Westbank Irrigation District

The Westbank Irrigation District Powers Creek Water Treatment Plant

Powers Creek Water Treatment Plant

The Westbank Irrigation District (WID) is an improvement district operating under the authority of the *Local Government Act*. It has a letters patent managed by five elected Trustees. WID is located in West Kelowna across the Okanagan Lake from the City of Kelowna. The area is well known for its sunny hot summers, friendly people, and wineries. WID serves a population of approximately 14,000 of the 29,000 within the boundary of the District of West Kelowna. The WID's water distribution system has 5,300 service connections. The construction of the water treatment plant was approved by ratepayers in 2005 to improve the safety and quality of drinking water, especially during the spring freshet.

Overview

The original water system was built in the 1920's and consisted of the Powers Creek watershed and Powers Creek. The uplands water system is comprised of six reservoir lakes (Tadpole; Dobbin; Horseshoe; Paynter; Jackpine; and Lambly (Bear) reservoirs). During the summer months base water flows are established from the upper elevation lakes and daily flow variations are managed via an automated head gate control at the Lambly reservoir. Construction of the Powers Creek Water Treatment Plant (PCWTP) was started in October 2005 and completed on schedule and under budget in February 2007.

Powers Creek WTP Intake

The $18,800,000 project included the cost of constructing the treatment plant, an 8 ML reservoir; and the addition of UV disinfection in 2008.

Powers Creek Water Treatment Plant

The facility offers a multi-barrier process that consists of an existing intake structure which receives water directly from Powers Creek and channels the water via gravity through a rotating screen, flash/rapid mix, coagulation, flocculation, clarification, and filtration processes. The unique part of the Powers Creek water treatment plant is that the clarification and filtration processes are combined within the same treatment cell. This combined process is referred to as In-Filter Dissolved Air Flotation (In-Filter DAF). The Powers Creek water treatment plant is the largest In-Filter DAF plant in Canada.

The treated water is then pumped approximately 10 metres vertically to an 8 ML treated water reservoir. Prior to entering the reservoir the treated water is further treated with both ultra violet and chlorine disinfection processes.

Classification:

***L**evel 4 Water Treatment Plant*

Plant Specifications:

Nominal Capacity:	*54 ML/day*
Hydraulic Capacity:	*81 ML/day*
Average Daily Flow:	*13.7 ML/day*
Annual Peak Flow:	*38 ML/day*
Annual Minimum Flow:	*5 ML/day*
2 Process trains	*3 Cells/train*

Powers Creek WTP & Reservoir

Intake:

Screening at the intake permits the removal of large objects such as logs, leaves, fish and other large foreign objects.

- Water from Powers Creek is fed to the plant by gravity from the intake.

Flash Mixing:

The primary purpose of the flash mix process is to rapidly mix and equally distribute the coagulant chemical throughout the raw water.

Specifications:

- The coagulant, Polyaluminum Chloride (PAC), is added and mixed rapidly as the raw water enters the facility. The mixing process must be complete and uniform to achieve the proper results.

Coagulation/Flocculation Tanks:

Coagulation is the process of clumping fine particles into larger particles, this increase is size and density will allow for removal by settling, skimming and filtering. Flocculation is the process of gentle mixing; this brings the particles together to increase size.

Specifications:

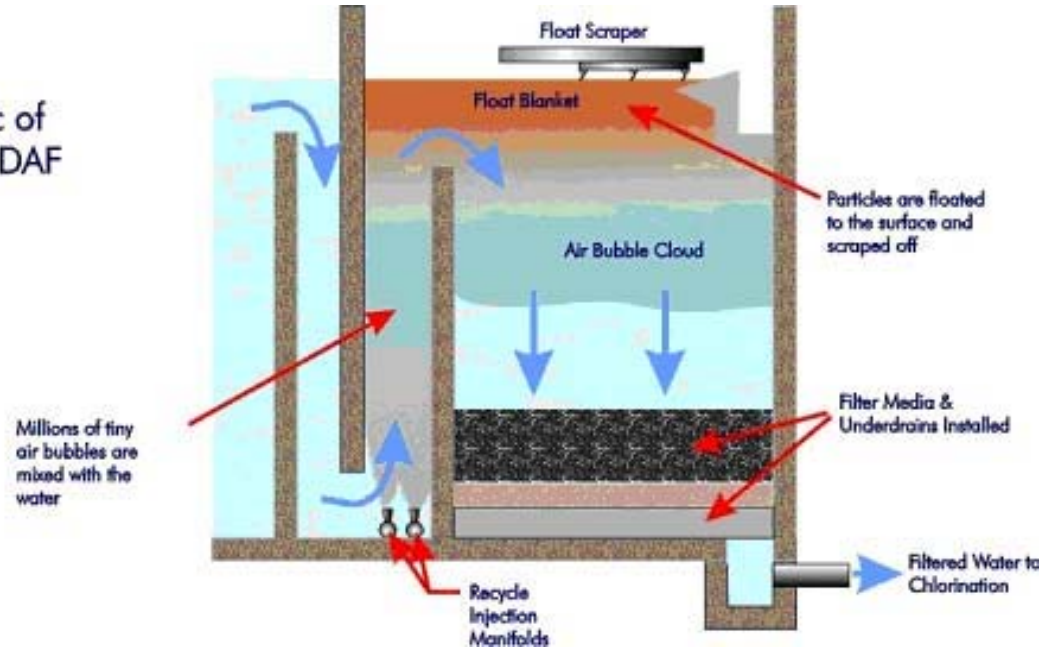
Tanks –	*6*	*(3 per train)*
Volume -	*152 m^3*	*(456 m^3 per train)*

- Flocculation tank is a continuation of the mixing process without the velocity.
- The mechanical flocculators are vertical propellers
- Flocculation basins are baffled to prevent short-circuiting of the water

Clarification – In-Filter Dissolved Air Flotation (In-Filter DAF):

Clarification is achieved by dissolving air in pressurized filtered water and then releasing the pressure to cause tiny air bubbles to be formed. These very tiny air bubbles attach themselves to the floc particles where they then float to the surface where the sludge is slowly removed by mechanical sweepers. The fact that filtration is part of the same process as clarification permits a smaller building footprint and reduced construction costs while achieving the treatment quality.

A Schematic of the In-Filter DAF Process



Specifications:

Tanks-	*6*	*(3 per train)*
Volume -	*156 m^3*	*(468 m^3 per train)*

- Clarified water then slowly moves downward through filter medium in the bottom of the same treatment cell.

Flocculation and In-Filter DAF Clarification process area. The area shown is the 3 treatment cells of train 1.

Filtration:

Filtration is the removal of particulate impurities and floc by passing the water through a filter bed. The impurities can consist of suspended materials (fine silts/sand and clay), colour colloids, and biological (bacteria) organisms.

- First, the water is filtered through a 600 mm layer of anthracite;
- Then the water passes through a 300 mm layer of specially graded sand.
- The sludge removed at the surface of this treatment cell is transported by gravity to concrete storage chambers. A centrifuge processes the sludge to produce a cake which is transported by truck to a designated landfill site.

Specifications:

Number of Filters	*6 (one filter bed located at the bottom of each clarification cell)*
Filtration Rate	*10.7 m/hr*
Filter Size	*6.0 m X 5.85 m*
Total Filter Depth	*900 mm thickness*
1st Medium – Anthracite	*600 mm thickness*

2nd Medium – Sand	*300 mm thickness*
Backwash Rate	*550 L/sec or 33 m^3 per minute*
Air Scour Rate	*30 m^3/min at 5 psi*

- After filtration the water flows through a specially designed under-drain that prevents the filter medium from passing through but allows filtered water passage.
- Filter run times vary from 48 to 120 hours depending on water source and quality.
- Run time before backwashing a filter is determined by a combination of particle counts, turbidity, and head loss, and is done by mechanical means. This consists of blowers for air scour and vertical turbine pumps for backwash water

Pumping:

Filtered water passes into a clearwell by gravity to be pumped to disinfection and then to the main balancing reservoir or to be pumped as backwash water for filter bed regeneration.

There are two large pumps and two small pumps used to pump water from the clearwell. The filtered water in the clearwell is handled in two different ways:

- The large pumps are used for pumping filtered water to the disinfection process and to the 8 ML treated water reservoir in the summer months and for backwashing the filter medium of treatment cells.
- The smaller pumps are used mainly during the winter months to pump filtered water to the disinfection process and to the 8 ML treated water reservoir.

Filtered Water Pump Room

Specifications:

Clearwell	*634 m^3*		
Pumps – Large	*(2)*	*125 Hp*	*417 L/sec at 15 m head*
Pumps – Small	*(2)*	*30 Hp*	*104 L/sec at 15 m head*

Future provision is allowed for 1 additional large pump when the plant is expanded to 82 ML/d.

Disinfection:

Disinfection is the selective destruction of pathogenic organisms. The Powers Creek water treatment plant utilizes two forms of disinfection as follows:

- **UV Disinfection:**

  A Trojan UV Swift 4L24 ultra violet reactor is first utilized to provide a 3-log (99.9%) reduction of *Cryptosporidium* and *Giardia.* This one reactor is designed to treat peak water flows for both the present design of 54 ML/d as well as for the ultimate expanded water treatment plant capacity of 81 ML/d.

- **Chlorine Disinfection:**

  Post chlorination is used after UV disinfection to provide final disinfection and to provide for residual disinfection within the distribution system.

  An end-of-line residual chlorine monitoring station was constructed in 2008 and this facility communicates to the water treatment plant to ensure that chlorine disinfection is

maintained at effective levels throughout the distribution system. This facility will also help to minimize the amount of chlorine required for this purpose.

The In-Filter DAF water treatment process significantly reduces the amount of chlorine required to effectively disinfect the water delivered to customers. Annual chlorine used at the PCWTP is approximately 30% of that required prior to treatment.

Trojan Swift 4L24 UV Reactor

Specifications:

UV Disinfection	*Trojan Swift 4L24*	*4 UV lamps (capacity for 8 UV lamps);* *Dual-action sleeve cleaning system;* *High efficiency electronic ballasts;* *UV output adjusted from 30% to 100%;*
Chlorine Disinfection	*Gaseous chlorine*	*1 metric ton cylinders;* *2 chlorine cylinders on line;* *2 chlorine cylinders on stand-by;* *Emergency shut-offs installed.*

Balancing Reservoirs:

After disinfection the fully treated water is stored in the balancing reservoir No. 1 adjacent to the Powers Creek water treatment plant. There are 3 additional balancing reservoirs within the distribution system.

Specifications:

Balancing Reservoir No.1	*8 ML*	*2 – 4ML concrete reservoirs*
Smith Creek Reservoir	*2 ML*	*3 – 0.67 ML concrete reservoirs*
Glenrosa Reservoir	*1.9 ML*	*1 – circular concrete reservoir*
Evergreen Reservoir	*0.4 ML*	*2 – 0.2 reservoirs*

Powers Creek WTP, UV Disinfection Chamber & 8 ML Balancing Reservoir No.1

Lab Data: (Values are for 2008)

		Turbidity	Alkalinity	Hardness	pH	Color	
		NTU	mg/l	mg/l	- Log H+	Apparent	True
Raw Creek Water	Average	1.34	33-50	33-56	6.3 – 7.8	20-80	14-60
Treated Water	Average	0.05	44	52	6.9	1.2 - 0.6	< 3

Operation:

The Westbank Irrigation District Powers Creek Water Treatment Plant and distribution system are operated and maintained by highly trained and certified operators. The plant contains a modern laboratory where water quality is monitored; which in turn assists the operators to adjust the plant performance to meet or exceed provincial drinking water quality objectives established by Interior Health as well as federal Canadian Drinking Water Quality objectives.

Cost of Water Treatment Operations: (based on total water demand for 2008)

- **Labour:** $\$0.047/m^3$
- **Chemicals:** $\$0.042/m^3$
- **Other:** $\underline{\$0.037/m^3}$
- **Total:** $\$0.127/m^3$

- **PCWTP Long Term Loan:** Costs based on total water demand for 2008 ($11 million @ 4.4948%; 20 year amortization)
  - Contribution from users: $\$0.1129/m^3$
  - Contribution from New Development: $\underline{\$0.0479/m^3}$
  - Total Cost of Long Term Loan: $\$0.1608/m^3$

Operations Staff:

- **Steve McGill** – EOCP Water Distribution – Level 4;
  – EOCP Water Treatment – Level 1;
  – AWWA Cross Connection Control Specialist.
- **Ole Christensen** – EOCP Water Distribution – Level 3;
  – EOCP Waste Water Treatment - Level 1;
  – EOCP Chlorine Handling Certificate;
- **Vince Woytas** – EOCP Water Distribution – Level 1;
  – EOCP Chlorine Handling Certificate.
- **Josh Visscher** – EOCP Water Distribution – Level 2.
- **Mark Maxson** – EOCP Waste Water Treatment - Level 4;
  – EOCP Water Treatment – Level 1;
  – EOCP Water Distribution – Level 1;
  – EOCP Chlorine Handling Certificate.

Distribution System:

- 80 Kilometres of water mains;
  300+ fire hydrants;
- 4 distribution pump houses;
  4 reservoirs; total storage of 12.3 ML;
- 5374+ service connections.

Other Information:

- Treatment plant provides protection against *Giardia Lamblia*, *Cryptosporidium*, water-borne bacteria, and viruses.
- Facility is operated by water sourced from 6 upland reservoir lakes within the Powers Creek watershed.
- Treated water is adjusted for a pH of 6.9 by the addition of caustic soda prior to distribution to customers.
- A very sophisticated SCADA system controls both the water treatment facility and the distribution system from a single location.
- A diesel generator provides backup power with the ability to run 50% (train 1) of the water treatment plant at full load capacity.
- All water testing is accomplished by a third party laboratory. Water quality testing for effective water treatment is done at the water treatment site laboratory.

Engineer: **Earth Tech (Canada) Inc. (now AECOM)** performed the pilot testing of the Powers Creek water as well as the preliminary & detailed engineering design & construction management for the PCWTP and the 8 ML Balancing Reservoir No. 1.

General Contractor: **Maple Reinders Inc.** managed the construction of the PCWTP and Balancing Reservoir No. 1 over a 17 month period from October 2005 to February 2007.

Residuals Management:

There are two types of waste residual that is produced by the Powers Creek water treatment plant:

- Liquid Residuals: Produced from the backwashing of treatment cell filter medium;
- Solid Residuals: Produced from the sludge collected from the DAF clarification process.

Residual DAF processing unit.

Liquid Residuals Treatment:

Water used for backwashing filter medium is stored in the backwash reservoir within the treatment plant and then processed through a stand alone Residual DAF clarification unit. The sludge produced from this process returns to the sludge storage containment for further processing by the centrifuge. The clarified water (centrate) leaving the residual DAF unit is transported by gravity directly to an engineered wetland area. The water slowly moves through the wetlands and ultimately decants into Powers Creek.

Solid Residuals Treatment:

All sludge collected from both the primary and residual DAF clarification processes is stored in the sludge containment within the treatment plant. On a regular basis the sludge is processed through a centrifuge to produce a cake consisting of all of the inorganic and organic solids as well as residual chemicals. This sludge cake is deposited into a container and once full the container is transported to the designated landfill and used as cover.

The centrate returns to the backwash reservoir.

Specifications:

Liquid Residual Treatment:	*Backwash reservoir:*	*1*	*975 m^3*
	Residual DAF unit	*1*	*Corix (DAF380) 2 ML/d*
Solids Residual Treatment:	*DAF Sludge Storage:*	*2*	*63 m^3* each
	Centrifuge:	1	Alfa Laval (ALDECG2-40)

Alfa Laval Centrifuge used to produce sludge cake.

Management & Administration:

- **Brian W. Jamieson, P.Eng.** – General Manager.
- **Ray McCall, C. Tech.** – Technical & Process Manager.
- **Lynda Wachter** – Administrative Manager.
- **Lis Nielsen** – Senior Administration Clerk.
- **Karen Bisceglia** – Junior Administration Clerk (part-time).

Westbank Irrigation District Water System Statistics (2008):

- **Connections:**
  - Residential: 5004
  - Commercial: 192
  - Industrial: 34
  - Agricultural: 144
  - **Total: 5374**
- **Water Meters:** All connections are metered and a consumption based water metered rate will be implemented in 2010.
- **Total Volume of Water Treated:** 4,909 ML
- **Maximum Daily Demand:** 37.7 ML