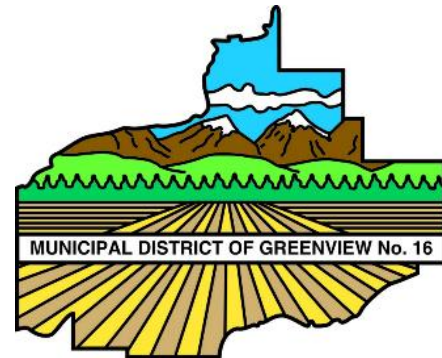


Alberta #1 Geothermal Project



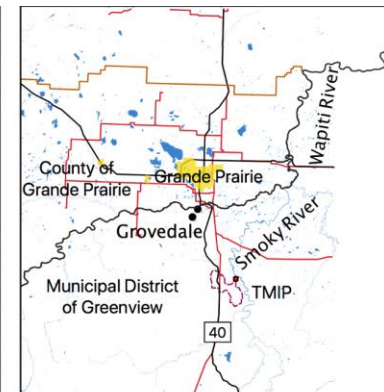
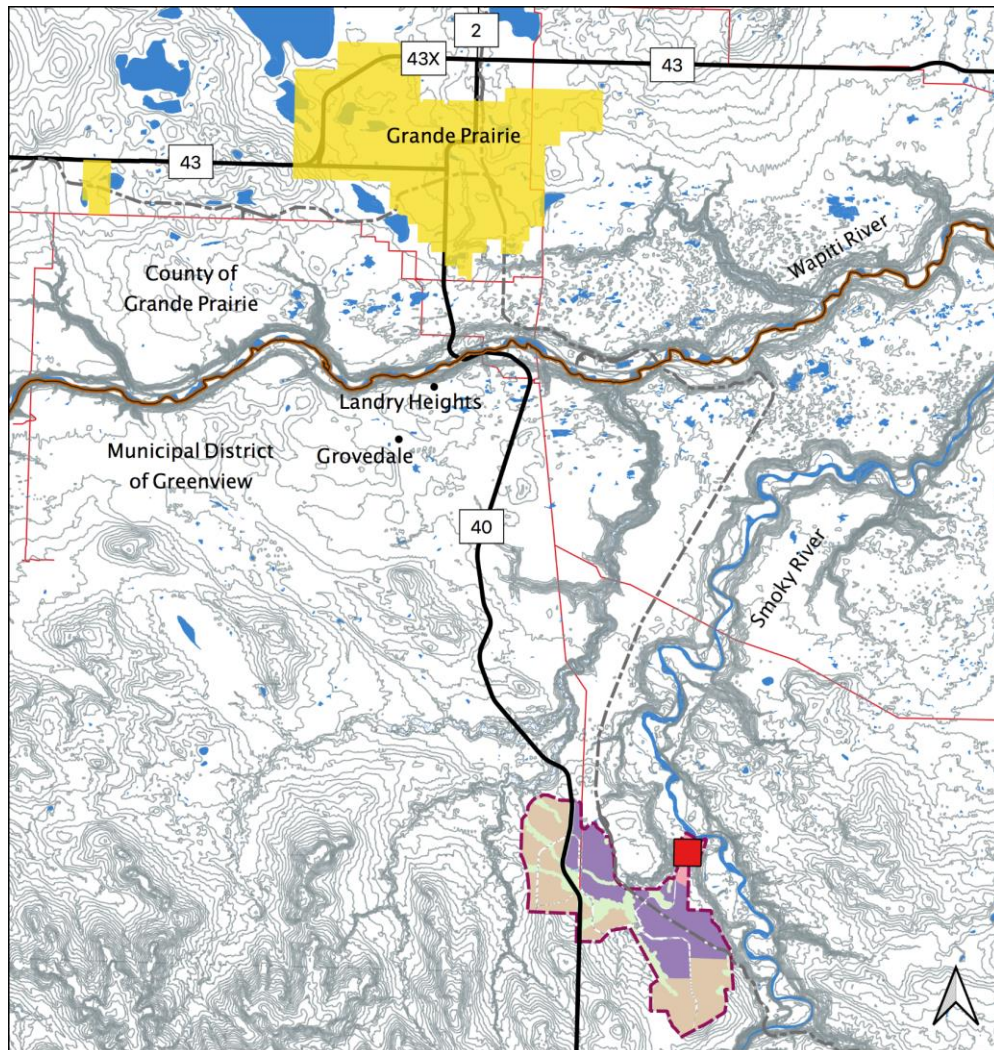
WHAT IS THE PROJECT?

- Proponent is the M.D. of Greenview No. 16
- M.D. of Greenview, County of Grande Prairie, City of Grande Prairie are the developers of the TMIP.
- Project is to be located on land located within the Tri-Municipal Industrial Partnership (TMIP), a multi-billion dollar heavy industrial park (HIP) project
 - HIP is projected to develop a thermal and electrical load of multiple hundreds of MW

WHAT IS THE PROJECT?

- 8MWe net (5MWe gross) electrical plant using deep geothermal fluid (brines)
- Associated direct-use infrastructure for heat use
- Estimated 6 production wells
 - Well-bores wider in diameter and deeper than typical oil and gas wells
- Target resource temperature is $\sim 120^{\circ}\text{C}$ with plans for both power generation and direct heat use.

PROJECT LOCATION



Tri-Municipal Industrial Partnership Basemap

Legend

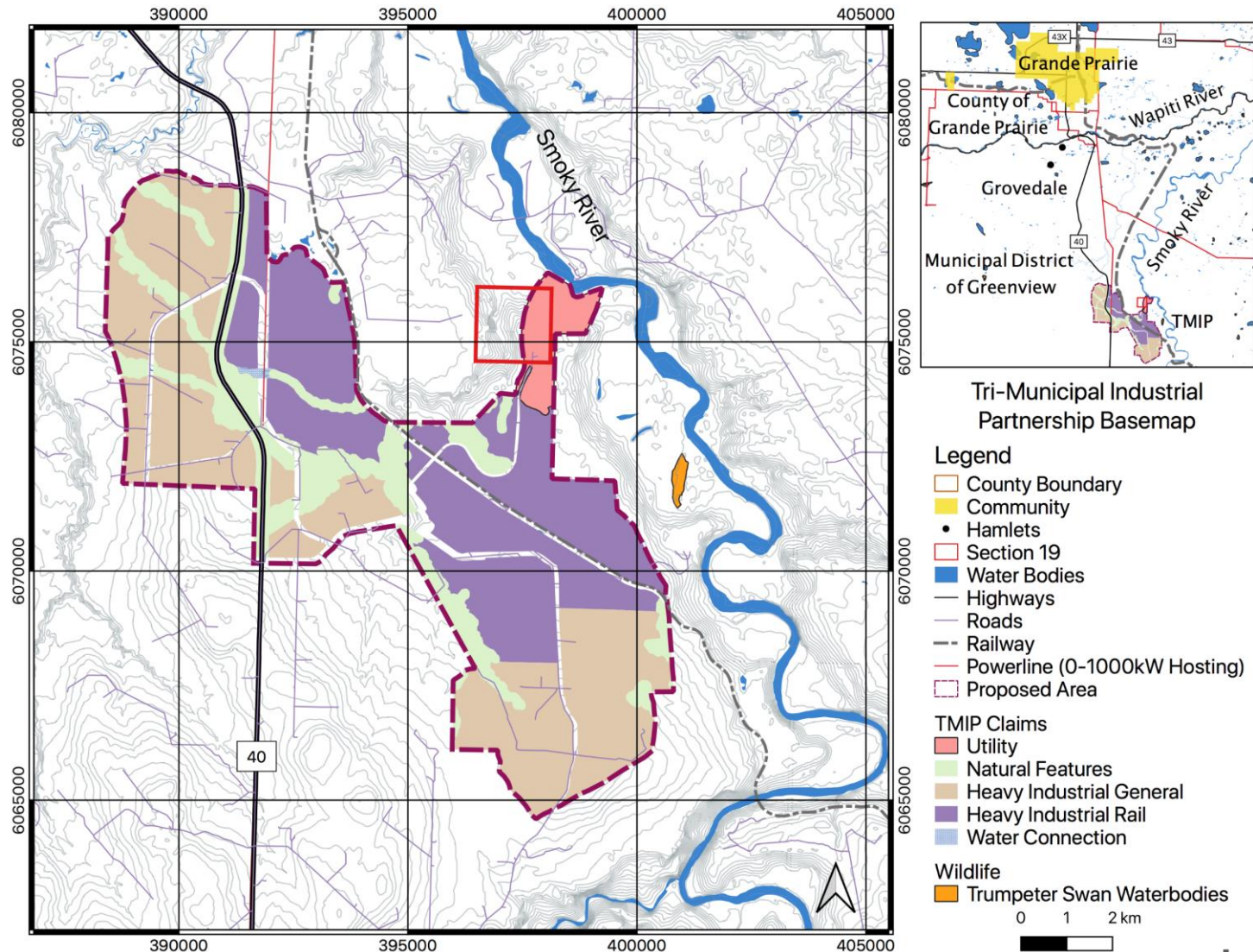
- County Boundary
- Municipal District Boundary
- Community
- Hamlets
- Section 19
- Water Bodies
- Highways
- Railway
- Powerline (0-1000kW Hosting)

TMIP Claims

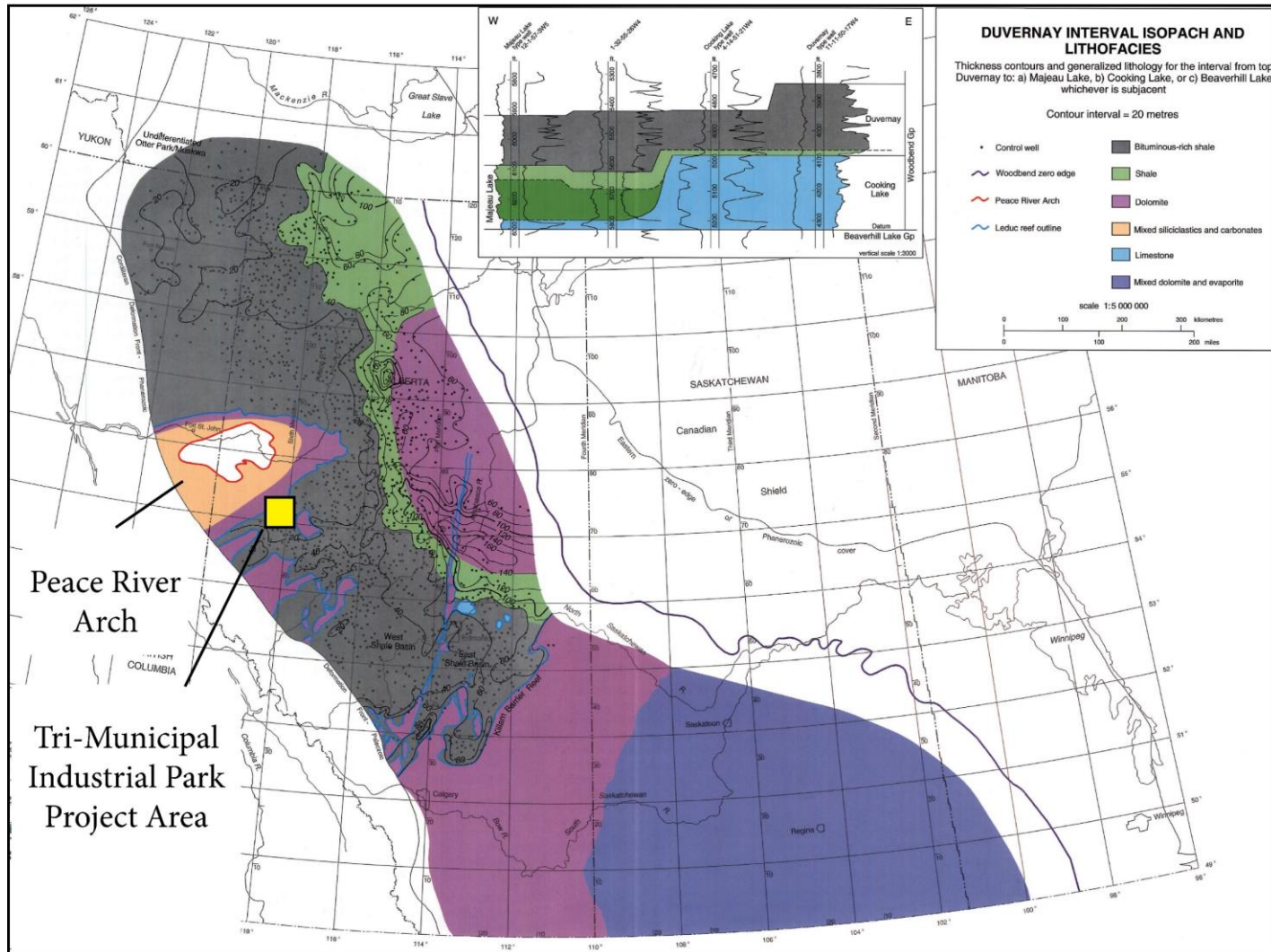
- Proposed Area
- Utility
- Natural Features
- Heavy Industrial General



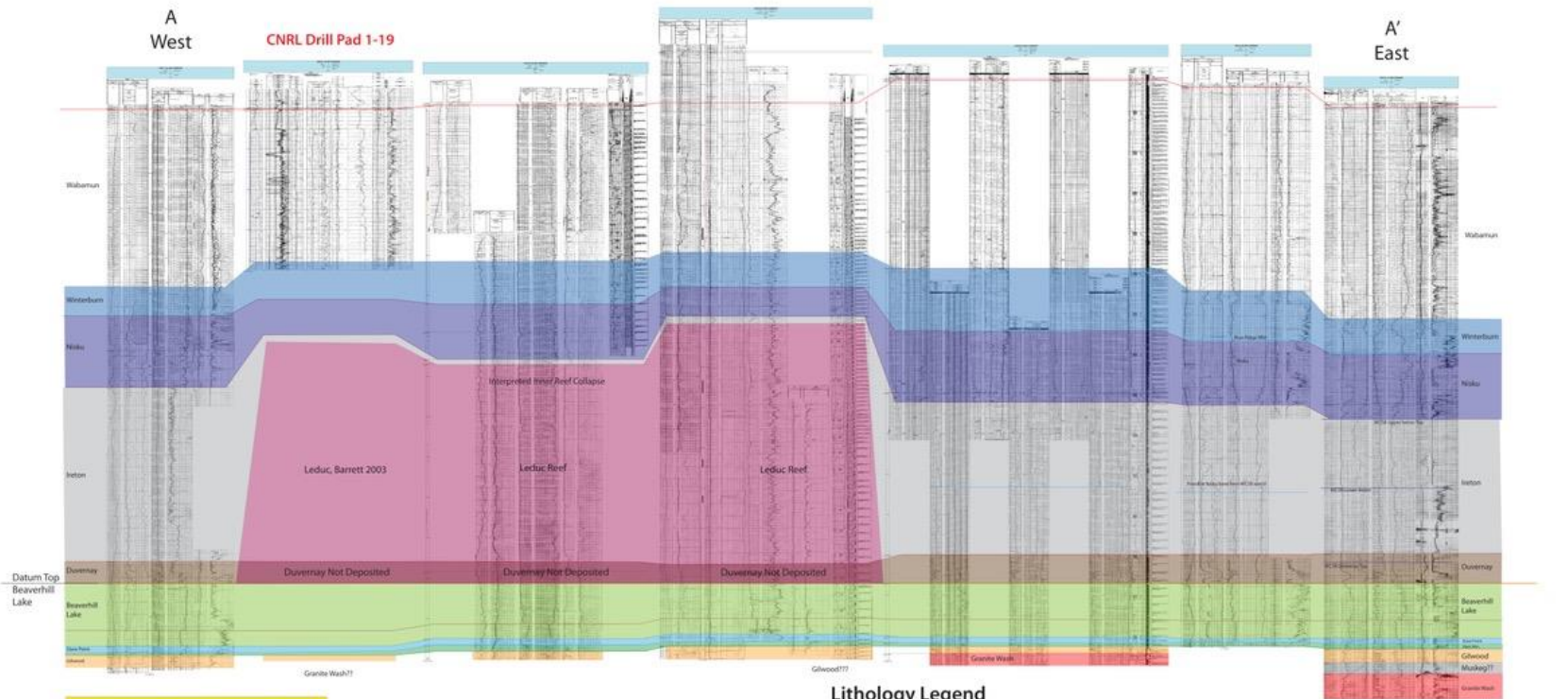
PROJECT LOCATION



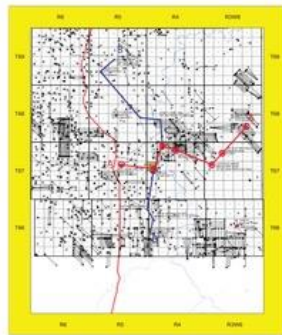
PROJECT LOCATION



STRATIGRAPHY



Lithology Legend
(Entire succession shown-Devonian age)

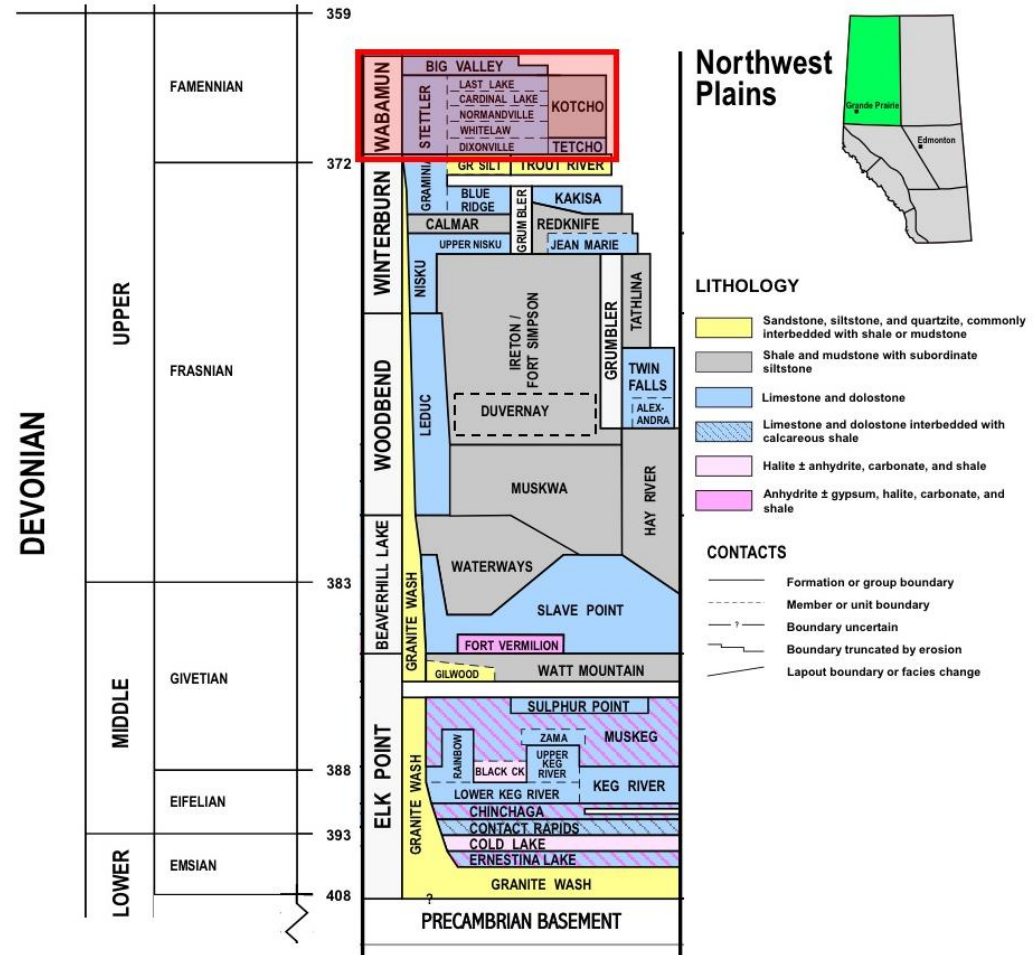


Terrapin Geothermics
Stratigraphic Cross Section A-A'
Wabamun Fm. to Precambrian Basement
MD of Greenview
Datum: Top Beaverhill Lake
No Horizontal Scale

White	Wabamun Limestone/Dolostone	Duvernay Organic-rich Lime Mudstone	Muskeg Evaporites
Blue	Winterburn Limestone/Dolostone	Beaverhill Lake Dolostone/Limestone	Granite Wash Arkosic Sandstone
Purple	Nisku Limestone/Dolostone	Slave Point Limestone/Dolostone	
Grey	Ireton Argillaceous Lime Mudstone	Watt Mountain Silty, Argillaceous Lime Mudstone	
Pink	Leduc Dolostone/Limestone	Gilwood Arkosic Sandstone	

TARGET FORMATIONS

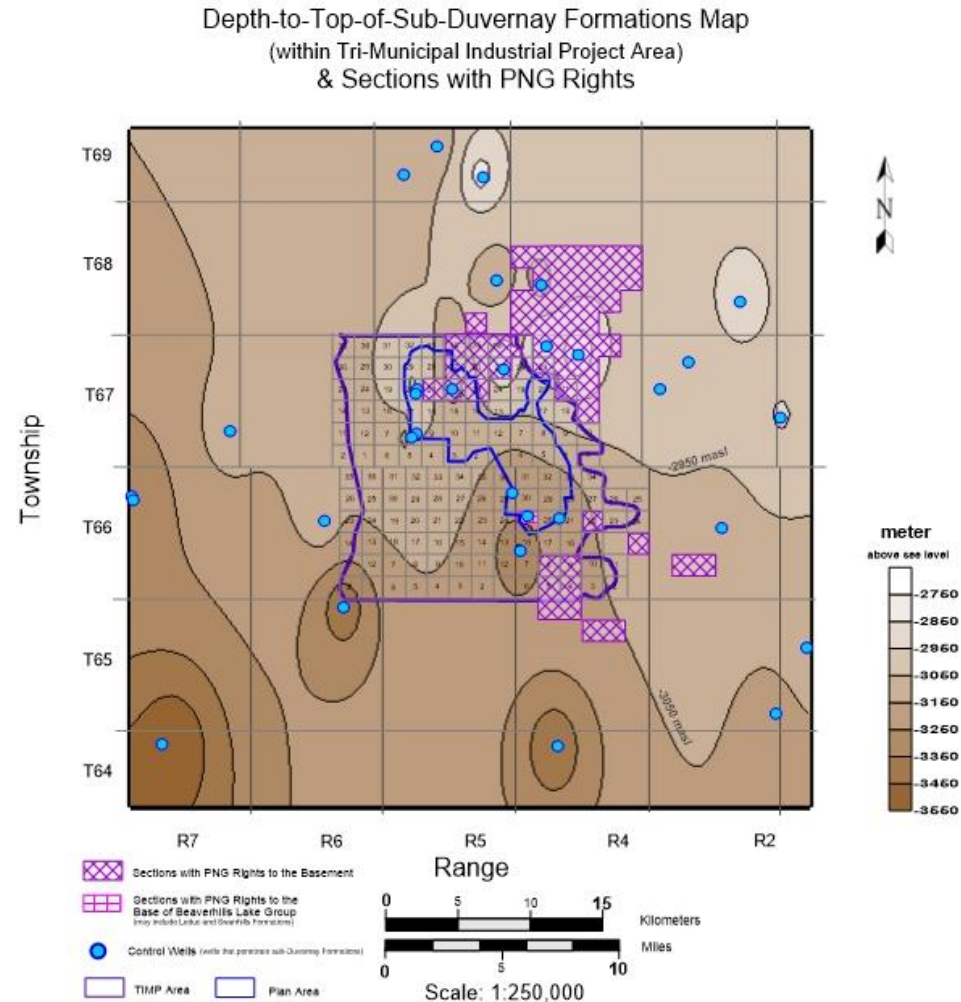
- Crown Agreement: exploration rights from base of Wabamun Group into Precambrian basement
- Productive formations: high temperature and high permeability/water flow
 - Reservoir size related to stratum thickness
- Project targets are Devonian strata and Precambrian basement
 - Beaverhill Lake Group, Watt Mountain F., Gilwood Member, Muskeg F., Granite Wash F.
- These deep strata (up to 4500m depth) show potential for high volume fluid flows at 120°C+



Adapted from Alberta Geological Survey, 2015

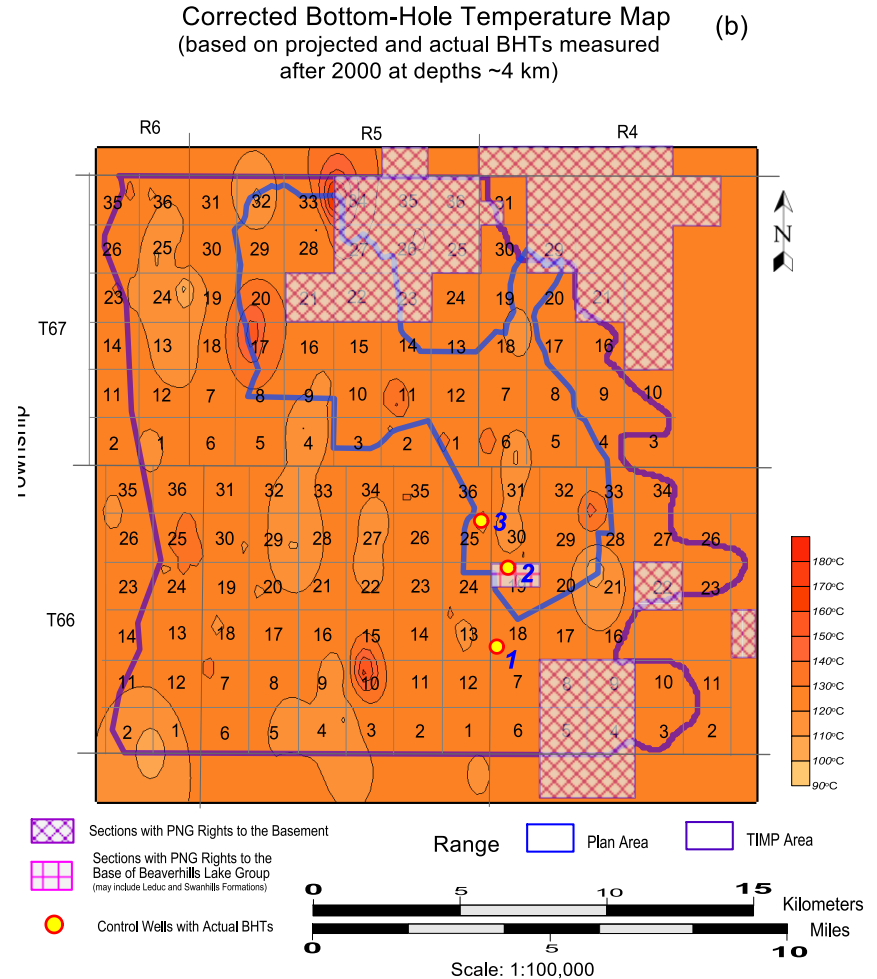
TARGET FORMATIONS

- Duvernay is ~3850 m depth and averages 29 m (22 – 33 m) in thickness in target area
- Duvernay is a tight siltstone formation, requiring fracturing to liberate the hydrocarbons
 - Hydrocarbon extraction in the region is focused on the Duvernay, Montney and related Late Devonian and Triassic aged formations
 - Limited potential to encounter hydrocarbons within this zone
- The Duvernay may also act as a thermal cap
 - Possible that temperatures are higher below the Duvernay than expected



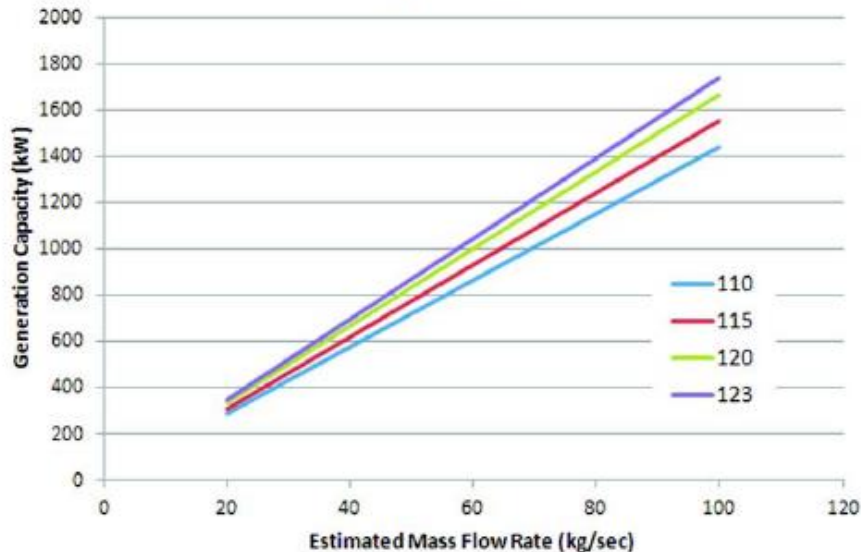
TARGET FORMATIONS

- Only 1 well in the target area has penetrated into the Gilwood with BHT=114° C
- Only 2 wells in the region have penetrated into the bedrock
- Fluid composition of the geofluids is alkali bicarbonate water with a pH of 7.8 – no indication of chemical issues
- All produced fluid is expected to be reinjected. Current reinjection formation is likely to be the Leduc Formation
- The formation typically only flows for months to a few years before redrilling is required

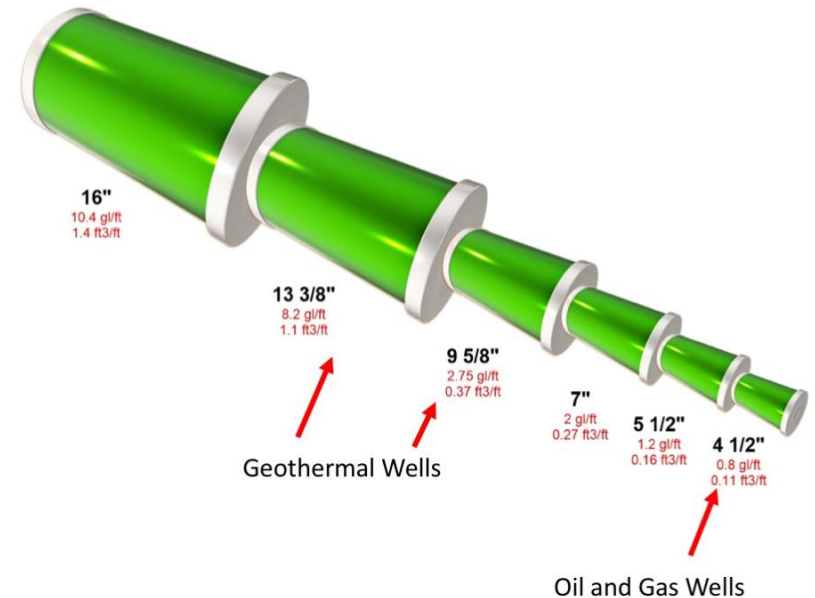


WATER FLOW & TEMPERATURE

Generation Capacity vs Mass Flow Rate
for a single well model



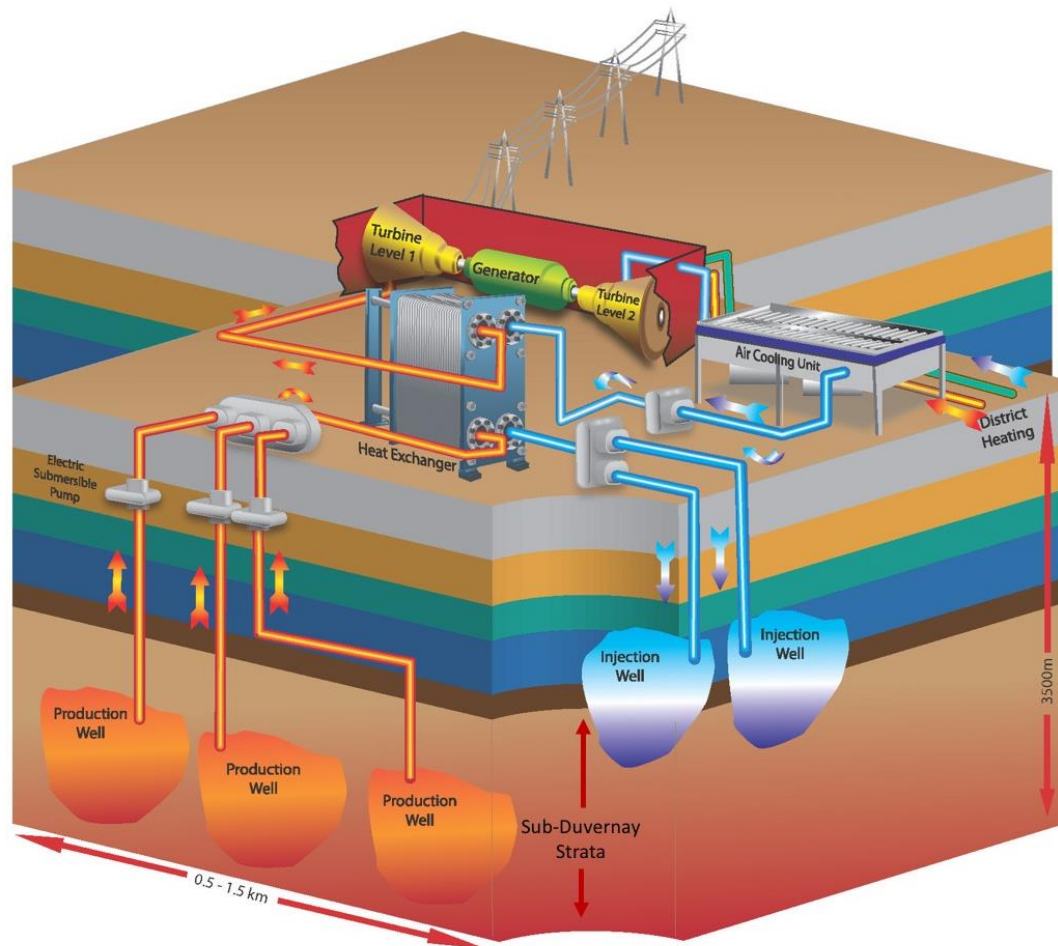
Walsh, 2013



- Required volumetric flow rate necessitates wells with wider diameters than O&G
- 3 production wells and 2 injection wells planned

- Exploration & production/injection well bores expected to be 9 5/8"
- May increase to 13 3/8" if necessary

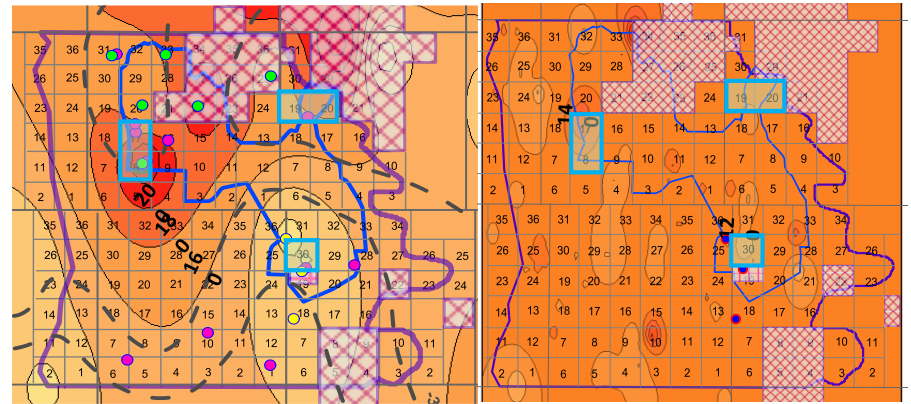
PROJECT DEVELOPMENT SCHEMATIC



DEEP Earth Energy Production Corp.

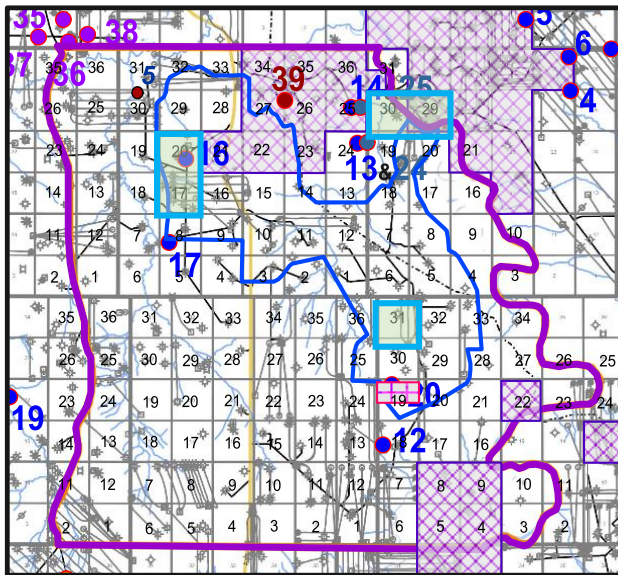
EXPLORATION FOCUS

Five sections have been chosen for exploration (blue squares) shown in relationship to isotherms, disposal wells, water flow rates and cumulative water production.

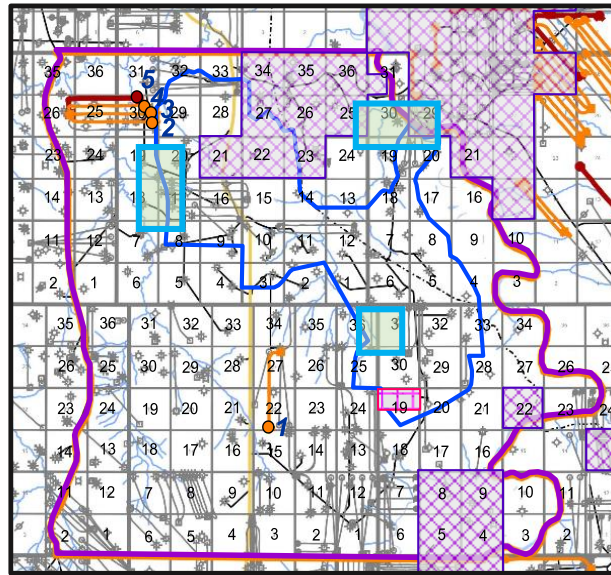


Sub-Duvernay; all data

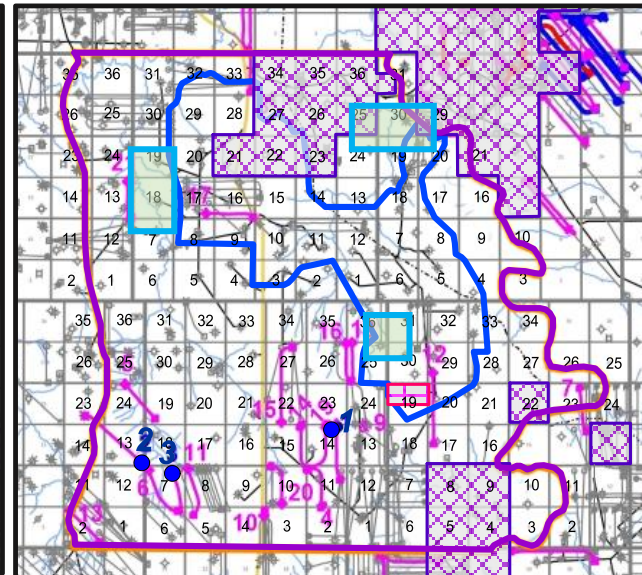
4000 m; yr 2000 - 2018



Disposal wells



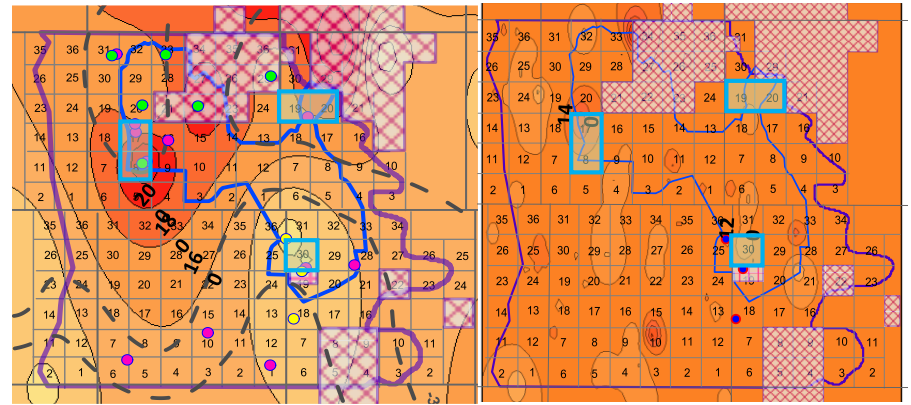
Water flow rates



Cumulative water production

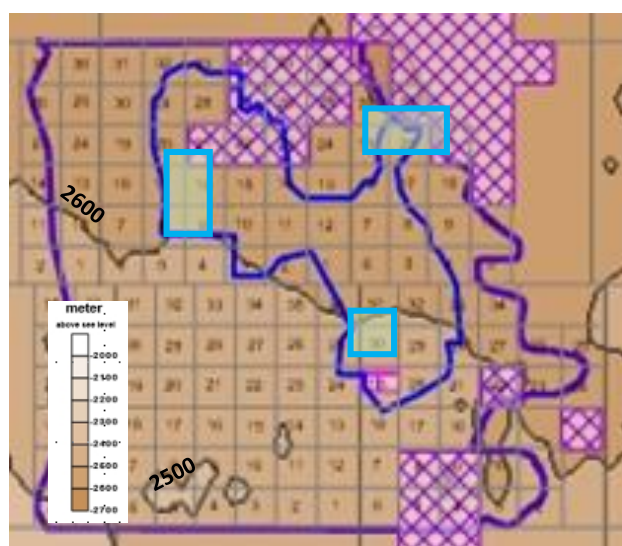
EXPLORATION FOCUS

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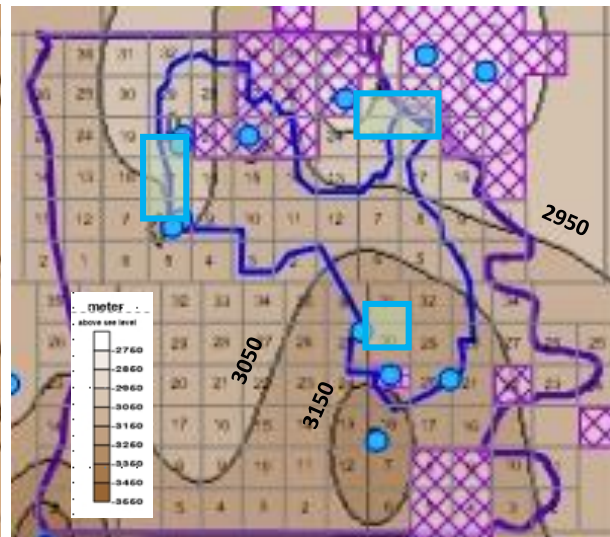


Sub-Duvernay; all data

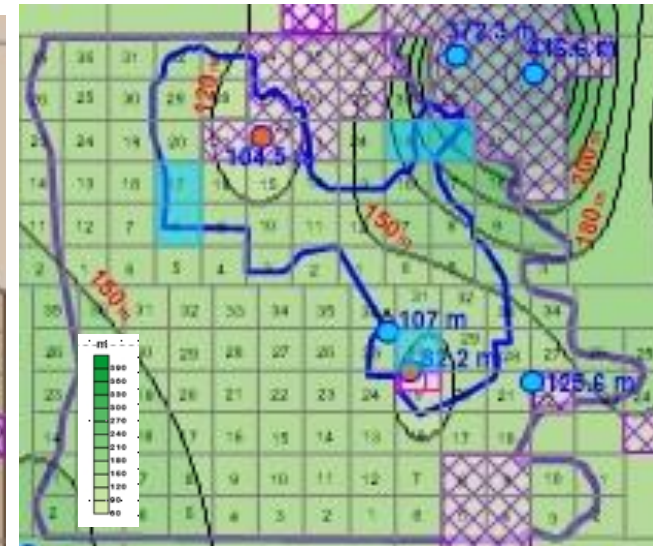
4000 m; yr 2000 - 2018



Depth to basement



Depth to sub-Duvernay



Thickness of
sub-Duvernay

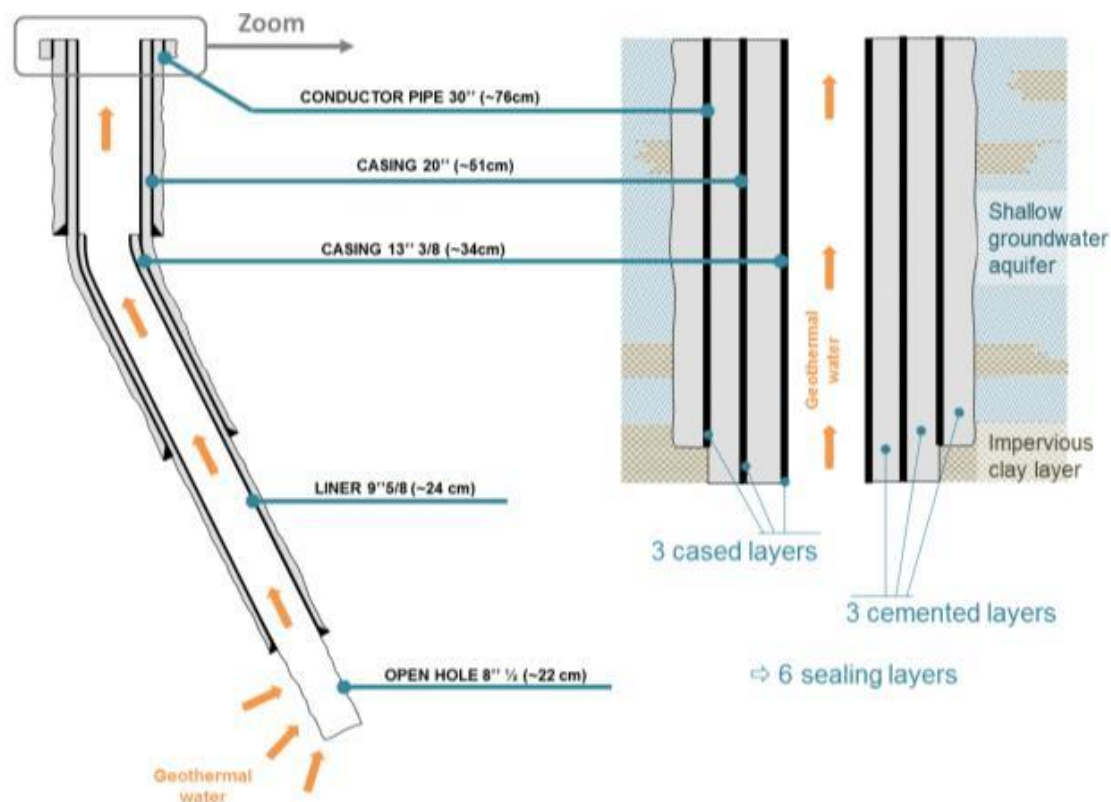
GEOHERMAL EXPLORATION & PRODUCTION WELLS



Rigs used for oil and gas drilling are used with some differences with mud handling and “loss of circulation” is celebrated. High temperature wells have additional nuances, such as double ram BOP due to temperature limitations of rubber BOPs

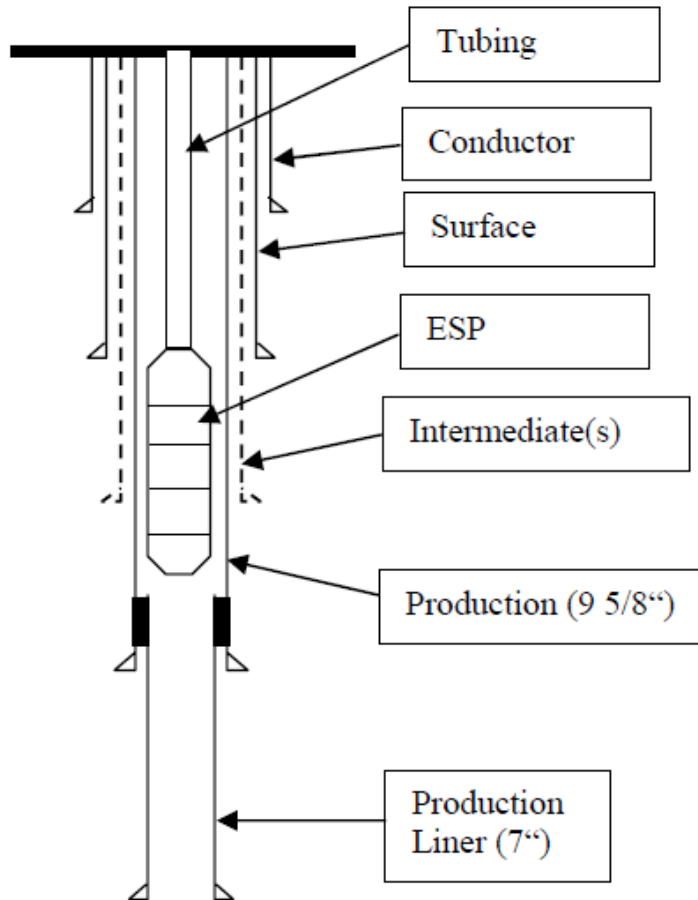
GEOHERMAL PRODUCTION WELLS

- High temperature cements are used for wells over 170°C
- lost circulation is only treated if it is above the production zone
- Open holes are not common; most have perforated liners.

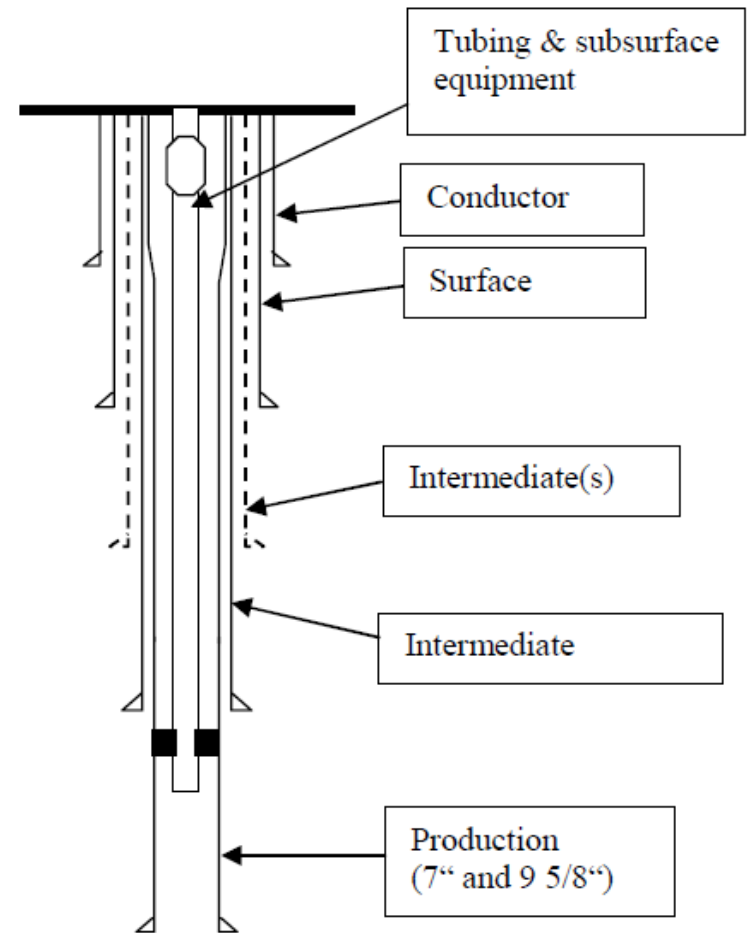


GEOHERMAL PRODUCTION WELLS AND OIL AND GAS WELLS

Figure: Teodoriu and Falcone (2008)



Geothermal: wide diameter; large well bore to accommodate deep set, large capacity pump; volumes of pumped fluids $\gg 30$ l/sec.



Oil and Gas: narrow diameters; shallow, small pumps; small diameter tubing often to depth.; volumes of pumped fluids < 30 l/sec.

POWER PLANT FACILITY



Lightning Dock Geothermal Power Plant, New Mexico (Cyrq Energy)

Alberta No. 1 needs 300l/sec @120°C for ~8MWe gross

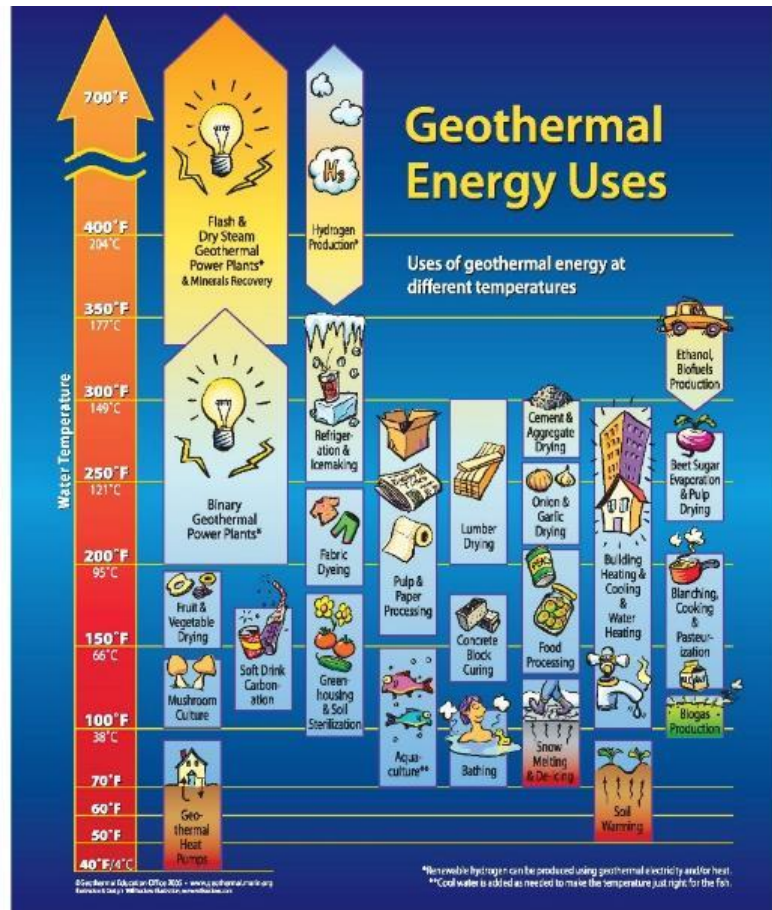
DIRECT USE ENERGY APPLICATIONS

Thermal applications include:

- Heating buildings
- Timber drying
- Crop drying
- Industrial process heating
- Commercial greenhouses
- Snow melting



Friðheimar greenhouse and restaurant,
Iceland



Geothermal Education Office, 2005

THANK YOU!

Alberta #1:
M.D. of Greenview No. 16
Geothermal Power Plant and Direct-Use
Thermal Facility

