



Flood Planning and Forecasting: Learning from Hurricane Sandy in New York

Benjamin J. Hwang, P.E. – WorleyParsons
Water Technologies Symposium (WaterTech 2014)
April 10, 2014

Contents / Today's Objectives

Utility Flood Protection

- Past
 - Impact of Super Storm Sandy
- Future
 - Resiliency Approach / Strategy
 - WaterRIDE Modeling
- Bridging the Gap to Tomorrow
 - Mitigation for Today
 - Lessons Learned

The Impact



- High, sustained winds combined with extreme flooding
- Unprecedented devastation
 - Significant tree, pole, wire and electrical facility damage
 - Severe flooding across LI's south shore / Rockaway Peninsula
 - ~90% of 1.1 million customers without power
 - Nor'easter 9 days later brought ~123k additional electrical outages
- Homes and businesses destroyed, including many employees involved in restoration

Damage Comparisons - Irene versus Sandy with November Nor'easter

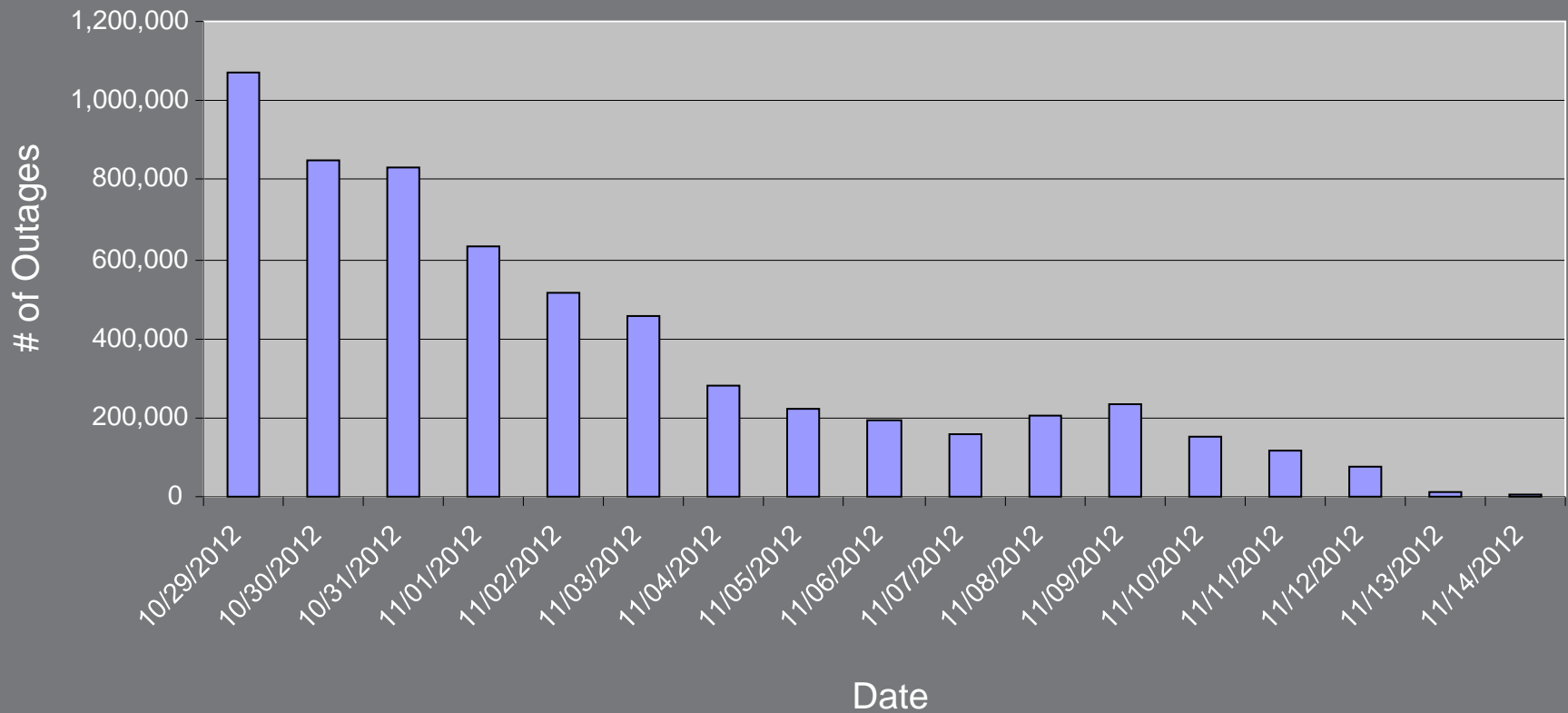


Tropical Storm Irene		Hurricane Sandy/Nor'easter
18,926	# Jobs	~ 40,000
523,000	# Customers Affected	1,194,000
61	Transmission Lines Damaged	137
22	Substations Affected	51
175	Distribution Lock-outs	455
2,700	High Voltage Linemen	5,918
1,300	Tree Trimmers	3,600
8	Days to Restore	16
1,196	Poles	4,400
1,320	Transformers	2,500
2,844	Cross Arms	7,600
241	Miles of Wire	426

Daily Customer Outages



Customers Out of Service



Past

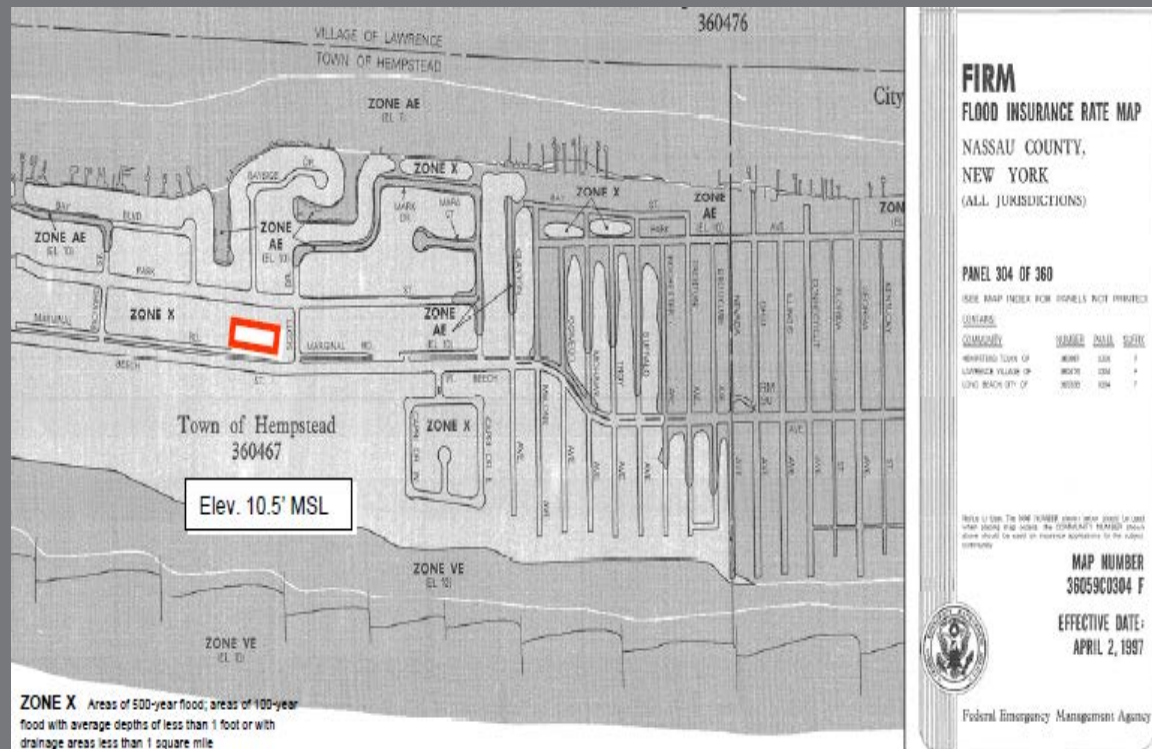
Present
(Bridge)

Future

Hurricane Sandy High Water Marks

FEMA Flood Maps

Substation	Lowest Grade Elevation	Hurricane Sandy High Water Mark
Arv	4.1'	10.2'
Atl	8'	10.62'
Bar	7.9'	9.4'
Cap	3.5'	4'
Fai	4.7'	6'
Far	5.1'	9.8'
Fir	12' ³	Dry
Lon	5.3'	9.1'
Nep	8.4'	11.54'
Oce	2.8'	5.7'
Par	4.2'	9'
Rob	14' ³	Dry
Roc	6.1'	10.9'
Woo	6.1'	8.6'



Note: Substation names are masked to maintain confidentiality

Project Overview

Past

Present
(Bridge)

Future

Flood Plain Project

During the recent Superstorm Sandy, a number of substations suffered unprecedented damage resulting from higher than anticipated flood water levels. The scope of work includes:

- Identification of the Flood Hazards in the service territory using the most current data, and defining the 100, 500 and 1,000 year flood zone elevations
- Industry recommendations for Coastal Utilities based on the recent past weather events in the US
- Modeling software that could be used locally to help predict flooding for our properties based on weather forecasts

Sandy Flood Impact Zone



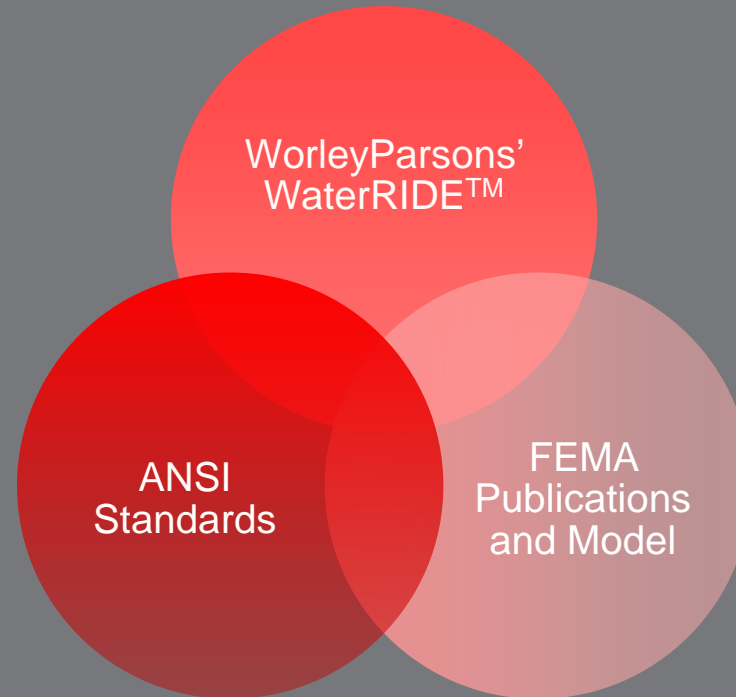
Source - FEMA

Resiliency Approach / Strategy



Engineering References

- Federal Sources
 - Executive Order 11988
 - FEMA Design Guide 543
- American Engineering Standards
 - ASCE 24-05
 - ASCE 7-10
- WorleyParsons WaterRIDE™ Model
 - Independent Assessment
 - Extrapolations to 1700-year Flood Return



Resiliency Approach / Strategy

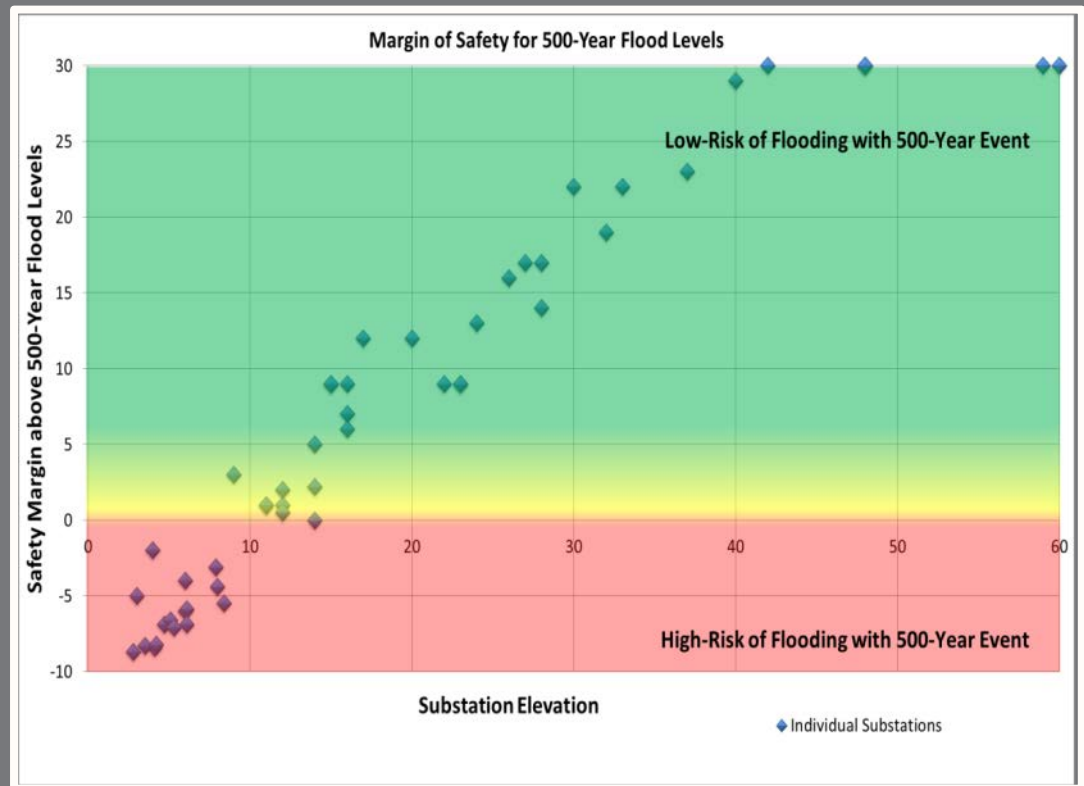
Past

Present
(Bridge)

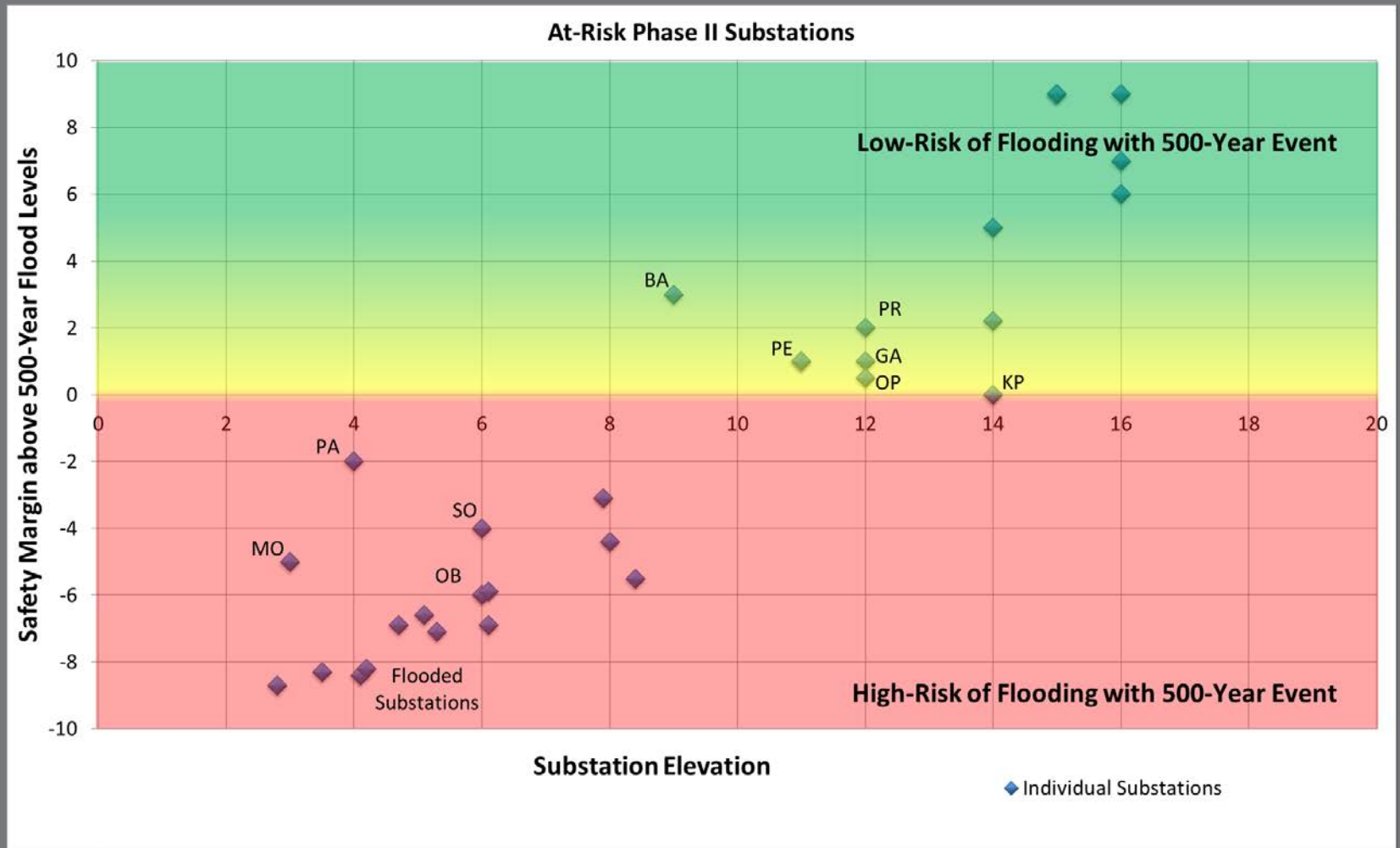
Future

WaterRIDE™ Software

- Independent Review and Verification
 - Numerous Revisions to FEMA Flood Maps
- Extrapolations for other return periods, 50-Year, 1000-Year, 1700-Year
 - Provide a frame of reference
 - Potential for marginal increase in capital expenditure for reduction in risk



Resiliency Approach / Strategy



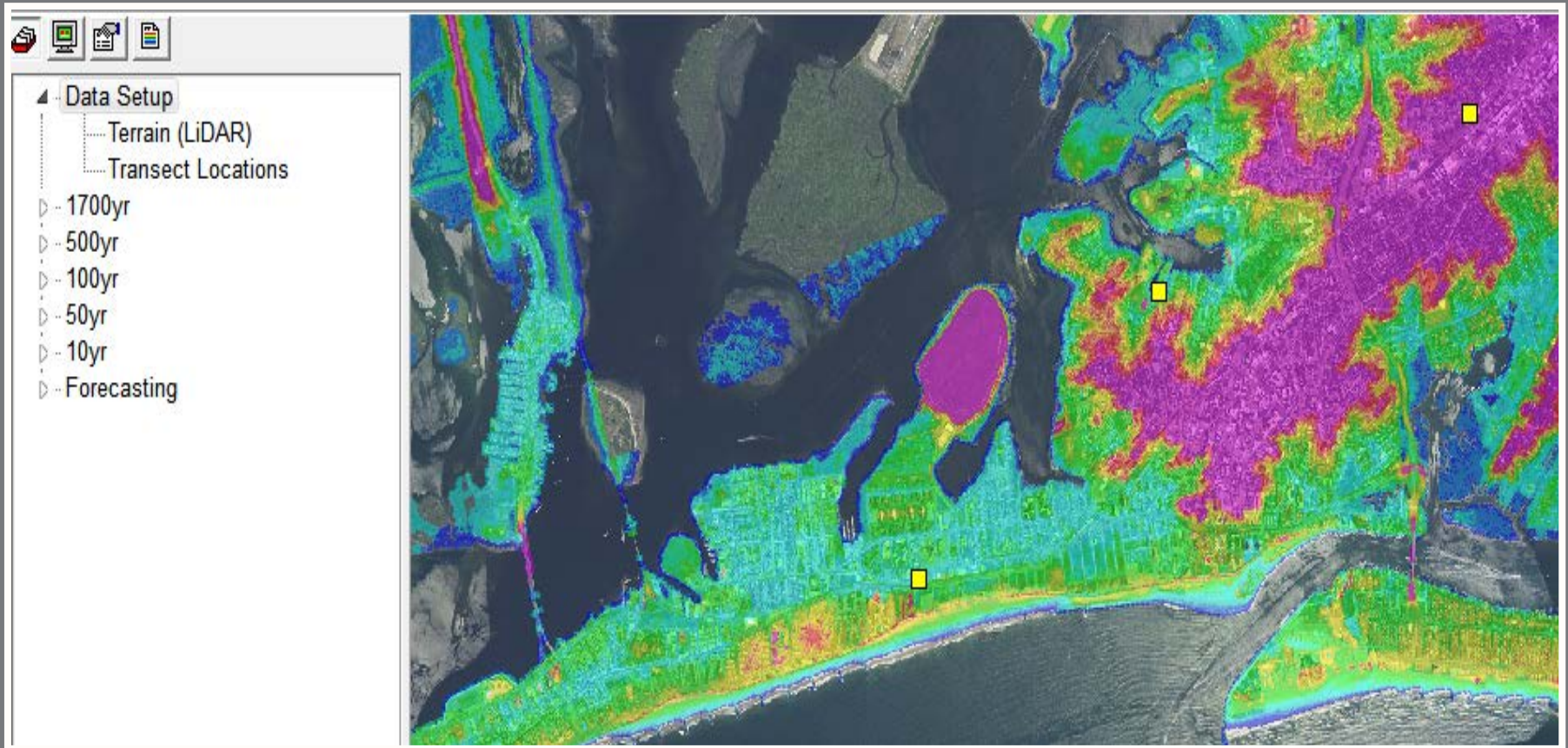
Note: Substation names are masked to maintain confidentiality

Project Deliverables

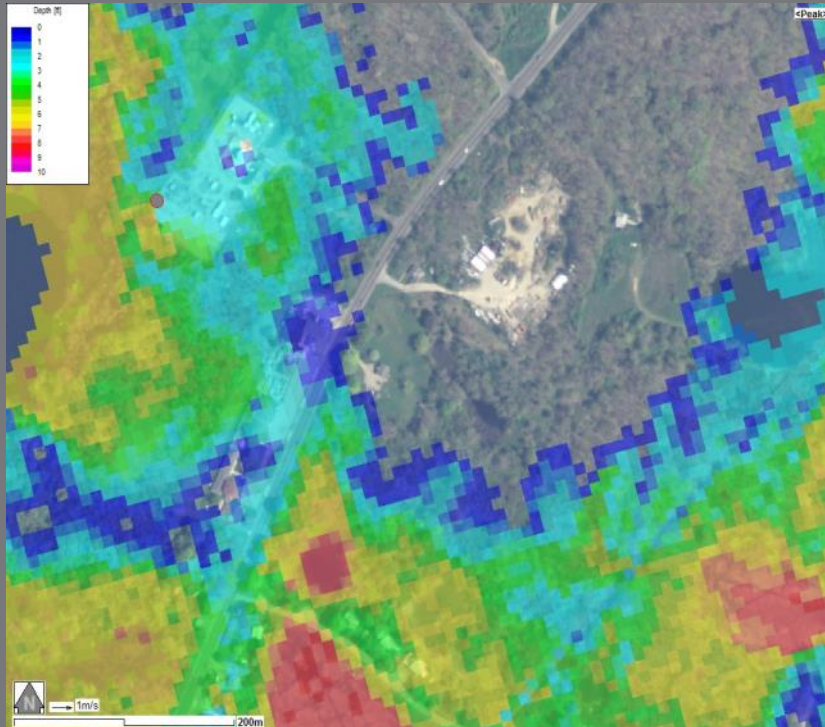
Past

Present
(Bridge)

Future



Project Deliverables



WaterRIDE™

Design Tool

- Various Flood Return Levels for Design Criteria
- Evacuation / Emergency Planning

Real-time Operations Tool

- Forecast Tool using Expected Storm Surge Heights
- Instant Text Messages if Approaching Critical Levels at Substations

Past

Present
(Bridge)

Future

Mitigation for Today

Temporary Protection



Past

Present
(Bridge)

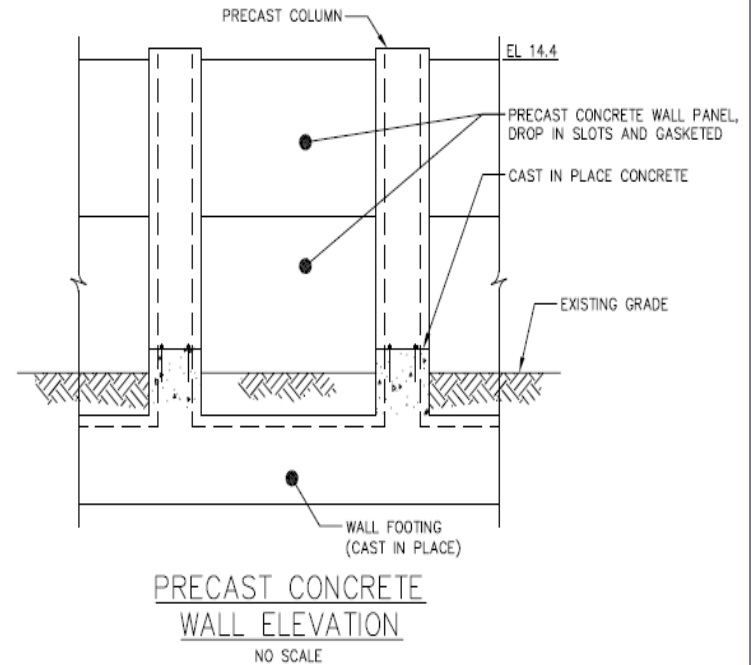
Future

Mitigation for Today

Permanent Protection



- Elevating Critical Equipment



- Alternative to raising equipment



Lessons Learned



Future Resiliency for Canada

- Now
 - Research Public Sources – Starting Data Points
 - Determine Alarm Flood Levels for Critical Equipment
 - Utilities – Transformer cabinets, switchgear
 - Public Services – Hospital back-up generators, electric feeds to first responders
- Near Future
 - Independent Assessment of Flood Levels
 - Annual Emergency Drills - coordinated emergency plans between public services and utilities
 - Update Design Standards (new substations, new municipal buildings)

Past

Present
(Bridge)

Future

Moving toward the Future



Questions for Future Mitigation