Engineering and Operational Risk and Reliability Analysis

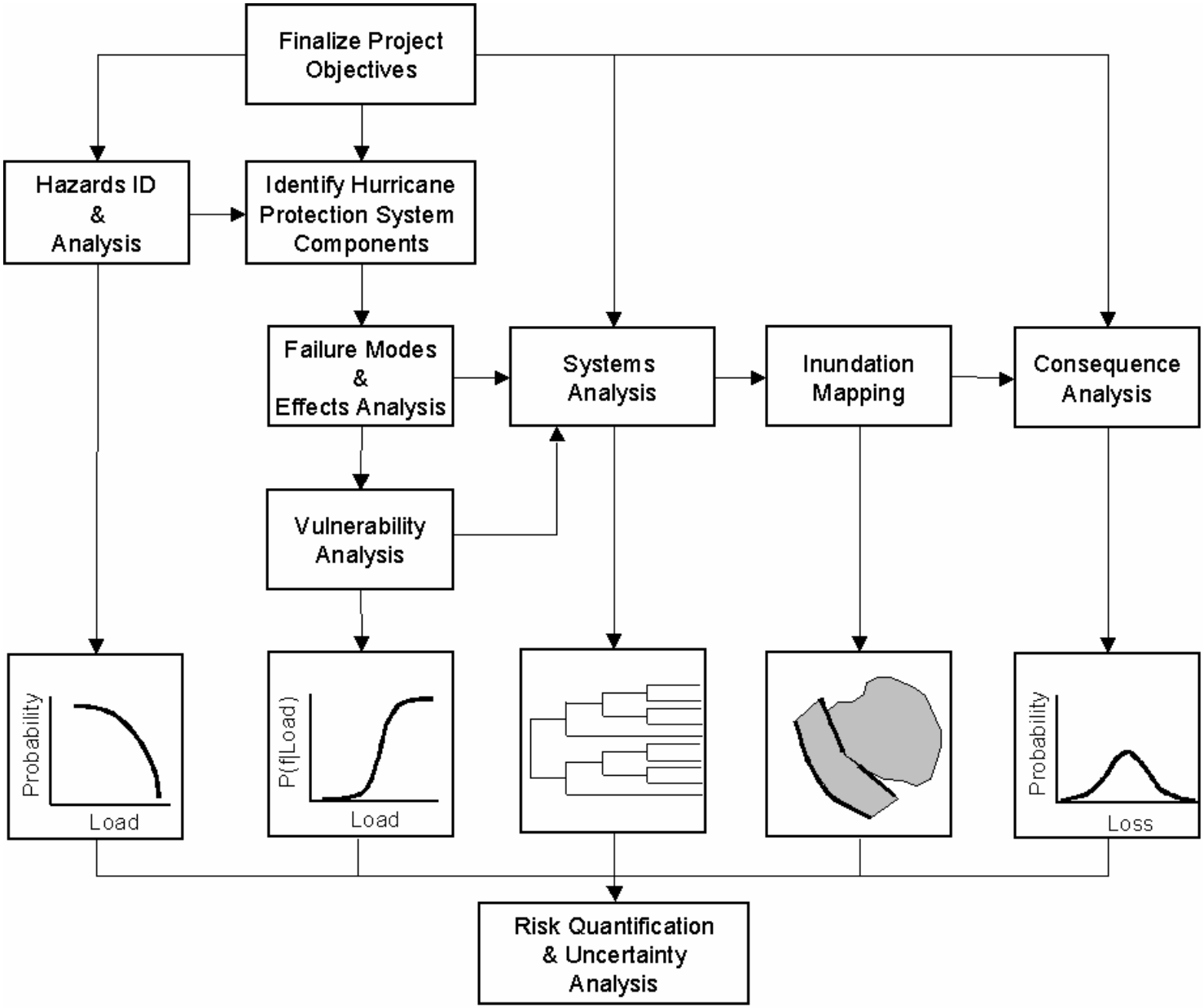
ERP Report 2
9-10 March 2006

Work Accomplished

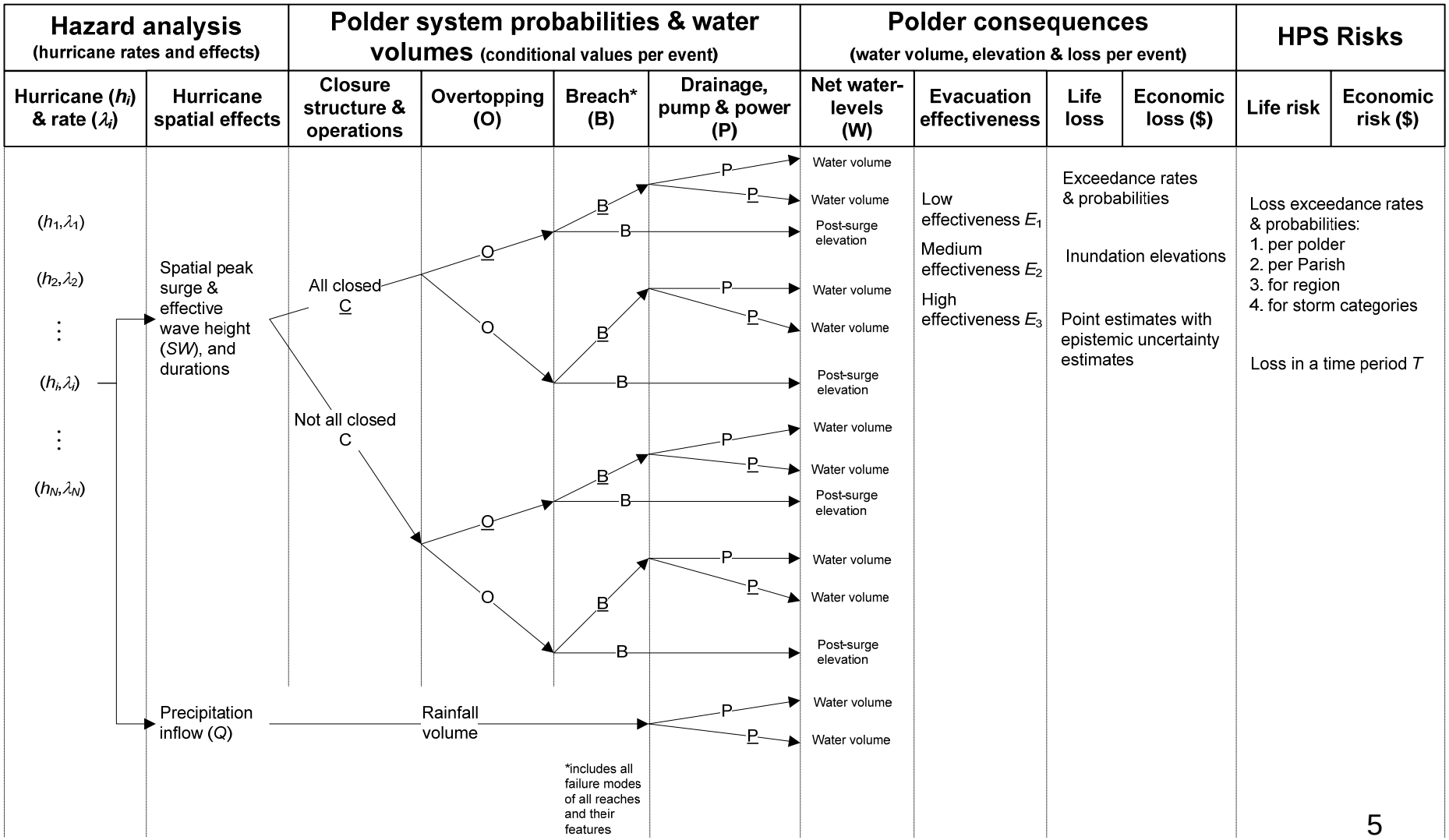
- Risk Model
- System/Polder Definitions
- Reliability Modeling
- Consequences Modeling
- Risk Communication

Risk Model

Overall Methodology



Event Tree


Hazard analysis
(hurricane rates and effects)
Polder system probabilities & water volumes (conditional values per event)
Polder consequences
(water volume, elevation & loss per event)
HPS Risks
Hurricane (h_i) & rate (λ_i)
Hurricane spatial effects
Closure structure & operations
Overtopping (O)
Breach* (B)
Drainage, pump & power (P)
Net water-levels (W)
Evacuation effectiveness
Life loss
Economic loss ($)
Life risk
Economic risk ($)
(h_1,λ_1)
(h_2,λ_2)
(h_i,λ_i)
(h_N,λ_N)
Spatial peak surge & effective wave height (SW), and durations
All closed C
Not all closed C
O
B
P
Water volume
Post-surge elevation
Precipitation inflow (Q)
Rainfall volume
*includes all failure modes of all reaches and their features
Low effectiveness E_1
Medium effectiveness E_2
High effectiveness E_3
Exceedance rates & probabilities
Inundation elevations
Point estimates with epistemic uncertainty estimates
Loss exceedance rates & probabilities:
1. per polder
2. per Parish
3. for region
4. for storm categories
Loss in a time period T

Region and Hurricanes

- Simulation of hurricanes
  - Estimate Joint probability distribution of in-region hurricane parameters
  - Select combinations of parameter ranges
  - Simulate each combination of parameters and obtain surge as S(x,y) and waves
  - Outputs: Surge plus waves & durations
  - Epistemic uncertainty in water elevation
- Hurricane rates
  - For hurricane runs, estimate rates
  - Epistemic uncertainty in rates

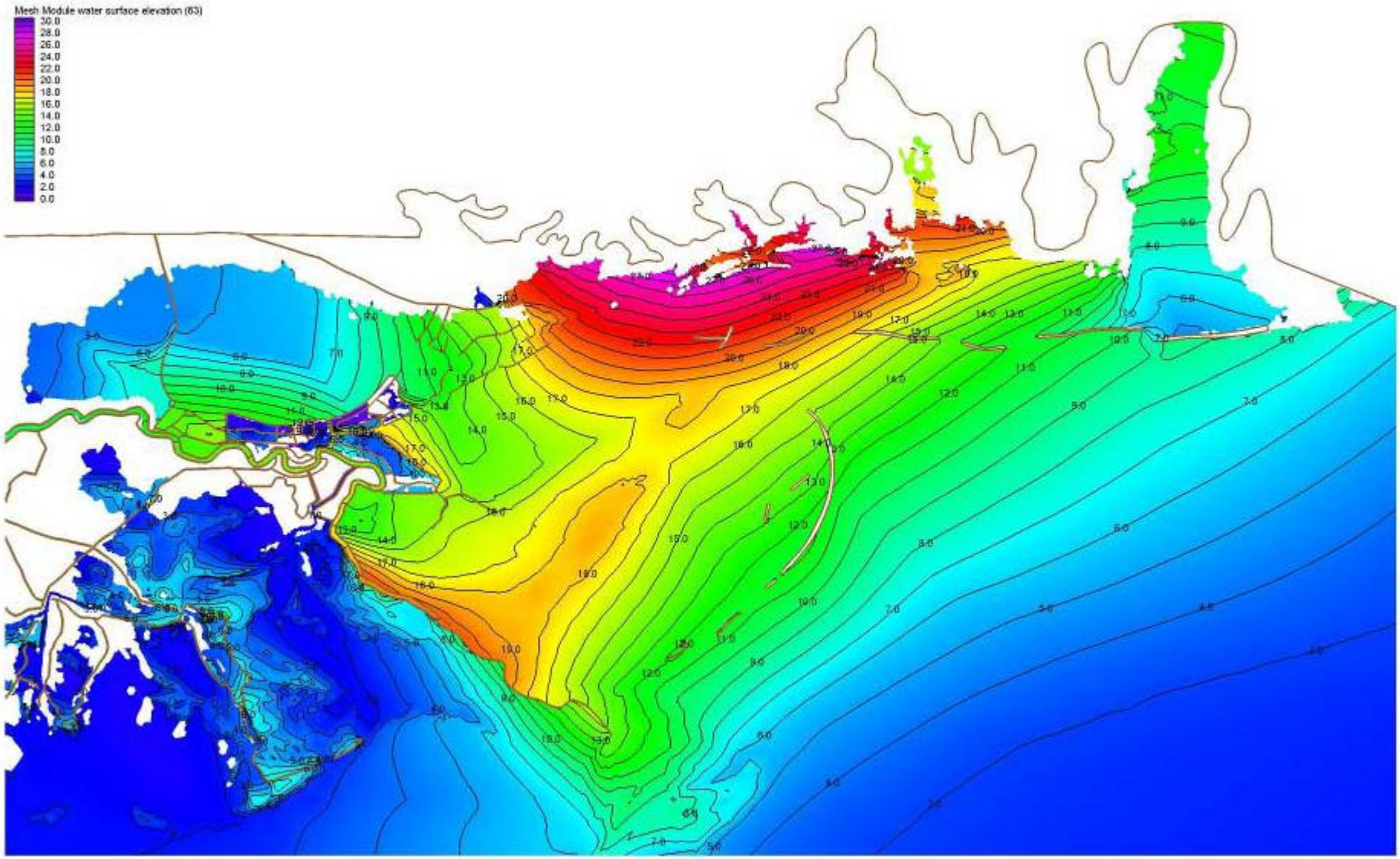
Parameters of Hurricanes

- Central pressure drop
- Radius of max wind
- Landfall location relative to downtown New Orleans, X
- Direction of track at landfall, θ ($\theta = 0$ for track pointing north, positive clockwise)
- Translational speed at landfall, V
- Holland's radial pressure profile parameter B

Hurricane Modeling

- Parameter sets developed for ADCIRC runs
- Low Res runs were used to study relationships between parameters
- Number of runs required was reduced by selecting parameter ranges considered possible for NO
- Approx. 1200 Med Res runs underway at UNC using DoD computer at ERDC and grid provided by Storm team
- Parameter sets adjusted as outputs are generated
- Approx. 40 High Res runs also underway to calibrate Med Res runs
- Waves to be incorporated based on recommendations of wave expert recently added to team
- Outputs: Surge plus significant wave height & durations, estimates of hurricane rates and uncertainties

Region and Hurricanes



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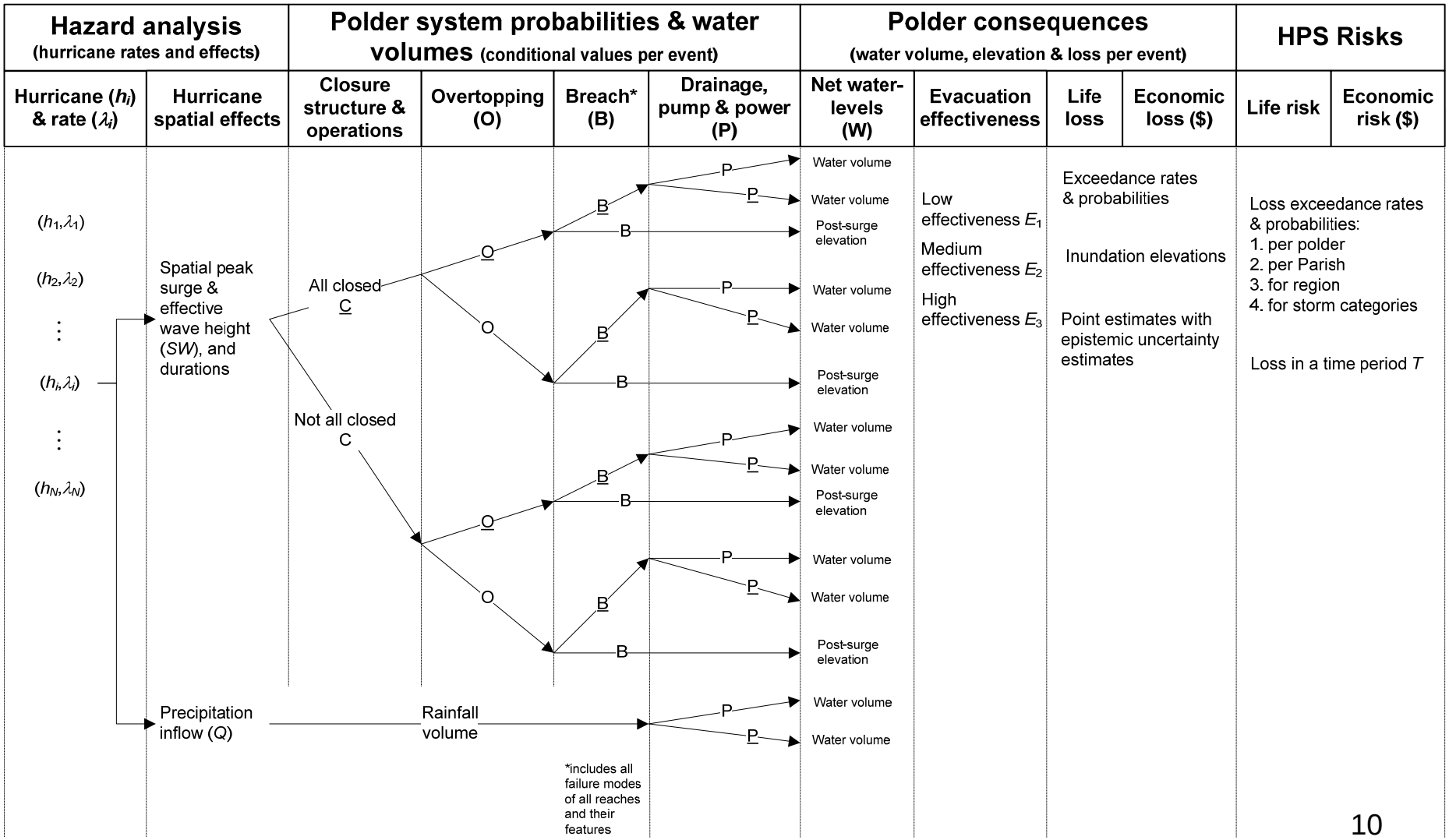
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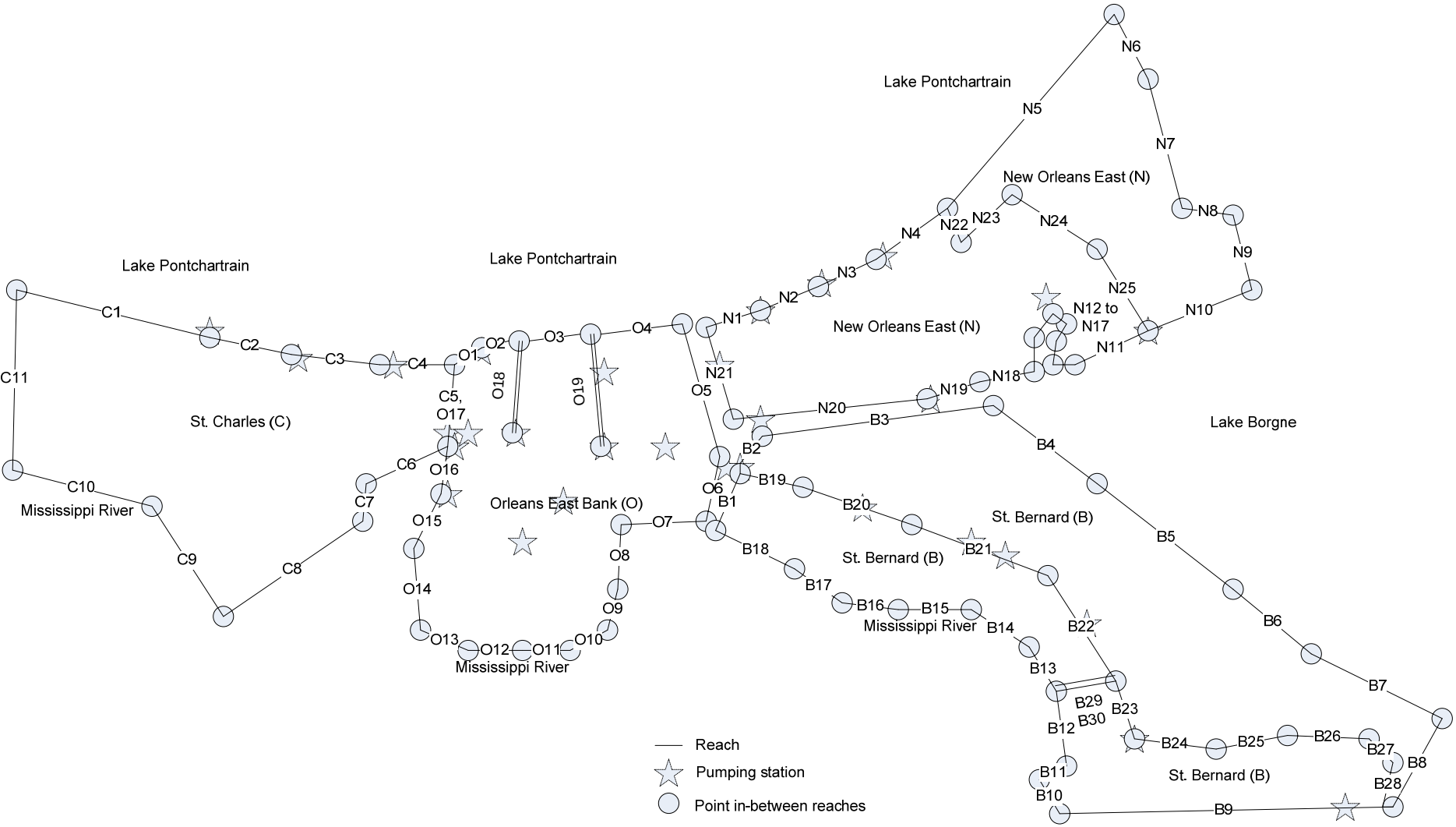
System Definition



Probabilistic Risk Model

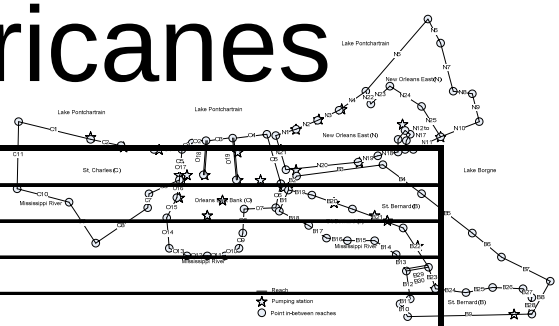
$$\lambda(C > c) = \sum_i \sum_j \lambda P(h_i) P(S_j \mid h_i) \quad for\ C > c$$

$P(h_i)$ is the probability of hurricane events of type i

$P(S_j \mid h_i)$ is the probability that the system is left in state j from the occurrence of h_i

Summations are evaluated based on meeting the condition $C > c$.

System Definition and Hurricanes



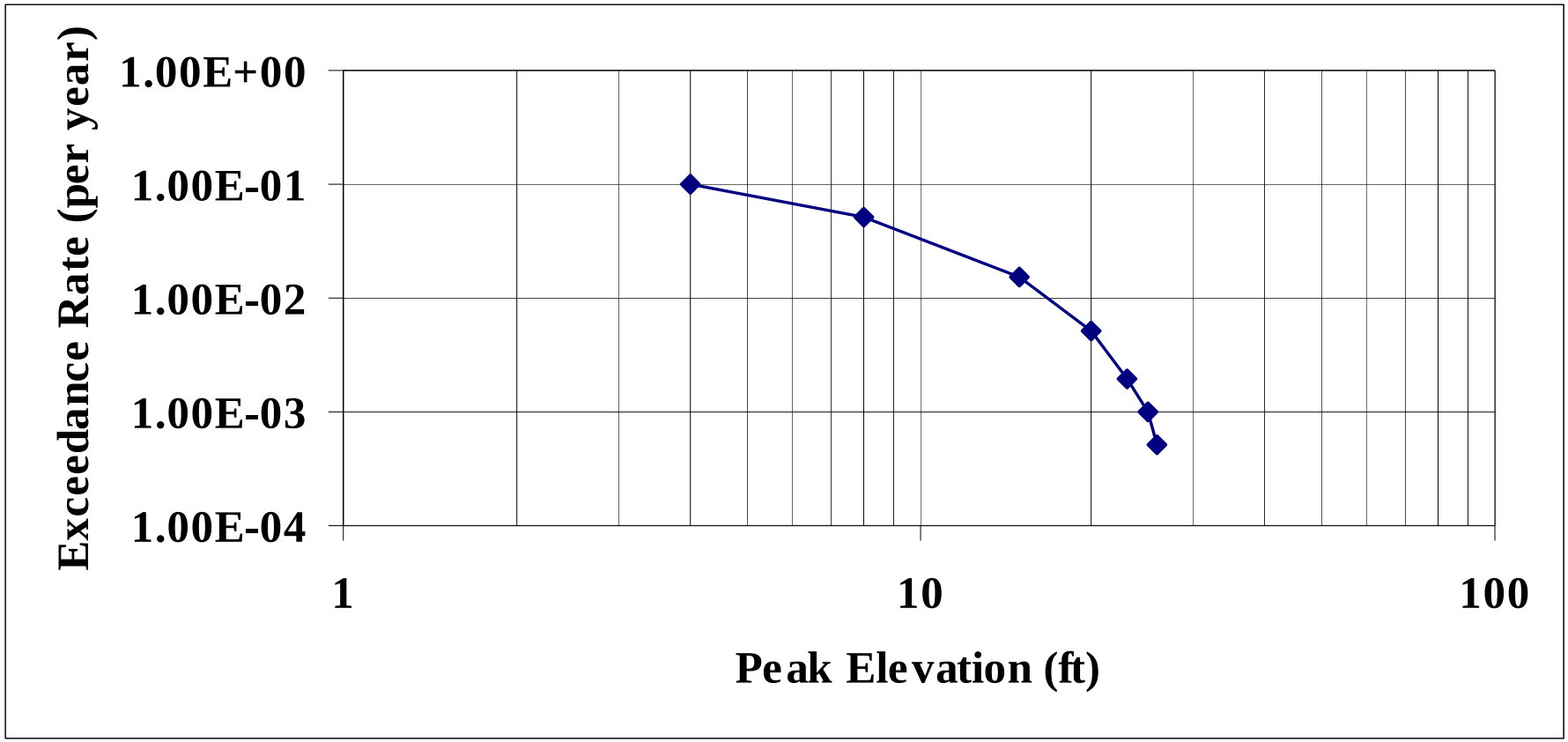
Reach Number	1
Reach start-end stations	To be provided
Reach coordinates	To be provided
Equal allocation to Sub-Polder(s)	1
Reach length (ft)	2000
Reach elevation (ft)	16
Mean (Weir Coeff.)[1]	3
COV (Weir Coeff.)	0.2

[1]Use 3.0 for floodwalls, 2.6 for levees, and 2.0 for gates

Hurricane Runs			1								
Run	Rate (R)		Surge+Waves		Duration		OT Length		OT Probability	OT Volume (Weir Eq)	
i	Mean	StD*	Hs		T		L		P(OT)	V|OT	
			Mean	StD*	Mean	StD*	Mean	StD*		Mean	StD
ID	event/yr	event/yr	ft	ft	sec	sec	ft	ft		ft^3	ft^3
1	5.00E-04	0.00E+00	25	0	5400	0	2000	0	1.00E+00	8.748E+08	1.750E+08
2	5.00E-04	0.00E+00	25	0	5400	0	2000	0	1.00E+00	8.748E+08	1.750E+08
3	7.50E-04	0.00E+00	24	0	5400	0	2000	0	1.00E+00	7.331E+08	1.466E+08
4	1.00E-03	0.00E+00	23	0	5400	0	2000	0	1.00E+00	6.001E+08	1.200E+08
5	1.00E-03	0.00E+00	22	0	5400	0	2000	0	1.00E+00	4.762E+08	9.524E+07
6	1.50E-03	0.00E+00	21	0	5400	0	2000	0	1.00E+00	3.622E+08	7.245E+07
7	2.00E-03	0.00E+00	20	0	5400	0	2000	0	1.00E+00	2.592E+08	5.184E+07
8	2.00E-03	0.00E+00	19	0	5400	0	2000	0	1.00E+00	1.684E+08	3.367E+07
9	2.00E-03	0.00E+00	18	0	5400	0	2000	0	1.00E+00	9.164E+07	1.833E+07
10	2.00E-03	0.00E+00	17	0	5400	0	2000	0	1.00E+00	3.240E+07	6.480E+06
11	3.50E-03	0.00E+00	16	0	5400	0	0	0	0.00E+00	0.000E+00	0.000E+00
12	5.00E-03	0.00E+00	15	0	4320	0	0	0	0.00E+00	0.000E+00	0.000E+00
13	5.00E-03	0.00E+00	14	0	3600	0	0	0	0.00E+00	0.000E+00	0.000E+00
14	5.00E-03	0.00E+00	13	0	3600	0	0	0	0.00E+00	0.000E+00	0.000E+00
15	5.00E-03	0.00E+00	12	0	3600	0	0	0	0.00E+00	0.000E+00	0.000E+00
16	5.00E-03	0.00E+00	11	0	3600	0	0	0	0.00E+00	0.000E+00	0.000E+00
17	5.00E-03	0.00E+00	10	0	3600	0	0	0	0.00E+00	0.000E+00	0.000E+00

* Reserved for future epistemic uncertainty analysis

Water Elevation (surge + wave)



Overtopping Volume (Weir Eq.)

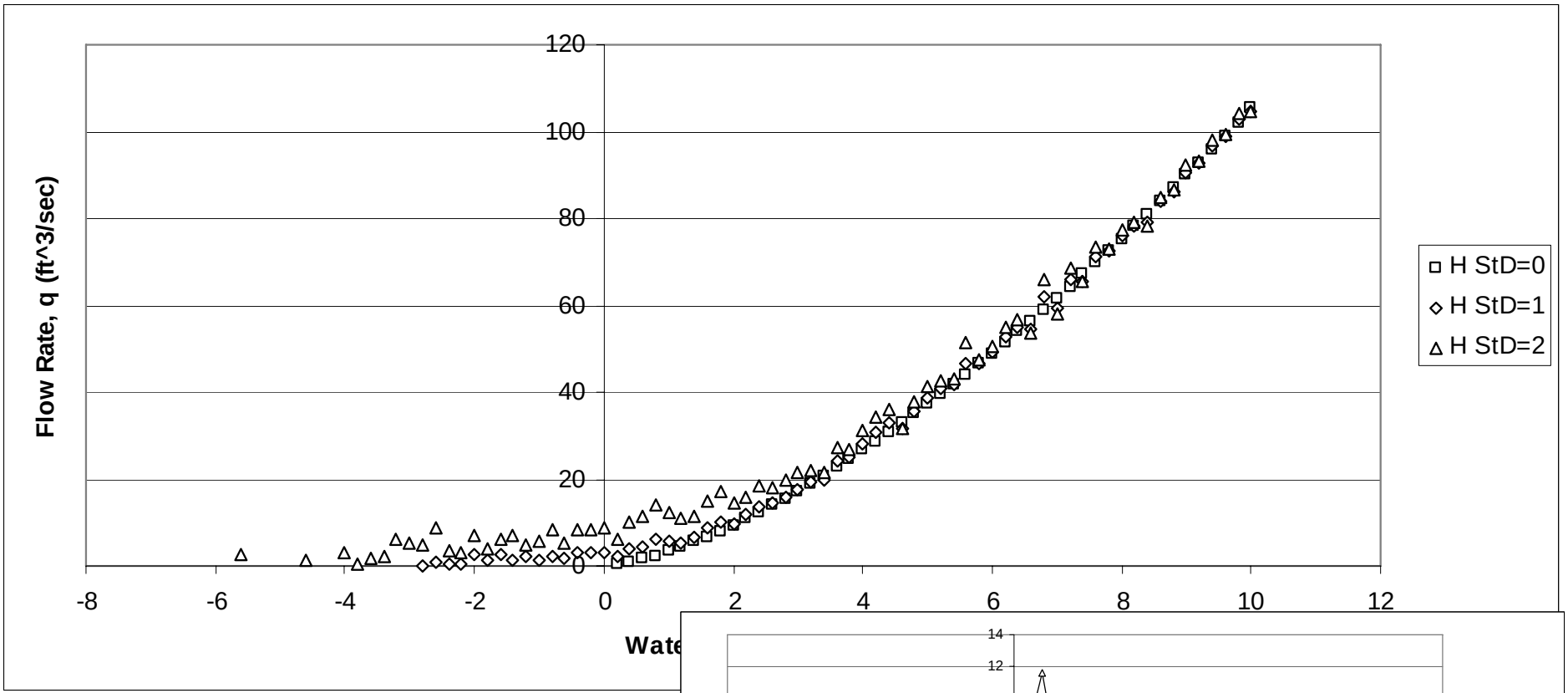
$$Q = C_W L H^{3/2} \qquad q = 3.33 H^{3/2}$$

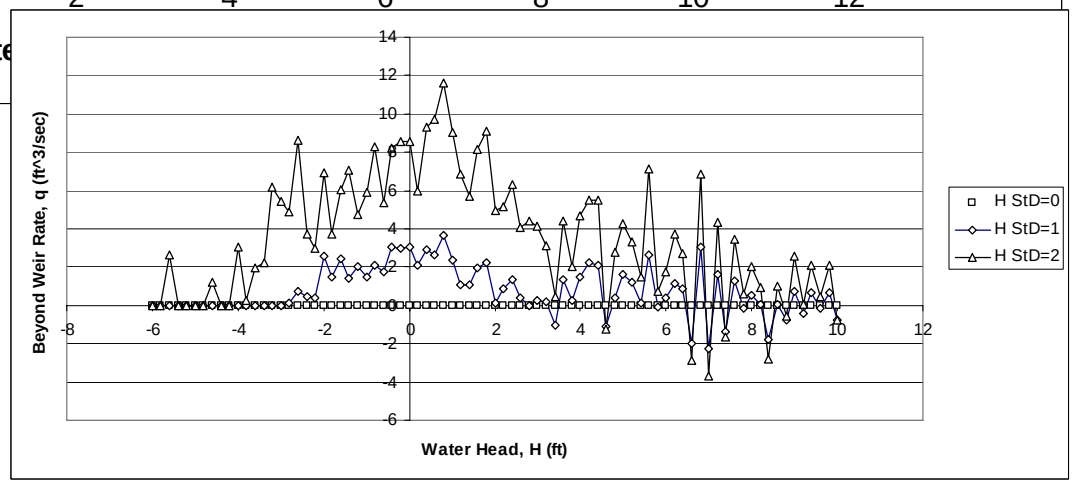
$$\overline{q} = \left(\overline{H} + 10\right)^{3.87577} \exp\left(0.01916 S_H - 6.92066\right)$$

$$S_q^2 = 80.65\left(\overline{H} + 10\right) + 165.67 S_H^2 - 1344.26 \quad if \geq 0; otherwise\, S_q^2 = 0$$

$$COV_V \cong \sqrt{COV_{C_w}^2 + COV_T^2 + COV_q^2 + COV_L^2}$$

Overtopping Volume





Overtopping Probability & Volume

$$\beta = \frac{\mu_R - \mu_L}{\sqrt{\sigma_R^2 + \sigma_L^2}}$$

$$\beta = \frac{\ln\left(\frac{\mu_R}{\mu_L}\sqrt{\frac{\delta_L^2+1}{\delta_R^2+1}}\right) - \mu_L}{\sqrt{\ln\left(\left(\delta_R^2+1\right)\left(\delta_L^2+1\right)\right)}}$$

$$F_V = \sum_{i=1}^{n} p_i F_{V_i}$$

R = HPS elevation

L = Surge and waves from a hurricane run

F = CDF

V = OT volume

p_i = OT probability

Overtopping Volumes

Summary by Sub-Polder	
1	2
To be provided	To be provided

Sub-Polder	1			Sub-Polder	2		
OT Probability		OT Volume (Weir Eq)		OT Probability		OT Volume (Weir Eq)	
P(OT)		V|OT		P(OT)		V|OT	
Mean	StD*	Mean	StD	Mean	StD*	Mean	StD
Prob.	Prob.	ft^3	ft^3	Prob.	Prob.	ft^3	ft^3
1.00E+00	NA	1.532E+09	1.918E+08		TBD		TBD
1.00E+00	NA	1.532E+09	1.918E+08		TBD		TBD
1.00E+00	NA	1.378E+09	1.658E+08		TBD		TBD
1.00E+00	NA	1.027E+09	1.306E+08		TBD		TBD
1.00E+00	NA	9.629E+08	1.121E+08		TBD		TBD
1.00E+00	NA	7.109E+08	8.421E+07		TBD		TBD
1.00E+00	NA	4.107E+08	5.527E+07		TBD		TBD
1.00E+00	NA	2.521E+08	3.551E+07		TBD		TBD
1.00E+00	NA	1.408E+08	2.001E+07		TBD		TBD
1.00E+00	NA	4.344E+07	6.846E+06		TBD		TBD

Volumes from other Features

Closures including gates

Reach number	1	2		
Sub-Polder allocation	1	1		
Feature number(s)	1, 2	3, 4, 5		
Total width (ft)	100	200		
Feature bottom elevation (ft)	15	16		
Open probability	0.1	0.5		

COV(Open Probability)* = 0.15

Probability All Closed = 0.45

Hurricane Runs			Expected Water Volume from Open Closures					
Run	Rate (R)						Closure Water Volume	
i	Mean	StD*					V(C)	
			Water Volume|Open		Water Volume|Open		Mean	StD
ID	event/yr	event/yr	Mean	StD*	Mean	StD*	ft^3	ft^3
1	5.00E-04	0.00E+00	3.42E+07	6.83E+06	2.39E+07	4.77E+06	1.535E+07	2.482E+06
2	5.00E-04	0.00E+00	3.42E+07	6.83E+06	2.39E+07	4.77E+06	1.535E+07	2.482E+06
3	7.50E-04	0.00E+00	2.92E+07	5.83E+06	2.29E+07	4.58E+06	1.437E+07	2.363E+06
4	1.00E-03	0.00E+00	2.44E+07	4.89E+06	1.47E+07	2.93E+06	9.780E+06	1.547E+06
5	1.00E-03	0.00E+00	2.00E+07	4.00E+06	1.60E+07	3.20E+06	1.000E+07	1.649E+06
6	1.50E-03	0.00E+00	1.59E+07	3.17E+06	1.07E+07	2.13E+06	6.921E+06	1.113E+06
7	2.00E-03	0.00E+00	1.21E+07	2.41E+06	4.07E+06	8.15E+05	3.244E+06	4.735E+05
8	2.00E-03	0.00E+00	8.64E+06	1.73E+06	1.66E+06	3.32E+05	1.695E+06	2.397E+05
9	2.00E-03	0.00E+00	5.61E+06	1.12E+06	1.93E+05	3.86E+04	6.578E+05	1.139E+05
10	2.00E-03	0.00E+00	3.05E+06	6.11E+05	0.00E+00	0.00E+00	3.055E+05	6.109E+04
11	3.50E-03	0.00E+00	1.08E+06	0.00E+00	0.00E+00	0.00E+00	1.080E+05	0.000E+00
12	5.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000E+00	0.000E+00
13	5.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000E+00	0.000E+00
14	5.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000E+00	0.000E+00

Breach Given Overtopping

Reach Number	1	2
Reach start-end stations	To be provided	To be provided
Reach coordinates	To be provided	To be provided
Equal allocation to Sub-Polder(s)	1	1
Reach length (ft)	2000	2000
Reach elevation (ft)	16	16
Time to breach (sec)	7200	10800

R = Time to breach

L = Overtopping time

COV(time to breach) = 0.5

Hurricane Runs			1				2		
Run	Rate (R)		Surge+Waves		Surge (only) elevation				
i	Mean	StD*	P(B|OT)		Hps				
			All Modes		Mean	StD			
ID	event/yr	event/yr	Mean	StD*	ft	ft			
1	5.00E-04	0.00E+00	0.35464	0	22.5	1.125			
2	5.00E-04	0.00E+00	0.35464	0	22.5	1.125			
3	7.50E-04	0.00E+00	0.35464	0	21.6	1.08	0.0442	0	19.44
4	1.00E-03	0.00E+00	0.35464	0	20.7	1.035	0.0183	0	18.63
5	1.00E-03	0.00E+00	0.35464	0	19.8	0.99	0.1091	0	17.82
6	1.50E-03	0.00E+00	0.35464	0	18.9	0.945	0.1091	0	17.01
7	2.00E-03	0.00E+00	0.35464	0	18	0.9	0.0183	0	10.8
8	2.00E-03	0.00E+00	0.35464	0	17.1	0.855	0.0183	0	10.26
9	2.00E-03	0.00E+00	0.35464	0	10.8	0.54	0.1091	0	9.72
10	2.00E-03	0.00E+00	0.35464	0	10.2	0.51	0.1091	0	9.18
11	3.50E-03	0.00E+00	0.35464	0	9.6	0.48	0.1091	0	8.64
12	5.00E-03	0.00E+00	0.199	0	9	0.45	0.1091	0	8.1

$$\beta = \frac{\ln\left(\frac{\mu_R}{\mu_L}\sqrt{\frac{\delta_L^2+1}{\delta_R^2+1}}\right) - \mu_L}{\sqrt{\ln\left(\left(\delta_R^2+1\right)\left(\delta_L^2+1\right)\right)}}$$

Breach Given No Overtopping

Reach Number	1	2
Reach start-end stations	To be provided	To be provided
Reach coordinates	To be provided	To be provided
Equal allocation to Sub-Polder(s)	1	1
Reach length (ft)	2000	1800
Reach elevation (ft)	16	16
Additional parameter	To be provided	To be provided

Hurricane Runs			1				2		
Run	Rate (R)		Surge		Surge (only) elevation		Surge		Surge (only)
i	Mean	StD*	P(B|NOT)		Hps		P(B|NOT)		Hps
			All Modes		Mean	StD	All Modes		Mean
ID	event/yr	event/yr	Mean	StD*	ft	ft	Mean	StD*	ft
1	5.00E-04	0.00E+00	0	0	22.5	1.125	0	0	20.25
2	5.00E-04	0.00E+00	0	0	22.5	1.125	0	0	20.25
3	7.50E-04	0.00E+00	0	0	21.6	1.08	0	0	19.44
4	1.00E-03	0.00E+00	0	0	20.7	1.035	0	0	18.63
5	1.00E-03	0.00E+00	0	0	19.8	0.99	0	0	17.82
6	1.50E-03	0.00E+00	0	0	18.9	0.945	0	0	17.01
7	2.00E-03	0.00E+00	0	0	18	0.9	0	0	10.8
8	2.00E-03	0.00E+00	0	0	17.1	0.855	0	0	10.26
9	2.00E-03	0.00E+00	0	0	10.8	0.54	0	0	9.72
10	2.00E-03	0.00E+00	0	0	10.2	0.51	0.01	0	9.18
11	3.50E-03	0.00E+00	0.01	0	9.6	0.48	0.01	0	8.64

Sub-Polder Reliability and Volumes

Non-Breach Water Volumes 1 out of 2

Parameters	
Polder Name	Polder X
Sub-Polder number	1
Sub-Polder Population at Risk	xxxxx
Additional parameter	
Additional parameter	
Additional parameter	

$$P_B(Polder) = 1 - \prod_{i=1}^{n} (1 - p_i)$$

Hurricane Runs			Non-B						
Run	Rate (R)		Overtopping			Precipitation		Water from Closures&Joints	
i	Mean	StD*	Probability	Overtopping Volume (V|OT)		Rainfall volume		Water volume	
			P(OT)	Mean	StD	Mean	StD	Mean	StD
ID	event/yr	event/yr		ft^3	ft^3	ft^3	ft^3	ft^3	ft^3
1	5.00E-04	0.00E+00	1.000E+00	1.532E+09	1.918E+08	5.000E+07	1.500E+07	1.535E+07	2.482E+06
2	5.00E-04	0.00E+00	1.000E+00	1.532E+09	1.918E+08	6.000E+06	1.800E+06	1.535E+07	2.482E+06
3	7.50E-04	0.00E+00	1.000E+00	1.378E+09	1.658E+08	6.000E+06	1.800E+06	1.437E+07	2.363E+06
4	1.00E-03	0.00E+00	1.000E+00	1.027E+09	1.306E+08	6.000E+06	1.800E+06	9.780E+06	1.547E+06
5	1.00E-03	0.00E+00	1.000E+00	9.629E+08	1.121E+08	6.000E+06	1.800E+06	1.000E+07	1.649E+06
6	1.50E-03	0.00E+00	1.000E+00	7.109E+08	8.421E+07	6.000E+06	1.800E+06	6.921E+06	1.113E+06
7	2.00E-03	0.00E+00	1.000E+00	4.107E+08	5.527E+07	6.000E+06	1.800E+06	3.244E+06	4.735E+05
8	2.00E-03	0.00E+00	1.000E+00	2.521E+08	3.551E+07	6.000E+06	1.800E+06	1.695E+06	2.397E+05
9	2.00E-03	0.00E+00	1.000E+00	1.408E+08	2.001E+07	6.000E+05	1.800E+05	6.578E+05	1.139E+05
10	2.00E-03	0.00E+00	1.000E+00	4.344E+07	6.846E+06	6.000E+05	1.800E+05	3.055E+05	6.109E+04
11	3.50E-03	0.00E+00	0.000E+00	0.000E+00	0.000E+00	6.000E+05	1.800E+05	1.080E+05	0.000E+00
12	5.00E-03	0.00E+00	0.000E+00	0.000E+00	0.000E+00	6.000E+05	1.800E+05	0.000E+00	0.000E+00
13	5.00E-03	0.00E+00	0.000E+00	0.000E+00	0.000E+00	6.000E+05	1.800E+05	0.000E+00	0.000E+00
14	5.00E-03	0.00E+00	0.000E+00	0.000E+00	0.000E+00	6.000E+05	1.800E+05	0.000E+00	0.000E+00
15	5.00E-03	0.00E+00	0.000E+00	0.000E+00	0.000E+00	6.000E+05	1.800E+05	0.000E+00	0.000E+00
16	5.00E-03	0.00E+00	0.000E+00	0.000E+00	0.000E+00	6.000E+05	1.800E+05	0.000E+00	0.000E+00
17	5.00E-03	0.00E+00	0.000E+00	0.000E+00	0.000E+00	6.000E+05	1.800E+05	0.000E+00	0.000E+00

Sub-Polder Reliability and Volumes

Non-Breach Water Volumes 2 out of 2

$$P_B(Polder) = 1 - \prod_{i=1}^{n} \left(1 - p_i\right)$$

Non-Breach Water Volume (ft^3)								
ures&Joints	NOT water volume & NotC		OT water volume & NotC		NOT water volume & C		OT water volume & C	
ume	Water volume		Water volume		Water volume		Water volume	
D	Mean	StD	Mean	StD	Mean	StD	Mean	StD
3	ft^3	ft^3	ft^3	ft^3	ft^3	ft^3	ft^3	ft^3
2.482E+06	6.535E+07	1.520E+07	1.597E+09	1.924E+08	5.000E+07	1.500E+07	1.582E+09	1.924E+08
2.482E+06	2.135E+07	3.066E+06	1.553E+09	1.918E+08	6.000E+06	1.800E+06	1.538E+09	1.918E+08
2.363E+06	2.037E+07	2.971E+06	1.398E+09	1.658E+08	6.000E+06	1.800E+06	1.384E+09	1.658E+08
1.547E+06	1.578E+07	2.373E+06	1.042E+09	1.306E+08	6.000E+06	1.800E+06	1.033E+09	1.306E+08
1.649E+06	1.600E+07	2.441E+06	9.789E+08	1.121E+08	6.000E+06	1.800E+06	9.689E+08	1.121E+08
1.113E+06	1.292E+07	2.116E+06	7.238E+08	8.424E+07	6.000E+06	1.800E+06	7.169E+08	8.423E+07
4.735E+05	9.244E+06	1.861E+06	4.200E+08	5.530E+07	6.000E+06	1.800E+06	4.167E+08	5.530E+07
2.397E+05	7.695E+06	1.816E+06	2.598E+08	3.556E+07	6.000E+06	1.800E+06	2.581E+08	3.556E+07
1.139E+05	1.258E+06	2.130E+05	1.420E+08	2.002E+07	6.000E+05	1.800E+05	1.414E+08	2.002E+07
6.109E+04	9.055E+05	1.901E+05	4.435E+07	6.849E+06	6.000E+05	1.800E+05	4.404E+07	6.848E+06
0.000E+00	7.080E+05	1.800E+05	7.080E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05
0.000E+00	6.000E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05
0.000E+00	6.000E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05
0.000E+00	6.000E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05
0.000E+00	6.000E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05
0.000E+00	6.000E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05
0.000E+00	6.000E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05	6.000E+05	1.800E+05

Sub-Polder Reliability and Breach

Breach Water Volumes 1 out of 2

Parameters
Polder Name
Sub-Polder number
Sub-Polder Population at Risk
Additional parameter
Additional parameter
Additional parameter

$$P_B(Polder) = 1 - \prod_{i=1}^{n} (1 - p_i)$$

Hurricane Runs									**Breach**
Run	Rate (R)		Reaches		Reaches		Drainage Structures		
i	Mean	StD*	P(B|OT)		P(B|NOT)		P(Drain.Structure)		
			Mean	StD*	Mean	StD*	Mean	StD*	
ID	event/yr	event/yr	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.	
1	5.00E-04	0.00E+00	5.018E-01	0.000E+00	0.000E+00	0.000E+00	2.000E-03	0.000E+00	
2	5.00E-04	0.00E+00	5.018E-01	0.000E+00	0.000E+00	0.000E+00	2.000E-03	0.000E+00	
3	7.50E-04	0.00E+00	6.009E-01	0.000E+00	0.000E+00	0.000E+00	2.000E-03	0.000E+00	
4	1.00E-03	0.00E+00	5.018E-01	0.000E+00	0.000E+00	0.000E+00	2.000E-03	0.000E+00	
5	1.00E-03	0.00E+00	7.466E-01	0.000E+00	0.000E+00	0.000E+00	2.000E-03	0.000E+00	
6	1.50E-03	0.00E+00	7.466E-01	0.000E+00	0.000E+00	0.000E+00	2.000E-03	0.000E+00	
7	2.00E-03	0.00E+00	5.018E-01	0.000E+00	0.000E+00	0.000E+00	2.000E-03	0.000E+00	
8	2.00E-03	0.00E+00	5.018E-01	0.000E+00	0.000E+00	0.000E+00	2.000E-03	0.000E+00	
9	2.00E-03	0.00E+00	7.466E-01	0.000E+00	0.000E+00	0.000E+00	2.000E-03	0.000E+00	
10	2.00E-03	0.00E+00	7.466E-01	0.000E+00	1.990E-02	0.000E+00	2.000E-03	0.000E+00	
11	3.50E-03	0.00E+00	7.466E-01	0.000E+00	3.940E-02	0.000E+00	2.000E-03	0.000E+00	
12	5.00E-03	0.00E+00	6.855E-01	0.000E+00	3.940E-02	0.000E+00	2.000E-03	0.000E+00	
13	5.00E-03	0.00E+00	6.502E-01	0.000E+00	3.940E-02	0.000E+00	2.000E-03	0.000E+00	

Sub-Polder Reliability and Breach

Breach Water Volumes 2 out of 2

$$P_B(Polder) = 1 - \prod_{i=1}^{n} (1 - p_i)$$

Breaches								
nes	Drainage Structures		Transitions		Breach Probability		Post-surge Elevation	
DT)	P(Drain.Structure)		P(Transition)		P(B)			
StD*	Mean	StD*	Mean	StD*	Mean	StD*	Mean	StD
Prob.	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.	ft	ft
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	5.05E-01	0.00E+00	17.8125	0.890625
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	4.98E-01	0.00E+00	17.8125	0.890625
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	5.97E-01	0.00E+00	17.1	0.855
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	4.98E-01	0.00E+00	16.3875	0.819375
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	7.41E-01	0.00E+00	14.355	0.71775
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	7.41E-01	0.00E+00	13.7025	0.685125
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	4.98E-01	0.00E+00	11.7	0.585
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	4.98E-01	0.00E+00	11.115	0.55575
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	7.41E-01	0.00E+00	9.18	0.459
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	7.41E-01	0.00E+00	7.7775	0.388875
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	3.91E-02	0.00E+00	7.32	0.366
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	3.91E-02	0.00E+00	6.8625	0.343125
0.000E+00	2.000E-03	0.000E+00	5.000E-03	0.000E+00	3.91E-02	0.00E+00	5.565	0.27825

Net Water Levels

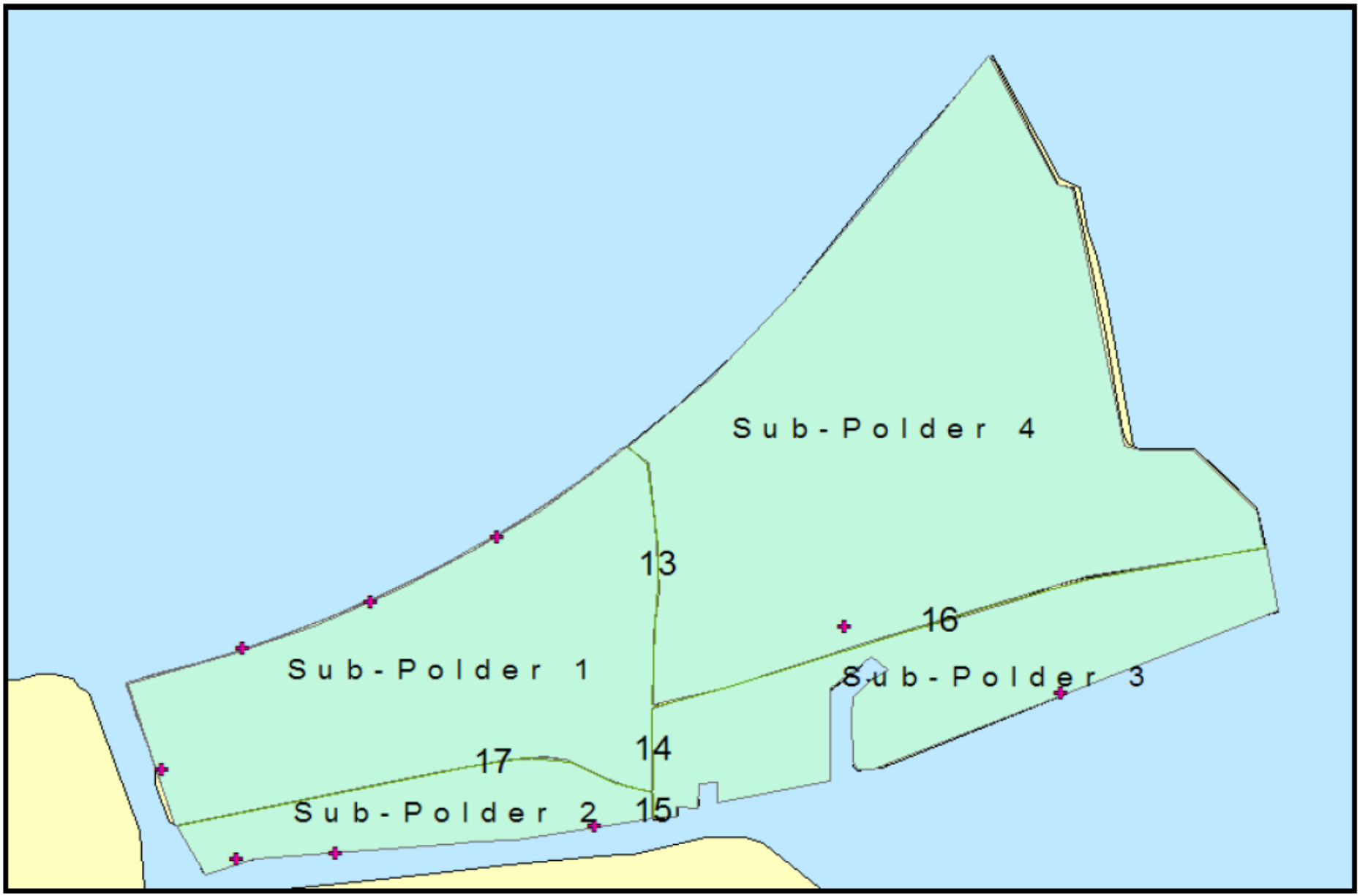
Parameters	
Polder Name	
Sub-Polder number	
Sub-Polder Population at Risk	
Additional parameter	
Pumping capacity COV	
Mean capacity of sub-Polder (ft^3)	
StD Capacity of Sub-Polder (ft^3)	

Hurricane Runs			**Pumping**	**Water Volume (ft^3) After Pumpi**			
Run	Rate (R)		Capacity	**NOT water volume & NotC**		**OT water volume & NotC**	
i	Mean	StD*	(including backflow)	Water volume		Water volume	
				Mean	StD	Mean	StD
ID	event/yr	event/yr		ft^3	ft^3	ft^3	ft^3
1	5.00E-04	0.00E+00	8.000E-01	5.228E+07	1.216E+07	1.277E+09	1.539E+08
2	5.00E-04	0.00E+00	1.200E+00	2.562E+07	3.679E+06	1.863E+09	2.302E+08
3	7.50E-04	0.00E+00	1.000E+00	2.037E+07	2.971E+06	1.398E+09	1.658E+08
4	1.00E-03	0.00E+00	6.000E-01	9.468E+06	1.424E+06	6.254E+08	7.835E+07
5	1.00E-03	0.00E+00	6.000E-01	9.600E+06	1.465E+06	5.874E+08	6.728E+07
6	1.50E-03	0.00E+00	6.000E-01	7.753E+06	1.270E+06	4.343E+08	5.054E+07
7	2.00E-03	0.00E+00	6.000E-01	5.546E+06	1.117E+06	2.520E+08	3.318E+07
8	2.00E-03	0.00E+00	6.000E-01	4.617E+06	1.090E+06	1.559E+08	2.134E+07
9	2.00E-03	0.00E+00	6.000E-01	7.547E+05	1.278E+05	8.522E+07	1.201E+07
10	2.00E-03	0.00E+00	6.000E-01	5.433E+05	1.141E+05	2.661E+07	4.109E+06
11	3.50E-03	0.00E+00	6.000E-01	4.248E+05	1.080E+05	4.248E+05	1.080E+05
12	5.00E-03	0.00E+00	6.000E-01	3.600E+05	1.080E+05	3.600E+05	1.080E+05

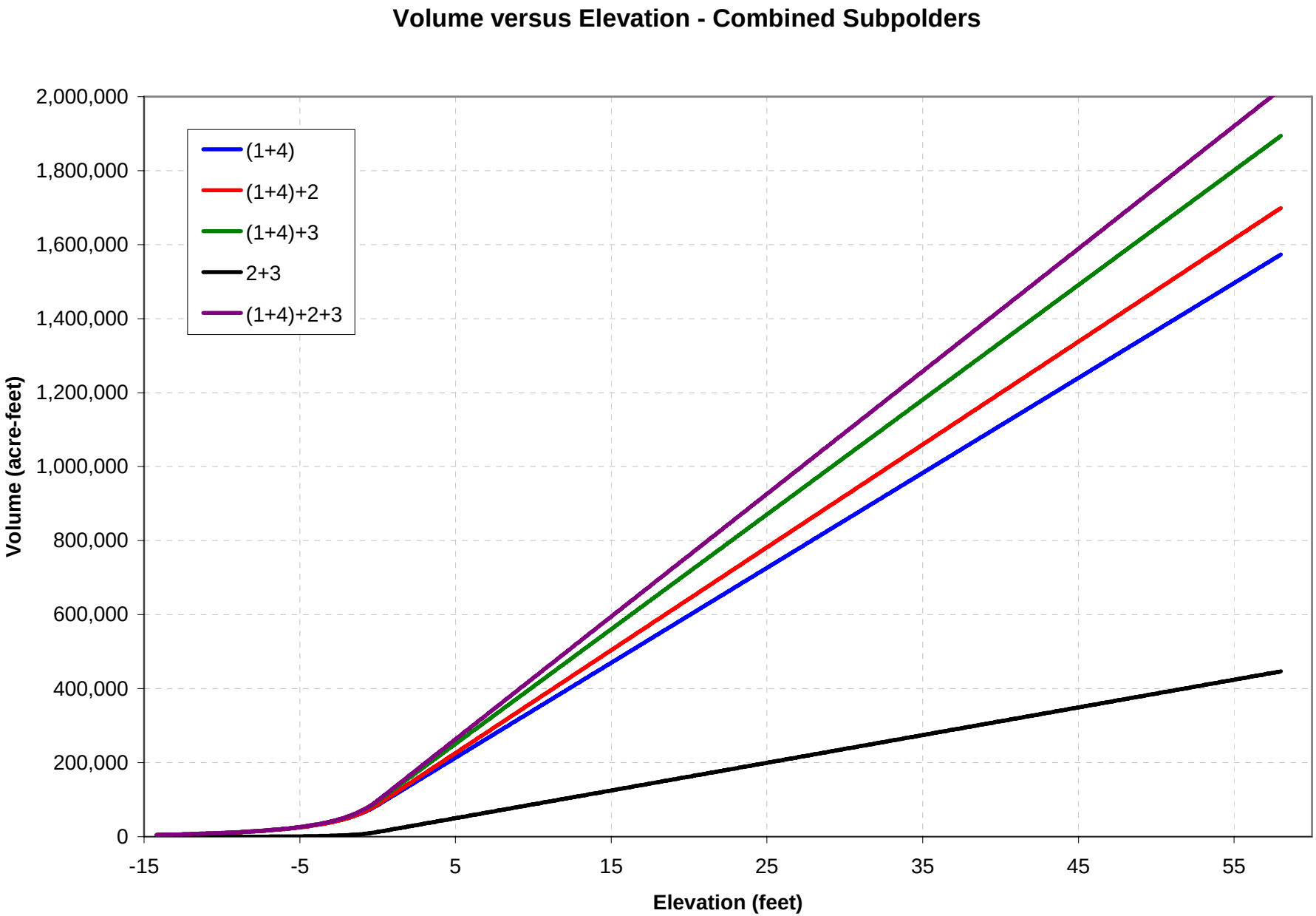
Net Water Levels

Water Volume (ft^3) After Pumping and Sub-Polder Interflow**							
ater volume & NotC		**OT water volume & NotC**		**NOT water volume & C**		**OT water volume & C**	
olume		Water volume		Water volume		Water volume	
	StD	Mean	StD	Mean	StD	Mean	StD
	ft^3	ft^3	ft^3	ft^3	ft^3	ft^3	ft^3
28E+07	1.216E+07	1.277E+09	1.539E+08	4.000E+07	1.200E+07	1.265E+09	1.539E+08
62E+07	3.679E+06	1.863E+09	2.302E+08	7.200E+06	2.160E+06	1.845E+09	2.302E+08
37E+07	2.971E+06	1.398E+09	1.658E+08	6.000E+06	1.800E+06	1.384E+09	1.658E+08
68E+06	1.424E+06	6.254E+08	7.835E+07	3.600E+06	1.080E+06	6.195E+08	7.834E+07
00E+06	1.465E+06	5.874E+08	6.728E+07	3.600E+06	1.080E+06	5.814E+08	6.727E+07
53E+06	1.270E+06	4.343E+08	5.054E+07	3.600E+06	1.080E+06	4.301E+08	5.054E+07
46E+06	1.117E+06	2.520E+08	3.318E+07	3.600E+06	1.080E+06	2.500E+08	3.318E+07
17E+06	1.090E+06	1.559E+08	2.134E+07	3.600E+06	1.080E+06	1.548E+08	2.134E+07
47E+05	1.278E+05	8.522E+07	1.201E+07	3.600E+05	1.080E+05	8.482E+07	1.201E+07
33E+05	1.141E+05	2.661E+07	4.109E+06	3.600E+05	1.080E+05	2.643E+07	4.109E+06
48E+05	1.080E+05	4.248E+05	1.080E+05	3.600E+05	1.080E+05	3.600E+05	1.080E+05
00E+05	1.080E+05	3.600E+05	1.080E+05	3.600E+05	1.080E+05	3.600E+05	1.080E+05

Net Water Levels



Net Water Levels



Polder Risk Profiles

Non-Breach
1 out of 2

Parameters		
Polder Name	Polder X	
Sub-Polder number		1
Sub-Polder Population at Risk	xxxxx	
Additional parameter		
Additional parameter		0.2
Additional parameter		
Additional parameter		

Hurricane Runs			Probabilities and W				
Run	Rate (R)		**NOT water volume & NotC**			**OT water volume & NotC**	
i	Mean	StD*	Probability	Water volume		Probability	Water volume
			(1-P(C))(1-P(B|NOT))	Mean	StD	(1-P(C))(1-P(B|OT))	Mean
ID	event/yr	event/yr	*(1-P(OT))	ft^3	ft^3	*P(OT)	ft^3
1	5.00E-04	0.00E+00	0.000E+00	5.228E+07	1.216E+07	2.740E-01	1.277E+09
2	5.00E-04	0.00E+00	0.000E+00	2.562E+07	3.679E+06	2.740E-01	1.863E+09
3	7.50E-04	0.00E+00	0.000E+00	2.037E+07	2.971E+06	2.195E-01	1.398E+09
4	1.00E-03	0.00E+00	0.000E+00	9.468E+06	1.424E+06	2.740E-01	6.254E+08
5	1.00E-03	0.00E+00	0.000E+00	9.600E+06	1.465E+06	1.394E-01	5.874E+08
6	1.50E-03	0.00E+00	0.000E+00	7.753E+06	1.270E+06	1.394E-01	4.343E+08
7	2.00E-03	0.00E+00	0.000E+00	5.546E+06	1.117E+06	2.740E-01	2.520E+08
8	2.00E-03	0.00E+00	0.000E+00	4.617E+06	1.090E+06	2.740E-01	1.559E+08
9	2.00E-03	0.00E+00	0.000E+00	7.547E+05	1.278E+05	1.394E-01	8.522E+07
10	2.00E-03	0.00E+00	0.000E+00	5.433E+05	1.141E+05	1.394E-01	2.661E+07
11	3.50E-03	0.00E+00	5.283E-01	4.248E+05	1.080E+05	0.000E+00	4.248E+05
12	5.00E-03	0.00E+00	5.283E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05
13	5.00E-03	0.00E+00	5.283E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05
14	5.00E-03	0.00E+00	5.283E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05
15	5.00E-03	0.00E+00	5.283E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05
16	5.00E-03	0.00E+00	5.283E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05
17	5.00E-03	0.00E+00	5.283E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05

Polder Risk Profiles *Non-Breach 2 out of 2*

bilities and Water Volumes for Non-Breach Branches							
& NotC		NOT water volume & C			OT water volume & C		
Vater volume		Probability	Water volume		Probability	Water volume	
Iean	StD	P(C)(1-P(B|NOT))	Mean	StD	P(C)(1-P(B|OT))	Mean	StD
t^3	ft^3	*(1-P(OT))	ft^3	ft^3	*P(OT)	ft^3	ft^3
1.277E+09	1.539E+08	0.000E+00	4.000E+07	1.200E+07	2.242E-01	1.265E+09	1.539E+08
1.863E+09	2.302E+08	0.000E+00	7.200E+06	2.160E+06	2.242E-01	1.845E+09	2.302E+08
1.398E+09	1.658E+08	0.000E+00	6.000E+06	1.800E+06	1.796E-01	1.384E+09	1.658E+08
6.254E+08	7.835E+07	0.000E+00	3.600E+06	1.080E+06	2.242E-01	6.195E+08	7.834E+07
5.874E+08	6.728E+07	0.000E+00	3.600E+06	1.080E+06	1.140E-01	5.814E+08	6.727E+07
4.343E+08	5.054E+07	0.000E+00	3.600E+06	1.080E+06	1.140E-01	4.301E+08	5.054E+07
2.520E+08	3.318E+07	0.000E+00	3.600E+06	1.080E+06	2.242E-01	2.500E+08	3.318E+07
1.559E+08	2.134E+07	0.000E+00	3.600E+06	1.080E+06	2.242E-01	1.548E+08	2.134E+07
8.522E+07	1.201E+07	0.000E+00	3.600E+05	1.080E+05	1.140E-01	8.482E+07	1.201E+07
2.661E+07	4.109E+06	0.000E+00	3.600E+05	1.080E+05	1.140E-01	2.643E+07	4.109E+06
4.248E+05	1.080E+05	4.323E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05	1.080E+05
3.600E+05	1.080E+05	4.323E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05	1.080E+05
3.600E+05	1.080E+05	4.323E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05	1.080E+05
3.600E+05	1.080E+05	4.323E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05	1.080E+05
3.600E+05	1.080E+05	4.323E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05	1.080E+05
3.600E+05	1.080E+05	4.323E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05	1.080E+05
3.600E+05	1.080E+05	4.323E-01	3.600E+05	1.080E+05	0.000E+00	3.600E+05	1.080E+05

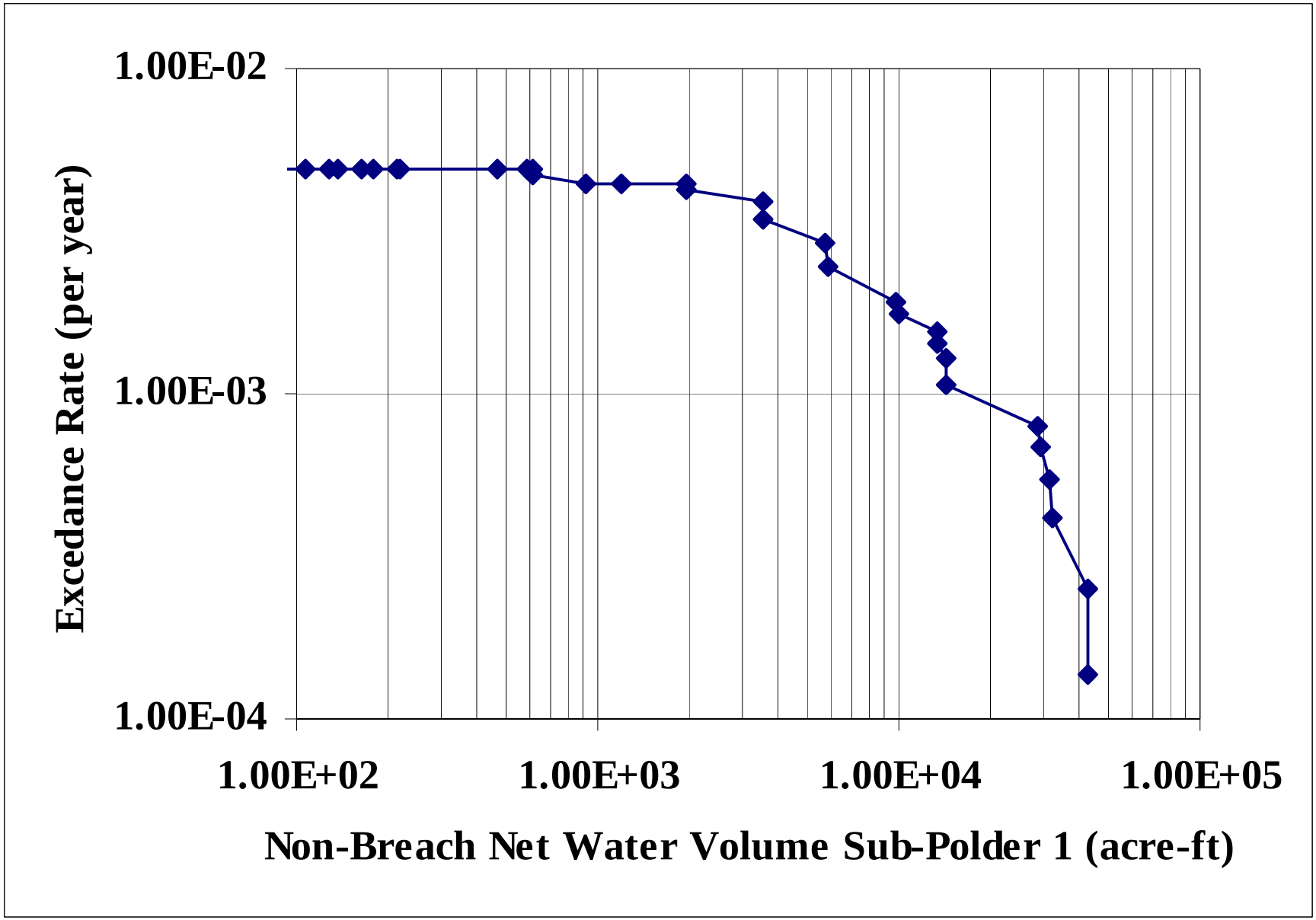
Polder Risk Profiles

Breach
1 out of 1

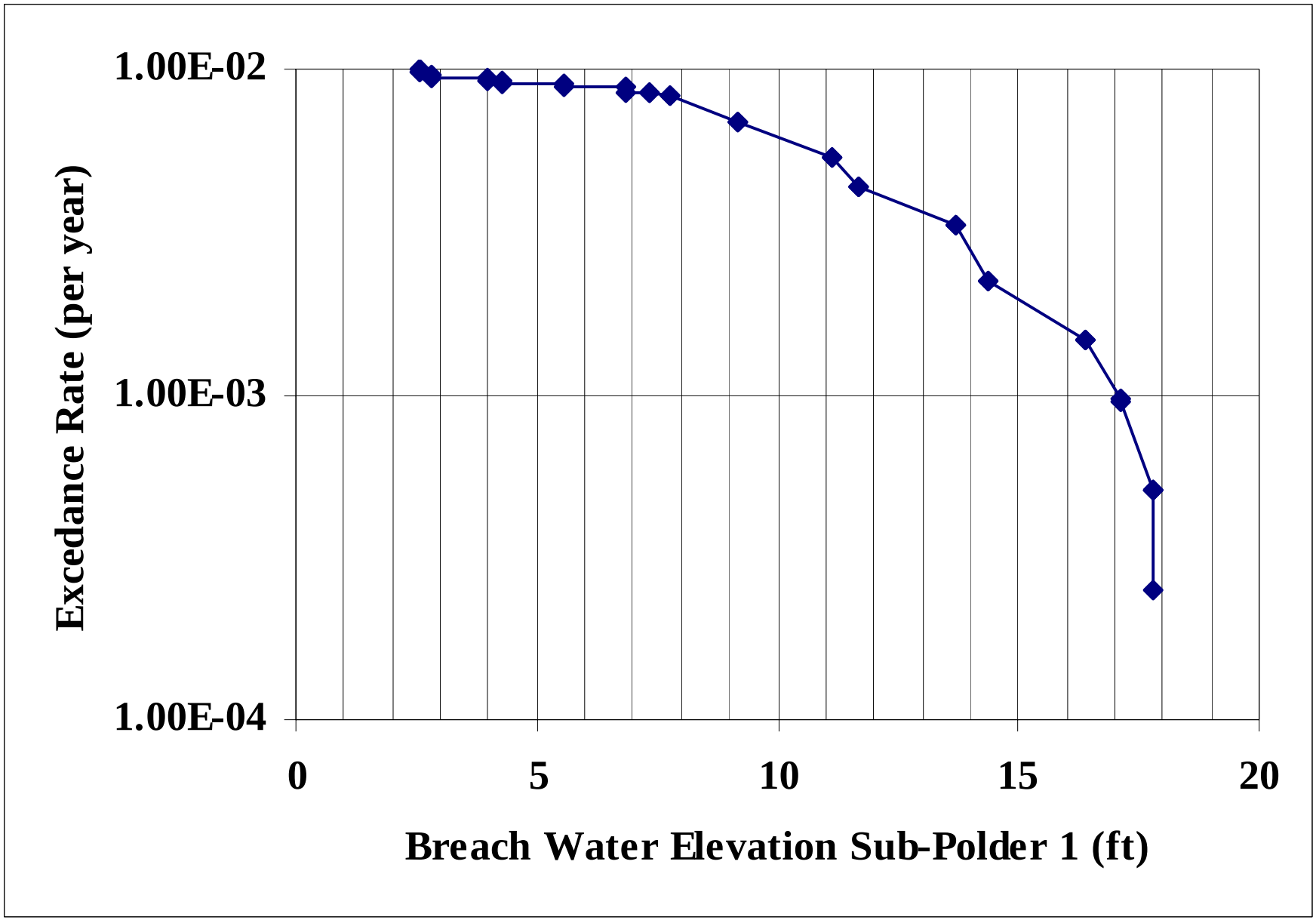
Parameters	
Polder Name	
Sub-Polder number	
Sub-Polder Population at Risk	
Additional parameter	
Additional parameter	
Additional parameter	
Additional parameter	

Hurricane Runs			**Probabilities and Water Elevation for Breach Branches**					
Run	Rate (R)		**Overtopping (OT)**			**Non-overtopping (NOT)**		
i	Mean	StD*	Probability	Water Elevation		Probability	Water Elevation	
			1-(1-P(B|OT)P(OT))	Mean	StD	1-(1-P(B|NOT)P(NOT))	Mean	StD
ID	event/yr	event/yr	*(1-P(FeatureT))	ft	ft	*(1-P(FeatureD))	ft	ft
1	5.00E-04	0.00E+00	5.043E-01	1.781E+01	8.906E-01	2.000E-03	1.781E+01	8.906E-01
2	5.00E-04	0.00E+00	5.043E-01	1.781E+01	8.906E-01	2.000E-03	1.781E+01	8.906E-01
3	7.50E-04	0.00E+00	6.029E-01	1.710E+01	8.550E-01	2.000E-03	1.710E+01	8.550E-01
4	1.00E-03	0.00E+00	5.043E-01	1.639E+01	8.194E-01	2.000E-03	1.639E+01	8.194E-01
5	1.00E-03	0.00E+00	7.479E-01	1.436E+01	7.178E-01	2.000E-03	1.436E+01	7.178E-01
6	1.50E-03	0.00E+00	7.479E-01	1.370E+01	6.851E-01	2.000E-03	1.370E+01	6.851E-01
7	2.00E-03	0.00E+00	5.043E-01	1.170E+01	5.850E-01	2.000E-03	1.170E+01	5.850E-01
8	2.00E-03	0.00E+00	5.043E-01	1.112E+01	5.558E-01	2.000E-03	1.112E+01	5.558E-01
9	2.00E-03	0.00E+00	7.479E-01	9.180E+00	4.590E-01	2.000E-03	9.180E+00	4.590E-01
10	2.00E-03	0.00E+00	7.479E-01	7.778E+00	3.889E-01	2.000E-03	7.778E+00	3.889E-01
11	3.50E-03	0.00E+00	5.000E-03	7.320E+00	3.660E-01	4.133E-02	7.320E+00	3.660E-01
12	5.00E-03	0.00E+00	5.000E-03	6.863E+00	3.431E-01	4.133E-02	6.863E+00	3.431E-01
13	5.00E-03	0.00E+00	5.000E-03	5.565E+00	2.783E-01	4.133E-02	5.565E+00	2.783E-01
14	5.00E-03	0.00E+00	5.000E-03	4.290E+00	2.145E-01	4.133E-02	4.290E+00	2.145E-01
15	5.00E-03	0.00E+00	5.000E-03	3.960E+00	1.980E-01	4.133E-02	3.960E+00	1.980E-01

Polder Risk Profiles

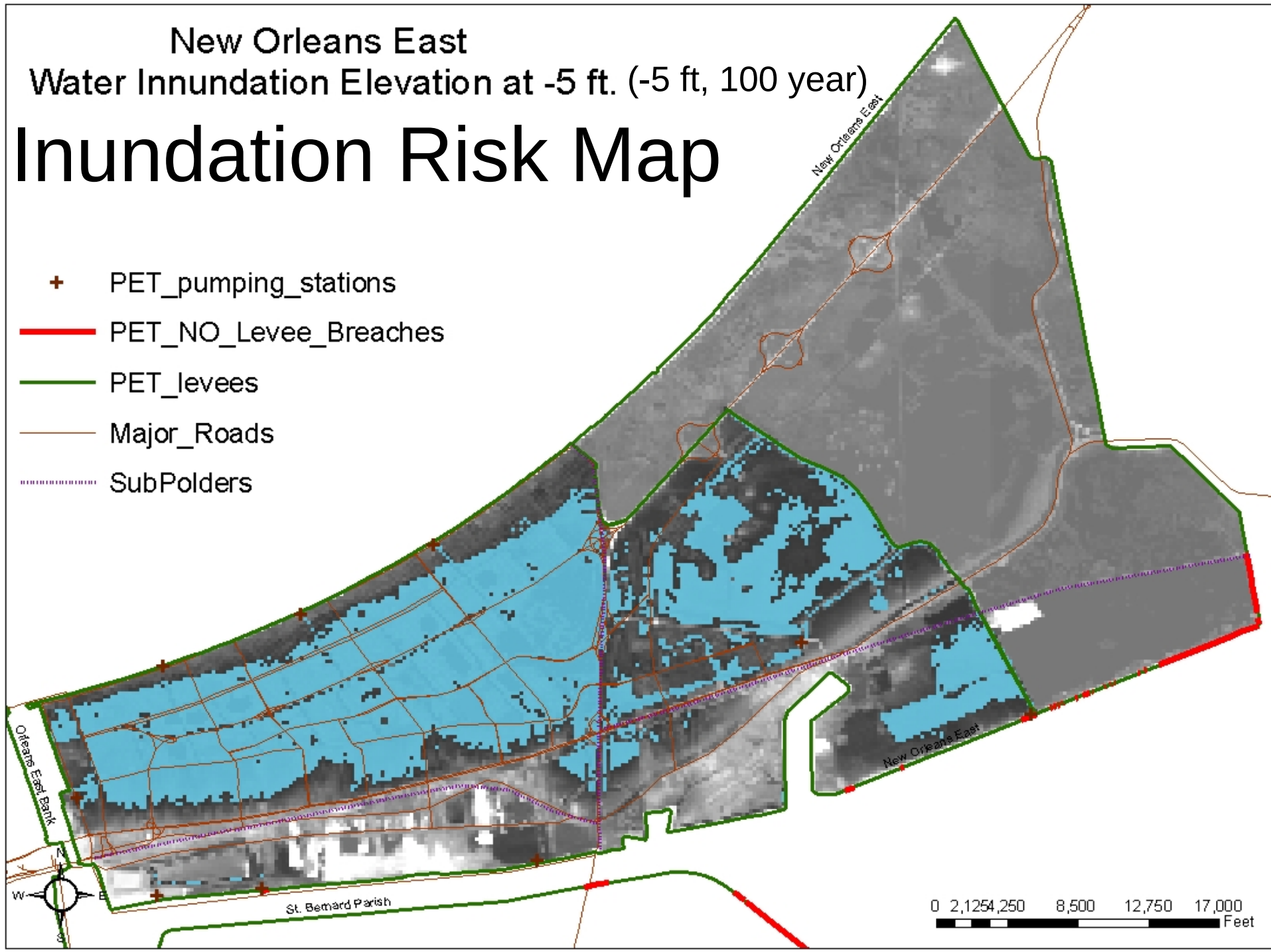


Polder Risk Profiles

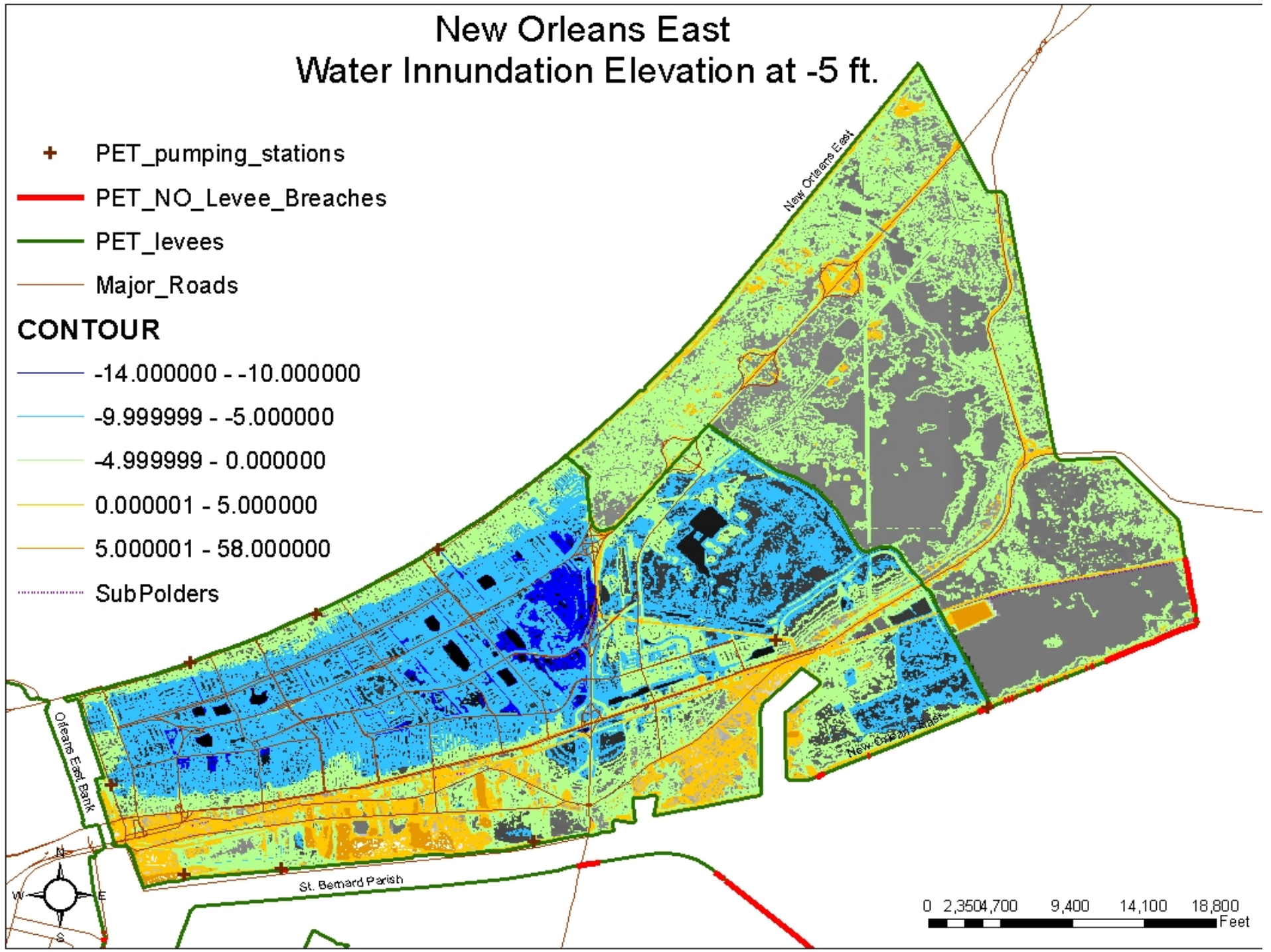


New Orleans East
Water Innundation Elevation at -5 ft. (-5 ft, 100 year)

Inundation Risk Map



New Orleans East
Water Innundation Elevation at -5 ft.



Region and Storm Risk Profiles

- Polder risk profiles
- Region risk profiles
- Risk profiles for storm categories
- Uncertainty bounds

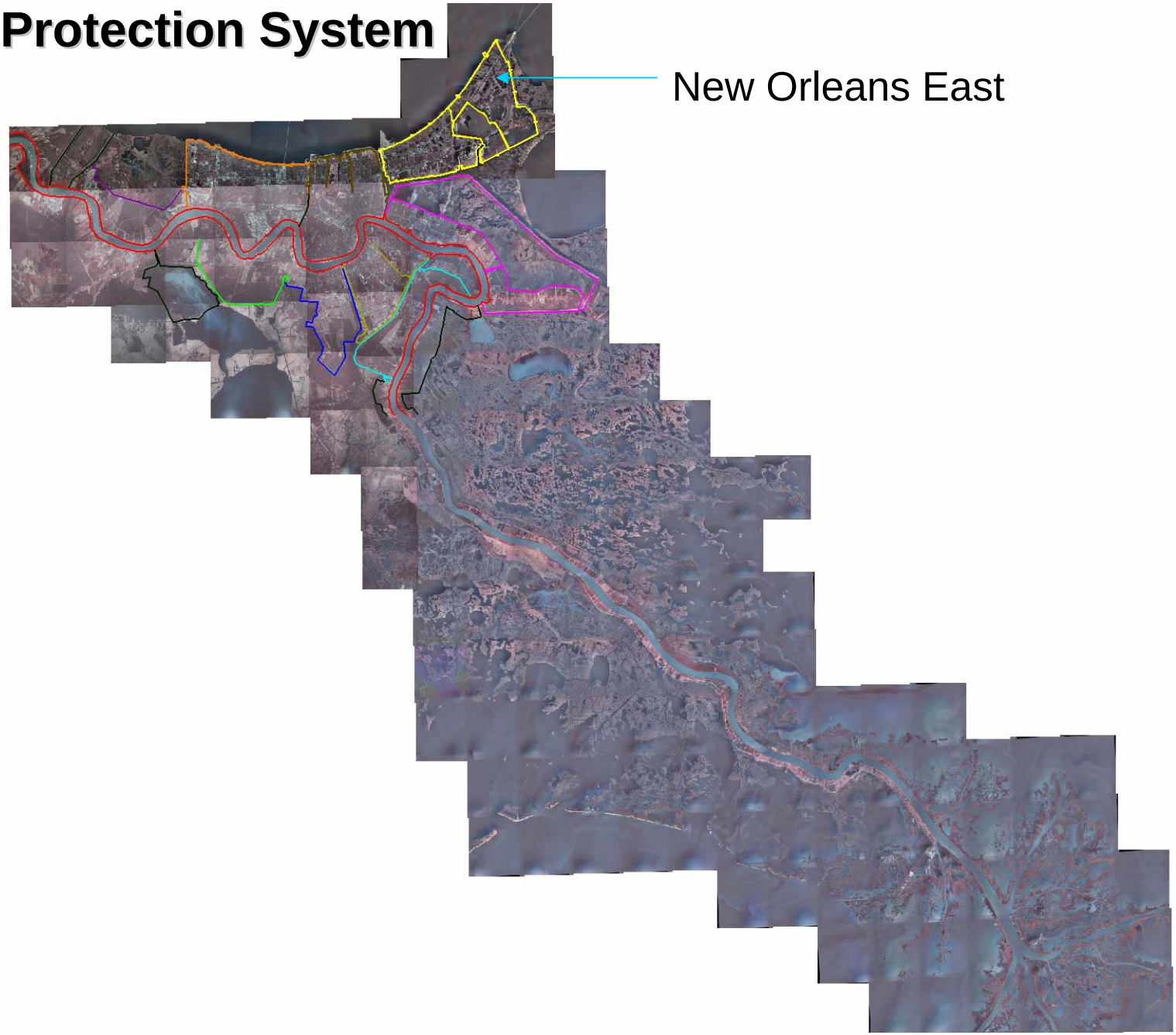
System/Polder Definitions

New Orleans East

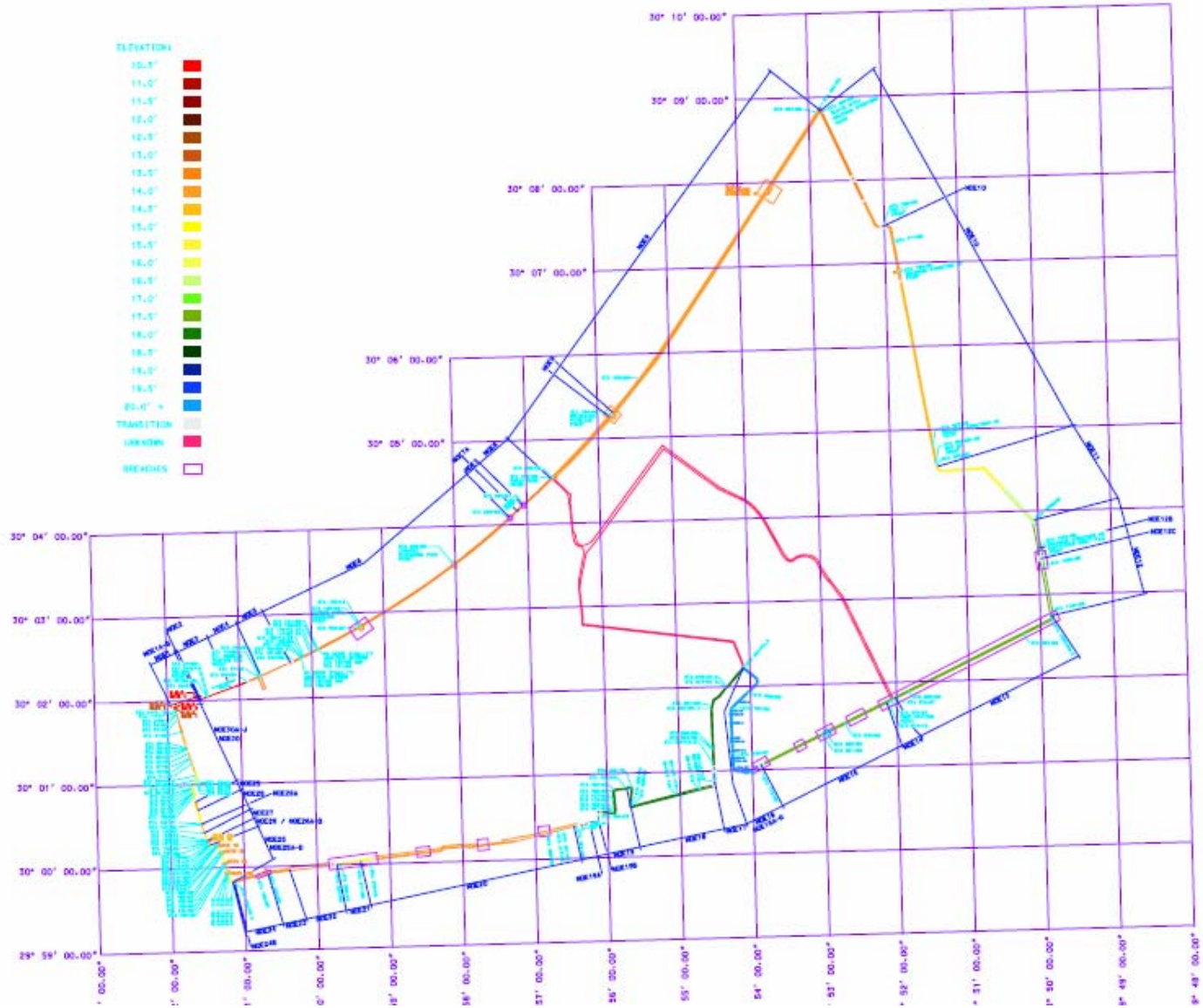
Polder Definitions

- Generate maps from DMs
- Overlay lat/long info
- Overlay elevations and stationing
- Overlay soil borings and profiles
- Locate critical features from aerial photos
- Field verify features and identify changed conditions
- Coordinate with TFG input repairs and modifications
- Generate spreadsheets
- Develop reaches based on engineering parameters

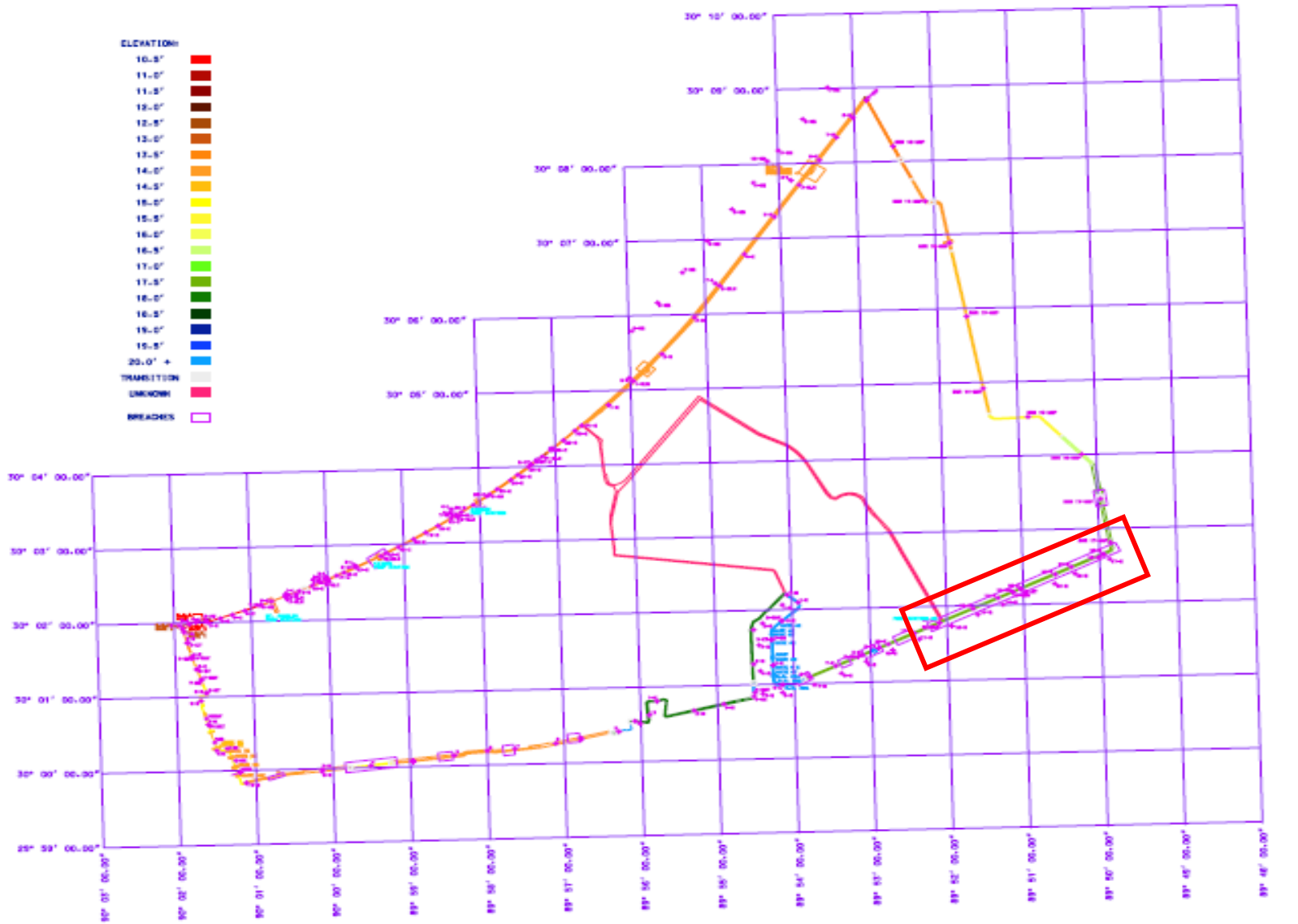
Hurricane Protection System

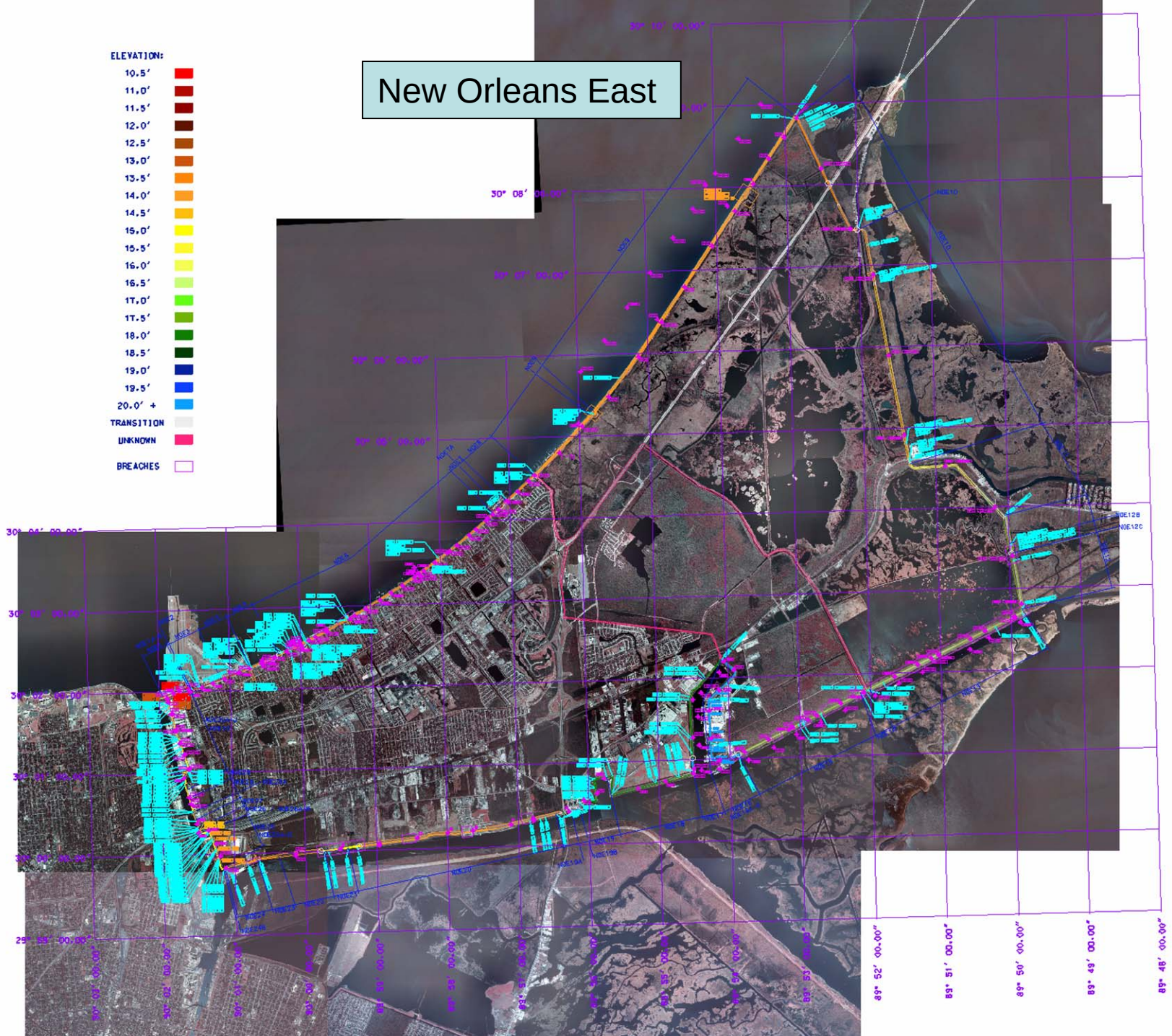


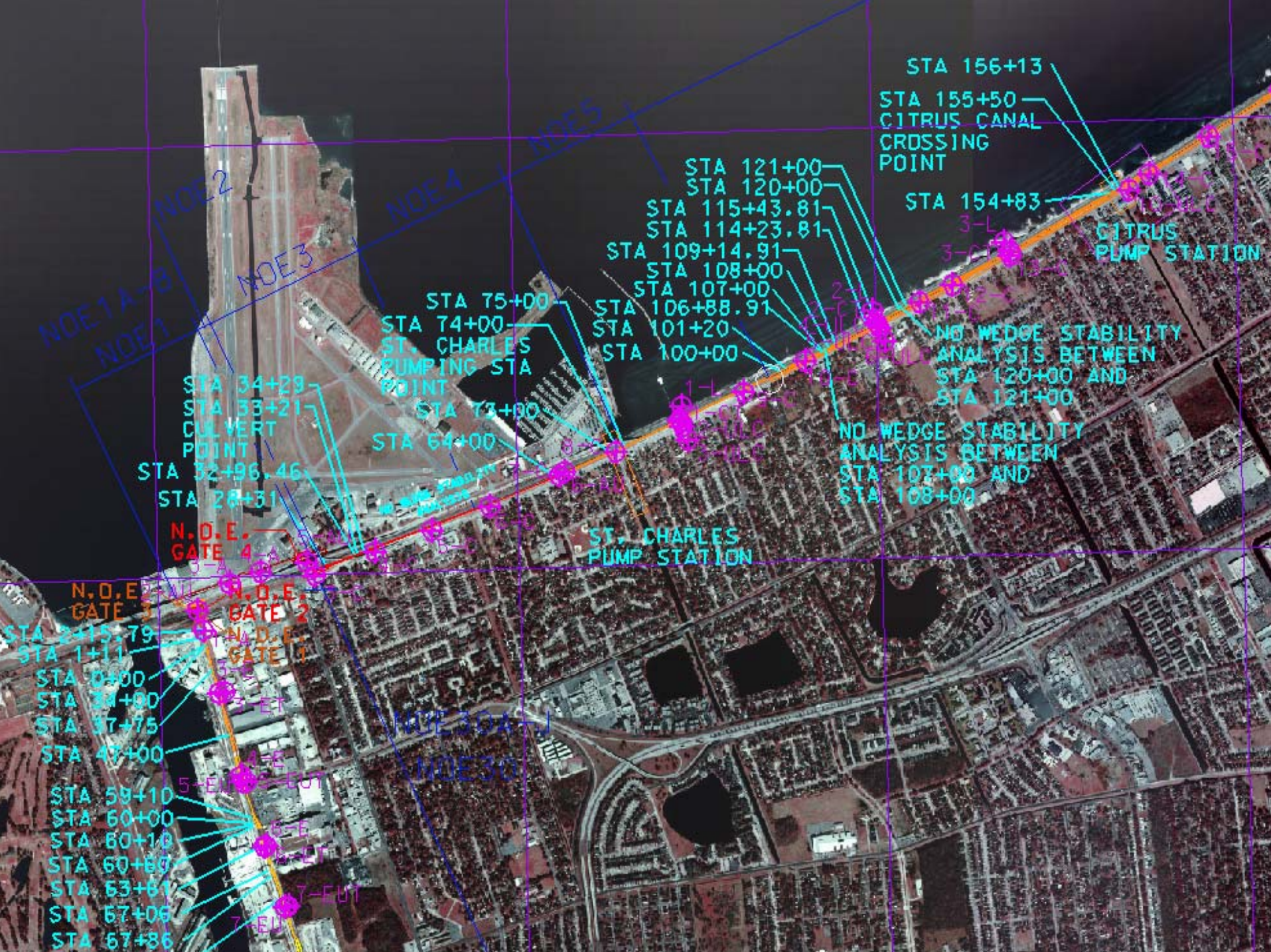
New Orleans East Polder



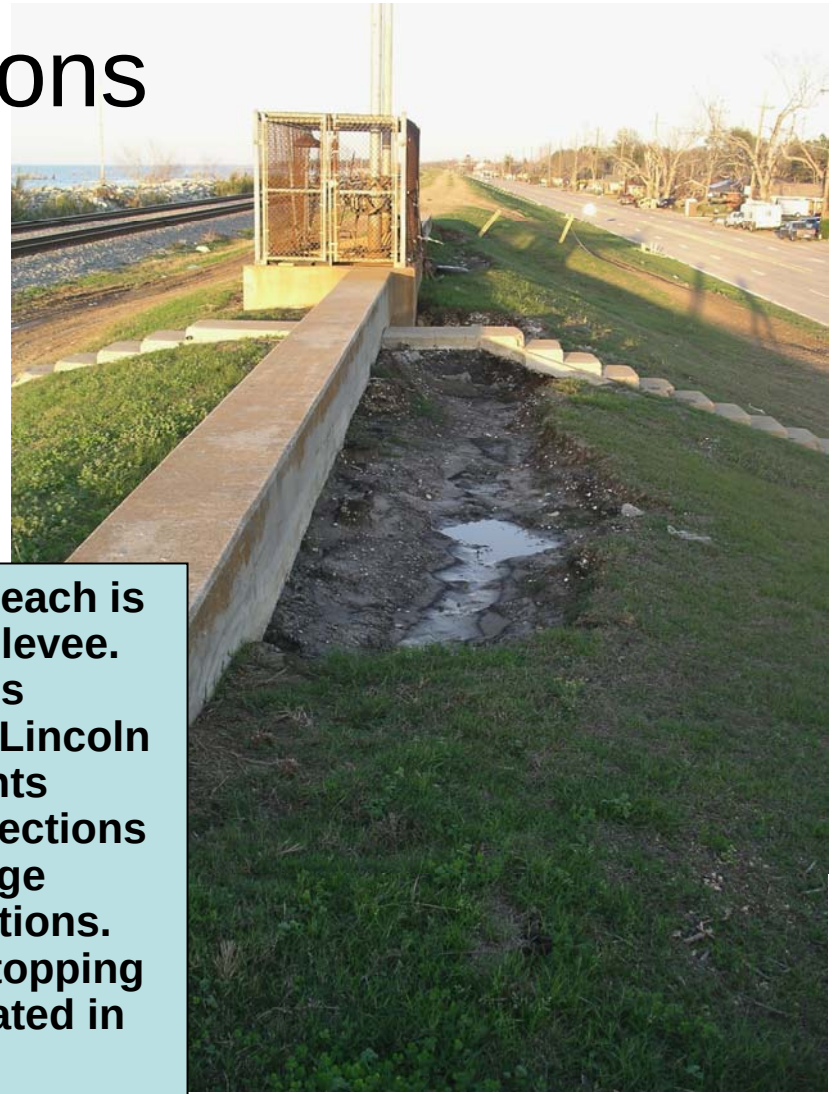
Borings Locations for NOE




New Orleans East
ELEVATION:
10.5'
11.0'
11.5'
12.0'
12.5'
13.0'
13.5'
14.0'
14.5'
15.0'
15.5'
16.0'
16.5'
17.0'
17.5'
18.0'
18.5'
19.0'
19.5'
20.0' +
TRANSITION
UNKNOWN
BREACHES


STA 156+13
STA 155+50
CITRUS CANAL
CROSSING
POINT
STA 154+83
CITRUS
PUMP STATION
STA 121+00
STA 120+00
STA 115+43.81
STA 114+23.81
STA 109+14.91
STA 108+00
STA 107+00
STA 106+88.91
STA 101+20
STA 100+00
NO WEDGE STABILITY
ANALYSIS BETWEEN
STA 120+00 AND
STA 121+00
NO WEDGE STABILITY
ANALYSIS BETWEEN
STA 107+00 AND
STA 108+00
STA 75+00
STA 74+00
ST. CHARLES
PUMPING STA
POINT
STA 73+00
STA 64+00
ST. CHARLES
PUMP STATION
STA 34+29
STA 33+21
CULVERT
POINT
STA 32+96.46
STA 28+31
N.O.E.
GATE 4
N.O.E.
GATE 3
N.O.E.
GATE 2
N.O.E.
GATE 1
STA 2+15.79
STA 1+11
STA 0+00
STA 34+00
STA 37+75
STA 47+00
STA 59+10
STA 60+00
STA 60+10
STA 60+60
STA 63+61
STA 67+06
STA 67+86
NOE1A-B
NOE1
NOE2
NOE3
NOE4
NOE5
NOE30A
NOE30

Feature Definitions



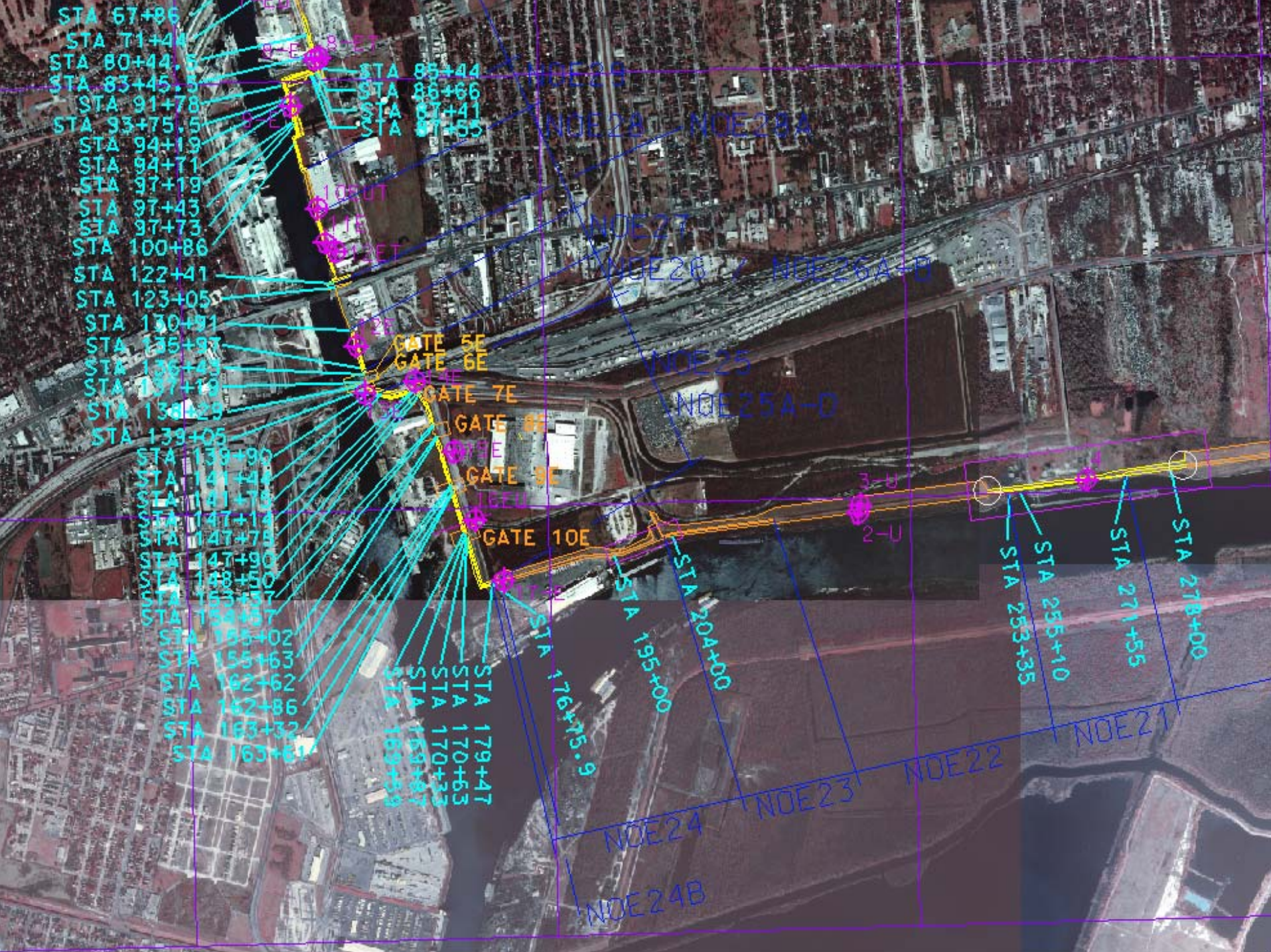
- **<u>Reach NOE6 (Citrus Lakefront DM).</u> This reach is defined by a 19,112 linear feet segment of levee. It begins at the end of the Stars and Stripes floodwall and ends at the west side of the Lincoln Beach floodwall. There are two "key" points within this segment: two small floodwall sections embedded within the levee for the discharge pipes of the Citrus and Jahncke Pump Stations. There was some minor scouring and overtopping of this levee at various locations, as indicated in Figure 4, but no failures.**


STA 646+07.9
STA 644+91.9
STA 690+00
STA 627+20
STA 625+07.4
STA 707+50
STA 740+00
STA 485+70
STA 492+29
STA 483+00
STA 482+00
STA 477+50
STA 476+50
STA 466+20
STA 464+50
STA 454+75
STA 772+00
NOE16
NOE16A-R
NOE17
NOE18

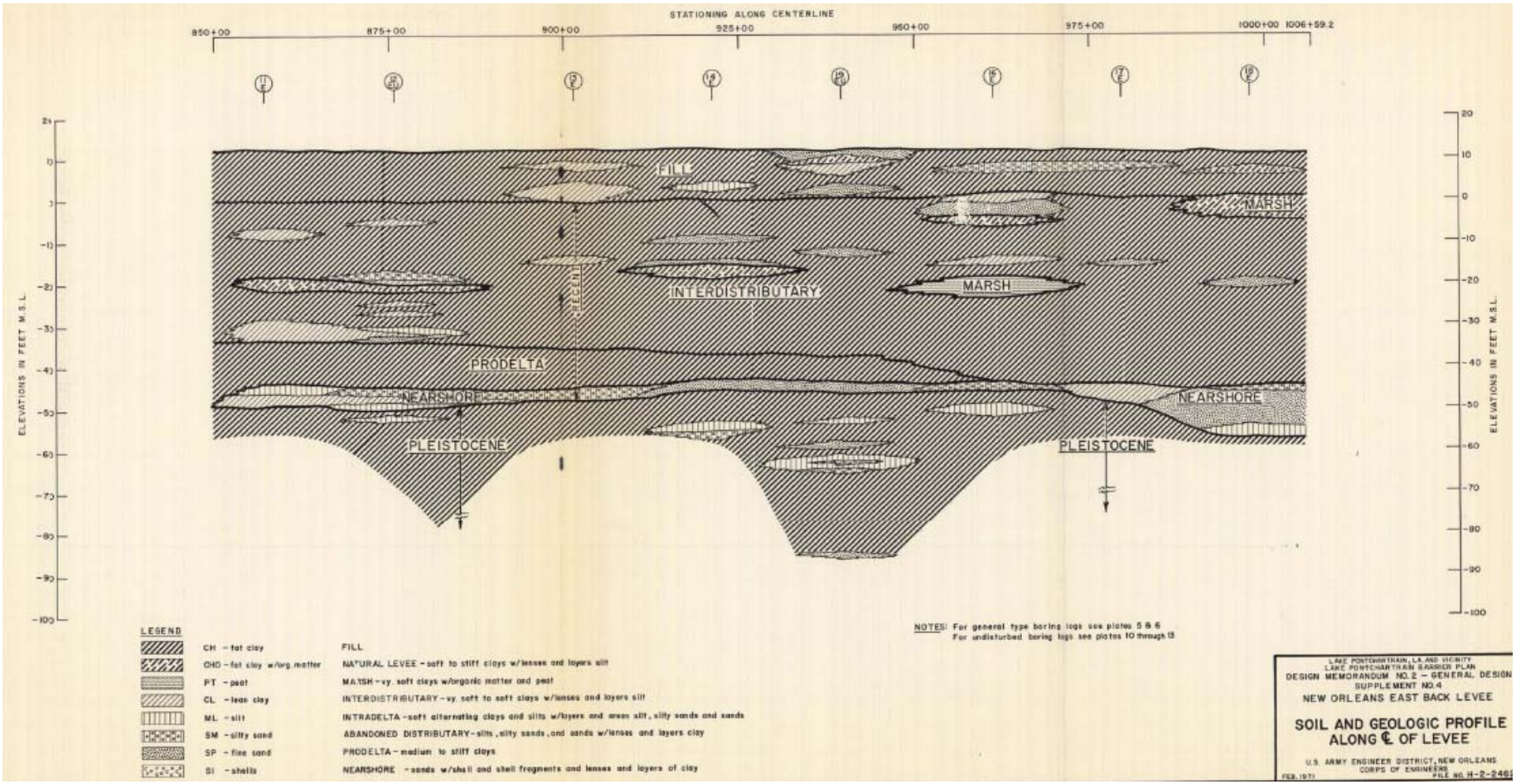
Reach Definition

- **<u>Reach NOE16 (East Back DM).</u> This reach consists of the east floodwall around the Michoud Canal. It is approximately 10,757 feet long. It starts at the GIWW and continues along the Michoud Canal where it joins with the Citrus Back floodwall. There are 18 key points along this reach for gated closures at industry and road crossings. However, from site inspections, it appears as if 5 of these gates are placed in the permanently closed position. As shown in Figure 9, the transition sheet pile floodwall at the beginning of this reach failed during Katrina.**

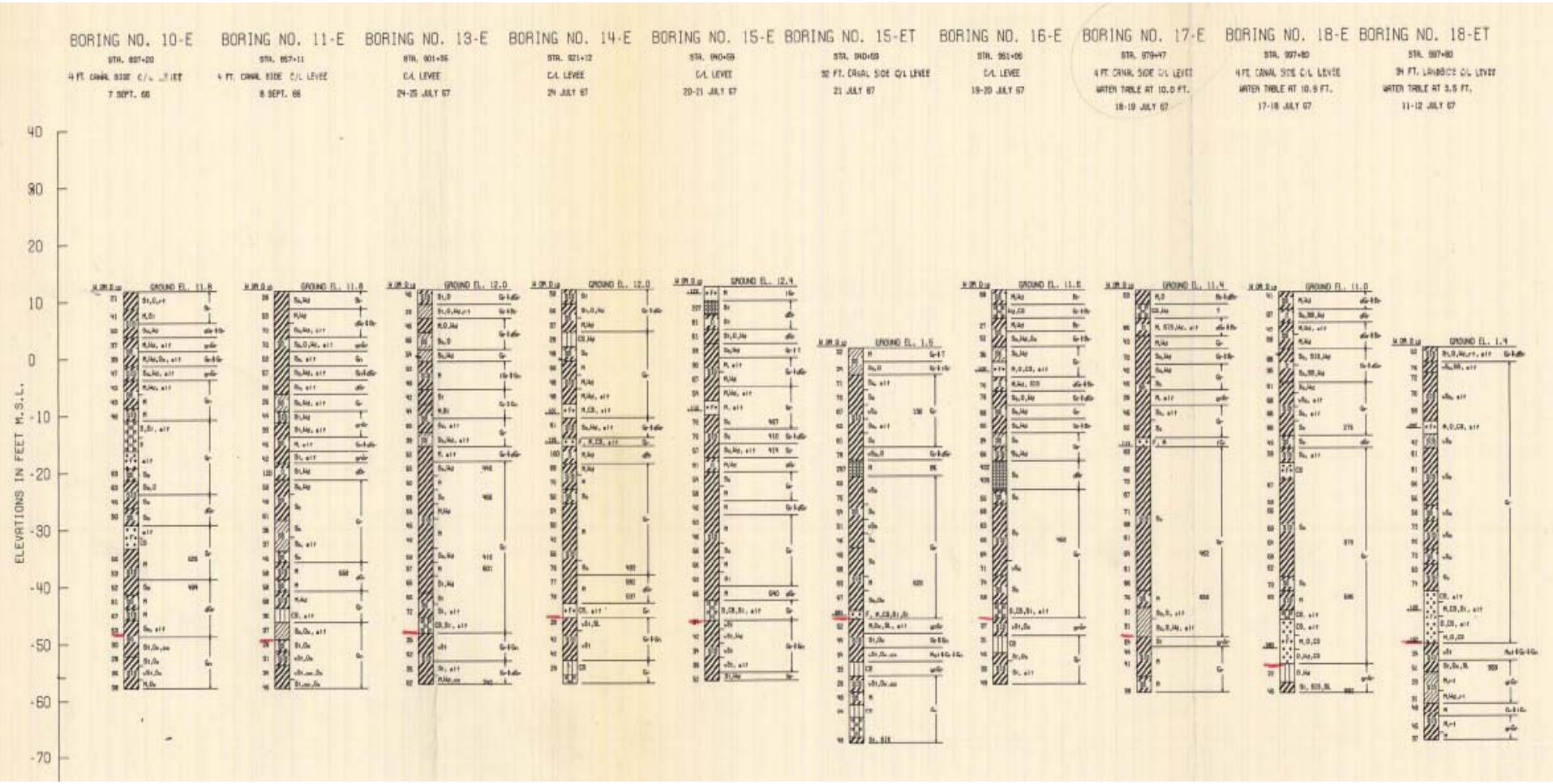
Figure 9. Floodwall Failure at East End of Michoud Canal FW


STA 67+86
STA 71+44
STA 80+44.5
STA 83+45.5
STA 91+78
STA 93+75.5
STA 94+19
STA 94+71
STA 97+19
STA 97+43
STA 97+73
STA 100+86
STA 122+41
STA 123+05
STA 130+91
STA 135+97
STA 136+43
STA 137+19
STA 138+29
STA 139+05
STA 139+90
STA 141+48
STA 141+78
STA 147+14
STA 147+79
STA 147+90
STA 148+50
STA 154+07
STA 155+02
STA 155+63
STA 162+62
STA 162+86
STA 163+32
STA 163+61
STA 85+44
STA 86+66
STA 87+41
STA 87+65
NOE28
NOE28A
NOE27
NOE26
NOE26A-B
NOE25
NOE25A-D
GATE 5E
GATE 6E
GATE 7E
GATE 8E
GATE 9E
GATE 10E
3-U
2-U
STA 176+75.9
STA 179+47
STA 170+63
STA 170+33
STA 169+81
STA 169+50
STA 195+00
STA 204+00
STA 253+35
STA 255+10
STA 271+55
STA 278+00
NOE24
NOE24B
NOE23
NOE22
NOE21

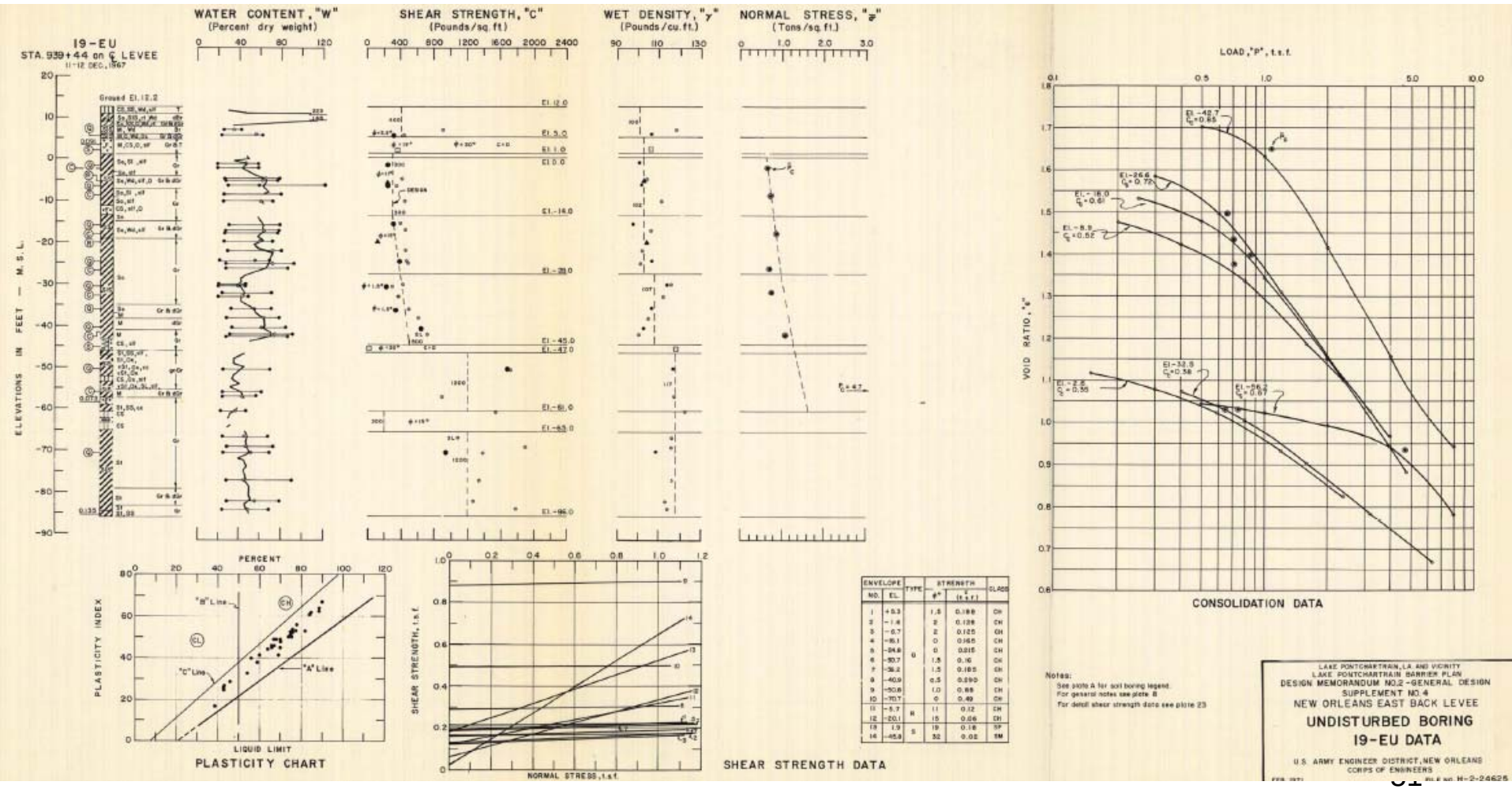
Geologic Cross Section - NOE East Back Levee



Boring Logs – NOE East Back Levee

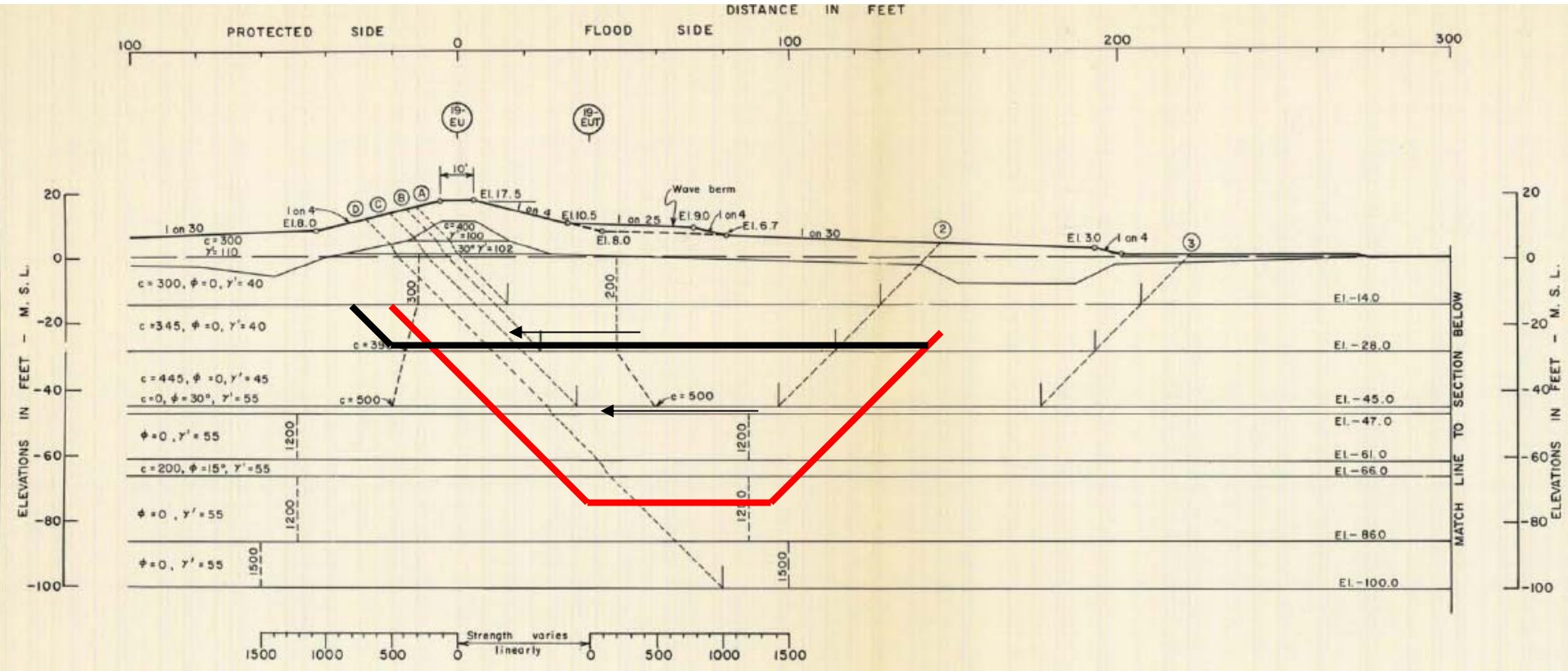


Undisturbed Boring – NOE East Back Levee

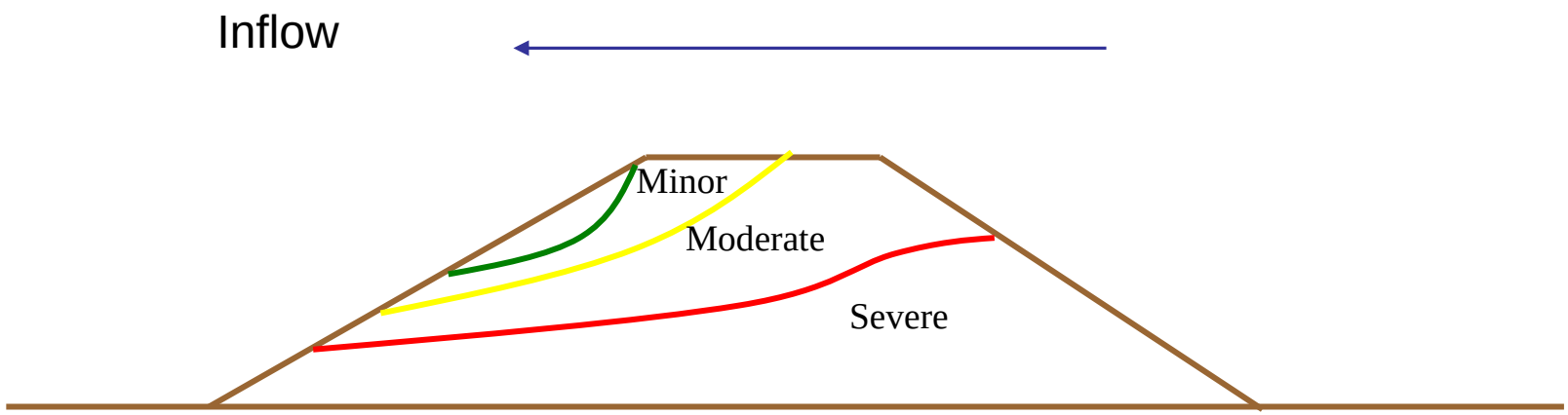


Failure Modes for Reliability Models

Levees – Local and global stability

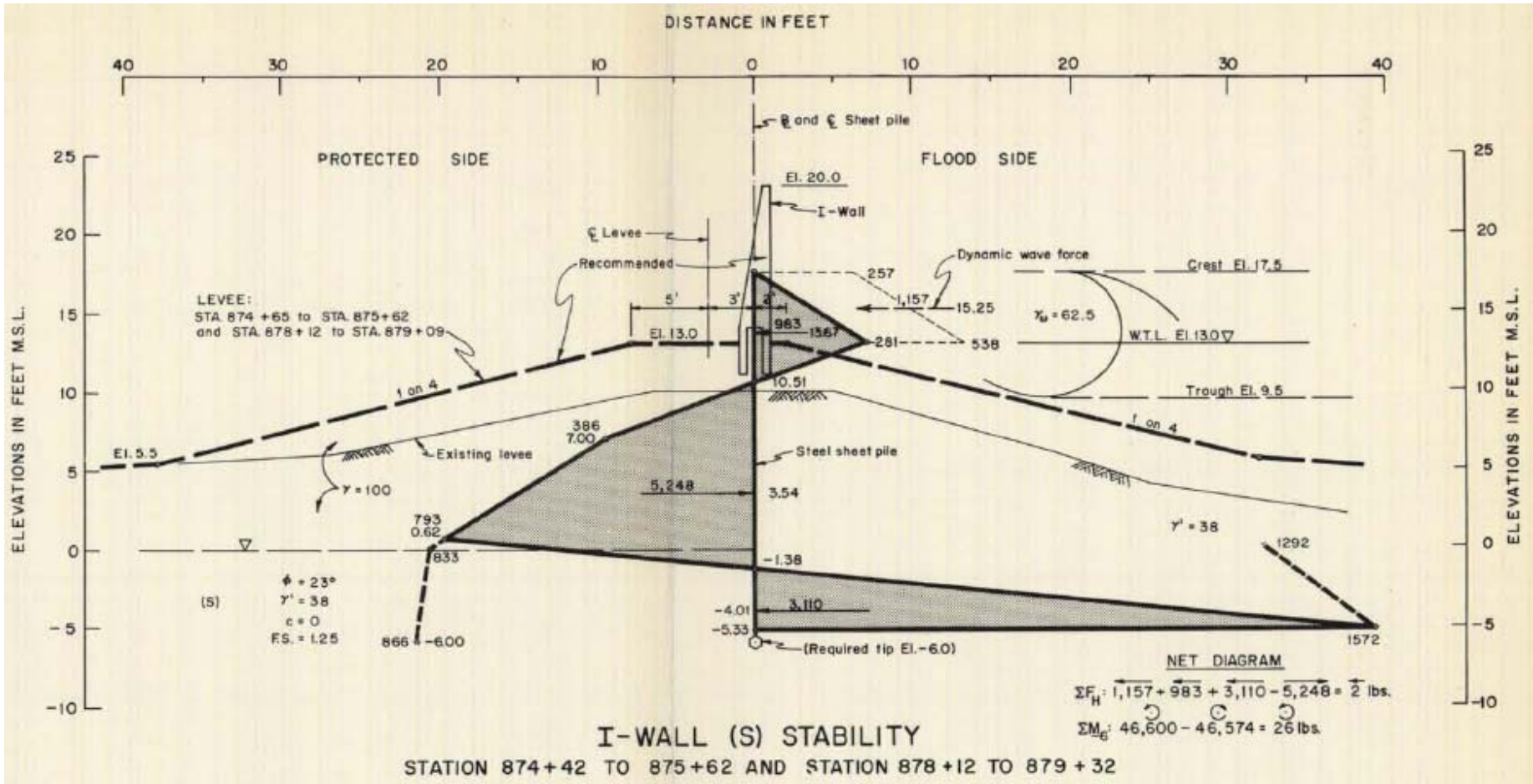


Levees - Erosion



Soil \ Erosion	Minor	Moderate	Severe
CH	x1	y1	z1
CL	x2	y2	z2
ML	x3	y3	z3

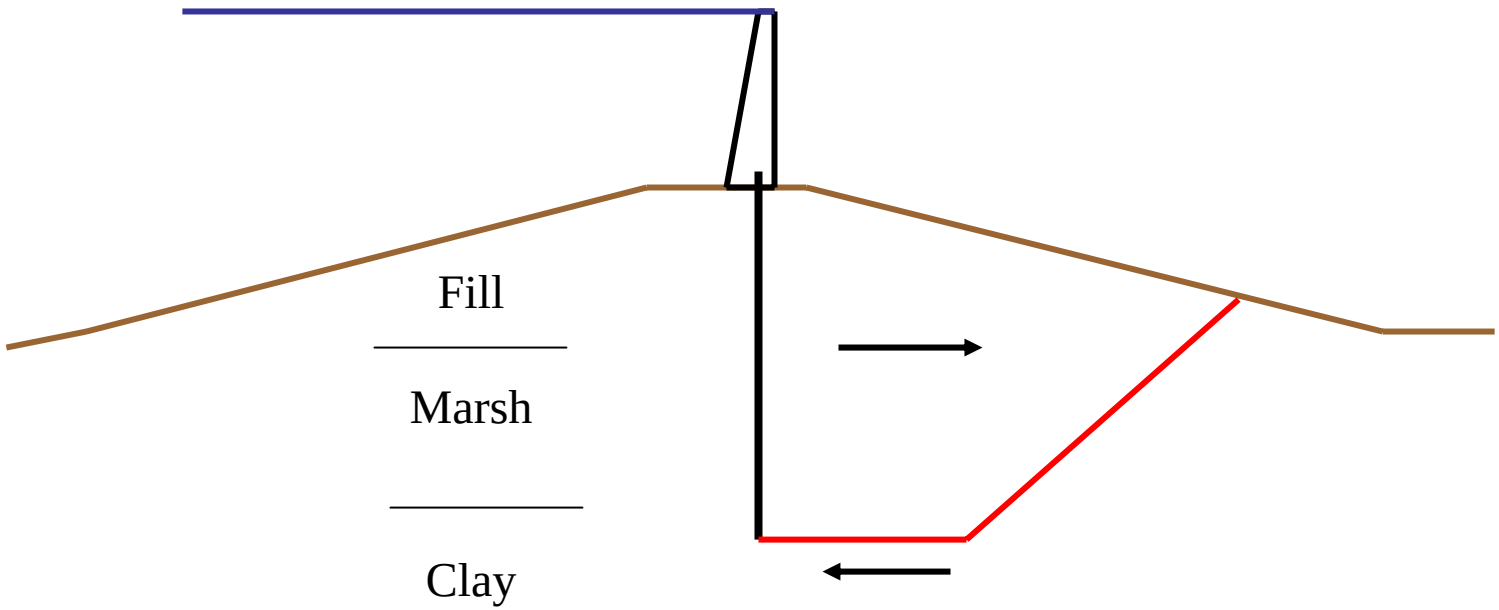
I-Wall Force/Moment Stability



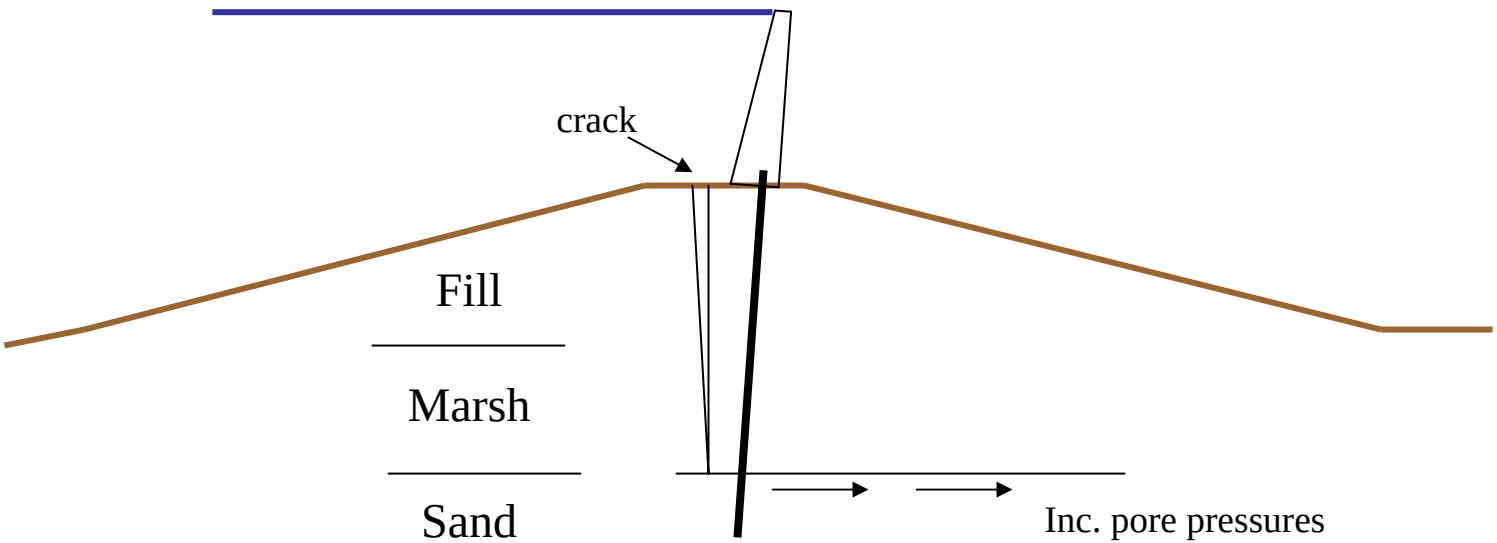
I-WALL (S) STABILITY

STATION 874+42 TO 875+62 AND STATION 878+12 TO 879+32

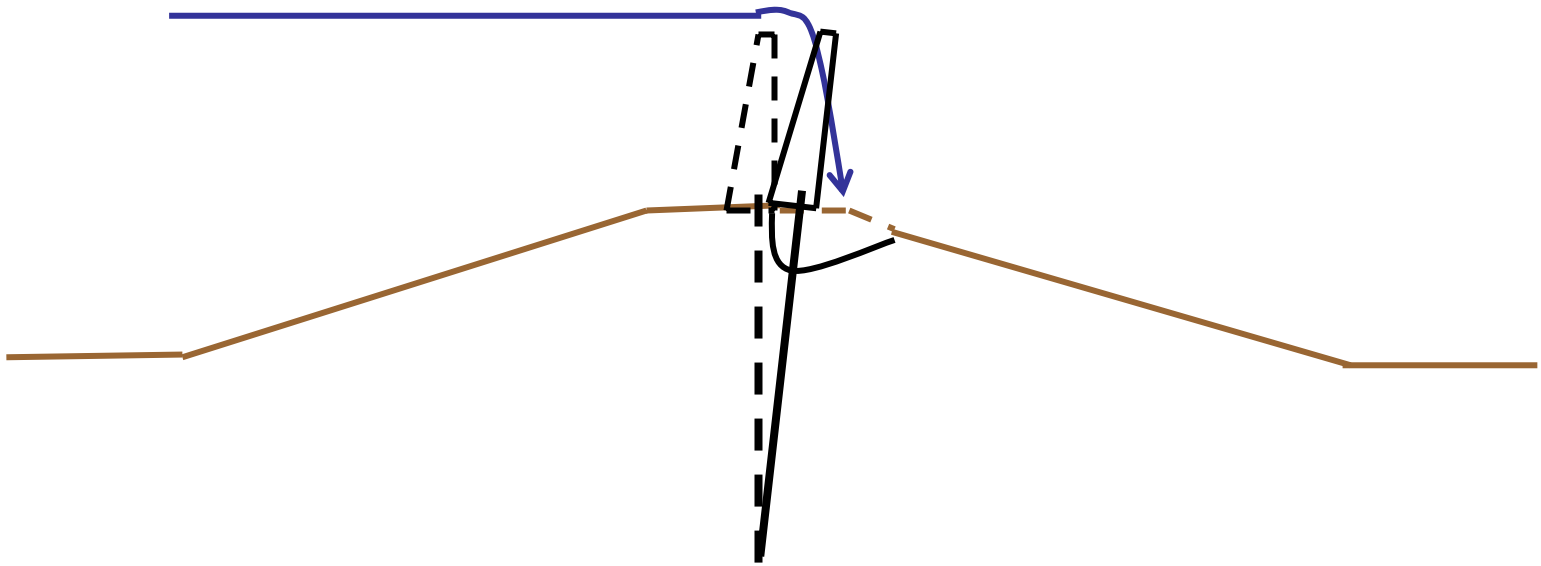
I-Wall - Translation



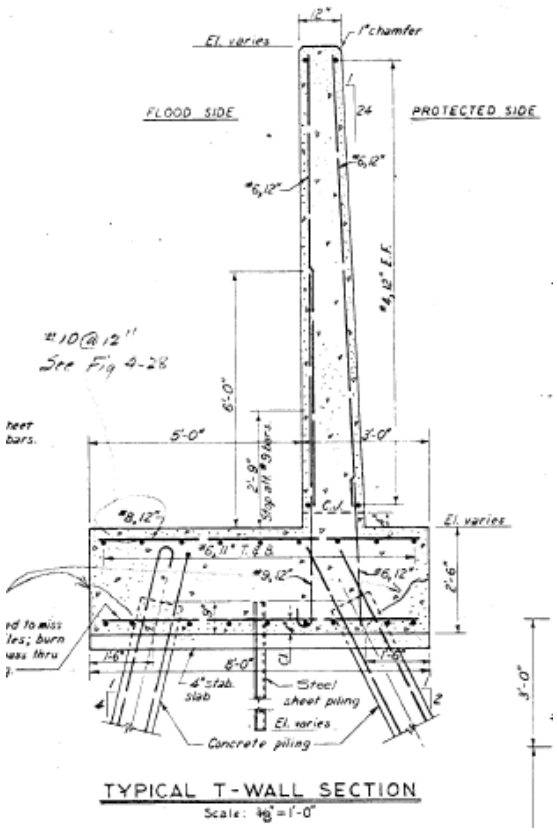
I-wall – Rotation, crack, uplift



I-wall – Erosion, stability



T-Walls – Pile Forces/Deflections



Combined Pile Loads

$$P_f = P[\frac{f_a}{F_a} + \frac{f_b}{F_b} > 1]$$

where,

f_a = axial load

F_a = allowable axial load

f_b = bending stress

F_b = allowable bending stress

Deflections

$$P_f = P[Y_a - y < 0]$$

where,

Y_a = allowable deflection

y = deflection

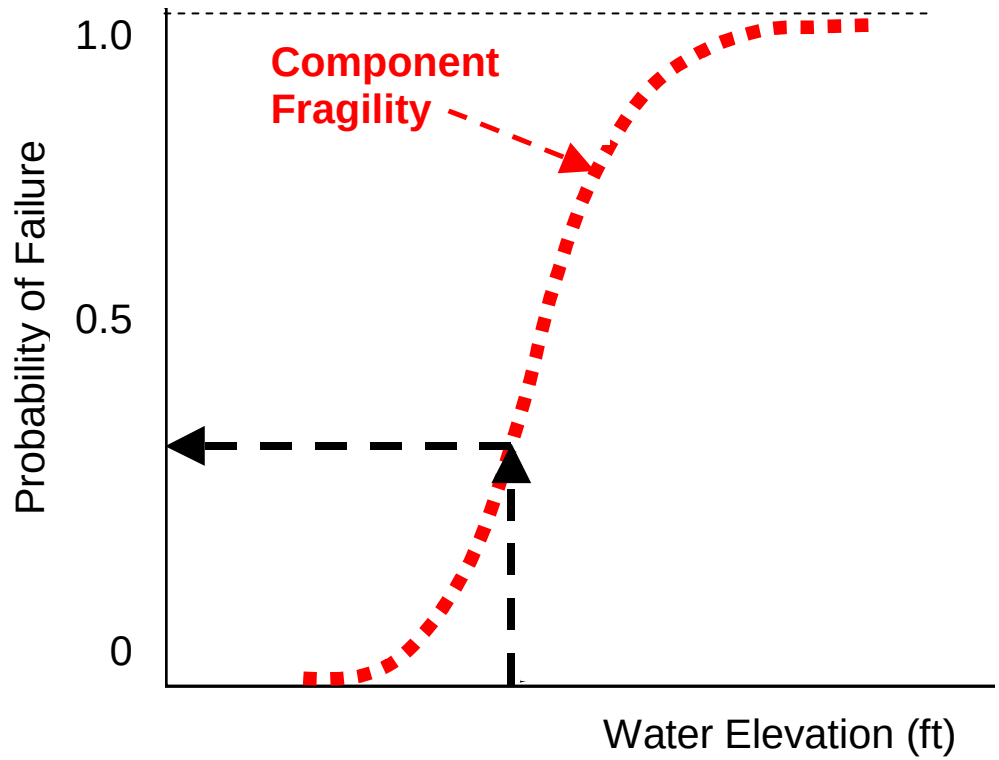
Spatial Variability

- Multiple long reaches of levees and I-walls
- Variation of soil materials (levee and foundation) with depth and length
- Use spatial correlation structure of soil properties
- Get “representative independent reaches”
- Use weakest link approach for fragility of levee length

Reliability Calculations

- Use GDM calculation methods and adaptive models to field behavior
- Calibrate GDM models with the levees and floodwall analyses
- Develop soil property uncertainties from field boring information
- Develop the probability of failures and fragility curves for components
- Account for spatial variation along levee lengths
- Combine and develop fragility curves for reaches

Fragility Curves



Consequences

Consequences

- Risk team input to Consequences team
- Factors to determine feasibility of evacuation and rescue
  - including rate of inundation
  - duration of inundation
  - velocity of flow.
- Four areas:
  - economic consequences
  - environmental consequences
  - social, cultural and historical consequences
  - life safety and health consequences.

Consequences

Outputs of the risk and reliability modeling

- Estimate of the probability of life loss and physical damage
- Probabilistic estimates of losses
- Inundation mapping
- Probabilities of flooding

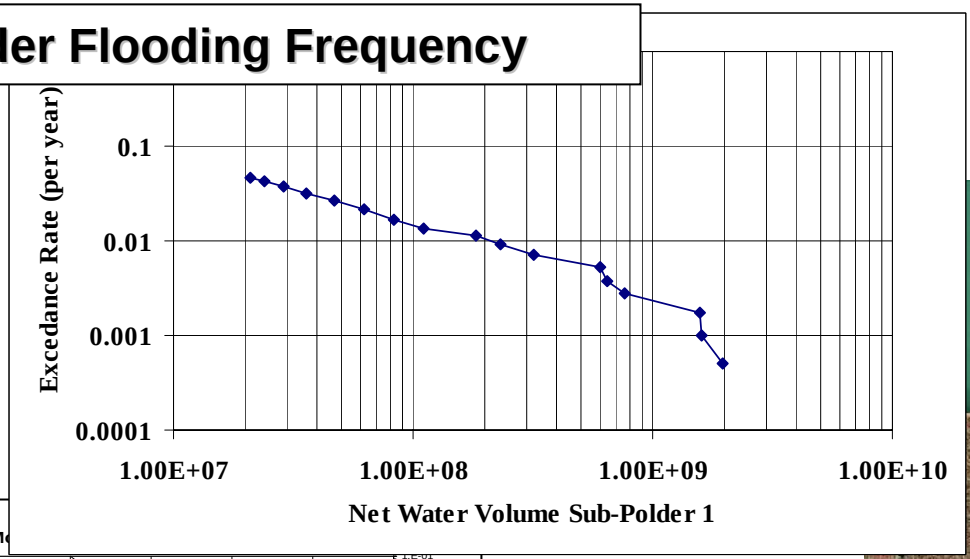
Progress

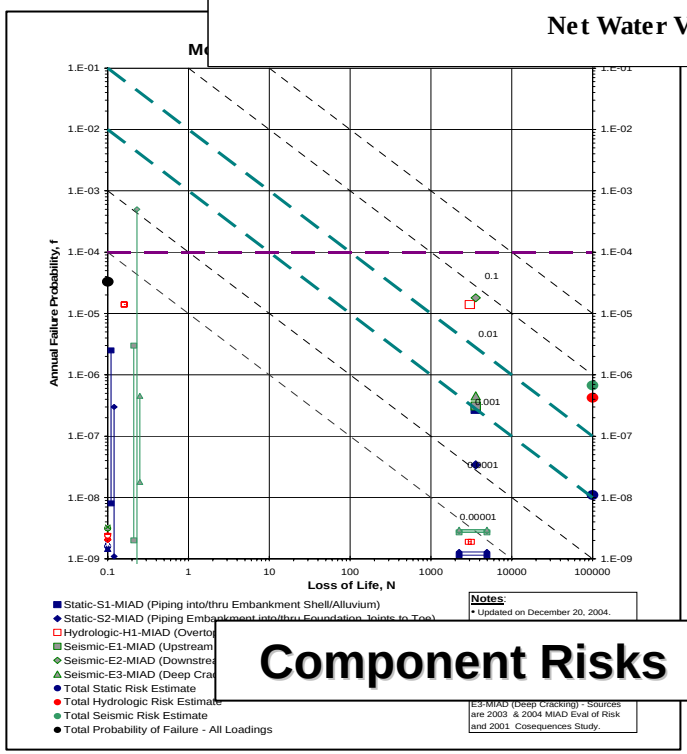
- Risk team liaison with Consequences team to the refine life loss model (lifesim)
- Social and demographic data being collected for the life loss estimation.
- Data being analyzed to develop relationships for the risk model.
- Detailed analysis of fatality data underway to relate socio-economic demographic information to specific risk factors for fatality.
- Liaison with Louisiana State University Hurricane Center
- LSU assessment of previous hurricane losses and modeling of expected losses due to future hurricanes valuable input to the understanding of consequences
- Limited consequence data available for the risk model

Display of Analysis Results

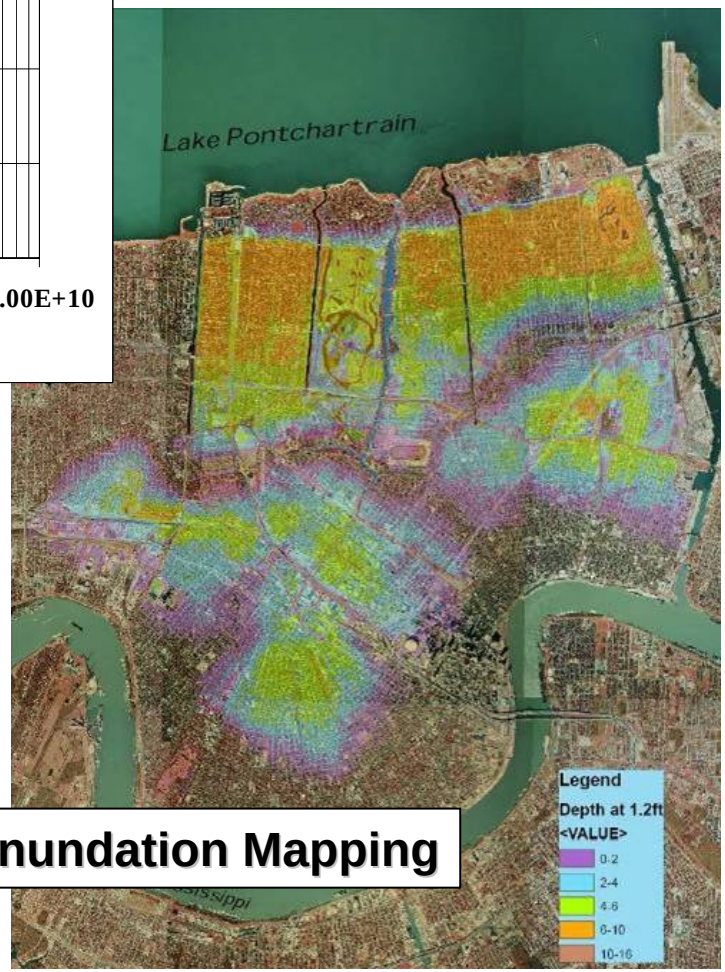
RESULTS OF THE ANALYSES

Polder Flooding Frequency



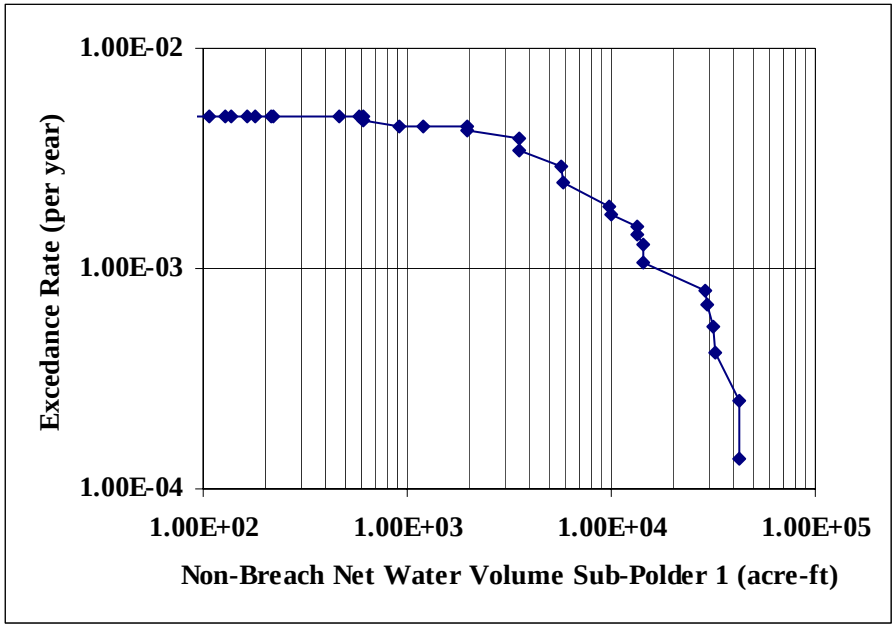


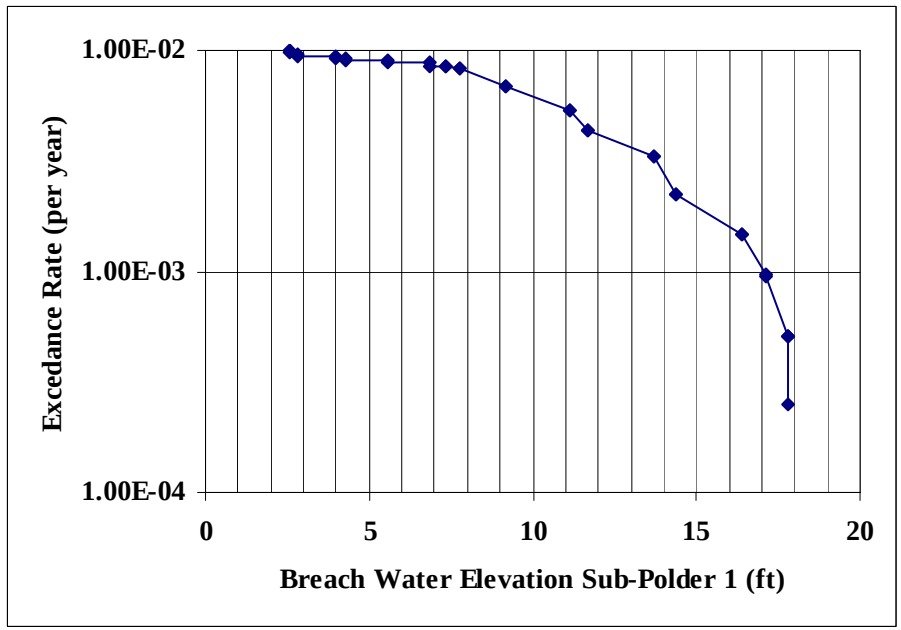
Component Risks

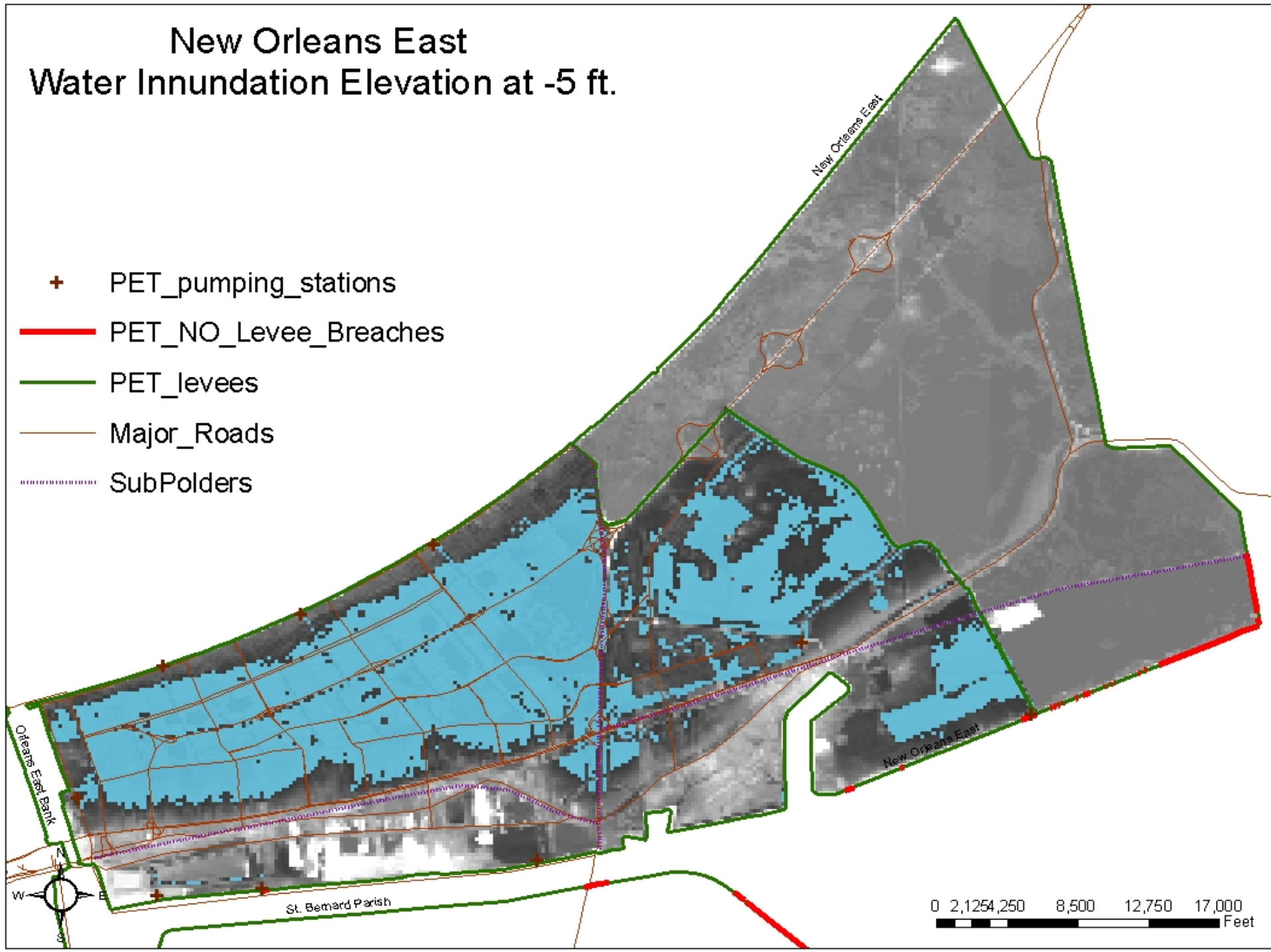


Inundation Mapping

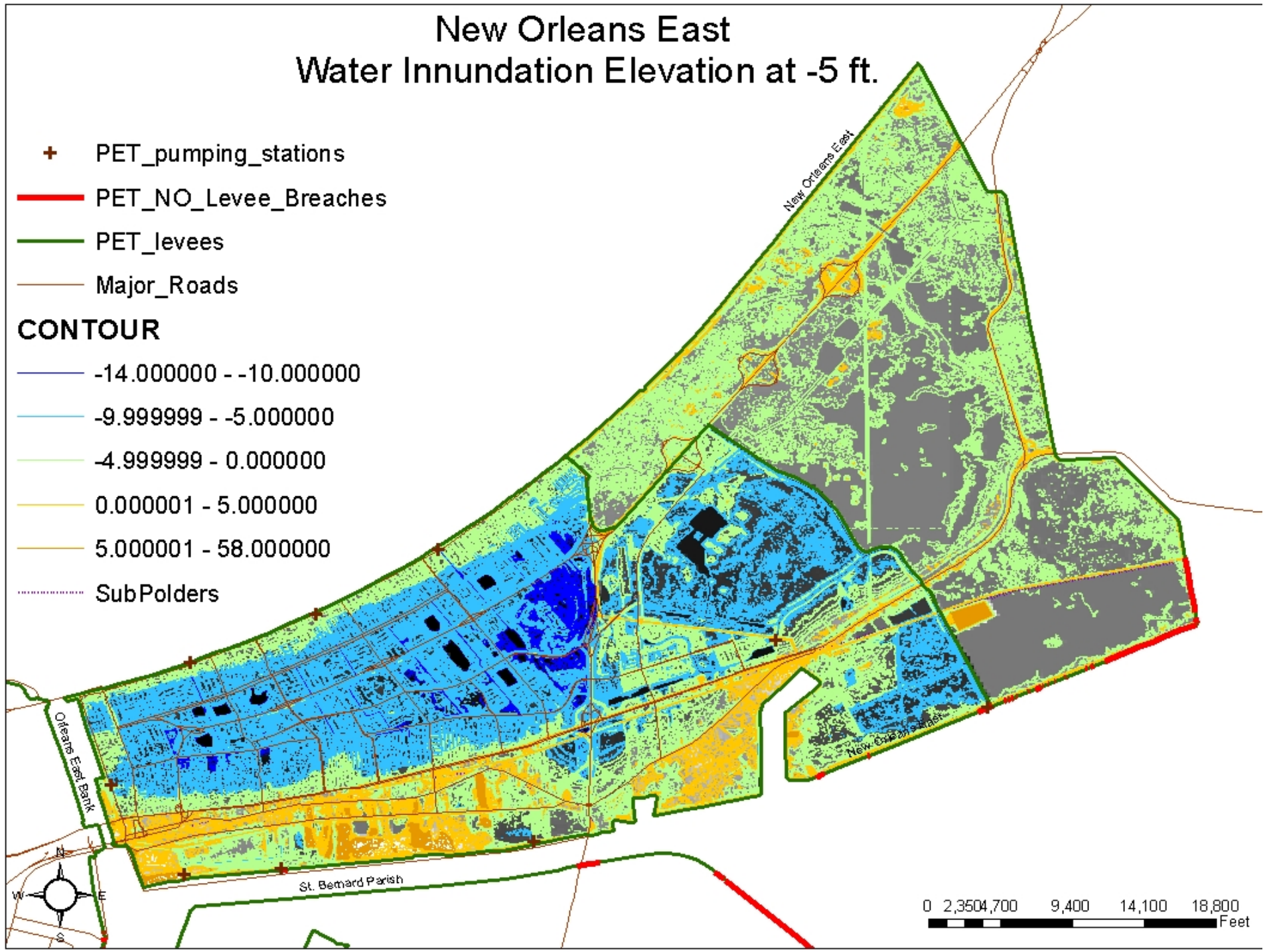
Polder Risk Profiles






New Orleans East
Water Innundation Elevation at -5 ft.
PET_pumping_stations
PET_NO_Levee_Breaches
PET_levees
Major_Roads
SubPolders
New Orleans East
New Orleans East
Orleans East Bank
St. Bernard Parish
0 2,1254,250 8,500 12,750 17,000
Feet

New Orleans East
Water Innundation Elevation at -5 ft.



Risk Communication

Expected Results

From early qualitative results, it seems clear that:

- Pre-Katrina New Orleans HPS risk would have been classified as high by tolerable risk guidelines in use in the US or overseas (including The Netherlands).
- Post-Katrina probability of HPS failure is expected to be lower due to repairs and improvements but may still be classified as high.
- Post-Katrina population at risk will be lower but potential life loss in the event of HPS failure would depend significantly on the warning and evacuation effectiveness
- The risk and reliability work is laying the foundation for an integrated risk management approach to design of HPS improvements.
- How should this message be conveyed?

Need for a Risk Communication Plan

- Task 10's mission is to quantify risks, however, the issues that the public are interested in do not fit nicely within the boundaries of IPET.
- It is unlikely that the audiences will be sympathetic to how these boundaries have been defined – therefore a risk communication strategy for IPET that is boarder than IPET is necessary.
- An effective risk communication plan will assist the leadership in responding to tough questions concerning the performance of the HPS and the IPET results.
- Questions will have linkages to other Corps programs and areas that are outside the Corps responsibilities such as evacuation issues and rebuilding plans for New Orleans.
- Finding ways to explain the risk numbers is important, but what really matters to people is explaining how the risk is being managed (infrastructure and organizational) and the assurance that this will work.
- In explaining the risk numbers, people want to know how they will be impacted.

Tough Questions Will Be Asked

- *Is the probability of HPS failure higher, lower or not demonstrably different from Pre-Katrina?*
- *What is being done to identify potential performance problems with the HPS, and prevent or control the risk of future failures?*
- *How will the community know that these measures are in place?*
- *What is the timetable for them?*
- *Who can we contact for more information or to report problems?*

Suggestions

- Get **Corps professional public relations experts** involved as soon as possible in developing a risk communication plan.
- **Identify the audiences** – Public,local, state and federal gov't… attorneys, media, etc.
- Find out **what information the audiences want and what concerns they have** –this process is essential to effective risk communication.
- Get **legal advice** on how to manage legal and liability aspects of risk communication rather than making lay assumptions about these considerations.
- Develop a **proactive media strategy.**
- Develop a **lay terminology** for key technical concepts where technical terms are unfamiliar to the general public.
- Find **informal as well as formal ways to interact with audiences** even prior to IPET final report completion.

Questions ?