Imperial Cold Lake Operations

Directive 54 Annual Submission

November 2019

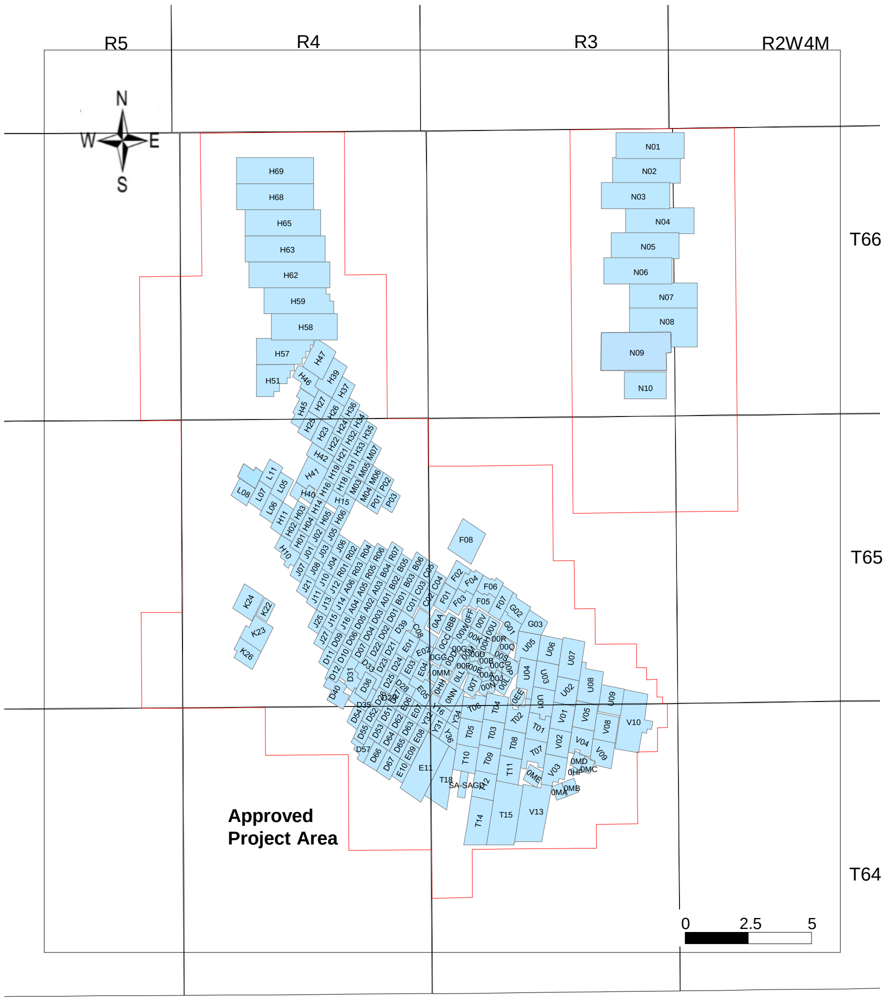
Outline

Imperial Cold Lake Operations annual Directive 54 submission provides a detailed performance update for the operating period of October 1st 2018 to September 30th 2019.

Imperial | Cold Lake

Background of Scheme

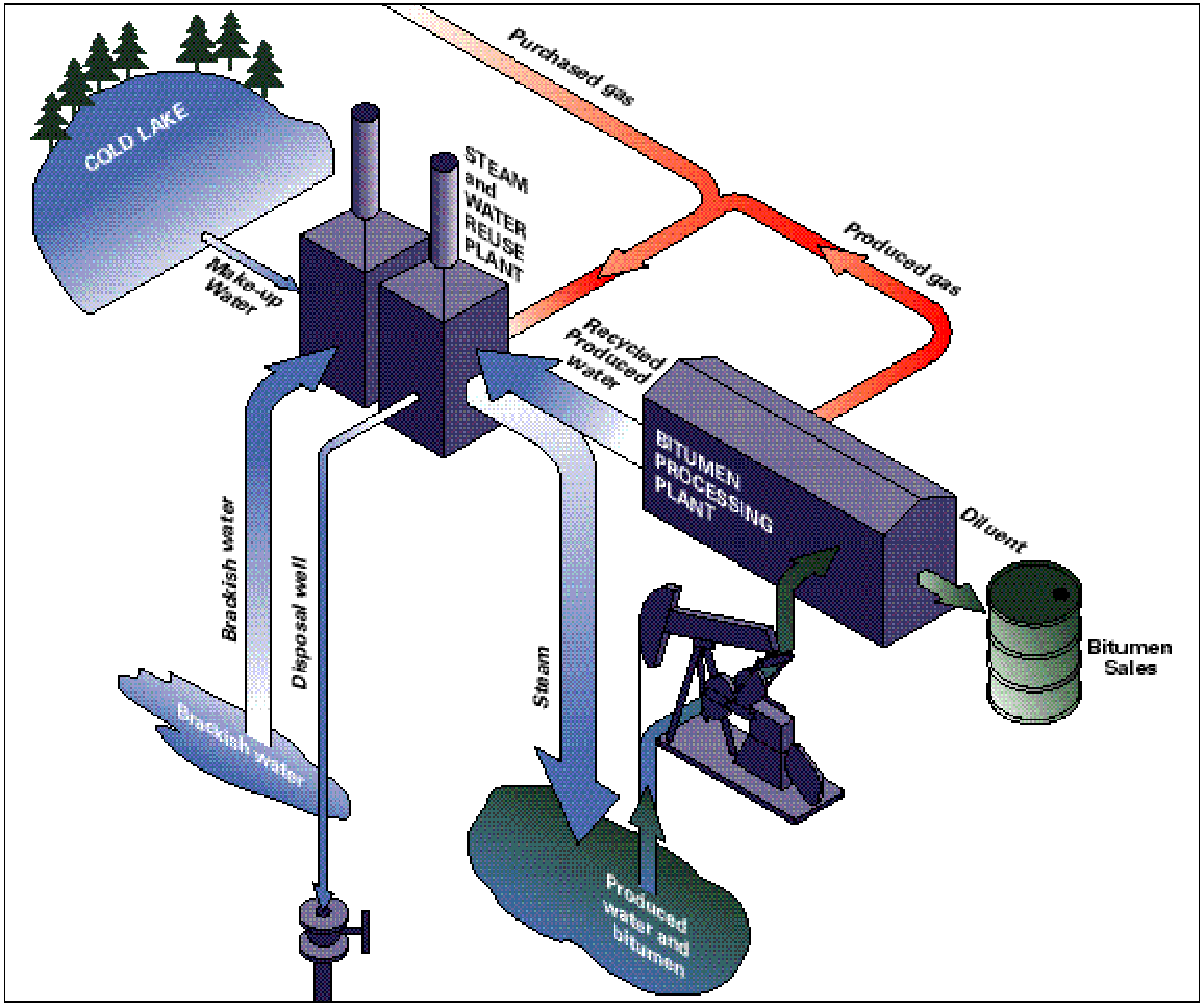
Background



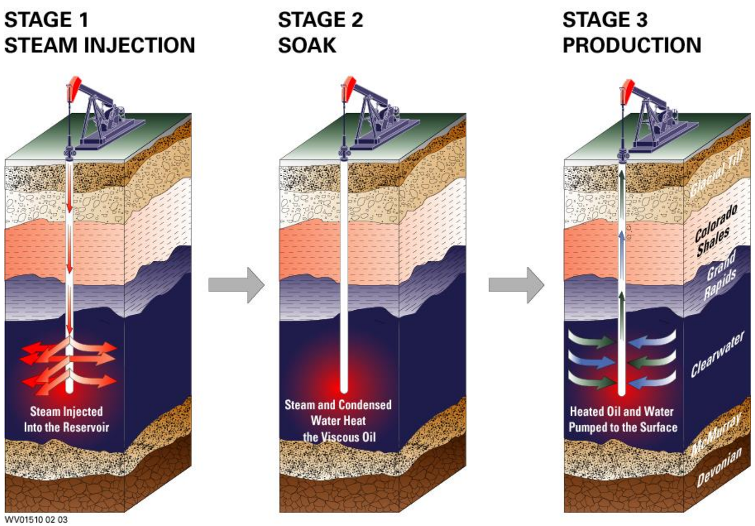
Development History

60's-70's	Lease acquisition Small scale research pilots
1975	10 kbd commercial pilot
'85-'94	Phase 1-10 > Maskwa > Mahihkan
2002	Phase 11-13 Mahkeses > Cogeneration facility
2004	Approval area expanded > Nabiye, Mahihkan North
2015	Phases 14-16 Nabiye > Cogeneration facility

Cold Lake Operations Process Overview



CSS Process Overview

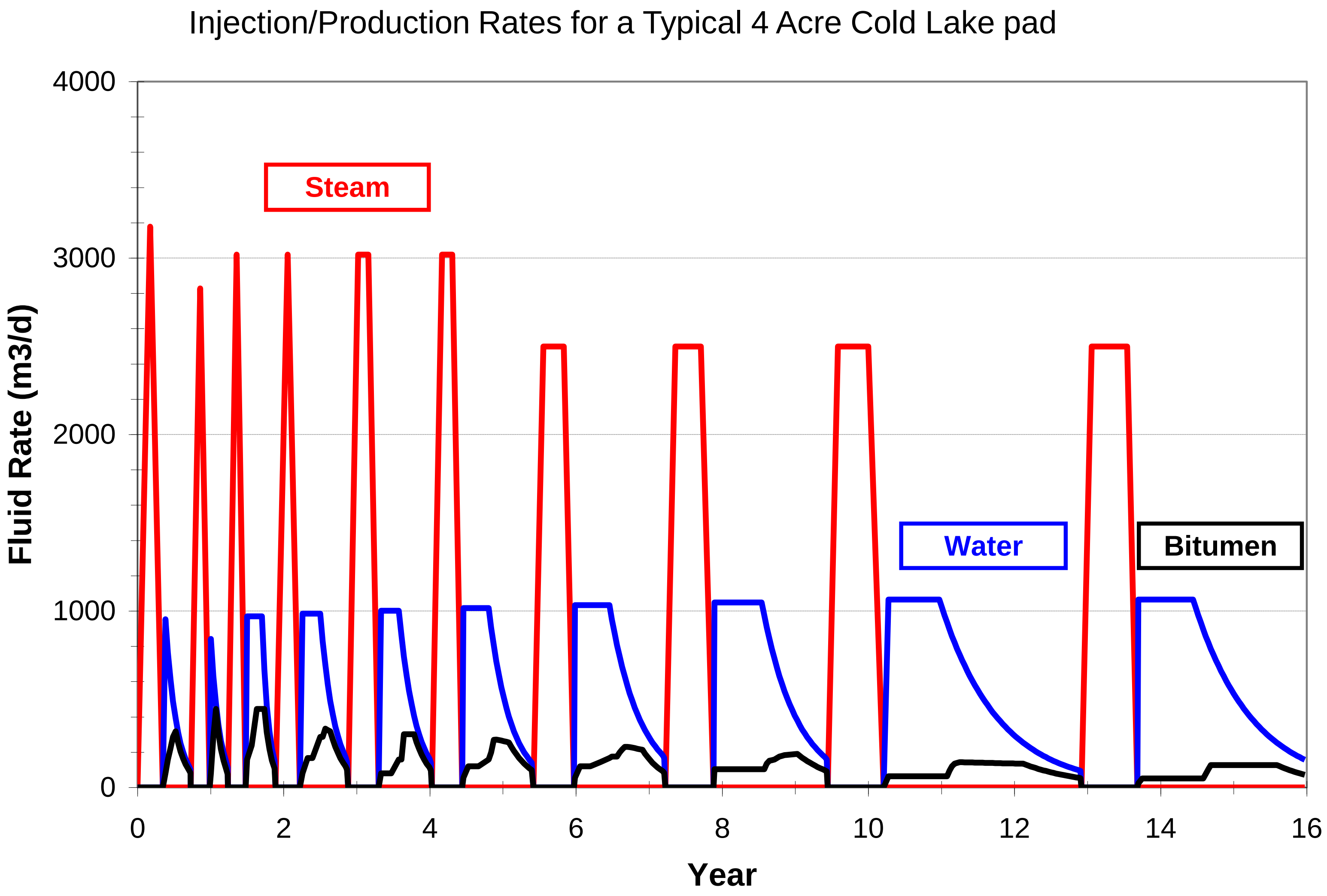


Mobilizing Agent:	Heat
Mobilizing Agent Delivery System:	Steam
Drive Mechanisms:	Compaction, solution gas drive, gravity drainage
Wells Required:	1
Well Type:	Deviated or horizontal
Operating Pressure:	Above fracture pressure

Cyclic Steam Stimulation

- High-pressure, high-rate, cyclic process with multiple drive mechanisms
  - > compaction
  - > solution gas drive
  - > gravity drainage
- Steam injection heats bitumen to reduce its viscosity (4 - 6 weeks)
- Brief soak phase to confirm casing integrity and control inter-well communication (2 days – several weeks)
- Length of the production period increases from a few months in early cycles to multiple years in late cycles
- Full well life: 8 -17 cycles and up to 50 years including follow-up processes

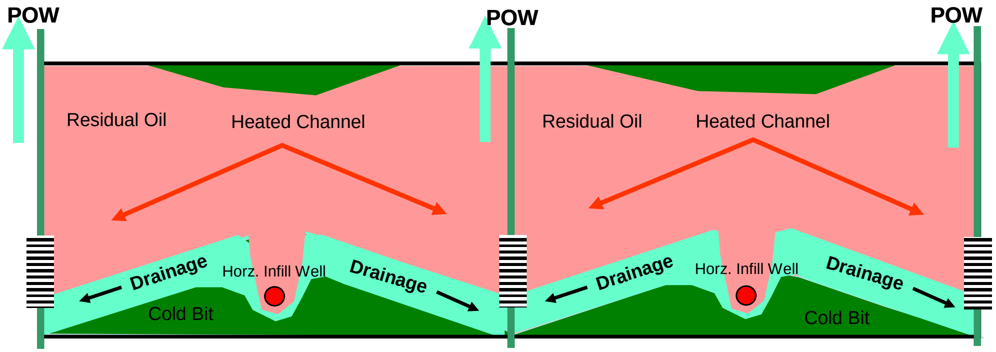
CSS Process Overview



Imperial | Cold Lake

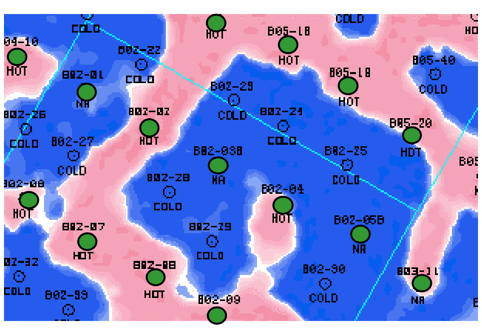
Injector Only Infills (IOI)
Horizontal Injector Producer (HIP)

IOI / HIP Schematic

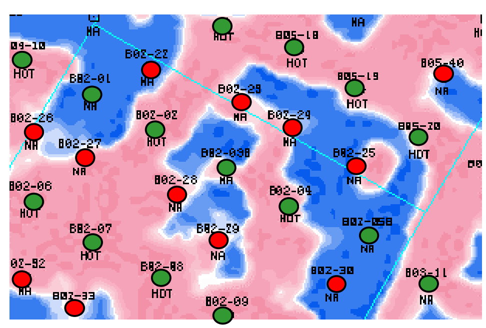


POW: Producer Only Well

Increase in steam conformance following infilling



Pre-Infill 3D Seismic



Post-Infill 3D Seismic

Hot reservoir (partially depleted)

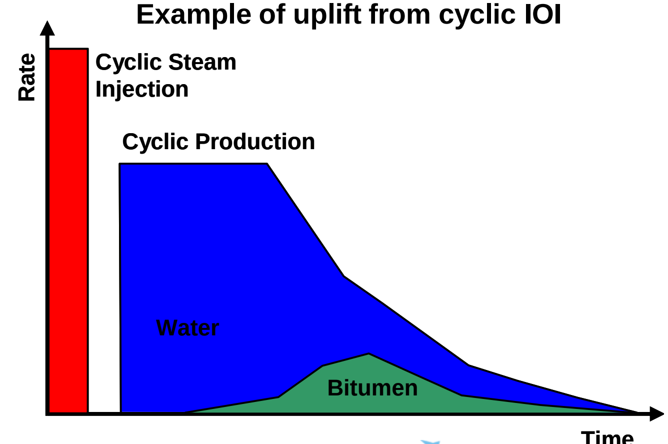
Cold reservoir (undepleted)

CSS wells

Infill wells

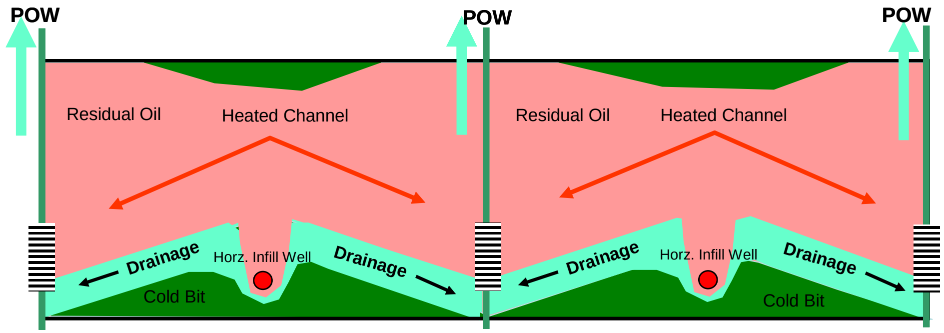
- Infill wells direct cyclic steam to cold bitumen
- Steam distribution in horizontal wells controlled by limited entry perforations (~20 holes/1000 m well)
- For IOI, existing deviated wells operate as cyclic producers. HIPs offer the ability to also produce from the horizontal infills.

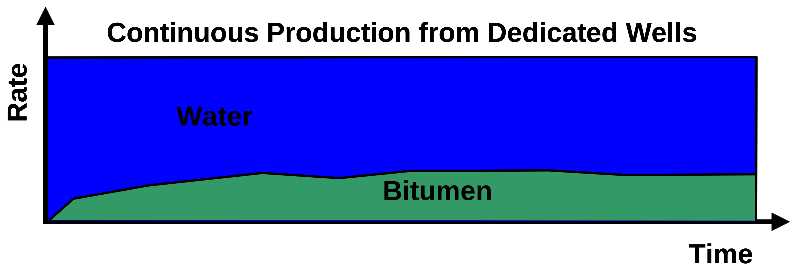
Example of uplift from cyclic IOI



Imperial | Cold Lake

Steamflood Process Overview

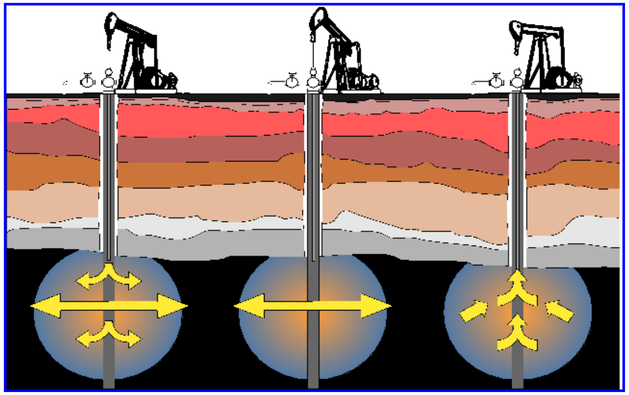




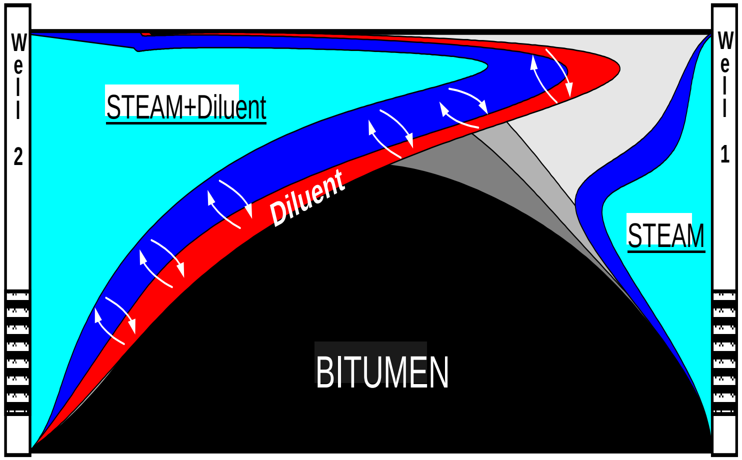
- Continuous steam injection, at low rates has the potential to:
  - > Lower operating costs
  - > Improve well operability
  - > Reduced casing stress
- Target reservoir pressure between 0.5 to 1.5 MPa
- Continuous rather than cyclical steam injection through dedicated injectors and production from dedicated producers

Imperial | Cold Lake

LASER Process Overview



CSS Thermal Process

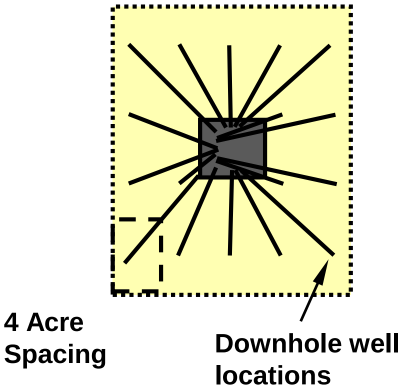


- Liquid Addition to Steam for Enhancing Recovery (LASER) is a mid/late-life technology
  > Follow-up process for CSS (cyclic steam stimulation)
  > Implemented with ~2-3 cyclic cycles remaining
  > Alternative to purely thermal processes
- LASER is a cyclic steam process with the addition of a C5+ condensate to the steam during injection
  > Enhances gravity drainage efficiency by reducing in-situ viscosity beyond thermal limit
  > Potentially increases the recovery by >5% of EBIP
- Key process performance indicators
  > Incremental OSR over a purely thermal baseline
  > Fractional recovery of injected solvent

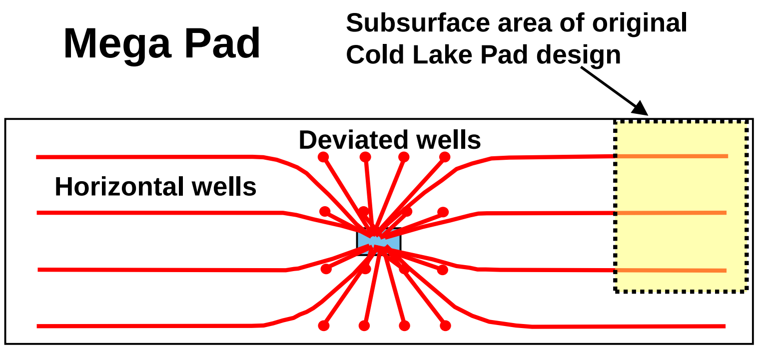
Imperial | Cold Lake

Pad Design

Original Pad Design



Mega Pad



- Wells drilled directionally from central lease location
  > Reduced environmental disturbance
  > Improved development economics
  > Increased operational efficiencies
- Original pad design 20 wells on 4 acre spacing
- Current pad designs
  > Up to 35 wells on 4 or 8 acre spacing
  > Mix of deviated and horizontal wells

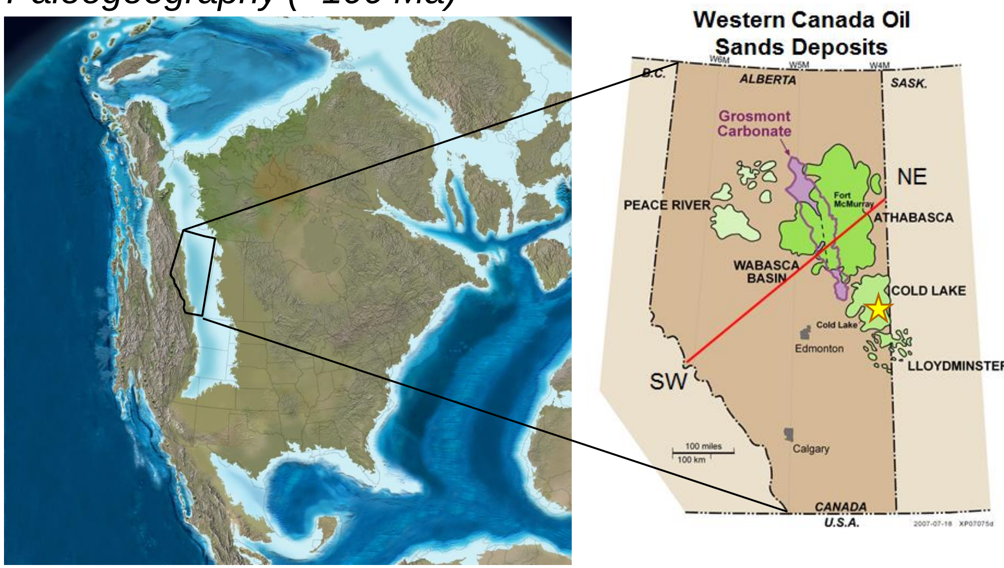
  

Imperial | Cold Lake

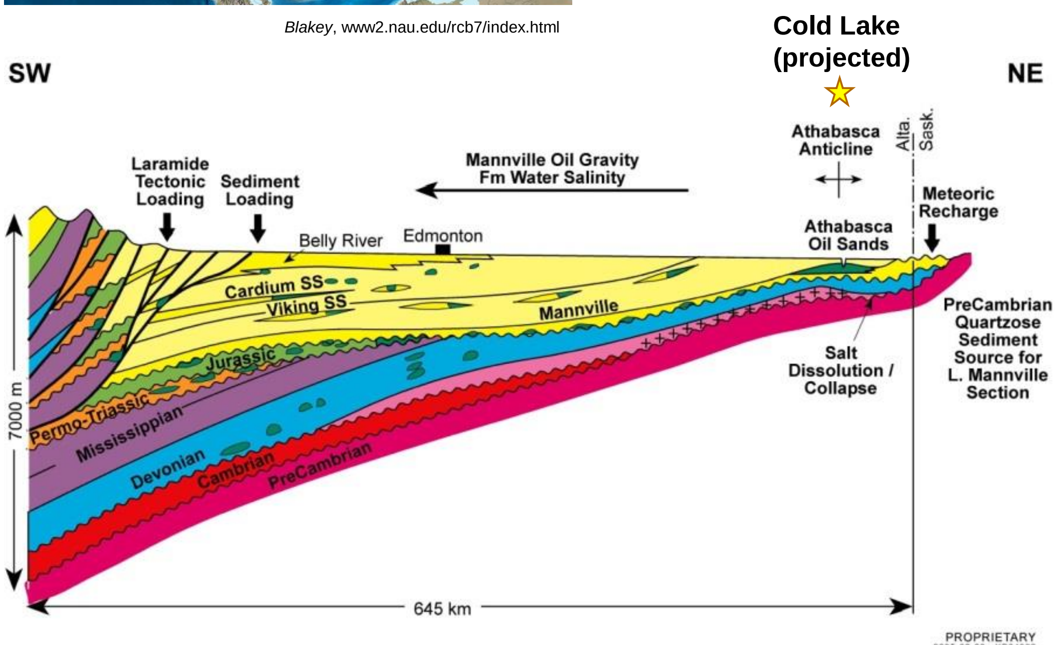
Geoscience

Mannville Group: Geologic Setting

Paleogeography (~100 Ma)



Blakey, www2.nau.edu/rcb7/index.html

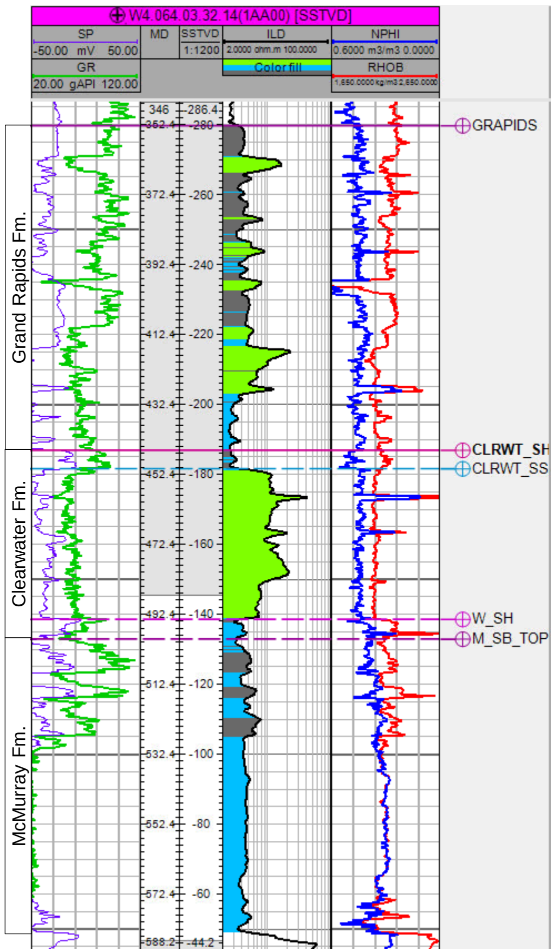


Depositional Environment

- Mannville Group deposited during Barremian to Albian time associated with fluvial drainage to the north toward the boreal sea (Western Interior Seaway)
- Western Canada Basin is a large foreland basin thickening to the west; marine & non-marine deposits
- Sub-divided into two lithostratigraphic units: 1) Lower tidally influenced fluvial (McMurray); and 2) Upper estuarine/shelf dominated (CLW & GR)
- Regional high to the east due to backbulge where salt dissolution and underlying Paleozoics likely controlled subsidence - Athabasca anticline

Representative Type Log

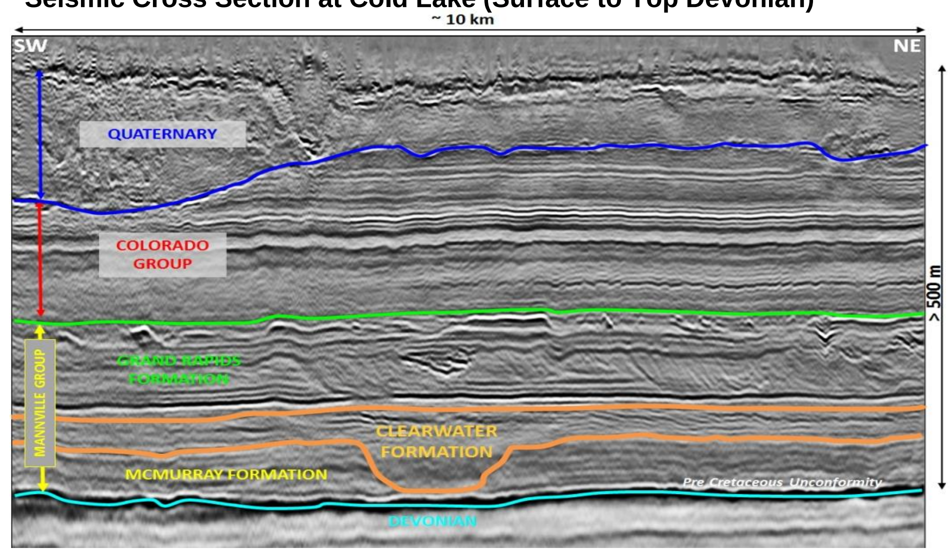
Representative Well Log Response – Mannville Group



Oil sand
Water sand
Shale

- Type well log through the Mannville Group, (Albian) of Cold Lake field, Alberta
- Primary reservoir is the Clearwater Formation, secondary targets comprise the Grand Rapids and McMurray formations (water bearing in type well).
- Clearwater Formation is a reservoir with a complex stratigraphic architecture that consists of a succession of deltaic and tidally influenced distributive fluvial systems
- Development to date has focused on the Clearwater in the central axis of the main fluvial valley complex

Seismic Cross Section at Cold Lake (Surface to Top Devonian)



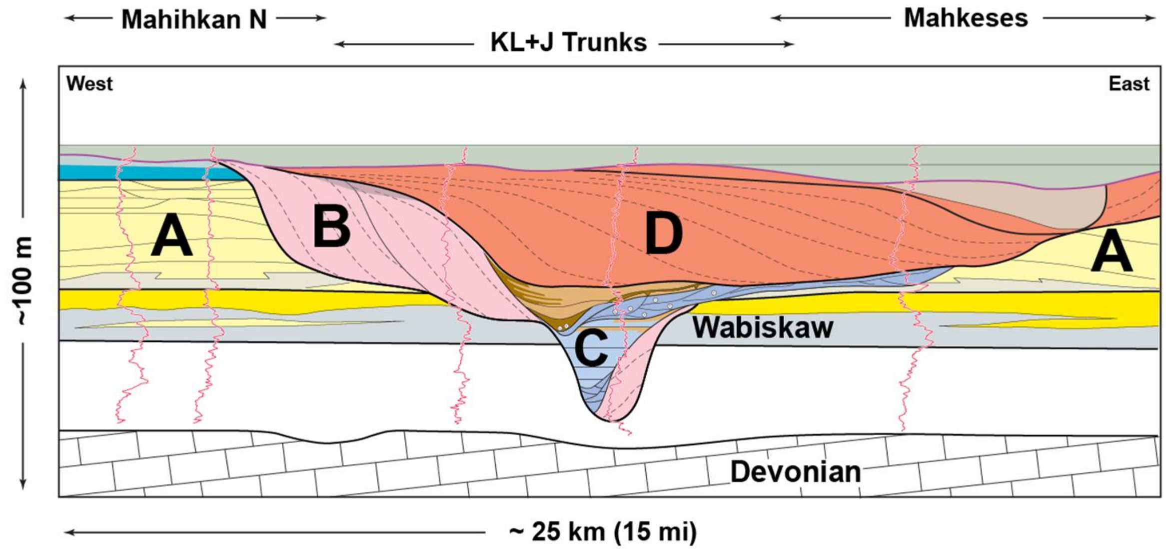
Stratigraphic Framework

History

- The Cold Lake Clearwater stratigraphic framework was updated in 2014/2015 to improve predictability of the increasingly complex recent & future development opportunities. This framework has continued to evolve, with an update of the Nabiye framework in 2017, and ongoing refinement and analysis of pad performance.

Ongoing Implementation

- Application of framework to Nabiye is providing insights into pad performance variations
- Improved predictability of environment of deposition (EOD) distribution and impact on reservoir quality (RQ) has assisted with understanding production characteristics at Mahihkan North
- Broader application in the field is fundamental to assessing potential for future development opportunities



Stratigraphic Units
A: Deltaic sediments
B: Fluvial terraces
C: Marine deposition
D: Final fluvial fill

Average Reservoir Properties and OBIP

Reservoir and Fluid Properties

Depth	Clearwater @ 400M	
Depositional Facies	Continental scale fluvial-deltaic system	
Sands	Unconsolidated, reactive, clay clasts	
Diagenetic Cements	Mixed-layer clays	
Bitumen API Gravity	10.2	
Bitumen Viscosity	100,000 cp @ 13 C 8 cp @ 200C	
Bitumen Saturation	Average 70%	
	Range	*Average*
Porosity	27 - 35%	32%
Permeability	1 - 4 Darcies	1.5 Darcies
Bitumen Wt %	6 - 14%	10.5%
Total Net Pay	0 - 60m	30m

Original-Bitumen-in-Place (OBIP)

Clearwater Fm	*8 Wt %*		*6 Wt %*	
	(E6m3)	*(MBO)*	*(E6M3)*	*(MBO)*
Entire Approval Area	2,250	14,150	2,609	16,410
Operating Portion[1]	1,888	11,875	2,185	13,740

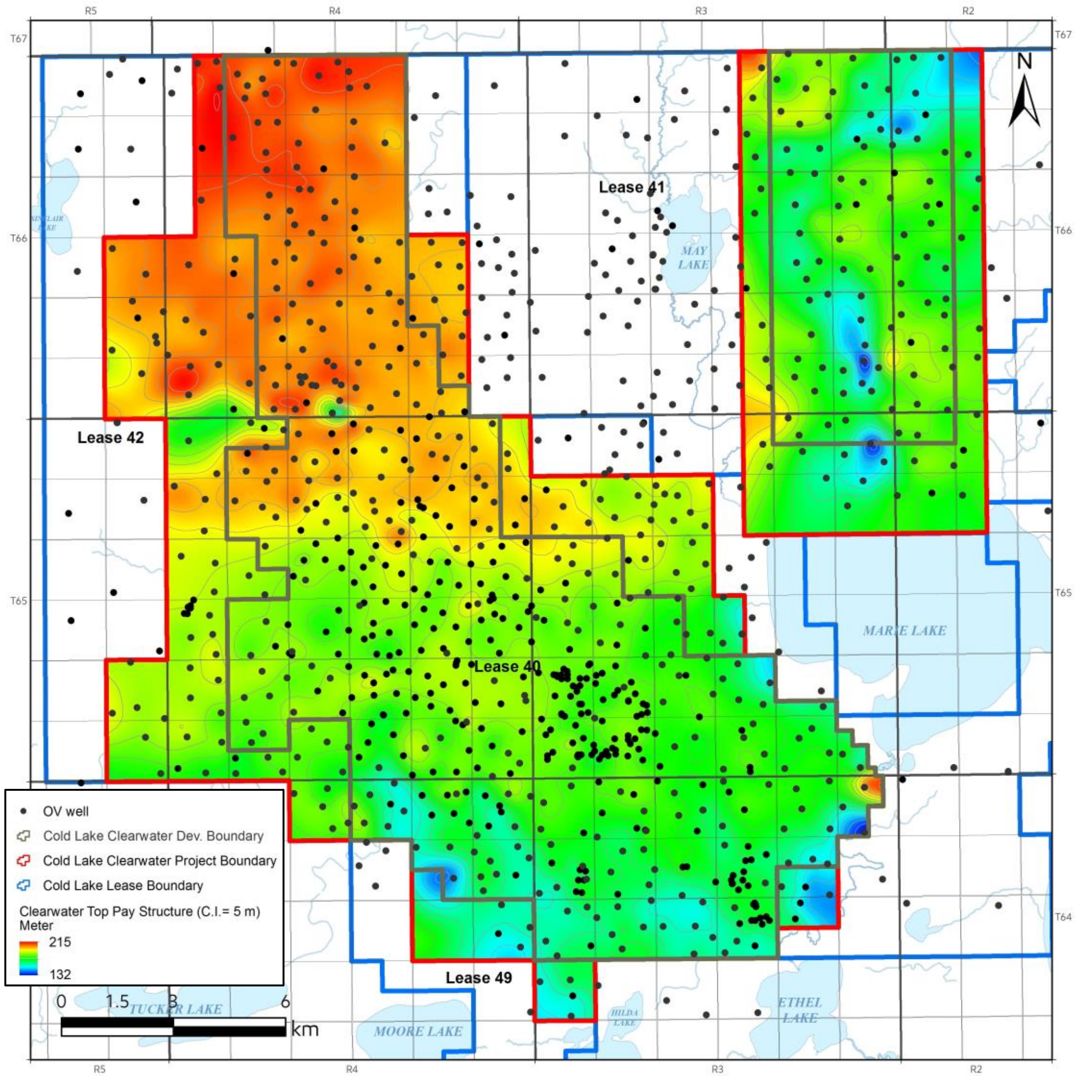
[1] Volume of main approved development area (i.e. excluding Nabiye)

CALCULATION METHOD

OBIP = A * H * V

A = area (m2)
H = Net pay (m)
V = Volumetric Factor = W * (2.64 – (1.64 * P))
W = Saturation (avg Wt %)
P = avg Porosity

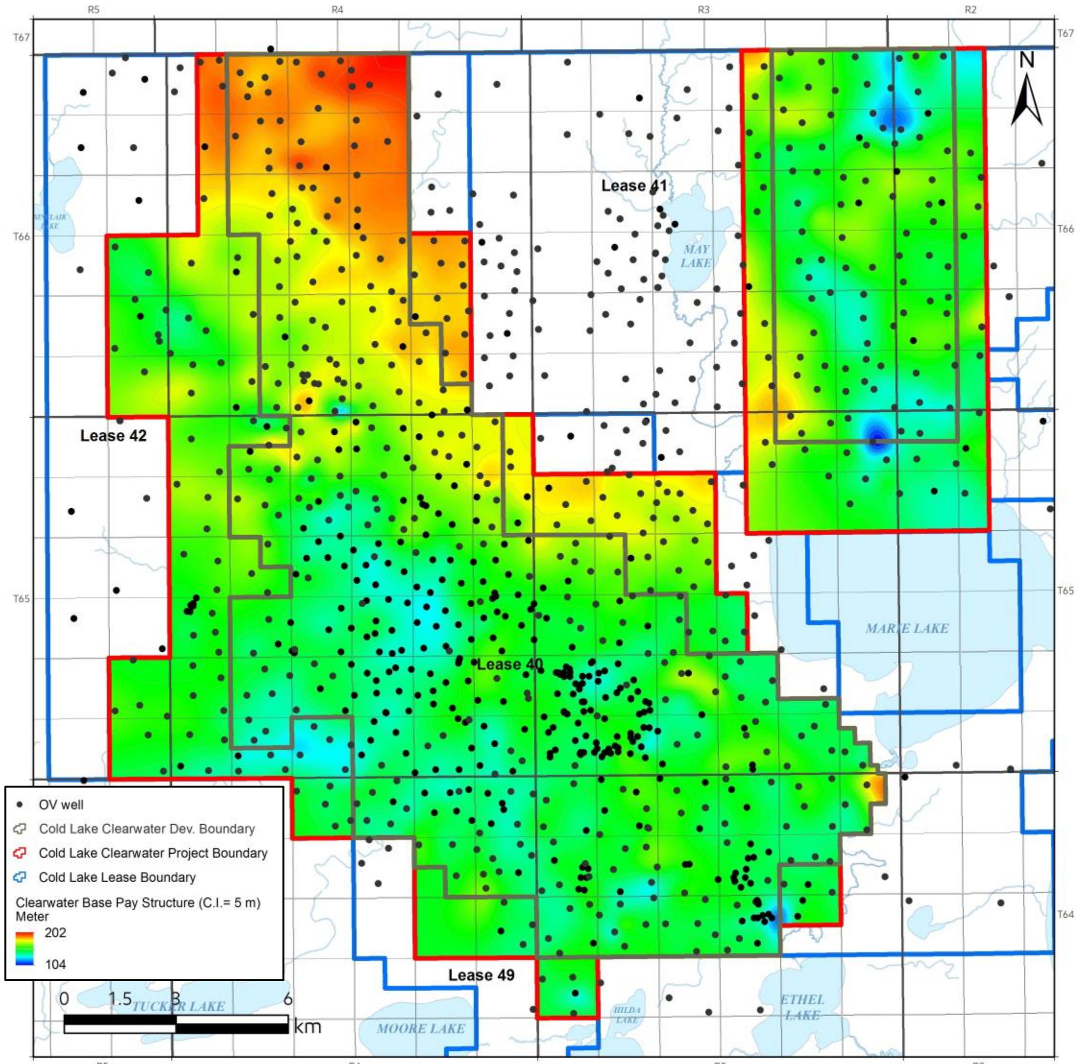
Top Bitumen Pay Structure



- Top of bitumen pay is a smoothly varying surface which gently dips from a high of 220m above sea level (A.S.L.) in the NW to a low of 136m A.S.L. in the SE
- Top of bitumen structure varies more greatly in the Nabiye area
- Mapped surface is either a rock/bitumen or a gas/bitumen contact

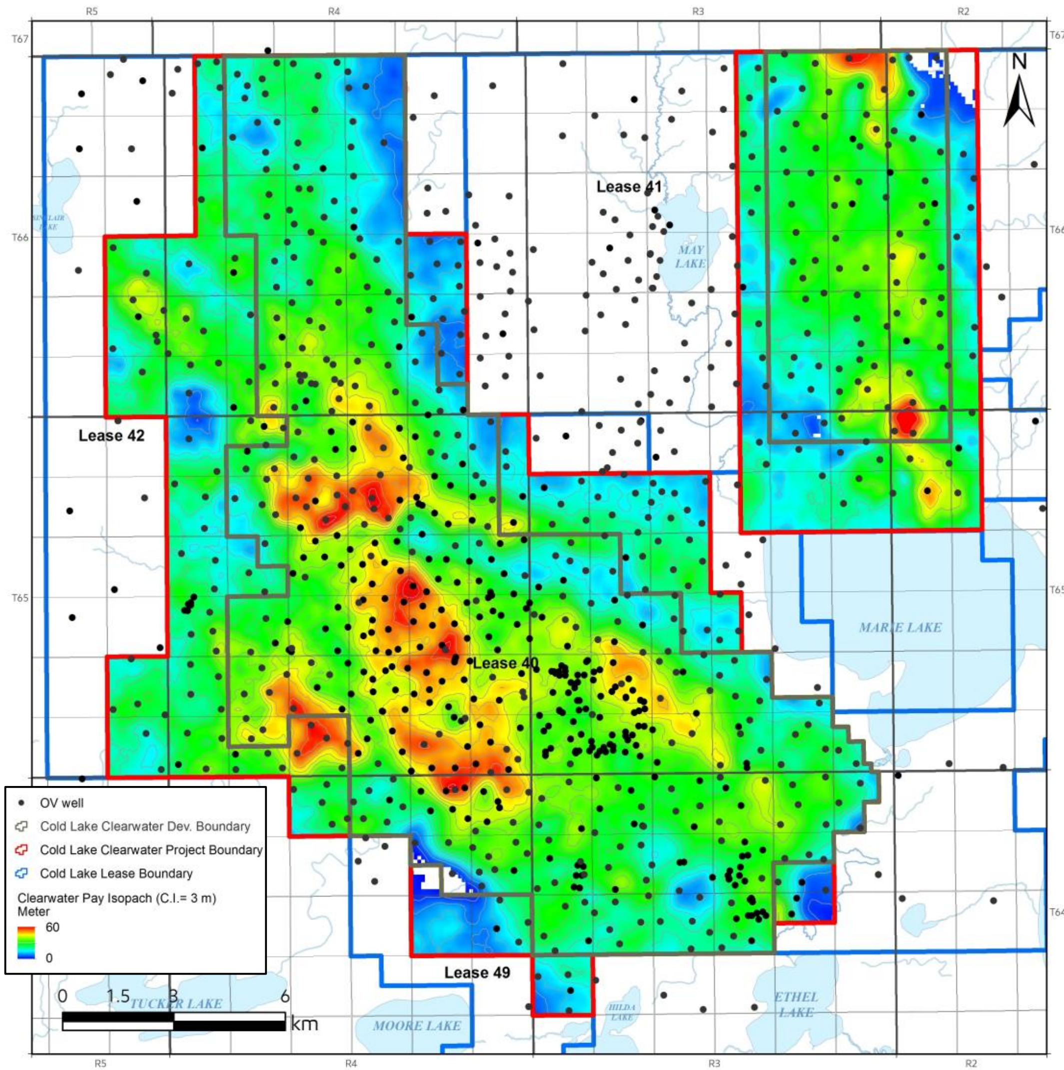
Imperial | Cold Lake

Base Bitumen Pay Structure



- Mapped surface is either a bitumen/rock, a bitumen/water transition zone or a bitumen/water contact
- Different successions, depending on their depositional environment are filled with varying amounts of sand and shale.

Isopach of Net Bitumen Pay (>8 wt %)

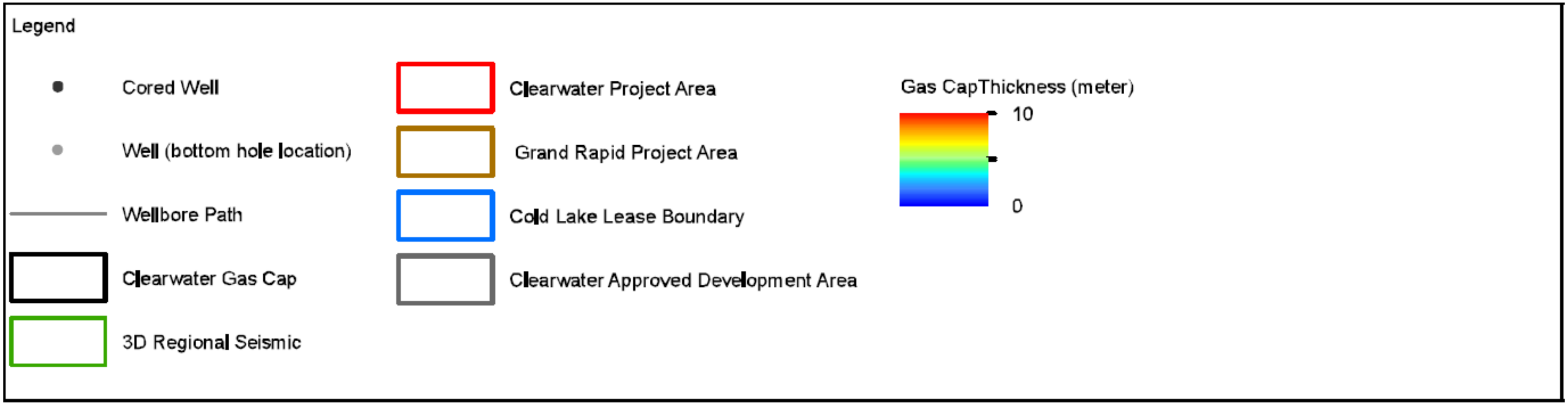


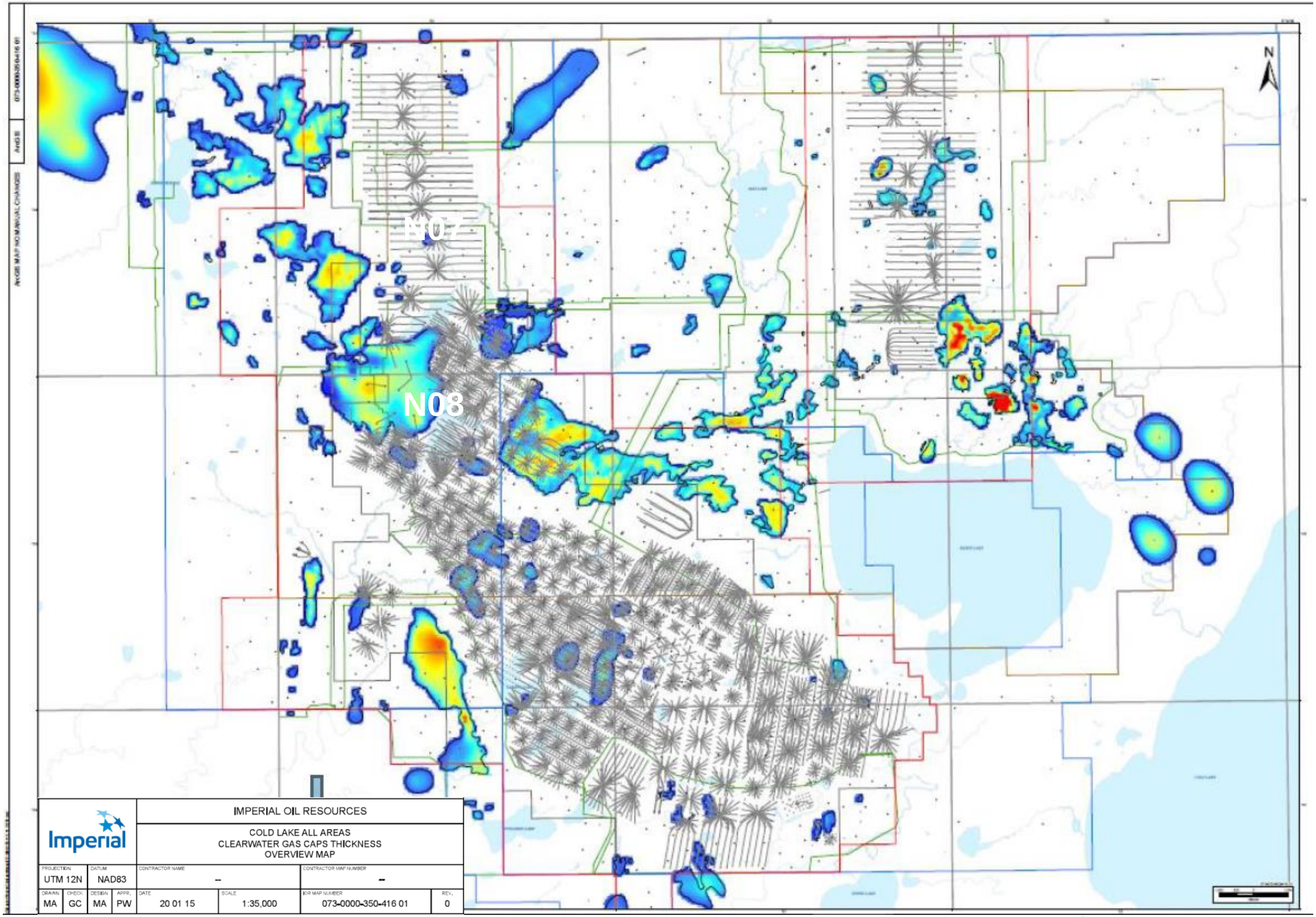
- Map illustrates distribution of pay above 8 wt% saturation cut off
- Thin pay and pay immediately adjacent to water included in isopach calculation
- Thickness trend is consistent with orientation of main valley incision

Imperial | Cold Lake

Gas Cap Isopach
(next slide)

NOTES:
Clearwater gas cap thickness January 2020 based on observed well penetrations and calibrated seismic response.





N
N07
N08
IMPERIAL OIL RESOURCES
Imperial
COLD LAKE ALL AREAS
CLEARWATER GAS CAPS THICKNESS
OVERVIEW MAP
PROJECTION UTM 12N
DATUM NAD83
CONTRACTOR NAME --
CONTRACTOR MAP NUMBER -
DRAWN MA
CHECK GC
DESIGN MA
APPR. PW
DATE 20 01 15
SCALE 1:35,000
IOR MAP NUMBER 073-0000-350-416 01
REV. 0

Representative Structural Well Log Cross Section

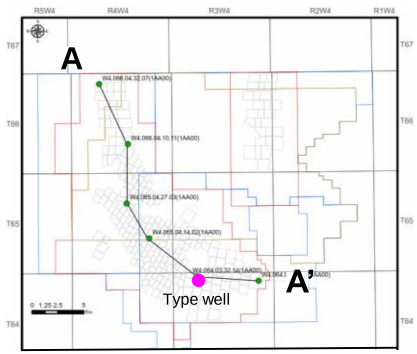
Cross section represents stratigraphic and structural variability within the Clearwater Formation from northwest to southeast .

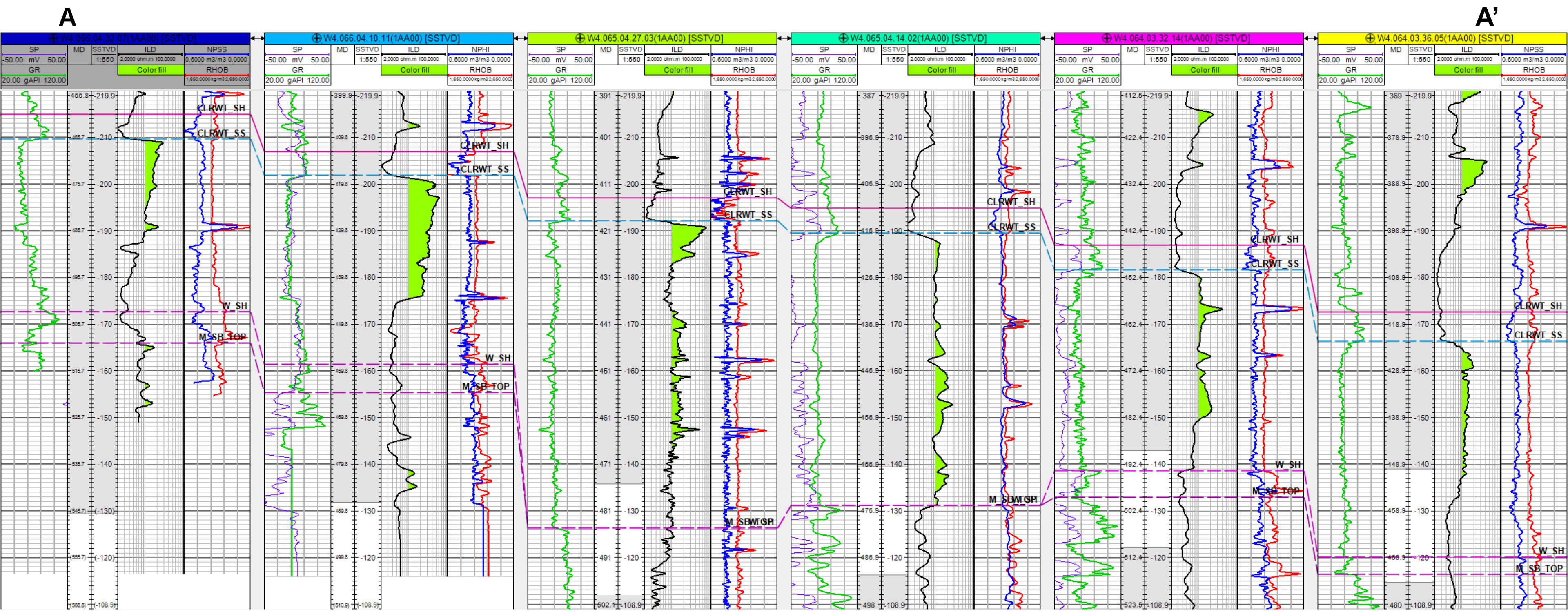
Cold Lake Leases

Approved project boundary

Developed pads

Grand Rapids project boundary

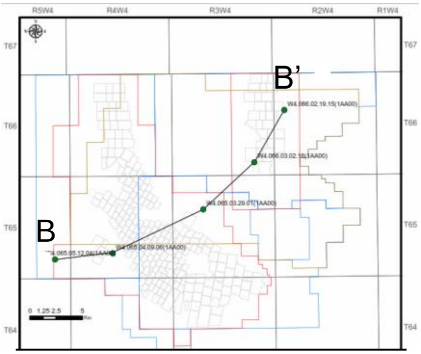




Imperial | Cold Lake

Representative Structural Well Log Cross Section

Cross section represents stratigraphic and structural variability within the Clearwater Formation from southwest to northeast.

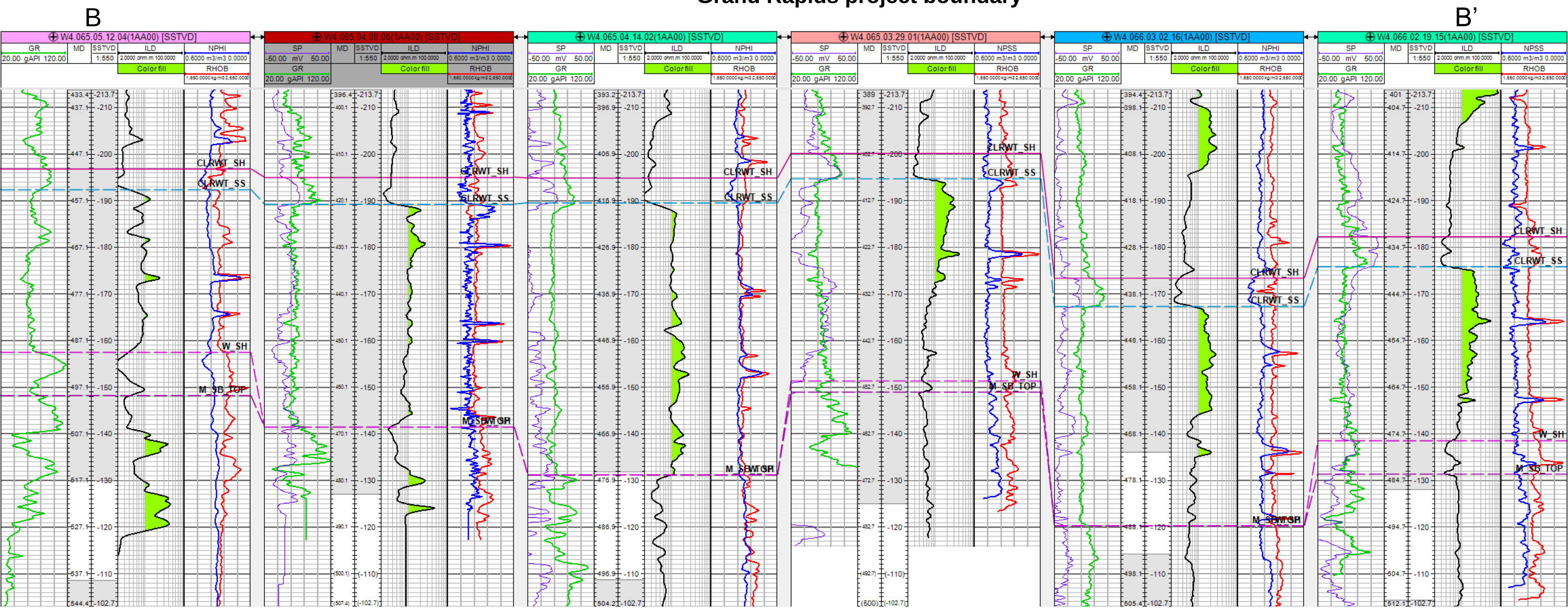


Cold Lake Leases

Approved project boundary

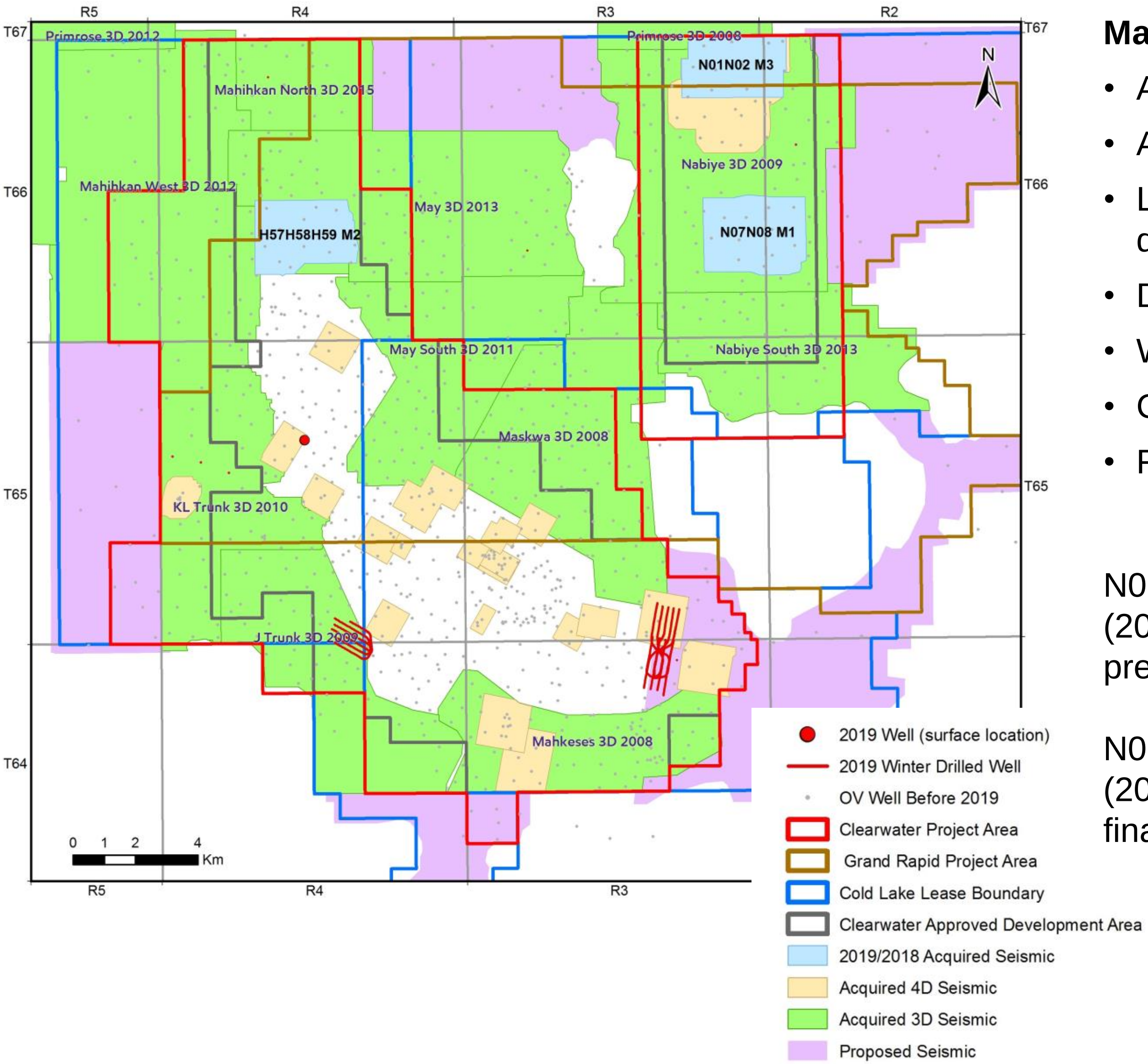
Developed pads

Grand Rapids project boundary



Imperial | Cold Lake

Approved Development Area



Map Illustrates:

- Approved Project Area
- Approved Development Area
- Location and extent of existing development pads
- Distribution of OV core holes
- Wells drilled in 2018/19
- Current 3D seismic coverage
- Future 3D Proposals

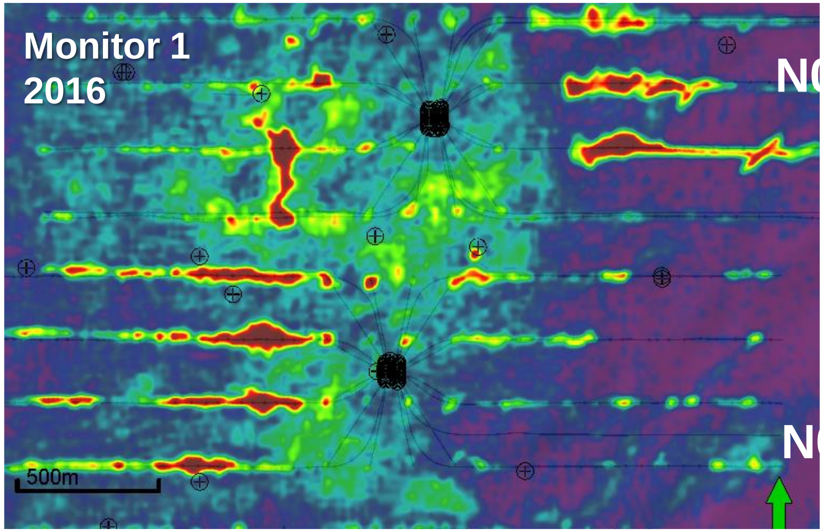
N01N02 M2 and N0708 M1 results (2018 acquisition) included in presentation

N01N02 M3 and H57H58H59 M2 (2019 acquisition) results pending final processing

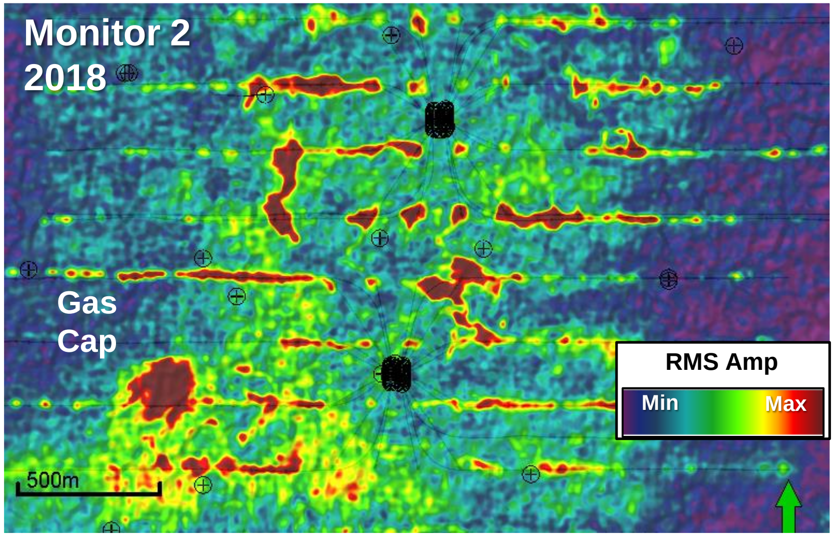
Imperial | Cold Lake

4D Seismic – Nabiye N01N02 Monitor 2 (2018)

2016 - 2009 4D diff Clearwater



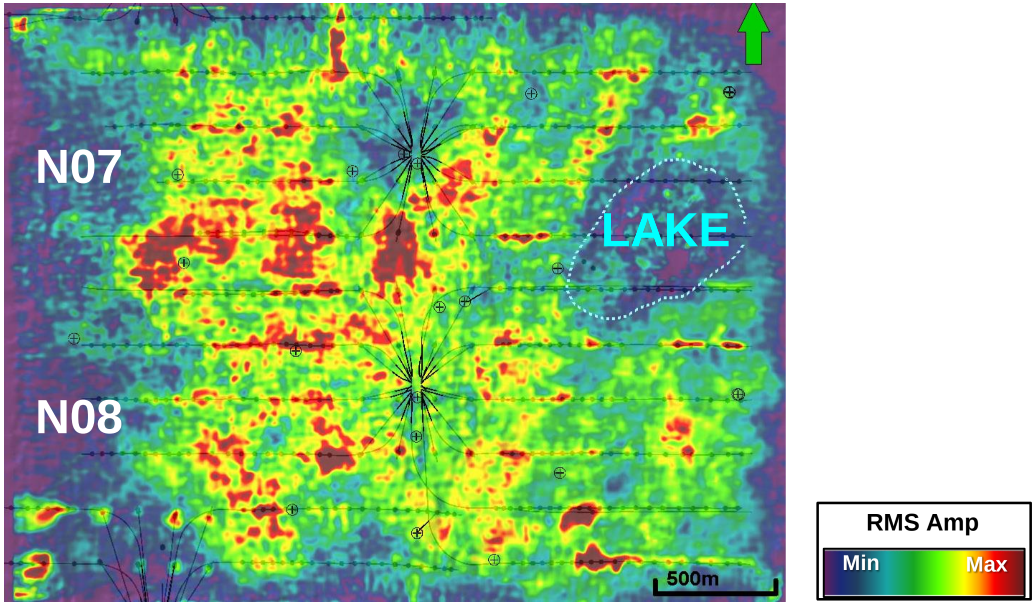
2018 - 2009 4D diff Clearwater



- N01/N02 Monitor 2
  - 4D monitor survey acquired in summer 2018 across pads N01 and N02. Final processing was completed in November 2018.
  - Original baseline survey (2009) re-processed with previous monitor survey (2016) and new monitor survey (2018) using same parameters
  - Difference volumes generated from baseline survey and monitor surveys
  - Examination of difference volume images and construction of interval attribute extraction maps used to identify post-steam seismic anomalies (PSSAs)
- Evidence of heel bias, changes in liner conformance and early communication between horizontal wells. Correlates to some confirmed liner issues.
- Monitor Survey #3 had been acquired in July 2019. Final processing results will be available in November 2019

4D Seismic – Nabiye N07N08 Monitor 1 (2018)

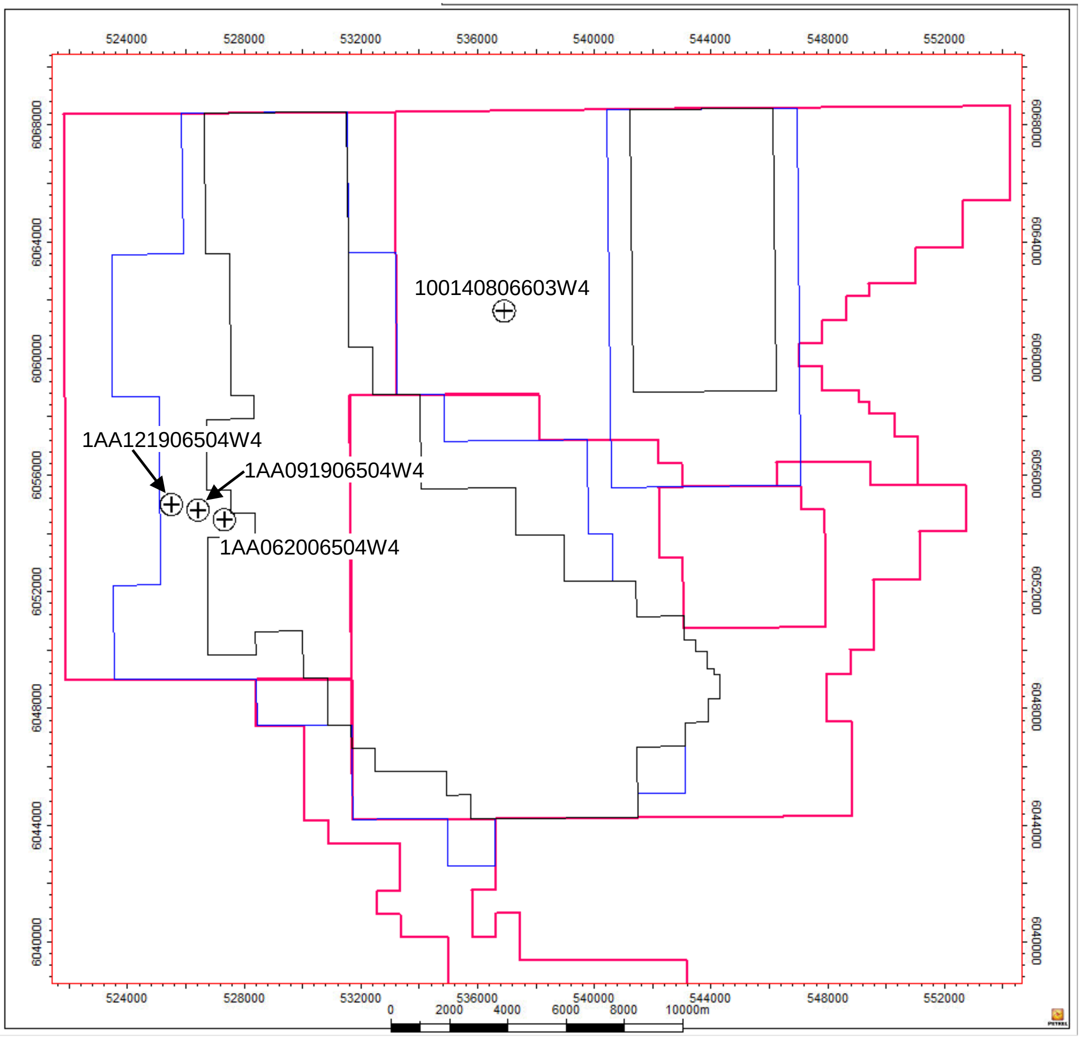
2018 - 2009 4D diff Clearwater



- N07/N08
  - 4D monitor survey acquired in spring 2018 across pads N07 and N08. Final processing was completed in October 2018.
  - Due to ongoing steaming operations, reservoir pressure was not optimized to baseline in-situ conditions across entire area and varied from 5 MPa to 8.8 MPa
  - Original baseline survey (2009) re-processed with new monitor survey (2018) using same parameters
  - Spring surface conditions, presence of fen and sump pit, and high Clearwater reservoir pressure affected the final results causing noisier data

- Evidence of heel bias, changes in liner conformance and early communication between horizontal wells

2018/2019 OV program cored wells



- Cold Lake lease boundary
- Cold Lake project boundary
- Cold Lake development boundary

<u>2018-2019 OV program cored wells</u>

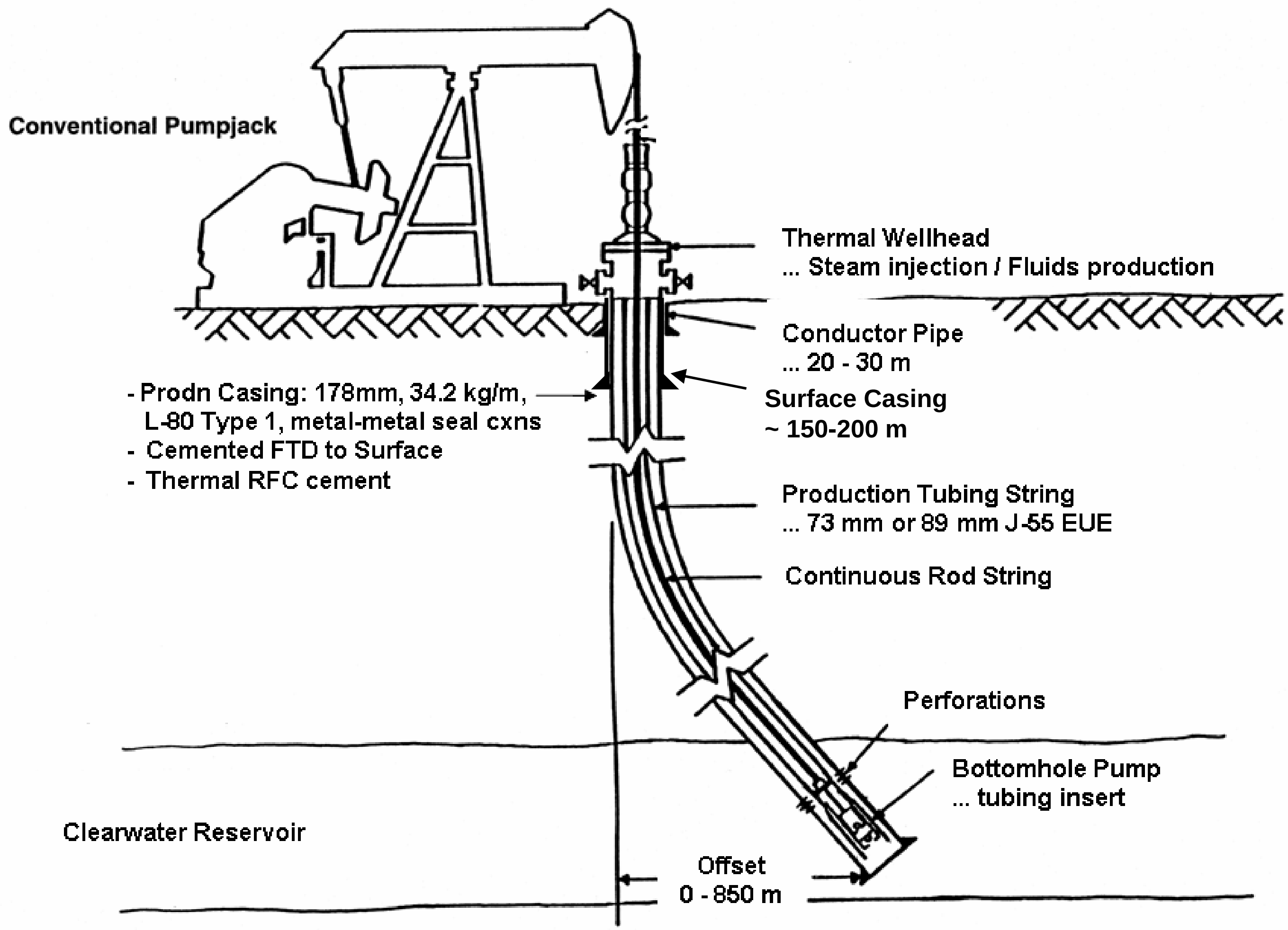
1. 100140806603W4
   - Dean Stark
   - SCAL ($S_{w,irr}$, $S_{o,\ residual}$, S_w)
2. 1AA062006504W4
   - Dean Stark
   - SCAL ($S_{w,irr}$, $S_{o,\ residual}$, S_w)
3. 1AA091906504W4
   - Dean Stark
4. 1AA121906504W4
   - Dean Stark

Dean Stark results (i.e., weight % bitumen) for the 4 cored wells were used to delineate the top and base of the reservoir. SCAL results are pending but will be used as inputs for reservoir simulation.

Imperial | Cold Lake

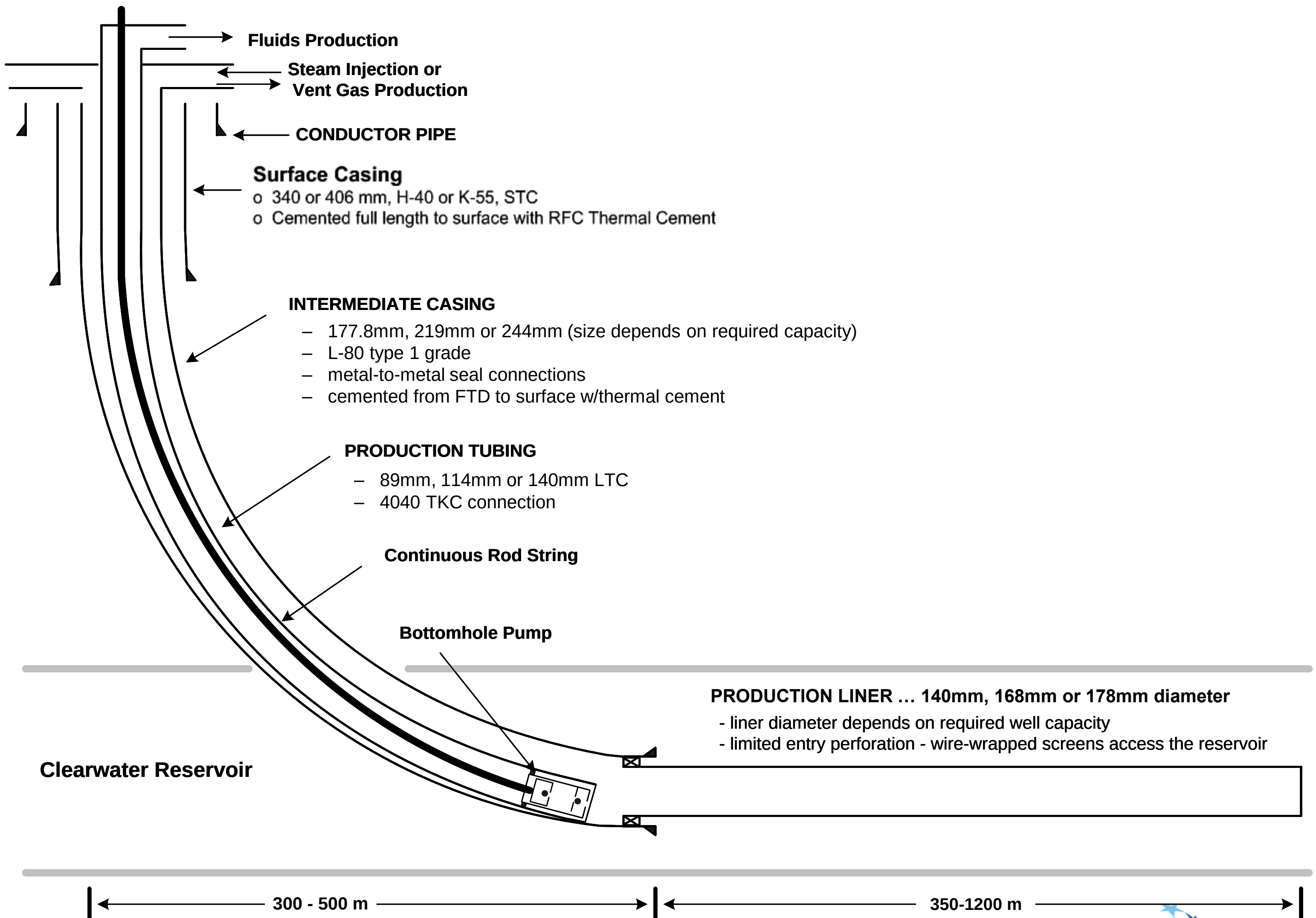
Subsurface

Typical Deviated CSS Well Design



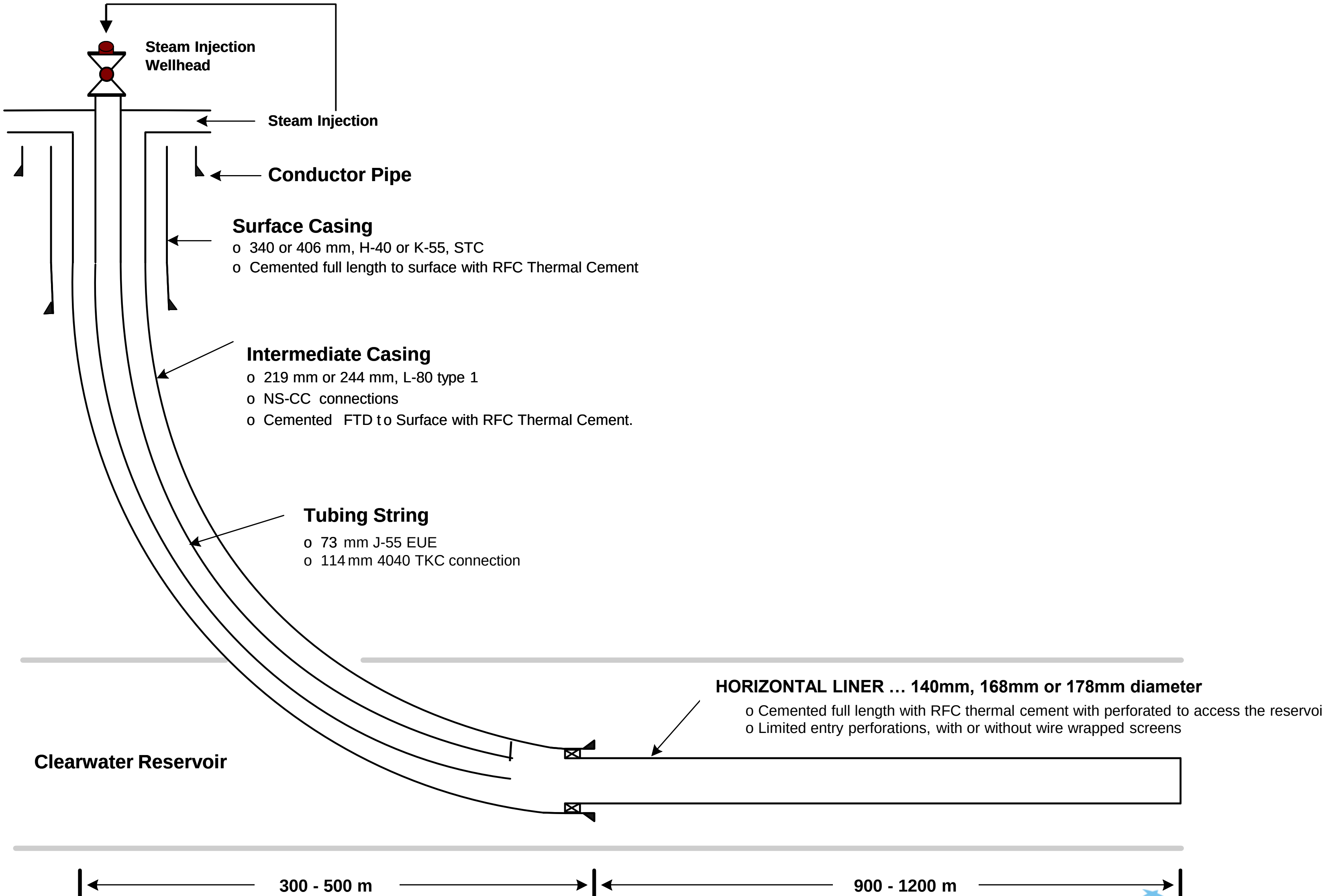
Imperial | Cold Lake

Horizontal CSS or HIP Well Design



Imperial | Cold Lake

Horizontal Steam Injection Well Design



Imperial | Cold Lake

Artificial Lift

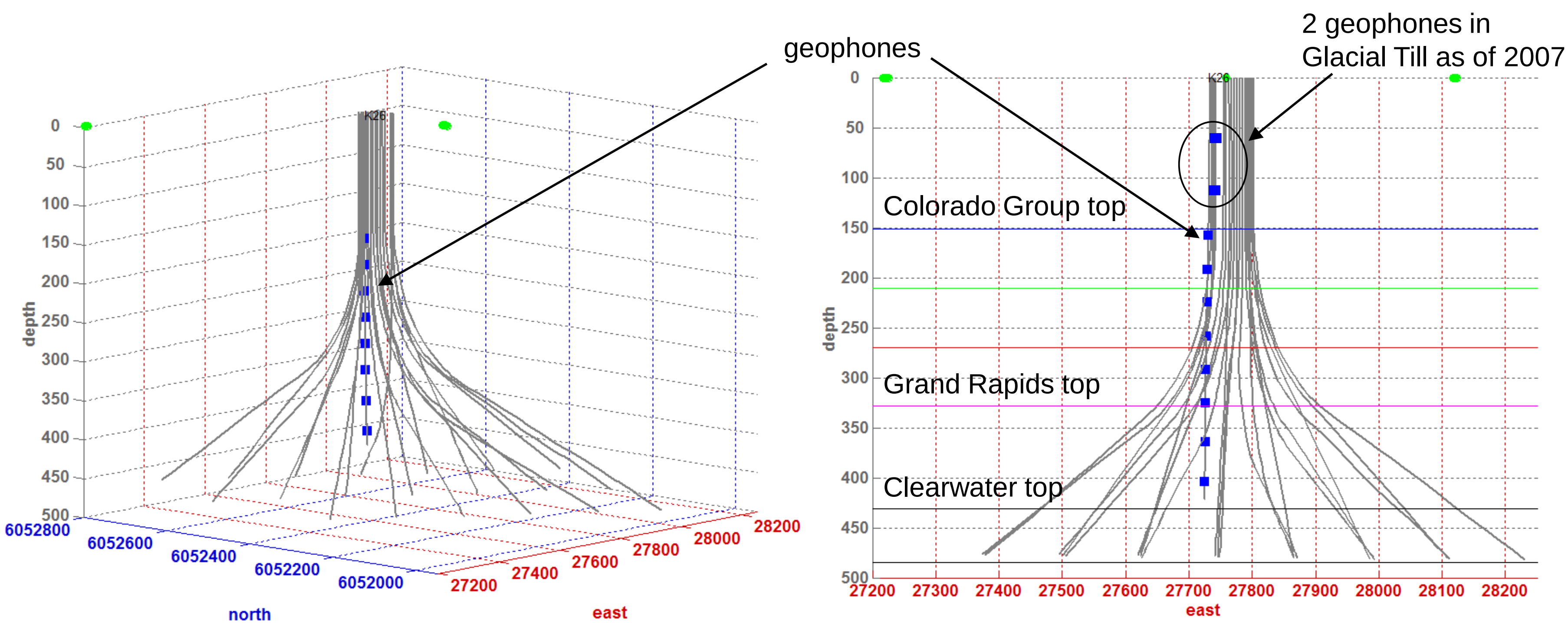
Pumpjack	Bottom Hole Pump Bore Sizes	Speed Range	Design Rate Range
160 - 173 - 86	38.1 mm 50.8 mm	7 SPM 16 SPM	25 m3/d 102 m3/day
228 - 173 - 86 or 320 - 213 - 86	50.8 mm 63.5mm	7 SPM 16 SPM	45 m3/d 160m3/day
456 - 213 - 144	63.5 mm 50.8 Long Stroke	4 SPM 14 SPM	42 m3/d 200 m3/d
912 - 305 - 192	82.5 mm 63.5 Long Stroke	4 SPM 11 SPM	90 m3/d 350 m3/d
1280 - 305 - 240	95.2 mm 82.5 mm Long Stroke	4 SPM 10 SPM	180 m3/d 500 m3/d
1824-365-240	108 mm 95.2 mm 82.5 mm Long Stroke	4 SPM 10 SPM	180 m3/d 640 m3/d

- Insert rod pumps used across field
- Size of lift system depends on:
  - Offset to reservoir target
  - Well deliverability: deviated versus horizontal wells
- Operating Conditions
  - Pumping temperature 75 – 180°C
  - Pump Intake pressure 6 MPa to less than 500 kPa
  - Average run life of rod pumps is between 550-650 days
- Corpac Variable Frequency Drive (VFD) Program
  - VFD's installed on 60% of producing wells
  - Using VFD controllers for inferred measurement, speed control, pumping unit shutdown and optimization

Instrumentation in Wells

- A passive seismic well with permanent omnidirectional geophones is installed at all new high pressure pads at Cold Lake since 1998
- Seismicity is monitored to detect fluid incursion and casing failures in uphole zones

Typical Passive Seismic Configuration

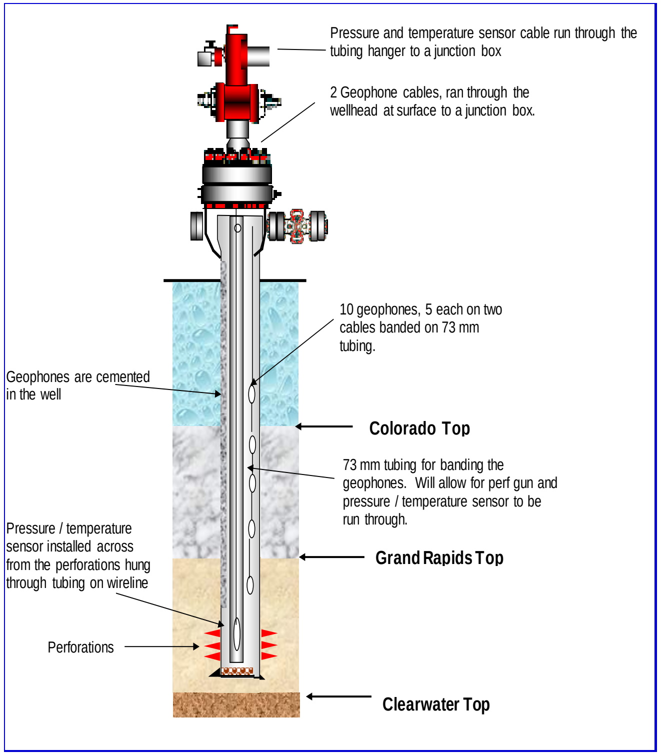


Imperial | Cold Lake

Instrumentation in Wells

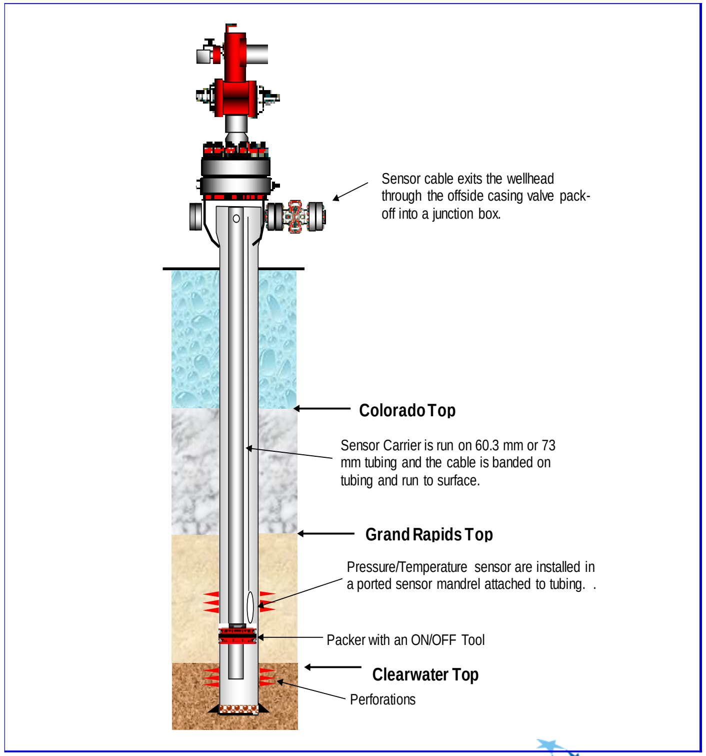
Hybrid Passive Seismic Well

- A hybrid Passive Seismic well design allows pressure monitoring in the Grand Rapids and passive seismic monitoring with cemented or non-cemented geophones in the same well.



Grand Rapids Pressure Monitoring Well

- There are several wells in the field used to monitor Grand Rapids pressure. These wells often monitor more than one interval. The configuration below provides pressure monitoring in one Grand Rapids interval and one Clearwater interval.



Well Integrity Measures and Mitigations

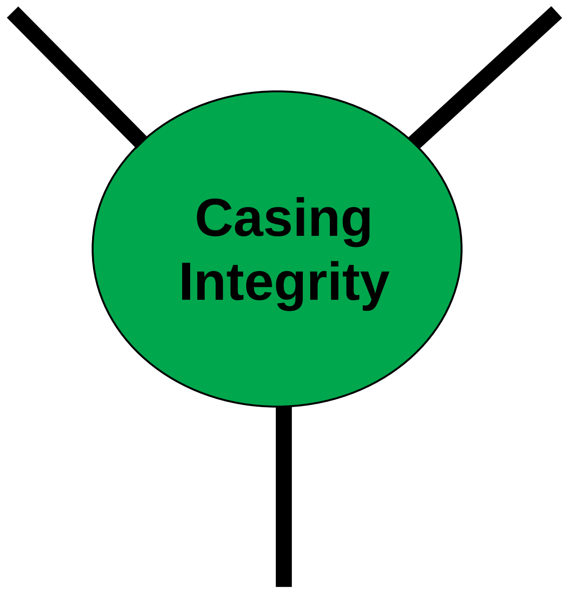
Well Integrity managed with strong Prevent, Detect, Respond & Recover processes.

Prevention

- Well Design & Construction Best Practices
- Well Operation & Inspection Best Practices
- Well Casing Repairs

Detection

- Multiple, complementary automated monitoring systems



Response & Recovery

- Defined Protocols for Assessing and Controlling Consequences

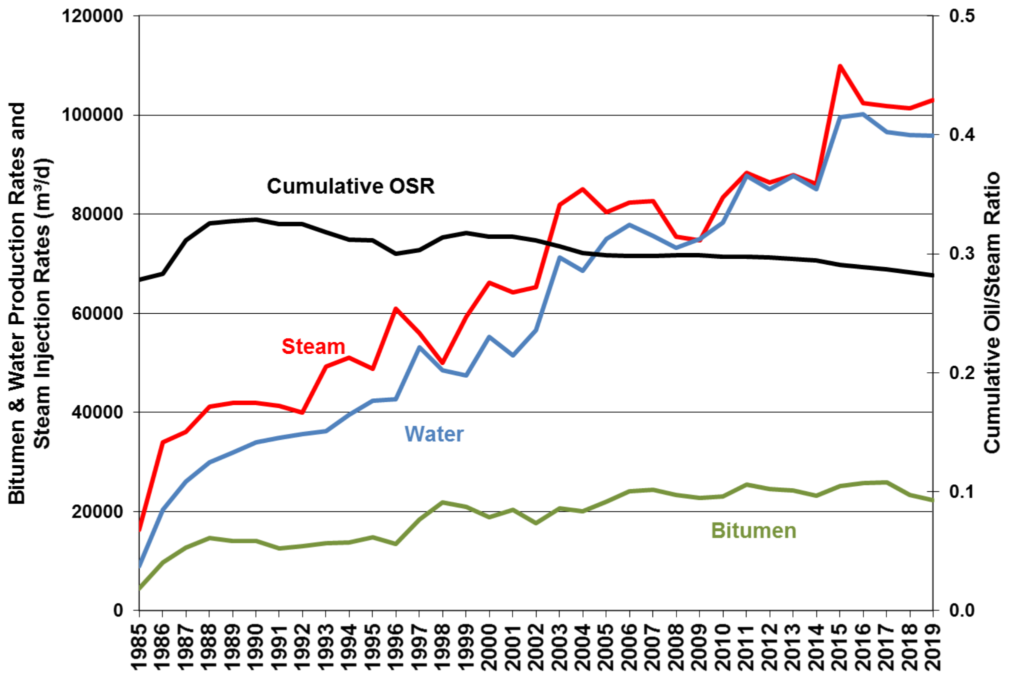
Scheme Performance

Cold Lake Recovery Determination

- Bitumen recovery in the Clearwater zone is a function of effective pay thickness and bitumen saturation
- Effective pay and bitumen saturations are determined from facies based descriptions of logs and cores obtained from the Clearwater zone at an 8 wt% cutoff
  - Shale and clay content are considered in the determination of effective pay
- Recovery predictions are based on performance type curves derived from field performance and reservoir simulation
- Adjustments are made for other factors impacting recovery such as:
  - Bottom water
  - Clearwater gas cap
  - Split pay
  - Adjacent reservoir depletion
  - Well spacing

Cold Lake Production Performance

Cold Lake Approval 8558 Area Production

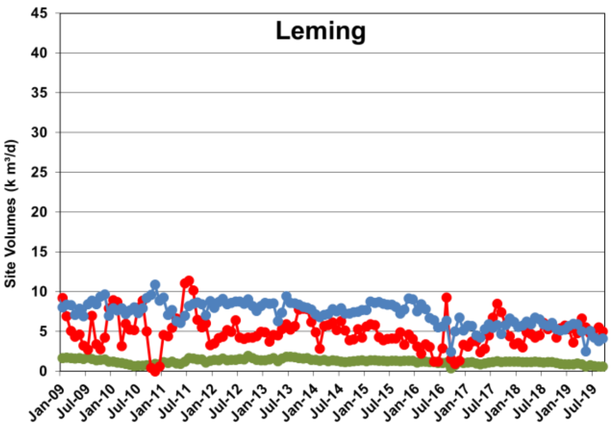


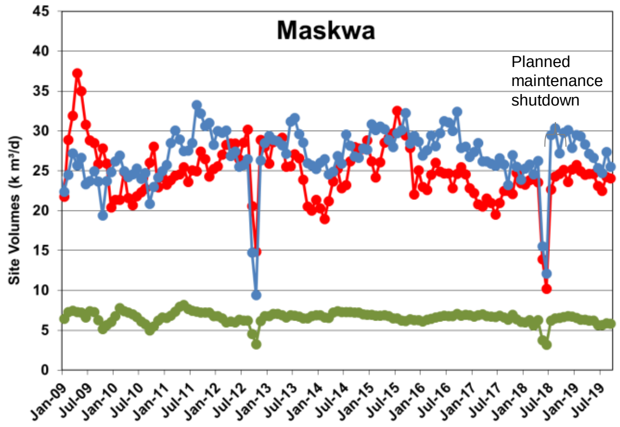
	Bitumen Production 10^3 m^3/d	Steam Injection 10^3 m^3/d	Cumulative OSR	Cumulative SOR
2018	23.3	101.4	0.28	3.5
2019 YTD Sept	22.4	103.0	0.28	3.6

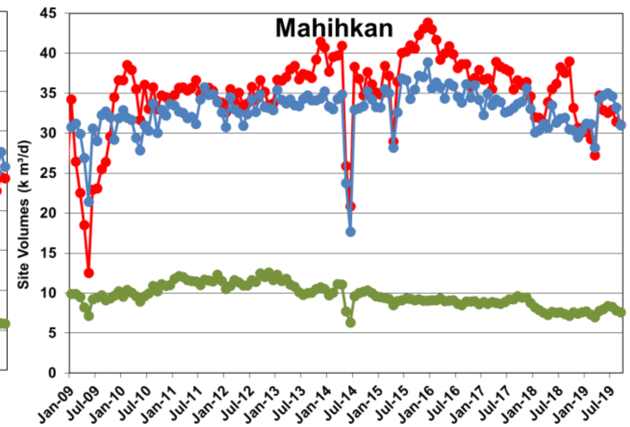
- Maximum daily bitumen production under approval 8558 of 40,000 m^3/d

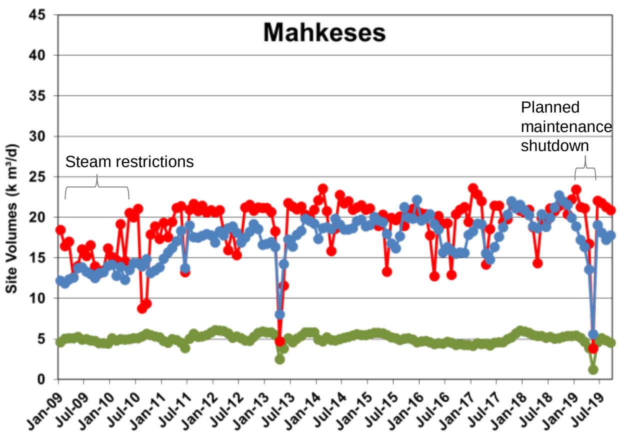
Notes
- Production data includes CSP and SA-SAGD pilot projects

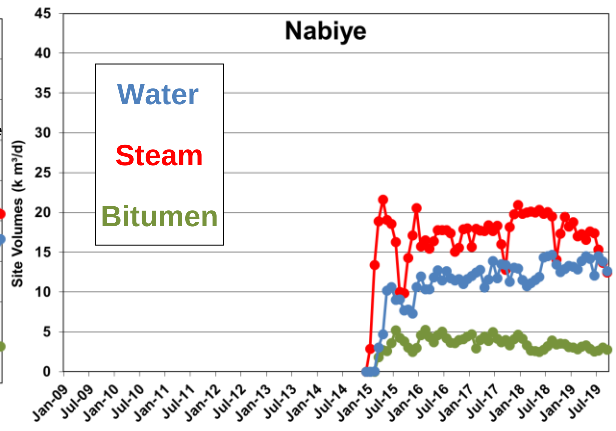
Individual Site Performance











Plant	2019 Sept YTD Average	
	OSR	SOR
Leming	0.16	6.1
Maskwa	0.25	3.9
Mahihkan	0.25	4.1
Mahkeses	0.23	4.4
Nabiye	0.18	5.5

Abandonment Outlook

Historic Assessments Supporting Abandonment Scope

- 'Flow Behind Pipe' assessment in 2011-2012 (E07 pad testing) confirmed:
  - Hydraulic isolation exists behind casing at key formation tops on Cold Lake wellbores.
  - Post-steam cement bond logs are not required as they do not reflect the high degree of hydraulic isolation behind casing.
- Aquifer isolation study completed in 2016 confirmed that isolation of aquifers at the time of full subsurface abandonment is not necessary

5 year outlook for pad well abandonment

- CC/GG pad subsurface abandonment completed; targeted surface abandonment (cut & cap) complete by year end 2019
- DD pad subsurface abandonment: 30 wells fully/partially abandoned, targeted full subsurface abandonment complete by year end 2019
- B03 pad abandonment progressed, 18 wells partially abandoned, 2 fully subsurface abandoned, remainder planned 2020+
- 20 Shale monitoring well abandonments: 14 fully subsurface abandoned, remainder planned 2020+
- Q and S pad scheme approval in place; abandonment planned 2020+
- Pads with support from adjacent pad steaming will continue operation

Individual Well Abandonment

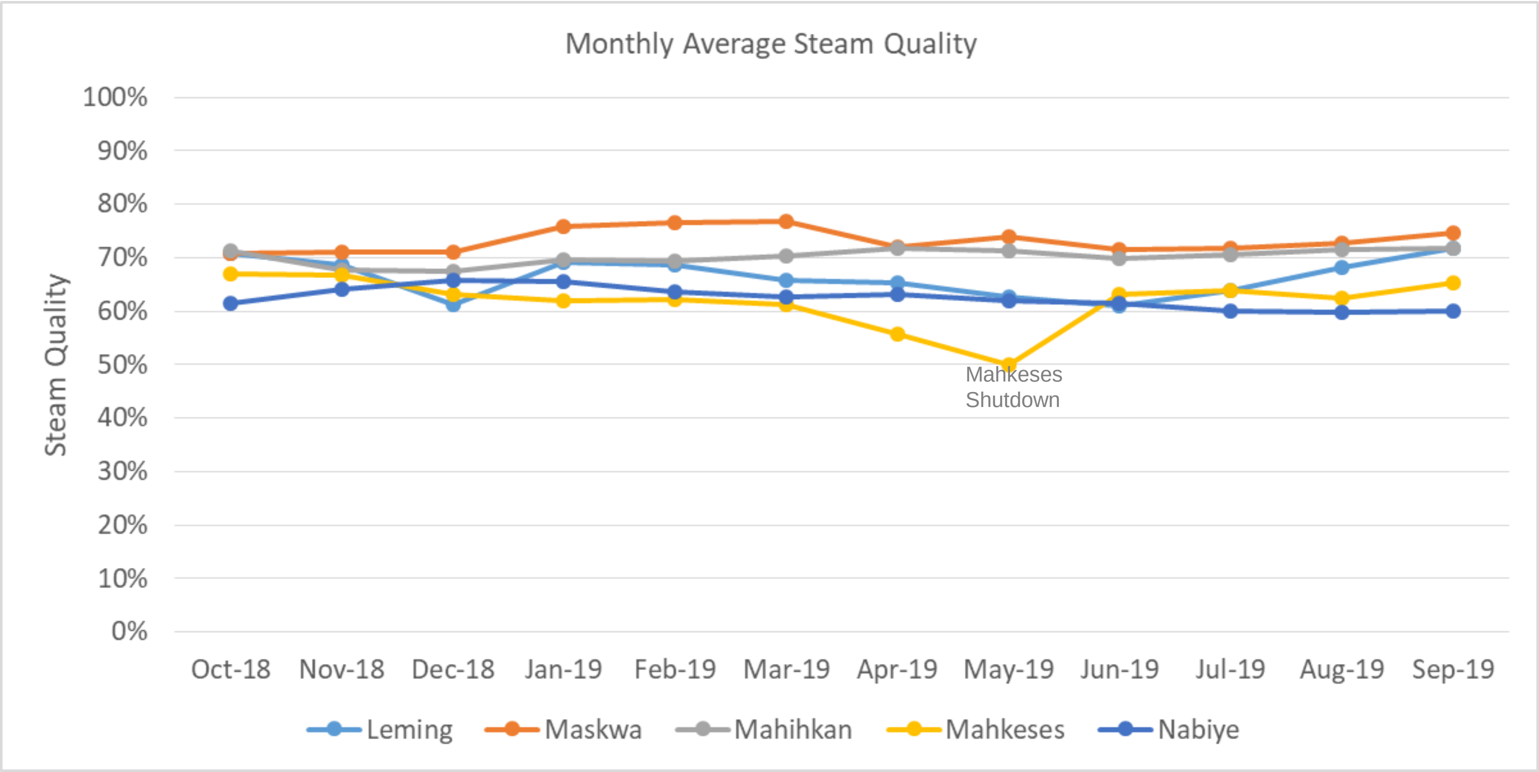
- Uneconomic end of life wells are zonally abandoned to meet Directive013
- 6 individual wells had appropriate abandonment work completed in 2019

Pads not steamed in prior 48 months

Pad	Plans
00N	Operating as water storage pad
00Q	All wells zonally abandoned in the Clearwater
00S	All wells zonally abandoned in the Clearwater
00V	Operating with support from adjacent pads
00W	Operating with support from adjacent pads
AAH	Operating with support from adjacent pads
0BB	Operating with support from adjacent pads
0CC	Subsurface Abandonment completed. Surface abandonment in progress
0DD	Abandonment in progress
0EE	All wells zonally abandoned in the Clearwater
0GG	Subsurface Abandonment completed. Surface abandonment in progress
0HH	Operating with support from adjacent pads
0LL	Operating with support from adjacent pads
A02	Operating with support from adjacent pads
A03	Operating with support from adjacent pads
A05	Operating with support from adjacent pads
B01	Operating with support from adjacent pads
B02	Operating with support from adjacent pads
B04	Operating with support from adjacent pads
B05	Operating with support from adjacent pads
D27	Operating with support from adjacent pads
D52	Operating with support from adjacent pads
D57	Abandonment process started, all wells zonally abandoned
D66	Abandonment process started, all wells zonally abandoned
E07	All but 2 wells abandoned, (2 monitoring)
E10	Operating with support from adjacent pads
H19	Operating with support from adjacent pads
H34	Operating with support from adjacent pads
J27	Operating with support from adjacent pads
L08	Operating with support from adjacent pads
M06	Operating with support from adjacent pads
P02	Operating with support from adjacent pads

Steam Quality

- Average district steam quality of 68% from Oct 2018 – Sep 2019

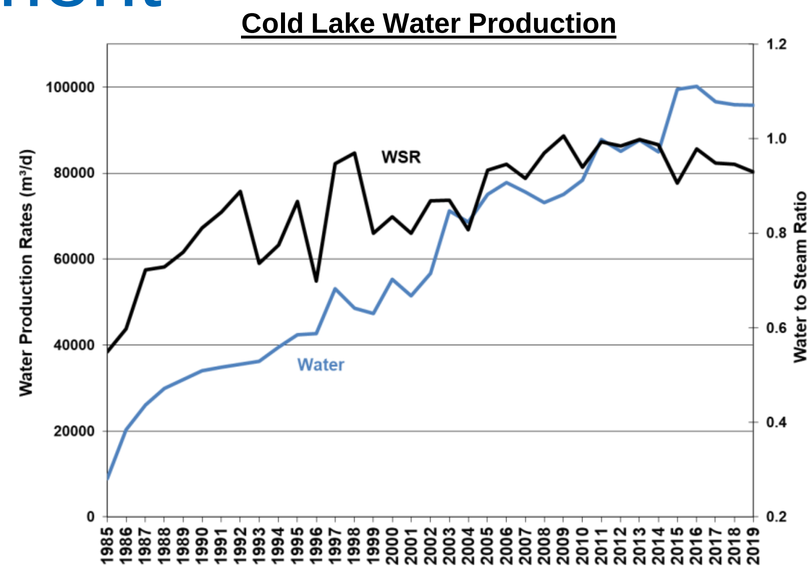


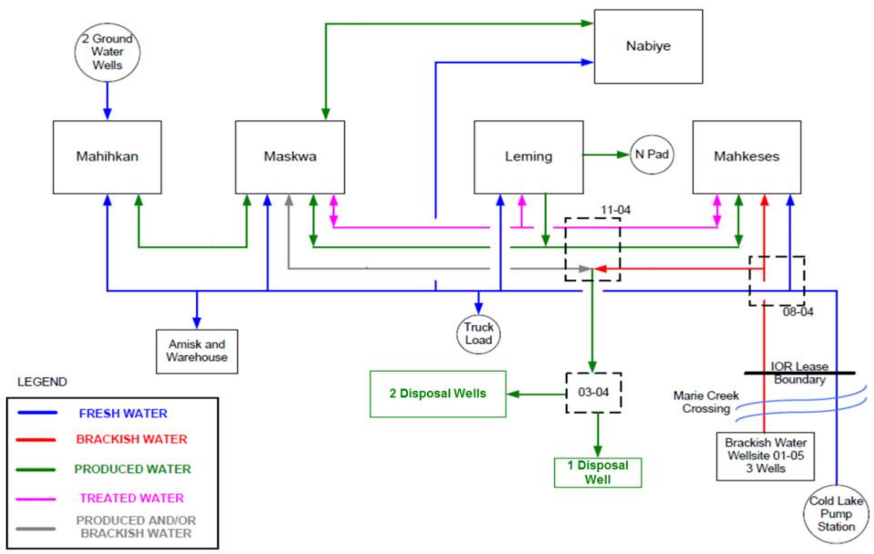
Imperial | Cold Lake

Cold Lake Water Management

- **Cold Lake Water Production**
  - Water to steam ratio has increased as pads move into later cycle production (late life CSS / steamflood)
    - Temporarily flat/down since 2015 resulting from Nabiye start-up and disposal restrictions
  - Typically field water deliverability is in excess of facility water handling capacity, requiring production shut-in

- **Operating Strategies**
  - Production shut-ins prioritized based on water to oil ratio to maximize oil production
  - Maximize steam injection quality
  - Minimize bringing water into the system
    - Freshwater and brackish water
  - Utilize out of zone disposal
    - Plans to add 4 additional disposal wells

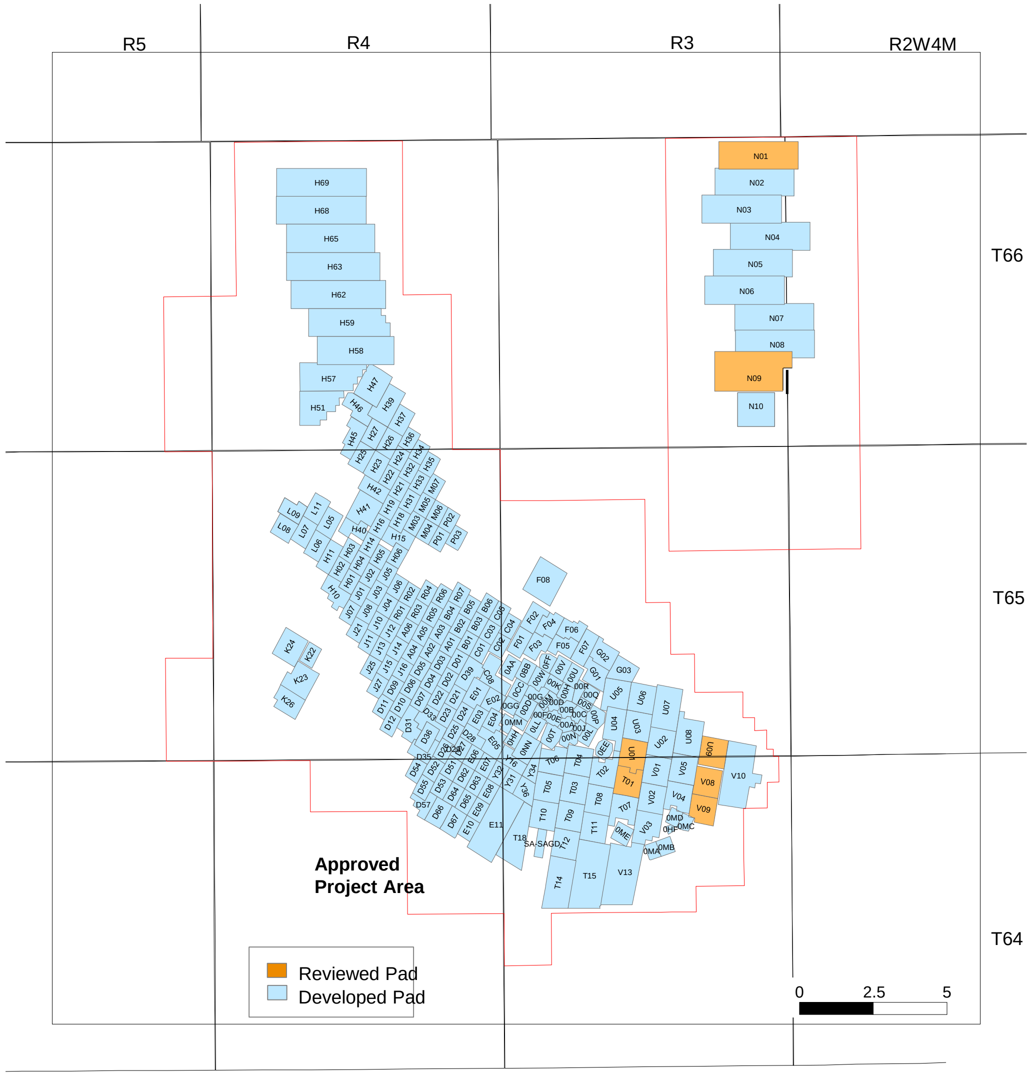




Imperial | Cold Lake

Pad Performance Reviews

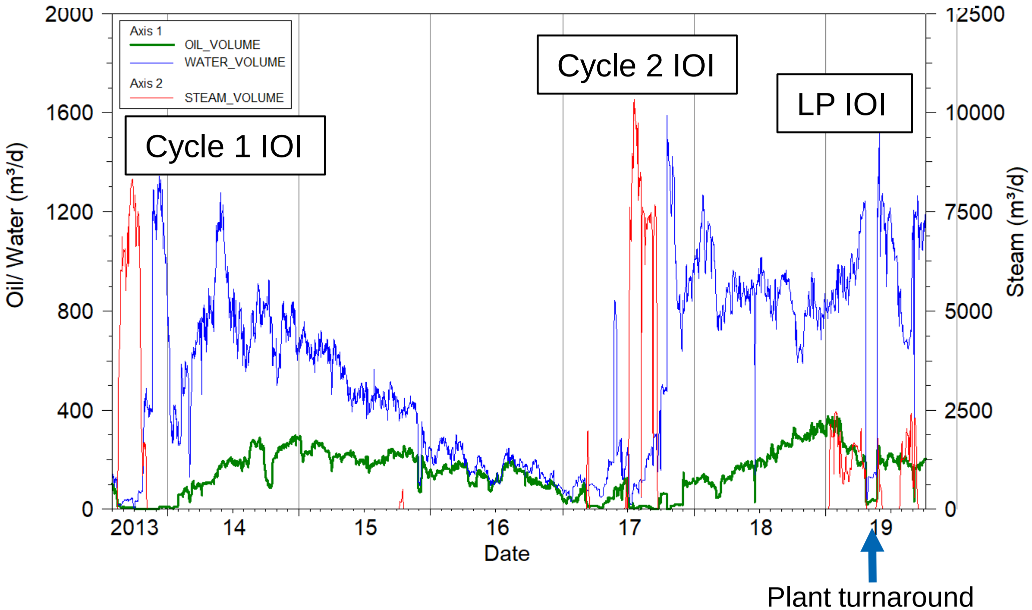
- The next 5 slides provide performance highlights for specific pads. For your convenience, these pads are highlighted on the map below.



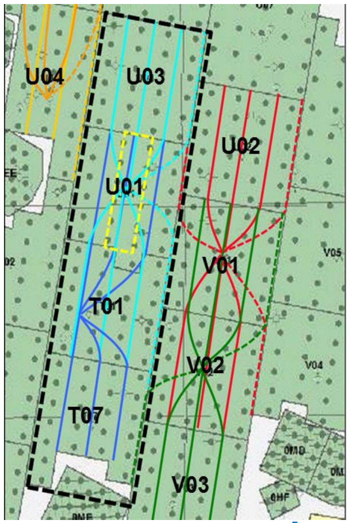
Mahkeses 8 ac IOI – U01 Pad/T01 IOI

- U01 is an 8 acre 25 well pad infilled by T01 Injector-Only-Infills (IOIs)
- Cycle 1 IOI steamed August – November 2013
  - Steamed fill-up volume through CSS wells, over fill-up volume through IOIs
  - Cycle 1 OSR performance as expected
- Cycle 2 IOI steamed June – September 2017
  - Steamed fill-up and over fill-up volume through both CSS wells and IOIs
    - Greater steam volume injected into IOIs in Cycle 2 vs Cycle 1
  - Peak production rate was greater than in Cycle 1
- Low pressure IOI steam trial early Jan – Oct 2019
  - Significant water influx, oil production dropped

U01 Pad & T01 IOIs under U01



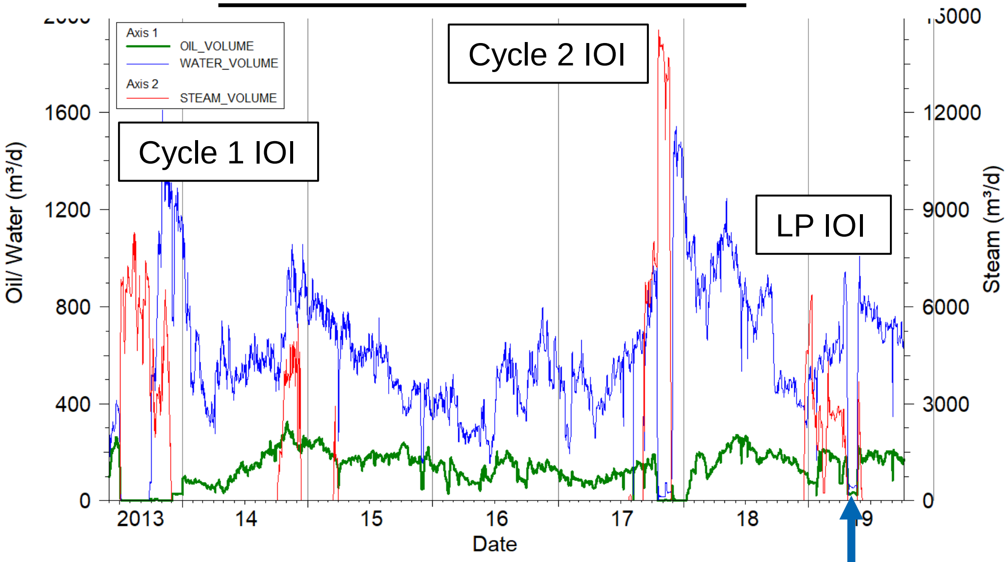
Pad Layout



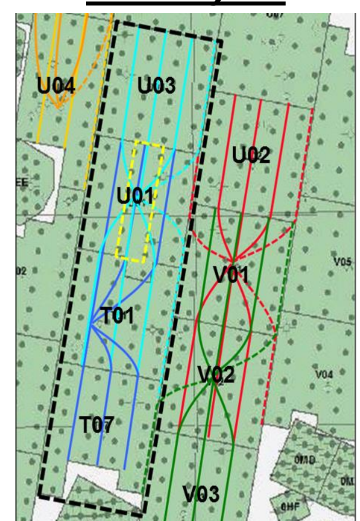
Mahkeses 8 ac IOI – T01 Pad/U01 IOI

- T01 is an 8 acre 23 well pad infilled by U01 Injector-Only-Infills (IOIs)
- Cycle 1 IOI steamed July – November 2013
  - T01 CSS wells preconditioned prior to injecting into the IOIs
  - T01 received 2 warm up cycles following Cycle 1 IOI steam
- Cycle 2 IOI steamed September – November 2017
  - Steamed fill-up and over fill-up volume through both CSS wells and IOIs
    - Greater steam volume injected into IOIs in Cycle 2 vs Cycle 1
- Low pressure IOI steam trial Jan - Apr 2019
  - Immediate oil uplift observed

T01 Pad & U01 IOIs under T01



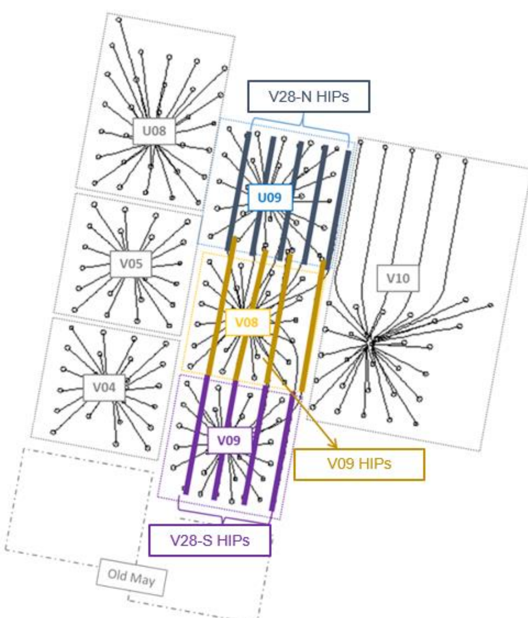
Pad Layout

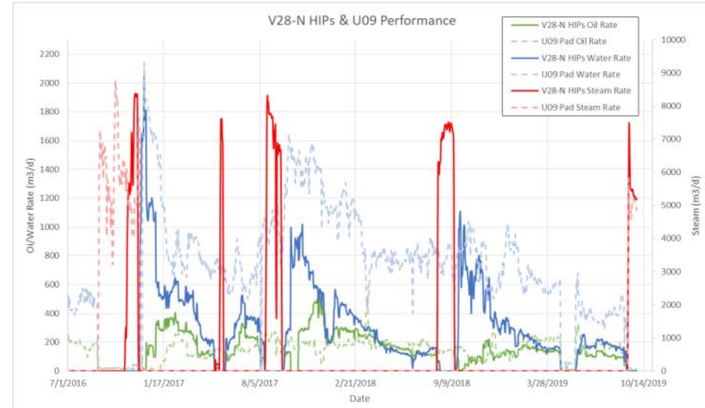


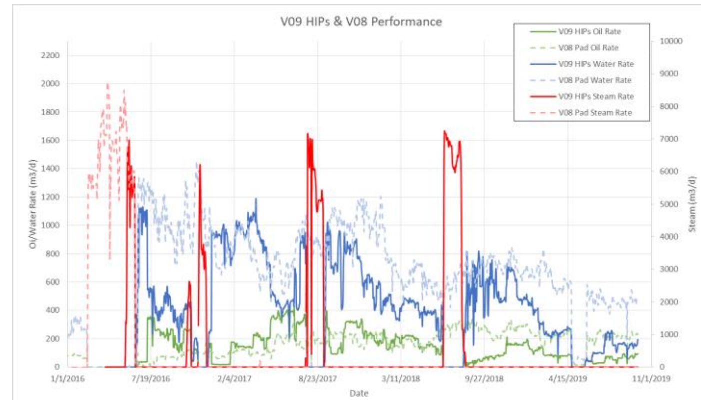
Mahkeses V28 & V09 HIPs

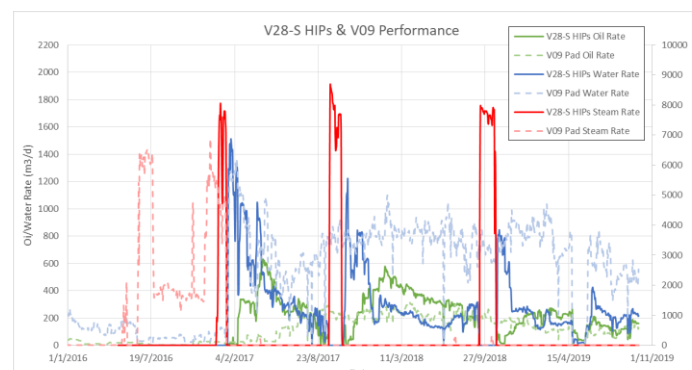
- U09, V08, V09 base pads steamed regular HPCSS cycles followed by the HIPs Cycle 1 in 2016
- HIPs Cycle 2 steamed between July – October 2017
- HIPs behaved similarly to an early cycle CSS pad in both Cycles 1 & 2
- HIPs Cycle 3 steamed between June – October 2018
  - HIP wells did not receive over fill-up volume due to inability to reach fracture pressure. Cycle 3 HIP performance below expectations

- Overall combined performance of the base pads and HIPs expected to meet forecast
- U09 and V28-N HIPs began concurrent steam September 2019



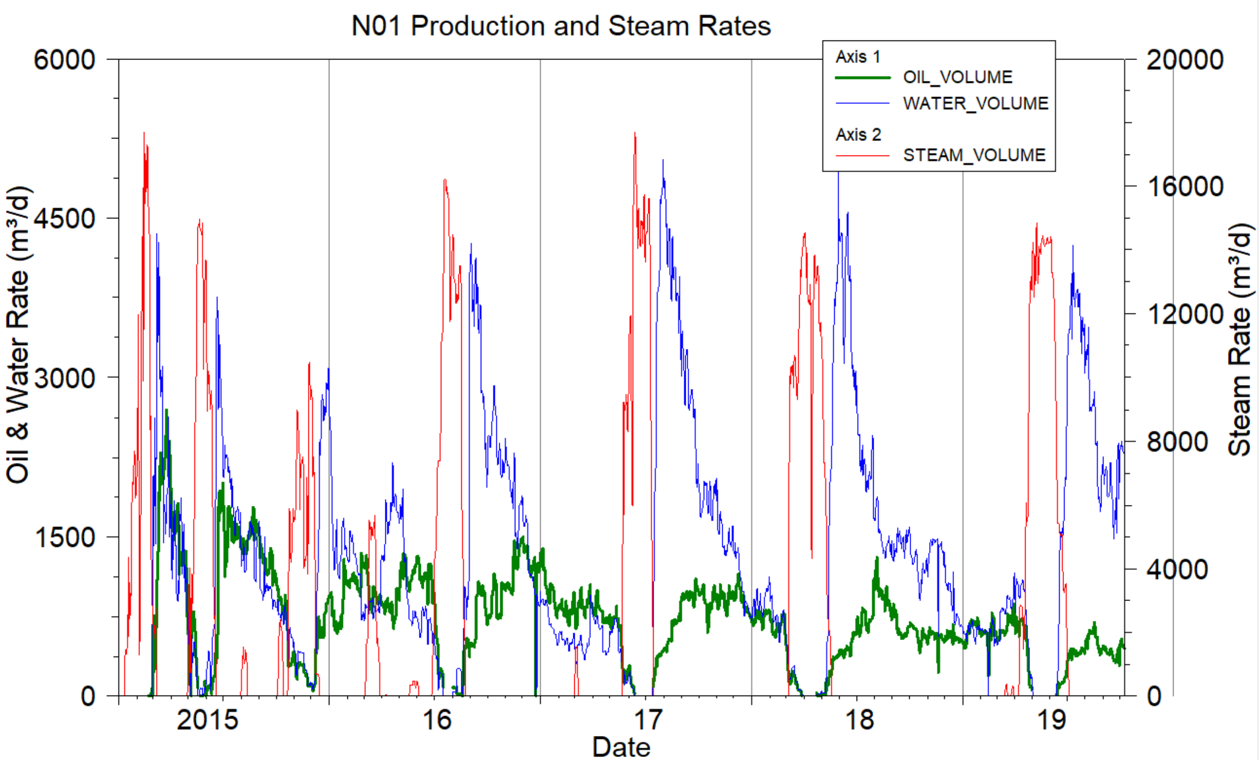






Nabiye N01 Pad

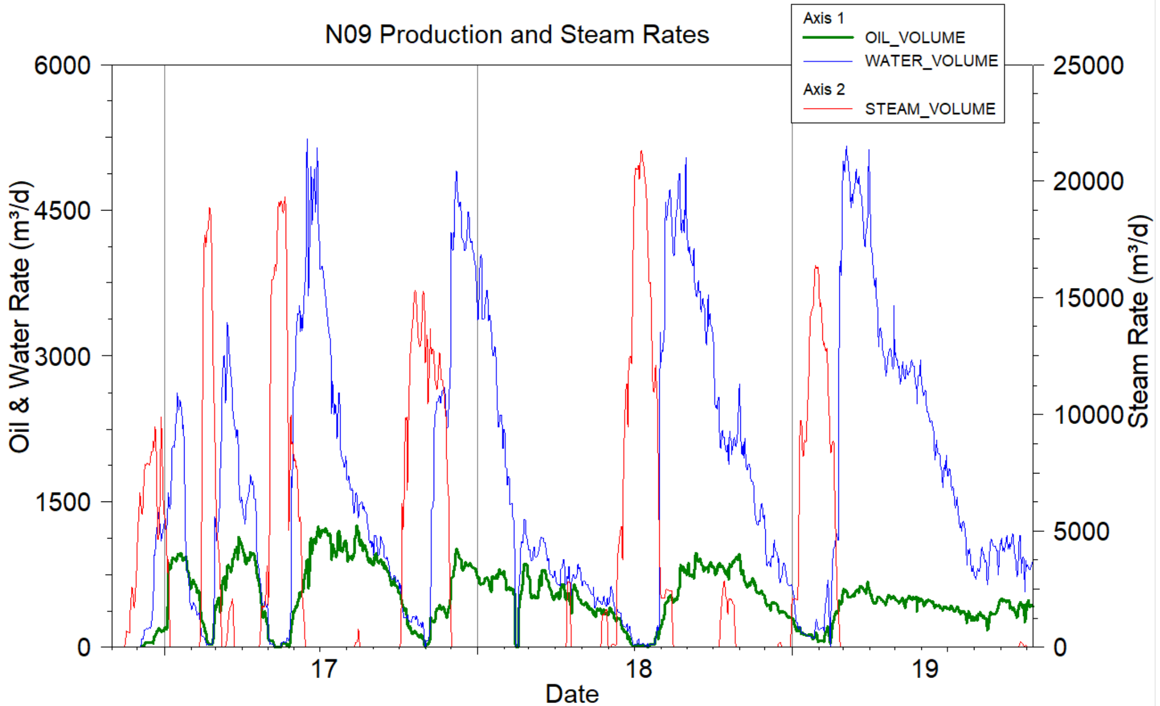
- Nabiye N01 is a 24 well pad (16 deviated, 8 horizontal), accessing 70 bottom-hole locations on 8 acre spacing
- Currently in the production phase of cycle 7
- Steam volumes have been reduced from Cold Lake best practices to manage pressure responses in the Grand Rapids
- Production performance is typical for CSS at Cold Lake



Imperial | Cold Lake

Nabiye N09 Pad

- Nabiye N09 is a 36 well pad (24 deviated, 12 horizontal), accessing 101 bottom-hole locations on 8 acre spacing
- Currently in the production phase of cycle 5
- Cycle 1 was split into two smaller injection cycles to mitigate the risk of pressure responses in the Grand Rapids formation. Steam volumes for each injection were roughly half of the typical first-cycle steam volume
- Fewer Grand Rapids responses have been observed compared to other Nabiye pads



Imperial | Cold Lake

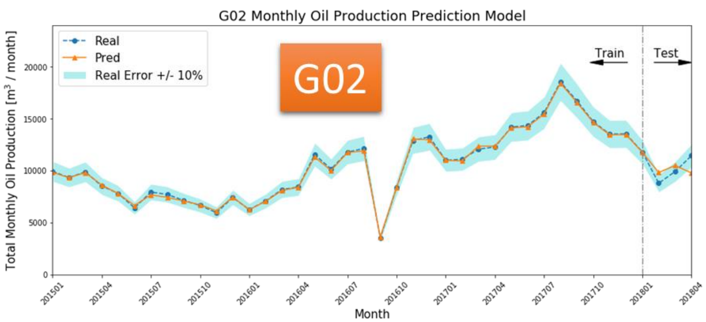
Late Life Steamflood Performance

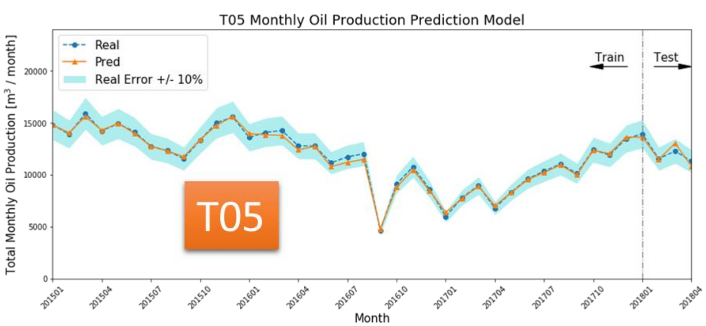
Late Life Steamflood

- Steamflood approved for entire Cold Lake Development Area and continues to be an important process for performance and long term recovery
- Currently ~123 infills on steamflood into 82 producing pads (~1,500 wells)

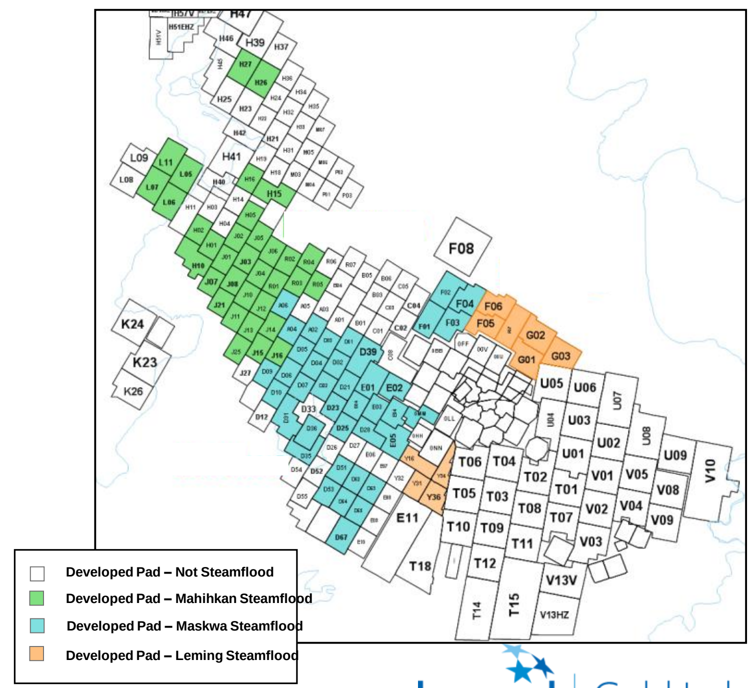
- Steamflood Optimization Tool developed and implemented
  - Leverages machine learning algorithms that generate a prioritized list of steam allocations based on OSR uplift
  - Cloud-based technology puts data in the hands of operations for decision making
  - Machine learning algorithms demonstrated ability to predict production within +/- 10% error

Machine learning Prediction (Pred) versus Actual production (Real)





Cold Lake Steamflood Pads



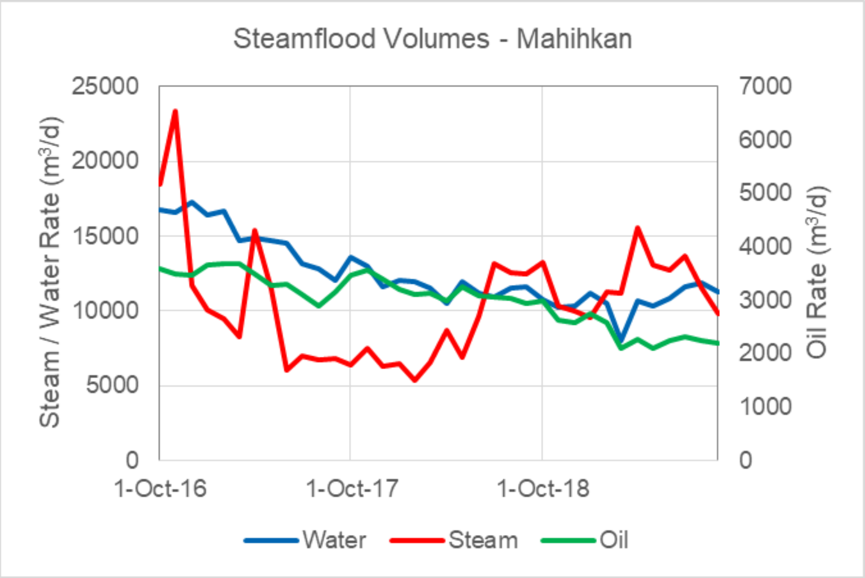
Imperial | Cold Lake

Late Life Steamflood

Mahihkan Steamflood Area

34 Pads: H01, H02, H05, H15, H16, H18, H26, H27, J01-J08, J10-J16, J21, J25, L05-L07, L11, R01-R05

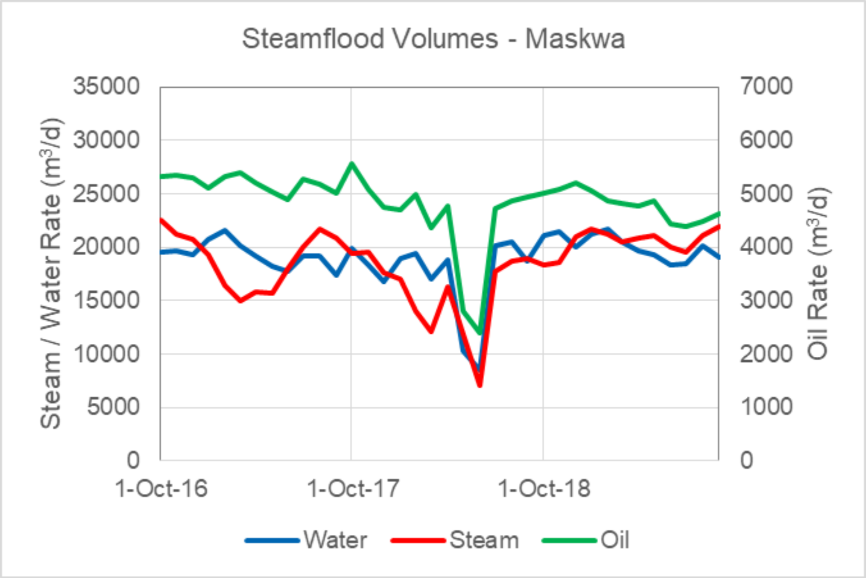
- Steamflood performance at Mahihkan as expected
- Low steamflood injection rates end of 2017, back to target rates as of Q2 2018
- Recovery factors in the range of 30-85% for pads in this area



Maskwa Steamflood Area

38 Pads: A02, A04, A06, D01-D07, D09, D10, D21-D25, D28, D31, D33, D35, D39, D51, D62-D65, D67, E01-E05, F01-F04, 0MM'//'

- Steamflood performance at Maskwa as expected
- Steady steamflood injection rates in the past year
- Recovery factors in the range of 30-70% for pads in this area



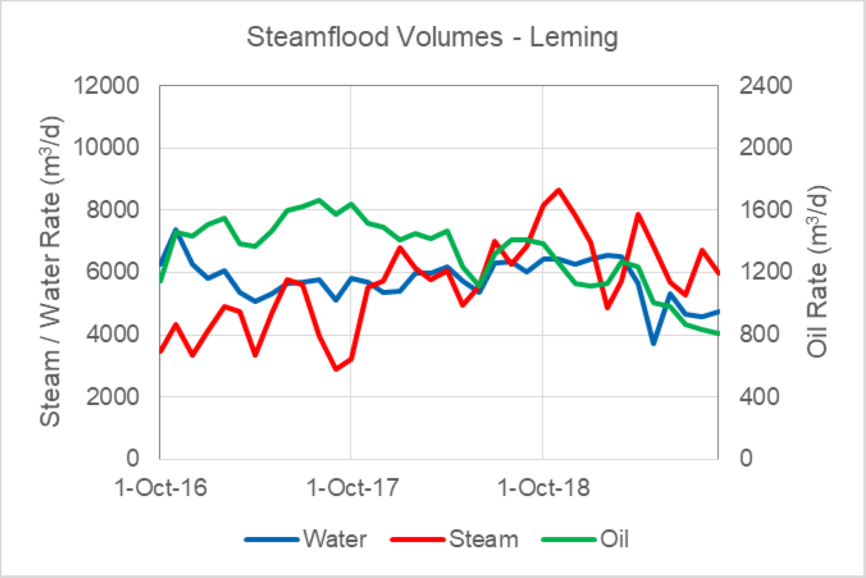
Imperial | Cold Lake

Late Life Steamflood

Leming Steamflood Area

10 Pads: F05, F06, F07, G01, G02, G03, Y16, Y31, Y34, Y36

- Steamflood performance at Leming as expected
- Oil rates have decreased slightly in the past year
- Recovery for pads in this area ranges from 30-60%



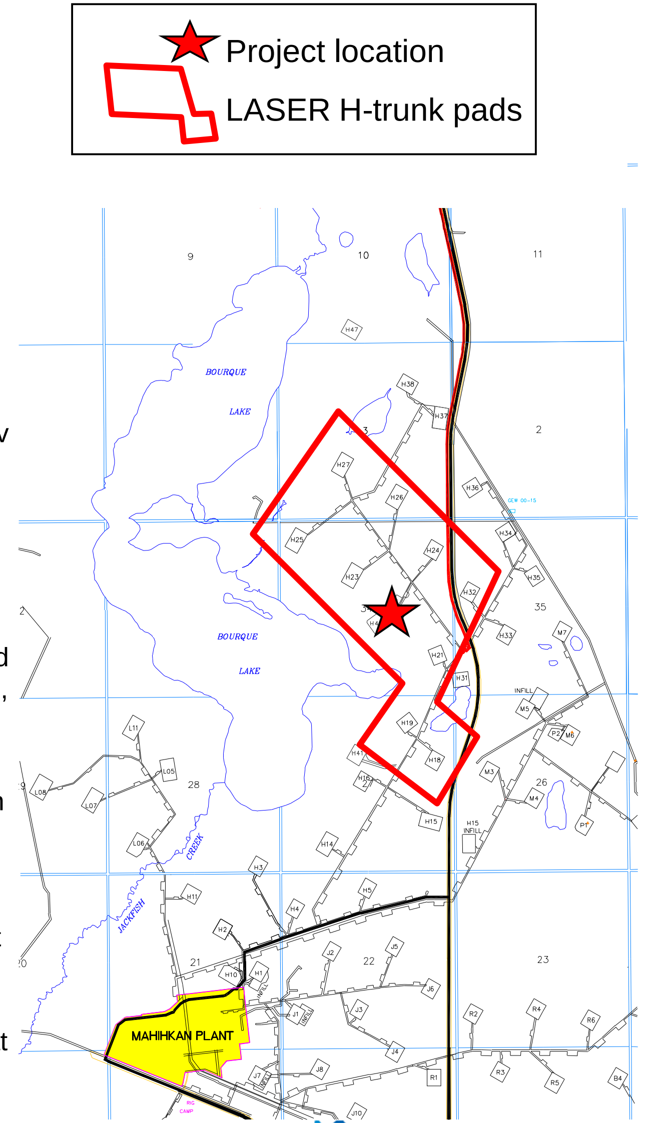
Imperial | Cold Lake

LASER Recovery Process

LASER H Trunk Project- Cycle 1 Summary

Background

- 10 pads in Mahihkan H-trunk – diluent injection complete
    - First cycle diluent injection began in Q3 2007 and was completed April 2009
- Diluent management
    - Distributed to pads via dedicated distribution pipeline
    - Produced back to Mahihkan Plant as part of common production stream
        - Produced diluent reduces future blend requirement
- Recovery equipment minimizes burning of flashed diluent in steam generators
    - Started up August 2008



Performance

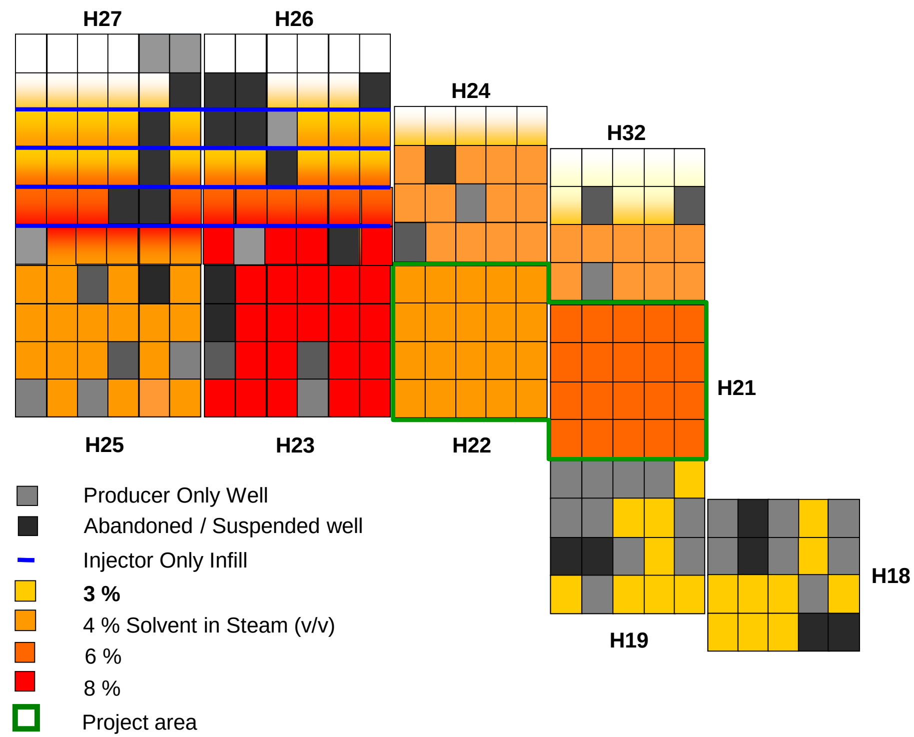
- Overall first cycle LASER performance was in line with expectations
  - Average 0.10 OSR uplift was achieved compared to no LASER implementation, due to the 5% v/v diluent injected with the steam in this first LASER cycle. This is approximately a 50% improvement in oil production performance.
  - Range of 0.04 to 0.18 OSR uplift for the 10 pads
  - 59% of the injected diluent was recovered in LASER cycle 1, in line with expectations
  - Range of 30% to 90% recovery of injected diluent for the 10 pads
  - Some fluid migration from the LASER pads was observed, primarily to other pads in the north and east, with the most significant impact being reduced OSR uplift and lower diluent recovery at H26, H27, H24, and H32 pads
  - LASER has been demonstrated to be effective in CSS, IOI, and CSS POW situations
  - Higher diluent concentration at H23 pad (8.6%) compared to other pads resulted in an increase in incremental bitumen production and OSR uplift for the cycle, but with an apparent lower diluent recovery. An estimated 0.18 OSR uplift and 49% diluent recovery was achieved at H23 pad, but with uncertainty in the high concentration assessment due to fluid migration between pads.
  - LASER has been demonstrated to be successful across a wide range of diluent concentrations at the H trunk project, but identification of an optimal diluent concentration for LASER from the field data is difficult due to the pad-to-pad fluid migration experienced in the cycle
  - Sustainability of LASER performance uplift has been demonstrated by the third cycle of LASER at H22 pad, with an estimated 0.14 OSR uplift in the cycle

Cycle 1 Laser H Trunk Project- Diluent Injection

Diluent injection complete in all 10 pads

Key Learning Initiative	# of Pads Location	Target (% v/v)	Actual (% v/v)
LASER POW	2		
9 injectors	H18	3%	3.2%
8 injectors	H19	3%	3.0%
LASER CSS	6		
Standard	H21	4%	6.1%
3rd LASER Cycle	H22	4%	4.5%
High Diluent	H23	8%	8.6%
Standard	H25	4%	4.4%
Potential Last Cycle	H24	3.5%	3.9%
Potential Last Cycle	H32	3%	3.9%
LASER IOI	2		
After 1 IOI cycle completed	H26	5%	4.4%
After 1 IOI cycle completed	H27	5%	4.6%

- Original LASER Pilot at H22 pad had 6% v/v of diluent injected in 8 wells (equivalent to ~2.4% v/v across a 20-well pad)
- Based on successful results at H22 Pilot, increased diluent to nominal average of 5% v/v for commercial implementation in 2007
- 8% v/v injected at H23 to test theory of increased benefits with higher concentration
- Remaining pads received diluent concentrations between 3-6% v/v
  - Lower diluent concentrations injected into pads with lower performance expectations



Injection Data for First LASER Cycle (10 pads)

Cumulative (km³)	to 09/30/2012
Steam Injection	6,246
Diluent Injection	297

Imperial | Cold Lake

Cycle 1 LASER H Trunk - Production Performance

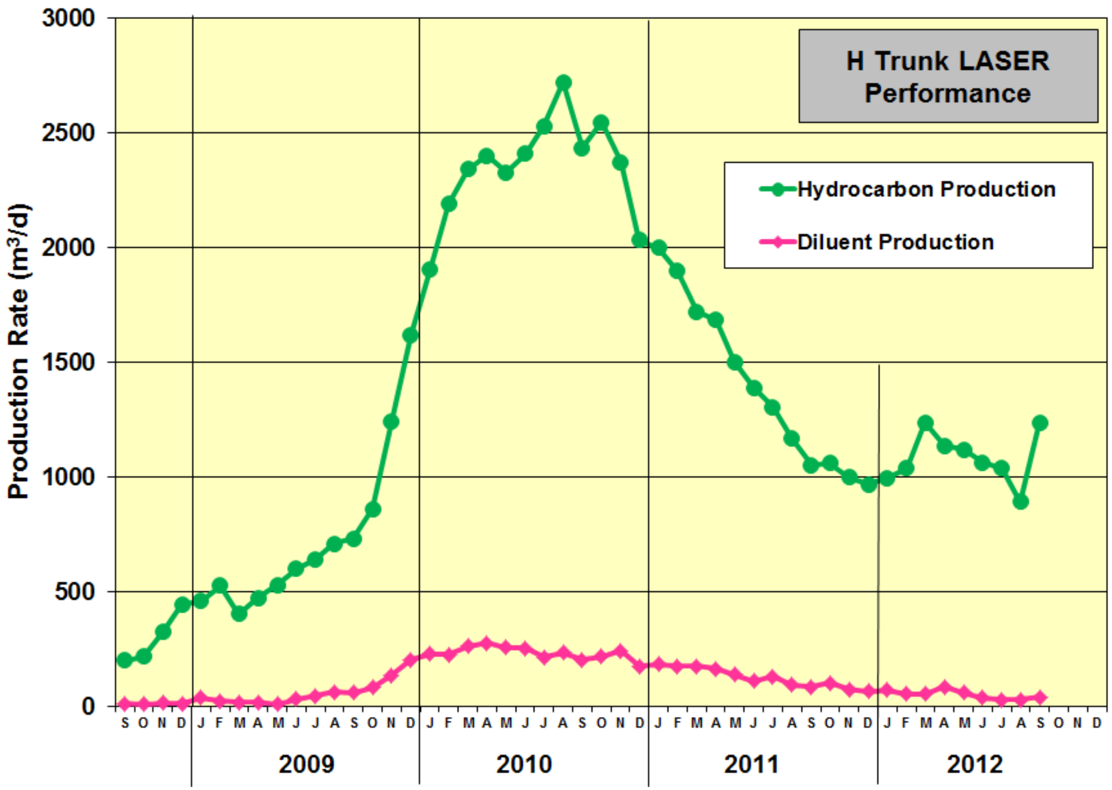
Production

- Steam injection cycle at the 10 pad H Trunk LASER implementation was completed in early 2009
- Oil production and diluent reproduction increased to peak rates in 2010 as expected
- Production declined throughout the remainder of the cycle, through 2011 and 2012
- The first H Trunk LASER cycle is complete and the overall incremental oil production and diluent recovery were in line with expectations.

- H18 and H19 began the production cycle in Q2 2008
  - Peak oil production rates were achieved in 2010 and wells on oil decline during 2011 & 2012
- H21, H22, H23, H25 began the production cycle in Q4 2008
  - Peak oil production rates were achieved in 2010 and wells on oil decline during 2011 & 2012
- H24, H26, H27, H32 began the production cycle in Q1 2009
  - Peak oil production rates were achieved in 2010 and wells on oil decline during 2011 & 2012

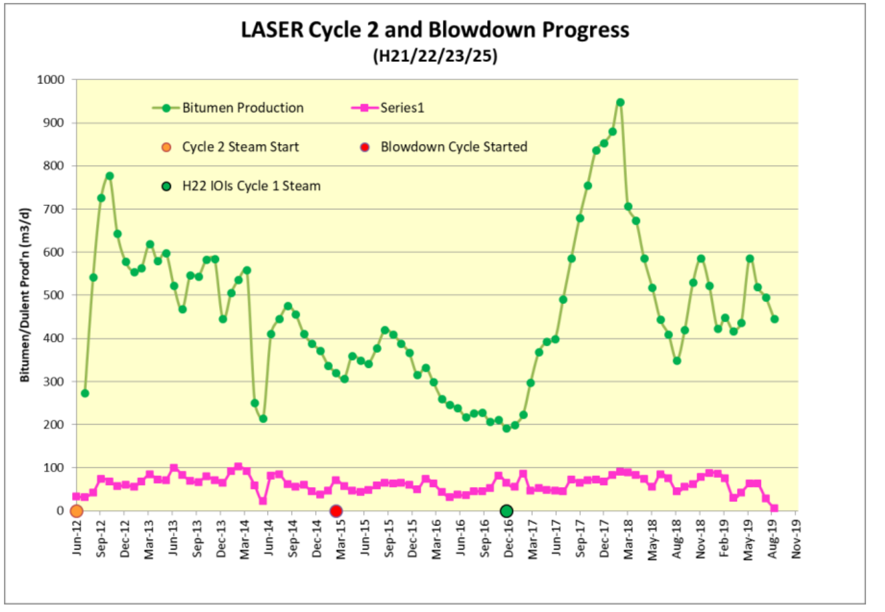
Production Data for First LASER Cycle (10 pads)

Cumulative (km^3)	to 09/30/2012
Hydrocarbon Production	1,886
Diluent Production	174



Imperial | Cold Lake

Cycle 2 LASER H Trunk - Production Performance



Background

- H21, H22, H23 and H25 steamed with diluent for cycle 2
- 2nd Cycle injection focus strictly on CSS strategy
- Focus on longer term performance understanding

Cycle 2 Injection

- Steamed with diluent from Sept - Dec 2012
- Total steam injection - 1638 km^3
- Total diluent injection – 77 km^3 (4.7% dil. v/v)
- Pressures of ~1.0 - 2.0 MPa achieved
  - Lower reservoir pressures compared to 1st LASER cycle
  - Higher level of depletion and inter-well communication across all pads

Production Performance

- Oil produced in Cycle 2: 534 km^3
- Diluent recovery to date: 310 km^3
- Cycle 2 production ended in Mar 2015. At the end of the cycle, the four pads averaged OSR increases of 0.12, exceeding the original expectation.
- Diluent production rates peaked in July 2013 and trended as expected, to a cumulative of 62% by the end of the cycle
- The four pads went into a blowdown cycle (March 2015) in which steam with no diluent was injected. Diluent reproduction continues to be tracked as recovery under blowdown will be a key learning for future LASER projects. The current cumulative recovery to date is 82%.
- H22 infills into H21, H23, H25 pads were first steamed in late 2016 and are currently in their 2nd cycle of steam. Increased bitumen and diluent production due to the infill steam is evident during the early 2017 through 2019 period shown the chart above.

Production to Date:

Updated to 9/1/2019	Cycle 1	Cycle 2	Blowdown
Cycle Start	May 2007	Jul 2012	Mar 2015
Diluent Injection, km^3	297	77	0
Diluent production, km^3	174	58	78
Cumulative Diluent Recovery %	59%	62%	82%

Imperial | Cold Lake

Mahihkan North LASER – Diluent Injection

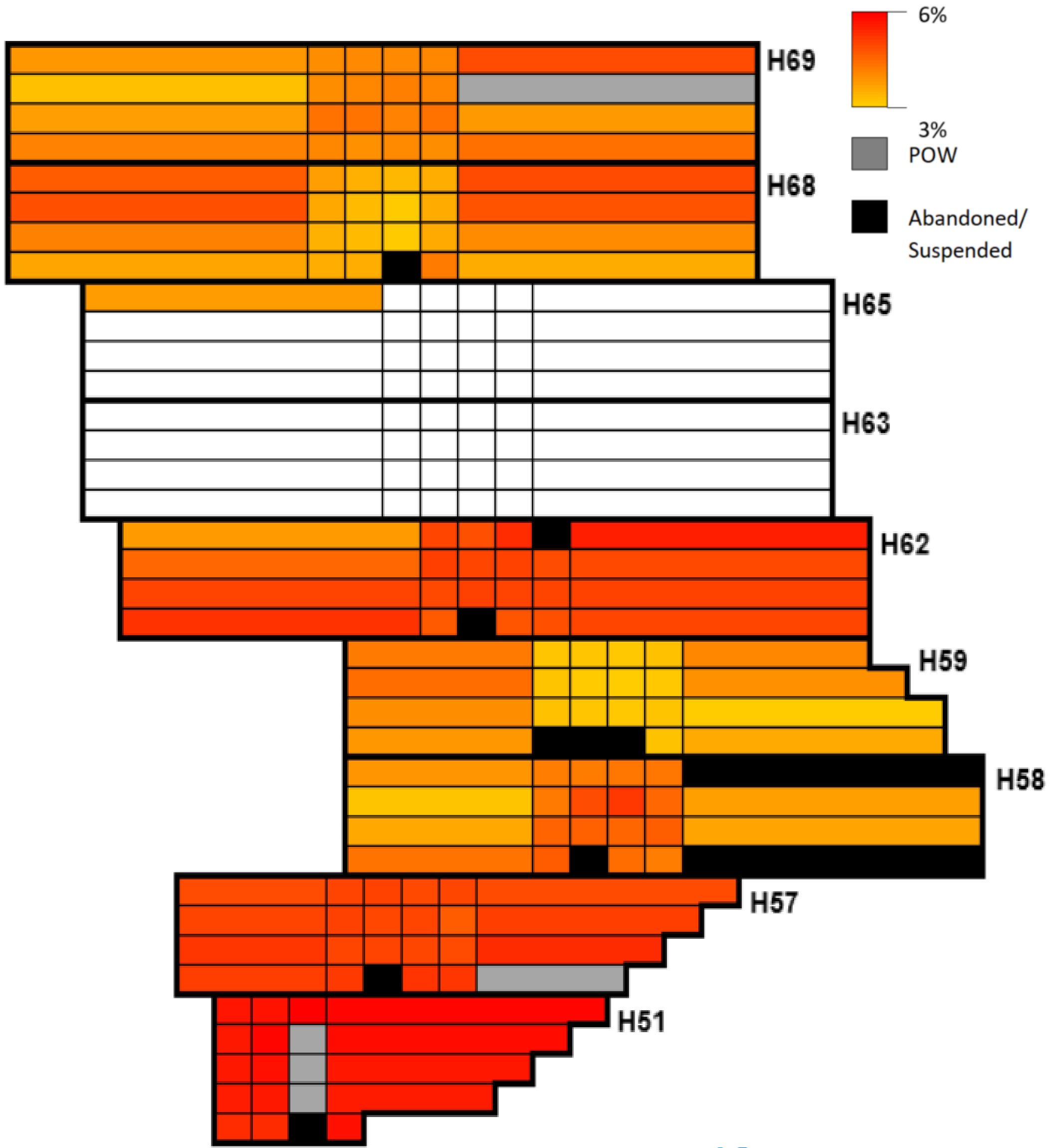
- Cycle 1 injection started May 15 2017. Diluent injection completed at 7 pads and ongoing at H63 and H65
- Targets differed at each pad due to factors such as geology and wellbore utility
- Lower than target injected into H59 and H68, respectively as as a result of diluent injection skid (DIS) reliability and operational challenges

Diluent Concentration by Pad:

Pad	Target (%v/v)	Actuals (%v/v)
H51	5.0	5.7
H57	5.0	5.0
H58	3.0	3.8
H59	5.0	3.5
H62	5.0	4.8
H65	-	2.3
H68	5.0	4.0
H69	3.0	3.8

Cumulative Injection:

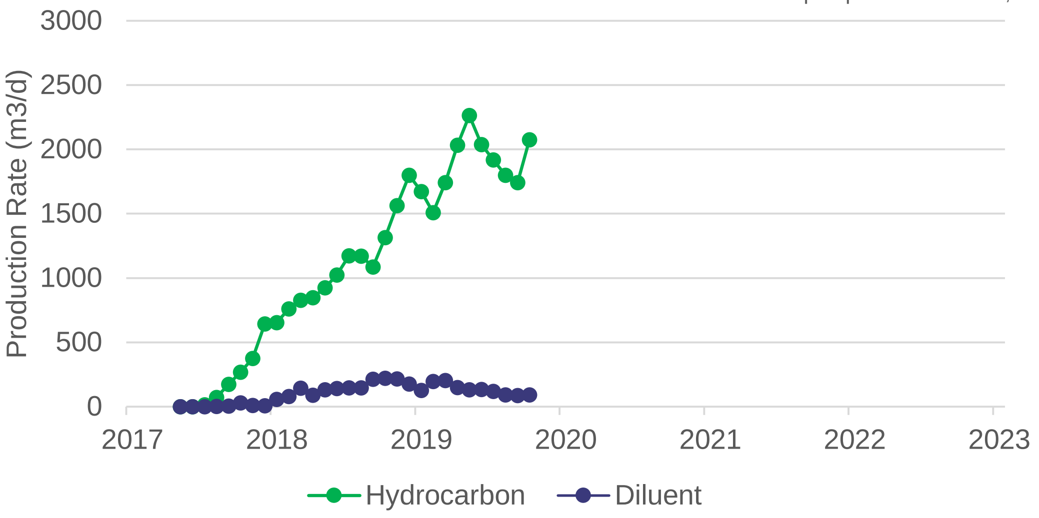
Fluid	Volume (km^3)
Steam	9030
Diluent	396



Mahihkan North LASER – Production

- Early performance is in line with current expectations however more time is needed to assess full LASER uplift
- Incremental uplift expectations have been adjusted based on recent observations and improvements on hydrocarbon measurement
- Diluent reproduction measurement applies the learnings from the pilots and first commercial trial

*Graph updated to Oct 31, 2019



Cumulative Production:

Fluid	Volume (km³)
Hydrocarbon	969
Diluent	84

Production Status:

Pad	Production Start	Production Status
H51	Q1 2018	At peak
H57	Q1 2018	Ramping
H58	Q3 2018	Ramping
H59	Q4 2018	Ramping
H62	Q1 2019	Ramping
H68	Q3 2017	Post peak rates
H69	Q3 2017	Post peak rates

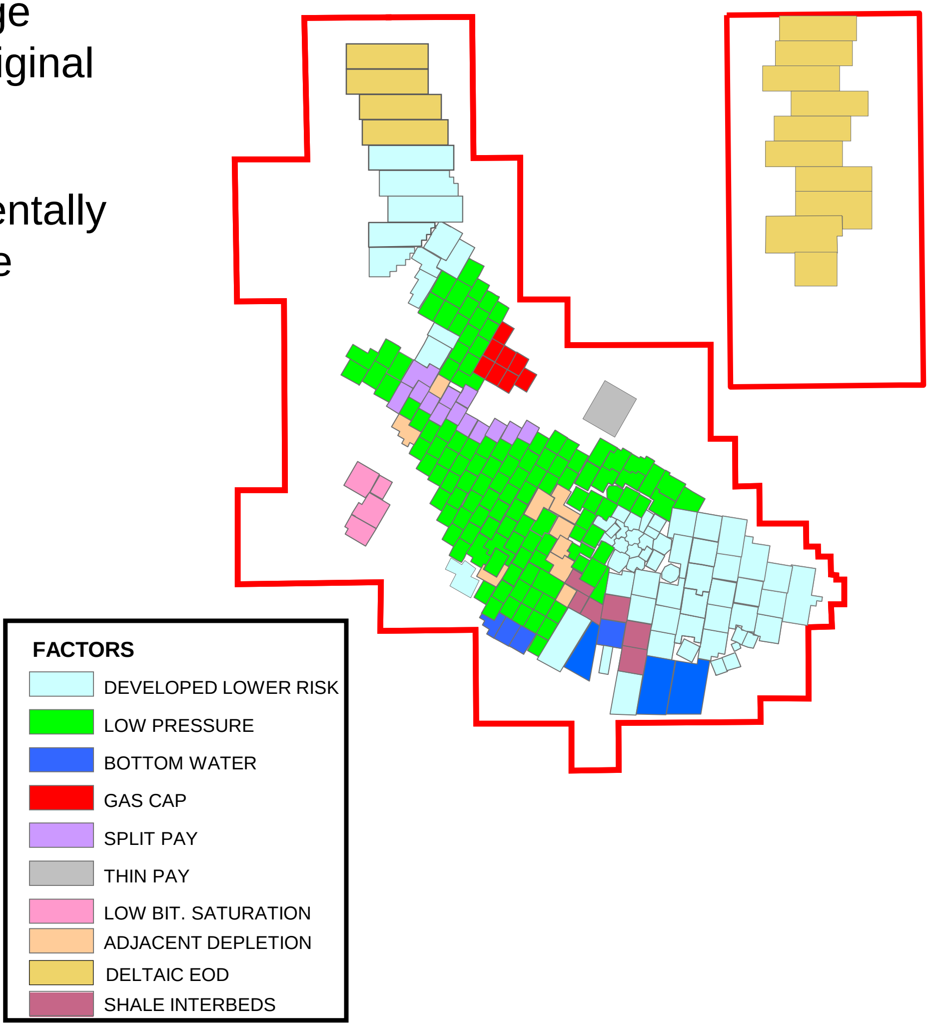
Factors Impacting Recovery

Factors Impacting Recovery

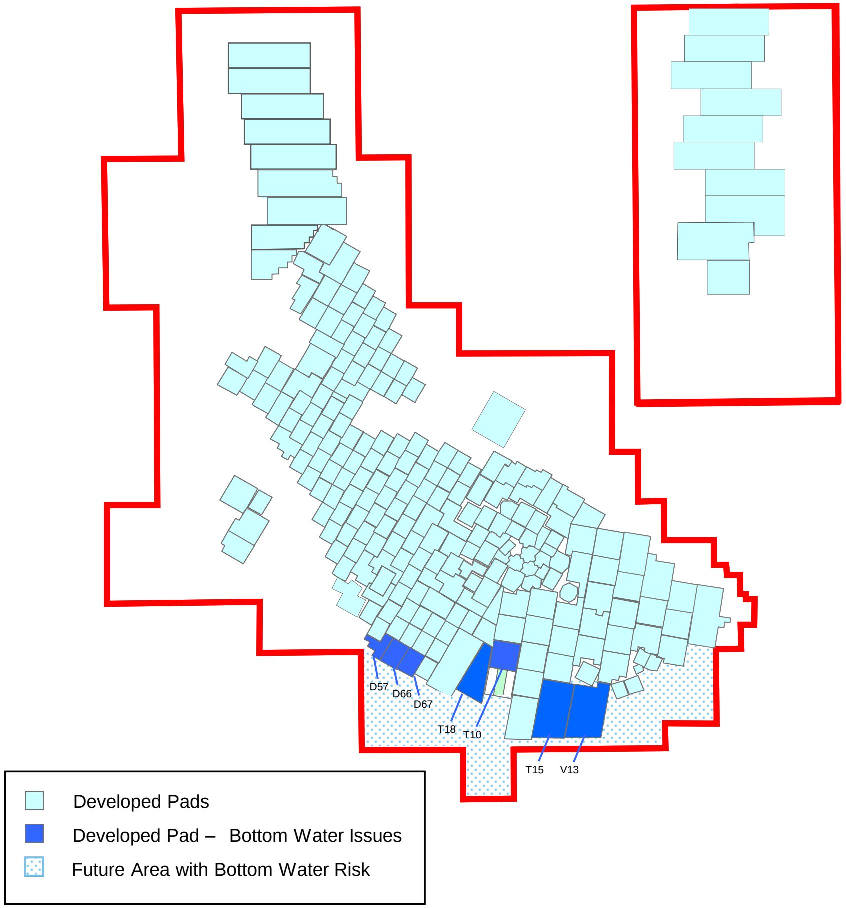
- Individual pad recovery expectations range from less than 10% to over 60% of the original effective bitumen in place

- The variation in recovery level is fundamentally a function of bitumen saturation and shale structure/distribution

- Additional reservoir challenges include:
  - Bottom water
  - Clearwater gas cap
  - Split pay
  - Adjacent reservoir depletion
  - Well Spacing



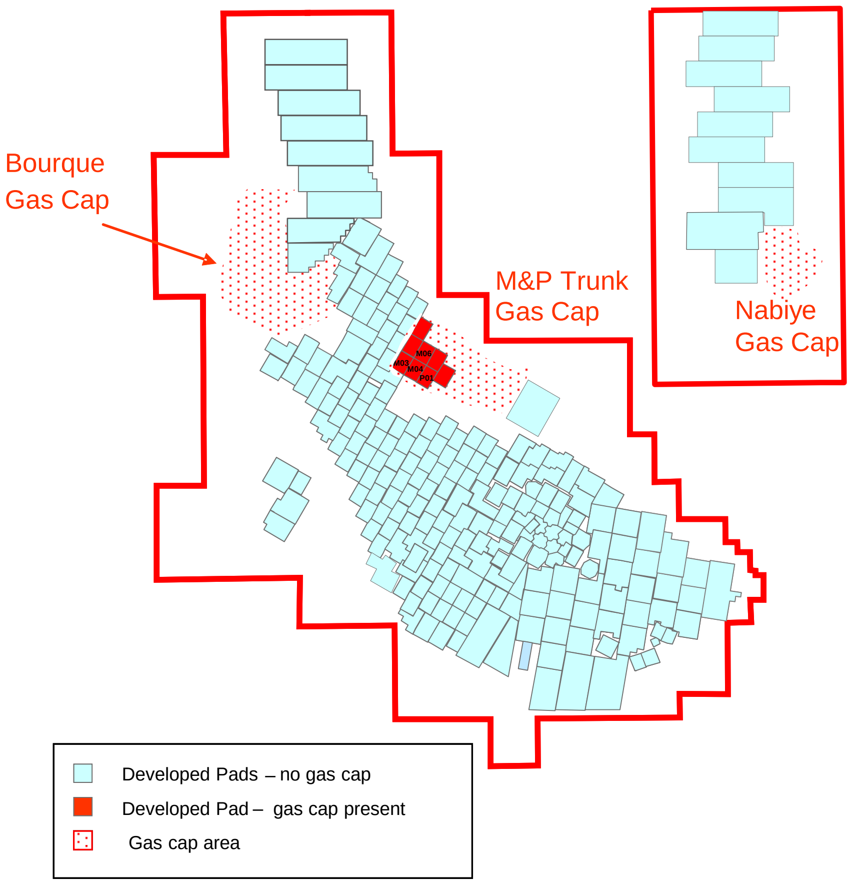
CSS Performance - Bottom Water



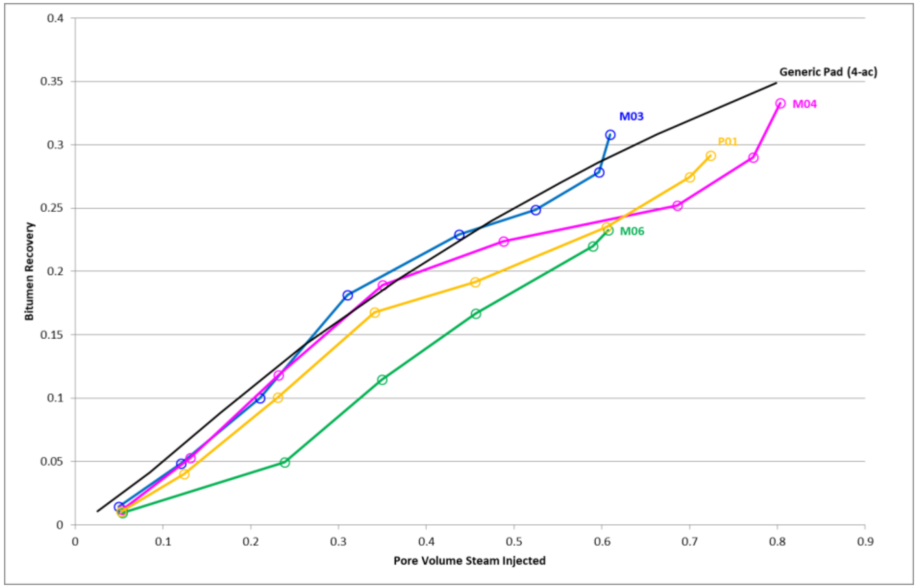
- Performance issues
  - Bottom water is a thief zone for steam injection
  - High mobility water excludes bitumen production
- Mitigation
  - Basal Wabiskaw shale provides seal for much of CLPP 1-13
  - Perforation standoff from transition zone and thin bottom water
  - Additional standoff required for thick bottom water in clean sand
  - Uphole recompletions of wet wells can be effective if sufficient separation is left between old and new perforations

Imperial | Cold Lake

CSS Performance - Gas Cap



Performance of Gas Cap Pads

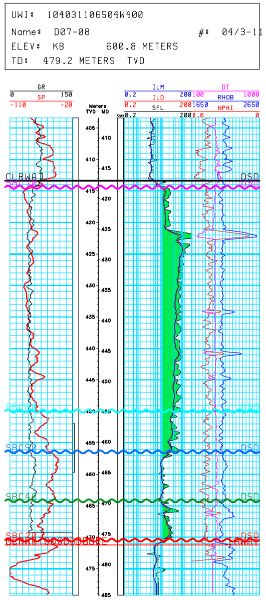


- Three significant Clearwater gas cap areas
  - M&P Trunk – producing
  - Bourque Lake gas cap – undeveloped
  - South Nabiye - undeveloped
- M&P Trunk pads exhibited poorer performance due to pressure losses to the gas cap
- Steaming all pads under a gas cap together reduces steam losses and improves performance
- Recovery expectations at M&P Trunk pads are 30-40% lower due to presence of gas cap

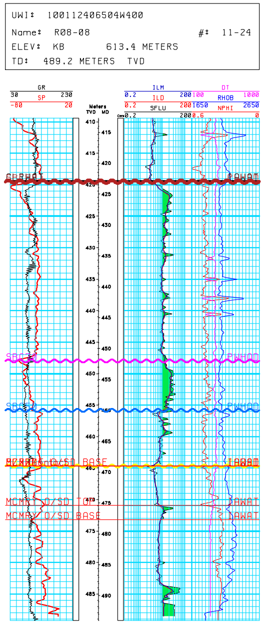
Imperial | Cold Lake

CSS Performance - Split Pay

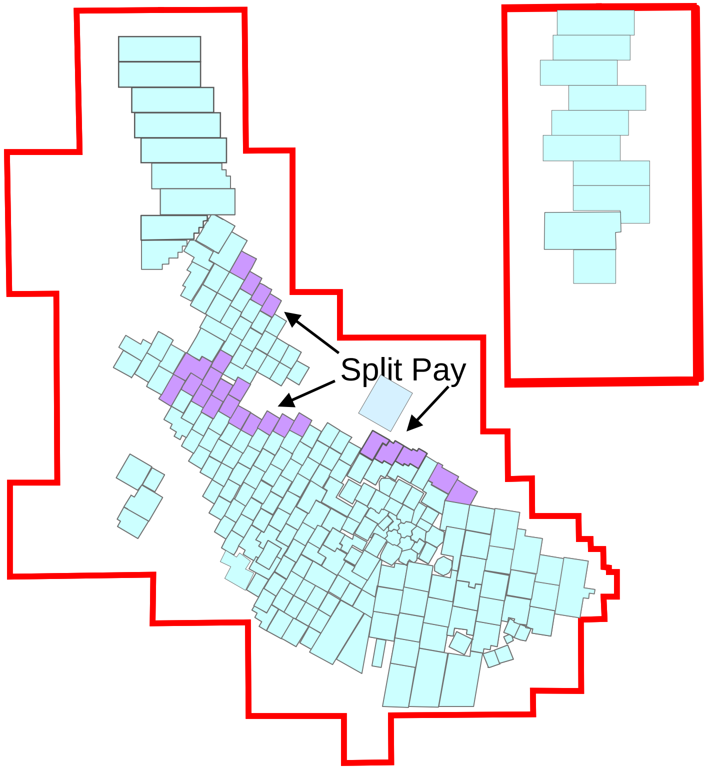
Thick Continuous Pay



Thin Split Pay



Interbedded sequence



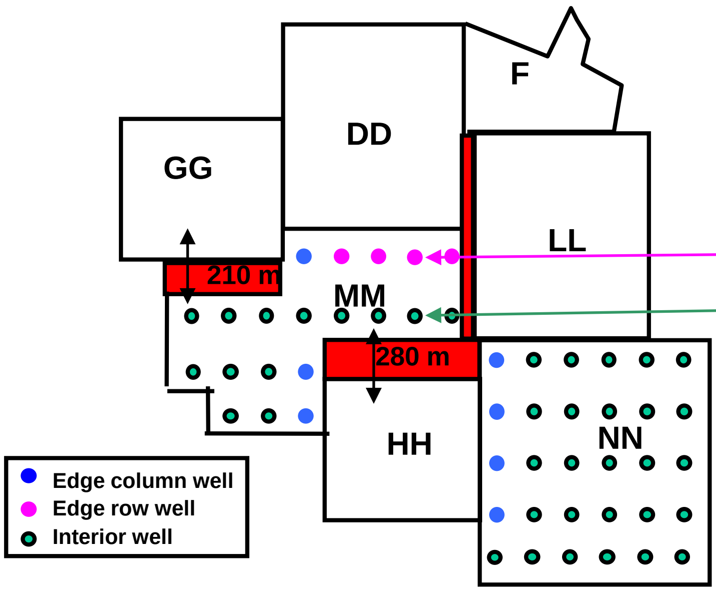
- Split pay occurs where an interbedded sequence has cut through lower reservoir sequences
- Interbedded sands and shales act as vertical permeability barrier between lower reservoir sequences and good quality sand in upper sequence

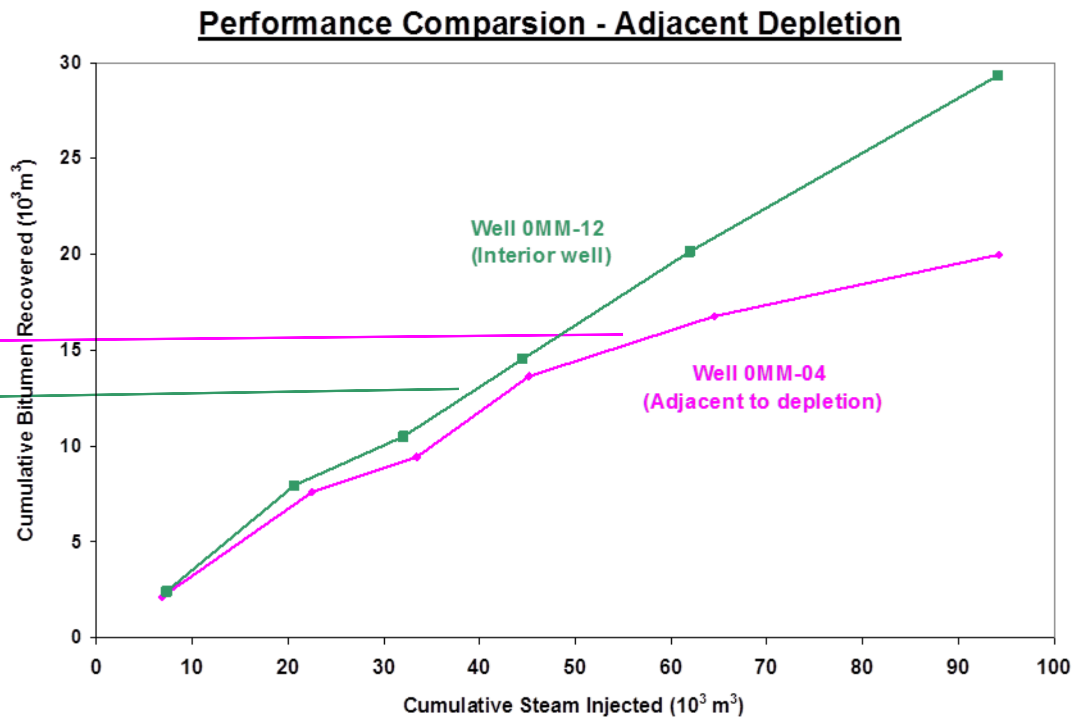
- Upper zone can be accessed through recompletion after lower zone depletion
- Concurrent depletion trials with limited entry perforations resulted in poor inflow performance
- Thin zones have substantially lower recovery due to heat losses to surrounding non-reservoir rock
- Split pay can be used to isolate effects of top fluids

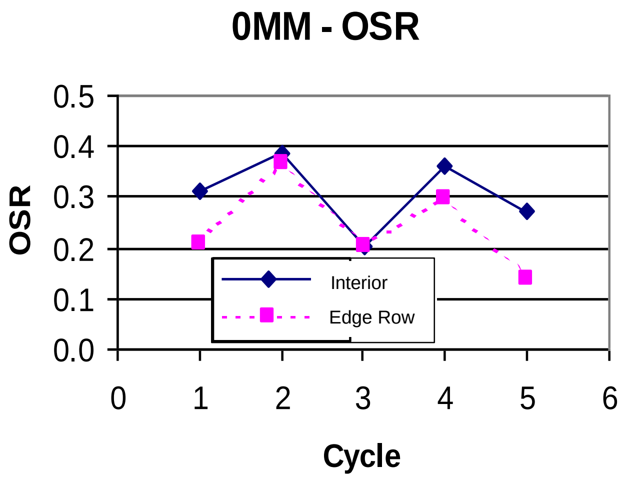
Imperial | Cold Lake

Adjacent to Depletion Example - MM Pad

- MM pad is adjacent to depletion in DD pad which acts as thief zone for steam



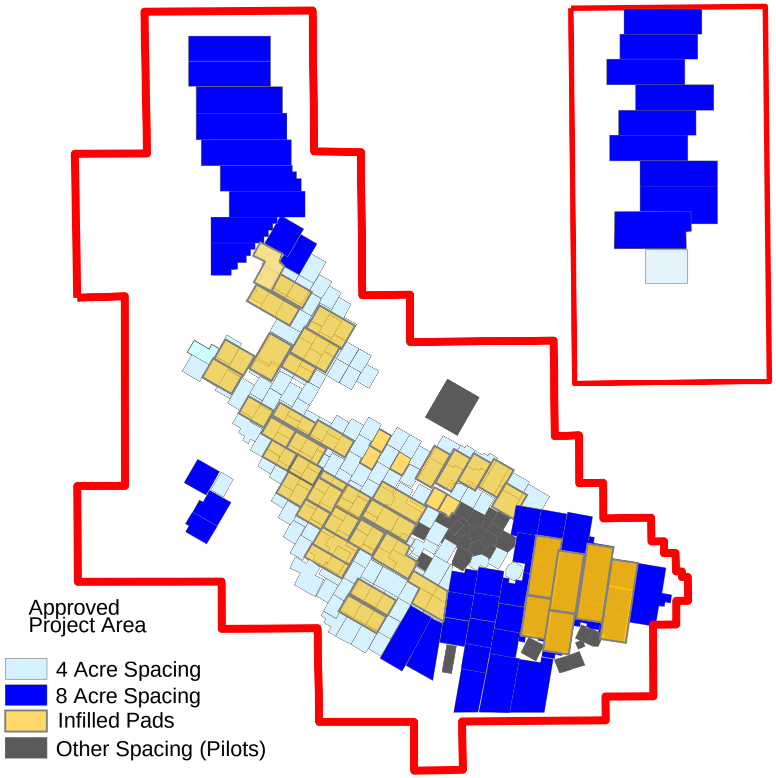




- Difficult to achieve high injection pressure after cycle 2 in edge row wells
- Low fluid production in edge row wells

Imperial | Cold Lake

Well Spacing



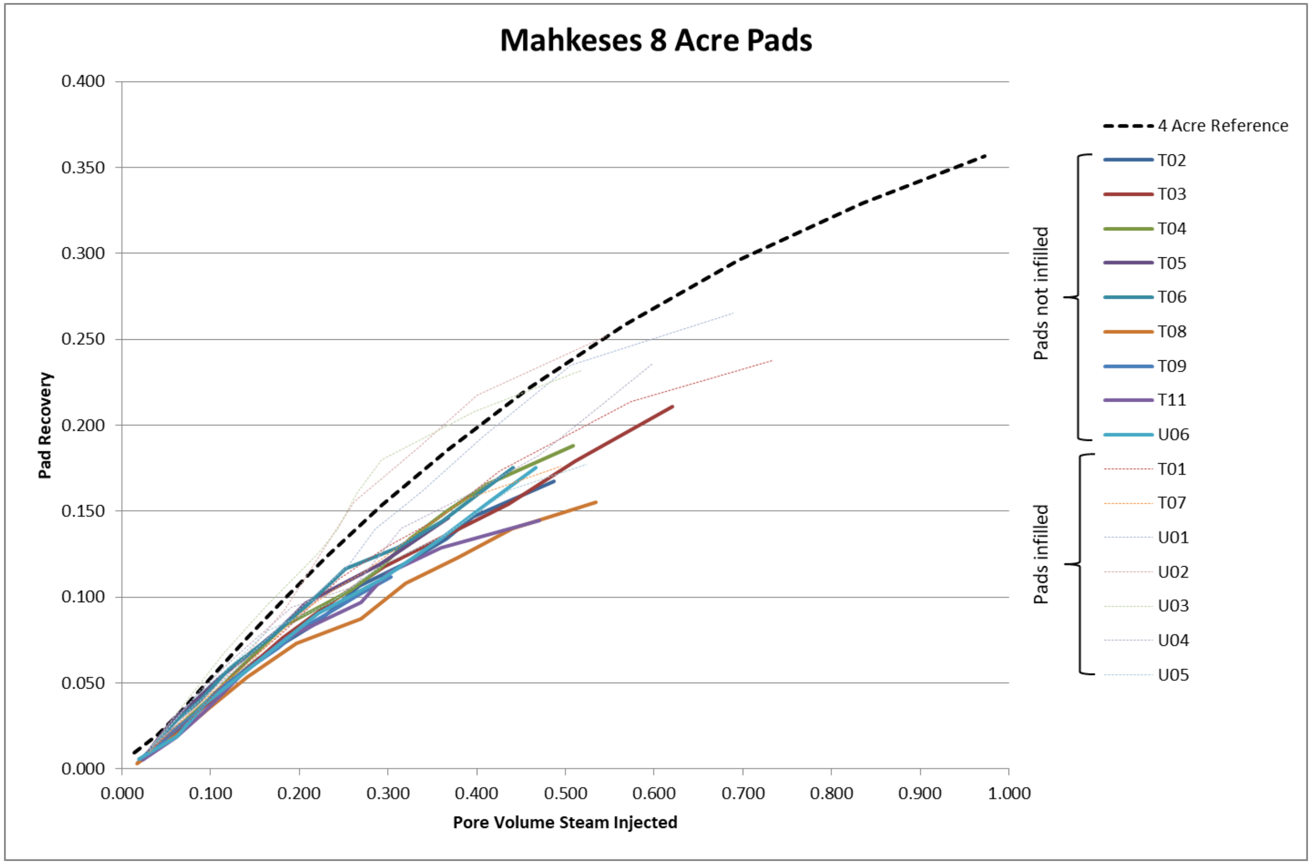
Infill Drilling

- Where economic, horizontal injector-only-infills are drilled between the rows of wells at mature pads
- Infill steam is directed to bypassed bitumen to increase recovery by 15 to 30% relative to CSS
- Infill steam injection volumes per pad are similar to CSS volumes
- For 8 Acre pads, infill wells can also be drilled as horizontal injection and production wells

- Commercial pads are developed on 4 acre, 8 acre or 11 acre well spacing
  - 4 acre spacing in the thicker central area of the field
  - 8 or 11 acre spacing in thinner resource areas
- Cycle steam injection volumes have been derived primarily from field operating experience with the objectives of:
  - Achieving high levels of reservoir conformance to mobilize cold bitumen
  - Managing inter-well communication
  - Limiting casing damage caused by shear stress
- Current steaming practices employ the same early cycle injection volume strategy for both 4 and 8 acre well spacings:[1 2]
  - > Cycle 1 8,000 m^3
  - > Cycle 2 7,000 m^3
  - > Cycle 3 8,000 m^3
  - Cycle 2 volumes are reduced because injected fluids are typically not fully reproduced in cycle 1
- Subsequent cycle high pressure steam injection volumes range up to 10,000 m^3 (volumes injected at dilation pressure)
  - Actual injection performance from previous cycles is used to develop the steaming strategy for an individual pad
- Wells drilled on 8 acre spacing are expected to operate through more cycles than those on 4 acre spacing
- Expected recovery from 8 acre spacing is approximately 80% of 4 acre recovery based on reservoir simulation
  - Existing 8 acre pads are not sufficiently mature to demonstrate lower recovery

[1]11 Acre Spacing steam strategy approved by the ERCB in July 2011 allowing for 12,000 m^3 over fill-up per cycle.
[2] At Nabiye the 1st two steam volumes are commissioning cycles (2500m3/bhl each). Cycle 1 volumes are limited 5,000 m3 per effective bottom-hole spacing. At N10 (4.7 acre) volume over fill-up is limited to 6000m3/bhl.

Impact of Well Spacing on Recovery



- 4 acre performance curve shown for equivalent resource to Mahkeses 8-acre pads
- Most mature Mahkeses pads not sufficiently depleted to validate ultimate recovery expectations

Pad Recovery

Pad	Net Pay (m)	Average Effective So	Effective OBIP (e3m3)	Drainage Area (m2)	Recovery to Sept 2019		Ultimate Recovery (% EBIP)
					e3m3	% EBIP	
00A	30	0.67	1184	193591	152	13%	EUR = Recovery to Date
00B	27	0.68	1772	231800	126	7%	EUR = Recovery to Date
00C	25	0.68	1559	211035	216	14%	EUR = Recovery to Date
00D	29	0.67	1236	169839	212	17%	EUR = Recovery to Date
00E	28	0.69	1257	207993	150	12%	EUR = Recovery to Date
00F	22	0.68	1079	152336	233	22%	EUR = Recovery to Date
00G	29	0.67	2097	262431	358	17%	EUR = Recovery to Date
00H	28	0.69	2010	257344	291	14%	EUR = Recovery to Date
00J	36	0.68	850	134339	249	29%	EUR = Recovery to Date
00K	31	0.70	1905	233962	489	26%	EUR = Recovery to Date
00L	35	0.72	2019	280504	450	22%	EUR = Recovery to Date
00M	26	0.66	982	129945	68	7%	EUR = Recovery to Date
00N	28	0.67	1648	245719	490	30%	EUR = Recovery to Date
00P	32	0.69	2341	331516	714	30%	EUR = Recovery to Date
00Q	35	0.73	1988	220552	342	17%	EUR = Recovery to Date
00R	33	0.71	1764	210698	116	7%	EUR = Recovery to Date
00S	26	0.68	1174	135701	136	12%	EUR = Recovery to Date
00T	35	0.70	2644	381551	846	32%	EUR = Recovery to Date
00U	28	0.76	2122	311961	1062	50%	50% - 52%
00V	29	0.74	2301	339636	757	33%	40% - 45%
00W	30	0.66	2103	337998	1373	65%	65% - 70%
0AA	30	0.69	2533	348059	1115	44%	EUR = Recovery to Date
0BB	32	0.66	2191	324732	1635	75%	75% - 77%
0EE	36	0.72	1854	273856	575	31%	EUR = Recovery to Date
0FF	34	0.70	1909	248143	1197	63%	63% - 65%
0HF	20	0.72	297	60352	102	34%	EUR = Recovery to Date
0HH	25	0.69	1210	218243	634	52%	52% - 55%
0LL	24	0.70	1734	327247	733	42%	42% - 45%
0MA	27	0.73	1454	202030	126	9%	EUR = Recovery to Date
0MB	29	0.70	1942	251322	452	23%	EUR = Recovery to Date
0MC	26	0.78	1087	206478	496	46%	EUR = Recovery to Date
0MD	30	0.73	816	209255	496	61%	EUR = Recovery to Date
0ME	31	0.71	2276	352968	533	23%	EUR = Recovery to Date

- Pad production updated to September 2019
- N10 Pad added to list
- Effective OBIP (Original Oil in Place) is volume of bitumen >8 wt% between top of Effective Pay and base of Effective Pay

Pad Recovery

Pad	Net Pay (m)	Average Effective So	Effective OBIP (e3m3)	Drainage Area (m2)	Recovery to Sept 2019		Ultimate Recovery (% EBIP)
					e3m3	% EBIP	
0MM	23	0.69	1659	336044	699	42%	42% - 45%
0NN	24	0.69	2613	521709	993	38%	40% - 45%
A01	31	0.69	2230	326575	955	43%	43% - 45%
A02	34	0.69	2486	334641	1114	45%	45% - 47%
A03	31	0.69	2235	335477	971	43%	43% - 45%
A04	35	0.77	2837	330758	1480	52%	52% - 55%
A05	28	0.69	1980	326066	806	41%	41% - 45%
A06	32	0.73	2554	335476	1121	44%	44% - 45%
B01	28	0.69	2058	327676	939	46%	46% - 50%
B02	26	0.74	2045	327521	1034	51%	51% - 55%
B03	28	0.73	2104	325540	1196	57%	57% - 60%
B04	27	0.70	2005	339121	998	50%	50% - 55%
B05	27	0.70	1998	326038	1457	73%	73% - 75%
B06	27	0.70	2013	329908	1073	53%	53% - 55%
C01	30	0.69	2150	330162	915	43%	43% - 45%
C02	26	0.71	1984	328513	1130	57%	57% - 60%
C03	32	0.73	2405	324721	1706	71%	71% - 73%
C04	26	0.73	1971	339736	926	47%	50% - 55%
C05	26	0.72	1946	326483	792	41%	41% - 45%
C08	34	0.70	5074	654866	1179	23%	50% - 60%
D01	30	0.69	2199	329560	987	45%	45% - 50%
D02	31	0.70	2233	327006	818	37%	45% - 55%
D03	39	0.70	2818	318726	1276	45%	45% - 50%
D04	41	0.76	3269	331740	1663	51%	51% - 60%
D05	38	0.75	2956	325578	1689	57%	57% - 65%
D06	48	0.81	3980	322502	2873	72%	75% - 77%
D07	42	0.78	3498	330569	2175	62%	65% - 70%
D09	40	0.79	3305	330529	2384	72%	75% - 77%
D10	41	0.78	3307	325822	2131	64%	65% - 70%
D11	24	0.71	2431	319000	80	3%	EUR = Recovery to Date
D12	28	0.71	2135	337254	563	26%	26% - 35%
D21	28	0.68	2014	328433	792	39%	45% - 50%
D22	34	0.75	2659	331754	1399	53%	53% - 55%
D23	40	0.72	2934	321196	1448	49%	50% - 60%
D24	29	0.67	2007	325503	911	45%	50% - 55%

Imperial | Cold Lake

Pad Recovery

Pad	Net Pay (m)	Average Effective So	Effective OBIP (e3m3)	Drainage Area (m2)	Recovery to Sept 2019		Ultimate Recovery (% EBIP)
					e3m3	% EBIP	
D25	35	0.72	2597	326409	1247	48%	48% - 55%
D26	37	0.79	3021	325318	1571	52%	52% - 55%
D27	34	0.72	2562	324687	1041	41%	41% - 43%
D28	30	0.68	2430	356683	814	33%	40% - 50%
D31	42	0.76	5743	561922	2440	42%	50% - 65%
D33	36	0.75	4385	499814	2005	46%	55% - 70%
D35	38	0.73	3427	368988	1038	30%	50% - 60%
D36	34	0.76	3447	431876	1108	32%	50% - 60%
D39	32	0.69	3867	555722	1103	29%	40% - 50%
D51	36	0.80	3019	332199	1189	39%	60% - 65%
D52	36	0.76	2904	333491	791	27%	27% - 30%
D53	33	0.74	2610	345284	1564	60%	55% - 65%
D54	23	0.69	1705	334858	651	38%	38% - 40%
D55	19	0.68	1363	327587	650	48%	48% - 50%
D62	33	0.76	2563	315544	1384	54%	55% - 70%
D63	30	0.70	2213	333936	1134	51%	55% - 65%
D64	32	0.76	2499	316147	1598	64%	64% - 65%
D65	30	0.75	2427	331446	1197	49%	50% - 60%
D66	13	0.73	1498	494818	187	12%	EUR = Recovery to Date
D67	27	0.74	3180	496595	685	22%	25% - 35%
E01	30	0.67	3179	514745	1152	36%	50% - 60%
E02	27	0.68	2321	409248	971	42%	42% - 50%
E03	29	0.67	2025	320130	936	46%	46% - 50%
E04	31	0.68	2293	343432	890	39%	40% - 50%
E05	31	0.67	3843	583592	1151	30%	50% - 60%
E07	34	0.68	2438	330043	263	11%	20% - 25%
E08	24	0.67	1734	328747	608	35%	35% - 40%
E09	26	0.73	1971	330440	709	36%	36% - 40%
E10	25	0.74	1946	330934	626	32%	32% - 40%
E11	20	0.71	8736	1846967	1301	15%	35% - 50%
F01	27	0.70	2770	454370	1127	41%	41% - 43%
F02	20	0.70	2174	484521	783	36%	36% - 40%
F03	28	0.71	3166	490118	1504	47%	47% - 55%
F04	20	0.69	2242	494641	1105	49%	49% - 55%
F05	27	0.74	2995	468232	1790	60%	60% - 65%

Pad Recovery

Pad	Net Pay (m)	Average Effective So	Effective OBIP (e3m3)	Drainage Area (m2)	Recovery to Sept 2019		Ultimate Recovery (% EBIP)
					e3m3	% EBIP	
F06	19	0.72	2141	482036	1119	52%	52% - 55%
F07	27	0.70	3282	541922	1574	48%	50% - 60%
F08	9	0.70	2687	1156520	502	19%	19% - 25%
G01	30	0.73	3852	559883	1759	46%	50% - 60%
G02	21	0.69	2585	573215	1171	45%	50% - 60%
G03	15	0.67	1734	561124	1183	68%	68% - 70%
H01	35	0.75	2763	329061	1887	68%	70% - 72%
H02	25	0.75	1949	328573	1196	61%	61% - 65%
H03	15	0.67	1048	328976	449	43%	43% - 50%
H04	17	0.71	1249	326043	514	41%	45% - 50%
H05	21	0.70	1547	330248	348	22%	25% - 30%
H10	17	0.67	2101	562300	633	30%	30% - 35%
H11	20	0.71	2234	488848	1344	60%	65% - 70%
H14	28	0.68	2043	330480	382	19%	20% - 25%
H15	28	0.72	3079	483319	1238	40%	40% - 50%
H16	30	0.74	2366	331325	982	42%	45% - 50%
H18	34	0.77	2718	329107	867	32%	35% - 45%
H19	26	0.77	2074	331169	1138	55%	65% - 70%
H21	30	0.76	2421	329180	1270	52%	60% - 65%
H22	34	0.77	2720	327643	1374	51%	51% - 60%
H23	34	0.77	4105	491422	2208	54%	65% - 70%
H24	29	0.77	2332	327075	753	32%	32% - 35%
H25	32	0.76	3786	489048	1935	51%	60% - 70%
H26	29	0.78	3574	493206	1168	33%	33% - 35%
H27	33	0.79	4048	489320	1468	36%	40% - 50%
H31	28	0.75	2161	327260	932	43%	45% - 50%
H32	29	0.74	2208	326110	740	34%	34% - 35%
H33	26	0.71	1923	329580	592	31%	35% - 40%
H34	20	0.72	1460	322027	323	22%	22% - 25%
H35	19	0.71	1447	329729	341	24%	25% - 35%
H36	22	0.72	1664	330145	354	21%	21% - 25%
H37	16	0.72	1838	491579	523	28%	30% - 35%
H39	22	0.74	3892	822158	585	15%	40% - 50%
H40	33	0.69	2949	411352	987	33%	45% - 55%
H41	27	0.73	4939	820397	1979	40%	60% - 65%

Pad Recovery

Pad	Net Pay (m)	Average Effective So	Effective OBIP (e3m3)	Drainage Area (m2)	Recovery to Sept 2019		Ultimate Recovery (% EBIP)
					e3m3	% EBIP	
H42	28	0.73	3181	481582	1525	48%	55% - 65%
H45	32	0.75	4343	606922	1023	24%	30% - 40%
H46	26	0.72	3557	598473	1578	44%	50% - 65%
H47	22	0.73	4901	984121	1185	24%	50% - 65%
H51	25	0.72	6700	1178021	1107	17%	40% - 50%
H57	21	0.72	8733	1113929	1481	17%	35% - 50%
H58	18	0.68	8726	2163530	2172	25%	40% - 50%
H59	18	0.70	9191	2185009	2464	27%	30% - 40%
H62	15	0.69	9144	1611388	1613	18%	20% - 40%
H63	11	0.67	6798	1630112	1362	20%	20% - 35%
H65	12	0.67	7266	1632973	1534	21%	21% - 35%
H68	13	0.68	7016	1510135	1308	19%	20% - 35%
H69	13	0.68	7816	1606809	931	12%	20% - 35%
J01	38	0.77	3002	322674	2211	74%	75% - 77%
J02	25	0.76	1926	319882	1355	70%	72% - 74%
J03	31	0.78	2576	334676	1806	70%	72% - 74%
J04	35	0.78	2804	323742	1907	68%	68% - 70%
J05	20	0.74	1515	326851	891	59%	60% - 65%
J06	31	0.74	2451	338008	1084	44%	50% - 60%
J07	28	0.75	2147	325143	1854	86%	86% - 88%
J08	34	0.83	3027	331895	2724	90%	90% - 92%
J10	36	0.83	3068	318930	2163	71%	71% - 73%
J11	37	0.80	3136	316976	1307	42%	42% - 50%
J12	34	0.80	2773	309991	1970	71%	71% - 73%
J13	40	0.86	3480	310583	2583	74%	75% - 77%
J14	43	0.82	3692	335978	1724	47%	65% - 70%
J15	39	0.84	3356	321799	2463	73%	73% - 75%
J16	41	0.82	3424	315616	2103	61%	65% - 70%
J21	32	0.78	2584	342840	1459	56%	56% - 60%
J25	30	0.75	2358	324313	904	38%	38% - 40%
J27	25	0.80	2080	328353	427	21%	21% - 25%
K23	15	0.65	2648	848469	684	26%	26% - 30%
K24	11	0.65	1897	809848	508	27%	27% - 30%
K26	14	0.66	1954	645847	307	16%	16% - 20%
L05	27	0.67	2831	495108	1398	49%	50% - 60%

Pad Recovery

Pad	Net Pay (m)	Average Effective So	Effective OBIP (e3m3)	Drainage Area (m2)	Recovery to Sept 2019		Ultimate Recovery (% EBIP)
					e3m3	% EBIP	
L06	20	0.72	2234	490761	1636	73%	75% - 77%
L07	20	0.74	2382	501860	1595	67%	67% - 70%
L08	8	0.65	812	473030	485	60%	60% - 65%
L09	24	0.66	2332	540745	499	21%	25% - 30%
L11	25	0.69	2755	489823	1580	57%	57% - 65%
M03	36	0.75	2807	327035	864	31%	31% - 35%
M04	32	0.76	2599	330753	865	33%	35% - 45%
M05	26	0.73	1998	327665	556	28%	30% - 35%
M06	25	0.73	1977	333545	459	23%	25% - 30%
M07	20	0.68	1454	328371	327	22%	22% - 25%
N01	19	0.65	10286	1466751	1191	12%	20% - 40%
N02	17	0.65	9255	1466266	793	9%	15% - 35%
N03	16	0.64	8243	1456341	622	8%	20% - 35%
N04	16	0.64	8306	1464531	741	9%	20% - 35%
N05	13	0.65	6720	1463532	575	9%	15% - 30%
N06	13	0.64	6215	1175505	460	7%	15% - 25%
N07	15	0.64	7349	1275777	506	7%	20% - 35%
N08	15	0.64	8701	1356662	613	7%	20% - 35%
N09	15	0.63	10867	2175394	537	5%	20% - 40%
N10	18	0.65	5686	1461900	46	1%	20% - 30%
P01	35	0.77	2730	317709	796	29%	30% - 35%
P02	25	0.73	1894	317130	347	18%	18% - 20%
P03	28	0.76	2255	329951	490	22%	22% - 25%
R01	32	0.74	2410	313829	1218	51%	51% - 55%
R02	32	0.71	2341	317549	927	40%	40% - 45%
R03	35	0.68	2580	336378	818	32%	35% - 40%
R04	28	0.70	2089	332424	504	24%	25% - 30%
R05	24	0.68	1734	325946	692	40%	40% - 50%
R06	17	0.71	1293	324779	475	37%	37% - 40%
R07	22	0.71	1631	337454	664	41%	41% - 43%
T01	28	0.72	4759	743062	1128	24%	40% - 50%
T02	29	0.71	5216	806525	870	17%	35% - 45%
T03	23	0.70	3997	775850	842	21%	25% - 35%
T04	23	0.68	3908	775056	735	19%	25% - 35%
T05	31	0.69	5528	774841	808	15%	25% - 35%

Pad Recovery

Pad	Net Pay (m)	Average Effective So	Effective OBIP (e3m3)	Drainage Area (m2)	Recovery to Sept 2019		Ultimate Recovery (% EBIP)
					e3m3	% EBIP	
T06	29	0.70	4696	710449	823	18%	40% - 50%
T07	33	0.72	5676	745035	999	18%	35% - 45%
T08	30	0.72	5401	774990	838	16%	35% - 45%
T09	29	0.70	5005	775378	560	11%	35% - 45%
T10	35	0.70	5996	774721	587	10%	15% - 20%
T11	26	0.70	4499	774660	650	14%	20% - 25%
T12	26	0.70	4553	775105	757	17%	20% - 30%
T14	19	0.72	6287	1404366	926	15%	25% - 40%
T15	19	0.72	9624	2275165	1158	12%	20% - 35%
T18	18	0.69	5366	1129443	616	11%	25% - 35%
U01	26	0.70	4668	809886	1236	26%	40% - 50%
U02	23	0.67	3772	777104	1039	28%	45% - 55%
U03	29	0.69	4931	775924	1141	23%	50% - 55%
U04	30	0.72	5162	742187	1211	23%	35% - 50%
U05	33	0.71	5912	805485	1047	18%	35% - 45%
U06	23	0.68	3840	776382	708	18%	20% - 30%
U07	22	0.68	5617	1177350	915	16%	25% - 35%
U08	20	0.68	4523	1052598	995	22%	25% - 40%
U09	21	0.69	3822	824646	975	26%	30% - 45%
V01	29	0.69	4915	775459	1151	23%	40% - 50%
V02	29	0.72	5226	775578	1003	19%	25% - 35%
V03	24	0.71	4454	807966	798	18%	20% - 30%
V04	29	0.71	4934	740131	1173	24%	40% - 55%
V05	27	0.67	4666	790676	1136	24%	40% - 55%
V08	30	0.72	5380	775455	1262	23%	40% - 55%
V09	27	0.77	4978	740326	1235	25%	40% - 50%
V10	20	0.71	8774	2046491	1539	18%	25% - 40%
V13	18	0.71	8516	2003100	1027	12%	15% - 25%
Y16	29	0.67	2444	439317	951	39%	40% - 50%
Y31	30	0.67	2146	326381	734	34%	40% - 50%
Y32	35	0.67	2539	328955	357	14%	45% - 50%
Y34	29	0.68	2123	376127	709	33%	40% - 45%
Y36	33	0.68	2917	437859	888	30%	40% - 50%

Future Plans

Pad Steaming Priorities

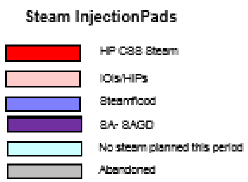
- Long-term steam plans developed annually
  - Targeted cycle timing based on historical performance and optimal cycle length
  - Development plans tied to projected steam demand at each site to fully utilize installed steam capacity

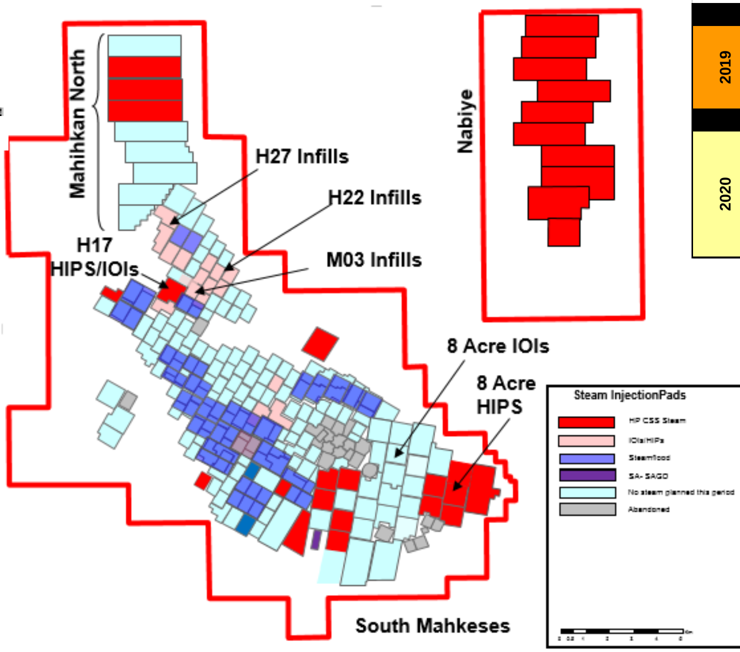
- Earlier cycle pads receive priority during periods of steam demand higher than plant capacity and for scheduling considerations
  - Pads are steamed less frequently as they mature (steam timing is less critical to performance)
  - Individual pad steaming suspended at an economic limit
  - Infill steamflood pads can operate effectively at a range of steaming rates, providing flexibility to steam scheduling

- Steam patterns are developed to balance cycle timing optimization, shear stress management and interwell communication

- Additional factors
  - Setback requirements between drilling and steaming operations

Steam Plans to End 2020





Steamflood Pads Steaming

	Infills	Plant	Status
Steamflood	T05 Infills	Leming	Steamflood
	00U Infills	Leming	Steamflood
	0FF Infills	Leming	Steamflood
	G02 Infills	Leming	Steamflood
	H01 Infills	Mahihkan	Steamflood
	H04 Infills	Mahihkan	Steamflood
	H11 Infills	Mahihkan	Steamflood
	H15 Infills	Mahihkan	Steamflood
	H17 Infills	Mahihkan	Steamflood
	H22 Infills	Mahihkan	Steamflood
	H24 Infills	Mahihkan	Steamflood
	J06 Infills	Mahihkan	Steamflood
	J07 Infills	Mahihkan	Steamflood
	J08 Infills	Mahihkan	Steamflood
	J10 Infills	Mahihkan	Steamflood
	J16 Infills	Mahihkan	Steamflood
	L09 Infills	Mahihkan	Steamflood
	A06 Infills	Maskwa	Steamflood
	D01 Infills	Maskwa	Steamflood
	D02 Infills	Maskwa	Steamflood
	D03 Infills	Maskwa	Steamflood
	D04 Infills	Maskwa	Steamflood
	D05 Infills	Maskwa	Steamflood
	D06 Infills	Maskwa	Steamflood
	D07 Infills	Maskwa	Steamflood
	D10 Infills	Maskwa	Steamflood
	D12 Infills	Maskwa	Steamflood
	D22 Infills	Maskwa	Steamflood
	D24 Infills	Maskwa	Steamflood
	E08 Infills	Maskwa	Steamflood
	E09 Infills	Maskwa	Steamflood
	F02 Infills	Maskwa	Steamflood
	F03 Infills	Maskwa	Steamflood

Mahihkan Steam Schedule

	Pad	Date	Cycle	Status	Steam Volume (m3/BHL Equivalent)
2019	M03 IOI	Apr	1	LPIOI	15,000
	H63	Jun	6	HPCSS	18,000
	H65	Sep	8	HPCSS	18,000
	H27 IOI	Sep	1	LPIOI	18,000
2020	H17 HIP	Jan	4	HPCSS	10,000
	L09	Jun	7	HPCSS	25,000
	M03 IOI	Jun	2	LPIOI	15,000
	H27 IOI	Sep	2	LPIOI	15,000
	H41	Oct	11	LPIOI	10,000
	H68	Nov	7	HPCSS	16,000

Maskwa Steam Schedule

	Pad	Date	Cycle	Status	Steam Volume (m3/BHL Equivalent)
2020	F08	Jan	7	HPCSS	17,000
	D40	Feb	1	HPCSS	7,000
	D29	May	7	CSD	32,000
	D40	Nov	2	HPCSS	8,000

Leming Steam Schedule

	Pad	Date	Cycle	Comments	Steam Volume (m3/BHL Equivalent)
2020	Y32	Jan	7	Subfrac	17000

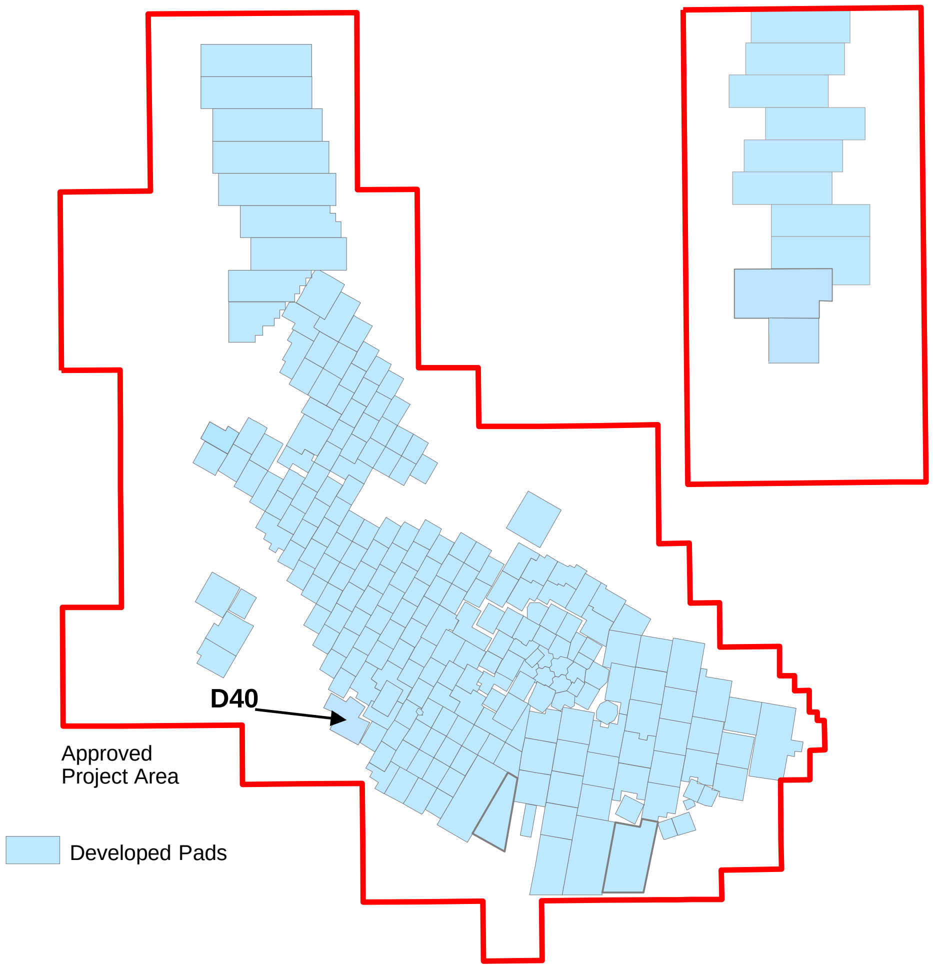
Nabiye Steam Schedule

	Pad	Date	Cycle	Status	Steam Volume (m3/BHL Equivalent)
2019	N07	Aug	7	HPCSS	6,000
	N08	Sep	6	HPCSS	6,000
	N10	Oct	3	HPCSS	5,000
	N09	Nov	6	HPCSS	5,000
	N02	Dec	7	HPCSS	7,000
2020	N03	Jan	7	HPCSS	6,000
	N04	Feb	8	HPCSS	7,000
	N05	Feb	8	HPCSS	7,000
	N06	Mar	8	HPCSS	6,000
	N07	Apr	8	HPCSS	6,000
	N08	May	7	HPCSS	6,000
	N09	Jun	7	HPCSS	6,000
	N10	Jul	4	HPCSS	5,000
	N01	Aug	8	HPCSS	10,000
	N02	Sep	8	HPCSS	7,000
	N03	Oct	8	HPCSS	6,000
	N04	Nov	9	HPCSS	7,000
	N05	Dec	9	HPCSS	7,000

Mahkeses Steam Schedule

	Pad	Date	Cycle	Status	Steam Volume (m3/BHL Equivalent)
2019	T18 Pad	Jul	6	HPCSS	22,000
	V28 HIPs (1-5)	Aug	4	HPCSS	15,000
	U09 Pad	Aug	9	HPCSS	27,000
	V05 Pad	Oct	10	HPCSS	43,000
	V09 HIPs (25-28)	Nov	4	HPCSS	15,000
	V08 Pad	Dec	10	HPCSS	42,000
2020	V04 HIPs (25-28)	Jan	1	HPCSS	7,000
	V28 HIPs (6-9)	Feb	4	HPCSS	15,000
	V09 Pad	Feb	10	HPCSS	45,000
	V04 Pad	Feb	10	HPCSS	30,000
	V10 Pad	Feb	8	HPCSS	28,000
	V05 HIPs (6-9)	Apr	1	HPCSS	7,000
	T12 Pad	Apr	11	HPCSS	30,000
	T09 Pad	May	11	HPCSS	29,000
	T06 Pad	Jul	12	HPCSS	40,000
	T05 Pad	Aug	12	HPCSS	35,000
	V04 HIPs (25-28)	Sep	2	HPCSS	9,000
	T04 Pad	Oct	12	HPCSS	40,000
	V05 HIPs (6-9)	Oct	2	HPCSS	7,000

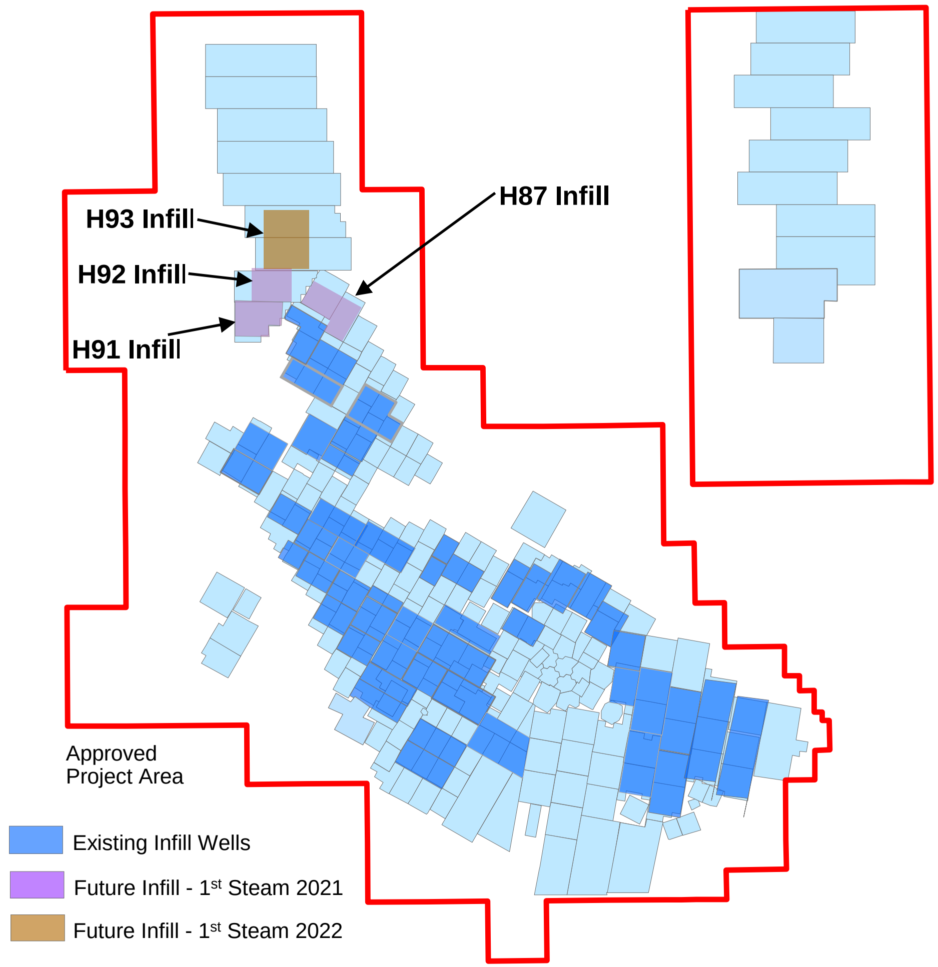
Pad Development Program



Pad	Drill Year	1st Steam
D40	2019	2020

Imperial | Cold Lake

Infill Drilling Program



Potential Drill and Steam Schedule

Infill Pad	Drill Year	1st Steam
H91	2020	2021
H92	2020	2021
H87	2020	2021
H93	2021	2022

Imperial | Cold Lake

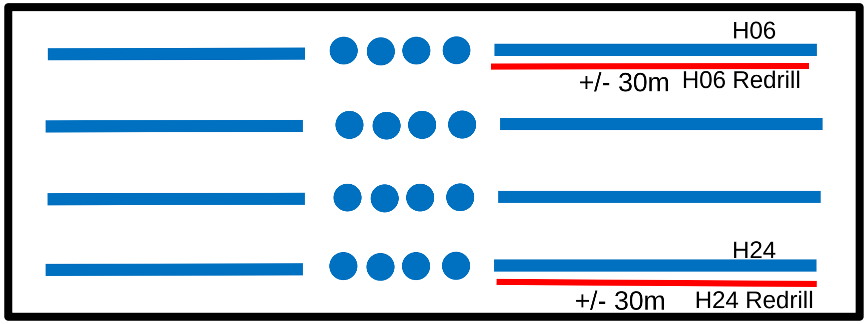
H58 Redrill Program

- Pad Status
  - H58-H06 and H24 were Clearwater Abandoned in 2015 after suspected Clearwater Top Failure
  - H58-H06 was converted to Lower Grand Rapids Monitoring Well in December 2017
  - H58 Pad is in CSS Cycle 8 production

- Project Scope
  - To redrill two horizontal wells with +/- 30m offset to the existing wellbores without adding any additional surface facilities

- Backup Project Scope
  - If issues encountered during redrilling, then drill maximum two Horizontal Injector Producers (HIPs) on the west side of the pad to infill western CSS horizontal wells

H58



T-13
SA-SAGD Pilot

Summary

Solvent Assisted - Steam Assisted Gravity Drainage pilot

Pilot Design:

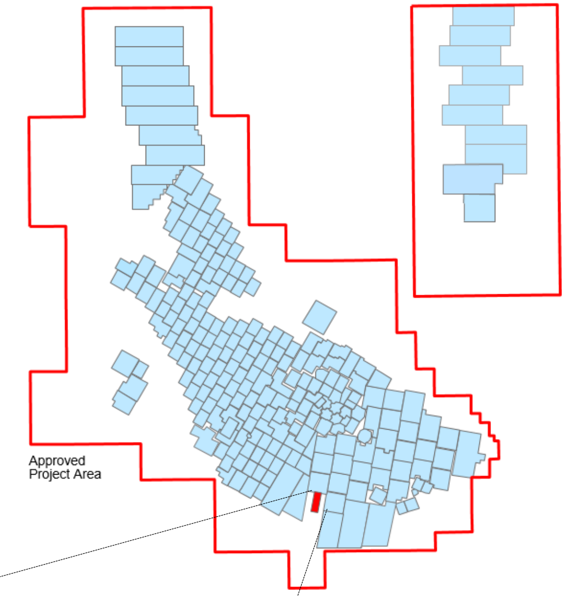
- Two horizontal well pairs (four wells)
- Six observation wells (OB wells)
- Injection and testing facilities
- Located in Mahkeses Field

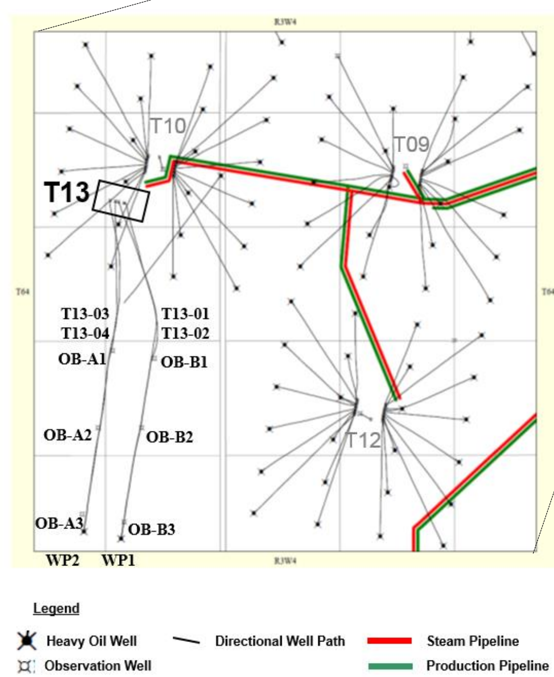
Key Milestones

- Q4 2009: Pilot start-up
- 2010 - 2012: WP2 SA-SAGD, WP1 SAGD
- 2012 - 2016: WP2 SAGD, WP1 SA-SAGD
- 2016: WP2 Shut-in, WP1 SAGD
- 2018: WP2 restarted SAGD
- 2019: WP1 instrumentation workover

Recovery to date:

	Cumulative Hydrocarbon Production (km3)	OBIP (km3)
T13	**231**	**1062**

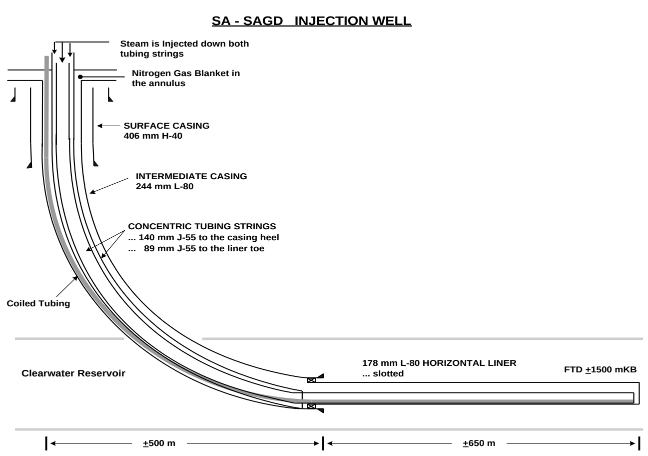


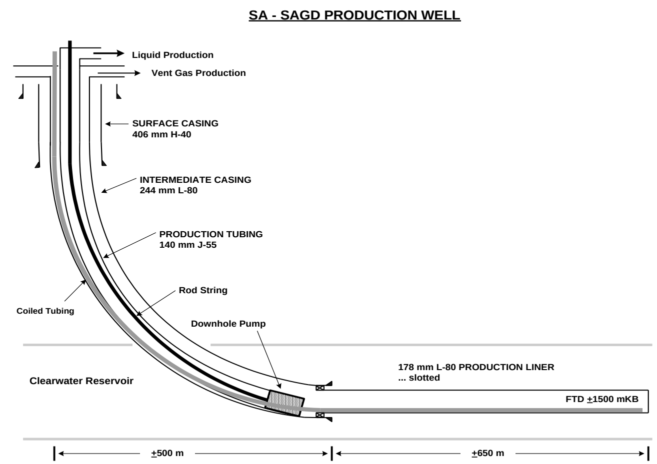


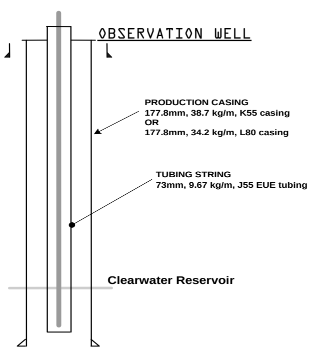
Imperial | Cold Lake

Well Schematics (SAGD / SA-SAGD Mode)

Well Type	Well configuration	Instrumentation
Injector	- Horizontal slotted liner - Toe / heel tubing injection strings - Intermediate casing - Instrumentation encased in a coiled tubing	- 12 thermocouples
Producer	- Horizontal slotted liner - Downhole pump at heel - Production tubing - Intermediate casing - Instrumentation encased in a coiled tubing	Well 3 - 3 bubble tubes & 20 thermocouples Well 1 - 10 ERD™ pressure & temperature measurements - DTS fiber
Observation	- Production casing - Tubing string for instrumentation	- 27 to 34 thermocouples (vary per well)







Imperial | Cold Lake

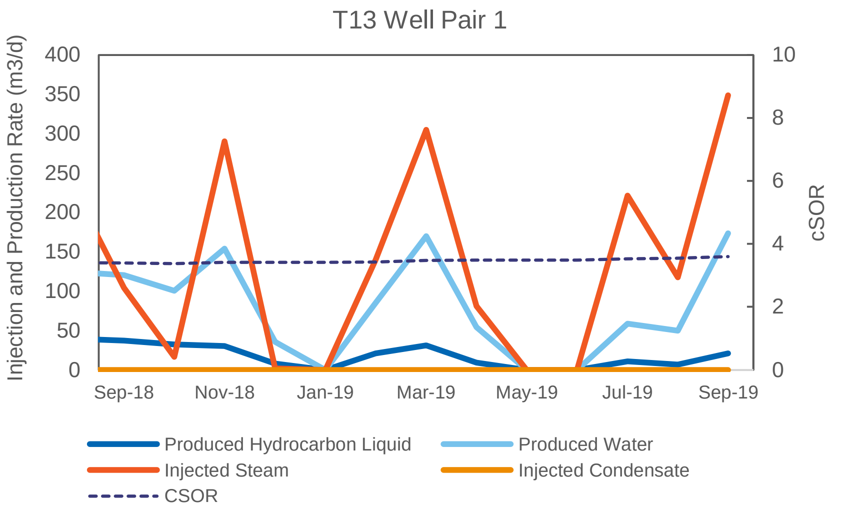
2019 Overview

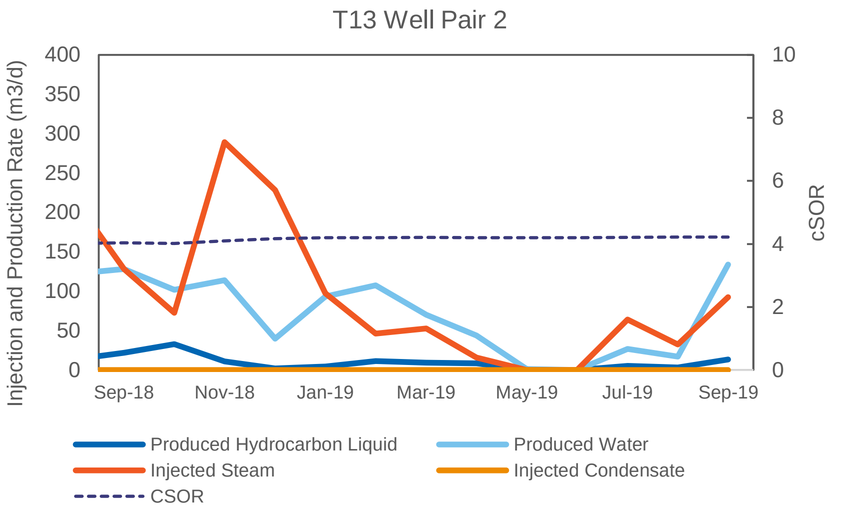
Key Events:

- Steam/Production Impacts
  - Mahkeses Plant PM (April – May)
  - T13 pad maintenance (May - July)
- WP1 workover: Dec - Feb
- WP1 / WP2: SAGD mode throughout reporting period

Future Plans:

- WP1: Optimize surveillance strategies
- WP2: Study lower pressure operation





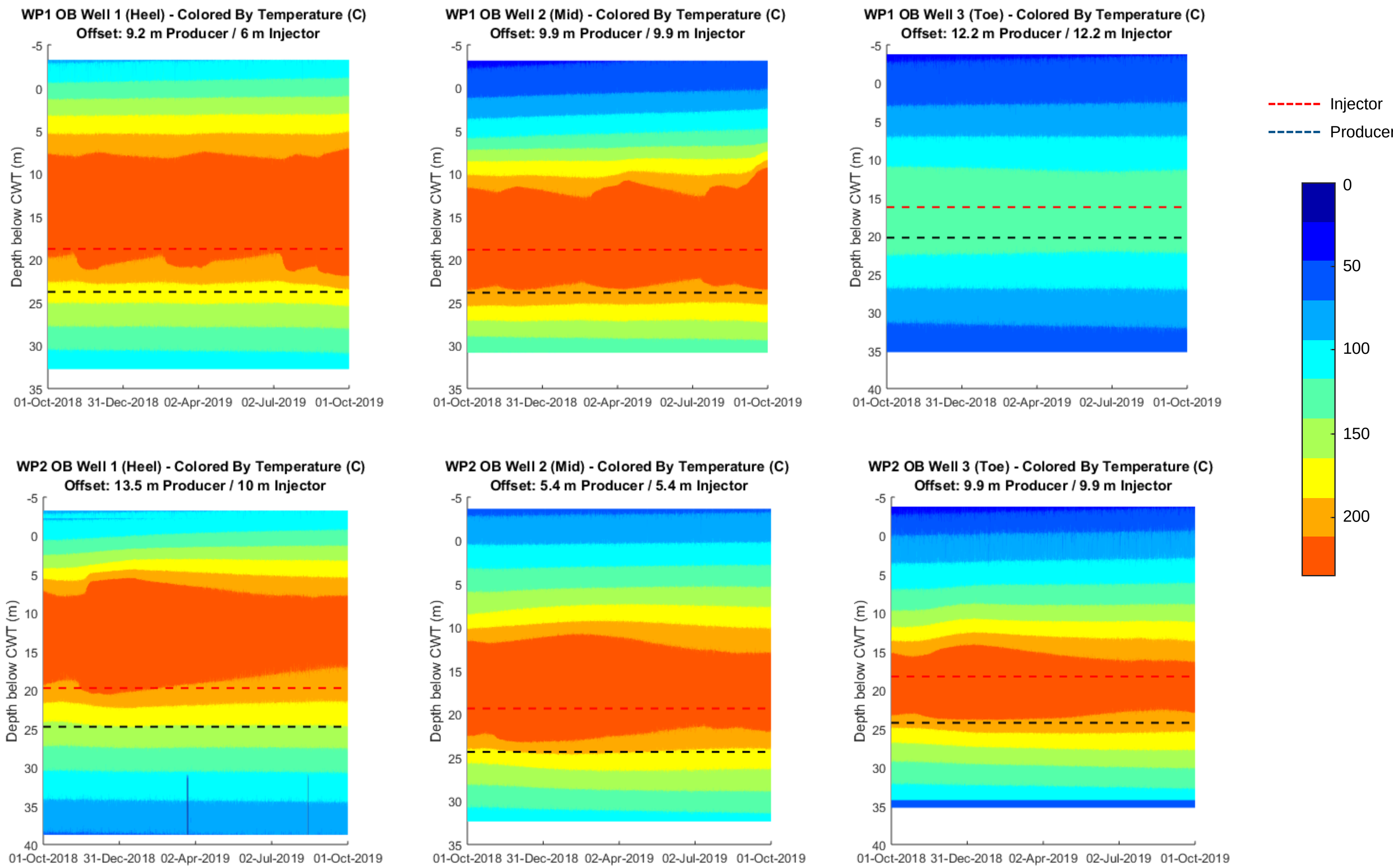
Imperial | Cold Lake

Observation Well Temperatures

- Temperature at observation (OB) wells provides a measure of amount of heat transferred to reservoir
- OB well temperature variances due to maintenance activities impacting steam injection

WP1

WP2



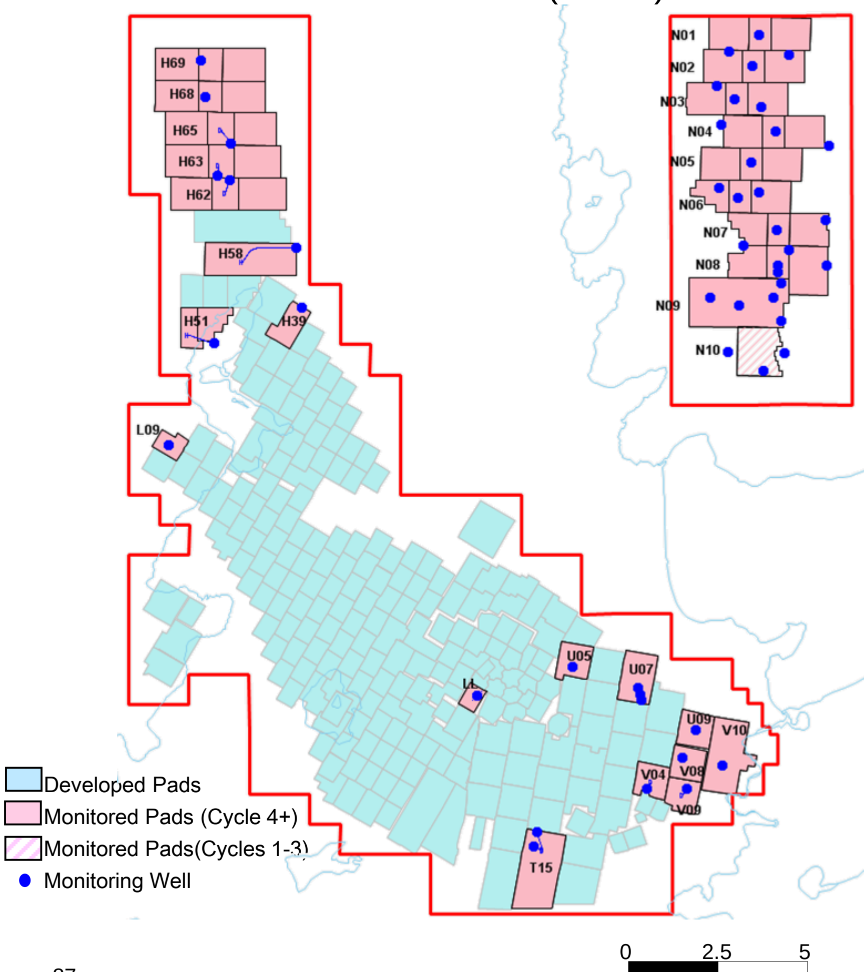
Imperial | Cold Lake

Other Discussion Items

Grand Rapids Monitoring Program

Objective

- Apply risk-based approach and monitor specific pads at Cold Lake for potential fluid excursions into the Grand Rapids formation
- If excursion occurs, identify sources, determine volumes, notify AER as required, mitigate, and take steps to limit future fluid excursions
- Cold Lake Commercial Scheme (8558II) amended Aug 2017 for Nabiye Operating Practices

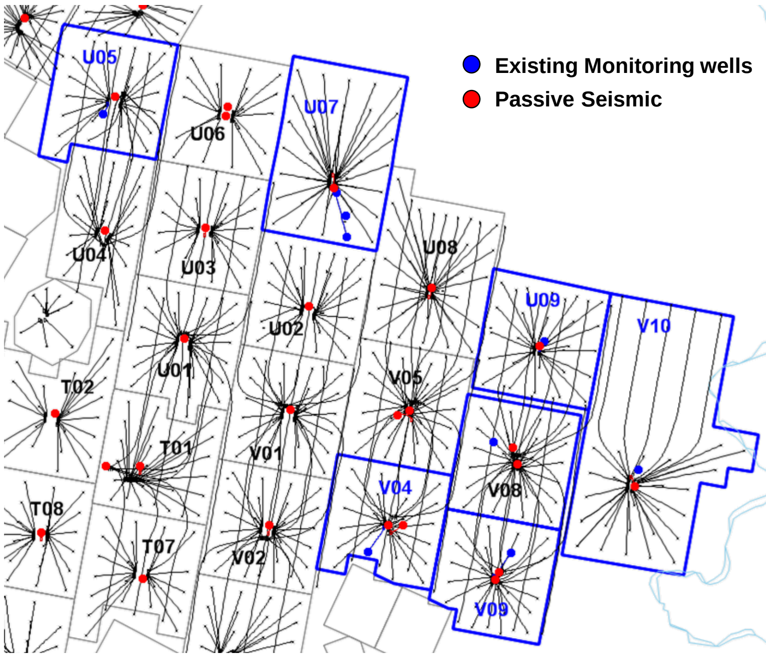


Pad	Basis
U05	Elevated Upper Grand Rapids (UGR) pressure
U07	Elevated Upper Grand Rapids (UGR) pressure
U09	Elevated Lower Grand Rapids (LGR) pressure
V04	Increase monitoring network
V09	Increase monitoring network
V10	Poor primary cement bond log
T15	Potential cement channels
LL	Unsuccessful abandonment of adjacent OV well
L09	Control pad
H39	Increase monitoring network
H51	Possible ghost hole in the Grand Rapids
H58	Increase monitoring network
H62	Poor primary cement bond log
H63	Poor primary cement bond log
H65	Increase monitoring network
H68	Control Pad
H69	Increase monitoring network
Nabiye	Geologic factors and proximity to FTS
V08	Increase monitoring network

U/V Trunk Grand Rapids Monitoring

Grand Rapids Monitoring Program

- All Pads: Standard passive seismic; Steam injection rates and pressures
- U05: One pressure monitoring well in UGR
- U07: One pressure monitoring well in LGR and two wells in UGR, and one additional passive seismic well to monitor the Grand Rapids
- U09: Monitoring discontinued at U09-08 in 2016 and U09-13 recompleted as UGR/LGR pressure monitoring well
- V04: One pressure monitoring well in LGR
- V08: One pressure monitoring well in LGR
- V09: One pressure monitoring well in LGR
- V10: One pressure monitoring well in LGR and UGR



Observations

- U07 - Pressure responses in the LGR and UGR observed at U07 in Cycle 2 and 3 were not observed in Cycle 4 when most likely source wells were selectively steamed. Poro-elastic response observed in Cycle 5 and minor fluid excursion observed at well U07-20 in Cycle 6 (2015) under Cold Lake steaming best practices. Fluid excursion was detected in Cycle 7 (2018).
- V10 - GR pressure responses at V10 diminished between cycles 2 – 6. Increased LGR pressure responses observed in Cycle 7 (2017) from a faulty downhole well packer. New monitoring well drilled and 3 legacy monitoring wells converted into HP CSS wells.
- U09 - Pressure responses in the LGR and UGR observed at U09-13 during Cycle 8 steam. Poro-elastic response observed in UGR and a fluid excursion detected in the LGR.

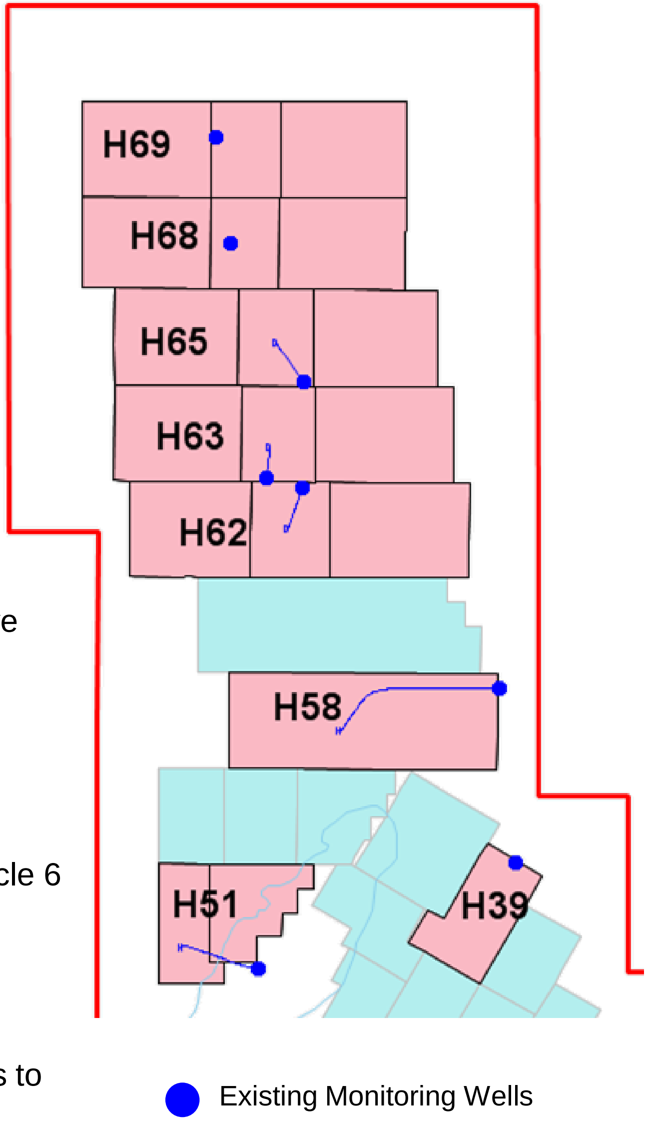
Conclusions

- Previous conclusion that excursions are an early cycle phenomenon is challenged by recent observations of excursions on pads that had a number of cycles without excursions
- High pressures in UGR bitumen zones can be highly localized

Mahihkan North Grand Rapids Monitoring

Grand Rapids Monitoring Program

- H39: 1 LGR & UGR pressure monitoring well
- H51: 1 LGR pressure monitoring well
- H58: 1 LGR pressure monitoring well
- H62: 1 LGR pressure monitoring well
- H63: 1 LGR pressure monitoring well
- H65: 1 LGR pressure monitoring well
- H68: 1 Hybrid Passive Seismic Well with LGR pressure monitoring
- H69: 1 LGR pressure monitoring well



Observations

- H51 – Fluid excursion was detected in Cycle 7 (2015). Monitoring well re-perforated into higher quality Lower Grand Rapids water sand 13 metres above original perforations. Fluid excursion was detected in Cycle 8 (2017)
- H58 – Fluid excursion was detected in Cycle 8 (2018)
- H62 – Fluid excursion was detected in Cycle 6 (2016)
- H63 – Only poro-elastic responses observed during steaming
- H68 – Possible excursion identified in Cycle 3 (2013). Poro-elastic responses observed during steaming Cycle 5 (2015). Fluid excursion was detected in Cycle 6 (2017)

Conclusions

- Cement channels on H62-H63 are not significant pathways for fluid excursions to the Grand Rapids

Imperial | Cold Lake

Nabiye Grand Rapids Practices

Factors that may impact fluid containment in the Clearwater formation at Nabiye

- Salt dissolution can create fractures in the overlying Clearwater shale
- Thicker overburden increases likelihood of vertical fracturing
- Presence of Mannville faults that intersect the Clearwater shale
- Proximity to CNRL Primrose East flow-to-surface events

Prevention Practices – Designed to prevent out-of-zone fluid excursions

- Implemented 4000 m3/EBHS* volume over fill-up target at all Nabiye pads
- Increased well spacing at Nabiye reduces uplift-induced stress changes in the Colorado shale
- Increased well spacing at Nabiye reduces risk of multi-well excursion event
- Proven drilling and cementing practices
- Nearby abandoned wells thoroughly reviewed and confirmed as being competent
- Extensive casing integrity program

Detection Practices – Designed to identify and locate excursions

- Pressure monitoring network of 29 wells covering 46 zones within the Grand Rapids
- Automated alarm system to detect rapidly changing pressure
- 4-D seismic surveys
- Passive seismic monitoring, well injectivity monitoring and casing integrity verification

4-D Seismic Surveys Acquired and Planned

2016	2018	2019	2020
N01-N04	N01,N02, N07, N08	N01, N02	N05, N06

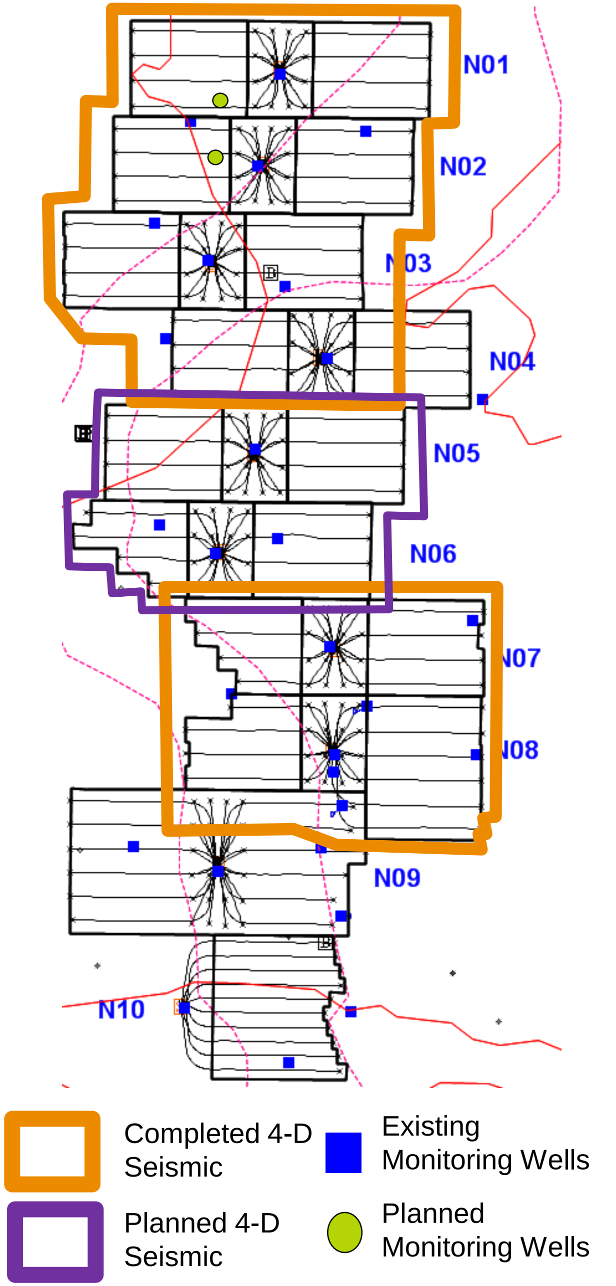
Response Practices – Designed to minimize the volume of excursions

- Identify suspect steaming wells which are then shut-in and may be re-started with lower target volumes
- Reduce steam to field when necessary to manage reduced target well volumes
- Reduce steam rates
- Re-steam suspect wells in the same or subsequent cycles to build horizontal stress to favour horizontal fractures

*EBHS – Equivalent Bottom Hole Spacing

Nabiye Grand Rapids Monitoring

Pad	Wells (year installed)	Monitored Zones	Fluid Excursion Confirmed
N01	N01 (2013)	LGR,UGR	All cycles
N02	N02-C (2014), N02-E (2016), N02-W (2016)	LGR,UGR	All cycles
N03	N03-C (2014), N03-E (2016), N03-W (2016)	LGR,UGR	All cycles
N04	N04-C (2014), N04-W (2016), N04-E (2019)	LGR,UGR	Cycles 1, 3, 5, 6,7
N05	N05 (2013)	LGR,UGR	Cycles 2, 3 and 5
N06	N06-C (2014), N06-E (2017), N06-W (2017)	LGR	Cycle 3,4,5,6,7
N07	N07-FMW* (2013), N07-C (2014), N07-E (2017)	LGR, UGR, PS	All cycles
N08	N08-C (2013), N08-FMW* (2014), N08-E (2017), N08-W (2017)	LGR, UGR, PS	All Cycles
N09	N09 (2014), N09-FMW1 (2015), N09-FMW2 (2015), N09-FMW3 (2015), N09-W (2018)	LGR, UGR, PS	All Cycles
N10	N10-S (2017), N10-C (2018), N10-FMW (2018)	LGR, UGR, PS	All Cycles
*Note: All FMW wells include passive seismic monitoring			



Observations
- Fluid excursions to the Grand Rapids have been observed at all Nabiye pads
- Post-steam seismic anomalies identified via 4-D seismic on pads N01, N02, N07 & N08

Conclusions
- Combination of geologic factors likely contributing to increased fluid excursions relative to the rest of Cold Lake
- Monitoring and response practices effective at identifying and mitigating fluid excursions

Plans
- Continue to apply the Prevention, Detection and Response Practices developed for Nabiye (see previous page)
- 2 additional Grand Rapids monitoring wells planned over N01 & N02 west horizontal wells
- Acquire 4-D Seismic over N05 & N06

Imperial | Cold Lake

N10-01 Steam Strategy

- Waiver received from AER to forego second commissioning cycle and proceed with full first cycle volumes of 4000 m3/EBHS
  - N10-01 well completed the first commissioning cycle successfully, however was unable to steam the second commissioning cycle due to operational complications
  - Strong communication from adjacent horizontal wells N09-36 & N10-02 (Chart 1) allowed Clearwater conformance regions to overlap between wells enabling second commissioning cycle to be waived
- N10-01 successfully completed cycle 1 (Chart 2)
  - N10-01 reached full steam volumes for cycle 1 of 4000 m3/EBHS
  - No evidence of Grand Rapids' excursions were observed

Chart 1: N10-02 Steam shown to increase pressure on N10-01

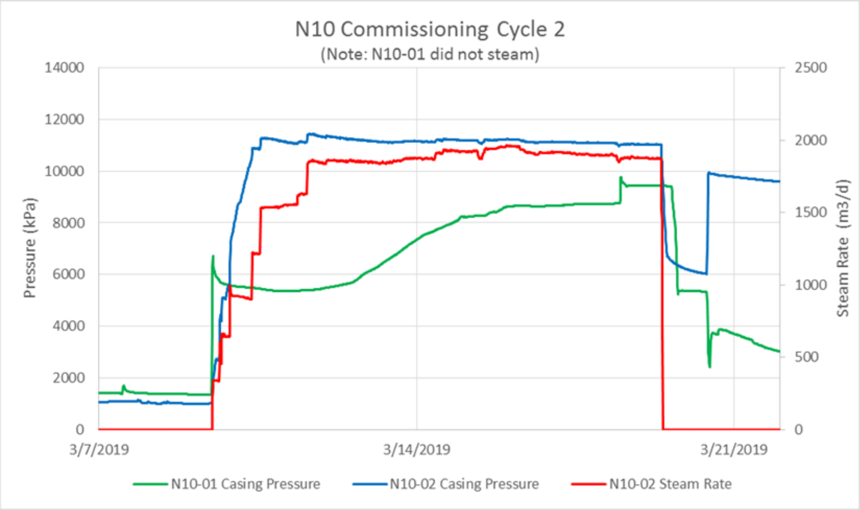
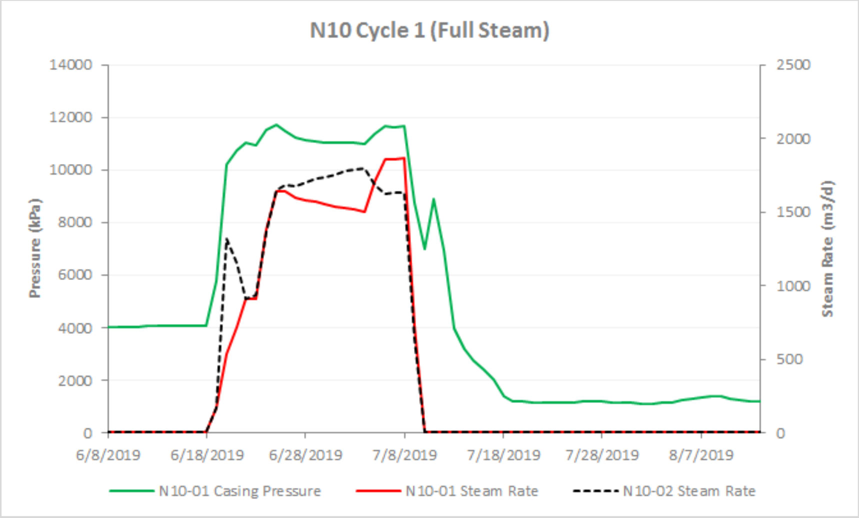


Chart 2: N10-01 Cycle 1 full steam



*EBHS – Equivalent Bottom Hole Spacing

Facilities

Facility Modifications

Mahkeses Plant Debottleneck

- Cleaned SRU inlet gas piping and upgraded HRSG duct burner controls
- Installed clean out hot taps for online line cleaning
- Installed additional hot lime softener outlet lines to reduce pressure loss
- Restored >4000m3/day treated water capacity lost due to line fouling

Leming Plant Enhanced Electrocoagulation “EEC” Pilot

- Pilot constructed in 2018/19
- Site tie-ins and commissioning Q2-3 2019
- Preliminary testing Q3 2019
- Pre-mature system fouling due to operational issues
- Next planned testing Q4 2019
- < See attachment 12 >

Leming Plant water treatment debottleneck

- Added 3rd WAC ION exchanger softener vessel
- New vessel is of alloy material designed for corrosive acid & caustic service, this change is a test in industry with avoiding the need for specialty internal linings
  - Internal linings in industry in this process has been challenged with reliability issues, leading to high maintenance cost
- Additional vessel improves the water recycle capability increasing capacity

Facility Performance

Outline

- Bitumen Treatment and Vapour Recovery
- Water Treatment
- Steam Generation
- Electrical Power Generation and Consumption
- Produced Gas Management

Facility Performance

Bitumen Treatment and Vapour Recovery

- Bitumen production remained within AER inlet license limits over reporting period

AER Inlet License	Maskwa	Mahihkan	Leming	Mahkeses	Nabiye
Bitumen License (m^3/d)	11,000	15,000	5,000	8,000	8,000
Actual Oct/18 – Sep/19 (m^3/d monthly avg)	6,328	7,571	1,215	4,627	3,079

- Issues & Limitations
  - Nabiye Grand Rapids formation mitigations limiting production

- Major Downtime
  - Mahkeses Plant Shutdown – 25 days total May/Jun 2019
  - Nabiye GTG/HRSG inspection – 25 days Sep/Oct 2019

- Major Equipment Failures
  - None

- Vapour Recovery Performance - >99% produced gas recovery Oct/18 to Sep/19
  - Recent activities to improve venting performance:
    - P1 / P3 piping modification re-designs to improve VRU effectiveness complete – work to be executed in 2020
    - Continued use of Forward Looking Infra-red (FLIR) camera
    - Optimizing tank PVRV settings and increased surveillance

Imperial | Cold Lake

Facility Performance

Water Treatment

- Water production remained within AER inlet licence limits over reporting period

AER Inlet License	Maskwa	Mahihkan	Leming	Mahkeses	Nabiye
Water License (m^3/d)	38,000	50,000	13,500	28,000	22,665
Actual Oct/18 – Sep/19 (m^3/d monthly avg)	27,715	32,111	6,305	17,347	13,442

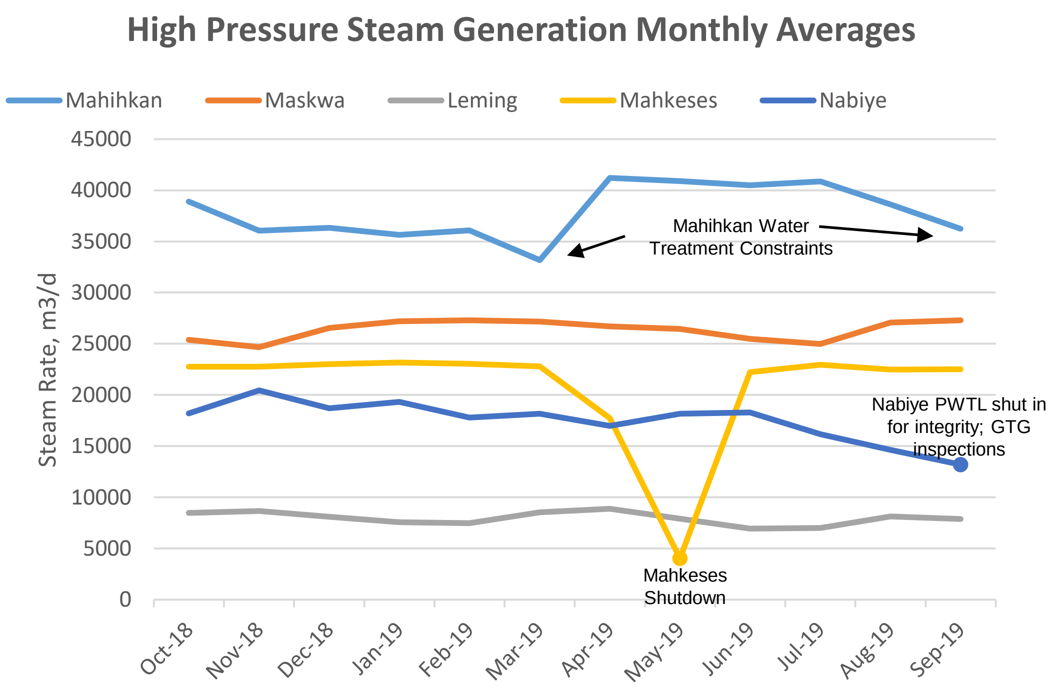
- Issues & Limitations
  - Continued focus on improving treated water transfer from Maskwa & Mahkeses to Leming
- Major Downtime
  - Mahkeses Plant Shutdown – 25 days total May/Jun 2019
  - Nabiye GTG/HRSG inspection – 25 days Sep/Oct 2019
- Major Equipment Failures
  - Treated water Transfer line failure between Maskwa & Leming resulting in several month shut-in
  - Corrosion found on Nabiye – Maskwa Produced Water Transfer line resulting in line shut-in proactively

Facility Performance

Steam Generation

Cold Lake District HP Steam Generation (m3/d)					
2014	2015	2016	2017	2018	2019 YTD
90,361	118,144	108,158	111,782	108,723	110,490

- Nabiye steam reduction -6,000 m³/d
  - Grand rapids formation mitigations and Produced Water Transfer Line shut in due to integrity concerns
- Major Downtime
  - Mahkeses Plant Shutdown – 25 days total May/Jun 2019
  - Nabiye GTG/HRSG inspection – 25 days Sep/Oct 2019
- Mahihkan water treatment constraints due to plugging in water treatment system on one train
- Major Equipment Failures
  - None



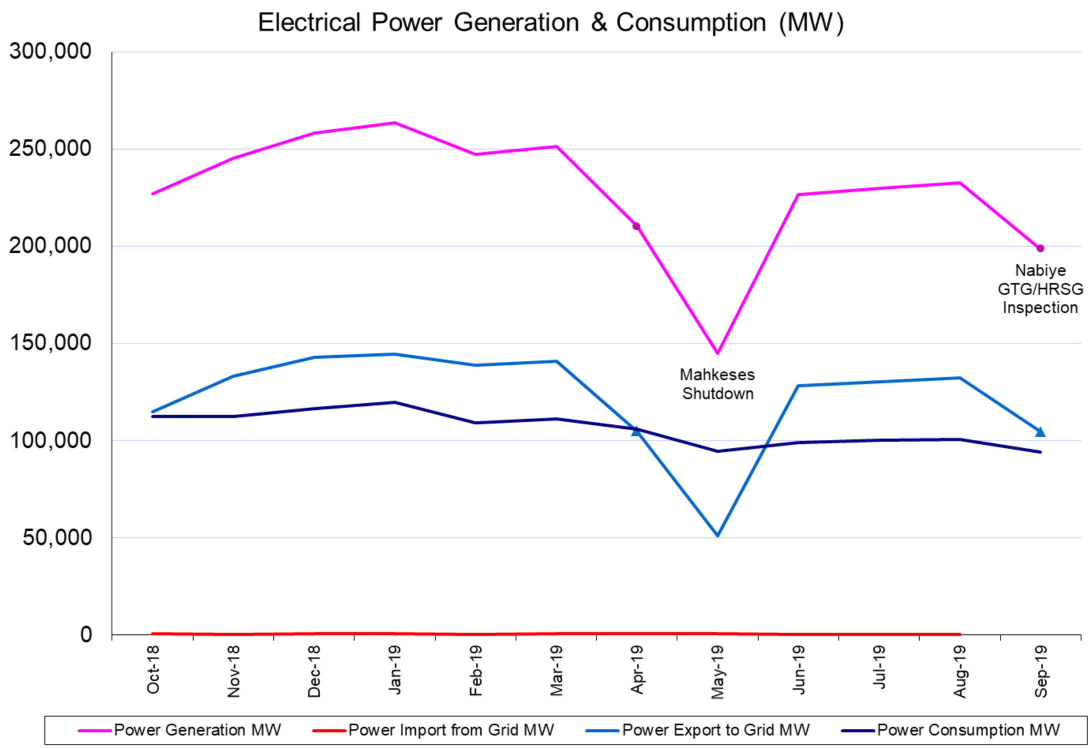
Imperial | Cold Lake

Facility Performance

Electrical Power Generation and Consumption

- Mahkeses & Nabiye Plants each have two gas turbine electrical power generators within a co-generation steam plant that generates power for the district and exports power to the Alberta power grid
- Power in 2019 was imported only to Imperial facilities that are outside the district power grid, from the Alberta power grid

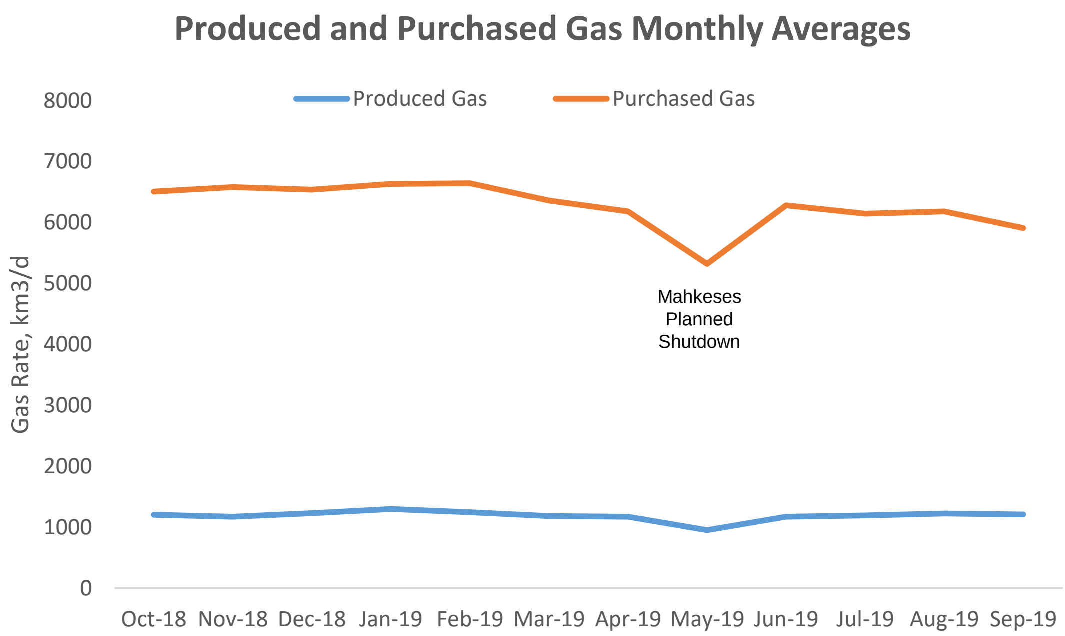
- Issues & Limitations
  - None
- Major Downtime
  - Mahkeses Plant Shutdown – 25 days total May/Jun 2019
  - Nabiye GTG/HRSG inspection – 25 days Sep/Oct 2019
- Major Equipment Failures
  - None



Facility Performance

Produced Gas Management

- All recovered produced gas used as fuel for high pressure steam generation
- Purchased sweet gas is used for steam generation (high and low pressure) and heater operation
- Issues and Limitations
  - None
- Major Downtime
  - As per bitumen and water summaries
- Major Equipment Failures
  - None



Water Use

<u>Water Management Strategy</u>

Minimize the need for non-saline water

- Maximize produced water recycling
- Utilize brackish make-up water where appropriate
- Use the non-saline groundwater withdrawal licence for Cold Lake water system maintenance or as a contingency source in the event of lower water levels in Cold Lake

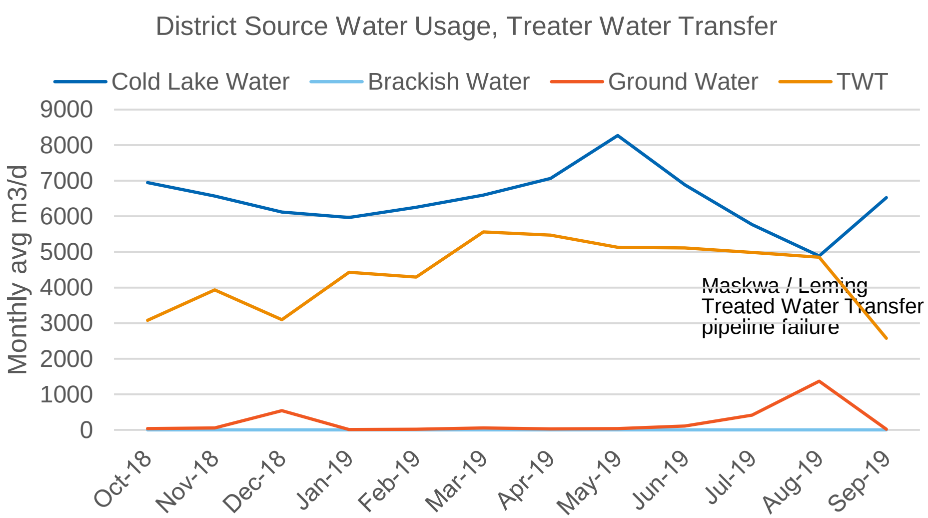
<u>Water Conservation & Improvements</u>

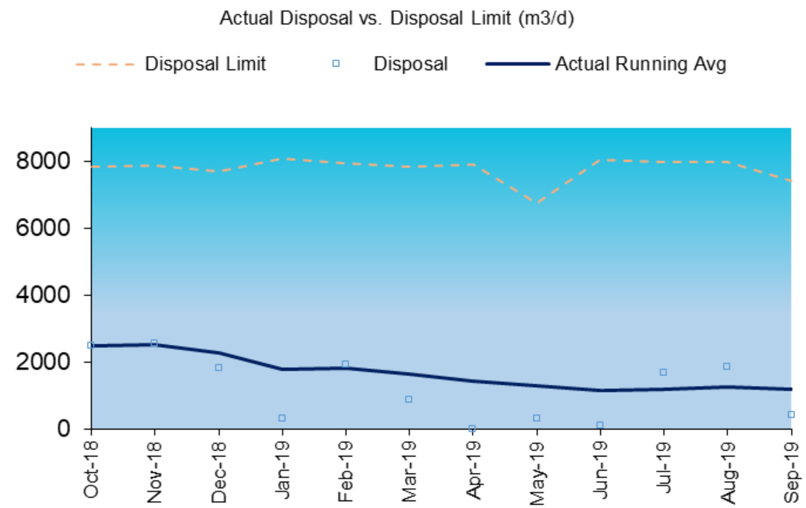
- Early 90's developed capability to utilize brackish water to supplement produced water
- Inter-site produced water transfer systems reduce make-up water requirements and limit disposal of produced water
- Newer facilities (Mahkeses & Nabiye) freshwater consumption significantly lower (<100 m^3/d)
- Treated water transferred from Maskwa & Mahkeses to Leming reduces freshwater usage
- Brackish water deliverability not an issue to date
- Inter-site steam transfer provides additional water use flexibility
- Commitment in 2017 renewal to continue to evaluate opportunities for non-saline water use reduction
- See next slides for other comments on freshwater consumption

Water Use and Disposal

- 2018-2019 ground water use only required during water system maintenance periods
- Transitioned to disposal limit formula November 2015
  - 2018 actual disposal volumes 1,855 m^3/d vs. disposal limit of 7,730 m^3/d
  - 2019 YTD Actual Disposal volumes 826 m^3/d vs. disposal limit of 7,769 m^3/d
- Drilling additional disposal wells to improve system reliability and flexibility (operational in 2020)

	Disposal Limit, m3/d	Actual Disposal m3/d
Oct-18	7,839	2,473
Nov-18	7,868	2,549
Dec-18	7,680	1,827
Jan-19	8,065	311
Feb-19	7,953	1,923
Mar-19	7,826	853
Apr-19	7,903	0
May-19	6,750	315
Jun-19	8,059	105
Jul-19	7,986	1,678
Aug-19	7,966	1,840
Sep-19	7,403	426

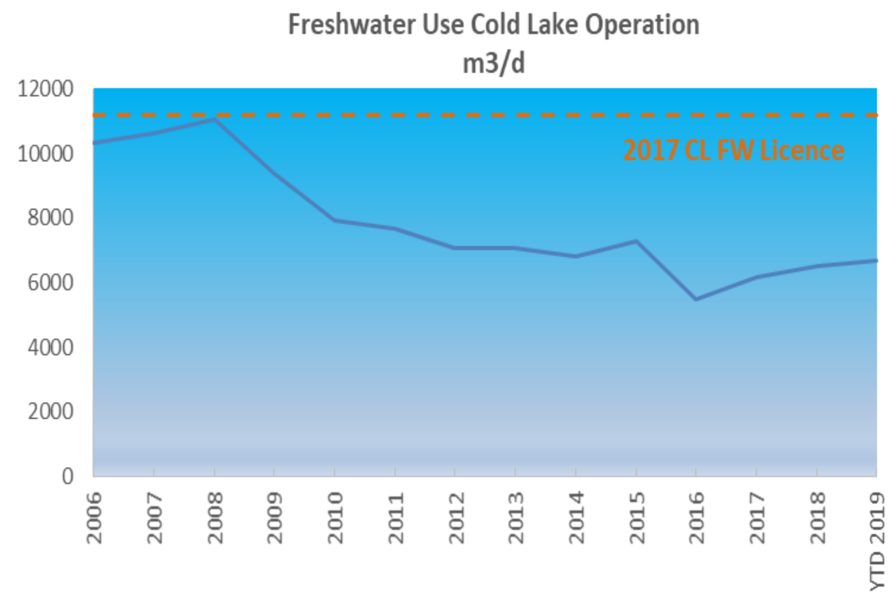


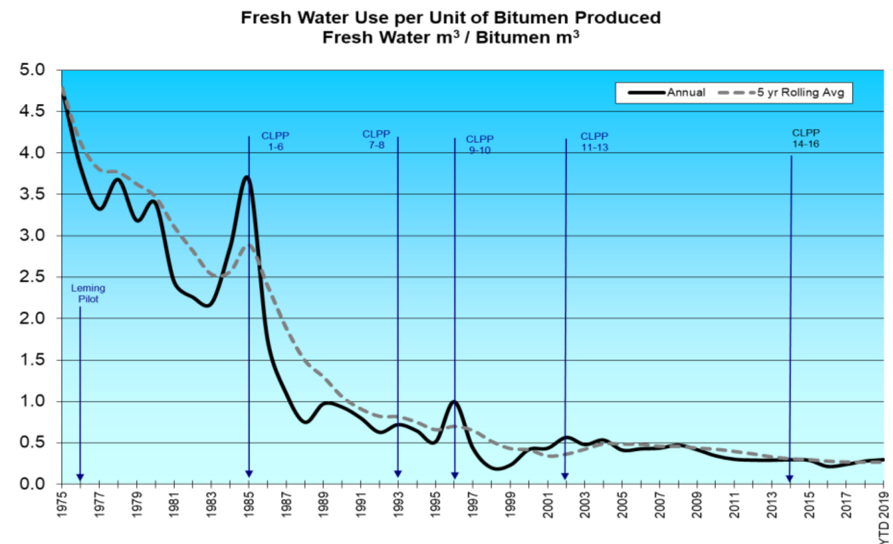


Imperial | Cold Lake

Freshwater Reduction

- Freshwater reduction continues to be key focus area
- 2019 YTD (Sept 30) non-saline water consumption ~6,697 m³/d, continuing strong performance since 2011
- 1M m³ of allocation from Cold Lake released during water license renewal driven by performance and focus on continued reductions
- Overall fresh water use has decreased ~40% over past 10 years
  - Technical assessments of alternatives ongoing in freshwater utility boilers, inlet cooling, and improved treated water transfer system reliability to further progress reduction opportunities
  - <u>Examples of fresh water use</u>: Leming production inlet cooling, Domestic use, safety showers / eyewashes, Feed water for specific boilers, Field wellhead and rig work activities, Emergency firewater supply





Imperial | Cold Lake

Measurement

Measurement

October 2018 – September 2019 profac

	Leming		Mahkeses		Maskwa		Mahihkan		Nabiye	
	Oil	Water	Oil	Water	Oil	Water	Oil	Water	Oil	Water
Oct-18	1.03	1.17	0.86	1.10	1.13	1.21	0.95	0.99	0.90	0.90
Nov-18	1.02	1.12	0.88	1.12	1.13	1.21	0.96	0.98	0.90	1.03
Dec-18	1.28	1.12	0.93	1.08	1.20	1.10	0.99	0.96	0.82	0.91
Jan-19	1.11	1.16	0.95	1.00	1.17	1.13	0.98	1.00	0.91	0.78
Feb-19	1.23	1.18	0.89	0.96	1.12	1.14	0.93	0.97	1.05	0.99
Mar-19	1.23	1.19	0.86	0.93	1.11	1.10	0.93	0.93	1.01	0.93
Apr-19	1.15	1.15	0.84	0.98	1.13	1.13	0.95	1.02	1.00	0.92
May-19	0.91	0.79	0.83	0.87	1.09	1.14	0.89	1.01	0.95	0.91
Jun-19	1.03	1.08	0.82	1.06	1.08	1.12	0.89	1.00	1.00	0.97
Jul-19	0.93	1.11	0.84	1.09	1.01	1.13	0.90	1.01	0.96	1.01
Aug-19	1.01	1.18	0.83	1.11	1.05	1.13	0.92	1.05	1.02	0.96
Sep-19	1.05	1.26	0.87	1.13	1.07	1.07	0.92	1.04	0.91	0.96

Cold Lake Operations continues to follow processes for well testing per our approved Measurement Accounting & Reporting Plan (MARP). Ongoing stewardship helped identify improvement opportunities with proration factors, and as such, a Well Test Task Force was stood up in 2019 to drive sustainable improvements in well testing performance and proration factors. Efforts are underway to improve well testing equipment availability and reliability. Proration factor performance and improvement efforts will continue to be stewarded and monitored on a monthly basis by management. Mahkeses and Leming fields were identified as focus areas. In addition, there are inherent well testing challenges due to the cyclical and integrated nature of in-situ operations (steam schedules / plant constraints including slowdowns and shutdowns). Rationale for proration factors outside of tolerance are provided in Petrinex as part of the CAI (Compliance Assessment Indicators).

Compliance

Compliance

Measurement and Reporting:

- There were zero Petrinex regulatory compliance issues with volume reporting for CLO for the reporting period Q4 2018-Q3 2019.
- Addressing improvement opportunity regarding well testing (Directive 17)

Environmental and Regulatory: Cold Lake Operations activities pursued without long-term adverse impact on the environment.

- Compliance with Scheme Approval 8558 and Approval 4510
- 17 AER Inspections
  - 2 awaiting results, 9 satisfactory inspections, 6 inspections that resulted in non-compliances *, **

    * Signage / tags (3); Calibration records (1); Erosion (1); Groundwater water wells not locked (1); Vegetation control (2); Secondary Containment (1)

    ** Note: Can have multiple findings per inspection – reported as 1 non compliance
- 5 voluntary self-disclosures
  - Proactive identification of improvement opportunities.
- 2 contraventions
  - 1 failed produced gas sample (could not access sample point)
  - 1 unauthorized use of source wells (have since educated workers on required notifications prior to conducting work)

Imperial | Cold Lake

Environment

Approval Renewals and Amendments

AER Approvals

- Received Scheme Approval 8558N, NN, O, OO, P, PP, Q and QQ

Approvals under the Environmental Protection and Enhancement Act (EPEA)

- EPEA amended to address newly approved Cold Lake Expansion Project (Grand Rapids SA-SAGD)
- Undergoing EPEA Renewal Application Draft

Approvals under the Water Act

- No change

Environmental and Community Initiatives

Imperial Cold Lake Operations continues to support environmental initiatives through both financial contributions and participation in regional committees.

- Cold Lake Operations provides significant annual funding to the arms-length joint provincial-federal government Oil Sands Monitoring (OSM) program.
- Imperial continues to be involved with COSIA (Canada's Oil Sands Innovation Alliance).
- Imperial sits on the LICA (Lakeland Industry and Community Association) board and committees as an industry member and to fund local environmental programs.
- Imperial holds the annual "Neighbor Night" that allows the community to learn and enquire about Cold Lake Operations.
- Imperial engages with Marie Lake Air and Watershed Society (MLAWS) and domestic well owners.
- Imperial consults and engages with 12 Indigenous communities within Cold Lake Operations.
- Imperial consults and engages with those Indigenous communities that have completed a Community Benefits Agreement.

Monitoring Programs – Wildlife

Cold Lake Operations continues to enhance and restore wildlife habitat.

- In 2019, Imperial achieved Wildlife at Work recertification from the Wildlife Habitat Council. Certification was initially obtained in 2010.
  - The Wildlife Habitat Council (WHC) created in 1988, is a nonprofit group of corporations, conservation organizations and individuals dedicated to enhancing and restoring wildlife habitat. WHC helps large landowners, like Imperial, manage their unused lands in an ecologically sensitive manner for the benefit of wildlife.

- Continue implementation of AEP-approved Wildlife Monitoring and Mitigation Plan and Caribou Mitigation and Monitoring Plan, which address wildlife habitat preservation measures.
  - These two separate plans will be superseded in May 2020 by a comprehensive Wildlife Mitigation and Monitoring Program which seeks to provide Mitigations and monitoring with thresholds for adaptive management directed by our updated Approval received in August 2018.

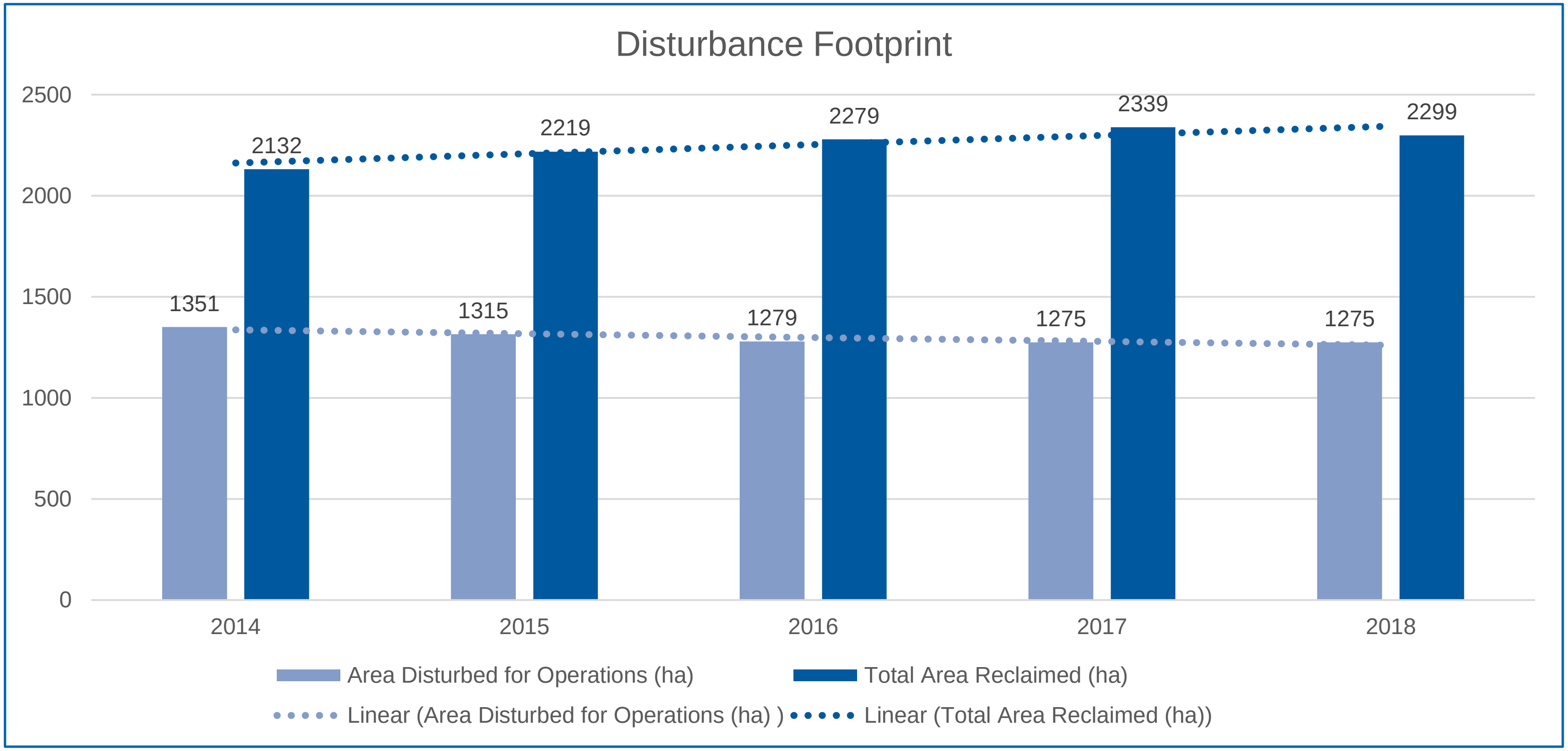
- Annual issuance of AEP *Research and Collection License*.

Monitoring – Reclamation

In 2018, CLO's approved MSL footprint was 14,243.1 ha, of which 25% (3574 ha) was impacted by operations.

Within the 3574 ha disturbed:

- 1275 ha was disturbed for production-associated activities
- 2299 ha was undergoing remediation or reclamation.



Imperial | Cold Lake

Monitoring – Vegetation

No impact to species richness have been observed.

Overview:

- In 2006 a long-term vegetation monitoring program was established, per the commitments made in Section 9, Subject 10 of the Imperial Nabiye and Mahihkan North EIA
- The monitoring program was revised in 2009

Pitcher Plant (Sarracenia purpurea)

Monitoring Results:

- 2018 Edge Effects Monitoring:
  - No biologically significant changes to ecosystem structure related to new development
  - Overall, no significant difference between baseline and species richness values during the Rare Plant survey
- 2018 Rare Plant Monitoring:
  - # of rare plant species monitored decreased – due to provincial status change (4 species remain in program)

Imperial | Cold Lake

Monitoring – Air Emissions

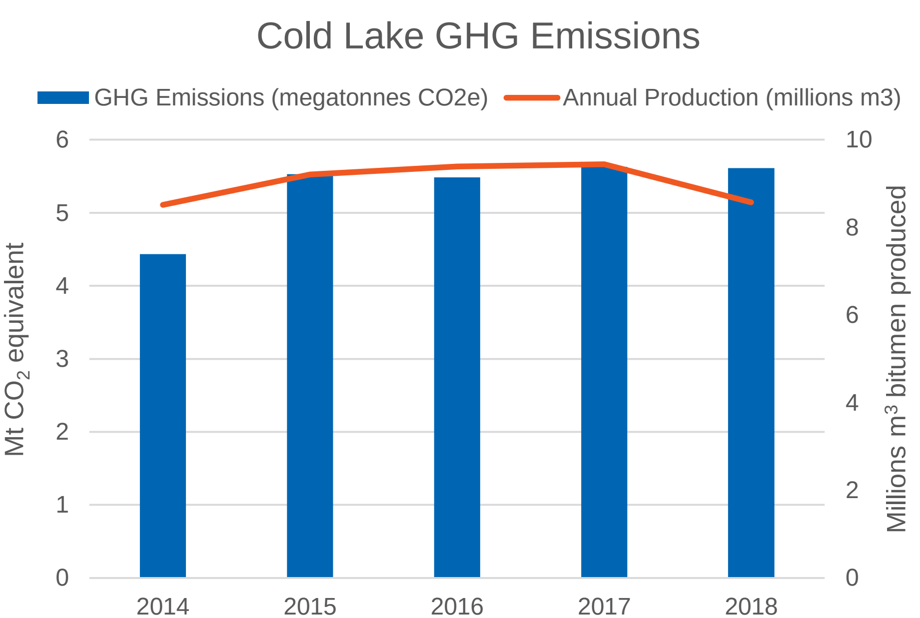
Cold Lake's greenhouse gas (GHG) emissions has been stable. Next generation technologies reducing emissions are being leveraged.

Examples include:

- **Liquid Addition to Steam for Enhancing Recovery** (LASER) reduces GHG intensity by 20 to 25% by adding solvent to the current Cyclic Steam Simulation process. LASER has been commercially demonstrated at 10 pads and deemed successful; it is being implemented at an additional 9 pads.

- **Cyclic Solvent Process** (CSP) is a non-thermal process that injects solvent instead of steam to recover bitumen. A $100-million pilot facility was initiated in 2014. Direct GHG emissions are reduced by approximately 90%.

- **Solvent-Assisted Steam-Assisted Gravity Drainage** (SA-SAGD) is a recovery process enhanced by the addition of solvent to the steam. It is the technology of choice for the Cold Lake Expansion Project (Grand Rapids reservoir) and other SAGD developments such as Aspen. Cold Lake has operated a $50M field pilot since 2010. A 25% reduction in GHG intensity compared to SAGD is expected.



Imperial | Cold Lake

Monitoring – Air Emissions

Satisfactory air quality is measured at the air monitoring station located at Cold Lake Operations and operated by LICA[1]. Data is shared with communities.

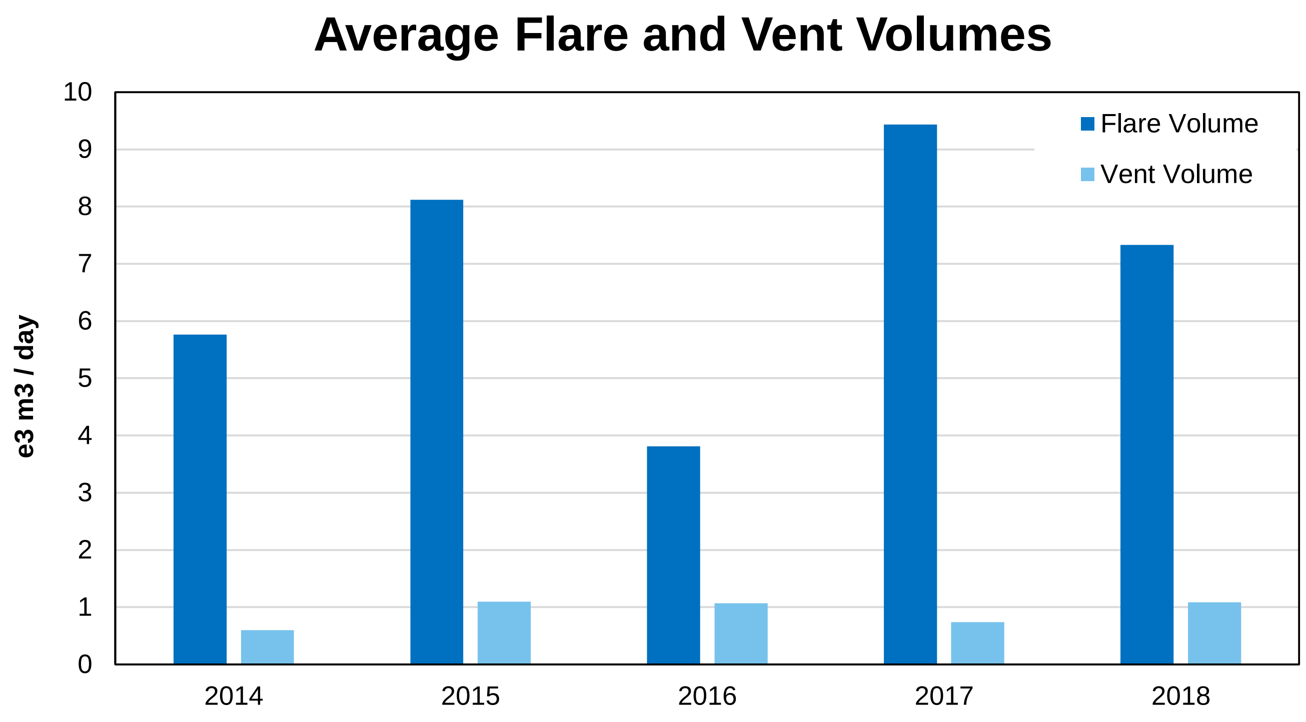
- The Maskwa station is maintained and operated by LICA (Lakeland Industry and Community Association).
  - Maskwa station performs continuous and passive monitoring of various compounds, such as SO_2, H_2S, NO_x, Total Hydrocarbons.
  - Alberta Ambient Air Quality Objectives includes target concentrations for certain compounds. Hourly average measurements are below the targets.

- Fugitives emissions detection program:
  - Annual program; each location sampled on a 3 year frequency.
  - Fugitives emissions are minor; represent less than 0.5% of Cold Lake Operations greenhouse gas (GHG) emissions.
  - Leak Detection and Repair (LDAR) program is implemented to detect unintentional hydrocarbon emissions (seals, valves, flanges, etc.).

[1] Sept 2018 – October 2019 data available on LICA website.

Monitoring Programs – Air Flare and Vent

Flare and vent volumes remain minimal. Less flaring in 2018 due to controlled nature of shutting-down and starting-up of Maskwa Plant.



Note: Flare volume does not include 'pilot & purge' gas flaring.

Monitoring - NO_x Emissions

The October 2018 – September 2019 NOx emissions from the Mahkeses and Nabiye gas turbines/ heat recovery steam generator (HRSG) exhaust stacks are in compliance with the *EPEA* approval, except for Mahkeses HRSG 14642 in May 2019. During commissioning of a newer model gas analyzer at the Mahkeses HRSG 14642 Continuous Emission Monitoring System (CEMS), the NOx emissions limit was exceeded for 27 hours.

The NOx emissions from the Nabiye 58 MW steam generator exhaust stack is 1.9 kg/hr (based on October 2019 manual stack survey), which is less than the *EPEA* approved limit of 8.75 kg/hr.

Table 1. NO_2 Emissions for the Co-generation Units at Mahkeses Plant

CEMS Station ID	Parameters	18-Oct	18-Nov	18-Dec	19-Jan	19-Feb	19-Mar	19-Apr	19-May	19-Jun	19-Jul	19-Aug	19-Sep
14641	Total hours NO_2 exceeding Stack Licenced Limits of 63 (kg/hr)	0	0	0	0	0	0	0	0	0	0	0	0
	Maximum NO_2 (kg/hr)	33	35	41	42	39	52	30	37	40	39	37	42
	Average NO2 (kg/hr)	30	30	32	34	34	29	25	29	35	34	34	36
14642	Total hours NO_2 exceeding Stack Licenced Limits of 63 (kg/hr)	0	0	0	0	0	0	0	27	0	0	0	0
	Maximum NO_2 (kg/hr)	36	39	40	40	41	40	35	166	41	40	37	39
	Average NO_2 (kg/hr)	31	33	34	35	37	32	30	50	34	32	32	33

Table 2. NO_2 Emissions for the Co-generation Units at Nabiye Plant

CEMS Station ID	Parameters	18-Oct	18-Nov	18-Dec	19-Jan	19-Feb	19-Mar	19-Apr	19-May	19-Jun	19-Jul	19-Aug	19-Sep
25573	Total hours NO_2 exceeding Stack Licenced Limits of 63 (kg/hr)	0	0	0	0	0	0	0	0	0	0	0	0
	Maximum NO_2 (kg/hr)	61	25	24	25	27	27	23	46	22	22	22	30
	Average NO_2 (kg/hr)	17	22	21	22	21	21	19	20	18	17	18	12
25572	Total hours NO_2 exceeding Stack Licenced Limits of 63 (kg/hr)	0	0	0	0	0	0	0	0	0	0	0	0
	Maximum NO_2 (kg/hr)	42	37	40	37	38	38	34	32	33	27	26	31
	Average NO_2 (kg/hr)	27	31	31	31	32	27	27	27	25	23	22	22

Sulphur Removal

Mahihkan Site – Plant Sulphur Removal

- Sustained reliability achieved over reporting period
- Achieved > 69.7% recovery in 4Q18, 1/2/3Q19 and was below emissions limit
- Achieved 95% uptime in 2018/2019
- Downtime related to SRU piping stainless steel upgrades and cold weather delays

Mahkeses Site – Plant Sulphur Removal

- Sustained reliability achieved over reporting period
- Achieved > 69.7% recovery in 4Q18, 1/2/3Q19 and was below emissions limit
- Achieved 100% uptime in 4Q18, 1/3/Q19
- Achieved 90% uptime in 2Q2019 – SRU offline for regular 5 year preventative maintenance

Leming Site – No Plant Sulphur Removal

- Leming SO_2 emissions were below limits in 4Q18, 1/2/3/Q19 and below daily emissions limit

Maskwa Site – No Plant Sulphur Removal

- Maskwa SO_2 emissions were below limits in 4Q18, 1/2/3/Q19 and had no exceedances of single day emissions limit (3Q18 ID 2001-03 Exception)

Nabiye Site – Plant Sulphur Removal

- Sustained reliability achieved over reporting period
- Achieved > 69.7% recovery in all quarters of 4Q18, 1/2/3Q19 and was below emissions limit
- Achieved 100% uptime in 4Q18, 1/2/3Q19

Sulphur Removal, SO_2 Emissions

- Compliant with D56, EPEA, and ID2001-3 over the review period

Calendar Quarter Average Sulphur Emissions By Plant (tonnes/day)															
Calendar Quarter	Leming Plant		Maskwa Plants		Mahihkan Plants			Mahkeses Plant			Nabiye Plant			District	
	Sulphur	SO_2	Sulphur	SO_2	Sulphur	SO_2	Removal	Sulphur	SO_2	Removal	Sulphur	SO_2	Removal	Sulphur	SO_2
Q4 2018	0.21	0.42	0.87	1.74	0.26	0.51	70.65%	0.44	0.87	70.61%	0.35	0.71	70.13%	2.61	5.22
Q1 2019	0.14	0.27	1.00	2.00	0.28	0.55	72.62%	0.54	1.07	70.78%	0.37	0.74	70.09%	2.32	4.64
Q2 2019	0.27	0.53	0.94	1.88	0.35	0.71	70.24%	0.17	0.34	73.89%	0.37	0.74	70.06%	2.10	4.20
Q3 2019	0.12	0.23	0.87	1.75	0.32	0.64	72.38%	0.37	0.74	70.34%	0.44	0.87	69.92%	2.12	4.23
	<1.0 t/d Sulphur		<1.0 t/d Sulphur*		<1.80 t/d SO_2		≥69.7.%	<1.08 t/d SO_2		≥69.7.%	<1.08 t/d SO_2		≥69.7.%	-	

Calendar Quarter Peak Day Sulphur Emissions By Plant (tonnes/day)												
Calendar Quarter	Leming Plant		Maskwa Plants		Mahihkan Plants		Mahkeses Plant		Nabiye Plant		District	
	Sulphur	SO_2	Sulphur	SO_2	Sulphur	SO_2	Sulphur	SO_2	Sulphur	SO_2	Sulphur	SO_2
Q4 2018	0.37	0.74	1.03	2.06	1.05	2.11	0.56	1.13	0.53	1.06	3.33	6.66
Q1 2019	0.22	0.45	1.12	2.25	1.15	2.29	0.68	1.35	0.56	1.12	3.01	6.02
Q2 2019	0.64	1.28	1.07	2.14	1.31	2.62	0.47	0.94	0.49	0.97	3.01	6.03
Q3 2019	0.20	0.40	1.04	2.09	1.08	2.15	0.54	1.08	0.74	1.48	2.90	5.81

- Note: Effective October 2019 – December 2020, received approval (i.e. temporary exemption) from meeting the 'sulphur recovery requirements' for Maskwa, Mahihkan, Mahkeses and Nabiye facilities (see below, approval also attached).

> (3) The Operator is exempt from meeting the recovery requirements as set out in Table 1 of AER *Interim Directive 2001-03: Sulphur Recovery Guidelines for the Province of Alberta* for the Maskwa, Mahihkan, Mahkeses and Nabiye facilities. This clause will expire on December 31, 2020.[1]

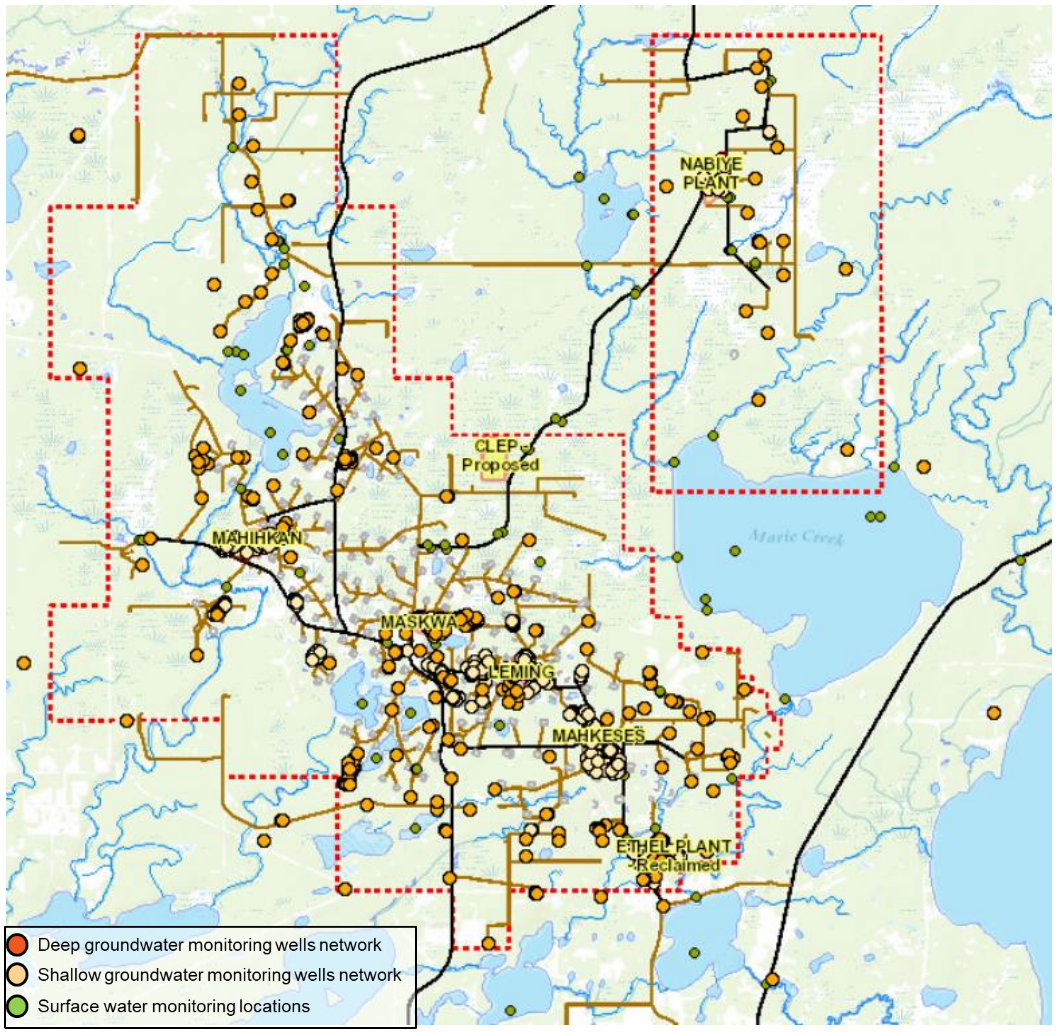
Cold Lake Waste Management

2018 Annual Waste	Volume (m^3 unless otherwise specified)
Class II Landfill	
Lime Sludge	29,355
All Other Waste Streams	43,393
Maskwa Ecopit (OWBSF)	
Oily Waste	5,712
Off Site Disposal / Recycled	
Empty Containers (EMTCON)	198
Steel	22
Wood (burned on site)	4,161
Landfill Leachate Collection and Recycle at Mahkeses Plant	16,032
Solid Waste (Rags, soils, etc.)	431
Liquid Waste (Glycol, etc.)	5,823
Sludge (sludge cont. hydrocarbons)	13,434

Imperial | Cold Lake

Monitoring Programs – Groundwater

Cold Lake Operations maintains an extensive groundwater monitoring program.



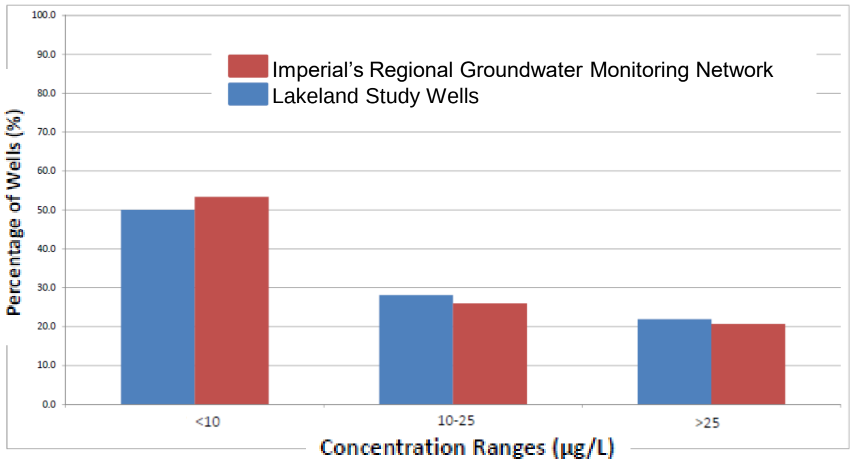
- Monitoring
  - 400 deep groundwater wells (including 17 domestic), and
  - 220 shallow wells
- Monitoring includes chemistry & water levels
- Drilling activity in 2018/2019
  - Deep:
    - E GEW 19-1 (BNV)
    - E GEW 19-2 (BNV)
  - Shallow:
    - 7 shallow groundwater wells installed near D39 Pad
    - MHP4-20-61
- 2018/2019 Abandonment:
  - No wells were abandoned

Imperial | Cold Lake

Monitoring Programs – Groundwater (Thermal Mobilization)

Based on groundwater monitoring to date, there is no evidence that mobilized arsenic has impacted domestic or livestock groundwater wells. Cold Lake Operations continues its extensive groundwater monitoring program.

- Imperial monitors thermally mobilized arsenic at D55, D57, L08, V10 pads.
- Field observations confirm that heat convection cells play a significant role in the release and transport of arsenic when the GW velocity is low.
- Laboratory experiments indicate that arsenic released by conductive heating is re-adsorbed when the GW is exposed to unheated sediments.
- Field study results indicate that peak arsenic concentrations and arsenic mass at D55 and D57 pads have declined as the arsenic plumes migrate down gradient. The average velocity of the dissolved arsenic is retarded relative to GW flow velocity. These observations indicate that arsenic attenuates as it moves down gradient.



A comparison of arsenic concentrations in wells tested by Alberta Health and Wellness (Lakeland Study Wells - 2000) and wells in Imperial's Regional Groundwater Monitoring Network (IOR Regional Wells - 2017) Drinking water guideline for arsenic is 10 µg/L.

- Additional downgradient monitoring wells are positioned to measure the rate and extent of attenuation.
- Imperial will submit a Groundwater Monitoring Thermal Proposal by March 31, 2020, as per the Assessment of Thermally-Mobilized Constituents in Groundwater for Thermal In Situ Operations Directive.
- Spring 2019- Conducted drilling program to further characterize the risk associate to thermal mobilization of constituents.

Imperial | Cold Lake

Monitoring Programs – Surface Water

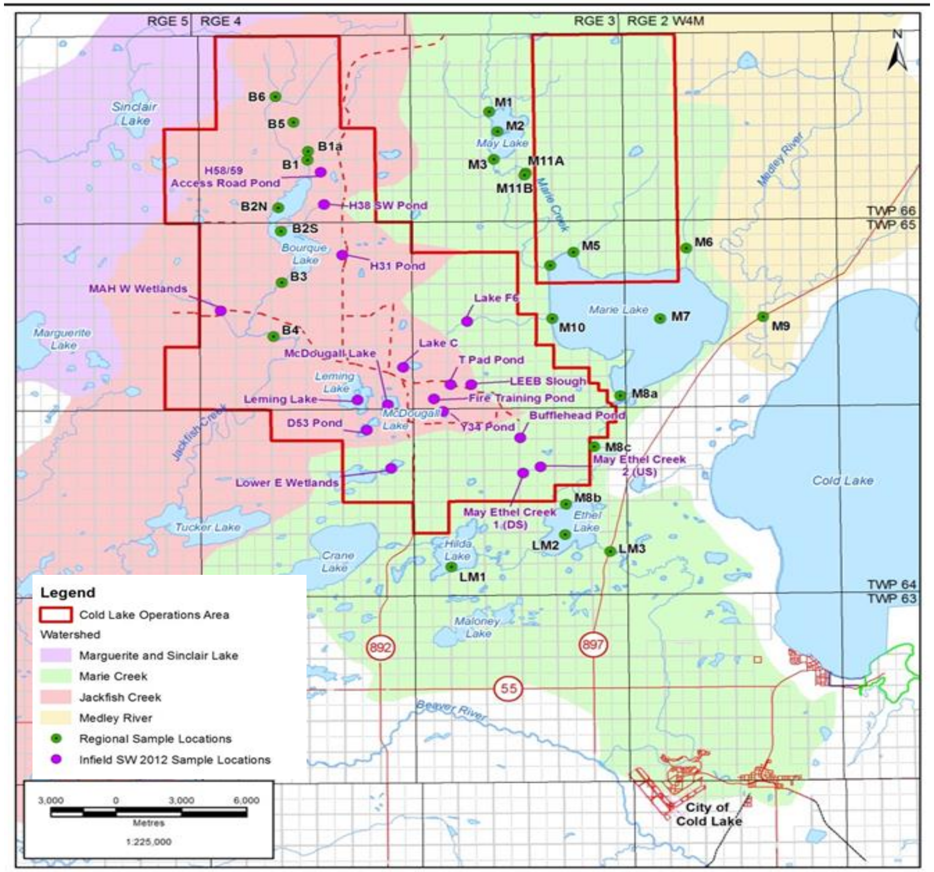
Cold Lake Operations maintains an extensive surface water monitoring program.

Comprised of the following components:

- Surface Water Quality Sampling (Regional, Infield, Wetlands)
- Level Monitoring (Lake, creeks, wetland piezometers)
- Long-term Wetland Monitoring Plots
- Diverted Runoff

Imperial | Cold Lake

Monitoring Programs – Surface Water



Sampling

- Spring and fall sampling of water bodies (routine water quality parameters (pH, alkalinity, hardness, etc), major cations and anions, forms of nitrogen, phosphorous, hydrocarbons, and trace elements)
- Flow measurements at selected creek sites
- Depth composite samples from canoe for both regional and infield lakes where depths are greater than 2 meters

Three Monitoring Programs

1. Regional Surface Water Monitoring
2. Infield Surface Water Monitoring
3. District Wetland Monitoring

Regional

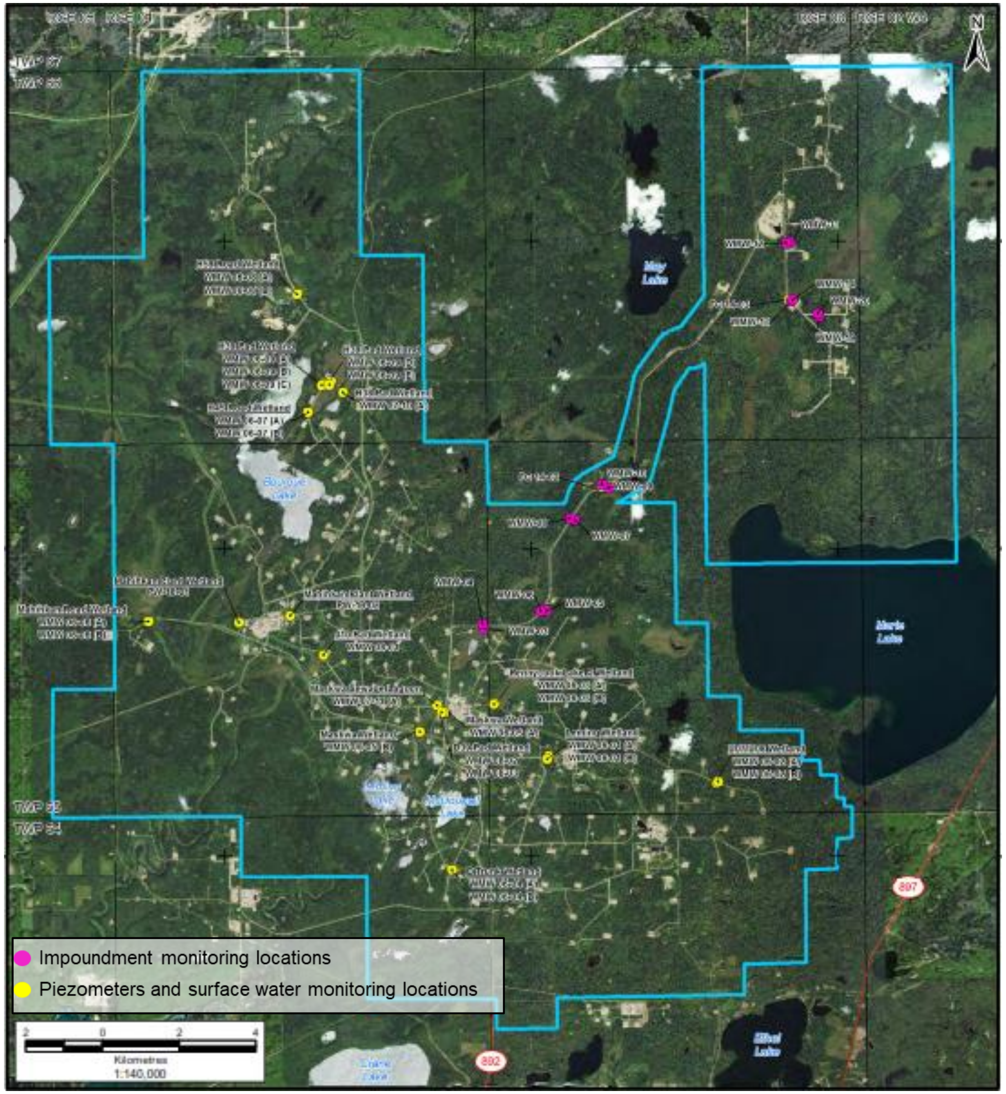
- Three major watersheds investigated, Marie Creek, Jackfish Creek and Medley River watersheds
- No trends indicating eutrophication or acidification of regional waterbodies/water courses
- Data Sharing
  - Beaver River Watershed Association (BRWA)
  - Alberta Lake Management Society (ALMS)
  - Marie Lake Air and Watershed Society (MLAWS)
  - Landowners, as required

Infield

- Sample surface water within boundaries of CLO area, 17 sites
- No trends indicating eutrophication of infield waterbodies/water courses

Imperial | Cold Lake

Monitoring Programs – Surface Water



District Wetland Monitoring

- Groundwater levels are monitored by a combination of transducers and manual measurements
- **2018 Results:**
  - Shallow GW had levels consistent with the historical range
  - Two Nabiye road impoundment monitoring wells suggest impoundment may be occurring (verification underway)
  - Water quality results were typically within expected ranges, with the exception of Maskwa wetland and Maskwa Sewage Lagoon wetland, which had an increase in chloride concentration (investigation underway)

Imperial | Cold Lake

Monitoring Programs – Surface Water Long-term Wetland Monitoring Plots

Vegetative stress was not identified the field assessments.

- Established in August 2006, as per EPEA 73534-00-04 Section 4.9.2a
- Purpose: Monitor long-term effects of groundwater withdrawals on wetland health, extent and distribution
  - Establishment of 11 plots
  - Baseline data collection
- Next Monitoring Date: 2020 (per 5 year monitoring schedule)
- 2015 Results
  - Evidence indicates that wetlands studied are influenced by precipitation, rather than groundwater levels.

Monitoring - Diverted Runoff

The 2018 runoff data is in compliance with the EPEA approval.

There were no releases outside of the EPEA limits in 2018.

Parameter	Limit
Discharge Volume	-
pH	6.0 – 9.5
Oil and Grease	No visible sheen
Chloride	500 mg/L

Month (Total)	Number of Releases	Total Volume Released (m^3)
Leming Plant	67	3,120
Leming & Mahkeses Field	205	132,391
Maskwa Plant	38	23,590
Maskwa Field	228	166,031
Mahihkan Plant	132	14,835
Mahihkan Field	230	74,257
Nabiye Field	91	36,560

Future Plans

Future Plans

- Continue industry sharing and participation as part of COSIA and CAPP to improve performance on fresh water use, emissions, etc.
- Continue to progress Enhanced Electrocoagulation (EEC) trial to reduce reliance on Hot Lime Softening technology
- Increase bitumen production capacity by adding injection and production wells (e.g. infills)
- Continue pilots of new recovery technologies to enhance profitability and reduce GHG intensity
- Increase produced water injection capacity by adding disposal wells

Attachments

Attachment 1

2019 Bitumen in Shale Report

Colorado Shale Monitoring Wells

Table 1 – Monitoring wells proposed for conversion to low-pressure producers

Well	UWI	License #	Comments
D51-05 (Colorado)	102/13-36-64-4W4/0	127833	Retain D51-10 as the pad monitoring well
D51-17 (Colorado)	100/09-35-64-4W4/0	127845	Retain D51-10 as the pad monitoring well
D02-02 (Colorado)	102/09-11-65-4W4/0	114515	
D21-12 (Colorado)	102/01-11-65-4W4/0	114815	
D21-15 (Colorado)	106/04-12-65-4W4/0	114818	
D22-14 (Colorado)	105/02-11-65-4W4/0	115055	
D23-13 (Lloydminster and Colony)	109/16-2-65-4W4/0	116121	
D65-11 (Colony)	105/04-36-64-4W4/0	188547	Run temperature log and take manual pressure reading before conversion

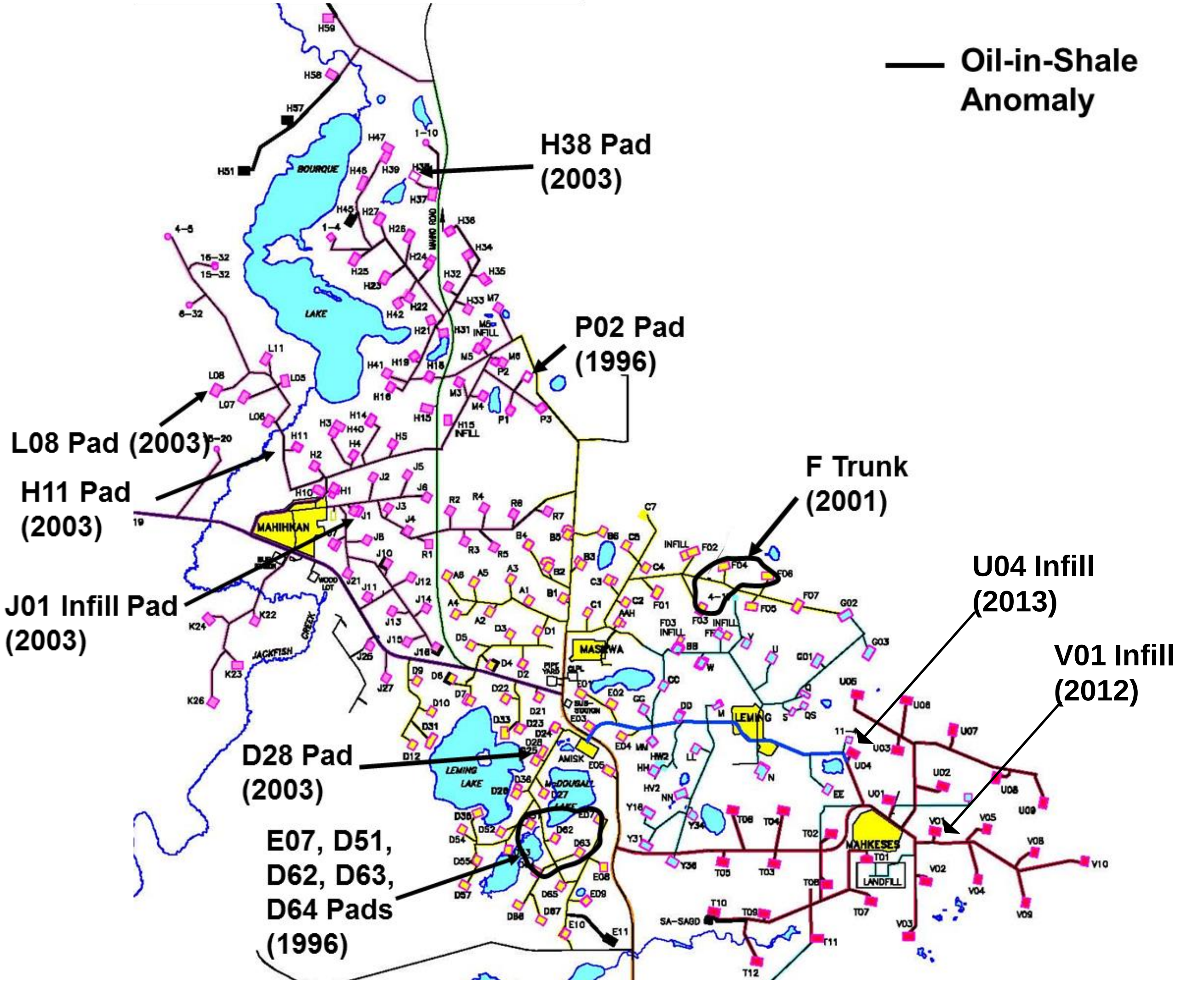
Table 3 – Wells proposed for continued monitoring

Well	UWI	License #	Comments
D51-10	100/16-35-64-4W4/0	127838	Retain D51-10 as the pad monitoring well
E07-PM1	112/15-36-64-4W4/0	218719	Retain E07-PM1 –continued HP steaming from D29 –failed sensor recently repaired
E07-14	108/15-36-64-4W4/0	189068	Retain E07-14 –continued HP steaming from D29
F04 CEW-7	114/09-18-65-3W4/0	265997	Retain F04 CEW-7 to monitor anomaly
H38-CEW-24	106/16-3-66-4W4/0	297208	

Table 2 – Colorado Evaluation Wells (CEWs) proposed for abandonment

Well	UWI	License #	Comments
D62-OB2	1AB/11-36-64-4W4/0	194968	Run temperature log and take manual pressure reading before abandonment
D63-OB2	112/11-36-64-4W4/0	199930	Run temperature log and take manual pressure reading before abandonment
D64-OB2	1AA/05-36-64-4W4/0	196036	Run temperature log and take manual pressure reading before abandonment
D07-CEW-5	112/03-11-65-4W4/0	265162	Run temperature log and take manual pressure reading before abandonment
F01 CEW-8	110/06-18-65-3W4/0	267431	
F02 CEW-6	112/10-18-65-3W4/0	265998	
F03 CEW-1	115/02-18-65-3W4/0	263666	Previously suspended
F03 CEW-2	111/08-18-65-3W4/0	263374	
F03 CEW-3	112/04-17-65-3W4/0	263493	Previously suspended
F03-16A	110/08-18-65-3W4/0	260559	
F04 CEW-9	103/13-17-65-3W4/0	265997	Previously suspended
F06 CEW-10	112/06-17-65-3W4/0	267585	
F07 CEW-13	112/02-17-65-3W4/0	267537	
14-17 CEW-12	102/14-17-65-3W4/0	268171	Previously suspended
FF CEW4	100/16-7-65-3W4/0	268445	Previously suspended
H37-CEW-18	111/09-3-66-4W4/0	284934	
H38-CEW-26	103/16-3-66-4W4/0	275128	
H38-CEW-27	107/15-3-66-4W4/0	277163	
J01-CEW-21	112/04-22-65-4W4/0	289972	No plans for this pad

Oil in Shale Summary



Oil In Shale Summary

No new oil in shale events to report

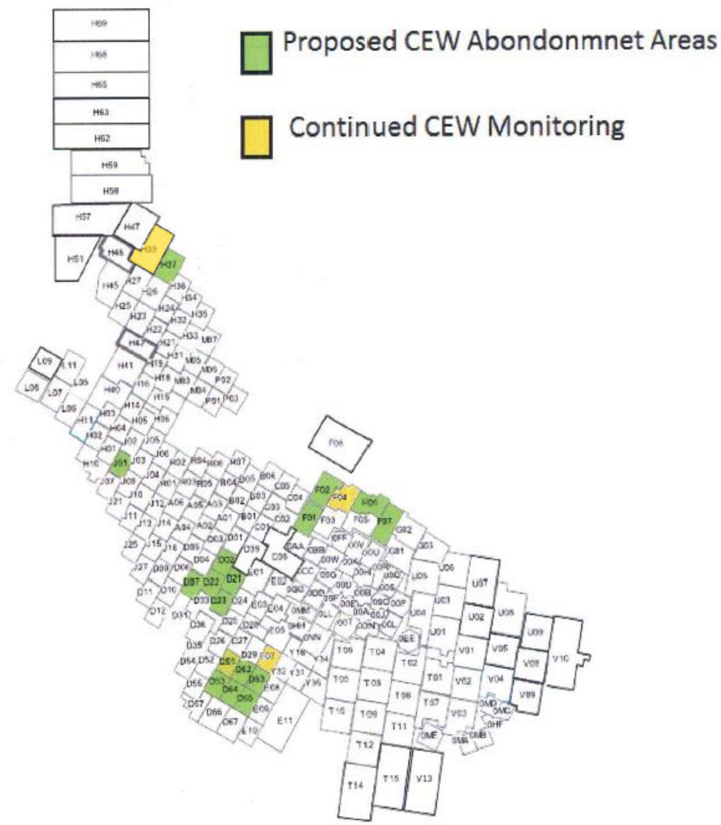
Location	Issue	Date of Discovery	Current Restriction?	Comments/ Commitments/ Results	Next Scheduled Steam Date
E07	Oil in Shale found during drilling at E07 pad	1997	No	E07 wells abandoned. Resource accessed via D29 horizontal wells. Shale pressure monitored while steaming.	2020; resource steamed via D29
F trunk	Oil in Shale found during re-drill at F03-16A	2001	No	Steaming restrictions lifted Sept 10, 2003. Anomaly area steamed 2006, including new infill wells. Shale pressure monitored and steam pattern adjusted to minimize shear stresses. One GEW shows <1.5 ppb benzene and below Canadian drinking water quality guidelines (CDWQG), consistent with thermally mobilized BTEX.	Steam Flood Ongoing (via infills)
L08	Oil reported during drilling of L08-01 and PS well on pad.	2003	No	Steaming restriction lifted June 13, 2003. No anomalous pressures in CEW observed since then. Groundwater appears to be consistent with historical data, with PHCs generally non-detect.	None
H38/H39	Oil reported during drilling of H38-12 and H38-22.	2003	No	Steaming restriction lifted Nov 25, 2004. No anomalous pressures in CEW observed since then. In Feb 2011 groundwater had benzene concentrations above CDWQG on H39. Since April 2013, PHC chemistry has been below CDWQG.	2021
H11	Oil reported during drilling of H11-02 and H11-05	2003	No	No anomalous pressures in CEW observed since 2003. Benzene observed in 2004 and 2005 but was subsequently below detection limit. Benzene was seen in GEW 11-7 in 2012, but has since been below CDWQG.	None

Oil In Shale Summary

Location	Issue	Date of Discovery	Current Restriction?	Comments/ Commitments/ Results	Next Scheduled Steam Date
J01 Infills	Oil reported during drilling of J01-H1	2003	No	No abnormal pressures at CEW during infill well steaming cycles. Groundwater shows no abnormal hydrocarbons.	Steam Flood Operations Ongoing
D28	Oil reported during drilling of D28-07 and D28-09.	2003	No	Steaming area via infill wells since 2012 with no anomalous pressure response at the CEW. Groundwater shows no abnormal hydrocarbons.	Steam Flood Ongoing (via infills)
V01	Oil in Shale found during drilling of V01-H28 infill	Nov 2012	No	Deep groundwater monitoring well installed – no impacts were observed	2022 (via infills)
U04	Oil in Shale found during drilling of U04-H26	Feb 2013	No	No groundwater monitoring drilled as there is no deep continuous aquifer to monitor	2022 (via infills)

Colorado Shale Monitoring Wells

- AER has approved Imperial's application to discontinue monitoring at 28 Colorado Shale monitoring wells in areas which have converted to low pressure steaming operations
- Of the 28 wells, 20 will be abandoned and eight will be returned to low pressure operation
- In a few areas with either high pressure steaming plans, or high pressure in the Colorado Shale, four monitoring wells will be maintained
- A list of these wells is on the next page

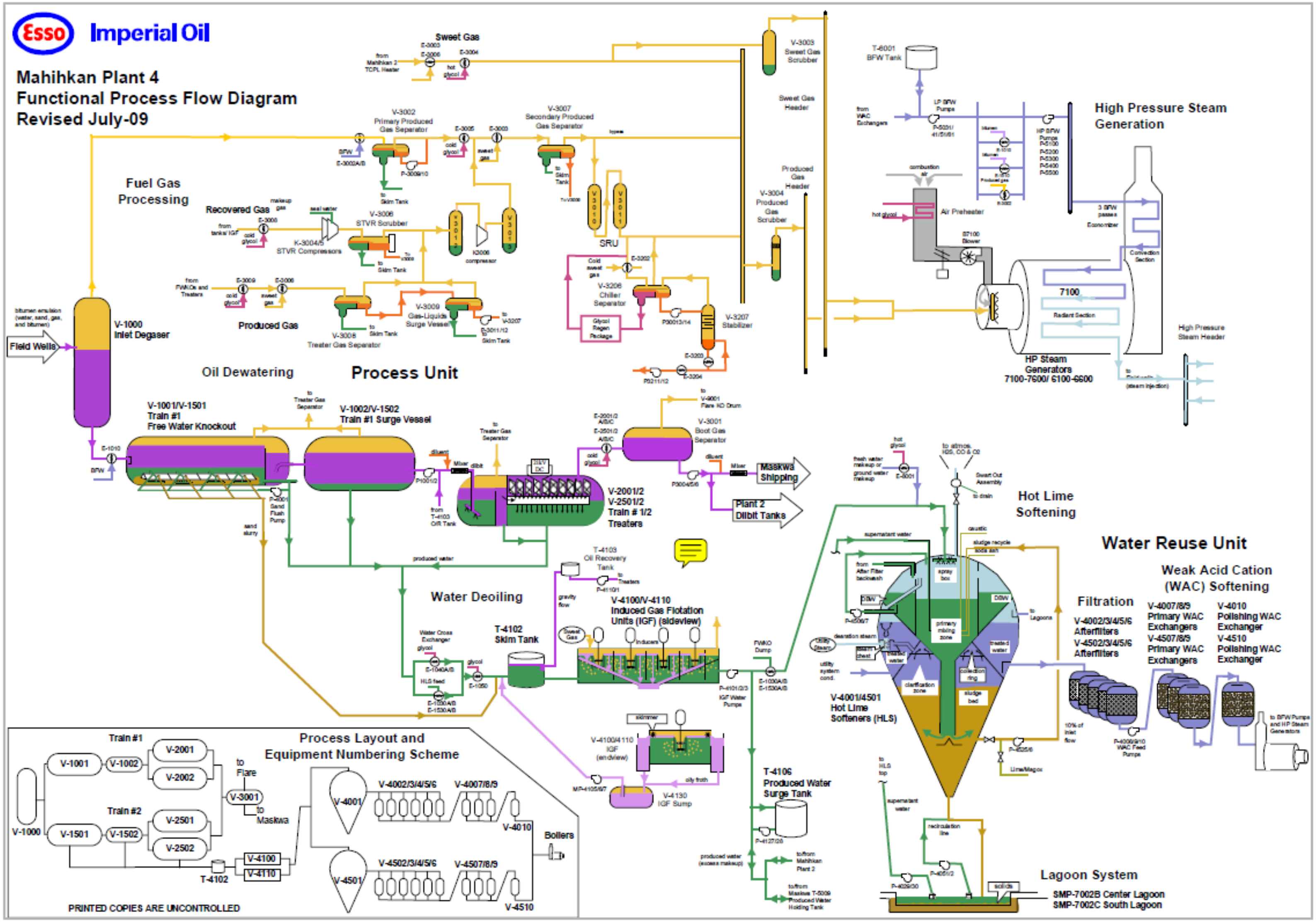


Imperial | Cold Lake

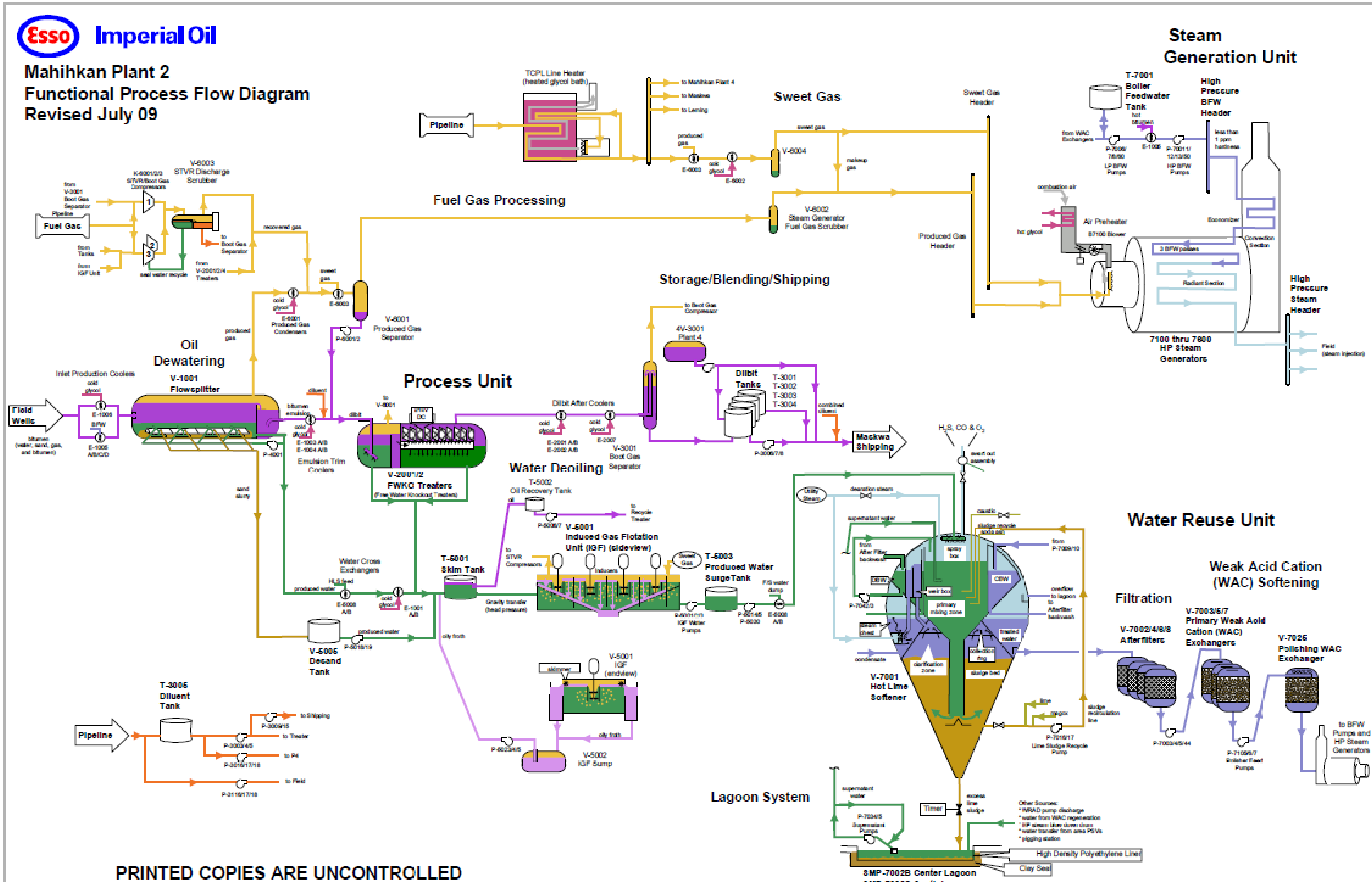
Attachment 2

Process Flow Schematics

Process Flow Schematics

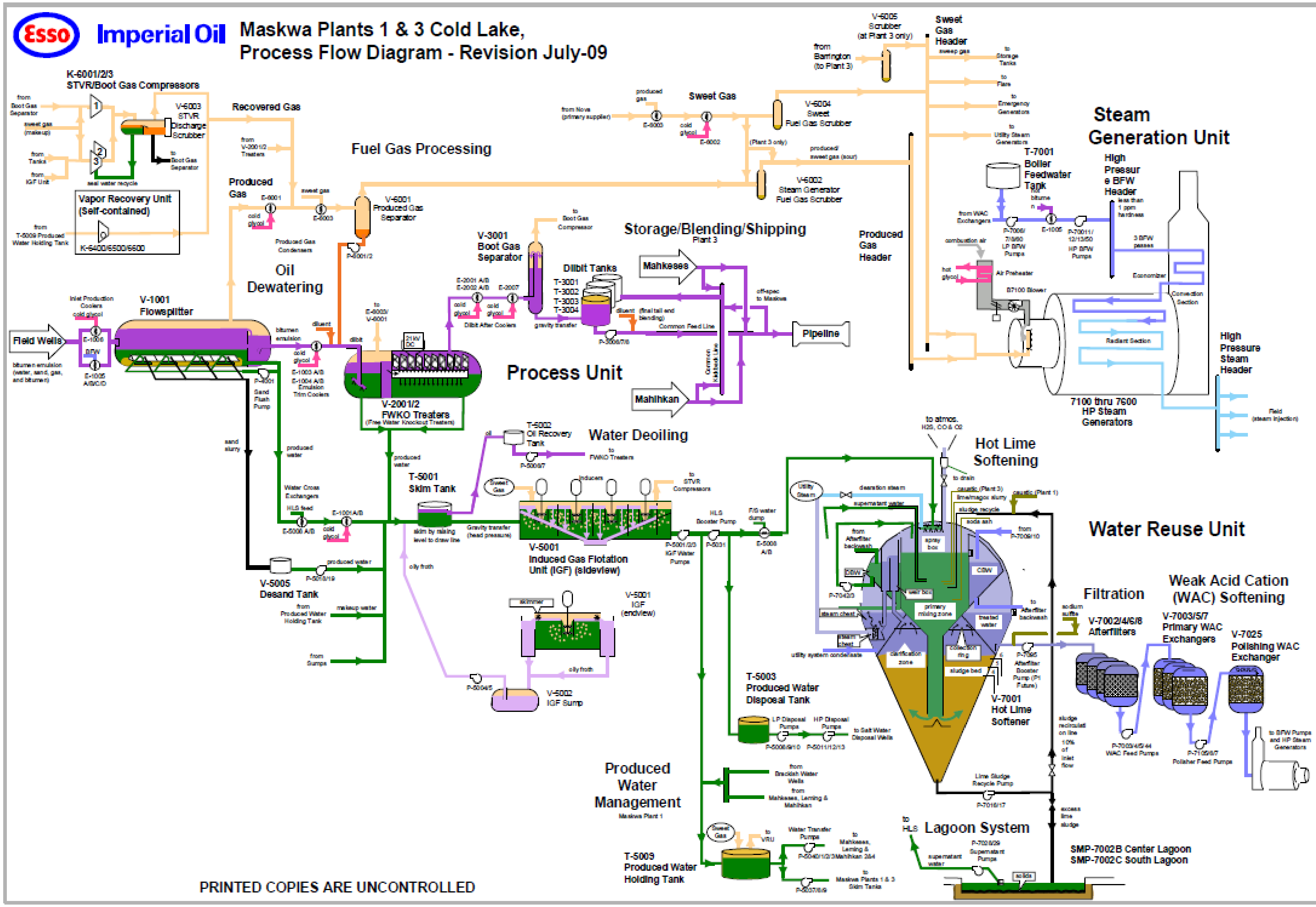


Process Flow Schematics



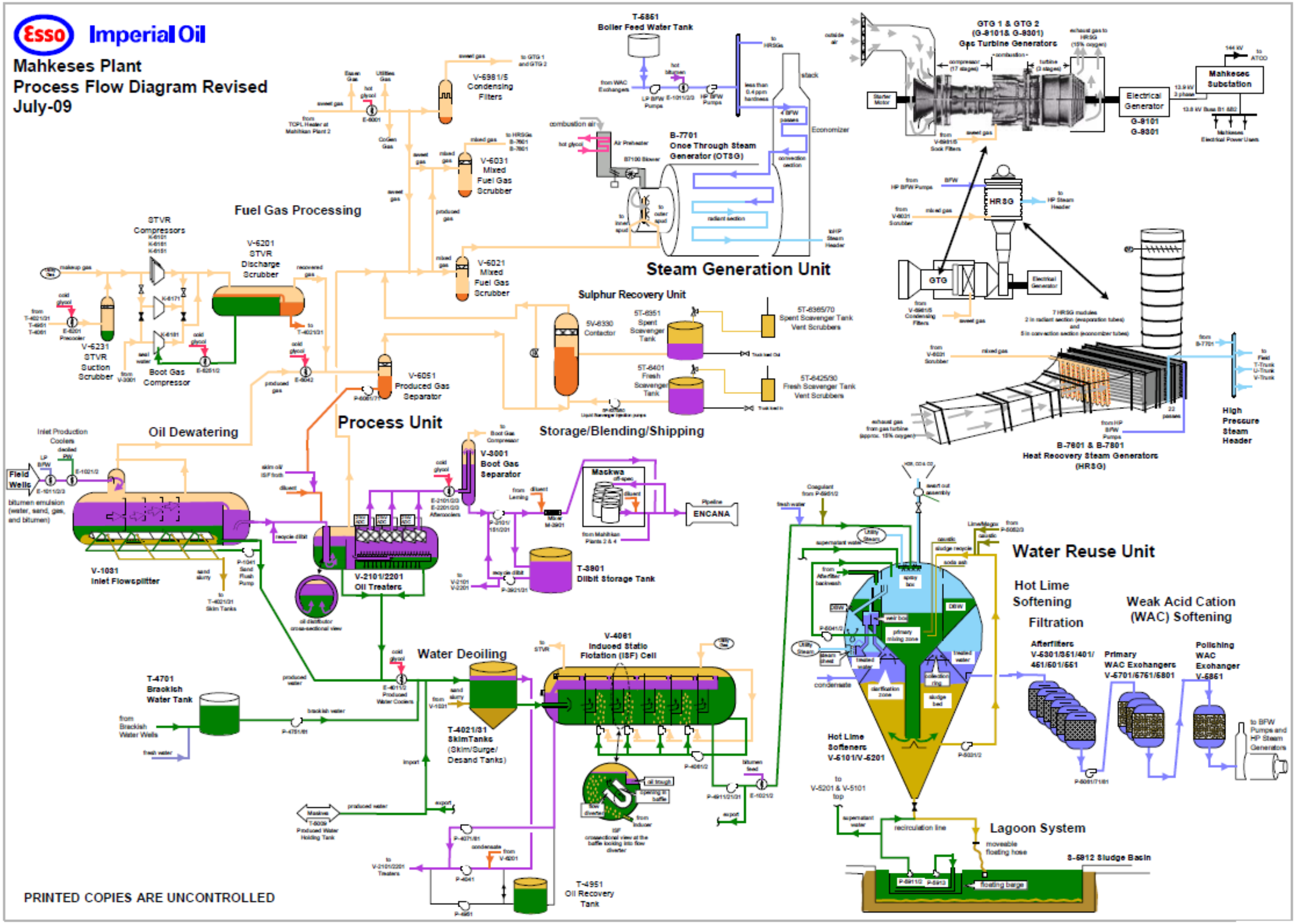
Imperial | Cold Lake

Process Flow Schematics

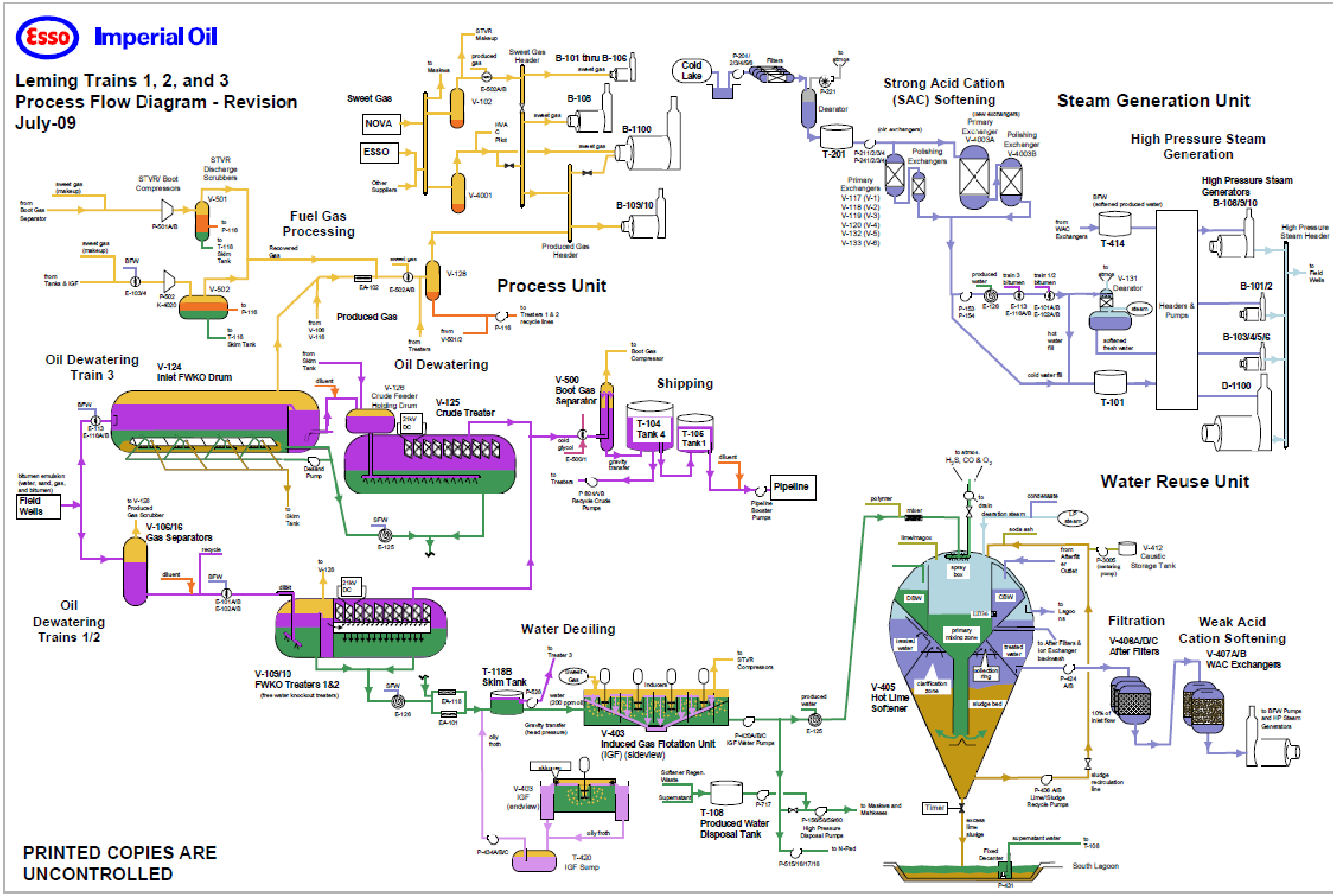


Imperial | Cold Lake

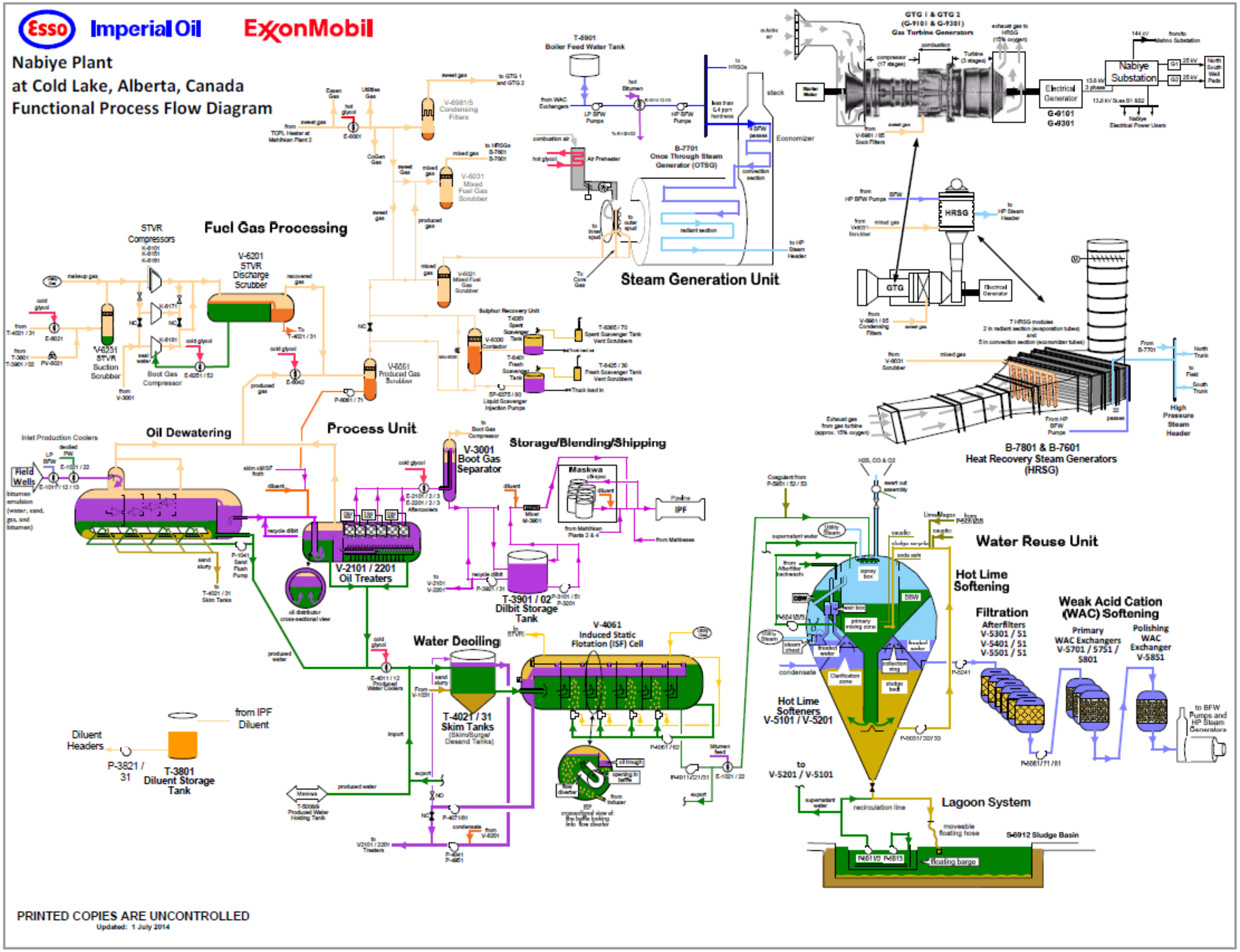
Process Flow Schematics



Process Flow Schematics



Process Flow Schematics



Attachment 3

Water Properties, Disposal and Storage

Water Properties

- Produced water and Brackish water both contain TDS (Total Dissolved Solids)
- Produced water contains silica (requires MgO treatment)
- Natural waters do not contain silica, tannin and are higher in magnesium
- Produced water contains tannin (helps mitigate Caustic Stress Corrosion Cracking)
- Produced water pH is a function of dissolved CO_2

Brackish and Fresh water well summary:

Well ID	*UWI*	*Regulatory Name*
Brackish water (1-05-65-02-W4M)		
BRAK1CLD	*1F1010506502W 400*	*BRAKISH WATER WELL #1*
BRAK2CLD	*1F2010506502W 400*	*BRAKISH WATER WELL #2*
BRAK3CLD	*1F3010506502W 400*	*IMP MARIE 3 COLDLK 1-5-65-2*
Groundwater (5-22-65-04-W4M) – Licence 00148301-02-00		
FW1-1 CLD	*1F1052206504W 400*	*ESSO FW E1-1 COLD LAKE WW 5-22-65-4*
FW1-2 CLD	*1F3052206504W 400*	*ESSO FW E1-2 COLD LAKE WW 5-22-65-4*
Cold Lake water (14-02-65-02-W4M) – Licence 00079923-02-00		
LEMFWCLD	*1L1140206502W 400*	*COLD LAKE FRESH WATER SOURCE*

Water properties summary:

Parameter	Produced Water	Brackish Water	Cold Lake Water	Ground Water	Disposal Water
pH	~6 to 7.5	~7.5	~7.5	~8	~6 to 7.5
Ca as CaCO3	150 - 300 ppm	85 ppm	90 ppm	200 ppm	150 - 400 ppm
Mg as CaCO3	5–25 ppm	95 ppm	40 ppm	150 ppm	5–100 ppm
Total Hardness as CaCO3	155–325 ppm	180 ppm	130 ppm	350 ppm	155–500 ppm
Alkalinity “M” Alkalinity “TIC”	450 ppm 300 ppm	1000 ppm 1000 ppm	150 ppm 150 ppm	550 ppm 550 ppm	450 ppm 300 ppm
Silica	150–350 ppm	< 10 ppm	< 5 ppm	< 15 ppm	50–350 ppm
Chloride	5000–8000 ppm	4000 ppm	< 5 ppm	< 20 ppm	2000–10000 ppm
TDS	~12000 ppm	~7000 ppm	~300 ppm	~800 ppm	5000-12000 ppm
Tannin	100–200 ppm	0 ppm	0 ppm	0 ppm	50–200 ppm
Dissolved Gases	CH4, CO2, H2S	CH4, CO2	Dissolved Oxygen	CO2	CH4, CO2, H2S

Imperial | Cold Lake

Produced Water Disposal - to Cambrian, Approval 4510

- Water disposal required due to high produced water levels (high water to steam ratios)
- Efforts to improve water recycle include reduced fresh water usage, improved steam generation and water reuse service factors, and improved water inter-plant transfer capability

Monthly Injection Volumes and Average Wellhead Injection Pressures

		2018						2019																	
WELL IDENTIFIER	Disposal Zone	OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER	
		(MPA)	(m^3)	(MPA)	(m^3)	(MPA)	(m^3)	(MPA)	(m^3)	(MPA)	(m^3)	(MPA)	(m^3)	(MPA)	(m^3)	(MPA)	(m^3)	(MPA)	(m^3)	(MPA)	(m^3)	(MPA)	(m^3)	(MPA)	(m^3)
00 01 19 064 03 4 00 (SWDFT701)	Cambrian	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
00 01 32 064 03 4 00 (SWDFT702)	Cambrian	12.2000	51,661.5	12.2000	48,530.8	12.2000	38,460.5	12.2000	9,559.4	12.200	46,385.4	12.2000	21,769.7	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
02 02 03 064 03 4 00 (SWDFT703)	Cambrian	11.9130	22,844.4	11.7000	26,644.4	11.3430	16,271.2	11.4000	0.0	11.400	4,934.5	11.4000	4,381.7	0.0000	0.0	11.4000	9,816.3	11.4000	2,723.1	11.4000	52,519.3	11.4000	57,279.6	11.4000	12,877.8
00 03 04 065 03 4 00 Abandoned	Cambrian																								
00 04 17 065 03 4 00 Abandoned	Cambrian																								
00 08 33 064 03 4 00 Abandoned	Cambrian																								
00 11 07 065 03 4 00 Abandoned	Cambrian																								
00 12 08 065 03 4 00 Abandoned	Cambrian																								
00 07 18 064 03 4 00 (SWDFT705)	Cambrian	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
00 11 22 064 03 4 00 Abandoned	Cambrian																								
TOTAL DISPOSAL (m^3)			74506		75175		54732		9559		51320		26151		0		9816		2723		52519		57280		12878
DAILY AVERAGE(m^3)			2403		2506		1766		308		1833		844		0		317		91		1694		1848		429

PW Disposal & Storage District Summary (m^3)

	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19
Disposal Volume, m3	54,664	43,609	18,413	15,295	46,250	22,955	84,618	33,374	42,602	64,868	81,578	73,885
Disposal Limit, m3	255,194	252,148	246,065	239,965	213,385	252,129	239,167	223,610	201,543	253,265	252,440	228,419
Actual Disposal, %	1.5%	1.2%	0.5%	0.4%	1.5%	0.7%	2.2%	1.0%	1.4%	1.7%	2.2%	2.1%
Disposal Limit, %	6.9%	6.9%	6.8%	6.8%	6.7%	7.2%	6.3%	6.7%	6.5%	6.6%	6.7%	6.5%

Actual Disposal (%) = Actual disposal / (Total produced water + Total Fresh water including run off and remediation + brackish water)
Disposal Limit (%) = Disposal Limit / (Total produced water + Total Fresh water including run off and remediation + brackish water)

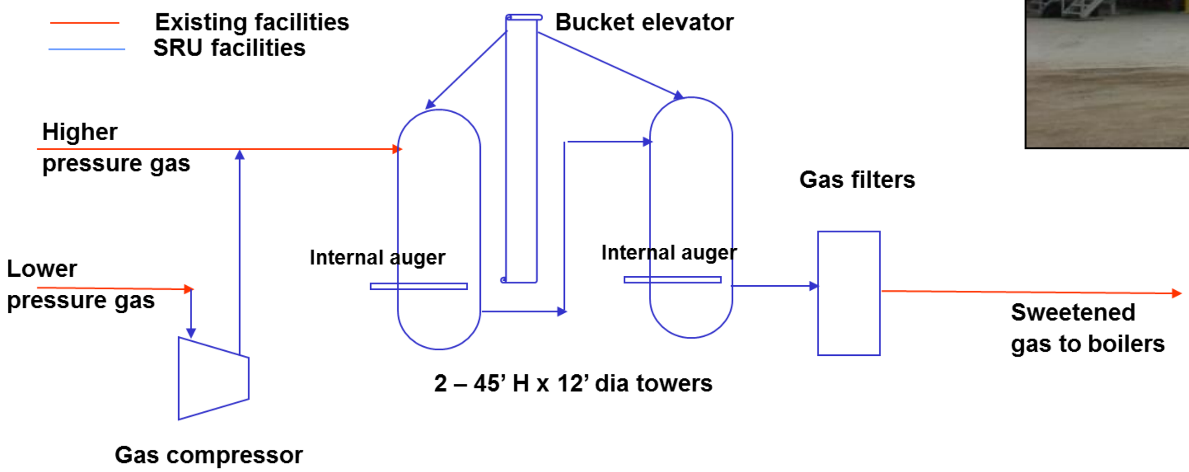
Imperial | Cold Lake

Attachment 4

Sulphur Recovery and Balances

Mahihkan SRU Description

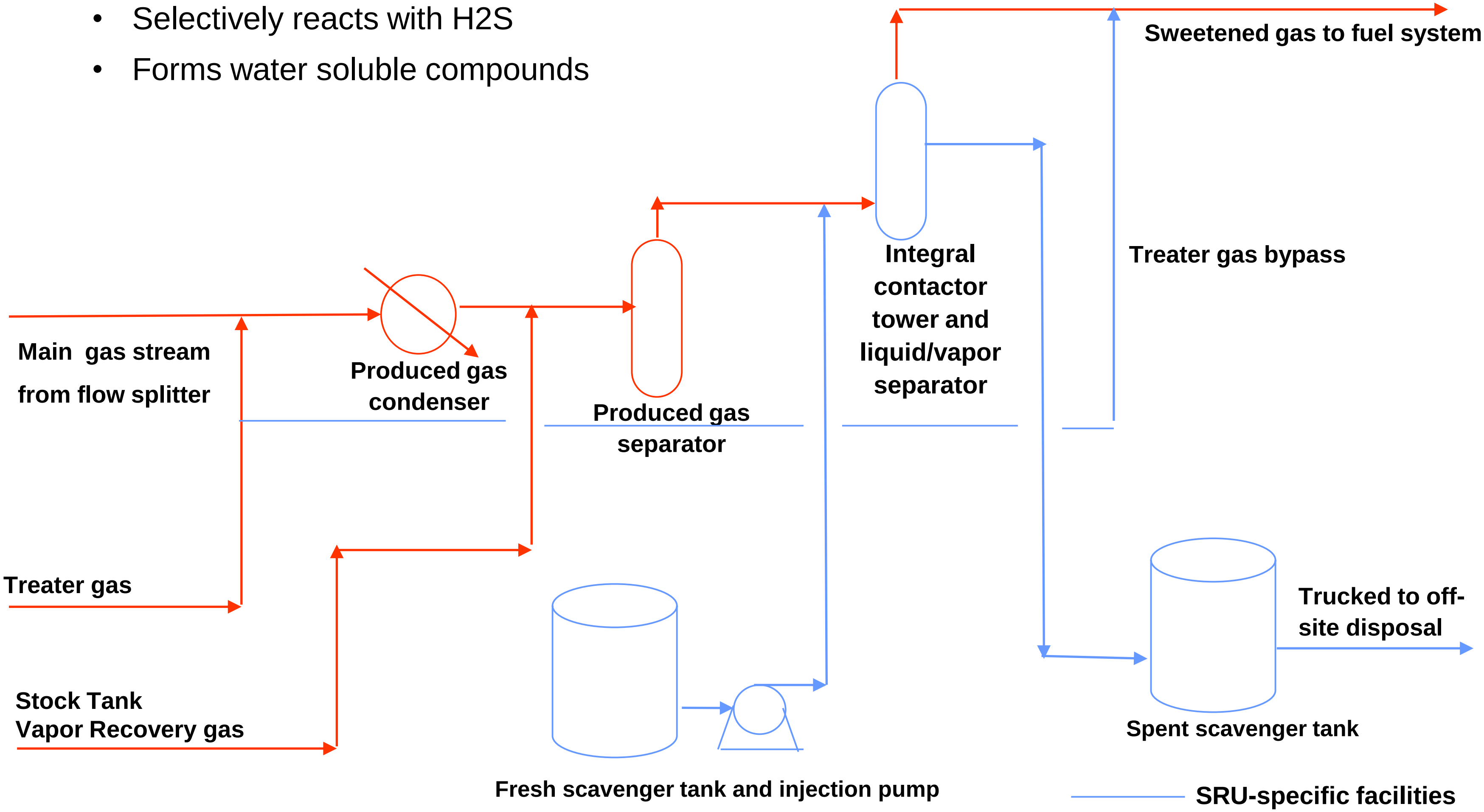
- 2 identical towers for batch operation: 12 ft Diameter by 45 ft Height
- Solid media H2S scavenger Sulphatreat XLP ®
- Piping and switching valves to allow parallel or series (lead/lag) operation. Bypass included for control of gas rate (pressure drop)
- Screw compressor skid to boost low pressure gas streams to SRU
- Media sock filters at outlet of SRU
- External portable auger and bucket elevator for media loading at top of contactor
- Internal auger for tower unloading



Mahkeses and Nabiye SRU Description

Active ingredient in the liquid scavenger is triazine –
Baker Petrolite Petrosweet HSW2001

- Selectively reacts with H_2S
- Forms water soluble compounds



Imperial | Cold Lake

Sulphur Measurement & Reporting

Sulphur (H_2S) Sampling Process

- Manual gas samples taken to monitor H_2S concentration
- Additional gas samples may be taken if increased frequency is desired (e.g. approaching license limits and/or increased variability in samples expected or performance control improvements)

	Gas sample locations	Sampling Frequency
Maskwa Plant	Inlet gas P1 & P3	Weekly
Mahihkan Plant	Inlet gas P2/P4, P4 SRU outlets, P4 Treater gas, P4 Combined gas	Weekly (P2) | MWF (P4)
Leming Plant	Inlet gas	Weekly
Mahkeses Plant	Inlet gas, SRU outlet, Treater Gas, Combined gas	TTh
Nabiye Plant	Inlet gas, SRU outlet, Treater Gas, Combined gas	TTh

- Sulphur measurement process accuracy is within the requirements of ID 2001-03 for reporting (+/- 0.1 tonnes S and +/- 0.1 km^3 gas)
- Sulphur emissions are documented on a daily basis and monitored against the quarterly limits for each plant

Imperial | Cold Lake

Cold Lake Plant Sulphur Balances

As per AER approval 8558 clause 24.2, Imperial is required to report monthly sulphur and comply on a calendar quarter year average basis for each plant.

Tonnes/Day	Month	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19
District	Sulphur Inlet	145.54	144.23	146.61	164.24	145.20	160.49	139.67	125.71	124.91	148.52	142.00	154.88
	Sulphur Removed	79.67	79.77	81.37	90.60	80.40	90.22	76.50	54.43	68.12	80.43	80.89	89.46
	Sulphur Emissions	65.87	64.46	65.24	73.64	64.80	70.28	63.17	71.28	56.80	68.08	61.11	65.42
	SO_2 Emissions	131.74	128.91	130.47	147.27	129.59	140.55	126.34	142.57	113.60	136.17	122.21	130.84
	Sulphur Recovery	54.74%	55.31%	55.50%	55.16%	55.37%	56.21%	54.77%	43.30%	54.53%	54.16%	56.97%	57.76%
Leming	Sulphur Inlet	6.73	8.00	4.76	4.09	2.59	5.57	5.49	14.17	4.58	3.62	4.06	2.99
	Sulphur Removed	0	0	0	0	0	0	0	0	0	0	0	0
	Sulphur Emissions	6.73	8.00	4.76	4.09	2.59	5.57	5.49	14.17	4.58	3.62	4.06	2.99
	SO_2 Emissions	13.46	15.99	9.51	8.17	5.17	11.14	10.99	28.34	9.15	7.24	8.12	5.97
	Sulphur Recovery	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Maskwa	Sulphur Inlet	25.16	26.98	27.73	31.33	26.50	32.05	29.28	29.91	26.33	27.28	26.38	26.81
	Sulphur Removed	0	0	0	0	0	0	0	0	0	0	0	0
	Sulphur Emissions	25.16	26.98	27.73	31.33	26.50	32.05	29.28	29.91	26.33	27.28	26.38	26.81
	SO_2 Emissions	50.32	53.96	55.46	62.67	53.00	64.09	58.56	59.81	52.66	54.57	52.75	53.62
	Sulphur Recovery	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mahihkan	Sulphur Inlet	32.78	31.12	29.74	30.15	31.18	29.79	37.74	36.75	33.95	37.09	35.67	33.36
	Sulphur Removed	22.94	24.94	22.26	21.40	21.35	23.43	29.26	22.97	23.93	23.84	27.49	25.48
	Sulphur Emissions	9.85	6.18	7.48	8.75	9.83	6.37	8.48	13.78	10.02	13.25	8.18	7.88
	SO_2 Emissions	19.69	12.36	14.97	17.50	19.67	12.73	16.95	27.55	20.04	26.50	16.37	15.76
	Sulphur Recovery	69.96%	80.14%	74.84%	70.98%	68.46%	78.63%	77.54%	62.51%	70.49%	64.28%	77.06%	76.38%
Mahkeses	Sulphur Inlet	39.35	45.55	49.50	56.80	53.00	56.02	33.40	0.00	26.67	39.84	32.84	41.84
	Sulphur Removed	27.63	31.98	34.74	39.86	37.22	40.29	23.59	0.00	20.80	28.07	23.03	29.46
	Sulphur Emissions	11.72	13.57	14.76	16.95	15.78	15.73	9.81	0.00	5.88	11.77	9.81	12.38
	SO_2 Emissions	23.44	27.15	29.52	33.89	31.56	31.45	19.62	0.00	11.76	23.55	19.62	24.76
	Sulphur Recovery	70.21%	70.20%	70.18%	70.17%	70.22%	71.93%	70.62%	#DIV/0!	77.96%	70.45%	70.13%	70.41%
Nabiye	Sulphur Inlet	41.51	32.58	34.88	41.86	26.68	42.32	33.76	44.89	33.39	40.68	43.05	49.89
	Sulphur Removed	29.10	22.85	24.37	29.34	18.79	29.55	23.66	31.46	23.39	28.52	30.37	34.53
	Sulphur Emissions	12.41	9.73	10.51	12.52	7.89	12.77	10.11	13.43	10.00	12.16	12.68	15.36
	SO_2 Emissions	24.82	19.45	21.01	25.04	15.78	25.54	20.21	26.87	20.00	24.32	25.35	30.72
	Sulphur Recovery	70%	70%	70%	70%	70%	70%	70%	70%	70.05%	70.11%	70.55%	69.21%

Attachment 5

Other Facility-Related Items

Plant License Limits

Agency	Maximum Daily Inlet Limits	Units	Maskwa	Mahihkan	Mahkeses	Leming	Nabiye	District
AER	Bitumen Inlet	m^3/d	11,000	15,000	8,000	5,000	8,000	40,000
AER	Gas Inlet	km^3/d	600	600	500*	250	280	--
AER	Water Inlet	m^3/d	38,000	50,000	28,000	13,500	22,665	--
AER	H_2S Inlet Composition	mol/kmol	9.99	10.00	9.99	9.99	20.00	--
AER	Sulphur Inlet	t/d	8.13	3.00	4.43	3.39	3.76	--
Agency	**Maximum Daily Emission Limits**	**Units**	**Maskwa**	**Mahihkan**	**Mahkeses**	**Leming**	**Nabiye**	**District**
AER	Sulphur	t/d	2.00	3.00	2.00	1.05	1.11	--
AER	NOx	kg/hr	196.66	167.3	135.00	80.24	135.75	--
AER	CO_2	t/d	4,532.00	4,500.00	4,917.00	1,596.40	4323.00	--
AER	Continuous Flaring	km^3/d	0	0	0	0	0	--
AER	Continuous Venting	km^3/d	0	0	0.02	0	0.16	--
AENV	Sulphur Dioxide (SO_2)	t/d	4.00	--	--	2.10	--	13.15
AENV	NOx	kg/hr	--	--	126.00	--	135.75	--
Agency	**Calendar Quarter-Year Daily AVERAGE Emission Limits**	**Units**	**Maskwa**	**Mahihkan**	**Mahkeses**	**Leming**	**Nabiye**	**District**
AER	Sulphur	t/d	1.00	--	--	1.00	--	--
AER	Inlet Produced Gas Sulphur Recovery	%	--	69.7%	69.7%	--	70.0%	--
AENV	Sulphur Dioxide (SO_2)	t/d	--	1.80	1.08	--	1.08	--

*Note: Mahkeses gas inlet license limit increased from 400 – 500 km3/d July 2019

Imperial | Cold Lake

Enhanced Electrocoagulation (Leming Plant Pilot)

Objective:

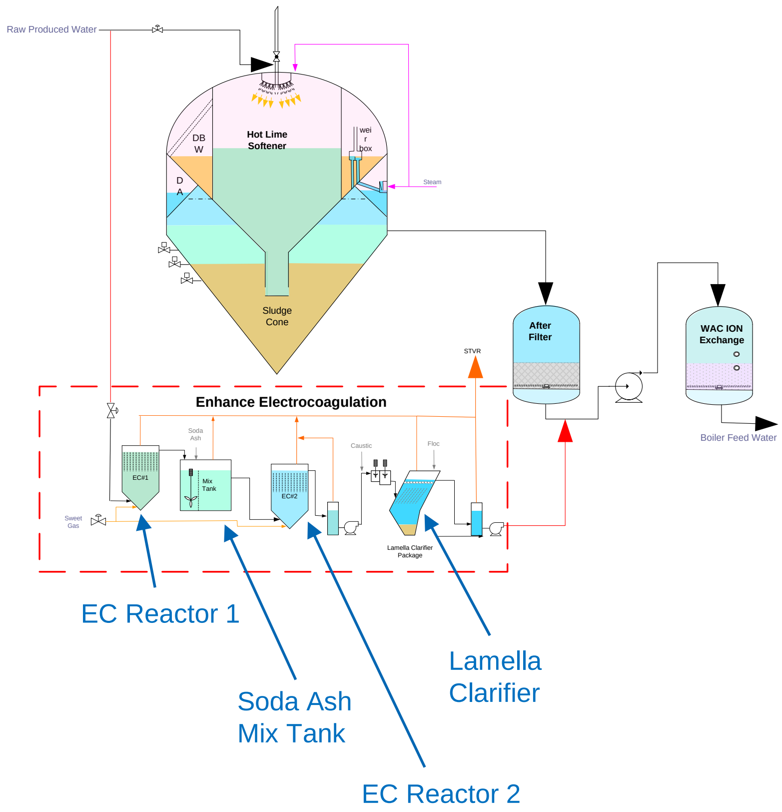
- Reduce operating cost and maintain/improve water recycle treatment reliability.

Opportunity:

- Alternative replacement of lime softeners and after filters.
- Less chemical usage resulting in less solids waste.
- Requires less heat energy, reduces GHG intensity.

Process:

- Primary electrocoagulation reactor with soda ash mix tank feeding into secondary electrocoagulation reactor. Solid separation is achieved with a lamella clarifier.
- Output is partially treated water similar to that of lime softening.



Imperial | Cold Lake

Appendices