

Occasional Reversal of Sewage Pumps to Mitigate Ragging

SCAP Collection Systems Committee Meeting
Alhambra, CA – Feb. 25, 2014

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L.A. County Sanitation Districts

Overview

- Magnitude of Ragging Problem
- Facility Design
- Equipment Selection
- Pump / FM Operation
- Case Studies and Solutions
- Deragging Electrical Solutions
 - Reverse Operation and Deragger
- Summary

Magnitude of Problem

- Baby wipes, feminine products, diapers, cleaning wipes disposable gloves, etc.
 - *Some flushable, others not (but who's reading the fine print)*
- Forecasted to rise 5% per year
- Decreasing wastewater flows – especially with drought
- Concentration of ragging matter increasing
- Old pumps and new (replacement) pumps can clog
- Millions spent on Public Outreach Campaigns / Education

Facility Design

- **Avoid large horizontal surfaced wetwells**
 - Deeper and narrow better with sloping to keep clean
- **Avoid too large suction piping**
 - Rags will accumulate in low flows and get sucked up at high flows in one mass
- **Pay attention to self-cleaning of wetwells**
 - Orientation and spacing of pumps
- **Pump selection**
 - Some pump/impeller types are better than others
 - Pumps have to fit the intended operation and hydraulics
- **Don't oversize the check valves**

Equipment Considerations

- **To Shred or Not to Shred**
 - Comminutors, macerators, chopper pumps
- **To Catch or Not to Catch**
 - Bar screens – manual and automatic, disposal and odors
- **Vortex impellers – Wemco Torque Flow**
 - Sacrifice efficiency by having a recessed impeller
- **Flygt N-style impeller**
 - Modified leading edge and relief groove
 - Slight reduction in efficiency and NPSH
- **Wemco Hidrosta**
 - Single blade and steep pump curve
- **Non Clog Channel - Blunt Leading Edges**
 - Best to level the playing field for all

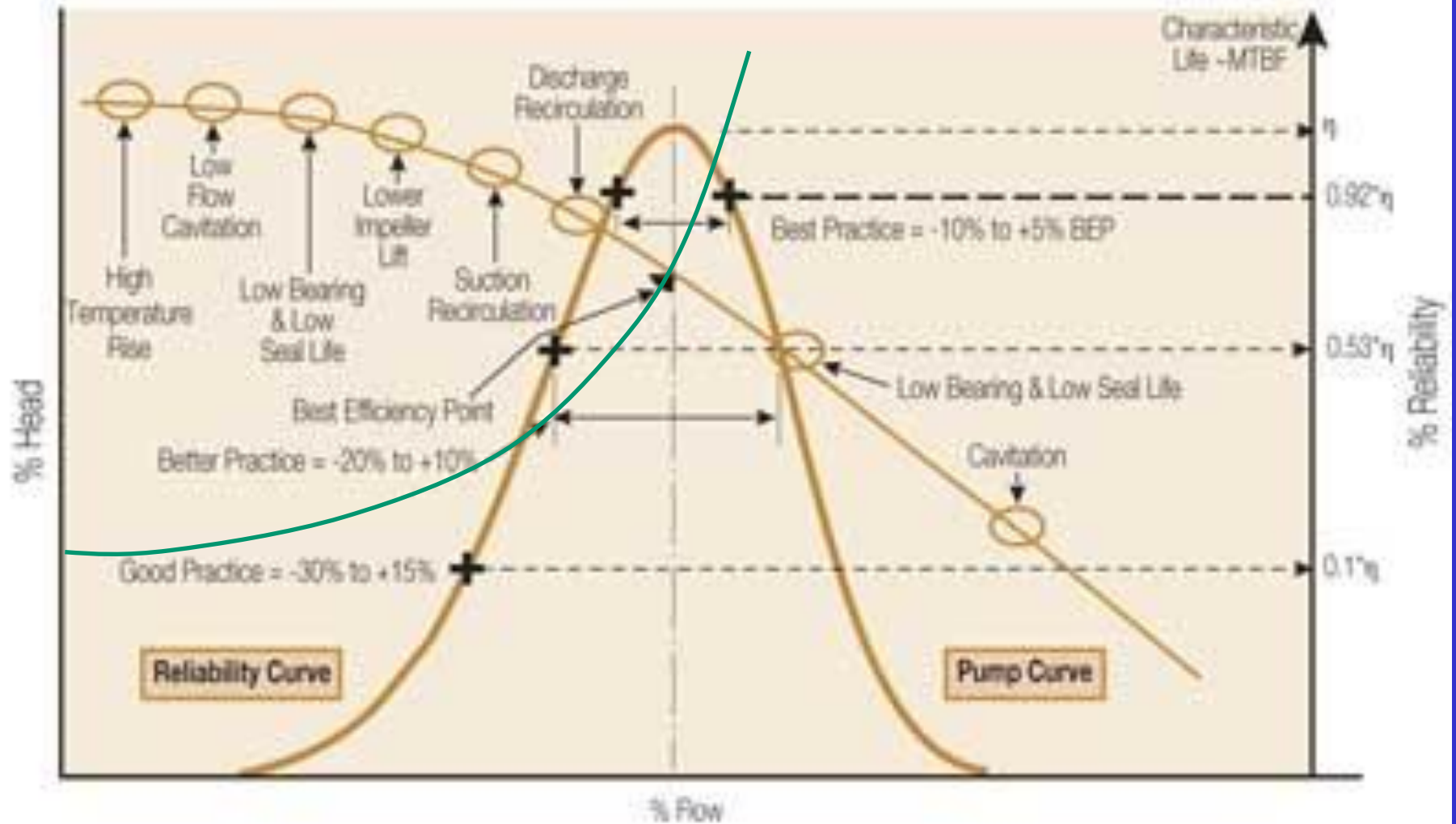


Try to Operate Pump According to Intended Design

- Operate close as possible to BEP
- Operate in the Acceptable Operating Range (AOR)
- Be careful about pump ramp down during low flow
- Be mindful that more static head means less AOR
- Keep tolerances tight (wear rings, base plate)
- Don't run too many pumps – the BEP and AOR's shift

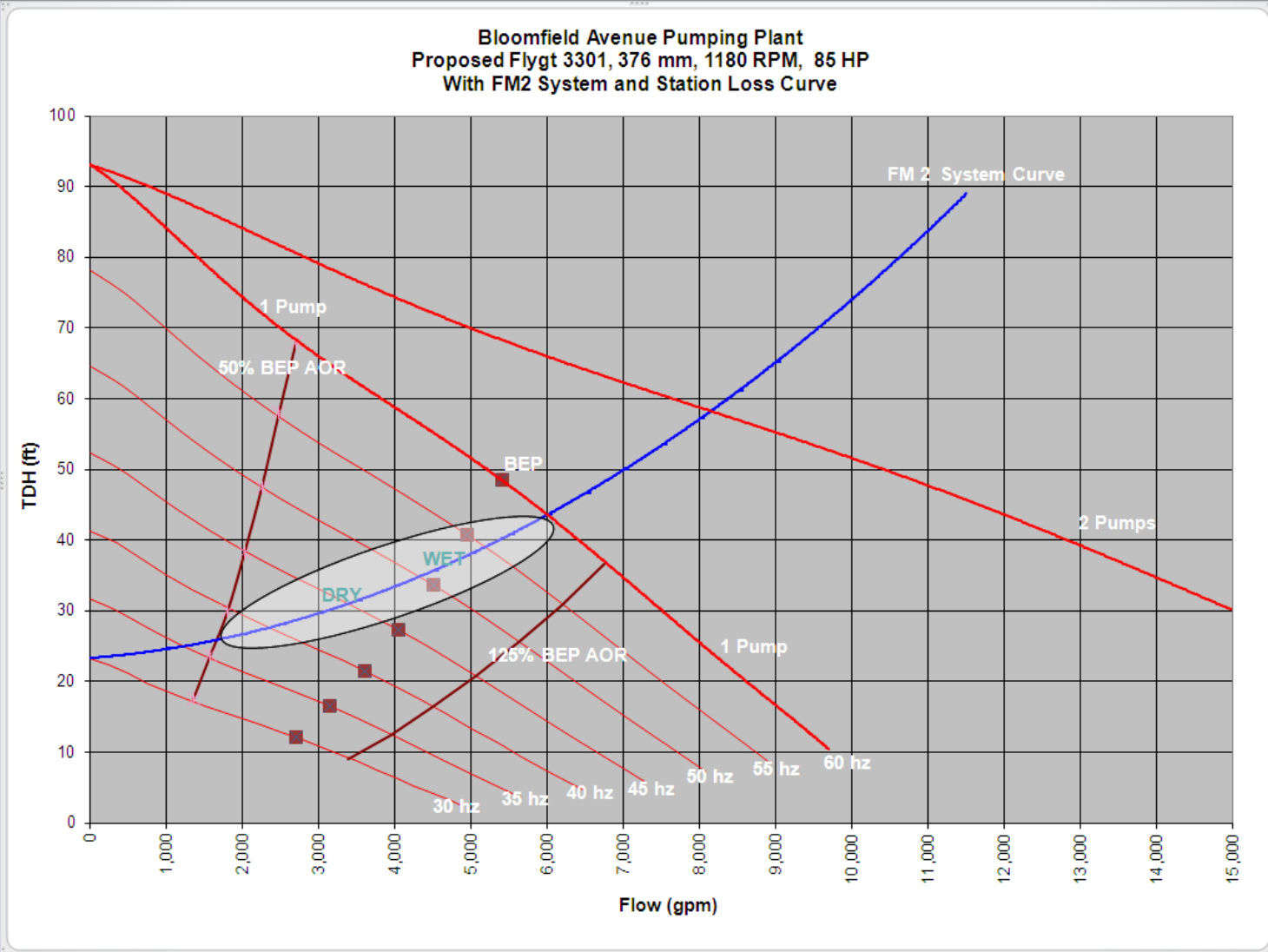
Pump Reliability

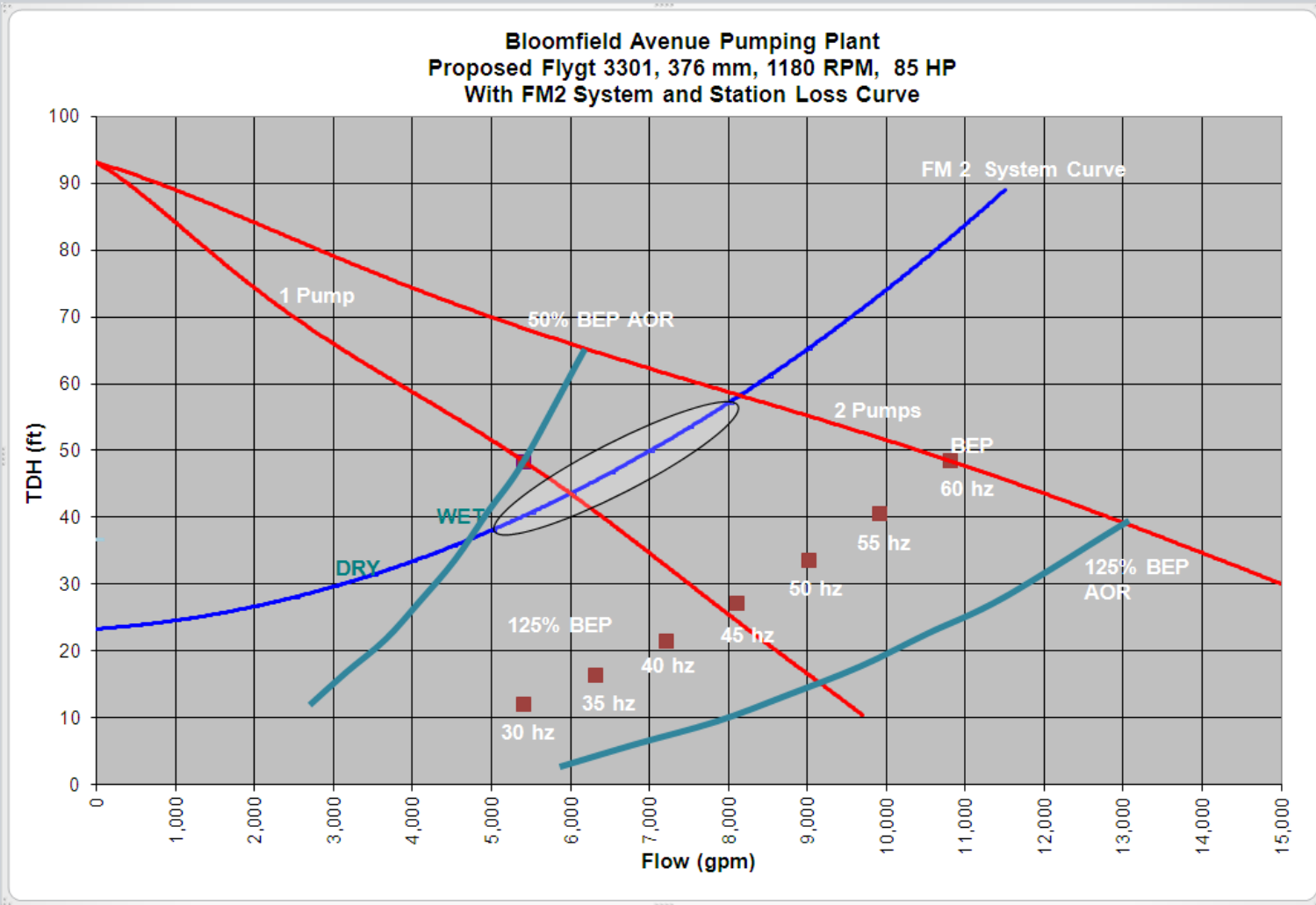
Figure 1. Factors impacting pump reliability and minimum flow



File Home Insert Page Layout Formulas Data Review View DM Acrobat PI Design Layout Format

Clipboard Font Alignment Number Styles Cells Editing





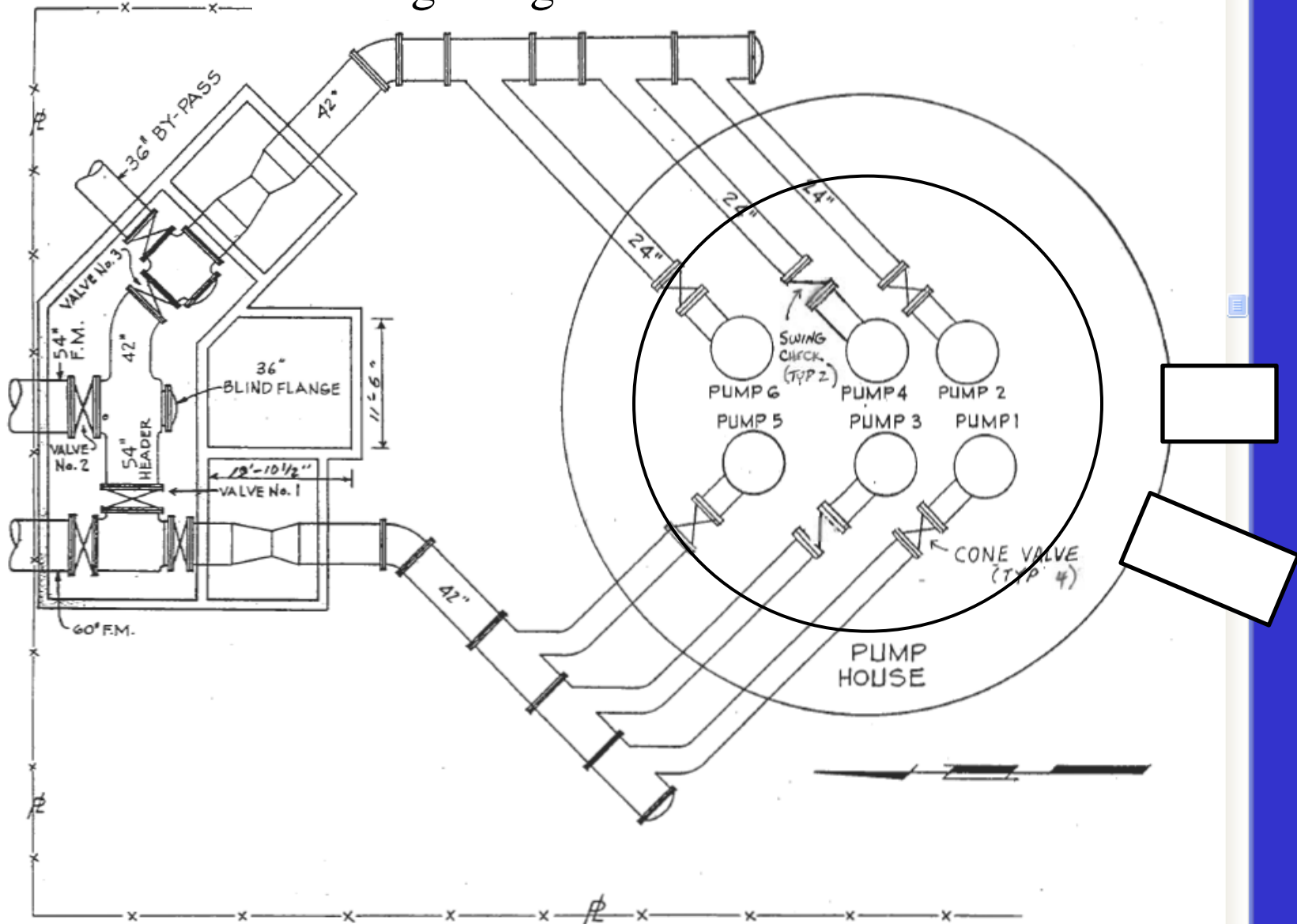
Pump Operational Strategies to Mitigate Ragging

- Better to run Fill and Draw (full speed) vs. Constant Level (reduced speed)
- Increase the minimum VFC speed setting (% , Hz, rpm)
- Switch pumps ON/OFF often – some flow reversal likely and rehydration of rags
- Increase the impeller and decrease check valve size
- Run the pump(s) that don't rag
- Keep the wetwell clean of debris

Long Beach Main Pumping Plant Ragging Occurred After Years of Operation

- System Curve and Pump Curve Testing
 - Low pump efficiencies – old pumps
- Replaced Cone Valves with Swing Checks
 - Ragging of check valves
- Replaced VFCs
- Rebuilt Pumps 2 and 6
 - Contractor noticed ragging/plugging during changeouts
 - Did not test well for Edison rebates
- SCE testing and PP Operator started to notice increased plugging
 - Started calling out Stationary mechanics to clear
- Ragging Mitigation and Pump Replacements

Existing Long Beach Main PP



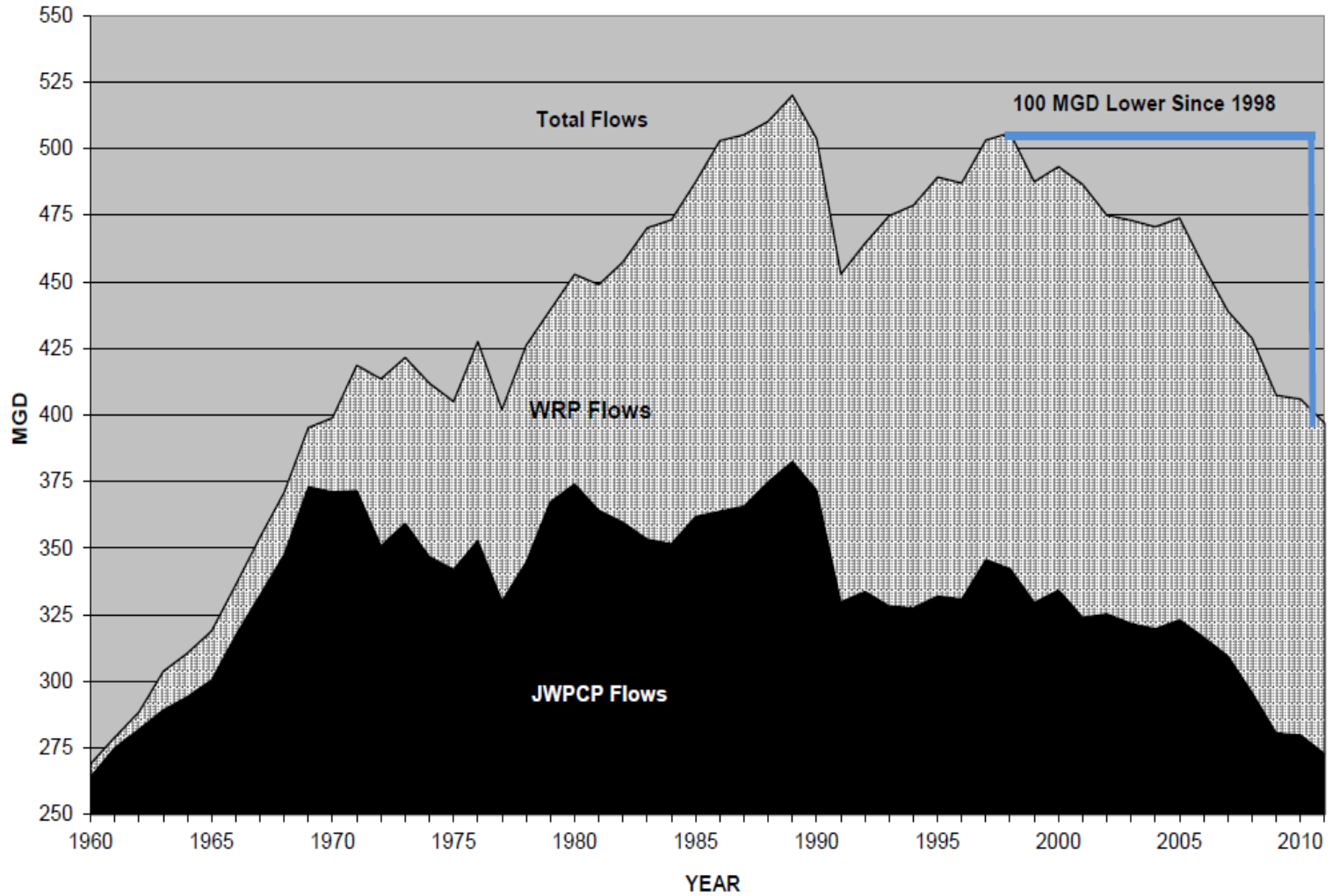
Existing Cone Valve



Milliken CCNE Check Valve Stored at LBMPP after Surge Tank Project



Joint Outfall Sewer Flows Cumulative Totals



Stationary Mechanics Deragging a 200 HP Pump Avg cost - \$450 per deragging



Sample of Pump Material



Sampling of Different Manholes for Source of Rags (10-25 min)...but they were everywhere



Ragging Mitigation Strategies Tried at LBMPP

- Raised minimum VFC setting
- Tried different wetwell levels
- Brief operation at full speed at startup
- Brief operation at full speed at shutdown
- Run pumps at full speed – abandoned constant level
- Run West pumps that rag up 20% of time
- PP Consultant - Recommendations

Development of Reverse Operation

- Pump repair company recommended backflushing
- Experience
 - Muffin Monsters at WWTP inlet works
 - Boat propellers reversing to get kelp off
 - Wife's Cuisinart – Grind and Puree
- Former student IW sent a picture of reversing contacts
- Told to design buy 2 new pumps and portable pump

Development of Reverse Operation Perserverance

- Kept asking everyone about reversing pumps
 - Sometimes successful or not
- Breakthrough finding out we could use VFC
- Internet search led to Scottish Water's experience
- Tough to get permission of Pump Manufacturer
- Had to wait for new VFCs to get installed and contract completed
- Had to wait for VFC Rep to come out
- Tested and Installed Forward / Reverse Switches
 - Run half speed in reverse for 30 seconds

Photo 1: Forward/Reverse Selector Switch
View of VFC Control Panel

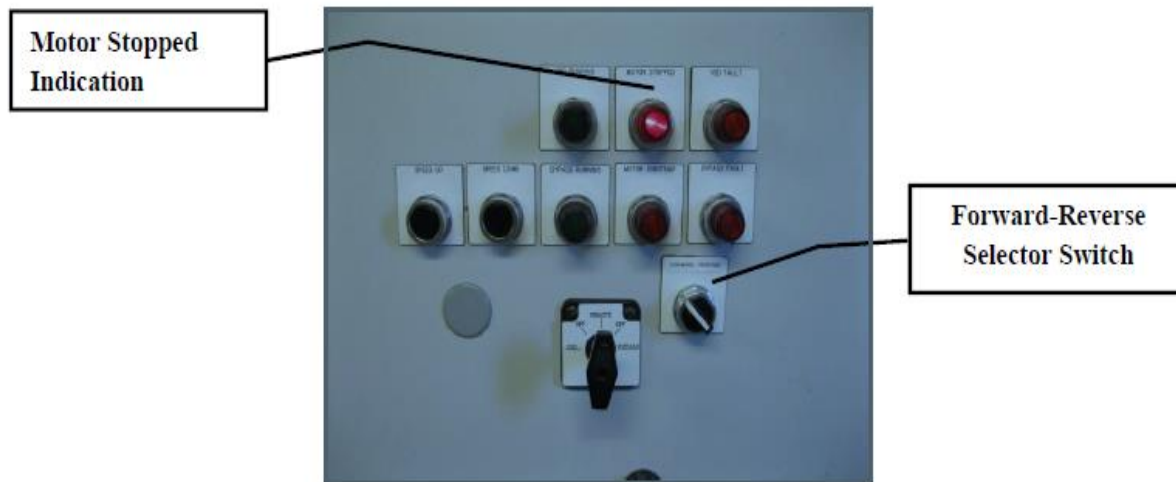
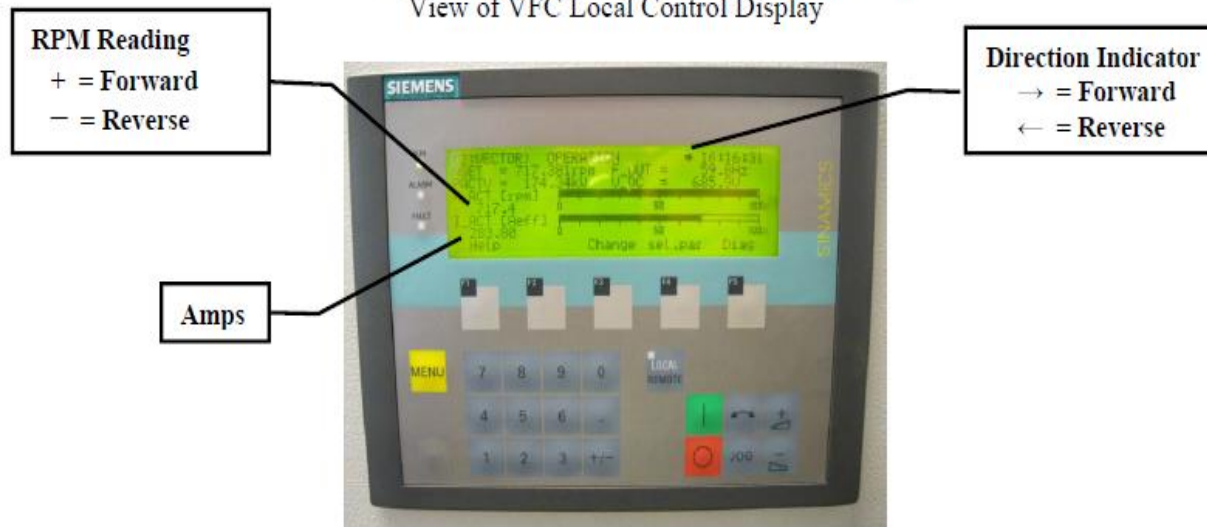
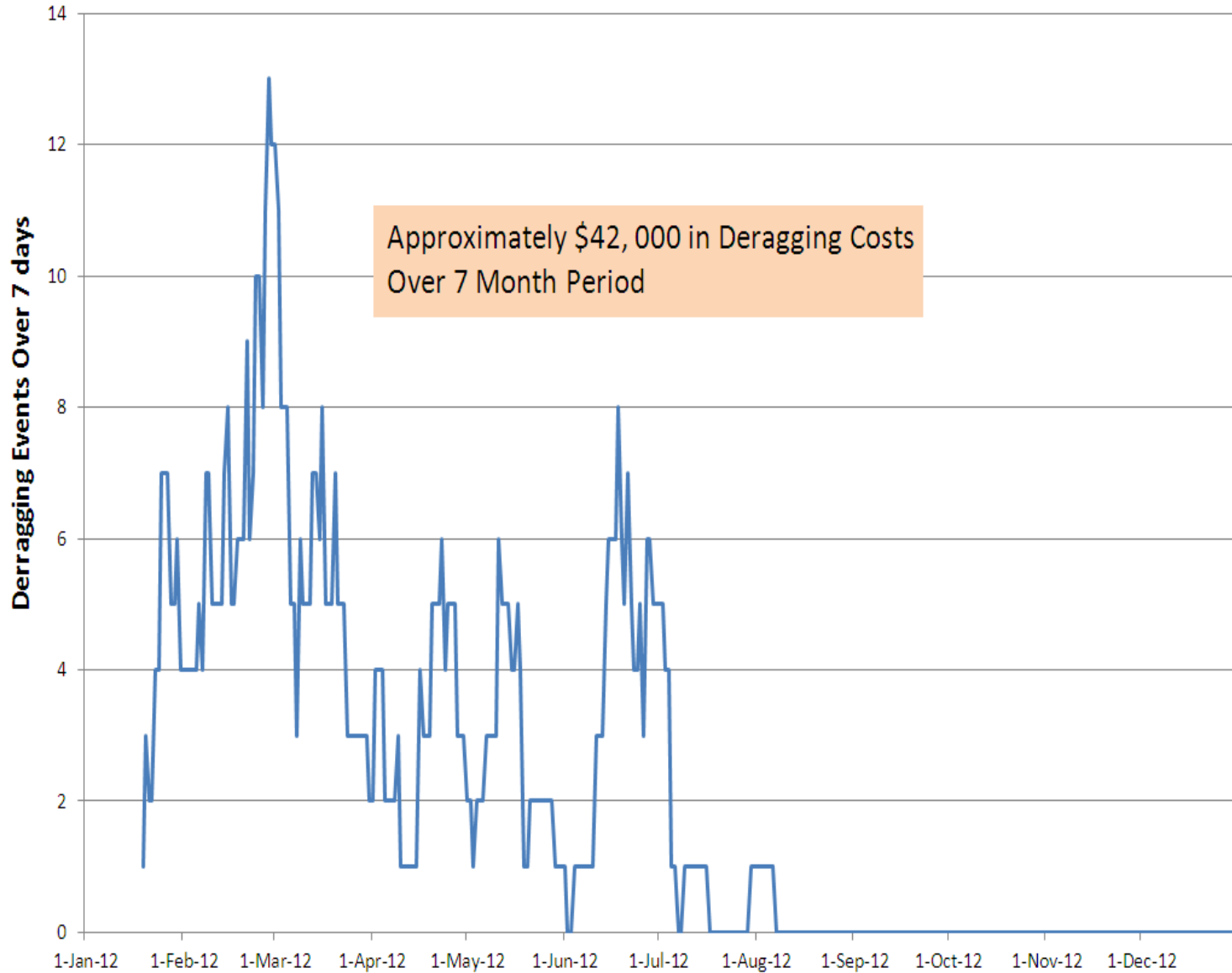


Photo 2: Showing Rotation Direction, Speed and Amps
View of VFC Local Control Display



7 Day Average of LBMPP Deragging



Approximately \$42,000 in Deragging Costs Over 7 Month Period

Long Beach Main PP - Relative Costs

- Surge Tank & Check Valve Installation - \$ 1.2 M
- Electrical Modifications Contract - \$ 2.1 M
- New Replacement Plant (\$50 M) - \$ 42 M

- Portable Pump Installation - \$ 350 K
- Flygt C Impeller Pump Installation - \$ 350 K
- WILO Pump Installation - \$ 350 K
- Consultant for Ragging Issue - \$ 30 K

- Forward / Reverse Switches - \$ 336

(no K or M – this is not an omission)

FIRST TESTED AND OPERATIONAL IN 2 DAYS !!!

Scottish Water – Use of Deragger II (Power of the Internet)

- Scotland 40,000 sq. mi. – L.A. County 4,000 sq. miles
- Significant response time – Lochs and Mountains
- Overflows into pristine environments
- Remote pumping plants
- Significant overtime costs and equipment mileage
- Over £ 1M (pounds) in savings (\$1.5 M)





Plockton, Scotland





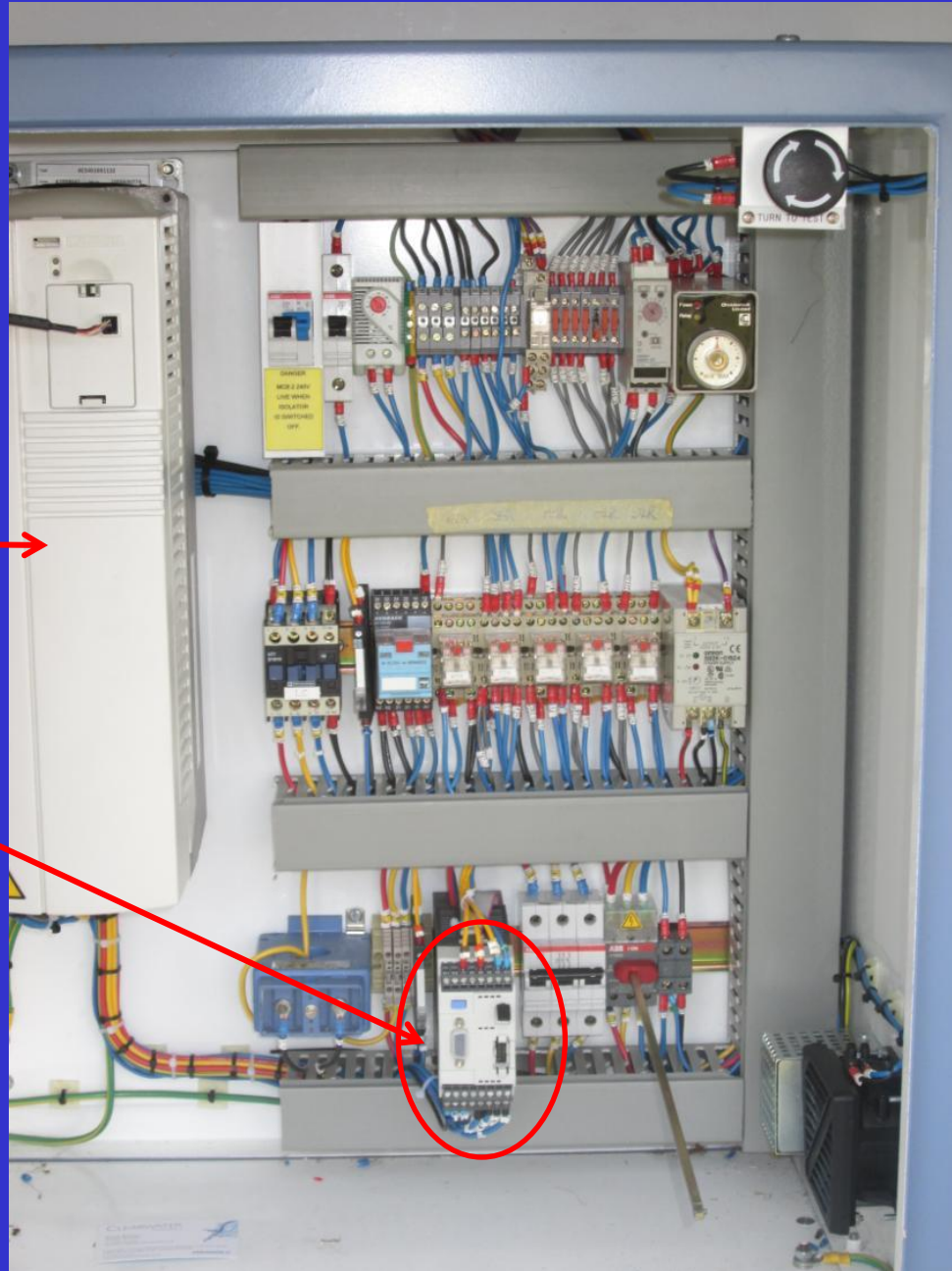
Typical Scottish Water Pump Control Enclosure



Typical Scottish Water Pump Control Panels



Typical Scottish Water Pump Controls



VFC →

Deragger
Replaces
overloads
4 wires

Western Avenue Pumping Plant – Deragger Trial



Deragger II Installation and Disable Switch



WESTERN

SERVER: LB PRIMARY - PP-SVR1

Sunday, February 23, 2014 1:46:09 PM

COMMUNICATION FAILURE	SWITCH BOARD POWER FAIL	PUMP 1 COMMON ALARM	DOOR SWITCH - COMMON
INTRUSION ALARM	CNTRL SYS AC POWER FAIL	PUMP 2 COMMON ALARM	KEY IN SWITCH-COMMON
STATION EMERGENCY	UPS FAILURE	PUMP 3 COMMON ALARM	DRYWELL HIGH LEVEL-COMMON
WET WELL HIGH LEVEL	GENERATOR ON LINE	PUMP 4 COMMON ALARM	PUMP 5 COMMON ALARM

WESTERN AVENUE PUMPING PLANT
 27845 1/2 WESTERN AVENUE
 RANCHO PALOS VERDES, CA 90732
 (310) 832-1824

CIRCUIT ID: 62HCQS000169-001PT (ATT)

COMBUSTIBLE GAS: 6.92 % LEL

GRADE: 148.92 25.50

OVERFLOW: 140.72 17.30

LAG1 START: 135.42 11.50

LAG2 START: 133.17 6.75

LAG3 START: 132.57 5.25

LEAD START: 131.87 4.25

LAG1 STOP: 127.67 4.25

LAG2 STOP: 127.82 4.50

LAG3 STOP: 127.57 4.25

EAL: 127.17 1.75

LIT 0%: 123.42 0.00

FLOOR: 123.42 0.00

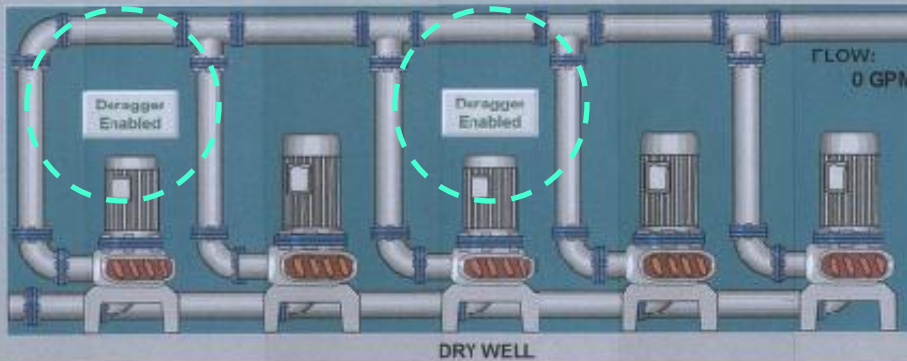
ELEV	LEVEL
128.98	5.56

WET WELL

SEC. WET WELL LEVEL: 128.95 5.53

SYSTEM IN: AUTO CONTROL CO: 0.00 %

PUMP 1	PUMP 3	PUMP 2	PUMP 4	PUMP 5
REMOTE	REMOTE	REMOTE	REMOTE	REMOTE
AUTO	AUTO	AUTO	AUTO	AUTO
NOT SEL'D	LAG 1	NOT SEL'D	NOT SEL'D	LEAD
VFC OFF	VFC OFF	VFC OFF	VFC OFF	VFC OFF
0.0 CO % 0 RPM	0.0 CO % 0 RPM	0.0 CO % 0 RPM	0.0 CO % 0 RPM	0.0 CO % 0 RPM
0.0 AMPS	0.0 AMPS	0.0 AMPS	0.0 AMPS	0.0 AMPS



NAP LOGIN COMM ALARMS BYPASS SETTINGS PRINT DATA TREND

USER: PP-SGADA\OPERATOR

Alarms

ACK Items in Summary 8 Unack Alm. 6, Sup. 0

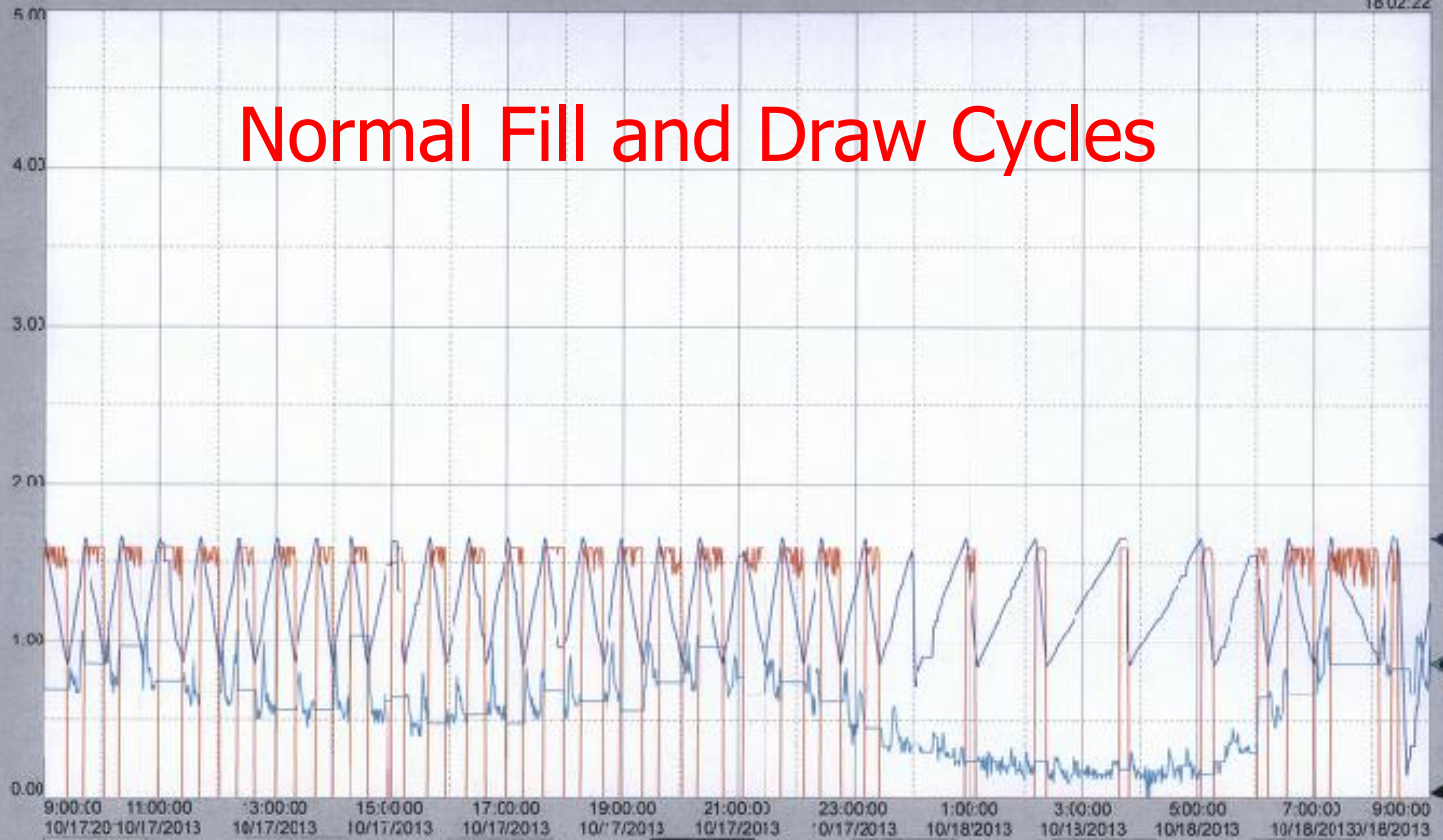
"Western_Pent"

WESTERN AVENUE PUMPING PLANT

Thursday, October 17, 2013 - Friday, October 18, 2013

18:02:22

Normal Fill and Draw Cycles



Caption	12:50:37	Min	Max	Units
WET WELL LEVEL	8.270.00	25.00	FEET	
PUMP 1 MOTOR CURRENT	0.000.00	200.00	AMPS	
PUMP 2 MOTOR CURRENT	0.000.00	200.00	AMPS	
INFLUENT FLOW-CALCULATED	514.900.00	3,000.00	GPM	
PUMP 1 RUNNING IN REVERSE	0.000.00	5.00	REVERSE	

24 Hour Span

12 Hour Span

1 Hour Span

PROCESS

PRINT



Print Chart

EXIT

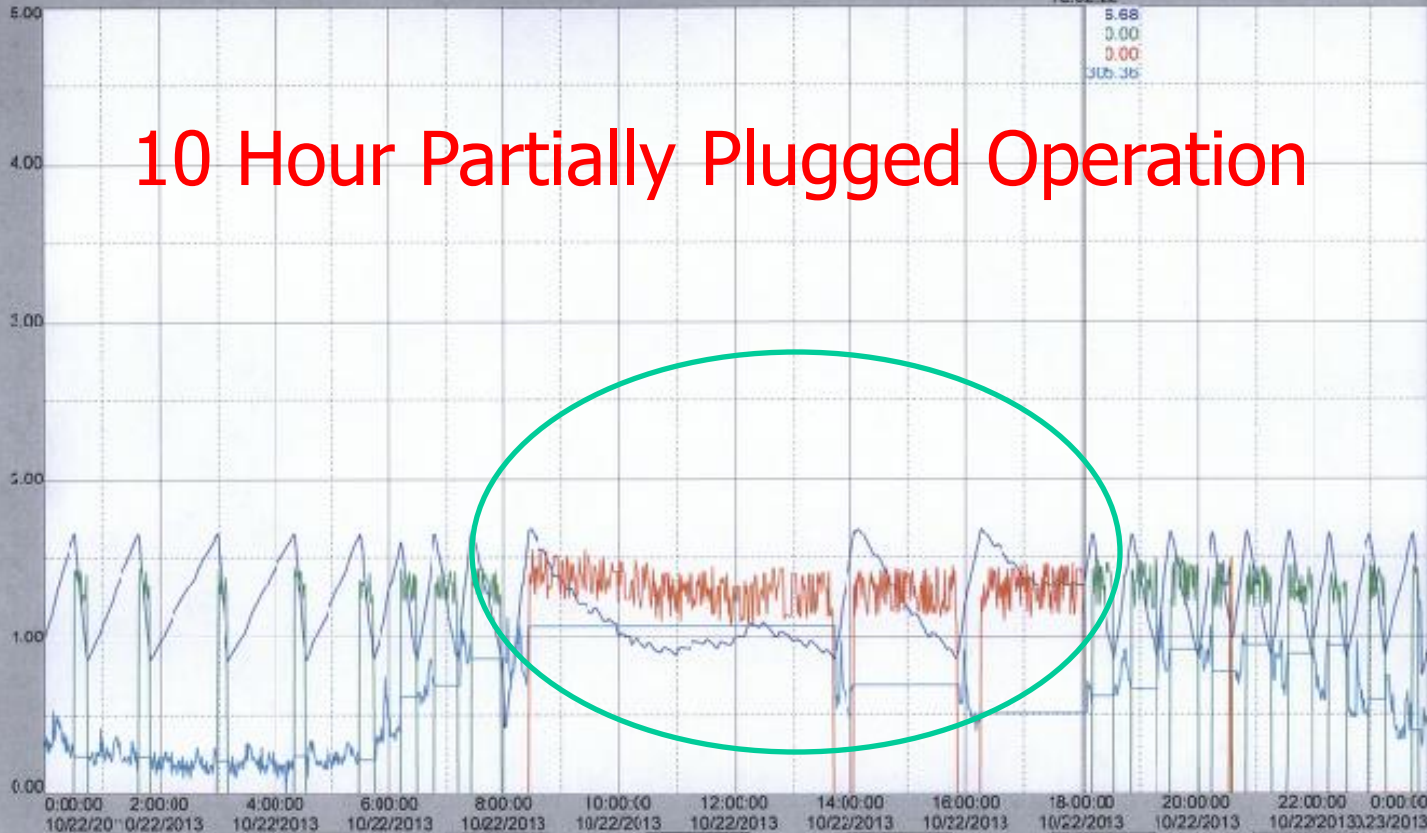
WESTERN AVENUE PUMPING PLANT

Tuesday, October 22, 2013 - Wednesday, October 23, 2013

1E:02:22

5.68
0.00
0.00
305.36

10 Hour Partially Plugged Operation



Caption	12:52:37	Mn	Max	Units
WFT WELL LEVEL	7.070.00		25.00FEET	
PUMP 1 MOTOR CURRENT	0.000.00		200.00AMPS	
PUMP 2 MOTOR CURRENT	0.000.00		200.00AMPS	
INFLUENT FLOW-CALCULATED	514.900.00		303,000.00GPM	
PUMP 1 RUNNING IN REVERSE	0.000.00		5.00REVERSE	

24 Hour Span

12 Hour Span

1 Hour Span

PROCESS

PRINT

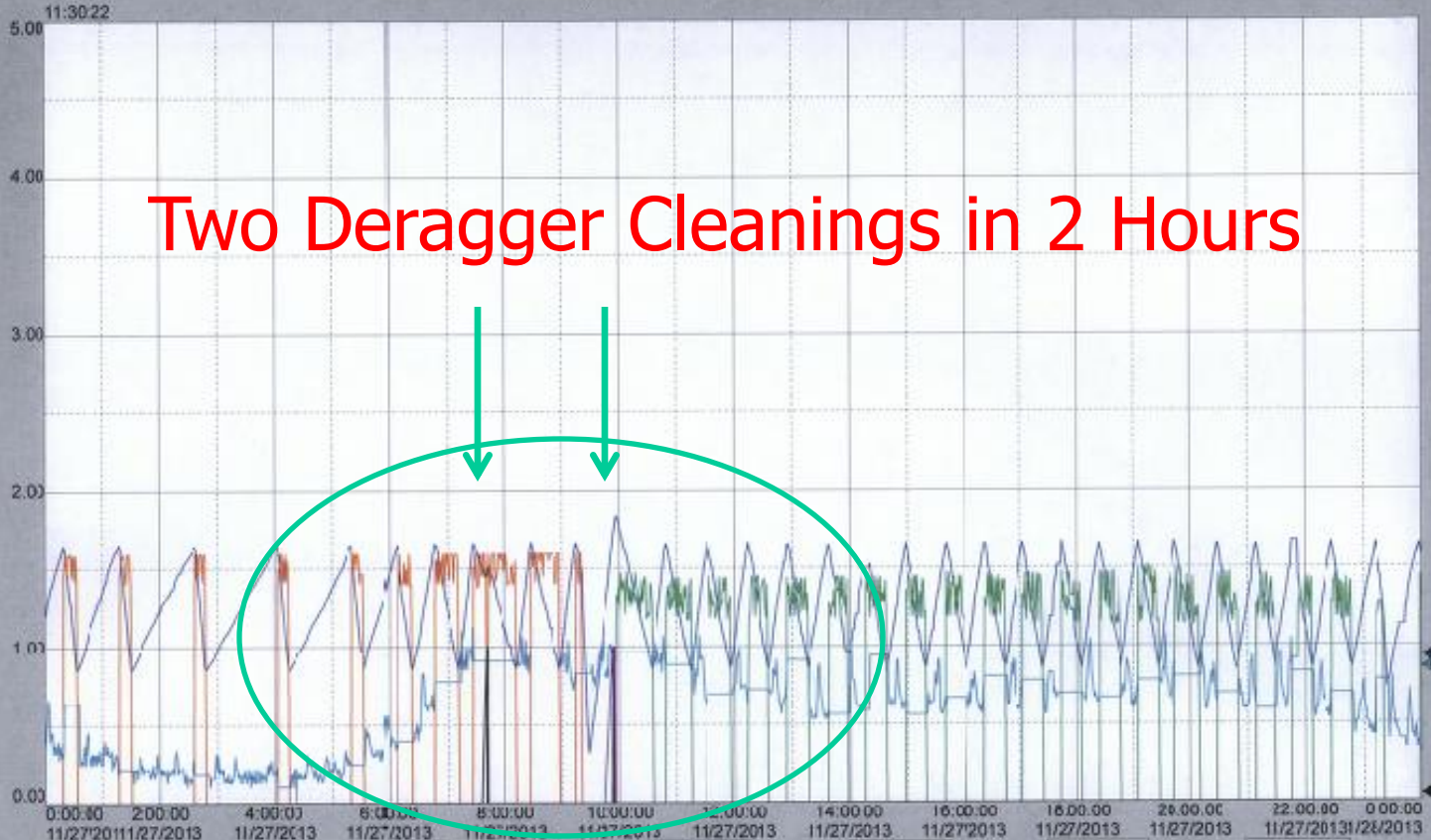


Print Chart

EXIT

WESTERN AVENUE PUMPING PLANT

Wednesday, November 27, 2013 - Thursday, November 28, 2013



Two Deragger Cleanings in 2 Hours

Caption	12:55:37	Min	Max	Units
WETWELL LEVEL		4.660	25.00	FEET
PUMP 1 MOTOR CURRENT		0.000	200.00	AMPS
PUMP 2 MOTOR CURRENT		0.000	200.00	AMPS
INFLUENT FLOW CALCULATED		514.900	003.000	GPM
PUMP 1 RUNNING IN REVERSE		0.000	5.00	REVERSE

24 Hour Span
12 Hour Span
1 Hour Span

PROCESS

PRINT



Print Chart

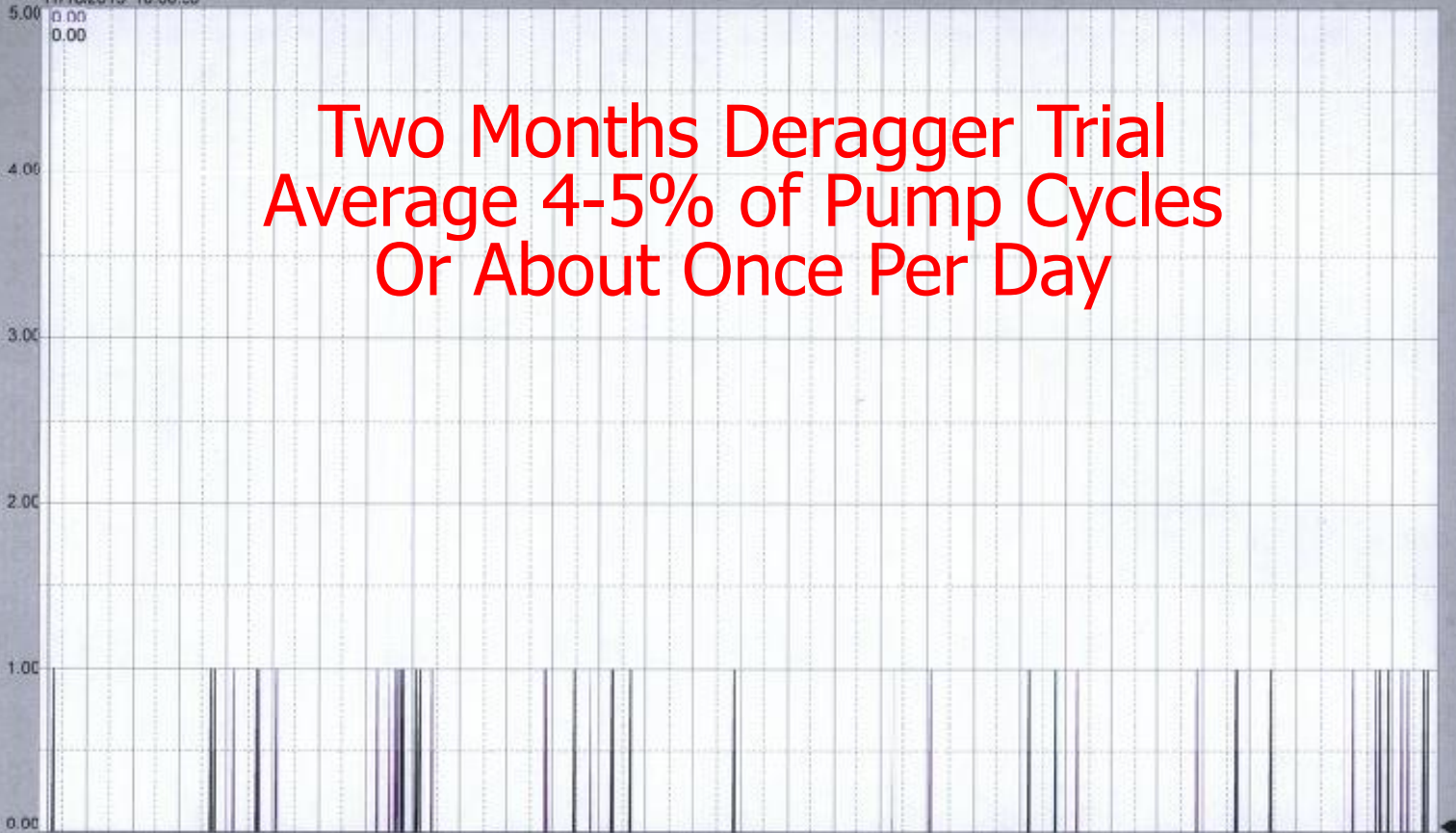
EXT

"Western_Pens"

WESTERN AVENUE PUMPING PLANT

Monday, November 18, 2013 - Friday, January 17, 2014

11/18/2013 10:00:58



0:00:03

11/18/2013

0:00:00

1/17/2014

Caption	12:39:37	Min	Max	Units
PUMP 1 RUNNING IN REVERSE	0.000	0.003	0.00	REVERSE
PUMP 2 RUNNING IN REVERSE	0.000	0.005	0.00	REVERSE

24 Hour Span

12 Hour Span

1 Hour Span

PROCESS

PRINT



Print Chart

EXIT

DERAGGER II

ELIMINATING PUMP BLOCKAGES

Status

Counters

Reset All

Counter values as saved on : 21/01/2014 08:54:40

Edit

Write new

Starts	<input type="text" value="564"/>	Motor run time (H)	<input type="text" value="0"/>
Anti Ragging Cleans	<input type="text" value="27"/>	Over Voltage Trips	<input type="text" value="0"/>
Anti Ragging Trips	<input type="text" value="0"/>	Under Voltage Trips	<input type="text" value="0"/>
Current Imbalance Trips	<input type="text" value="0"/>	Phase Loss Trips	<input type="text" value="0"/>
Over Current Trips	<input type="text" value="0"/>	Frequency Trips	<input type="text" value="0"/>
Under Current Trips	<input type="text" value="0"/>	Dry Well Trips	<input type="text" value="0"/>
Overload Trips	<input type="text" value="0"/>	Overload Accumulator	<input type="text" value="1"/>

Home

CLEARWATER
CONTROLS

Connection status : **Not Connected** Deragger Serial Number : ????? Firmware Version : ?????

Deragger II - Retrofit

- Anti-ragging electronic pump control device
- Plugs into/replaces motor overloads
- DOL, Star/Delta, Variable Speed & Soft Start
- Retrofit into existing control panels
- Provides standard pump protection
- Short payback period typically in months
 - Reduces callout and power usage
- Smart system – cleans pump when it is needed
- Saves electricity all the time – green solution

Deragging Electrical Solutions

- **Electrician Switching Two Leads (3-phase)**
 - Labor intensive – usually too late, too big to clear
- **Manual Forward / Reverse Switch**
 - Not a smart system - relies on operator, could plug early
- **Automate with SCADA**
 - Not a smart system - relies on elapsed run time
- **Clearwater Controls – Deragger II**
 - Smart system – low cost retrofit, real time monitoring
- **Emerson Drives – Control Techniques**
 - Smart system – purchase new drives, real time monitoring
- **Flygt Experion Drives**
 - Smart system – purchase new drives, real time monitoring
- **Other Solutions ????**

Summary

- No more manual deragging (or at least very limited)
- Reversing pumps often enough...is enough
- Decreases PM, Reactive PM, spills
- Energy efficiency increase, can use old pumps longer
- Electrical switches and VFC programming
- Smart Instrumentation – VFCs or Deragger
- Get Pump Manufacturer Involved – new pumps can rag
- Make it a part of Equipment Specifications

More Information

- Graham McIvor – Clearwater Controls - Deragger
Scotland
- Art Yee – Industrial Technical Services (ITS)
Brea, CA
- Marty Ponton – Ponton Industries
Yorba Linda, CA

Introduction

- 34 years of wastewater experience
- Treatment Plant Operator – Grade V
- Shift Supervisor – 400 mgd facility
- Operations Engineer – 14 years
- Districts have 11 WW facilities
- Design – 7 years
- Collection Systems – 6½ years
- Pumping Plant Engineer – over 50 PPs
- Pump replacements 3 HP to 450 HP
- Grade IV Collection Systems
- Grade IV Mechanical Technologist
- B.S. / M.S. Loyola Marymount Univ.
- Taught Unit Process - Harbor College
- Other accomplishments...

Problems Away From BEP and AOR

From BEP to the Left

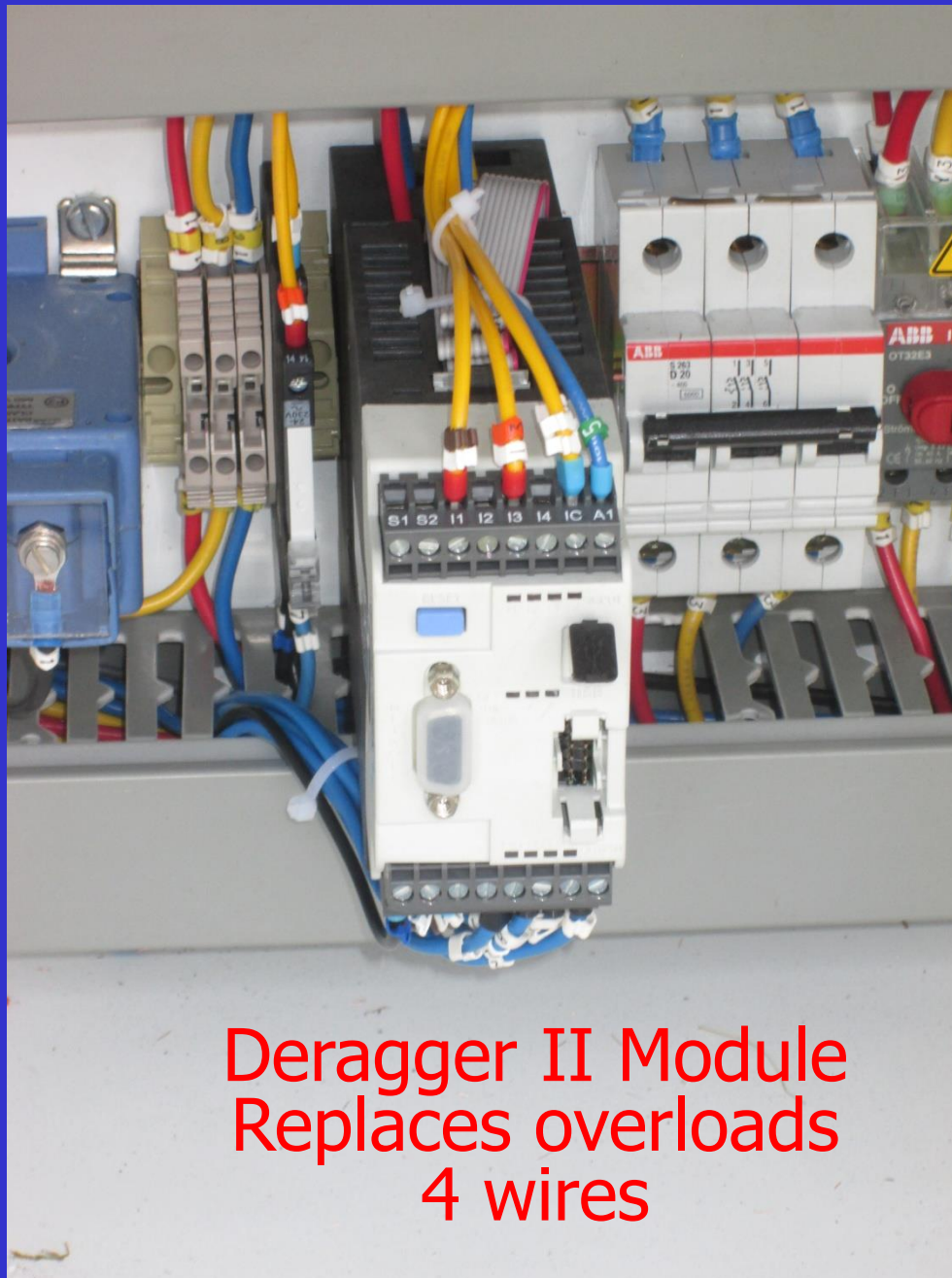
- Discharge recirculation
- Suction recirculation
- Lower impeller life
- Low bearing and seal life
- Low flow cavitation
- High temperature rise

From BEP to the Right

- Low bearing and seal life
- Classic high flow cavitation

Two Case Studies

- **Diamond Street Pumping Plant**
 - 2 existing pumps replaced with 3 new smaller pumps
 - Manufacturer recommended cutting impellers for better BEP fit
 - Not enough capacity – pump and check valve ragging
 - Careful measurements of head
 - Full sized impellers solve ragging
- **Western Avenue Pumping Plant**
 - 2 existing pumps replaced with 2 small and 3 large pumps
 - Small pump only 4 inch channel impellers
 - Oversized suction lines and large wetwell accumulating rags
 - Went away from Constant Level / Variable Speed to Full Speed
 - Reduced to only occasional ragging – few times per month
 - Wetwell issue solved by rotating pumps



Deragger II Module
Replaces overloads
4 wires

Acknowledgements

- Muffin Monsters – Forward and Reverse
- Jessie Kerins - former student, IW - LACSD
- Jacob Ferriera - Flygt Pumps
- Wheeler Newman - WILO Pumps
- Mike Meyers - Flowserve (Worthington) Pumps
- Hugh Risdon - LACSD
- John Akrofi - Siemens/Robicon
- Graham McIvor - Clearwater Controls
- Art Yee - Industrial Technical Services
- Jack Weber - Vaughan Industrial Repair
- Garr Jones - Brown & Caldwell
- Wen Wang – Multi W – HOMA Pumps



01/13/2014 10:50

Up for CWEA State – Gimmicks and Gadgets Award

APCO Bottom Buffer Check Valve



Previous White Point Pumping Plant Failures



450 HP Diesel Driven Portable Pump



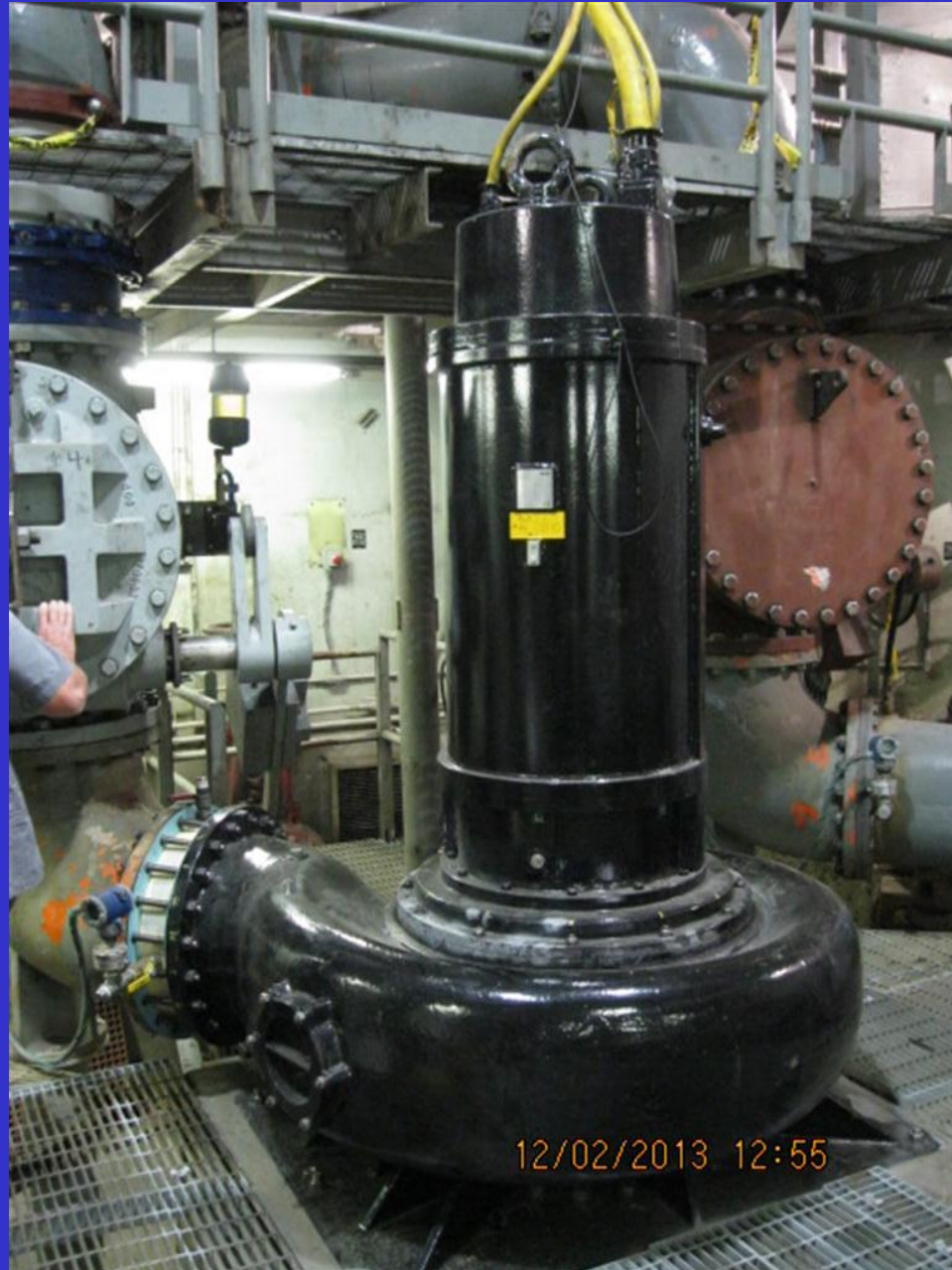
Existing Worthington Pump Impeller Two Pumps Replaced



250 HP Flygt Pump – 3 Port C Impeller



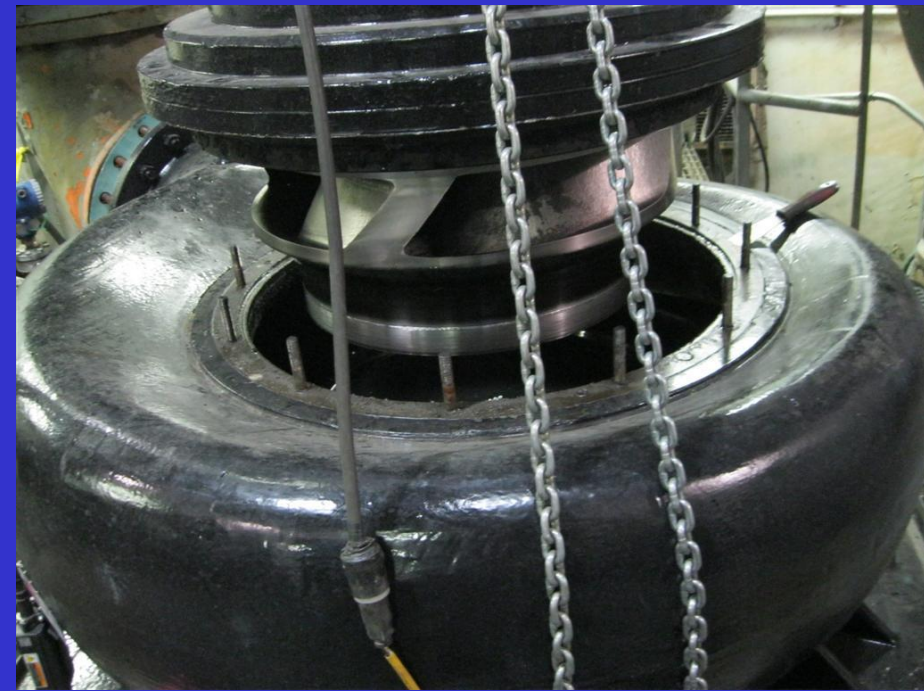
245 HP WILO Pump – 4 Port Closed Impeller



Deragging Vertically Mounted Swing Check Valve



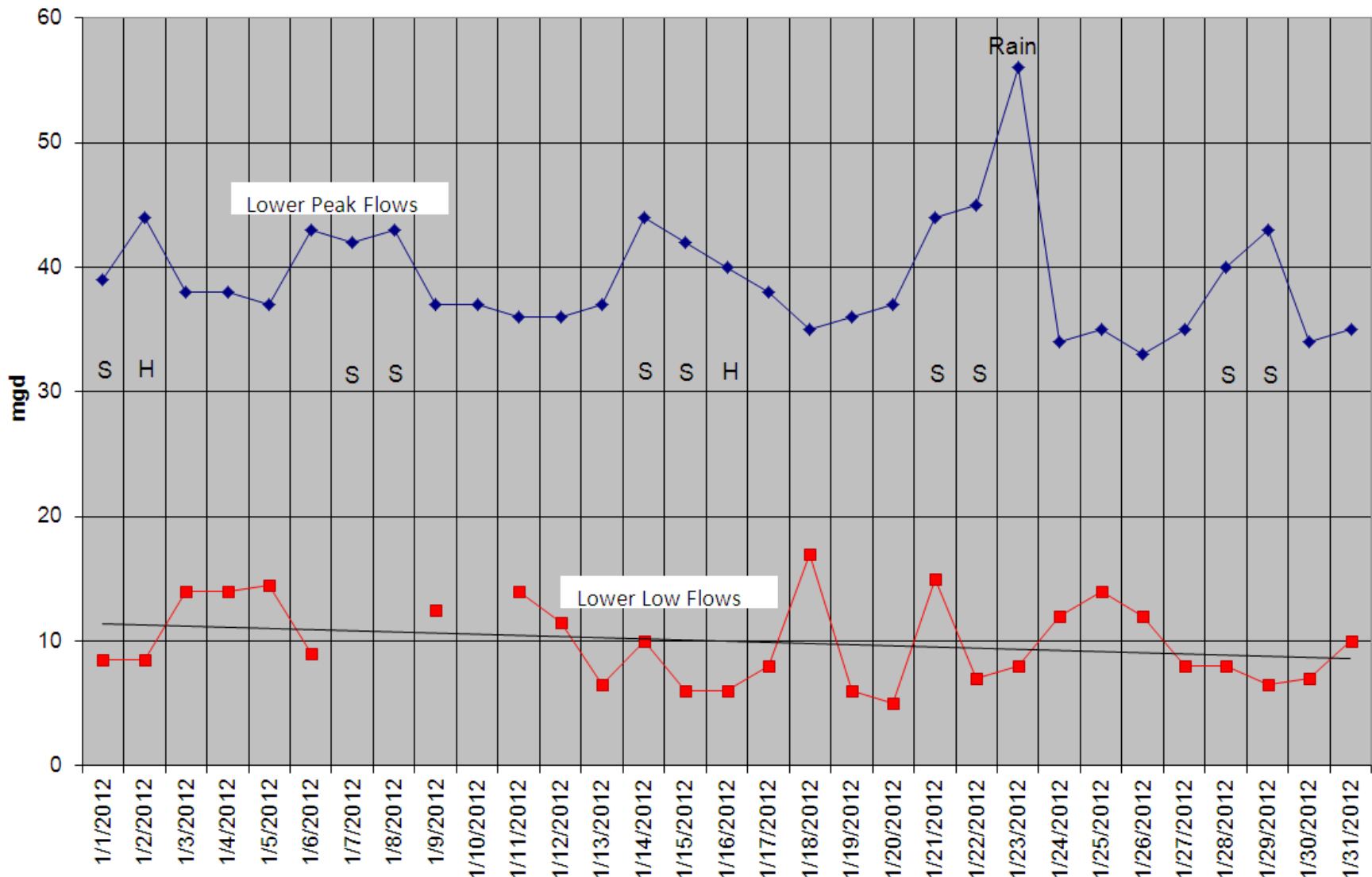
WILO Pump Deragging



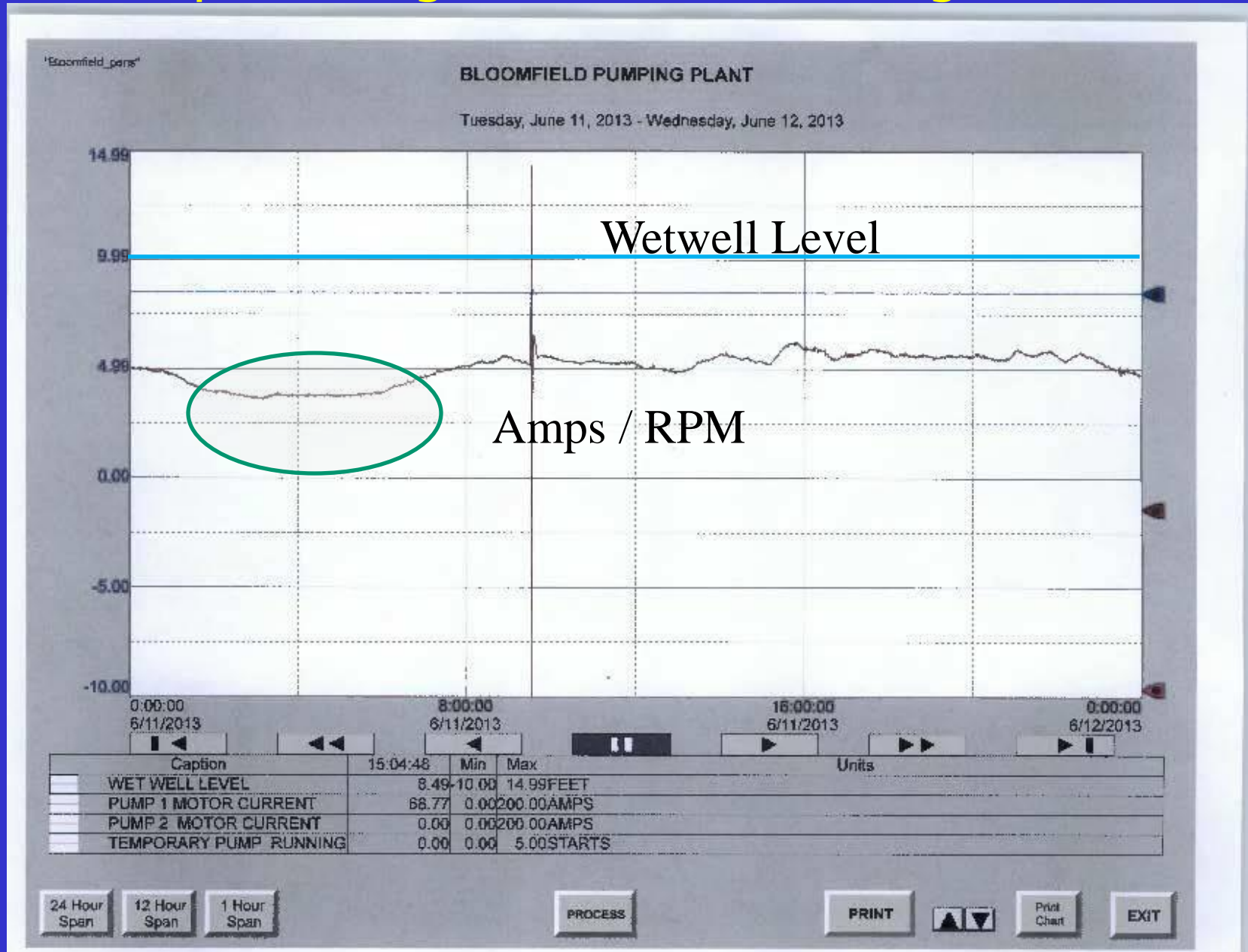




LBMPP Peak and Low Flows - January 2012



Ragging Due to Constant Level Operation Pump Running Outside AOR During Low Flow

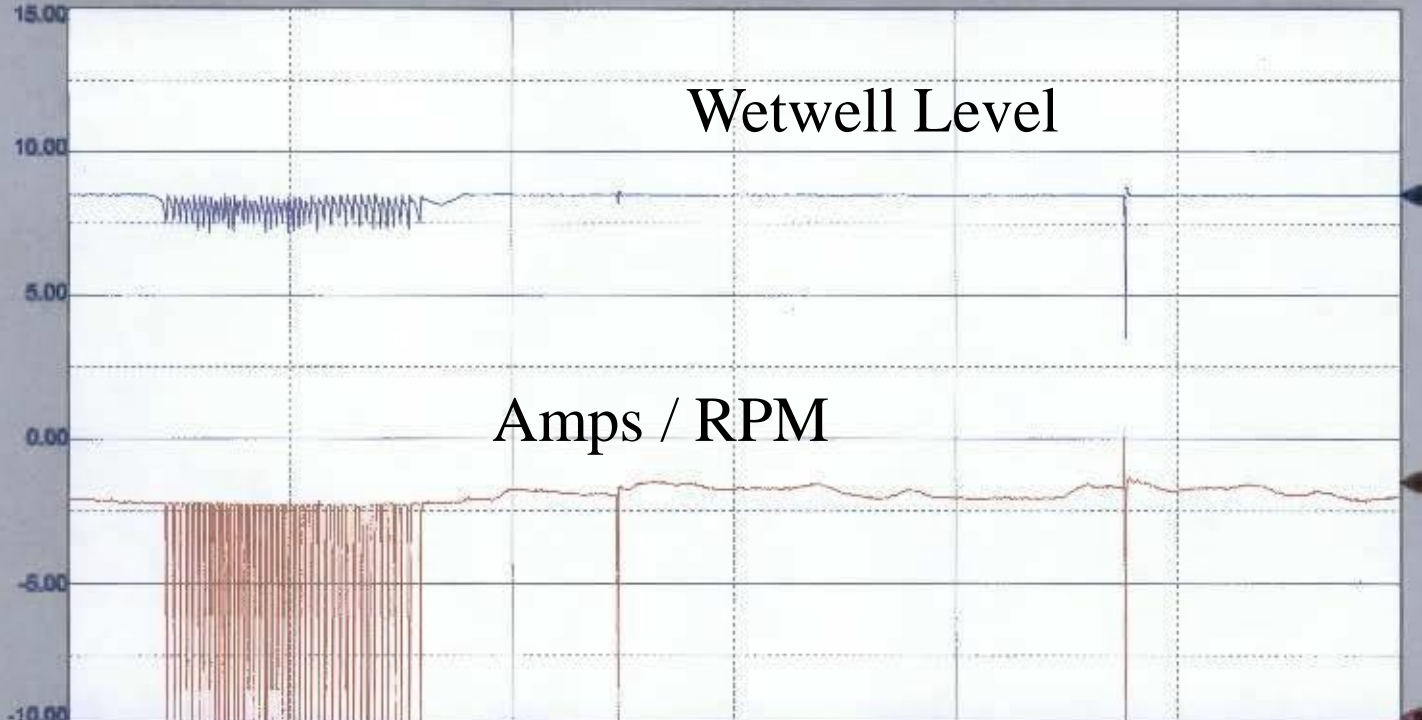


Fill and Draw During Low Flow Running Within Acceptable AOR

"Bloomfield_pens"

BLOOMFIELD PUMPING PLANT

Thursday, July 18, 2013 - Friday, July 19, 2013



0:00:00 8:00:00 16:00:00 0:00:00
7/18/2013 7/18/2013 7/18/2013 7/19/2013

Caption	15:01:16	Min	Max	Units
WET WELL LEVEL	8.51	10.00	15.00	FEET
PUMP 1 MOTOR CURRENT	68.06	0.00	200.00	AMPS
PUMP 2 MOTOR CURRENT	0.00	0.00	200.00	AMPS
TEMPORARY PUMP RUNNING	0.00	0.00	5.00	STARTS

24 Hour Span 12 Hour Span 1 Hour Span PROCESS PRINT Print Chart EXIT