Navigation Infrastructure Management

Portland District Perspective

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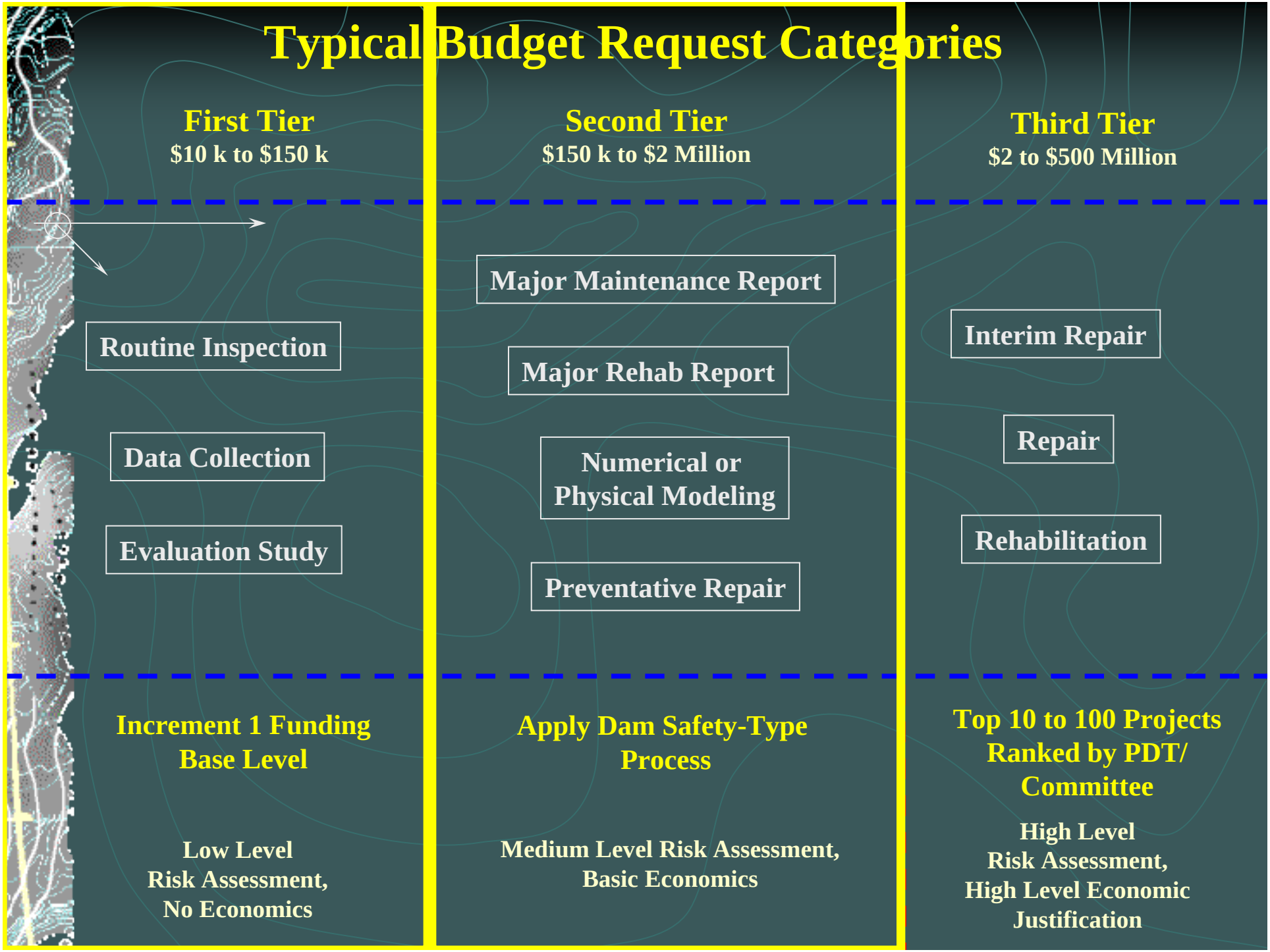
Things to Consider

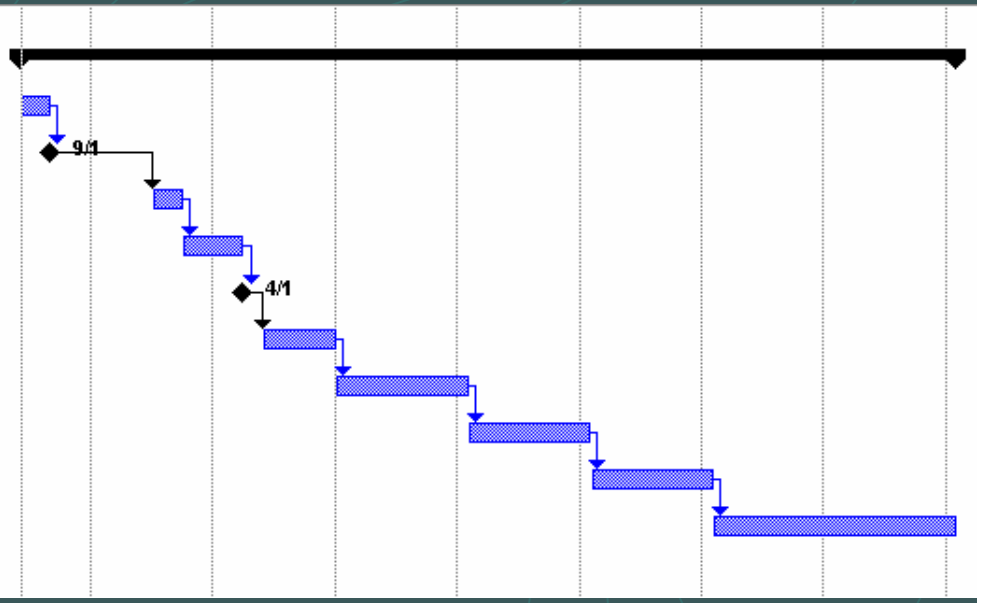
- 2-Year Out Input into Budget Cycle
- Typical Timeline of Repair Action from Problem Identification to Construction
- Different Levels of Risk and Consequence Analysis
- Fix-as-Fails Environment with Low Level of Base Level Funding
- Intermediate and Partial Investments Need to be Considered
- Opportunities for Crossing Project Authority Boundaries – Contribute to Smart Asset Management

Typical Budget Request Categories

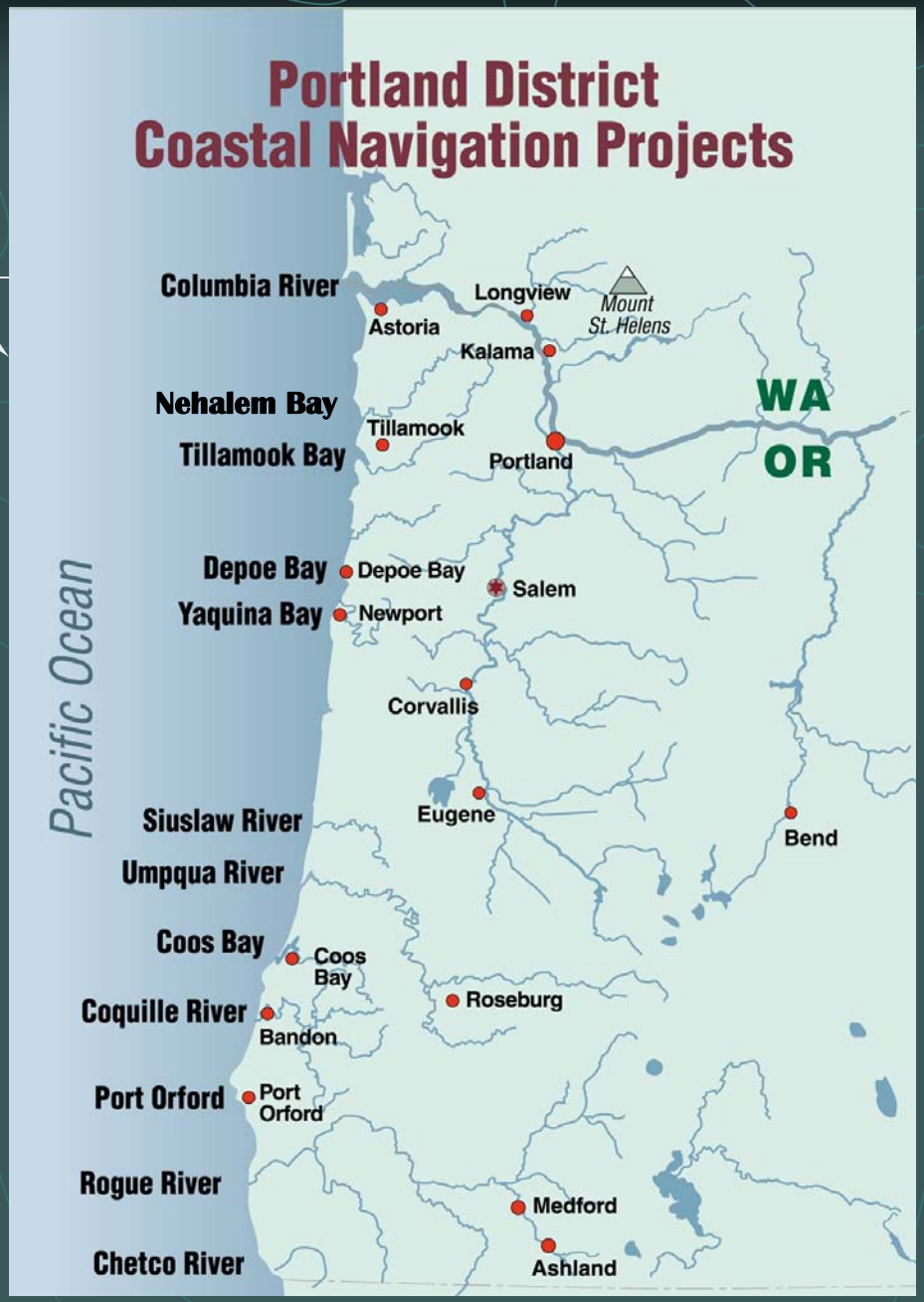


Typical Timeline for Infrastructure Action

Coastal Infrastructure Action	**Mon 6/2/08**	**Mon 2/1/16**
Routine Inspections	Mon 6/2/08	Fri 8/29/08
Problem Identification	Mon 9/1/08	Mon 9/1/08
Data Collection	Mon 7/6/09	Wed 9/30/09
Data/Project Evaluation	Thu 10/1/09	Wed 3/31/10
Decision to Repair	Thu 4/1/10	Thu 4/1/10
Numerical / Physical Modeling	Tue 6/1/10	Fri 12/31/10
Major Maintenance or Major Rehab	Mon 1/3/11	Tue 1/31/12
Detailed Design Report	Wed 2/1/12	Fri 2/1/13
Plans & Specifications	Mon 2/4/13	Mon 2/3/14
Construction	Tue 2/4/14	Mon 2/1/16



- **Total timeline from Problem Identification to Construction Start estimated at 5.5 to 8 years.**
- **Assumes constant and timely funding at each level. Interruptions in funding stream can add 2 to 10 years to overall process.**



11 Jettied Entrances

(Including Mouth of Columbia River)

30 Miles – Rubblemound

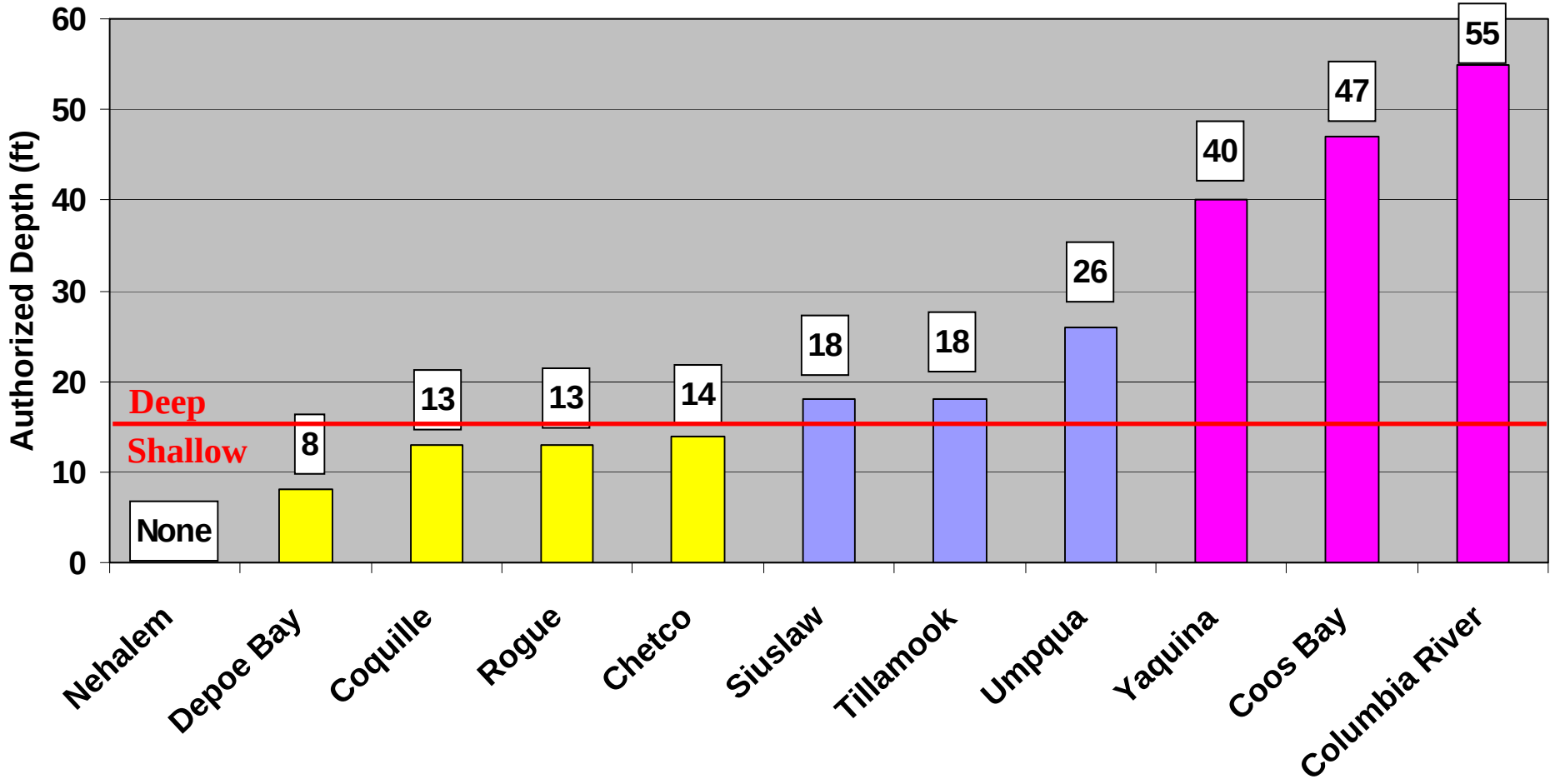
Construction / Repair - $2.0 Billion

Armor Size – 10 to 50 ton

Program Goal to Avoid:

- **Loss of federal investment in infrastructure**
- **Increased project costs (dredging, emergency repair)**
- **Impacts to project function**
- **Environmental impacts (shoreline, shoal impacts)**
- **Loss of life**

Authorized Entrance Channel Depths at Portland District Entrances



USACE definitions for deep/shallow draft are based on authorized project depth.

Key Elements of AM Program

- **Project Assessment:**
  - Project feature evolution (structure, channel, shoreline, shoals)
  - Forcing environment (waves, currents, foundation, power)
  - Project function and economic importance
- **Communication / Coordination:**
  - Identify rates of change and levels of risk
  - Be able to identify alternative types and levels of action
  - Be able to project no action impacts to structures and function
  - Timely reporting into budget cycle

Base Level Investigations

- Two–Tiered Approach
  - Routine Inspections
    - Annual - $6 to $15 k / project
    - Yearly Inspection Reports
    - Update Coastal Projects Matrix and Critical Infrastructure Spreadsheet
  - Evaluation Study
    - Conducted as identified by Routine Inspections
    - Structure and Hydrographic Surveys ($120 k)
    - Engineering Assessment ($10 to $30 k)
    - Budget and Project Recommendations

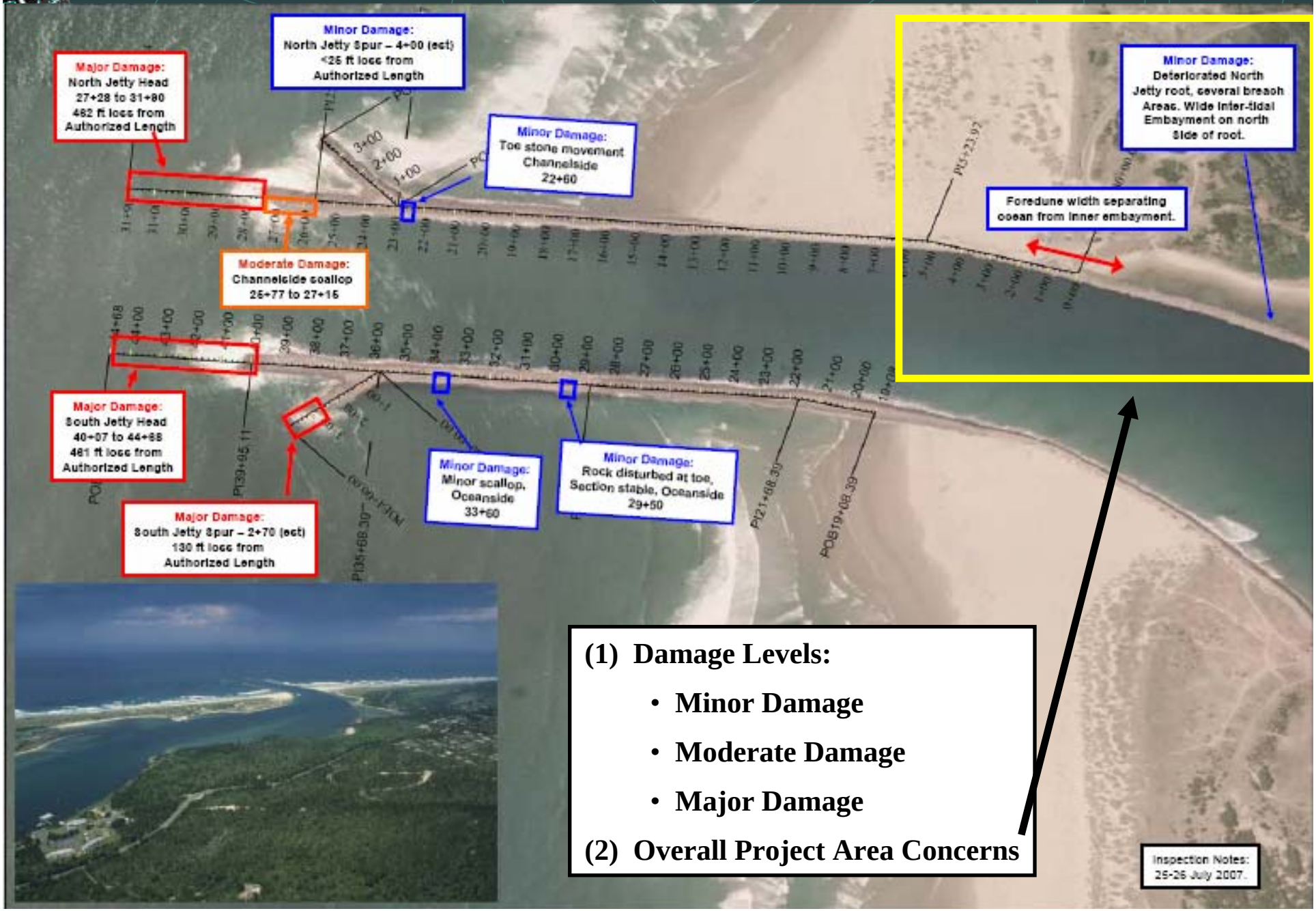
Base Level Inspections

Base Level Inspections

- Field Inspections of Projects (GPS – Damage Zones)
- Aerial, Oblique, and Satellite Photographs
- Regular Communication with Ports and Coast Guard

Ground inspections note new and progressive damage as well as changes in project performance or stability.

Identification and Tracking of Damage Zones and Potential Problem Areas



Aerial photographs can illustrate location / extent of damage.

Oblique photos can show damage or damage effects more clearly.

Base Level Inspection Criteria

- Inspections must be conducted by experienced coastal engineers.
- Due to funding, time, and personnel restrictions, inspection and reporting efforts must be streamlined.
- Product of inspection must be relevant to the engineering assessment and the budget process.

Evaluation Study

Conducted as Identified by Base Level Inspections

- Surveys - Photogrammetric and Multi-beam fathometer
- DTM of Structures & Comparison to Design Section
- Original and Current Design Criteria
- Project History – Construction, Channel, Shoals, Shoreline
- Projection of No-Action Structural & Functional Impacts
- Projection of Repair Costs

Design Criteria and Understanding of Structure Evolution

Design Parameter	1966	1978	1988	2001
Wave Height (ft)				
Above 0 ft m.l.l.w.	21.8	20.2	28.0	33.0
Below 0 ft m.l.l.w.	21.8	20.2	22.0	31.0
Water Level (ft, m.l.l.w.)	+10	+8	+10	+13
Stability Coefficient				
Above 0 ft m.l.l.w.	7.1	8.1	7.1	8.0
Below 0 ft m.l.l.w.	7.1	8.1	4.6	4.0
Stone Density (pcf)				
Main Body	167	167	167	165
Toe Berm				178
Structure Sideslope (V:H)				
Above 0 ft m.l.l.w.	1:2	1:2	1:2	1:2.5
Below 0 ft m.l.l.w.	1:1.5	1:1.5	1:1.5	1:4.0
Crest Elevation (ft,MLLW)	+20	+20	+20	+20
Crest Width (ft)	30	30	30	40
Armor Stone Size (tons)				
Main Body	22.0	18.9	31.1	38.0
Toe Berm	22.0	18.9	31.1	29.0

Siuslaw River, OR Jetties original construction

- North Jetty (length = 4090 ft)
  Sta. –63+75 to –22+85

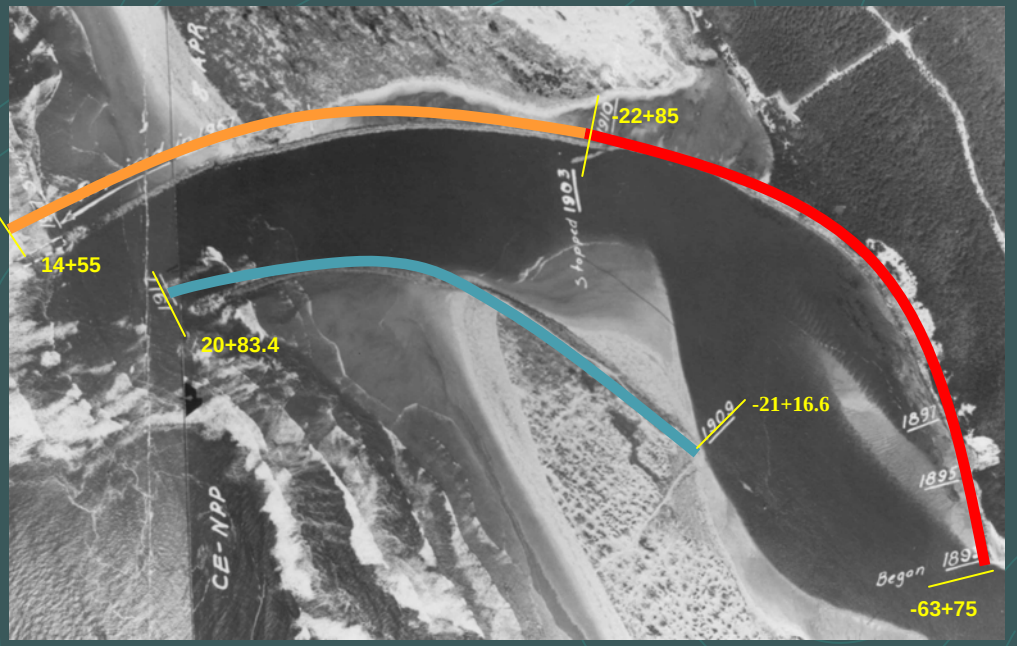
  1893 - 1901

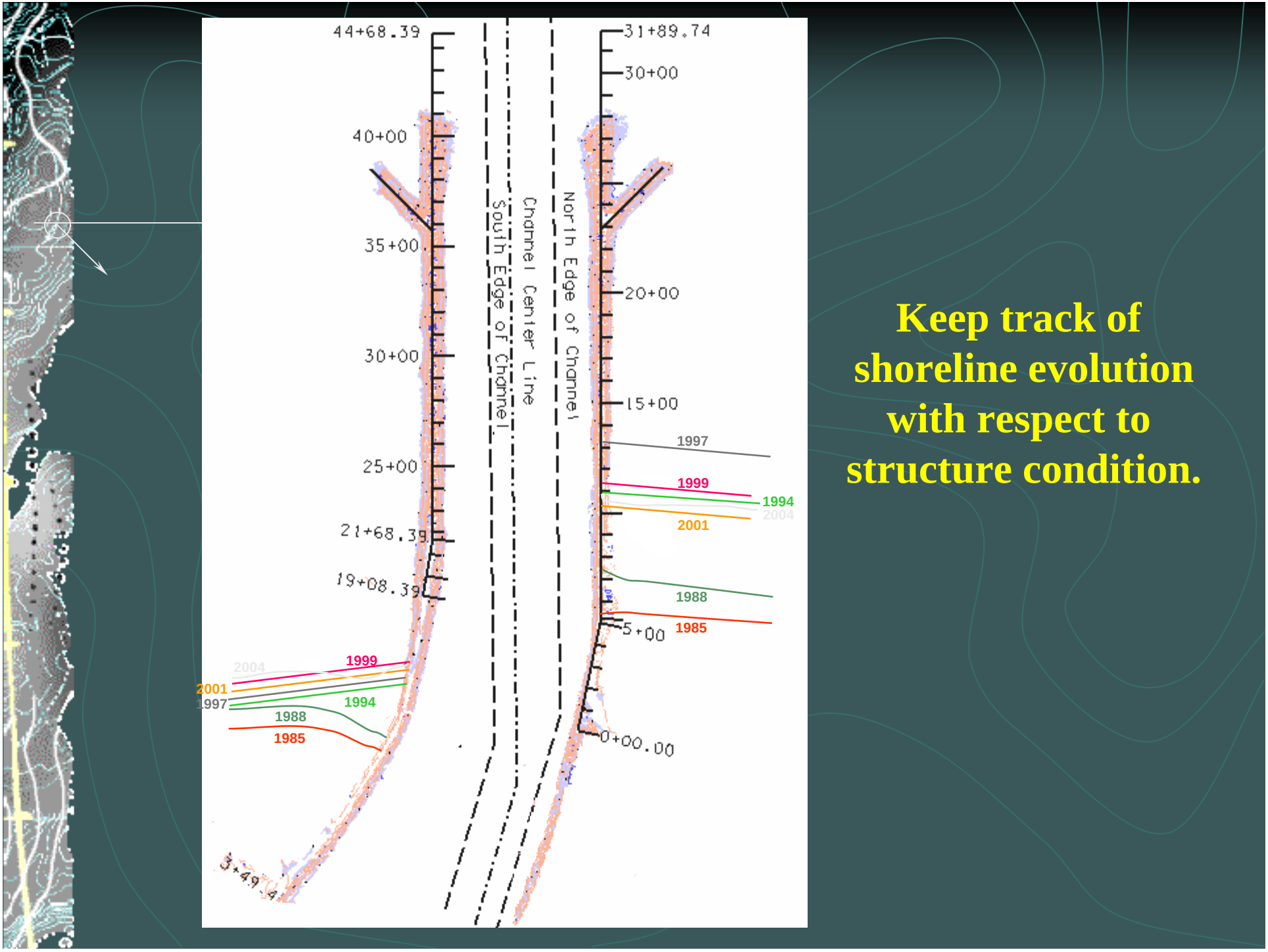
- North Jetty (additional 3740 ft)
  Sta. –22+85 to 14+55

  1912 - 1917

- South Jetty (length = 4200 ft)
  Sta. –21+16.6 to 20+83.4

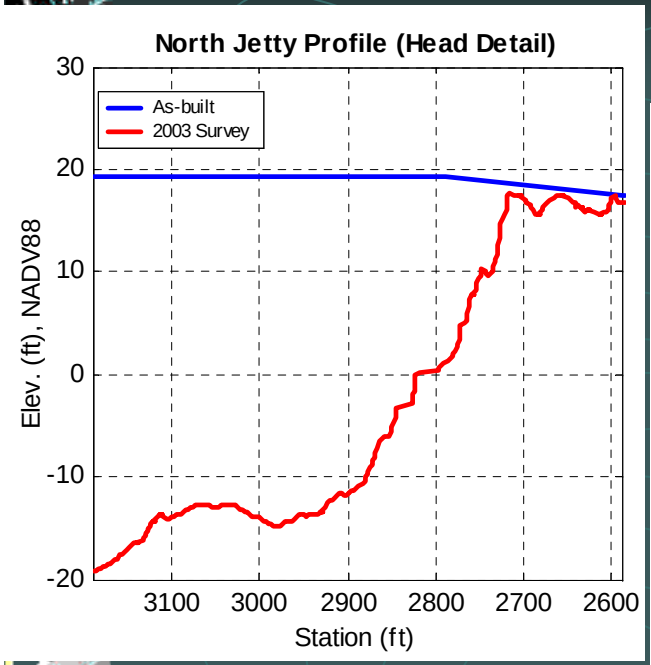
  1916 - 1917

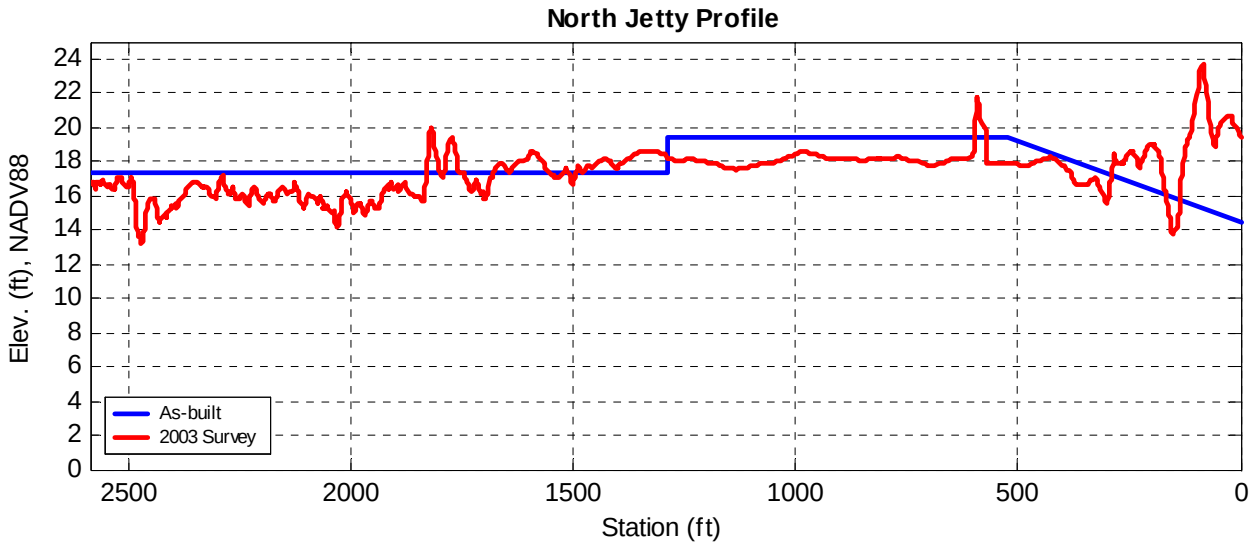




Keep track of shoreline evolution with respect to structure condition.

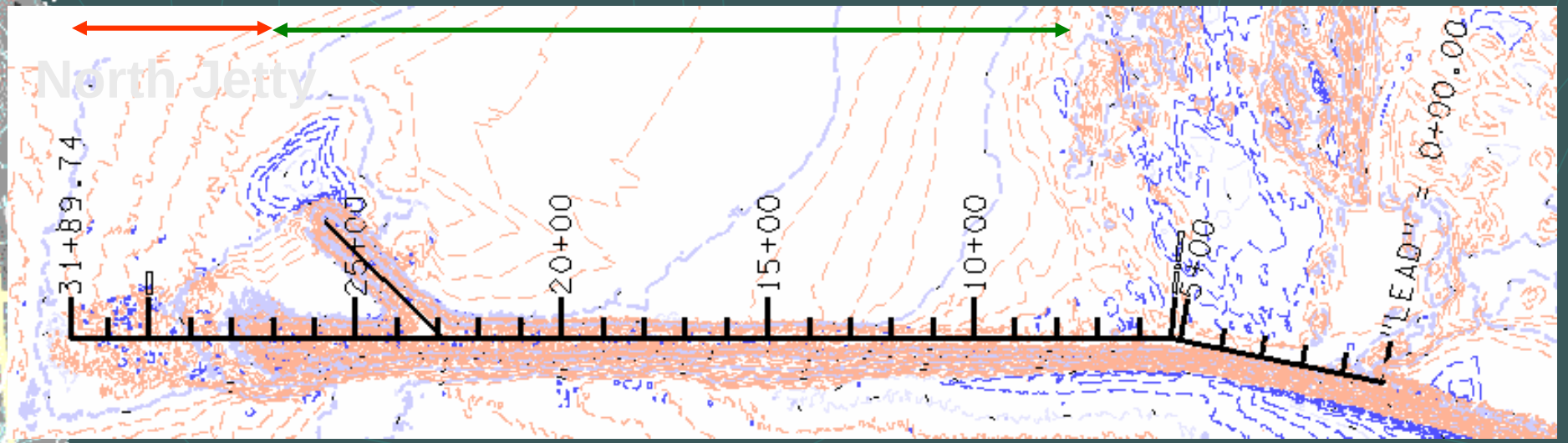
Profile and cross section comparison to original design.

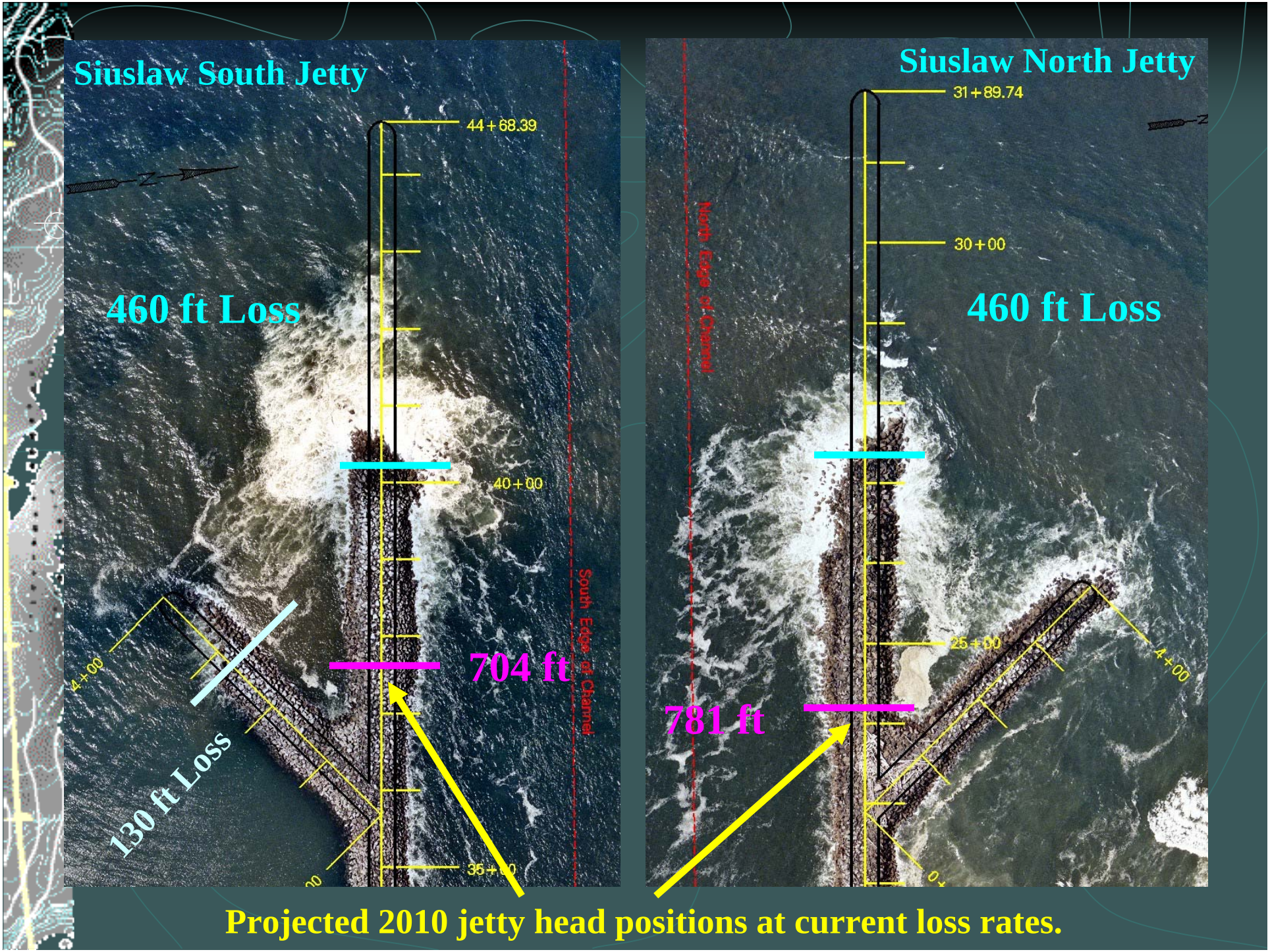




Major damages

Minor to moderate damages





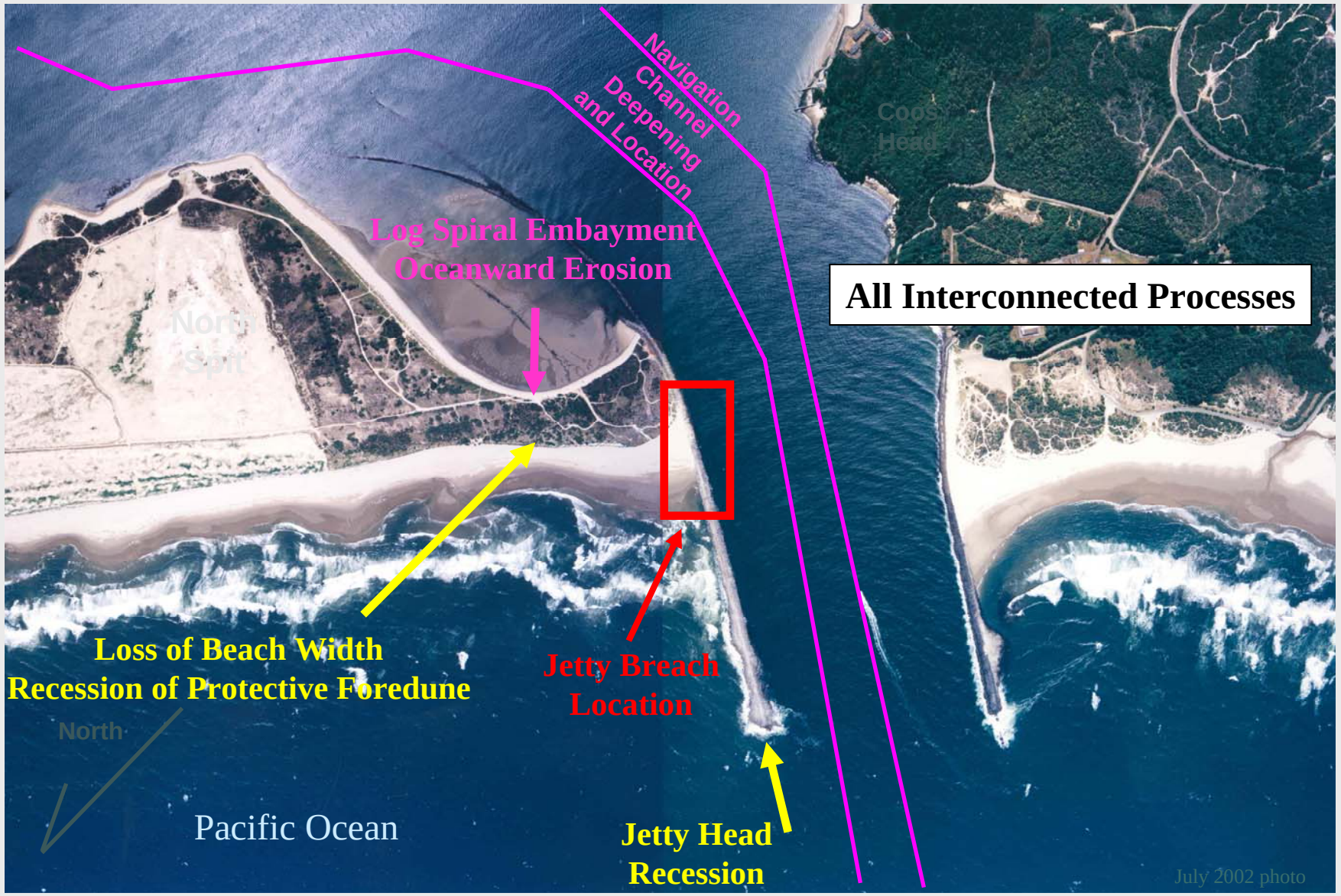
Projected 2010 jetty head positions at current loss rates.

Estimated Quantities of Repair Stone and Estimated Repair Cost

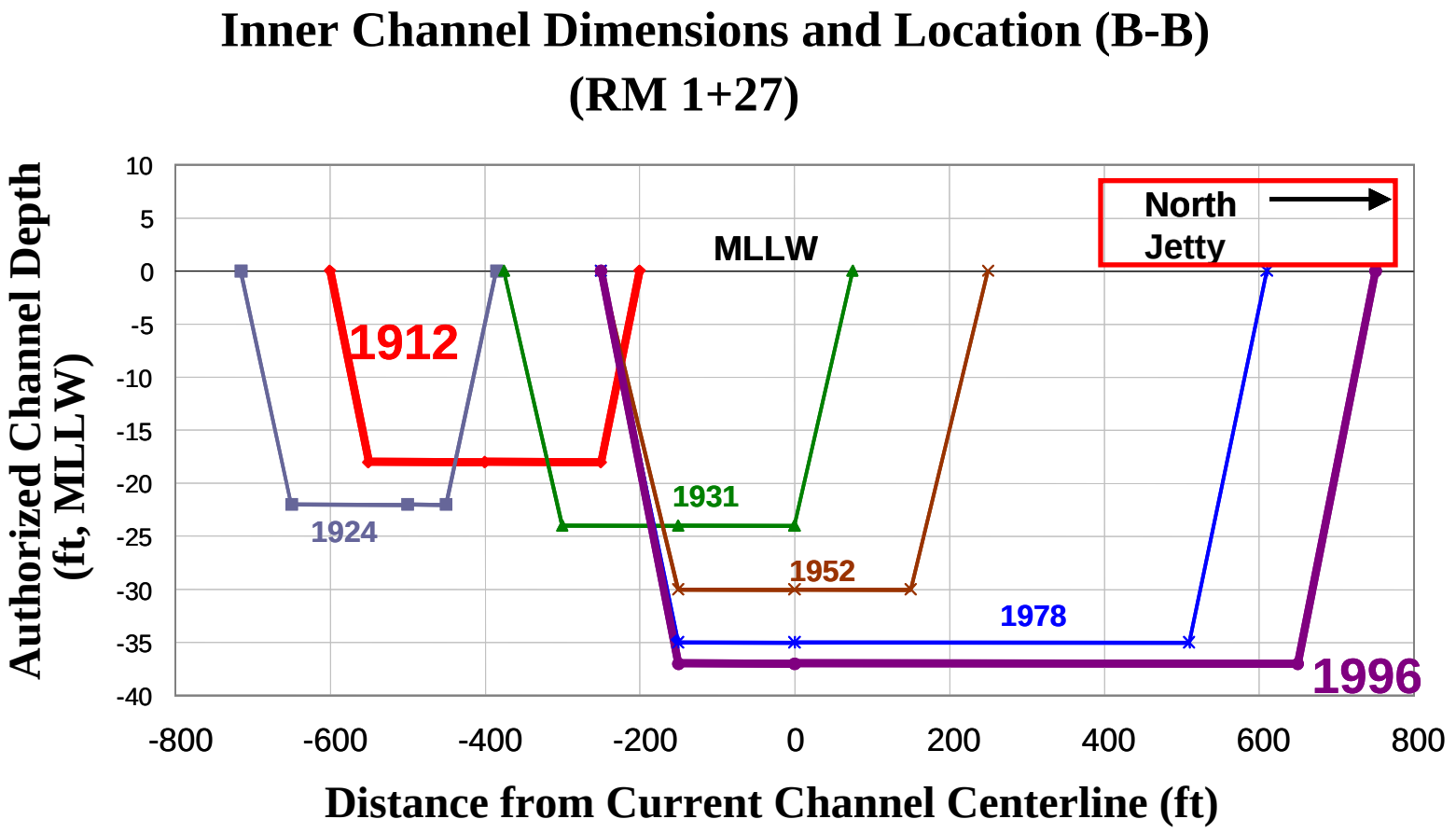
Jetty	Estimated Tons to Repair		Estimated Cost to Repair	
	2004	2010 (Projected)	2004	2010 (Projected)
North Jetty	115590	192685	$11,559,013	$19,268,457
South Jetty	112504	177907	$11,250,421	$17,790,713
North Jetty Spur	3544	4252	$354,356	$425,227
South Jetty Spur	13375	35932	$1,337,507	$3,593,179
Total Project	**245013**	**410776**	**$24,501,297**	**$41,077,576**

Continued Loss of Federal Investment Dollars

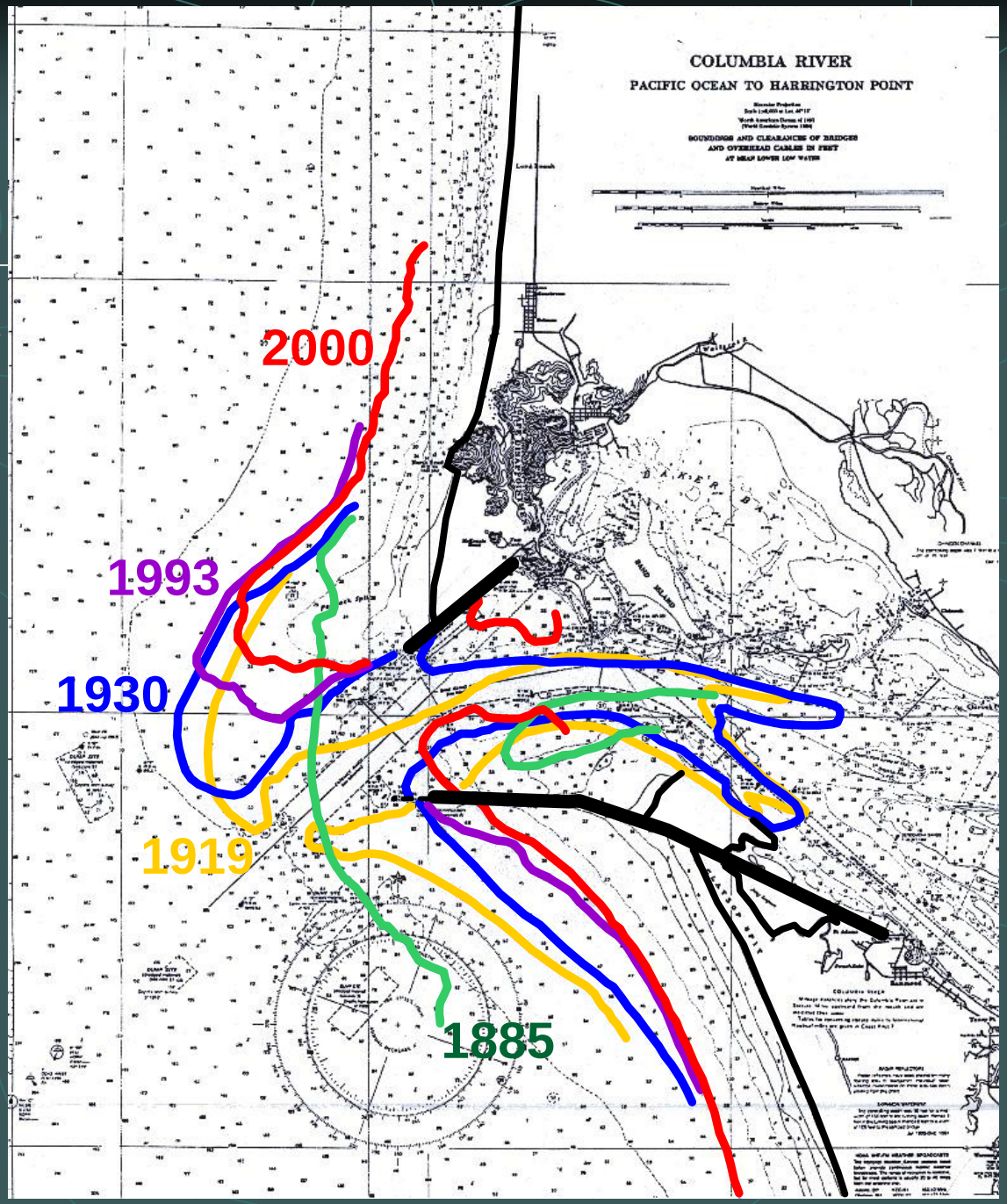
Understand Project Interrelationships and Apply Preventative Measures



Channel Improvement Influence on North Jetty Root



Gradual Movement of Inner Channel Centerline Toward North Jetty & Increase in Channel Cross-Sectional Area



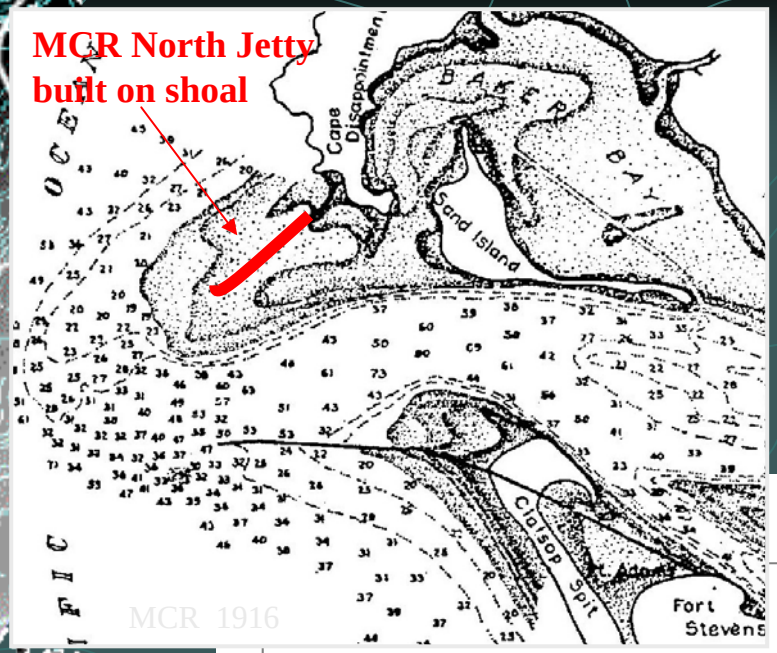
US Army Corps of Engineers
Portland District

Ebb Tidal Shoal Evolution

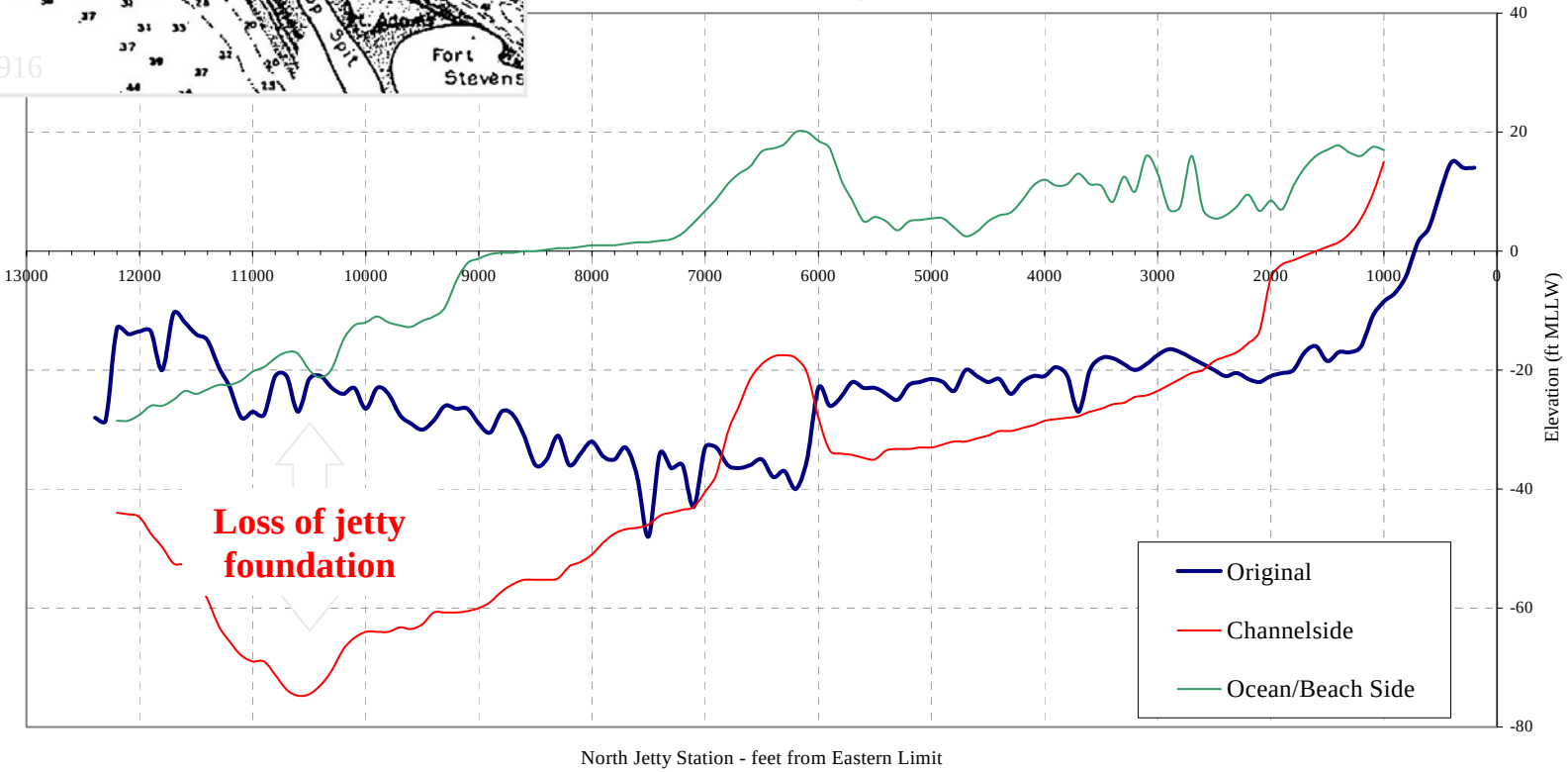
Map of –40 ft contours around MCR @ 5 time periods

The ebb tidal shoal is receding at an accelerated rate between 1993 and 2000.

Shoal evolution impacts on structures.



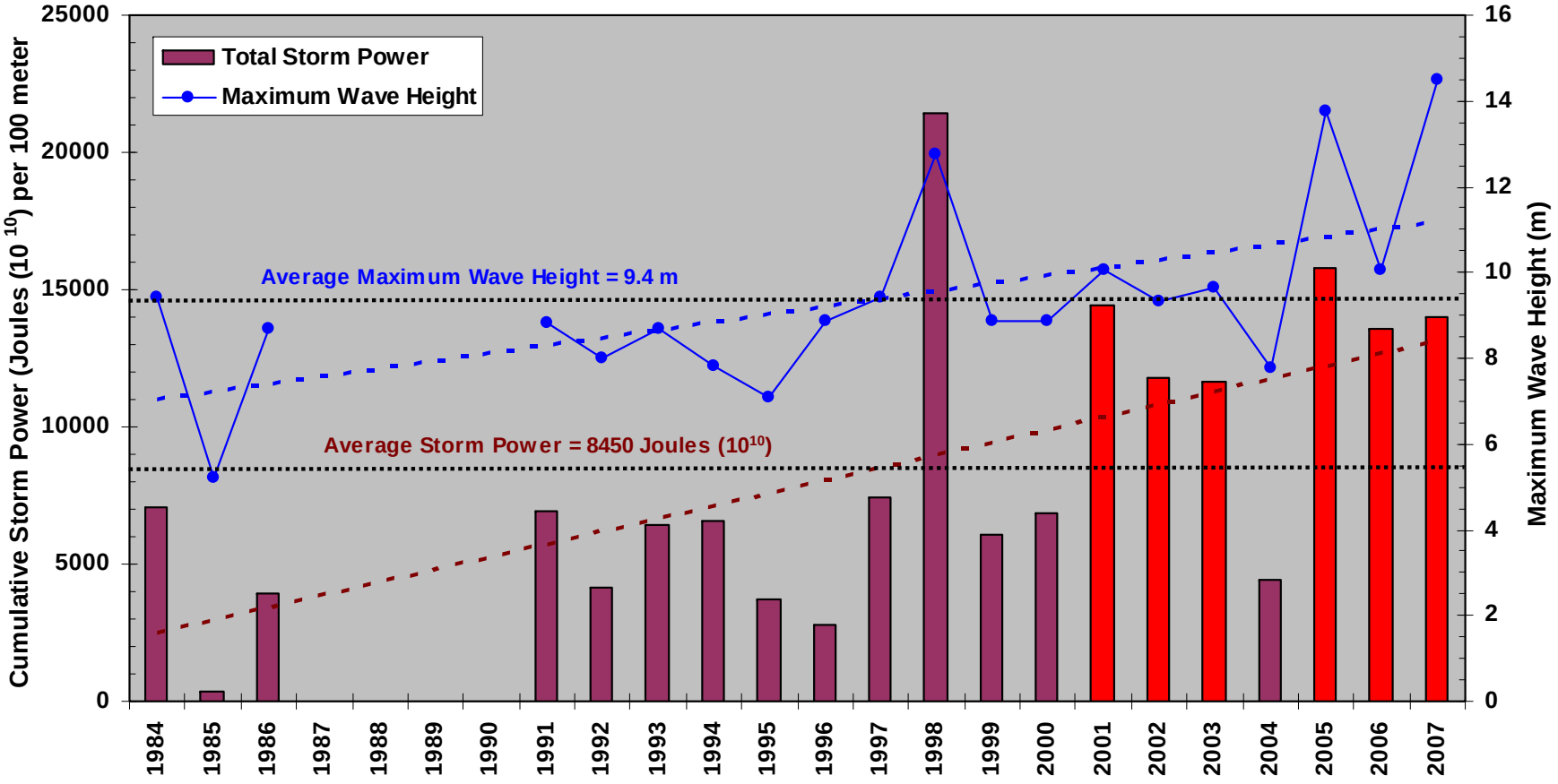
Profile along North Jetty Toe



DRAFT

Storm Climate Intensity (1984 to 2008)

(Using Cumulative Storm Power and Maximum Wave Height)



Note: 2007/2008 Cumulative Storm Power through 8 April 2008, all other years through June

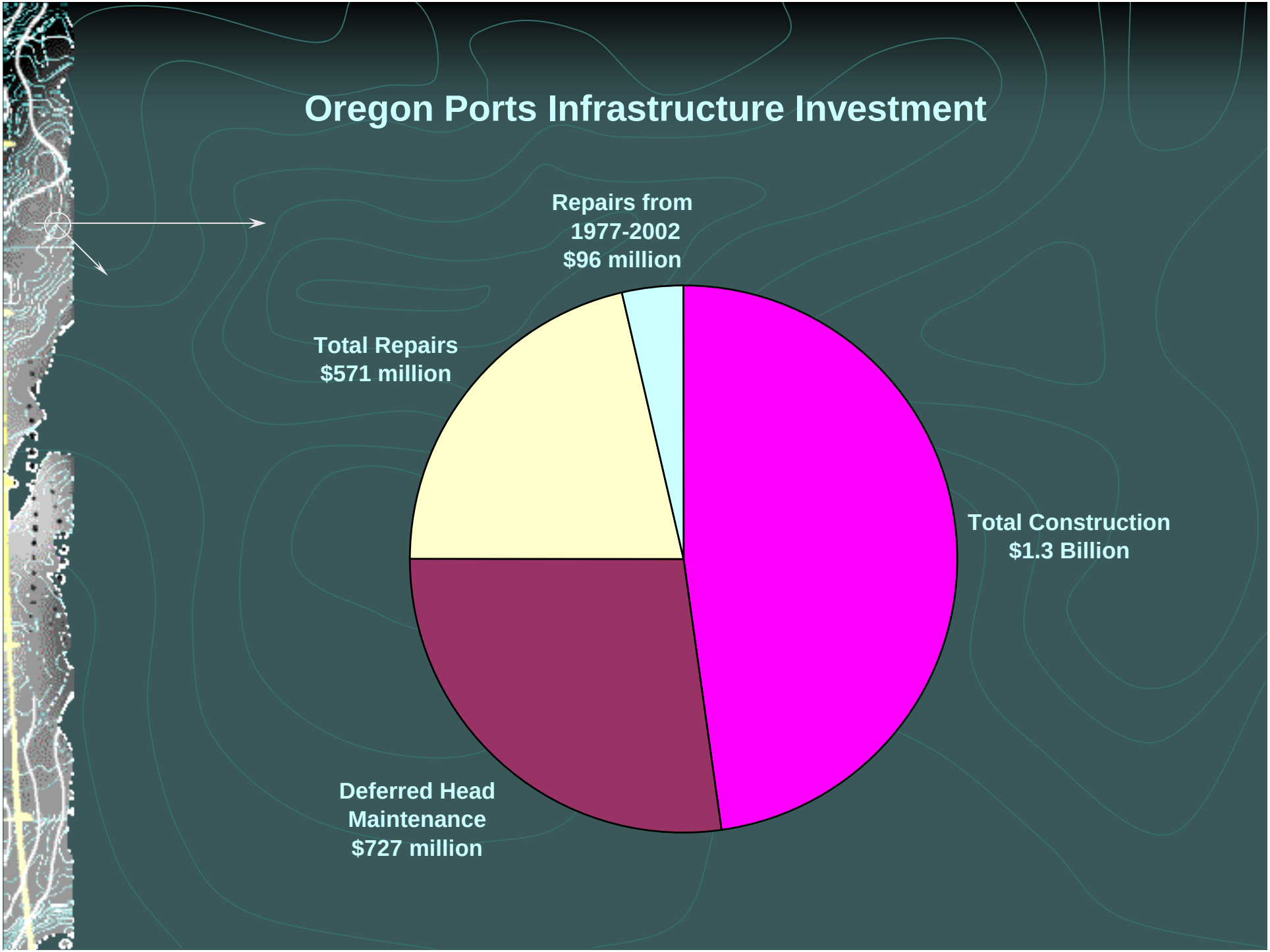
Potential changes in loading environment can influence damage progression and level of risk.

Project Significance

Available Information to Evaluate Project Status and Significance

- Initial project investment
- Maintenance over project life; over past 25 years
- Deferred jetty head maintenance (safety)
- Average annual waterborne commerce value
- Economic contribution of Ports to State
- Vessel usage of ports (commercial, recreational, charter)
- Coast Guard presence
- Potential for Loss of Life

Oregon Ports Infrastructure Investment



Average Annual Waterborne Commerce Value of Oregon Ports : 1995-1998

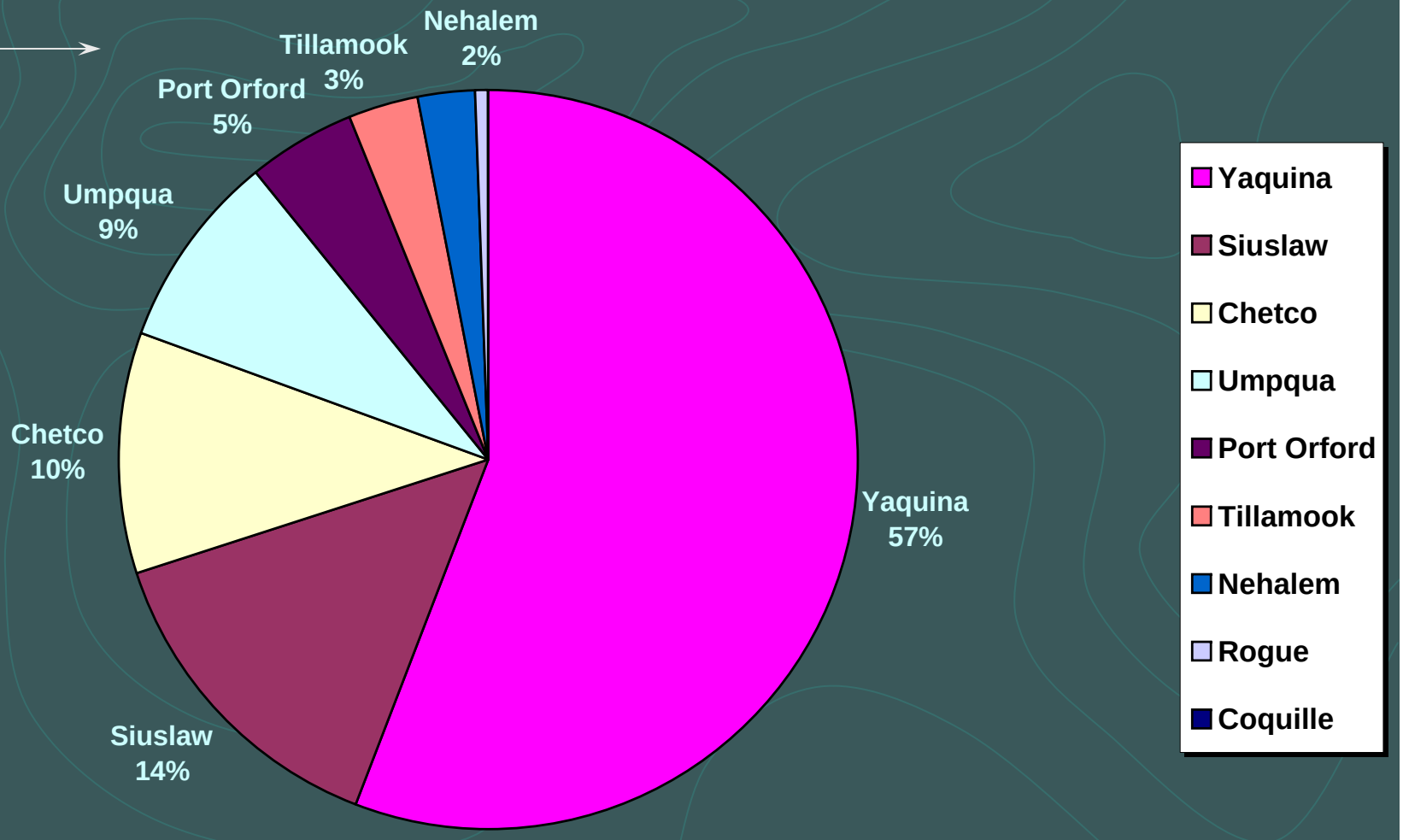
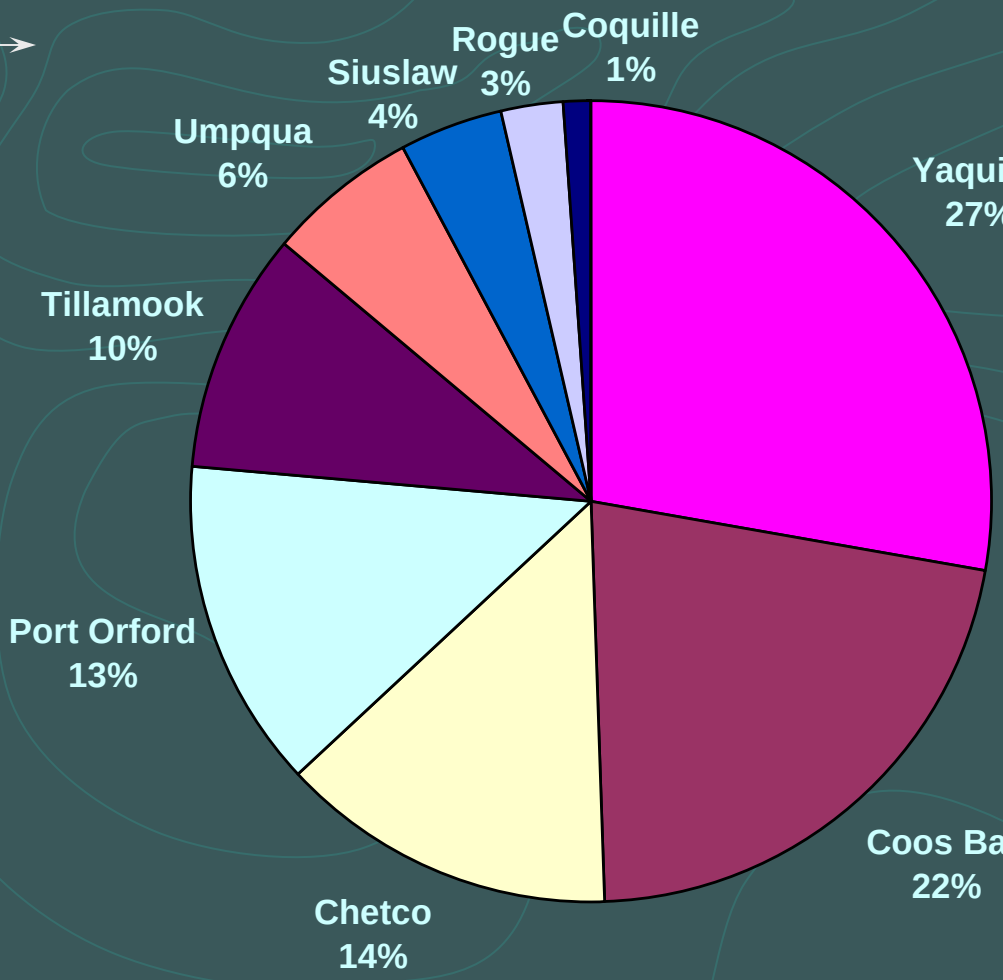


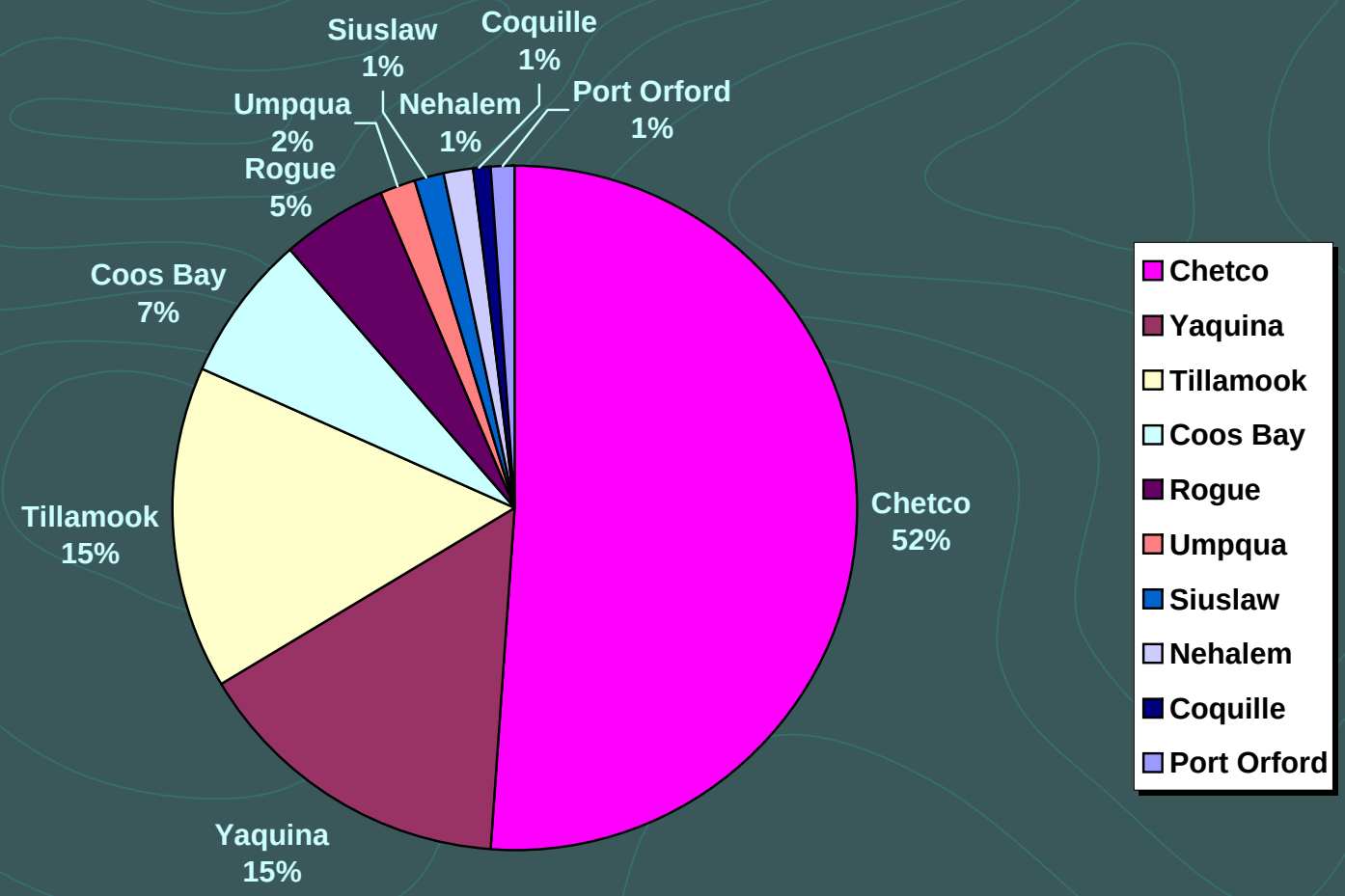
Chart is based on state total excluding MCR and Coos Bay

Commercial Vessel Usage of Oregon Coastal Ports: 1995-1998



Excludes MCR

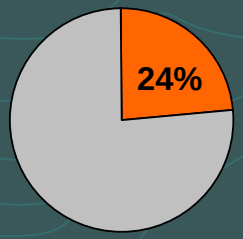
Recreational/Charter Vessel Usage of Oregon Coastal Ports: 1995-1998



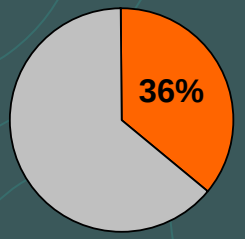
Excludes MCR

Yaquina

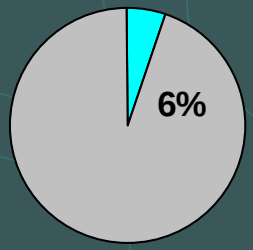
Total Repair Costs: $82 million (1889-2003)



Recent Repair Costs: $30 million (1977-2003)



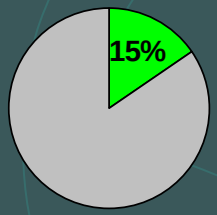
Annual Waterborne Commerce Dollars: $ 32 million



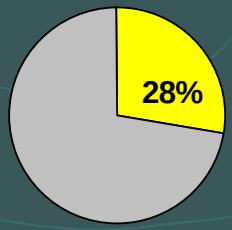
Economic Contributions : $122 million in Personal Income

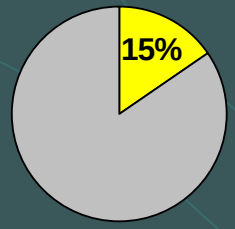
$25 million in Tax Generation

6,129 Jobs



Vessel Usage: **High Commercial** **Medium Recreational/Charter**



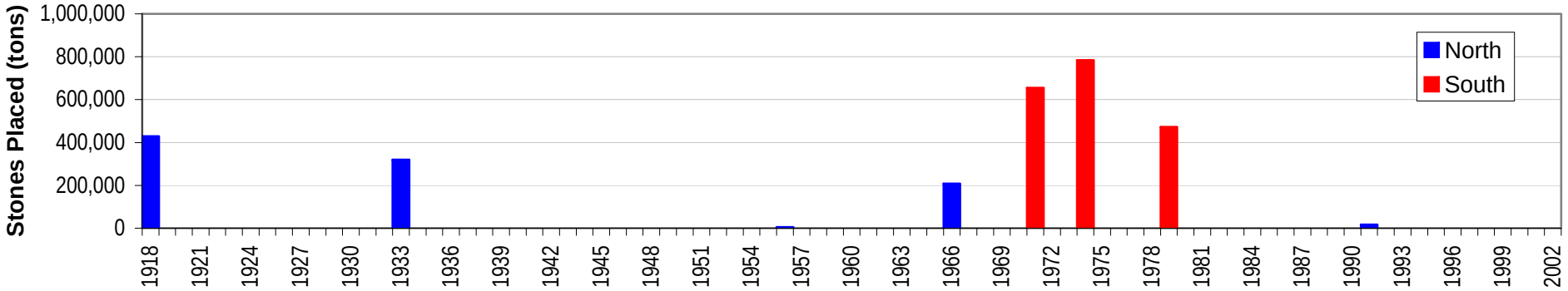


Strategic Importance : High

Tillamook

	Percentage of Repairs per year	Deferred Jetty Head Maintenance (million $$)	Loss from Head	Head Condition	Trunk Condition	Root Condition	Chance of Failure
North Jetty	1.33%	$12	350’	Poor	Fair	Poor	High
South Jetty	0%	$15	450’	Poor	Fair	Good	High

Construction:	**2.4 M tons**	**$143 M**
Repair:	**0.5 M tons**	**$30 M**
Deferred Head Maintenance:	**0.3 M tons**	**$27 M**



Minimum Program Requirements

- Collect adequate base level information to identify and prioritize higher level investigation and actions.
- Use preventative and interim repairs judicially to prevent rapid loss of function and expensive emergency actions.
- Sufficient investigation to identify safety concerns.
- Develop communication tools of sufficient detail for upward reporting and justification.

Reporting Tools

Reporting Tools

- Yearly Inspection Reports
- Coastal Projects Matrix
- Critical Infrastructure Spreadsheet
- 5-Year O&M Plan
- Aerial and Oblique Photographs
- Economic and Usage Ranking of Projects

Coastal Projects Matrix

- Project History
  - Construction date and length
  - Last maintenance date and location
  - Current studies
- Structure Condition/Damage Area
  - Head, Trunk, Root Condition
  - Length lost form Head
- Navigation Use
  - Commercial, Recreational, Charter Vessel Usage
  - Coast Guard Presence
- Level of Concern
  - Chance of Structural Failure
  - Chance of Functional Failure
  - Navigation Concerns
  - Degree of Urgency Ranking

COASTAL NAVIGATION PROJECT STATUS - PORTLAND DISTRICT (USACE)

Coastal Navigation Project	Project History					Structural Condition/Damage Area				Navigation Use of Project				Level of Concern			Degree of Urgency Ranking
	Construction Date	Constructed Length	Last Maintenance Date	Location of Maintenance	Current Studies	Length Lost (using GPS)	Jetty head	Jetty Trunk	Jetty Root	Commercial	Recreational	Charter	Coast Guard Presence	Chance of Structural Failure	Consequences of Failure	Navigation Concerns	
High Navigation Use Projects *(ordered by vessel volume within high use category)*																	
Columbia River Entrance																	
North Jetty (06/06) [9]	1913-1917	12,200'	2005	trunk	MR/CO	2061' [1]	Poor	Poor	Poor	High	High	High	All Year	High		High	1
South Jetty (06/06)	1885-1895	34,850'	2006-2007	trunk	MR/CO	6247' [2]	Poor	Poor	Fair	11299	100530	4642		High			
Jetty A (06/06)	1939	10,000'	1961	trunk/head	MR	886' [3]	Poor	Fair	Good					High			
Chetco Entrance																	
North Jetty (06/06)	1957-1958	1,300'	1969	450' ext.	-	0'	Fair	Good	Good	Med	High	Low	All Year	Low		Low	10
South Jetty (06/06)	1957-1959	1,570'	1996	root/trunk	-	10'	Fair	Good	Good	6743	39139	845		Low			
Harbor Breakwater (06/06)		1781'	2006	head	CO	-	Fair	Good	Good								
Yaquina Entrance																	
North Jetty (06/05)	1889-1896	7,000'	2001	head	MT	352' [4]	Good	Good	Good	High	Med	High	All Year	Med		High	6
South Jetty (06/05)	1881-1896	8,600'	1972	1800' ext.	-	16'	Good	Good	Good	14394	8741	5282		Low			
Coos Bay Entrance																	
North Jetty (06/05)	1891-1898	9,600'	2002	root	EV/MT	1117' [5]	Poor	Fair	Poor	High	Med	Low	All Year	Med		High	3
South Jetty (06/05)	1924-1929	4,580'	1963-1964	all	-	328' [6]	Fair	Good	Good	11012	5739	1029		Med			
Tillamook Entrance																	
North Jetty (04/05)	1914-1918	5,700'	2004	root	MT	480'	Poor	Fair	Poor	Med	Med	Med	All Year	High		High	2
South Jetty (04/05)	1969-1979	8,000'	-	-		816'	Poor	Poor	Fair	5161	10141	2482		High			
Medium/Low Navigation Use Projects *(ordered by vessel volume within medium/low use category)*																	
Port Orford										Med	Low	Low	N/A				
Breakwater (06/06)	1968	550'	-	-	-	0'	Fair	Poor	Good	6932	772	18		High		High	4
Rogue River Entrance																	
North Jetty (06/06)	1960-1961	3,300'	1966	trunk	-	9'	Fair	Good	Fair	Low	Low	Med	Seasonal	Med		Low	8
South Jetty (06/06)	1959-1960	3,400'	-	-	-	0'	Poor	Poor	Fair	1843	476	3349		High			
Umpqua Entrance																	
North Jetty (06/05)	1917-1919	8,000'	1977	trunk/head	-	0'	Fair	Good	Good	Low	Low	Low	All Year	Med		Med	7
South Jetty (06/05)	1933-1934	4,200'	1963	all	-	176' [8]	Poor	Fair	Good	2978	4266	164		High			
Training Jetty (06/05)	1950-1951	6,100'	1978-1980	3144' ext.	-		-	Good	Fair					Med			
Siuslaw Entrance																	
North Jetty (06/05)	1892-1901	9,740'	1984-1985	1900' ext.	EV	464'	Poor	Fair	Good	Low	Low	Low	All Year	High		Med	5
South Jetty (06/05)	1910-1913	6,245'	1984-1985	2300' ext.	EV	419'	Poor	Good	Good	2199	639	466		High			
North Jetty Spur (06/05)	1984-1985	400'	1984-1985	-	EV	10'	Fair	Good	Good								
South Jetty Spur (06/05)	1984-1986	400'	1984-1985	-	EV	130'	Poor	Good	Good								
Coquille Entrance																	
North Jetty (06/06)	1892-1909	4,200'	1957	trunk	-	0	Good	Good	Good	Low	Low	Low	Seasonal	Low		Low	9
South Jetty (06/06)	1881-1901	2,700'	1954-1955	head	-	0'	Poor	Fair	Good	506	319	669		High			
Nehalem Entrance																	
North Jetty (93/05)	1916-1919	3,500'	1981-1982	all	-	<25'	Fair	Good	Good	Low	Low	N/A	N/A	Low		Low	11
South Jetty (93/05)	1910-1916	4,950'	1981-1982	all	-	<25'	Fair	Good	Good	66	930	0		Low			

5-Year O&M Plan

- **Monitoring:** Routine monitoring to assess structural and functional performance of project
- **Data Collection:** Structural and hydrographic survey data collection to identify degree of identified problem.
- **Data Assessment and/or Modeling:** Preliminary study to assess functional impacts of problem and budget needs.
- **MMR or MRR:** Design report which quantifies degree and extent of repair and recommended plan.
- **P&S:** Document which leads into repair construction.
- **Interim Repair Construction:** An out-of-cycle repair that requires an accelerated track due to potential impacts.
- **Construction:** Planned for repair construction.

5 – Year Plan Estimate

Coastal Navigation Project	FY06 (YR-1)	Estimated Cost ($K)	FY07 (YR1)	Estimated Cost ($K)	FY08 (YR2)	Estimated Cost ($K)	FY09 (YR3)	Estimated Cost ($K)	FY10 (YR4)
1. Columbia River Entrance									
North Jetty	All Struct. - Major Rehab Repo	500	All Struct. - Major Rehab Repo	570	All Struct. - Major Rehab Repo	513	All Struct. - Major Rehab Repo	315	Rehab Repair 1 - P&S
South Jetty	South Jetty Interim Repair Con	7700	System Model Studies	200					
Jetty A	North Jetty Interim Repair Con	200			Interim Repair Report 2	154	Interim Repair 2 - P&S	158	Interim Repair 2 - Const.
	Regional Sed. Management Stu	200	Data Collection	150	Data Reduction	31			
	Jetty Monitoring	25	Jetty Monitoring	25	Jetty Monitoring	26	Jetty Monitoring	26.3	Jetty Monitoring
2. C&LW									
Sand Island Pile Dikes			Pile Dikes - Major Maint. Rep	150	Pile Dikes - P&S	205	Pile Dike Repair - Const.	10500	
Arturia Breakwater			Astoria Breakwater - Const.	1200					
Hammond Breakwater			Hammond Brkwater - Eval. Stu	60	Hammond Brkwater - P&S	103	Hammond Brkwater - Const.	4200	
3. Nehalem Entrance									
North Jetty									
South Jetty	Jetty Monitoring	9	Jetty Monitoring	9	Jetty Monitoring	9.2	Jetty Monitoring	9.5	Jetty Monitoring
4. Tillamook Entrance									
North Jetty	N&S Jetty Heads - P&S	200	North Jetty Head - Const.	7000	South Jetty Head - Const.	11300			
South Jetty			N&S Jetty Trunk Repairs - P&	200	&S Jetty Trunk Repairs - Con	20500	&S Jetty Trunk Repairs - Con	10500	
			N&S Jetty Length - Eval. Stud	200			N&S Jetty Length Extension - D	210	&S Jetty Length Extension -
			Data Collection	120	Data Reduction	31			
	Shoreline Monitoring	15	Shoreline Monitoring	15	Shoreline Monitoring	15.4	Shoreline Monitoring	15.8	Shoreline Monitoring
	Jetty Monitoring	9	Jetty Monitoring	9	Jetty Monitoring	9.2	Jetty Monitoring	9.5	Jetty Monitoring
5. Depoe Bay Entrance									
Breakwater									
6. Yaquina Entrance									
North Jetty					N. Jetty Length - Eval Study	300			
			DDR Completion	20					
South Jetty	Jetty Monitoring	9	Jetty Monitoring	9	Jetty Monitoring	9.2	Jetty Monitoring	9.5	Jetty Monitoring
7. Siuslaw Entrance									
North Jetty			N&S Jetties-Major Maint. Rep	250	N&S Jetties - P&S	205	N&S Jetties Repair - Const.	15750	N&S Jetties Repair - Cons
South Jetty	Jetty Monitoring	10	Jetty Monitoring	10	Jetty Monitoring	10.3	Jetty Monitoring	10.5	Jetty Monitoring
8. Umpqua Entrance									
North Jetty			Data Collection	120	Data Reduction	31			N&S Jetties - Major Maint. F
South Jetty									
Training Jetty	Jetty Monitoring	10	Jetty Monitoring	10	Jetty Monitoring	10.3	Jetty Monitoring	10.5	Jetty Monitoring
9. Coos Bay Entrance									
North Jetty	N. Jetty - Major Maint. Rep.	50	N. Jetty - Major Maint. Rep.	550	North Jetty - P&S	205	North Jetty Repair - Const.	26250	
South Jetty			Data Collection	120	Data Reduction	31			
			North Spit Erosion - Eval. Stu	30					
	N. Jetty Root - P&S	60	N. Jetty Root - Interim Const	2000					

Critical Infrastructure Spreadsheet

- Developed every year for all district projects
- Intended to cull out projects with imminent failure and potential for significant impacts
- Uses general dam safety system guidelines
- Key input:
  - Frequency of threshold loading
  - Expected chance of failure given threshold loading
  - Estimated consequences of failure

Critical Infrastructure Spreadsheet
(Uses Dam Safety Risk Guidelines)

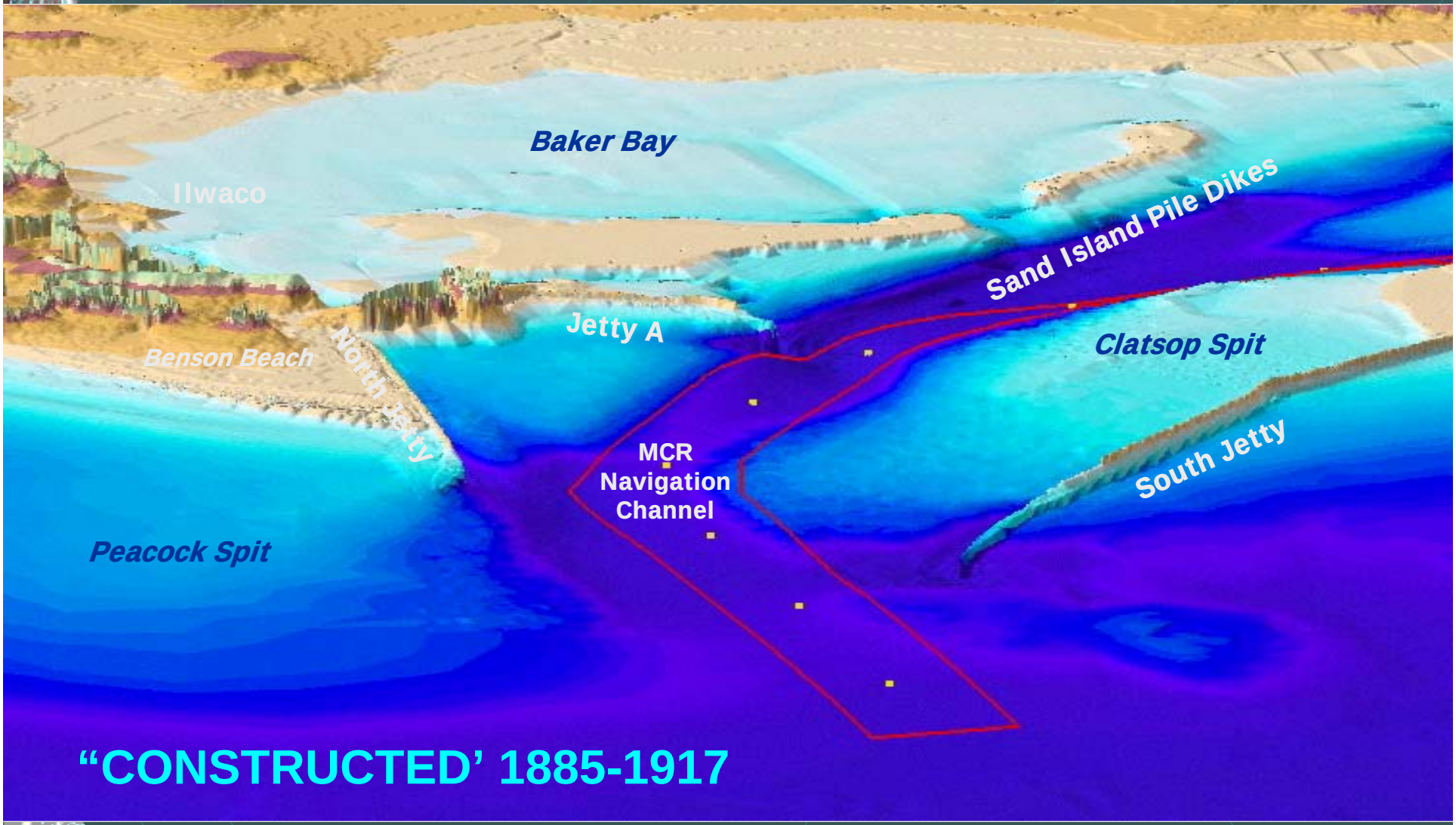
Business Line	Ranking		Project	Feature	Phase	Description of Unsatisfactory Performance	Annual Frequency of Loading	Conditional Probability of Unsatisfactory Performance	Annual Probability of Unsatisfactory Performance	Consequences of the Unsatisfactory Performance	Matrix Ranking Value
	District Rank	Focus Area Rank									
Navigation		1	Mouth of the Columbia River	South Jetty Ocean Reach B Sta. 258 to 290 3200 ft	Repairs	Potential breach (20% probability, 5-year wave)	Very Often	Very High	Very Likely	Catastrophic - rapid sediment infill of navigation channel, serious impacts to navigation, economic impacts to ports/commerce, rapid deterioration of jetty, increased jetty repair and dredge costs	1.0
Navigation		2	Coos Bay	North Jetty Root Sta. 45 to 47 200 ft	P&S / Repair	Ocean shoreline and north jetty root would be breached. Ocean flow would flank north jetty.	Very Often	Very High	Very Likely	Catastrophic - rapid sediment infill of navigation channel, serious impacts to navigation, economic impacts to port/commerce, rapid deterioration of jetty, increased jetty repair and dredge costs	1.0
Navigation		3	Mouth of the Columbia River	North Jetty South Jetty Jetty A	Major Rehab Rpt	Continued deterioration and failure of primary navigation structures.	Very Often	Very High	Very Likely	Catastrophic - rapid sediment infill of navigation channel, serious impacts/safety to navigation, economic impacts to ports/commerce, rapid deterioration of jetty, increased jetty repair and dredge costs	1.0
Navigation		4	Mouth of the Columbia River	South Jetty Root Sta. 160 to 185 2500 ft	Major Rehab Rpt	Potential for breach of weakened jetty root resulting in rapid structural deterioration and loss of land mass behind jetty root.	Very Often	Very High	Very Likely	Critical - sediment infill of navigation channel, rapid deterioration of jetty, increased jetty repair and dredge costs, increased loss of shoreline at vulnerable jetty root.	3.0
Navigation		5	Mouth of the Columbia River	North Jetty Trunk Sta. 86 to 92 600 ft	Major Rehab Rpt	Potential for breach of weakened jetty trunk resulting in rapid structural deterioration and sediment flow through jetty breach.	Very Often	Very High	Very Likely	Critical - sediment infill of navigation channel, rapid deterioration of jetty, increased jetty repair and dredge costs, increased loss of shoreline at vulnerable jetty root.	3.0
Navigation		6	Mouth of the Columbia River	North Jetty Cap 100 ft	Major Rehab Rpt						3.0
Navigation		7	Coos Bay	North Jetty	Major Maint. Rpt						3.0
Navigation		8	Coos Bay	North Jetty Cap 100 ft	Major Maint. Rpt						3.0
Navigation		9	Mouth of the Columbia	North Jetty Root Sta. 40 to 55	Major Rehab Rpt	Potential for breach of weakened jetty root resulting in rapid structural	Very Often	High	Likely	Critical - rapid sediment infill of navigation channel, rapid deterioration of jetty, increased jetty	5.0

Description of Unsatisfactory Performance
Annual Frequency of Loading
Probability of Unsatisfactory Performance
Annual Probability of Unsatisfactory Performance
Consequences of Unsatisfactory Performance

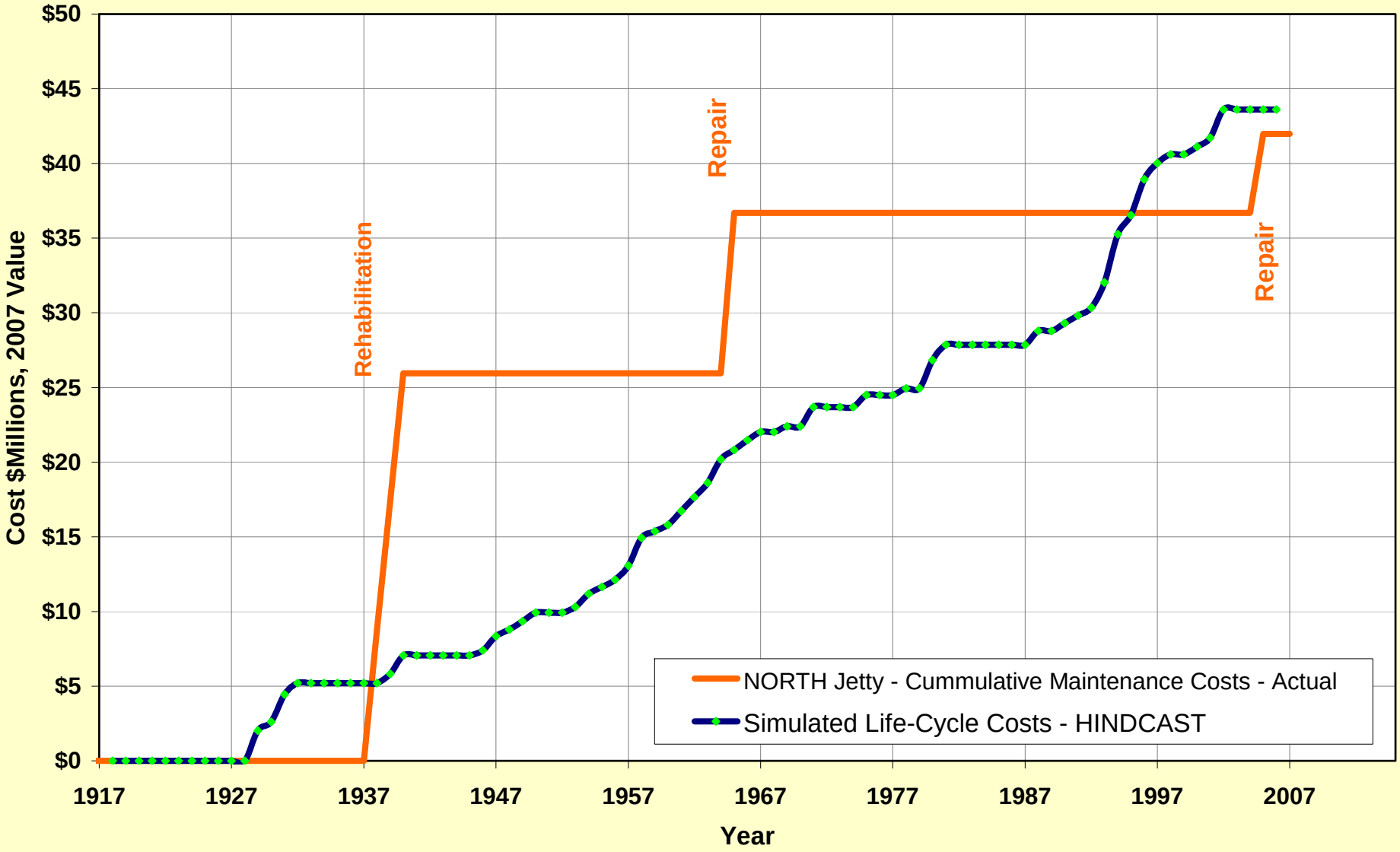
Major Rehabilitation Analysis Tools

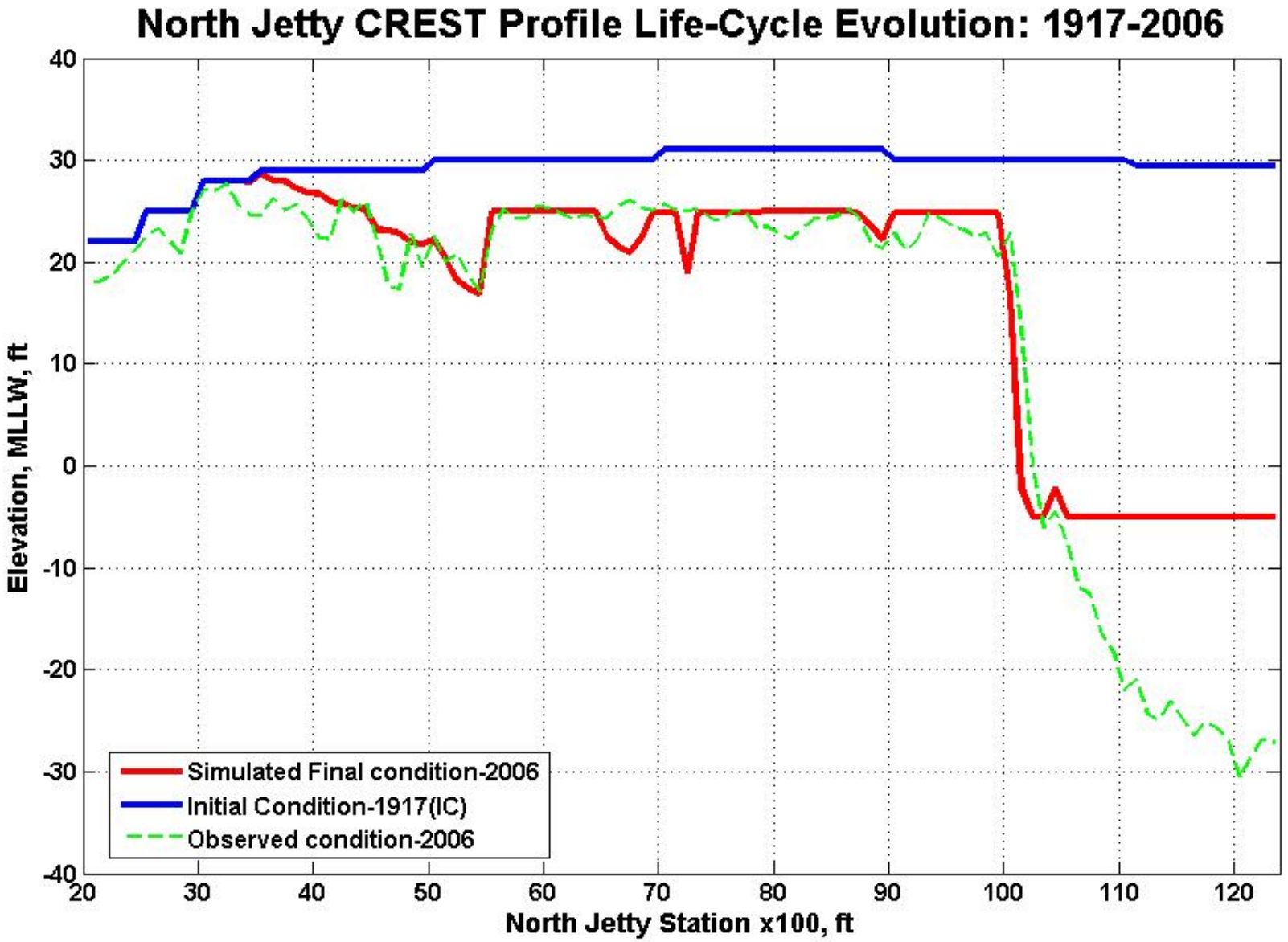
MCR Bathymetry Showing Location of Shoals & Jetties

Excessive Erosion of Shoals Can Lead to Loss of Jetty Foundation = Loss of Jetty

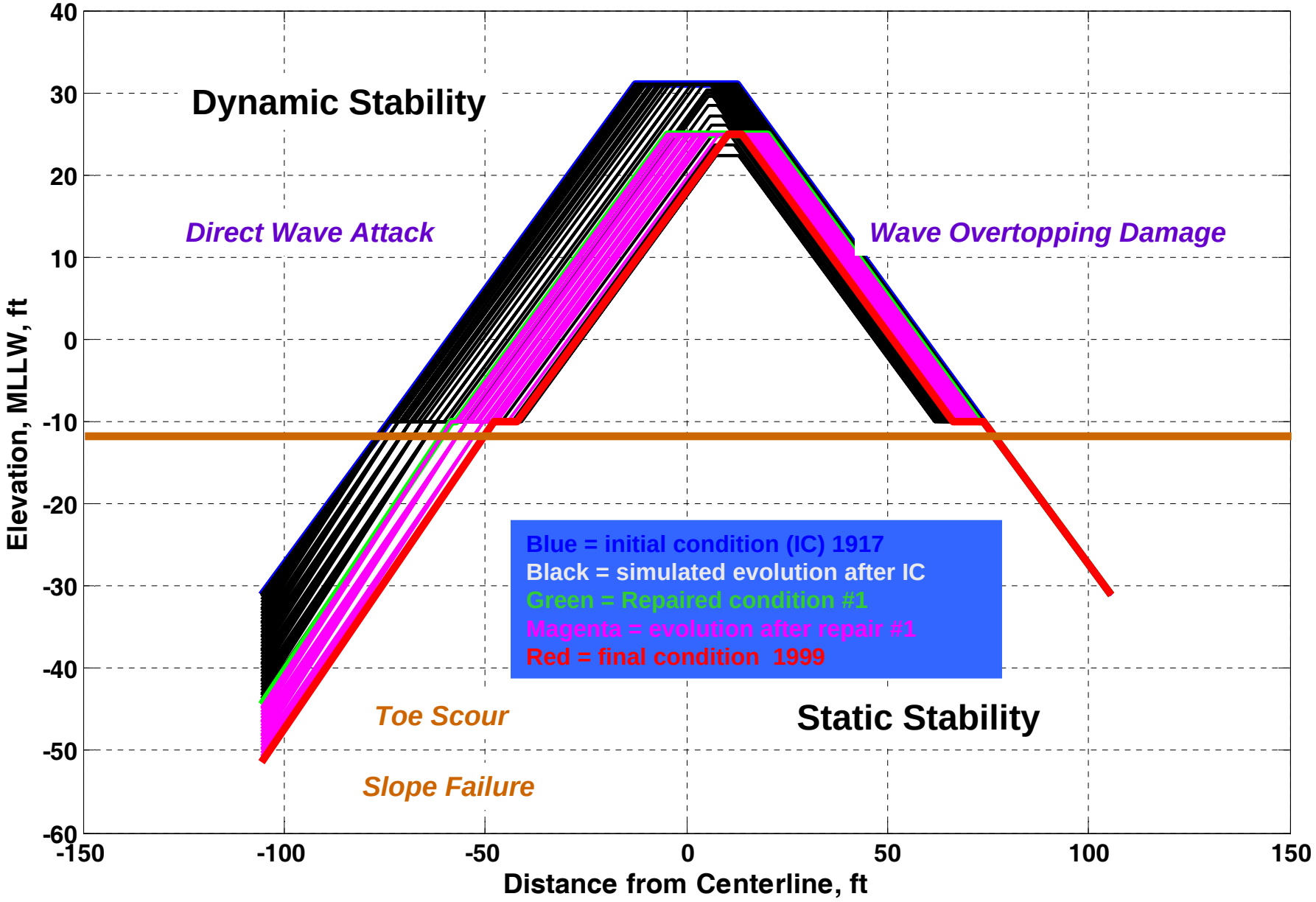


Actual and Simulated Cummulative Life-Cycle Costs
MCR North Jetty



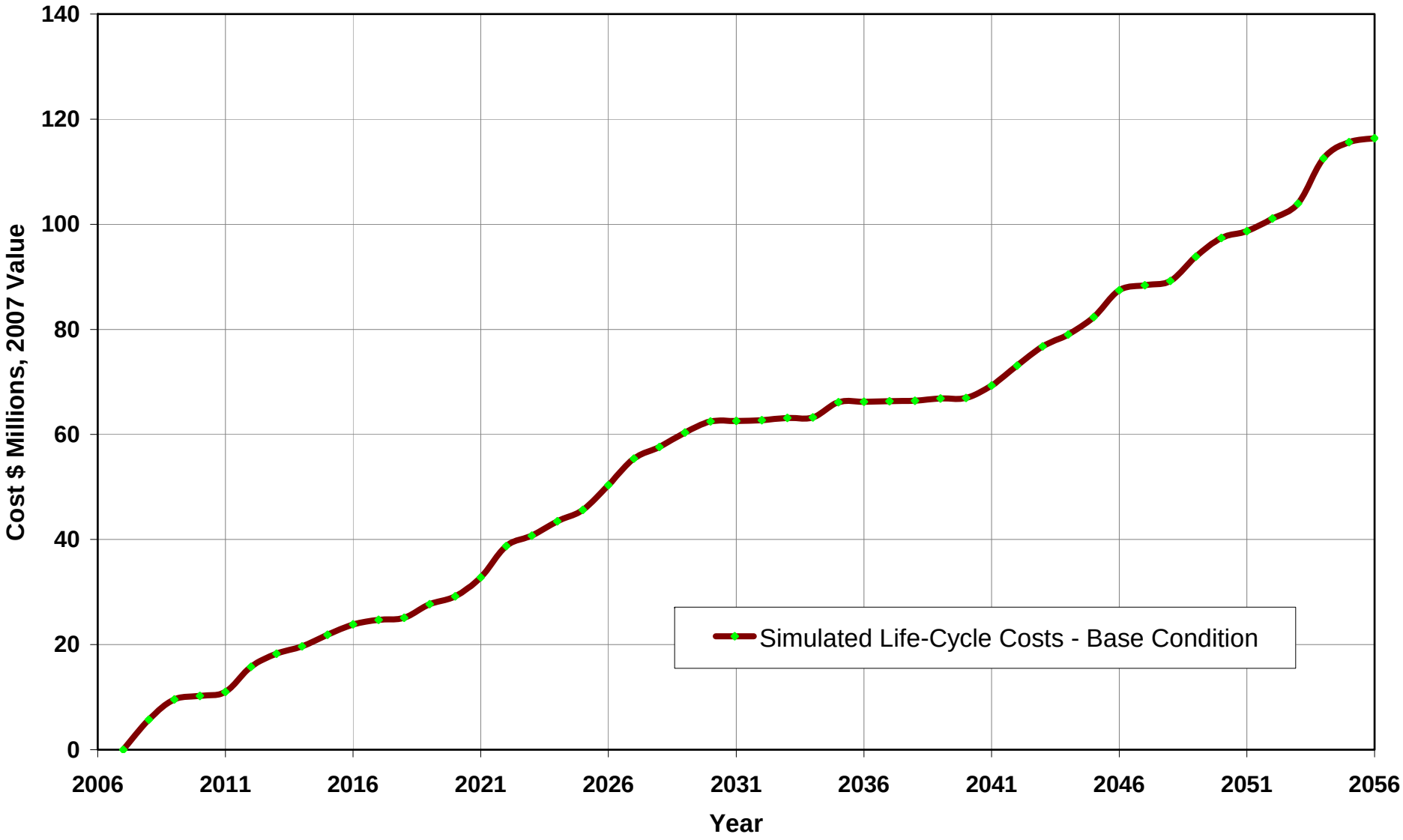

North Jetty CREST Profile Life-Cycle Evolution: 1917-2006
Elevation, MLLW, ft
North Jetty Station x100, ft
40
30
20
10
0
-10
-20
-30
-40
20
30
40
50
60
70
80
90
100
110
120
Simulated Final condition-2006
Initial Condition-1917(IC)
Observed condition-2006

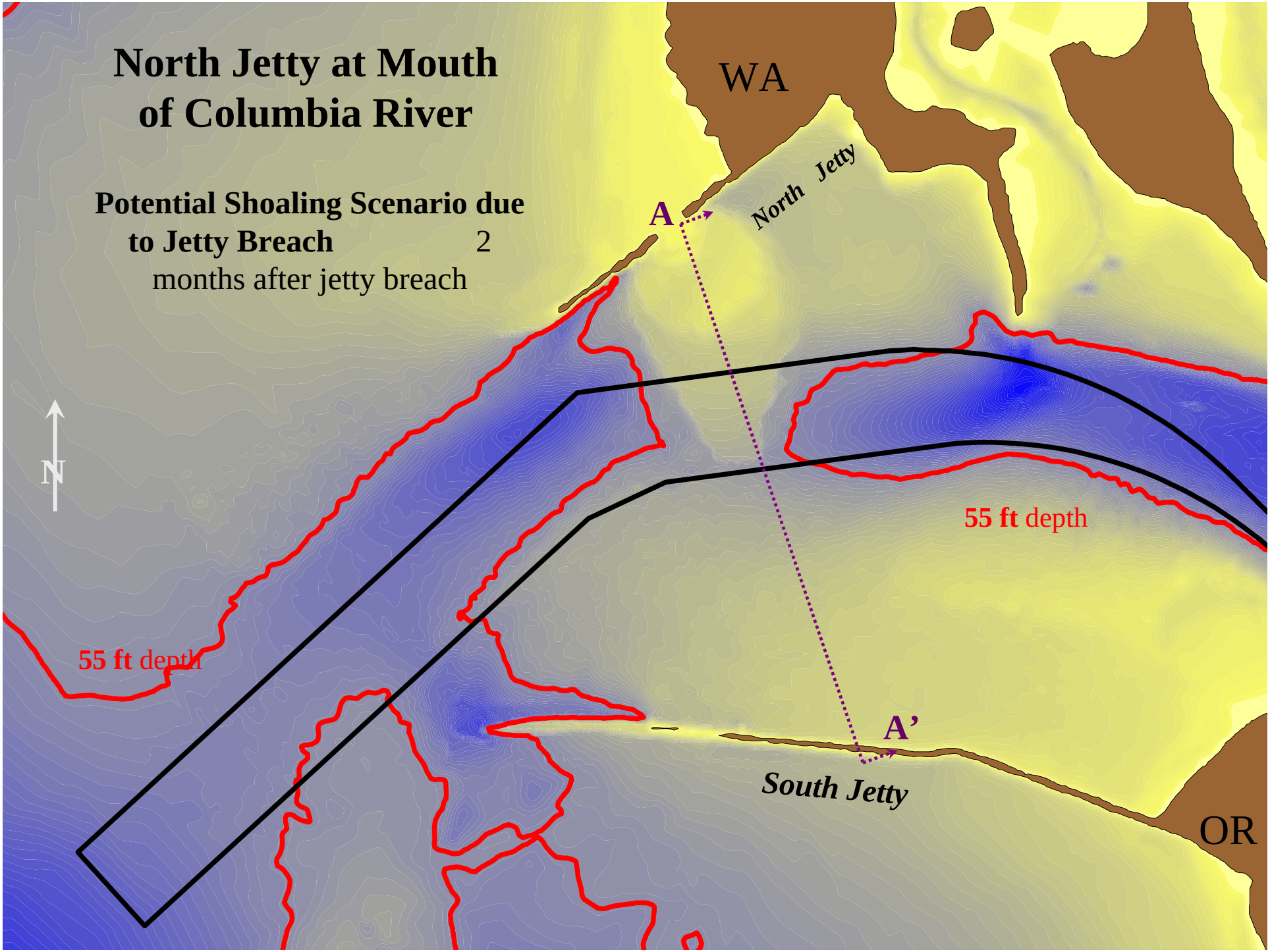
North Jetty Cross Section Life-Cycle Evolution(1917-2005) for STA =82.5



CHANNEL SIDE

BEACH SIDE


FORCAST Cummulative Life-Cycle Costs
MCR North Jetty 2006-2056
Cost $ Millions, 2007 Value
140
120
100
80
60
40
20
0
2006
2011
2016
2021
2026
2031
2036
2041
2046
2051
2056
Year
Simulated Life-Cycle Costs - Base Condition


North Jetty at Mouth of Columbia River
Potential Shoaling Scenario due to Jetty Breach
2 months after jetty breach
WA
North Jetty
A
N
55 ft depth
55 ft depth
A'
South Jetty
OR