



Canadian Natural

**SURFACE OPERATIONS,
COMPLIANCE, AND ISSUES NOT
RELATED TO RESOURCE
EVALUATION AND RECOVERY**

February 6, 2019

PREMIUM VALUE. DEFINED GROWTH. INDEPENDENT.

Outline - Surface Operations, Compliance, and Issues Not Related to Resource Evaluation and Recovery

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Outline - Surface Operations, Compliance, and Issues Not Related to Resource Evaluation and Recovery

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Primrose, Wolf Lake, and Burnt Lake Annual Directive 54 Presentation

AER	Alberta Energy Regulator	EPEA	Alberta Environmental Protection and Enhancement Act
ALMS	Alberta Lake Management Society	Fm	Formation
AGP	above-ground pipeline	FTS	flow to surface
AQHI	Alberta Quality Health Index	GOR	gas oil ratio
BFW	boiler feedwater	ha	hectare
BRWA	Beaver River Watershed Alliance	ISF	induced static flow
BV	Bonneyville	kPa	kiloPascal
BS&W	basic sediment and water	LICA	Lakeland Industrial and Community Association
CEMS	continuous emissions monitoring system	m ³	cubic metre
Cl	chlorine	m ³ /d	cubic metres per day
CL	Cold Lake	MARP	Measurement, Accounting & Reporting Plan
CPF	central processing facility	mg/l	milligrams per litre
CSS	cyclic steam stimulation	ML	Muriel Lake
CWE	cold water equivalent	MPa	Mega Pascal
DI	Depletion Index	Mwh	Megawatt hour
DCS	Digital Control System	MWHIP	Maximum wellhead injection pressure
DDS	digital data submission	NOx	oxides of nitrogen
E3	Empress 3	Obs	observation
e3m3	thousand cubic metres		
EL	Ethel Lake		

Primrose, Wolf Lake, and Burnt Lake Annual Directive 54 Presentation

ORF	oil removal filter
PEP	Primrose East Plant
PNP	Primrose North Plant
PSP	Primrose South Plant
PAW	Primrose and Wolf Lake
profac	proration factor
QAP	Quality Assurance Program
SO ₂	sulphur dioxide
SR	Sand River
t/d	tonnes per day
tCO ₂ e	tonnes of carbon dioxide equivalents
TDS	total dissolved solids
UWI	unique well identifier
VRU	vapour recovery unit
WDW	water disposal well
WLP	Wolf Lake Plant
WSW	water source well

Facilities

- Detailed site survey plans - refer to included drawings:
 - Wolf Lake Plant plot plan
 - Primrose Plant plot plans (South, North, East)
 - Typical pad plot plan (Primrose East)
- Simplified plant schematic - refer to included drawings:
 - Wolf Lake / Primrose simplified plant facilities schematic
- Summary of modifications:
 - Wolf Lake Disposal Pump/Well Additions
 - Wolf Lake Produced Water Debottlenecking: U1 Skim Tank and ORFs, U9 WAC
 - Wolf Lake Slop Management - Tricanter Trial
 - Primrose South OTSG controls upgrades
 - Primrose East BFW/Emulsion Exchangers

Specific Project Update

- Wolf Lake Produced Water Debottleneck
 - Phase 4 near completion
 - Produced water deoiling expansion (Unit 1 Skim tank conversion and ORF addition)
 - Additional WAC exchanger added in U9 (ion exchange water treatment vessels)
 - Additional pumps and associated facilities for WDW 6/7
 - Additional WDW 15/16 wells drilled and tied into existing injection system
 - Glycol system expansion

Wolf Lake CPF Performance

- Bitumen and water treatment
 - Overall water quality and oil treating targets were met:
 - Exceeded produced water treating records
 - Treating challenges existed due to large number of wellbore acid stimulations

Facility Performance

- Power generation/consumption on a monthly basis

Primrose and Wolf Lake - 2018 Power Generation and Consumption

Month	Power Generation	Power Consumption	Net
	MWh	MWh	MWh
January	66,205	72,917	-6,713
February	60,486	67,032	-6,546
March	64,135	69,856	-5,721
April	41,540	64,626	-23,086
May	58,024	69,014	-10,990
June	55,337	65,213	-9,876
July	56,591	64,424	-7,833
August	56,353	70,026	-13,674
September	58,067	63,870	-5,803
October	61,547	69,022	-7,475
November	58,294	59,565	-1,271
December	55,866	62,195	-6,329

Sources:

Energy Components - Cogen Accounting Report 6, PSEP - Primrose Power Plant Monthly Management Summary
 Power consumption was taken from EC CV4330 - Total CNRL Electrical Load

- Power is bought and or sold to the grid as the field electrical demand changes, generation level is constant
- Canadian Natural reports all power produced or consumed, and conducts an annual net settlement of power generated or consumed with the Alberta Utilities Commission (AUC)

Facility Performance

- Gas Usage on a monthly basis

	Total Purchased Gas ¹	Total Solution Gas Conserved	Total Vented Gas	Total Solution Gas Flared ²	Solution Gas Conserved
Month	e3m3	e3m3	e3m3	e3m3	%
January	148,641	18,992	7.3	50	99.7%
February	139,802	16,425	6.2	36	99.8%
March	166,165	17,369	4.7	62	99.6%
April	132,714	16,772	0.5	125*	99.3%
May	154,089	20,693	11.8	178*	99.1%
June	147,617	16,598	3.4	72	99.6%
July	135,143	15,091	3.9	183*	98.8%
August	149,970	16,845	5.5	99*	99.4%
September	133,255	14,582	10.7	1394*	91.3%
October	143,825	14,136	2.0	1251*	91.9%
November	134,822	10,605	1.5	283*	97.4%
December	144,895	15,726	3.3	74	99.5%

NOTES:

- Total purchased gas does not include gas from site gas wells
- Solution gas flared volumes are corrected to remove purchased gas to flare

*OneStop notifications for non-routine flaring events

Facility Performance

- Flaring & Solution Gas Conservation Compliance
 - All Primrose and Wolf Lake facilities are equipped for gas conservation except one pilot well, 15BM – granted exemption in 2004
 - New pads (since 2004) are built with VRUs or are linked to a neighboring pad's VRU
- Solution Gas Flare Volumes
 - 2018 Sep/Oct PSP turnaround received variance for planned maintenance high flaring events.
 - Various non-routine flaring event notifications submitted via OneStop.
 - High solution gas conservation all remaining months for normal operation.
- Facility Venting Compliance
 - No routine venting in the field
 - No routine venting at Primrose North, South, East and Wolf Lake plants
 - Vapour recovery on all major sources of solution gas at Wolf Lake
 - Troubleshooting high venting events from Unit 2 skim tank.

Facilities – Greenhouse Gas Emissions

- PAW Greenhouse Gas Emissions

Month	2018 (tCO ₂ e)
January	301,300
February	285,900
March	348,200
April	270,000
May	319,800
June	317,700
July	291,200
August	322,600
September	278,700
October	303,600
November	276,500
December*	295,800
Year Total	3,611,300

* Forecast

Measurement and Reporting

- Measurement, Accounting & Reporting Plan (MARP) for Wolf Lake / Primrose Thermal Bitumen Scheme Approved May 1st, 2007. Annual updates in March.
- AER MARP audit was conducted on Oct 26th 2016. First round response was submitted on December 7th 2016.
 - MARP meters are being updated as per the Supplemental information provided to the AER.
- Methods for estimating well production and injection volumes reported to Petrinex
 - Produced emulsion from the scheme is commingled at the battery. Bitumen and water production from the battery is prorated to each well using monthly proration test data and proration factors.
 - $\text{Total Battery Oil (Water) / Total Test Oil (Water) at Wells} = \text{Oil (Water) Proration Factor}$
 - $\text{Oil (Water) Proration Factor} * \text{Each Well Test Oil (Water) Volume} = \text{Oil (Water) Allocated to Each Well}$

Measurement and Reporting (con't)

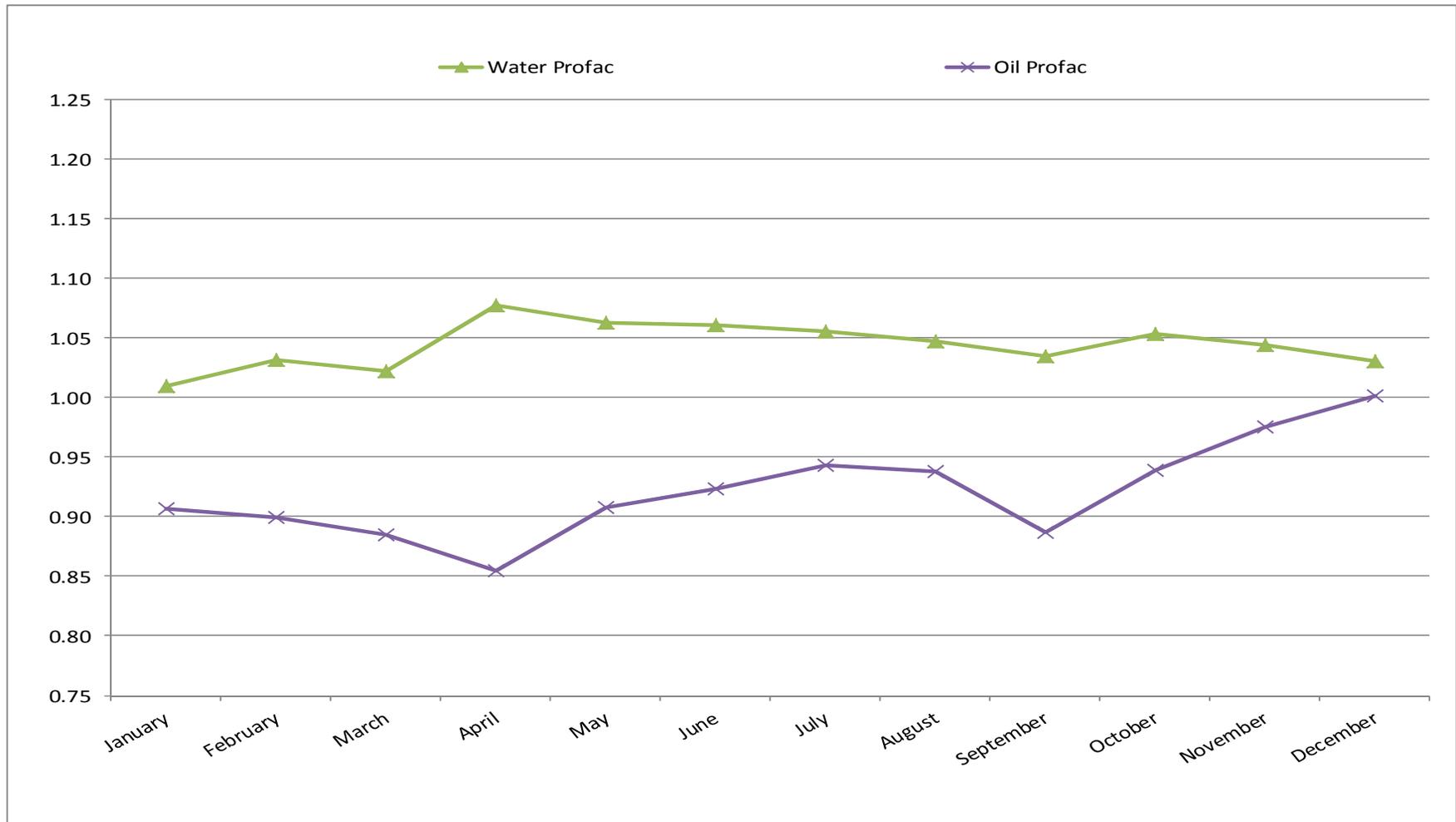
- Gas allocated to each well is determined by GOR (gas oil ratio) for the battery
 - $\text{Total Solution Gas Produced} / \text{Total Battery Oil} = \text{Gas Oil Ratio}$
 - $\text{Gas Oil Ratio} * \text{Oil Allocated to Each Well} = \text{Gas Allocated to Each Well}$
- Injected volumes of steam and water are not estimated, they are continuously measured at wellhead
- Some pads have capability to take steam from Primrose South or Primrose North. Combined proration factor for both plants used for steam transfer volume estimation.

Measurement and Reporting (con't)

- Test Durations
 - Canadian Natural field operations has identified the test durations, gross fluid rates and BS&W results required to obtain valid proration test data for each well
 - Most wells have 4 hour proration test durations; however some wells may be tested from 1 to 6 hours depending on their unique operating conditions and cycle maturity
 - Each well is tested each month and may be tested several times throughout the month

Measurement and Reporting – Proration Factors

- 2018 Monthly Average Oil and Water Profac



Water Production, Injection, and Uses

- Primrose & Wolf Lake Project Water Source Well Listing

Non-saline Water Source Wells		Saline Water Source Wells	
Wolf Lake	Primrose ¹	Grand Rapids ²	McMurray
1F1/12-10-066-05W4M (E3)	1F1/10-05-067-04W4M (EL)	102/10-08-066-05W4M	1F1/11-06-067-03W4M
1F2/12-10-066-05W4M (ML)	1F1/14-05-067-04W4M (EL)	102/05-16-066-05W4M	1F1/16-12-067-04W4M
1F1/06-10-066-05W4M (ML)	1F2/15-05-067-04W4M (EL)	104/05-16-066-05W4M	1F1/11-05-067-03W4M
1F2/06-10-066-05W4M (ML)	04-14-067-03W4M (BV)	109/01-17-066-05W4M	1F2/13-18-067-03W4M
1F1/13-10-066-05W4M (ML)	NW 08-068-04W4M (EL)	107/02-17-066-05W4M	1F1/14-08-067-03W4M
1F2/13-10-066-05W4M (E3)	NW 08-068-04W4M (EL)	106/08-17-066-05W4M	1F1/12-09-067-03W4M
02-07-066-05W4M (SR) ³	14-04-067-04W4M (EL)	107/08-17-066-05W4M	1F2/12-09-067-03W4M
06-08-066-05W4M (SR) ³	11-05-067-04W4M (EL)		1F1/10-08-067-03W4M
	10-05-067-04W4M (EL)		1F1/02-12-067-03W4M
	10-05-067-04W4M (EL)		1F1/07-06-067-03W4M
			1F1/16-06-067-03W4M

Notes:

1. Primrose non-saline water source wells are utility or domestic/sanitary use only
2. Grand Rapids Fm. source wells not currently in use
3. Wolf Lake field office domestic/sanitary water source wells

Water Production, Injection, and Uses

- Water Uses: Saline and non-saline
 - Saline water uses
 - Primary source of boiler feed water make-up
 - De-sand quench, filter backwash – ends up as boiler feed water
 - Non-saline water uses
 - Utility water, utility steam, seal flush and gland water, slurry make-up, dilution water, filter backwash, quench water
 - Burnt Lake Plant historically used Fish Hatchery effluent for boiler feed water. Due to pipeline integrity concerns Fish Hatchery effluent for Burnt Lake boiler feed water stopped early 2017. Primrose East E-pond water continued to be used until the end of April 2018.
 - Occasional boiler feed water make-up as required
 - Sanitary/domestic purposes at each plant, the Wolf Lake office, PRS camp
 - Drilling, well servicing, ice road construction, and dust control
- Water Act Licences
 - Non-saline (Quaternary) groundwater monitored and reported per Water Act license requirements

Water Production, Injection, and Uses

- Water Quality Assessment
 - Cold Lake Fish Hatchery Effluent – Low Lift Pump Station (no longer in use)
 - Average TDS = 134 mg/L
 - Quaternary Water Source Wells – Empress Unit 3 & Muriel Lake Formation Aquifers
 - 2018 Average TDS = 606 mg/L
 - McMurray Fm. Water Source Wells
 - Average TDS = 7,276 mg/L

Water Production, Injection, and Uses

- Non-saline, saline, produced and steam injection volumes

Primrose and Wolf Lake - 2018 Monthly Average Water and Steam Volumes

Month	Surface Water ¹	Non-Saline Groundwater ²	Saline Groundwater ³	Produced Water	Steam Injection	Actual Water Disposal	Water Disposal Limit ⁴
	m ³ /d	m ³ /d	m ³ /d	m ³ /d	m ³ /d	%	%
January	384	3,203	10,773	70,309	73,950	15.9	17.9
February	363	2,806	8,613	76,282	76,695	14.1	17.4
March	391	2,717	18,554	65,860	82,832	4.6	24.1
April	471	3,186	22,626	58,186	66,590	17.7	26.8
May	198	2,981	16,621	66,783	76,145	9.0	26.1
June	470	2,990	16,675	70,353	78,371	9.4	26.1
July	532	2,786	15,032	69,815	70,666	19.1	25.9
August	387	2,791	10,806	79,891	79,529	16.3	25.5
September	514	2,790	13,039	69,289	71,861	19.1	25.8
October	14	2,821	13,584	78,992	78,206	22.2	25.8
November	78	2,774	12,776	62,597	75,458	9.9	25.8
December	59	3,084	17,254	64,374	74,905	15.1	26.2
Average	322	2,911	14,696	69,394	75,434	14.4	24.5

Notes:

1. Surface water comprised of diversion from Primrose East E-Pond and surface water runoff.
2. Non-saline groundwater from Wolf Lake water source wells
3. Saline groundwater from McMurray Formation aquifer
4. Dir. 81 Water Disposal Limit as per Approval No. 9140MM

PAW Project Groundwater License Allocation and Use

PROJECT	LICENSE #	POINT OF DIVERSION	EXPIRY DATE	ALLOCATION (m ³ /yr)	PURPOSE	2018 Total Usage (m ³ /y)	Comments
Primrose (Wolf Lake)	238513	12-10-066-05 W4M	9-Sep-2022	1,095,000	Make-up and Utility	1,062,595	
		12-10-066-05 W4M					
		6-10-066-05 W4M					
		6-10-066-05 W4M					
		12-10-066-05 W4M					
		13-10-066-05 W4M					
Primrose South	238519	10-05-067-04 W4M	5-May-2028	20,000	Injection & Drilling	39,155	Allocation Exceedance Reported AER Alleged Contravention Report #348896
		14-05-067-04 W4M					
		15-05-067-04 W4M					
Primrose North	269703	NW-08-068-04 W4M	5-May-2030	996	Office / Utility	287	
		NW-08-068-04 W4M		7,500	Process / Utility	4,662	
Primrose East	246769	04-14-067-03 W4M	5-May-2028	18,250	Office and Utility	519	
Primrose South Camp	364242	14-04-067-04 W4M	6-Mar-2025	12,775	Camp Utility	593	
Primrose Office	364971	11-05-067-04 W4	25-Mar-2025	2,555	Office	-	N/A
Wolf Lake Office	365400	02-07-066-05 W4	7-Apr-2025	1,460	Office	-	N/A
Wolf Lake Office	365684	06-08-66-5W4	13-Oct-2025	12,775	Office	2,697	
Primrose Booster	365236	10-05-067-04 W4	7-Apr-2025	4	Lab use	-	N/A
Primrose Lab	364976	10-05-67-04 W4	24-Mar-2025	1,095	Miscellaneous	403	
Wolf Lake Drilling TDL	387388	NW 10-66-5-W4	Jan 1 - 2018	60,000	Drilling, Workovers, Dust Control	12,862	

Drawdown Limits at non-saline water source wells

- Non-saline water diverted at the Wolf Lake CPF (*Water Act* Licence No. 00238513-01-00) is almost exclusively used for utility water source but occasionally small amounts of groundwater is used as boiler feed water.
 - There are four Wolf Lake water source wells
 - the maximum observed drawdown in the wells exceeded 50% in two wells.
 - However, during non-pumping periods, the water levels in each water source well consistently recovered to near pre-pumping levels indicating that the observed drawdown is due to well losses or skin effects and not reflective of the water level in the aquifer, which is expected to be much higher.
- Canadian Natural is confident that the maximum allowable drawdown of at 150 m radius from the source wells did not exceed 50% available head in 2018.

Source Well Water Level Summary

Well Name	GIC Well ID	Top of Aquifer (masl)	Estimated Pre-pumping Water Level ¹ (masl)	Estimated Pre-pumping Water Level Date	Available Head ² (masl)	2018 Average Water Level (masl)	2018 Minimum Water Level (masl)	2018 Maximum Drawdown (m)	2018 Maximum Drawdown (% of Available Head)	Completion Unit
WSW 01 (E3)	289458	515.34	629.75	9/16/1996	114.41	627.19	624.60	5.15	5%	Empress Formation Unit 3 Aquifer
WSW 02 (ML)	Not Available	543.38	630.12	10/5/1996	86.74	629.51	627.52	2.60	3%	Muriel Lake Formation Aquifer
WSW 03 (ML)	217941	549.17	630.11	10/5/1996	80.94	627.06	578.73	>51.38 ³	>63% ³	Muriel Lake Formation Aquifer
WSW 04 (ML)	289457	551.60	629.32	4/6/1999	77.72	626.09	616.43	12.90	17%	Muriel Lake Formation Aquifer
WSW 06 (E3)	217959	504.89	629.63	8/30/1996	124.74	596.66	565.25	64.38	52%	Empress Formation Unit 3 Aquifer

Notes:

masl - metres above sea level

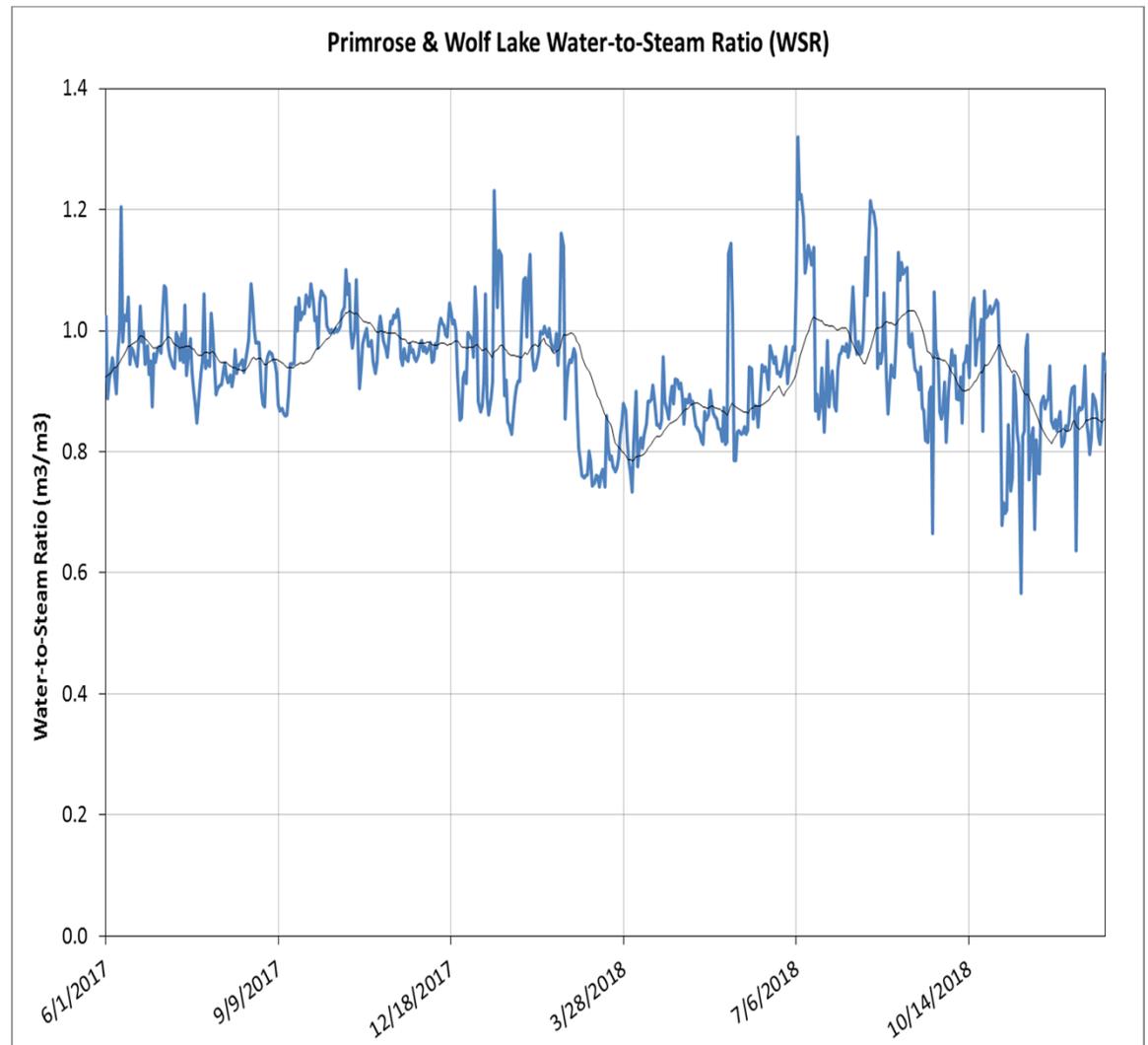
¹ - based on earliest available non-pumping water levels

² - calculated from top of aquifer subtracted from estimated pre-pumping water level

³ - transducer periodically above water level, 2018 drawdown may be greater

Directive 81 Amendment Update

- Historical Water-to-Steam Ratio (WSR) has increased
 - Expanded low pressure operations
 - Enhanced CSS steaming strategy
 - Fluctuations due to cyclic nature of CSS operations in PRN/PRS
- 2018 WSR troughs due to:
 - pipeline apportionments (March) and curtailments (November, December)
- 2019+ forecasted to return WSR's of 1.05+



Directive 81 Amendment Update

- Steam Demand
 - Various TAs and steam impacting outages: April, July, September
- Disposal Usage
 - Pipeline apportionments (March), field decline (April/May), differential curtailments (November) resulted in reduced disposal requirements
- Facility Debottlenecking Updates
 - Phase 4 on-going near completion as noted on Specific Project Update slide
 - Wolf Lake Expansion scoping on-going

Month	Produced Water	Steam Injection	Actual Water Disposal	Water Disposal Limit ⁴
	m ³ /d	m ³ /d	%	%
January	70,309	73,950	15.9	17.9
February	76,282	76,695	14.1	17.4
March	65,860	82,832	4.6	24.1
April	58,186	66,590	17.7	26.8
May	66,783	76,145	9.0	26.1
June	70,353	78,371	9.4	26.1
July	69,815	70,666	19.1	25.9
August	79,891	79,529	16.3	25.5
September	69,289	71,861	19.1	25.8
October	78,992	78,206	22.2	25.8
November	62,597	75,458	9.9	25.8
December	64,374	74,905	15.1	26.2
Average	69,394	75,434	14.4	24.5

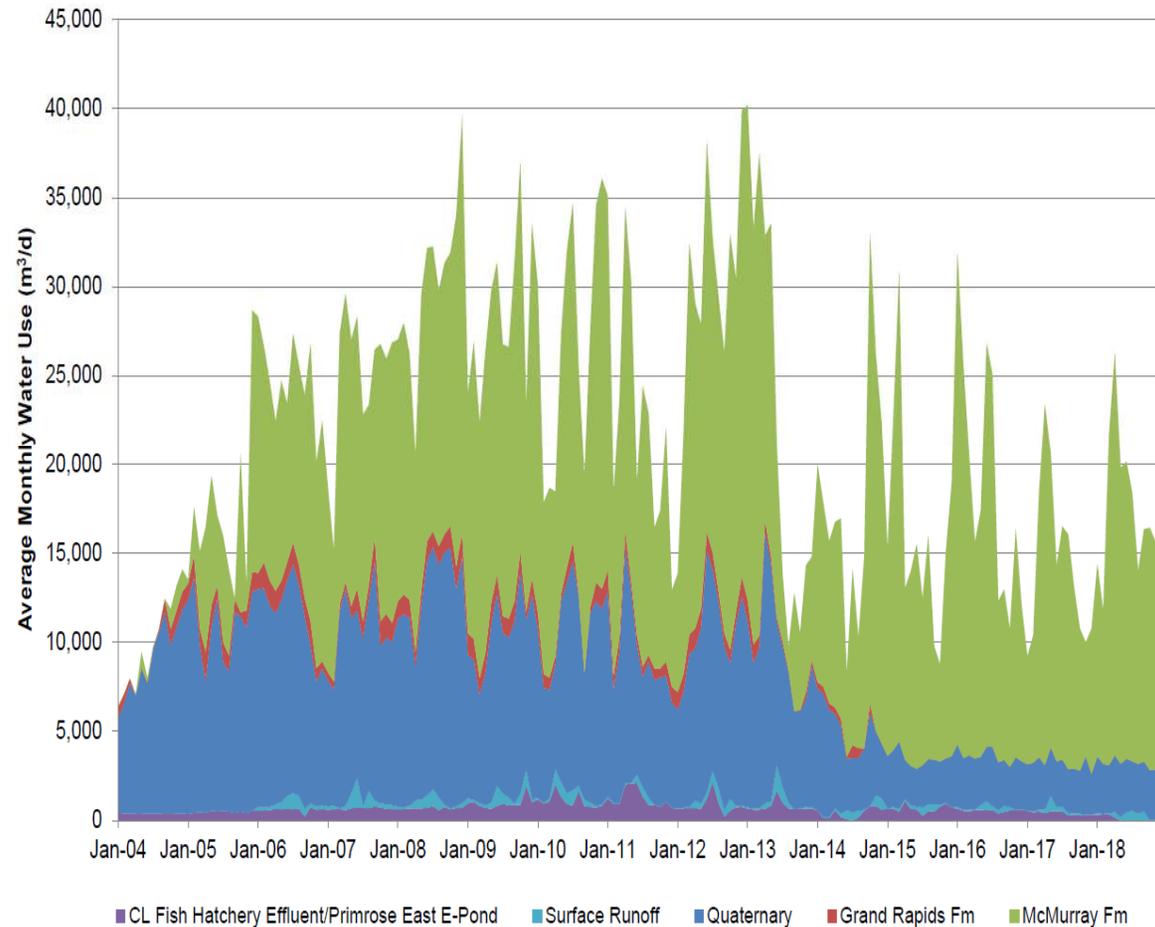
Water Production, Injection, and Uses

2018 PAW Water Use:

- McMurray Fm. Saline Water
 - Avg. 14,729 m³/d
- Quaternary Non-Saline Water
 - Avg. 2,911 m³/d
- Plant Runoff Surface Water
 - Avg. 226 m³/d
- Primrose East E-Pond*
 - Avg. 289 m³/d (during usage)

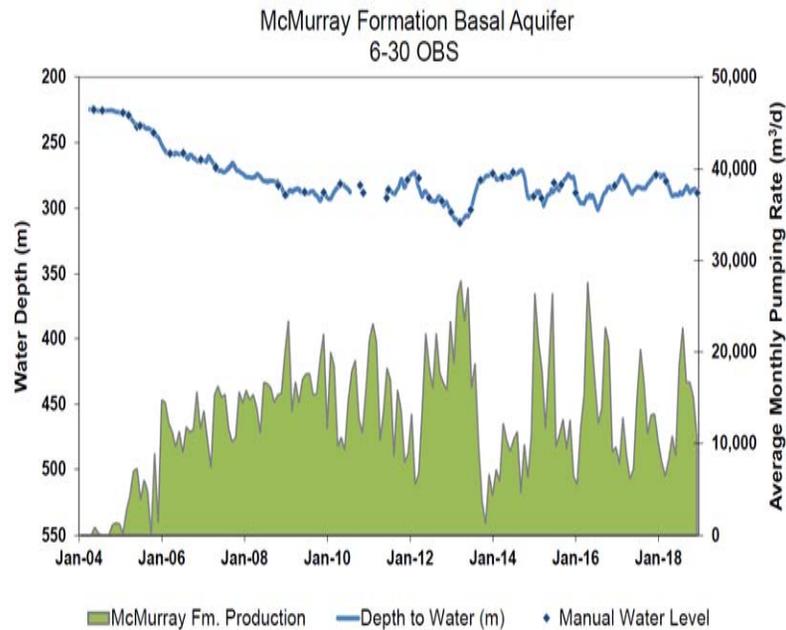
*Cold Lake Fish Hatchery Effluent pumping to Primrose East E-Pond ended in early 2017. Primrose East E-Pond usage ended in April 2018.

PAW Water Use (Saline & Non-Saline)

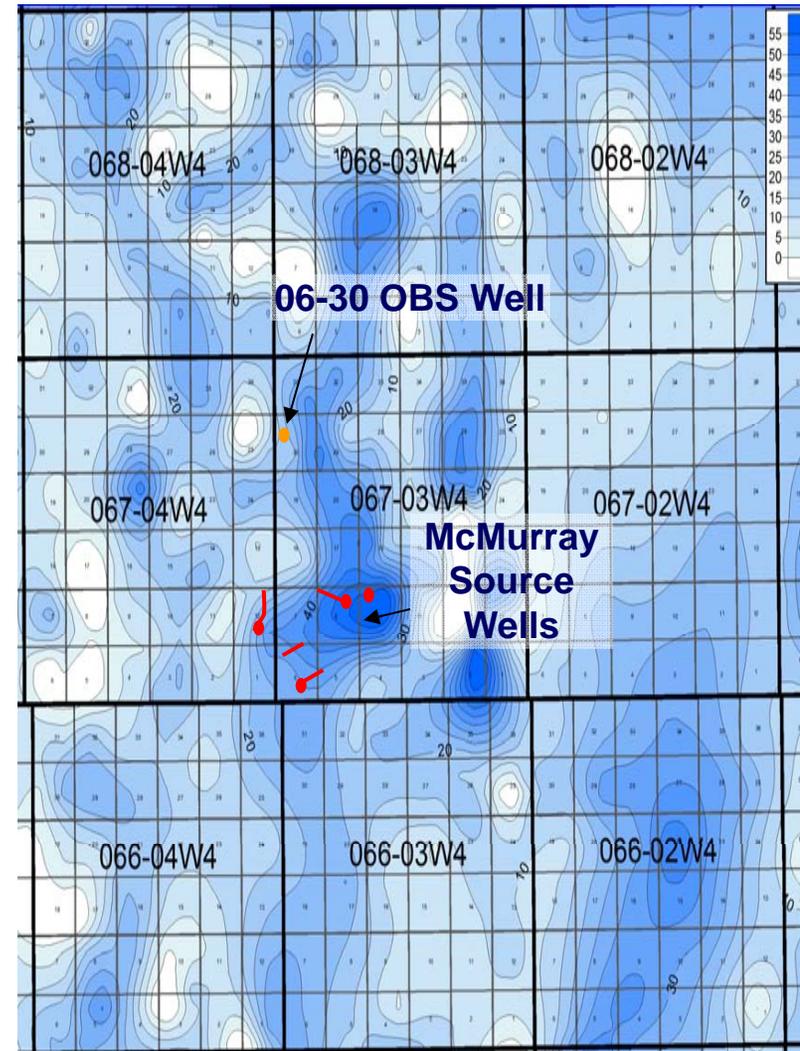


McMurray Saline Water Supply

- Producing wells:
 - 4 horizontal and 6 vertical wells
- 2018 production:
 - Average: 14,729 m³/d
 - Maximum: 26,696 m³/d
- Drawdown of approximately 63m in 6-30 OBS well:



McMurray Formation Basal Aquifer Isopach Map



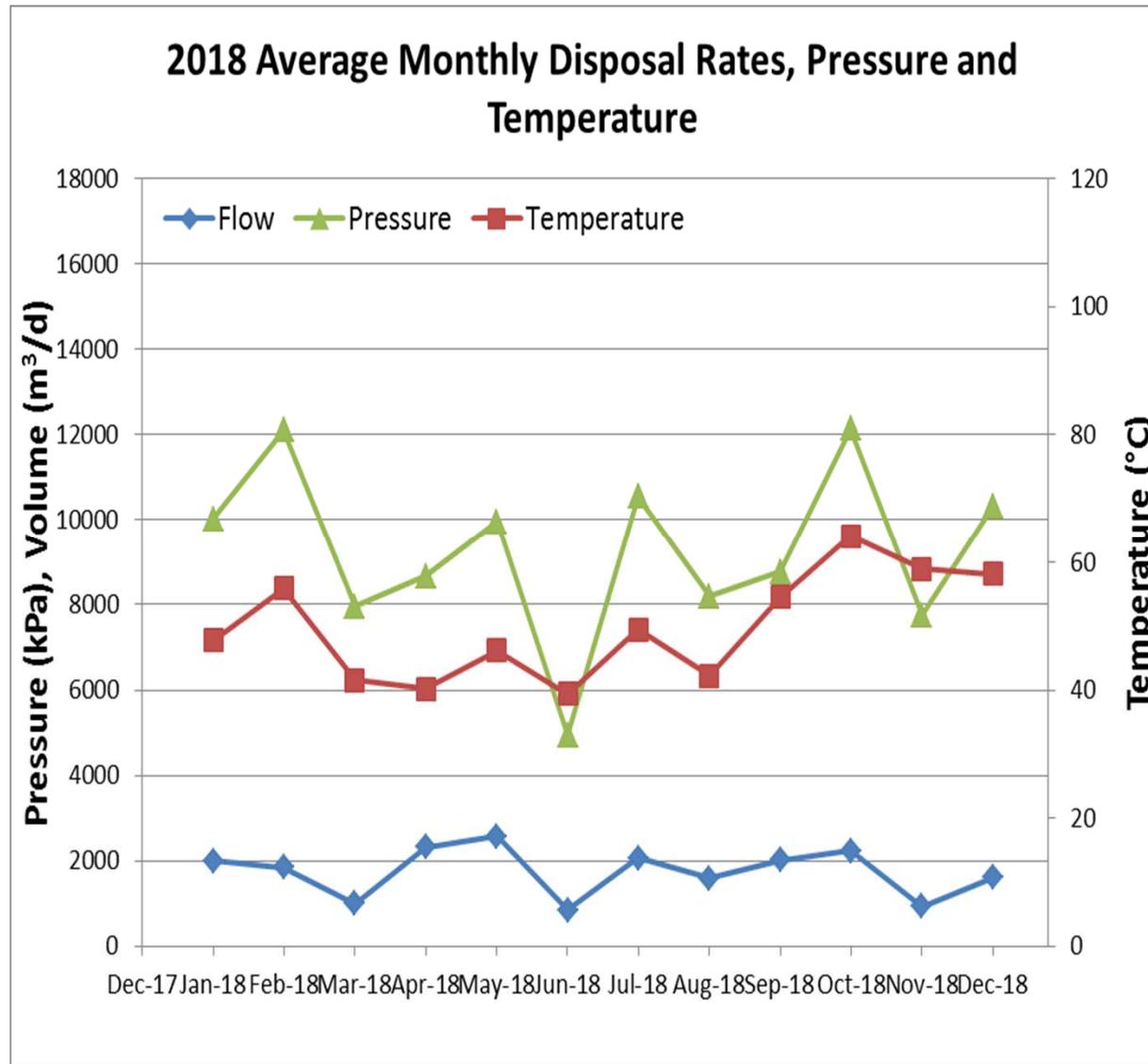
Water & Waste Disposal Wells, Landfill Waste UWI List & Disposal Compliance

- Wolf Lake Project Disposal Water Well UWI Listing

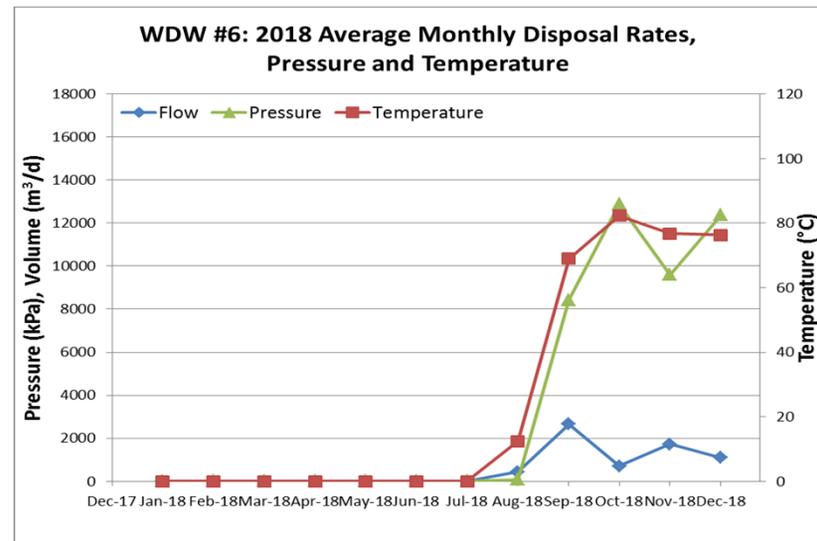
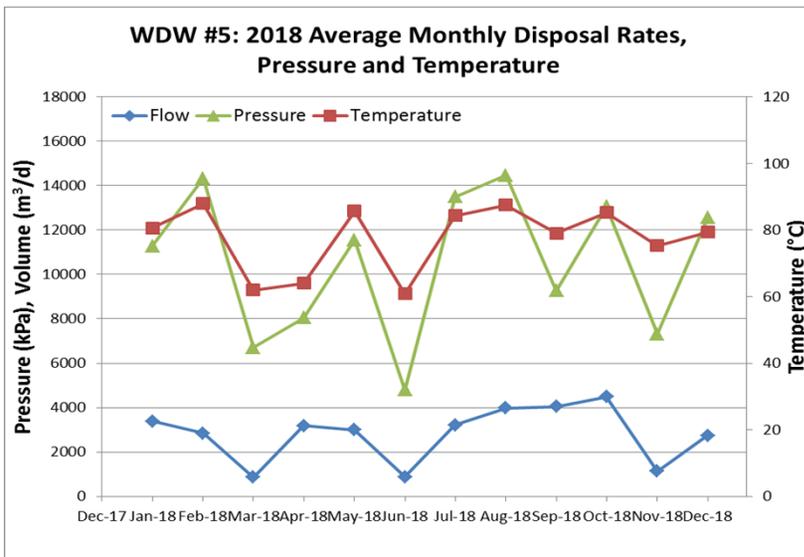
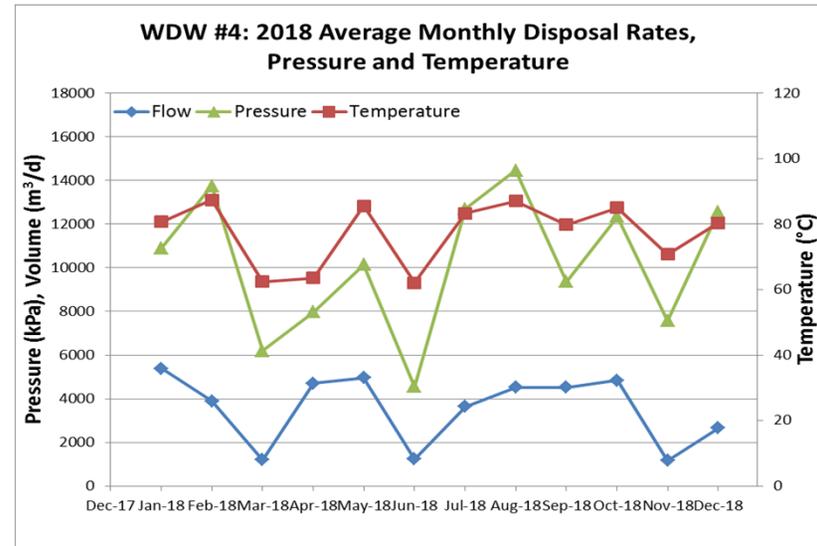
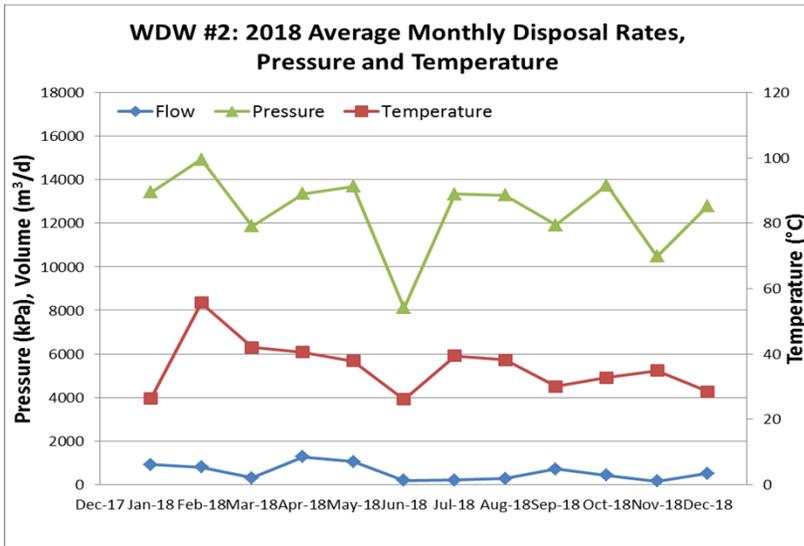
Wolf Lake	
Well	Formation
WDW #2 - 100/10-08-066-05W4	Mid Cambrian
WDW #4 - 100/05-08-066-05W4	Mid Cambrian
WDW #5 - 100/15-07-066-05W4	Mid Cambrian
WDW #6 - 100/14-06-066-05W4	Mid Cambrian
WDW #7 - 100/01-07-066-05W4	Mid Cambrian
WDW #9 - 100/14-05-066-05W4	Mid Cambrian
WDW #11 - 100/07-08-066-05W4	Mid Cambrian
WDW #14 - 102/06-09-066-05W4	Mid Cambrian
WDW #15 - 112/15-08-066-05W4	Mid Cambrian
WDW #16 - 100/16-05-066-05W4	Mid Cambrian
OBS WDW #1 - 100/09-08-066-05W4	Mid Cambrian

- Wolf Lake (WDW #2, 4, 5, 6, 7, 9, 11, 14, 15 and 16)
 - WDW #9 was re-activated in late 2015
 - Wells WDW #11 & 14 were drilled and completed in 2016
 - Suspended WDW #1 converted into an Obs well in 2018
 - Wells WDW #6, 7, 15 & 16 were drilled and completed in 2018

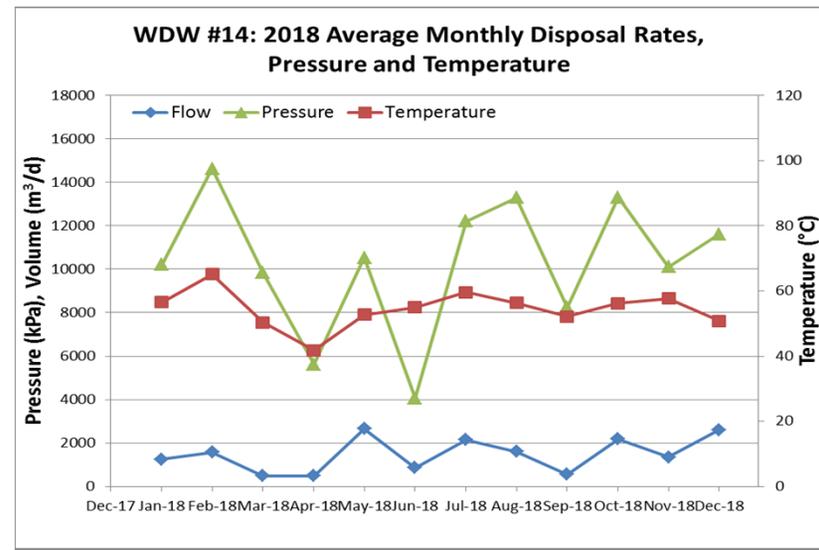
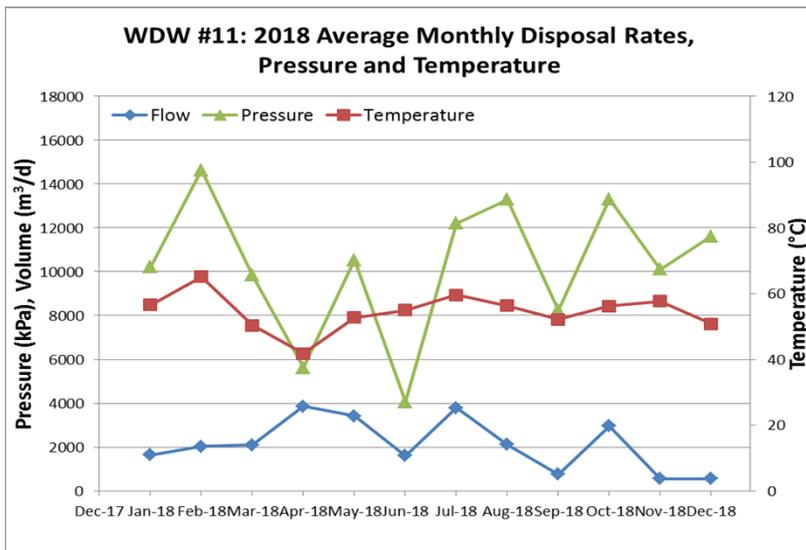
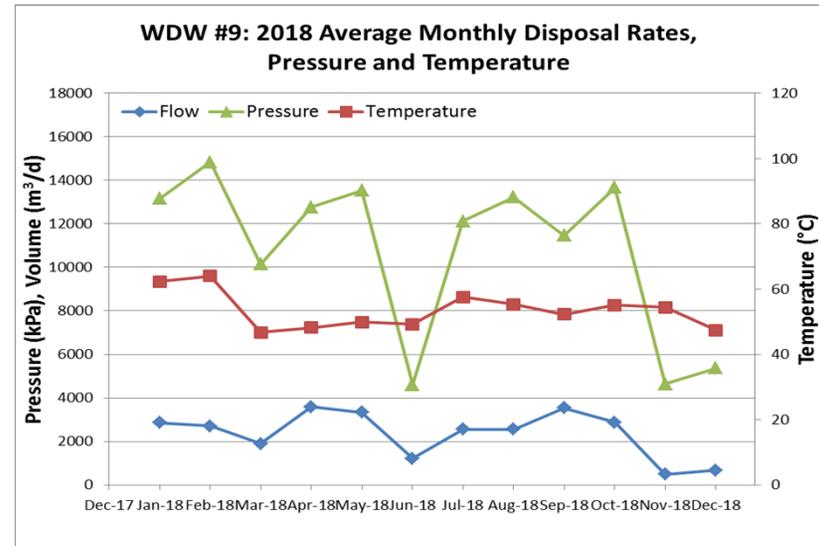
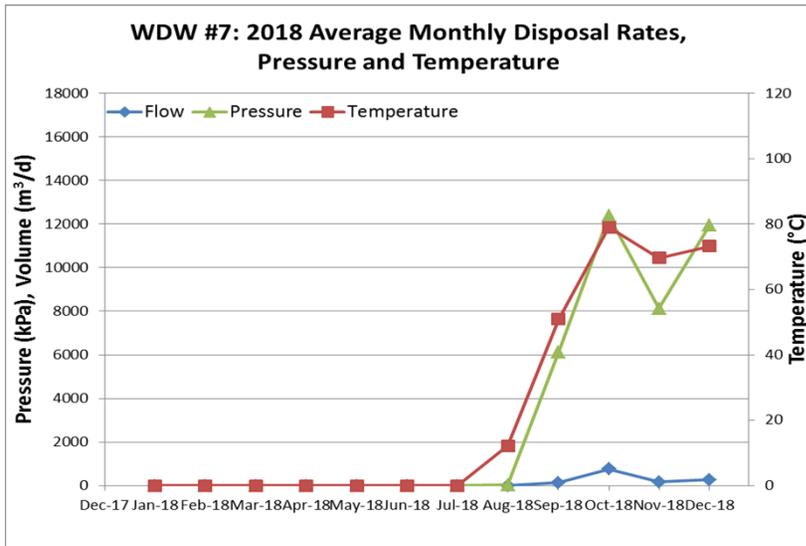
Water & Waste Disposal Wells, Landfill Waste Wolf Lake Disposal Volumes



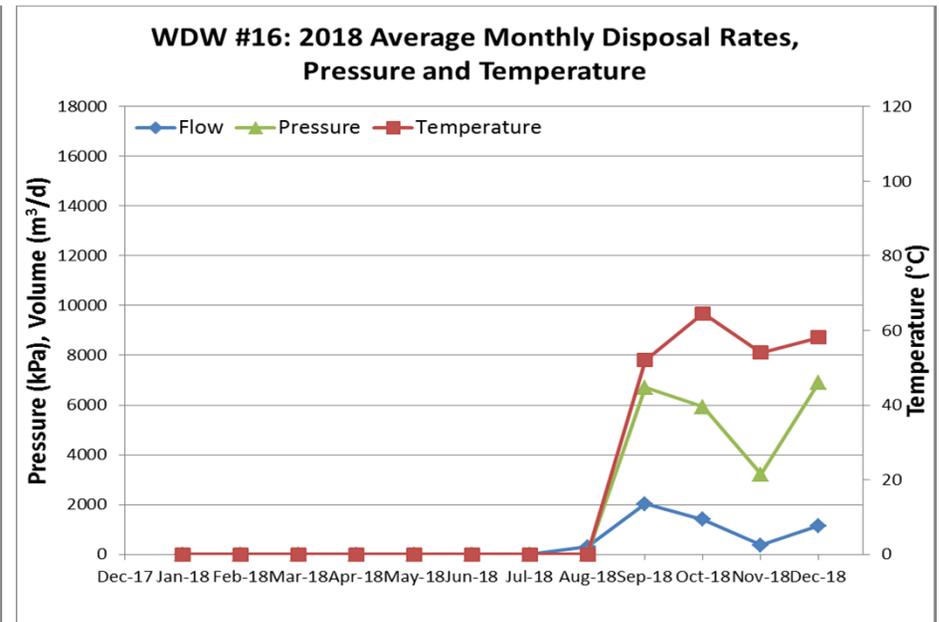
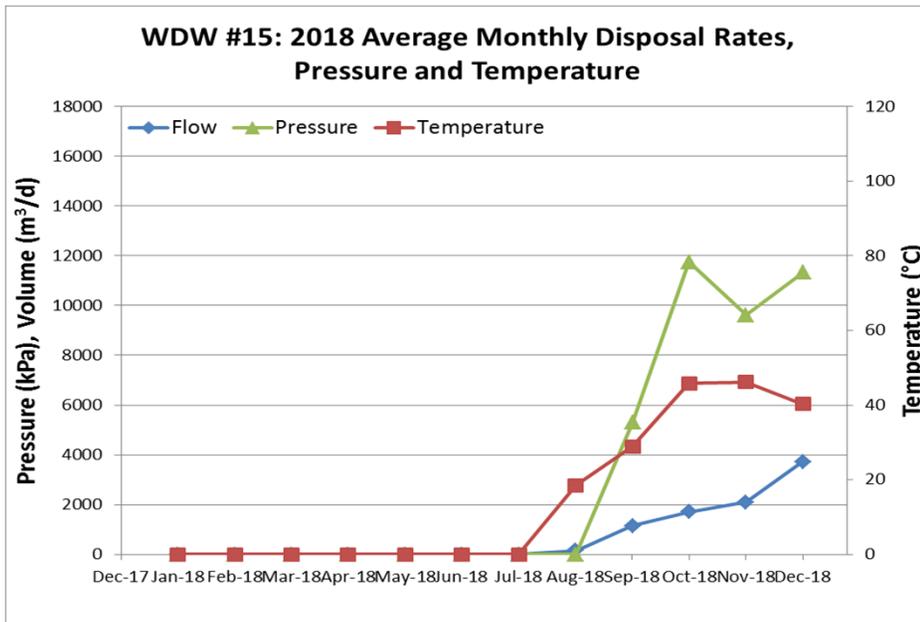
Water & Waste Disposal Wells, Landfill Waste Wolf Lake Disposal Volumes



Water & Waste Disposal Wells, Landfill Waste Wolf Lake Disposal Volumes

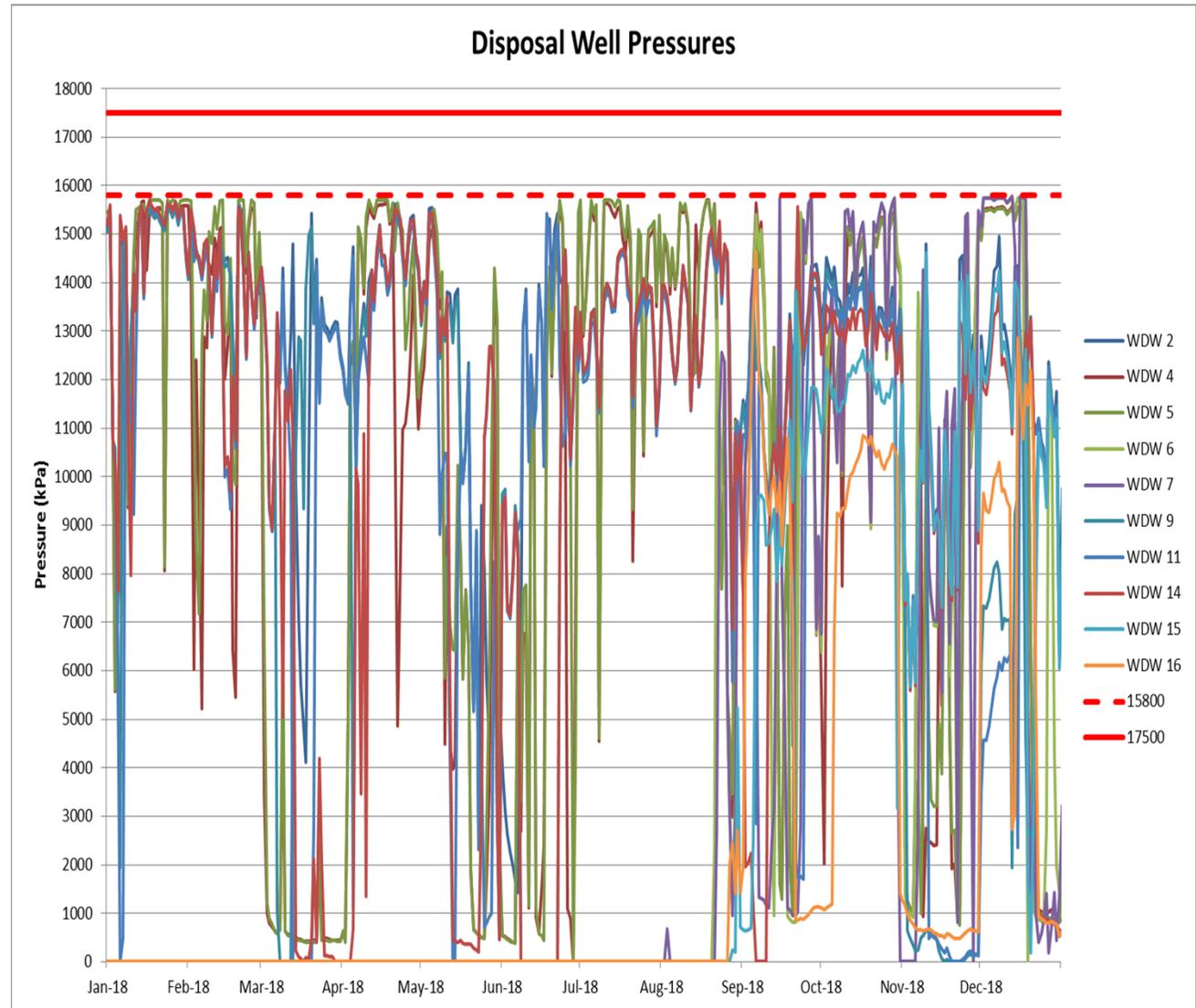


Water & Waste Disposal Wells, Landfill Waste Wolf Lake Disposal Volumes



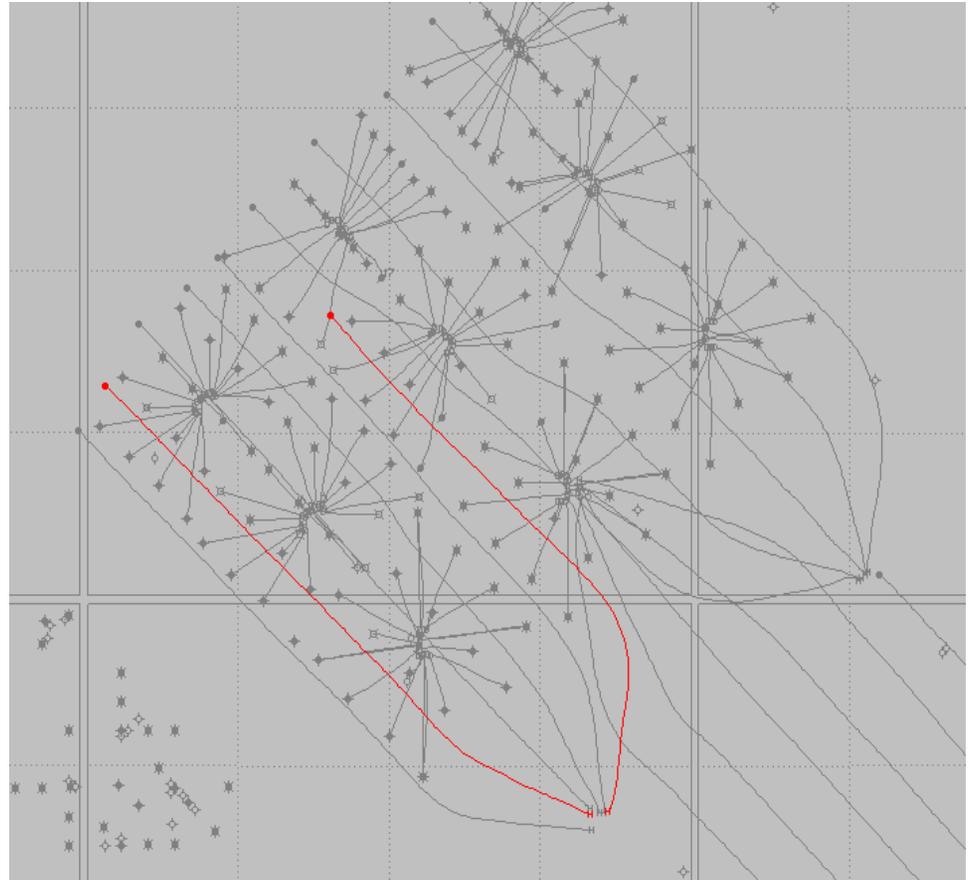
Wolf Lake Disposal Well Pressures

- Injection Pressures did not exceed 17,500 kPa in 2018
 - Pressures can exceed 15,800 kPa, up to 17,500 kPa for a maximum 24 hr. period for up to 2% of the operating time per calendar year (Approval 8672E) Injection Pressures did not exceed 17,500 kPa in 2018



Water & Waste Disposal Wells, Landfill Waste Wolf Lake Water Storage

- M2 Storage Approval No. 9108A
 - No activity in 2018
 - Storage has not been used since 2017
 - There are no immediate plans to reactive it
- Historical activities
 - M2-S well zonally suspended in Oct 2017
 - M2 Storage line abandoned



Water & Waste Disposal Wells, Landfill Waste Wolf Lake Water Storage Summary

- Waste to Tervita Lindbergh Cavern
 - 13 m³ – Lime Sludge
 - 2,992 m³ – Hydrocarbon Sludge and Sand
 - 40 m³ – Hydrovac Material
 - 50 m³ – Contaminated Soil
 - 1,047 m³ – Well Workover Fluids
 - 3,480 m³ – Hydrocarbon Waste
 - 546 m³ – Waste Water
 - 86 m³ – High Solids Produced Water
 - 56 m³ – Ion Exchange Resin/Liquids
 - 2 m³ – Glycol Solutions
 - 10 m³ – Waste Corrosive Liquids

Water & Waste Disposal Wells, Landfill Waste Wolf Lake Water Storage Summary

- Waste to Newalta Elk Point TRD Facility
 - 50 m³ – Hydrocarbon Sludges and Sand
 - 55 m³ – Lime Sludge
 - 31,719 m³ – Crude Oil/Condensate Emulsions
 - 1 m³ – Waste Water
- Waste to Secure Tulliby Lake TRD Facility
 - 988 m³ – Hydrocarbon Sludges and Sand
 - 14 m³ – Lime Sludge
 - 4,915 m³ – Crude Oil/Condensate Emulsions
 - 102 m³ – Well Workover Fluids
 - 191 m³ – Waste Water
 - 9 m³ – Filter Backwash Liquid

Water & Waste Disposal Wells, Landfill Waste Wolf Lake Water Storage Summary

- Waste to RBW (bins)
 - 336 m³ – contaminated soils, plastics, filters, asbestos, dessicant, batteries, glycol, fluorescent tubes, caustic acids, activated carbon, scrap metal, used lube oil, corrosion inhibitors, solvents, chemicals, waste water, used electronics and empty containers
- Waste to Tervita (bins)
 - 86 tonnes – contaminated soils, empty containers, filters, rags, absorbents, dessicant, used electronics and chemicals

Wastewater and Surface Water

- Wastewater

- All facilities including: Wolf Lake Plant, Primrose South Plant, Primrose North Plant, Primrose East Plant, Burnt Lake Facility and Wolf Lake Administration (new building), have the wastewater stored in tanks
 - Tanks are emptied and hauled to local municipal facilities for disposal.
- Wolf Lake Administration (old building) has a separate waste/septic field

- Surface Runoff Handling

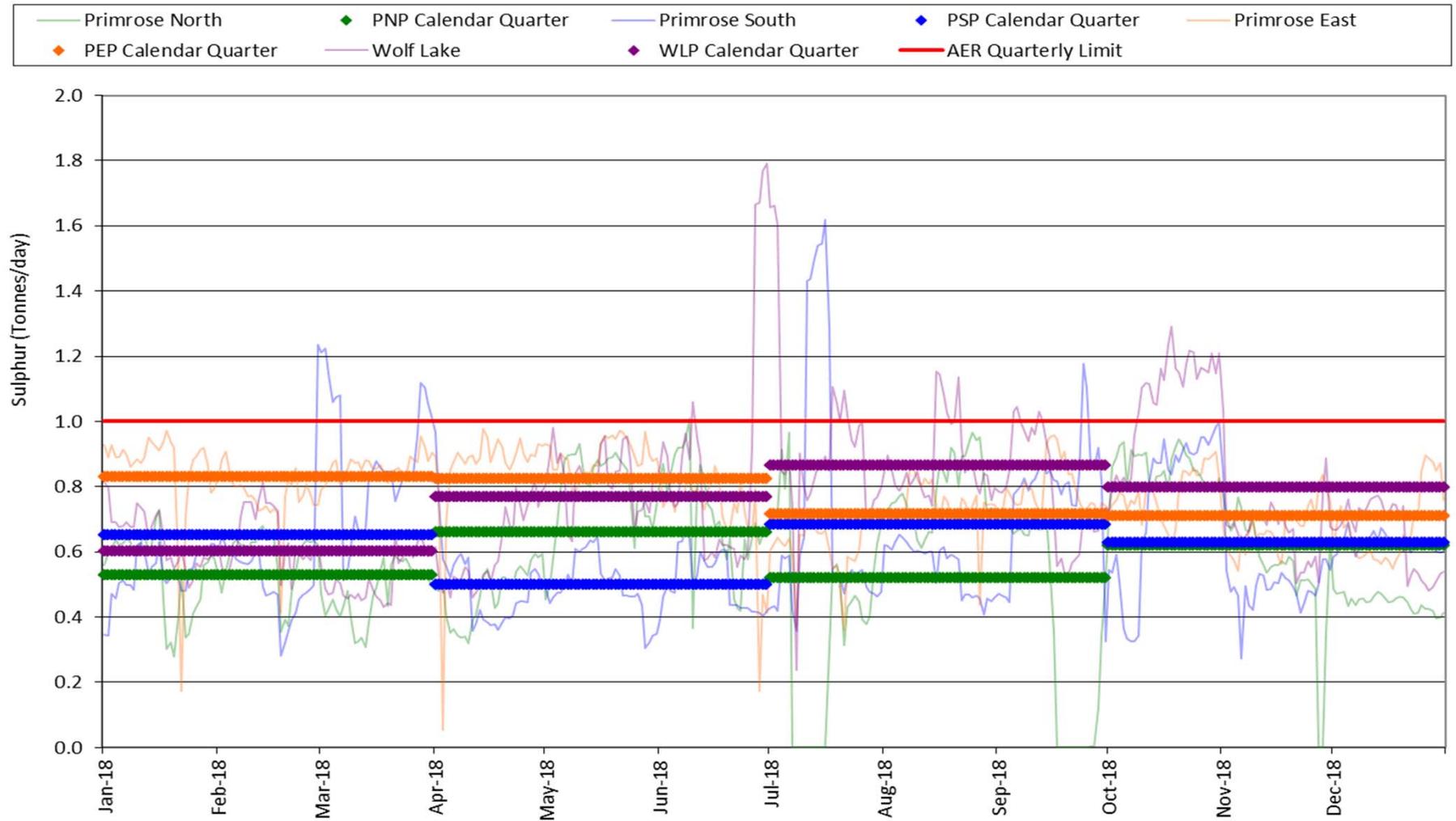
- The Primrose and Wolf Lake facilities have a total of 7 surface water run off handling ponds.
- The surface water is either released to adjacent crown lands or used as per existing Water Act licenses for purposes such as: steam injection, dust control, and drilling uses.
- Volumes from the handling of wastewater and surface water runoff are both reported annually as part of the Industrial Waste Water submission due March 31, 2019.

Sulphur Production

- EPEA approval limits for SO₂:
 - PSP + WLP = 6.7 t/d
 - PNP = 2.0 t/d
 - PEP = 2.0 t/d
- Quarterly averages for all steam plants < 1.0 t/d sulphur
- Contingency for compliance with ID 2001-3 is currently to restrict/delay production to maintain sulphur level below 1 t/d quarterly average
 - To maintain SO₂ levels below 2 t/d, production from the Primrose North area wells/pads were held back for short durations during Q2/3 2018
 - Wolf Lake Plant sulphur spike in June 2018 was as a result of higher entrained solution gas back from Primrose area facilities.
 - Primrose South Plant sulphur spike in July 2018 was a result of Primrose North Plant outage and higher emulsion (solution gas volumes) due to production swaps.
 - Canadian Natural does not plan to install sulphur recovery at this time

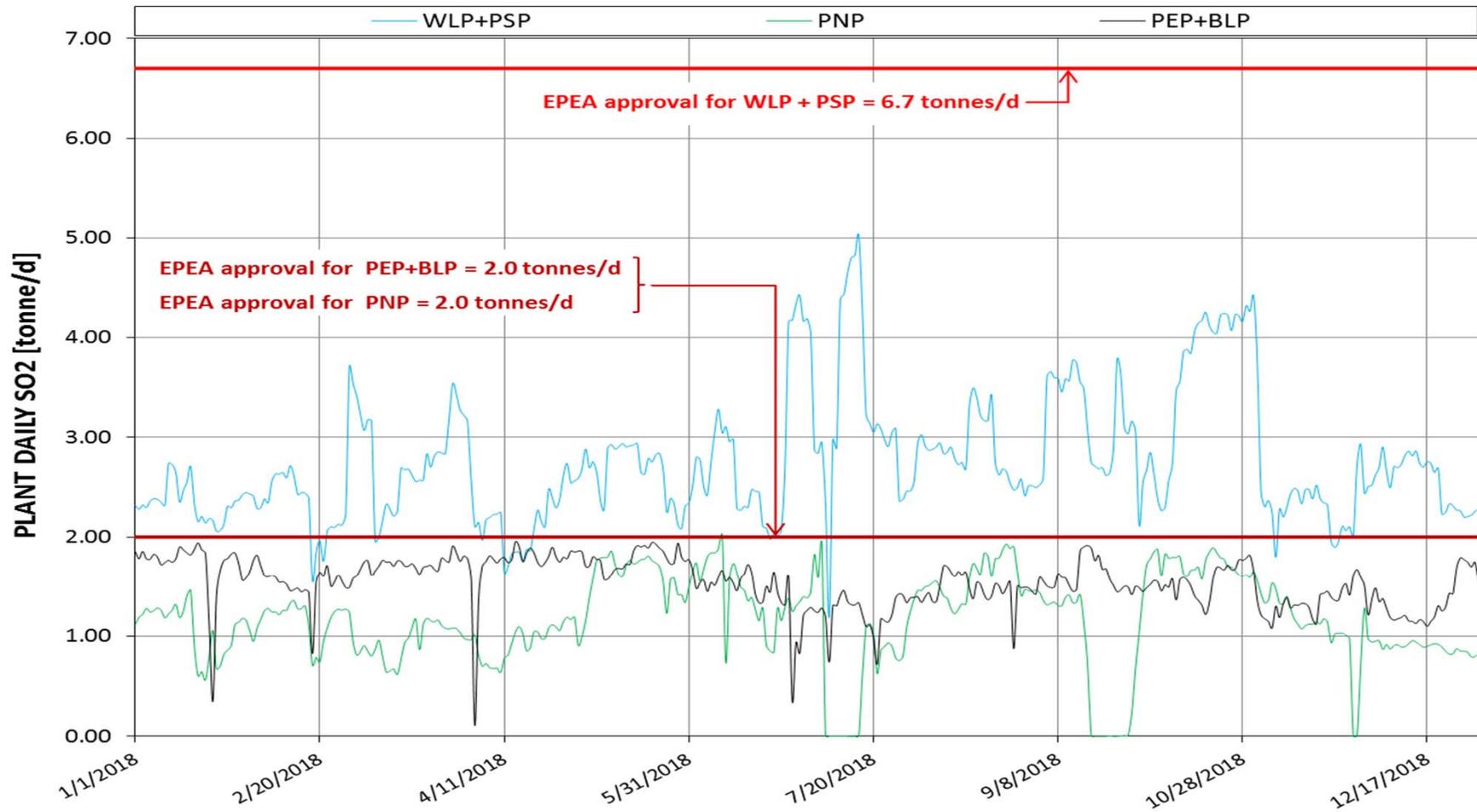
Sulphur Production

- 2018 Primrose and Wolf Lake Sulphur Emissions



SO₂ Emissions

- 2018 Primrose and Wolf Lake SO₂



*EPEA approval limits are on a daily basis

Environmental Summary

EPEA Approval and Amendments

- The Primrose and Wolf Lake Project currently operates under EPEA Approval 11115-04-00, as amended
 - EPEA Approval amendment 11115-04-01 was approved on April 6, 2018
 - Addition of the 164 kW compressor emission source to the Primrose North area
 - Compressor was installed in the field at 12-13-068-05W4
 - Approval 11115-04-00 expires September 30, 2025

Environmental Summary Compliance

- Compliance Issues

- EPEA Approval: Air Related

- A new CEMS analyzer was installed in the Primrose North Plant on June 2, 2018 on the 4H:4100 stack. This CEMS became certified August 7 at 00:00, at which time it started producing quality assured data.
 - A new CEMS analyzer was installed in the Primrose East Plant on June 22, 2018 on the H:4100 stack. This CEMS became certified August 7 at 00:00, at which time it started producing quality assured data.
 - A third party audit was completed on the CEMS QAP on January 15, 2019.

- There were no SO₂ exceedances in 2018

- There were no NO_x exceedances in 2018

Environmental Summary Compliance

- Compliance Issues – Water Related

- AER Reference # 339655, Diversion License 238513-02-00

- Location: Wolf Lake Source Well WSW 06 (13-10-066-05 W4M)
 - The pressure transducer was lost downhole and could not be retrieved for the May data download. This resulted in 4 missed weekly readings during May.
 - Contravention Date: May 2018.

- AER Reference # 339956, Diversion License 364242

- Location: Primrose South Camp (14-04-067-04 W4M)
 - It was not possible to collect the weekly water level reading due to an obstruction in the well.
 - Contravention Date: June 18, 2018.

- AER Reference # 348307, Diversion License 238513-02-00

- Location: Wolf Lake Source Well WSW 06 (13-10-066-05 W4M)
 - The shutdown sensor which prevents the pump from exceeding the daily maximum diversion failed to operate as programmed. As a result the pumping volume at Wolf Lake Source Well WSW 6 exceeded the daily limit of 3,305 m³/day on three days (Nov 25, Dec 9, Dec 17, 2018)
 - Contravention Date: November 28, 2018.

- AER Reference # 348896, Diversion License 238519-02-00

- Location: Primrose South (10-05-067-04 W4M)
 - The pumping volume at Primrose South Source Well exceeded the annual allocation of 20,000 m³.
 - Contravention Date: December 18, 2018.

Environmental Summary Monitoring Programs

- Environmental Monitoring Programs currently underway include:
 - Wildlife Monitoring and Mitigation Plan
 - Caribou Monitoring and Mitigation Plan
 - Wetlands and Hydrology Monitoring Program

Environmental Summary Monitoring Programs

- Breeding Song Bird Surveys
 - Breeding songbird surveys completed in June of 2018 using autonomous recording units (ARUs).
 - The ARU surveys targeted all songbird species present in the PAW study area, with a focus on documenting the mixedwood forest and old growth forest songbird communities.
- Wildlife Response to Linear Features
 - A total of 31 remote cameras were deployed in the study area as part of the habitat enhancement program monitoring.
 - Remote cameras deployed along treated (e.g., mounding, tree felling, and seedling planting) and reference seismic lines documented predator and human use of the linear features in portions of the PAW study area.
 - Camera maintenance was performed three times in 2018 to check/replace batteries and download photos.

Environmental Summary Monitoring Programs

- Remote Camera Surveys
 - 26 remote cameras are deployed throughout the PAW study area as part of the general remote camera monitoring program which documents the presence, spatial distribution and relative abundance of mammals in relation to anthropogenic disturbance on the landscape..
 - Remote cameras were visited three times during 2018 to replace batteries and download photos.
- Maintenance of Nest boxes and Bat boxes
 - Boxes provide supplemental habitat for wildlife
 - 12 bird nest boxes and 2 bat roosting boxes maintained across the Project area.
 - Boxes visited twice during 2018
 - Evidence of bird use was noted at four boxes while northern flying squirrel use was noted at three additional boxes. One box had fallen and was found destroyed when visited in 2018.
- Wildlife Sighting Cards
 - Canadian Natural staff and contractors are required to record wildlife sightings while working on site. Observations are recorded on sighting cards and submitted to Canadian Natural environmental staff for incorporation into annual reports.

Environmental Summary Monitoring Programs

- Hydrology, Wetlands and Water Quality Monitoring Program
 - Wetland Monitoring Component
 - Preliminary observations of 2018 wetland monitoring program's re-measurement data indicates that there were only minor differences in overall species richness among monitoring and reference sites compared to previous years.
 - Hydrology Monitoring Component
 - During the 2018 monitoring program all lakes appeared to exhibit hydrological regimes similar to those of past years except for Sinclair Lake, which exhibited a rapid decrease in lake level beginning in late April.
 - The rapid lake level decreases are likely attributed to a natural phenomenon such as the breaching of one of the beaver dams at the outlet of Sinclair Lake. .
 - Water Quality Component
 - Surface water quality samples from Burnt Lake and Sinclair Lake indicate there were no large deviations observed in the analytical results when compared with those from previous years.

Environmental Summary

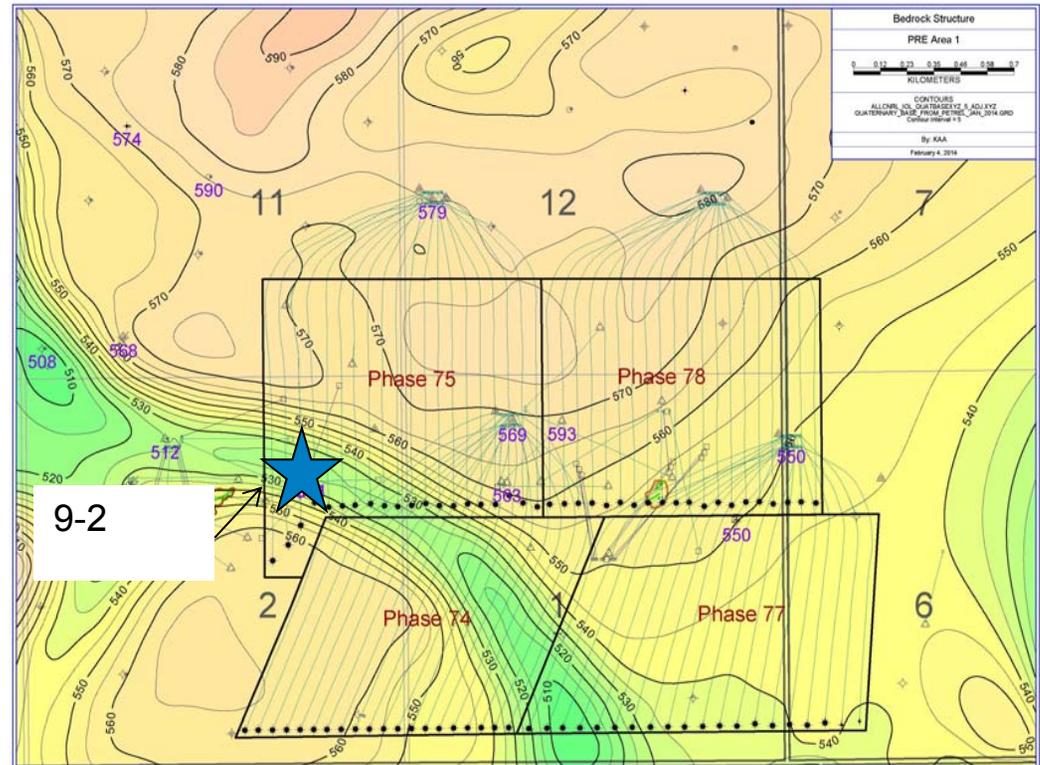
Arsenic Mobility Investigation

- Arsenic Mobility Research Program Description
 - Long-term research program at Z8 Pad ongoing since 2001.
 - Evaluating the liberation of arsenic associated with elevated groundwater temperatures from steaming a thermal pad.
 - Thirty-five groundwater monitoring wells installed primarily in shallow and deep Quaternary aquifers (Empress, Bonnyville and Sand River formations).
 - Monitoring temperature, chemistry and water level data in all wells to complete temporal assessments associated with steaming with a focus on the Empress and Sand River.
- Research Program Highlights from 2018
 - Empress aquifer results consistent with historical findings
 - Thermal and arsenic plumes associated with historical CSS are migrating downgradient of the pad.
 - Temperature and arsenic concentrations beginning to increase at on-pad monitoring wells associated with steamflood.
 - On-going groundwater data collection to understand flow system and geochemistry of the Sand River aquifer.
 - Groundwater data collected during current steamflood will be compared to findings from previous CSS operations.

Environmental Summary

Groundwater Monitoring and Management

- Groundwater monitoring well installed at 09-02-067-03W4M as per the Primrose East Area 1 steamflood application
 - Installed in 2014 to monitor changes in the Muriel Lake Aquifer associated with steamflood operation
 - No anomalous groundwater chemistry or pressure data observed
 - In situ temperature reflects ambient conditions



Environmental Summary

Groundwater Monitoring and Management

- 2009 Flow to Surface (FTS):
 - On-going application of the Pad 74 Risk Management Plan including monitoring, sampling and reporting.
 - Monitoring and sampling results continue to be reported to AER/ESRD via EPEA Approval (since March 2012).
- 2013 Flow to Surface (FTS):
 - On-going deep groundwater monitoring program including quarterly monitoring and sampling, and annual reporting.
 - On-going shallow groundwater monitoring and annual reporting.
- Groundwater monitoring results indicate very limited subsurface impacts associated with FTS events.

2018 FTS Update

- 2018 FTS Monitoring Activities Summary:
 - On-going monitoring of shallow & deep groundwater.
 - On-going monitoring of sentinel wells around fluid levels in Fissure Containment Structures (FCS).
 - On-going monitoring of physical condition of all sites (i.e. erosion, surface water monitoring).
- 2018 FTS Milestone Summary:
 - Construction of the new Fissure Containment Structure (FCS) was completed at Pad 74.

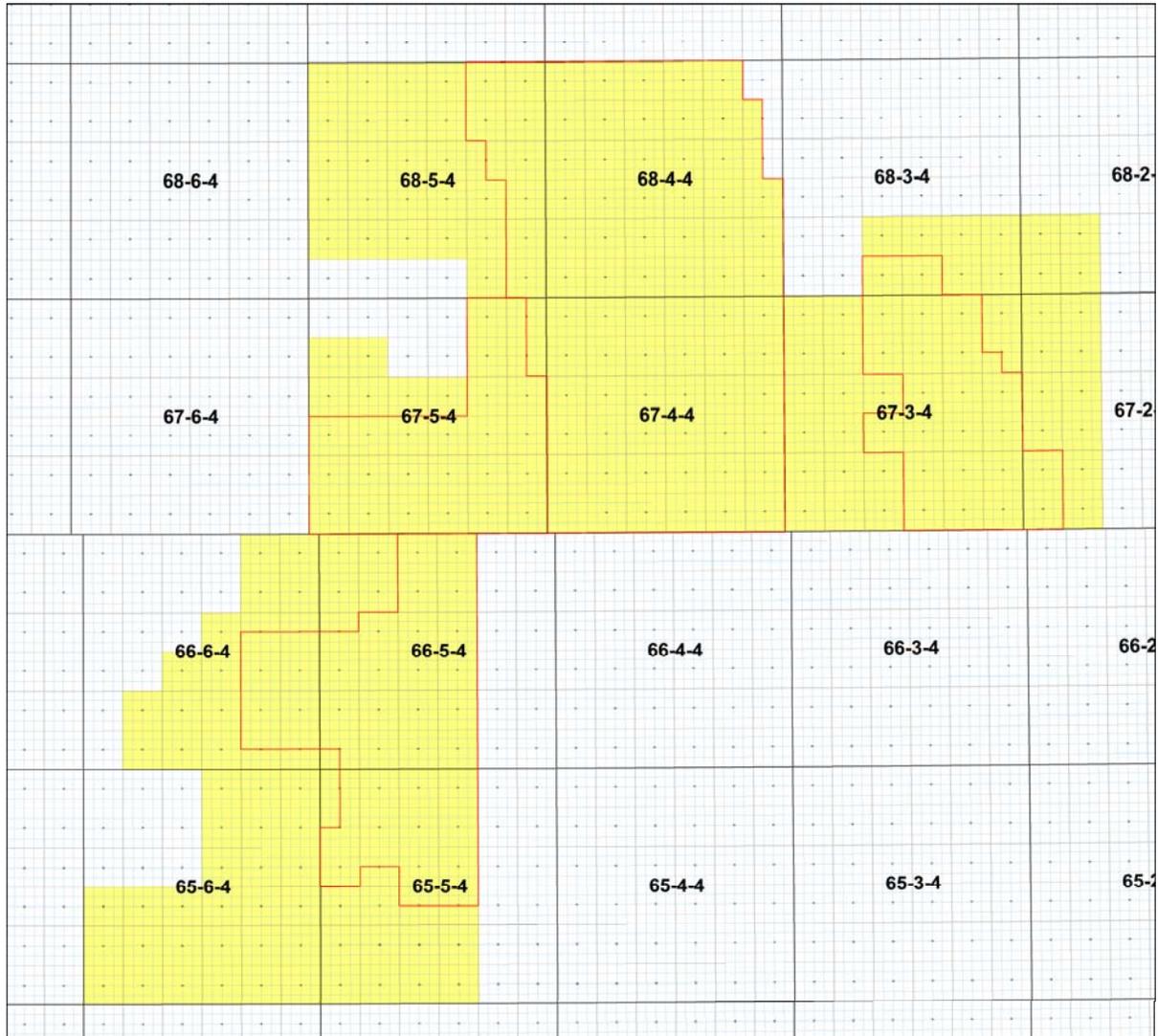
Environmental Summary Monitoring Programs

- Reclamation activities in 2018:
 - Re-vegetation Program consisted of reforesting 18.4 ha
 - Approximately 46,500 tree and shrub seedlings were planted.
 - Planting on borrows areas accounted for 11.40 ha
 - total of 34,440 tree and shrub seedlings
 - In-fill planting and remedial on Borrow pits accounted for 7.00 ha
 - 12060 tree and shrub seedlings.
 - Three well pads and corresponding access roads were reclaimed in the Wolf Lake lease area
 - 10.2 ha of area reclaimed and reforested.
- Proposed activities in 2019:
 - Reclamation and reforestation of borrow pits in Primrose North.

Environmental Summary Regional Initiatives

- 2018 LICA Highlights:
 - 89 school programs from K – 12 were delivered including:
 - X-Stream Science which is a water quality testing program developed for high school students,
 - Little Green Thumbs where students care for an indoor garden and learn about the environment and their community
 - Clean Air Responsible School where students receive an interactive presentation about air quality and then given the chance to collect air quality data around their school.
 - 4 different workshops were offered to the community and LICA coordinated a shoreline clean-up at Jessie Lake with Notre Dame High School as part of the Great Canadian Shoreline Clean-up.
 - LICA also provided a significant number of programs to summer camps and presented at numerous community events (i.e. fishing derbies and Canada Day celebrations) throughout the summer.
 - LICA continued to partner with Alberta Lake Management Society (ALMS) to conduct water quality sampling programs, with help from community volunteers, at 10 lakes throughout the region.
 - This has provided enough data to be able to see long term trends. LICA received a grant from AEP for a riparian restoration project along the Beaver River which included planting 2,000 seedlings along a ½ mile length of riparian area. The project also included an aerial riparian assessment of Moose Lake River, the data showed that much of the riparian area was healthy along this river.
 - LICA has been monitoring regional air quality for 10 years with a network of continuous and passive monitoring stations.
 - In 2016, LICA deployed its Portable Air Monitoring System (PAMS) in Bonnyville to collect air quality data. Data showed that H₂S, likely originating from Jessie Lake, was responsible for the perennial odour associated with this local water body. Led by LICA and in co-operation with its stakeholders, efforts to improve water quality conditions in Jessie Lake are being implemented. To complement this, the PAMS was redeployed at the east end of Jessie Lake in October 2018 to collect air quality data for another year.

Approval 9140QQ – Oil Sands Primrose Wolf Lake



Approval 9140 – 2018 Amendments

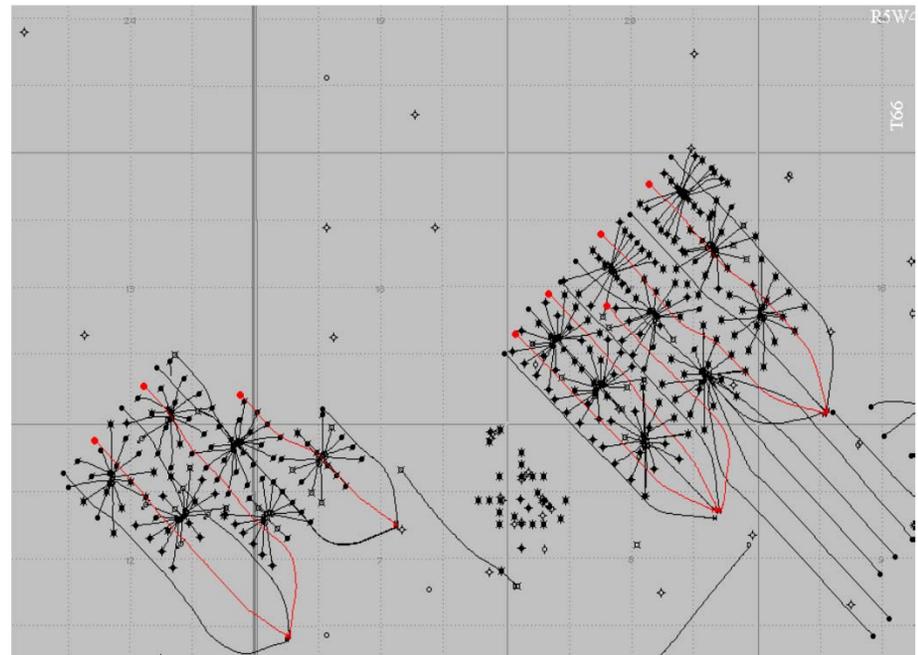
- Amendment MM
 - Directive 081 Waiver
- Amendment NN
 - Addition of 164 kW compressor to the Primrose North area
- Amendment OO
 - Primrose East Phases 90-95 Modified Steam, Risk Assessment and Mitigation
- Amendment PP
 - Directive 017 Alternative Testing Technology
- Amendment QQ
 - Steamflood follow-up process

Approval 9108A – Wolf Lake Water Storage Amended October 2015

- Approval 9108A was amended in October 2015 at the request of the AER
 - The Operator must install daily pressure monitoring in the Lower Grand Rapids Formation at the 07/02-17-066-05W4M/2 well by December 31, 2015,
 - In the event that fluid migration is detected at this well, the Operator must immediately notify the AER In Situ Authorizations Group and submit a plan to assess and mitigate the potential impact of disposal operations within 60 days of detection.

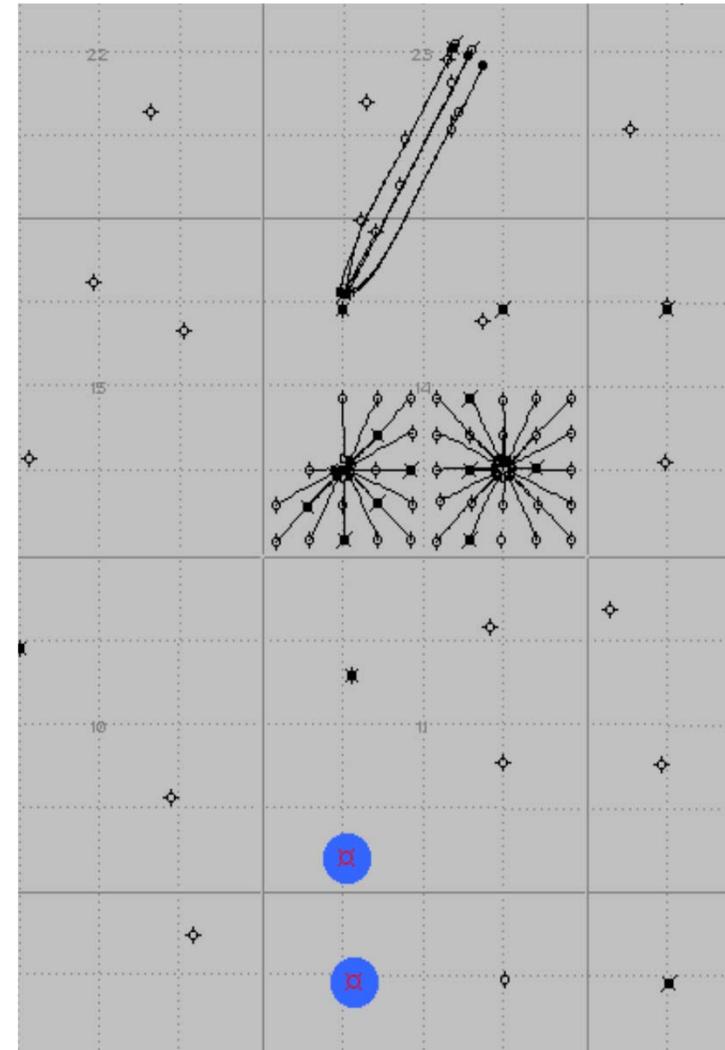
- Directive 054

- (a) Summary of monthly injected and produced volumes/well
- (b) Well/Formation Integrity and pressure monitoring
- (c) Remaining Reservoir Water Storage
- (d) Water Balance, Bitumen Volumes and Incremental Recovery
- (e) Overall performance and 2016 plans
- (f) Discussion of produced water utilization & fresh water reductions



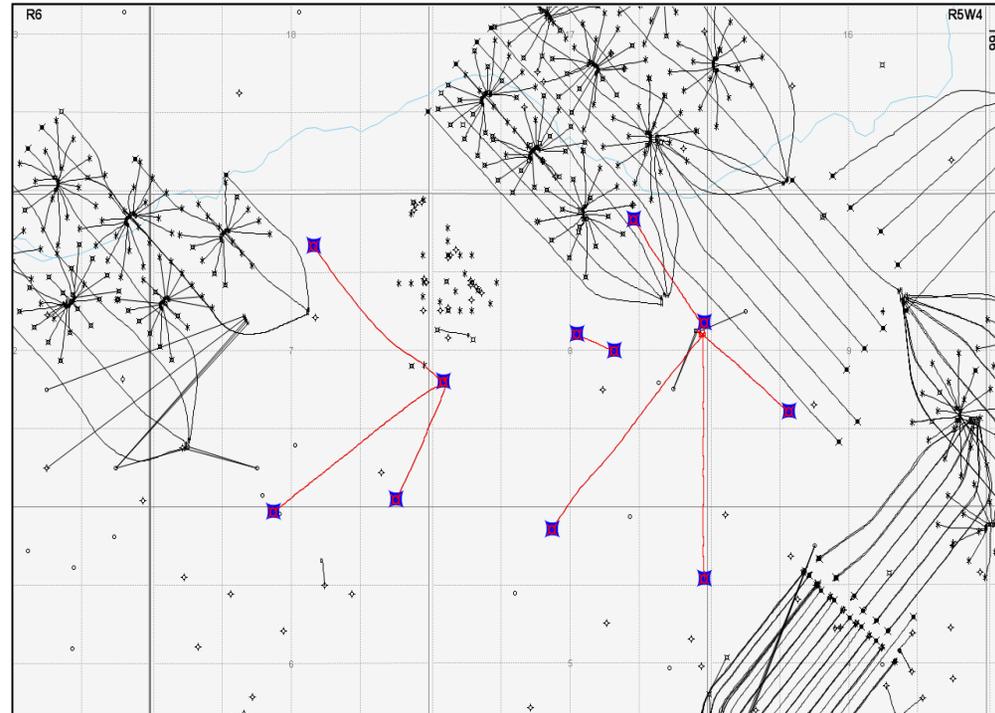
Approval 8186A – Burnt Lake Water Disposal Approved February 1999

- Approval Compliance Requirements
 - Directive 51 Compliance
 - Maximum Injection Pressures (kPa)
 - F1/11-02-067-03W4/0 abandoned
 - 00/03-11-067-03W4/0 zonally abandoned
- F1/11-02-067-03W4 was abandoned in November 2016
- 00/03-11-067-03W4/0 zonally abandoned in November 2008



Approval 8672E – Wolf Lake Deep Disposal Approved June 2010

- Operational injection pressure limit 15,800 kPa
- Maximum injection pressure 17,500 kPa for a 24 hour period (up to 2% of operating time per calendar year)
- Amendments:
 - 8672B – Increase in MWHIP for WDW#1, 2, 4, 5 and 9 from 13.7 to 15.8 MPa
 - 8672C – Addition of WDW#11 and WDW#14
 - 8672D – Increase upper pH limit to 12.5 for all wells
 - 8672E – Increase in MWHIP for WDW#11 and #14 to 15.8 MPa
 - 8672F – Addition of WDW#6, WDW #7, WDW#15 and WDW#16



- Disposal wells under Approval 8672F:

- | | |
|------------------------------------|---------------------------------|
| – OBS WDW#1 - 100/09-08-066-05W4/0 | – WDW#9 - 100/14-05-066-05W4/0 |
| – WDW#2 - 100/10-08-066-05W4/0 | – WDW#11 - 100/07-08-066-05W4/0 |
| – WDW#4 - 100/05-08-066-05W4/0 | – WDW#14 - 102/06-09-066-05W4/0 |
| – WDW#5 - 100/15-07-066-05W4/0 | – WDW#15 - 112/15-08-066-05W4/0 |
| – WDW#6 - 100/14-06-066-05W4/0 | – WDW#16 - 100/16-05-066-05W4/0 |
| – WDW#7 - 100/01-07-066-05W4/0 | |

Approval 8673A – Cavern Disposal

Approved October 2000

- Approval Compliance Requirements
 - Monitoring Maximum Injection Pressures
 - Did not exceed maximum allowable injection pressure
 - Annual Report
 - 2019 Report will be prepared following annual cavern sounding
- Salt Cavern 1 – 118/12-8-66-5W4
 - Cavern volume (as of May 2018 sounding) 165,755 m³
 - Wash water 223,659 m³
 - Cavern wash water is sent to disposal wells
 - Oily waste (bitumen) 500 m³
 - Solid waste 24,980 m³
 - Next Cavern sounding expected in April 2019

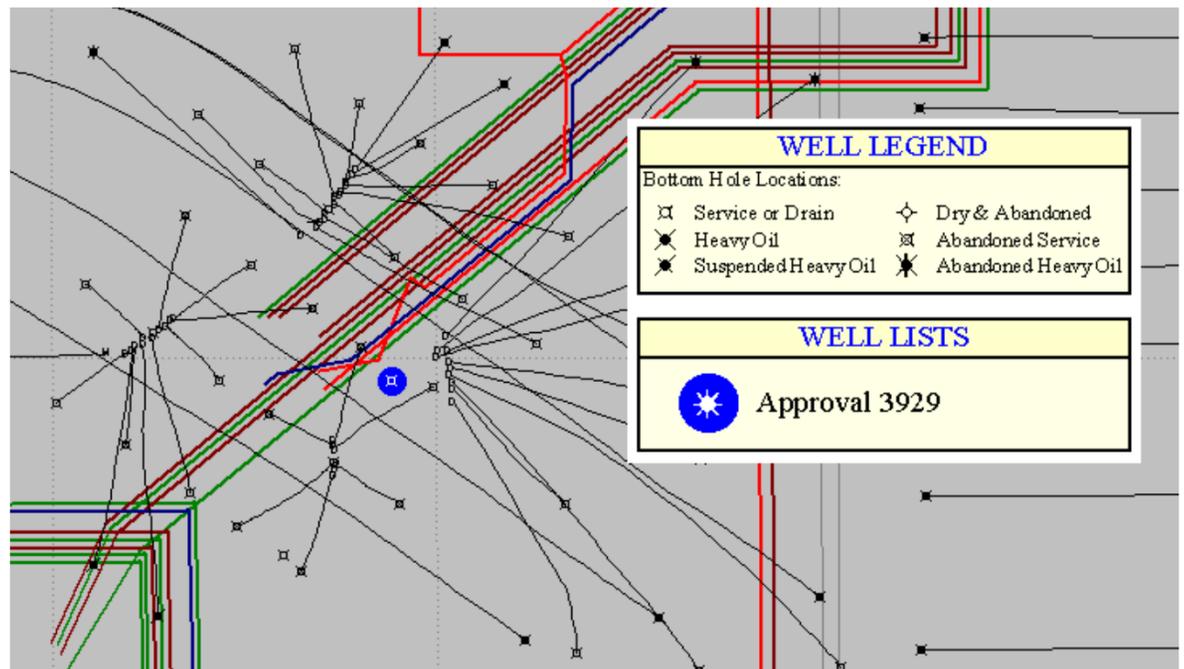
Approval 8673A – Cavern Disposal

Approved October 2000

- Approval Compliance Requirements
 - Cavern #2 was approved for disposal in June 2016
 - Monitoring Maximum Injection Pressures
 - Did not exceed maximum allowable injection pressure
 - Annual Report
 - 2019 Report will be prepared following annual cavern sounding
- Salt Cavern 2 - 119/12-8-66-5W4
 - Cavern volume (as of April 2018 sounding) 103,191 m³
 - Wash water 184,163 m³
 - Cavern wash water is sent to disposal wells
 - Oily waste (bitumen) 225 m³
 - Solid waste 4,606 m³
 - Next Cavern sounding expected in April 2019

Approval 3929A – Primrose Class 1b Disposal Amended September 2011

- Approval Compliance Requirements
 - Originally approved 1983
 - Transferred to Canadian Natural from Dome Petroleum – September 2011
 - Directive 51 Compliance
 - Maximum Wellhead Injection Pressures (kPa)
 - 03/10-05-067-04W4/0
 - 6,000 kPa
 - Well suspended in July 2011



Additional Disposal Approvals

- Approval No. 4128D – Class II Disposal
 - Transferred to Canadian Natural from Dome Petroleum – September 2011
 - Directive 51 Compliance
 - 02/10-05-067-04W4/0 = 16,000 kPa.
 - Well suspended in March 2016

Compliance Disclosures

- Reportable spills
 - 6 reportable spills were reported during 2018 including;
 - 1 produced water
 - 3 boiler feed water
 - 1 regen waste water
 - 1 water from lime sludge softener
- Digital Data Submissions (DDS)
 - Notifications/Submissions were entered into the DDS as per Directives in 2018.
- Dam Safety Act
 - Dam Safety Inspection was conducted by Terracon on July 18, 2018 at the Lime Sludge Ponds(LSP).
 - The LSP received a water license which was an action item from 2017. (00400948-00-00)
 - AER completed a Primrose East Plant Dam Inspection on August 22, 2018 at the E-Pond.

Future Plans

- Wolf Lake Acid Job Handling Improvements
 - Improvements to slop oil and rag layer treatment
 - Improvements to skim oil handling
- Wolf Lake Expansion Scoping
- Wolf Lake Plant BFW Quality Improvements Project
- Primrose North Field CSS Pad Add Commissioning/Start-up
- PSP OTSG Controls Upgrades (remaining generators)
- WLP OTSG Controls Upgrades (CSA Compliance)
- Burnt Lake Upgrades
- Integrity pipeline pigging
- Various small sustaining capital projects
 - To replace aging infrastructure and equipment
 - To reduce operating costs
 - To improve environmental performance



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