Wellfield Analysis Graph -

A new approach to site-wide LFG well analysis

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SCS Engineers

New Mexico Recycling and Solid Waste Conference

September 20, 2023

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A Brief History of LFG Wellfield Analysis

Tables and Graphs

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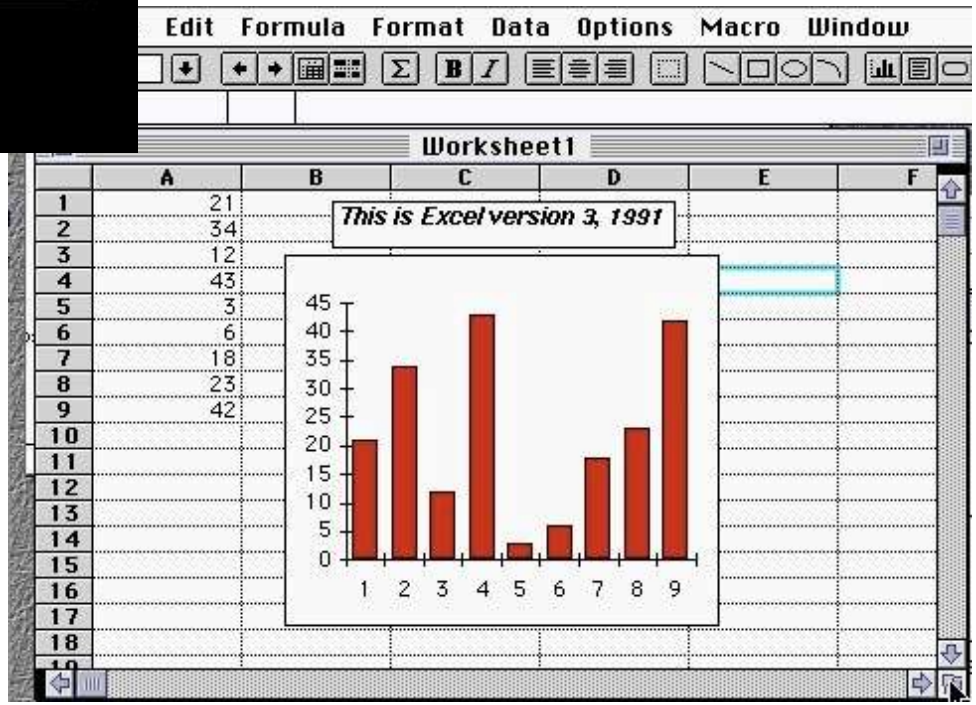
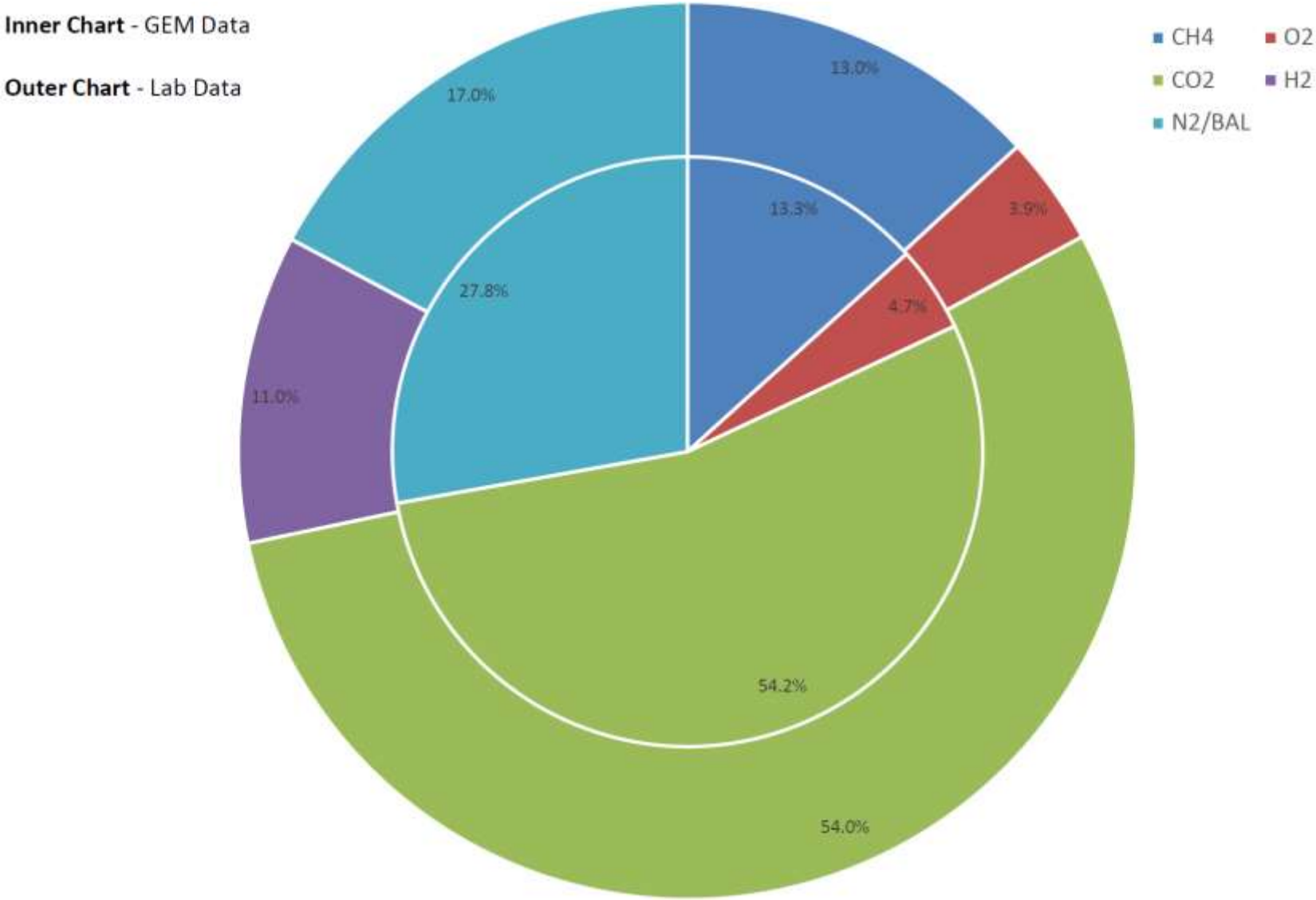
First, there were tables

Point ID	Point Nam	Date Time	CH4	CO2	O2	Bal	CO	Init Tem	Adj Tem	Init Flow	Adj Flow	Init Static Pres	Adj Static Pres	Baro	Init Diff Pres	Adj Diff Pres	Init Powe	Adj Powe
Well0001	Well0001	3/28/2012 8:14	60	37	0	2.6		58	58	24	35	-7.5	-7.5	28.5	0.134	0.269	906	1294
Well0001	Well0001	3/28/2012 8:15	61	37	0	2.5		58	58	31	32	-7.5	-7.5	28.5	0.207	0.225	1140	1189
Well0001	Well0001	4/4/2012 14:14	61	38	0	1		64	64	4		-8.5	-8.5	28.5	0.005	0	177	
Well0001	Well0001	4/4/2012 14:16	61	38	0	0.8		64	64	4		-8.4	-8.4	28.5	0.004	-0.002	153	
Well0001	Well0001	4/29/2010 14:36	62	37	0	0.2		66	66	14	13	-4.5	-4.5	28.7	0.046	0.04	546	510
Well0001	Well0001	4/29/2010 14:38	62	38	0	0.2		66	66	34	34	-4.5	-4.5	28.7	0.25	0.253	1287	1295
Well0001	Well0001	12/30/2010 10:35	61	39	0	0.1		56	56	45	45	-7.9	-7.9	28.8	0.441	0.432	1678	1660
Well0001	Well0001	12/30/2010 10:36	60	40	0	0.1		55	56	39	38	-7.9	-7.9	28.8	0.33	0.314	1439	1402
Well0001	Well0001	2/1/2010 10:09	61	39	0	0.1		49	49	7	5	-5.3	-5.3		0.01	0.01		
Well0001	Well0001	2/1/2010 10:11	61	39	0	0.1		49	49	12	12	-5.4	-5.4		0.03	0.04		
Well0001	Well0001	2/11/2010 14:29	59	41	0	0.1		45	45	32	32	-5.3	-5.3		0.22	0.22		
Well0001	Well0001	2/11/2010 14:31	60	40	0	0.1		45	45	30	30	-5.3	-5.3		0.2	0.2		
Well0001	Well0001	2/19/2010 10:04	63	37	0	0.1		52	52	41		-5.9	-5.9		0.36	-0.03		
Well0001	Well0001	2/19/2010 10:06	62	38	0	0.1		52	52	20	22	-5.9	-5.9		0.09	0.11		
Well0001	Well0001	2/24/2010 14:03	59	41	0	0.1		50	50	8	7	-5	-5		0.02	0.01		
Well0001	Well0001	2/24/2010 14:05	60	40	0	0.1		50	50	8	7	-5	-5		0.02	0.01		
Well0001	Well0001	3/5/2010 10:13	62	38	0	0.2		50	50	24	23	-6.5	-6.5		0.13	0.12		
Well0001	Well0001	7/14/2010 14:15	59	41	0	0.1		85	84	17	17	-4.1	-4.1	28.8	0.074	0.071	646	632
Well0001	Well0001	7/14/2010 14:17	59	41	0	0.2		84	84	15	15	-4.1	-4.1	28.8	0.059	0.057	568	560
Well0001	Well0001	7/29/2010 11:11	62	38	0	0.1		81	81	11	11	-3.3	-3.3	28.8	0.029	0.028	422	420
Well0001	Well0001	7/29/2010 11:08	62	38	0	0.1		82	81	11	11	-3.3	-3.3	28.8	0.028	0.029	421	427
Well0001	Well0001	4/14/2010 10:27	62	37	0	0.2		63	63	8	9	-7.5	-7.5	29.2	0.014	0.018	304	342
Well0001	Well0001	4/14/2010 10:28	62	38	0	0.1		63	63		18	-6	-6	29.2	-0.003	0.072		681
Well0001	Well0001	4/22/2010 13:47	62	38	0	0.1		82	84	3	9	-3	-3.1	28.6	0	0.02	126	343
Well0001	Well0001	3/5/2010 10:14	62	38	0	0.1		50	50	19	19	-6.5	-6.5		0.09	0.08		
Well0001	Well0001	3/11/2010 15:37	63	37	0	0.5		60	60	11	10	-4.1	-4.1		0.03	0.02		
Well0001	Well0001	3/11/2010 15:38	62	37	0	0.7		61	61	7	8	-4.1	-4.1		0.01	0.02		
Well0001	Well0001	3/18/2010 14:49	62	38	0	0.1		65	65			-3.6	-3.7		-0.01	-0.01		
Well0001	Well0001	3/18/2010 14:51	62	38	0	0.1		64	64	7	7	-3.7	-3.7		0.01	0.01		
Well0001	Well0001	3/25/2010 9:48	62	38	0	0.1		56	57	17	17	-4.6	-4.6		0.07	0.06		
Well0001	Well0001	3/25/2010 9:50	61	39	0	0.1		57	57	13	13	-4.6	-4.6		0.04	0.04		
Well0001	Well0001	4/2/2010 9:40	64	36	0	0.1		66	67	22	21	-5.6	-5.6		0.11	0.1		
Well0001	Well0001	4/2/2010 9:41	63	37	0	0.1		67	67	18	17	-5.6	-5.6		0.07	0.07		
Well0001	Well0001	9/8/2010 15:57	62	38	0	0.1		76	75	1		-5.8	-5.8	28.7	0	-0.002	43	
Well0001	Well0001	9/8/2010 15:58	61	39	0	0.1		75	74	4	4	-5.8	-5.8	28.7	0.004	0.005	152	170

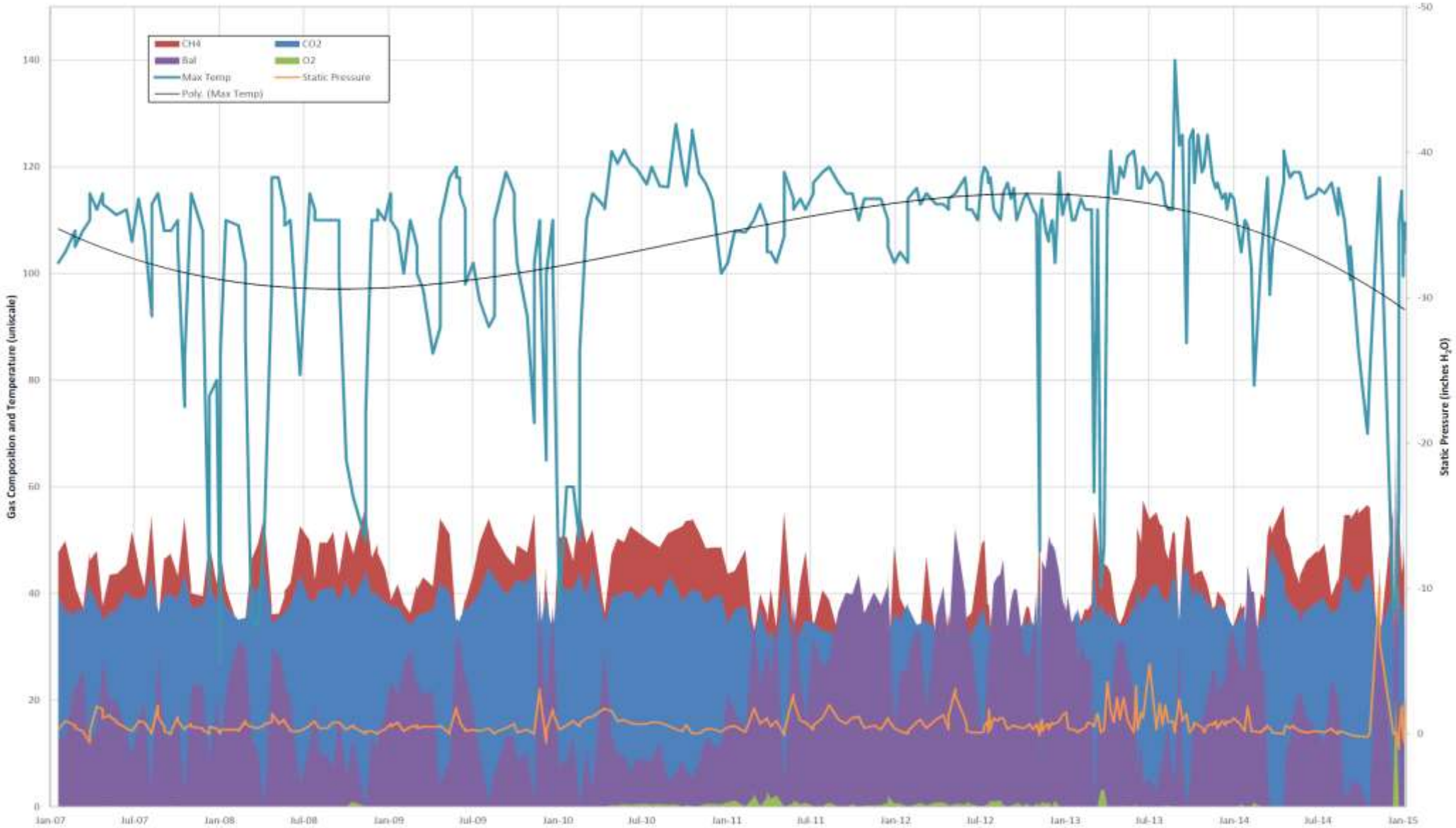
Then, there were graphs



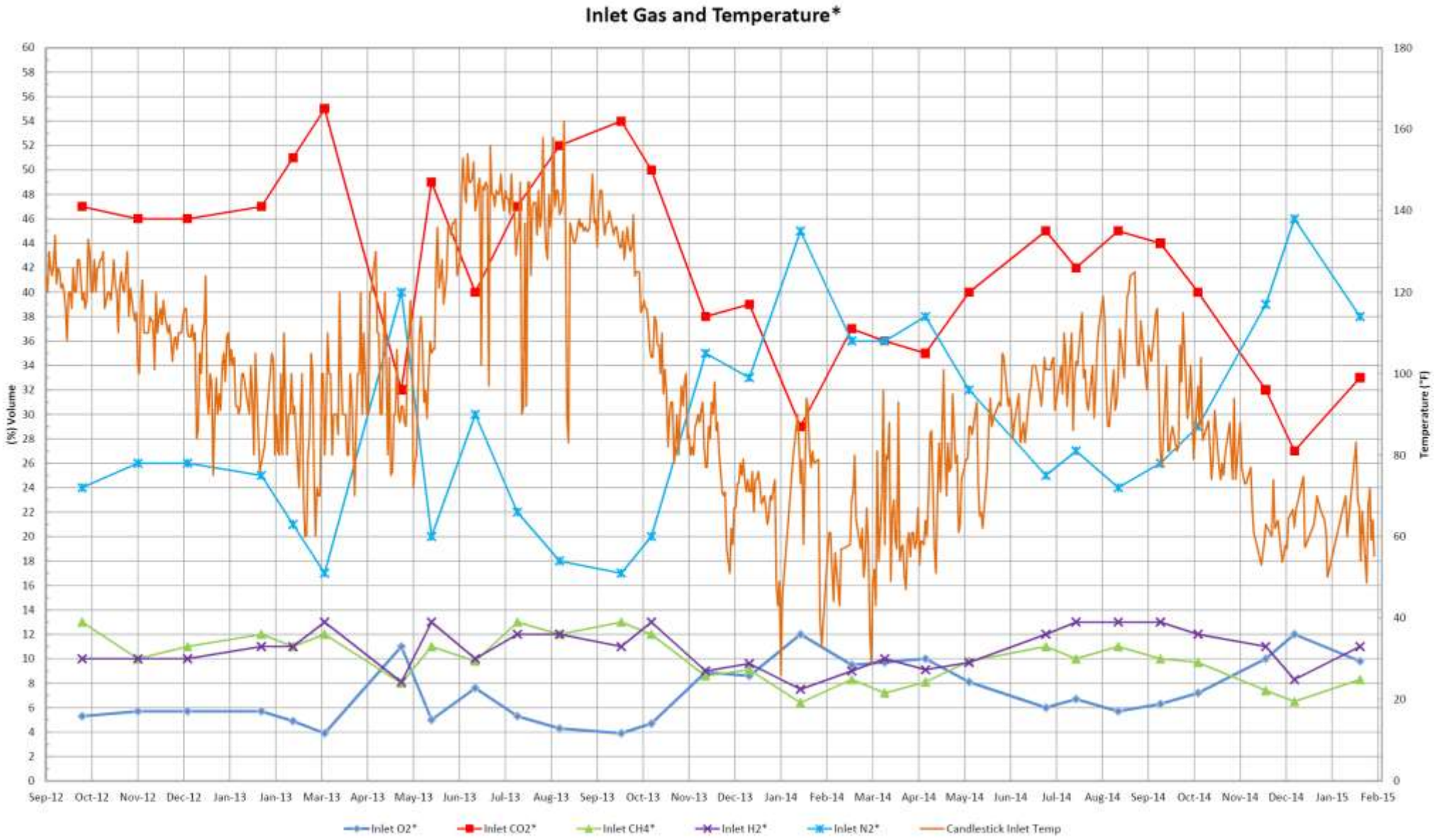
Gas Composition Pie Charts



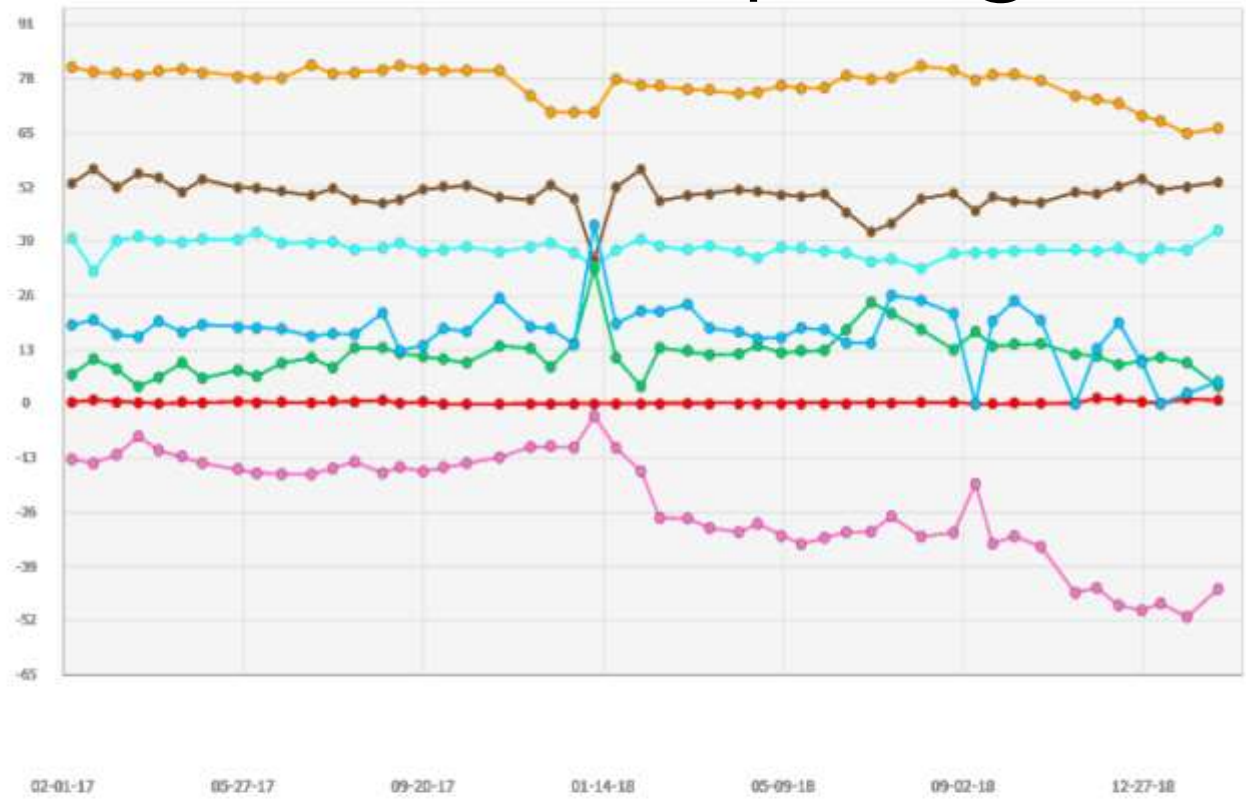
Area Graphs


CH4
CO2
Bal
O2
Max Temp
Static Pressure
Poly. (Max Temp)
Gas Composition and Temperature (unlscale)
Static Pressure (inches H2O)
0
20
40
60
80
100
120
140
-50
-40
-30
-20
-10
0
Jan-07
Jul-07
Jan-08
Jul-08
Jan-09
Jul-09
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15

Multiple Parameter Graph



SCS eTools Graphing



Point IDs / Names
BFIEW095 / EW-095

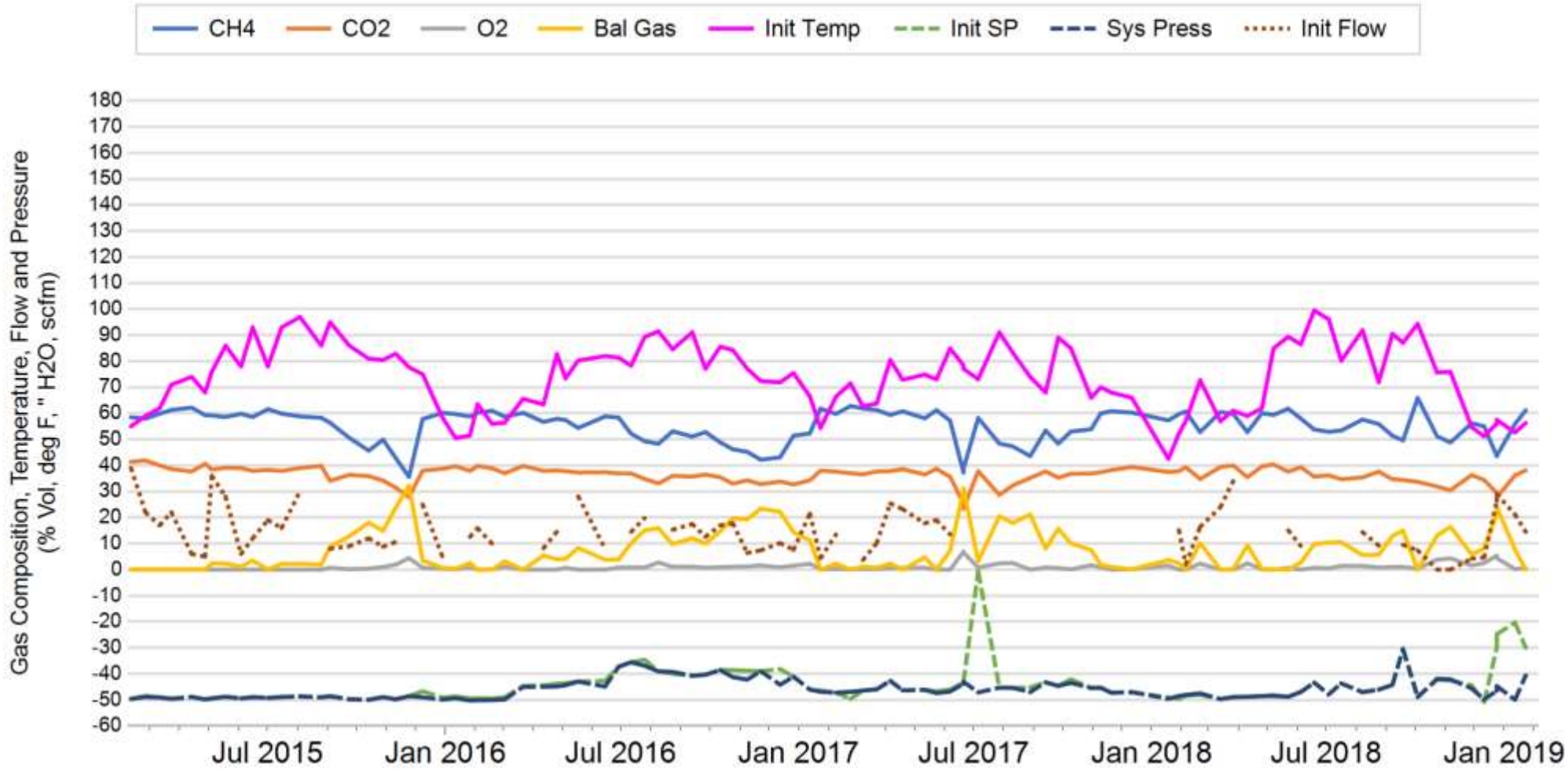
Parameter / Unit
- CH4 / %
- CO2 / %
- O2 / %
- BalGas / %
- InitTemp / deg. F
- InitStaticPress / in. H2O
- AdjFlow / scfm

Parameter Chart: Uniscale
Date Range : 02/01/2017 to 02/28/2019

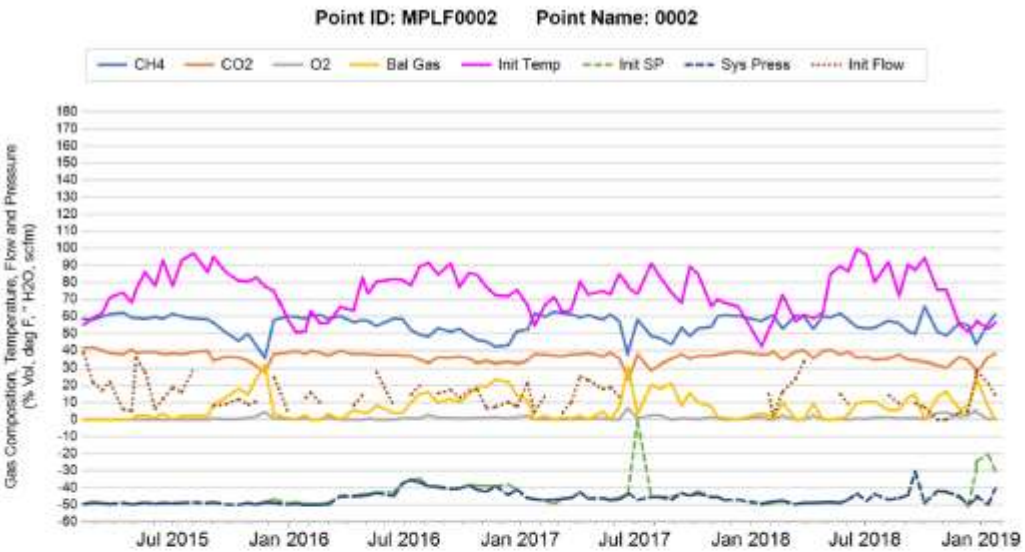
Chart generation date:02/23/2019

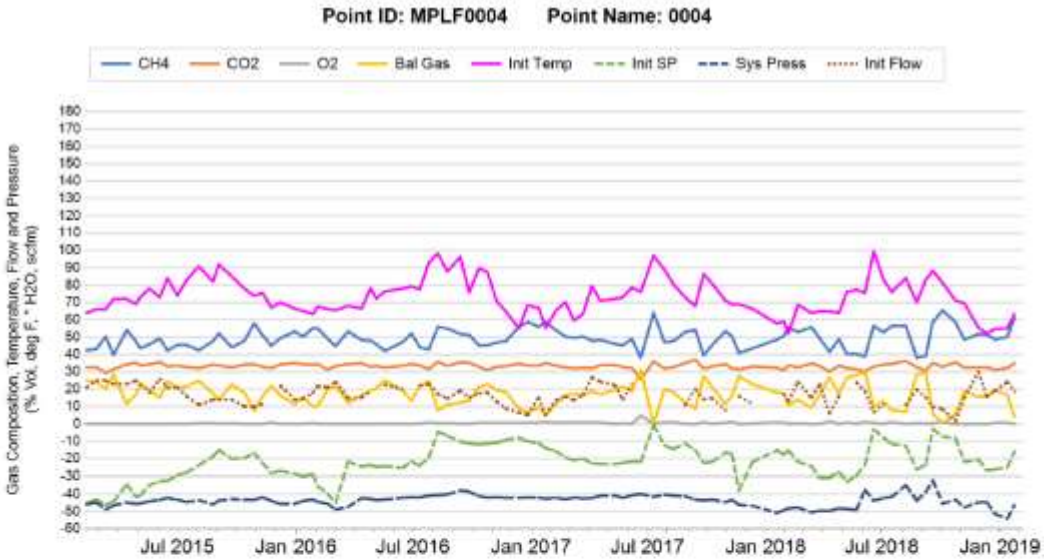
SCSeTools

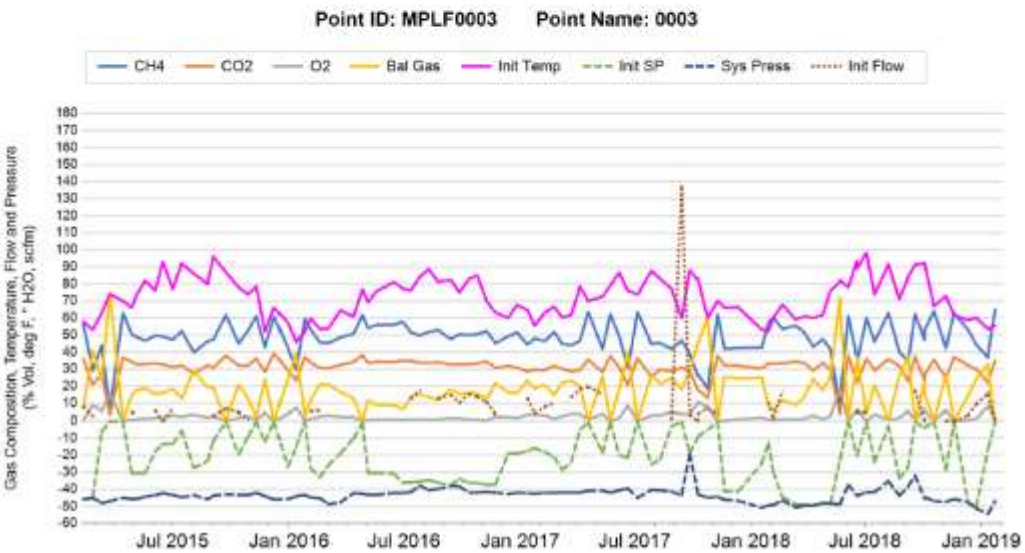
SCS eTools Wellfield Parameter Report

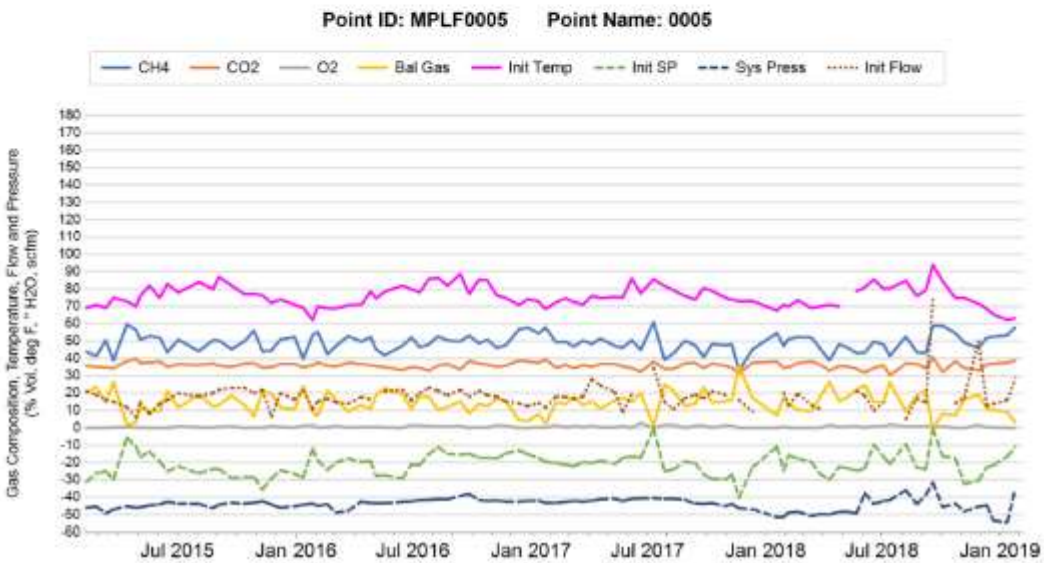


Monthly Review of All Wells

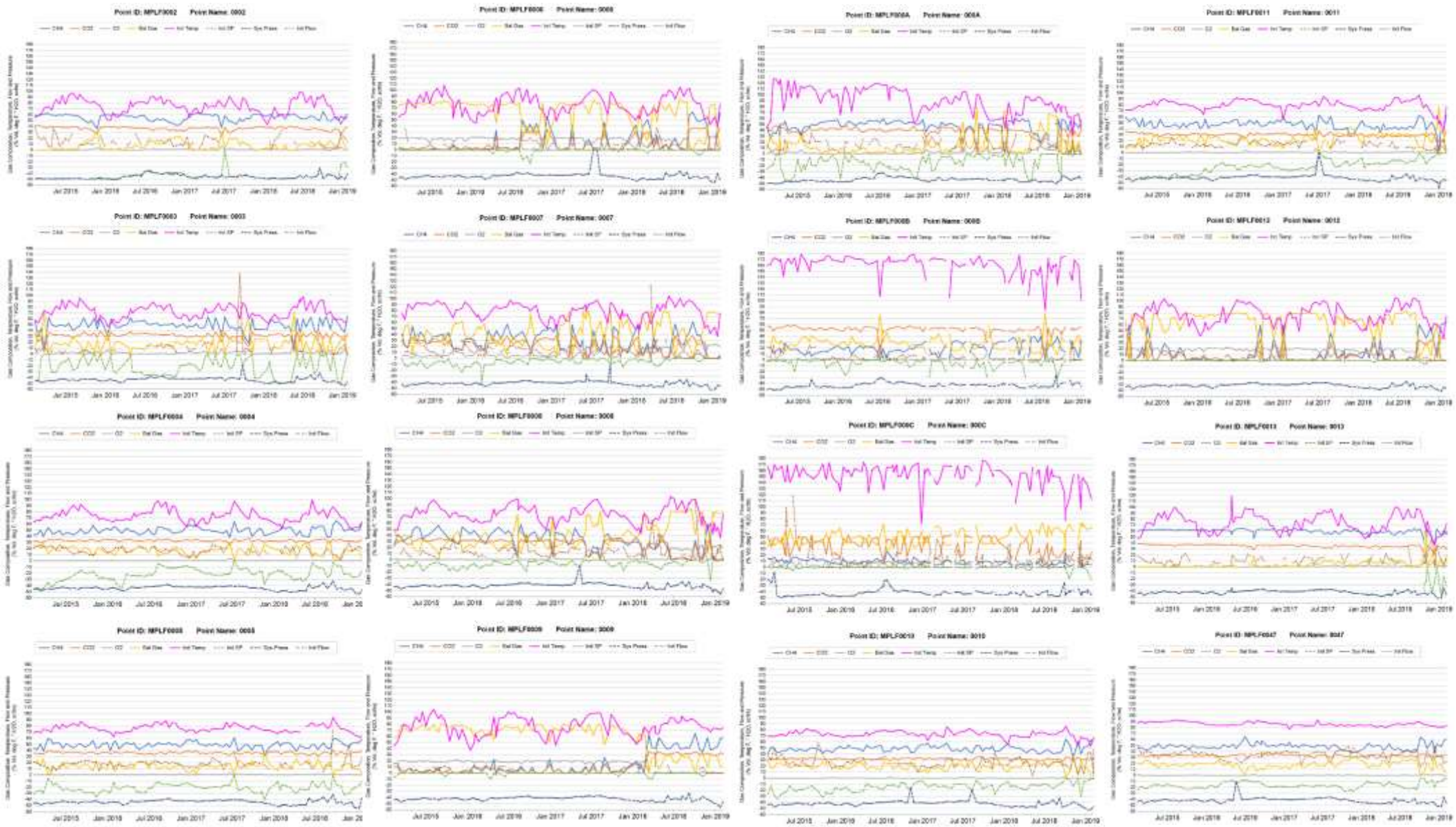








Monthly Review of All Wells



Monthly Review of All Wells

Monthly Review of All Wells

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There HAS to be a Better Way…

(for complete wellfield analysis)

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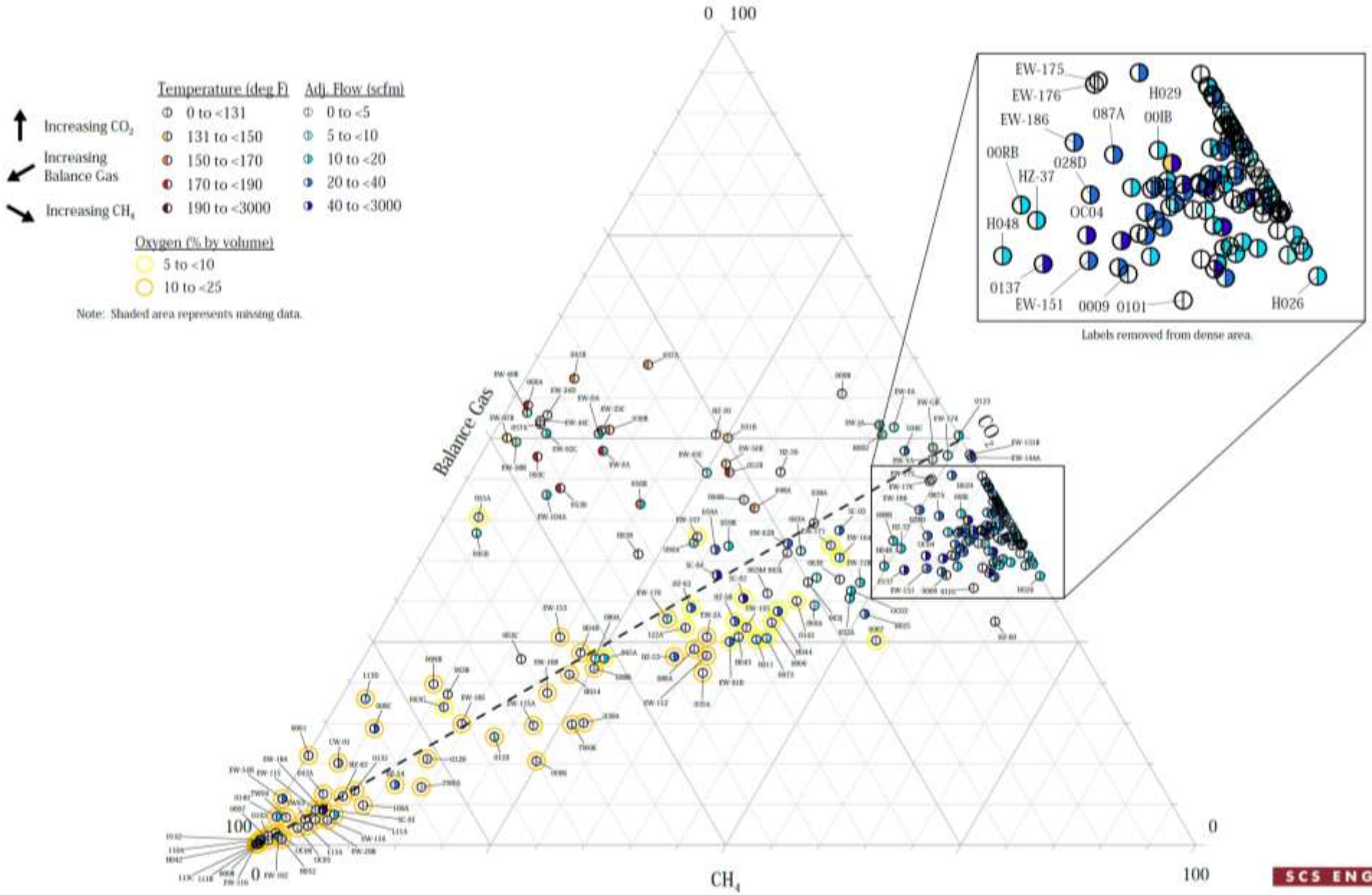
SCS Wellfield Analysis Graph – Site 1 – January 2023



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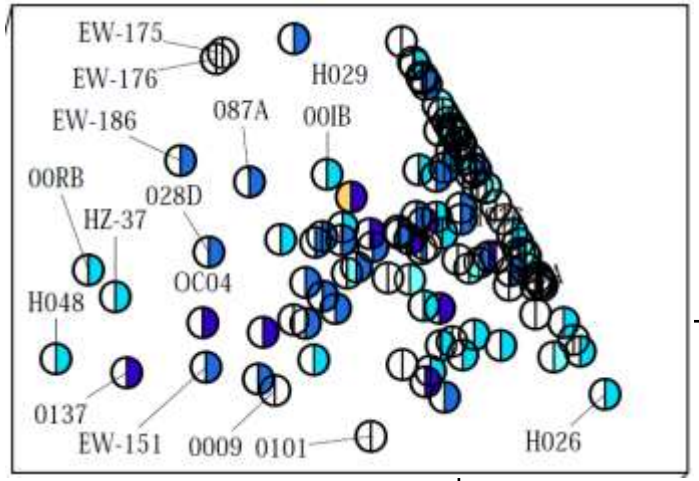
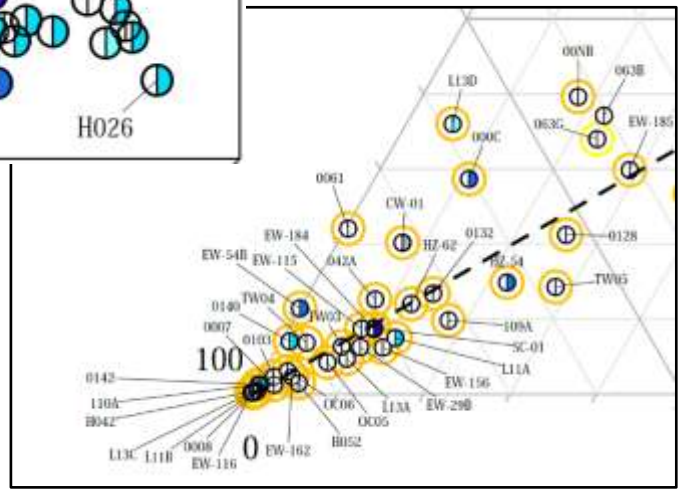
Benefits

- One Graph
- All Wells
- 6 Parameters per Well
- Integrates key ratios
- Multi-use (site-level and wellhead)





Increasing CO_2

Increasing Balance Gas

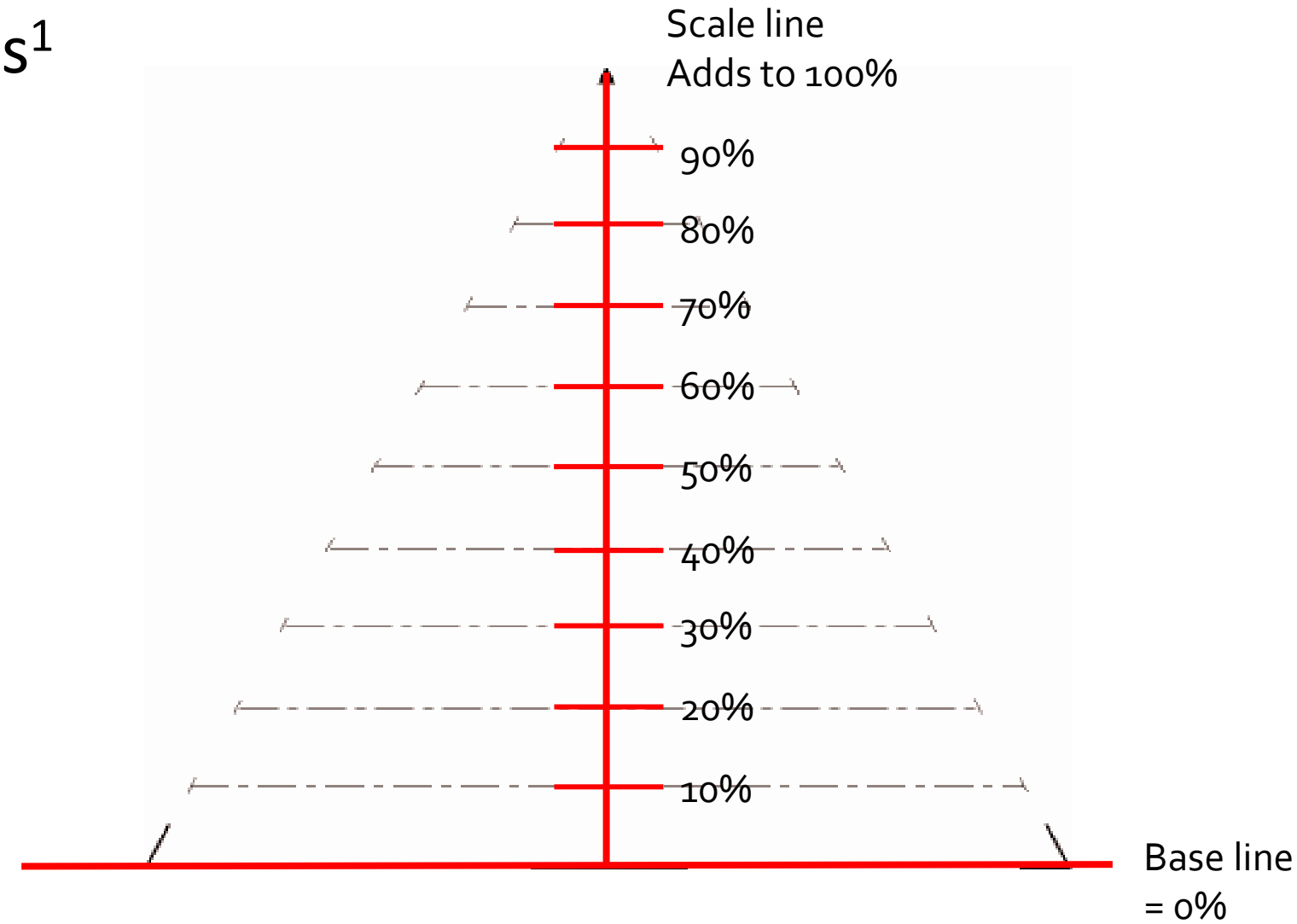
Increasing CH_4

Temperature (deg F)	Adj. Flow (scfm)
0 to <131	0 to <5
131 to <150	5 to <10
150 to <170	10 to <20
170 to <190	20 to <40
190 to <3000	40 to <3000

Oxygen (% by volume)

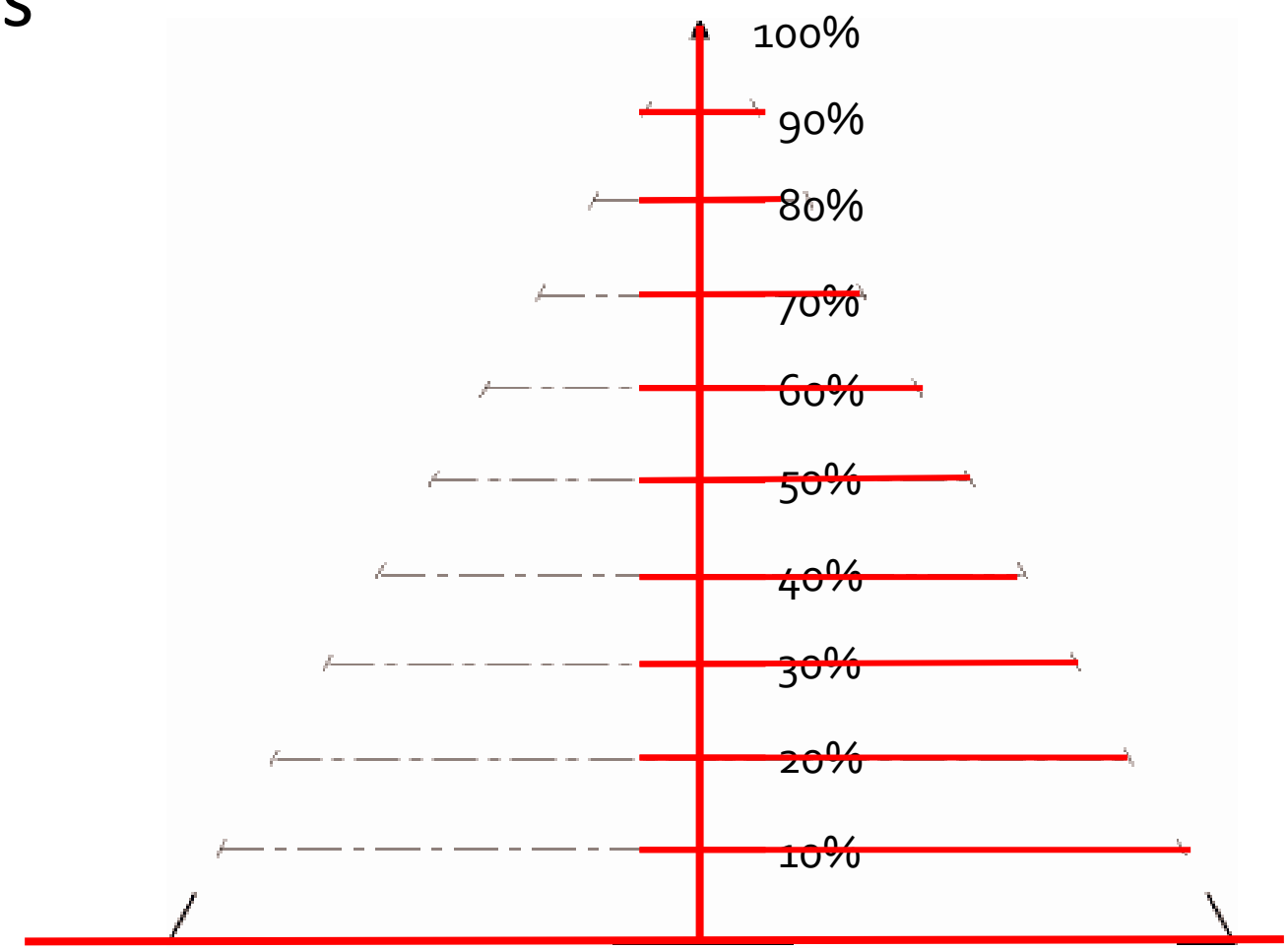
- 5 to <10
- 10 to <25

Reading Ternary Diagrams[1]

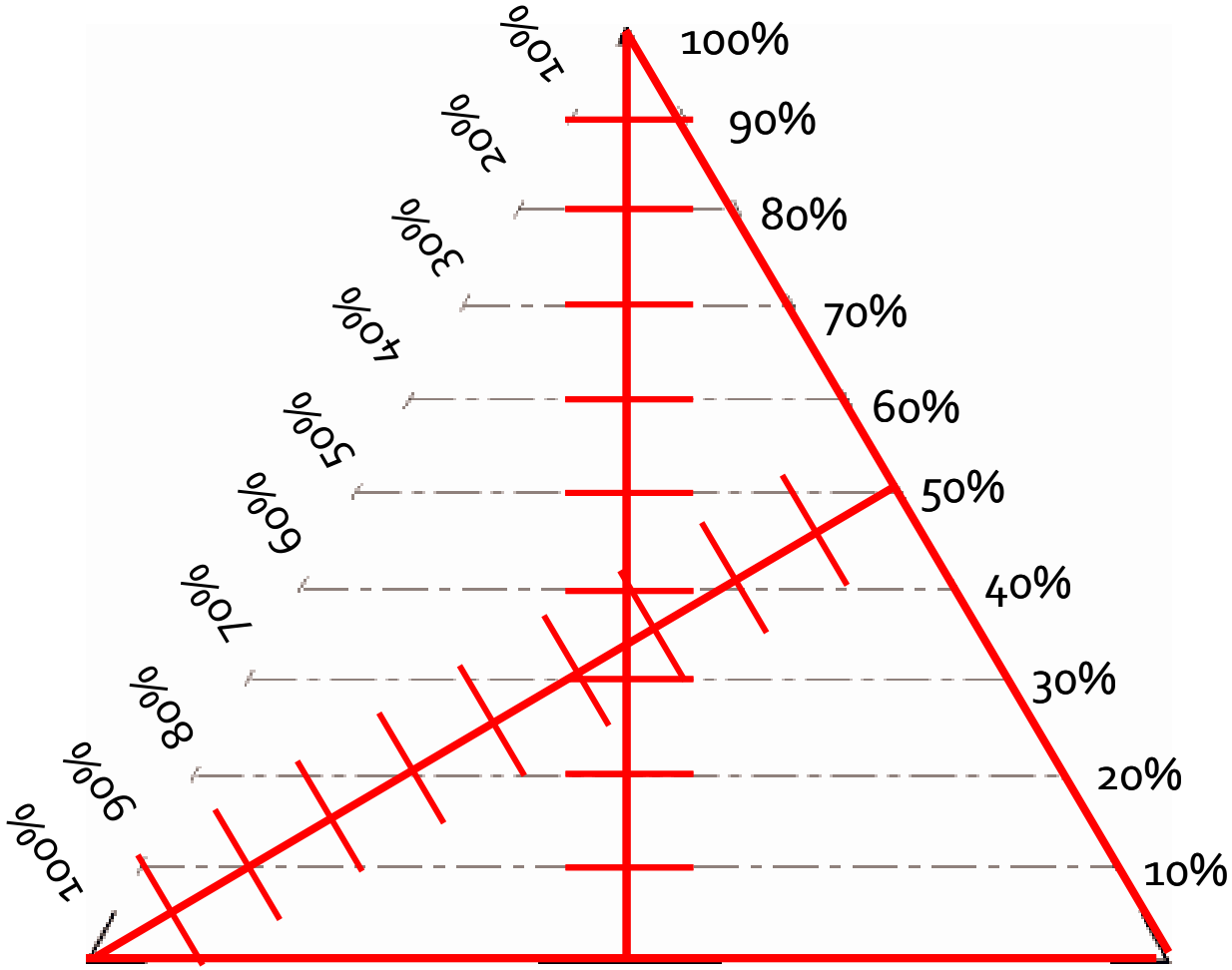


[1]From PowerPoint presentation on Sedimentary Rock Classification; Lynn S. Fitcher, Department of Geology and Environmental Science, James Madison University, 2006
http://csmres.jmu.edu/geollab/Fichter/Fichter/Fichterls.html

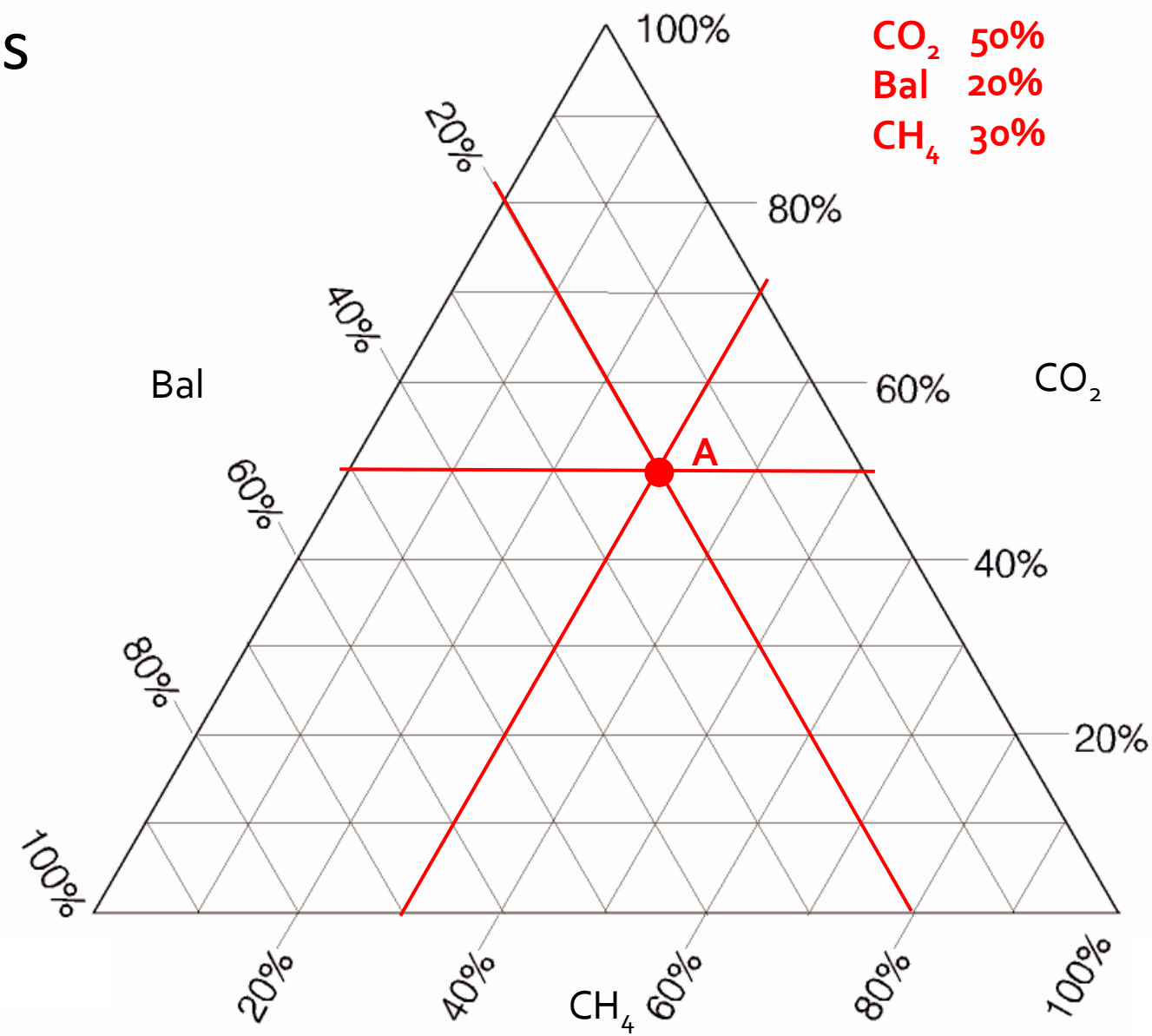
Reading Ternary Diagrams

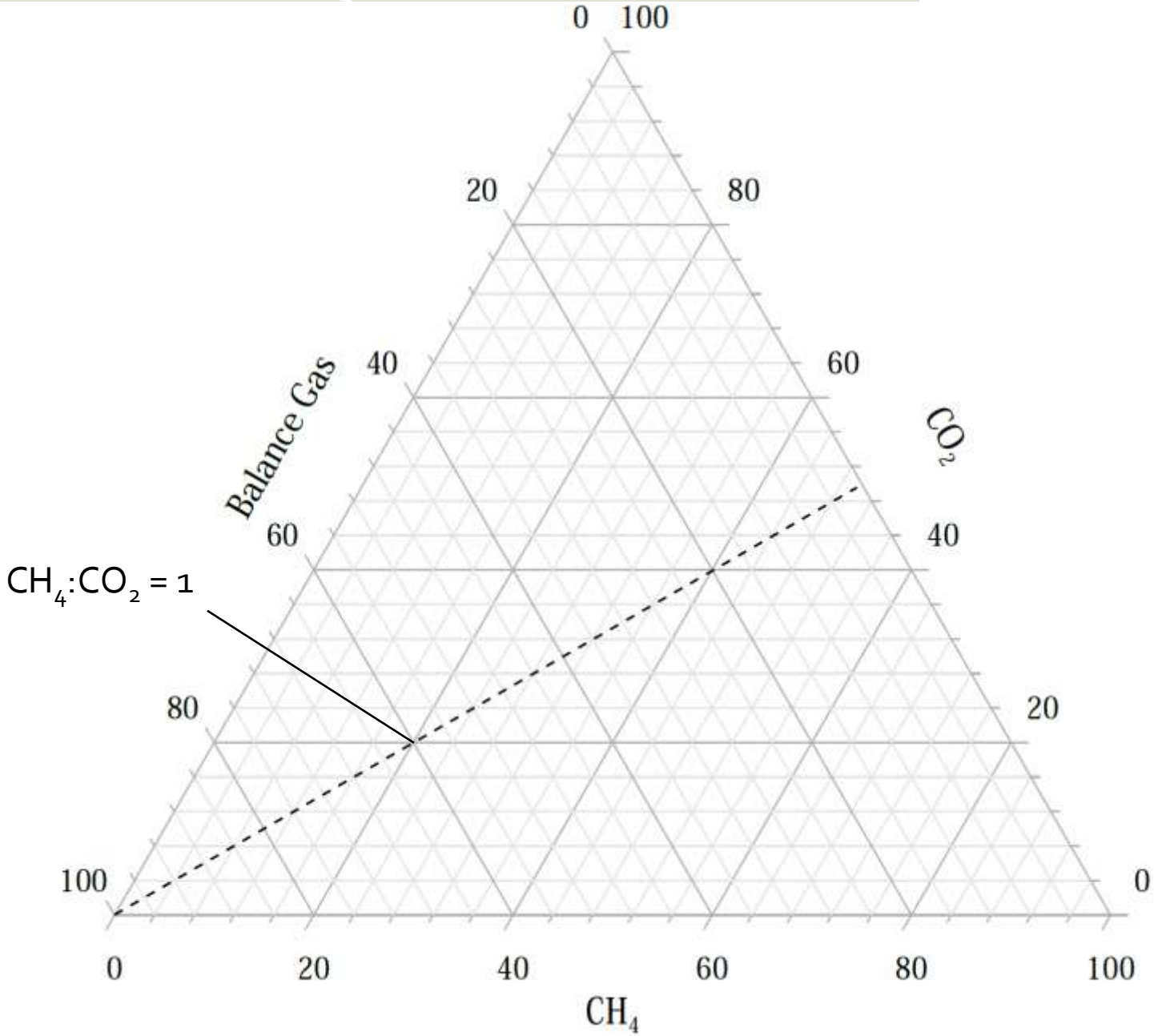


Reading Ternary Diagrams



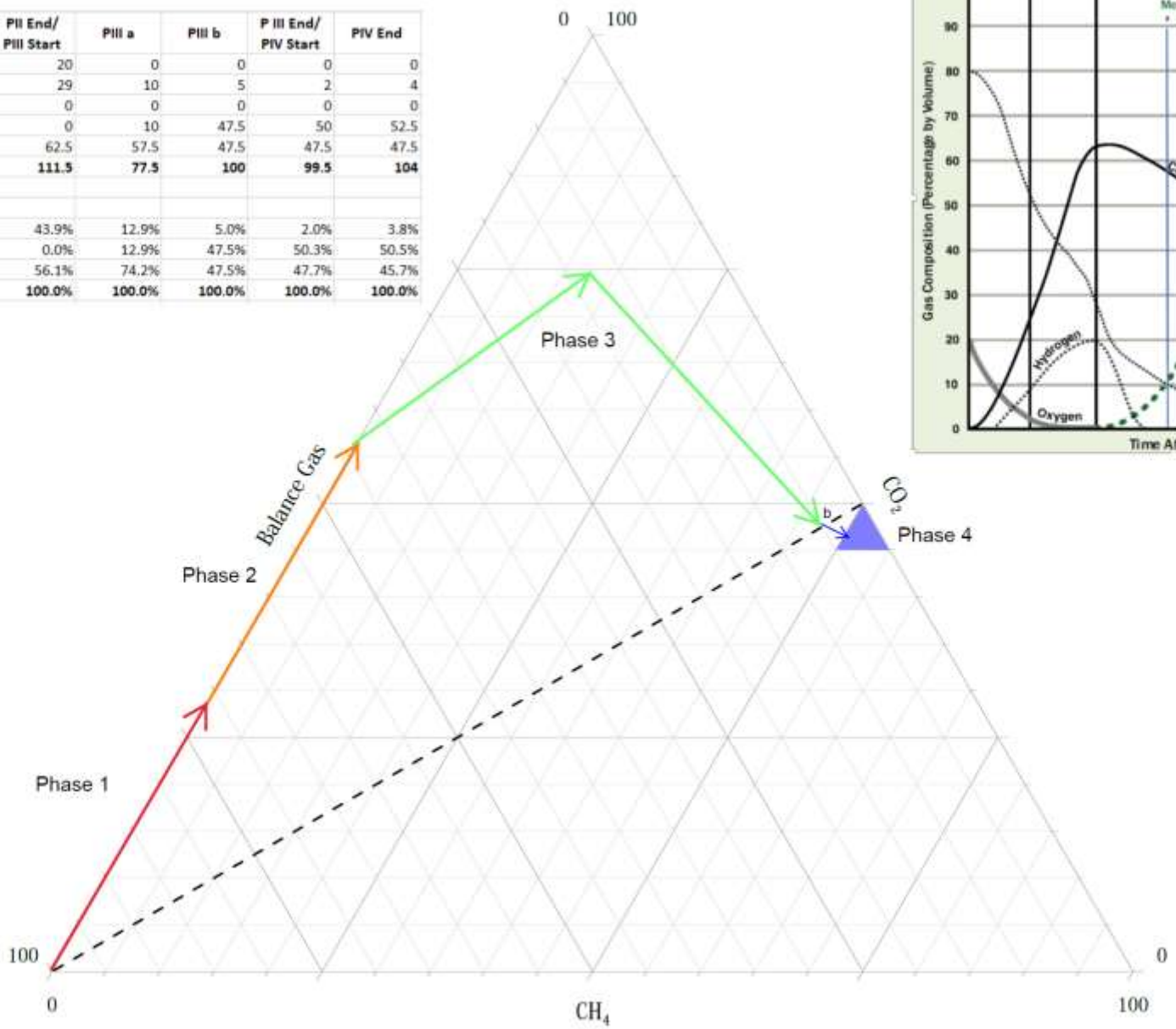
Reading Ternary Diagrams

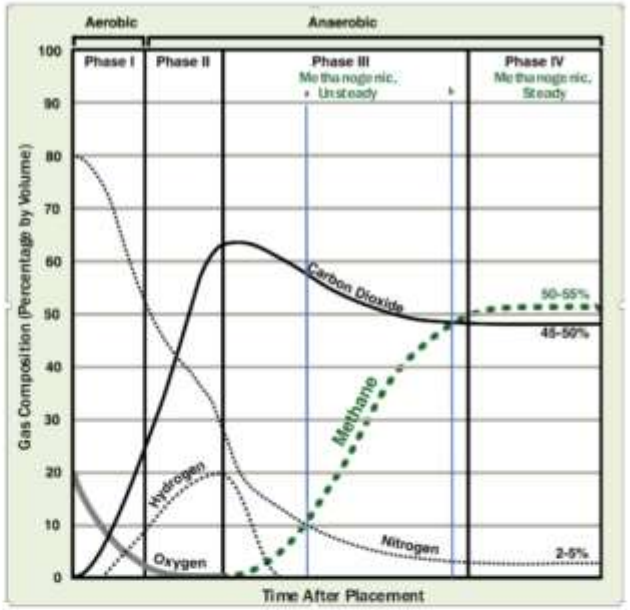



0
100
20
80
40
60
60
40
80
20
100
0
Balance Gas
CO_2
CH_4
CH_4:CO_2 = 1
0
20
40
60
80
100

LFG Generation Phases

	PI Start	PI End/ PII Start	PII End/ PIII Start	PIII a	PIII b	P III End/ PIV Start	PIV End
H2	0	9.5	20	0	0	0	0
N2	80	52.5	29	10	5	2	4
O2	20	2.5	0	0	0	0	0
CH4	0	0	0	10	47.5	50	52.5
CO2	0	25	62.5	57.5	47.5	47.5	47.5
Total	**100**	**89.5**	**111.5**	**77.5**	**100**	**99.5**	**104**
Normalized							
Bal	100.0%	71.3%	43.9%	12.9%	5.0%	2.0%	3.8%
CH4	0.0%	0.0%	0.0%	12.9%	47.5%	50.3%	50.5%
CO2	0.0%	28.7%	56.1%	74.2%	47.5%	47.7%	45.7%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**





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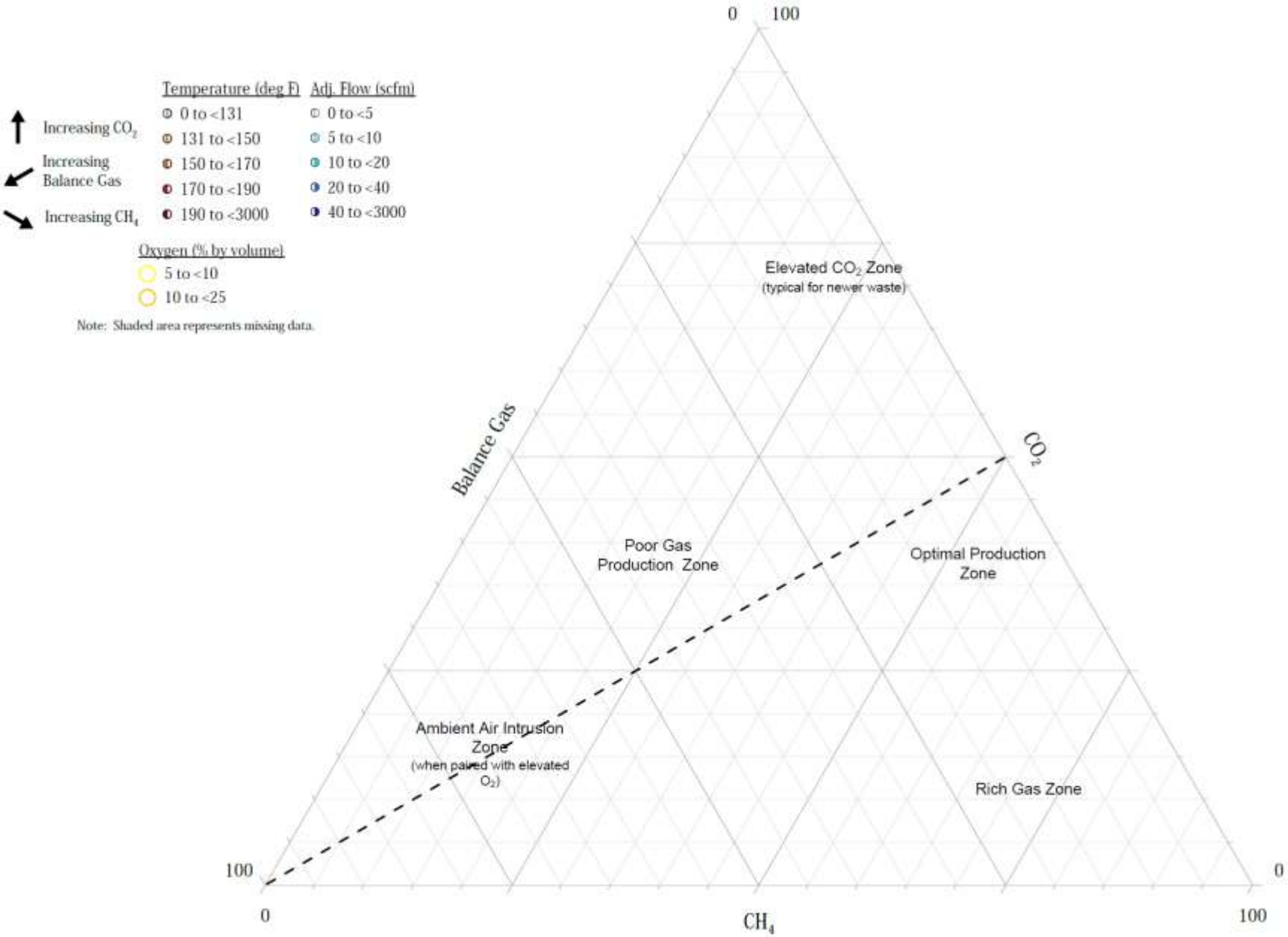
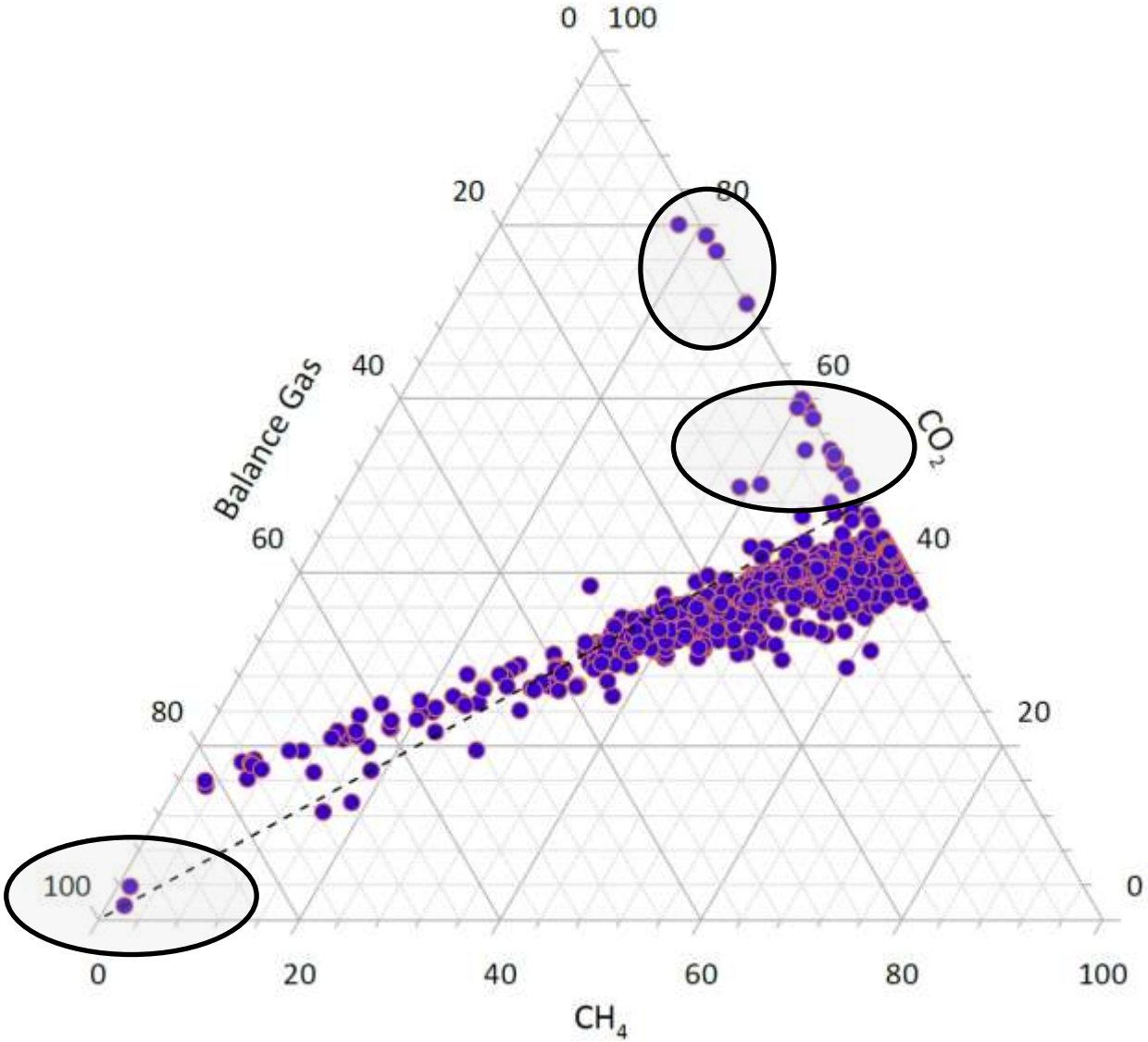
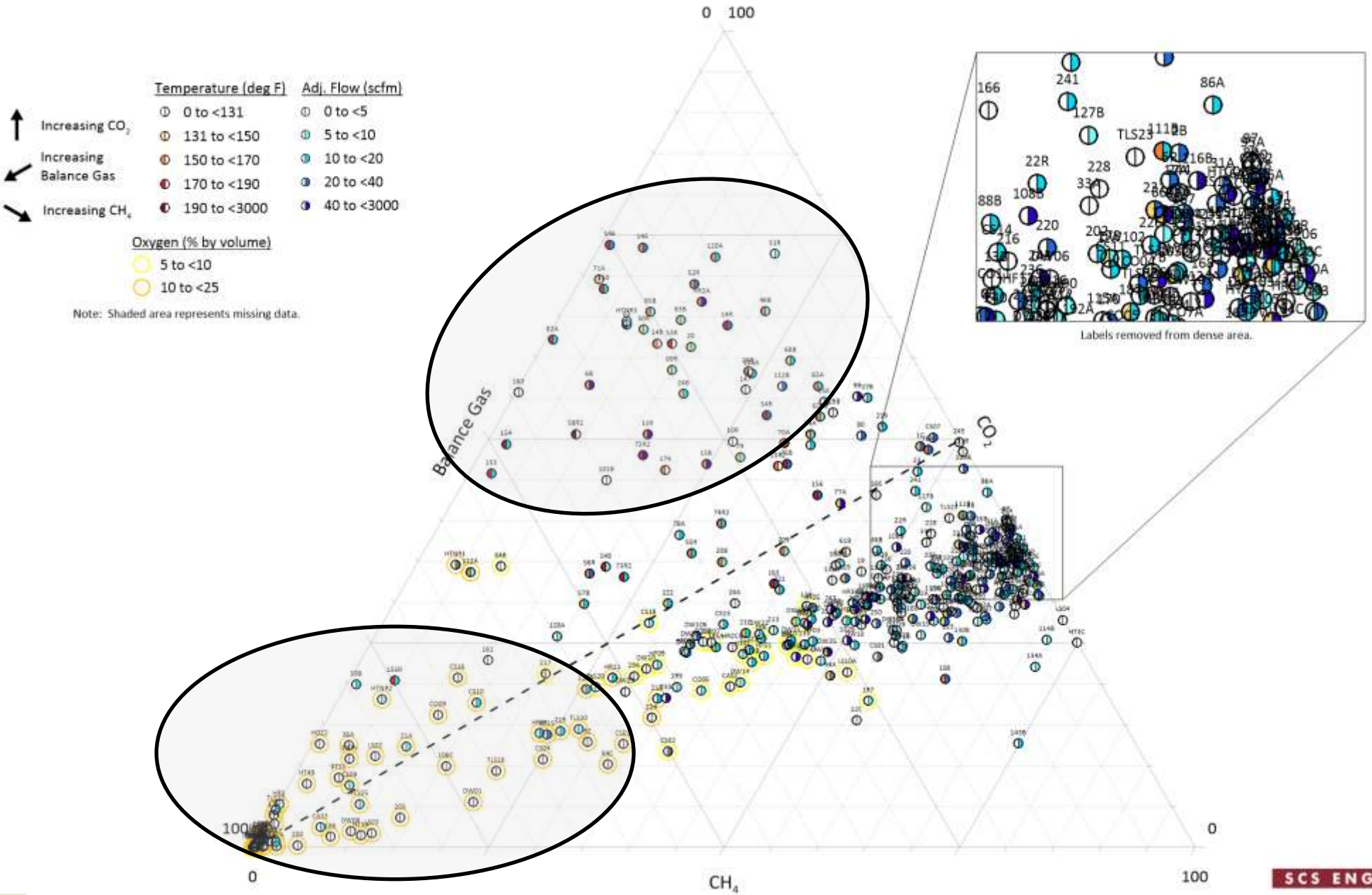
SCS Wellfield Analysis Graph - Zones



SCS Wellfield Analysis Graph
Site 2 – August 2022



SCS Wellfield Analysis Graph – Site 3 – January 2021



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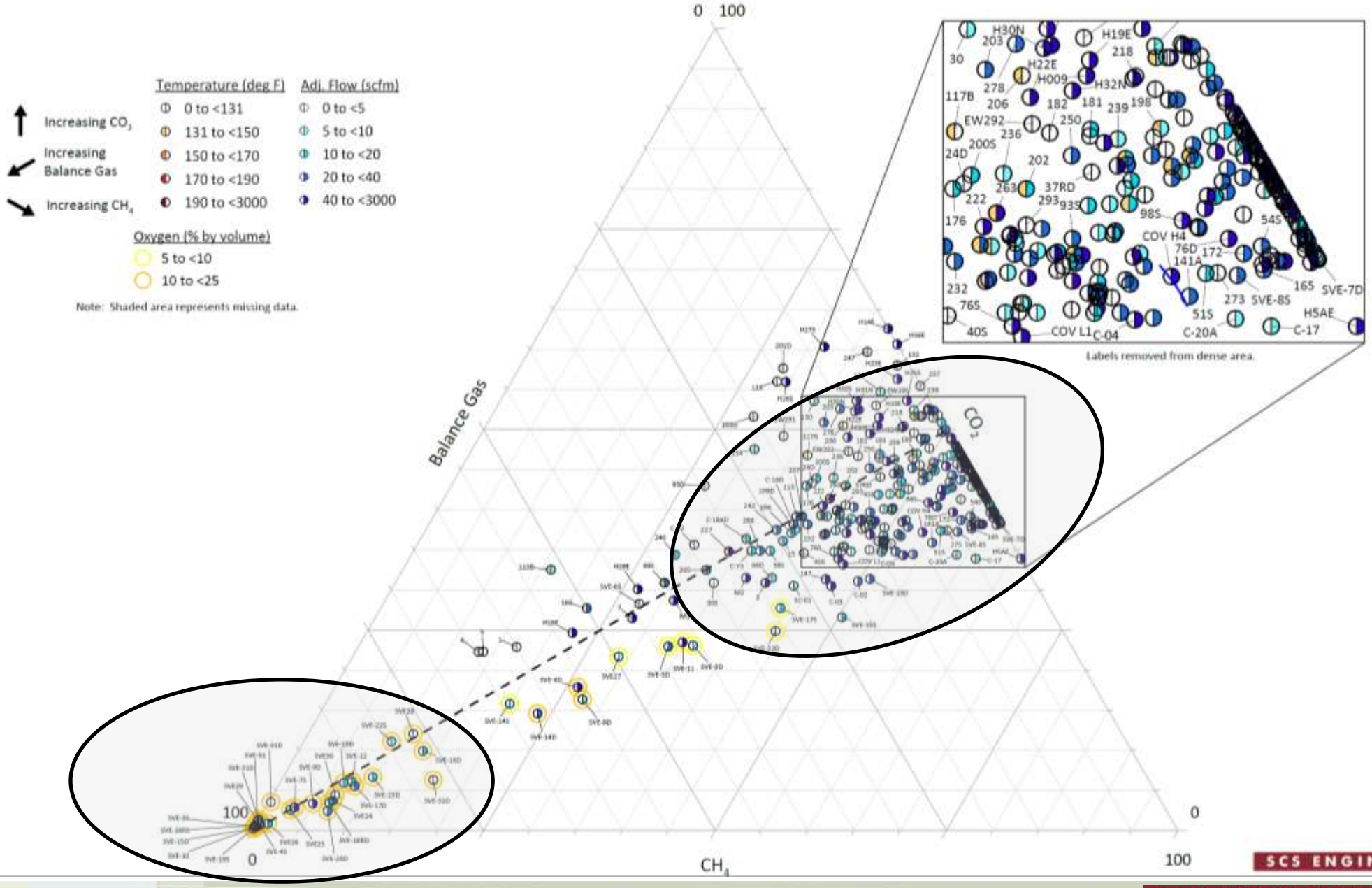
SCS Wellfield Analysis Graph – Site 4 – Early December 2022



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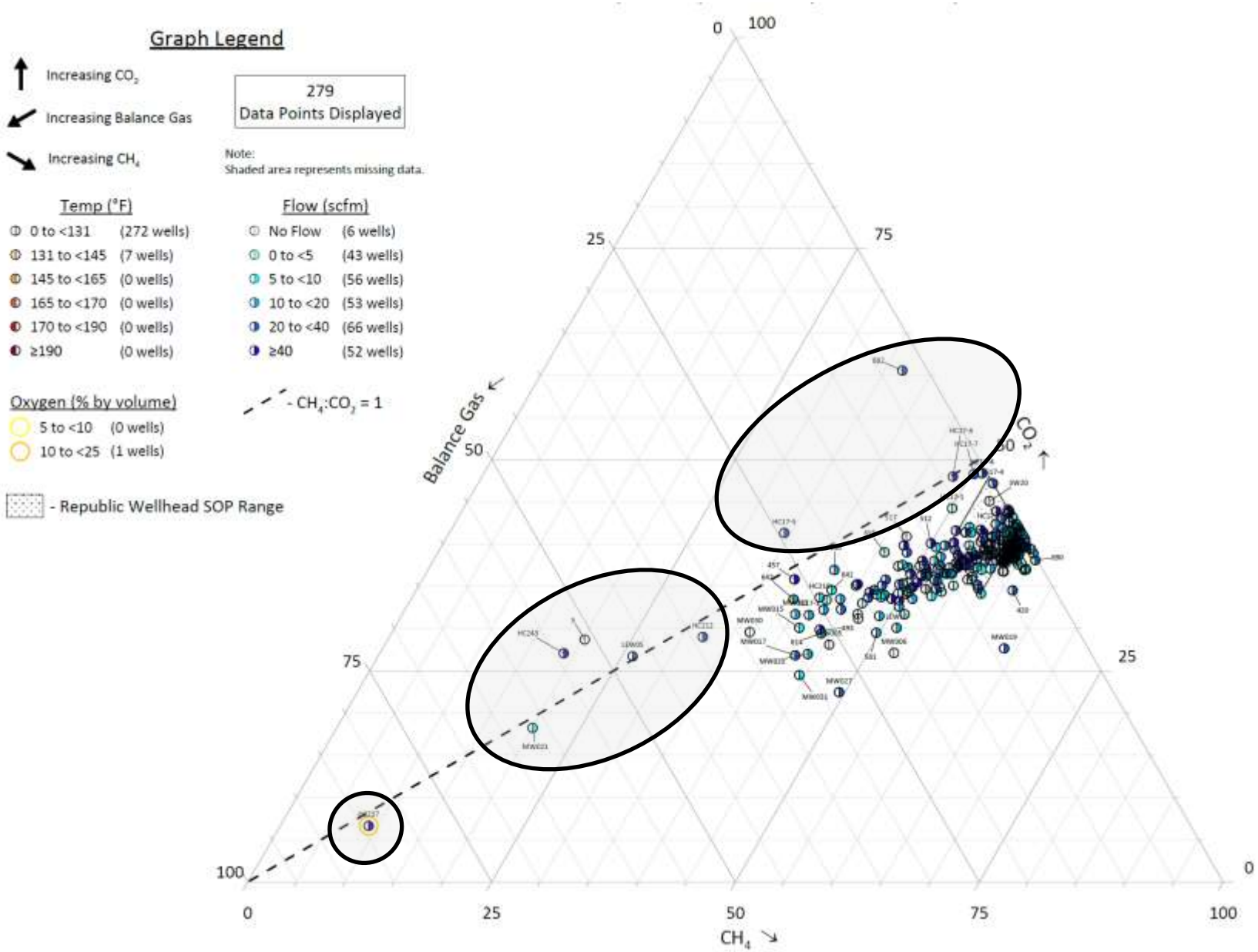
SCS Wellfield Analysis Graph – Site 5 – April 2022



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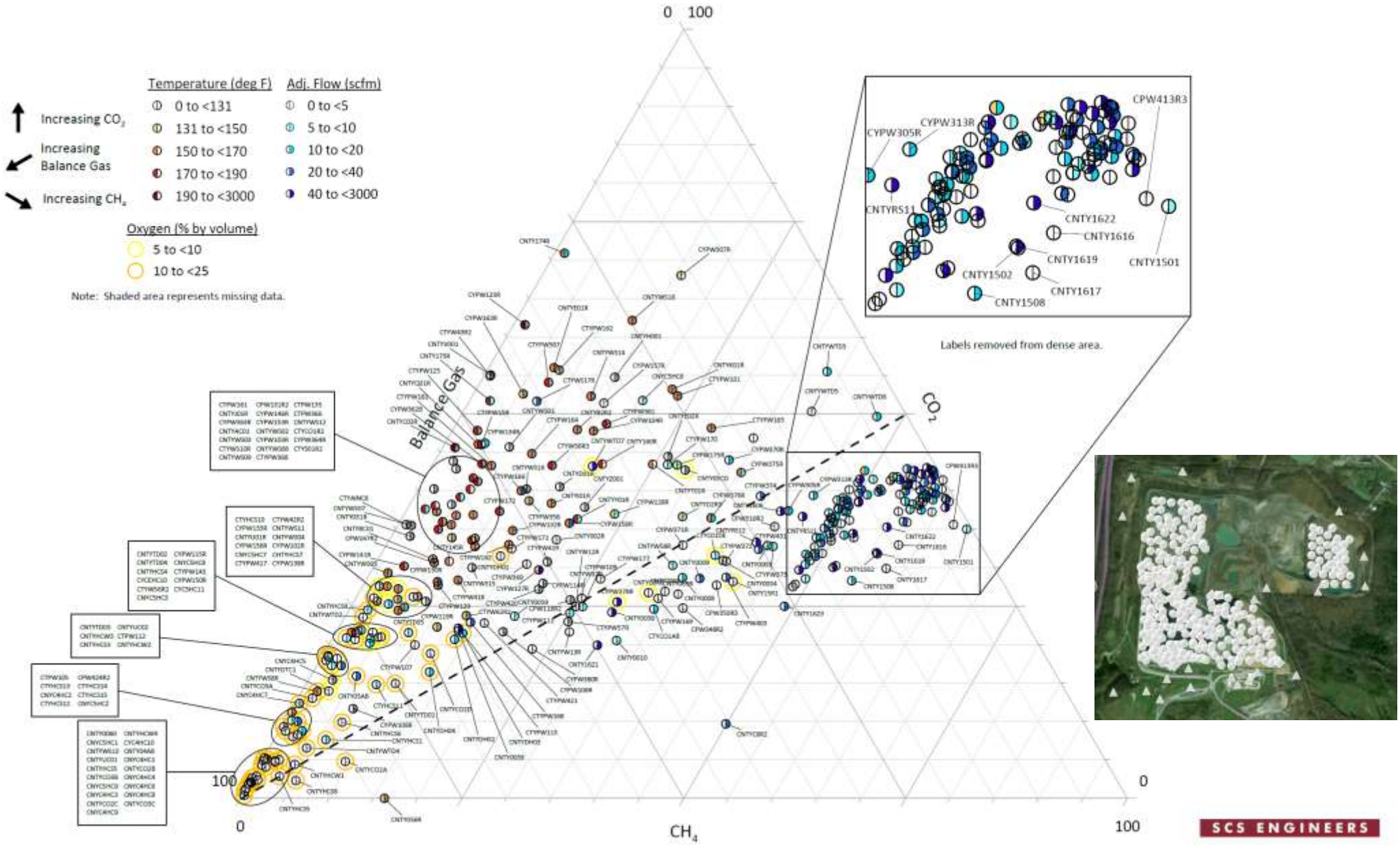
SCS Wellfield Analysis Graph – Site 6 – October 2021



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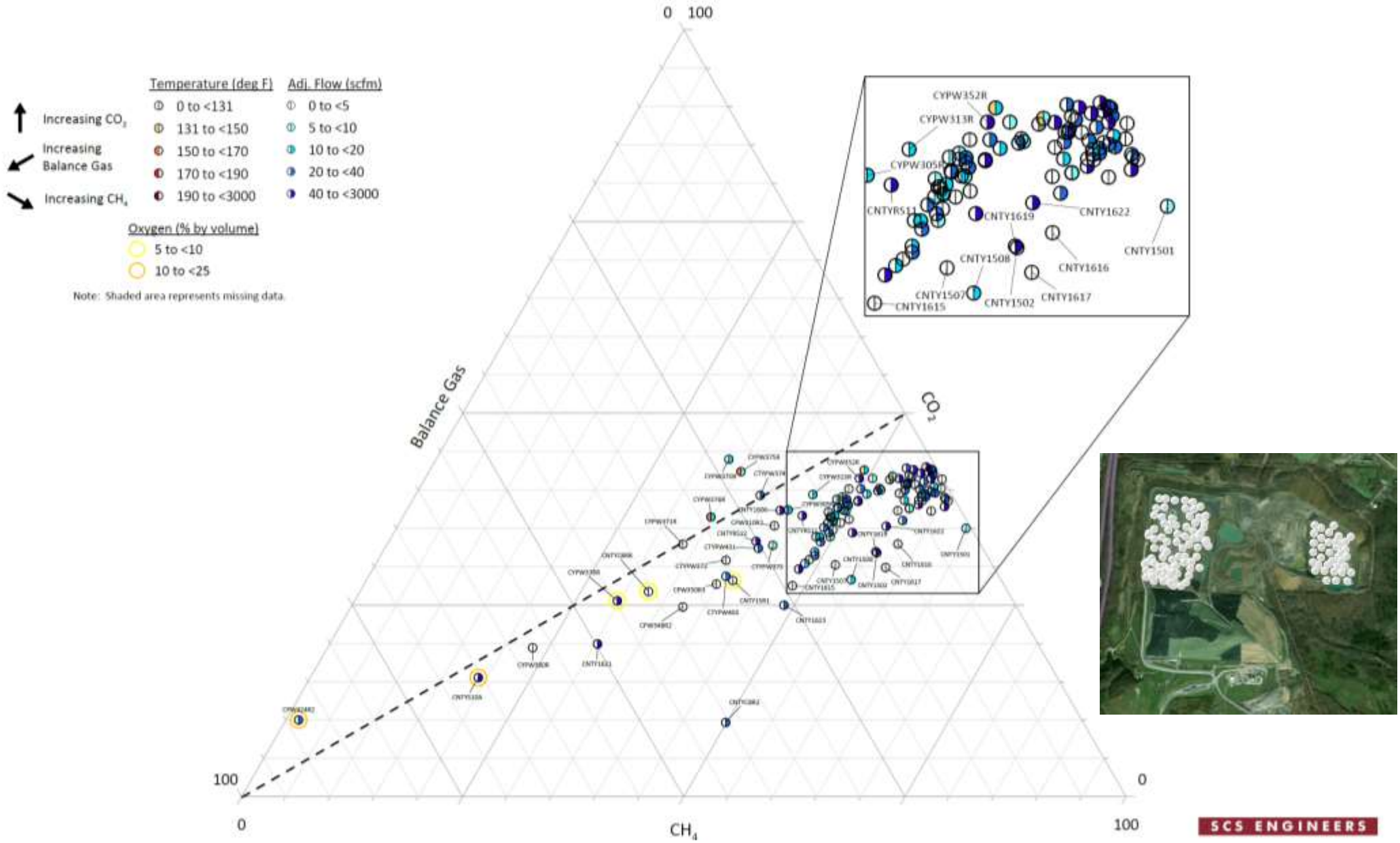
SCS Wellfield Analysis Graph – Site 6 (170 acre area) – October 2021



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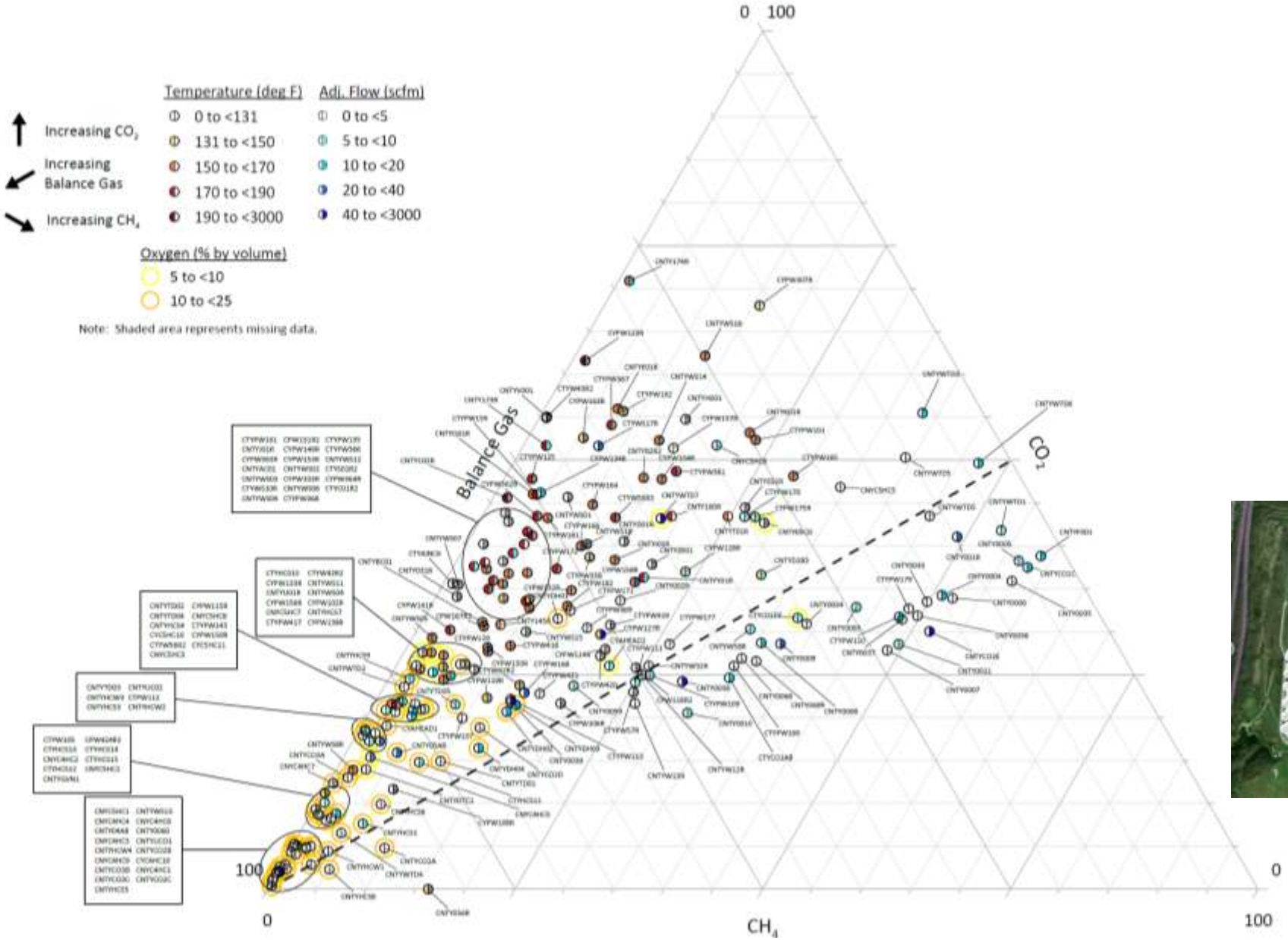
SCS Wellfield Analysis Graph – Site 6 (88 acre area) – October 2021



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Individual Well Analysis

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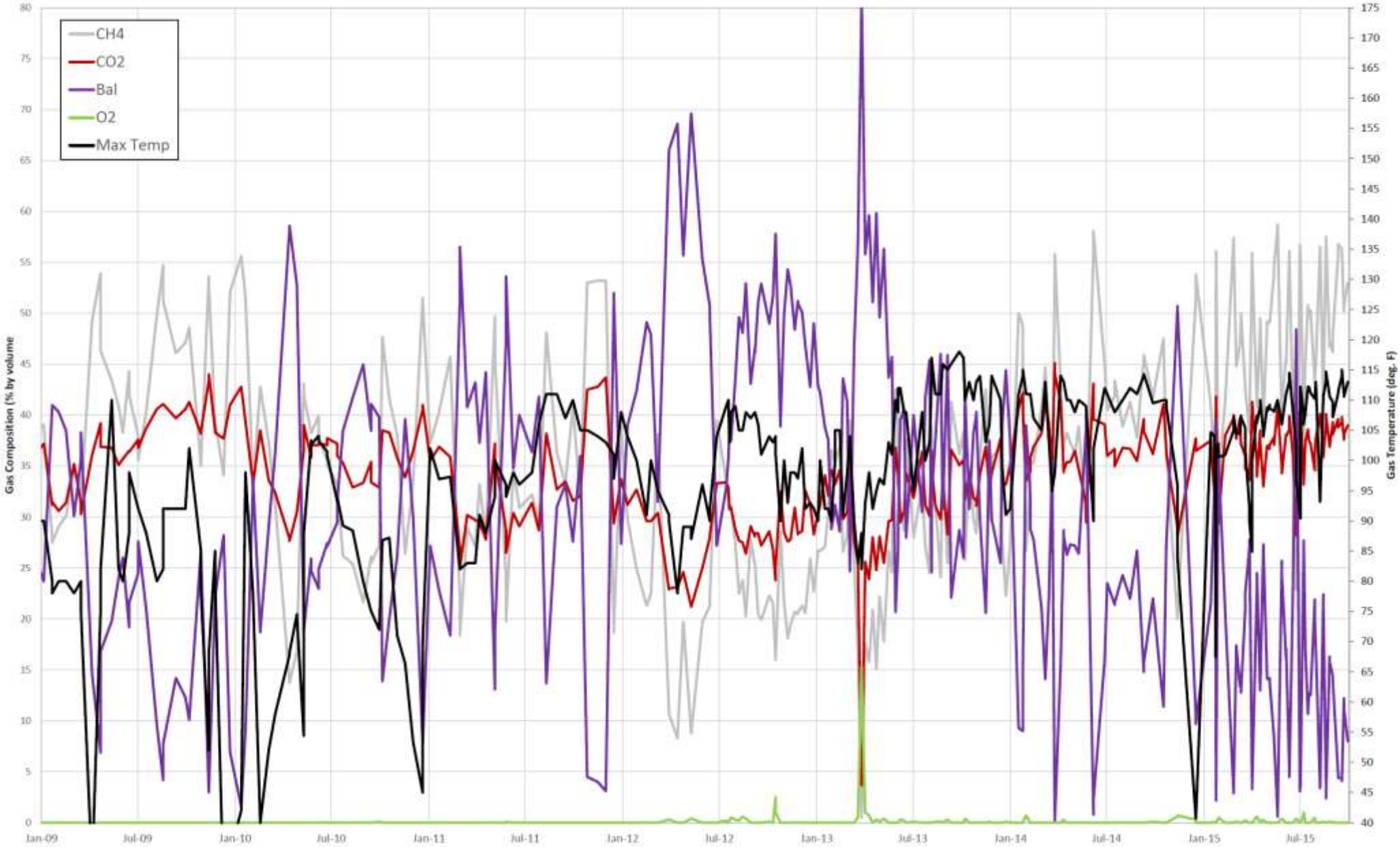
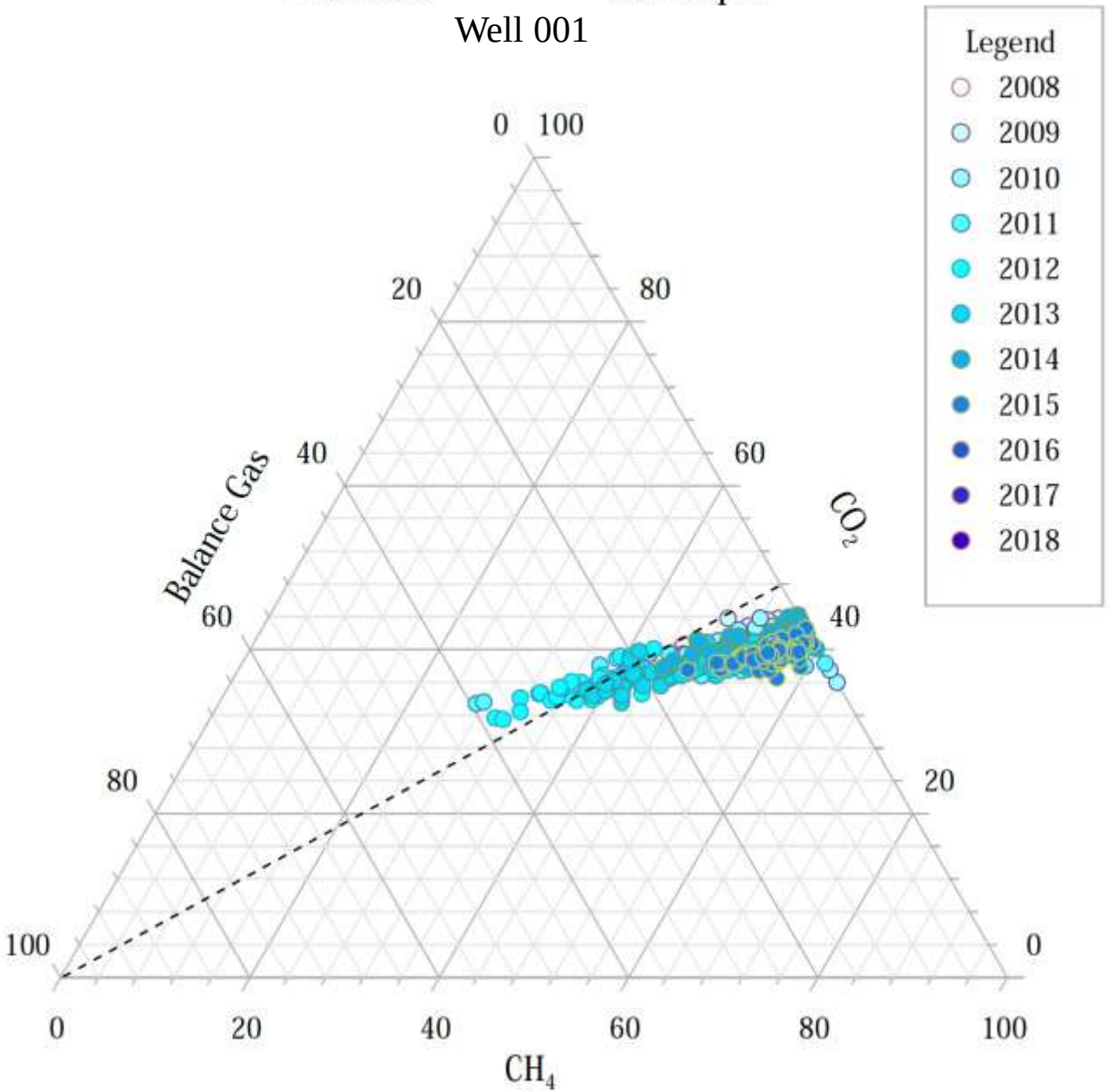
Well 001


CH4
CO2
Bal
O2
Max Temp
Gas Composition (% by volume
Gas Temperature (deg. F)
Jan-09
Jul-09
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15
Jul-15

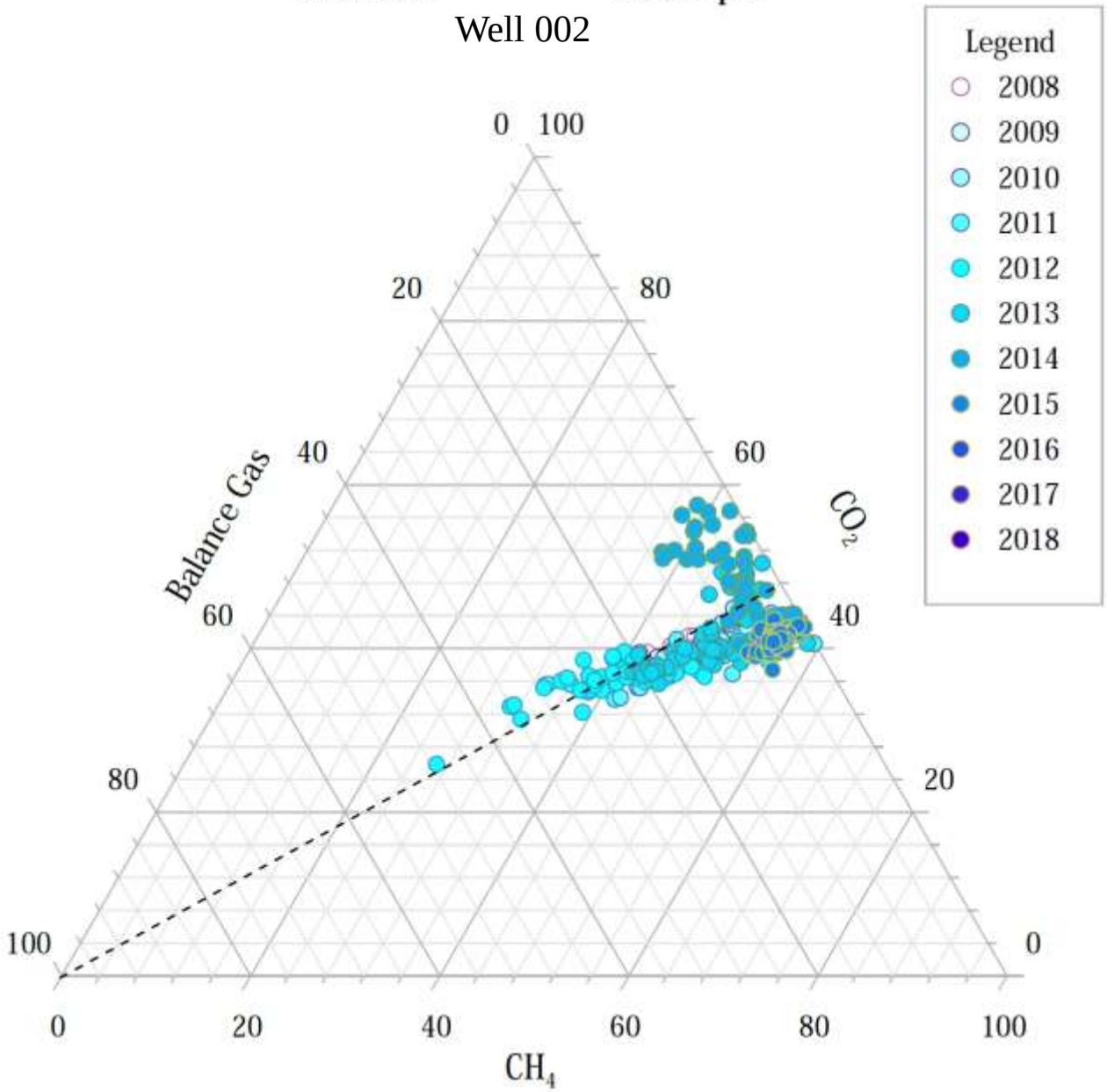
Wellhead Composition Graph

Well 001



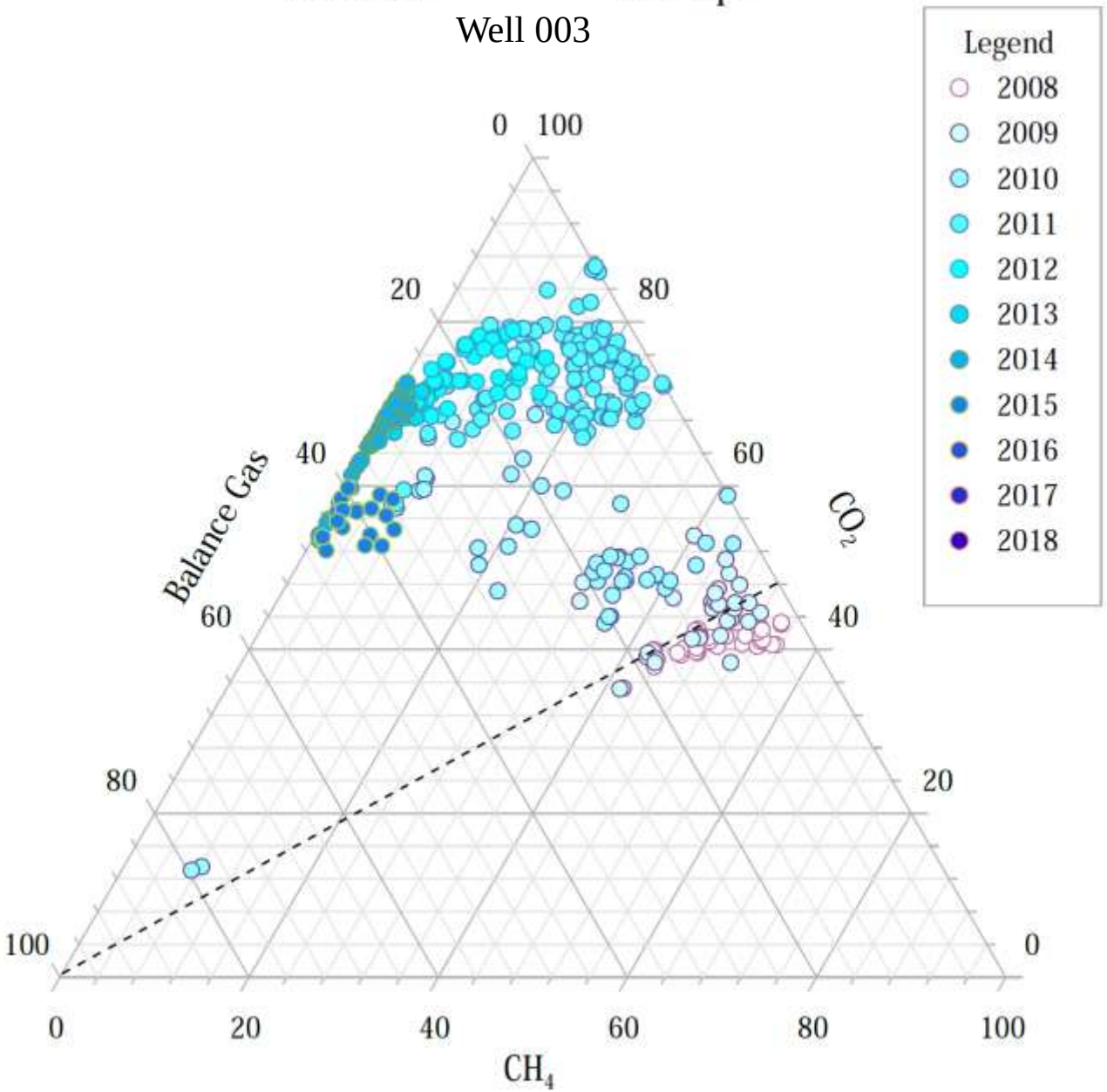
Wellhead Composition Graph

Well 002



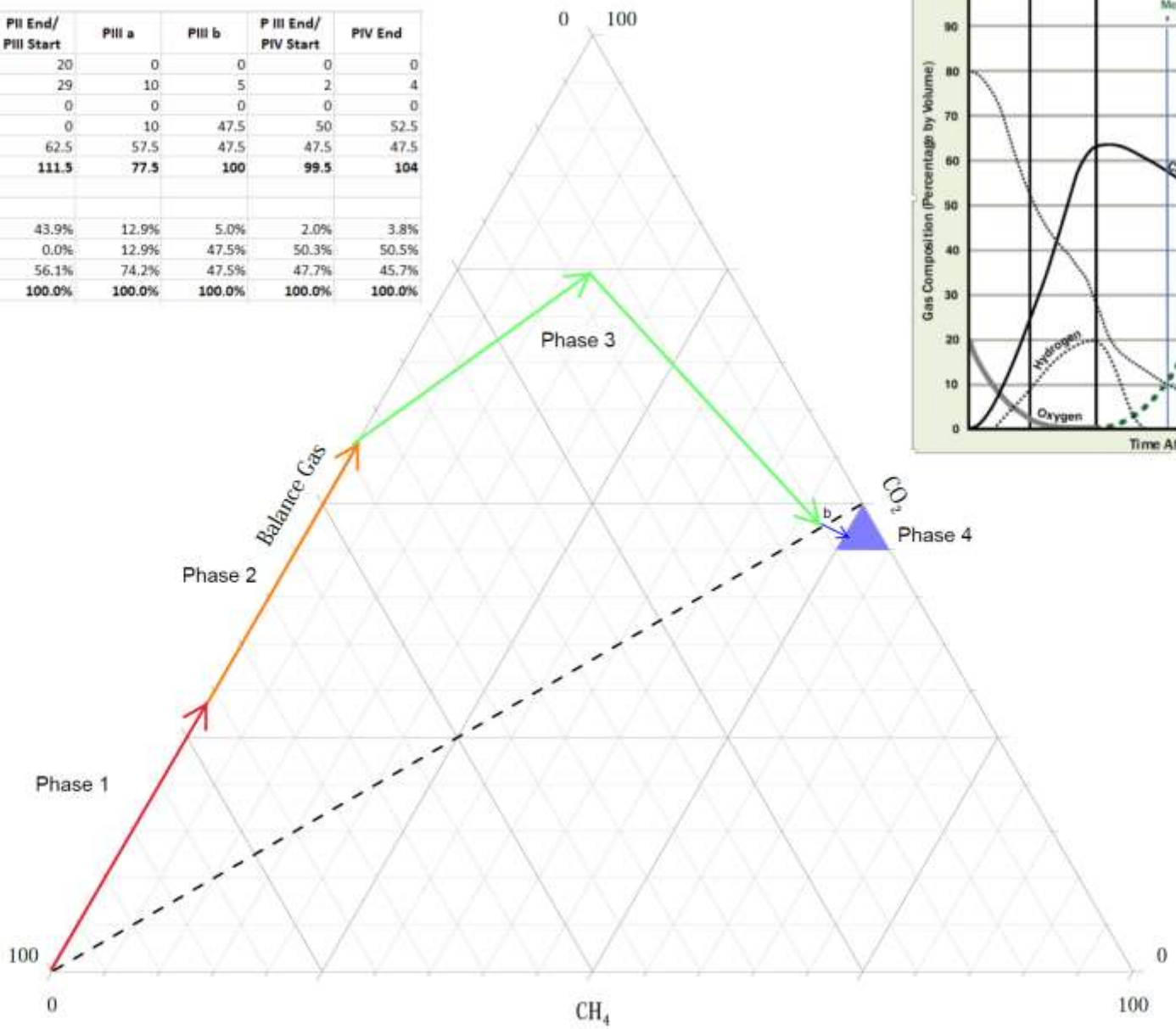
Wellhead Composition Graph

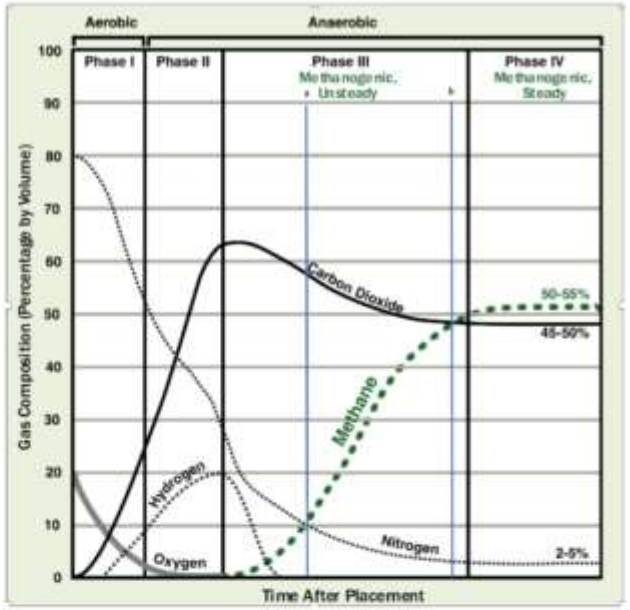
Well 003



LFG Generation Phases

	PI Start	PI End/ PII Start	PII End/ PIII Start	PIII a	PIII b	P III End/ PIV Start	PIV End
H2	0	9.5	20	0	0	0	0
N2	80	52.5	29	10	5	2	4
O2	20	2.5	0	0	0	0	0
CH4	0	0	0	10	47.5	50	52.5
CO2	0	25	62.5	57.5	47.5	47.5	47.5
Total	**100**	**89.5**	**111.5**	**77.5**	**100**	**99.5**	**104**
Normalized							
Bal	100.0%	71.3%	43.9%	12.9%	5.0%	2.0%	3.8%
CH4	0.0%	0.0%	0.0%	12.9%	47.5%	50.3%	50.5%
CO2	0.0%	28.7%	56.1%	74.2%	47.5%	47.7%	45.7%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**





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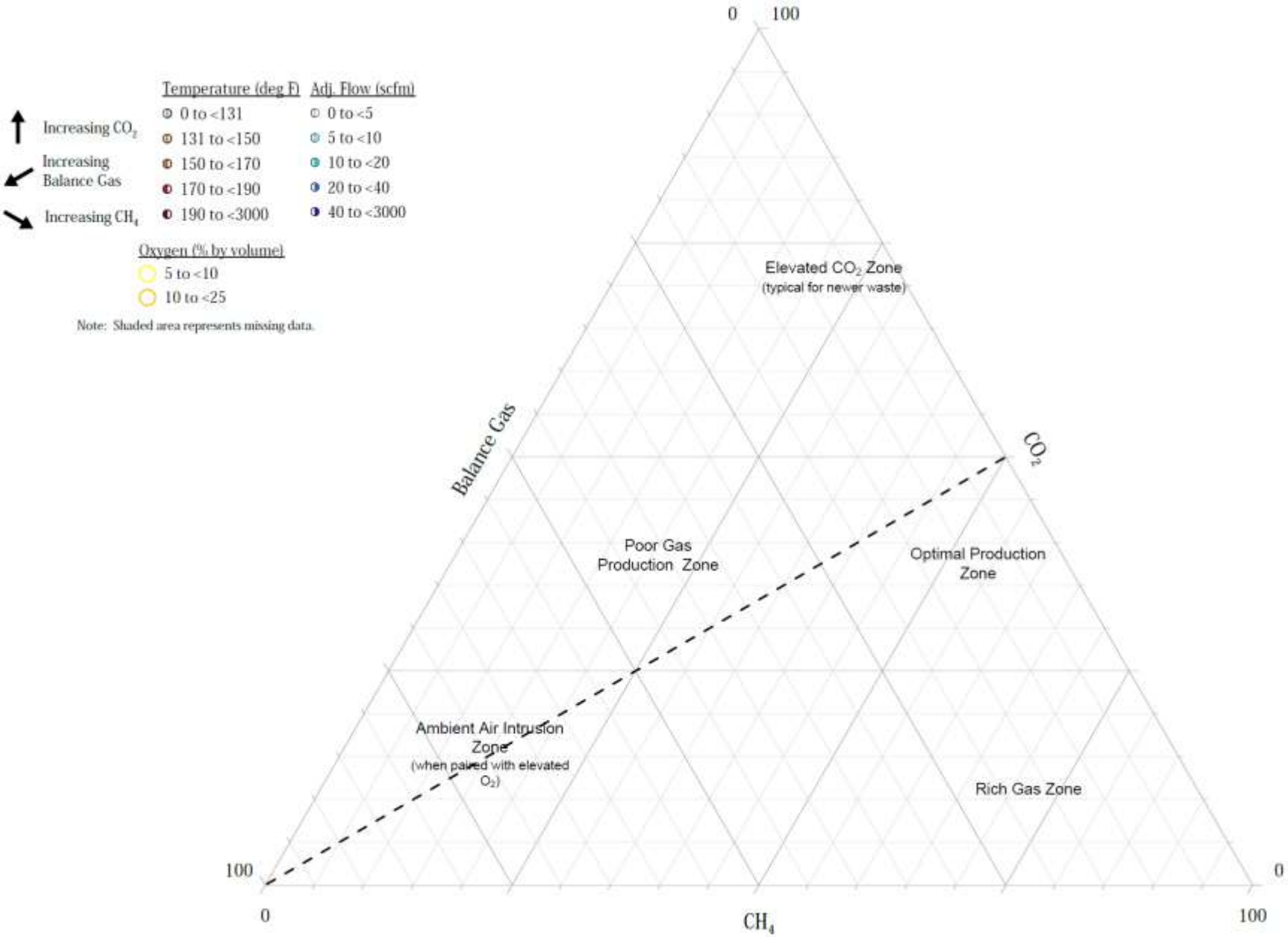
SCS Wellfield Analysis Graph - Zones



Data Processing

- Monthly wellfield
  - Pull monthly LFG dataset
  - Use most recent reading for each well
- Wellhead
  - Pull all readings
- Normalize dataset
  - $CH_4+CO_2+Bal = 1$
- Post onto a Ternary Graph
  - I used Grapher by Golden Software

Questions and Comments?

Thanks for Your Time

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SCS Engineers

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