

Assessing the Performance of the North Dorchester Bay Tunnel System

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Agenda

- The Good News: NDB Tunnel meets LTCP levels of CSO and stormwater control
- Background
- Performance assessment
 - Assessment approach
 - Rainfall events
 - Data sources and types
 - Data analysis
- Results
- Conclusions and recommendations



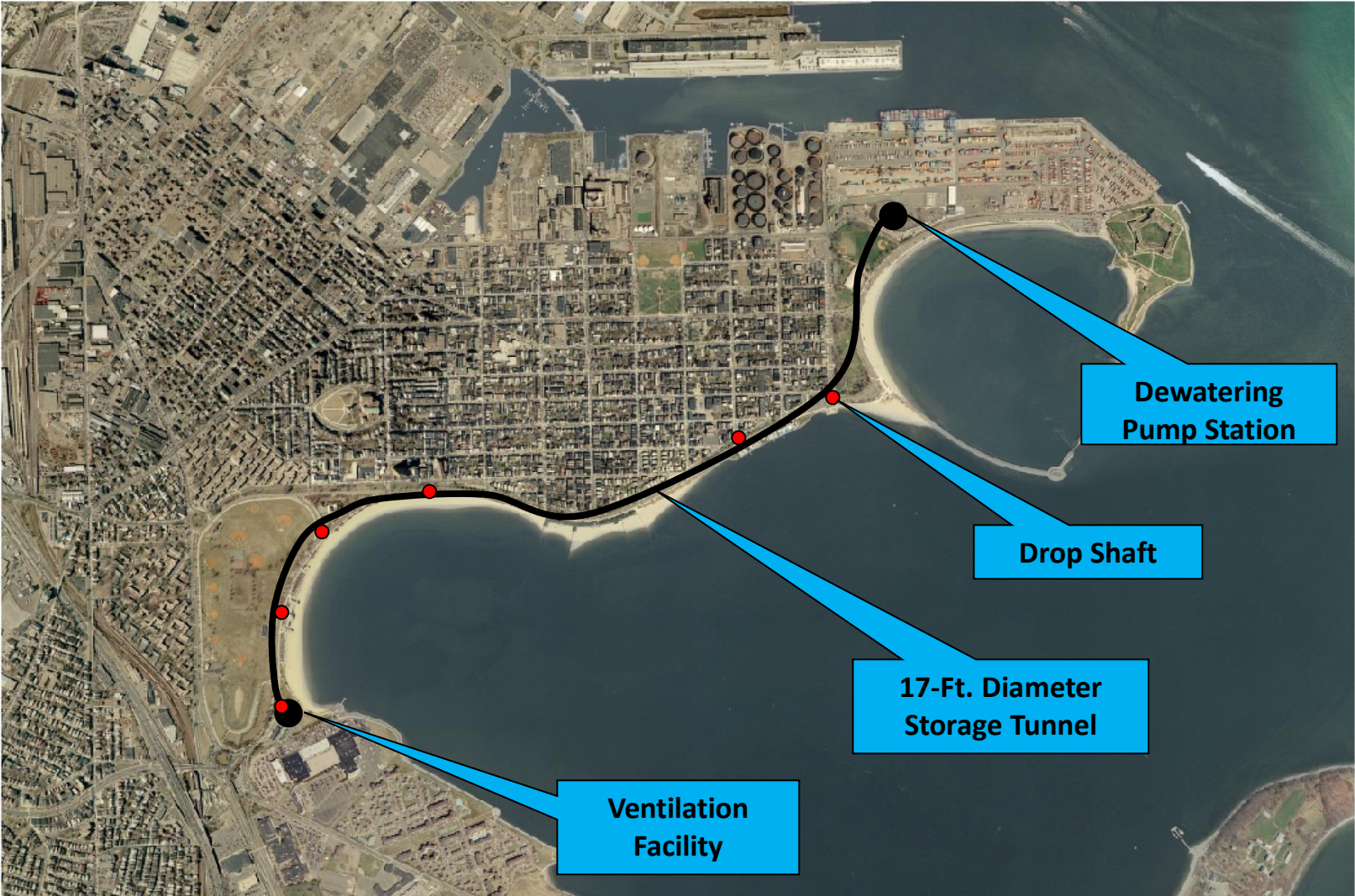
Overview of MWRA CSO Control Program – By the Numbers

- \$900 million
- 82 construction contracts
- 33 engineering contracts
- 10 planning & technical assistance contracts
- 184 court milestones
- 35 CSO control projects
- Of 84 CSO outfalls:
 - 34 closed
 - 5 with 25-year level of control
 - 41 reduced to a minimal number of annual discharges
 - 4 treated
- 3.3 Billion gallons / year in 1988
- 1.5 Billion gallons / year in 1992, 51% treated
- 0.4 Billion gallons / year, 93% treated at program completion

Overview of Post-Construction Monitoring and Performance Assessment

- Required by Federal District Court Boston Harbor case
- CSO performance assessment must demonstrate compliance with CSO LTCP levels of control
- Compliance to be demonstrated through:
 - Collection system monitoring data (flow and level)
 - Updated collection system modeling (InfoWorks ICM)
 - Water quality assessments (data collection and modeling)
- Work began in November 2017
- Completion scheduled for December 31, 2021

North Dorchester Bay Tunnel System



North Dorchester Bay Tunnel System – Key Statistics

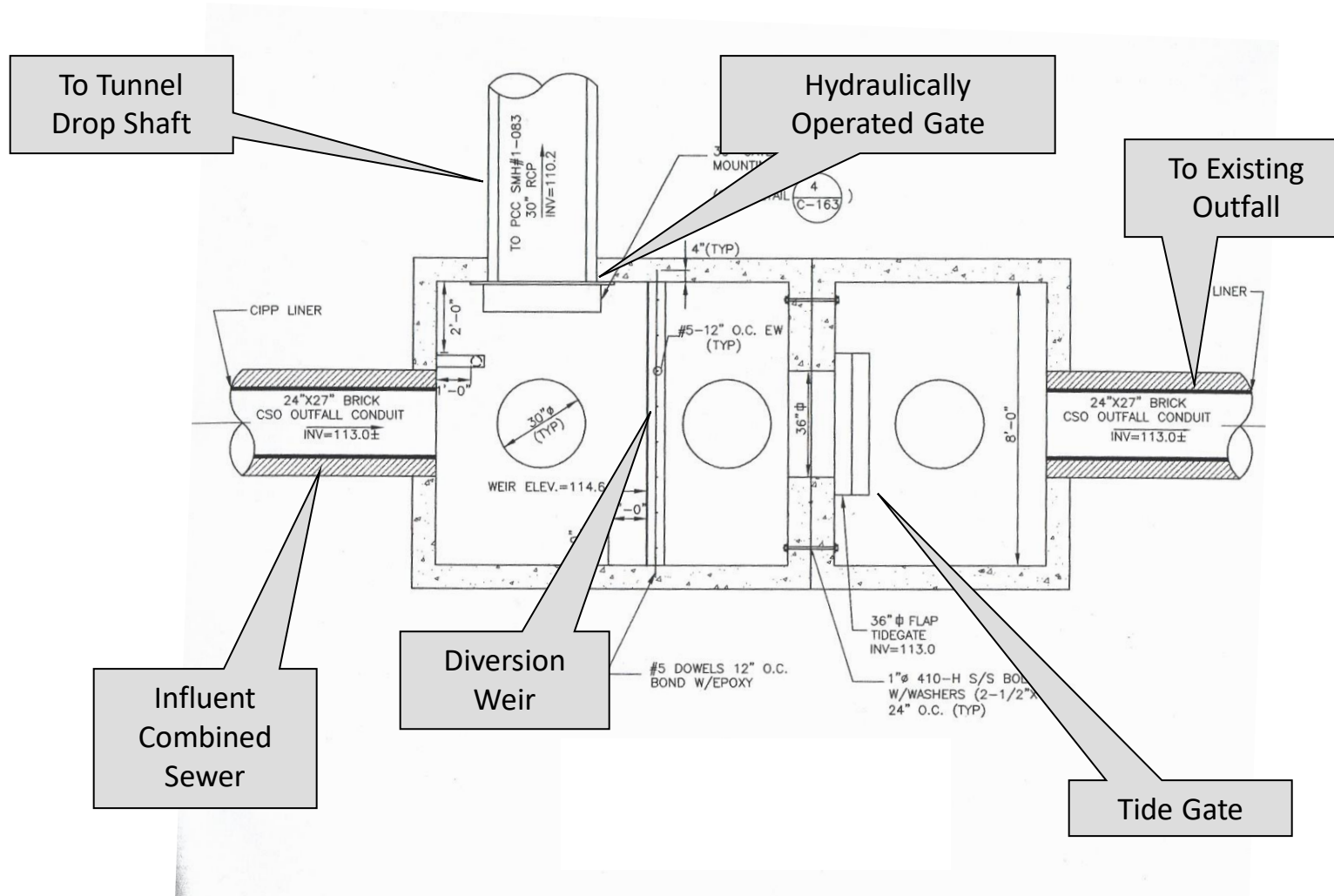
- \$228.4 Million
- May 2011 completion date
- 10,832 ft. long
- 17 ft. inside diameter
- Mined in soft ground
- 6 CSO & stormwater diversion structures
- 15 MGD dewatering pump station
- 24-inch dewatering force main
- Below-grade odor control facility



North Dorchester Bay Tunnel System Operation – Design Intent

- Eliminate CSO discharges to South Boston Beaches in up to 25-year, 24-hour storm
- Control stormwater discharges to South Boston Beaches in up to 5-year, 24-hour storm
- Control stormwater discharge from outfall BOS 087 in up to 1-year, 24-hour storm
 - Capture first 1 MG “first flush” stormwater, with rest discharged to Morrissey Blvd. Drain
- Pump out tunnel during & after storms, as interceptor capacity allows
- Operate diversion structure gates and dewatering pump station via operational strategy designed to meet LTCP goals and maximize available storage capacity

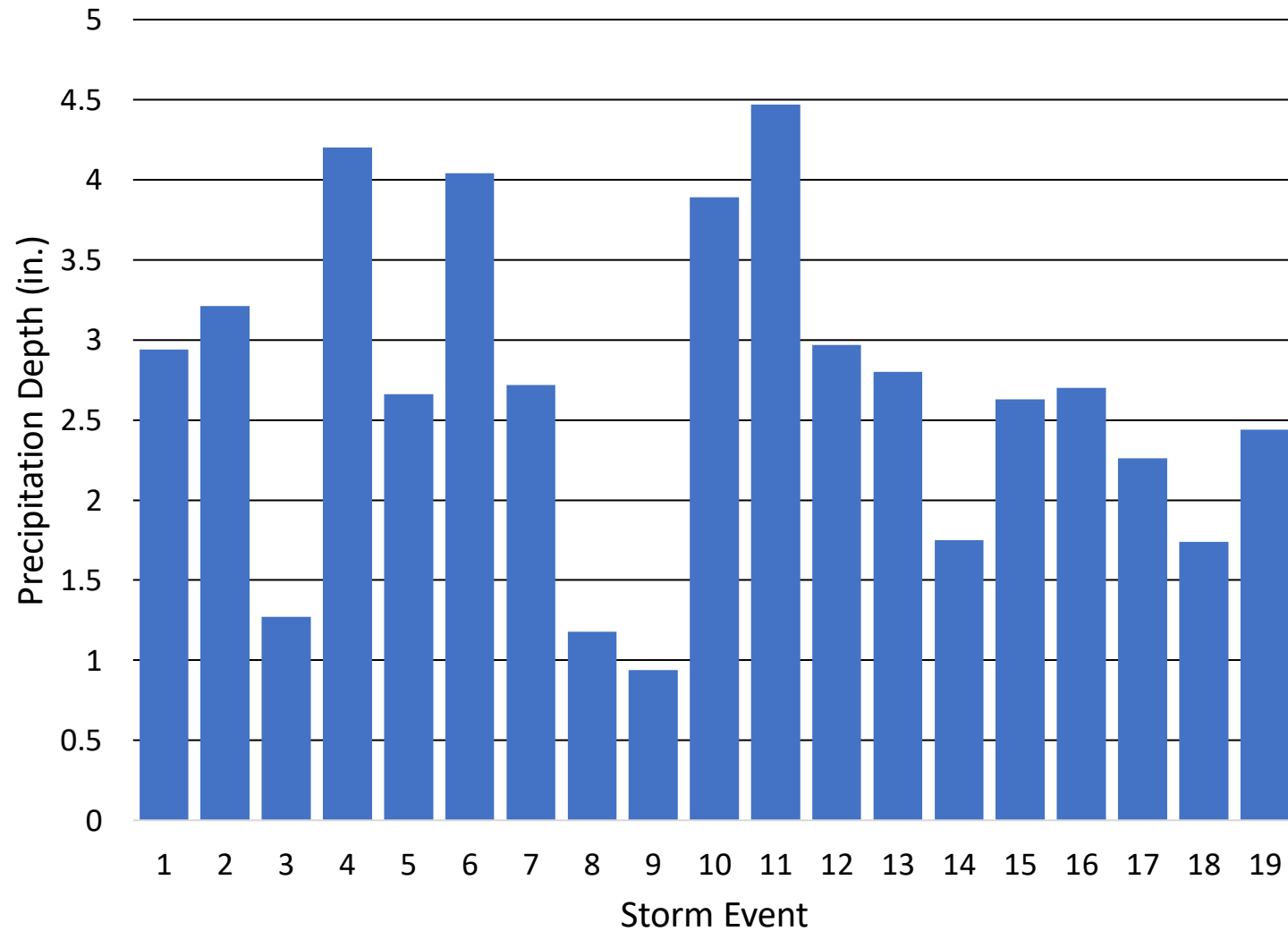
Typical CSO Diversion Structure



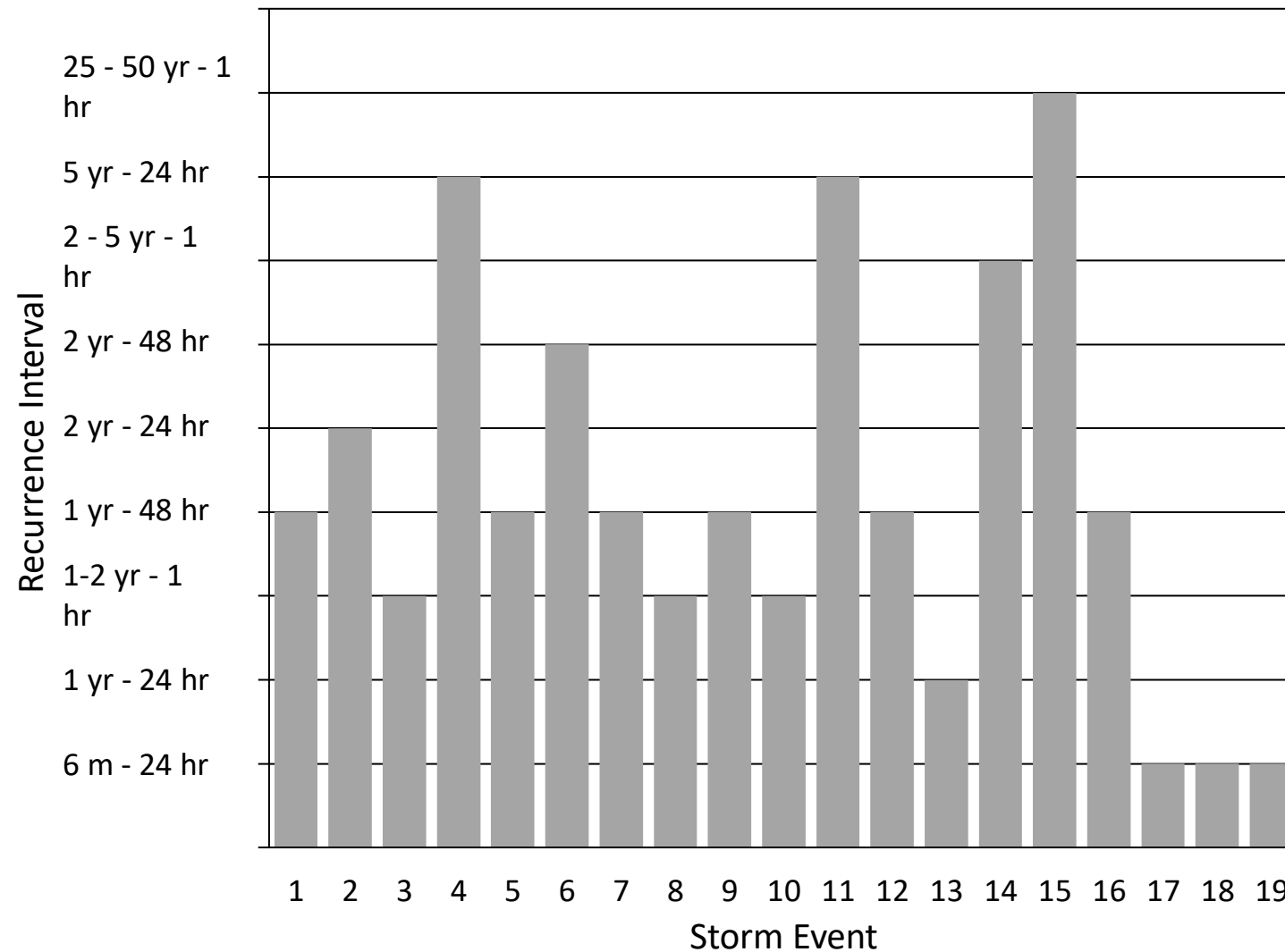
Post-Construction Assessment Approach

- Date range: May 2011 to December 2018
- Analyzed rainfall records and storm event data from sensors installed throughout tunnel system
- Data obtained from MWRA SCADA system
- Selected larger events (approx. 1-year recurrence interval or larger) for analysis
- 19 events identified

Rainfall Depth for Selected Events



Recurrence Interval for Selected Events



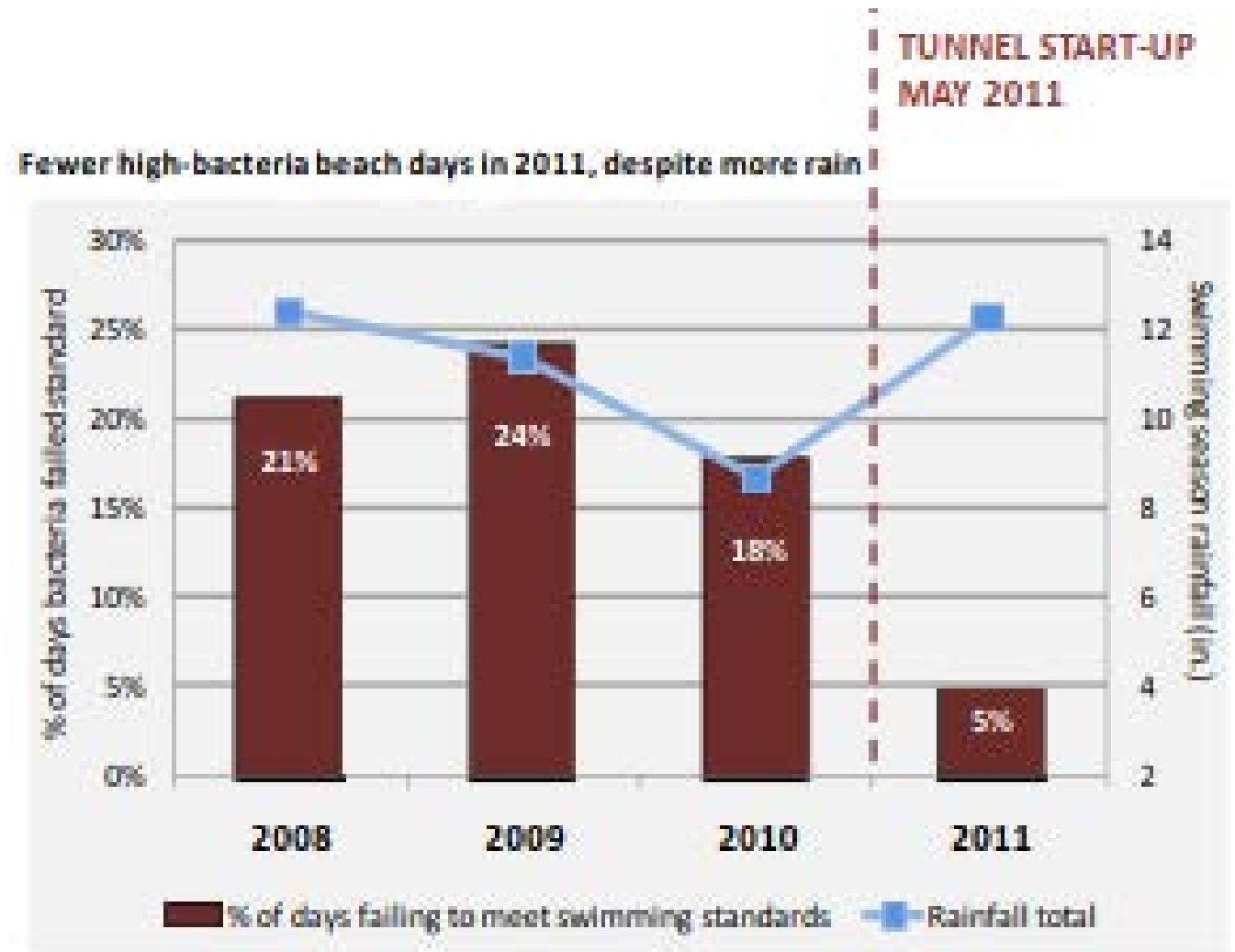
Sensor Locations Analyzed

- Diversion structures (BOS 081, 082, 084, 085, 086, and 087)
 - Both CSO and stormwater diversion structures
 - Stormwater diversion only at BOS 087
- Dewatering pump station
- South Boston Interceptor
- Regulator RE-082 (receives dewatering discharge)



Types of Data Gathered & Analyzed

- Level
- Flow
- Locations selected based on review of MWRA NDB Tunnel Control Strategy and operation manuals



Data Analysis

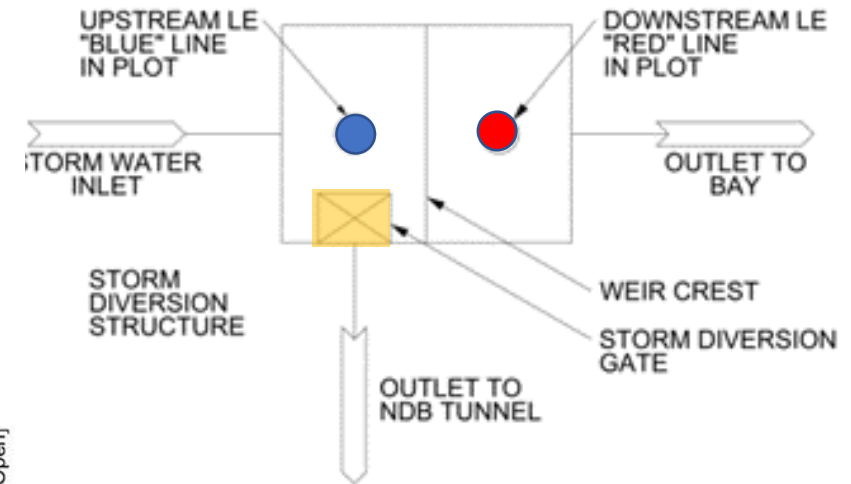
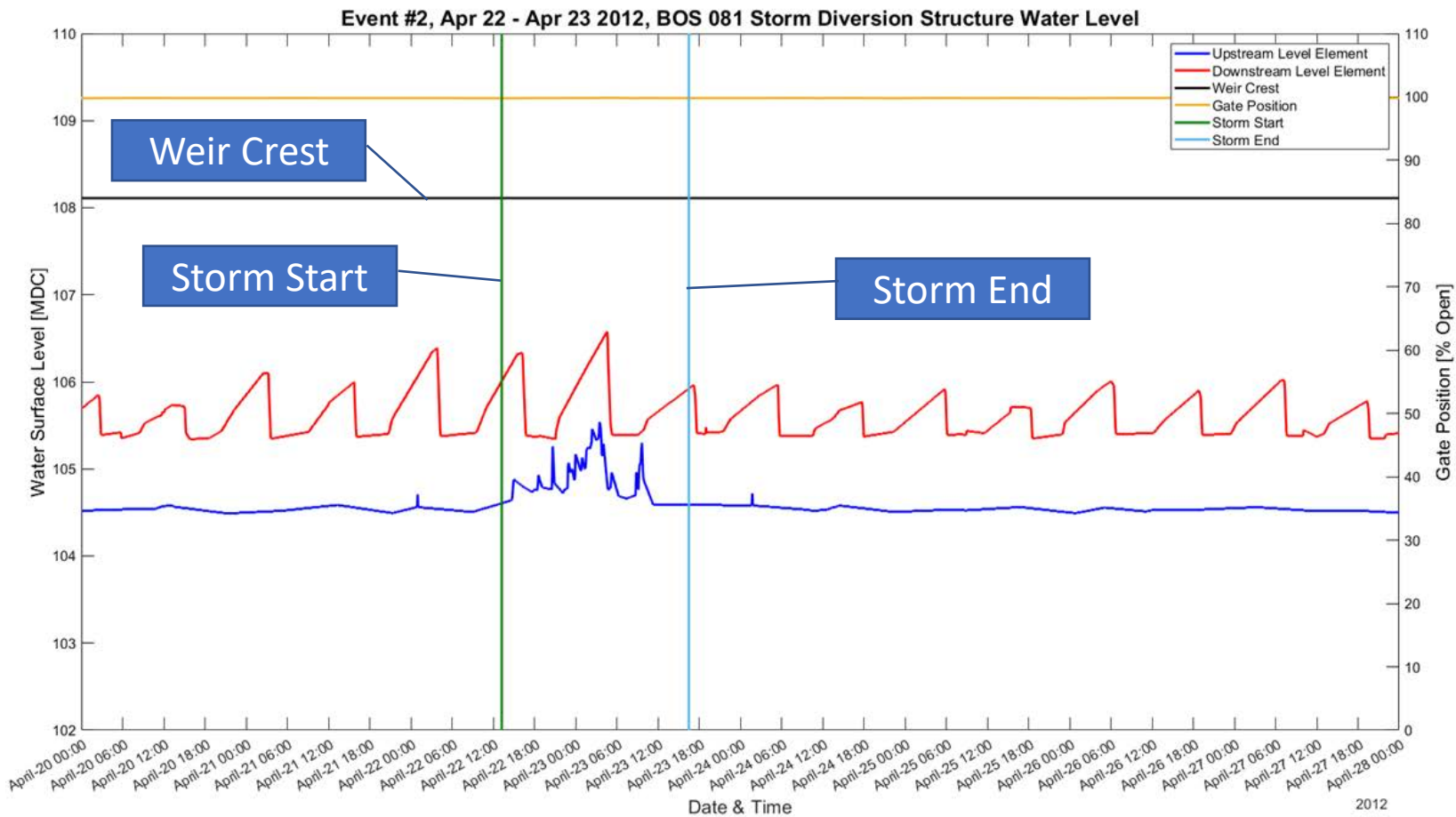
- MathWorks MATLAB software used to process data and generate plots for system assessment
- Plots prepared for all 19 storms and for all locations
- Compared measured data to:
 - Physical constraints (e.g., liquid level vs. weir height in diversion structure)
 - Operational decisions (e.g., sufficient pumping to maintain tunnel storage volume)
- Enabled assessment of overall tunnel system performance

Results

- Plots showed consistent performance, meeting:
 - LTCP requirements
 - Tunnel system performance expectations
- With two 5-year, 24-hour events, demonstrated tunnel system meets 5-year, 24-hour CSO + stormwater requirement
- System data & operational records extrapolated to demonstrate tunnel system meets 25-year, 24-hour CSO storage requirement

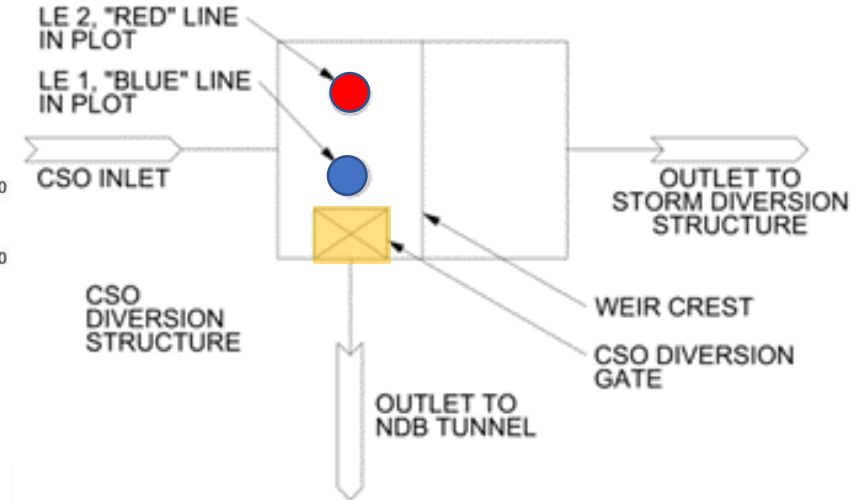
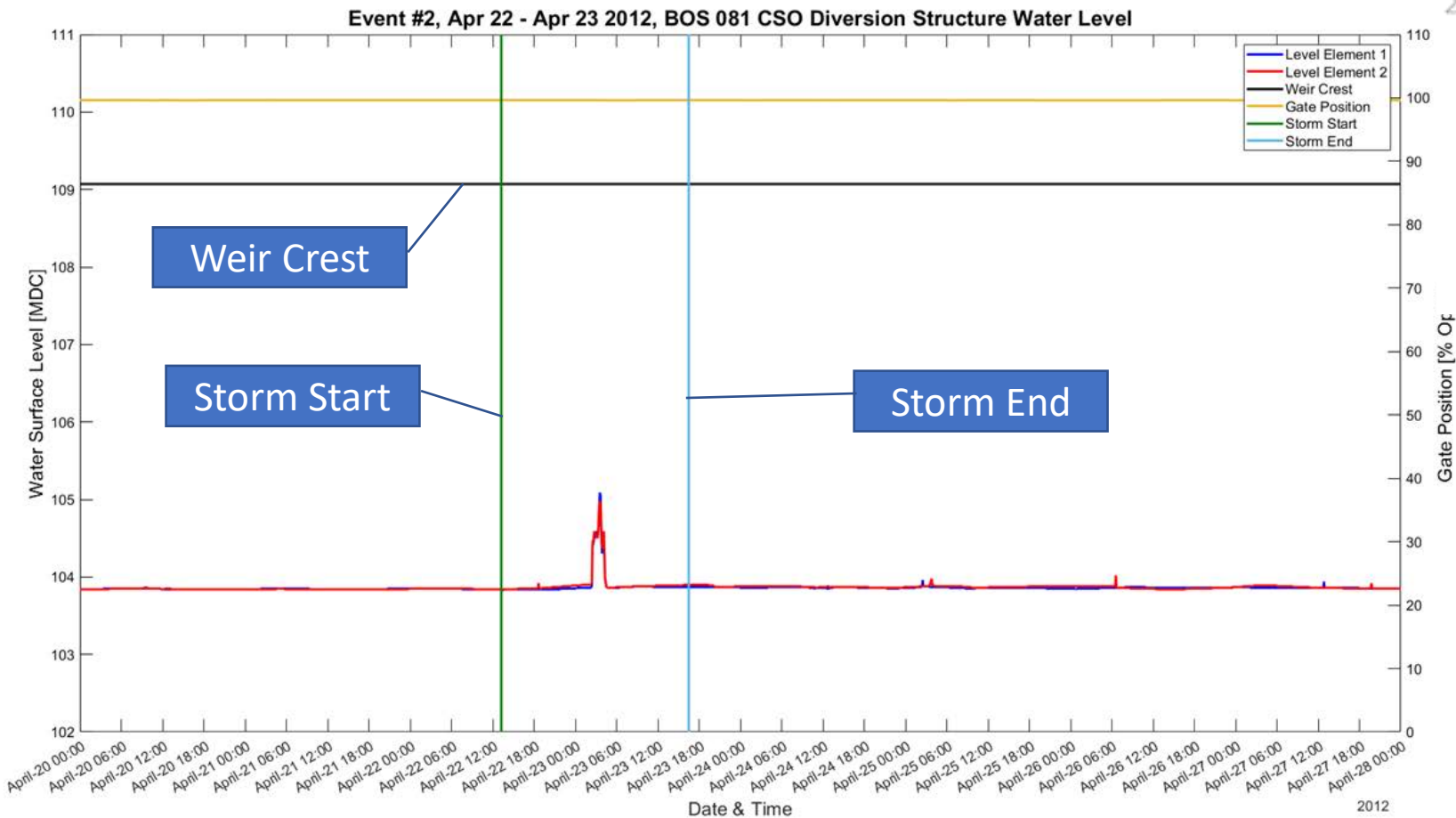


Event #2 – BOS 081 Stormwater Diversion Structure Water Level



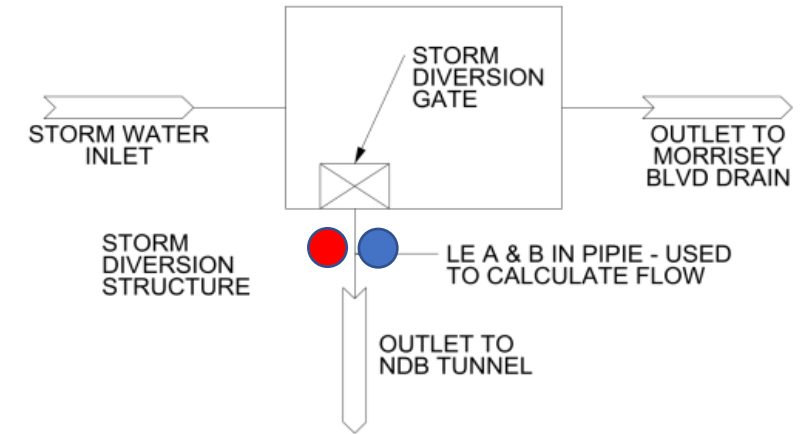
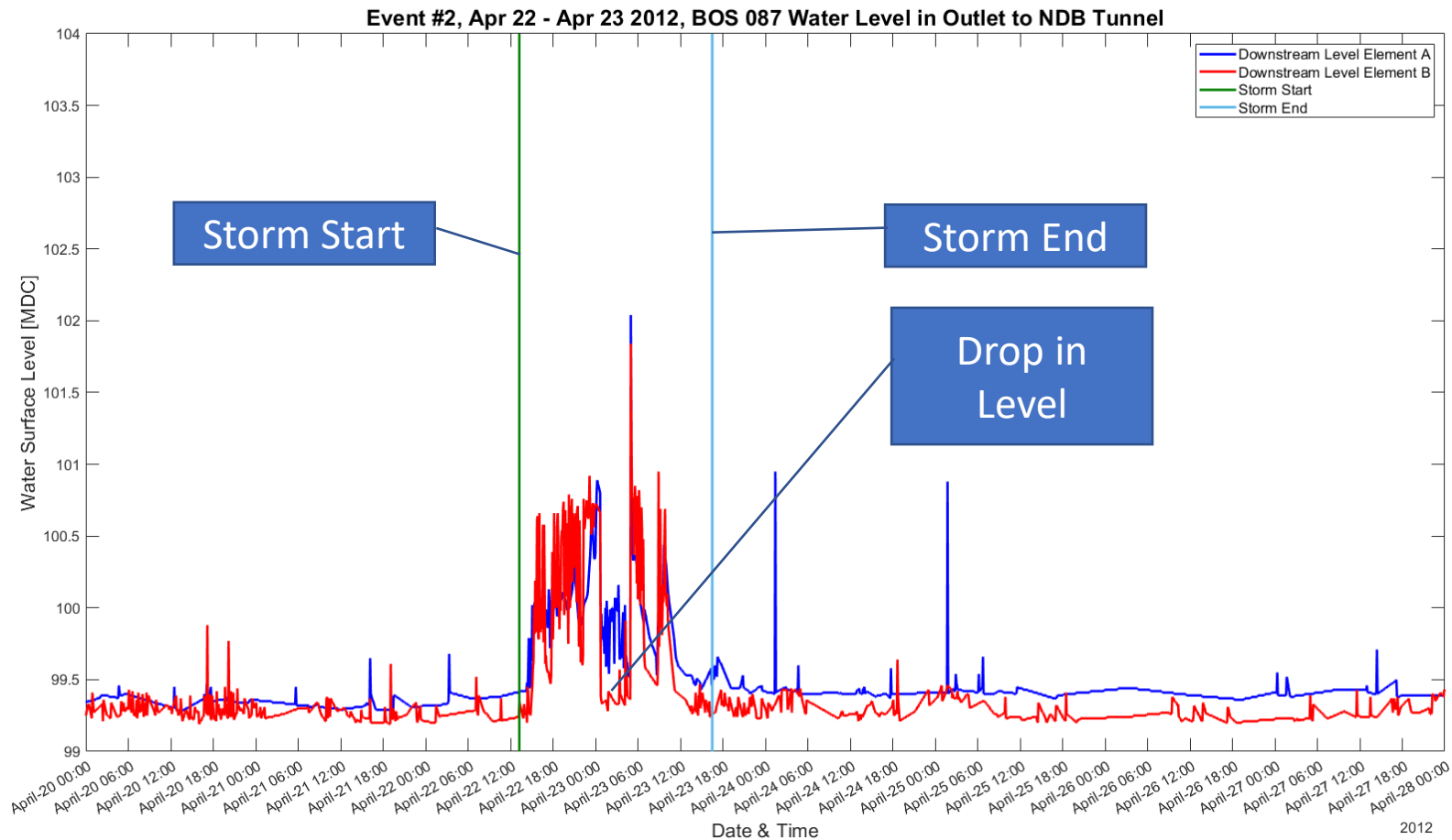
- Tide remains below weir
- Gate remains open
- All stormwater enters tunnel

Event #2 – BOS 081 CSO Diversion Structure Water Level



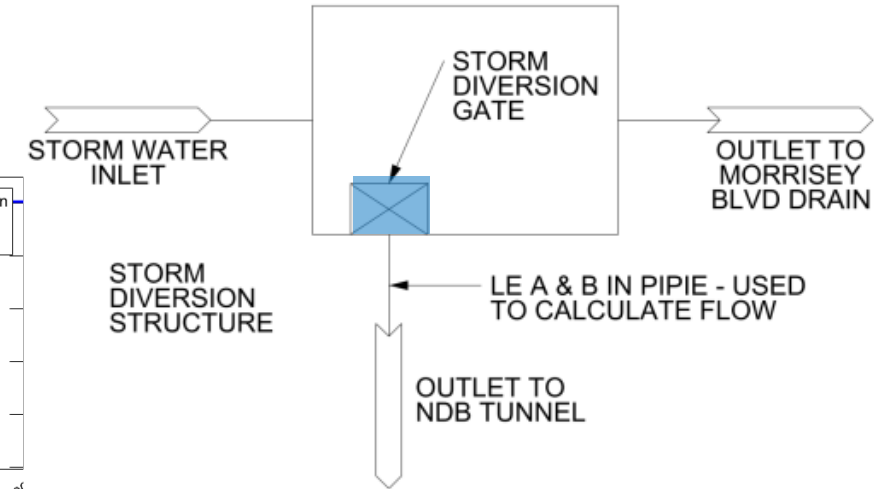
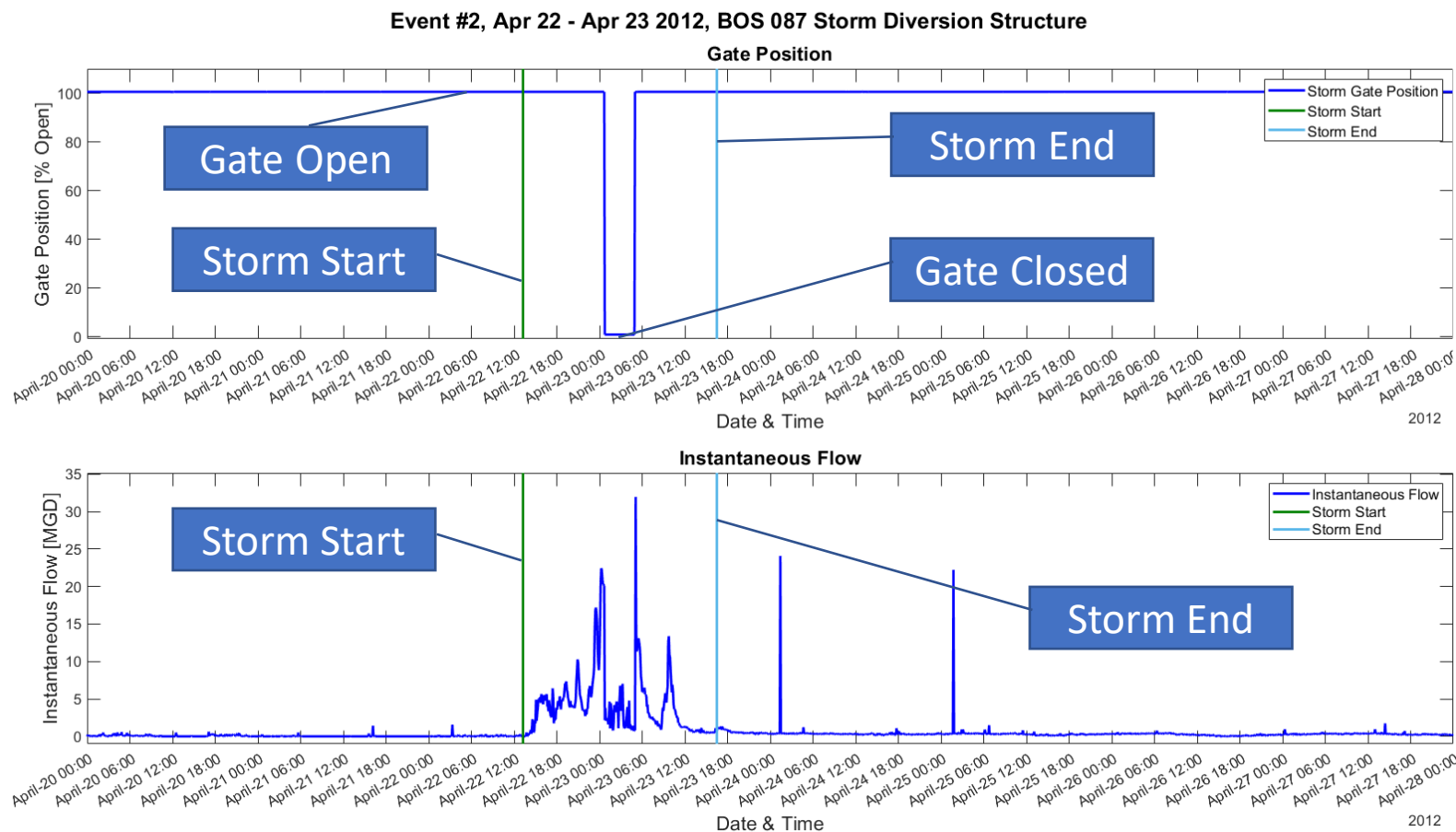
- Level elements tracking consistently
- CSO depth below weir and enters tunnel

Event #2 – BOS 087 Water Level in Outlet to NDB Tunnel



- Level elements tracking well
- Level drops for about 5 hours

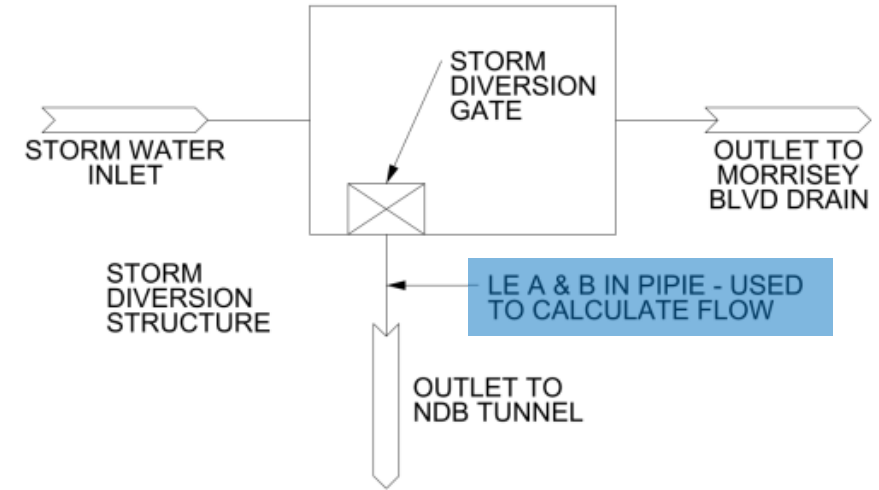
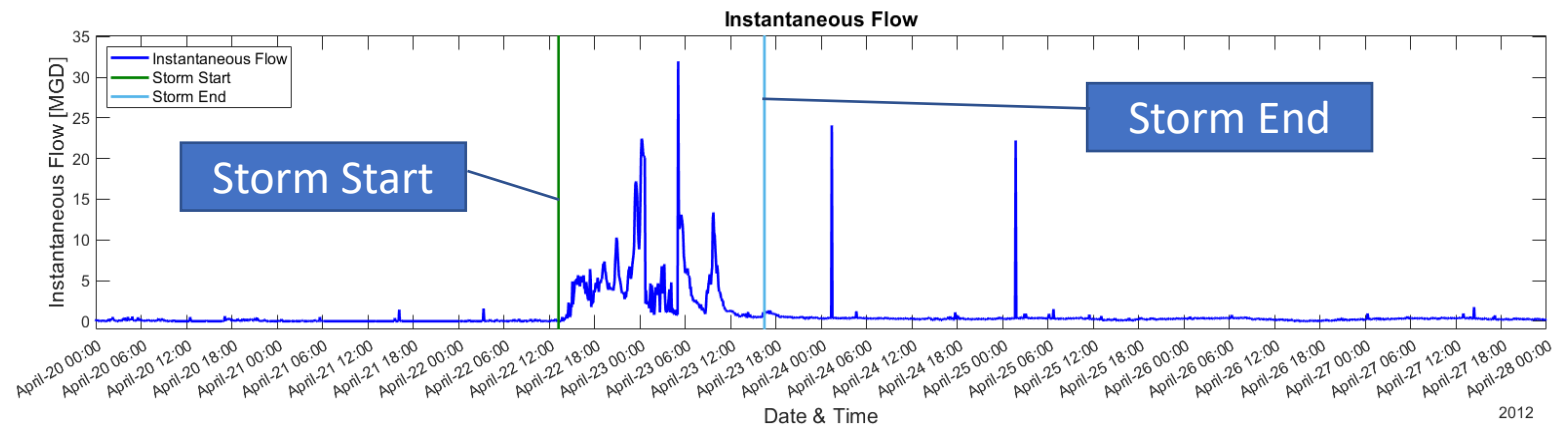
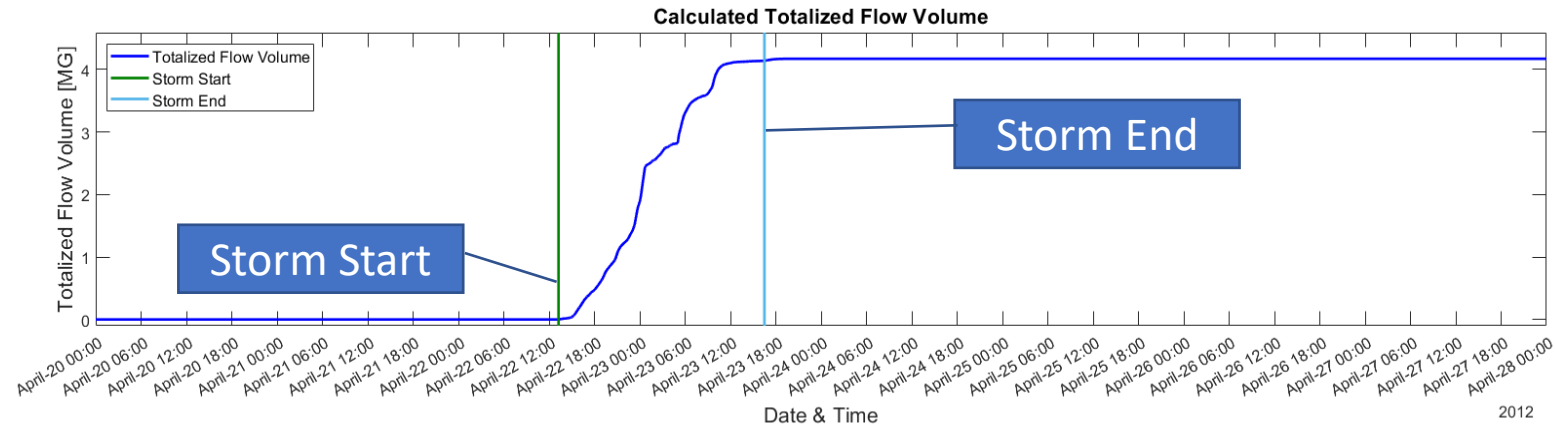
Event #2 – BOS 087 Stormwater Diversion Structure Gate Position & Instantaneous Flow



- Drop in level (and computed flow) coincides with gate closure
- Non-zero flow due to sensor noise

Event #2 – BOS 087 Stormwater Totalized & Instantaneous Flow

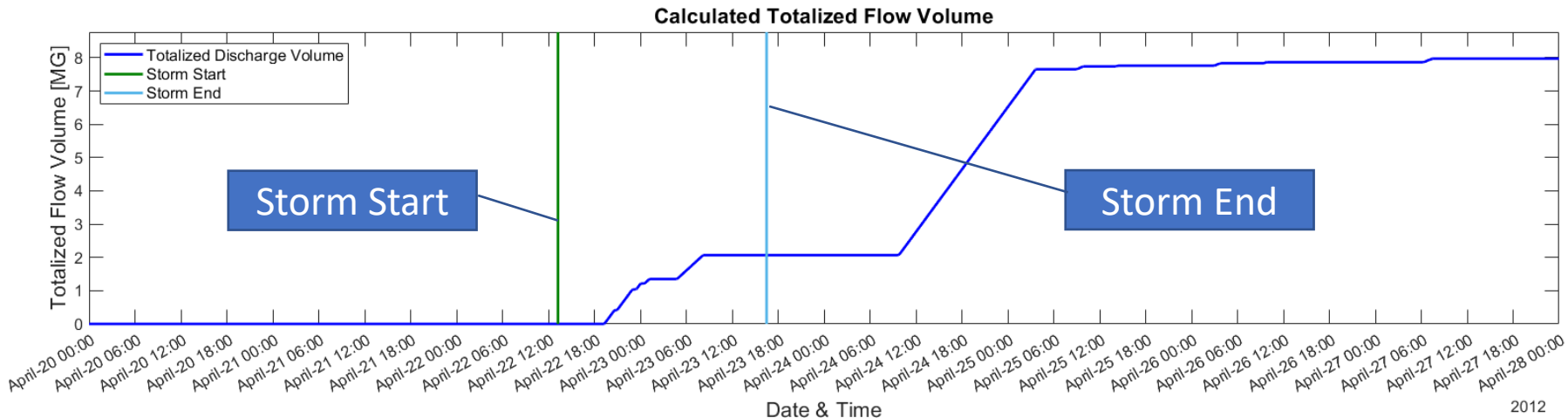
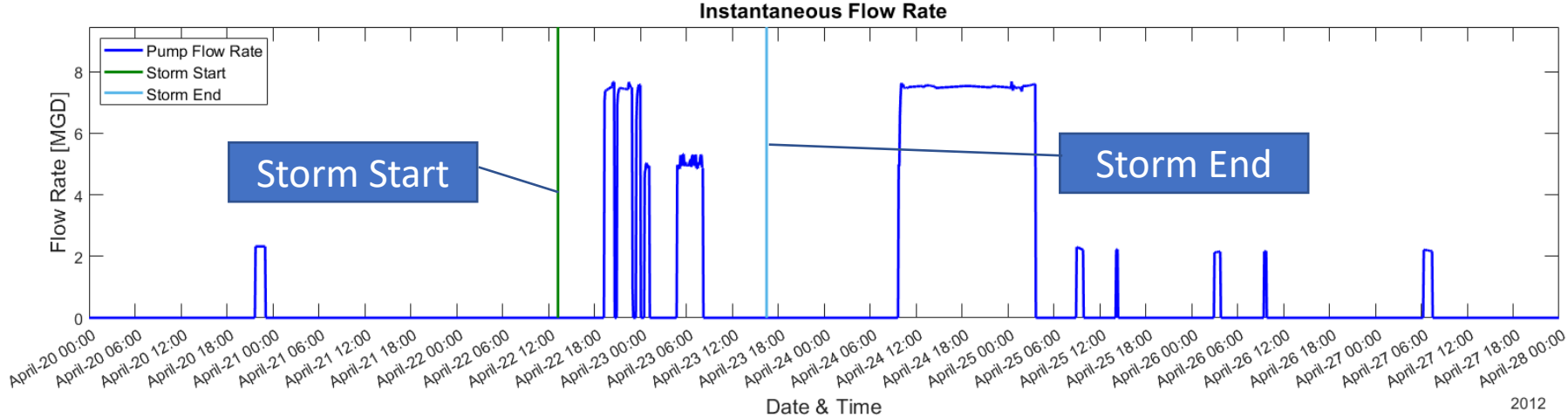
Event #2, Apr 22 - Apr 23 2012, BOS 087 Storm Diversion Structure



- About 2.4 MG admitted to tunnel when gate closed – exceeded first flush requirement
- Over 4 MG total admitted
- MWRA uses BPJ to optimize gate position

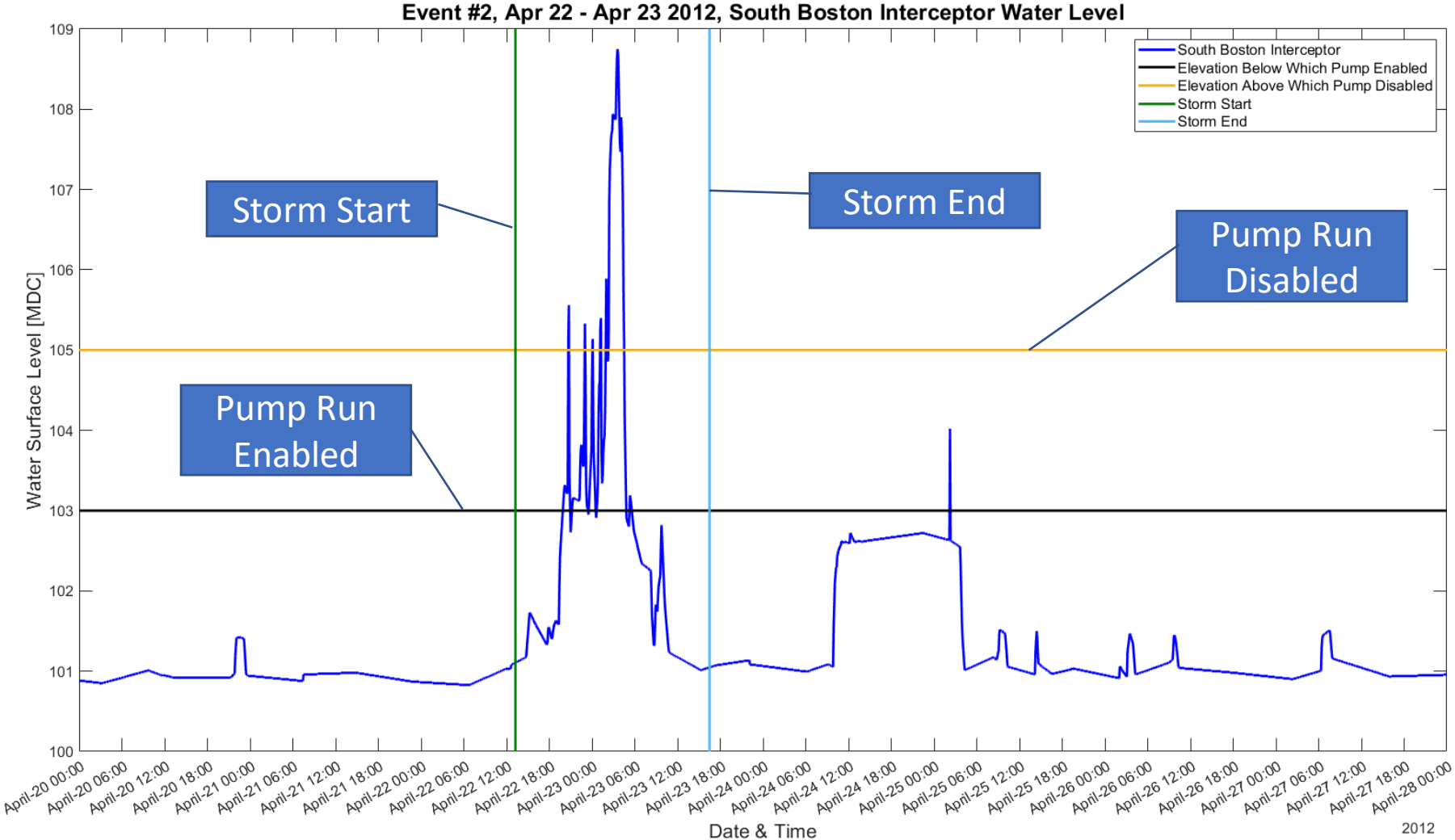
Event #2 – Dewatering P.S. Flow

Event #2, Apr 22 - Apr 23 2012, Dewatering Pump Station Discharge Flow



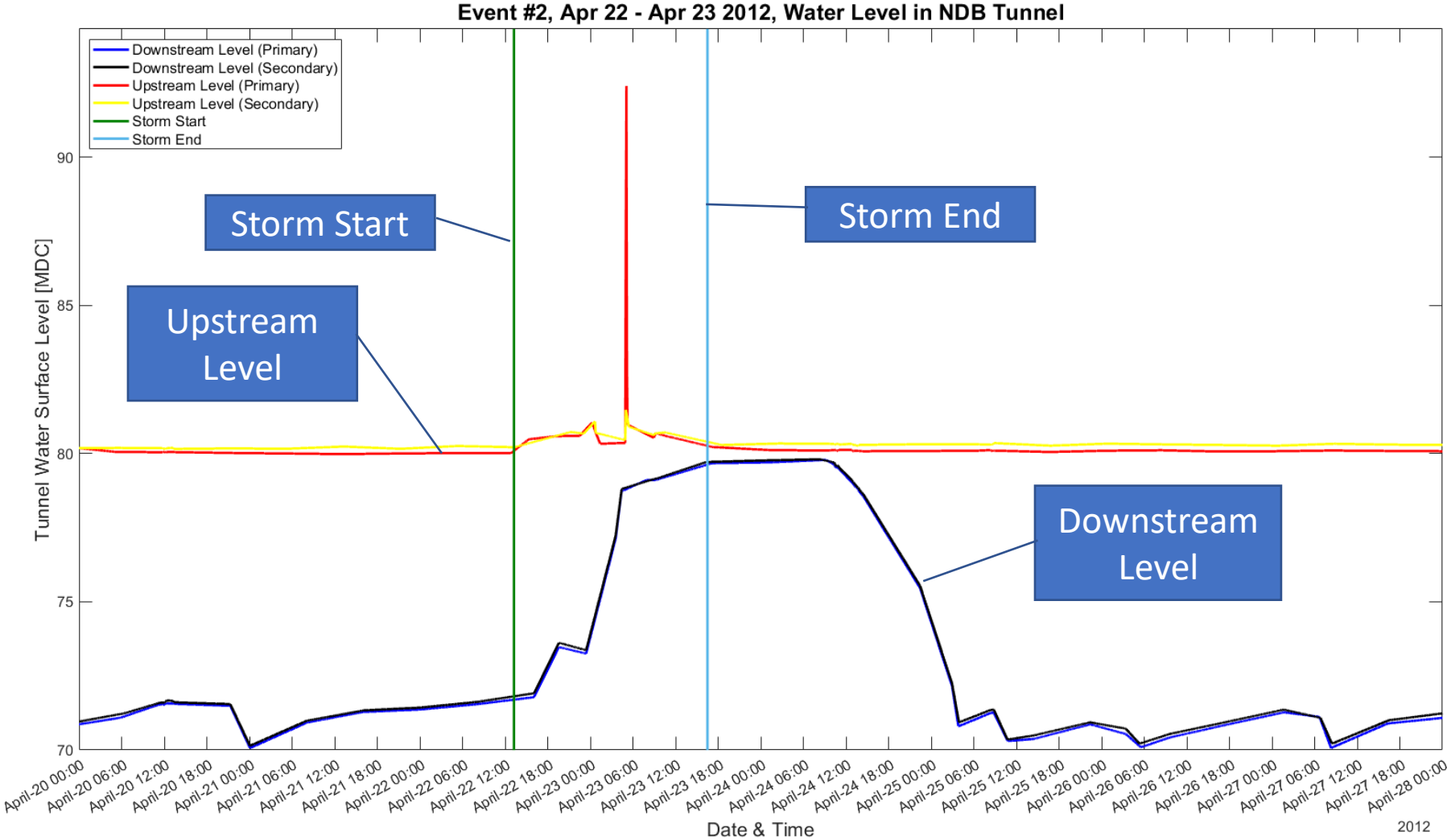
- Pumping occurred during event as SBI capacity available
- About 7.7 MG pumped for this event

Event #2 – SBI Water Level



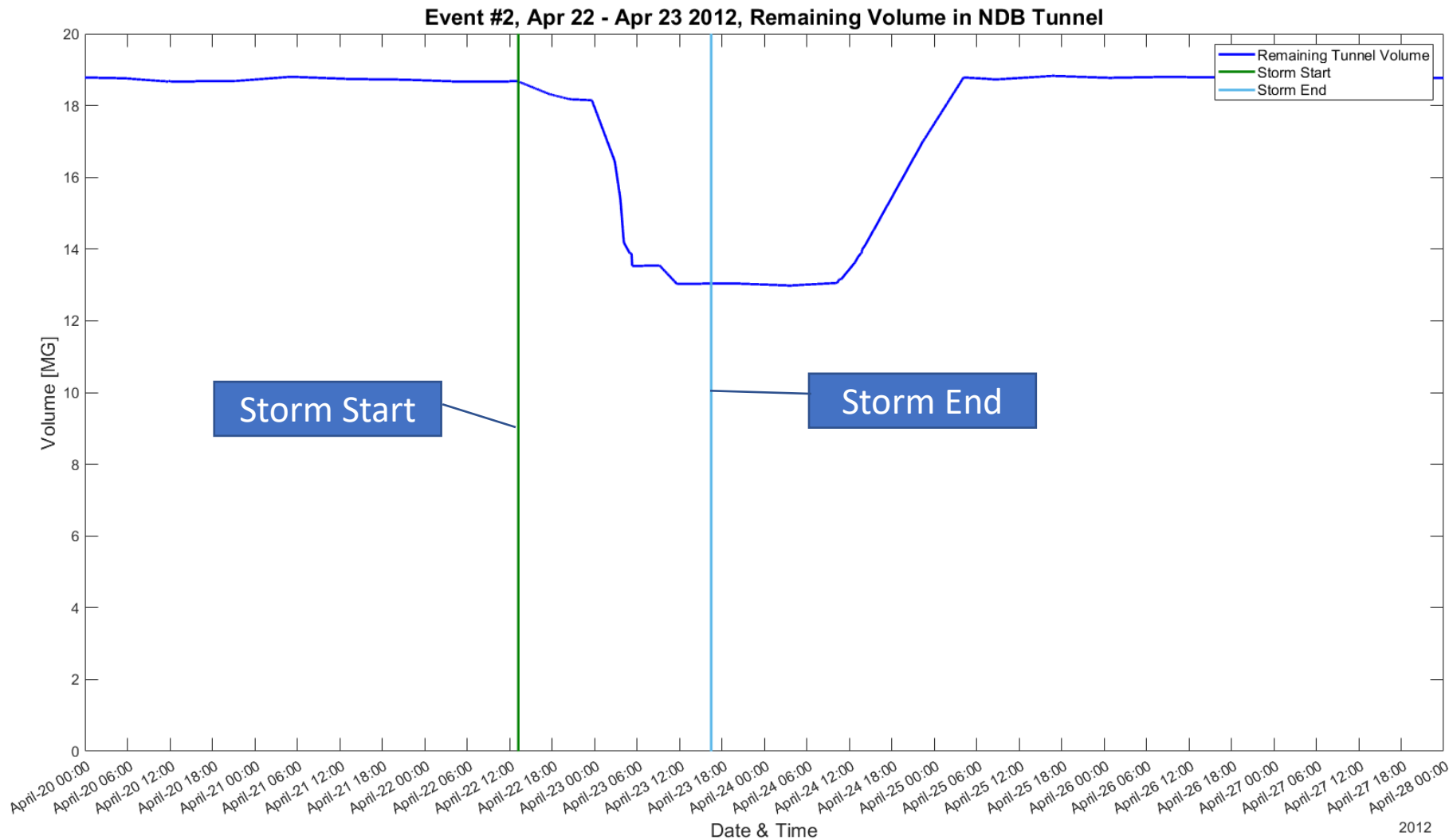
- Note pump starts/stops due to high SBI level
- Note pump enabled early & late during event
- Note 2 ft dead band between pump enabled & disabled

Event #2 – Tunnel Water Level



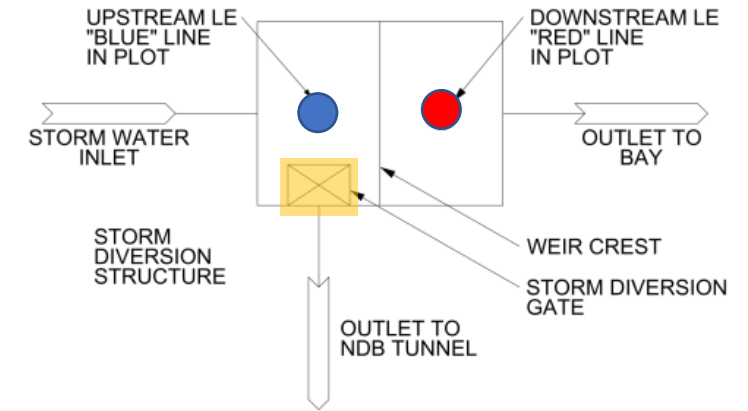
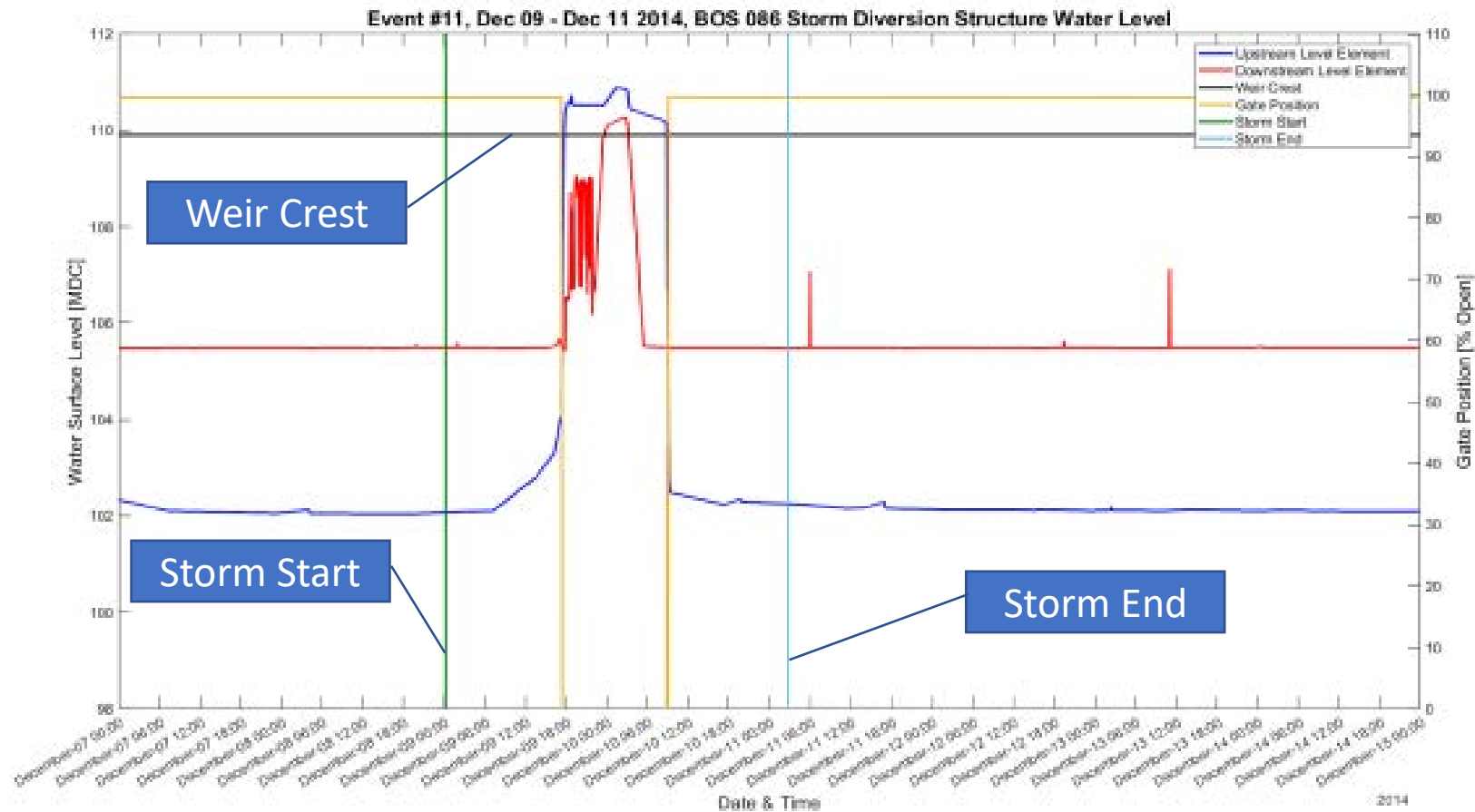
- Drop in downstream level due to dewatering during event
- Spike in upstream level due to BOS 087 flow interfering with sensor

Event #2 – Remaining Tunnel Volume



- Remaining volume varies inversely with tunnel level
- Returns to full capacity at end of pump-out

Event # 11 – BOS 086 Stormwater Diversion Structure Water Level



- Event # 11 – 5-yr. storm
- Atypical, but appropriate response: stormwater gate closed and weir over-topped

Demonstration That NDB Tunnel Meets 5-Yr, 24-Hr and 25-Yr, 24-Hr Storage Requirements

- With two 5-year, 24-hour events, data used to demonstrate attainment of 5-year, 24-hour CSO + stormwater requirement
- Since a 25-year, 24-hour event did not occur during period of data analysis, system data & operational records extrapolated to demonstrate requirement was met
 - Used design data to compute incremental CSO volume between 5-year, 24-hour and 25-year, 24-hour events (7.3 MG)
 - Used data from event Nos. 4 & 11 (5-year, 24-hour events) to compute available tunnel volume
 - Adjusted for volume dewatered & BOS 087 stormwater stored
 - Computed available tunnel volume > 7.3 MG, demonstrating 25-year, 24-hour CSO storage requirement was met

Conclusions and Recommendations

- Based on recorded performance in selected events NDB Tunnel meets performance goals
- Operational strategies implemented are consistent with design intent
- NDB Tunnel attains LTCP CSO and stormwater levels of control
- Routine repair needs identified are continuously being addressed



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