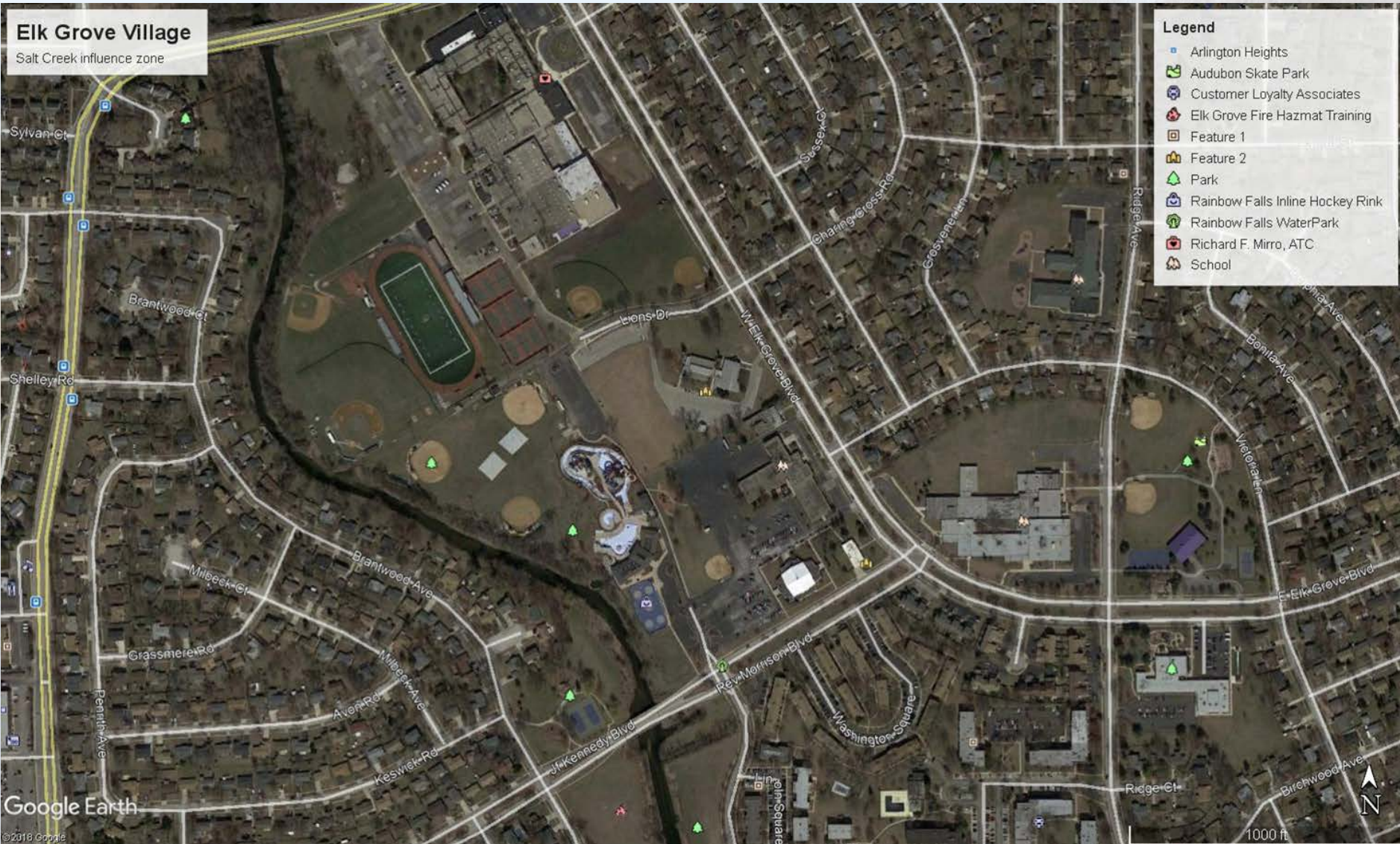




Real-Time Operations of the Busse Reservoir

Presenters: John Wills, PE, CPESC; Scott La Vanne, PE, CFM

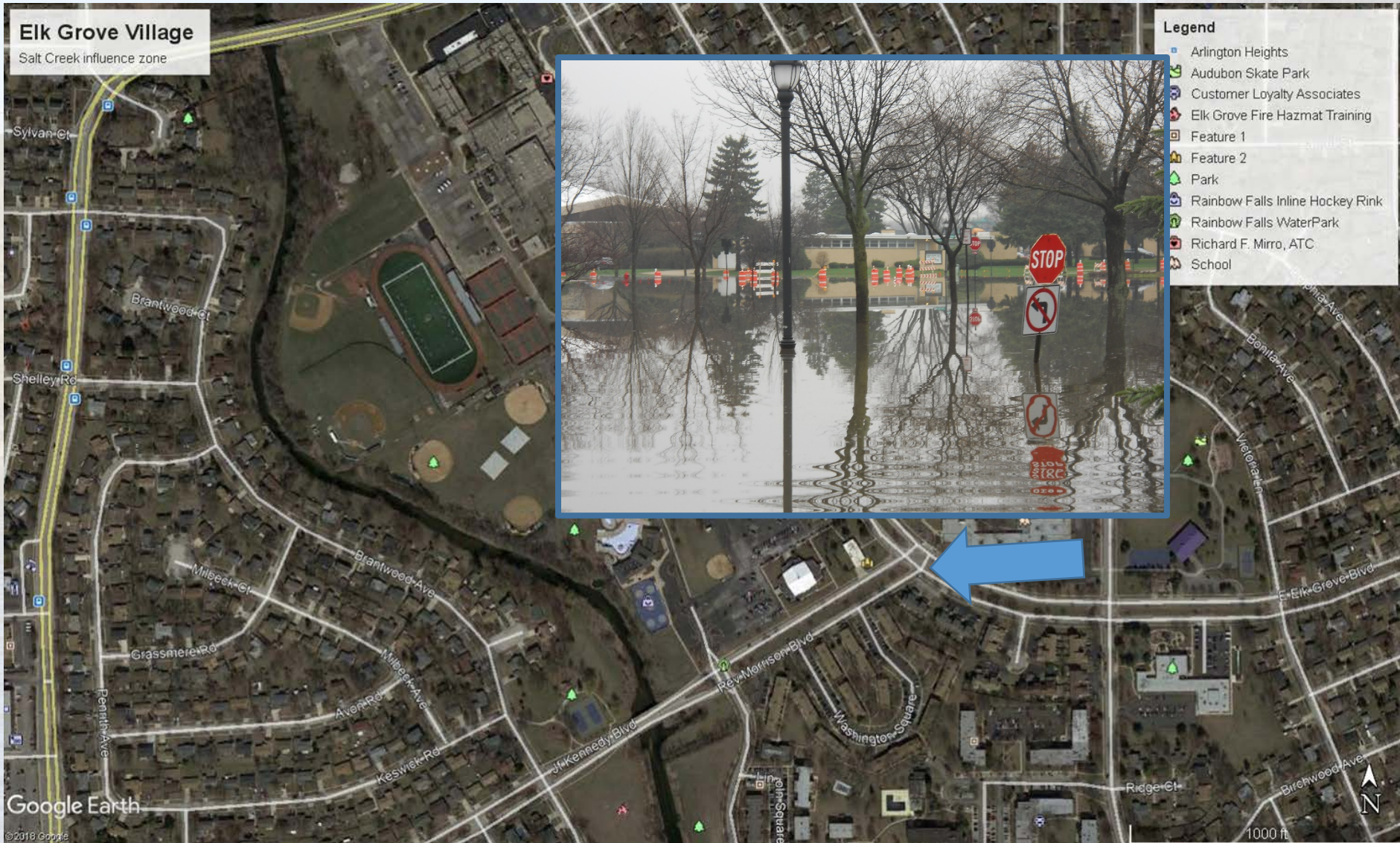
Flooding Frustrations



Flooding Frustrations



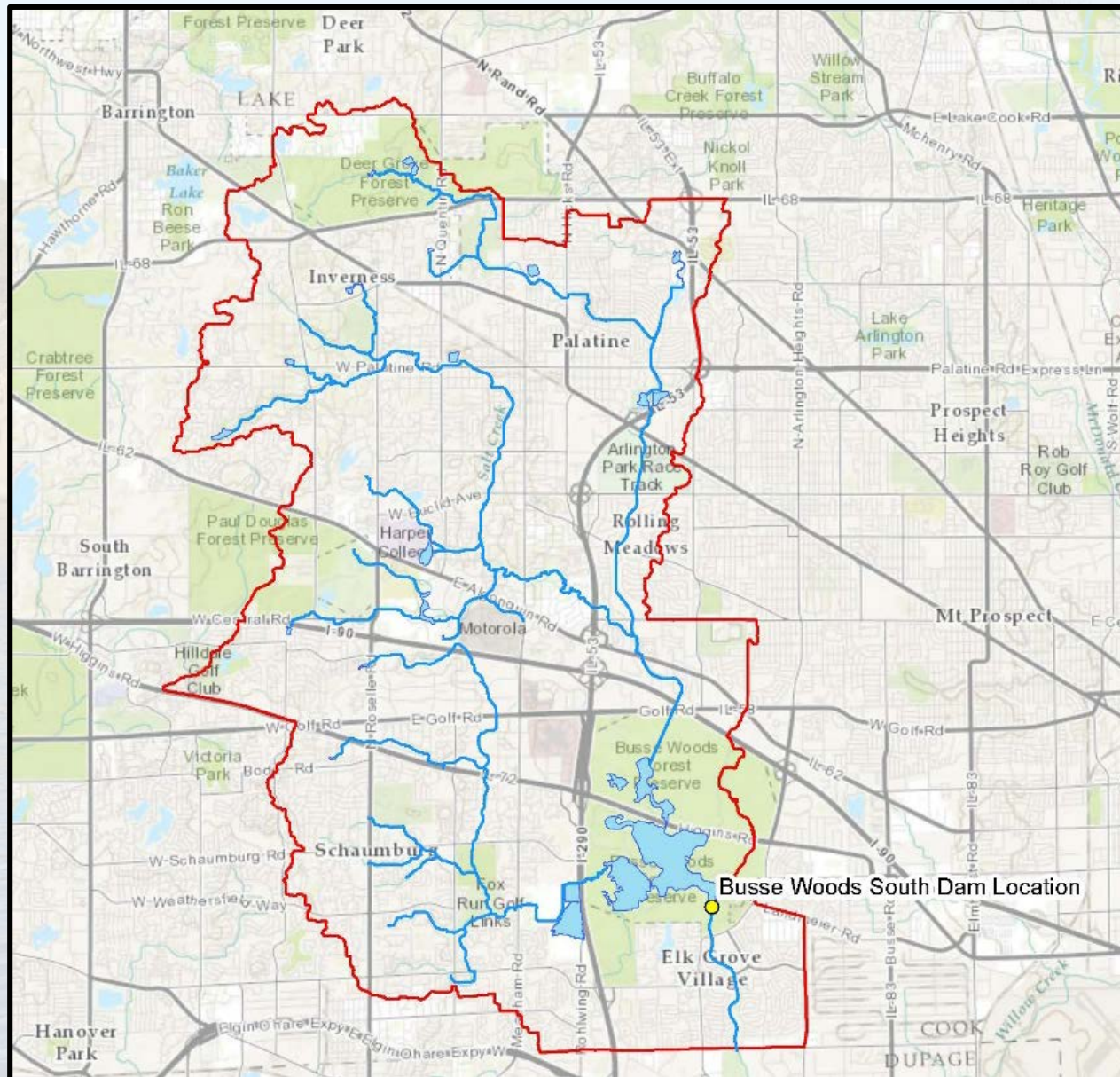
Flooding Frustrations

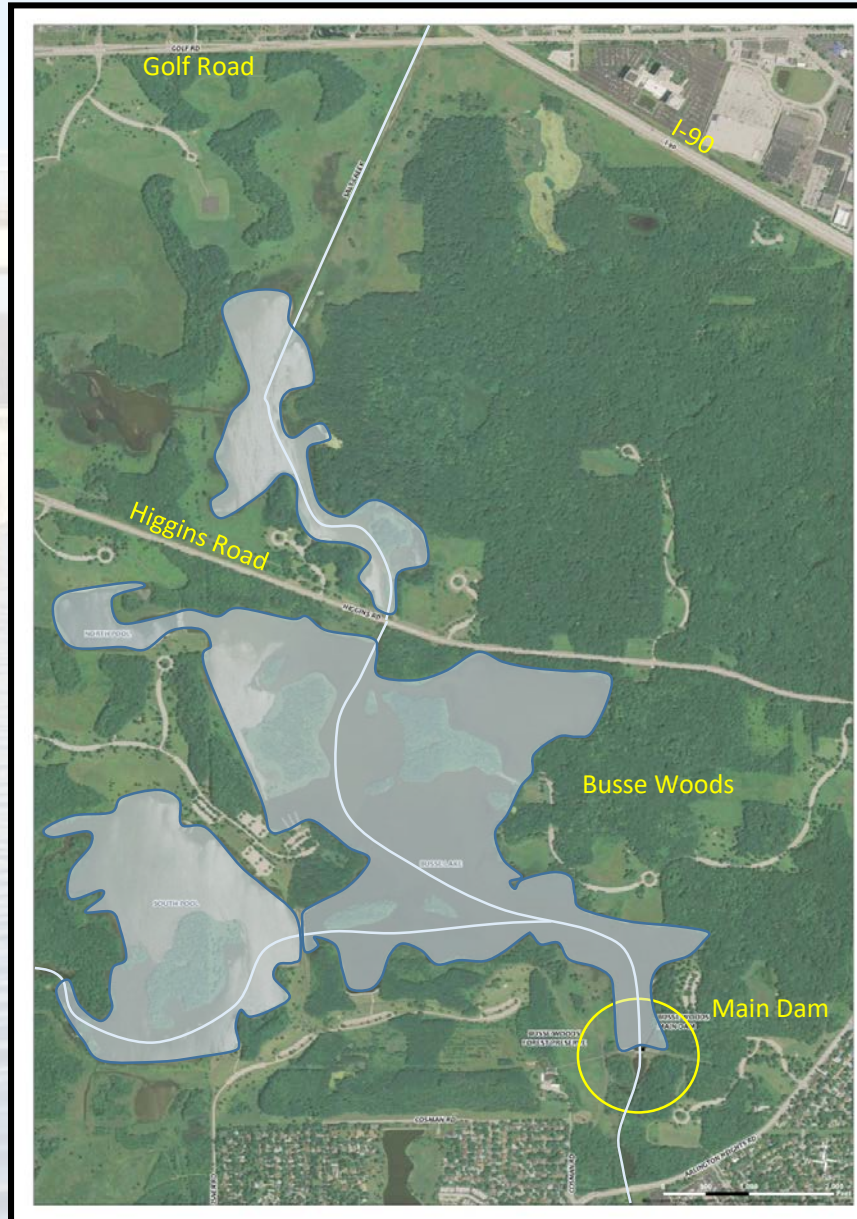


Flooding Frustrations



Watershed & Location





Busse Dam Original Weir



Busse Dam Original Weir



Busse Dam New Gate



Busse Dam New Gate



Busse Dam New Gate

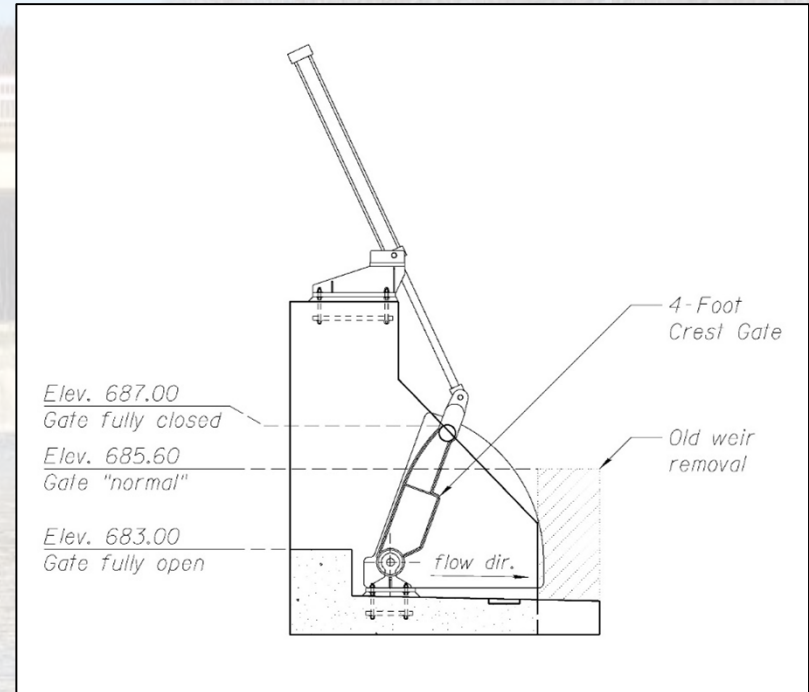


Sensor Locations

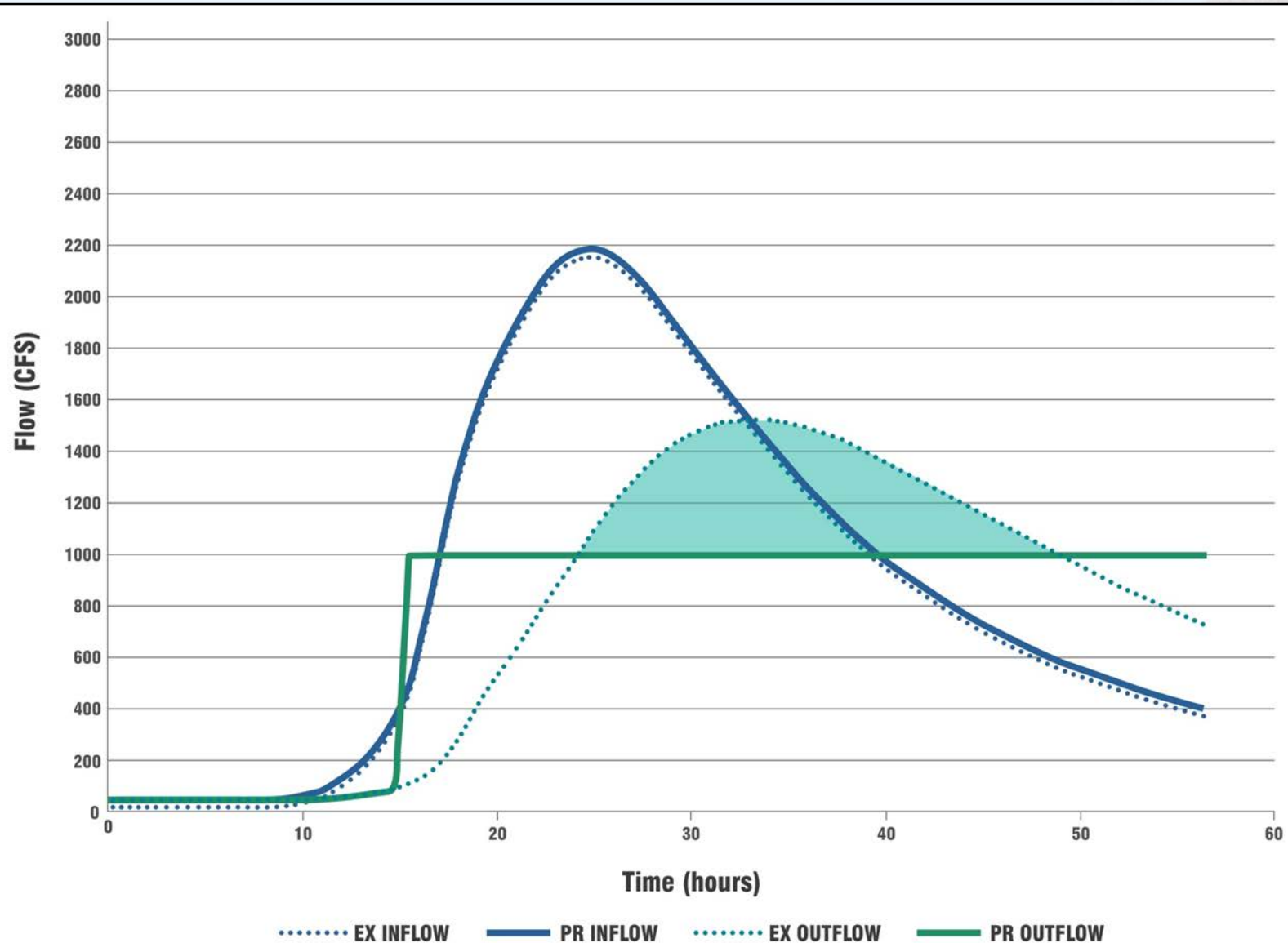


Busse Operations

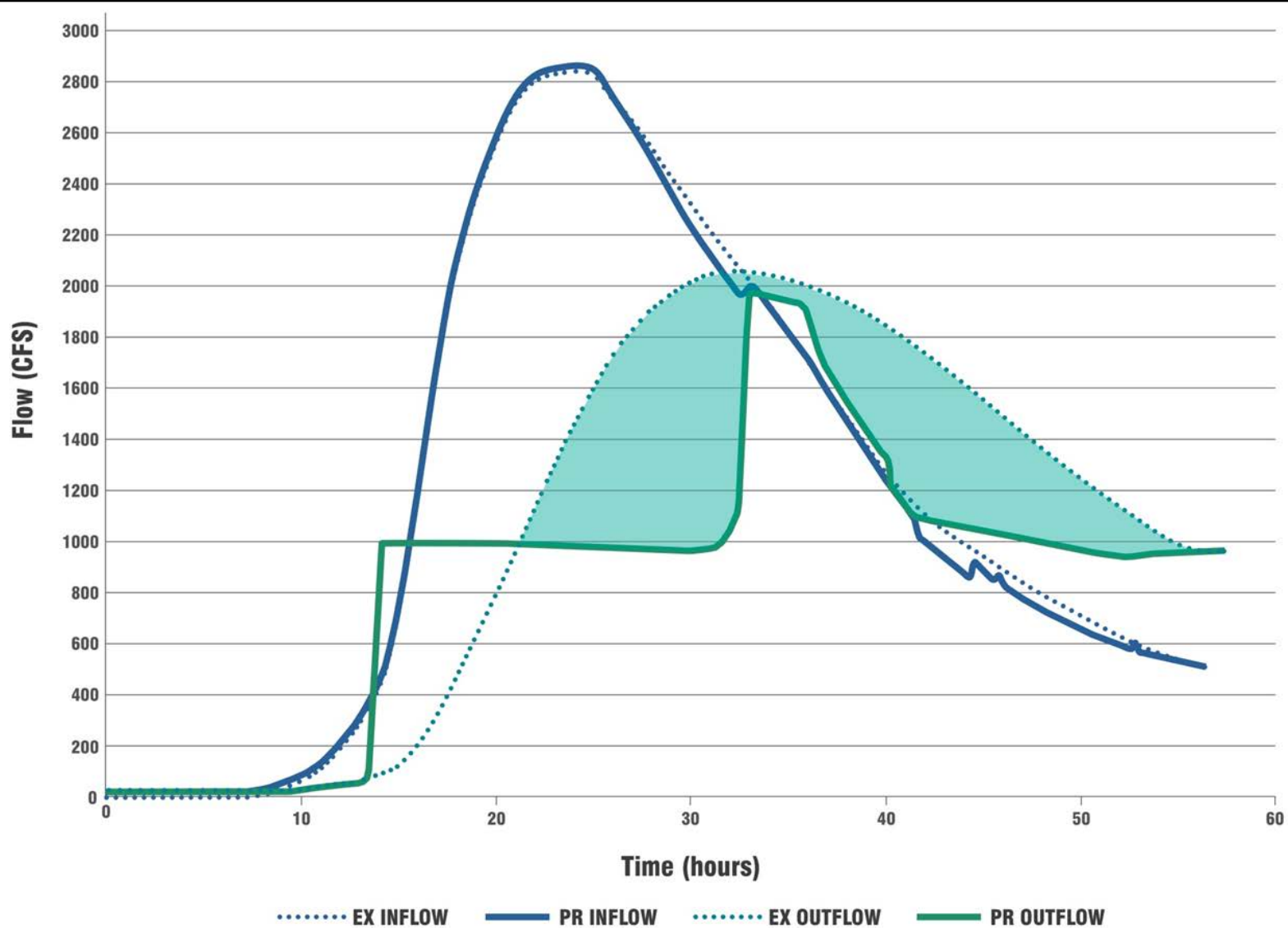
- Operational Limitations
 - Physical Constraints
 - Flood Definitions
 - IGA
 - Management Resources
- Design Operating Scheme
- Implemented Operating Scheme



Design Operations (10-yr event)

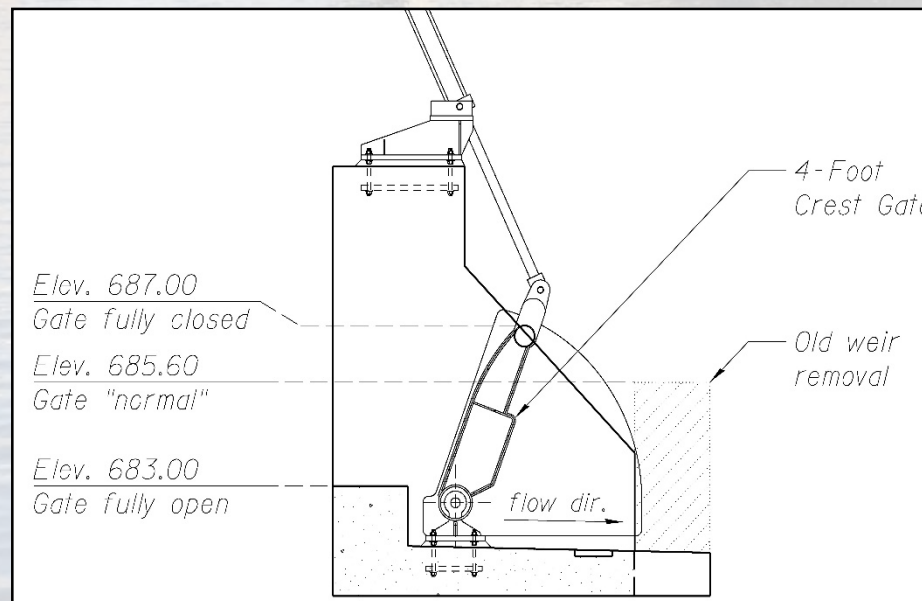


Design Operations (25-yr event)



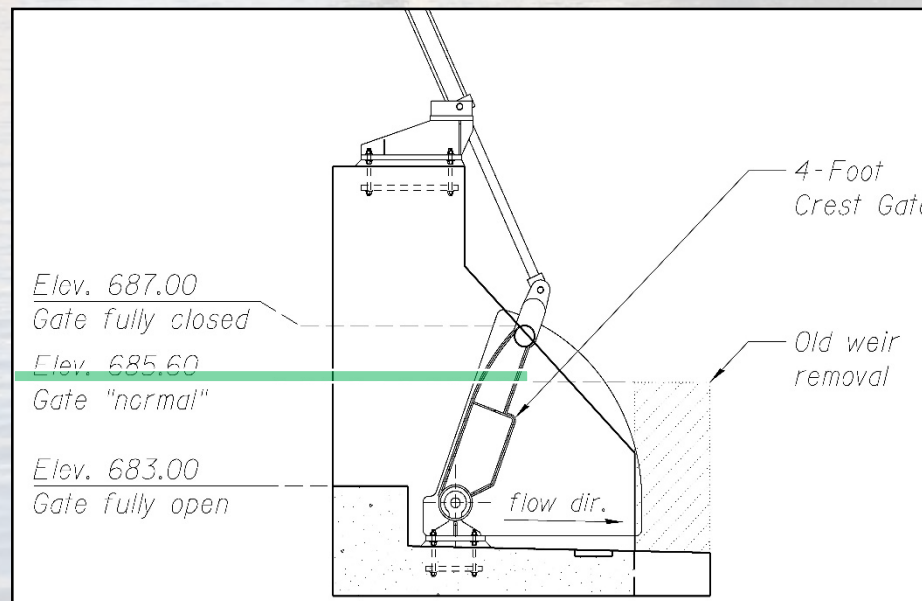
Operations Implemented

Operational Level:	Level 1	Level 2	Level 3	Level 4	Level 5
Attempt to Maintain reservoir elevation of:					
by opening (lowering) gate up to:					
to achieve a maximum flow rate of:					
Continue until reservoir stage is:					
Downstream effect:					



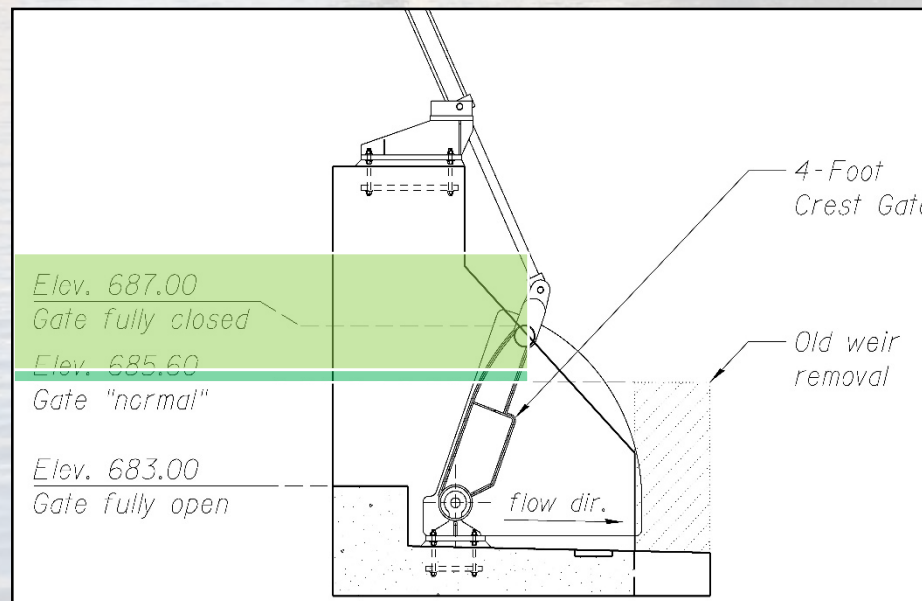
Operations Implemented

Operational Level:	Level 1	Level 2	Level 3	Level 4	Level 5
Attempt to Maintain reservoir elevation of:	685.6				
by opening (lowering) gate up to:	1.1'				
to achieve a maximum flow rate of:	300 CFS				
Continue until reservoir stage is:	685.8				
Downstream effect:	Flow is just below bankful				



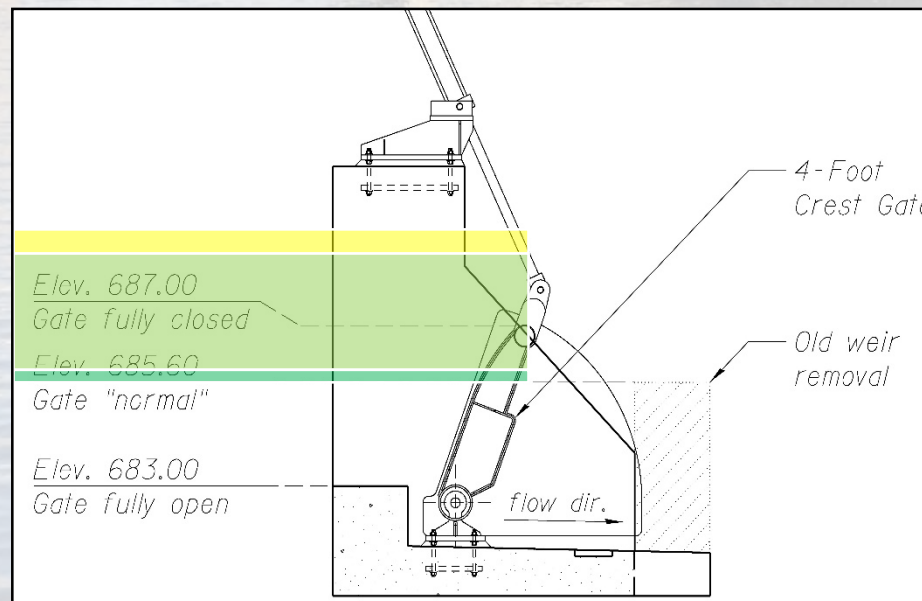
Operations Implemented

Operational Level:	Level 1	Level 2	Level 3	Level 4	Level 5
Attempt to Maintain reservoir elevation of:	685.6	685.8			
by opening (lowering) gate up to:	1.1'	1.5'			
to achieve a maximum flow rate of:	300 CFS	500 CFS			
Continue until reservoir stage is:	685.8	688.0			
Downstream effect:	Flow is just below bankful	Low-laying baseball fields and pedestrian trail inundated			



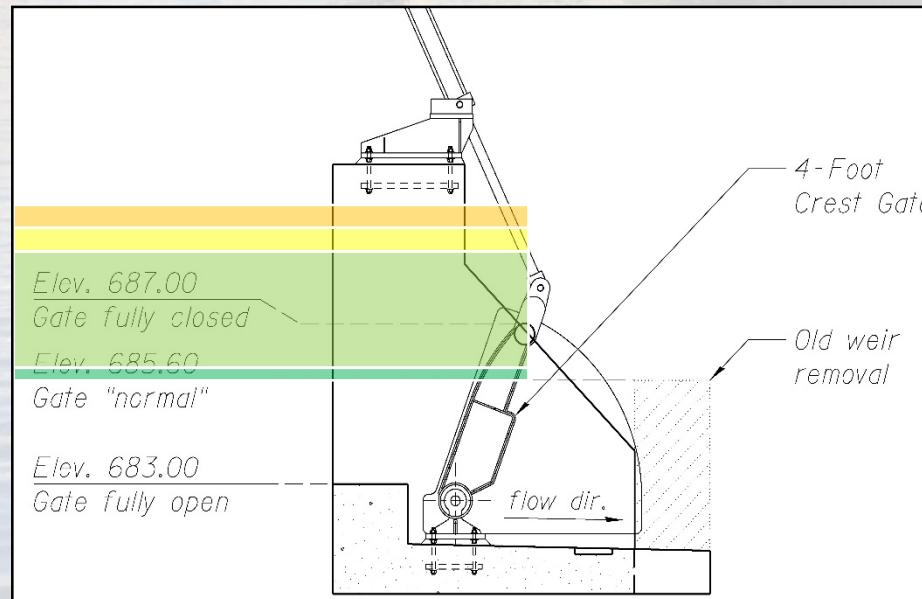
Operations Implemented

Operational Level:	Level 1	Level 2	Level 3	Level 4	Level 5
Attempt to Maintain reservoir elevation of:	685.6	685.8	688.0		
by opening (lowering) gate up to:	1.1'	1.5'	2.0'		
to achieve a maximum flow rate of:	300 CFS	500 CFS	700 CFS		
Continue until reservoir stage is:	685.8	688.0	688.5		
Downstream effect:	Flow is just below bankful	Low-laying baseball fields and pedestrian trail inundated	Some water on pavement – road passable		



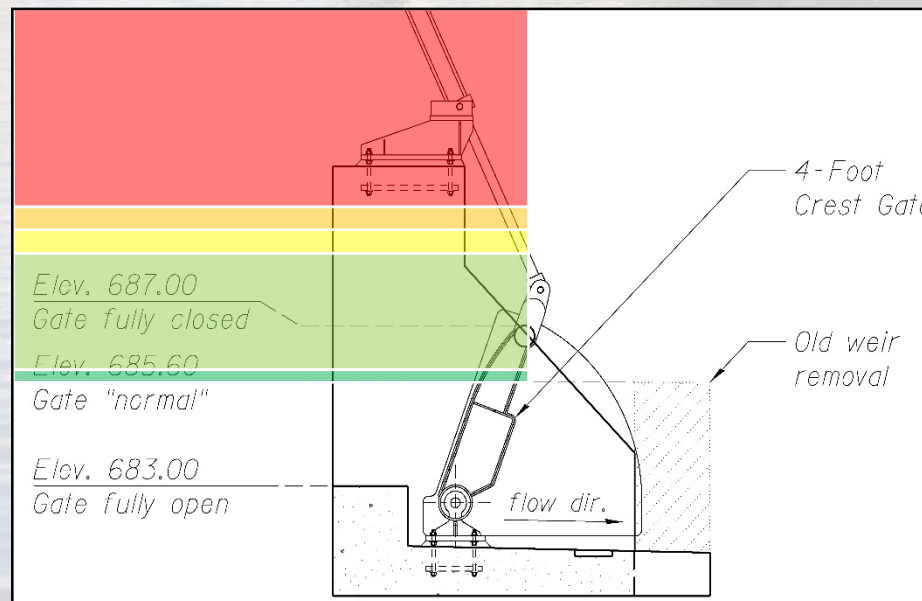
Operations Implemented

Operational Level:	Level 1	Level 2	Level 3	Level 4	Level 5
Attempt to Maintain reservoir elevation of:	685.6	685.8	688.0	688.5	
by opening (lowering) gate up to:	1.1'	1.5'	2.0'	2.4'	
to achieve a maximum flow rate of:	300 CFS	500 CFS	700 CFS	1000 CFS	
Continue until reservoir stage is:	685.8	688.0	688.5	689.0	
Downstream effect:	Flow is just below bankful	Low-laying baseball fields and pedestrian trail inundated	Some water on pavement – road passable	Additional water on pavement – one lane closed	

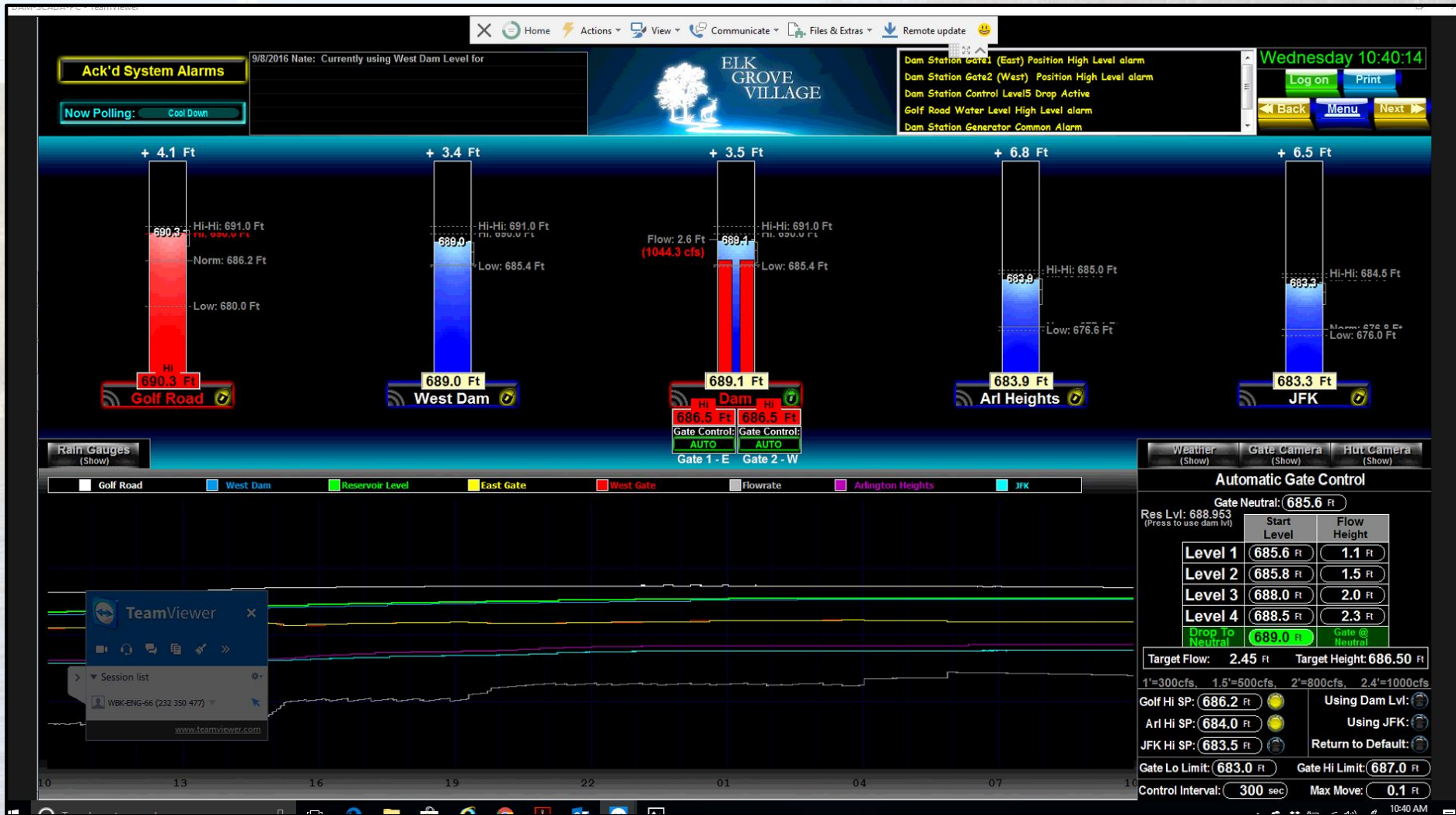


Operations Implemented

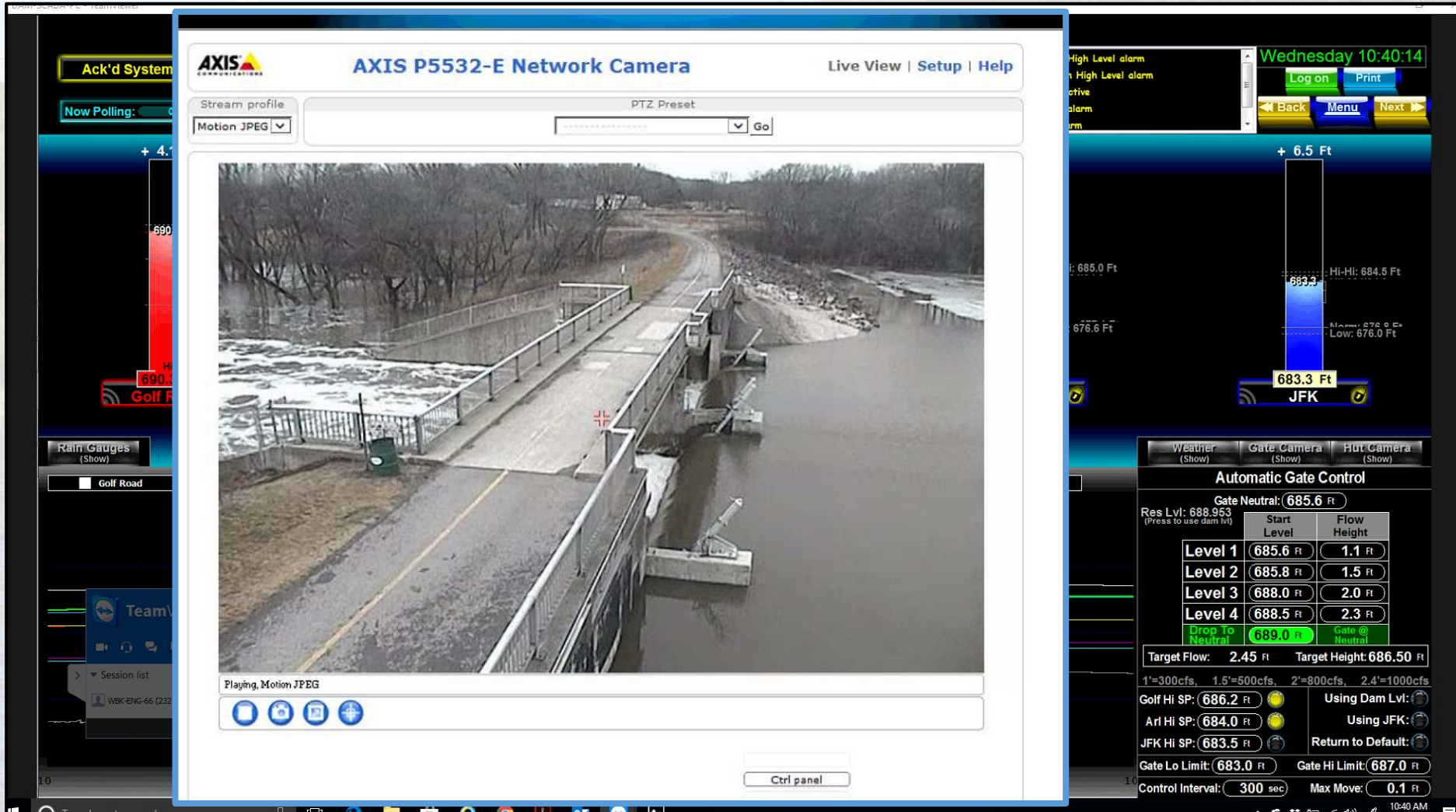
Operational Level:	Level 1	Level 2	Level 3	Level 4	Level 5
Attempt to Maintain reservoir elevation of:	685.6	685.8	688.0	688.5	689.0
by opening (lowering) gate up to:	1.1'	1.5'	2.0'	2.4'	Normal (685.6)
to achieve a maximum flow rate of:	300 CFS	500 CFS	700 CFS	1000 CFS	>1000 CFS
Continue until reservoir stage is:	685.8	688.0	688.5	689.0	< 689.0
Downstream effect:	Flow is just below bankful	Low-laying baseball fields and pedestrian trail inundated	Some water on pavement – road passable	Additional water on pavement – one lane closed	Storm dependent



Operations Level Real Time Data



Operations Level Real Time Data




Operations Level Real Time Data

AXIS P5532-E Network Camera Live View | Setup | Help

Stream profile: Motion JPEG

PTZ Preset: Camera - Gate Closeup Go




Playing, Motion JPEG

Ctrl panel

AXIS P5532-E Network Camera Live View | Setup | Help

Stream profile: Motion JPEG



Playing, Motion JPEG

Ack'd System

Now Polling: + 4.1

690.4

Golf Road

Rain Gauges (Show)

Golf Road

Team

Session list

WBK-ENG-66 (232)

10:40 AM

Real Time Data-Trends Overview

Home Actions View Communicate Files & Extras Remote update



Monday 10:48:16

Log on Print

Main

Water Levels Trend

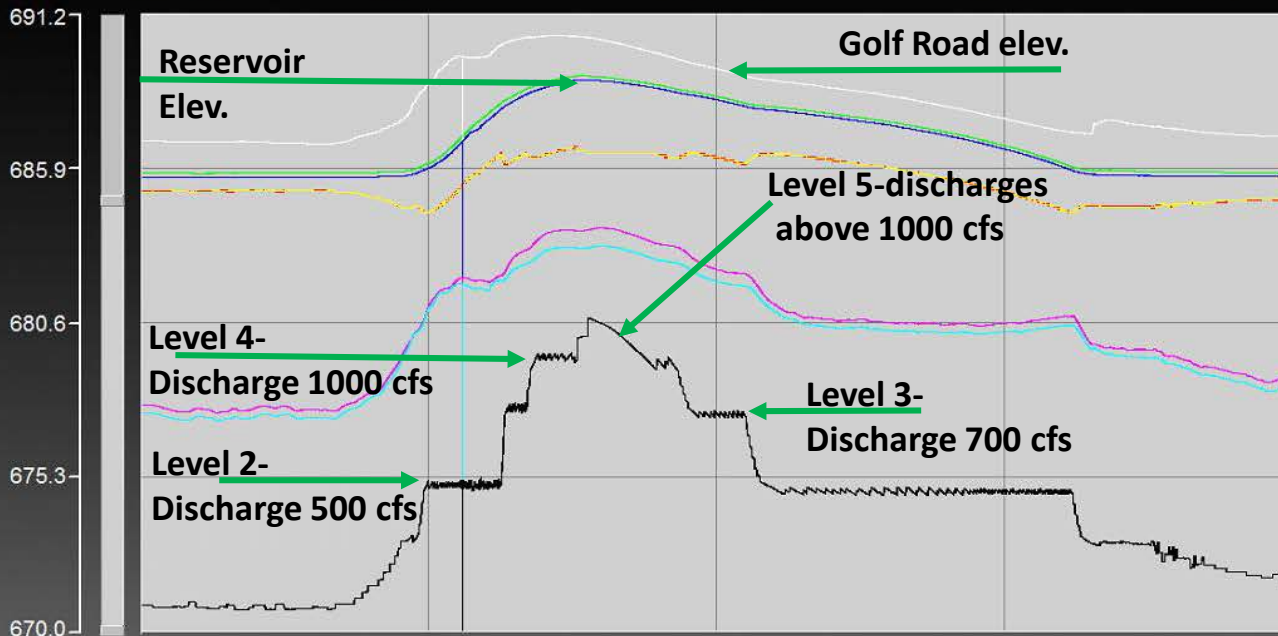
Feb 17
23:55:17

Feb 20
02:38:28

Feb 22
05:21:39

Feb 24
08:04:50

Feb 26
10:48:01



DAM_Wtr_lvl_sweet

685.79 685.82

DAM_GT1E_pos_sweet

685.18 684.92

DAM_GT2W_pos_sweet

685.14 684.96

GLF_Wtr_lvl_sweet

686.91 687.07

WDM_Wtr_lvl_sweet

685.64 685.67

ARL_Wtr_lvl_sweet

677.80 678.59

JFK_Wtr_lvl_sweet

677.51 678.29

DAM_GT_Flowrate_combined

88.99 166.27

23:55:17

10:48:01

23:55:17

Zoom In

8d 10h 52m 44s

Zoom Out

10:48:01

4 hours

1 hour

1440 minutes

30 minutes

10 minutes

Update to current

Save To File Filename: C:\USERS\SCADA\DESKTOP\DATADUMP.CSV

Sample interval for Data Dump: Every 300 seconds

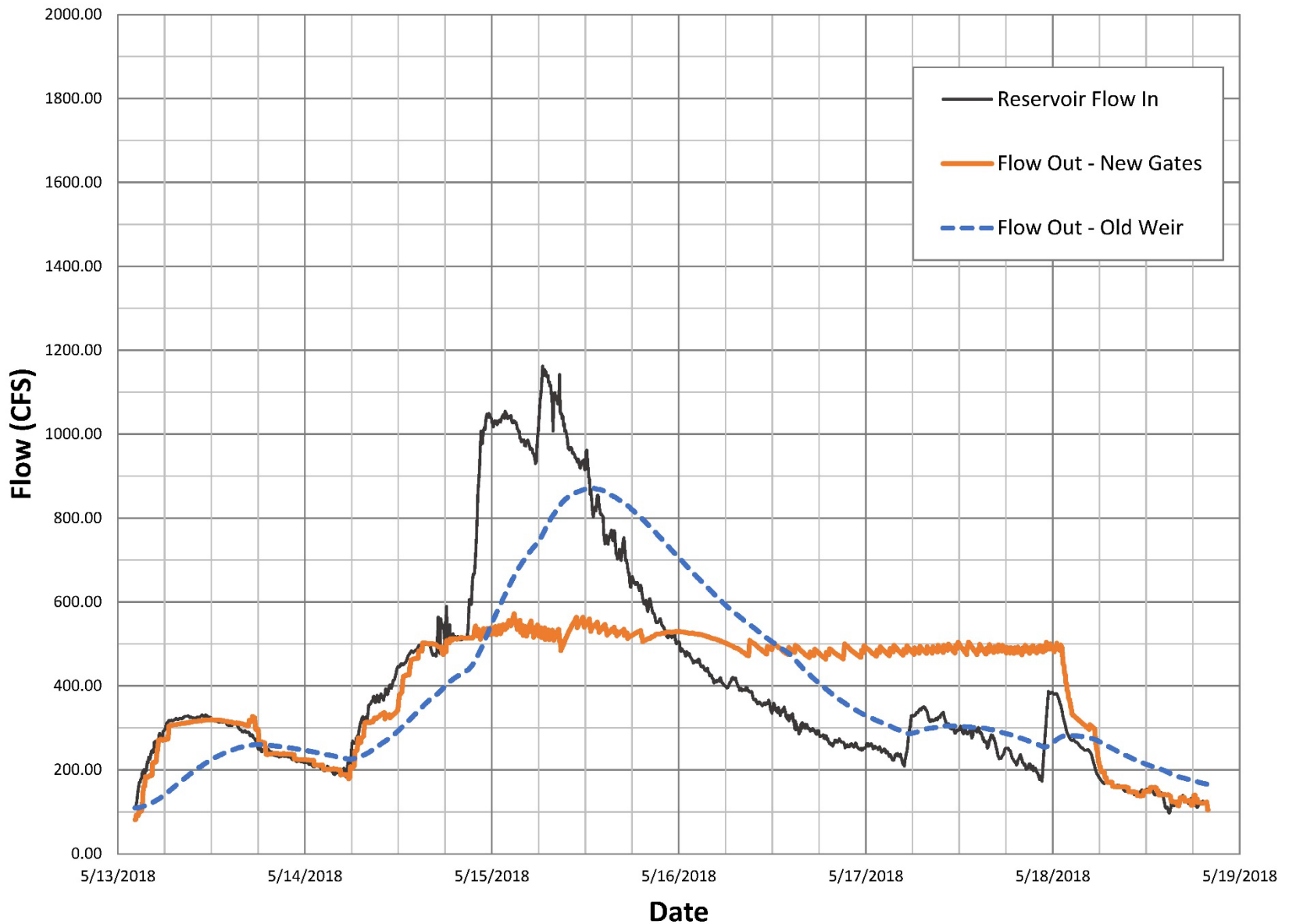
TeamViewer

Session list

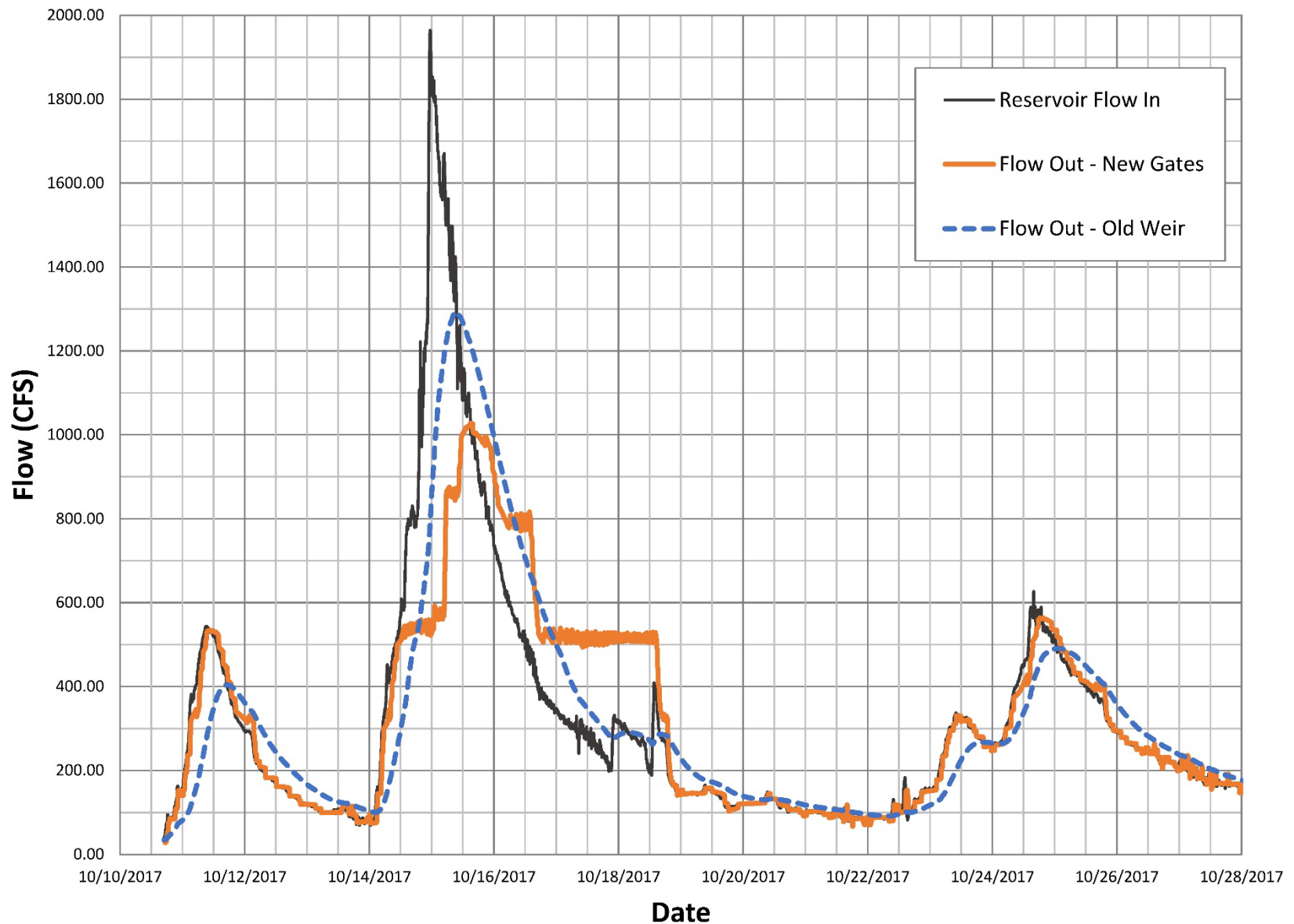
WBK-ENG-66 (232 350 477)

www.teamviewer.com

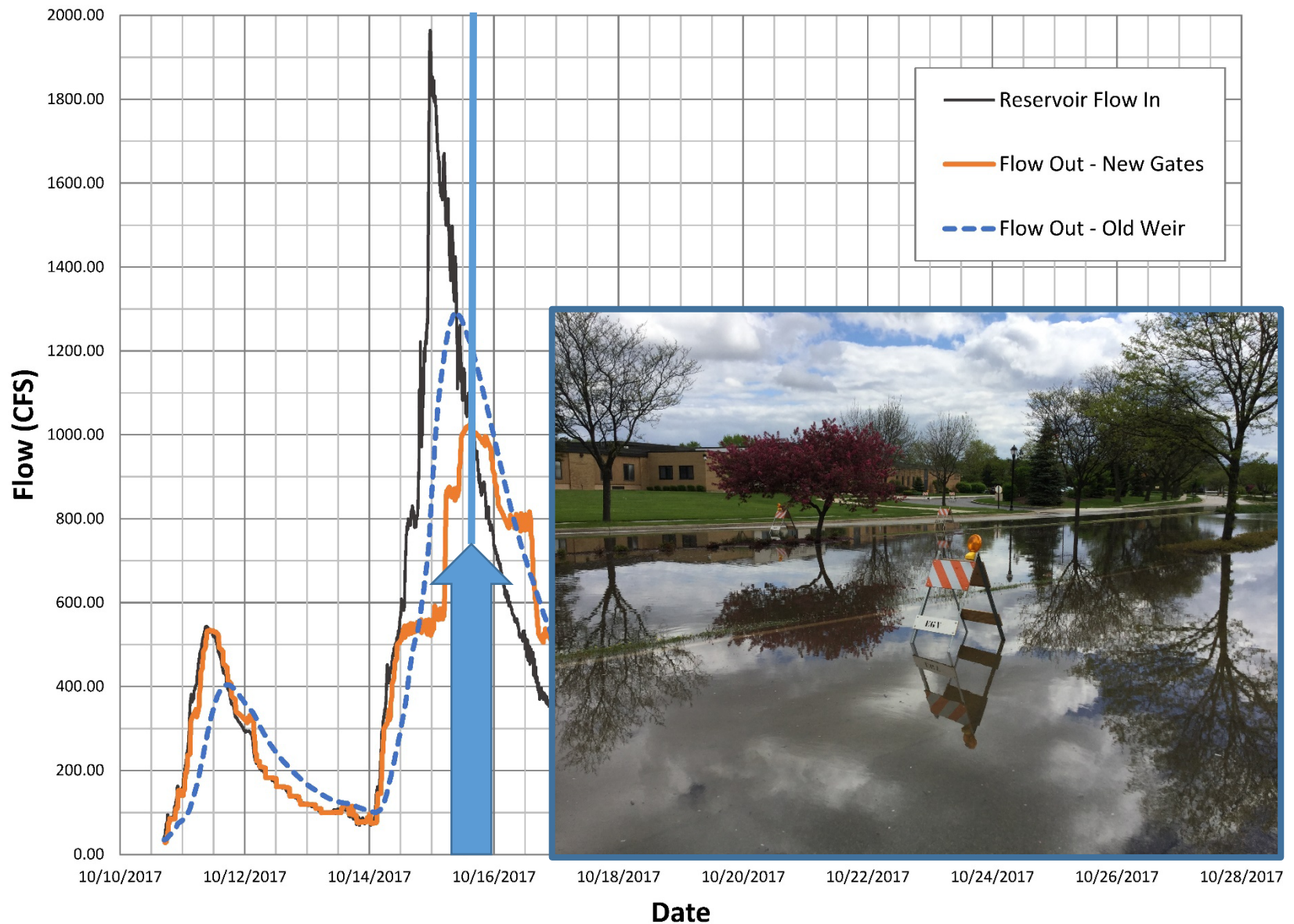
Level 2 Operation



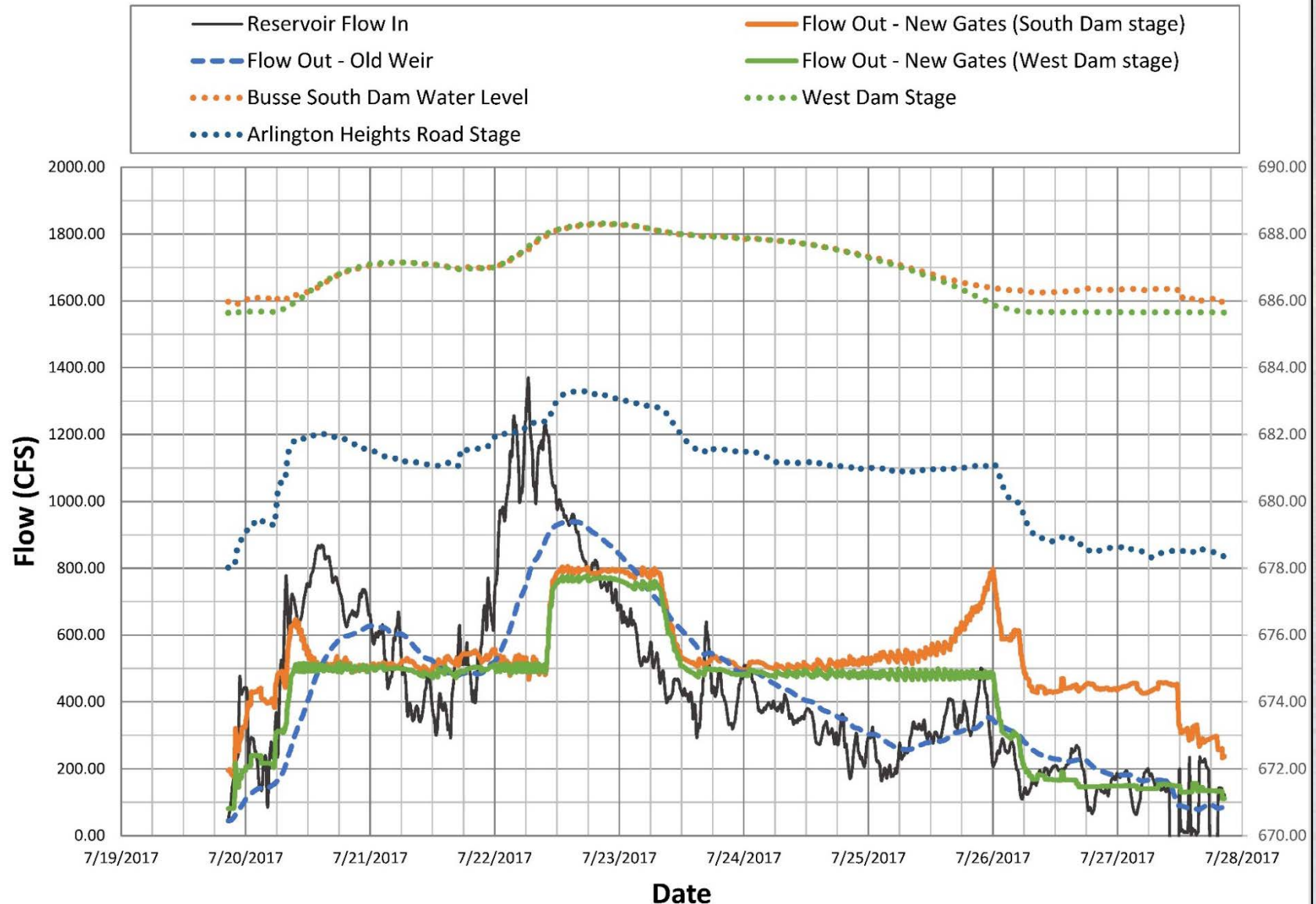
Level 4 Operation-multiple storms- matching inflow/outflow



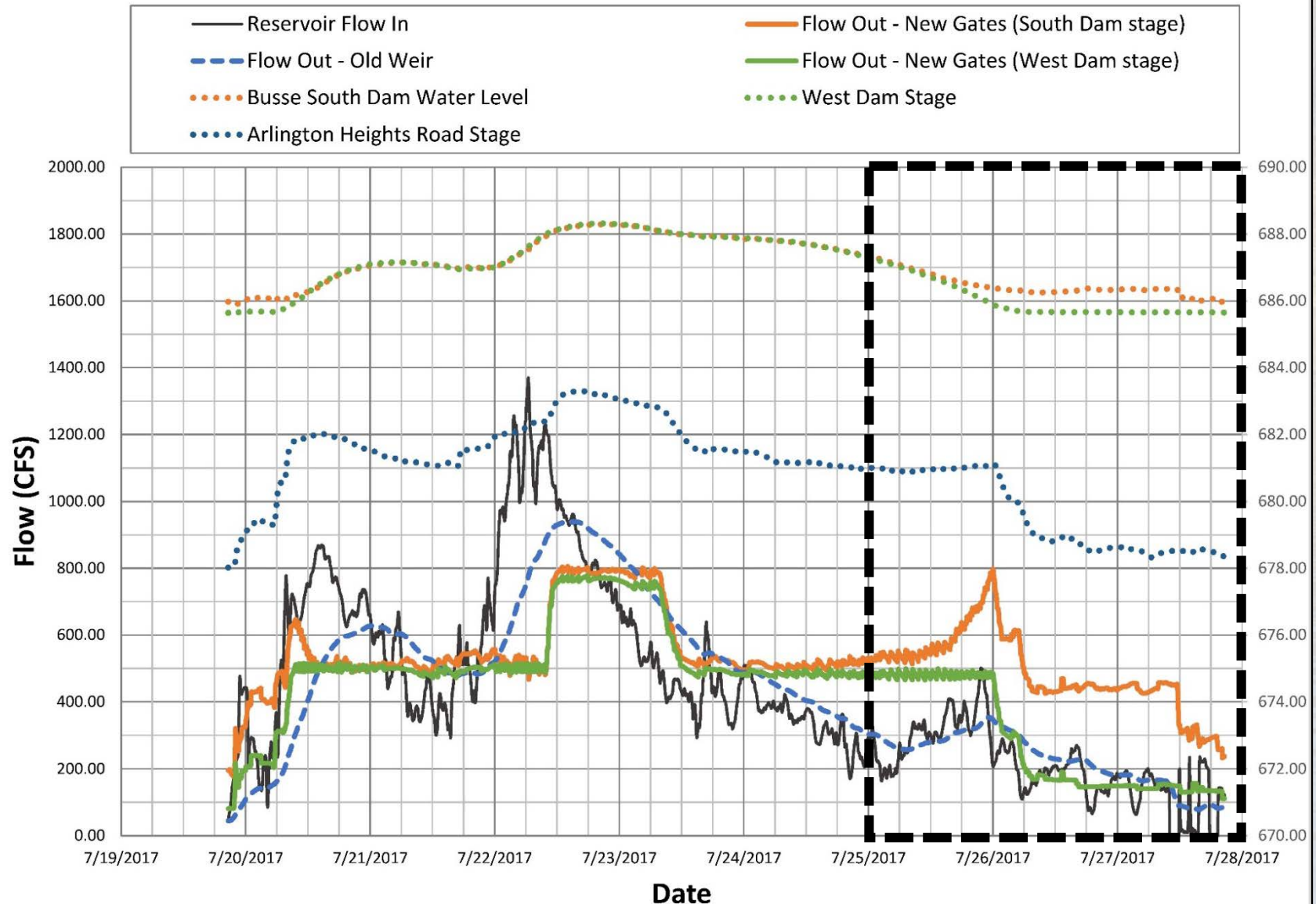
Level 4 Operation-multiple storms-matching inflow/outflow



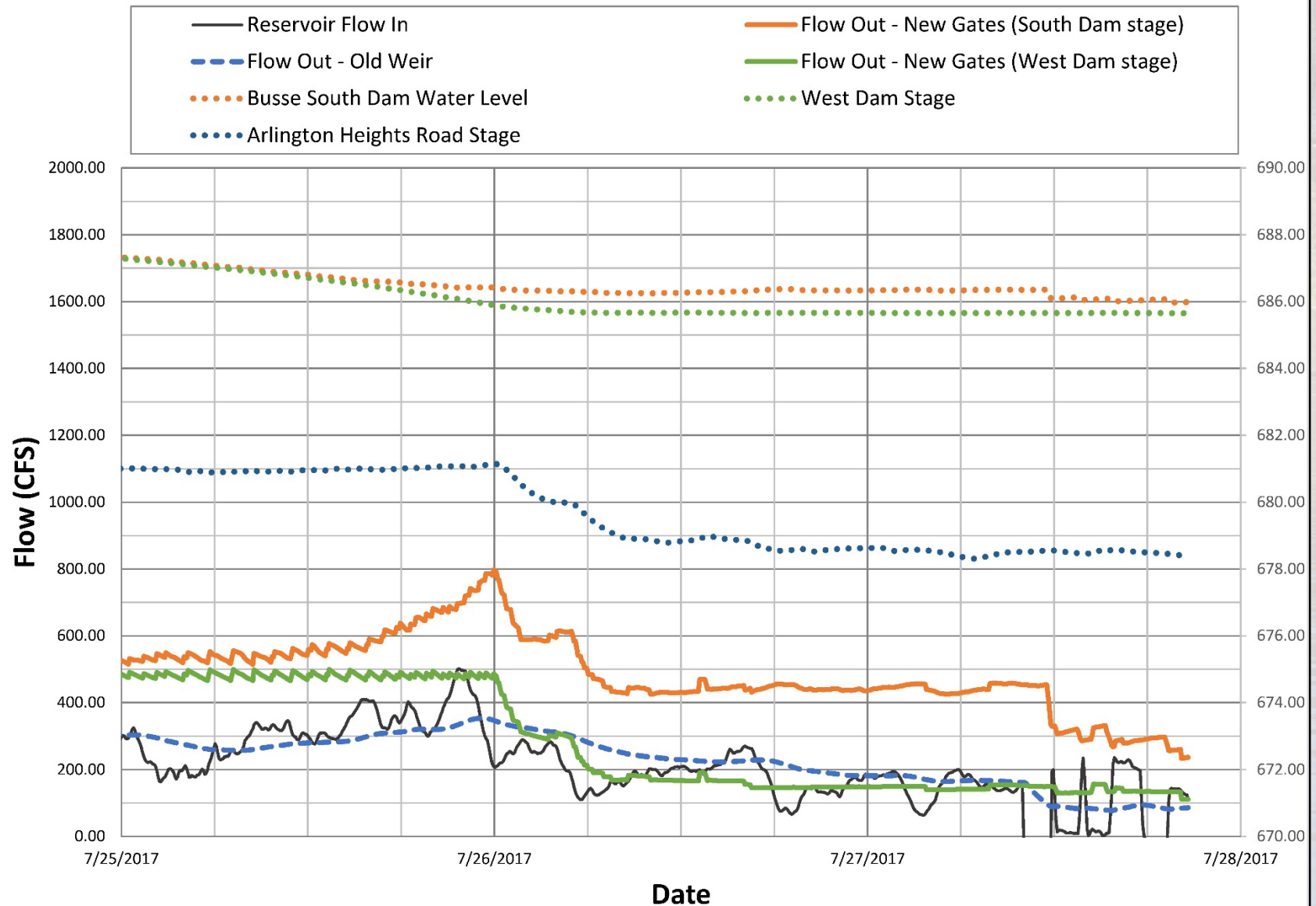
Level 3 Operation—Sensor Mismatch at the Dam



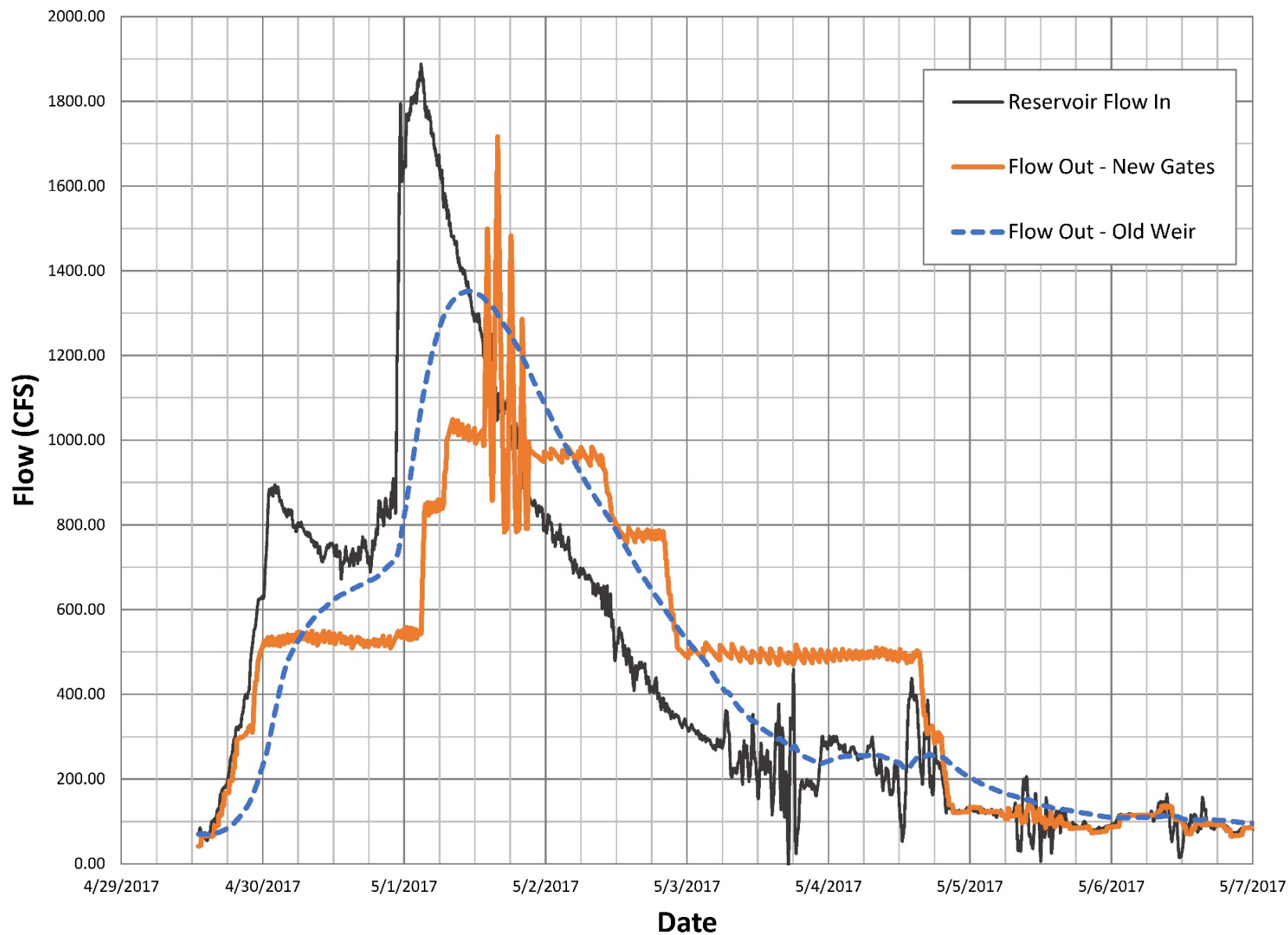
Level 3 Operation—Sensor Mismatch at the Dam



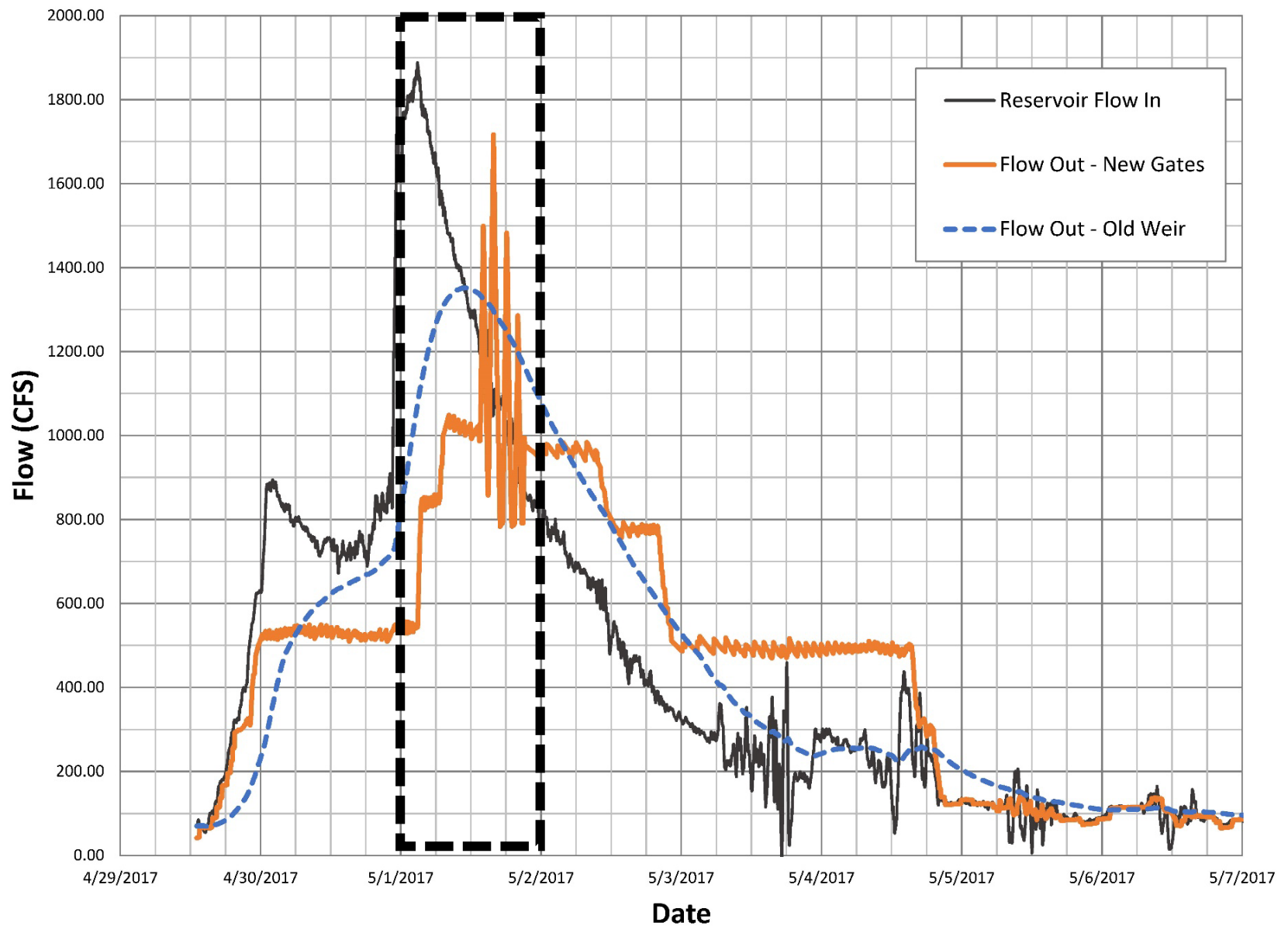
Sensor Mismatch—backup Operations



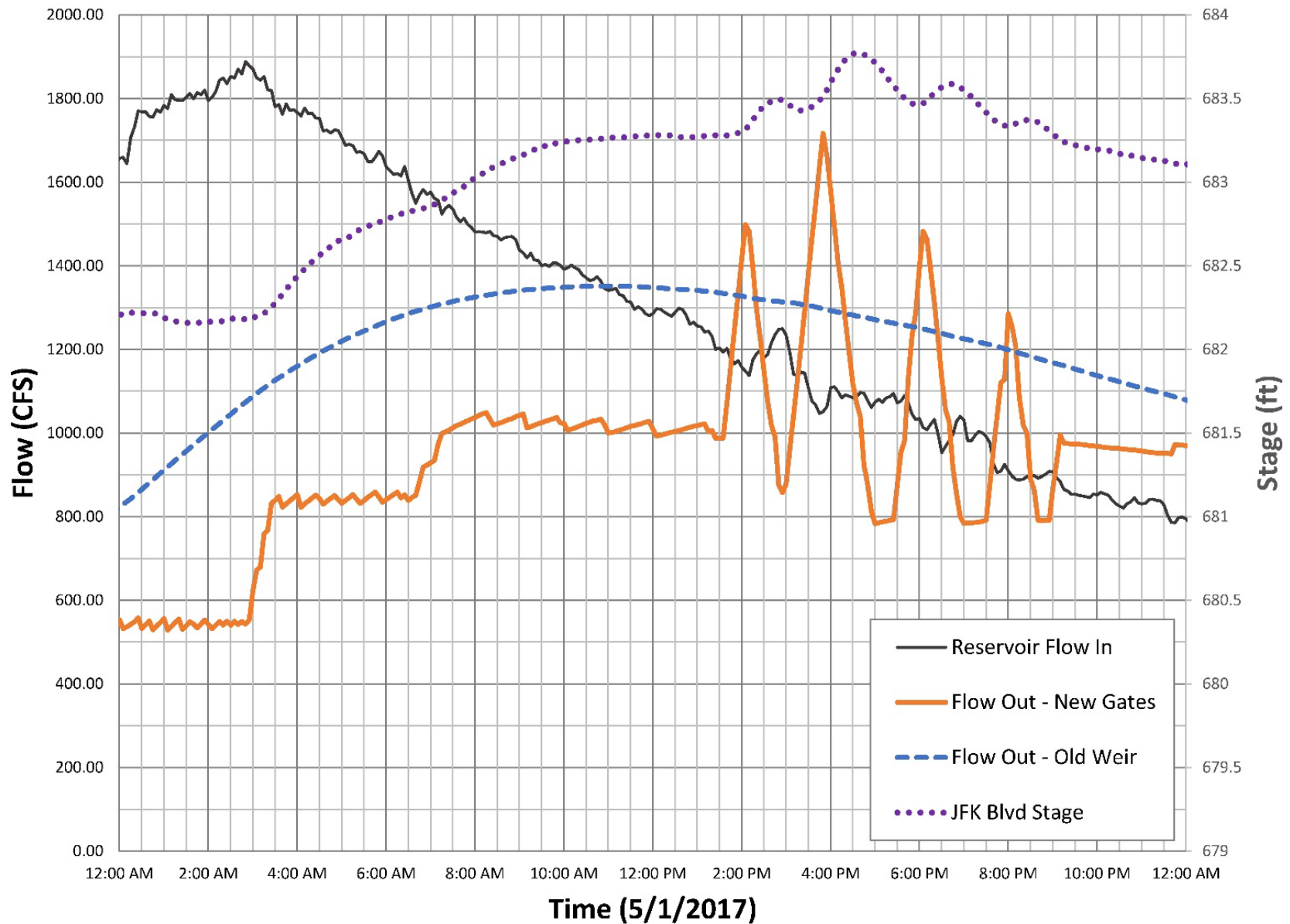
First Level 5 Operation-2017



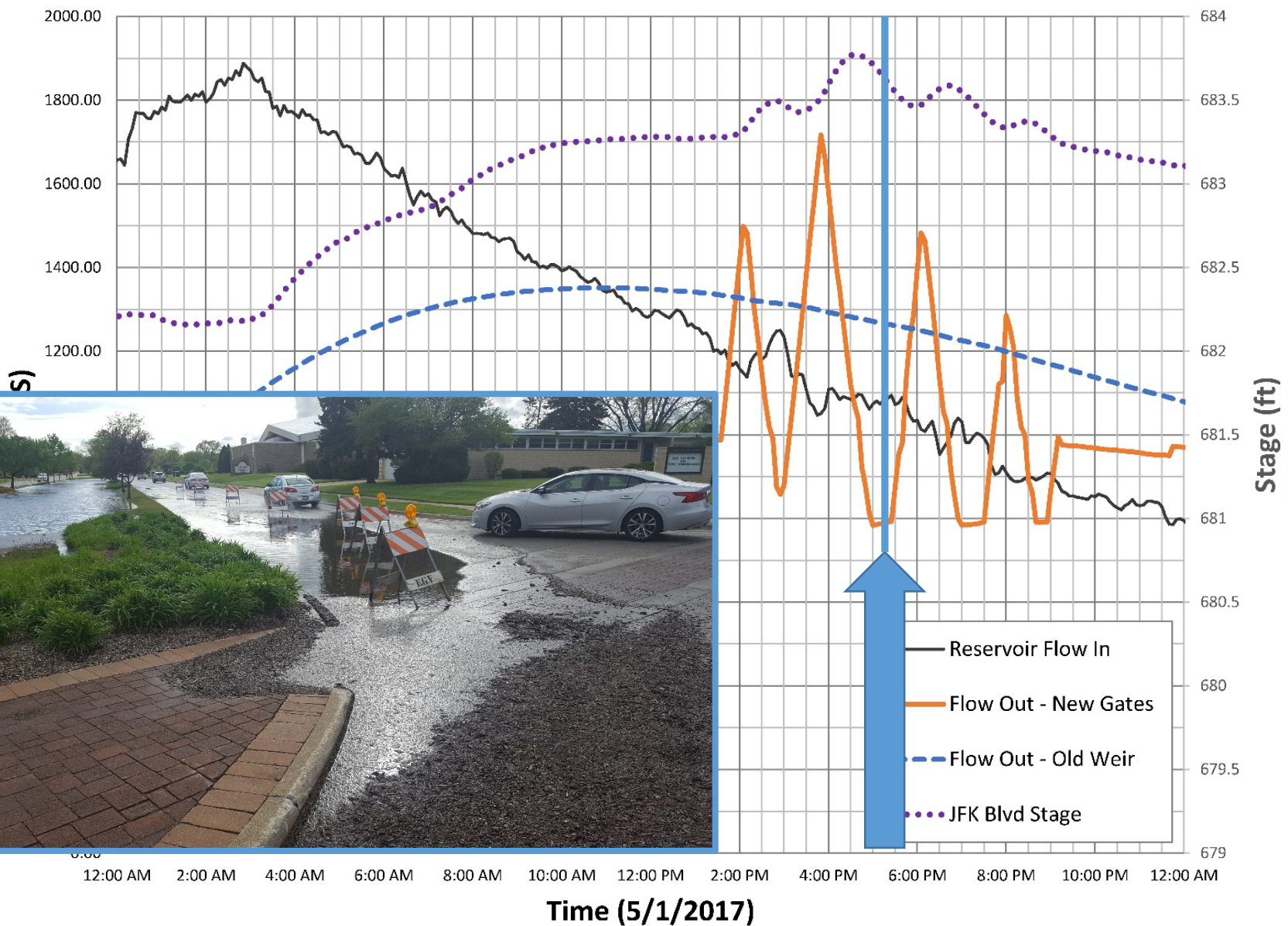
First Level 5 Operation-2017



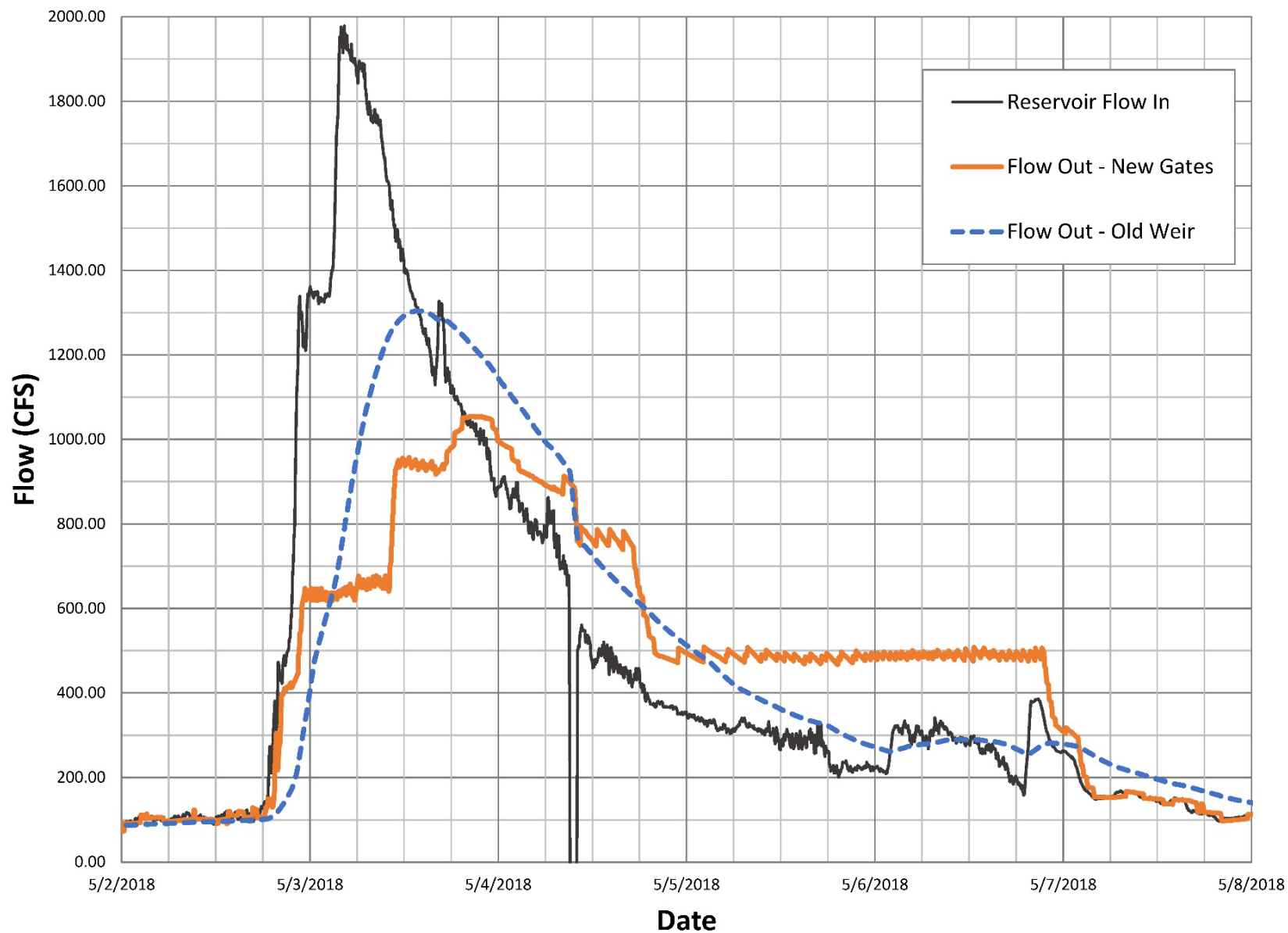
First Level 5 Operation-2017



First Level 5 Operation-2017



Level 5 Operation 2018



The Three-Year take aways

- We can improve on earlier thinking in flood mitigation strategy.
- Need to translate rules from available data into physical and practical consequence
- Communication and translation between rules and PLC program
- Stay curious about rules
- Coordination between operations and maintenance
- It's mechanical – things will break!

Reactive Systems

- Data Driven
- Rule Bound

Predictive Application

- Mining Weather Data
 - Rain cell change and movement
 - Hydrologic model to convert to runoff-inflow hydrograph
- Multiple reactive schemes as a first step
- Feedback loop and learning



The End—The Beginning... *Questions?*