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WATER | WASTE | ENERGY

Using Saline Water For Hydraulic Fracturing: An Overview of Emerging Technology Opportunities

Patrick Leslie, B.Sc., B.A.

Director of Technology and Innovation
Integrated Sustainability Consultants

Overview

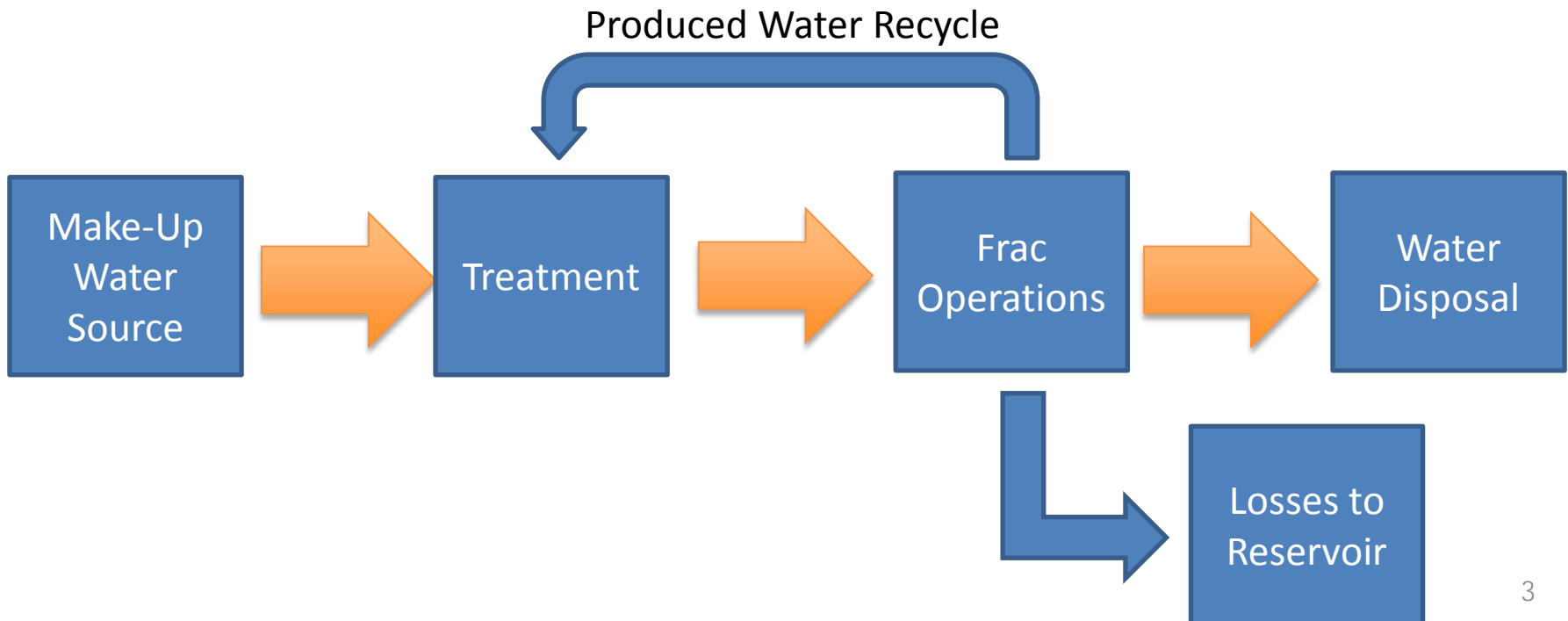
- Background: Saline Water and Fracing
- Exploring Saline Water Use
- Effects on Frac Operations
- Choosing the Right Technology
- New Technologies
- Conclusion

Saline Water Characteristics

- Produced Water
- Deep Aquifer Source Water



- TDS >4,000 mg/L
- Non-potable
- Heavy Metals
- Alkaline Earth Metals
- Norms

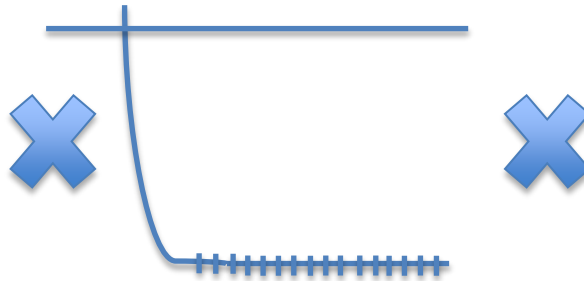


Fracing Operations

Single Development
Water Use Up to:



8000 m³ of Water/
Frac Stage



12 Frac Stages/
Well



16 Wells/
Pad

Industry Trends

Current & Projected Number of Wells

Resource Play	2013	2014	3-5 Year
Deep Basin	887	1037	1500
Duvernay	100	200	500
Horn River/Liard	48	98	250
Montney	800	850	1500
Total Pressure Pumping Wells	5564	6044	8285
Total Conventional Wells	5336	5956	5715



Exploring Saline Water Use

- Operational Risk
- Corporate Social Responsibility
- Public Perception
- OPEX/CAPEX

Comparable Industry

- Oil Sand Operators Using Saline Water:

cenovus
ENERGY



ConocoPhillips

 **MEG Energy Corp.**



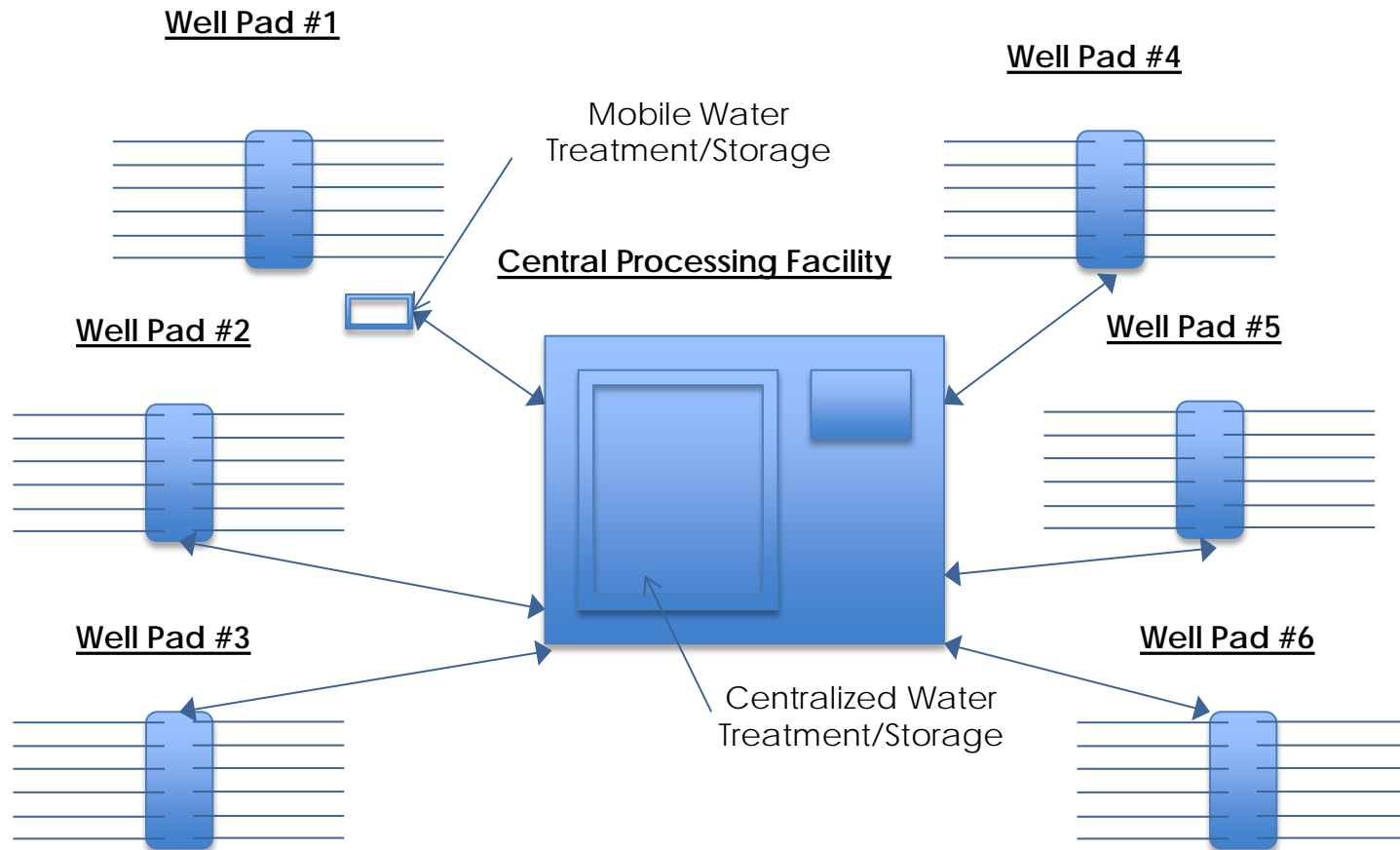
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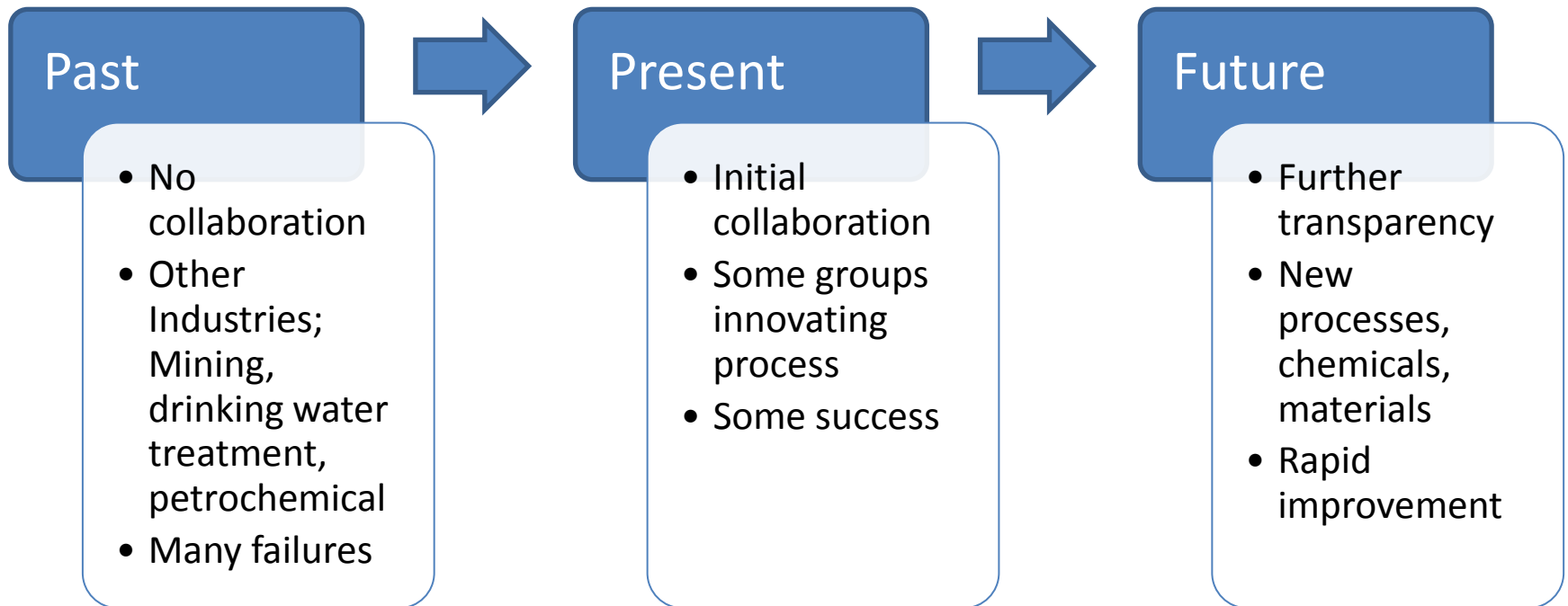


Cenovus – Foster Creek – NewsWire.ca

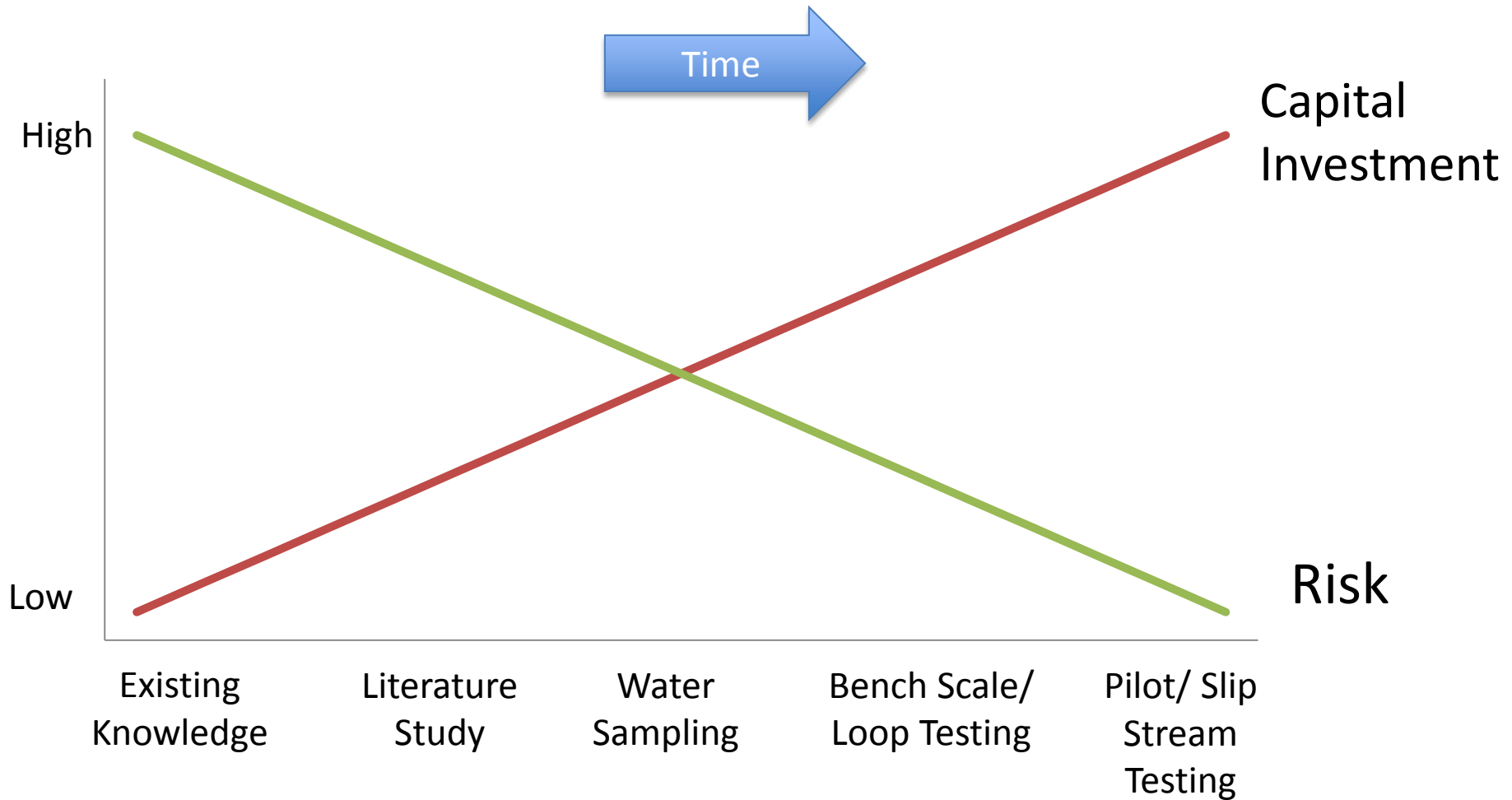
Effects on Existing Operations



Evolution of Technology Adoption



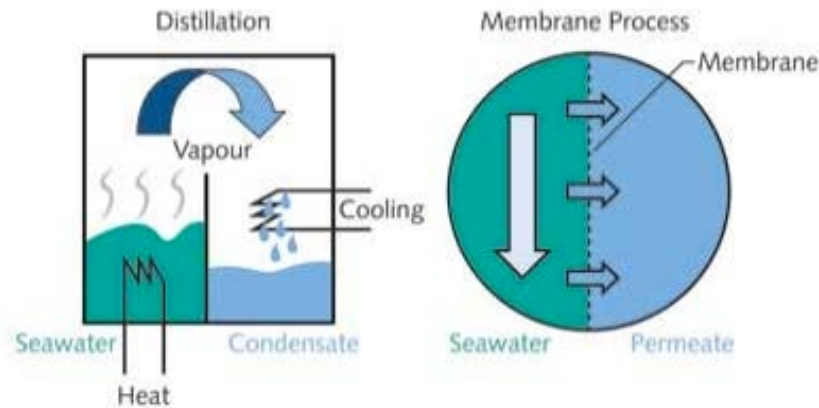
Risk Optimization for New Technology

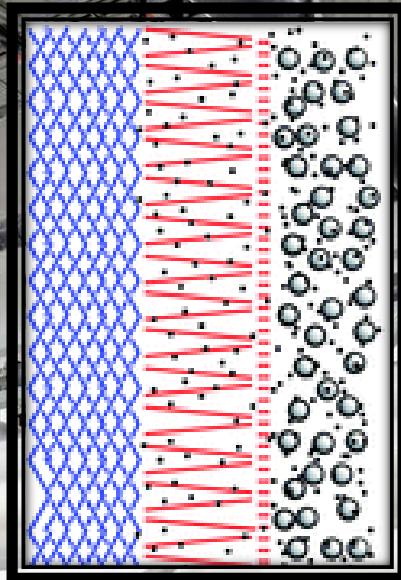


Water Treatment To Fresh Equivalent

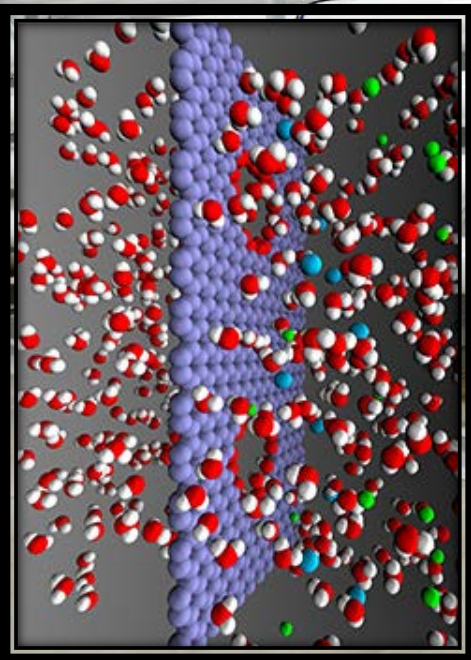
Evaporation Vs. Membranes

Figure 2. Desalination scheme

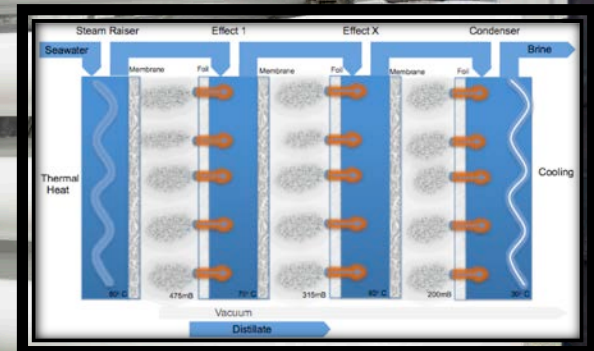




Typical RO
Membrane



Graphene
Membrane



Multiple Effect
Thermal Membrane

Saline Compatible Fracing Operations

- Treatment to Completions Compatibility:
 - Solids Removal
 - Hardness Removal
 - Scale Prevention

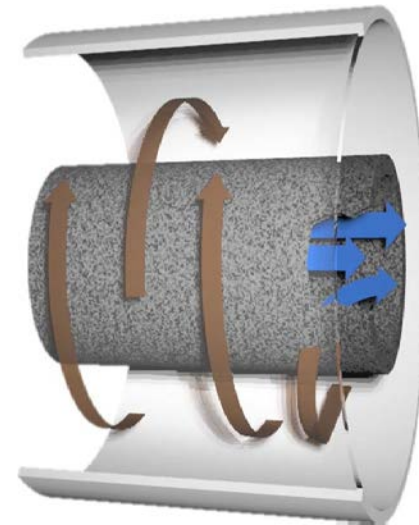
Saline Compatible Frac Chemicals

Water Quality Parameter	Slickwater
Temperature (°C)	3-40 ^b
pH	5.0-8.0 ^b
Chloride (mg/L)	<90,000 ^b
Hardness (mg/L CaCO ₃)	<15,000 ^b
Total Suspended Solids (mg/L)	50 (<100µm) ^b

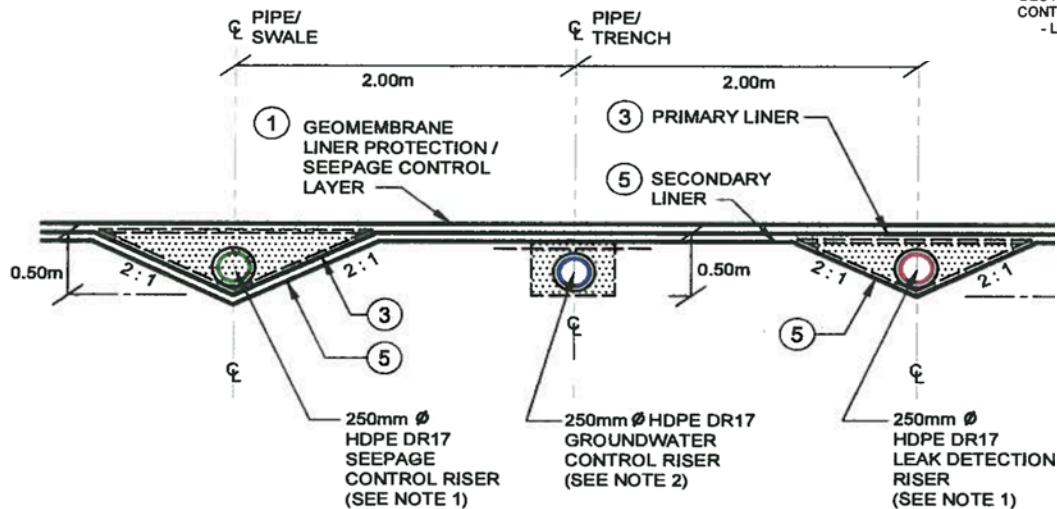
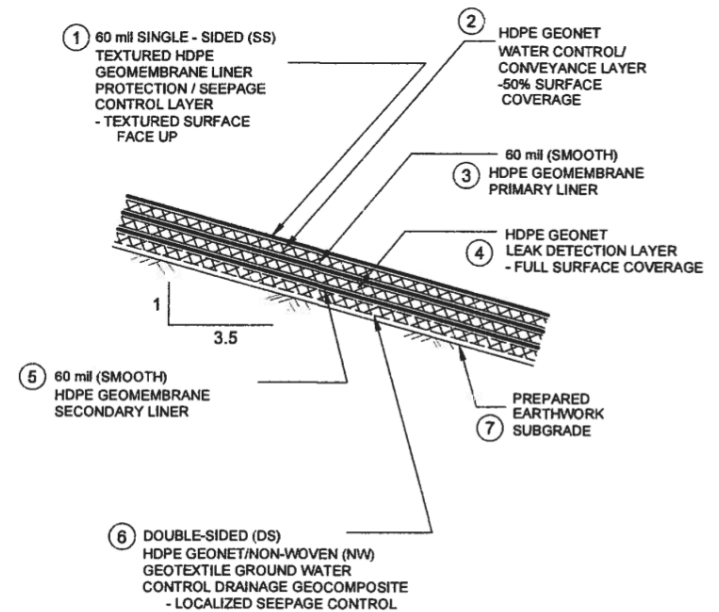


Solids Removal

- High Flux
- Self Cleaning
- Variety of Membrane/Mesh Options
- High Contaminant Loading Compatible



Triple Pond Liner



Conclusion

- OPEX/CAPEX Saving
- Public Perception/Local Stakeholder Engagement
- Early Development – Long Term Success
- Timing is Right



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Questions

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