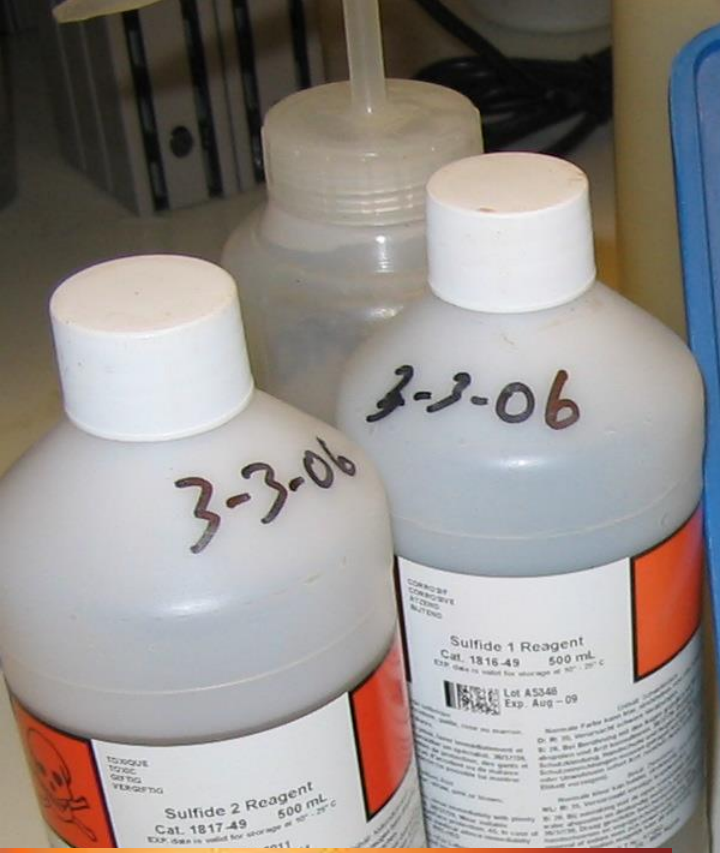
Action Plan to Reduce Odors

Develop and determine the desired objective

- Use GIS, map the wastewater collection system
- Collect data
- Consider treatment options
- Perform lab bench testing
- Perform pilot testing
- Analyze data

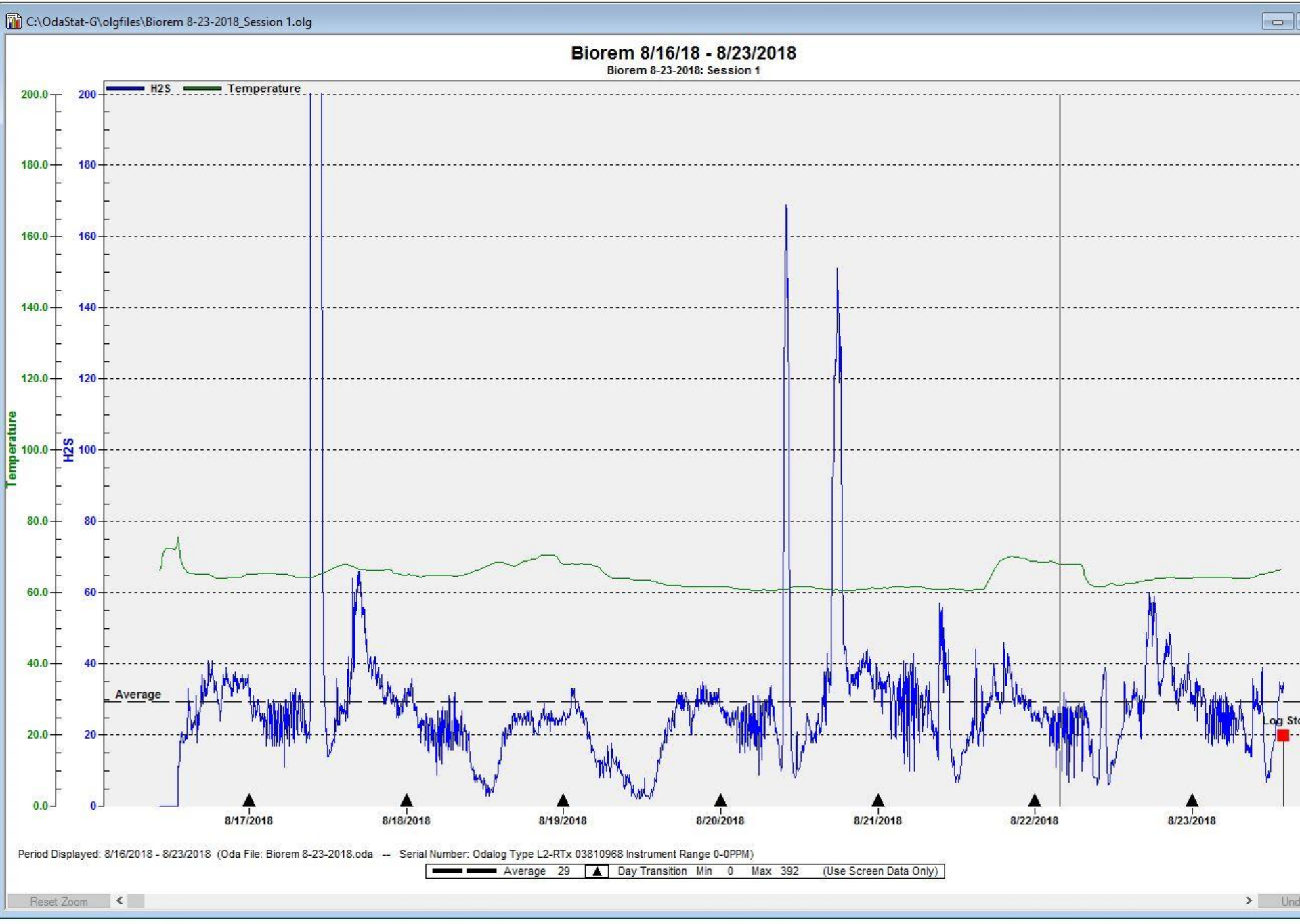


Hydrogen Sulfide Test Kit,
Model HS-WR, Color Disc
Product # 22380


GAS MIXTURE
GAS COMPOSITION
CONCENTRATION (MOLE%)
PRAXAIR
GAS
Gas Composition
PRAXAIR
COMPRESSED GAS, N.O.S.
UN1956
Refillable Cylinder
2-28-11
GAS
Gas Composition
PRAXAIR
OdaLog
H2S
Gas Logger
MSA ALTAIR 4X
GASALERTMICRO 5 PID
GASALERTMICRO 5
No PID
New O2 IN side

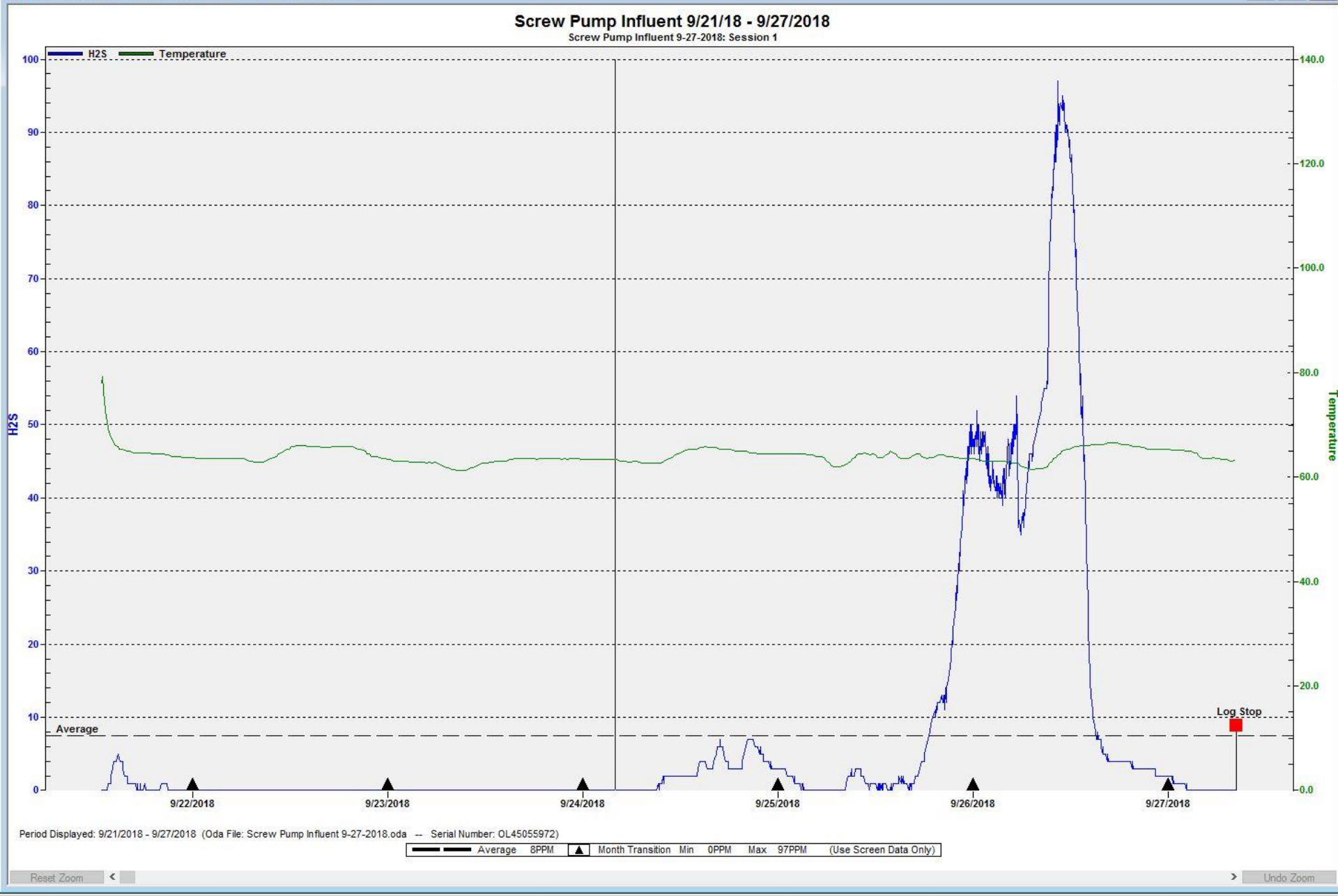
Plant Upset Data

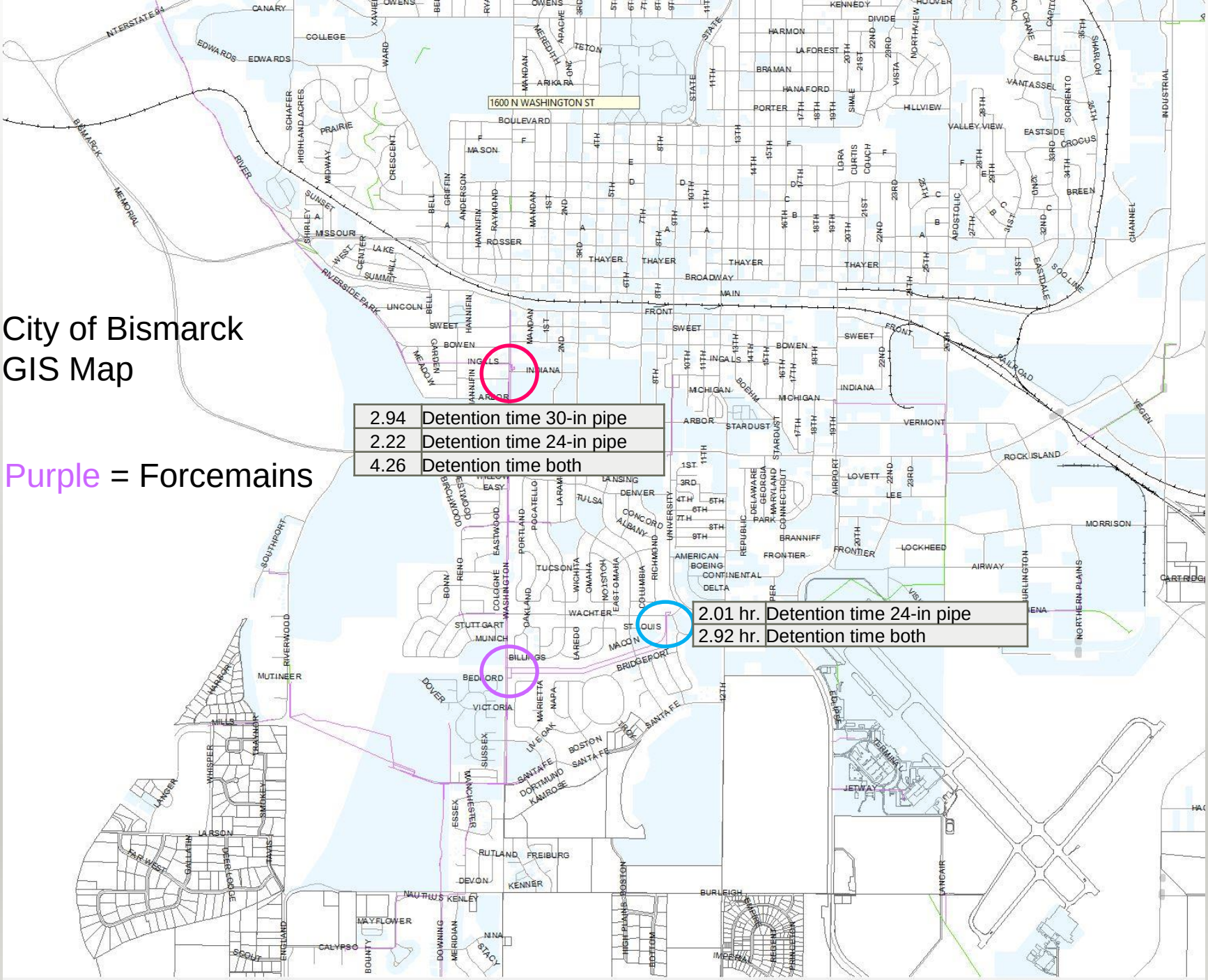
	Biorem		Screw Pump Infl.				
Date	H2S Avg.	H2S Peak	H2S Avg.	H2S Peak	Comment	Effl NH3	Effl CBOD
7/19/18	21	163				**6.7**	**6**
7/26/18	21	109			Washington and Wachter force mains	**20.8**	**20**
8/2/18	28	99			Rotate both force mains daily	18.6	19
8/9/18	24	277			Rotate both force mains daily	24.0	20
8/16/18	34	307			Rotate both force mains weekly	22.6	19
8/23/18	29	392			8/20/18 TF infl. 1.6 diss H2S	28.4	17
8/30/18	37	121			Rotate both force mains weekly	18.9	16
9/6/18	26	95			Rotate both force mains daily	14.5	15
9/13/18	45	337				23.8	20
9/21/18	29	67	1	10	**Rotate both force mains**	**27.3**	**17**
9/27/18	36	90	8	**97**	Rotate to monthly add NaOH	24.0	16
10/4/18	24	53	1	6	No rotation	25.8	17
10/11/18	32	76	1	10	No rotation	16.7	12
10/19/18	30	274	1	9	No rotation	22.9	16
10/25/18	35	324	1	9	Rotate both force mains, w/caustic	8.3	15
11/1/18		51	1	7	added on 9/21	**3.9**	14


C:\OdaStat-G\olgfiles\Biorem 8-23-2018_Session 1.olg
Biorem 8/16/18 - 8/23/2018
Biorem 8-23-2018: Session 1
H2S
Temperature
Average
8/17/2018
8/18/2018
8/19/2018
8/20/2018
8/21/2018
8/22/2018
8/23/2018
Period Displayed: 8/16/2018 - 8/23/2018 (Oda File: Biorem 8-23-2018.oda -- Serial Number: Odalog Type L2-RTx 03810968 Instrument Range 0-0PPM)
Average 29
Day Transition Min 0 Max 392 (Use Screen Data Only)
Reset Zoom

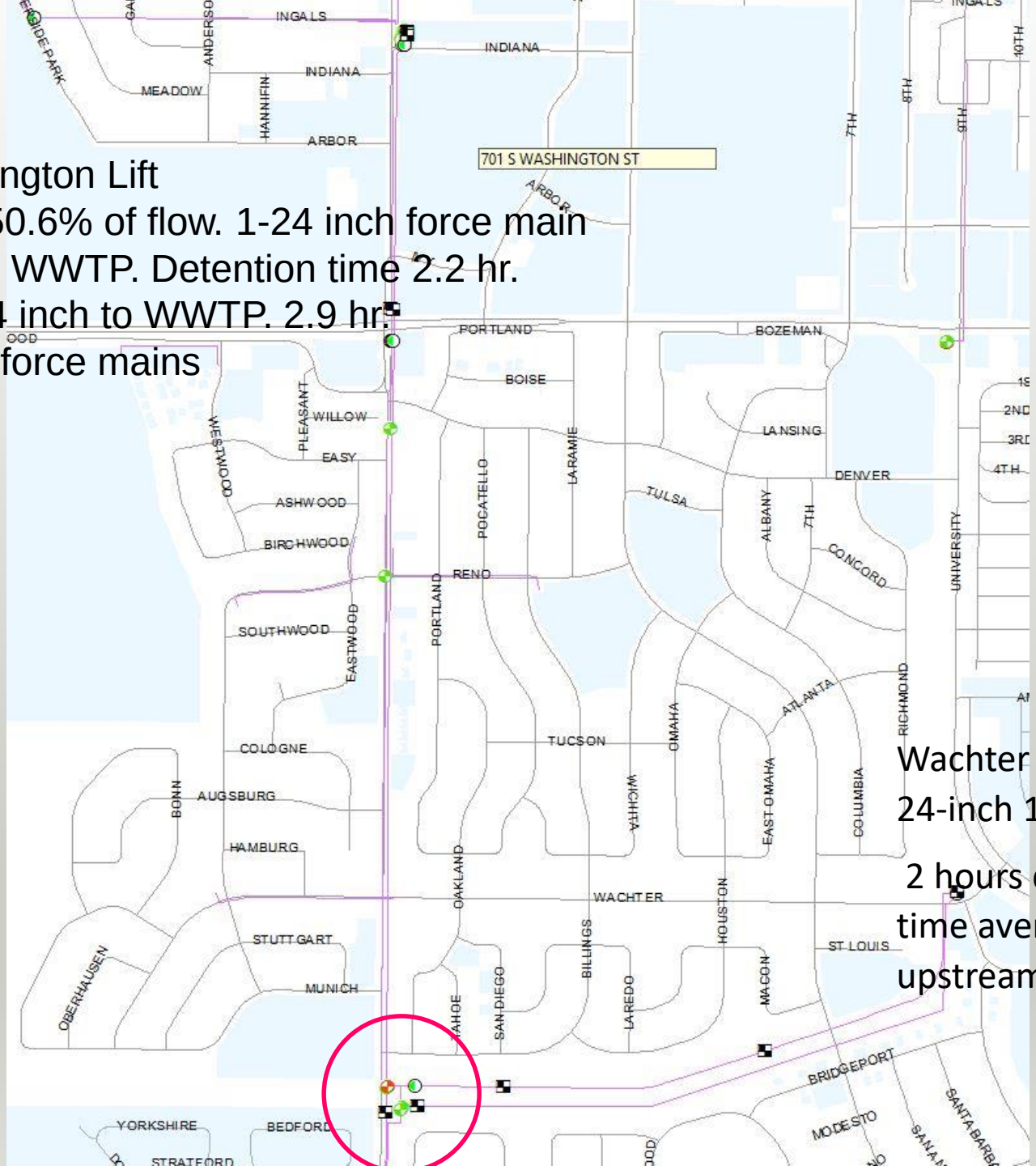

Screw
Pump
Infl.
le Earth

C:\OdaStat-G\olgfiles\Screw Pump Influent 9-27-2018_Session 1.olg




City of Bismarck
GIS Map
Purple = Forcemains
2.94 Detention time 30-in pipe
2.22 Detention time 24-in pipe
4.26 Detention time both
2.01 hr. Detention time 24-in pipe
2.92 hr. Detention time both
1600 N WASHINGTON ST

2018 Washington Lift
3.2 MGD. 50.6% of flow. 1-24 inch force main
12,600 ft. to WWTP. Detention time 2.2 hr.
30 inch + 24 inch to WWTP. 2.9 hr.
2 upstream force mains



Wachter Lift 2.9 MGD
24-inch 10,359 feet

2 hours detention time average. 2 upstream force mains.


MUNICH
BILLINGS
YORKSHIRE
BEDFORD
STRATFORD
DOVER
NOTTINGHAM
BUCKINGHAM
SHERWOOD
VICTORIA
IRVINE
CAMBRIDGE
OXFORD
CANTERBURY
SUSSEX
PICCADILLY
LONDON
ESSEX
MANCHESTER
WARWICK
WASHINGTON

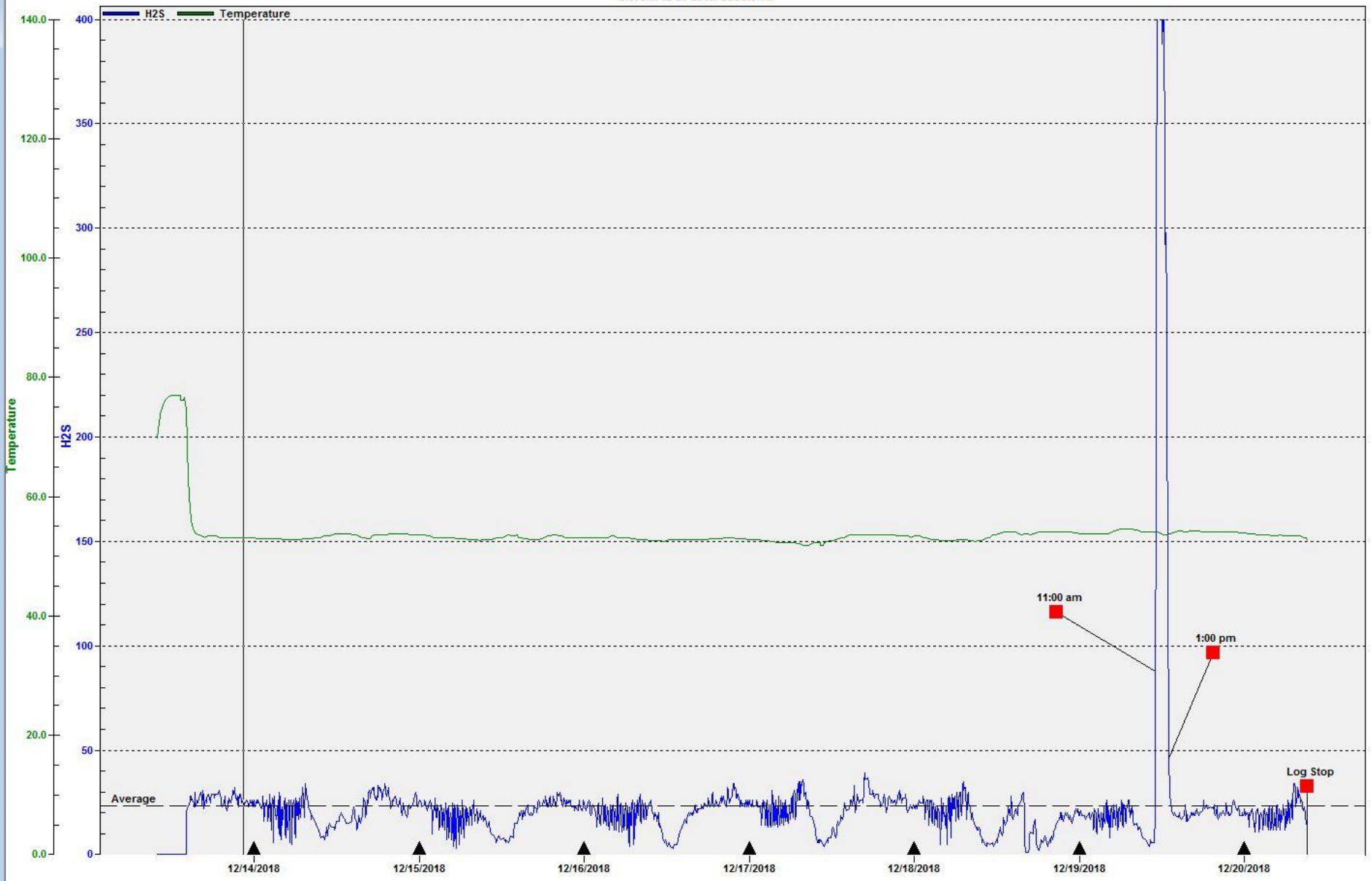
Plant Upset Data

	Biorem		Screw Pump Infl.				
Date	H2S Avg.	H2S Peak	H2S Avg.	H2S Peak	Comment	Effl NH3	Effl CBOD
11/22/18	25	61	3	12		1.9	9
11/29/18	30	95	7	42		3.3	10
12/6/18	20	36	2	13		1.7	10
12/13/18	28	57	2	11	12/17/18, shut down TF3	2.5	10
12/20/18	23	**499**	4	**55**	12/19, rotate Washington after 2.5 mo.	9.9	15
12/28/18	29	55	3	25	12/26 Wachter after 2.5 mo., then daily	9.5	18
1/3/19	21	242	4	22	1/4/19 Stop rotating both force mains	**23.1**	**24**
1/10/19	21	69	4	18	for two months	28.4	20
1/17/19	14	32	5	19		27.6	16
1/24/19	20	36	4	18		15.4	14
2/1/19	14	43	5		Flushed TF 2, on 2/5/19	18.8	18
2/7/19	19	55	4	14	Flushed TF 1, on 2/13/19	10.2	14
2/14/19	14	30	9	36	TF 1 & 2 placed in series	**6.7**	21

When the dissolved H2S increases over 1 mg/L to the trickling filters the final effluent BOD and ammonia spike with a 6 – 7 week recovery.

Biorem 12/13/18 - 12/20/2018

Biorem 12-20-2018: Session 1

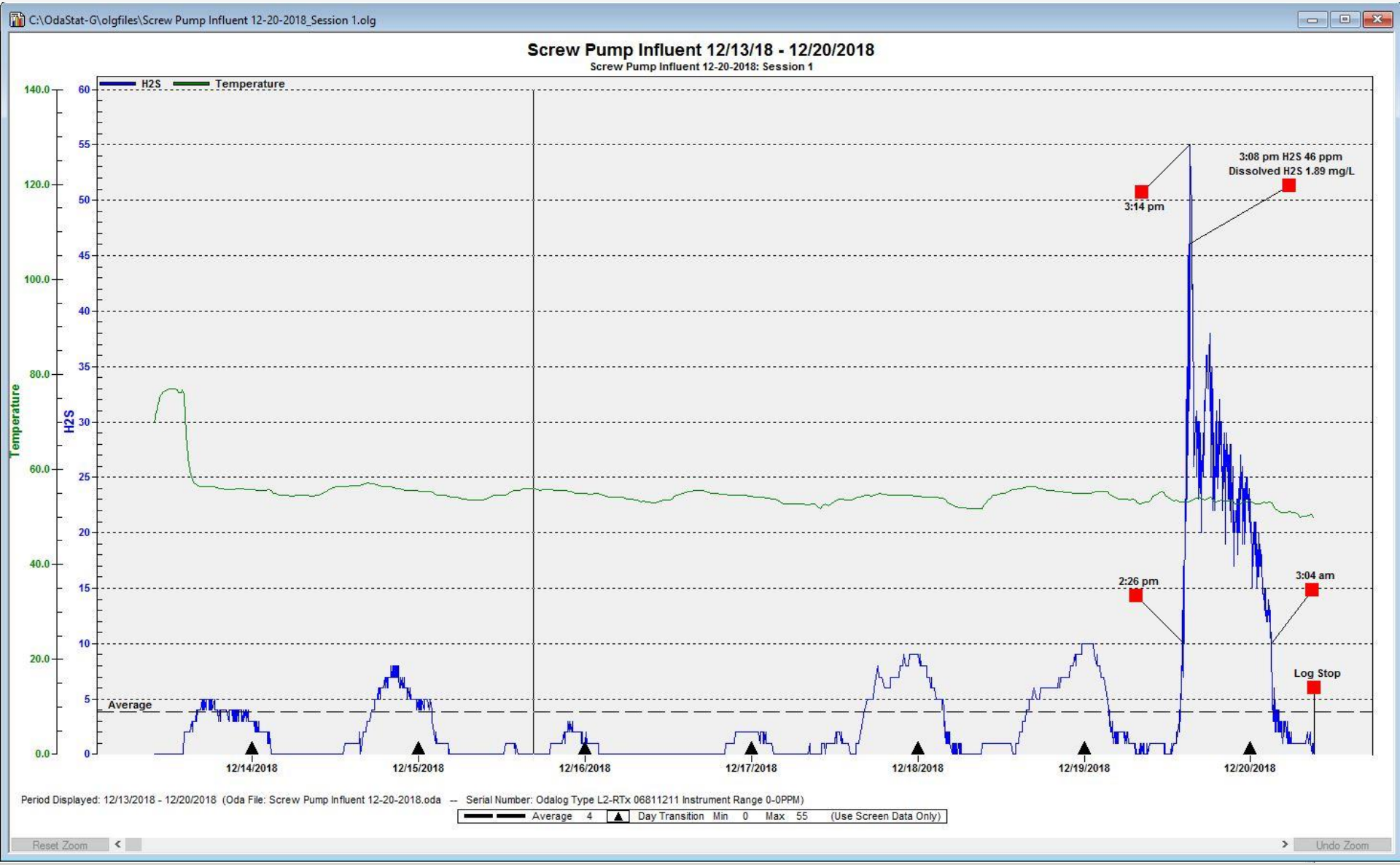


Period Displayed: 12/13/2018 - 12/20/2018 (Oda File: Biorem 12-20-2018.oda -- Serial Number: Odalog Type L2-RTx 06811214 Instrument Range 0-0PPM)

Average 23 | Day Transition Min 0 Max 499 (Use Screen Data Only)

Reset Zoom

Undo Zoom


C:\OdaStat-G\olgfiles\Screw Pump Influent 12-20-2018_Session 1.olg
Screw Pump Influent 12/13/18 - 12/20/2018
Screw Pump Influent 12-20-2018: Session 1
H2S
Temperature
3:08 pm H2S 46 ppm
Dissolved H2S 1.89 mg/L
3:14 pm
2:26 pm
3:04 am
Log Stop
Average
12/14/2018
12/15/2018
12/16/2018
12/17/2018
12/18/2018
12/19/2018
12/20/2018
Period Displayed: 12/13/2018 - 12/20/2018 (Oda File: Screw Pump Influent 12-20-2018.oda -- Serial Number: Odalog Type L2-RTx 06811211 Instrument Range 0-0PPM)
Average 4
Day Transition Min 0 Max 55 (Use Screen Data Only)
Reset Zoom
Undo Zoom


THE COWFISH
SUSHI · BURGER · BAR
SUSHI BURGER BAR
VIVO
Italian kitchen
VIVO

Current Strategy to Prevent H2S Toxicity

When rotating the Washington or Wachter force main

- Divert the wastewater through flow equalization for dilution, mixing and aeration.
- Max the ferric chloride dose during the two - three hours of elevated H2S.

Sampling Pretreatment Influent

Sampling Pretreatment Effluent

Table 7-2. Dosage Information from Liquid Phase Odor Control Methods.

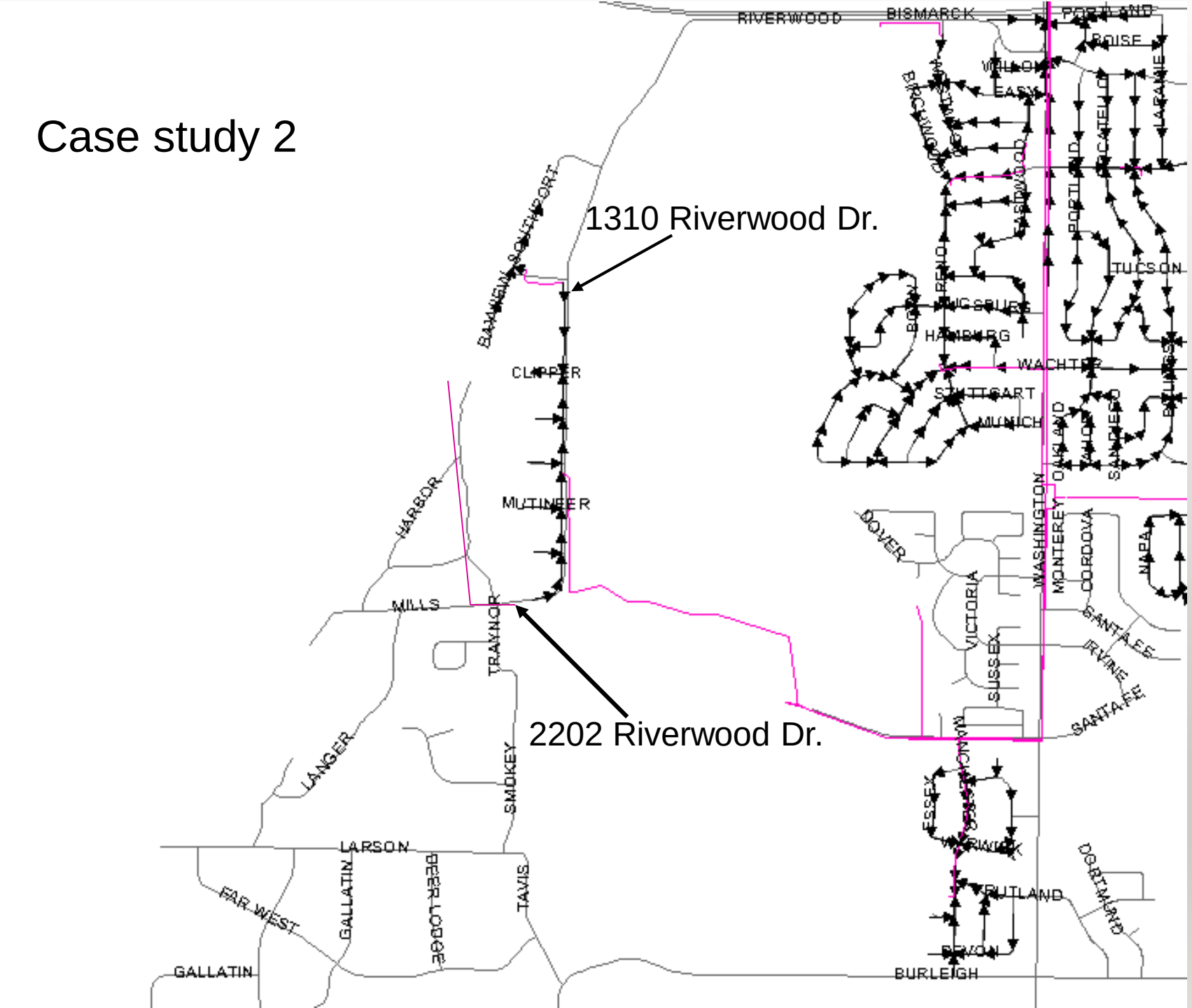
Chemical	Concentration (% by weight)	Solution Density (lb/gal.)	Dose (lb/lb of Sulfide Removed)	
			Low	High
Pure O_2	95	gas	Not directly comparable to other chemicals	
Cl_2 gas	100	gas	4	15
NaOCl	15	9.7	10	15
H_2O_2	50	10.0	1	4
$KMnO_4$	5	8.7	6	7
$NaMnO_4$	20	9.8	7	8
$FeCl_2$	30	10.0	4	12
$FeSO_4$	6	10.0	5	14
$FeCl_3$	40	10.8	3	7
$Ca(NO_3)_2$	60	12.1	4	15
NaOH	50	11.4	Doses must be compared to other methods on a case-by-case basis as they are not directly related to sulfide concentration alone	
$Mg(OH)_2$	63	13.3		

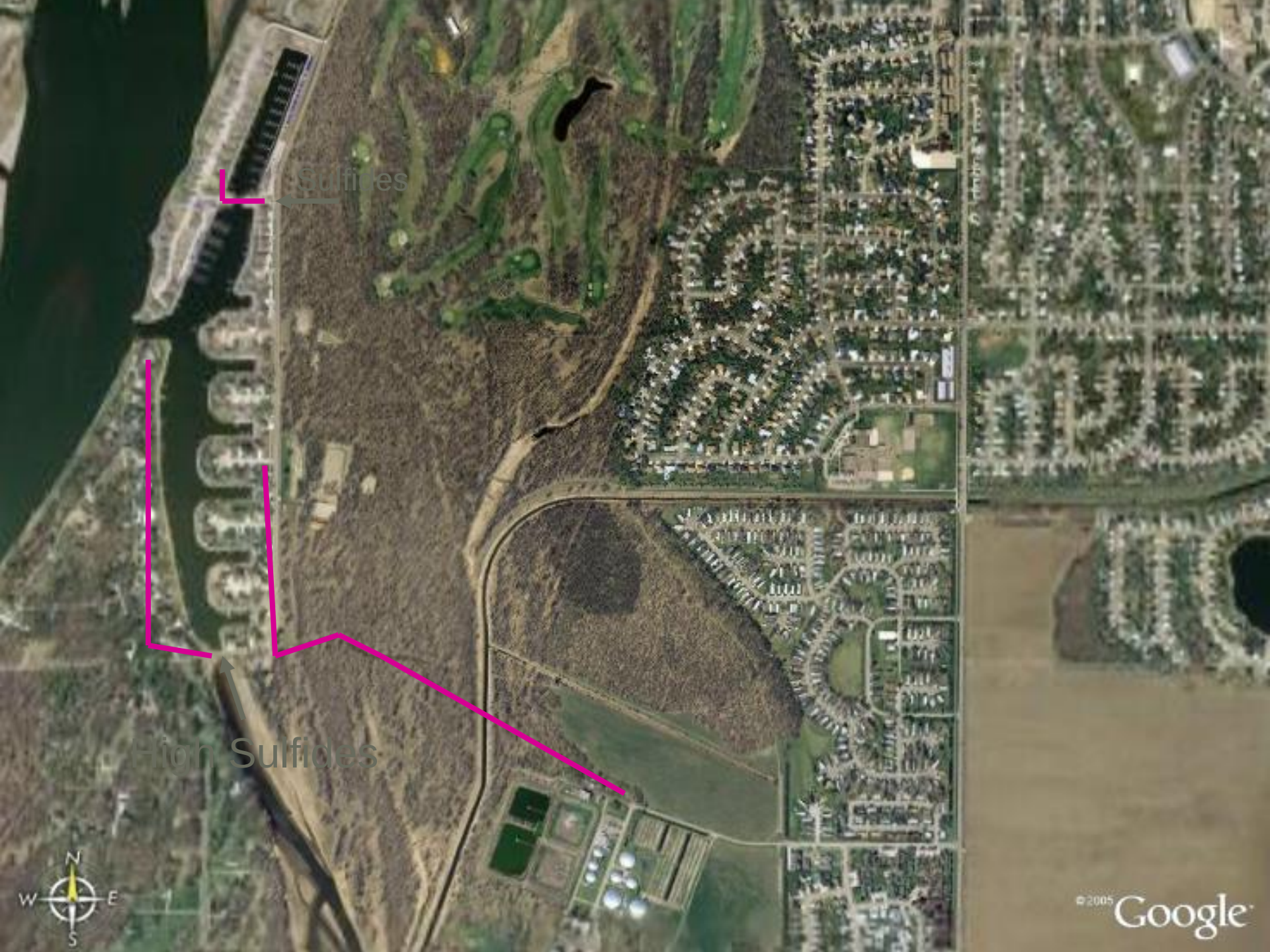
Minimization of Odors and Corrosion in Collection Systems Phase 1 WERF 2007

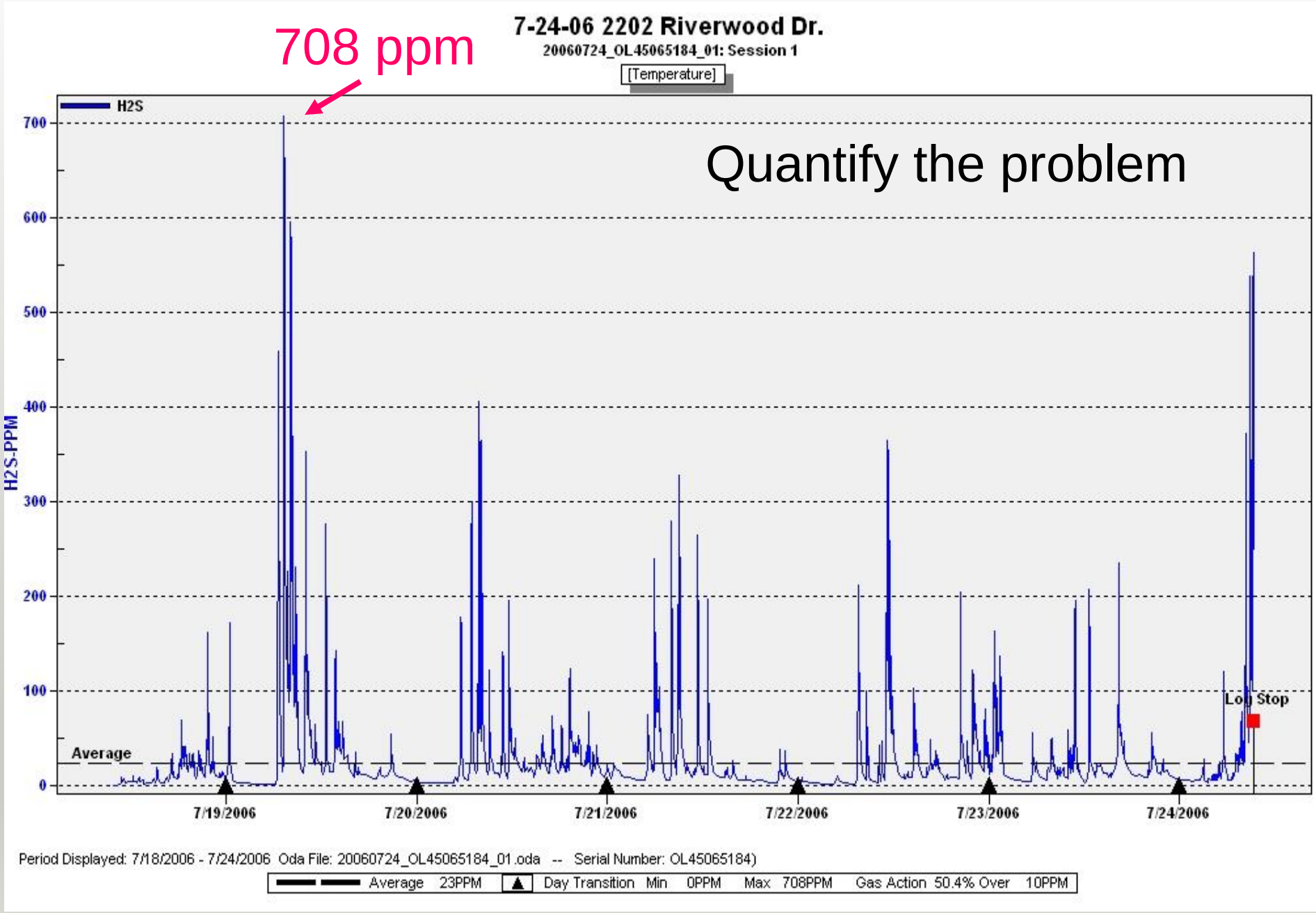
Private 3-mile forcemain case study 1

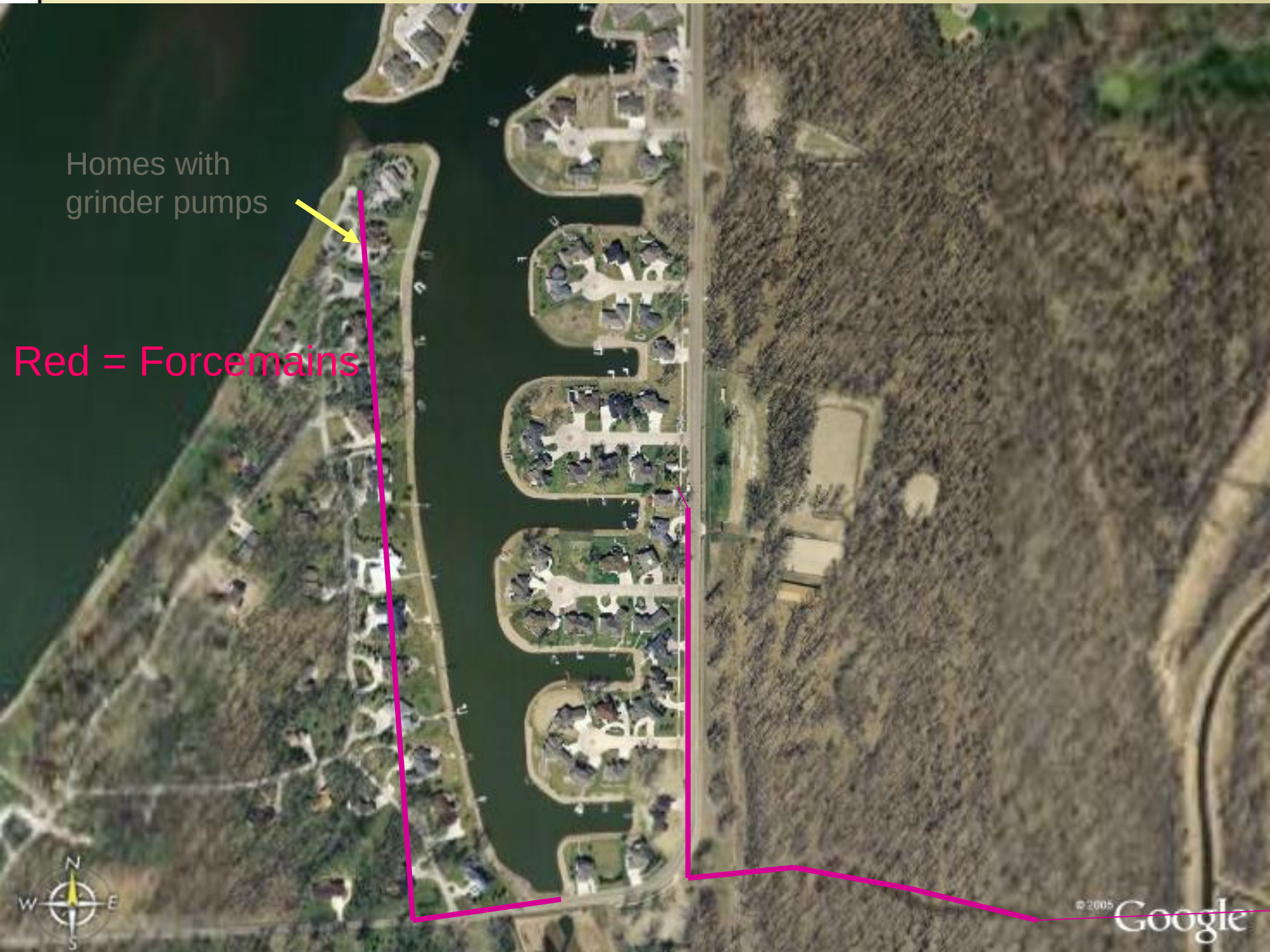
Date	Dissolved H2S mg/l	Air H2S mg/l	Comments
9/22/1999		53	No Chemical Addition
6/8/2000	35	<2	No Treatment
8/11/2000	**46**		No Treatment
10/16/2000	45		
10/19/2000	0		Adding 4 gallons 5.25% bleach/day
11/21/2000	2.5		
1/11/2001	9.5		Adding KMnO4
4/30/2001	15		Adding KMnO4
5/22/2001	0.65		Adding 3 gallons 5.25% bleach/day
6/10/2002	0.15		
7/26/2002	0.1		Adding 3 gallons azone/day
11/7/2002	0.1		
4/28/2003	0.05		

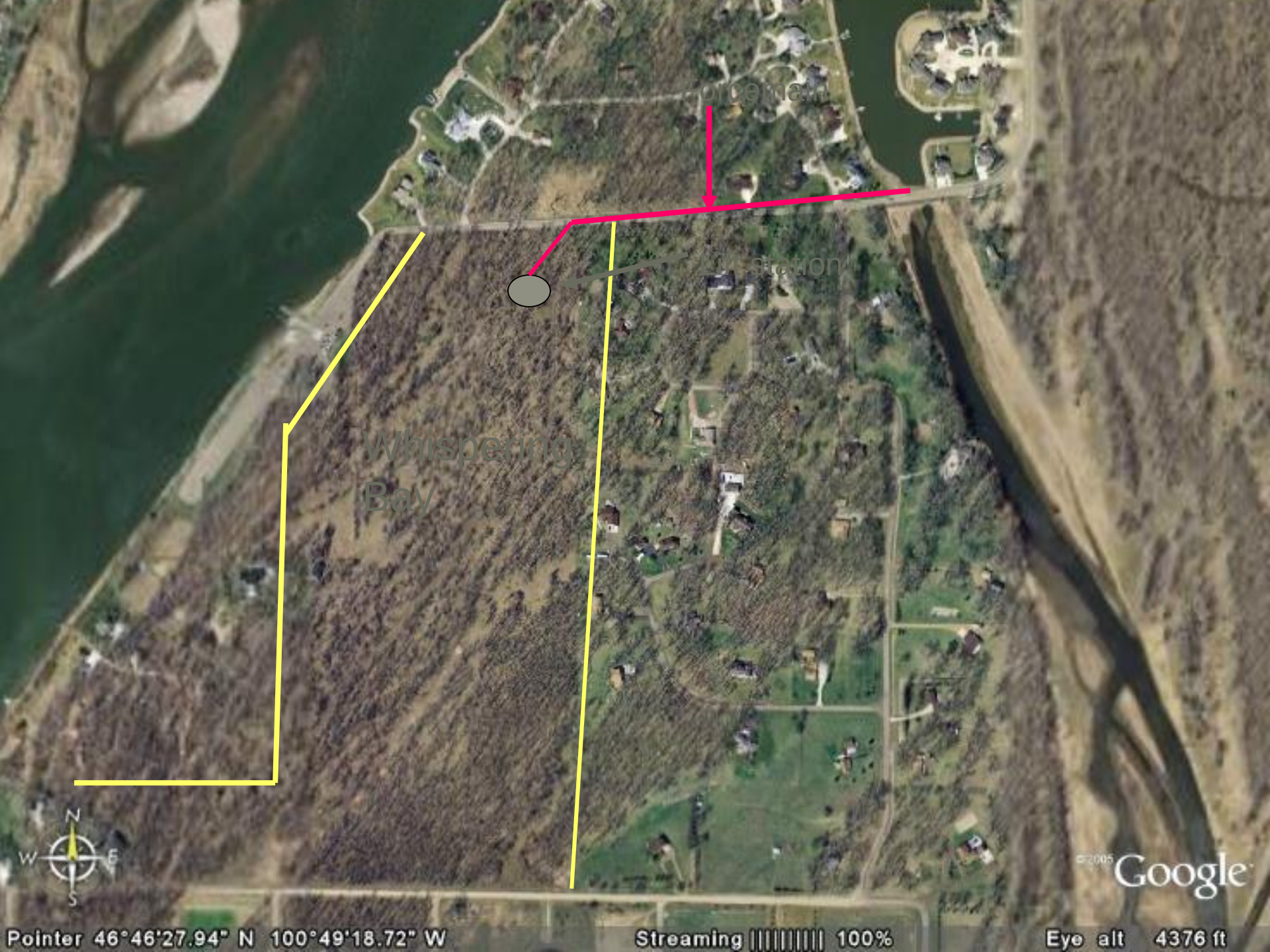
Case study 2


1310 Riverwood Dr.
2202 Riverwood Dr.
RIVERWOOD
BISMARCK
BOISE
LARAMIE
PORTLAND
TUCSON
RENO
HAMBURG
WACHTER
STUTTGART
MUNICH
OAKLAND
SANDIEGO
BLUNDSTONE
WASHINGTON
MONTEREY
CORDOVA
NAPA
SANTA FE
IRVINE
SUSSEX
VICTORIA
DOVER
ESSEX
RUTLAND
BURLEIGH
ORTIMARO
CLIPPER
MUTINEER
HARBOR
MILLS
TRAYNOR
SMOKEY
LANGER
LARSON
TAVIS
BEAR LODGE
GALLATIN
FAR WEST
GALLATIN


Sulfides
High Sulfides
N
W
E
S
© 2005 Google

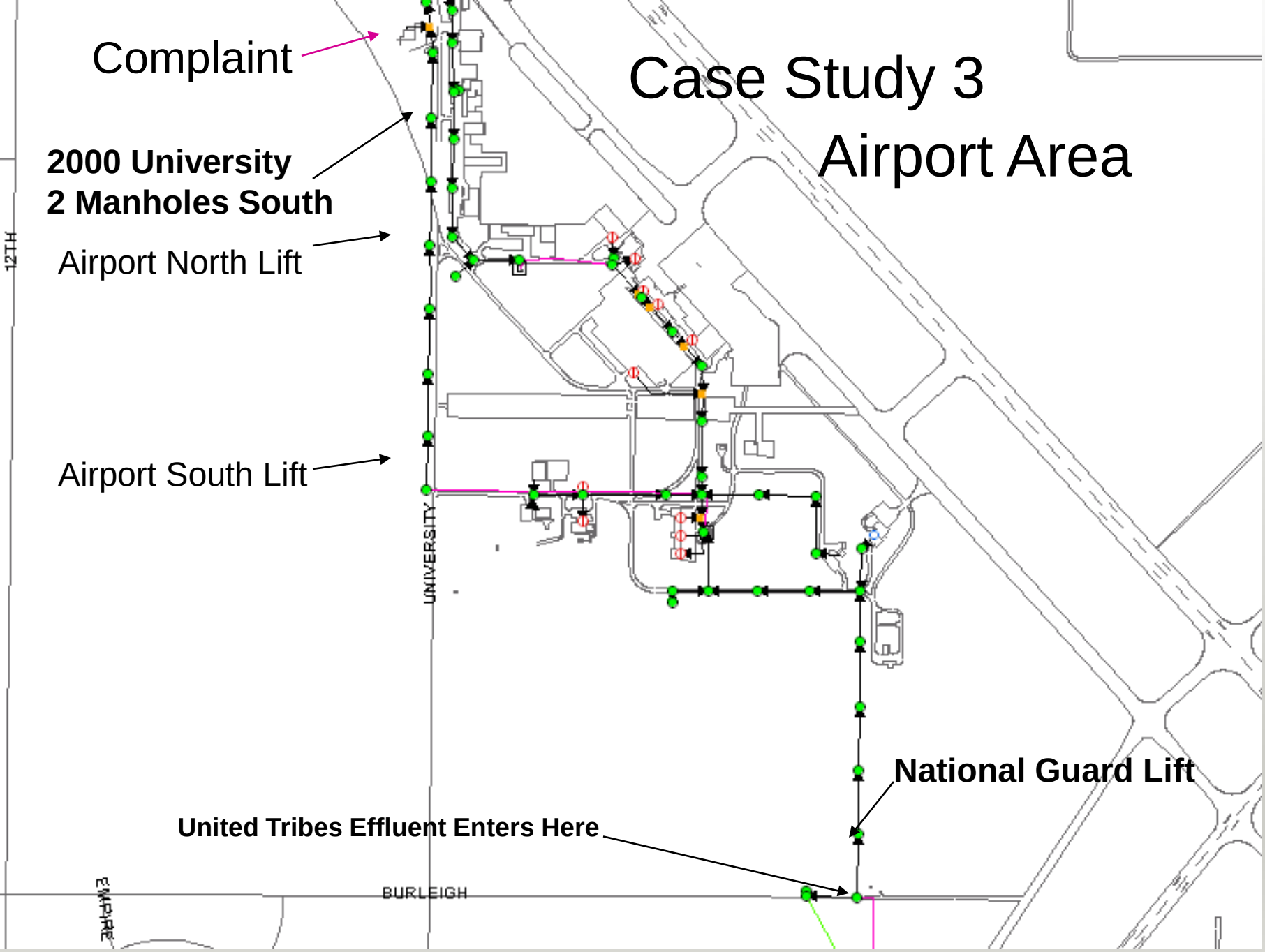

708 ppm
7-24-06 2202 Riverwood Dr.
20060724_OL45065184_01: Session 1
[Temperature]
Quantify the problem
H2S
H2S-PPM
700
600
500
400
300
200
100
0
Average
Log Stop
7/19/2006
7/20/2006
7/21/2006
7/22/2006
7/23/2006
7/24/2006
Period Displayed: 7/18/2006 - 7/24/2006 Oda File: 20060724_OL45065184_01.oda -- Serial Number: OL45065184)
Average 23PPM
Day Transition Min 0PPM Max 708PPM Gas Action 50.4% Over 10PPM


Homes with
grinder pumps
Red = Forcemains
N
W
E
S
© 2005 Google


Ordeman
Lift Station
Whispering
Bay
N
W
E
S
©2005 Google
Pointer 46°46'27.94" N 100°49'18.72" W
Streaming 100%
Eye alt 4376 ft

Riverwood Drive Solutions

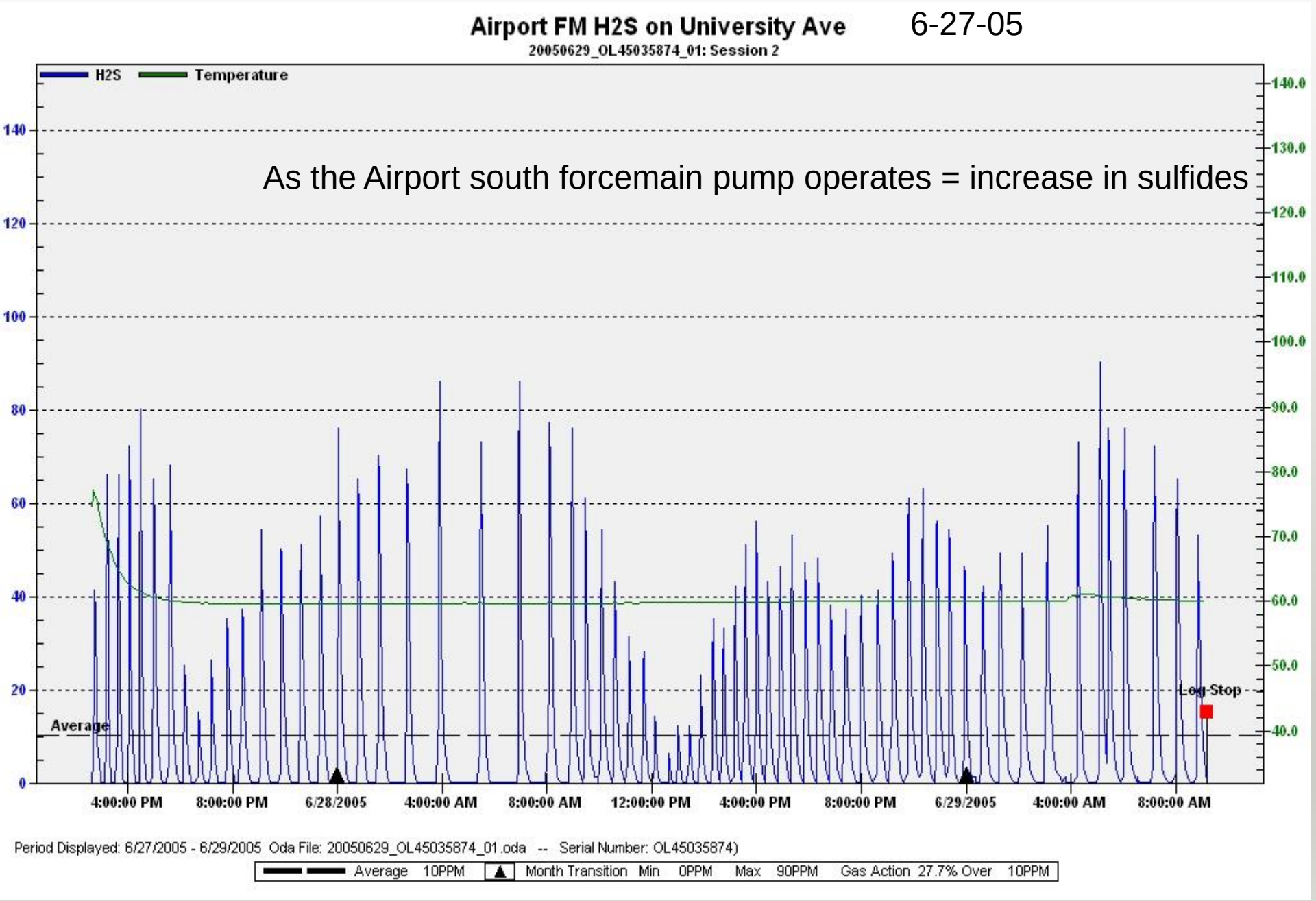
- Increase pumping frequency of private lift station, lower pump set points
- Reduce holding time of wastewater in private holding tanks with grinder pumps
- Increase water flow through Whispering Bay during summer months


Complaint
Case Study 3
Airport Area
2000 University
2 Manholes South
Airport North Lift
Airport South Lift
National Guard Lift
United Tribes Effluent Enters Here
UNIVERSITY
BURLEIGH
12TH


Complaint
2000 University
2 Manholes South
Airport North Lift
Airport South Lift
National Guard Lift
Effluent
12TH
UNIVERSITY
BURLEIGH
EMPIRE

Airport Area Sulfide Testing Data

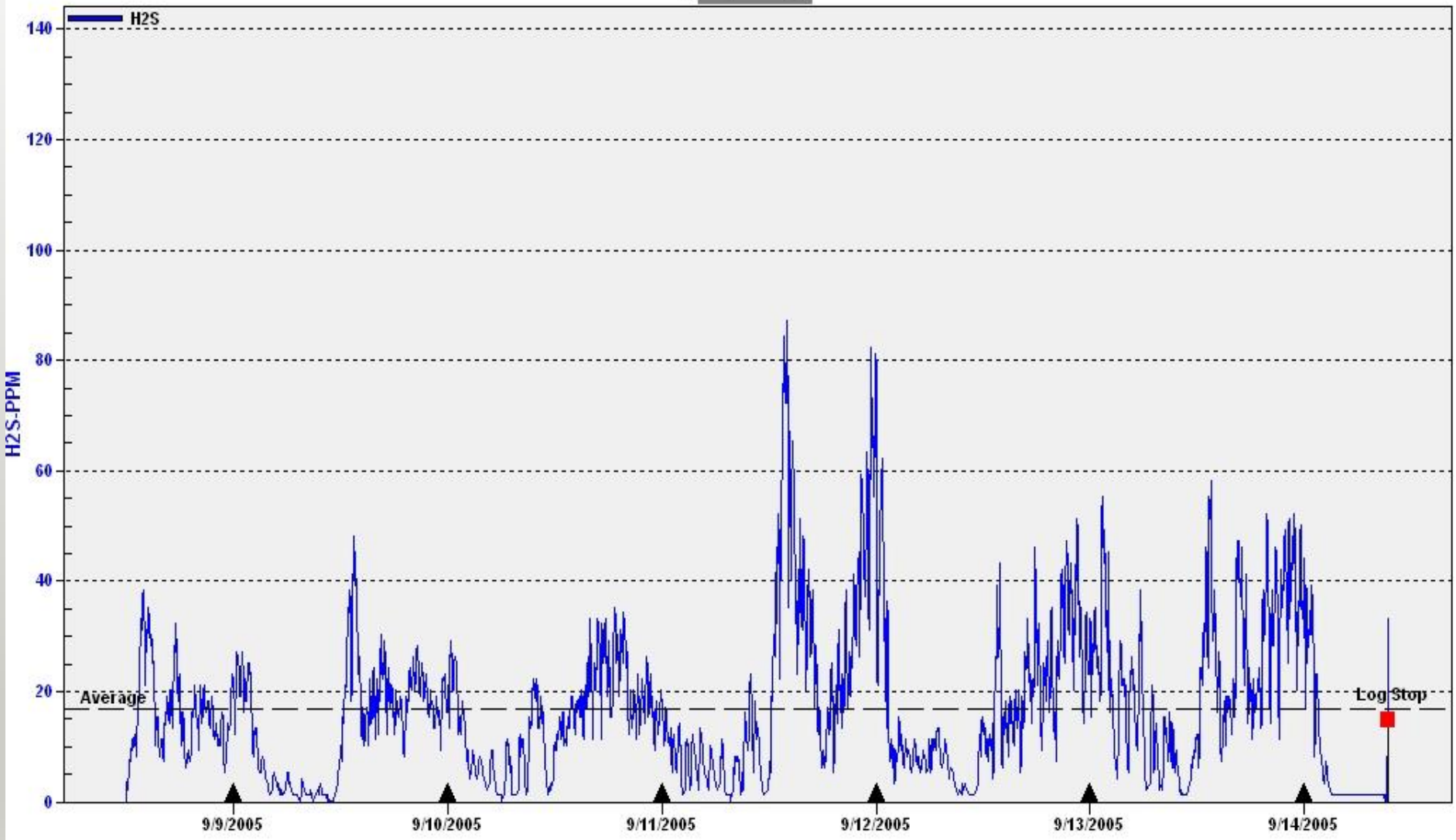
		Dissolved	Air			
Date	Time	Sulfides	Sulfides	pH	Sample Location	
		mg/l	mg/l			
6/14/05	10 a.m.		**45, 39**		East	Vent from 2000 University Drive
6/14/05	10 a.m.		29		West	Vent
6/16/05	11 a.m.		1, 4		Gate 100	Manhole 3710
6/16/05			2		Manhole	1 S 2000 University
6/16/05			1		Manhole	2 S 2000 University
6/17/05			8		Manhole	1 NW 2000 University
6/17/05	2:05 PM		10		Manhole	2 NW 2000 University
6/17/05			11		Manhole	3 NW 2000 University
6/17/05	2:15 PM		5		Manhole	4 NW 2000 University
6/17/05	2:25 PM		1		Manhole	5 NW 2000 University
6/17/05	2:29 PM		0		Manhole	6 NW 2000 University
6/17/05			33, 26		Manhole	1 S 2000 University
6/17/05	3:10 PM		7, 1		Manhole	3 S 2000 University
6/17/05	3:18 PM		0		Gate 100	Manhole 3710
6/20/05	3:25 PM	1.0		7.8	Manhole	2 S 2000 University
6/20/05	3:30 PM	**6.25**		7.88	Manhole	2 S 2000 University
6/27/05	3:20 PM		59		Manhole	2 NW 2000 University
6/27/05	15:00				Manhole	First manhole upstream of Airport Maintenance Building Lift added 3 gallons of 5% bleach
6/28/05	9:00				Manhole	First manhole upstream of Airport Maintenance Building Lift added 3 gallons of 5% bleach
7/5/05	13:00	1.7		7.8	Manhole	2 S 2000 University


Airport FM H2S on University Ave
6-27-05
20050629_OL45035874_01: Session 2
H2S
Temperature
As the Airport south forcemain pump operates = increase in sulfides
Average
Log Stop
4:00:00 PM
8:00:00 PM
6/28/2005
4:00:00 AM
8:00:00 AM
12:00:00 PM
4:00:00 PM
8:00:00 PM
6/29/2005
4:00:00 AM
8:00:00 AM
Period Displayed: 6/27/2005 - 6/29/2005 Oda File: 20050629_OL45035874_01.oda -- Serial Number: OL45035874)
Average 10PPM
Month Transition Min 0PPM Max 90PPM Gas Action 27.7% Over 10PPM

2000 University 2 Manholes South 9-14-05

20050914_OL45055972_01: Session 1

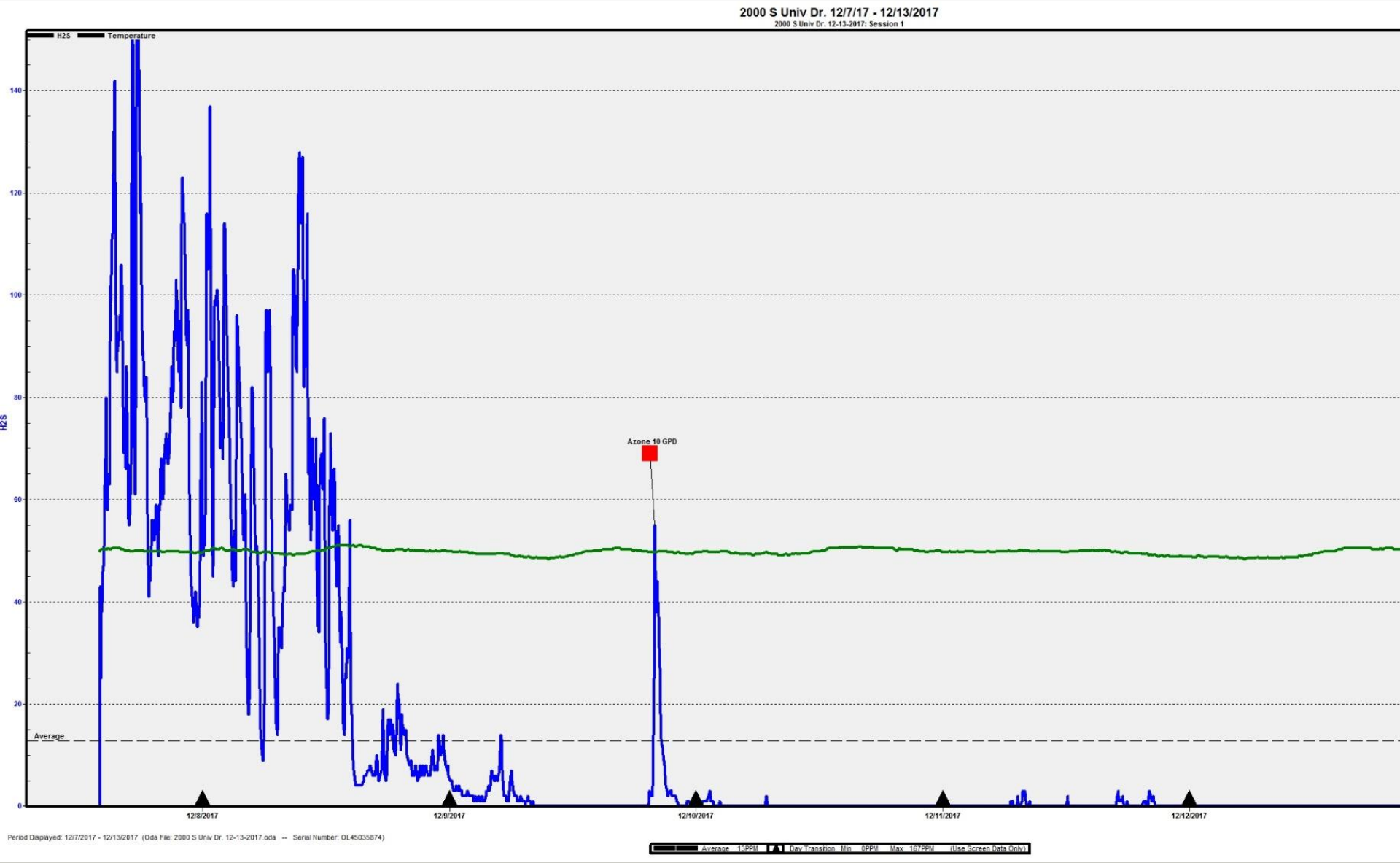
[Temperature]



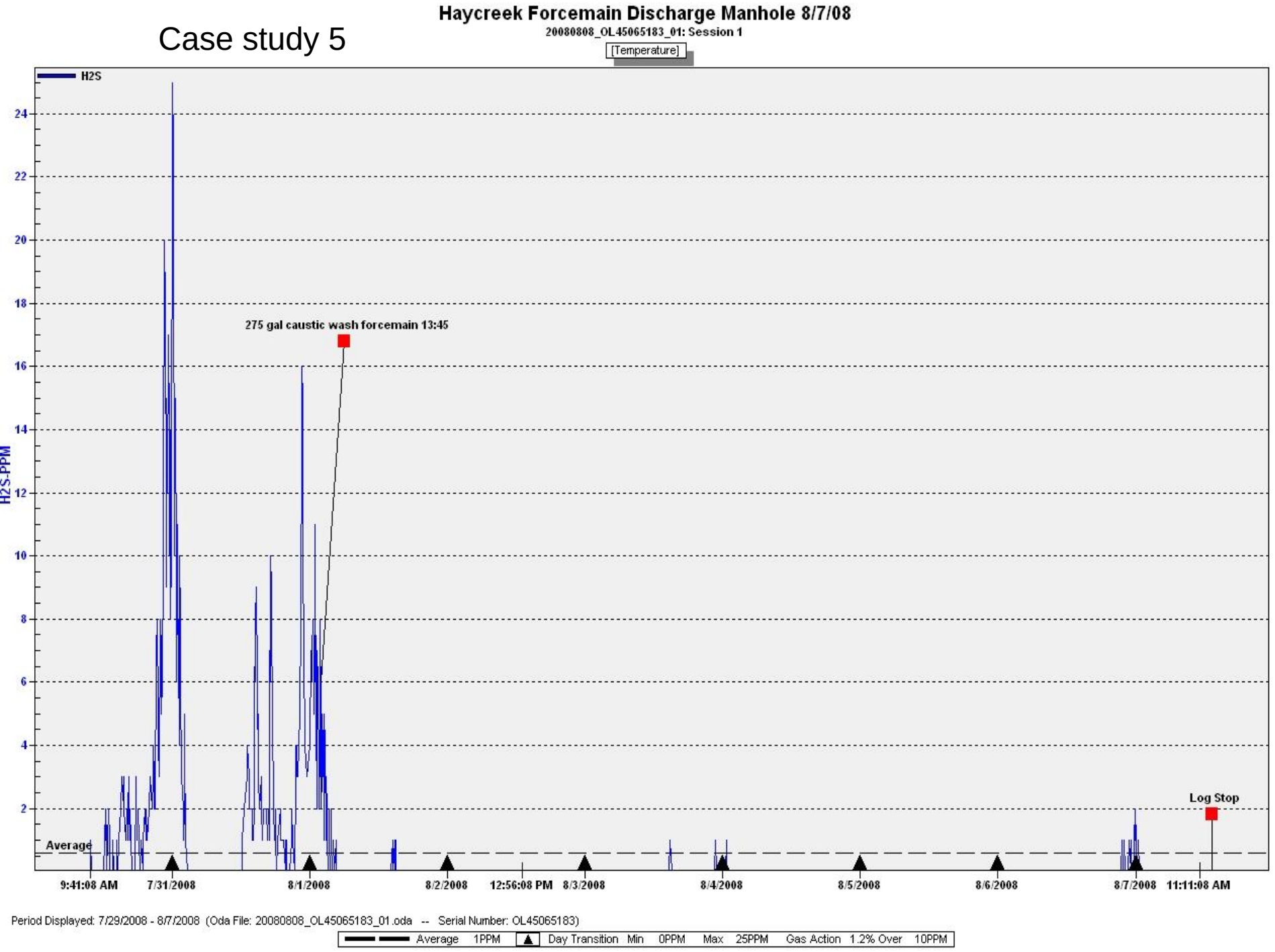
Period Displayed: 9/8/2005 - 9/14/2005 Oda File: 20050914_OL45055972_01.oda -- Serial Number: OL45055972)

Average 17PPM | Month Transition | Min 0PPM | Max 87PPM | Gas Action 61.5% Over 10PPM

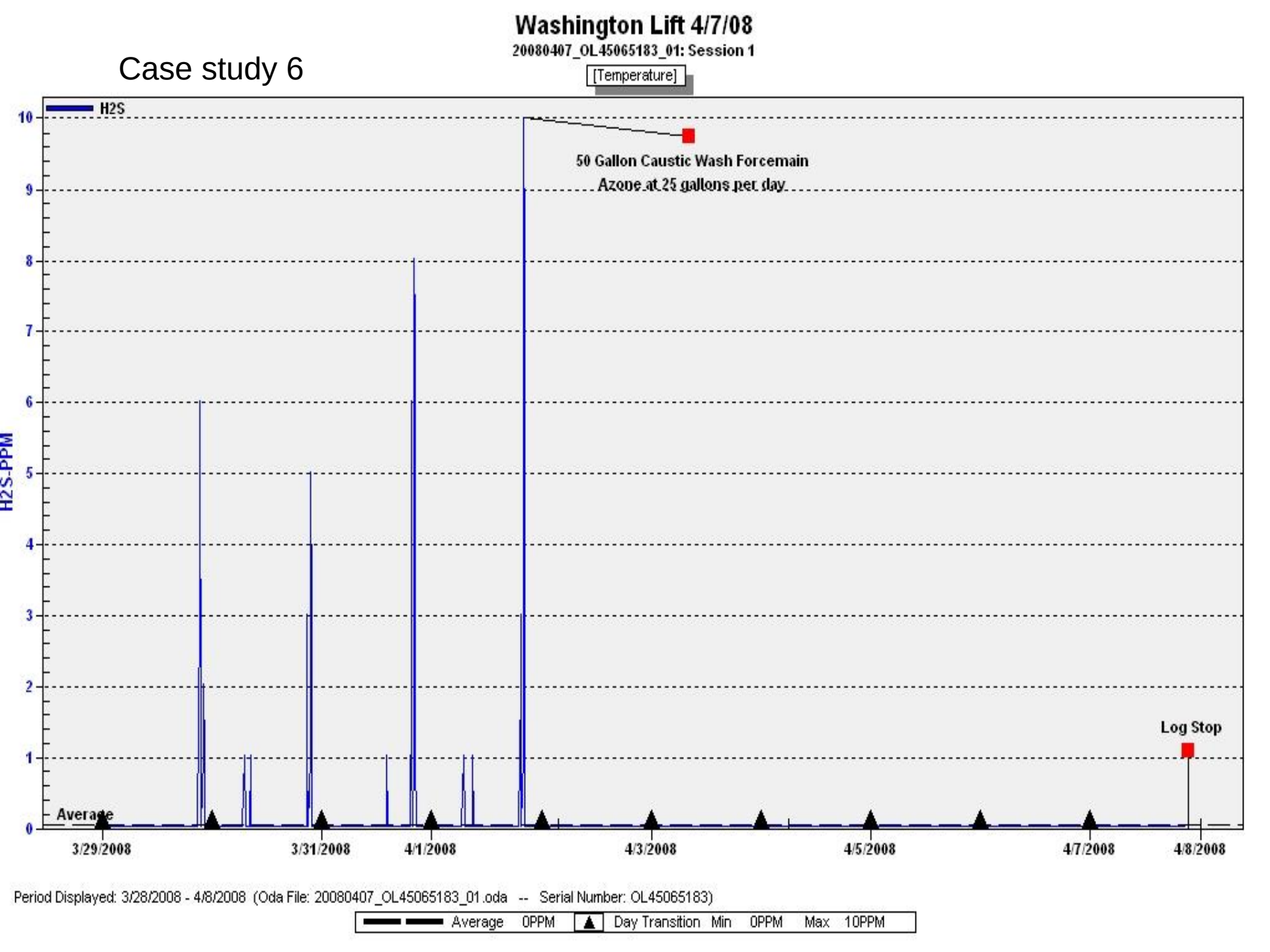

DANGER
SODIUM
HYPOCHLORITE
27 1:54PM


2000 S Univ Dr. 12/7/17 - 12/13/2017
2000 S Univ Dr. 12-13-2017: Session 1
H2S
Temperature
H2S
140
120
100
80
60
40
20
0
Azone 10 GPD
Average
12/8/2017
12/9/2017
12/10/2017
12/11/2017
12/12/2017
Period Displayed: 12/7/2017 - 12/13/2017 (Oda File: 2000 S Univ Dr. 12-13-2017.oda -- Serial Number: OL45035874)
Average 13PPM
Day Transition Min 0PPM Max 167PPM (Use Screen Data Only)

Case study 5

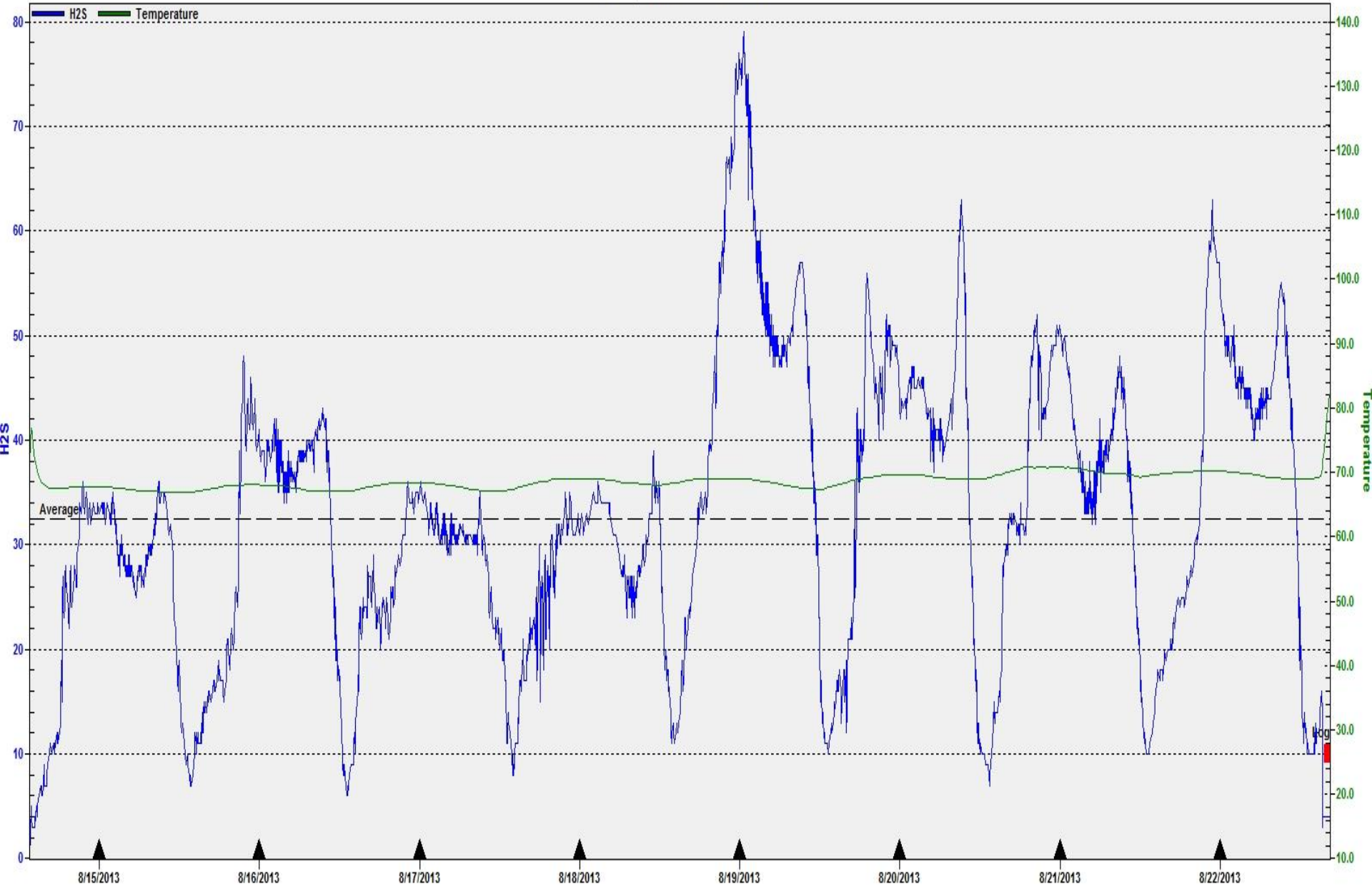

Haycreek Forcemain Discharge Manhole 8/7/08
20080808_OL45065183_01: Session 1
[Temperature]
H2S
H2S-PPM
24
22
20
18
16
14
12
10
8
6
4
2
275 gal caustic wash forcemain 13:45
Log Stop
Average
9:41:08 AM
7/31/2008
8/1/2008
8/2/2008
12:56:08 PM
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
11:11:08 AM
Period Displayed: 7/29/2008 - 8/7/2008 (Oda File: 20080808_OL45065183_01.oda -- Serial Number: OL45065183)
Average 1PPM
Day Transition Min 0PPM Max 25PPM Gas Action 1.2% Over 10PPM

Case study 6


Washington Lift 4/7/08
20080407_OL45065183_01: Session 1
[Temperature]
H2S
H2S-PPM
50 Gallon Caustic Wash Forcemain
Azone at 25 gallons per day
Log Stop
Average
10
9
8
7
6
5
4
3
2
1
0
3/29/2008
3/31/2008
4/1/2008
4/3/2008
4/5/2008
4/7/2008
4/8/2008
Period Displayed: 3/28/2008 - 4/8/2008 (Oda File: 20080407_OL45065183_01.oda -- Serial Number: OL45065183)
Average 0PPM
Day Transition Min 0PPM Max 10PPM

Washington Lift 8/15 - 8/22/2013

Washington Lift 8-22-2013: Session 1



Period Displayed: 8/14/2013 - 8/22/2013 (Oda File: Washington Lift 8-22-2013.oda -- Serial Number: OL45055972)

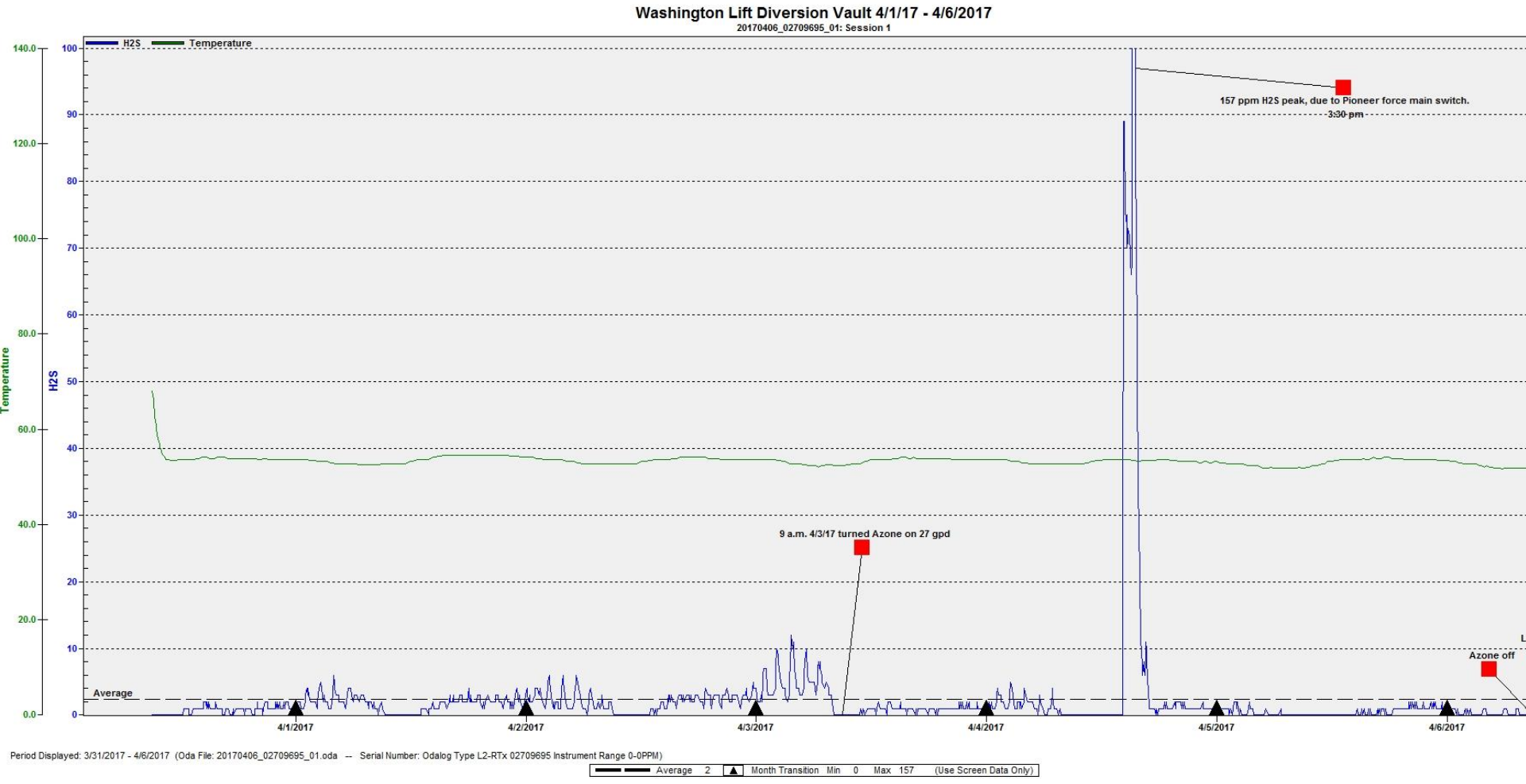
Average 32PPM | Month Transition Min 0PPM Max 79PPM (Use Screen Data Only)

Washington Lift 9/9 - 9/16/13

Washington Lift 9-16-2013: Session 1

Period Displayed: 9/9/2013 - 9/16/2013 (Oda File: Washington Lift 9-16-2013.oda -- Serial Number: OL45025783)

Average 6PPM | Month Transition Min 0PPM Max 41PPM (Use Screen Data Only) (Apply Sensor Decay)


Washington Lift Diversion Vault 4/1/17 - 4/6/2017
20170406_02709695_01: Session 1
H2S
Temperature
157 ppm H2S peak, due to Pioneer force main switch.
3:30 pm
9 a.m. 4/3/17 turned Azone on 27 gpd
Azone off
Average
4/1/2017
4/2/2017
4/3/2017
4/4/2017
4/5/2017
4/6/2017
Period Displayed: 3/31/2017 - 4/6/2017 (Oda File: 20170406_02709695_01.oda -- Serial Number: Odalog Type L2-RTx 02709695 Instrument Range 0-0PPM)
Average 2
Month Transition Min 0 Max 157 (Use Screen Data Only)

Jar Testing Ferric Chloride

How Did We Get Here?

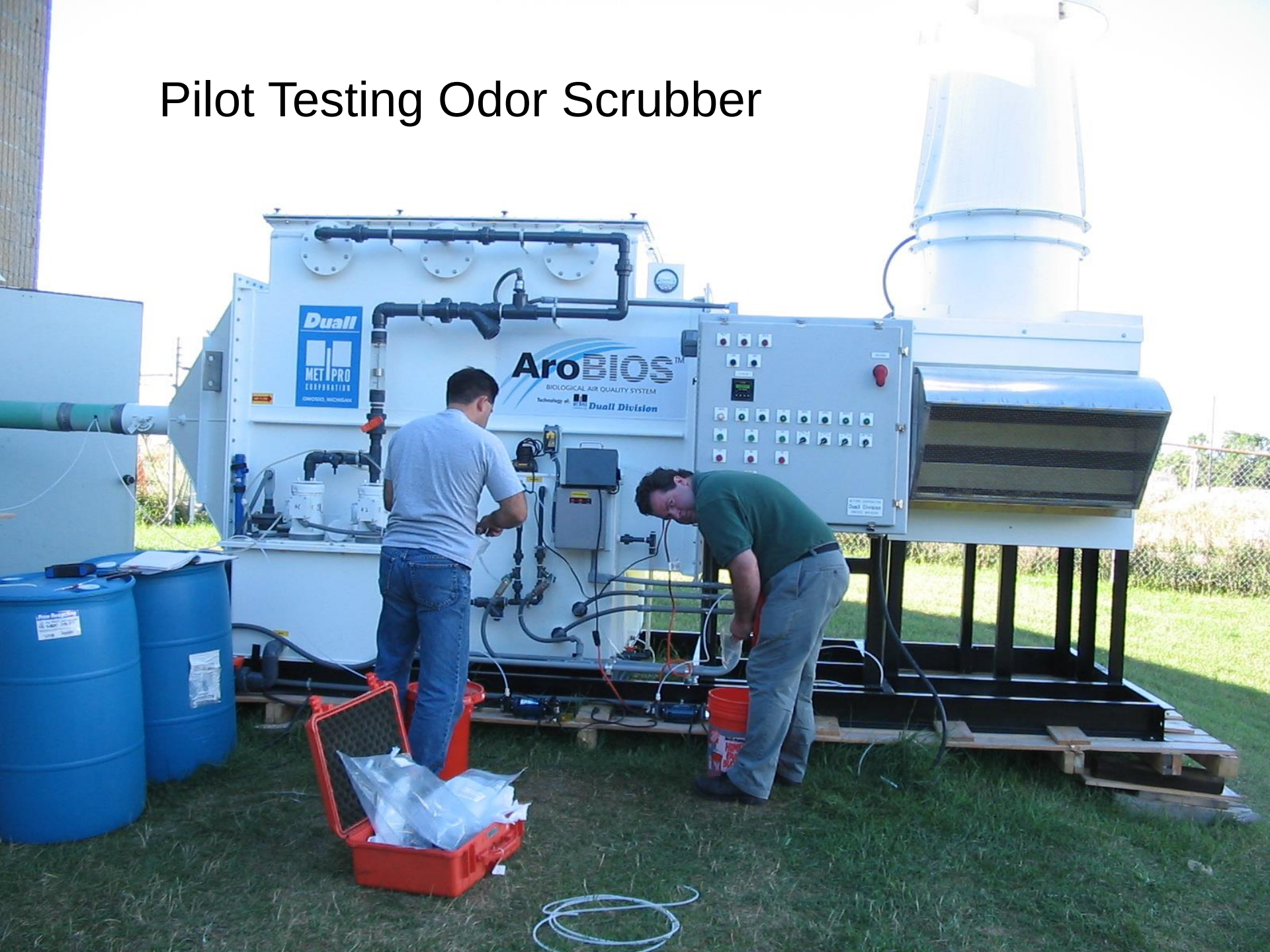
- Historical information
- Investigation of original assumptions
- Jar/bench testing
- Allocation of resources
- Pilot testing
- Follow up monitoring

Air Stream Odor Removal

Air Treatment Alternatives, from WEF MOP-22, 1995

	Frequency of use	Cost Factor	Advantage	Disadvatage
Packed-Tower Wet Scrubber	High	Moderate Capital and O&M	Effective and reliable	Chemical consumption No VOC removal
Fine Mist wet scrubber	Medium	High Capital Cost that tower	Low chemical consumption VOC removal	Large vessel, need to soften scubber water
Carbon	High	Depends or removal freq	No moving parts	Dilute H2S only, high cost w/ high VOC
Biofilter	Medium	Low Capital and O&M cost	Simple, VOC effective	Media replacement, moisture monitoring
Thermal Oxidizer	Low	High Capital & Energy Cost	Effective, VOC removal	Economical for high H2S, difficult to treat
Acivated Sludge	Low	Economical	Simple, low O&M, effective	Blower corrosion, not for high H2S
Masking agents	High	Dependent on usage	Low capital, for sporatic odors	Only mask, no VOC removal

Pilot Testing Odor Scrubber



Pilot Testing a Biofilter

Filtration Removal Options for Low Air Flow

Treatment Alternatives

- State the alternative treatment strategies
- Calculate the capital, chemical and operational costs
- List advantages & disadvantages of each option
- Get approval to pilot test
- Add cost to budget/financial plan

Recommendation

- Summarize the research results
- Recommend the strategies
- Identify action items
- After implementation provide follow-up verification of actual conditions

Summary

- Wastewater odor complaints are most often associated with hydrogen sulfide gas
- H2S can be oxidized or precipitated with chemicals
- Vapor phase odors can be treated with biological and/or chemical treatment methods
- Method selection should depend upon the concentration, efficiency, air flow and cost

Summary

- Treat each location to remove odors as unique
- Jar test to help identify which chemicals work for the local wastewater and conditions before pilot testing
- Test the water and air for hydrogen sulfide before and during treatment, conditions change during the year, expect to make adjustments.
- Never expect to eliminate all odors all of the time from any process

Questions?

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