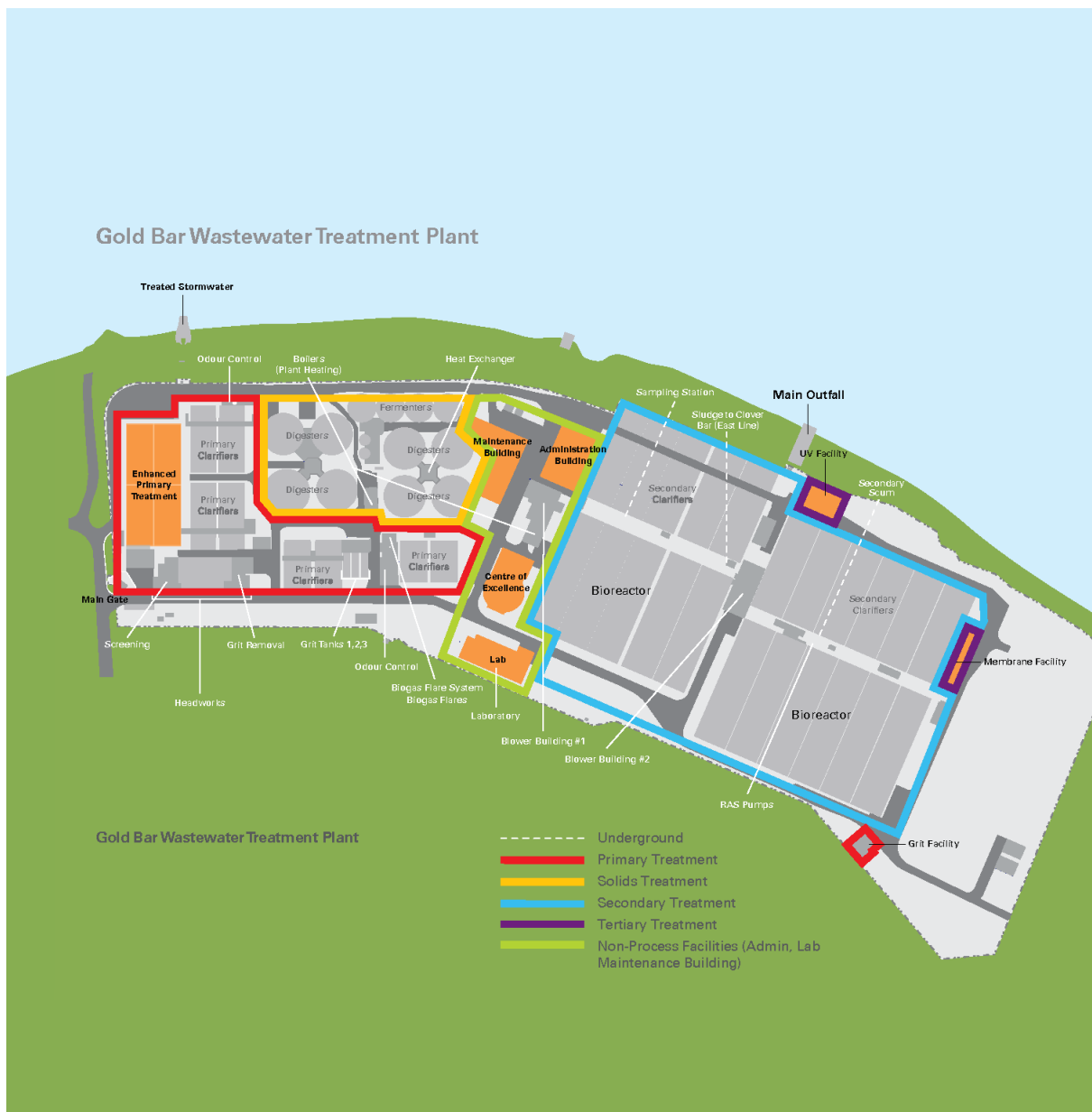




# Gold Bar Wastewater Treatment Process

Gold Bar Wastewater Treatment Plant is one of the most innovative wastewater treatment operations in North America.

Its tradition of wastewater treatment excellence is evident today with the plant's Wastewater Research and Training Centre, part of the **Edmonton Waste Management Centre of Excellence**. Learn more about the treatment processes, technologies and equipment of Gold Bar.



## Treatment Process

### Pre-treatment

As incoming raw wastewater flows through Gold Bar's aerated grit tanks, heavy material (sand, rocks) drops to the bottom while large, lighter material (plastics, paper, rags, wood, etc.) is trapped by the large bar screens at the ends of the tanks. Removing this material is necessary to prevent damage to equipment and allow for the following treatment processes to focus on removing the organic matter and pollutants.

Once the large inorganic solid matter and grit is removed from the raw wastewater it is trucked to the City of Edmonton Waste Management Centre.

### 1a. Primary treatment (for normal, dry weather periods)

During normal, dry weather periods, the wastewater effluent flows directly from the pre-treatment stage directly to the regular primary treatment clarifiers where approximately 50% of the wastewater's impurities are removed. In the deep clarifier tanks, the heavier solids (sludge) settles to the bottom while the lighter solids (scum) rises to the top. Both sludge and scum are then scraped or skimmed off and piped away for solids handling, while the primary effluent (as it is referred to following this stage) travels on to the secondary treatment phase.

From this point forward in the treatment process, the solids and liquids are, for the most part, dealt with separately.

### 1b. Enhanced primary treatment (for wet weather flows)

The wastewater collection system has two types of sewers—sanitary and combined sewers. Combined sewers, which are typical of older areas of the city, carry sanitary and storm water in a single pipe. In newer areas a sanitary and storm water system do this work separately.

During heavy wet weather periods the combined sewers (~ 15% of total system) often collect more runoff than they can handle creating wastewater overflows to the river. Without the overflows there would be no way of keeping untreated wastewater in those areas from backing-up into household basements or from spilling out of manholes and flooding roadways.

Recent upgrades at the Gold Bar Plant, however, have significantly reduced the amount of untreated overflow entering the river. These overflows are instead sent to Gold Bar's Enhanced Primary Treatment clarifiers, after the pre-treatment step, which lets the plant to take in and treat more peak seasonal flows (e.g. summer storms and spring snowmelt).

## How does enhanced primary treatment work?

### Action 1: Addition of alum

Most of the large pieces of grit and organic matter are removed in the grit removal system. Much of what remains is extremely small in size and carries a negative electrostatic charge on its surface. Due to electrostatic charges between particles, separating the solids from the liquids is difficult without help from a coagulant.

Aluminum sulphate, alum, is used as the primary coagulant. When added to the wastewater the alum dissolves into an aluminum ion and a sulphate radical. The positively charged aluminum ion neutralizes the negatively charged particles in the wastewater, allowing them to bind together and settle. This process is almost instantaneous and particle destabilization is practically complete in less than one second. The aluminum ion then hydrolyzes, forming a jelly-like aluminum hydroxide floc, which catches and gathers the destabilized particles.

### Action 2: Addition of polymer

Aluminum hydroxide floc has a relatively weak physical structure which is prone to break up. A polymer, which acts as a "glue" of sorts, is added to the wastewater as the aluminum hydroxide floc is being formed. The polymer strengthens the floc and helps to bind adjacent flocs creating larger clumps that settle more easily due to their size and weight.

### Action 3: Flocculation

The formation of larger floc clumps is improved by gentle mixing. Careful selection of the mixing energy is required to achieve sufficient collisions without causing the flocs to break up. Efficient floc formation will occur when mixing energy and chemical additions are optimized.

### Action 4: Plate settling

At normal operating rates, up-flow clarifiers require very large surface areas to avoid suspended particulates being carried over in the effluent. The use of plate settlers removes the need for such large surface areas. Flocculated wastewater flows upward between the inclined plates of the plate settler.

As the plates are closely spaced, the particulates in suspension have only a short distance to fall before settling on the plate surface. Further clumping of the floc takes place as it gathers on the inclined plate surface and slides down to exit at the bottom of the plate module. This results in better solids-liquid separation and clarifier operation rates that are up to 10 times more efficient than clarifiers that are not equipped with plate settlers.

#### **Action 5: Sludge collection**

A slowly moving rake mechanism at the bottom of the tank collects and moves sludge settled underneath the plates across the entire tank and into a small concrete box known as a sludge sump. The rake consists of a chain and an attached series of planks, called a chain and Flite system. Sludge that has accumulated in the sump is pumped to the anaerobic digesters for further treatment prior to disposal.

#### **Action 6: Scum collection**

Some light materials in the wastewater, together with the foam formed through mixing, float to the surface. This material, called scum, is collected using a rake mechanism similar to that used for sludge removal. In places where the rakes cannot reach, a water spray is used to move the scum. Scum is then collected in a concrete box known as a scum pit, where it is mixed with some additional water in the pit. It is then pumped as slurry and mixed with sludge originating from other locations within the Gold Bar Plant before awaiting treatment.

#### **Action 7: Air scour**

During treatment, some of the floc may stick to the clarifier plates, preventing sliding down to the bottom of the tank where it is collected as sludge. Over time, accumulated floc on the plates can reduce the capacity and overall effectiveness of the plates, requiring the plates to be cleaned occasionally. To loosen this accumulated floc, large volumes of air are bubbled through the plates.

The loosened floc then slides off the plates, collecting at the bottom of the tank as sludge. This process, known as air scour, will ensure that the plates remain clean and effective.

## **2. Secondary Treatment**

The remaining organic matter in the effluent are dissolved solids that will not settle out by gravity alone and therefore cannot simply be scraped out by rakes or machines. So Gold Bar harnesses the wastewater's biological properties, namely the microorganisms (bacteria, fungi, protozoa) and organic matter, to further clean the effluent.

Microorganisms feed on the dissolved organic matter and other pollutants, breaking them down. The microorganisms multiply in large bioreactor tanks and their appetite for waste materials is further stimulated by mixing in large volumes of air.

### **2a: Biological nutrient removal**

Modifications to the secondary bioreactors allow the microorganisms to also remove the nutrients phosphorus and ammonia which can be harmful if released back to the river in high concentrations. Once these nutrients have been taken care of, the secondary effluent is sent for final clarification.

### **2b: Final Clarification**

Upon leaving the bioreactor, effluent enters the secondary clarifiers which work much like the primary clarifiers. In this case, the well-fed microorganisms bind together as a 'floc', settle to the bottom and from there are removed by mechanical rakes. By this stage almost all the impurities have been removed.

Most of this settled floc is channeled back into the bioreactors, while a small portion is removed, thickened and pumped to the digesters for solids treatment.

## **3. Tertiary Treatment**

Gold bar was upgraded with tertiary treatment, which further improves effluent quality, in December 2001. Tertiary treatment disinfects the final effluent and also removes phosphorus and ammonia. These processes are non-chemical.

### **3a: UV disinfection**

Before being returned to the North Saskatchewan River after almost 18 hours of treatment, the clear wastewater effluent is disinfected using high intensity ultra-violet light. In a few short minutes, this chemical-free process destroys any of the harmful bacteria that remain and renders the treated wastewater safe for contact during recreational activities (e.g. boating, wading and fishing).

Following disinfection, the wastewater, having been treated in accordance with regulatory standards, can now be safely returned

to the North Saskatchewan River via the plant's main outfall.

### **3b: Membrane filtration**

About 5% of the final treated effluent bypasses UV disinfection and goes straight to membrane filtration, producing high-grade process water for industry. Membrane filters are a series of porous synthetic strands containing millions of microscopic pore openings that allow water to pass through but act as a barrier to even the smallest bacteria.

This filtering process is referred to as 'effluent polishing', and produces the same disinfection quality as if it were treated by UV.

## **Solids handling**

### **Fermenters**

Primary sludge's first stop is the fermenters—four unheated, anaerobic (no oxygen) vessels. After 3-7 days, the thickened sludge is sent first to a blend tank, to be mixed with secondary sludge (see Final Clarification) just prior to its longer stay in the digesters where it undergoes further treatment. Liquid from the fermenters, which has become enriched by what are known as 'volatile fatty acids' or VFAs, is used in the secondary treatment process and is an essential ingredient in what's known as 'Biological Nutrient Removal'.

### **Digesters**

Anaerobic digesters, which are maintained at 37°C, serve in breaking down and stabilizing the massive amounts of organic sludge removed during the treatment processes. The digesters do in weeks what in nature would take many months. Some of the odorous biogas (60-65% methane) produced by the sludge digesting or breaking down is captured and used to heat the Gold Bar plant buildings and digesters. Digested sludge (~ 2-4% solids) is pumped some 11 KM to offsite storage lagoons at Clover Bar for further thickening, processing and distribution.

### **Biosolids**

As the solids and liquid gradually separate, the liquid is pumped back to the Gold Bar plant for treatment. The thickened sludge, referred to at this stage as 'biosolids', is handled by our drainage team, who either apply the biosolids on agricultural fields or use it as an input for their co-composter, also located at their Clover Bar site. Biosolids contain significant concentrations of nitrogen and phosphorus; they have been used around the world for decades as a fertilizer and a soil amendment.

### **About EPCOR**

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