You Can't Run A Plant Using Science!

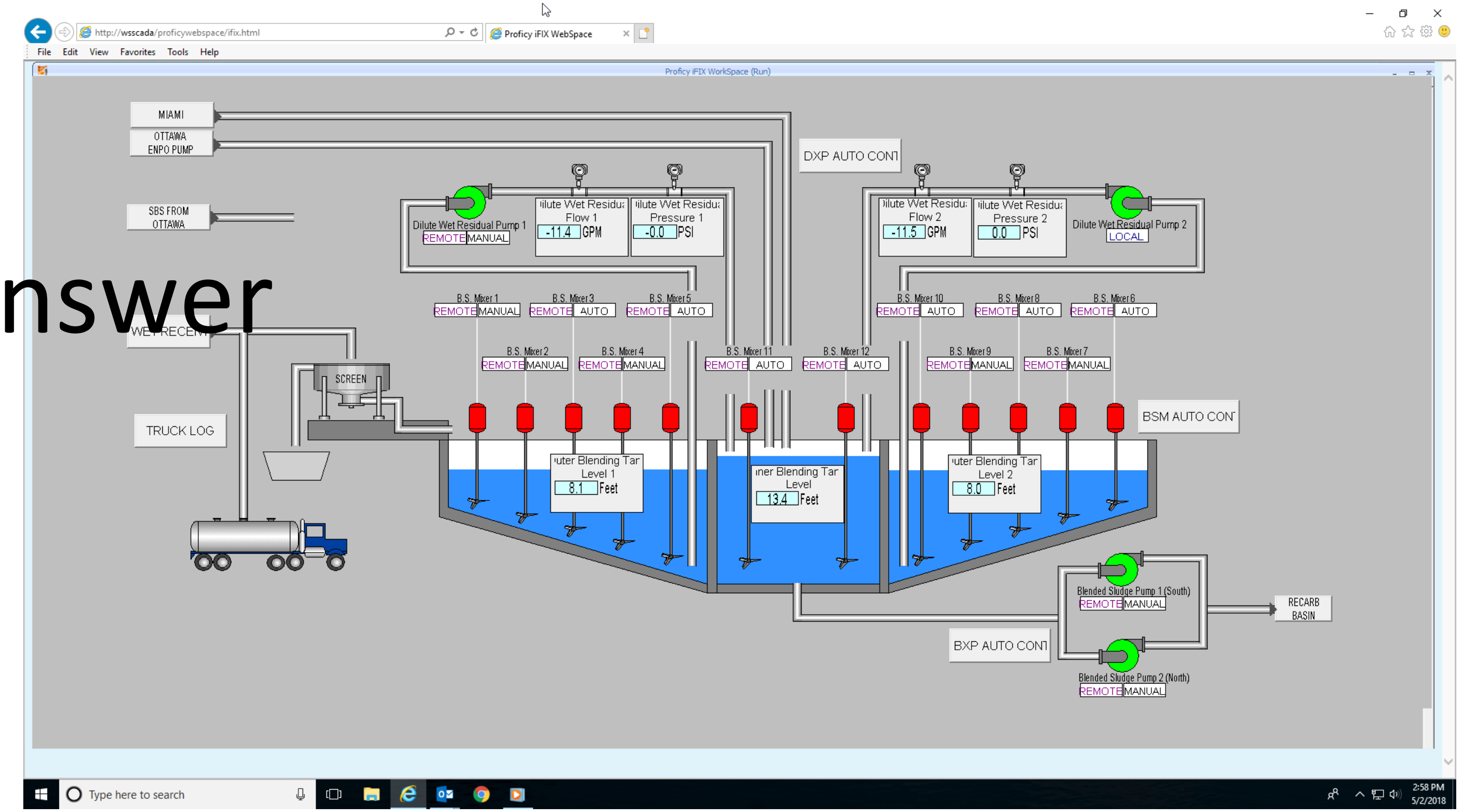
(*Psst…Yes You Can!*)

Using Lab, SCADA, Operational, and Design data to predict and optimize plant performance

DAYTON

Agenda

- Background
- Questions to Answer
- Data Sources
- Solutions
- Conclusions



Dayton Water System

- Ottawa WTP
  - 1952
  - Conventional Treatment
  - Precipitative Lime Softening
  - 96 MGD Design Capacity
  - 40 MGD Average Daily

Lime Reclamation Facility

- Completed in 1957
- 150 tpd Capacity
- Recycle softening residuals
- CaO reused at WTPs

Techniques and Economics of Calcining Softening Sludges

Joint Discussion

A joint discussion presented on Jul. 14, 1959, at the Annual Conference, San Francisco, Calif.

Calcination Techniques—*William B. Crow*

A paper presented by William B. Crow, Cons. Engr., Black & Assocs., Inc., Gainesville, Fla.

RECALCINATION of softening plant sludge is a process in which the sludge, concentrated in a centrifuge to at least 60 per cent solids, is burned at 2,000°F, the calcium carbonate and magnesium hydroxide present being converted to oxides.

The greater portion of the carbonate hardness present in natural waters is normally due to calcium bicarbonate,

20–25 per cent excess lime. The difference between the theoretical conversion and actual recovery is attributable to mechanical losses in the dewatering and dust recovery equipment. The calcium carbonate is decomposed by heat, yielding calcium oxide and carbon dioxide as follows:

$$CaCO_3 + \Delta \rightarrow CaO + CO_2\uparrow$$

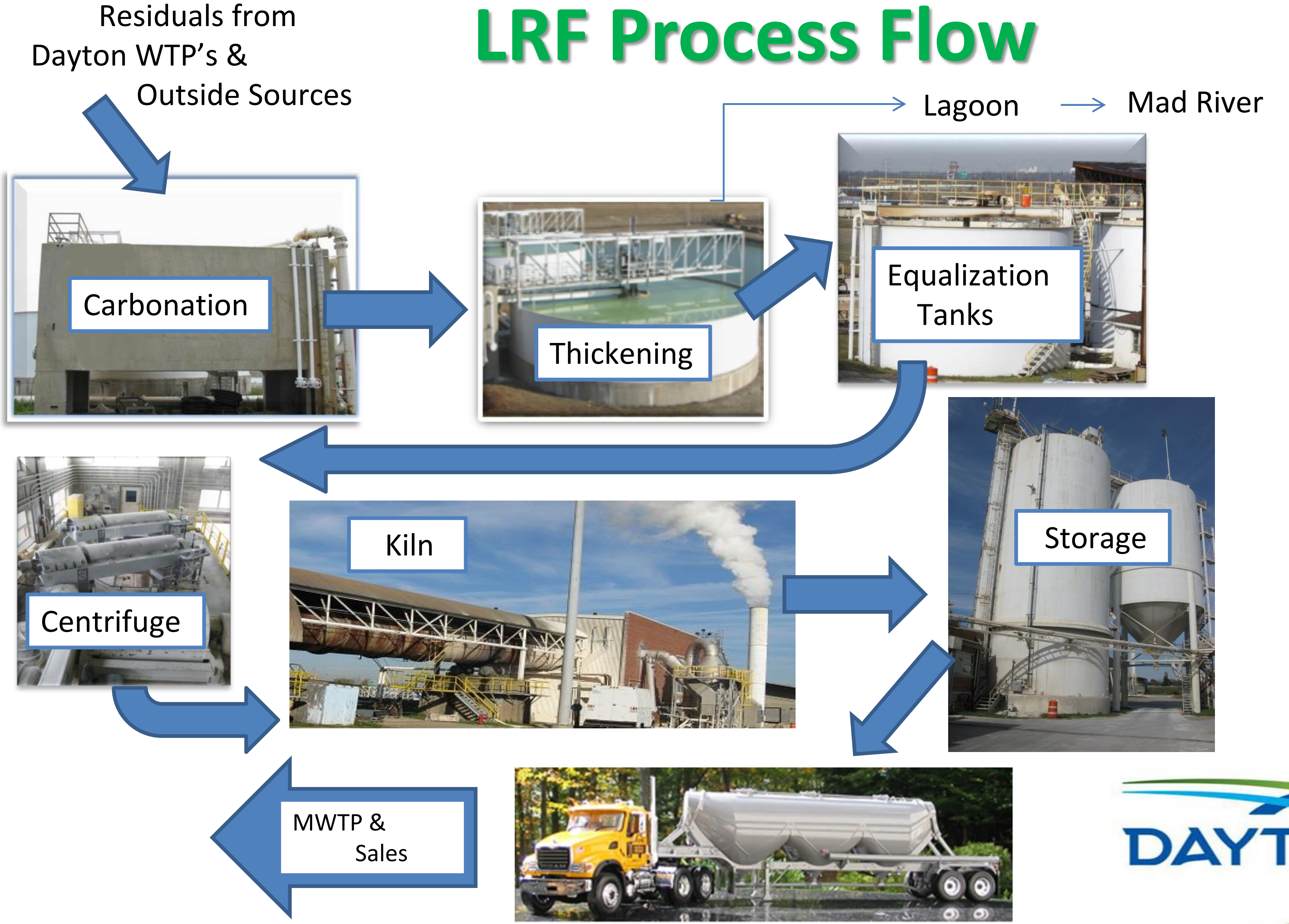
DAYTON

Dayton Water System

- Miami WTP
  - 1965
  - Four Up-flow Clarifiers
  - Precipitative Lime Softening
  - 96 MGD Design Capacity
  - 30 MGD Average Daily

DAYTON

LRF Process Flow



Chemistry of the Kiln

Softening residuals from Dayton WTP's

1st Stage : Carbonation

$$CaCO_3 + Mg(OH)_2 + 2\ CO_2 \rightarrow Mg(HCO_3)_2 + CaCO_3$$

solid   solid   gas from kiln   liquid   process solids

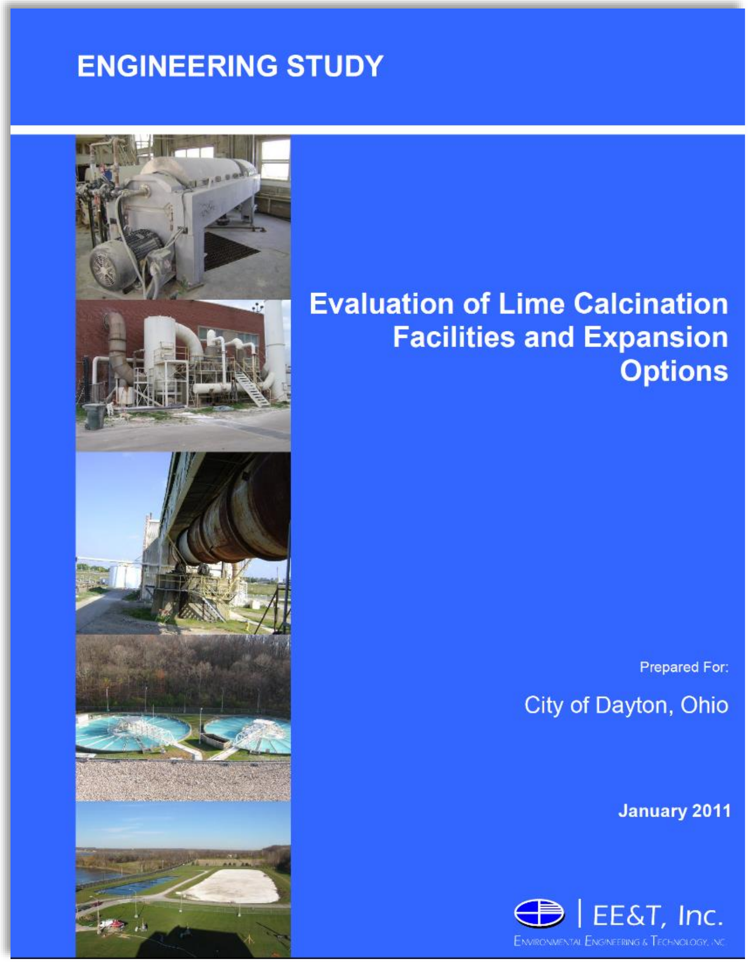
Chemistry of the Kiln

2nd Stage : Calcination

$$CaC0_3 \xrightarrow[\Delta]{} CaO + H_2O + CO_2 \uparrow$$

- 2000° F
- CO_2 for Carbonation in Stage 1

2010 Evaluate LRF



Inception of Importing Residuals

- 2010 EE&T Study
- Proposed a residuals-handling facility
- 2012 Demonstration study

DAYTON

2014 LRF Expansion

City of Dayton, Ohio
Lime Reclamation Expansion
PRELIMINARY DESIGN REPORT

Project #200-23773-14001

December 2014

PRESENTED TO

City of Dayton
Department of Water Supply & Treatment
3210 Chuck Wagner Lane
Dayton, Ohio 45414

PRESENTED BY

Tetra Tech, Inc.
250 W. Court Street,
Suite 200 W
Cincinnati, Ohio 45202

P +1-513-333-3676
F +1-513-241-0354
www.tetratech.com

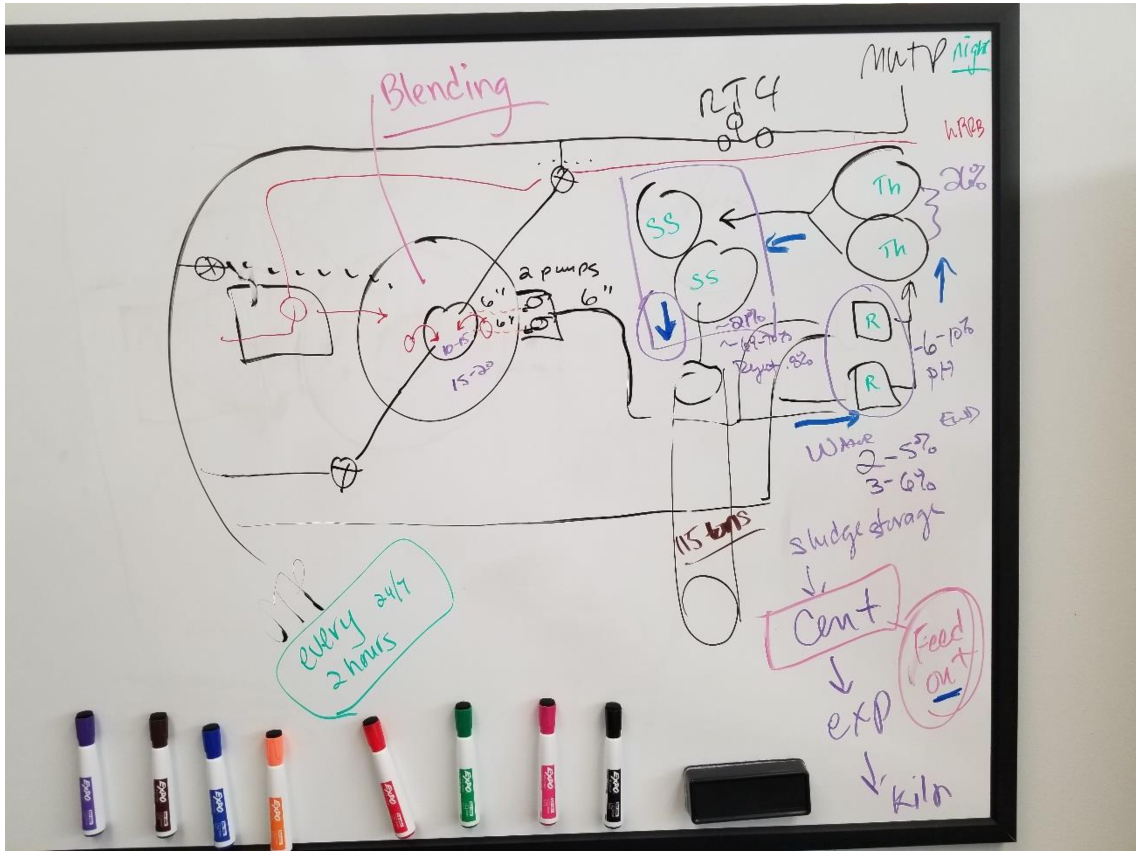
Prepared by:

James Rydquist Project Manager	Date
James Christopher Process Lead	Date

New Facilities

New Facility - New Challenges

- No “shake down” period
- Operators asked to operate differently
- New challenges
- Growing pains
- Much frustration
- Task Force met weekly



DAYTON

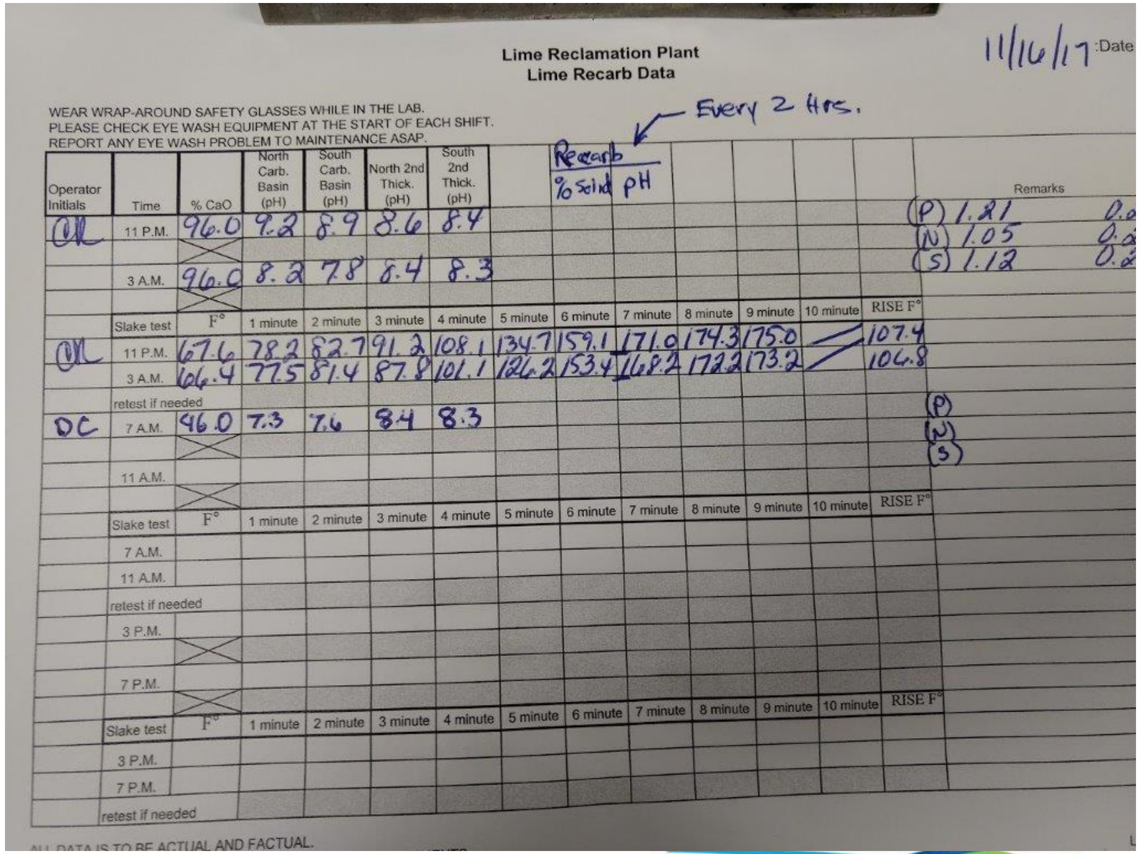
Questions to Answer

- How many pounds of residuals are produced?
- How many gallons of residuals are we pumping?
- What is the WTP pumping rate and schedule?
- Do storage demands meet capacity?
- How much lime are we producing?
- What are our lime quality goals?
- What are the critical parameters to produce quality lime?
- Were our previous assumptions correct?

DAYTON

Data Sources

- Lab Water Quality Data
  - Raw and Effluent data
  - Stoichiometry of Rx
- Operator Logs
  - Pumping scheme
  - Operational changes
- SCADA iHistorian Query
  - SCADA stores lots of data
  - Administrator can show you



Lime Reclamation Plant
Lime Recarb Data

11/16/17 :Date

WEAR WRAP-AROUND SAFETY GLASSES WHILE IN THE LAB.
PLEASE CHECK EYE WASH EQUIPMENT AT THE START OF EACH SHIFT.
REPORT ANY EYE WASH PROBLEM TO MAINTENANCE ASAP.

Every 2 Hrs.

Operator Initials	Time	% CaO	North Carb. Basin (pH)	South Carb. Basin (pH)	North 2nd Thick. (pH)	South 2nd Thick. (pH)		Recarb %Solid	pH	Remarks
[illegible]	11 P.M.	96.0	9.2	8.9	8.6	8.4				(P) 1.21 / (N) 1.05 / (S) 1.12
	3 A.M.	96.0	8.2	7.8	8.4	8.3				

Operator Initials	Slake test	F°	1 minute	2 minute	3 minute	4 minute	5 minute	6 minute	7 minute	8 minute	9 minute	10 minute	RISE F°
[illegible]	11 P.M.	67.6	78.2	82.7	91.2	108.1	134.7	159.1	171.0	174.3	175.0		107.4
	3 A.M.	66.4	77.5	81.4	87.8	101.1	126.2	153.4	168.2	172.2	173.2		106.8
	retest if needed												

Operator Initials	Time	% CaO	North Carb. Basin (pH)	South Carb. Basin (pH)	North 2nd Thick. (pH)	South 2nd Thick. (pH)	Remarks
DC	7 A.M.	46.0	7.3	7.6	8.4	8.3	(P) (N) (S)
	11 A.M.						

Slake test	F°	1 minute	2 minute	3 minute	4 minute	5 minute	6 minute	7 minute	8 minute	9 minute	10 minute	RISE F°
7 A.M.												
11 A.M.												
retest if needed												

Time	% CaO
3 P.M.	
7 P.M.	

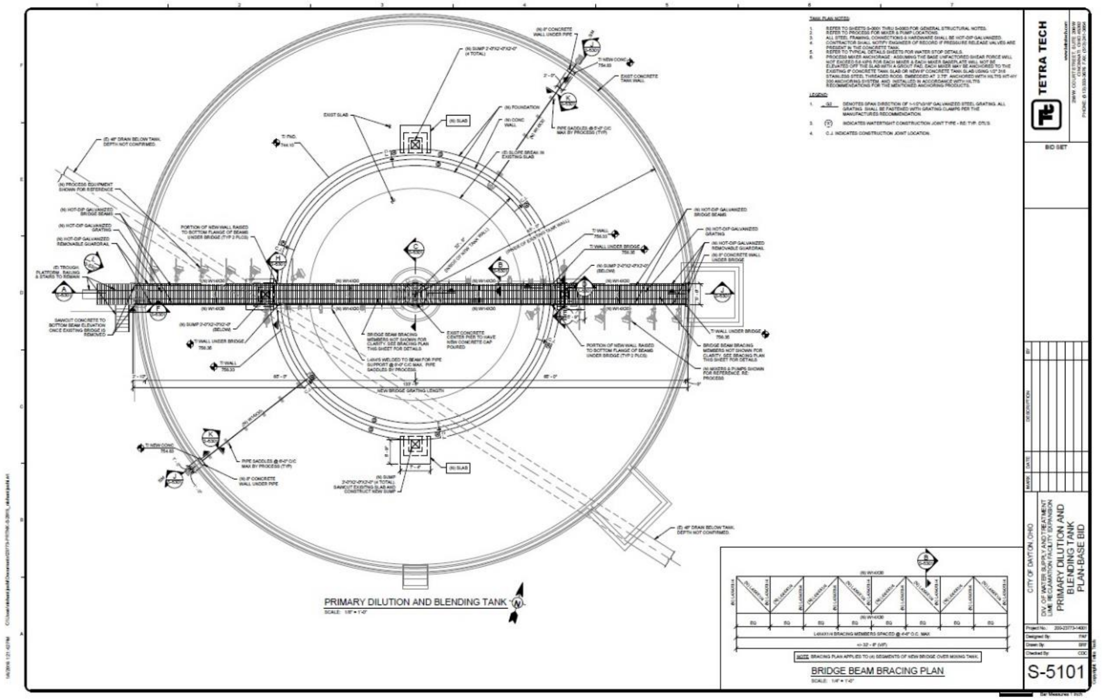
Slake test	F°	1 minute	2 minute	3 minute	4 minute	5 minute	6 minute	7 minute	8 minute	9 minute	10 minute	RISE F°
3 P.M.												
7 P.M.												
retest if needed												

ALL DATA IS TO BE ACTUAL AND FACTUAL.

DAYTON

Data Sources

- Plant Diagrams
  - Storage Capacity
  - Piping, valves
- Equipment Specs
  - Pump curves
- Operator's Knowledge
  - Hands-on knowledge
  - Day-to-day Operations knowledge



How Much Solids Are We Producing?

- If You Know:
  - Raw Water Quality
  - Finished Water Quality
  - Water Production
  - Stoichiometry
- Solids Produced

Chemistry of Lime Softening

$$CO_2 + Ca(OH)_2 \rightarrow CaCO_3\downarrow + H_2O$$

$$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3\downarrow + 2H_2O$$

$$Mg(HCO_3)_2 + Ca(OH)_2 \rightarrow MgCO_3 + CaCO_3\downarrow + 2H_2O$$

$$MgCO_3 + Ca(OH)_2 \rightarrow Mg(OH)_2\downarrow + CaCO_3\downarrow$$

DAYTON

Lab Data

Sample Collect Start	Water Production, MGD	Total Alkalinity, mg/L $CaCO_3$	Calcium Hardness, mg/L $CaCO_3$	Mg Hardness, mg/L $CaCO_3$	Turbidity, NTU	pH, S.U.	CO_2, mg/L $CaCO_3$	Ca Hardness, mg/L $CaCO_3$	Mg Hardness, mg/L $CaCO_3$	Turbidity	OWTP Ca Removal, mg/L $CaCO_3$	OWTP Mg Removal, mg/L $CaCO_3$	OWTP Turb Removal, NTU	OWTP CO_2 Removal, mg/L $CaCO_3$	OWTP Ca Removal, Tons	OWTP Mg Removal, Tons	OWTP Turb Removal, Tons	OWTP CO_2 Removal, Tons	OWTP Residual Production, Tons/MG	OWTP Residual Production, Tons	Theoretical CaO Produced, Tons
1-Mar	37.06	276	204	126	3.57	7.52	17.49	72	92	0.029	264	88.4	5.31	17.49	40.80	13.66	0.82	2.70	1.56	57.98	30.50
2-Mar	41.63	276	206	132	6.41	7.5	18.30	58	105	0.03	296	70.2	9.57	18.30	51.38	12.19	1.66	3.18	1.64	68.41	35.60
3-Mar	42.4																				
4-Mar	42.84																				
5-Mar	40.11	272	194	130	2.97	7.55	16.10	44	125	0.023	300	13	4.42	16.10	50.18	2.17	0.74	2.69	1.39	55.78	29.32
6-Mar	37.97	274	194	130	2.64	7.56	15.85	48	114	0.033	292	41.6	3.91	15.85	46.23	6.59	0.62	2.51	1.47	55.95	29.58
7-Mar	36.91	272	202	120	1.72	7.59	14.70	55	114	0.025	294	15.6	2.54	14.70	45.25	2.40	0.39	2.26	1.36	50.31	26.69
8-Mar	35.37																				
9-Mar	40.52	266	200	130	2.56	7.7	11.20	58	114	0.025	284	41.6	3.80	11.20	47.99	7.03	0.64	1.89	1.42	57.55	30.81
10-Mar	42.99																				
11-Mar	44.9																				
12-Mar	45.02	262	180	130	2.63	7.67	11.81	44	113	0.022	272	44.2	3.91	11.81	51.06	8.30	0.73	2.22	1.38	62.31	33.24
13-Mar	39.21																				
14-Mar	37.09	264	194	122	1.4	7.67	11.90	54	103	0.03	280	49.4	2.06	11.90	43.31	7.64	0.32	1.84	1.43	53.11	28.53
15-Mar	38.43	274	202	118	2.21	7.61	14.15	63	103	0.023	278	39	3.28	14.15	44.55	6.25	0.53	2.27	1.39	53.59	28.45
16-Mar	39.78	280	194	130	2.31	7.62	14.14	49	114	0.025	290	41.6	3.43	14.14	48.11	6.90	0.57	2.35	1.46	57.92	30.80
17-Mar	45.31																				
18-Mar	42.61																				
19-Mar	36.48	252	180	128	1.34	7.62	12.72	47	113	0.024	266	39	1.97	12.72	40.46	5.93	0.30	1.94	1.33	48.63	25.98
20-Mar	33.56	270	202	118	2.02	7.61	13.95	49	113	0.033	306	13	2.98	13.95	42.82	1.82	0.42	1.95	1.40	47.01	25.00
21-Mar	33.16	274	198	134	2.65	7.62	13.83	54	107	0.025	288	70.2	3.94	13.83	39.82	9.71	0.54	1.91	1.57	51.99	27.74
22-Mar	35.85	276	198	126	2.15	7.58	15.26	48	114	0.035	300	31.2	3.17	15.26	44.85	4.66	0.47	2.28	1.46	52.27	27.73
23-Mar	38.32	276	210	126	2.18	7.62	13.94	62	96	0.035	296	78	3.22	13.94	47.30	12.46	0.51	2.23	1.63	62.50	33.47
24-Mar	42.29																				
25-Mar	38.2																				
26-Mar	34.27	292	200	134	1.29	7.44	22.18	76	86	0.027	248	124.8	1.89	22.18	35.44	17.83	0.27	3.17	1.65	56.72	29.83
27-Mar	32.03	278	186	142	1.36	7.64	13.41	58	115	0.031	256	70.2	1.99	13.41	34.19	9.38	0.27	1.79	1.42	45.63	24.40
28-Mar	31.12	280	200	122	0.853	7.6	14.79	51	120	0.026	298	5.2	1.24	14.79	38.67	0.67	0.16	1.92	1.33	41.43	22.03
29-Mar	30.85	272	188	136	0.881	7.61	14.05	68	99	0.029	240	96.2	1.28	14.05	30.87	12.38	0.16	1.81	1.47	45.22	24.22
AVG	**38.49**	**272.95**	**196.42**	**128.11**	**2.27**	**7.60**	**14.73**	**55.68**	**108.42**	**0.03**	**281.47**	**51.18**	**3.36**	**14.73**	**45.18**	**8.21**	**0.54**	**2.36**	**1.46**	**56.30**	**29.90**
Std Dev	**4.17**	**8.26**	**8.21**	**6.31**	**1.24**	**0.06**	**2.55**	**9.20**	**9.88**	**0.00**	**19.02**	**31.58**	**1.86**	**2.55**	**5.76**	**4.53**	**0.33**	**0.43**	**0.10**	**6.72**	**3.46**
Median	**38.32**	**274**	**198**	**130**	**2.18**	**7.61**	**14.14**	**54**	**113**	**0.027**	**288**	**41.6**	**3.22**	**14.14**	**44.55**	**7.03**	**0.51**	**2.23**	**1.43**	**53.59**	**28.53**
MIN	**30.85**	**252**	**180**	**118**	**0.853**	**7.44**	**11.20**	**44**	**86**	**0.022**	**240**	**5.2**	**1.24**	**11.20**	**30.87**	**0.67**	**0.16**	**1.79**	**1.33**	**41.43**	**22.03**
MAX	**45.31**	**292**	**210**	**142**	**6.41**	**7.7**	**22.18**	**76**	**125**	**0.035**	**306**	**124.8**	**9.57**	**22.18**	**51.38**	**17.83**	**1.66**	**3.18**	**1.65**	**68.41**	**35.60**

Calculate CO2 Removed

$$HCO_3 = \frac{TA - 5.0 * 10^{(pH-10)}}{1 + 0.94 * 10^{(pH-10)}}$$

$$\text{Free } CO_2 = \frac{2 * HCO_3 * 10^{(6-pH)} * 100}{44 \text{ g/mol } CO_2}$$

- Standard Methods 4500-CO_2 D

DAYTON

Residuals Removed

Softening Residuals / MG =

$$8.34*[2*Ca_{removed}+2.6*Mg_{removed}+1.5*NTU_{removed}+CO_{2\ removed}]$$

*JAWWA March 2008 "Implementing Residuals Management: Cost Implications for Coagulation and Softening Plants"

**CO_2 removal not accounted for in original paper.

DAYTON

Residuals Produced

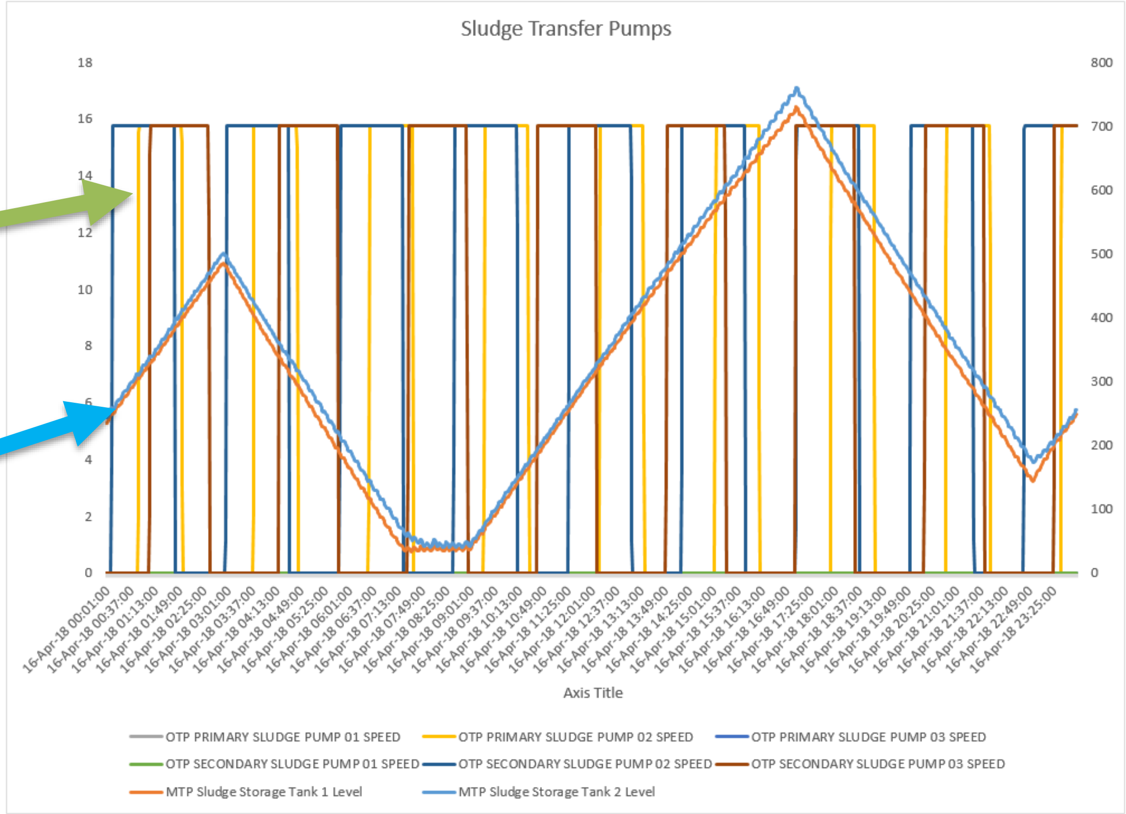
Ottawa	Influent	Effluent	Removal
35 MGD			
Alkalinity	275 mg/L		
Ca Hardness	204 mg/L	58 mg/L	292 mg/L
Mg Hardness	130 mg/L	109 mg/L	54.6 mg/L
pH	7.59		
CO2	15.36 mg/L		15.36 mg/L
Turbidity	3.66 NTU	0.030 NTU	5.445 NTU
lb/MG			3,064 lb/MG
Tons/day			**54 tons/day**

Miami	Influent	Effluent	Removal
34 MGD			
Alkalinity	287 mg/L		
Ca Hardness	223 mg/L	71 mg/L	304 mg/L
Mg Hardness	127 mg/L	80 mg/L	122.2 mg/L
pH	7.40		
CO2	23.27 mg/L		23.27 mg/L
Turbidity	1.91 NTU	0.04 NTU	2.655 NTU
lb/MG			3,771 lb/MG
Tons/day			**64 tons/day**

DAYTON

What is our pumping rate and schedule?

- Joe* says, "*Ottawa sludge pumps run 40 min out of 120 min*"
  - True for one pump
  - But we have **6 pumps**
- Jack* says, "*Miami only pumps sludge at night*"
  - Unless the tanks are full
- **Verify, don't assume**
  - Query SCADA
  - 24 hr graph



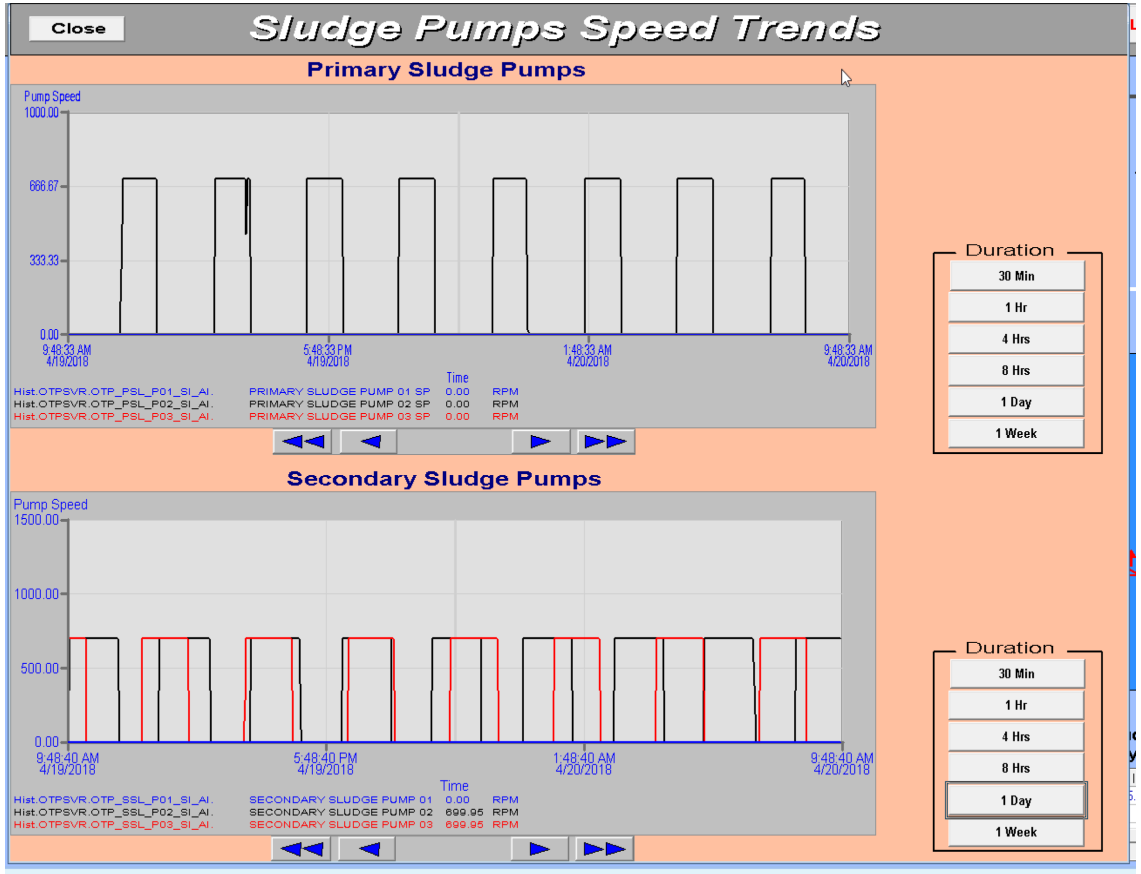
*Names have been changed to protect the innocent

Query SCADA

- Miami Tank Level
  - Convert to gallons
- Ottawa Pump Speed
  - Convert rpm to gpm
- Ottawa Run Time

How many gallons of residuals are we *really* pumping?

- SCADA: Run Times
  - Query SCADA
  - Run time and frequency
  - Is scale correct?
    - Says 700 gpm, but is it?
- Pump and Motor Specs



DAYTON

What's our *real* pumping rate?

- Primary Sludge Pump Speed
  - Verify Pump Rate
  - Pump Specs
    - 1000 gpm @ 900 rpm
  - Remember SCADA said 700 gpm, but actually rpm

= 700 rpm/900 rpm * 1000 gpm

= **778 gpm** → **11% more**

Dayton, OH WWTP
AS43079

EQUIPMENT LIST

PRIMARY SLUDGE PUMPS
PSL-P001-01, PSL-P001-02, PSL-P001-03

QTY	EQUIPMENT	DESCRIPTION	
3	Moyno Model 1K620G1 CDQ ASA, Single Stage Progressive Cavity Pump with Shaft Sleeve	Design Flow:	1000 GPM @ 40 ft
		Pump Speed:	180 RPM
		Inlet:	10" 125# FF
		Discharge:	10" 125# FF
		Rotor:	Tool Steel/Chrome Plated
		Stator:	Nitrile
		Castings:	Cast Iron
		Bearings:	B10 Life Min 30,000 hours
		Inspection Ports:	(2) 180° apart on suction housing
3	60 HP Reliance Electric AC Motor	RPM:	900
		Voltage:	230/460
		Phase:	3
		Cycle:	60
		Enclosure:	PROT-XE (Energy

DAYTON

What's our *real* pumping rate?

- Secondary Sludge Pump Speed
  - Verify Pump Rate
  - Pump Specs
    - 500 gpm @ 1200 rpm
  - Remember SCADA said 700 gpm, but actually rpm

= 700 rpm/1200 rpm * 500 gpm

= **<u>292 gpm</u>**

Dayton, OH WWTP
AS43078

<u>EQUIPMENT LIST</u>

SECONDARY SLUDGE PUMPS
SSL-P001-01, SSL-P001-02, SSL-P001-03

QTY	EQUIPMENT	DESCRIPTION	
3	Moyno Model 1J175G1 CDQ ASA, Single Stage Progressive Cavity Pump with Shaft Sleeve	Design Flow:	500 GPM @ 40 ft
		Pump Speed:	306 RPM
		Inlet:	10" 125# FF
		Discharge:	10" 125# FF
		Rotor:	Tool Steel/Chrome Plated
		Stator:	Nitrile
		Castings:	Cast Iron
		Bearings:	B10 Life Min 30,000 hours
		Inspection Ports:	(2) 180° apart on housing
3	25 HP Reliance Electric AC Motor	RPM:	1200
		Voltage:	460
		Phase:	3
		Cycle:	60
		Enclosure:	Prot-XE (Energy

DAYTON

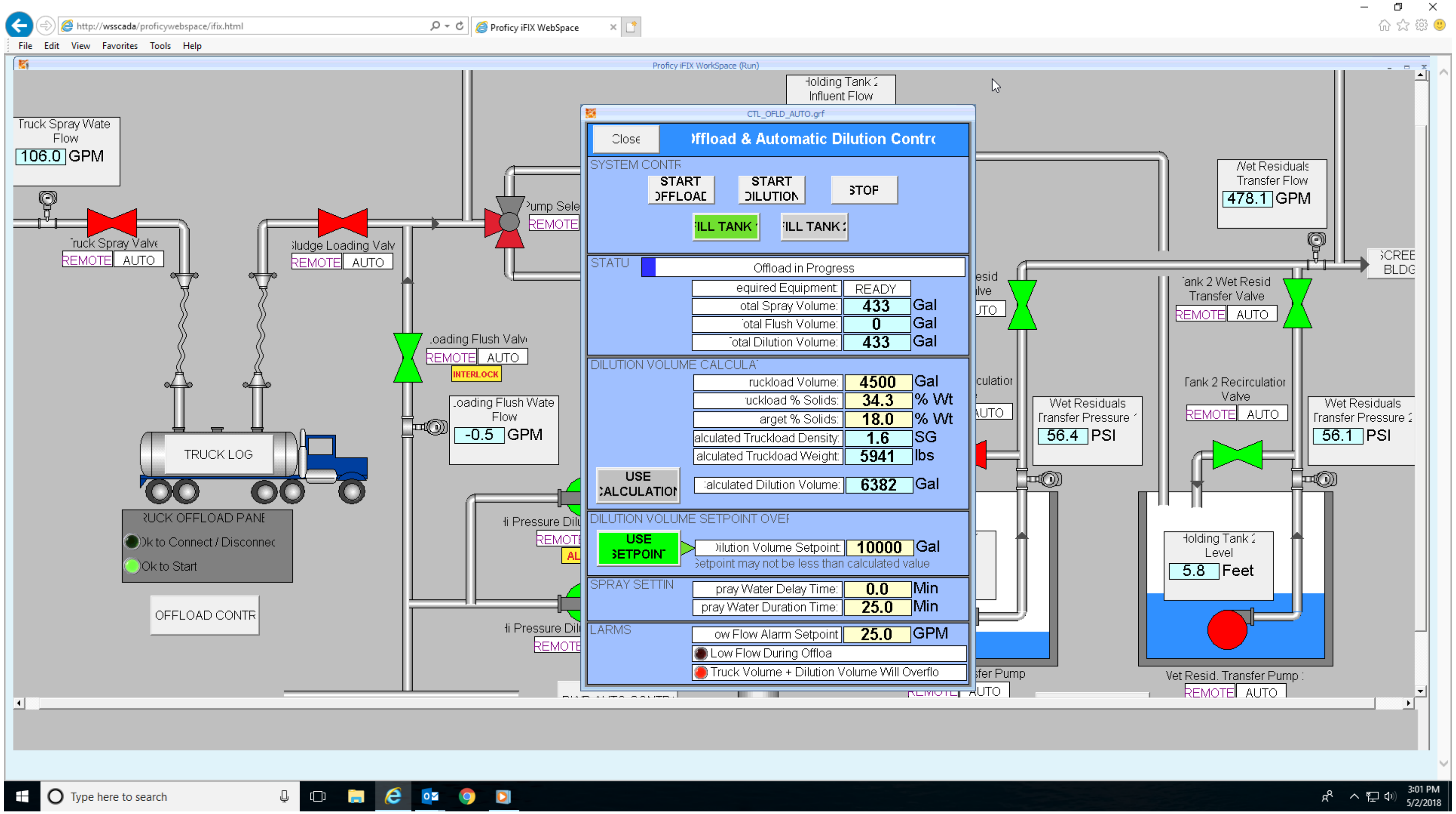
Query SCADA

M1

	A	B	C	D	E	F	G	H	I	J	K	L
1	start	3/16/18 0:00										
2	end	3/17/18 0:00										
3												
4												
5		MTPSVR.CF-LOC-	MTPSVR.C	OTPSVR.OTF	OTPSVR.O	OTPSVR.O	OTPSVR.O	OTPSVR.O	OTPSVR.OTP_S	LRFSVR.LRF_W	MTPSVR.CF-LO	MTPSVR.CF-LOC
6												
7	Timestamp	MTP Sludge Storage Tank 1 Level	MTP Sludge Storage Tank 2 Level	OTP PRIMARY SLUDGE PUMP 01 SPEED	OTP PRIMARY SLUDGE PUMP 02 SPEED	OTP PRIMARY SLUDGE PUMP 03 SPEED	OTP SECONDA RY SLUDGE PUMP 01 SPEED	OTP SECONDA RY SLUDGE PUMP 02 SPEED	OTP SECONDARY SLUDGE PUMP 03 SPEED	Wet Resid Transfer Flow to Sludge Blending	**Miami Sludge Transfer Pump 1 Status (F_CV)**	**Miami Sludge Transfer Pump 2 Status (F_CV)**
1448												
1449	Max	19.30764395	19.4339	699.9726	699.973	0	0	699.948	699.9475708	510.7722225		
1450	Min	2.258156264	3.90895	579	544	0	0	793	297			
1451	**OWTP Pump Eff**			77.77%	77.77%	0.00%	0.00%	58.33%	58.33%			
1452		11	11									
1453		3.2	4									
1454		1440	1440	579	544	0	0	793	297	258	859	638
1455		1440	1440	1440	1440	1440	1440	1440	1440	1440	1440	1440
1456	Rated pump gpm			1000	1000	1000	500	500	500		0	392.4077807
1457	actual gpm			777.74733	777.747	0	0	291.645	291.6448212		0	392.4077807
1458	Pump Run Time, min			**1123**			**1090**			**258**		
1459	Feet	24.84948768	22.525									
1460	Gallons	131,320	119,036	315,209	423,095	0	0	231,274	86,619			
1461	**WTP Gallons**	**250,356**		**1,056,196**						**131,779**		
1462	**Total Gallons**			**1,306,552**								
1463	**Residuals, Tons**	**64.00**		**54.00**						104.6433221		
1464	**% Solids**	**6.13%**		**1.23%**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**17.00%**		
1465	**% Solids to Recarb**	**3.88%**										
1466		1.040238846	1	1.0077967	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1.120158724		
1467												
1468										0		
1469												
1470												

... | LRF Tank Level | LRF Tanks | WRRB Chart | WRRB | Sheet5 | Sludge Pumps Chart | **Sludge Pumps** | Residuals | Sheet1 | PLT Resid | OWTP | ...

WRRB SCADA



DAYTON

Putting It All Together

16-Mar	to	17-Mar				
Primary Basin, gal	#######		Blending tank			
Outer Tank	770,057		Blending tank,	271,894	Level	13.4
Blending Transfer Pump, gpm	400		Pumps, gpm	400	Gallons	242,892
# Pumps	2		# Pumps	2	%Solids	9.88%
Run Time	425		Run Time	755		
Gallons Pumped	340,000		Gallons	604,000		
Miami Flow, MGD	34		MTP Sludge Pumps, gpm	392.41		
Avg. Residuals	1.91		Run time	1497		
MTP Residuals, Tons	64.82		MTP Gal	250,356		
			MTP % Solids	6.21%		
OttawaFlow, MGD	35		OTP Gal	1,056,196		
Avg. Residuals	1.56		OTP % Solids	1.24%		
Ottawa Residuals, Tons	54.61		Total WTP Gal	1,306,552		
OTP 1° Sludge Pumps, gpm	777.75					
Primary gal.	738,303					
OTP 2° Sludge Pumps, gpm	291.64					
Secondary gal.	317,893					
Wet Residuals Building						
Pump, gpm	511		WRRB %	18		
Run Time, min	258		Specific	1.13		
WRRB, gal	131,779		WRRB, Dry	111.59		
North Recarb Basins	Blending	Miami	South Recarb Basins	OTP	Flow to 1 Basin	Flow to 2 Basins
Volume, gal	29,600		29,600			
gpm	800	392.41		1069.39	2262	2262
Recarb Det. Time, min	37.00	75.43		27.68	13.09	26.17
Solids to Recarb, %						
N. Thickener		S. Thickener	Thickener			
Thickener, gal	281,161	281,161	gpm	1131		
Sludge Blanket Depth, ft	6	7	Det. Time, min	248.62	Resids, lb	462038.34
Sludge Blanket, gal	181,928	206,736	gal/day-ft2	491.01	lb/day-ft2	69.65
SOR, gpm/ft2	0.11		WOR, gpm/ft	1.85	Det. Time, min	173.43
N. Sludge Storage			S. Sludge			
Feet	19		Feet	15		
Gallons	100,408		Gallons	79,269		
Residuals, Dry Tons	231.02		Lime, Calc. Tons	129.37		

- Calculate % Solids
- Detention Time
- Gallons of Residuals
  - Produced
  - Imported
- Tons of Residuals
  - Produced
  - imported
- Estimate CaO produced

How many gallons of residuals are we pumping?

- Ottawa

  Primary Sludge Pumps

  = 778 gpm x 579 min = 315,209 gal

  = 778 gpm x 544 min = 423,095 gal

  Secondary Sludge Pumps

  = 292 gpm x 793 min = 231,274 gal

  = 292 gpm x 297min = 86,619 gal

  = **1,056,196 gal**

- Miami

  Tank diameter: 15 ft

  = 15^2 x 3.14 x 7.48 gal/ft^3

  = 5285 gal/ft per tank

  Level Change

  - Tank 1 = (19 - 2) + (11 – 3) = 25 ft
  - Tank 2 = (19 – 4) + (11 – 4) = 23 ft

  = 5285 gal/ft x 48 ft

  = **250,356 gal**

How many gallons of residuals are we pumping?

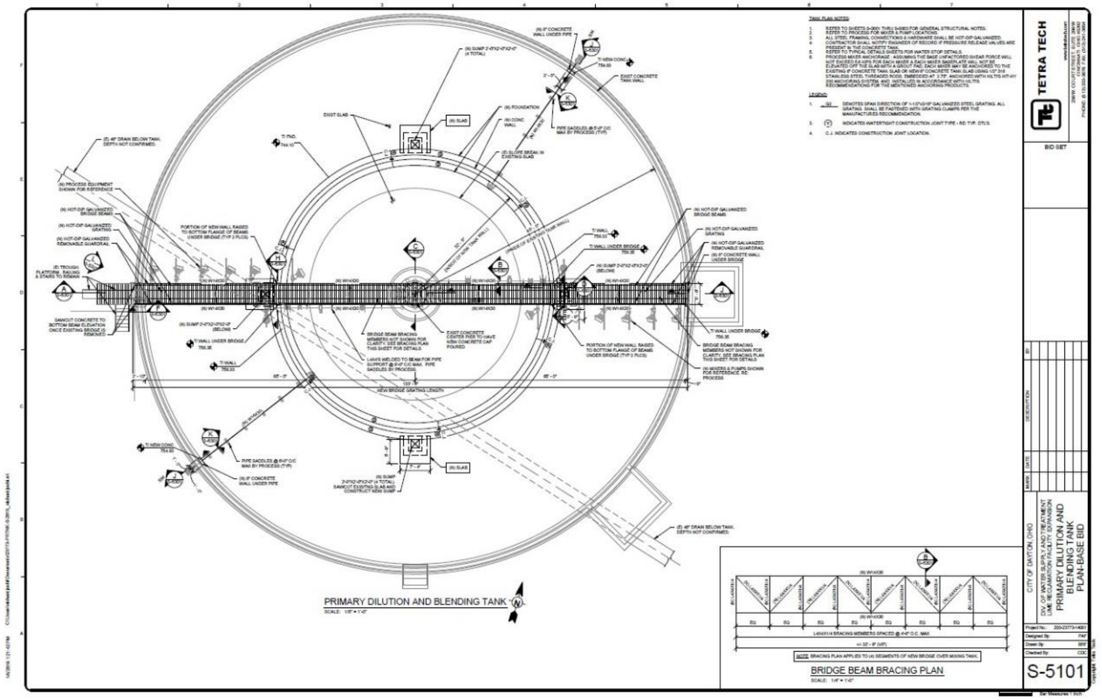
- Wet Residuals Bldg (WRRB)
  - = 510 gpm x 258 min
  - = 131,779 gal

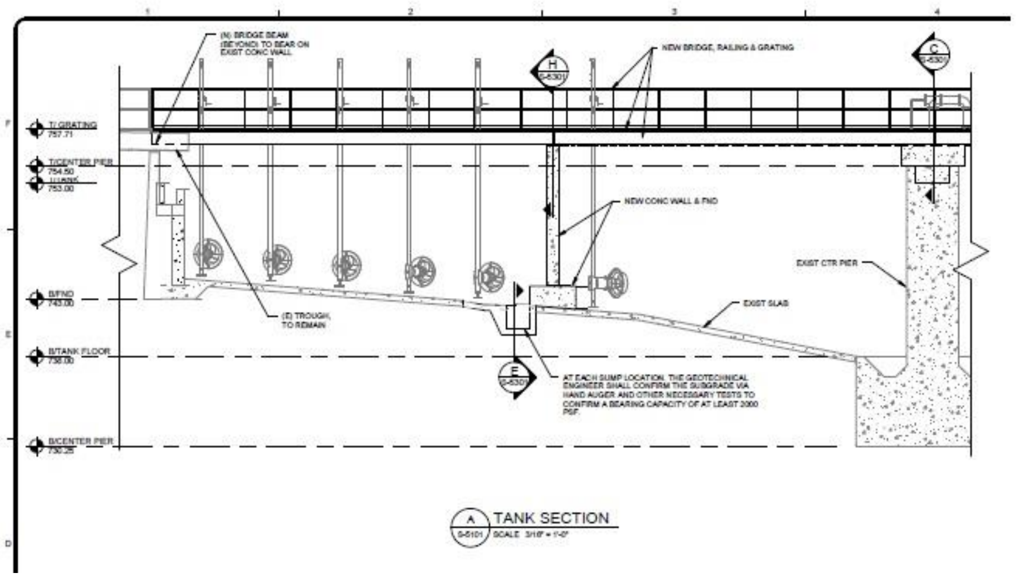
- Total Gallons
- = 1,056,196 +250,356 + 131,779

- Total Gallons = **1,438,331 gal**

DAYTON

Do storage demands meet capacity?





Do storage demands meet capacity?

- Inner Tank = 319,747 gal
  - 2 Pumps @ 400 gpm
- Outer Tank = 722,204 gal
- Primary Basin = **1,041,951 gal**

= 1,041,951 gal - 1,438,331 gal

= -396,380 gal

Do you see a problem?

DAYTON

How much lime are we producing?

How much lime are we producing?

- Wait a minute…
  - If we're producing 100 tpd;
  - Then how can storage between all WTP's be full??
  - Production ≠ Use + Sales
  - Why?

Are we calculating production correctly?

- **Tons/Day Calculation**

= (Centrifuge*1440*(%slurry-%rej)/100****8.34****0.56)/2000

- But lime slurry is more dense than water isn't it?

  YES!

- **Specific Gravity, sg** = 100/((%slurry/**2.71**)+(100-%slurry))
  - $CaCO_3$ is ***2.71 g/cm³***

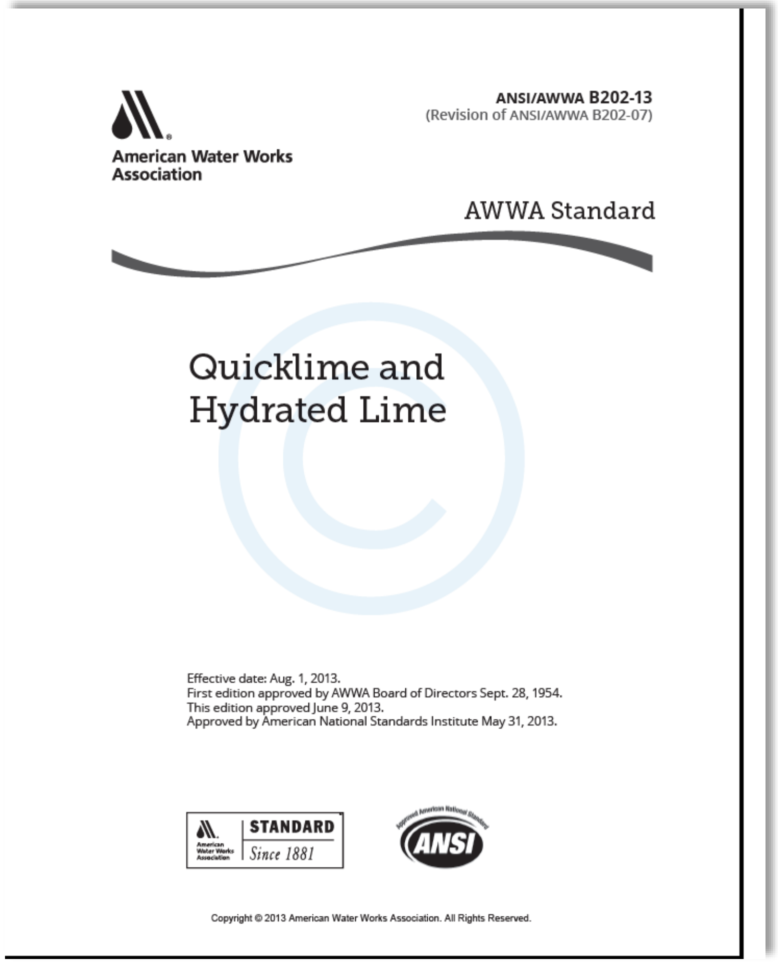
New Tons/Day Calculation

= (centrifuge*1440*(%slurry-%rej)/100*8.34*sg*0.56)/2000

- Slurry 14-25% solid
- ***10-14%*** *more* Dense = ***10-14%*** *more* Production
- Production = Sales + Use!!

DAYTON

What are our lime quality goals?



ANSI/AWWA B202-13
(Revision of ANSI/AWWA B202-07)

American Water Works Association

AWWA Standard

Quicklime and Hydrated Lime

Effective date: Aug. 1, 2013.
First edition approved by AWWA Board of Directors Sept. 28, 1954.
This edition approved June 9, 2013.
Approved by American National Standards Institute May 31, 2013.

STANDARD Since 1881

ANSI

AWWA Standard B202-13

- >80% CaO
- Minimum of 18^{o}F (10^{o}C) rise within 3 min
- Maximum Slake temperature within 20 min
- <5% insoluble

Slaking Rates

- High Reactive Lime 72^{o}F (40^{o}C) < 3min and finish slaking in 10min.
- Med. Reactive Lime 72^{o}F (40^{o}C) in 6min and finish slaking within 10-20min.
- Low Reactive Lime 72^{o}F (40^{o}C) > 6min and finish slaking within 20min.

DAYTON

What are our lime quality goals?

- >88% CaO
- Minimum of 18^{o}F rise within 3 min
- Maximum Slake within 10 min
- <1% insoluble
- 72^{o}F in 6min, and finish slaking within 10 min
- <10% product Pass #20 Sieve

What are the critical parameters to produce quality lime?

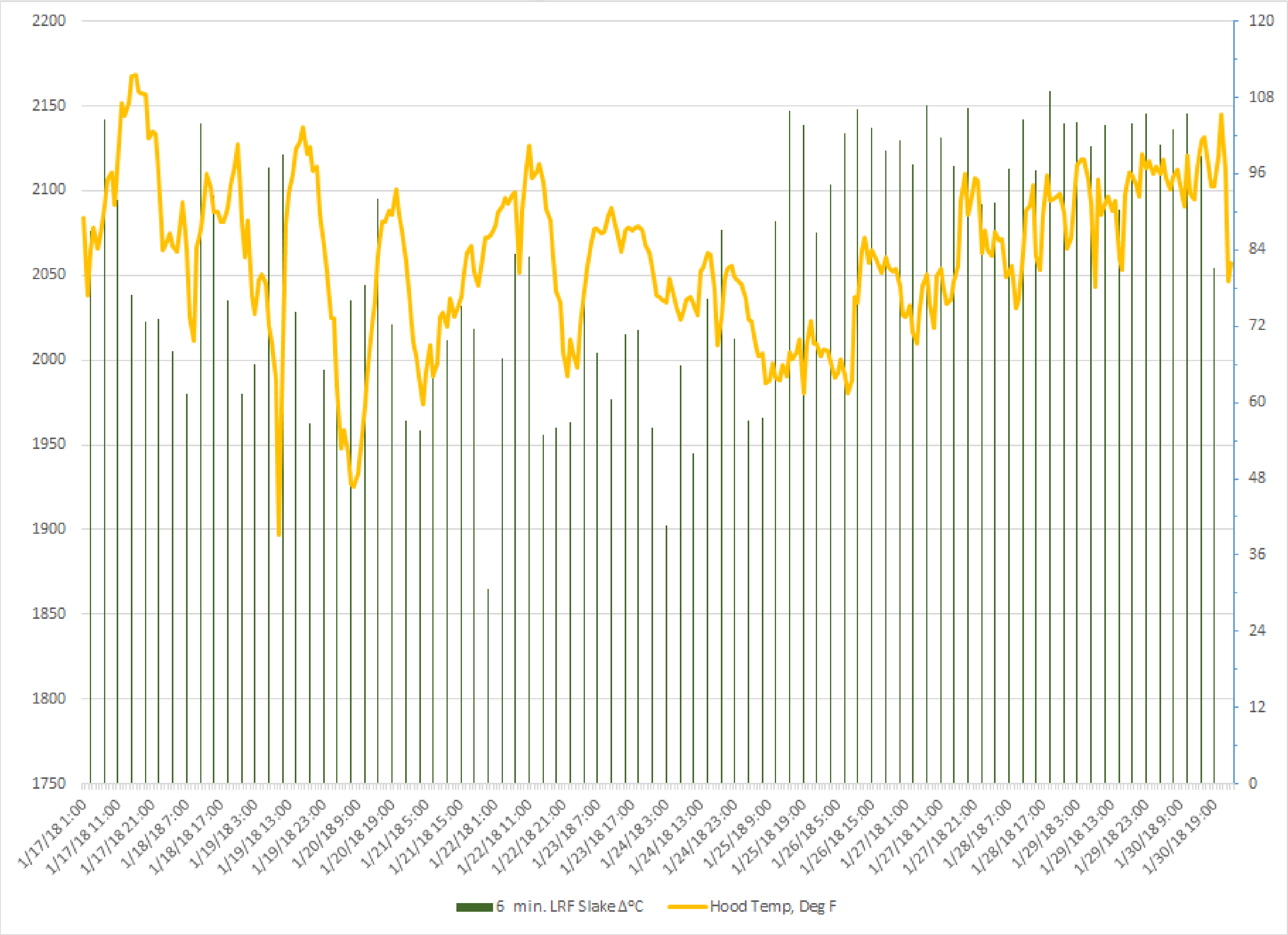
- Residuals feed rate
- Gas flow
- Oxygen level
- Draft
- Primary air flow
- Air flow rate
- Venturi differential pressure
- Chains section temperature
- Hood temperature
- Product temperature
- Expansion chamber temperature
- Product bed thickness
- Carbonation pH

DAYTON

Operating Temperatures

- Exp. Chamber: 300 – 400°F
- Hood: 1950 – 2100° F
- Product: 1000 – 1050°F
- Chains : 1100 – 1200°F

Temperature vs Slake



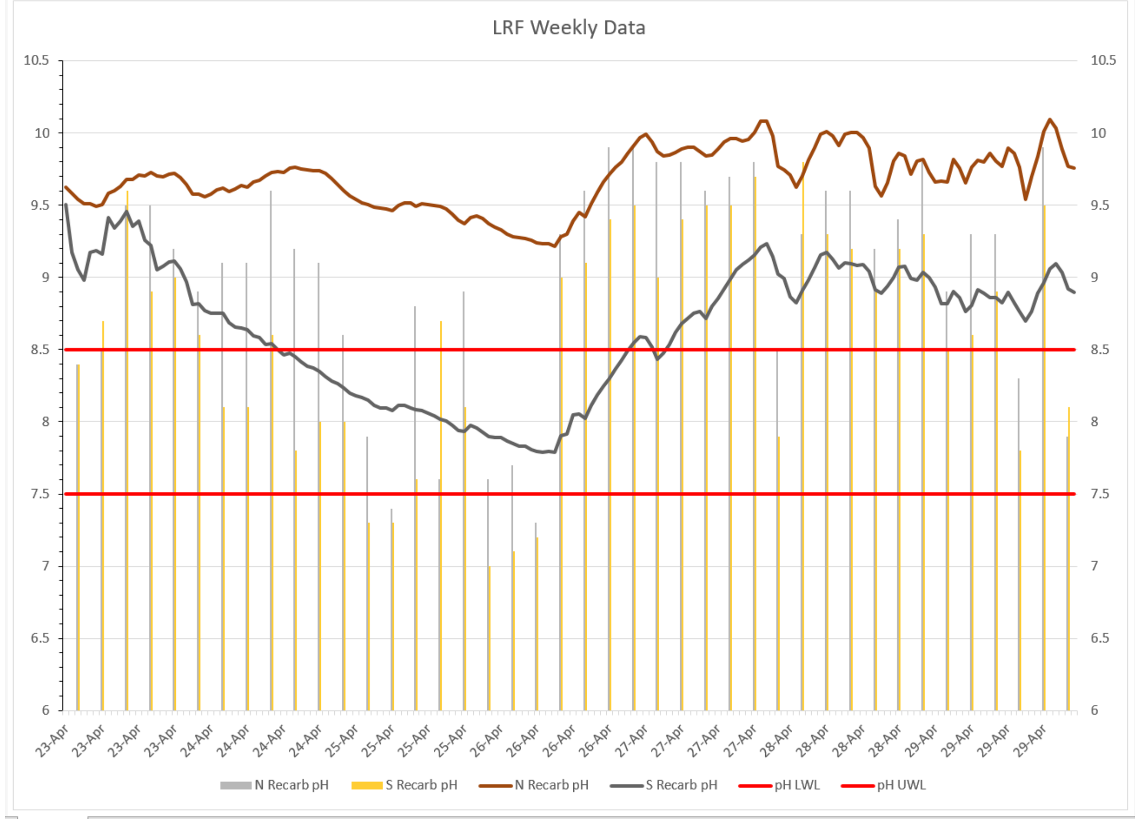
DAYTON

Carbonation pH

- Recarb Basin pH: 7.5-8.5
- <7.5 Dissolve $CaCO_3$
  - Less product
- > 8.5 Precipitate $Mg(OH)_2$
  - Lower CaO content
  - "Mud rings"

DAYTON

Carbonation pH



- Current pH not in range
- Adjust flow
- Upgrade CO_2 Blowers
- Add SCADA Trending

What are the critical parameters to produce quality lime?

Bi-weekly	01-Mar-18					Med React Lime	Med React Lime					
Expected Range	0.8-3.5%	1950-2100^{o}	10X tpd	>12,000	>100 gpm	>18^{o}F	>72^{o}F	<10 min.	7.5-8.5 S.U.	7.5-8.5 S.U.	>100 tons	>3.35 mm, >50 %
LCL, UCL='+2σ	Exp. Chamber % O2	Hood Temp, ^{o}F	Kiln Speed rpm	Id Fan cfm	Centrifuge gpm	3 min. LRF Slake Δ^{o}C	6 min. LRF Slake Δ^{o}C	Total Slake Time	N Recarb pH	S Recarb pH	Product Tons, Adjusted	Sieve Analysis
AVG	2.25	2049.79	1082.15	14234.33	139.86	25.62	86.15	9.08	8.45	8.63	116.05	60.02
MIN	0.00	1543.98	13.03	9633.39	0.00	16.20	55.70	7.00	7.00	7.10	0.00	51.06
MAX	5.81	2131.95	1144.75	16102.87	149.18	45.90	106.80	10.00	9.90	9.90	139.96	75.12
STDEV	0.56	46.19	83.12	857.09	9.61	5.65	13.60	0.77	0.84	0.84	33.67	8.32
VAR	0.32	2127.35	6888.69	732409.65	92.00	31.46	182.60	0.59	0.69	0.70	1119.91	62.35
LCL	1.13	1957.41	915.90	12520.14	120.65	14.33	58.94	7.53	6.77	6.94	48.72	43.37
UCL	3.38	2142.18	1248.39	15948.52	159.08	36.91	113.35	10.63	10.13	10.31	183.38	76.66
In Spec, %	98.2%	95.5%	99.4%	98.8%	99.4%	94.8%	84.4%	100.0%	22.7%	20.0%	97.4%	100.0%

Quality Control

CITY OF DAYTON water one source Regional • Reliable • Renewable

City of Dayton Division of Water Supply and Treatment
Central Water Quality Laboratory
3210 Chuck Wagner Lane
Dayton, Ohio 45414
937-333-6093

Lime Quality Results

Location: Dayton Lime Reclamation Facility
Date/Time Sampled: 3/12/2018
Sampler Collector:
Facility ID Name: OWTP Slaker
Dayton WQ Laboratory Ohio EPA Approval Numbers: Chemical – 983 Microbiological - 200

Parameter	Results	Units	Method	Date Analyzed	Analyst
Percent CaO	92.1	%	HCl Titrimetric	3/12/2018	DM
Total Hardness	1,710,000	mg/L	EDTA Titrimetric	3/12/2018	DM
Calcium Hardness	1,610,000	mg/L	EDTA Titrimetric	3/12/2018	DM
Calcium	684,822	mg/L	Calculation	3/12/2018	DM
Percent Calcium as $CaCO_3$	94.15	%	Calculation	3/12/2018	DM
Magnesium Hardness	100,000	mg/L	Calculation	3/12/2018	DM
Magnesium	24,331	mg/L	Calculation	3/12/2018	DM
Percent Magnesium as $CaCO_3$	5.85	%	Calculation	3/12/2018	DM
Percent Insoluble	0.316	%	Gravimetric	3/12/2018	DM

Slaking Results

Temperature rise (minutes)

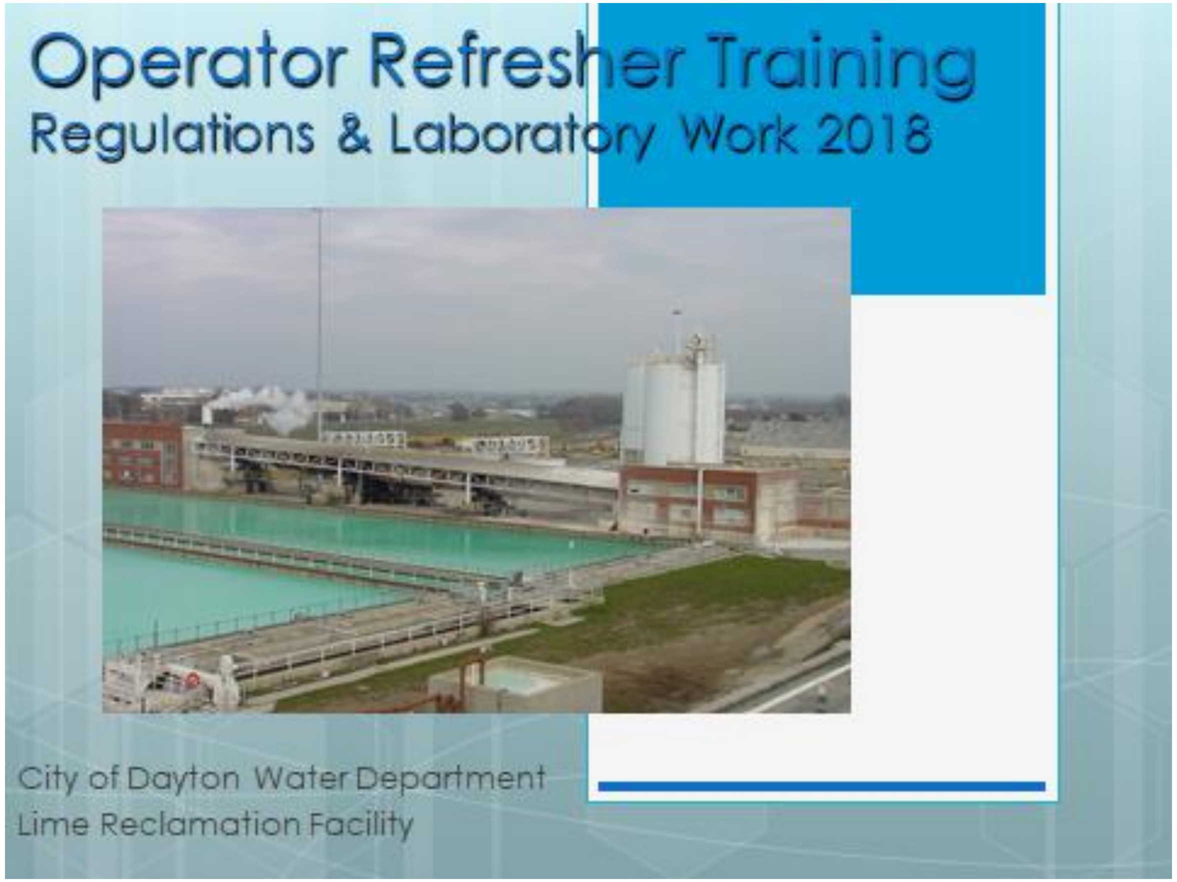
Date	Start (°C)	3	4	5	6	7	8	9	10	Δ °C	Slake Time
3/12/2018	27.1	40.4	52.2	64.5	72.1	75.3	76.4	76.6		49.5	9 Min

Sample Time Date: 4/15/18 1500 Analysis Date : 4/16/18				
Sieve Analysis				
Sieve Size		Retained		% Passing
1/4"	6.330	255.5	577.9	69.34
6	3.350	315.4	262.5	31.50
12	1.700	181.7	80.8	9.69
20	0.841	60.9	19.9	2.39
100	0.149	17.1	2.8	0.34
200	0.074	2.7	0.1	0.01
325	0.044	0.1	0.0	0.00
Pan		0.0	0.0	0.00
Total		833.3		

DAYTON

Were our previous assumptions correct?

- Some were
- Many were not
- Re-learn
- Plan for future



Solutions

- Coordinate Pumping
- Upgrade CO_2 Blower
- Add Pumps
- Piping
- Training

DAYTON

Conclusions

- The ***DA*** in **SCADA** stands for ***D**ata **A**cquisition*
  - Lots of information stored is untapped
- Know your chemistry
  - *Make your teacher proud*
- Put lab data to use
- Reacquaint yourself with **Plant Diagrams**
- Don’t be afraid to question high paid consultants
  - They work for you

DAYTON

Conclusions

- Use similar technique for:
  - Residuals management
  - Filter Growth
  - Backwash
  - ???

Acknowledgements

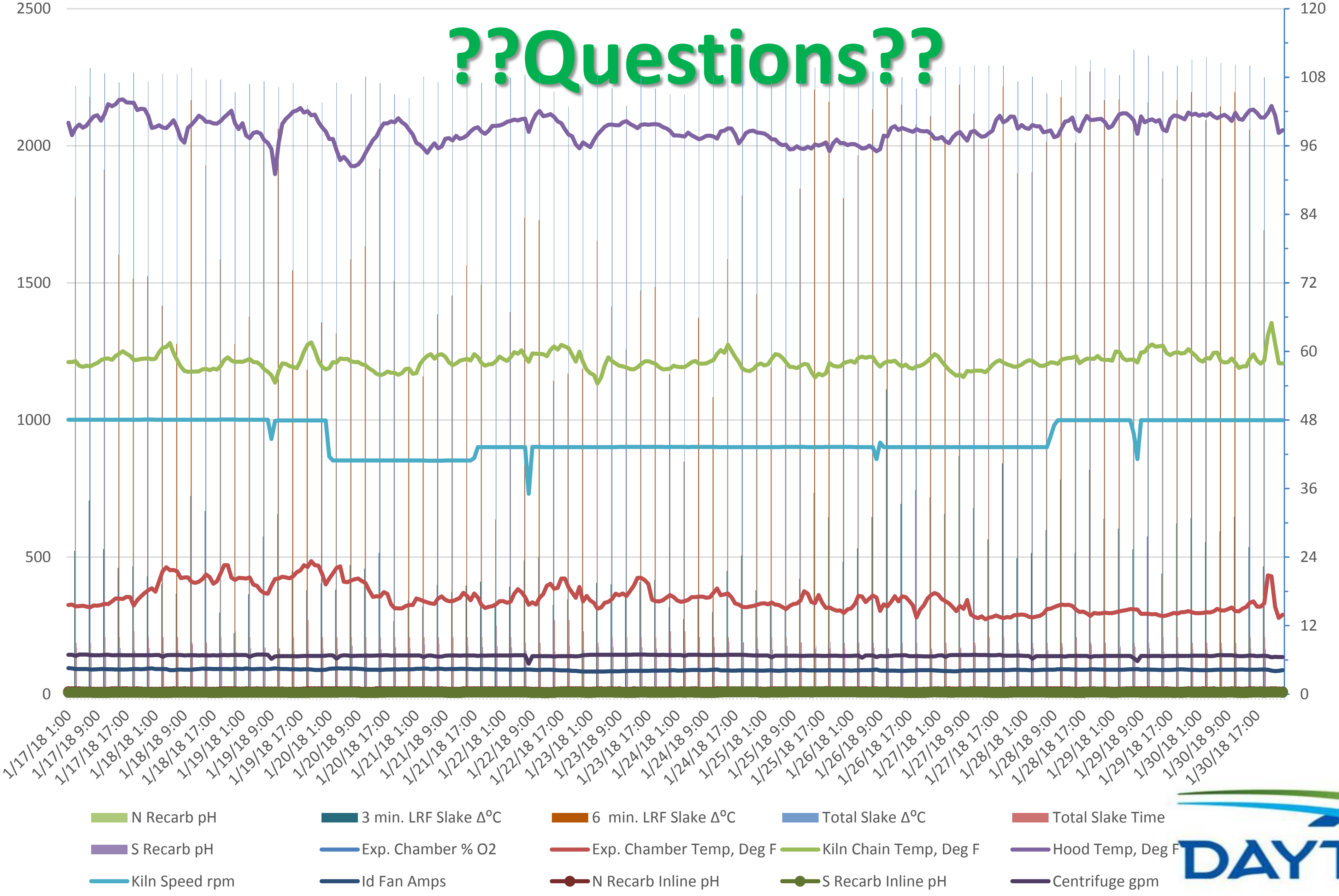
Keshia Kinney
James Blevins
Jeff Dahlin
Shannon Zell
Liz Zelinski
Brandon Turner
Rachel Easter
Rachael Osborne
Mike Rosselet
Lime Reclamation Staff
Emily Fuson
Debbie Herman – Tetra Tech

References

- Roth, Damon K., et al, "Implementing Residuals Management: Cost Implications for Coagulation and Softening Plants", *JAWWA,* March 2008
- Crowe, William B., "Techniques and Economics of Calcining Softening Sludges", *JAWWA,* March 1960
- Black, A.P., et al, "Recovery of Calcium and Magnesium Values From Lime-Softening Sludges", *JAWWA* October 1971
- *Standard Methods for the Examination of Water and Wastewater*, 22nd ed., 2012

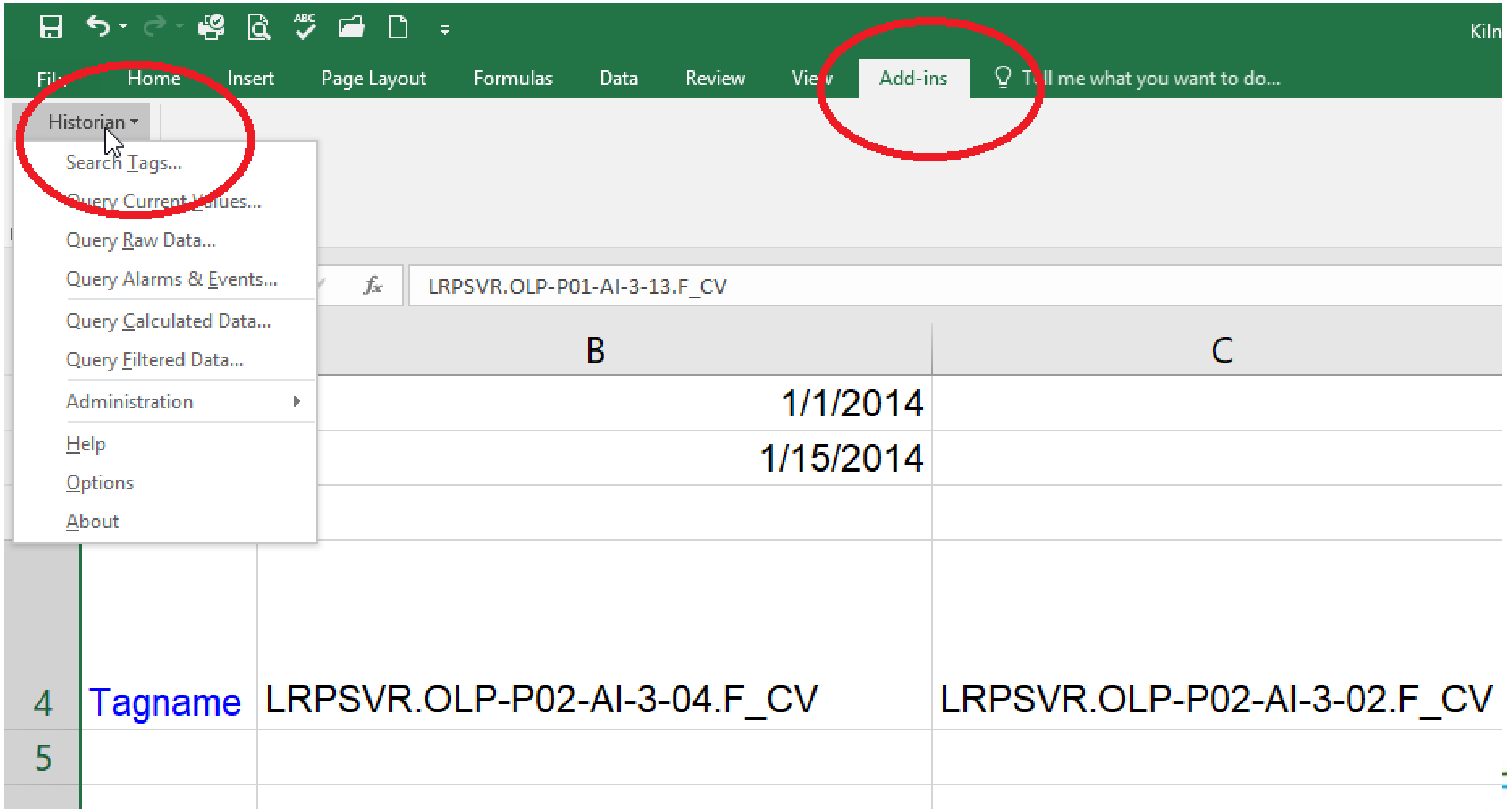
DAYTON

??Questions??



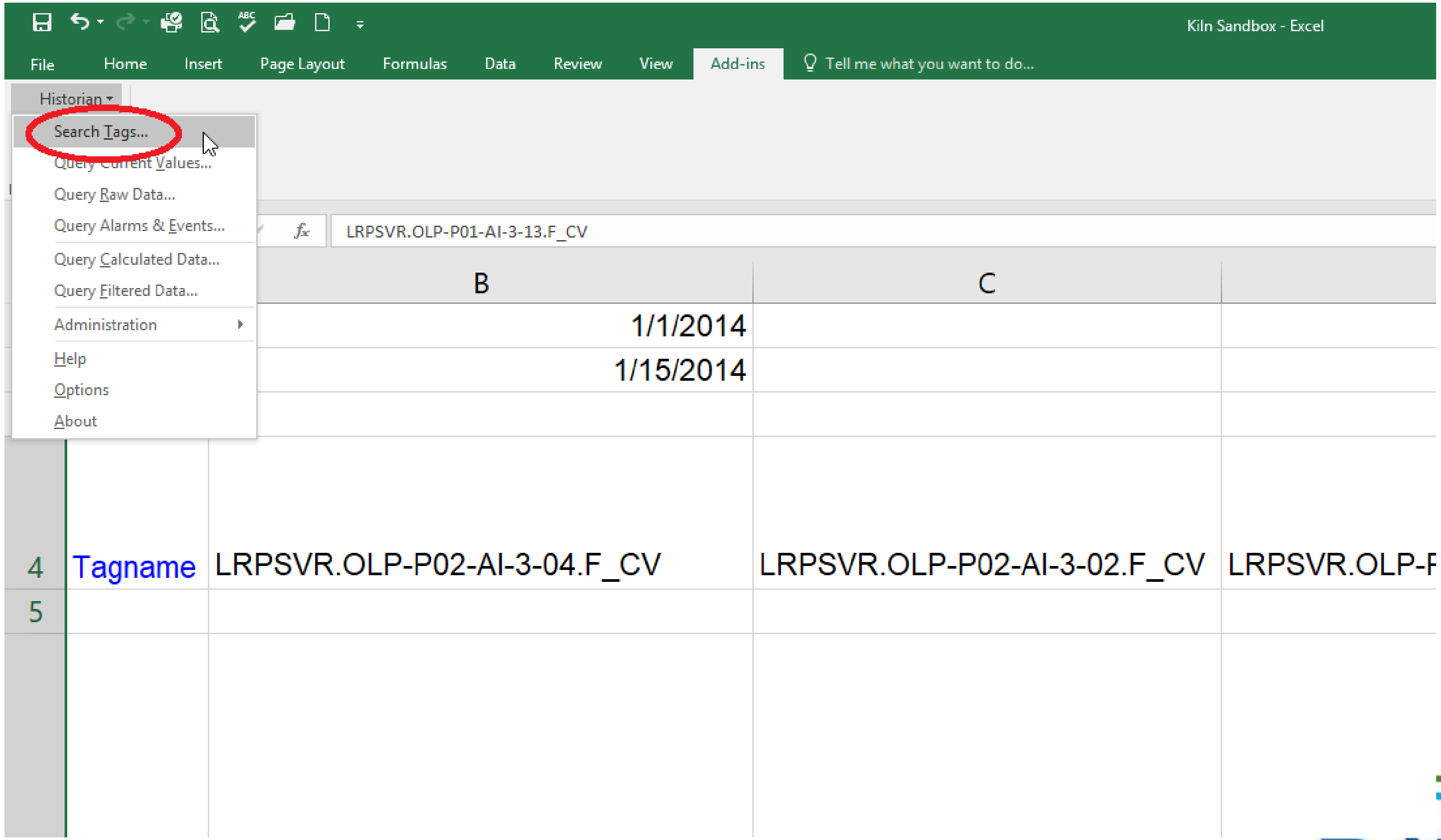
DAYTON

Excel Add-in



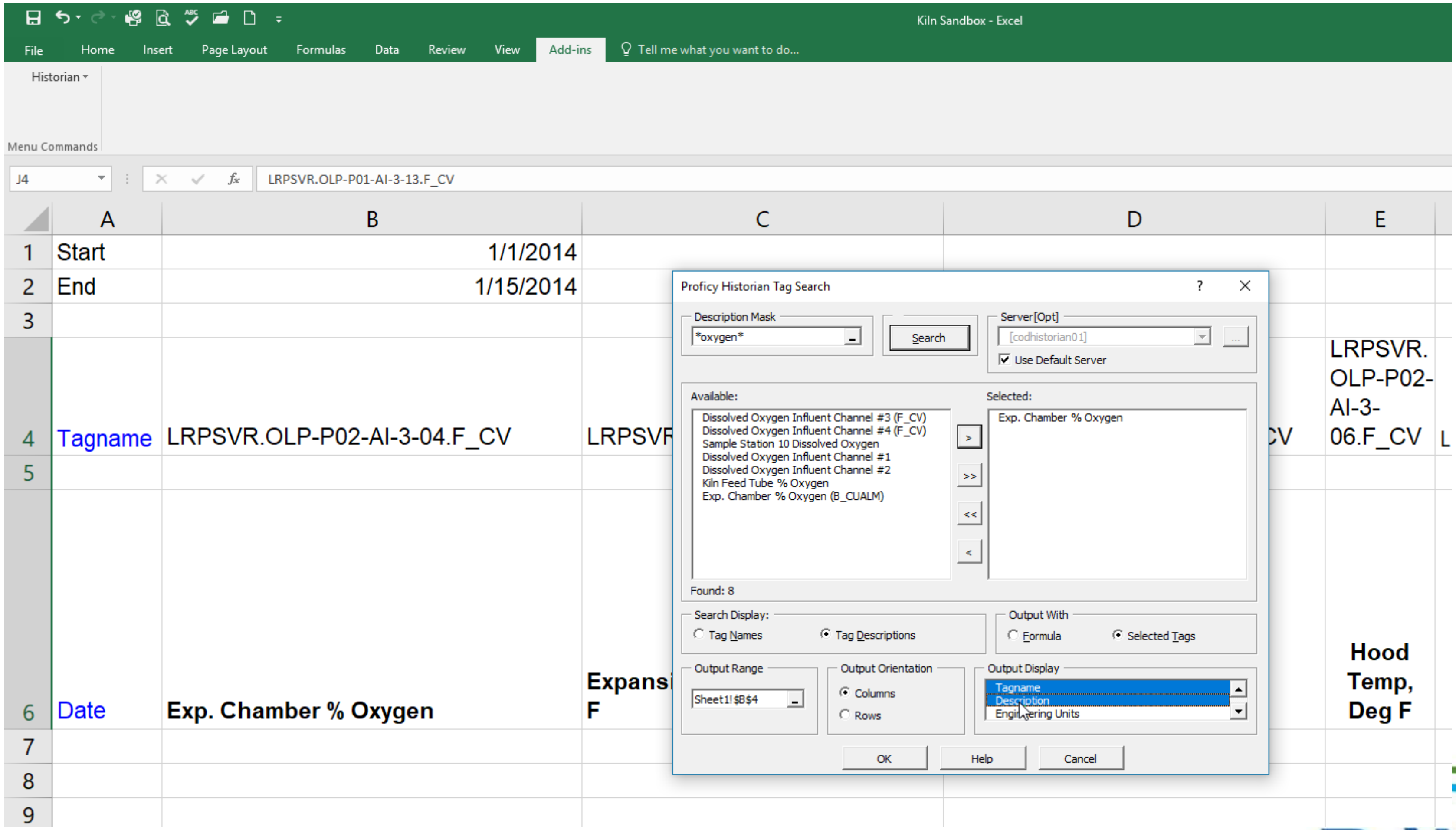
DAYTON

Search SCADA Tags



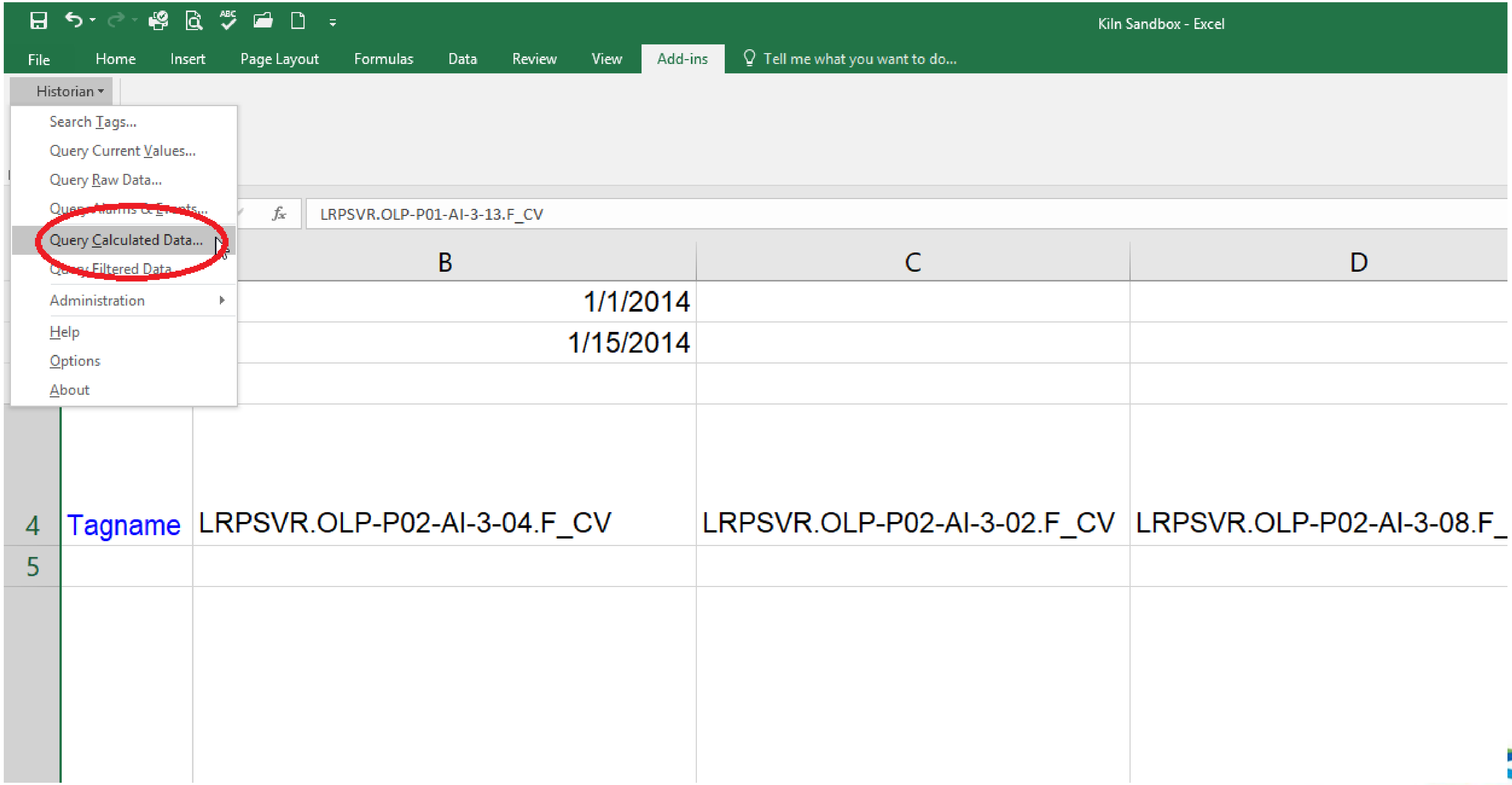
DAYTON

Search SCADA Tags



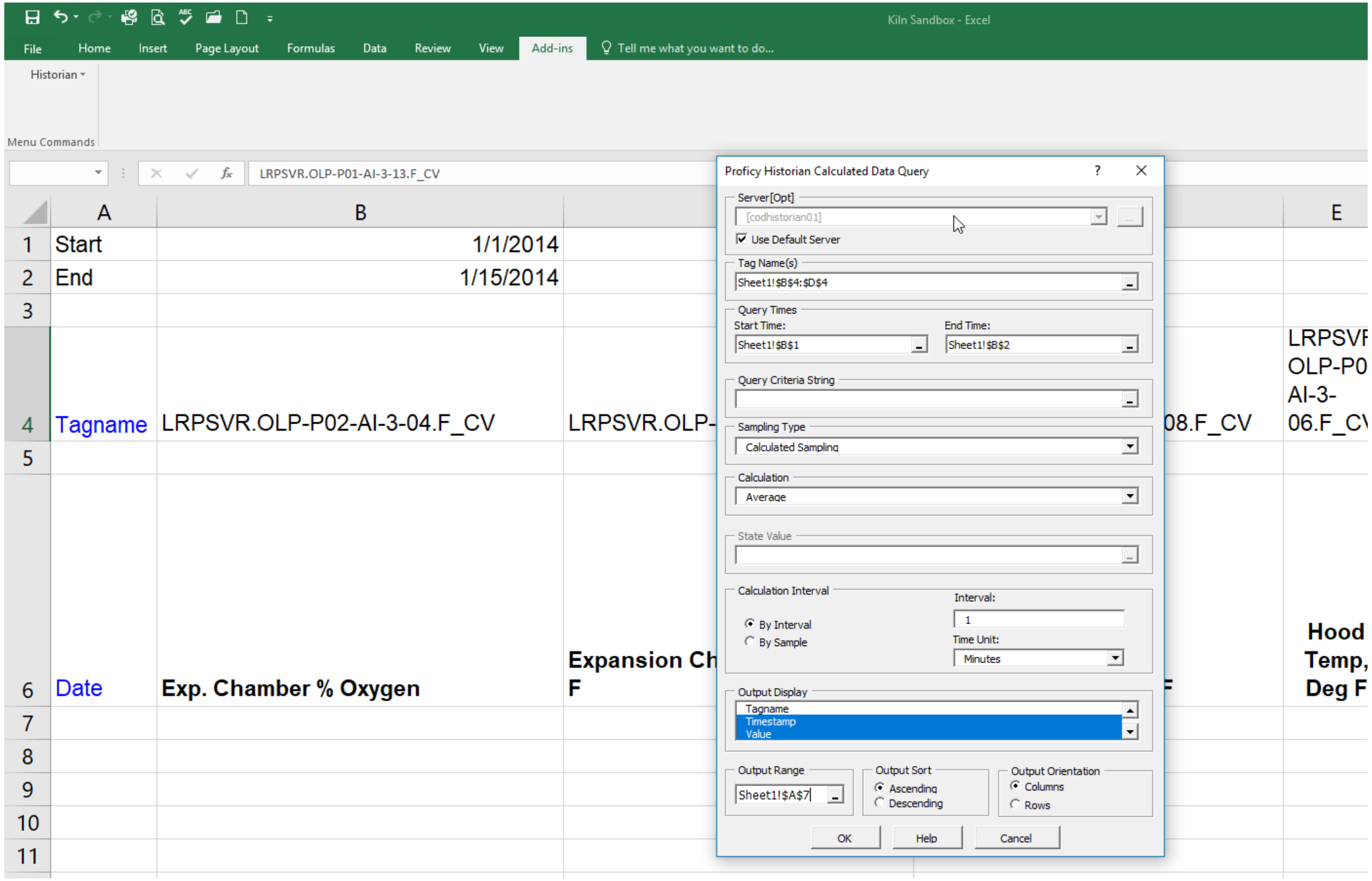
DAYTON

Query SCADA Data

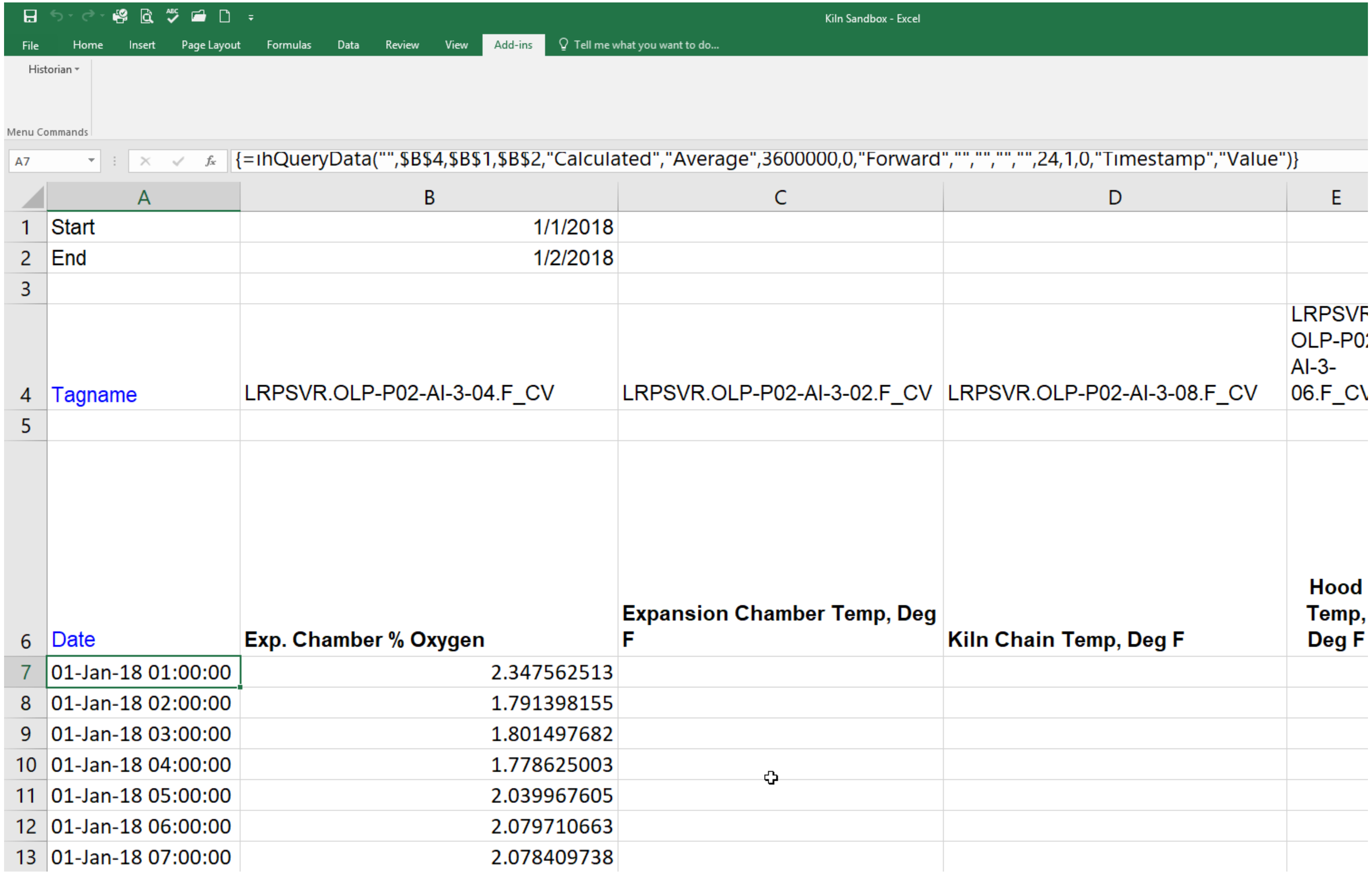


DAYTON

Query SCADA Data



SCADA Data in Excel



	A	B	C	D	E
1	Start	1/1/2018			
2	End	1/2/2018			
3					
4	Tagname	LRPSVR.OLP-P02-AI-3-04.F_CV	LRPSVR.OLP-P02-AI-3-02.F_CV	LRPSVR.OLP-P02-AI-3-08.F_CV	LRPSVF OLP-P0: AI-3- 06.F_CV
5					
6	Date	**Exp. Chamber % Oxygen**	**Expansion Chamber Temp, Deg F**	**Kiln Chain Temp, Deg F**	**Hood Temp, Deg F**
7	01-Jan-18 01:00:00	2.347562513			
8	01-Jan-18 02:00:00	1.791398155			
9	01-Jan-18 03:00:00	1.801497682			
10	01-Jan-18 04:00:00	1.778625003			
11	01-Jan-18 05:00:00	2.039967605			
12	01-Jan-18 06:00:00	2.079710663			
13	01-Jan-18 07:00:00	2.078409738			

Add Excel Formulas

	A	B	C	D	E	F	G	H	I	J	K	
1	start	3/16/18 0:00										
2	end	3/17/18 0:00										
3												
4												
5		MTPSVR.CF-LOC-	MTPSVR.C	OTPSVR.OTF	OTPSVR.O	OTPSVR.O	OTPSVR.O	OTPSVR.O	OTPSVR.OTP_S	LRFSVR.LRF_W	MTPSVR.CF-LO	MTPSV
6												
7	Timestamp	MTP Sludge Storage Tank 1 Level	MTP Sludge Storage Tank 2 Level	OTP PRIMARY SLUDGE PUMP 01 SPEED	OTP PRIMARY SLUDGE PUMP 02 SPEED	OTP PRIMARY SLUDGE PUMP 03 SPEED	OTP SECONDA RY SLUDGE PUMP 01 SPEED	OTP SECONDA RY SLUDGE PUMP 02 SPEED	OTP SECONDARY SLUDGE PUMP 03 SPEED	Wet Resid Transfer Flow to Sludge Blending	**Miami Sludge Transfer Pump 1 Status (F_CV)**	**Miami Transfe Pump 2 (F_CV)**
1448												
1449	Max	19.30764395	19.4339	699.9726	699.973	0	0	699.948	699.9475708	510.7722225		
1450	Min	2.258156264	3.90895	579	544	0	0	793	297			
1451	**OWTP Pump Eff**			77.77%	77.77%	0.00%	0.00%	58.33%	58.33%			
1452		11	11									
1453		3.2	4									
1454		1440	1440	579	544	0	0	793	297	258	859	
1455		1440	1440	1440	1440	1440	1440	1440	1440	1440	1440	
1456	Rated pump gpm			1000	1000	1000	500	500	500		0	392.4
1457	actual gpm			777.74733	777.747	0	0	291.645	291.6448212		0	392.4
1458	Pump Run Time, min			**1123**			**1090**			**258**		
1459	Feet	24.84948768	22.525									
1460	Gallons	131,320	119,036	315,209	423,095	0	0	231,274	86,619			
1461	**WTP Gallons**	**250,356**		**1,056,196**						**131,779**		
1462	**Total Gallons**			**1,306,552**								
1463	**Residuals, Tons**	**64.00**		**54.00**						104.6433221		
1464	**% Solids**	**6.13%**		**1.23%**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**17.00%**		
1465	**% Solids to Recarb**	**3.88%**										