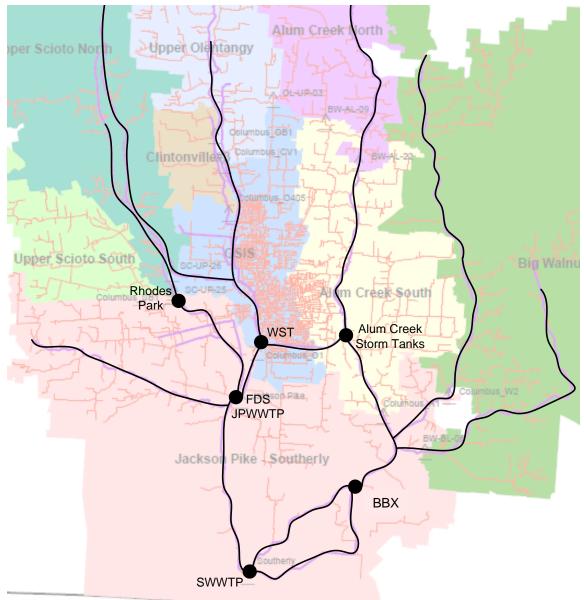
Columbus Collection and Treatment System Real Time Wet Weather Operational Implementation

> <u>Presenters</u> Ed Heyob, CDM Smith Automation Engineer

Kim Brown, JPWWTP Supervisor II



Existing Collection System







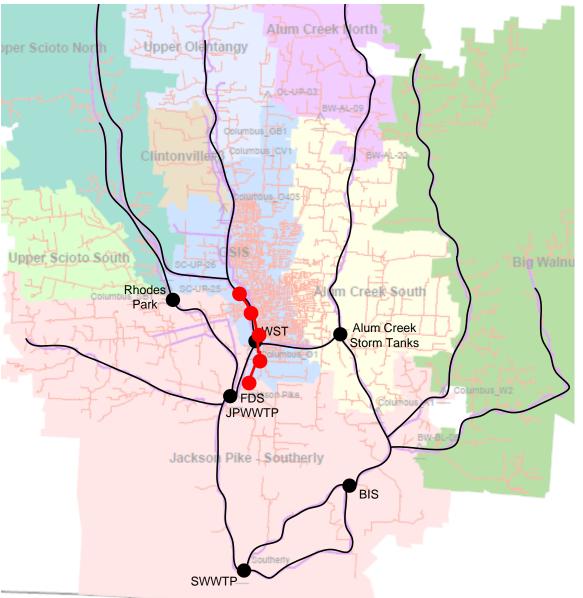
OARS Tunnel Addition

OARS Tunnel

- 23,000 feet long
- 20 ft diameter
- ~180 ft deep
- Four drop shafts
- 63MG storage

OARS Dewatering Pump Station

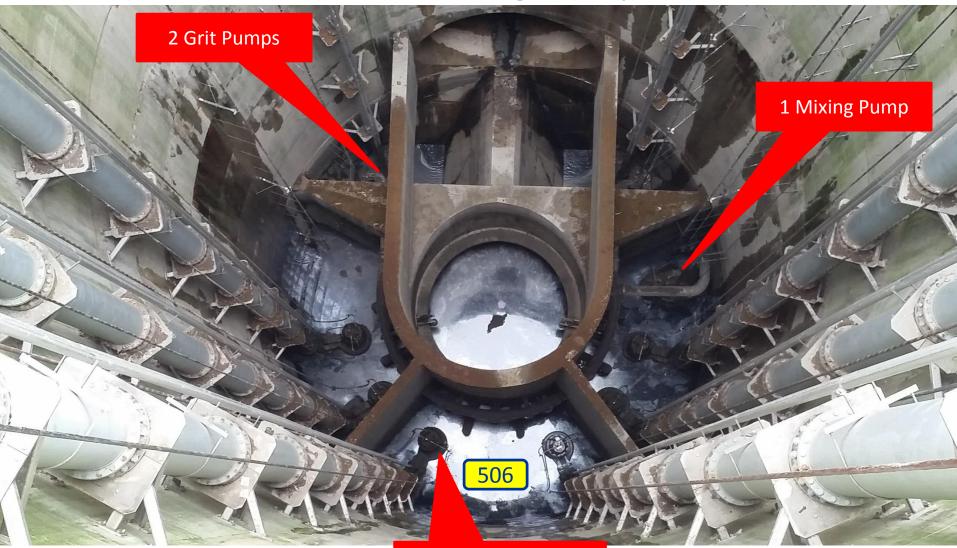
- Tunnel must be pumped empty to be ready for next wet weather event
- 9 pumps
- 4 level sensors
- Complex control circuits







OARS Dewatering Pump Station



6 Dewatering Pumps

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715 – Elevation picture taken from



OARS Dewatering Pumps



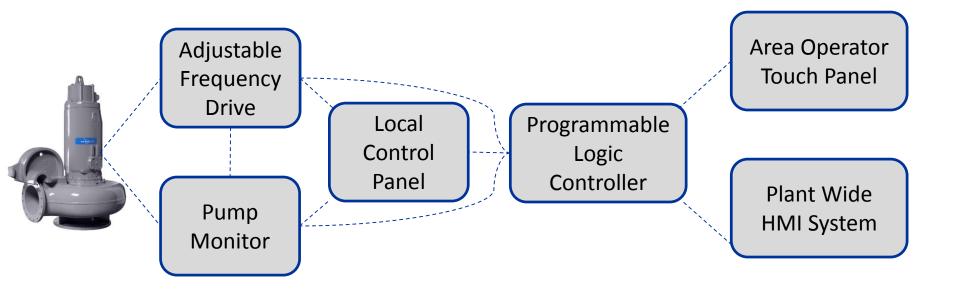
Dewatering Pumps

- Two pumping zones to deal with depth of tunnel
- Zone 2 2 pumps, 4160V, 450HP, 20MGD each
- Zone 1 4 pumps, 4160V, 800HP, 15MGD each
- Grit Pumps 2 pumps, 480V, 105HP, 1MGD each
- Mixing Pump 1 pump, 480V

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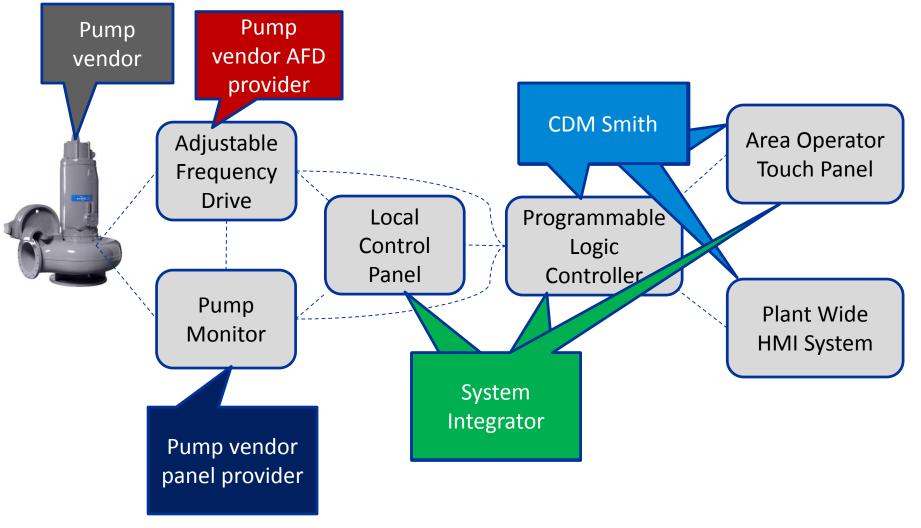
Many Items in Control Circuit







Many Different Providers

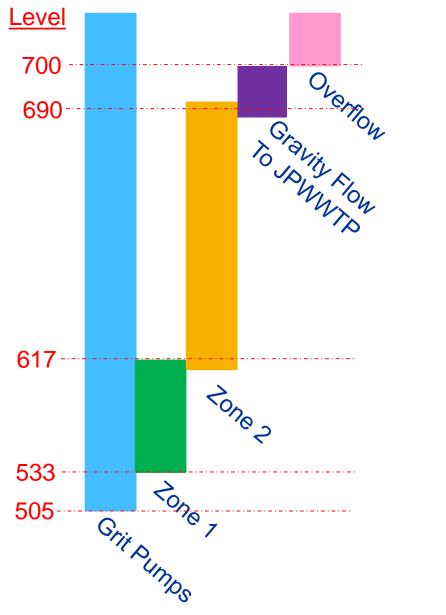


Electrical sub responsible for all wires between them





Complex Control Strategy



- Each pump has an operating depth range
- Tunnel can be completely filled and flow by gravity to JPWWTP which requires throttling of gates to control the flow
- Speed of pumps must be varied with depth to maintain operation on favorable pump curve
- Many pump protective interlocks





Level Measurement Complexities





Local Control Panel



Display in AFD Room



Display in AFD Room



- 4 Hydrostatic level sensors
- 1 each grit sump

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- 2 for dewatering pumps
 - Automatic failover
- Multiple local displays
- Must be correct to compare to other plant influent levels
- 0.25% accuracy is about ½ foot error

11885	ODS LEVEL 1	506.19 to 721.19 FT	690.83
11886	ODS LEVEL 2	506.23 to 721.23 FT	690.83
11887	OARS GRIT SUMP 1 LEVEL	501.21 to 721.21 FT	690.85
11888	OARS GRIT SUMP 2 LEVEL	501.18 to 721.18 FT	690.84

Plant Wide HMI System

Equipment Values

Equipment	Value
Zone 1 Pump, AFD, Rails & Brackets	~\$600,000 Each (4 total)
Zone 2 Pump, AFD, Rails & Brackets	~\$500,000 Each (2 total)
Grit Pump, AFD, Rails & Brackets	~\$170,000 Each (2 total)
Mixing Pump, Starter, Nozzles	~\$500,000

Testing must reduce risks due to equipment values.



"Press & Pray" is not a good method to manage risks





Something this complex doesn't get "turned on" one day



The first pump start with sewage





Testing and Validation

Live System Operation

Wet testing with controlled fill events

Pump bump testing

Simulated tunnel filling/emptying

Testing of interlocks

Simulated motor start/stop with PLC

Simulated motor start/stop with hardwired controls

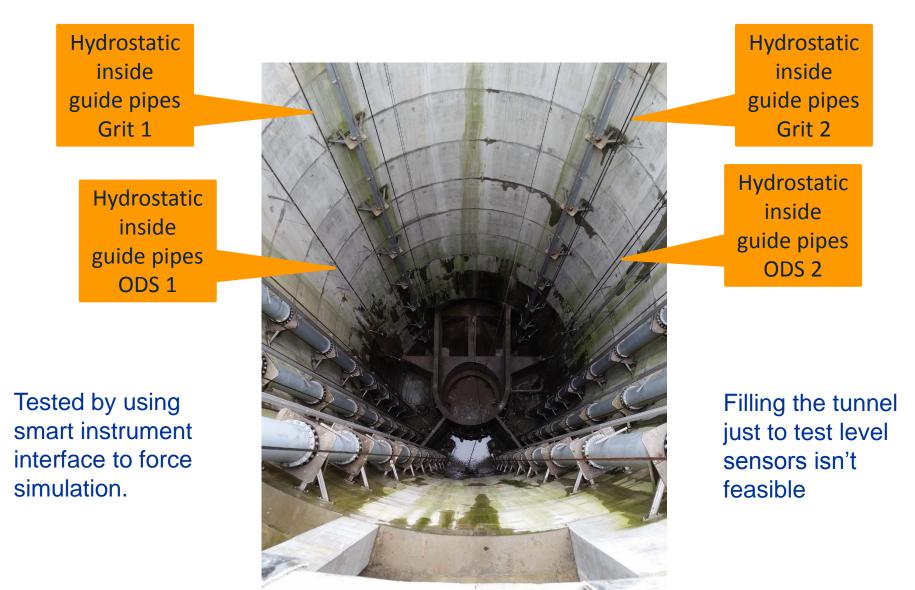
Equipment Monitoring Signals

Process Monitoring Signals





Process Monitoring Signals







Pump Operation Simulation



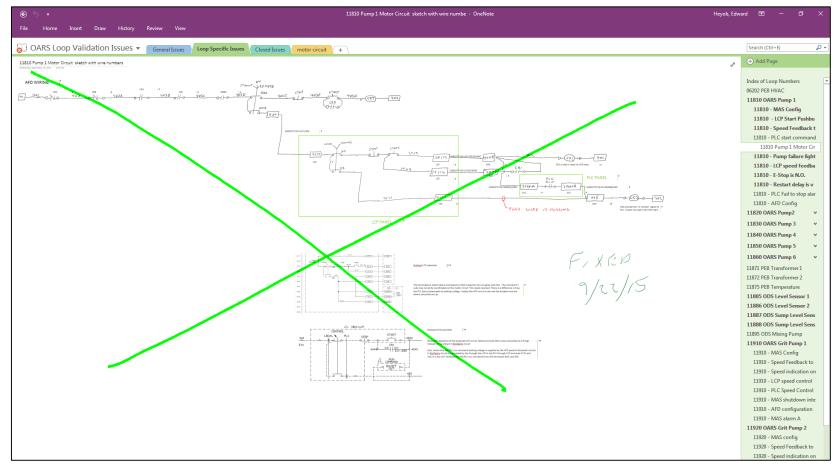
Medium Voltage Adjustable Frequency Drive

- Cannot operate pumps without sewage
- Medium voltage AFD has a motor simulation mode
- Allows for full testing of local and PLC circuits without starting the pump
- Testing without even having the pump attached was possible with a jumper to bypass the pump protection devices
- Many wiring issues fixed between the multiple vendor panels and electrical contractor. Several failed lights & indicators replaced.
- 480VAC pumps were simulated tested by removing motor leads from AFD





Tracking and Coordinating Circuit Issues



Every circuit issues was tracking individually. Microsoft Surface with OneNote was used as it could capture pictures, drawings and hold markups. Allowed for detailed notes in field with quick conversion to PDF to coordinate with Contractor, Construction Manager and Design Professional.





Simulated Tunnel Filling/Emptying

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	PRINT		LARMS	MAIN	N MENU	OVERVIEW	SYSTEM	PROC	ESS /IEW	PROCESS MENU	HELP	ВАСК		
	PUMP 1		PUM	P 2		PUMP 5		PUMP 6	AUTO	OCONTROL	PUMP 3		PUMP 4	
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Simulated testing occurred many months before pumps were installed in shaft

AFD Simulation Mode allowed for initial testing of automatic logic against the actual control circuits.

This uncovered some additional circuit issues on pump shutdown with restart delay timer effecting the "remote" status signal to the PLC.



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Pump Bump Testing

First time medium voltage applied to pumps in field



Video of each pump spinning the correct direction. Pumps tested on surface before being lowered in. Allowed for easier inspection and troubleshooting.



Special submersible cables with plug terminations. One of them was not terminated correctly. Found during bump testing and fixed.





- Test each pump by doing a volume draw down test over its operating range
- Tunnel holds ~60MG
- Utilize surface sewer to fill tunnel for pump testing
- Fill tunnel during dry weather ideally
- Repeat multiple times to test
 each pump

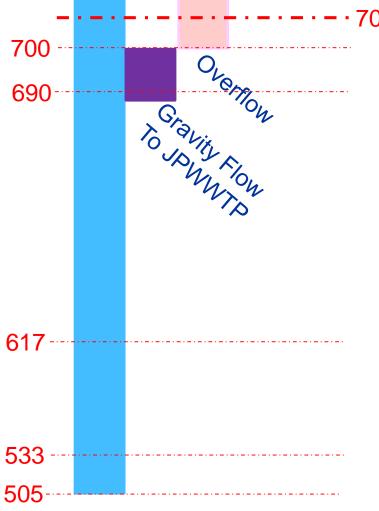


First tunnel filling test Flow enters the dewatering pumps station





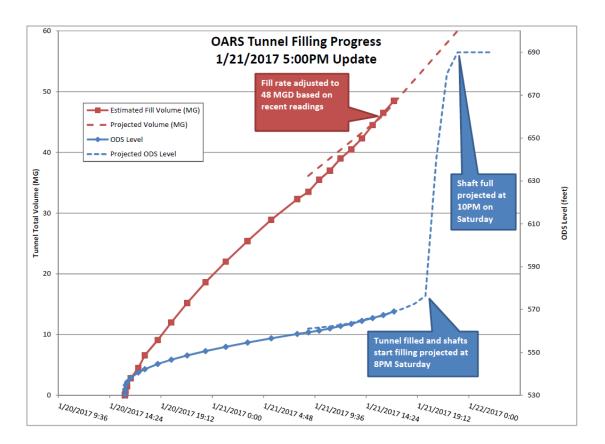




- 704 Invert of northern shaft used to fill tunnel
 - Invert of filling sewer is higher than overflow at end of tunnel
 - Must manage the filling process with crews called in to stop the filling process
 - Surface sewer flow is variable adding uncertainty to the procedure
 - Pumps not tested yet so they can't be used during first fill to slow the rate of filling
 - Flow must be stopped or sent by gravity to Jackson Pike WWTP. Capacity must be available to receive it.







- Filling projections done to aid the team in responding
- Flow calculated based on the volume change in the tunnel
- Far majority of tunnel volume is in the tunnel, not in the shafts. Notice rapid rise at end as shafts are filling
- Shafts can fill in 1 to 2 hours
- One fill test was filling shafts at 1ft/min



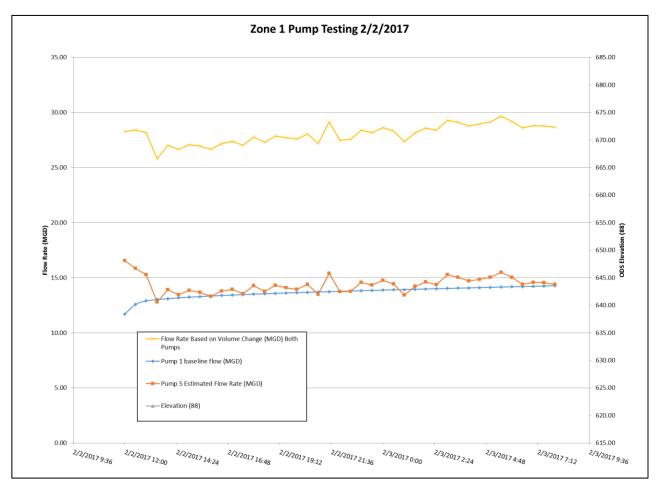


RESET CALL COMPLETION	CALLS NOT COMPLETE	RS TUNNEL AND SHAFT FILLING CALL OUT ACTIONS CURRENT ODS LEVEL 512.57 FT CURRENT FDS LEVEL 689.00 FT ODS IS ABOVE 580.6 FT LEVEL OK SMOC Dispatch Action: Call crew in to operate OARS Shaft 6 gates in 2 to 3 hours to redirect flow as shafts are now filling. JPWWTP Action: Call plant manager and advise that the tunnel is full. Review status of FDS and WGC gates. Visually verify level at ODS. ODS IS ABOVE 640.6 FT LEVEL OK SMOC Dispatch Action: Verify crew is headed toward Shaft 6. About 1 hour until first gate movement needed							Common graphics at JPWWTP, SWWTP ar SMOC to coordinate actions				
		JPWWTP Action:	JDOSD2_JOD5.gr		Show Tags			ODS WET TES	TING		4/21/2017 4:23:27 PM	CDM	
٦	CALLS NOT COMPLETE	ODS IS ABOVE SMOC Dispatch A	LEVEL (FT)	PRINT	ALARMS	MAIN MENU	OVERVIEW	SYSTEM		PROCESS	HELP BACK		
RESET CALL COMPLETION	CALLS COMPLETED	JPWWTP Action:	715.00								-		
C	CALLS NOT COMPLETE	ODS IS ABOVE SMOC Dispatch A	615.00 -				\uparrow	~~~~		~			
ACK CALLS COMPLETE	CALLS NOT COMPLETE	JPWWTP Action:	565.00 -				J	<u> </u>				PPED 0 %	
C	CALLS NOT COMPLETE	SWWTP Action: A	515.00 4:08:14 PM 4/1/2017	4:08:14 PM 4/2/2017	4:08:14 Pk 4/3/2017	vi 4:08:14 4/4/20	1 PM 4:08	14 PM 4:08: 2017 4/6/	1 <u>4 PM</u> 4		PUMP 2 STO PUMP 3 STO	PPED 0 % PPED 0 %	
C	CALLS COMPLETED	ODS IS ABOVE SMOC Dispatch A	Hist.J_AB.JFDS_LI Hist.J_AB.JODS_SI Hist.J_AB.JFDS_VI	11390C_LI_USG 2011884_ACTIVE .V11950_ZI_USG	S.F_CV _LI_USGS.F S.F_CV	FDS LEV SELECTI SMR WE	TIME /EL TRANSMITTER ED ACTIVE ODS LE EIR GATE POS (F_C	A USGS LEVEL VEL USGS (F_C	690.58 685.29 690.94	47772017 4	PUMP 5 STO PUMP 6 STO	PPED 0 %	
	CALLS NOT COMPLETE	JPWW/TP Action:	Hist.S_AB.SRSP_L	4 HR	8 HR	4.044	S LEVEL (F_CV)		654.91			DMM 25 %	
	CALLS NOT COMPLETE	SWWTP Action: 7	SET CURREN	т		scioto	SMR	UPSTREAM OSI	S DSR83	T WGC	SUMP 1		
				s tunnel fil Ll actions	L	MAIN	_				GRIT 1 SUMP 2 GR 512.5 FT	T2	
						691.55 FT			05 FT		1 ODS 512.6 FT		
				655.24 F	INTERCONNE TO SWW							7	
				IJC	ICS 6.	/ L		TOTAL FLO 82.6 MG				3	
		_										Ç	



Pump Wet Testing Progressive Testing

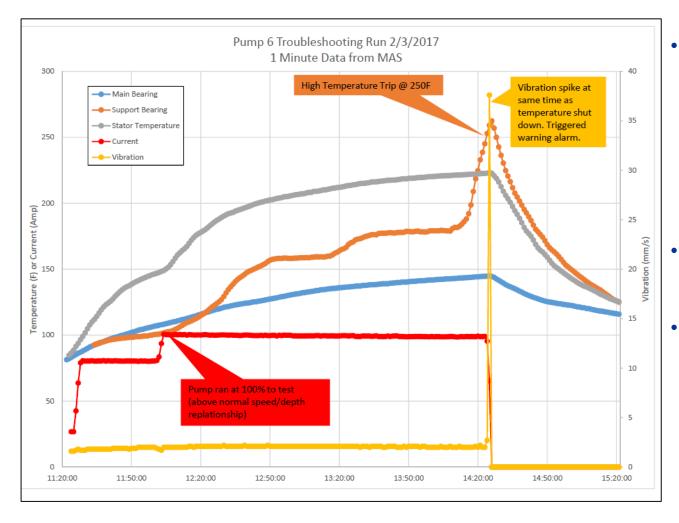
- Pump flow rate estimated by drop in tunnel level and calculated tunnel volume
- Subsequent testing runs built on data from previous runs for each pumps baseline performance
- Due to testing of circuits before, equipment ran without control system issues.







Wet Testing Issues

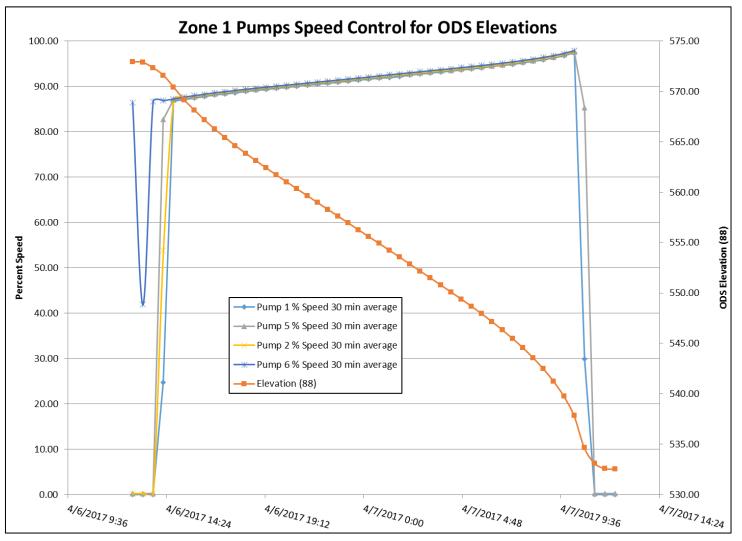


- Pump 6 had a
 manufacturing issue
 that resulted in high
 bearing temperature
 shut down after
 several hours of
 operation
- Manufacturer pulled pump and repaired it
 - Internal pump monitoring only way to know what is going on under 100+ feet of sewage





Wet Testing Success

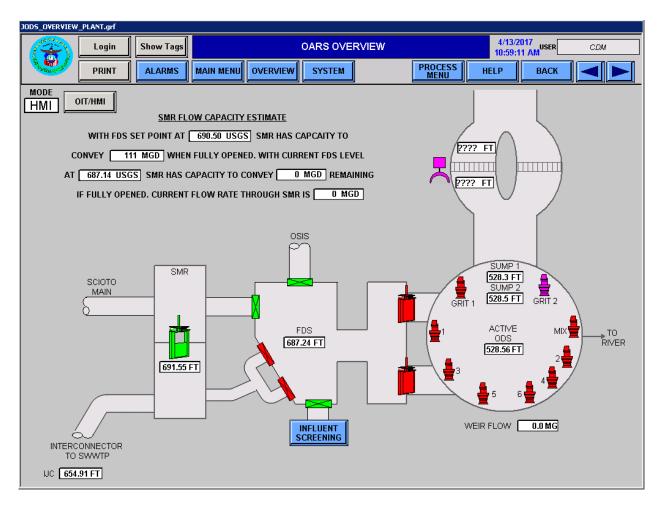


All four Zone 1 pumps operation run including Pump 6. Notice change of speed with depth





Preparing for Live Operation



- Wet testing helped establish interactions between tunnel pump station and surface sewers at JPWWTP
- Many graphic and automatic programming adjustments being made
- SOP being prepared with lessons learned from testing
- Final construction items being completed

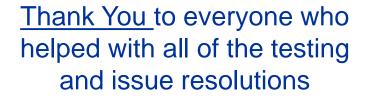






SURVEYING · CONSTRUCTION SERVICES













Will it be this nice out when its put on-line? Questions?

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