10	0.00	
# of tanks		Additional Process Tanks	0.10	0.00	
# of chemicals added for processes	3	Chemical Addition (varying dependent upon degree of treatment)	0.10	78.00	
# of clarifiers		Circular Clarifiers	0.25	0.00	
# of clarifiers		Chain and Flight Clarifiers	0.25	0.00	
# of clarifiers		*Traveling Bridge Clarifiers*	*X*		
# of clarifiers		Squircle Clarifiers	0.25	0.00	
X	1	Pumps	100.00	100.00	
# of trains		Rotating Biological Contactor	0.15	0.00	
# of TFs		Trickling Filters	0.15	0.00	
# of tanks		Sequencing Batch Reactor	0.15	0.00	
# of mixers	7	Mechanical Mixers	0.10	182.00	
# of blowers	3	Aeration Blowers	0.20	156.00	

# of cartridges	4	Membrane Bioreactor	0.10	104.00	
# of systems		Subsurface Disposal System	0.10	0.00	
X		Groundwater Discharge	0.10	0.00	
# of digesters	1	Aerobic Digestion	0.10	26.00	
# of digesters		Anaerobic Digestion	0.20	0.00	
# of basins		Gravity Thickening	0.10	0.00	
# of belts	2	Gravity Belt Thickening	0.15	78.00	
# of presses	2	Belt Filter Press	0.15	78.00	
# of units		Mechanical Dewatering (Plate Frame and Centrifuges)	0.15	0.00	
# of units		Dissolved Air Floatation	0.10	0.00	
X		Chlorination (gas)	0.10	0.00	
X		Chlorination (liq.)	0.20	0.00	
X		Dechlorination (gas)	0.10	0.00	
X		Dechlorination (liq.)	0.20	0.00	
# of racks	6	Ultraviolet	0.10	156.00	
# of units		Biofilter	0.50	0.00	
# of units		Activated Carbon	0.50	0.00	
# of units		*Wet Scrubbers*	*X*		
# of screens		Microscreens	0.10	0.00	
# of units		*Pure Oxygen*	*X*		
# of units		Final Sand Filters	0.20	0.00	
# of different types of probes	10	Probes/Instrumentation/Calibration	0.10	260.00	
		End of Chart 2 – Maintenance SUBTOTAL:			**1699.00**

Begin Chart 3 – Laboratory Operations

Frequency of test	# of times test is run for selected time frame	Tests	Hours	Calculated	Subtotal
		Acidity	0.75	0.00	
		Alkalinity, total	0.75	0.00	

52	2	Biochemical Oxygen Demand (BOD)	2.50	260.00	
		Chemical Oxygen Demand (COD)	2.50	0.00	
		Chloride	0.50	0.00	
		Chlorine, Total Residual	0.25	0.00	
52	1	Coliform, Total, Fecal, E.Coli	1.00	52.00	
		Dissolved Oxygen (DO)	0.25	0.00	
		Hydrogen Ion (pH)	0.25	0.00	
		Metals	3.00	0.00	
		Toxicity	2.00	0.00	
52	1	Ammonia	2.00	104.00	
		Total Nitrogen	2.00	0.00	
		Oil and Grease	3.00	0.00	
		Total and Dissolved Phosphorus	2.00	0.00	
52	2	Solids, Total, Dissolved, and Suspended	3.00	312.00	
		Specific Conductance	0.25	0.00	
		Sulfate	1.00	0.00	
		Surfactants	1.00	0.00	
12	2	Temperature	0.25	6.00	
		Total Organic Carbon (TOC)	0.25	0.00	
		Turbidity	0.25	0.00	
		Bacteriological Enterococci	1.00	0.00	
		Lab QA/QC Program	1.00	0.00	
		Process Control Testing	3.00	0.00	
52	2	Sampling for Contracted Lab Services	0.25	26.00	
		Sampling for Monitoring Groundwater wells	0.50	0.00	
		End of Chart 3 – Laboratory Operations SUBTOTAL:			**760.00**

Begin Chart 4 – Biosolids/Sludge Handling

Unit Descriptons	# of Units	Process	Hours	Calculated	Subtotal
	1	Belt Filter Press	3.00	780.00	
		Plate & Frame Press	1.50	0.00	
		Gravity Thickening	0.25	0.00	

	1	Gravity Belt Thickening	0.25	65.00	
		Rotary Press	0.25	0.00	
		Dissolved Air Floatation	0.50	0.00	
		Alkaline Stabilization	0.25	0.00	
		Aerobic Digestion	0.50	130.00	
		Anaerobic Digestion	0.25	0.00	
		Centrifuges	1.00	0.00	
Choose Range		Composting	**2.00**	0.00	
		Incineration	*X*		
		Air Drying – Sand Beds	0.50	0.00	
		Land Application	0.50	0.00	
	1	Transported Off-Site for Disposal	1.00	260.00	
		Static Dewatering	1.00	0.00	
		End of Chart 4 – Biosolids/Sludge Handling SUBTOTAL:			**1235.00**

		Begin Chart 5 – Yardwork			
Unit Descriptons	**# of Units**	**Process**	**Hours**	**Calculated**	**Subtotal**
	1	Janitorial/Custodial Staff	100	100.00	
		Snow removal	60	0.00	
	1	Mowing	100	100.00	
# of vechicles	1	Vehicle Maintenance	25	25.00	
	1	Facility Painting	60	60.00	
		Rust removal	60	0.00	
		End of Chart 5 – Yardwork SUBTOTAL:			**285.00**

	Begin Chart 6 – Automation/SCADA		
	Automation/SCADA	**Yes/No**	
	Automated attendant or Interactive voice recognition (IVR) equipment	**No**	

Automated Meter Reading (AMR), Touchpad meters or other automated metering technology	No
Automatic Call Director (ACD)	No
Billing system	No
Computerized Facilities Management (FM) System	No
Computerized preventative maintenance	No
Computerized recordkeeping	No
E-mail	Yes
Geographical Information System (GIS)	No
Integrated purchasing and inventory	No
Internet website	No
Laboratory Information Management System (LIMS)	No
Local Area Network (LAN)	Yes
Supervisory Control and Data Acquisition (SCADA)	Yes
Telemetry	Yes
Utility customer information system (CIS) package	No

End of Chart 6 – Automation/SCADA

Begin Chart 7 – Considerations for Additional Plant Staffing

Activities	Yes/No
Management responsibilities (i.e., human resources, budgeting, outreach, training, town/city meetings, scheduling, etc.) and responsibility for clerical duties (i.e., billing, reports, correspondence, phones, time sheets, mailings, etc.)	No
Plant staff responsible for collection system operation and maintenance, pump station inspections, and/or combined sewer overflows	No
Plant operators responsible for snow plowing, road/sidewalk repair, or other municipal project	No
Plant staff involved in generating additional energy	No

	Plant receives an extra high septage and/or grease load (higher than designed organic and grease loadings) or plant takes in sludge from other treatment plants	**No**
	Plant is producing a Class A Biosolid product	**No**
	Plant operators responsible for operating generators and emergency power	**No**
	Plant responsible for industrial pre-treatment program	**No**
	Plant staff responsible for plant upgrades and large projects done both on-site and off-site (i.e., collection systems, manholes, etc.)	**No**
	Plant operators responsible for machining parts on-site	**No**
	Age of plant and equipment (over 15 years of age)	**No**
	End of Chart 7 – Considerations for Additional Plant Staffing	