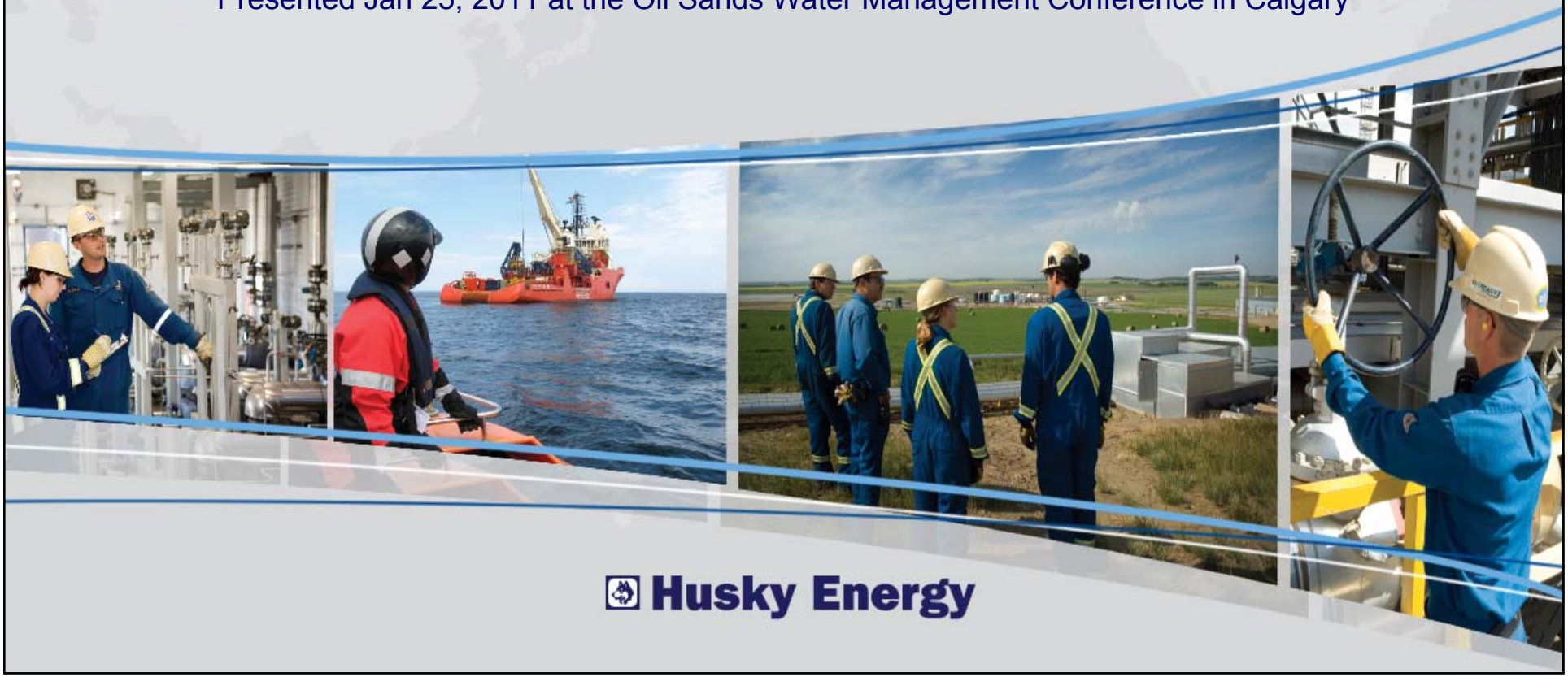
OIL SANDS WATER DE-OILING

CHALLENGES AND INNOVATION

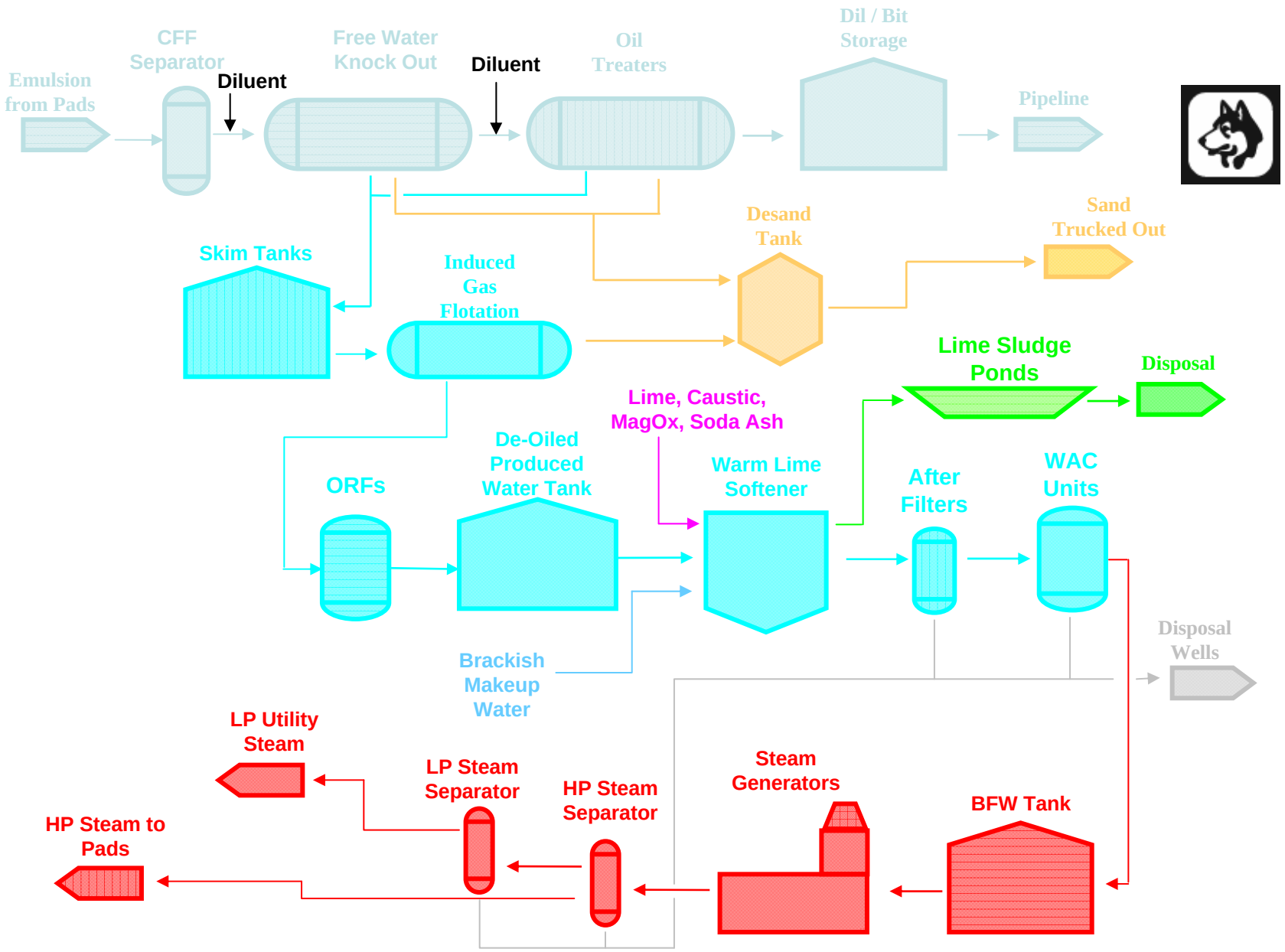
Presented Jan 25, 2011 at the Oil Sands Water Management Conference in Calgary



Husky Energy

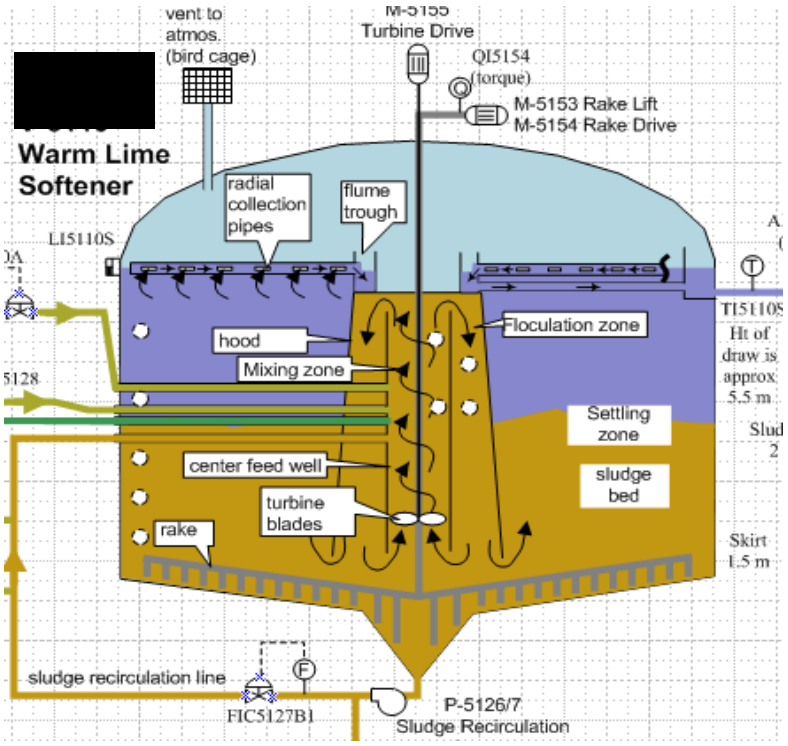
Agenda

- **Results and consequences of Ineffective de-oiling**
- **Focus areas for improvement**
- **It starts in the field**
- **FWKO & treater interface control**
- **Primary de-oiling**
- **Secondary de-oiling (polishing)**
- **Dissolved hydrocarbon removal**
- **The Prize**


Emulsion from Pads
CFF Separator
Diluent
Free Water Knock Out
Diluent
Oil Treaters
Dil / Bit Storage
Pipeline
Skim Tanks
Induced Gas Flotation
Desand Tank
Sand Trucked Out
Lime Sludge Ponds
Disposal
Lime, Caustic, MagOx, Soda Ash
ORFs
De-Oiled Produced Water Tank
Warm Lime Softener
After Filters
WAC Units
Disposal Wells
Brackish Makeup Water
LP Utility Steam
LP Steam Separator
HP Steam Separator
Steam Generators
BFW Tank
HP Steam to Pads

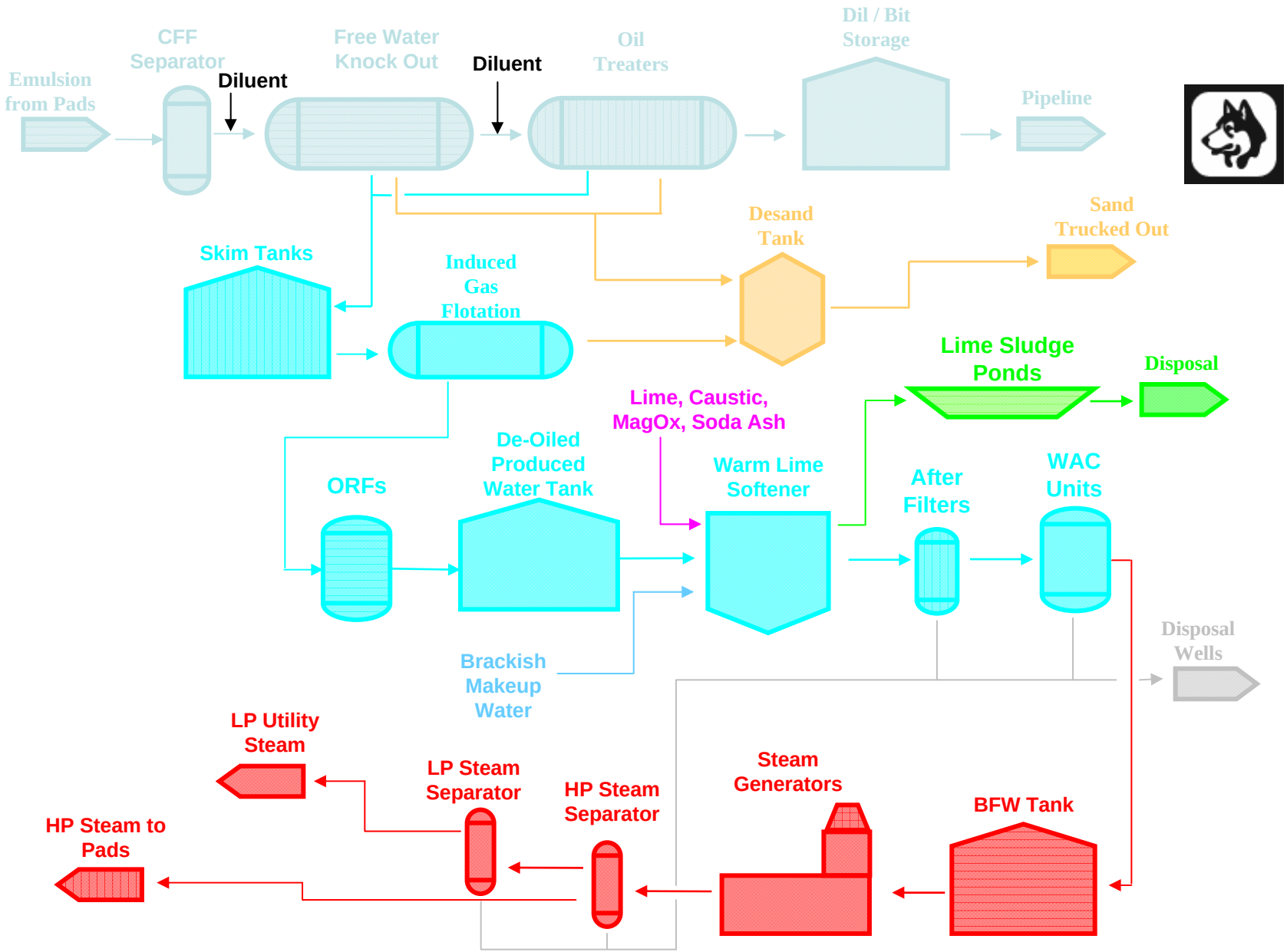
Impacts

- WLS is able to handle some O&G
  - Excess sludge make / increased chemical use
  - Loss of sludge bed control / increased lime waste
- Contaminate WAC resin
- Impacts an MVC also
  - Foaming / mist carryover
  - Fouls blowdown systems
  - Pond cost for emergencies
  - Trucking cost
- Fouling of disposal wells
- Loss of throughput



Impacts

- Dissolved organics not effectively removed by any of the current upstream processes
- Extreme de-oiling system upsets increase the TOC loading in the BFW steam
- Fouled OTSG tubes
  - Extreme case – tube rupture
  - Increased pigging frequency
  - Decreased tube life
  - Less up-time
- Loss of throughput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Improvements – Start in the Field

- Emulsion is a tight mixture of water and bitumen (oil) and solids (sand or clay)
- Addition of demulsifier chemistry as close to the wellhead as possible

Innovations

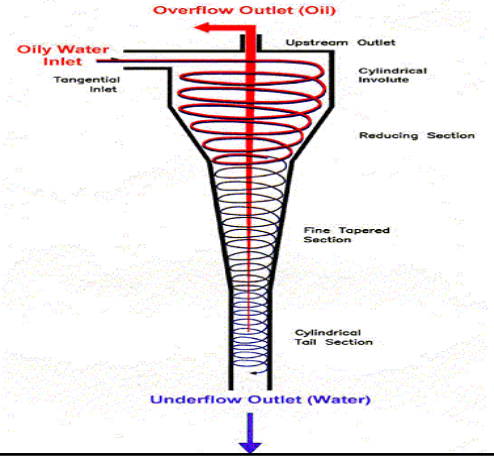
- Addition of REB in the field
- Automated dosage control
  - ppm (m/m) basis
- Oil sands chemical focus
- Asphaltene chemistry

Improve FWKO & Treater Interface

- Keep RAG layer control to max residence time
- Trim addition of DEO & Increased use of REB
- Full vessel level detection (not single point)
- Consider where the RAG dumps to

Innovations

- Multi-point conductivity string
- Nuclear level detection
- Hydrocyclone used for RAG treating
- On-line variable orifice for cyclone
- Improved decanter centrifuges
- On-site slop treating (3rd party)



Improve Primary De-oiling

- Very large tanks with attention to internals
- Smaller tank with focus on flow path (gunbarrel)
- On-line sludge removal
- Polymer chemistries

Innovations

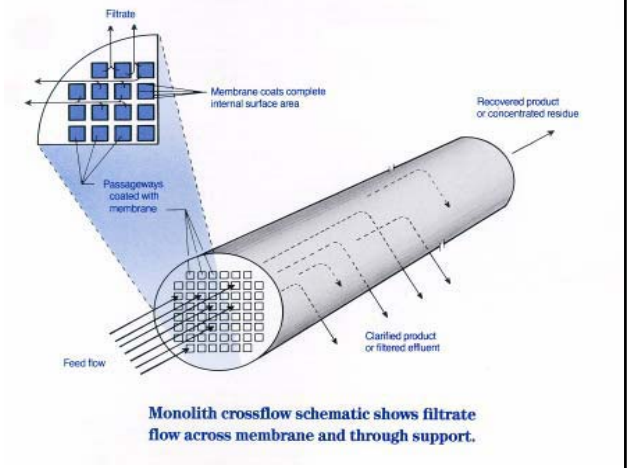
- Combined skim & IGF
- Micro-bubble flotation (MBF)
- Improved IGF designs (many)
- Ceramic membrane de-oiling

Improve Secondary De-oiling

- Not much change here in basic mechanism
- Additional media agitation during backwash
  - Mixers
  - Full media fluidization & circulation

Innovations

- Ceramic membrane pilot
- Ceramic membrane de-silication
  - Combine de-oiling with WLS
- Ultra-filtration



Monolith crossflow schematic shows filtrate flow across membrane and through support.

Improve Dissolved Organics Removal

- Maybe a function of selected Diluent
- Maybe a factor of connate water as make-up
- Limiting factor to increased BFW cycles / Produced water re-use & less make-up water
- Major impact on boiler tube fouling

Innovations

- Purifics Photo-Cat system
  - Also utilizes ceramic membranes

Photo-Cat Water Purification

The Prize

- Enable more efficient BFW treatment systems
  - Hot membrane Reverse-Osmosis
  - Compact and efficient MVC's
- Enable Modular Drum Boilers
- Hotter BFW (Ideal SAGD cycle)
  - Lower fuel gas cost
  - Lower carbon footprint
- Smaller footprint
  - Distributed steam & process
- Increased bitumen recovery
  - Chase smaller deposits