



**C16OU (Location ID – 334416)**

**SVE Background Information**

Document Date – 1/13/2014

**REPORT OF WORK COMPLETED**

On March 12, 2013, LT Environmental Inc. (LTE) advanced eight soil borings to depths ranging from 15 to 25 feet (ft) below ground surface (bgs) to assess and remediate a cuttings vault. LTE contracted Site Services Drilling Company of Golden, Colorado, to install the soil borings using hollow stem augers for the installation of passive soil vapor extraction (SVE) wells. On March 13 and 14, 2013, seven of the soil boring were over-drilled using hollow stem auger and converting the borings into SVE wells for the purpose of in-situ remediation

Vent turbines were secured to the top of each passive SVE well in order to promote bioremediation of identified hydrocarbon impacts. Residual TPH concentrations ranged from 780 milligrams per kilogram (mg/kg) to 2,000 mg/kg. LTE collected Observation and Monitoring (O&M) data on a monthly basis beginning May 2013. O&M activities were postponed after the November 2013 site visit due to winter conditions.

EDGE OF WORKING SURFACE

WELLHEADS

ACCESS ROAD

SEPARATOR

TANK BATTERY

SVEN03

SVEN02

SVEW02

SVEW01

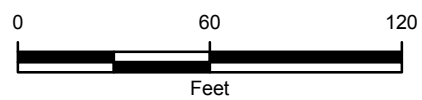
SVEE02

SVEE01

SVEE03

**LEGEND**

□ SOIL VAPOR EXTRACTION WELL



SITE DIAGRAM  
C160U  
MESA COUNTY, COLORADO

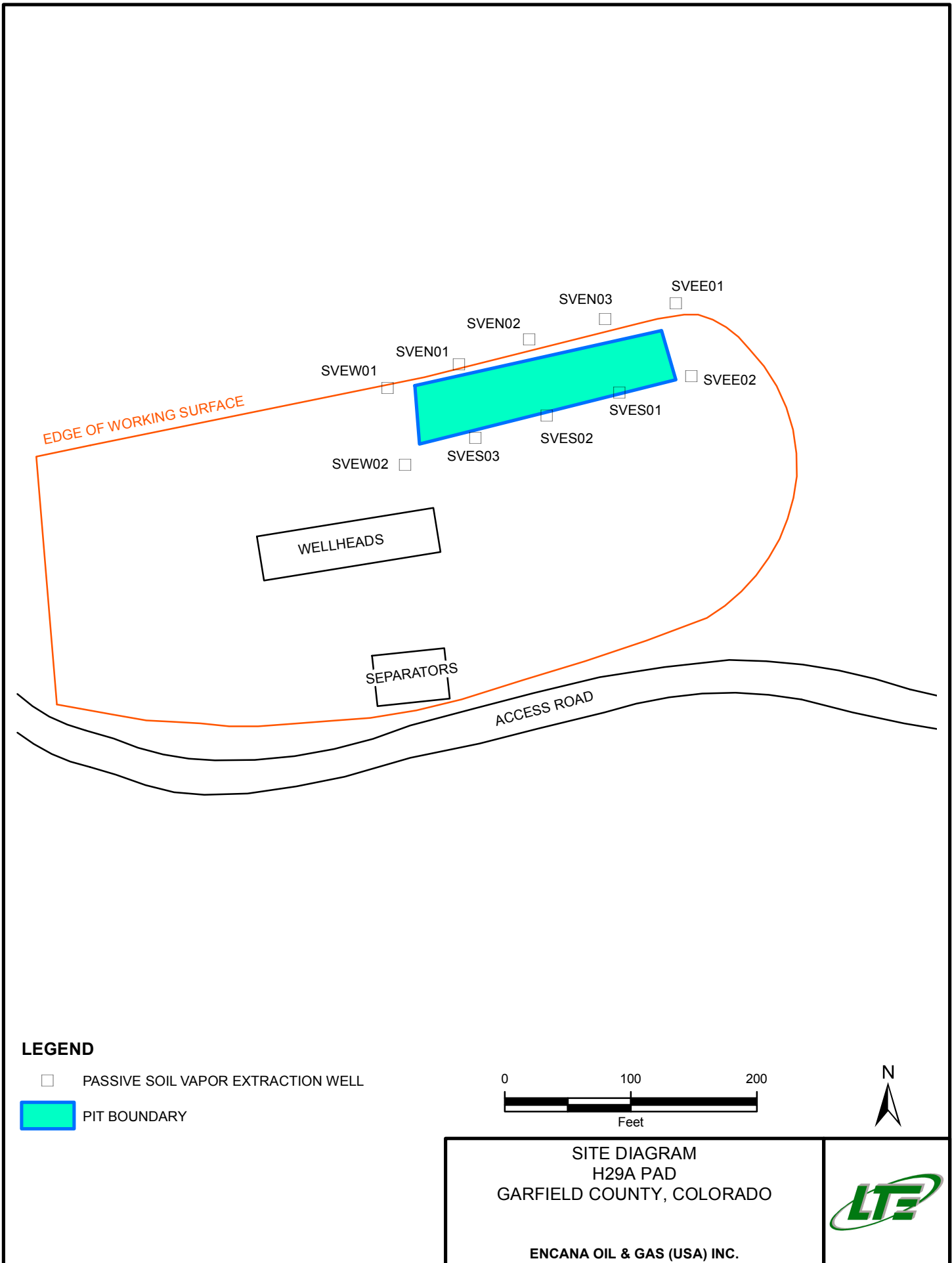
ENCANA OIL & GAS USA INC.



**Encana C16OU Pad**  
**Passive Soil Vapor Extraction Well Data**  
**Remediation Trending and Observations**

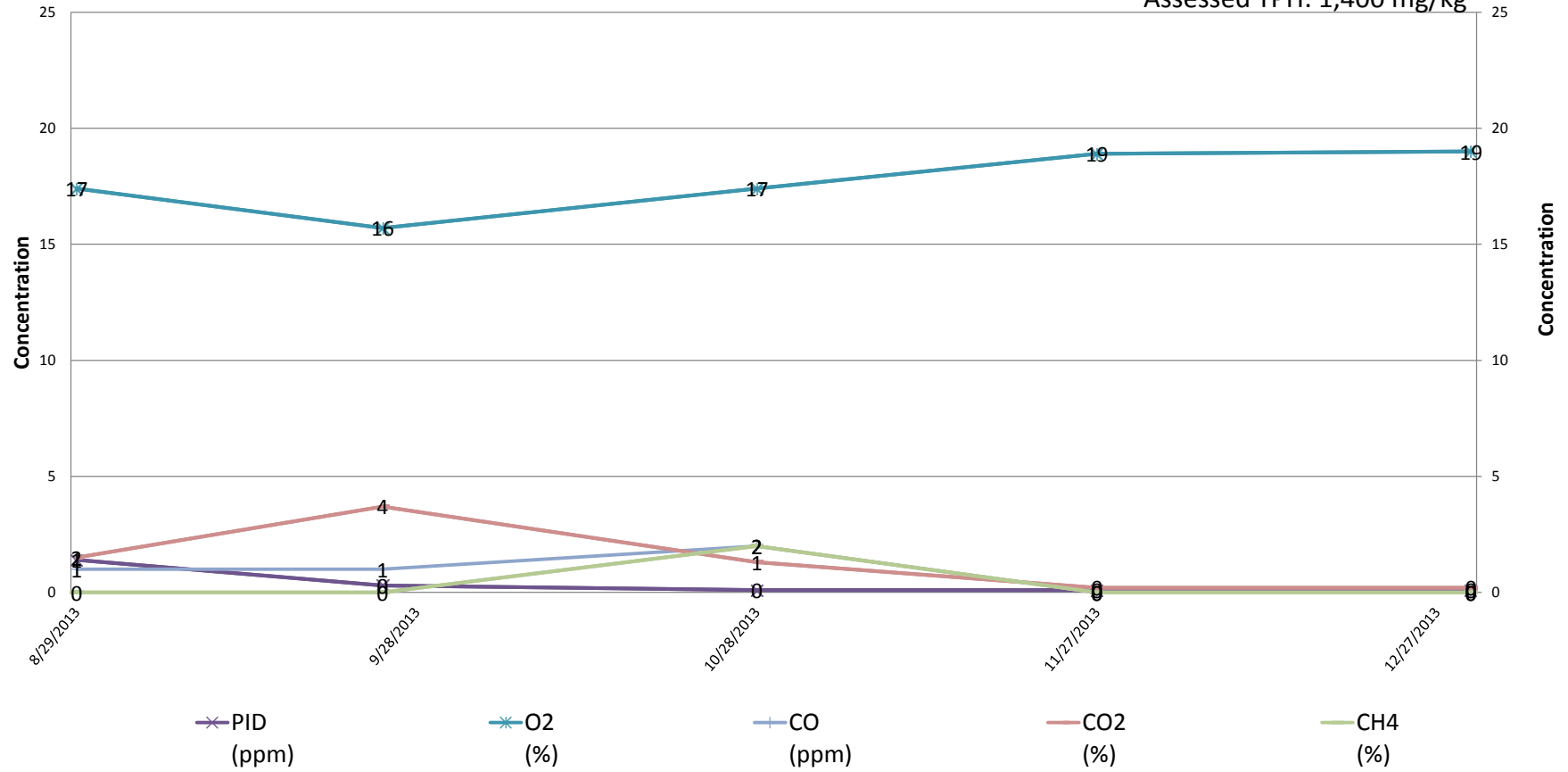
Subsurface soil contains a microbial population that “feeds” off organic material such as hydrocarbons. Soil vapor extraction (SVE) wells are installed to enhance and observe subsurface bio-parameters. Bio-parameters are indicators which are monitored to evaluate the subsurface environment that has been established and how active the microbial bacteria are at degrading residual organic material and hydrocarbons through the process of bio-degradation. The bio-parameters monitored for the purposes of evaluation are: oxygen, carbon dioxide, carbon monoxide, and methane. Ambient oxygen levels should be around 20.946%; however a decrease in this percentage indicates a displacement of oxygen due to another off-gas such as methane, carbon dioxide and carbon monoxide. Carbon dioxide is a direct byproduct of the microbial degradation of hydrocarbons. Carbon monoxide is generally associated with the combustion of hydrocarbons but can act as a pollutant in air and displace oxygen levels. Methane is a direct byproduct of the microbial degradation of organic material such as cellulose, fecal matter and plant fiber. In addition, a photo ionization detector (PID) was utilized to monitor gasoline range hydrocarbons and decreases over time. The following trends and observations can be made from the attached bio-parameter monitoring data:

- Data being evaluated was collected from 5/29/2013 through 11/26/2013.
- PID readings have been observed in all SVE wells and have ranged from 0.0 to 18.7 ppm.
- PID concentrations have decreased over time.
- Oxygen levels have been observed in all SVE wells ranging from 8.0 to 20.9%.
- All SVE wells show oxygen concentrations are generally high and/or increasing over time.
- Carbon dioxide concentrations appear moderate and decrease over time.
- Carbon monoxide concentrations appear minor or insignificant in all wells.
- Methane concentrations appear moderate and decrease over time in SVEW02 and SVEE01, but are non-existent in all other wells.
- The subsurface environment appears to be fairly active microbially.
- Winter months have reflected a drop in activity which is expected to rebound this Spring.
- Additional bio-parameter monitoring through this Spring should be conducted to observe the rebound in microbial activity and verify if hydrocarbon degradation continues to occur.
- Soil confirmation borings could be conducted this Summer if certain significant bio parameters stabilize.



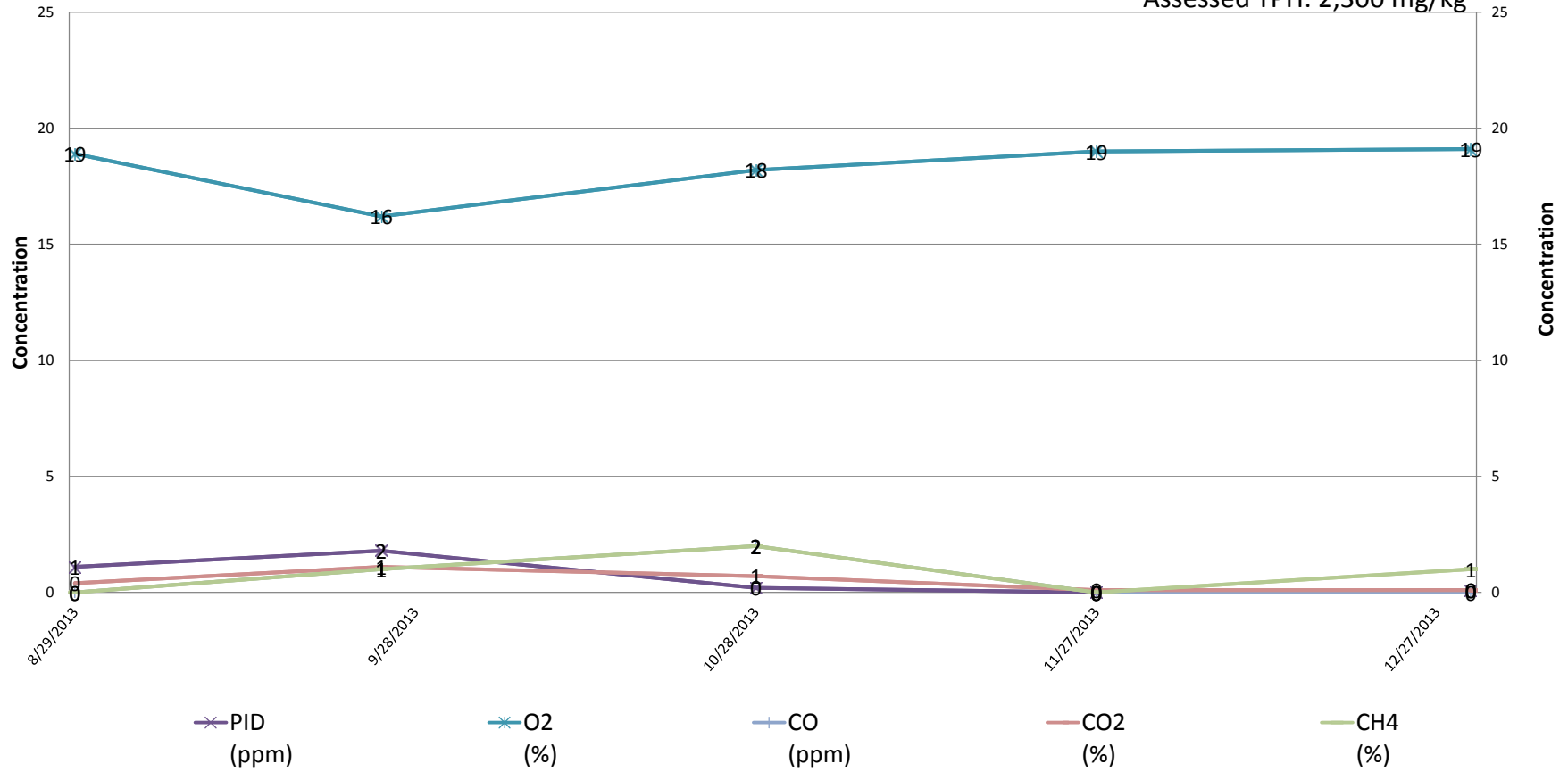
# Encana - H29A Pad - SVEE01

Assessed TPH: 1,400 mg/kg



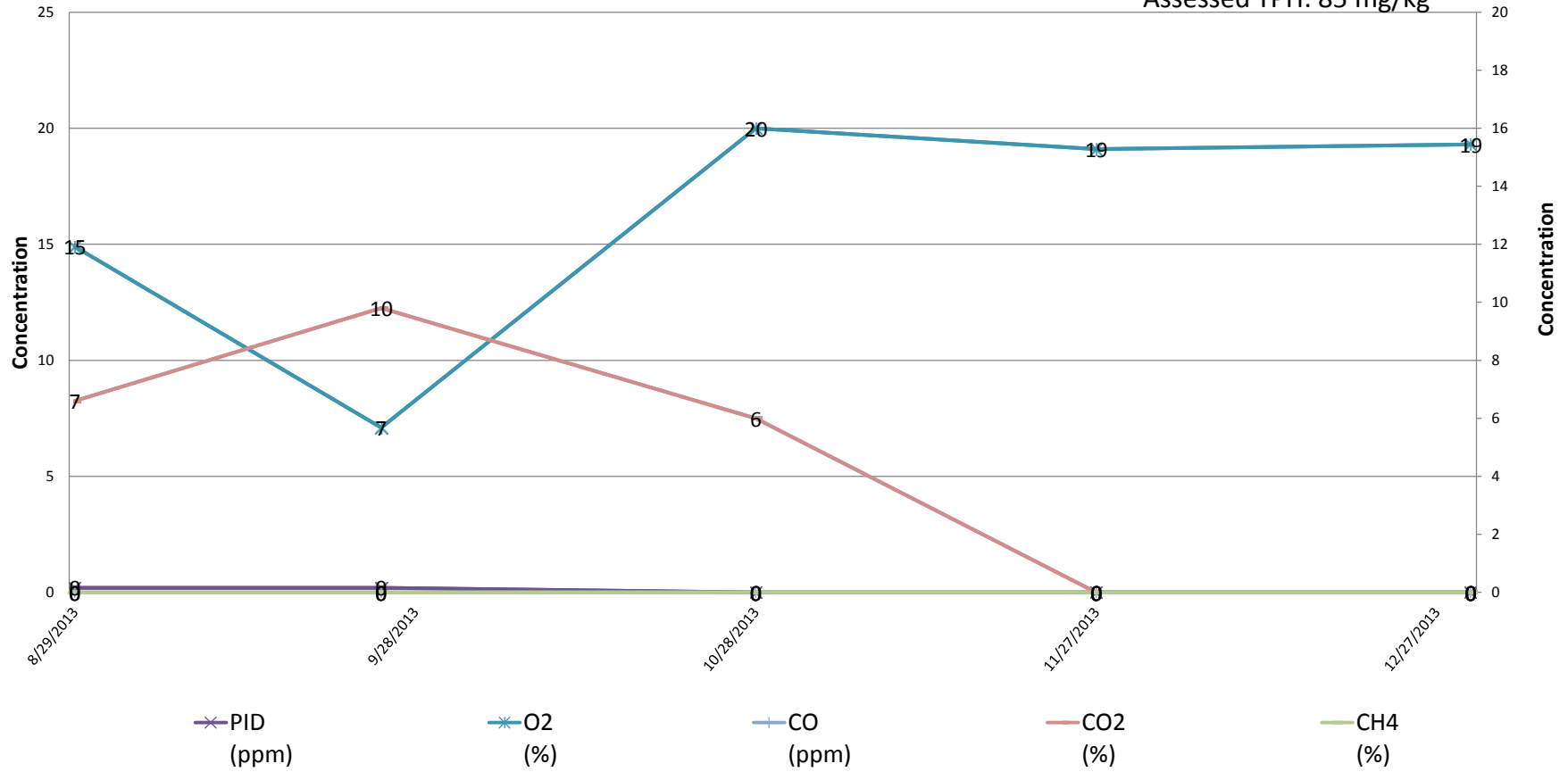
# Encana - H29A Pad - SVEE02

Assessed TPH: 2,300 mg/kg



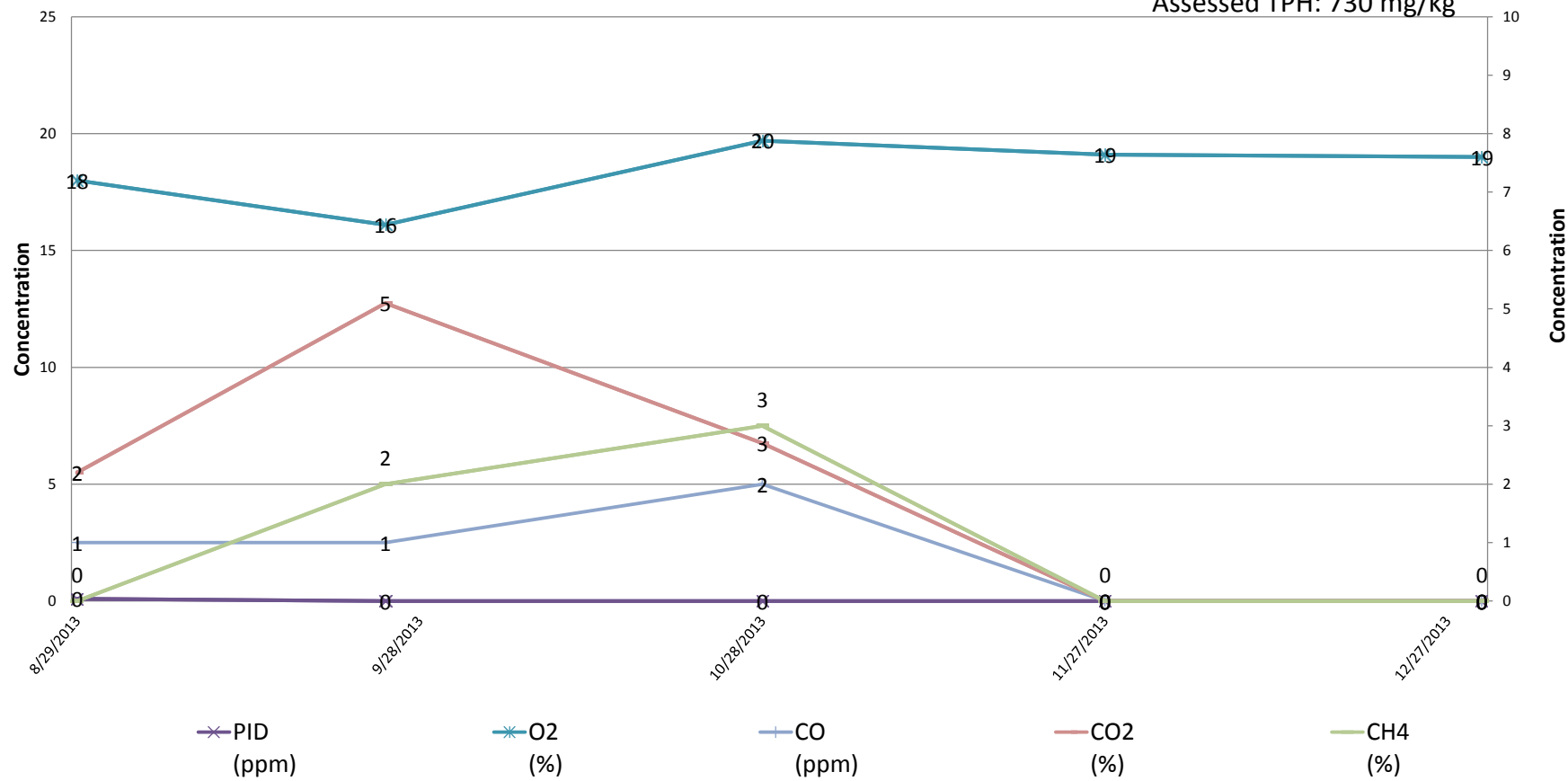
# Encana - H29A Pad - SVEN01

Assessed TPH: 85 mg/kg



# Encana - H29A Pad - SVEN02

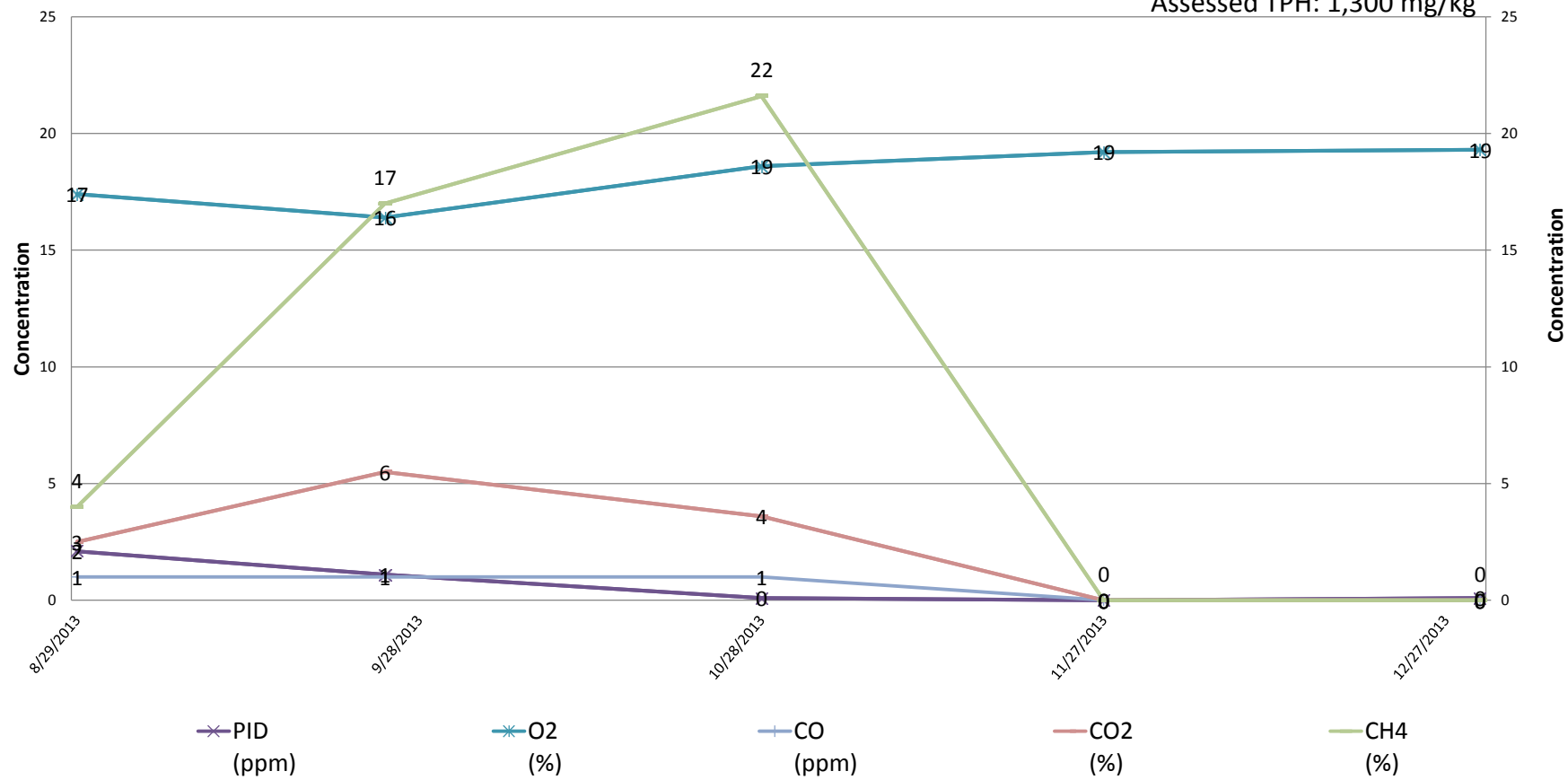
Assessed TPH: 730 mg/kg





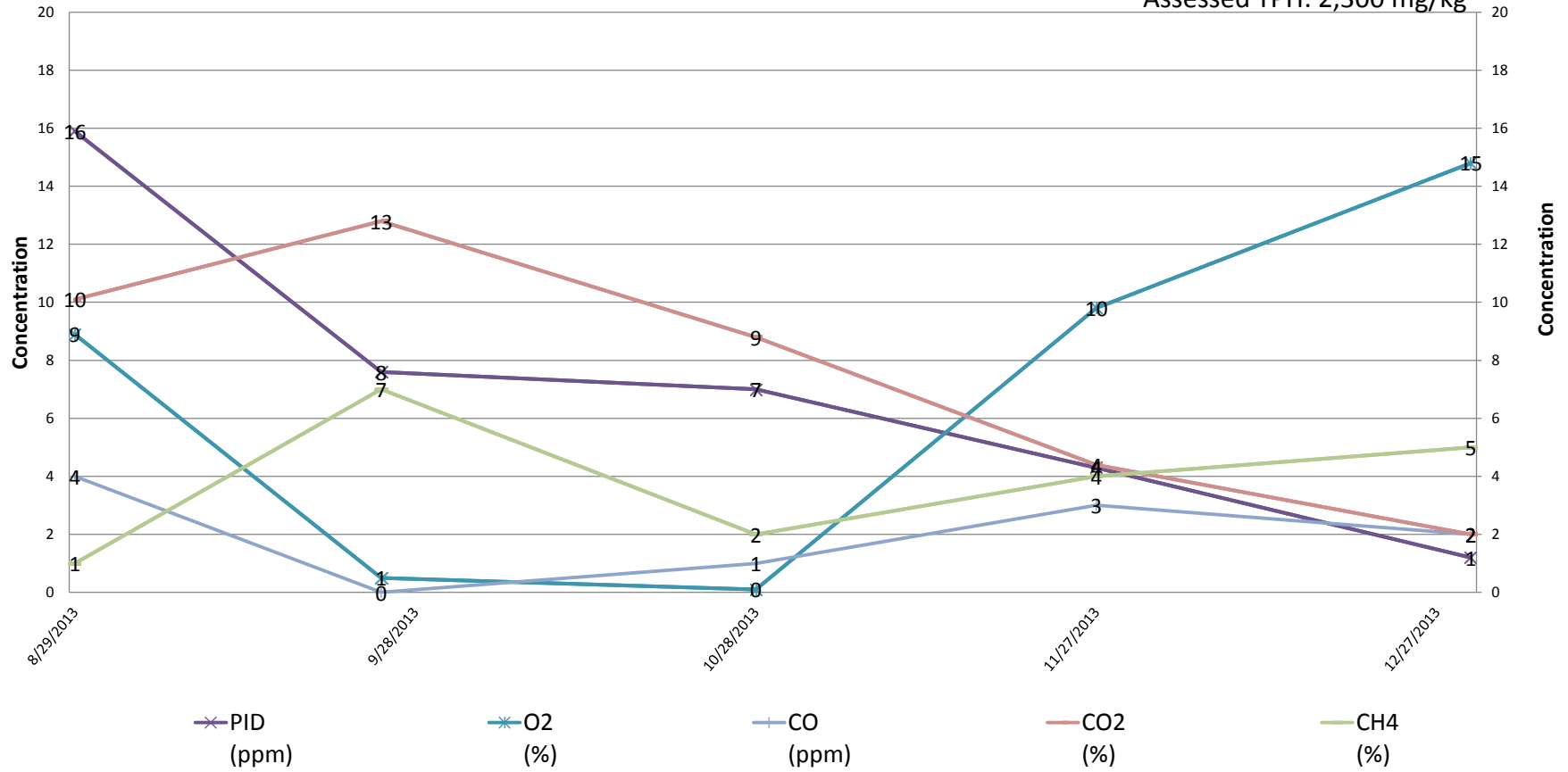
### Encana - H29A Pad - SVEN03

Assessed TPH: 1,300 mg/kg



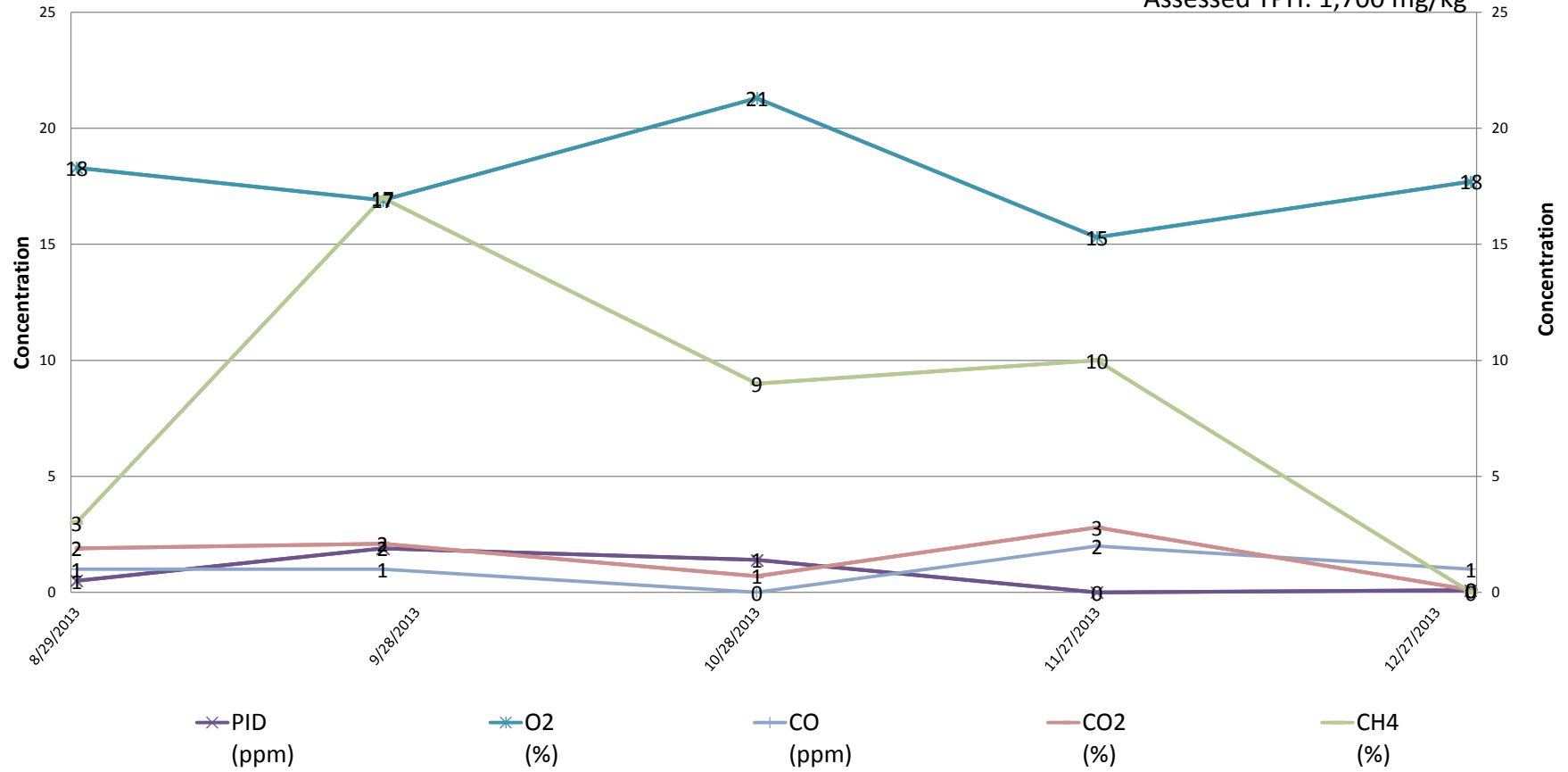
# Encana - H29A Pad - SVES01

Assessed TPH: 2,300 mg/kg



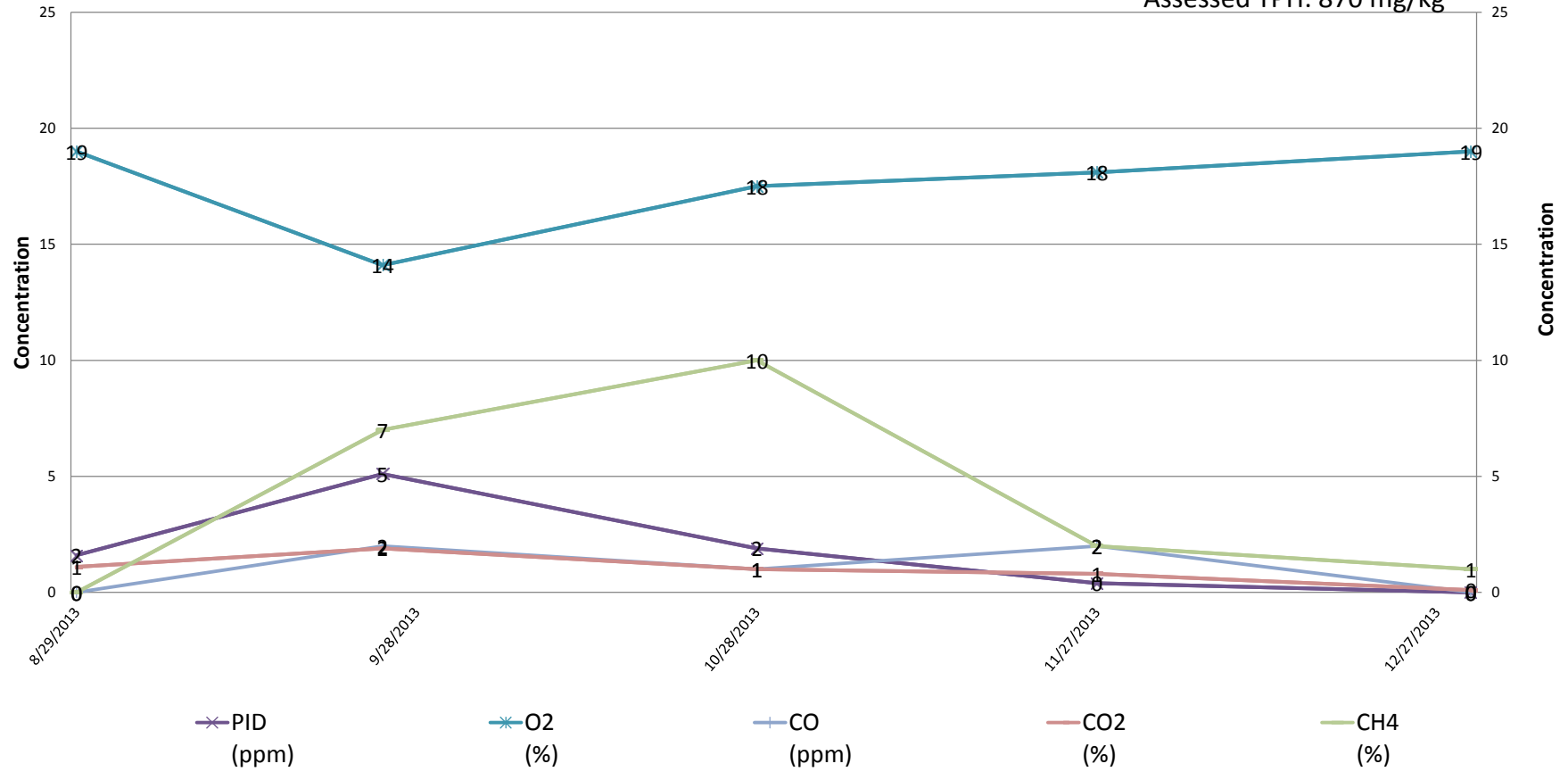
# Encana - H29A Pad - SVES02

Assessed TPH: 1,700 mg/kg



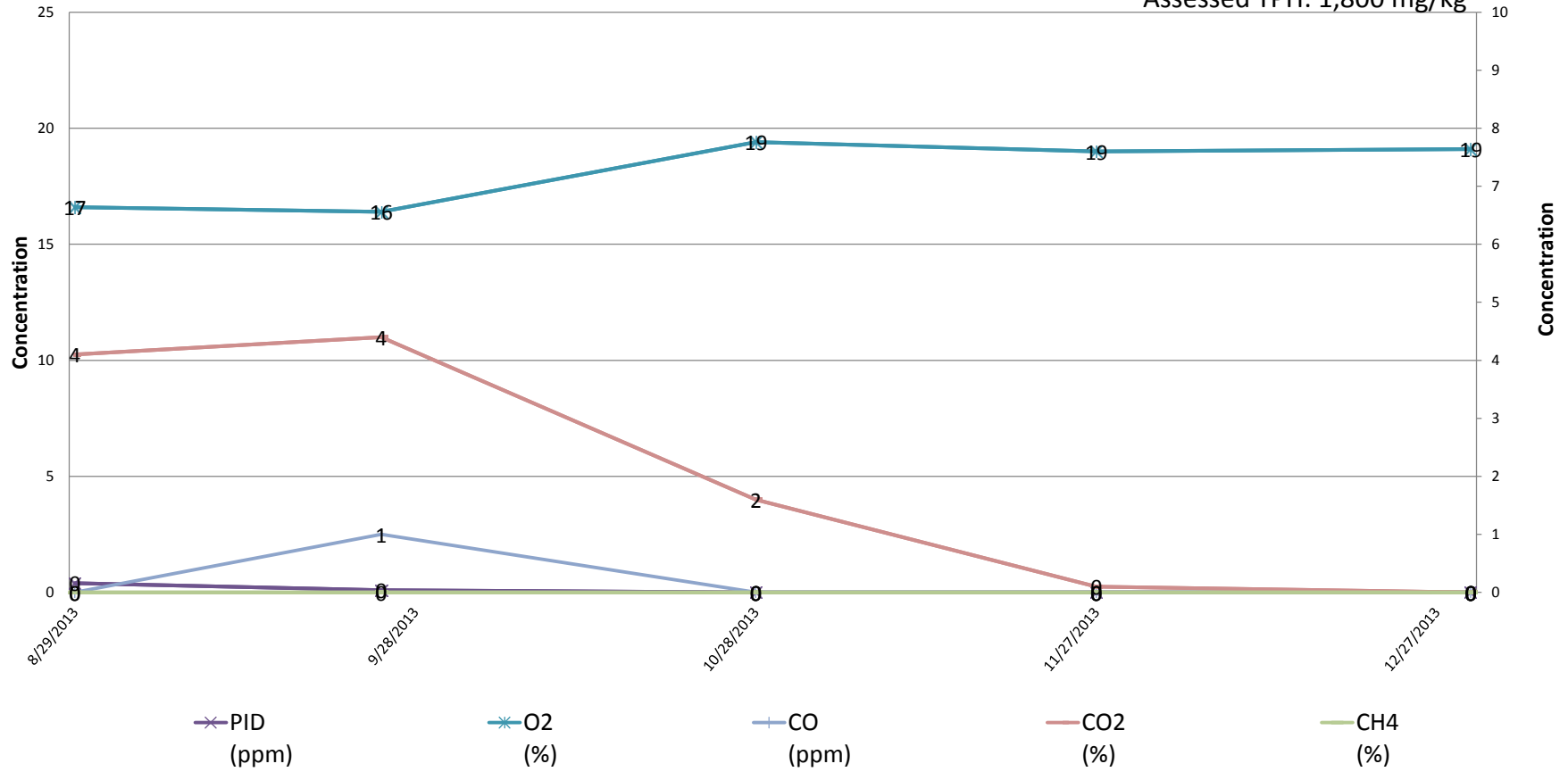
# Encana - H29A Pad - SVES03

Assessed TPH: 870 mg/kg



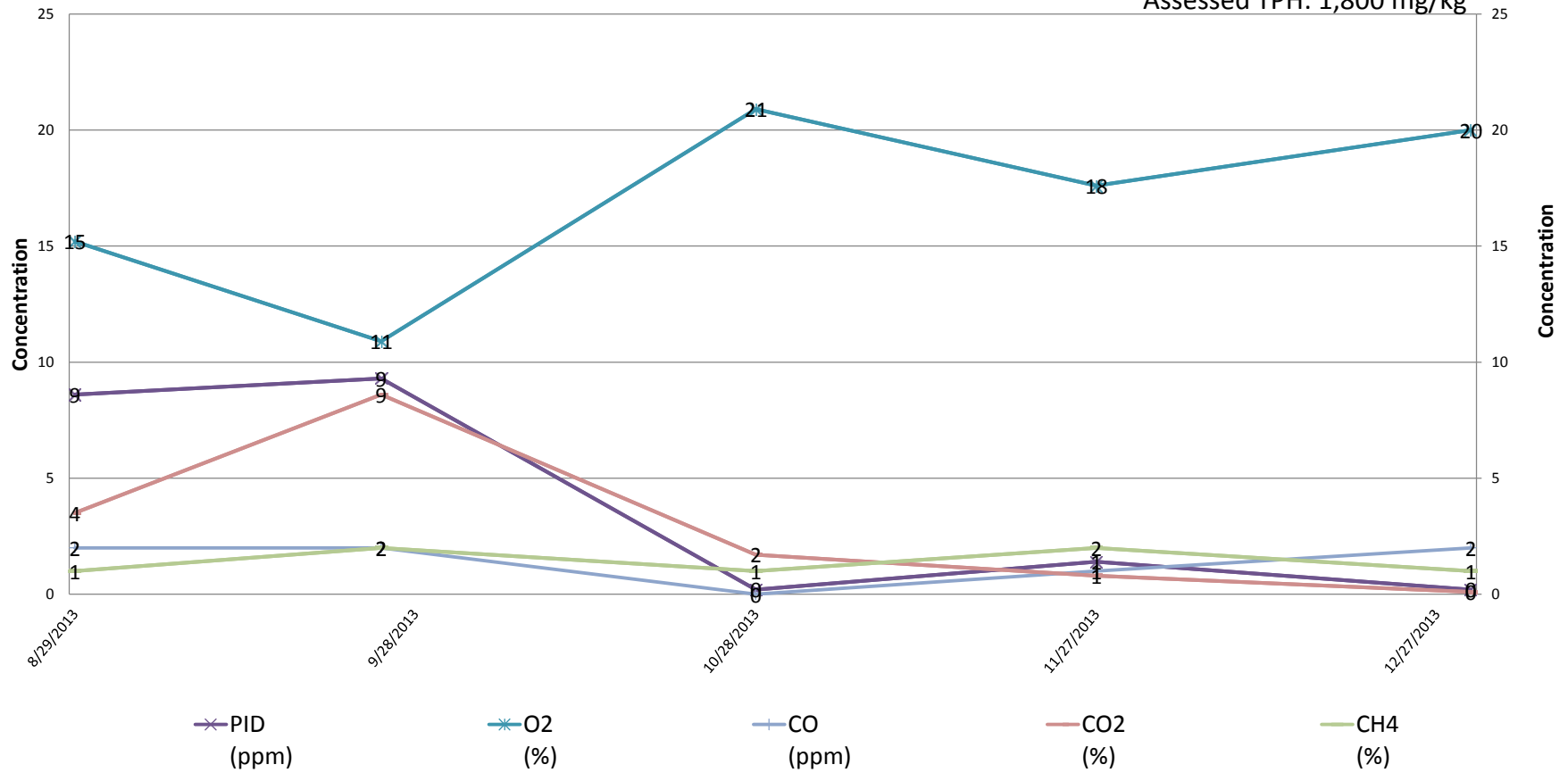
# Encana - H29A Pad - SVEW01

Assessed TPH: 1,800 mg/kg



# Encana - H29A Pad - SVEW02

Assessed TPH: 1,800 mg/kg



**Table 1**  
**Operation and Maintenance Field Parameters**  
**C16OU Well Pad**  
**Encana Oil & Gas (USA) Inc.**  
**Garfield County, Colorado**

Well ID	Date	Velocity (fpm)	Flow (cfm)	Temperature (°F)	PID (ppm)	O <sub>2</sub> (%)	H <sub>2</sub> S (ppm)	CO (ppm)	CO <sub>2</sub> (%)	CH <sub>4</sub> (%)	*TPH mg/kg
SVEN03	5/29/2013	3	0.525	74.3	11.5	16.4	0	3	2.1	0	2,000
	6/25/2013	30	1.11	114.2	4.7	13.5	0	3	7.9	0	
	7/31/2013	26	0.862	111	12.4	8	0	3	>20.0	0	
	8/26/2013	37	0.371	88.5	4.6	11.7	0	1	18.3	0	
	9/23/2013	2	0.0218	79.2	0	20	0	0	0	0	
	10/31/2013	1	0.0218	55.8	0.2	18.6	0	0	0.2	0	
	11/26/2013	15	0.153	60.8	0.1	17.9	0	2	1.5	0	
SVEN02	5/29/2013	35	0.0436	72.2	2.1	20.3	0	0	0.3	0	1,400
	6/25/2013	7	0.371	107.5	1.3	20.5	0	0	0.2	0	
	7/31/2013	55	1.106	108.5	7.8	18.9	0	3	2	0	
	8/26/2013	26	0.655	86.3	0.4	20.3	0	0	0.5	0	
	9/23/2013	27	0.415	75.1	0	20.3	0	0	0	0	
	10/31/2013	2	0.0436	52.3	0.1	19.3	0	0	0	0	
	11/26/2013	19	0.175	60.1	0	19.6	0	0	0	0	
SVEW02	5/29/2013	10	1.57	73.2	18.7	18.8	0	2	1.1	0	1,300
	6/25/2013	25	0.525	105.5	4.9	20.3	0	0	0	0	
	7/31/2013	30	0.805	106.9	6.7	13.1	0	5	15.7	21	
	8/26/2013	10	0.305	88.2	3.9	18.6	0	1	2.8	0	
	9/23/2013	32	0.535	70.2	0	20.1	0	0	0	0	
	10/31/2013	6	0.0875	50.2	0.3	19.3	0	0	0.1	0	
	11/26/2013	5	0.0875	61.2	0.4	19	0	2	0.5	0	
SVEW01	5/29/2013	35	1.25	70	0.9	20.9	0	0	0	0	1,500
	6/25/2013	22	0.0436	104.5	1.6	20.3	0	0	0.6	0	
	7/31/2013	1	0.0218	108.3	0.9	20.3	0	1	0.9	0	
	8/26/2013	21	0.349	86.2	0.1	18.7	0	1	1.5	0	
	9/23/2013	1	0.0218	73.1	0	19.8	0	0	0.3	0	
	10/31/2013	1	0.0436	57.4	0	19.3	0	0	0.3	0	
	11/26/2013	3	0.0436	60.4	0	19.8	0	0	0	0	
SVEE02	5/29/2013	13	0.305	69.9	1.2	20.3	0	0	0.3	0	1,000
	6/25/2013	39	2.73	99.2	1.5	20.6	0	0	0.2	0	
	7/31/2013	0	0	106.6	1.1	20.4	0	0	0.8	0	
	8/26/2013	26	0.566	87.6	1.2	20	0	1	0.8	0	
	9/23/2013	1	0.0218	71	0	20	0	0	0	0	
	10/31/2013	1	0.0218	57.7	0.1	19.3	0	0	0.3	0	
	11/26/2013	6	0.0875	58.3	0	19.7	0	0	0	0	

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**C16OU Well Pad**  
**Encana Oil & Gas (USA) Inc.**  
**Garfield County, Colorado**

Well ID	Date	Velocity (fpm)	Flow (cfm)	Temperature (°F)	PID (ppm)	O <sub>2</sub> (%)	H <sub>2</sub> S (ppm)	CO (ppm)	CO <sub>2</sub> (%)	CH <sub>4</sub> (%)	*TPH mg/kg
SVEE01	5/29/2013	150	3.21	68.3	12.4	13.2	0	2	7.4	0	780
	6/25/2013	44	0.525	104.1	4	17.2	0	1	3.6	0	
	7/31/2013	55	1.21	107.2	9.1	9.5	0	2	>20.0	7	
	8/26/2013	73	1.27	86.4	0.9	17.6	0	1	3.1	0	
	9/23/2013	0	0	70	0	20.1	0	0	0	0	
	10/31/2013	2	0.0436	55.4	0.1	19.5	0	0	0.3	0	
	11/26/2013	37	1.33	57.8	0	18.6	0	3	1.2	0	
SVEE03	5/29/2013	3	0.566	73.5	8.4	20.2	0	3	0.4	0	1,800
	6/25/2013	16	0.83	99.3	3.2	20.3	0	0	0.4	0	
	7/31/2013	10	0.393	107.3	2	20.9	0	0	1	0	
	8/26/2013	30	0.565	86.5	0.1	20.4	0	0	0.1	0	
	9/23/2013	2	0.0418	71.9	0.1	20.3	0	0	0	0	
	10/31/2013	1	0.0218	53.5	0.1	19.4	0	0	0.1	0	
	11/26/2013	9	0.307	62.1	0	19.9	0	0	0	0	

Notes:

fpm - feet per minute

cfm - cubic feet per minute

mg/kg - milligrams per kilogram

TPH - total petroleum hydrocarbons

PID - photoionization detector

ppm - parts per million

O<sub>2</sub> - oxygen

H<sub>2</sub>S - hydrogen sulfide

CO - carbon monoxide

CO<sub>2</sub> - carbon dioxide

CH<sub>4</sub> - methane

°F - degrees fahrenheit

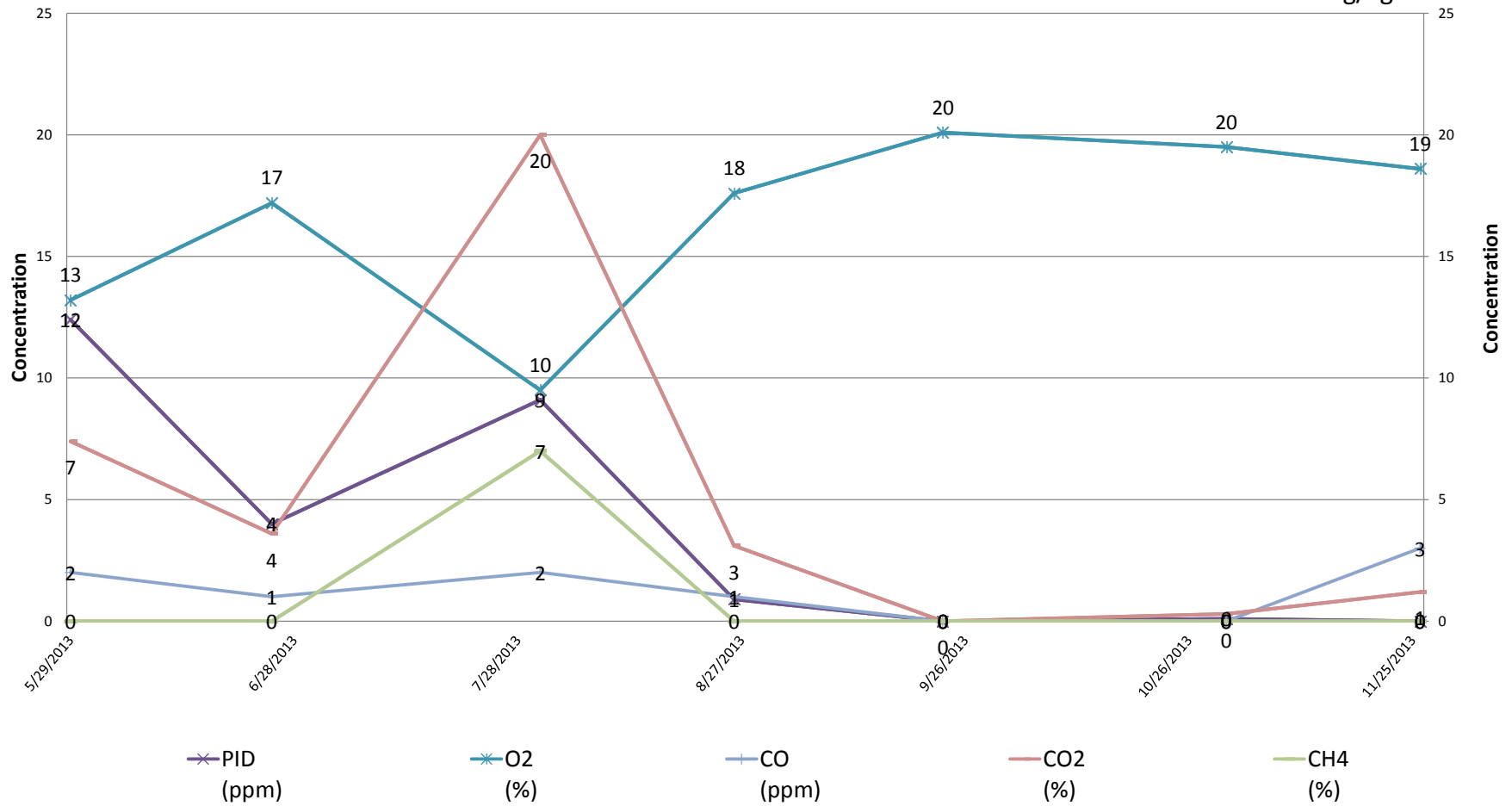
NA - not analyzed

\*TPH values indicate concentrations in soil at time of well installation



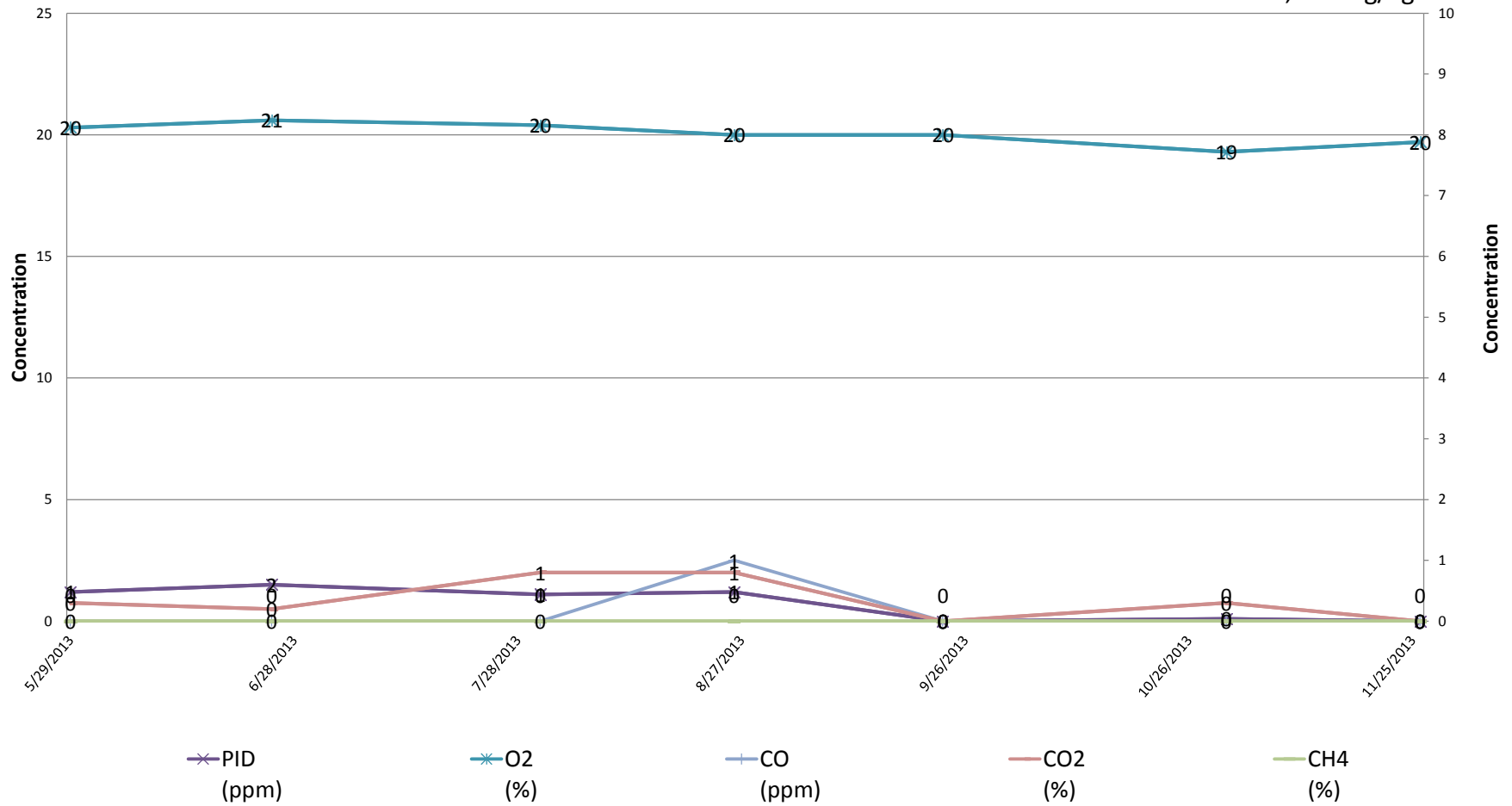
# Encana - C16OU Pad - SVEE01

Assessed TPH: 780 mg/kg



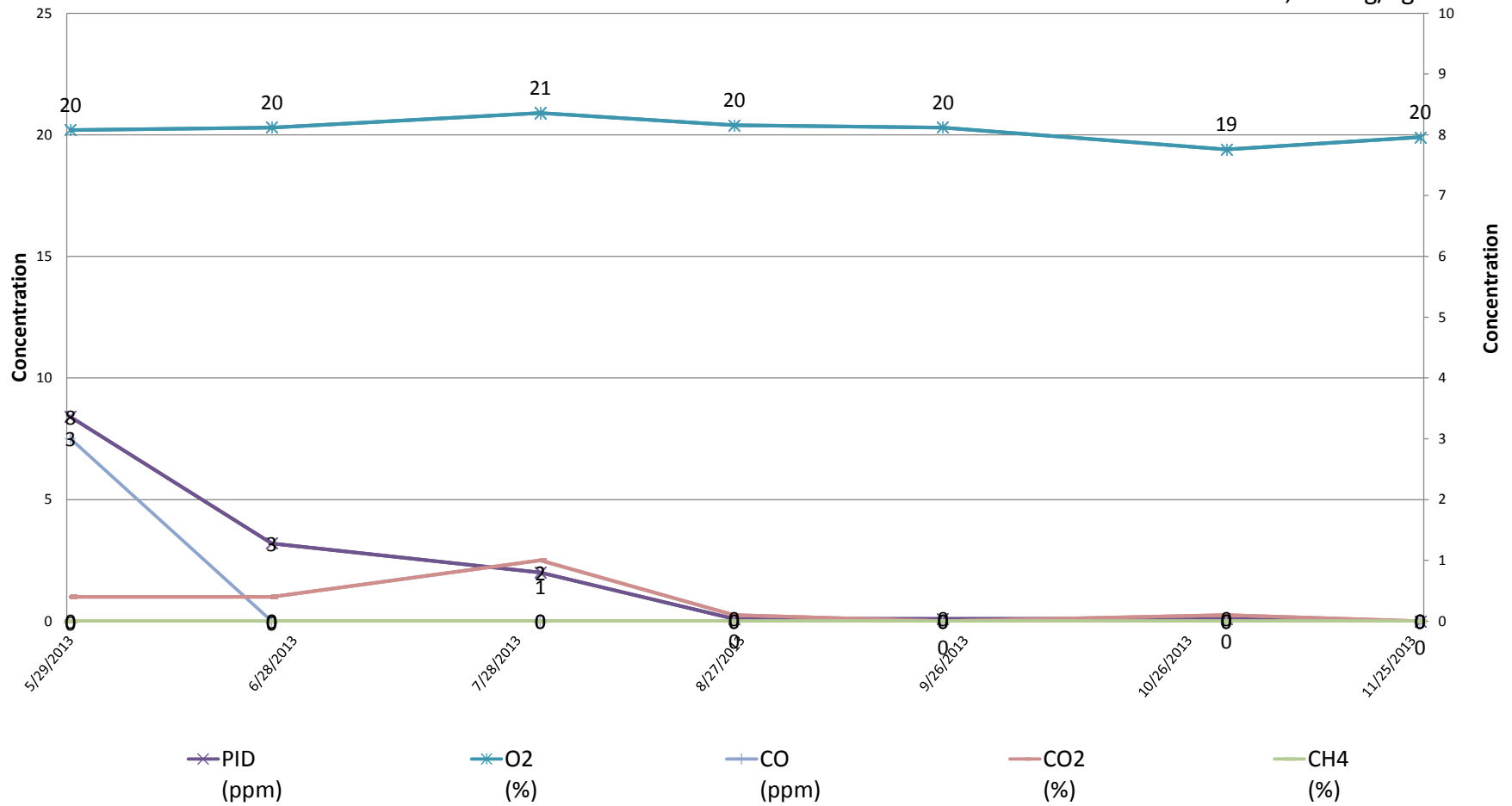
# Encana - C16OU Pad - SVEE02

Assessed TPH: 1,000 mg/kg



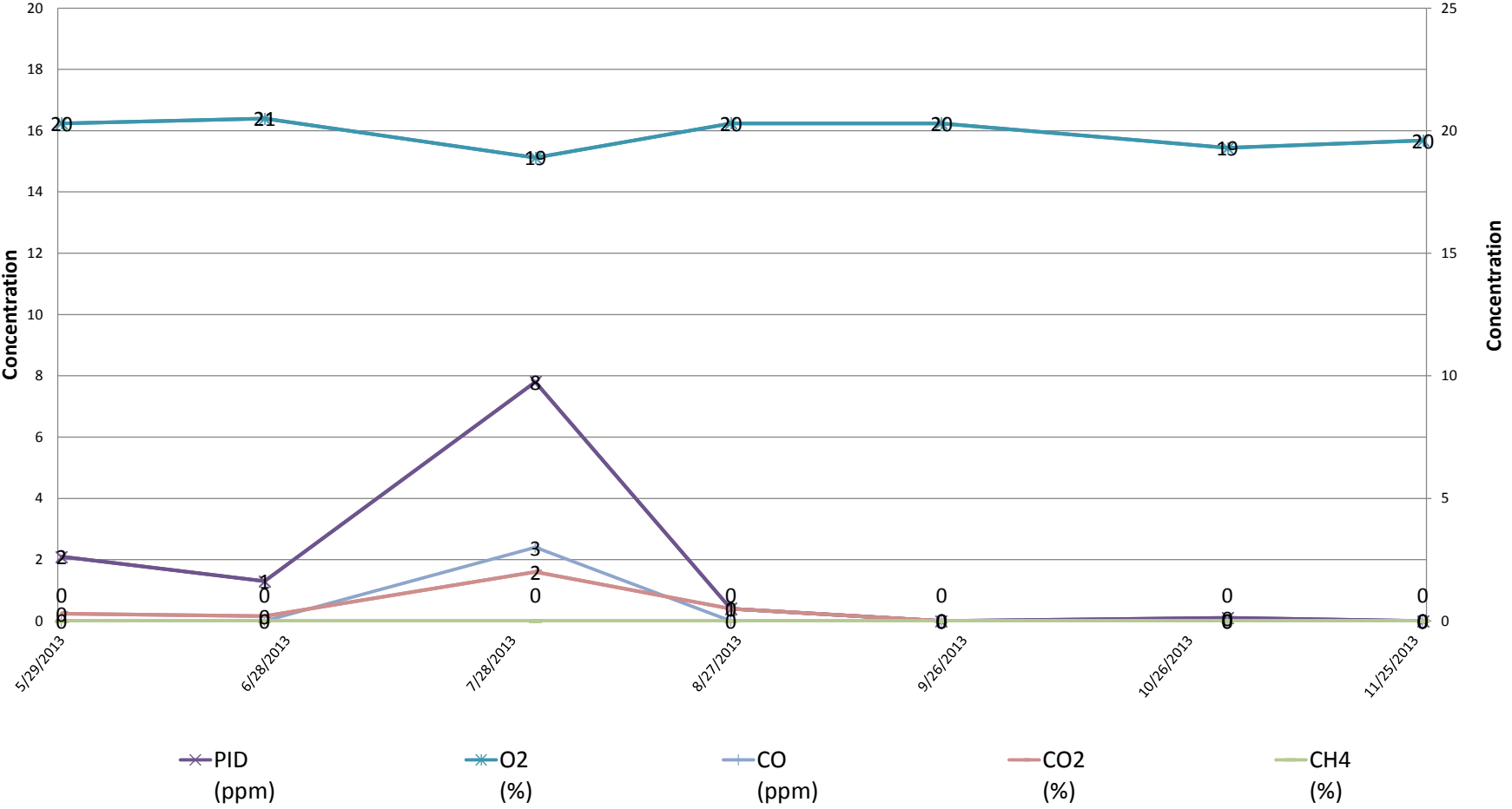
# Encana - C16OU Pad - SVEE03

Assessed TPH: 1,800 mg/kg



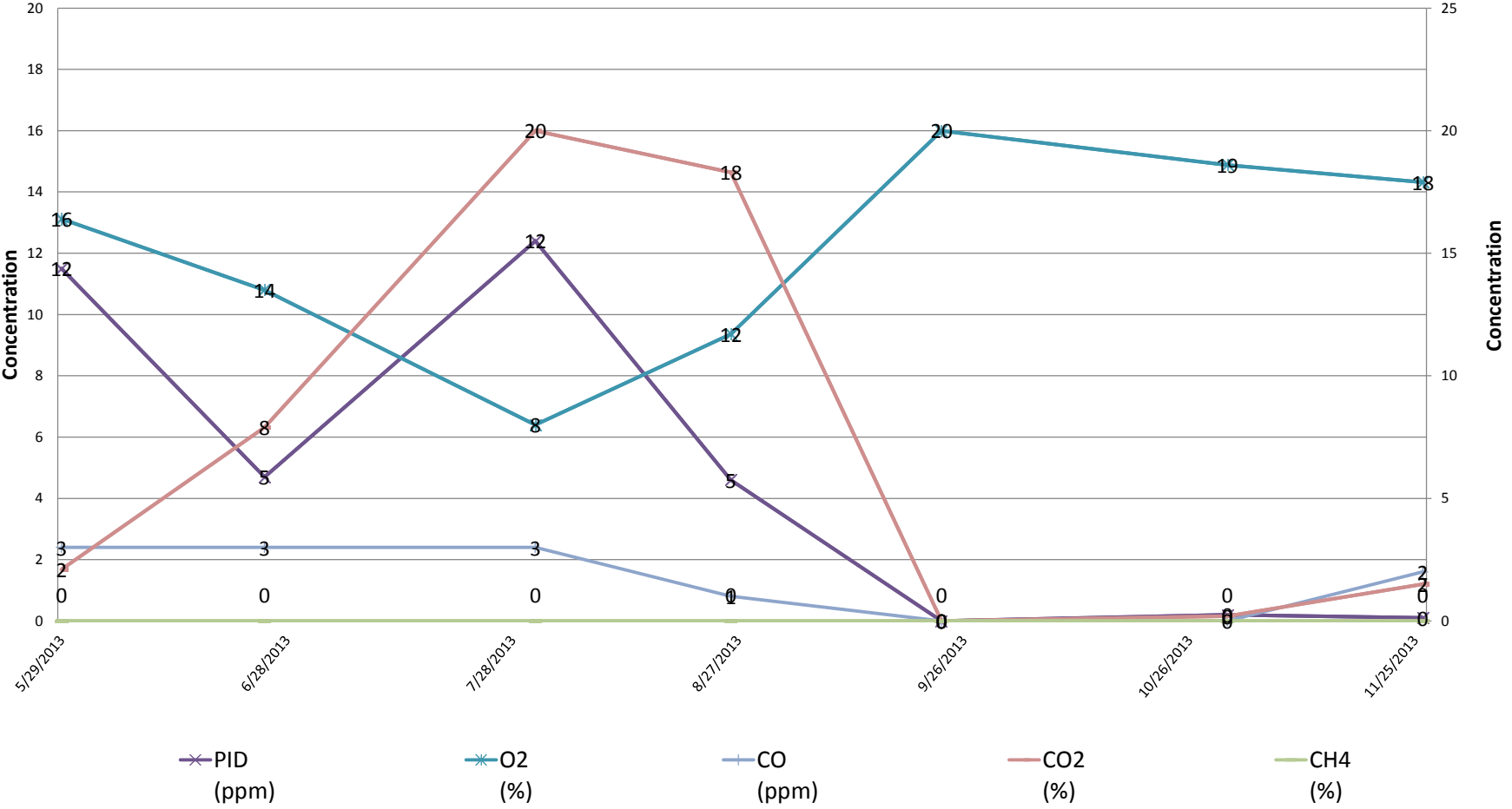
Encana - C16OU Pad - SVEN02

Assessed TPH: 1,400 mg/kg



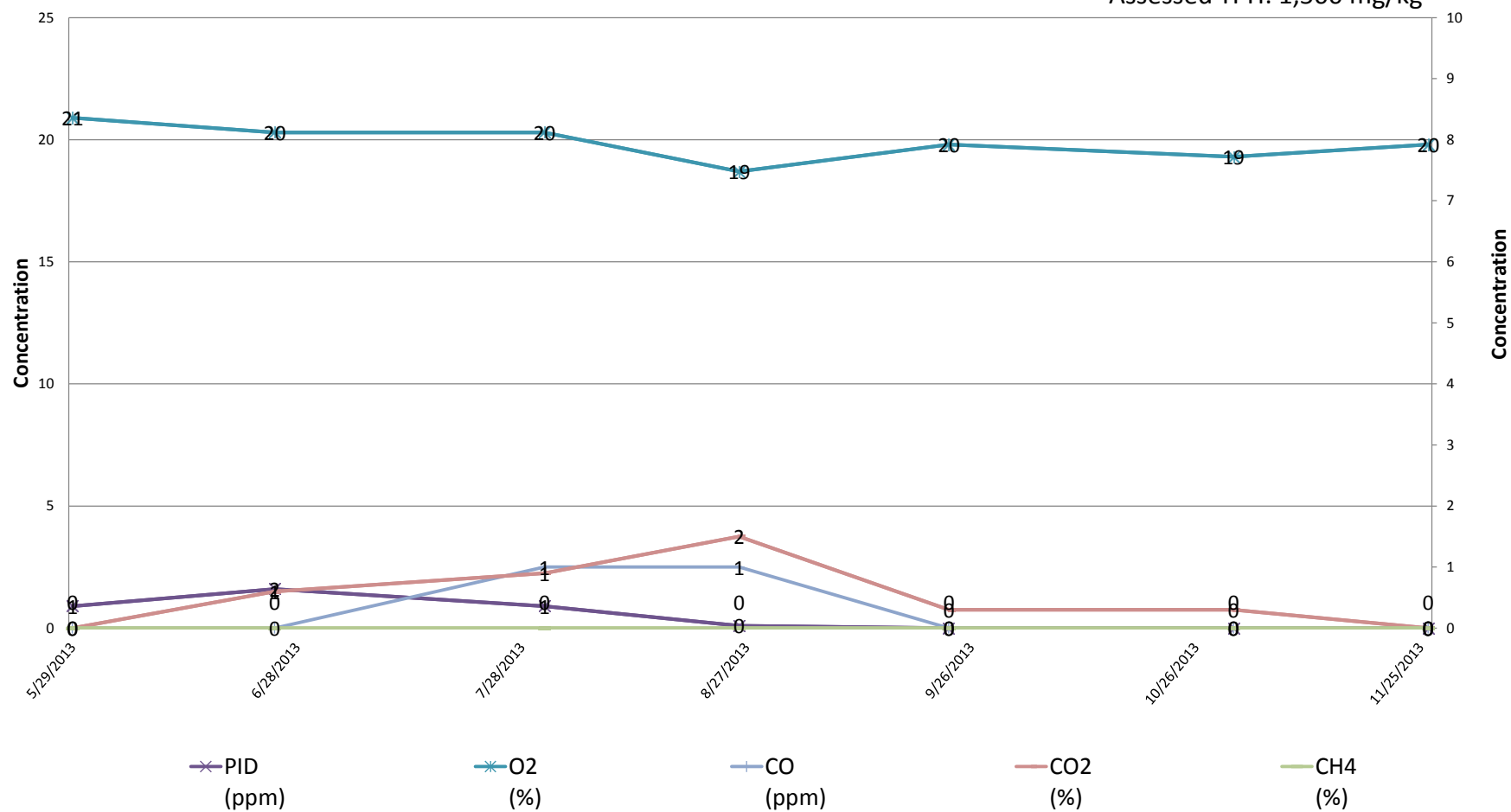
Encana - C16OU Pad - SVEN03

Assessed TPH: 2,000 mg/kg



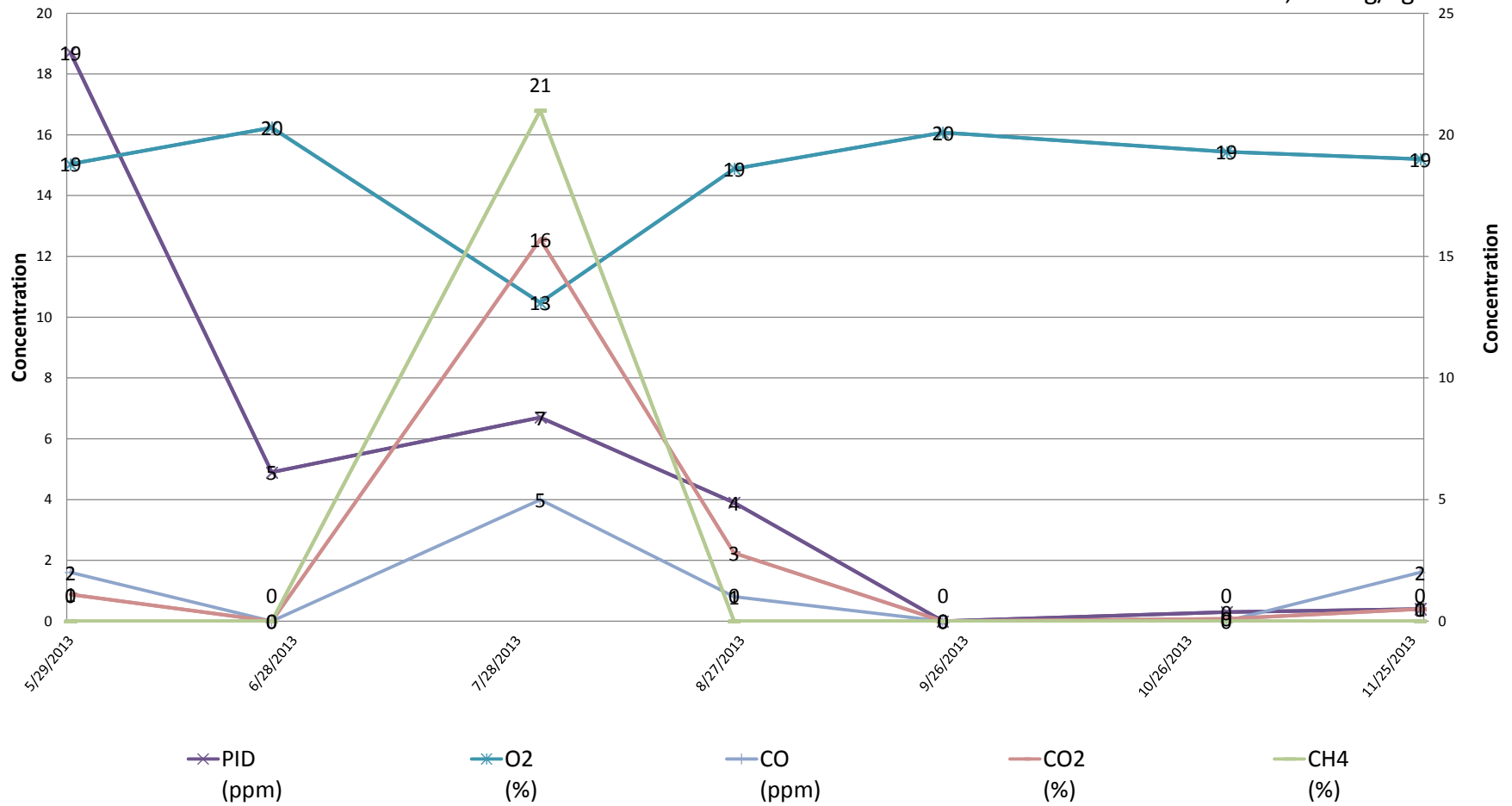
# Encana - C16OU Pad - SVEW01

Assessed TPH: 1,500 mg/kg



# Encana - C16OU Pad - SVEW02

Assessed TPH: 1,300 mg/kg



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**Garfield County, Colorado**

Well ID	Date	Velocity (fpm)	Flow (cfm)	Temperature (°F)	PID (ppm)	O <sub>2</sub> (%)	H <sub>2</sub> S (ppm)	CO (ppm)	CO <sub>2</sub> (%)	CH <sub>4</sub> (%)	*TPH mg/kg
SVEN03	5/29/2013	3	0.525	74.3	11.5	16.4	0	3	2.1	0	2,000
	6/25/2013	30	1.11	114.2	4.7	13.5	0	3	7.9	0	
	7/31/2013	26	0.862	111.0	12.4	8.0	0	3	>20.0	0	
	8/26/2013	37	0.371	88.5	4.6	11.7	0	1	18.3	0	
	9/23/2013	2	0.0218	79.2	0.0	20.0	0	0	0.0	0	
	10/31/2013	1	0.0218	55.8	0.2	18.6	0	0	0.2	0	
	11/26/2013	15	0.153	60.8	0.1	17.9	0	2	1.5	0	
	4/25/2014	76	1.62	82.2	0.7	8.5	0	2	>20.0	0	
	5/30/2014	23	0.525	73.0	0.1	18.3	0	0	0.7	0	
	7/1/2014	28	0.610	104.7	0.0	17.6	0	0	2.3	0	
	8/1/2014	39	0.850	88.6	0.0	15.2	0	3	4.3	0	
	9/4/2014	2	0.0218	87.2	0.0	20.9	0	0	0.0	0	
	10/7/2014	13	0.105	82.3	0.0	18.7	0	1	1.9	0	
SVEN02	5/29/2013	35	0.0436	72.2	2.1	20.3	0	0	0.3	0	1,400
	6/25/2013	7	0.371	107.5	1.3	20.5	0	0	0.2	0	
	7/31/2013	55	1.106	108.5	7.8	18.9	0	3	2	0	
	8/26/2013	26	0.655	86.3	0.4	20.3	0	0	0.5	0	
	9/23/2013	27	0.415	75.1	0.0	20.3	0	0	0.0	0	
	10/31/2013	2	0.0436	52.3	0.1	19.3	0	0	0.0	0	
	11/26/2013	19	0.175	60.1	0.0	19.6	0	0	0.0	0	
	4/25/2014	39	0.635	81.2	0.0	16.3	0	2	4.4	0	
	5/30/2014	27	0.565	71.3	0.0	18.8	0	0	0.1	0	
	7/1/2014	42	1.03	103.2	0.0	20.7	0	0	0.3	0	
	8/1/2014	27	0.500	87.6	0.0	20.9	0	0	0.1	0	
	9/4/2014	1	0.0218	86.8	0.0	20.9	0	0	0.0	0	
	10/7/2014	1	0.0218	81.7	0.0	20.9	0	0	0.6	0	
SVEW02	5/29/2013	10	1.57	73.2	18.7	18.8	0	2	1.1	0	1,300
	6/25/2013	25	0.525	105.5	4.9	20.3	0	0	0	0	
	7/31/2013	30	0.805	106.9	6.7	13.1	0	5	15.7	21	
	8/26/2013	10	0.305	88.2	3.9	18.6	0	1	2.8	0	
	9/23/2013	32	0.535	70.2	0.0	20.1	0	0	0.0	0	
	10/31/2013	6	0.0875	50.2	0.3	19.3	0	0	0.1	0	
	11/26/2013	5	0.0875	61.2	0.4	19.0	0	2	0.5	0	
	4/25/2014	94	1.55	81.0	3.7	8.7	0	1	>20.0	8	
	5/30/2014	41	0.980	71.0	0.0	20.3	0	0	0.0	0	
	7/1/2014	63	1.43	103.9	0.0	15.7	0	0	2.8	0	
	8/1/2014	31	0.700	90.7	0.0	14.2	0	1	1.0	0	
	9/4/2014	3	0.0436	86.8	0.0	20.9	0	0	0.2	0	
	10/7/2014	4	0.0218	83.4	0.3	19.1	0	0	1.3	0	



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**Encana Oil & Gas (USA) Inc.**  
**Garfield County, Colorado**

Well ID	Date	Velocity (fpm)	Flow (cfm)	Temperature (°F)	PID (ppm)	O <sub>2</sub> (%)	H <sub>2</sub> S (ppm)	CO (ppm)	CO <sub>2</sub> (%)	CH <sub>4</sub> (%)	*TPH mg/kg
SVEW01	5/29/2013	35	1.25	70.0	0.9	20.9	0	0	0	0	1,500
	6/25/2013	22	0.0436	104.5	1.6	20.3	0	0	0.6	0	
	7/31/2013	1	0.0218	108.3	0.9	20.3	0	1	0.9	0	
	8/26/2013	21	0.349	86.2	0.1	18.7	0	1	1.5	0	
	9/23/2013	1	0.0218	73.1	0.0	19.8	0	0	0.3	0	
	10/31/2013	1	0.0436	57.4	0.0	19.3	0	0	0.3	0	
	11/26/2013	3	0.0436	60.4	0.0	19.8	0	0	0.0	0	
	4/25/2014	49	0.635	81.1	0.0	18.3	0	1	1.8	0	
	5/30/2014	103	1.90	74.3	0.1	17.7	0	0	2.1	0	
	7/1/2014	59	1.33	103.5	0.0	20.5	0	0	0.5	0	
	8/1/2014	29	0.700	92.4	0.0	20.9	0	0	3.2	0	
	9/4/2014	1	0.0218	87.0	0.0	20.9	0	0	0.1	0	
	10/7/2014	30	0.900	83.0	0.0	20.9	0	0	0.1	0	
SVEE02	5/29/2013	13	0.305	69.9	1.2	20.3	0	0	0.3	0	1,000
	6/25/2013	39	2.73	99.2	1.5	20.6	0	0	0.2	0	
	7/31/2013	0	0.000	106.6	1.1	20.4	0	0	0.8	0	
	8/26/2013	26	0.566	87.6	1.2	20.0	0	1	0.8	0	
	9/23/2013	1	0.0218	71.0	0.0	20.0	0	0	0.0	0	
	10/31/2013	1	0.0218	57.7	0.1	19.3	0	0	0.3	0	
	11/26/2013	6	0.0875	58.3	0.0	19.7	0	0	0.0	0	
	4/25/2014	49	0.500	81.9	0.8	16.4	0	1	4.4	0	
	5/30/2014	68	1.24	69.4	0.4	19.5	0	0	0.5	0	
	7/1/2014	96	1.71	96.3	0.0	19.3	0	0	1.2	0	
	8/1/2014	10	0.153	83.0	0.0	20.9	0	0	1.9	0	
	9/4/2014	1	0.0436	86.4	0.0	20.9	0	0	0.0	0	
	10/7/2014	24	0.109	83.2	0.0	20.9	0	0	0.2	0	
SVEE01	5/29/2013	150	3.21	68.3	12.4	13.2	0	2	7.4	0	780
	6/25/2013	44	0.525	104.1	4	17.2	0	1	3.6	0	
	7/31/2013	55	1.21	107.2	9.1	9.5	0	2	>20.0	7	
	8/26/2013	73	1.27	86.4	0.9	17.6	0	1	3.1	0	
	9/23/2013	0	0.0000	70.0	0.0	20.1	0	0	0.0	0	
	10/31/2013	2	0.0436	55.4	0.1	19.5	0	0	0.3	0	
	11/26/2013	37	1.33	57.8	0.0	18.6	0	3	1.2	0	
	4/25/2014	135	2.11	80.0	3.1	9.9	0	1	19.1	0	
	5/30/2014	43	0.975	74.1	1.2	18.9	0	0	1.7	0	
	7/1/2014	112	2.05	101.2	0.3	14.3	0	0	4.4	0	
	8/1/2014	30	0.700	89.3	0.0	19.9	0	0	4.5	0	
	9/4/2014	2	0.0436	89.0	0.0	20.9	0	0	0.0	0	
	10/7/2014	6	0.0875	81.7	0.1	14.8	0	0	6.0	0	

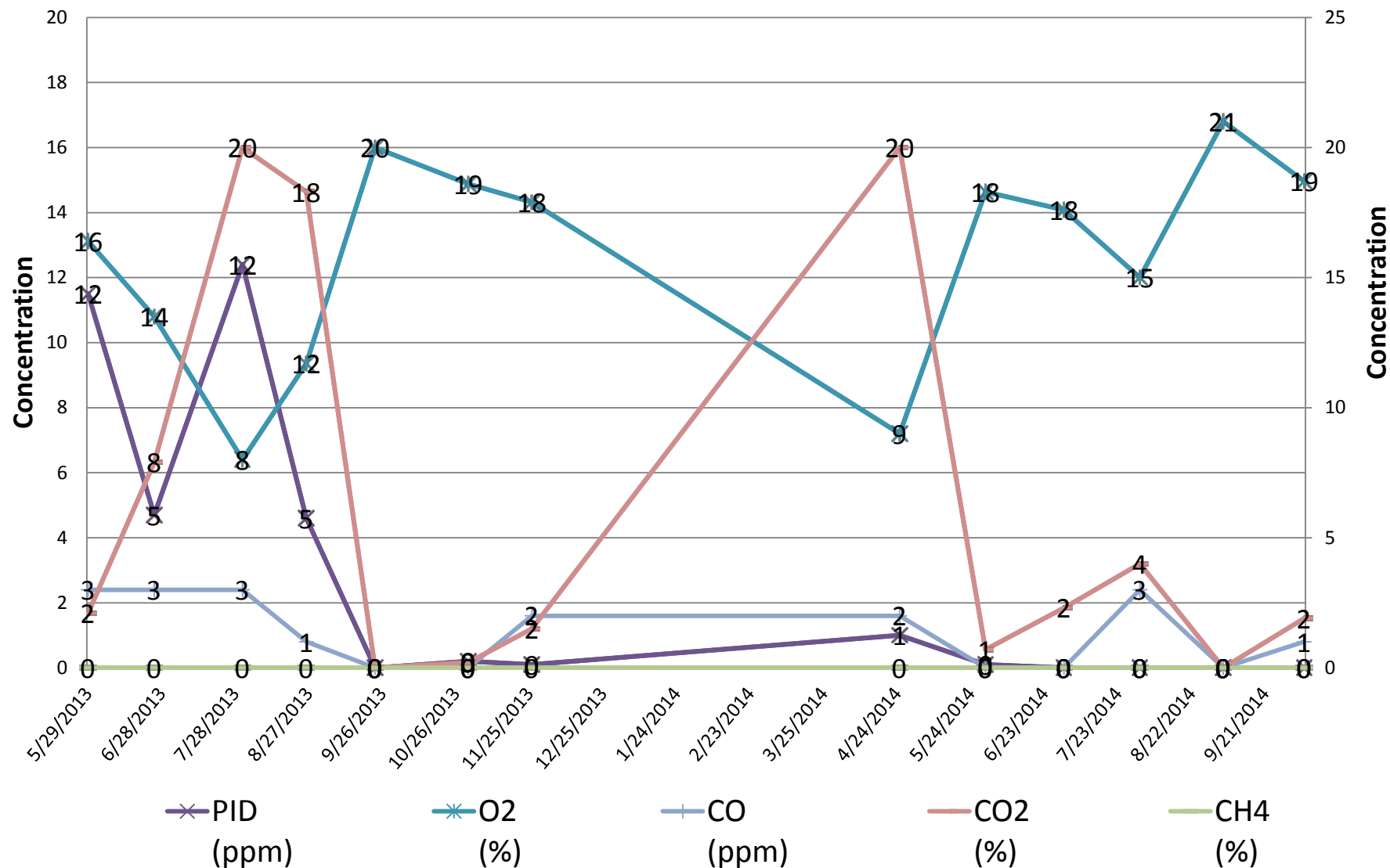
Table 1  
Operation and Maintenance Field Parameters  
C16OU Well Pad  
Encana Oil & Gas (USA) Inc.  
Garfield County, Colorado

Well ID	Date	Velocity (fpm)	Flow (cfm)	Temperature (°F)	PID (ppm)	O <sub>2</sub> (%)	H <sub>2</sub> S (ppm)	CO (ppm)	CO <sub>2</sub> (%)	CH <sub>4</sub> (%)	*TPH mg/kg
SVEE03	5/29/2013	3	0.566	73.5	8.4	20.2	0	3	0.4	0	1,800
	6/25/2013	16	0.830	99.3	3.2	20.3	0	0	0.4	0	
	7/31/2013	10	0.393	107.3	2	20.9	0	0	1	0	
	8/26/2013	30	0.565	86.5	0.1	20.4	0	0	0.1	0	
	9/23/2013	2	0.0418	71.9	0.1	20.3	0	0	0.0	0	
	10/31/2013	1	0.0218	53.5	0.1	19.4	0	0	0.1	0	
	11/26/2013	9	0.307	62.1	0.0	19.9	0	0	0.0	0	
	4/25/2014	144	2.15	81.7	0.0	18.3	0	1	1.9	0	
	5/30/2014	71	1.03	73.1	0.2	20.1	0	0	1.1	0	
	7/1/2014	33	0.702	100.9	0.0	20.1	0	0	0.8	0	
	8/1/2014	22	0.545	86.4	0.0	20.4	0	0	0.8	0	
	9/4/2014	1	0.0218	88.9	0.0	20.9	0	0	0.3	0	
	10/7/2014	23	0.565	81.0	0.0	20.9	0	0	0.2	0	

Notes:  
 fpm - feet per minute  
 cfm - cubic feet per minute  
 mg/kg - milligrams per kilogram  
 TPH - total petroleum hydrocarbons  
 PID - photoionization detector  
 ppm - parts per million  
 O<sub>2</sub> - oxygen  
 H<sub>2</sub>S - hydrogen sulfide  
 CO - carbon monoxide  
 CO<sub>2</sub> - carbon dioxide  
 CH<sub>4</sub> - methane  
 °F - degrees fahrenheit  
 NA - not analyzed  
 \*TPH values indicate concentrations in soil at time of well installation

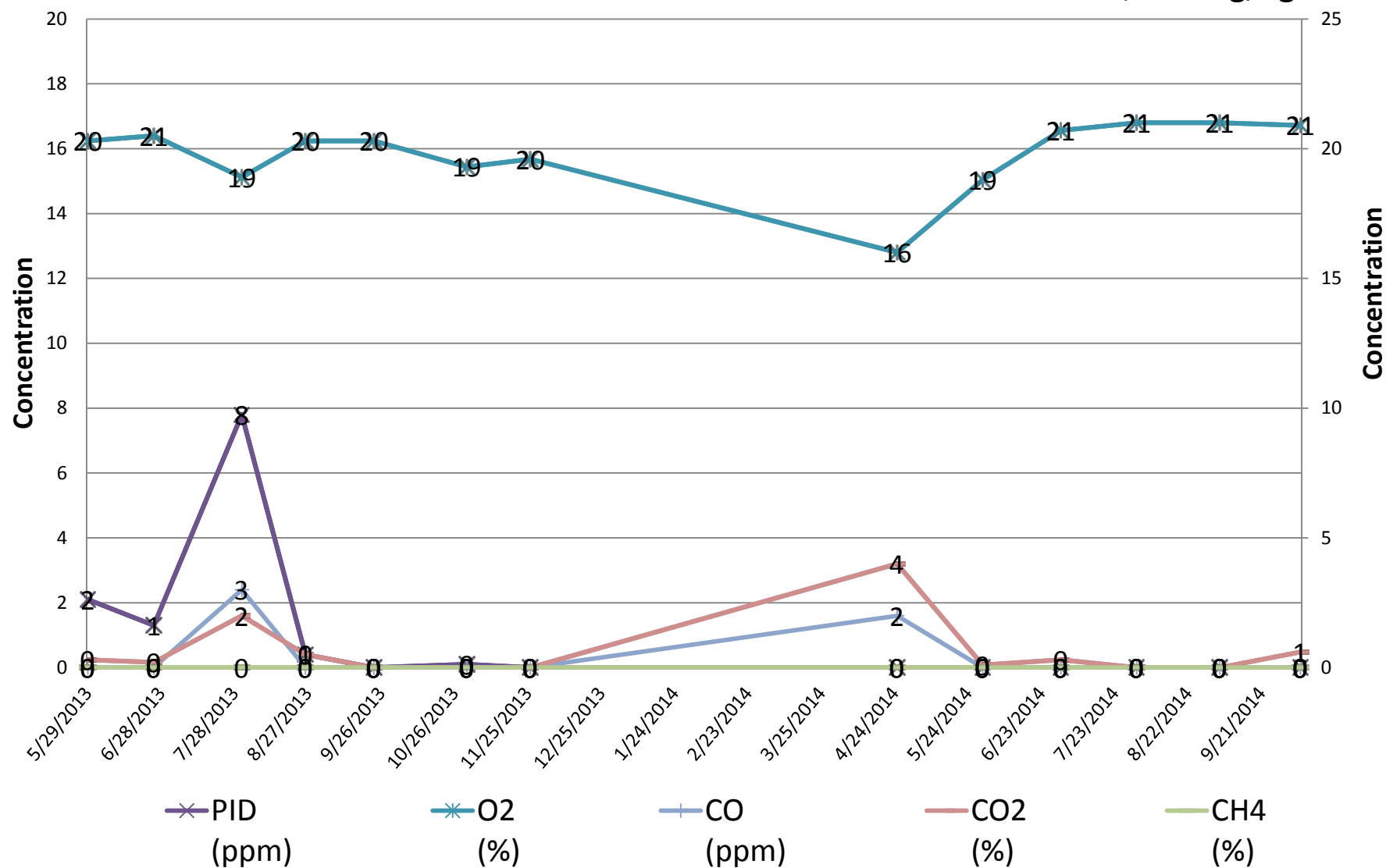
# Encana - C16OU Pad - SVEN03

Assessed TPH: 2,000 mg/kg



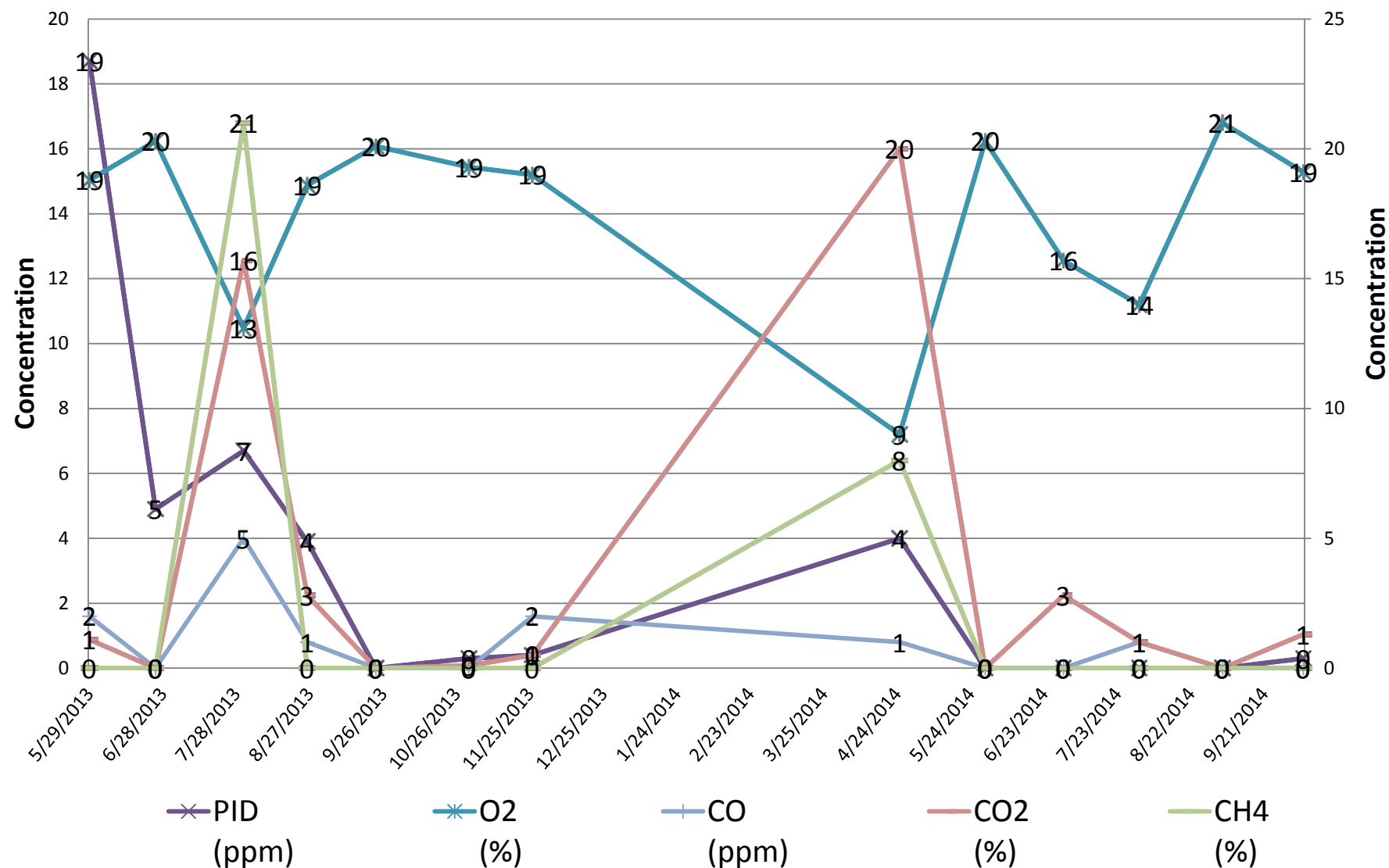
## Encana - C16OU Pad - SVEN02

Assessed TPH: 1,400 mg/kg



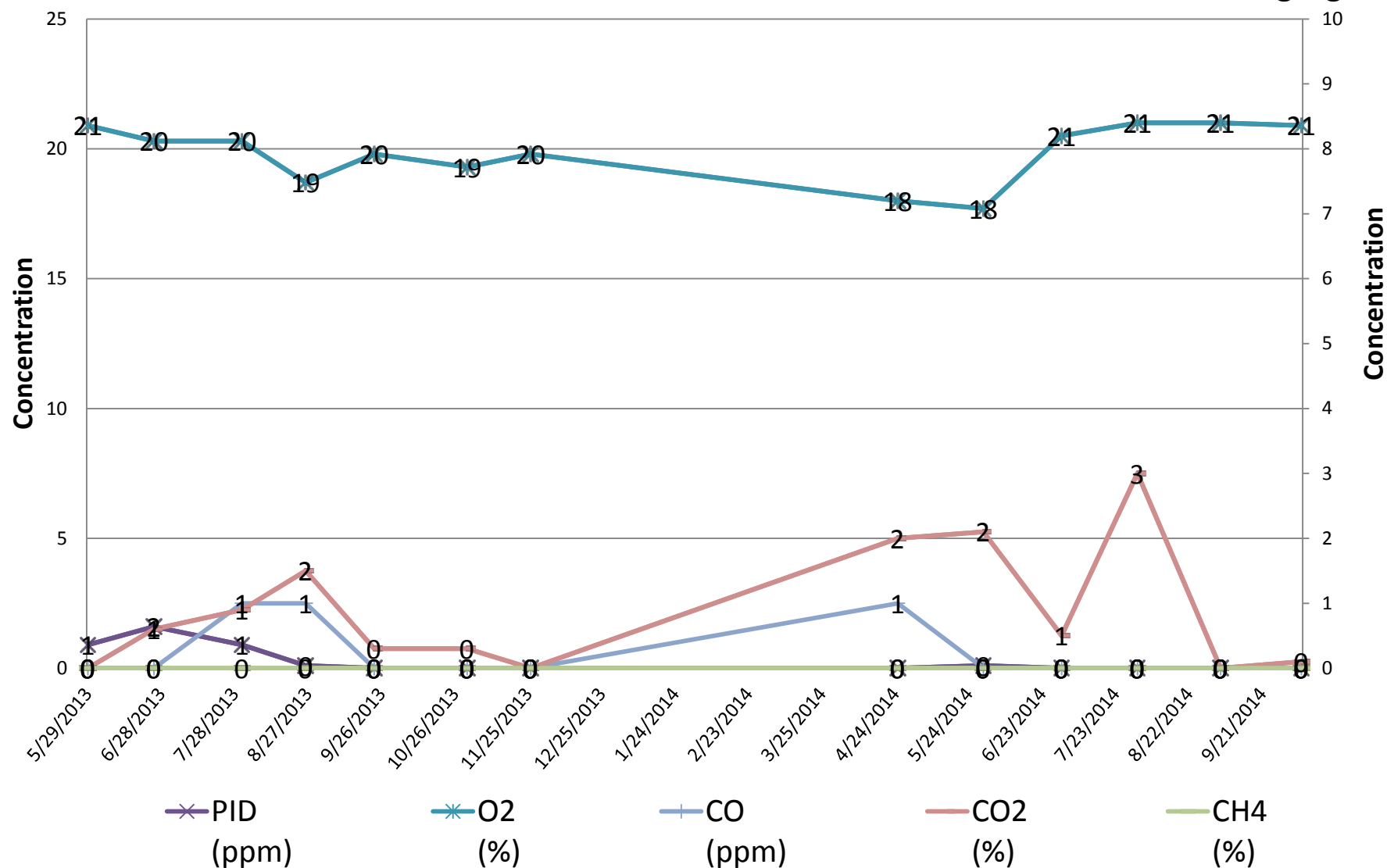
# Encana - C16OU Pad - SVEW02

Assessed TPH: 1,300 mg/kg



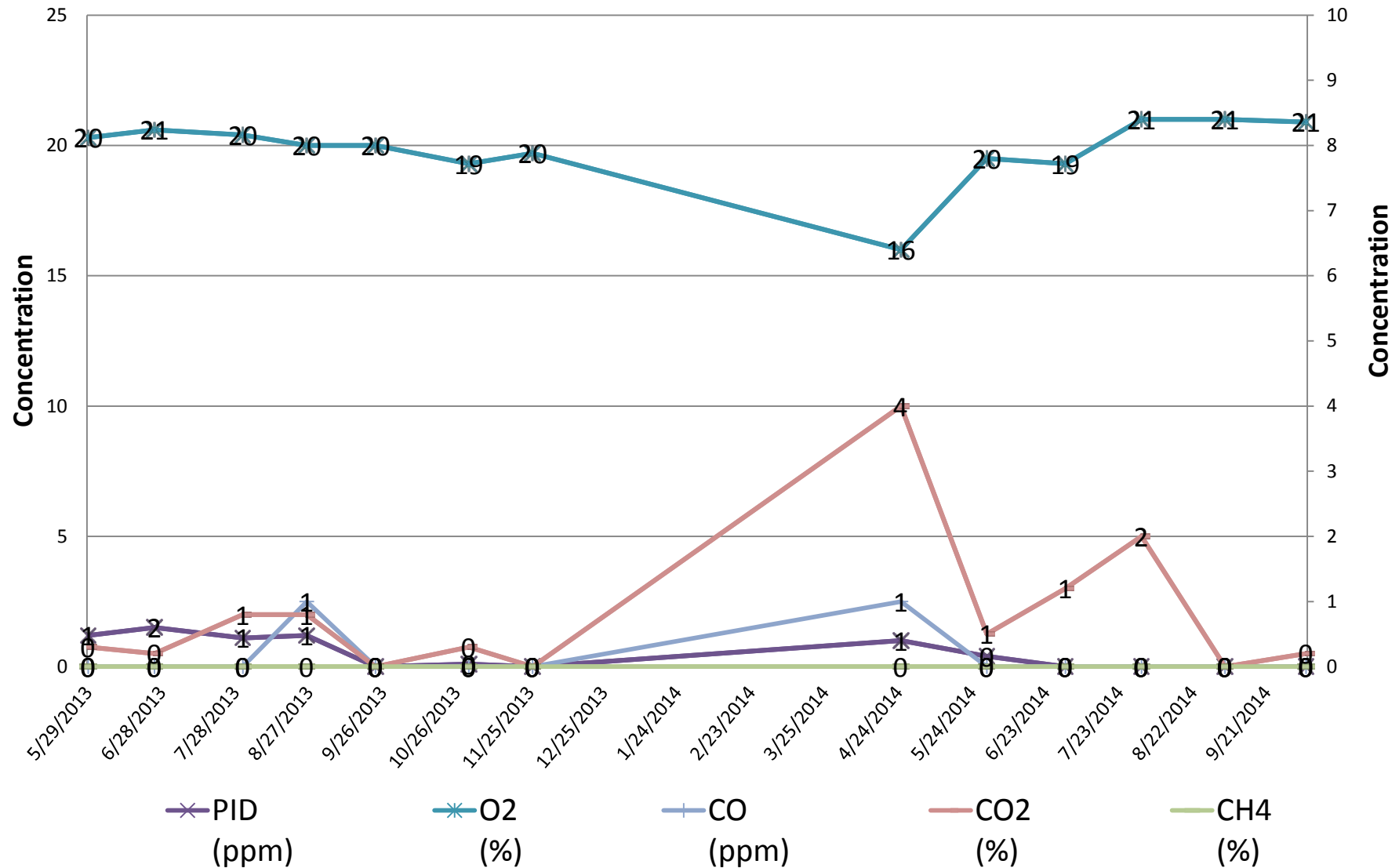
# Encana - C16OU Pad - SVEW01

Assessed TPH: 1,500 mg/kg



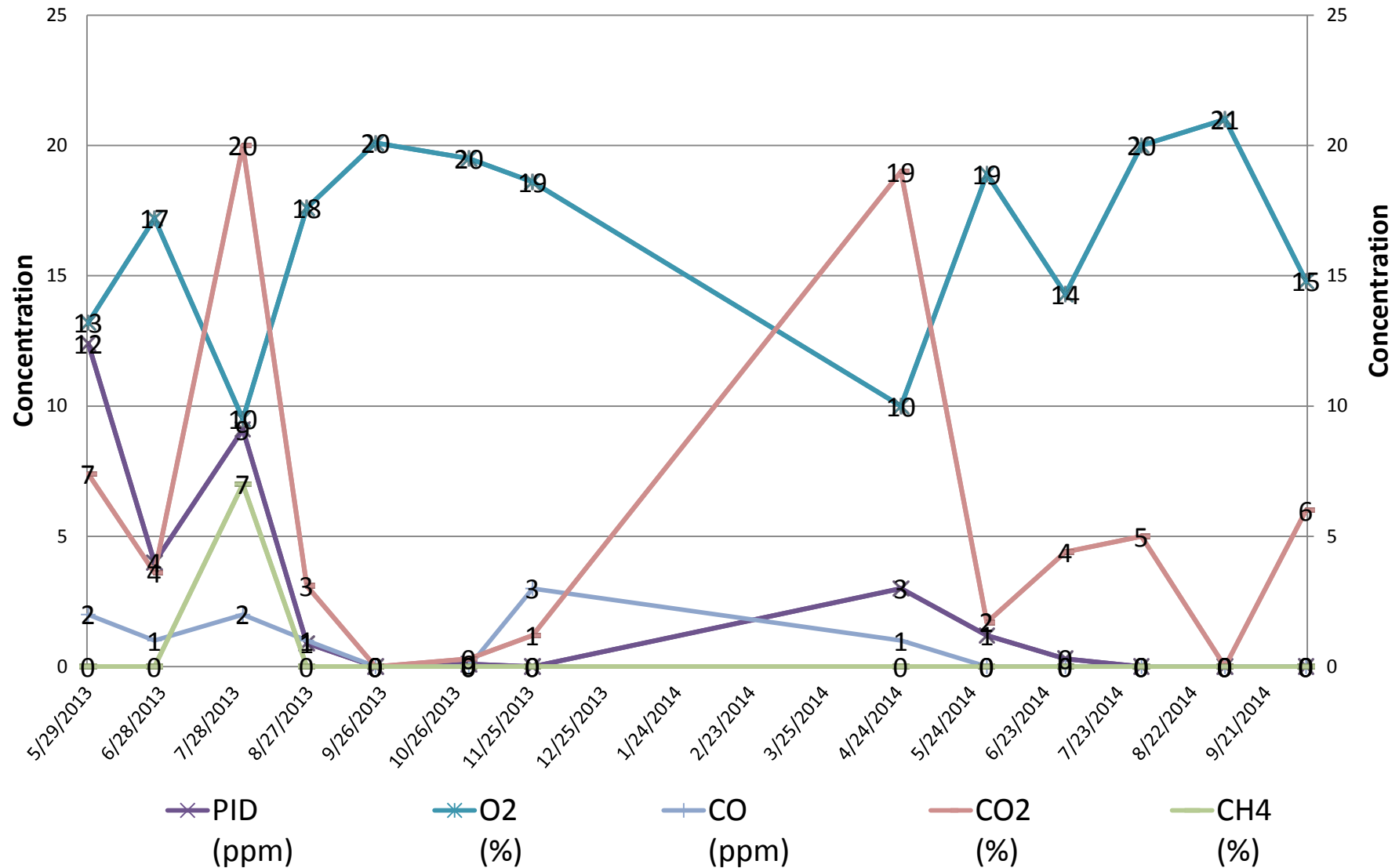
# Encana - C16OU Pad - SVEE02

Assessed TPH: 1,000 mg/kg



# Encana - C16OU Pad - SVEE01

Assessed TPH: 780 mg/kg





# Encana - C16OU Pad - SVEE03

Assessed TPH: 1,800 mg/kg

