



**Canadian Natural**

**DIRECTIVE 54 SECTION 3.1.2  
SURFACE OPERATIONS, COMPLIANCE, AND ISSUES  
NOT RELATED TO RESOURCE EVALUATION AND  
RECOVERY**

# 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

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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 <sup>3</sup>	cubic metre
Cl	chlorine	m <sup>3</sup> /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

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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 <sub>2</sub>	sulphur dioxide
SR	Sand River
t/d	tonnes per day
tCO <sub>2</sub> 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

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- 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:
  - Primrose South DCS upgrades
  - Primrose South HRSG controls upgrade
  - Wolf Lake slop oil 10-T-122 conversion
  - Wolf Lake fire and gas detection upgrades
  - Various pad pumpjack motor upsizing
  - S1A redrills/stepouts

## Specific Project Update

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- Wolf Lake Produced Water Debottleneck
  - Phase 3 completed
    - Inlet separation improvements
    - Additional LSF's added in U11 (lime softening filters)
    - U1 Inlet train modified to improve performance and capacity
    - Additional disposal pumps added for WDW 4/5
    - U9 produced water booster pump addition
  - Phase 4 in scoping and engineering
    - Additional WLS (warm lime softener) in U9
    - Additional disposal pumps
    - Additional coolers and improved heat exchange

## Wolf Lake CPF Performance

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- Bitumen and water treatment
  - Overall water quality and oil treating targets were met:
    - Set 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 - 2017 Power Generation and Consumption

Month	Power Generation	Power Consumption	Net
	MWh	MWh	MWh
January	64,450	74,298	-9,848
February	57,210	66,347	-9,138
March	63,827	72,315	-8,488
April	58,672	59,578	-906
May	41,255	65,571	-24,316
June	17,875	45,221	-27,346
July	44,756	69,394	-24,638
August	57,150	70,700	-13,551
September	54,963	65,401	-10,438
October	61,598	67,391	-5,793
November	63,156	71,589	-8,433
December	66,146	75,652	-9,506

Sources:

Energy Components - Cogen Accounting Report 6, PSEP - Primrose Power Plant

Power consumption was taken from BPIMS CV4338 (Total CNRL Electrical Load) / EC CV4330

- 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	Total Solution Gas Conserved	Total Vented Gas	Total Solution Gas Flared	Solution Gas Conserved
Month	e3m3	e3m3	e3m3	e3m3	%
January	134,112	18,286	1.7	110	99.4%
February	118,627	17,183	0.5	71	99.6%
March	138,451	18,927	0.3	50	99.7%
April	99,480	15,376	0.9	69	99.6%
May	123,382	18,532	1.8	111	99.4%
June	103,792	17,556	2.5	67	99.6%
July	134,940	18,448	6.5	37	99.8%
August	133,550	18,085	8.2	98	99.5%
September	126,887	13,797	7.0	28	99.8%
October	133,174	15,975	13.0	107	99.3%
November	134,651	17,707	8.3	66	99.6%
December	130,145	19,498	9.8	48	99.8%

\*Total purchased gas does not include gas from site gas wells

\*Solution gas flared volumes are corrected to remove purchased gas to flare

\*Total gas vented includes brackish water associated vent gas

\*Total Purchased Gas and Total Vented Gas for the month of December to be confirmed following Petrinex submission.

## Facility Performance

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- 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
  - No 2017 high flaring events. High solution gas conservation.
- Facility Venting Compliance
  - No routine venting in the field
  - No routine venting at Primrose North, South or East plants
  - Vapour recovery on all major sources of solution gas at Wolf Lake

## Facilities – Greenhouse Gas Emissions

- PAW Greenhouse Gas Emissions

Month	2017 (tCO <sub>2</sub> e)
January	323,100
February	283,600
March	327,200
April	246,200
May	314,900
June	270,700
July	339,200
August	340,900
September	323,100
October	331,600
November	327,100
December*	307,500
Year Total	3,735,100

\* Forecast

## Measurement and Reporting

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- 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 26<sup>th</sup> 2016. First round response was submitted on December 7<sup>th</sup> 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)

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- 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)

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- Test Durations

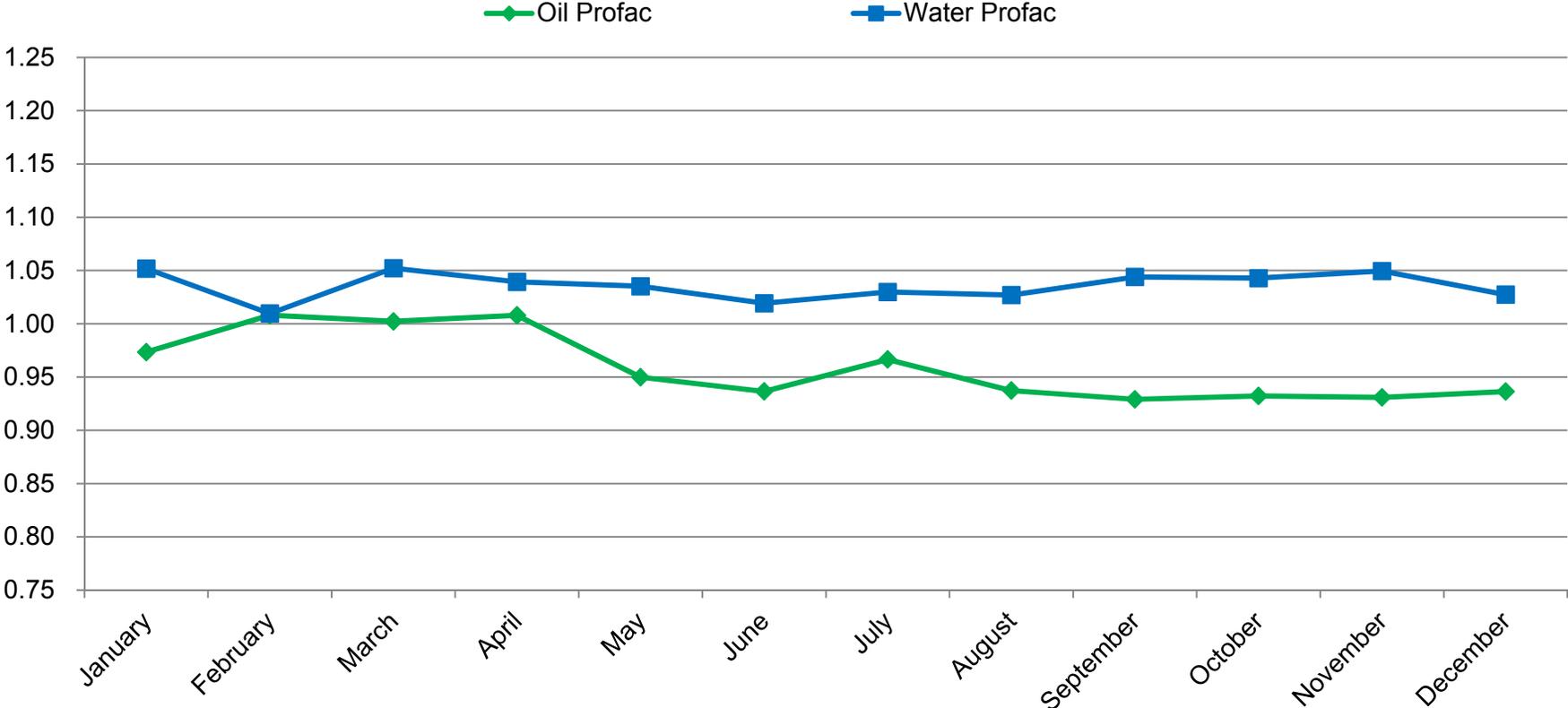
- Canadian Natural field operations has identified the test durations, gross fluid rates and BS&W results required to obtain valid proration test data for each well
- Most wells have 4 hour proration test durations; however some wells may be tested from 1 to 6 hours depending on their unique operating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

## MARP Meter Temperature and Pressure Correction

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- Canadian Natural submitted an Application under Directive 17 to waive temperature and/or pressure compensation requirements until completion of online compensation on May 31, 2017
  - Temperature and pressure compensations on the Priority 1 and Priority 2 meters have been completed
    - Canadian Natural will back correct the data reported in Petrinex for Priority 1 and 2 meters by the end of Q2 2018
  - Priority 3 meters are currently being addressed and are targeted to be completed by the end of Q2 2018.
    - Delay in completion of Priority 3 meters pressure compensation have been delayed primarily due to project activities in the past and the upcoming turnaround in April 2018.
    - Priority 3 meters primarily consists of BFW meters which already have online temperature compensation.
    - Impact of pressure compensation on these meters is estimated to be minimal.

# Measurement and Reporting – Proration Factors



## 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 <sup>1</sup>	Grand Rapids <sup>2</sup>	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) <sup>3</sup>	14-04-067-04W4M (EL)	107/08-17-066-05W4M	1F2/12-09-067-03W4M
06-08-066-05W4M (SR) <sup>3</sup>	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

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- 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
    - Fish Hatchery effluent used as boiler feed water make-up at Burnt Lake and occasionally used as cooling water in emulsion line flowback
    - 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

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- Water Quality Assessment

- Plant Runoff Surface Water – Burnt Lake Plant, PRN Plant, PRS Plant

- Average TDS = 147 mg/L

- Cold Lake Fish Hatchery Effluent – Low Lift Pump Station

- Average TDS = 134 mg/L

- Quaternary Water Source Wells – Empress Unit 3 & Muriel Lake Formation Aquifers

- Average TDS = 583 mg/L

- Grand Rapids Fm. Water Source Wells

- Average TDS = 9,721 mg/L

- McMurray Fm. Water Source Wells

- Average TDS = 7,276 mg/L

- Produced Water Quality

- Typical parameters: TDS = 6,670 mg/L, Cl = 3,390 mg/L, pH 7.45, hardness = 163 mg/L

## Water Production, Injection, and Uses

Primrose and Wolf Lake - 2017 Monthly Water and Steam Volumes

Month	Surface Water <sup>1,3</sup> m <sup>3</sup> /d	Non-Saline Groundwater <sup>4</sup> m <sup>3</sup> /d	Saline Groundwater <sup>5</sup> m <sup>3</sup> /d	Produced Water m <sup>3</sup> /d	Steam Injection m <sup>3</sup> /d	PW Recycled %	Actual Water Disposal %	Water Disposal Limit <sup>2,6</sup> %
January	540	2,607	6,052	74,846	75,740	93.0	9.6	17.0
February	504	2,731	7,159	69,419	74,556	95.1	8.4	17.2
March	610	2,935	14,900	64,771	76,698	96.8	6.3	18.9
April	608	2,500	20,292	49,382	59,020	94.0	17.1	20.9
May	1,377	2,728	16,513	70,384	75,249	97.5	15.0	19.0
June	770	2,545	10,979	65,652	66,953	94.0	18.2	18.3
July	787	2,625	13,083	80,580	82,372	84.9	16.5	18.2
August	429	2,443	13,174	80,027	82,904	86.9	14.3	18.3
September	375	2,534	10,197	80,180	80,661	87.8	14.6	17.7
October	379	2,409	7,985	83,418	79,979	85.8	15.1	17.3
November	314	3,286	6,386	85,211	83,854	86.9	14.2	16.8
December	348	2,258	8,151	82,153	83,083	89.0	12.4	17.4
<b>Average</b>	<b>587</b>	<b>2,632</b>	<b>11,265</b>	<b>73,835</b>	<b>76,756</b>	<b>91.0</b>	<b>13.5</b>	<b>18.1</b>

Notes:

1. Fish Hatchery treated effluent (stored in Primrose East E-pond) used for Burnt Lake Pilot steam generation (Water Act License #78374-00-00)

2. Surface Water volumes not included in D81 Water Disposal Limit calculation. All surface water used for steam generation will be included going forward.

3. Surface water comprised of effluent diversion from Cold Lake fish hatchery, Primrose East E-Pond, and surface water runoff

4. Non-saline groundwater from Wolf Lake water source wells

5. Saline groundwater from McMurray Formation aquifer

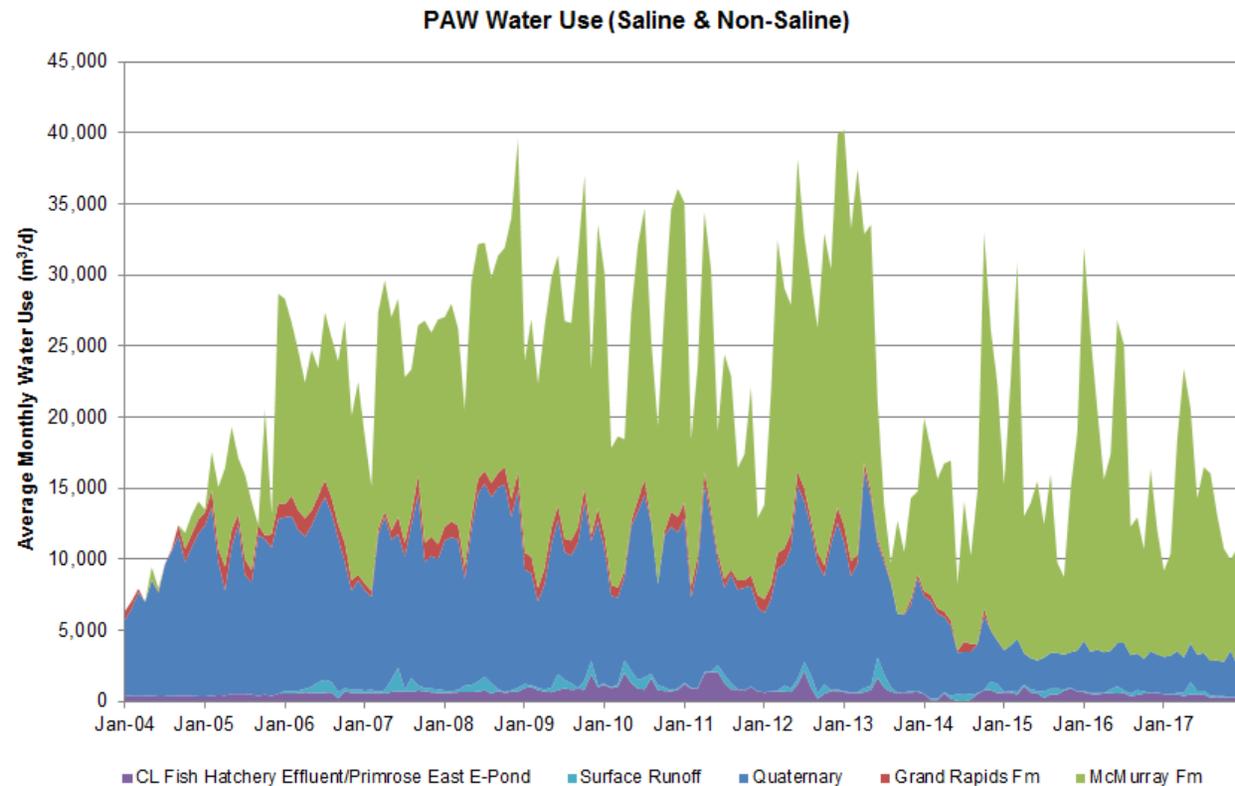
6. Directive 81 Water Disposal Limit as per Approval No. 9140W, Dp 0.16.

$$\text{PW Recycled} = \frac{(\text{Total PW} - \text{PW to Disposal})}{\text{Total PW}}$$

# Water Production, Injection, and Uses

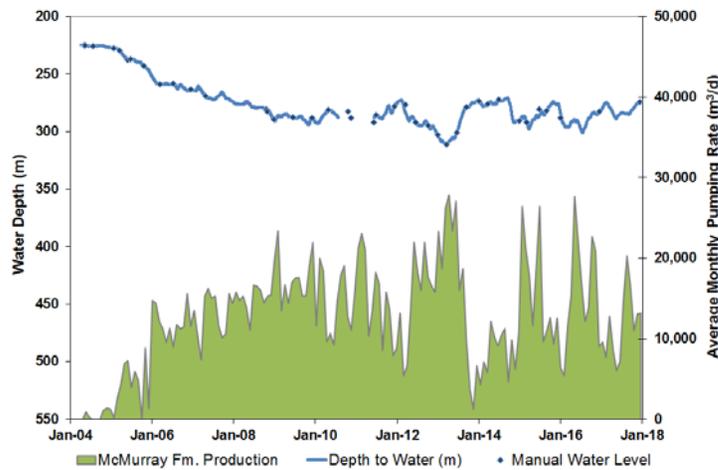
## 2017 PAW Water Use:

- McMurray Fm. Saline Water
  - Avg. 11,265 m<sup>3</sup>/d
- Grand Rapids Fm. Saline Water
  - Avg. 0 m<sup>3</sup>/d
- Quaternary Non-Saline Water
  - Avg. 2,632 m<sup>3</sup>/d
- Plant Runoff Surface Water
  - Avg. 180 m<sup>3</sup>/d
- Cold Lake Fish Hatchery Surface Water Effluent/Primrose East E-Pond
  - Avg. 409 m<sup>3</sup>/d

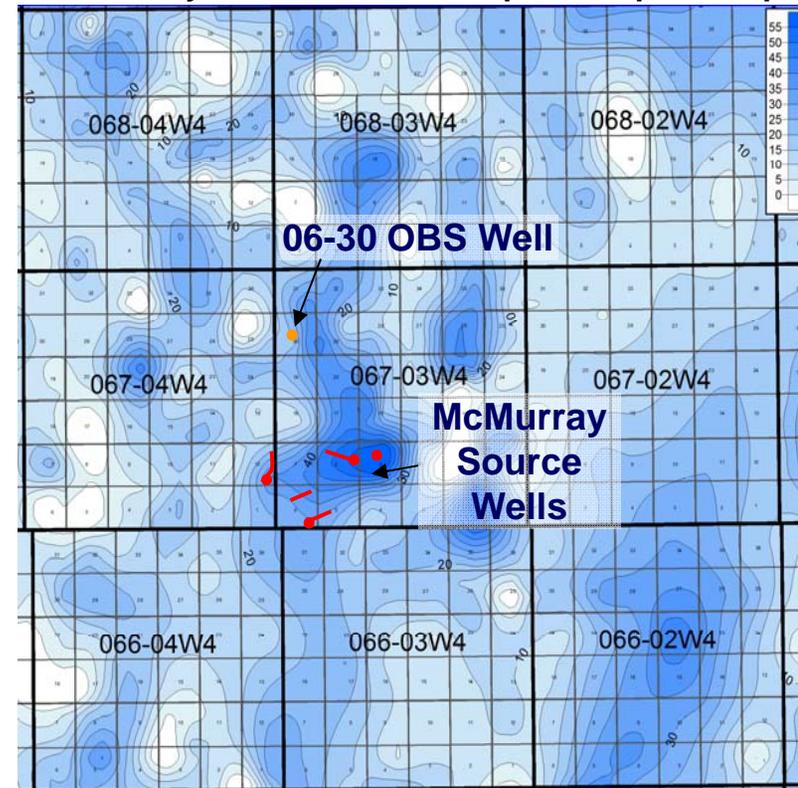


# McMurray Saline Water Supply

- Producing wells
  - 4 horizontal and 6 vertical wells
- 2017 production
  - Average: 11,265 m<sup>3</sup>/d
  - Maximum: 29,390 m<sup>3</sup>/d
- Drawdown of 50 m (500 kPa) in 6-30 OBS well



McMurray Formation Basal Aquifer Isopach Map



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

- Primrose & Wolf Lake Project Disposal Water Well UWI Listing

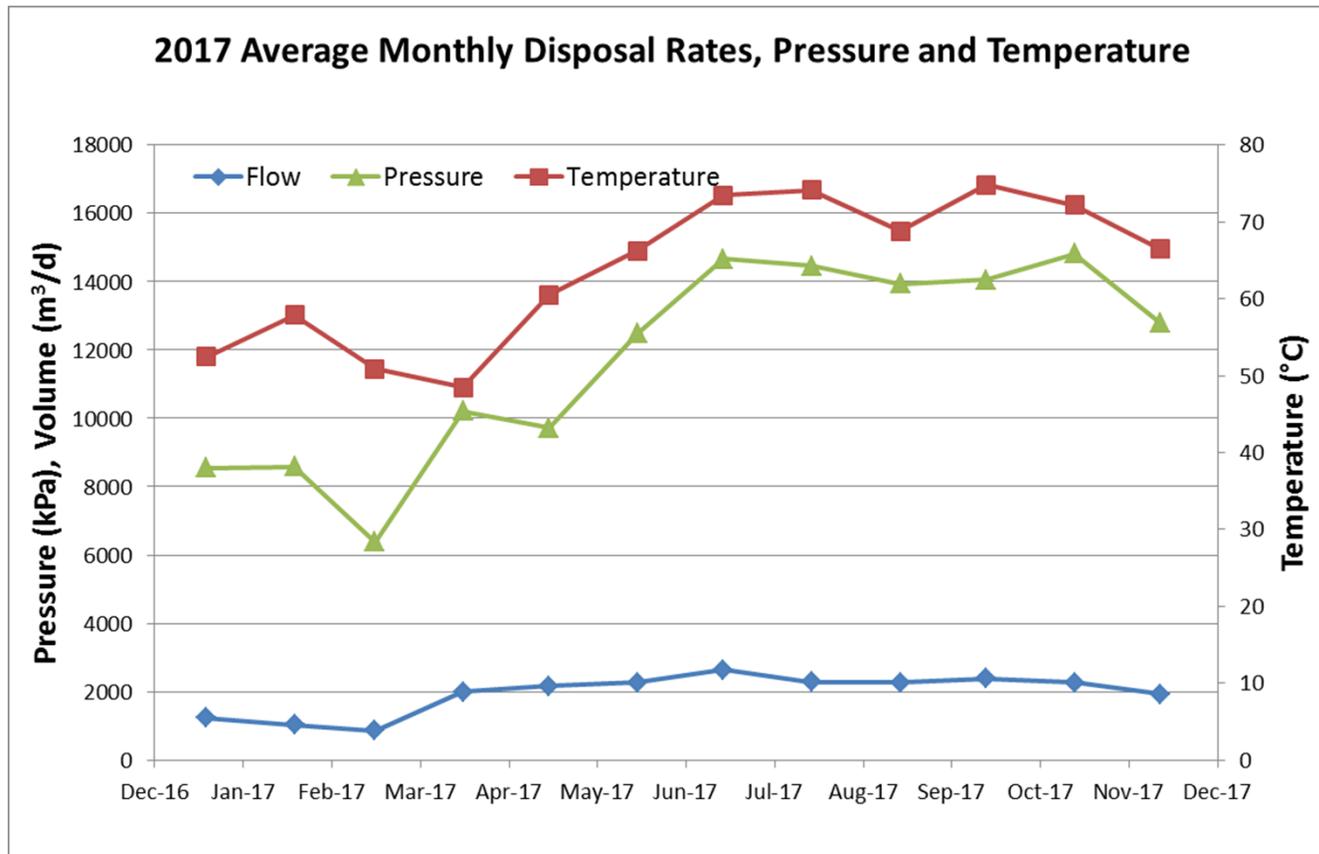
Wolf Lake		Primrose South	
Well	Formation	Well	Formation
WDW #2 - 100/10-08-066-05W4	Mid Cambrian	103 /10-05-067-04W4/00	McMurray
WDW #4 - 100/05-08-066-05W4	Mid Cambrian		
WDW #5 - 100/15-07-066-05W4	Mid Cambrian		
WDW #9 - 100/14-05-066-05W4	Mid Cambrian		
WDW #11 - 100/07-08-066-05W4	Mid Cambrian		
WDW #14 - 102/06-09-066-05W4	Mid Cambrian		

- Wolf Lake (WDW #2, 4, 5 ,9, 11 & 14)
  - WDW #9 was re-activated in late 2015
  - Wells WDW #11 & 14 were drilled and completed in 2016

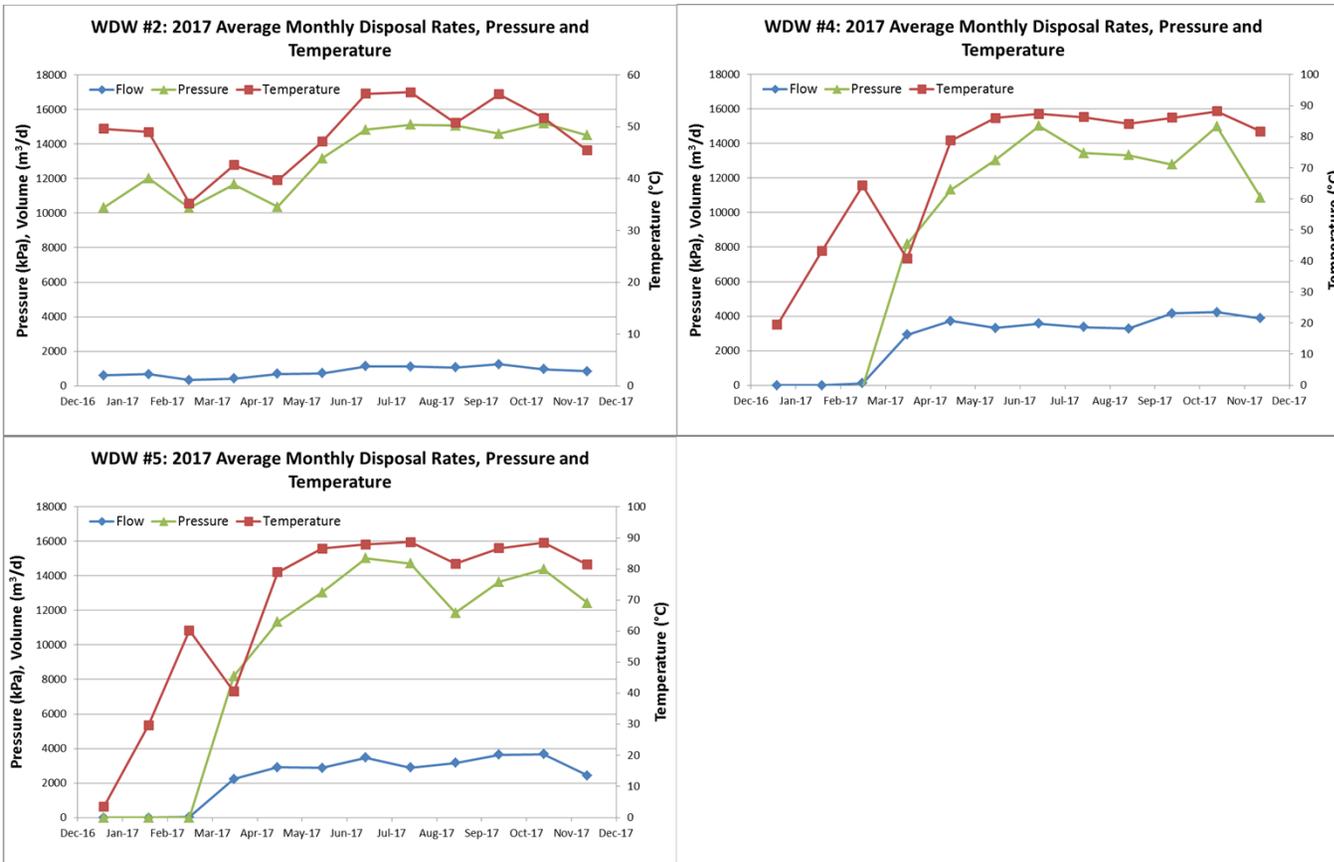
## Primrose South

- 103/10-05-067-04/W4 - Well is suspended (bridge plug)

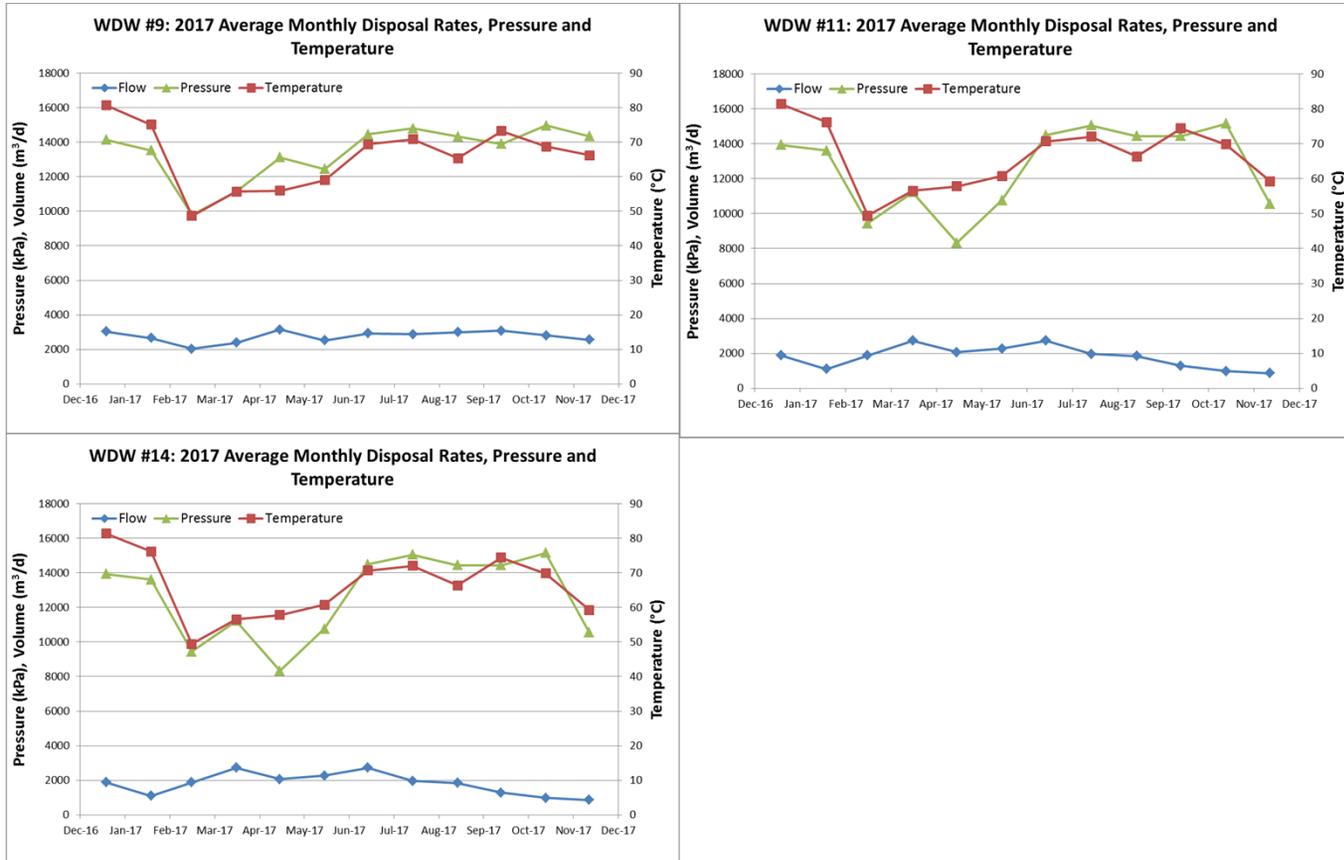
# Water & Waste Disposal Wells, Landfill Waste Wolf Lake Disposal Volumes



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

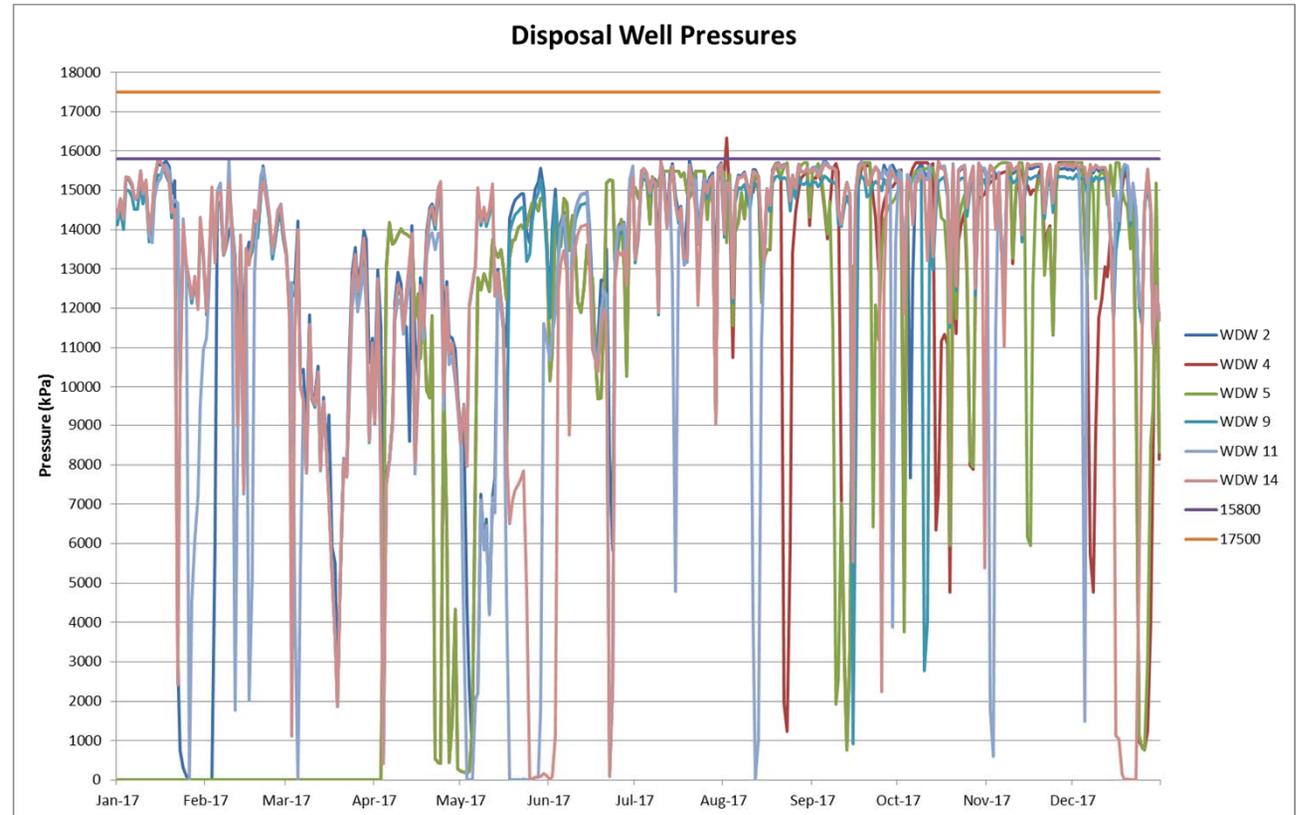


# Water & Waste Disposal Wells, Landfill Waste Wolf Lake Disposal Volumes



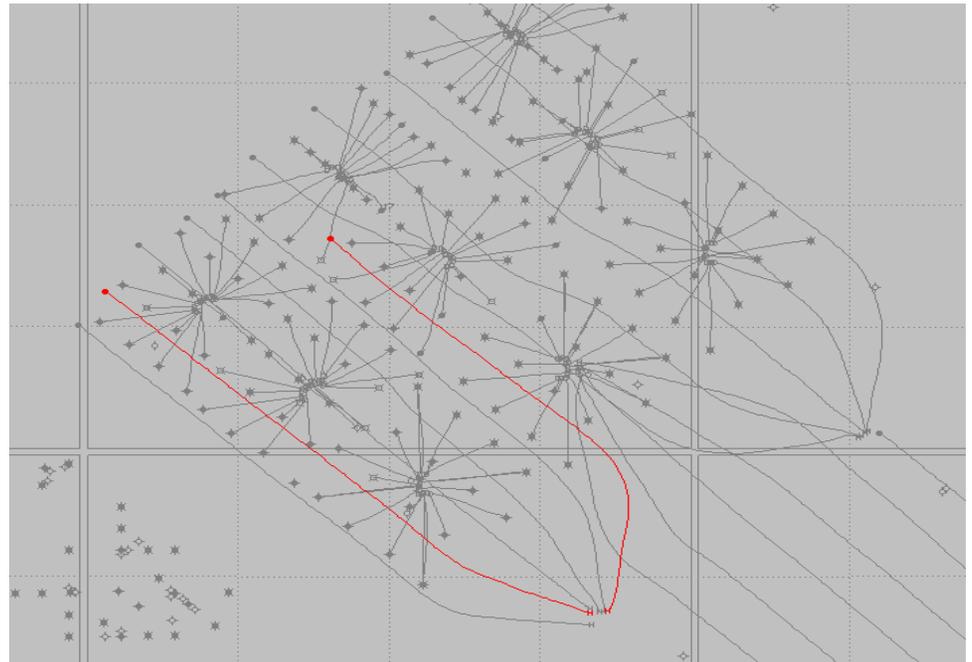
## Wolf Lake Disposal Well Pressures

- Injection Pressures did not exceed 17,500 kPa in 2017
  - 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)



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

- Water is stored in the C3 Formation
  - Converted two wells to injectors in June 2003
- Injected 1,012,605 m<sup>3</sup> total
  - 551,910 m<sup>3</sup> to M2-S
    - 49,217 m<sup>3</sup> in 2017
  - 460,695 m<sup>3</sup> to M2-E
    - 22,512 m<sup>3</sup> in 2017
- M2-S well zonally suspended in Oct 2017
  - M2 Storage line abandoned



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

- Wolf Lake Water Storage – Disposal Volumes

Year	Month	M2_E				M2_S			
		Gross (m <sup>3</sup> /d)	Oil (m <sup>3</sup> /d)	Water (m <sup>3</sup> /d)	Water Inj (m <sup>3</sup> /d)	Gross (m <sup>3</sup> /d)	Oil (m <sup>3</sup> /d)	Water (m <sup>3</sup> /d)	Water Inj (m <sup>3</sup> /d)
2003		21	2	20	243	40	1	39	292
2004		0		0	21	28	0.2	28	49
2005					0.3				4
2006									
2007					146				174
2008									
2009									
2010					16				0.03
2011					5.39				0.14
2012					5.19				0.09
2013					3005.91				3741.37
2014					16270				17616.9
2015					4106.0				4594.0
2016					275.0				306.0
2017	Jan				345.5				352.2
	Feb				249.7				246.1
	Mar				113.6				103.3
	Apr				42.9				124.5
	May				0.0				457.2
	Jun				0.0				230.7
	Jul				0.0				108.9
	Aug				0.0				0.0
	Sep				0.0				0.0
	Oct				0.0				0.0
	Nov				0.0				0.0
	Dec				0.0				0.0

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

- Wolf Lake Water Storage – Produced 2017 Volumes

Year	Month	M2_B				M2_C				M2_D			
		Gross (m3/d)	Oil (m3/d)	Water (m3/d)	Water Inj. (m3/d)	Gross (m3/d)	Oil (m3/d)	Water (m3/d)	Water Inj. (m3/d)	Gross (m3/d)	Oil (m3/d)	Water (m3/d)	Water Inj. (m3/d)
2017	Jan	0	0	0	0	0	0	0	0	0	0	0	0
	Feb	0	0	0	0	0	0	0	0	0	0	0	0
	Mar	0	0	0	0	0	0	0	0	0	0	0	0
	Apr	0	0	0	0	0	0	0	0	0	0	0	0
	May	0	0	0	0	0	0	0	0	0	0	0	0
	Jun	0	0	0	0	0	0	0	0	0	0	0	0
	Jul	0	0	0	0	0	0	0	0	0	0	0	0
	Aug	0	0	0	0	0	0	0	0	0	0	0	0
	Sep	0	0	0	0	0	0	0	0	0	0	0	0
	Oct	0	0	0	0	0	0	0	0	0	0	0	0
	Nov	0	0	0	0	0	0	0	0	0	0	0	0
	Dec	0	0	0	0	0	0	0	0	0	0	0	0

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

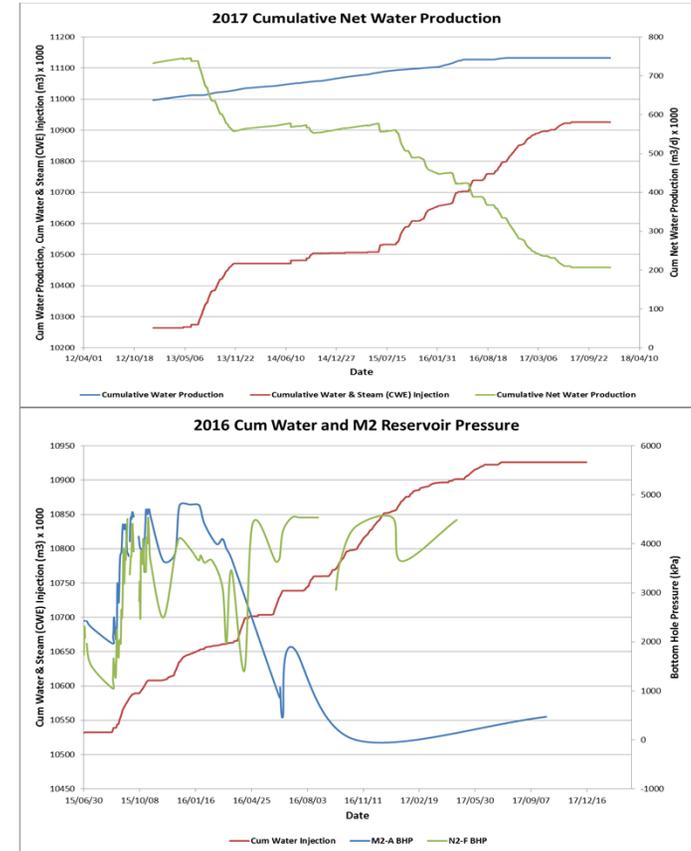
- Formation Integrity and Pressure Monitoring

- AER Approval No. 9108A was amended to use a Lower Grand Rapids Formation observation well to monitor for migration of fluids out of the zone in lieu of logging the wells used as water injectors
  - Pressures did not exceed the allowable 9 MPa on the Grand Rapids Formation observation well during water injection
- M2-E passed packer isolation test on Aug 9, 2017
- M2-S failed packer isolation test on Aug 9, 2017
- M2-S was suspended in Oct 2017. Pressure tested casing, no integrity concerns.

- Wolf Lake Water Storage – Reservoir

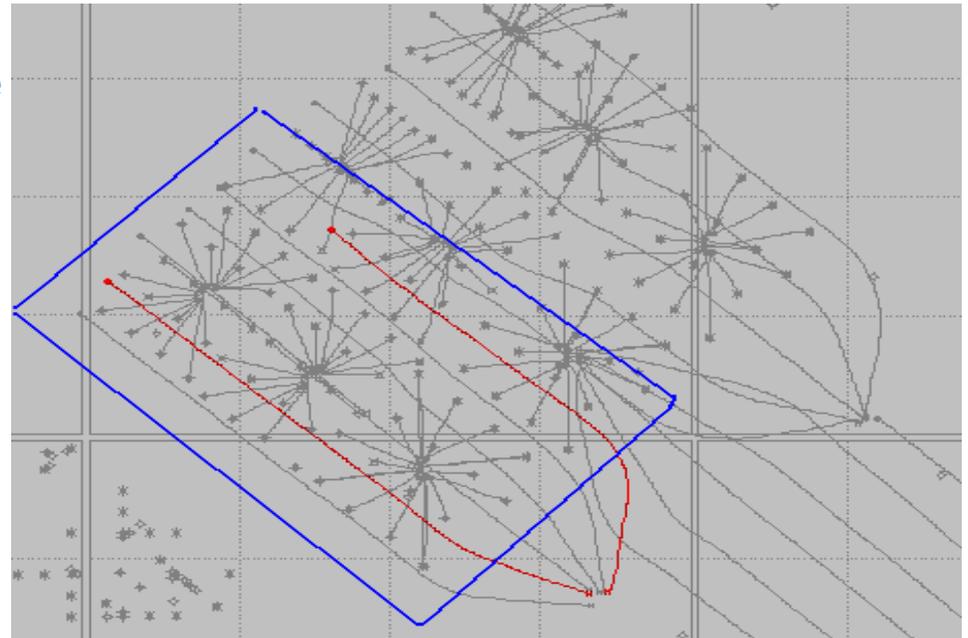
- M2 & N2 Cumulative DI = 1.09
  - Cumulative Gross Production = 11,897,602 m<sup>3</sup>
  - Cumulative Oil Production = 1,490,048 m<sup>3</sup>
  - Cumulative Steam Injected = 9,971,916 m<sup>3</sup> CWE
  - Cumulative Water Injected = 904,571 m<sup>3</sup>
- M2 & N2 Remaining Voidage = 1,021,115 m<sup>3</sup>

$$DI = \frac{\text{Total Fluid Produced (Bitumen + Water)}}{\text{Total Fluid Injected (CWE)}}$$



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

- From the outlined area (M2 wells and N2-F)
  - Total Injected Water = 1,012,605 m<sup>3</sup> since Jan '03
  - Total Produced Water = 728,465 m<sup>3</sup> since Jan '03
  - Difference = 284,140 m<sup>3</sup>
- M2 storage will not be used in 2018
- Stored water is produced through horizontal wells surrounding the M2-E and M2-S injector wells and sent to Wolf Lake water treatment plant for recycle.
- No production in 2017.



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

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- Injectors appear to communicate readily with offset wells
- Wells will not be used for water disposal
- M2-S suspended
- M2 line abandoned
- M2-E and M2-S are classified as disposal wells on S-4 forms

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

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- Waste to Tervita Bonnyville Landfill
  - 1,110 tonnes – Contaminated Soil (crude oil, condensate, produced & salt water)
  - 2 tonnes – Process Sludge
  - 46,082 tonnes – Lime Waste
- Waste to Tervita Cavern
  - 220 m<sup>3</sup> – Hydrocarbon Sludge
  - 45 m<sup>3</sup> – Crude Oil/Condensate Emulsions
  - 389 m<sup>3</sup> – Filter Media
  - 43 m<sup>3</sup> – Produced Water
  - 76 m<sup>3</sup> – Well Workover Fluids
  - 3 m<sup>3</sup> – Wash Fluid Water
  - 9 m<sup>3</sup> – Hydrovac Material

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

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- Waste to Newalta Elk Point TRD
  - 1,417 tonnes – Hydrocarbon Sludges
  - 19,873 tonnes – Crude Oil/Condensate Emulsions
- Waste to Secure Tulliby Lake TRD
  - 8,568 m<sup>3</sup> – Hydrocarbon Sludge
  - 1,921 m<sup>3</sup> – Sand
  - 2 m<sup>3</sup> – Drilling Waste
  - 21 m<sup>3</sup> – Wash Water/Contaminated Water
  - 71 m<sup>3</sup> – Crude Oil/Condensate Emulsions
  - 115 m<sup>3</sup> – Contaminated Soil

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

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- Waste to RBW (bins)
  - 353 m<sup>3</sup> – contaminated soils, plastics, empty containers, filters, batteries, glycol, fluorescent tubes, mercury, scrap metal, waste paint, used electronics, NORM's, rags & absorbents.
- Waste to Tervita (bins)
  - 73 m<sup>3</sup> – contaminated soils, filters, rags, pads, scrap metal and debris.

# Wastewater and Surface Water

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- 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, 2018.

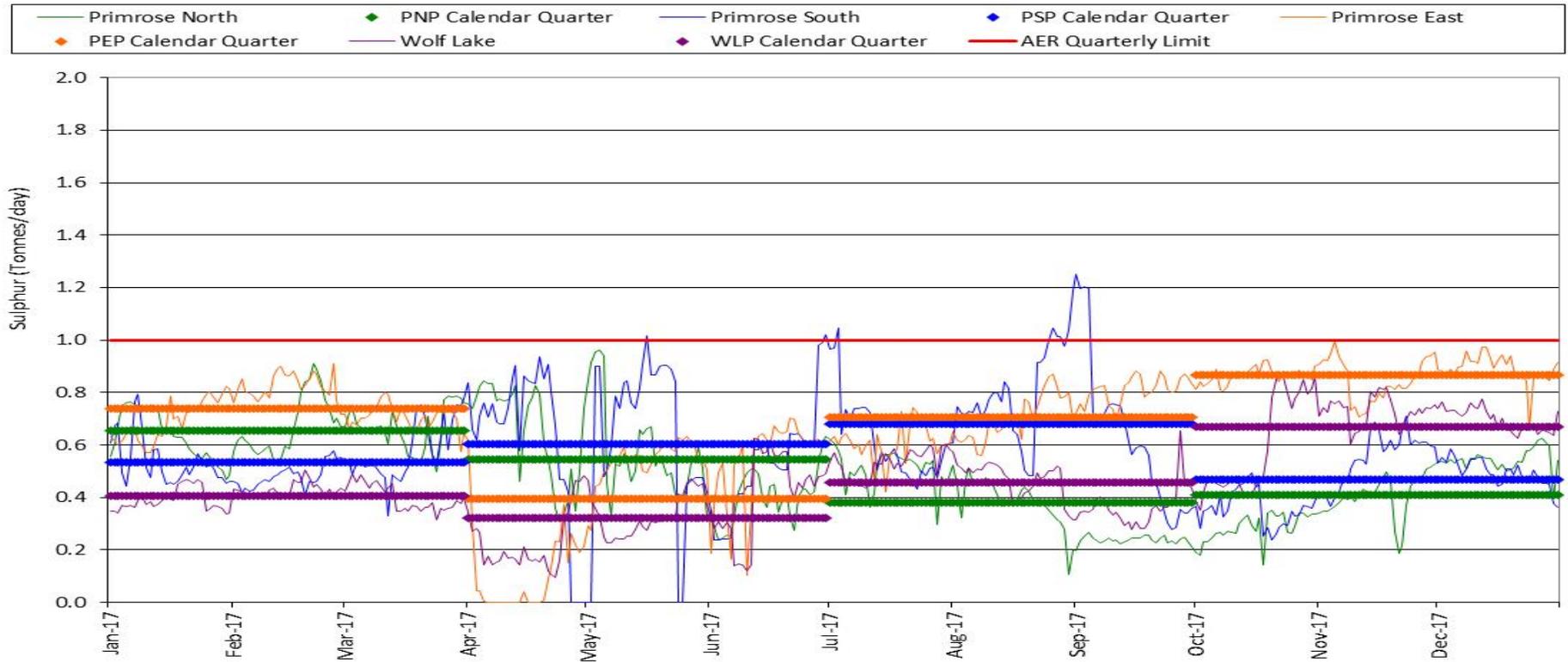
## Sulphur Production

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- EPEA approval limits for SO<sub>2</sub>:
  - 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 SO<sub>2</sub> levels below 2 t/d, production from the Primrose East area wells/pads were held back for short durations during Q4 2017
  - Canadian Natural does not plan to install sulphur recovery at this time

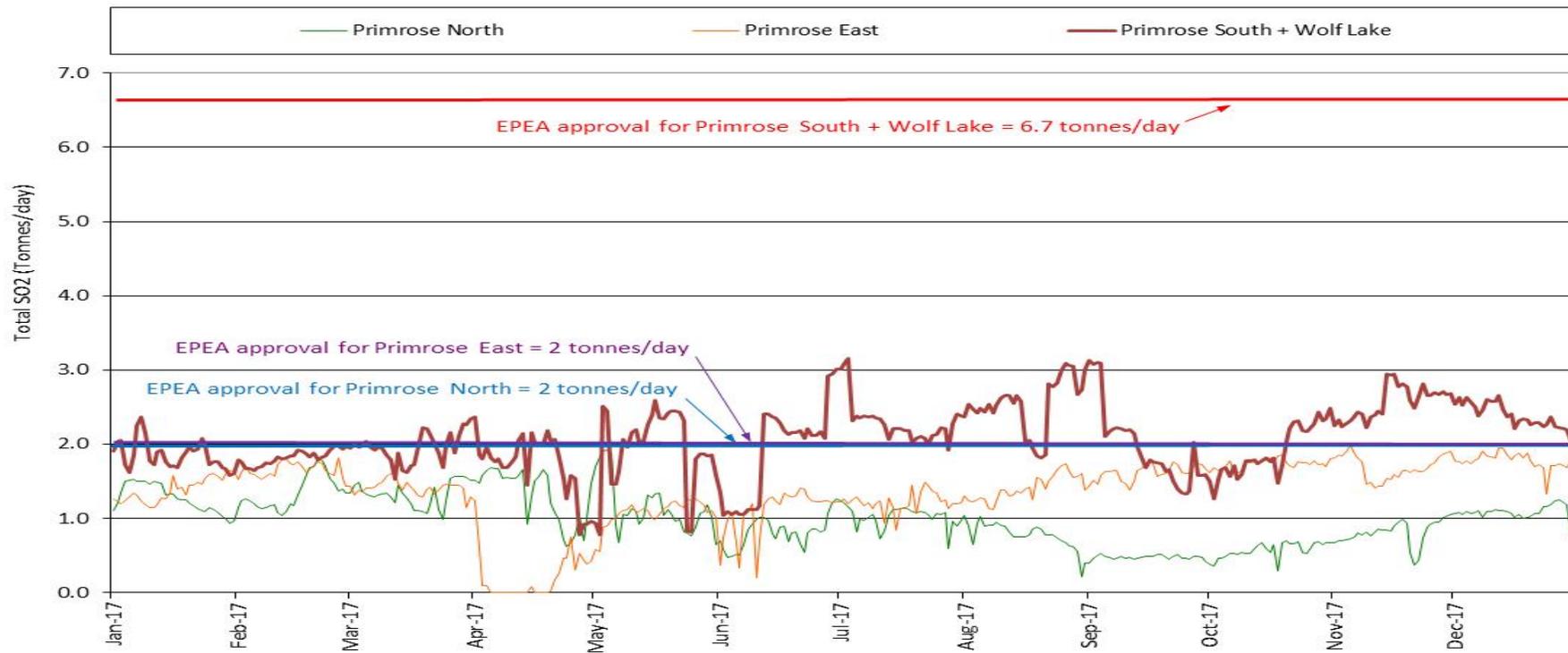
# Sulphur Production

2017 Primrose & Wolf Lake Sulphur Emissions



# SO<sub>2</sub> Emissions

2016 Primrose & Wolf Lake SO<sub>2</sub> Emissions



## Environmental Summary

### EPEA Approval and Amendments

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- The Primrose and Wolf Lake Project currently operates under EPEA Approval 11115-04-00
  - Approval 11115-04-00 expires September 30, 2025
  - On December 6, 2017 Canadian Natural received an amendment to extend the Soil Monitoring Program Report and Soil Management Program Proposal submission date from January 31, 2018 to March 31, 2018.

# Environmental Summary

## Compliance

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- Compliance Issues

- EPEA Approval: Air Related

- A new CEMS analyzer was installed on June 2, 2017 on the HRSG 2F-4003 stack. It was commissioned on June 19, 2017. The CEMS became certified September 15 at 00:00, at which time it started producing quality assured data.
    - Permission was granted from the AER on May 18, 2017 to have one CIC# used for any contraventions during commissioning. Canadian Natural and the AER understood a NO<sub>x</sub> exceedance could occur due to tuning being required during the Burner Management System (BMS) commissioning. There were five contraventions during commissioning.
    - A third party audit was completed on the CEMS QAP on January 18, 2018.
    - There were no SO<sub>2</sub> exceedances in 2017.

## Environmental Summary

### Compliance

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- Compliance Issues

- EPEA Approval: Air Related Continued:

- There were six hourly NOx exceedances in 2017. The 77.1 kg/hour average NOx emissions from the Cogen, as per CEMS reading on the 2F-4003 stack, was exceeded as follows:
    - AER Reference # 326156: During the hour beginning at 17:00 on June 25, 2017 the value was 134.9 kg/hr. Due to BMS dynamic testing on the Primrose South Plant Cogen (HRSG).
    - AER Reference # 326156: During the hour beginning at 08:00 on July 11, 2017 the value was 77.1349 kg/hr. During the hour beginning at 10:00 on July 12, 2017, the value was 79.93 kg/h. Calibration settings on the new CEMS unit were resulting in "held" data.
    - AER Reference # 326156: During the hours beginning at 14:00 and 15:00 on Aug 2, 2017 the value was 77.183 kg/hr and 79.205 kg/hr respectively. Due to BMS dynamic testing on the Primrose South Plant Cogen (HRSG).
    - AER Reference # 331933: During the hour beginning at 14:00 November 17, 2017 the value was 85.72 kg/hr. The Gas Turbine firing mode had changed for unknown reasons.

# Environmental Summary

## Compliance

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- Compliance Issues: Water Related

- AER Reference # 320580, Diversion License 00238513

- Location: Wolf Lake Source Wells WSW 02, WSW4, WSW6
    - Daily maximum pumping rate exceeded over five days (2% to 8% above the daily maximum rate)
    - Notified field operations to keep water usage below allowable daily maximum

- AER Reference # 322325, Diversion License 00238513

- Location: Wolf Lake Source Well WSW 02
    - Pressure transducer became stuck in the well and could not be pulled and downloaded
    - Weekly manual water levels recorded until new transducer installed

- AER Reference # 329445, Diversion License 00238513

- Location: Wolf Lake Source Well WSW 02
    - Pressure transducer accidentally replaced in well outside of dip tube; transducer then became stuck in the well and could not be pulled and downloaded
    - Weekly manual water levels recorded until new transducer installed

# Environmental Summary

## Compliance

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- Compliance Issues: Water Related

- AER Reference # 332028, Diversion License 00238513

- Location: Wolf Lake Source Well WSW 02
    - Replacement pressure transducer stuck in dip tube, could not be pulled and downloaded
    - Weekly manual water levels recorded until new transducer installed. New transducer hung at higher depth and installed on direct read cable so it no longer has to be removed from the well for manual download.

- AER Reference # 332690, Diversion License 00238513

- Location: Wolf Lake Source Well WSW 04
    - Daily maximum pumping rate exceeded over six days (2% to 15% above the daily maximum rate)
    - There is a trip on the pump set 50 m<sup>3</sup>/d below the 3,300 m<sup>3</sup>/d pumping limit. However, there was an issue with the logic in the automatic shut-off system and the well did not shut off once it reached 3,250 m<sup>3</sup>/d. Canadian Natural is looking for a better solution for the automatic shut-off for all six water source wells once they reach daily limits. WSW #4 is currently shut-in until a new solution is implemented and tested.

# Environmental Summary

## Compliance

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- Compliance Issues

- Land Related:

- AER Reference # 322997 – Pad AC12
    - AER Reference # 322998 – Pad AC15
    - AER Reference # 322999 – Pad AC16
    - On April 7, 2017, while conducting inspections of the surface water release activities, 3 sites were noted as having erosion concerns which caused sedimentation to venture off lease into the adjacent forested areas. This contravened EPEA approval Schedule V, Section 8 – the approval holder shall not release any industrial runoff in a manner which will cause flooding or erosion. A Temporary Field Authorization (TFA) was issued to allow for off lease low impact clean up activities under TFA 172912.
    - Location:
      - Primrose South Field – AC12 (09-30-067-04-W4M)
      - Primrose South Field – AC15 (08-04-067-04-W4M)
      - Primrose South Field – AC16 (16-04-067-04-W4M )

## Environmental Summary

### Monitoring Programs

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

## Environmental Summary

### Monitoring Programs

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- Winter Track Count Surveys
  - Canadian Natural conducted winter track count surveys across the PAW Project area in March 2017.
- Remote Camera Surveys
  - Two camera monitoring programs were implemented in 2017: a general site-wide camera monitoring program, and an effectiveness monitoring study associated with the Habitat Enhancement Program.
  - These two programs included 56 cameras in 2017
- General Monitoring Program
  - The remote camera program was adjusted in September 2017, following authorization from the AER to replace winter track count surveys with an expanded site-wide camera study design.
  - Cameras were deployed to survey a range of disturbance densities across the PAW Project area. The objectives of the program are to document the presence, distribution and abundance of mammals in the PAW Project area, and to assess mammal response to disturbance density.

## Environmental Summary

### Monitoring Programs

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- Cameras at Habitat Enhancement Sites
  - Remote cameras are deployed to monitor the effectiveness of caribou habitat restoration treatments (i.e., mounding, tree felling, rollback, seedling planting) implemented on legacy seismic lines. Camera data are used to document the effectiveness of treatments at reducing predator and human use by comparing detection rates between treated and non-treated sites. The objective of the program is to document the effectiveness of treatments at reducing predator and human use by comparing detection rates between treated and non-treated sites.
- Above-ground Pipeline Pre-construction Wildlife Surveys
  - Canadian Natural completed a series of wildlife surveys along corridors where new above-ground pipeline (AGP) will be constructed to link new well pads to the existing network of AGP on site.
  - The objectives of these surveys were to identify areas where crossing opportunities could be installed to facilitate animal movement across the AGP, and to guide the construction design based on the Above Ground Pipeline Wildlife Crossing Directive.

# Environmental Summary

## Monitoring Programs

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- **Wildlife Sighting Cards**
  - Canadian Natural staff and contractors are required to record wildlife sightings while working on site.
  - Observations are incorporated into annual reports.
- **Reporting**
  - First Comprehensive Wildlife Report (CWR) submission for the PAW Project under EPEA Approval No. 11115-04-00 submitted.
  - The CWR summarized wildlife mitigation and monitoring activities completed in 2016 but also included multi-years analyses (2015-2016) for certain key programs.
- **Wildlife Mitigation**
  - Monitoring was completed at three different types of over-pipe crossing structures (culverts, wooden structures, and winter roads).
  - Results demonstrated the use over-pipe crossing structures by all mammalian species detected. As part of this program, Canadian Natural also demonstrated that winter roads built over the AGP are used by wildlife and that many species are more likely to cross on these roads than on other types of crossing structures. Monitoring results suggest that all crossing structures, regardless of type or width, provide value for wildlife and contribute to effective mitigation of Project effects on wildlife movement.

# Environmental Summary

## Monitoring Programs

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- Wildlife Monitoring

- The Project level wildlife monitoring program consisted of remote camera monitoring of habitat restoration sites and amphibian surveys targeting western toad.
- Camera monitoring provided evidence for the effectiveness of habitat restoration efforts in achieving the objectives of reducing human and carnivore use of treated linear disturbances. Significantly fewer grey wolves, carnivores (pooled species group including black bear, Canada lynx, coyote, fisher, grey wolf and red fox), and humans (in off-road vehicles) were detected on treated lines compared to untreated lines.
- Western toad presence was confirmed at 24 survey plots (29%) and the majority of observations occurred in the northwest portion of the Project area. Western toads were also detected in the Wolf Lake portion of the Project area where previous monitoring and baseline surveys had not recorded this sensitive species. Western toad occurrence observed in 2016 was greater than that recorded during monitoring surveys in 2007 (19%) and during baseline surveys in 2000 (2%), 2005 (17%) and 2006 (4%).

# Environmental Summary

## Monitoring Programs

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- Hydrology, Wetlands and Water Quality Monitoring Program
  - Wetland Monitoring Component
    - Preliminary observations of the PAW wetland monitoring program's 2017 re-measurement data indicates that there were only minor differences in overall species richness among monitoring and reference sites compared to previous years.
    - Sites continuously show variation between wetland community types (i.e., treed, shrubby, and graminoid) more so than within wetland community types. Plant vigour in most ground subplots was rated as excellent (4) or good (3) with no or little evidence of stress; however, there were a few subplots where plant vigour was listed as only fair.
  - Hydrology Monitoring Component
    - During the 2017 monitoring program, all lakes appeared to exhibit hydrological regimes similar to those of past years with the exception of Sinclair Lake which exhibited a rapid decrease in lake level, dropping approximately 1.0 m, between April 29 and June 6, 2017.
    - All other lake level variations were typically dominated by spring runoff events and the precipitation inputs experienced during the open-water season this year. As of October 4, 2017, Burnt Lake, Loseman Lake and North Reference Lake experienced lake levels which were elevated when compared to their average historical levels. In contrast, Sinclair Lake had an average elevation that was 0.16 m lower than the historical average as of October 3, 2017.

# Environmental Summary

## Monitoring Programs

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### – Water Quality Component

- Based on the to-date results for the surface water quality samples from Burnt Lake and Sinclair Lake, there were no large deviations observed in the analytical results when compared with those from previous years.
- No guideline exceedances were present in the samples taken from Sinclair Lake and the only exceedances present in the samples from Burnt Lake were phenols in all of the June samples and a single iron exceedance in October. These exceedances are similar to historical results from Burnt Lake.
- The only detectable guideline exceedance present in the soil samples taken was total arsenic, which exceeded in all of the sediment samples taken from Sinclair Lake. These results are similar to historical results and suggest that elevated arsenic levels are naturally occurring in the sediments at Sinclair Lake. Continued monitoring of the surface water will be recommended to identify any potential changes over time and to determine if these results are indicative of trends in the surface water quality at each lake.

## Environmental Summary

### Monitoring Programs

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- Reclamation activities in 2017:
  - Re-vegetation Program consisted of reforesting 28.2 ha
  - Approximately 74,108 tree and shrub seedlings were planted.
    - Planting on borrows areas accounted for 6.0 ha
      - total of 21,120 tree and shrub seedlings
    - In-fill planting and remedial on Dome Well sites and access roads accounted for 4.2 ha
      - 9848 tree and shrub seedlings.
    - Flow to surface borrows planting accounted for 17.5 ha
      - Total of 43,140 trees and shrub seedlings
- Proposed activities in 2018:
  - Reforestation of 3 reclaimed well pads and access roads in Wolf Lake

## 2017 FTS Update

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- 2017 FTS Monitoring Activities Summary:
  - Continue monitoring of all sites.
  - 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).
- Compliance
  - August 1, 2017 received a low risk non compliance regarding the presence of various weeds. Required to submit a vegetation management for the FTS sites. Also noted the site was not maintained in a clean condition. Pallets, rig mats, debris was present at the lease entrance which required removal prior to next inspection.
  - No noncompliance in regards to surface water releases at the FTS sites

## 2017 FTS Update

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- 2017 FTS Milestone Summary:
  - Completion of final report of 09-21 FTS was submitted to AER on October 31, 2017.
  - Completion of final report for 02-22 FTS was submitted to AER on November 30, 2017.

## Environmental Summary

### Regional Initiatives

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- LICA Airshed Zone
  - The LICA Airshed Zone is responsible for operating a regional air monitoring network for part of the Lakeland and adjacent area inclusive of passive and continuous monitoring networks.
  - In addition to posting the air monitoring network results to the LICA website, the LICA Airshed Zone also posts real time air monitoring results for the regional Alberta Quality health Index (AQHI)
  - Promotes understanding of air quality in the region.

# Environmental Summary

## Regional Initiatives

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- 2017 LICA Highlights:

- Lakeland Industry & Community Association (LICA) was restructured to eliminate independent standing committees. The airshed, watershed and staff all report to the same board of directors.
- The Beaver River Watershed Association (BRWA) focused resources on riparian restoration projects. There are three distinct areas of focus. Private land riparian restoration included restoration of a ¼ section of riparian area along the Beaver River. Since the initiation of the program, additional efforts are being made to expand the program with other landowners. Agricultural crown land riparian restoration has been a partnership with the municipalities and AEP to identify riparian lands to be revegetated. The third component are aerial riparian assessments. Two assessments were completed within the Beaver River watershed to help identify areas that would benefit from a riparian restoration project. Maps were created to support this program, which was completed with in-kind support from CNRL.
- The Alberta Lake Management Society (ALMS) program continued in the Lakeland area with industry funding. Ten lakes were included in the program, additional funding for Jessie Lake was provided to support the program that was conducted by the LICA airshed.
- The LICA Airshed conducts regional air quality monitoring within the Lakeland area. The passive network has 27 stations and is based on a 3 x 3 township grid pattern. There are three continuous stations and one portable station. In June 2016 the portable station was moved into the town of Bonnyville. An unusually high number of exceedances of the AAAQO for H<sub>2</sub>S was observed. It would appear that Jessie Lake, within the town of Bonnyville, is the source. The airshed and watershed are working together on an appropriate management response.

# Environmental Summary

## Arsenic Mobility Investigation

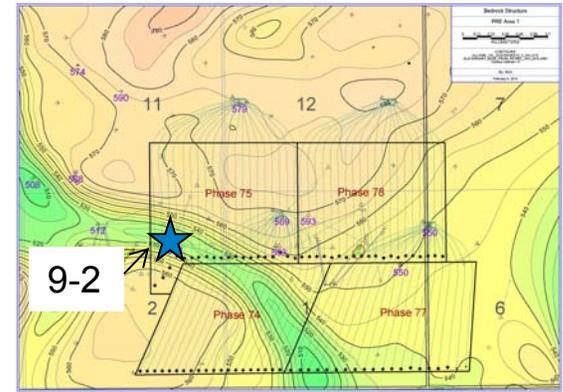
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- Arsenic Mobility Research Program Description
  - Long-term research program at Z8 Pad ongoing since 2001.
  - Evaluating the liberation of arsenic associated with elevated groundwater temperatures from steaming a thermal pad.
  - Thirty-five groundwater 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 2017
  - 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 deep monitoring wells.
  - 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.

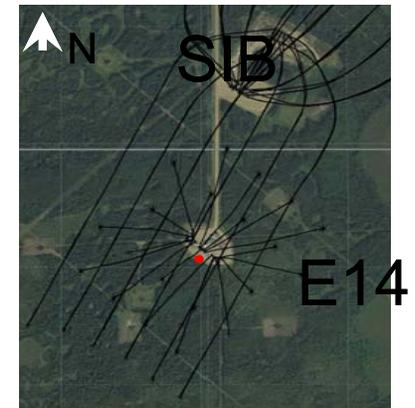
# Environmental Summary

## 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



- Groundwater monitoring well installed at E14 Pad (16-32-065-05W4M) as per Clause 12 of Commercial Scheme Approval 9140I for S1B Pad
  - Clause 12 required groundwater monitoring in the deepest non-saline aquifer over the S1B drainage area
  - Completed in the Muriel Lake Formation Aquifer
  - No anomalous groundwater levels, temperature, or chemistry results observed since the well was installed in 2010
  - Clause 12 rescinded from Scheme Approval in August 2017



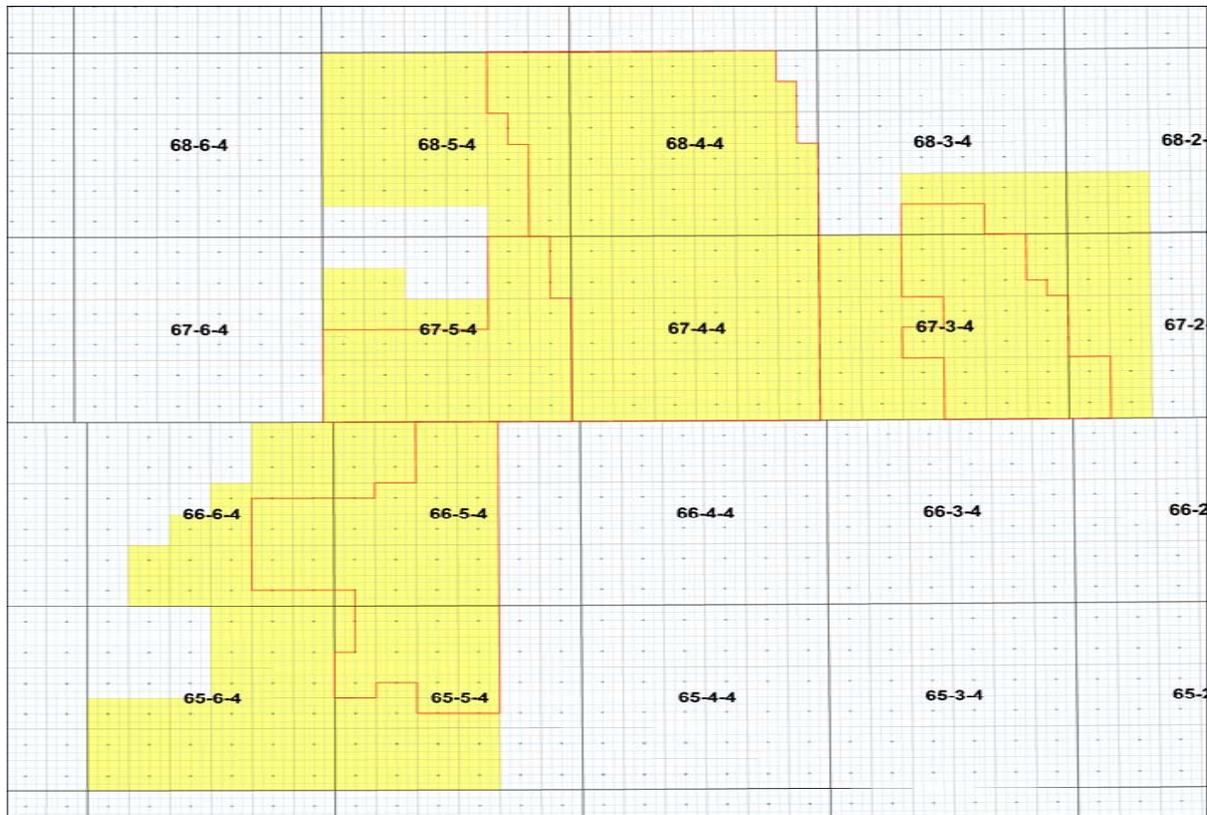
## Environmental Summary

### Groundwater Monitoring and Management

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- 2009 Flow to Surface (FTS):
  - Pad 74 Risk Management Plan revised to align with 2013 FTS Risk Management Plans. Approved in October 2017.
  - On-going application of the Pad 74 Risk Management Plan including monitoring, sampling and reporting.
  - Monitoring and sampling results are 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.
  - Risk Management Plans approved in March 2017
- Groundwater monitoring results indicate very limited subsurface impacts associated with FTS.

# Approval 9140LL – Oil Sands Primrose Wolf Lake



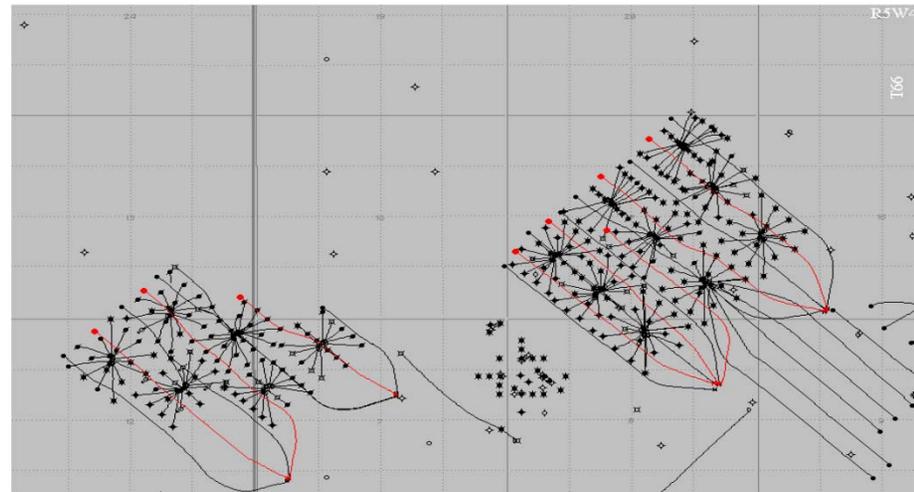
# Approval 9140 – 2017 Amendments

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- Amendment GG
  - Bitumen Production Increase to 23,000 m<sup>3</sup>/d
- Amendment HH
  - Approval to develop Primrose South Phases 44-49
- Amendment II
  - Primrose East Phases 90-95 Modified Steam, Risk Assessment and Mitigation
- Amendment JJ
  - AER update due to ABS migration error
- Amendment KK
  - Removal of clause 12
- Amendment LL
  - Approval to develop Primrose North Area 4

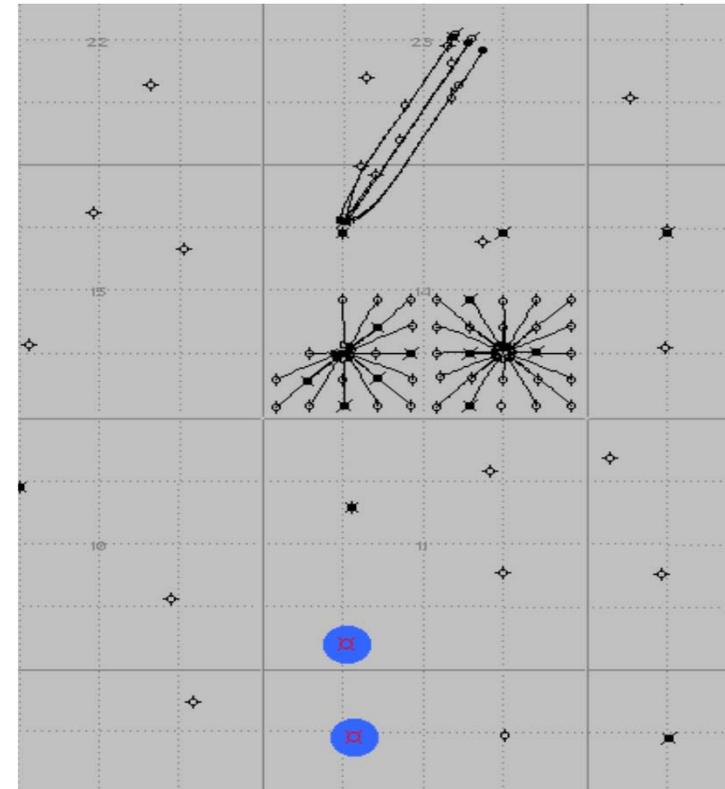
# Approval 9108A – Wolf Lake Water Storage Amended October 2015

- 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



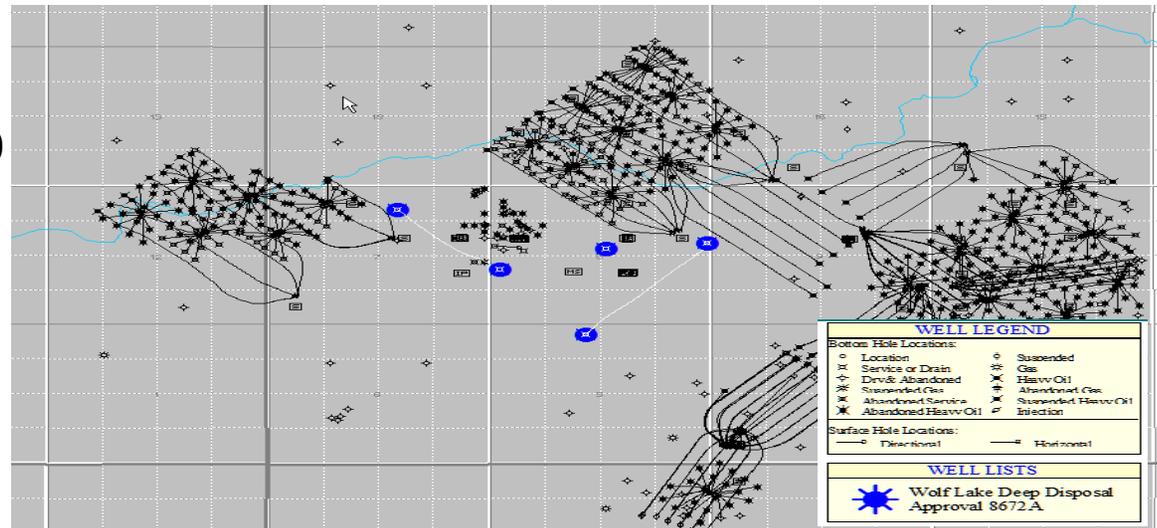
# Approval 8186A – Burnt Lake Water Disposal Approved February 1999

- 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
- No disposal water is now recovered and re-used



# 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)
- 2016 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



- Disposal wells under Approval 8672E:
  - WDW#1 - 100/09-08-066-05W4/0
  - WDW#2 - 100/10-08-066-05W4/0
  - WDW#4 - 100/05-08-066-05W4/0
  - WDW#5 - 100/15-07-066-05W4/0
  - WDW#9 - 100/14-05-066-05W4/0
  - WDW#11 - 100/07-08-066-05W4/0
  - WDW#14 - 102/06-09-066-05W4/0

## Approval 8673A – Cavern Disposal Approved October 2000

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- Approval Compliance Requirements
  - Monitoring Maximum Injection Pressures
    - Did not exceed maximum allowable injection pressure
  - Annual Report
    - 2018 Report will be prepared following annual cavern sounding
- Salt Cavern 1 – 118/12-8-66-5W4
  - Cavern volume (as of April 2017 sounding) 178,160 m<sup>3</sup>
  - Wash water 271,915 m<sup>3</sup>
    - Cavern wash water is sent to disposal wells
  - Oily waste (bitumen) 8,000 m<sup>3</sup>
  - Solid waste 21,753 m<sup>3</sup>
  - Next Cavern sounding expected in April 2018

## Approval 8673A – Cavern Disposal Approved October 2000

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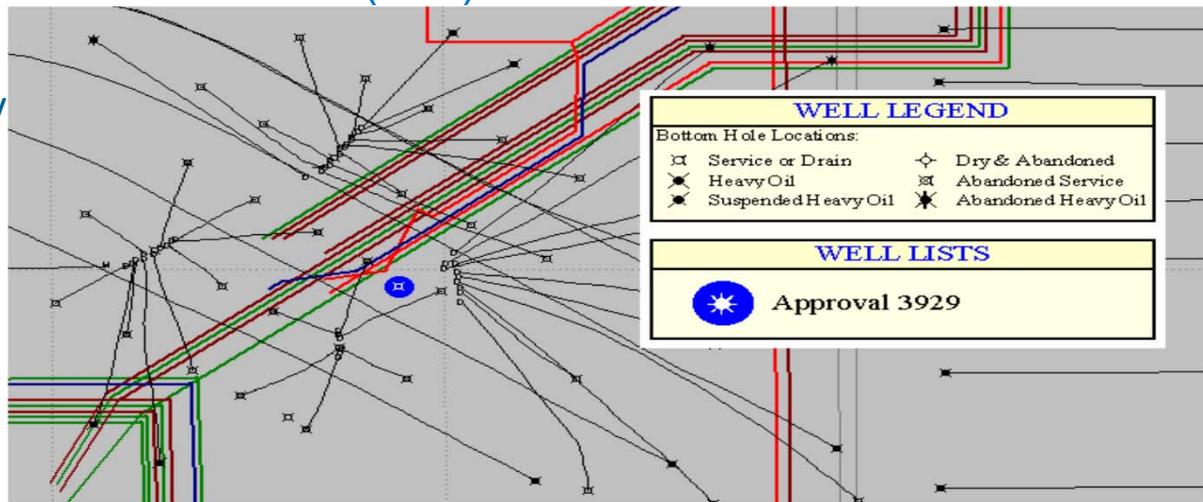
- Approval Compliance Requirements
  - Cavern #2 was approved for disposal in June 2016
  - Monitoring Maximum Injection Pressures
    - Did not exceed maximum allowable injection pressure
  - Annual Report
    - 2018 Report will be prepared following annual cavern sounding
- Salt Cavern 2 - 119/12-8-66-5W4
  - Cavern volume (as of April 2017 sounding) 68,790 m<sup>3</sup>
  - Wash water 364,701 m<sup>3</sup>
    - Cavern wash water is sent to disposal wells
  - Next Cavern sounding expected in April 2018

## 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 currently  
suspended



# Additional Disposal Approvals

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- 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

## Lime Sludge Pond Leakage

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- There are two lime sludge ponds at the Wolf Lake CPF
  - Ponds are emptied and excavated on a rotating annual basis.
- Weeping tile is installed that leads to a sump that is pumped back to the ponds.
- Groundwater wells surrounding the ponds are monitored twice per year.
- Leakage rate calculated and monitored
  - Approved action leakage trigger rate of 75 m<sup>3</sup>/day
  - The maximum and average calculated leakage rate is submitted to the AER in the Annual Wastewater and Runoff Summary Report
    - 2016 maximum value was 12.2 m<sup>3</sup>/d and the average was 2.6 m<sup>3</sup>/d

# Compliance Disclosures

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- Reportable spills
  - 5 reportable spills were reported during 2017 including;
    - 2 produced water
    - 1 boiler feed water
    - 2 emulsion
- Digital Data Submissions (DDS)
  - Notifications/Submissions were entered into the DDS as per Directives in 2017.
- Dam Safety Act
  - Wolf Lake Lime Sludge Ponds A /B and Primrose East E Pond were self disclosed as dams, the first construction and dam safety reports were completed in 2017.

# Compliance Disclosures

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- Voluntary Self Disclosures
  - February 2017:
    - Approval 9140 and 8672 – Submission of VSD in regards to well head injection pressure exceedance (Disposal approval 8672) and bottom hole injection pressure exceedance (Scheme Approval and formation expansion exceedance (Scheme Approval 9140)

## Future Plans

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- Wolf Lake Produced Water Debottlenecking
  - Phase 4 in the scoping stages for 2018 execution
- Wolf Lake Acid Job Handling Improvements
  - Improvements to slop oil and rag layer treatment
  - Improvements to skim oil handling
- Wolf Lake Disposal Improvements
- Primrose East Heat Exchanger Installation
- Burnt Lake Upgrades
- PSP OTSG Controls Upgrades
- PSP DCS Upgrades
- Integrity pipeline pigging
- Pad Add construction to start in 2018

# Future Plans

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- Various small sustaining capital projects
  - To replace aging infrastructure and equipment
  - To reduce operating costs
  - To improve environmental performance



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