

# PRODUCED WATER

## Recovery Options

### Creating Water Solutions

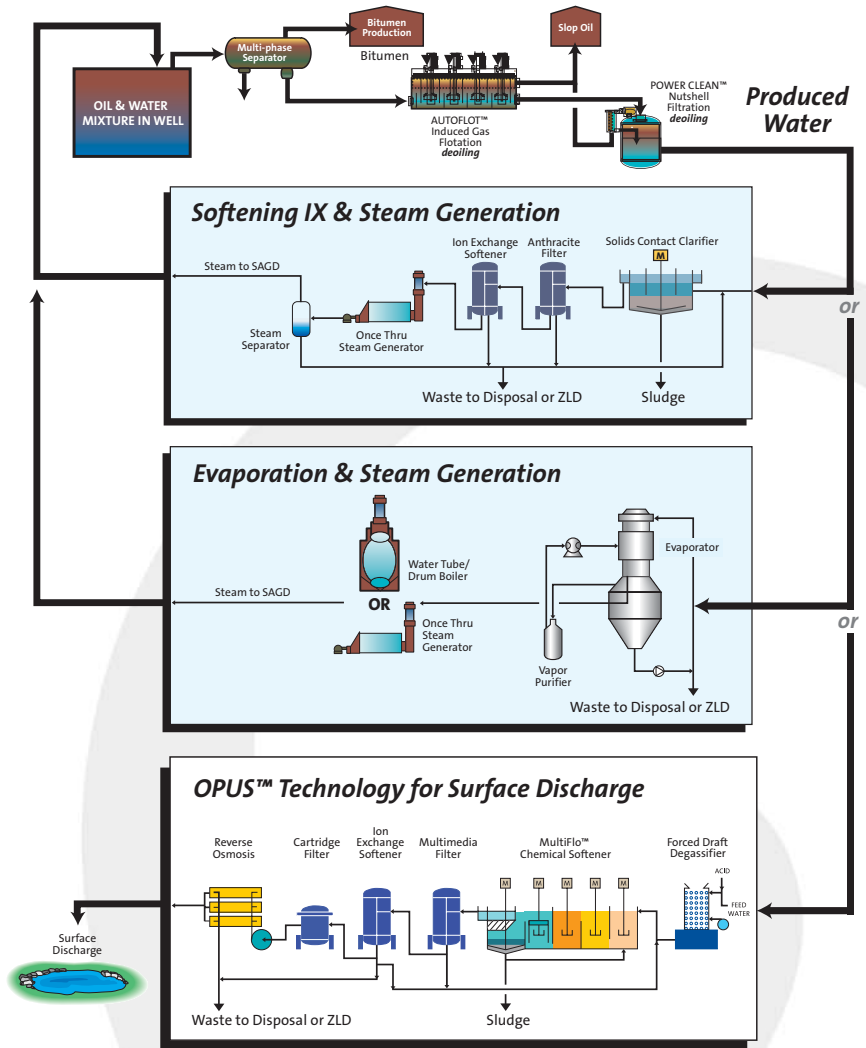
Veolia Water Solutions & Technologies (VWS) offers producers several different approaches for produced water treatment and recovery for heavy oil projects. Using integrated VWS technologies, each of these options provides customers with its own set of benefits and advantages, depending upon the specific produced water parameters and steam generation requirements of the site.

These robust solutions can fully meet today's growing produced water challenges in heavy crude oil and natural bitumen (oil sands) production, such as those found in Canada, the United States, China, the Middle East, and South America.

### Technologies for Reliable Operations

The VWS group of companies possesses the technological expertise that integrates produced water treatment and steam generation to provide the optimal solution for each application. This expertise can also be used to treat produced water to a quality that is suitable for surface discharge or to fully close the system by employing a Zero Liquid Discharge system. All of these effective technology options are designed to provide years of continuous and reliable operation. Advanced technologies and the experience of identifying critical produced water treatment requirements are critical to maximizing re-use and maintaining optimum steam generation.

### Water Treatment for Produced Water



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### *Technologies for Produced Water Applications*

#### **Steam Generation Treatment Options**

##### **Softening IX for OTSG Feedwater**

Softening IX represents the “conventional” option for treating produced water through a series of chemical treatment steps to meet the quality necessary for a once-through steam generator (OTSG). The Softening IX process was developed for conventional oil recovery where there is more hardness than silica. The process train typically consists of induced gas flotation (Autoflot™), nutshell filtration (Power Clean™), softening, and ion exchange. This process has been used in California, Alberta, and other heavy oil sites outside of North America. Depending on the application, VWS can provide conventional or Multiflo™ high-rate chemical softening upstream of the polishing ion exchange step.

##### **Evaporation for Boiler or OTSG Feedwater**

The use of evaporation to treat produced water for steam generation is a reliable approach in heavy oil and SAGD applications. VWS has developed a process based on proven technologies that uses evaporation for produced water treatment and eliminates boiler blowdown. The process transfers all of the heat from the boiler feedwater into the steam injection well. This system utilizes 100% of the feedwater while generating greater than 98% quality steam. Use of this technology reduces the capital and operating costs of water treatment and steam generation equipment.



#### **Surface Discharge Treatment**

##### **OPUS™**

The OPUS™ technology consists of multiple treatment processes, involving degasification, chemical softening, media filtration, ion exchange softening, cartridge filtration and reverse osmosis (RO) technologies. The pretreatment processes ahead of the RO are designed to reduce the hardness, metals and suspended solids in the feed water. The RO process operates at an elevated pH, which effectively controls biological, organic and particulate fouling, eliminates scaling due to silica, and increases the rejection of silica and boron.

#### **Zero Liquid Discharge - Closing the Loop**

##### **ZLD Systems for Produced Water**

Brine crystallizers, when integrated with water treatment and steam generation processes, provide a ZLD (zero liquid discharge) option when deep well injection or surface discharge are prohibitive. A ZLD system can be added to any of the produced water recovery options as a high-solids thermal process. VWS is the industry leader for the design of high-solids concentration and ZLD systems.



Solutions & Technologies

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