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Collaborative Shoreline Management and Climate Change Adaptation Planning on Lake Erie

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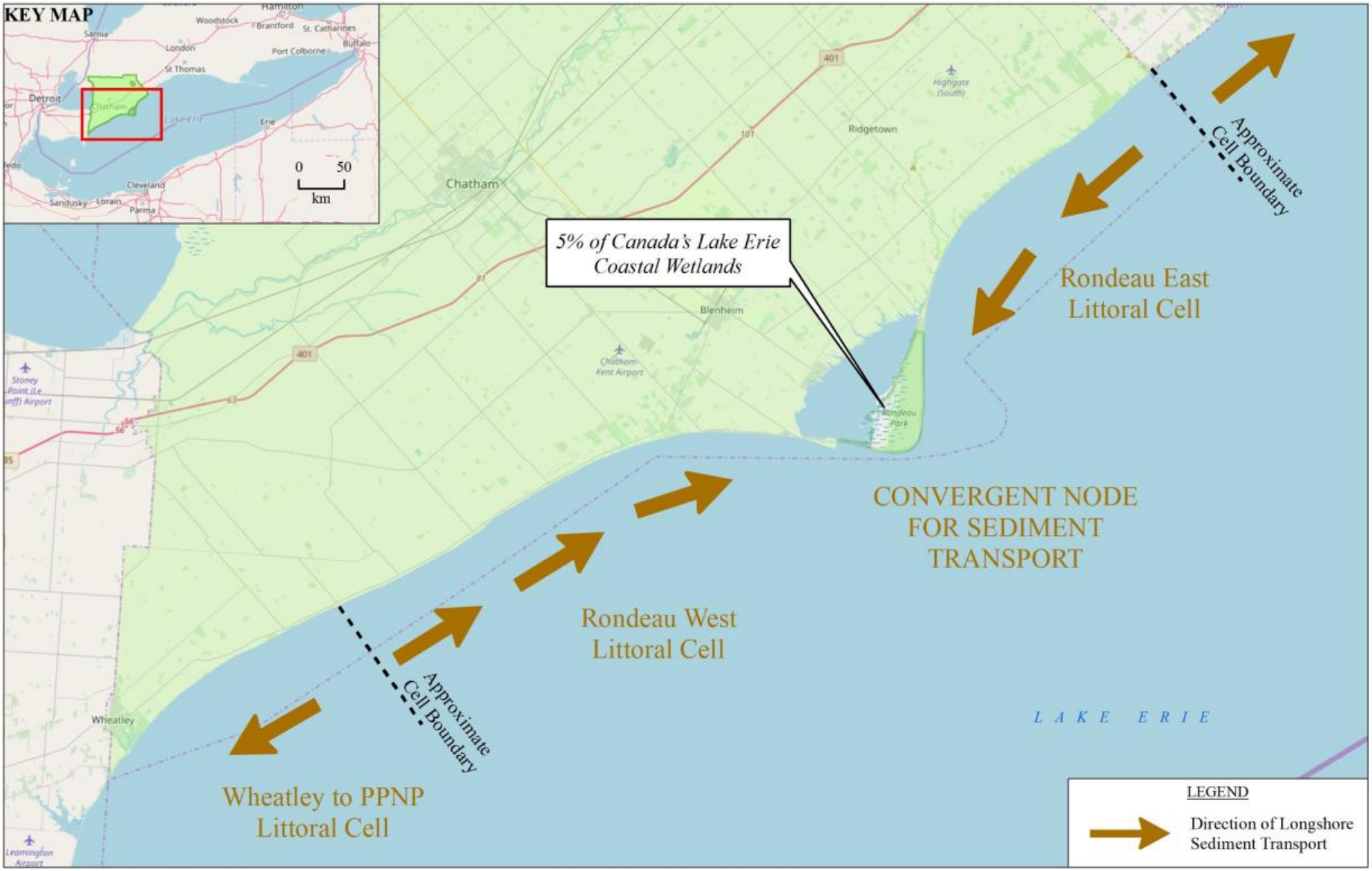
Linda Mortsch, University of Waterloo
Baird & Associates
RWDI

Presentation Overview

- I – NRCan Sponsored Study
- II – Stream 1 Climate Investigation
- III – Stream 2 CK Shoreline Study
- IV - Questions



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Chatham-Kent Lake Erie Study Shoreline and Littoral Cell Boundaries

Background Map: OpenStreetMap

N
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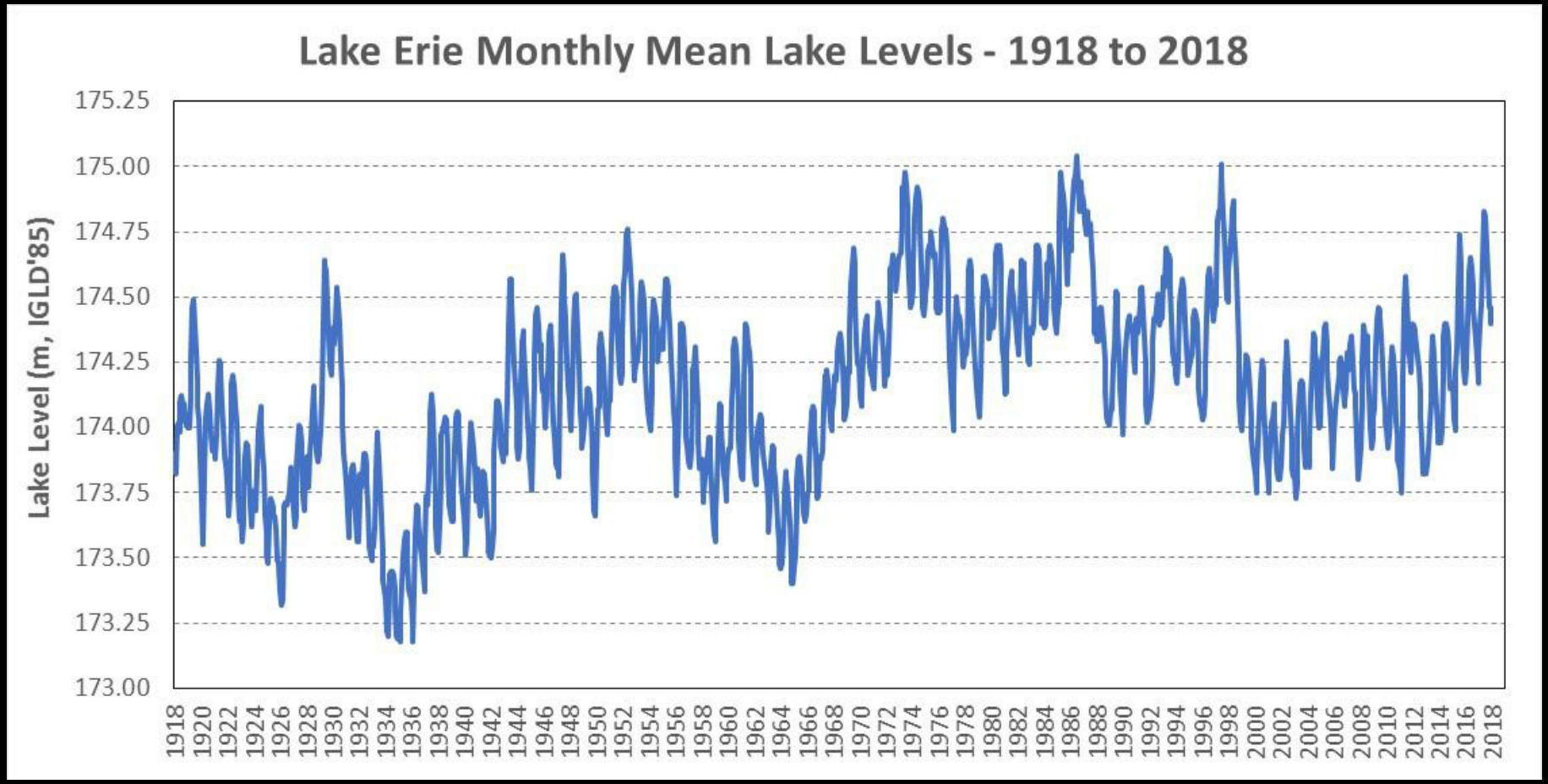
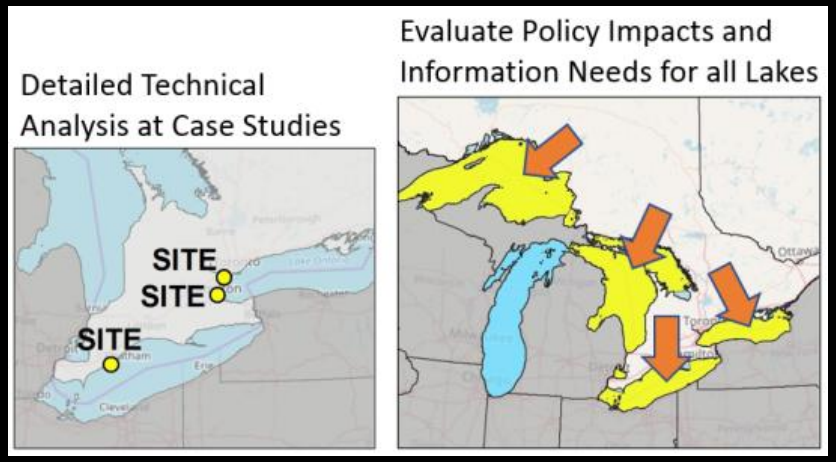
km

Lake Erie Water Levels

- Monthly Means



I – NRCan Sponsored Study



A Very Large Collaboration

- Produced through Canada's Climate Change Adaptation Platform, with support from Natural Resources Canada

- Matching Non-federal Funds and In-Kind Support from:
  - Municipality of Chatham-Kent
  - Lower Thames Valley Conservation Authority
  - Conservation Authorities Coastal Working Group (21 CAs)
  - Halton Region, City of Burlington, Halton Conservation
  - Credit Valley Conservation

Natural Resources Canada | Ressources naturelles Canada

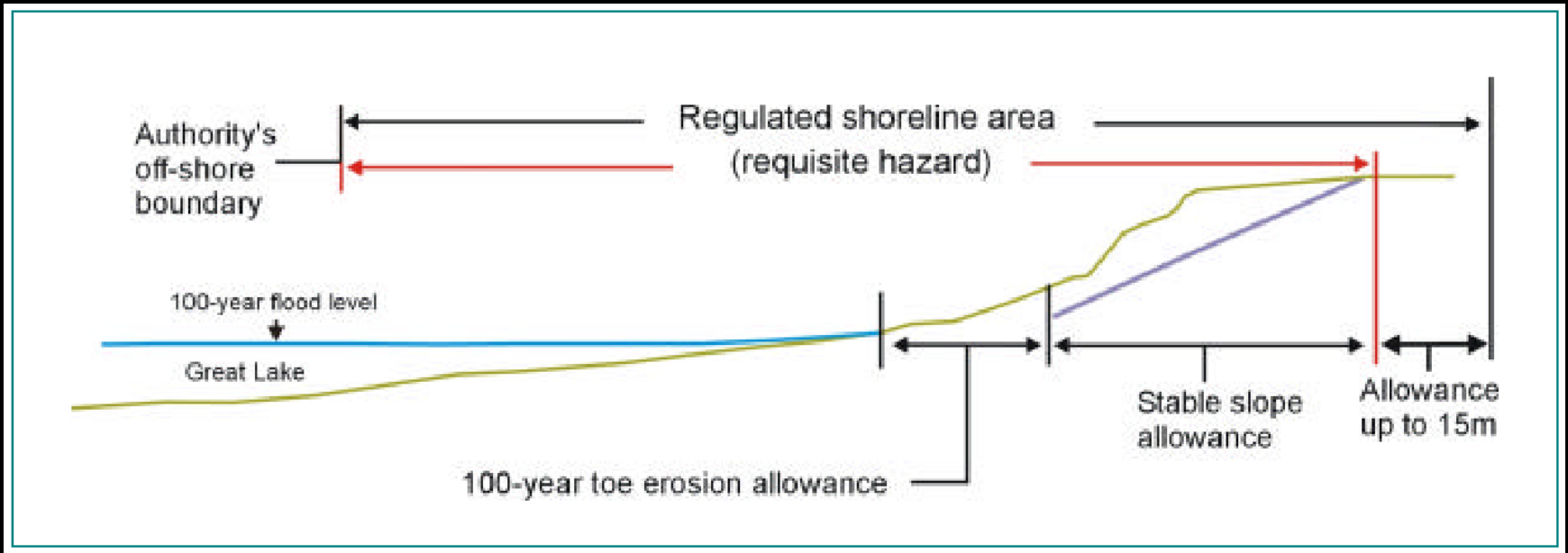
Canada

Rationale and Objectives for the Project

- Historically, majority of CC research in the Great Lakes has focused on Hydro climate studies (water levels)
- The project will:
  - Address knowledge gaps on climatic processes that influence coastal storms, ice, and adaptation responses
  - Using four case studies, co-develop expertise and approaches for integrating climate change into adaptation strategies for the Great Lakes coast
- This type of work has never been completed in the Great Lakes and will be an important first step for adaptation

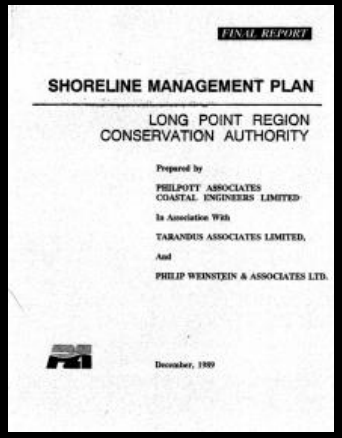
Climate Stationarity is the Foundation of our Hazard Mapping Methodology

- Predict the future based on the past



OLD (pre-2000) Shoreline Management Plans

- Shoreline Management was synonymous with Shoreline Armouring
- A better name would be ‘Hazard Mitigation Planning for New Shoreline Development’
- Limitations are linked to the narrow CA mandate along the shoreline and lack of broader agency participation


FINAL REPORT

SHORELINE MANAGEMENT PLAN

LONG POINT REGION CONSERVATION AUTHORITY

Prepared by

PHILPOTT ASSOCIATES COASTAL ENGINEERS LIMITED

In Association With

TARANDUS ASSOCIATES LIMITED,

And

PHILIP WEINSTEIN & ASSOCIATES LTD.

December, 1989


LAKE ONTARIO SHORELINE MANAGEMENT PLAN

Submitted to the

Central Lake Ontario Conservation Authority
Ganaraska Region Conservation Authority
Lower Trent Region Conservation Authority

By

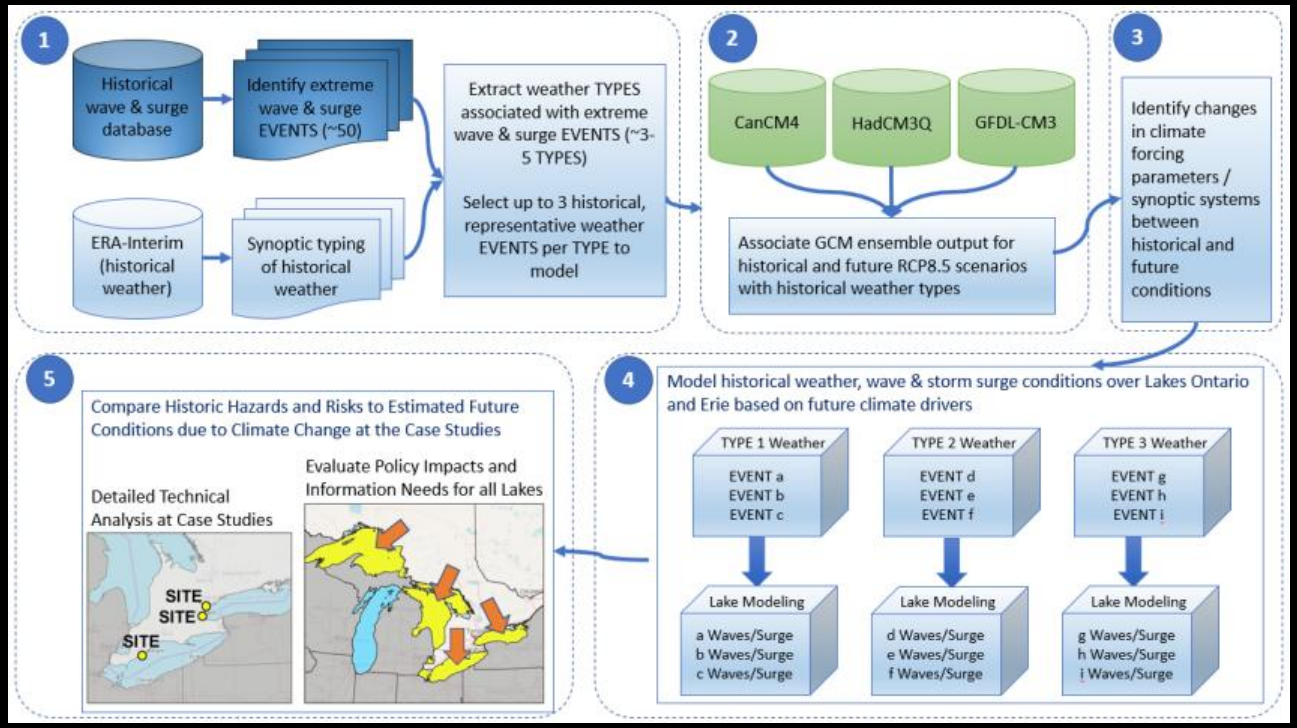
Sandwell Swan Wooster Inc.
in association with
Beak Consultants Limited and EDA Collaborative

December 1990

Steering Committee

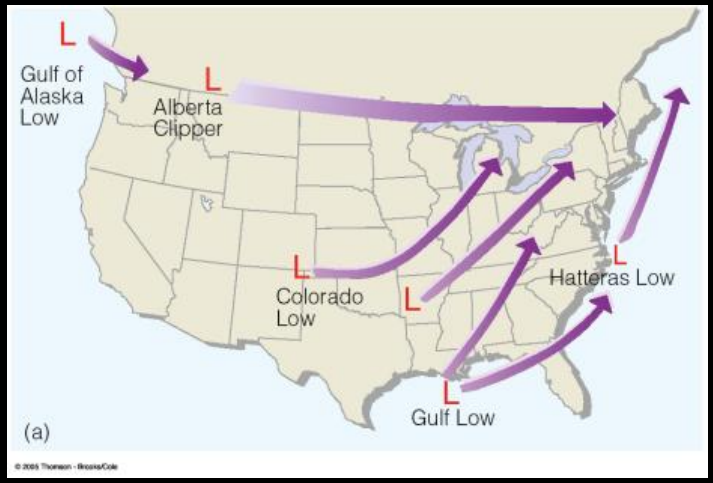
Representative	Agency
Bruce McAllister	Municipality of Chatham-Kent
Thomas Kelly	Municipality of Chatham-Kent
Tim Dick	Municipality of Chatham-Kent (alternate)
Mark Peacock	Lower Thames Valley CA
Jason Wintermute	Lower Thames Valley CA (alternate)
Teresa Labuda	Halton Region CA
Joe Nethery	Municipality of Halton
Anne Gariscsak	Municipality of Halton (alternate)
John Sinnige	Credit Valley CA
Amonjot Singh	Credit Valley CA (alternate)
Ryan Stainton	MECP/MNRF
Pamela Lamba	MECP
tbd	MMAH
Mike Shantz	ECCC
Janette Anderson	ECCC
John Sommerville	NRCan
Al Douglas	Ontario Centre for Climate Impacts and Adaptation
Jennifer Boehme	IJC
David Bucaro	USACE
Linda Mortsch	Consultant
Pete Zuzek	Consultant
Kevin Grootendorst	Consultant

II – Stream 1 Climate Investigation



Climate Analysis

- Storm Typing: characterize the weather patterns that produce the most extreme storm conditions on Lake Erie and Lake Ontario
- Examples include: Colorado Lows, Alberta Clipper, Post-tropical Storms (former hurricanes)
- Use NCAR GCM output to evaluate these storms for the historic period (1976 to 2005) and the future (2071 to 2100)
- Learn about changes in frequency
- Changes in storm ensemble

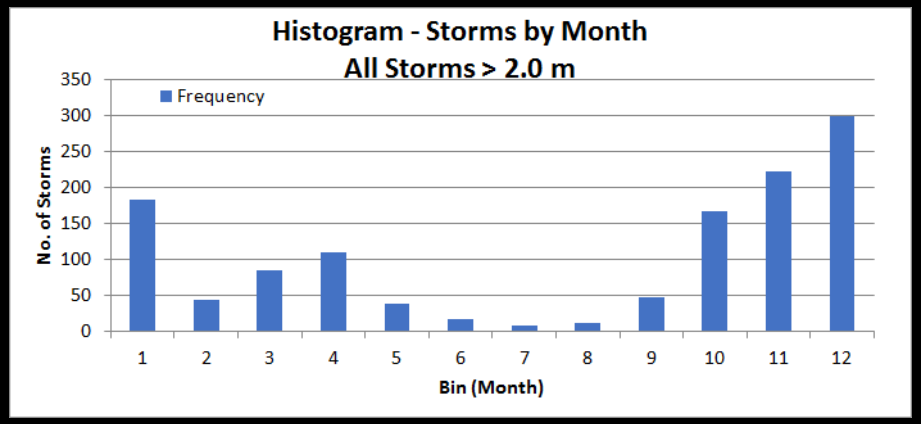


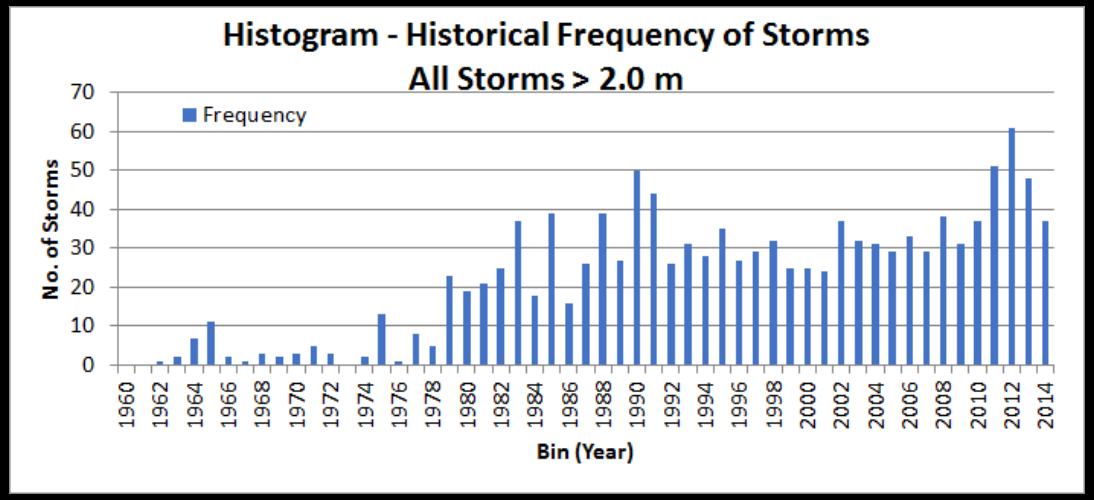
1960-2014 Storm Listing (WIS Station 92,154)

Rank	Start	End	Peak	Hm0 (m)	TP (s)	Coming from Dir (deg)	YEAR	MONTH
1	19871215100000	19871216220000	19871216020000	5.9	9.2	223	1987	12
2	20091209180000	20091211220000	20091210010000	5.7	9.1	225	2009	12
3	19820104140000	19820105110000	19820105000000	5.5	9.0	228	1982	1
4	19951005130000	19951006050000	19951005230000	5.4	9.5	75	1995	10
5	19851202040000	19851203030000	19851202130000	5.1	8.5	227	1985	12
6	19981110140000	19981112040000	19981111090000	4.9	8.4	225	1998	11
7	20131026040000	20131027000000	20131026130000	4.8	8.4	222	2013	10
8	20020309160000	20020310220000	20020310030000	4.7	8.4	230	2002	3
9	20141124040000	20141125180000	20141124220000	4.6	8.1	227	2014	11
10	19901203060000	19901203220000	19901203140000	4.6	8.5	85	1990	12
11	20110415090000	20110416170000	20110415220000	4.6	8.4	77	2011	4
12	20111122130000	20111123100000	20111123000000	4.5	8.4	77	2011	11
13	19800107010000	19800108050000	19800107090000	4.5	8.2	206	1980	1
14	19790406030000	19790406220000	19790406090000	4.5	8.3	238	1979	4
15	19900125190000	19900126110000	19900126030000	4.5	8.1	211	1990	1
16	20121226100000	20121227080000	20121226210000	4.5	8.4	76	2012	12
17	20021129030000	20021130020000	20021129130000	4.5	7.9	215	2002	11
18	19820110160000	19820112020000	19820111020000	4.5	8.1	220	1982	1
19	20130411110000	20130412100000	20130412010000	4.4	8.6	76	2013	4
20	20120302230000	20120303230000	20120303080000	4.4	8.0	227	2012	3
21	19921225060000	19921226070000	19921225170000	4.4	7.9	222	1992	12
22	19991229210000	19991230100000	19991230010000	4.4	7.7	212	1999	12
23	20071223170000	20071224200000	20071224010000	4.4	7.8	228	2007	12
24	20130118220000	20130119170000	20130119030000	4.3	7.7	211	2013	1
25	20111109200000	20111110080000	20111110030000	4.3	7.8	231	2011	11
26	19980320210000	19980321220000	19980321040000	4.3	8.5	70	1998	3
27	19991225210000	19991226140000	19991226070000	4.3	7.9	224	1999	12
28	19901106000000	19901106110000	19901106040000	4.3	7.8	225	1990	11
29	19800111040000	19800112160000	19800111180000	4.2	7.9	202	1980	1
30	20090928070000	20090929130000	20090928200000	4.2	7.8	228	2009	9

PRELIMINARY

Storms by Month and Year (1960-2014, Hs > 2.0)

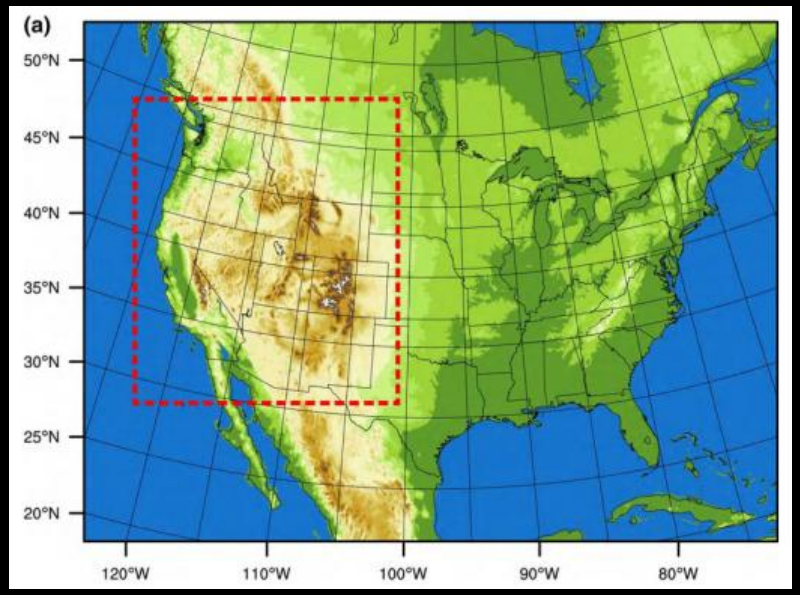




PRELIMINARY

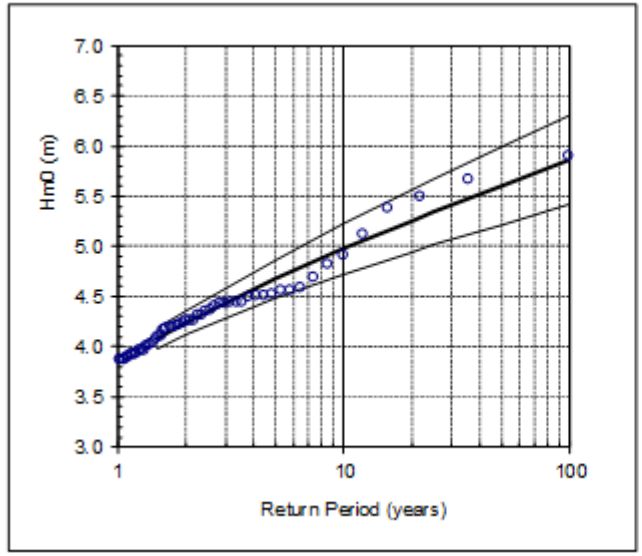
Storm Intensity

- Weather Research and Forecasting Model (WRF) output for a historical 2000 to 2013 simulation (4 km grid)
- Future WRF modeling with modified boundary conditions forced by a high-end emission scenario (Liu et al, 2016)
- Wind and Pressure data at 4 km grid
- WRF simulates lake ice effects
- Extract historical / future storms
- Drive wave and surge models



Outputs from Climate Investigation

- Extreme Value Analysis for historical / future wave and storm surge for western Lake Erie and Lake Ontario
- Information on changes in storm frequency and total wave energy impacting the shoreline
- Evaluate implications for coastal hazards and regulations
- Knowledge on future lake level from other sources

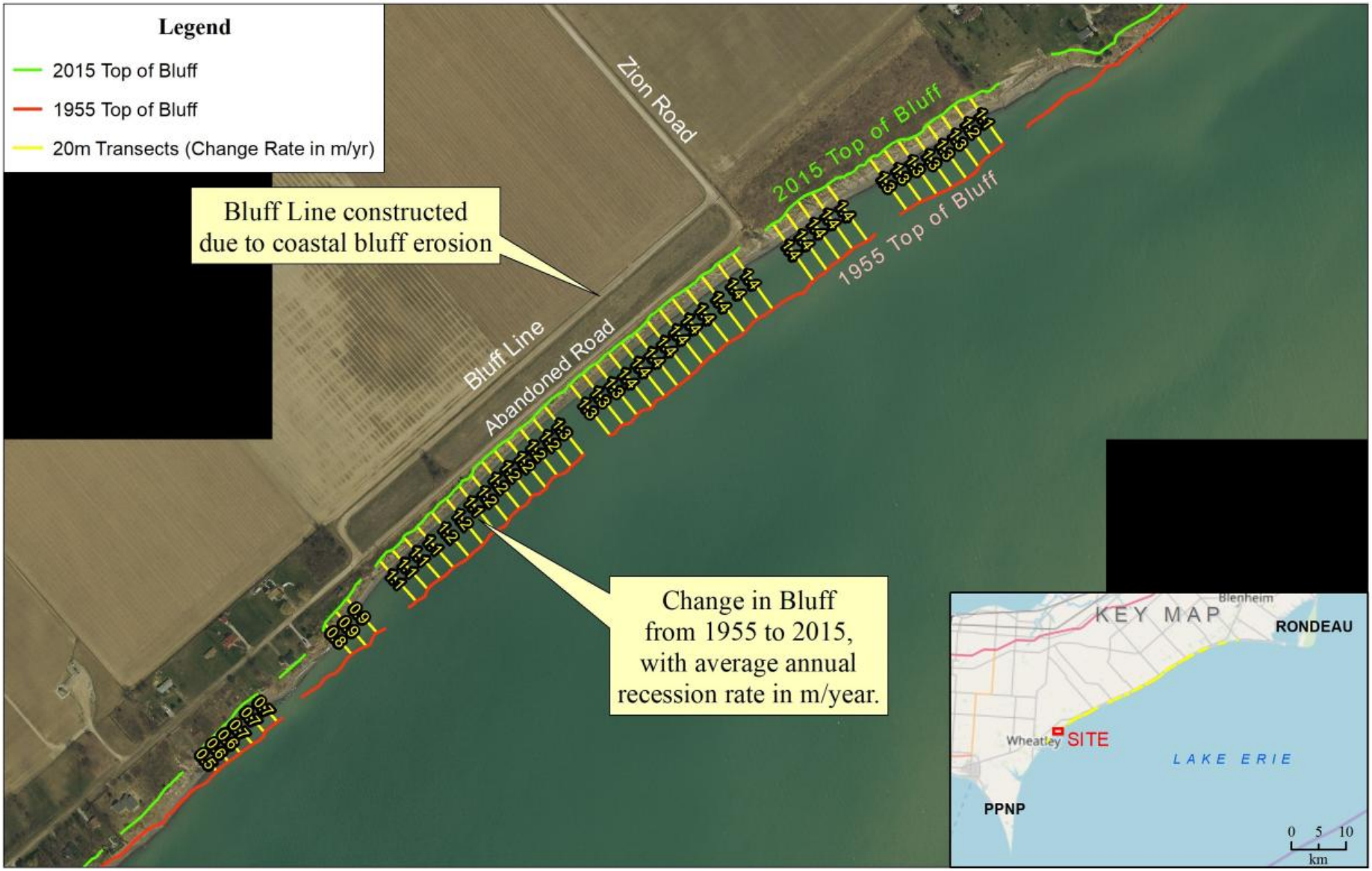


Return Period

Tr	X(T)	Confidence Limit Upper	Lower
1.5	4.08	4.2	4.0
2	4.24	4.4	4.1
5	4.68	4.9	4.5
10	4.98	5.2	4.7
20	5.26	5.6	4.9
25	5.34	5.7	5.0
50	5.61	6.0	5.2
100	5.87	6.3	5.4
200	6.11	6.6	5.6
500	6.43	7.0	5.9

III – Chatham-Kent Shoreline Study

Eroding Bluffs and Slope Instability



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Road Re-alignment in Response to Coastal Bluff Erosion

Municipality of Chatham-Kent

Data Sources:
- 1955 aerials provided by LTVCA
- 2015 SWOOP provided by ECCC
- OpenStreetMap

N
W E
S

0 50 100 200
m

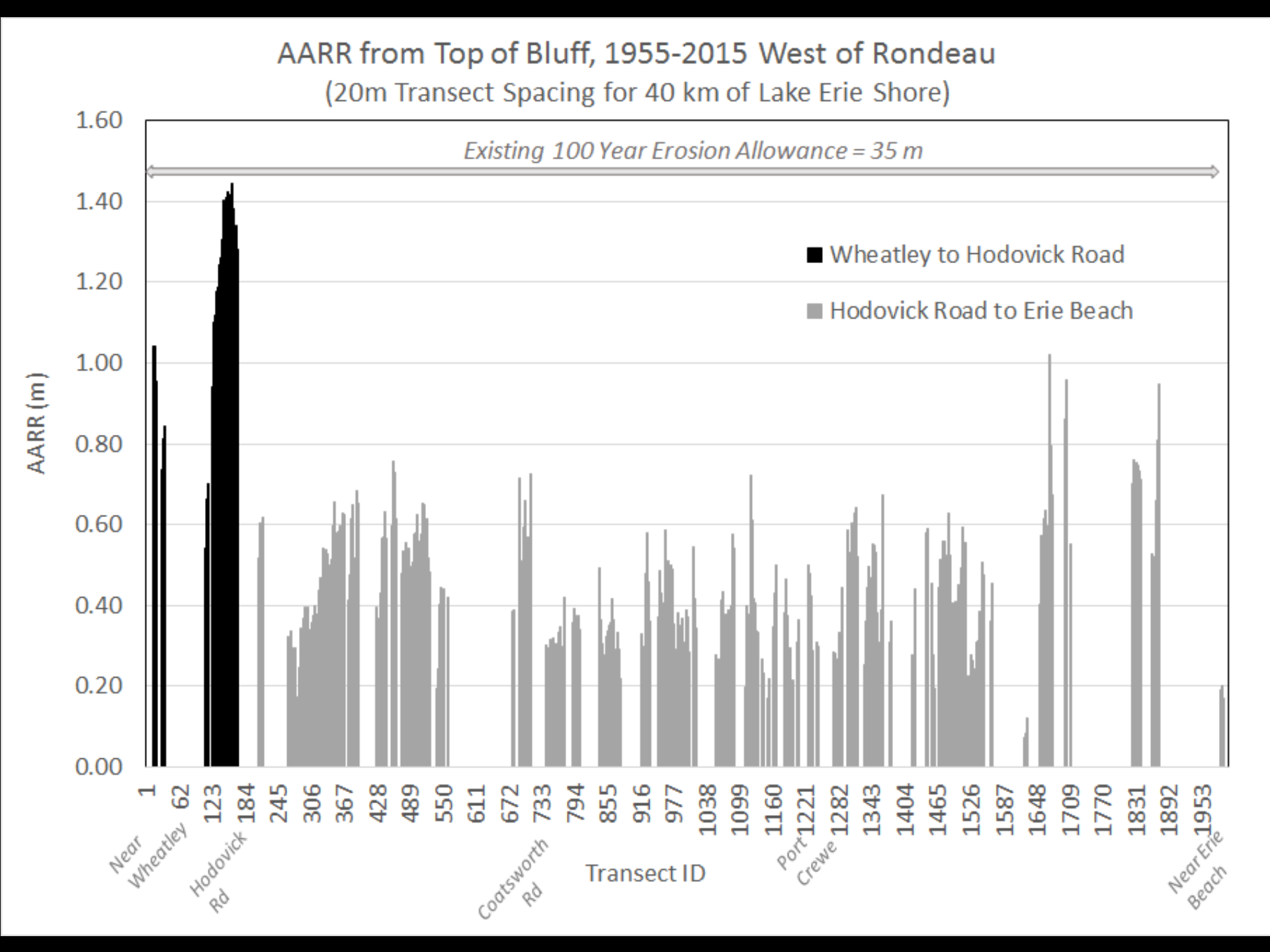
AARR from Top of Bluff, 1955-2015 West of Rondeau
(20m Transect Spacing for 40 km of Lake Erie Shore)
Existing 100 Year Erosion Allowance = 35 m
Wheatley to Hodovick Road
Hodovick Road to Erie Beach
AARR (m)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1
62
123
184
245
306
367
428
489
550
611
672
733
794
855
916
977
1038
1099
1160
1221
1282
1343
1404
1465
1526
1587
1648
1709
1770
1831
1892
1953
Near Wheatley
Hodovick Rd
Coatsworth Rd
Port Crewe
Near Erie Beach
Transect ID

Image: 2015 orthophoto

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1868 Shoreline Map Superimposed on 2015 Orthophotograph of Erieau.
The Town of Erieau was a series of Migrating Islands in 1868.

Municipality of Chatham-Kent

Data Sources:
- 2018 survey of the barrier beach by LTVCA
- 2015 orthophoto provided by ECCC
- 1868 shoreline plot obtained from local business during 2018 field work campaign

N
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0 200 400
m

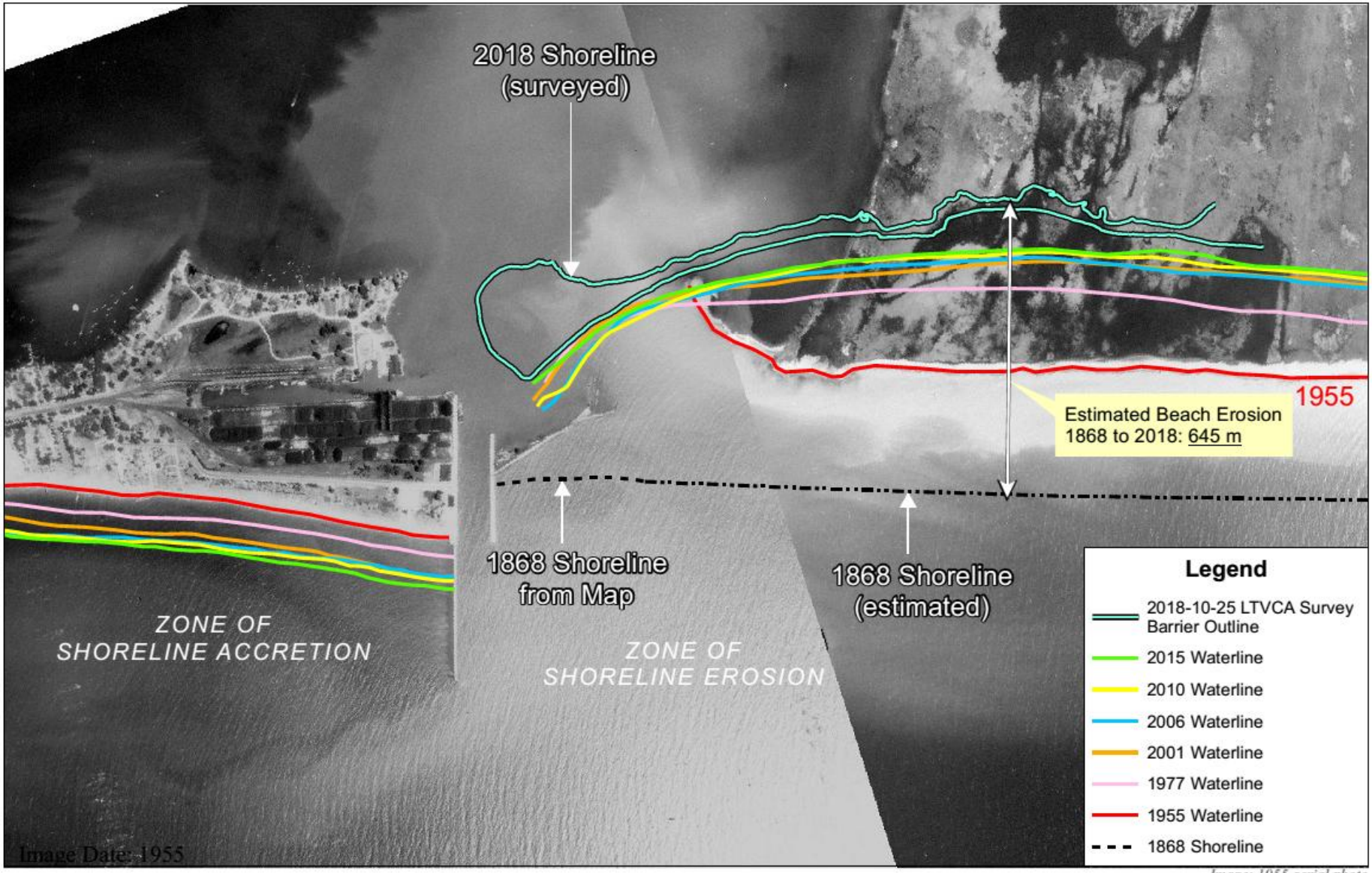

Image: 1955 aerial photo

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Change in Beach Position in the Town of Erieau and Rondeau Provincial Park from 1868 to 2018

Data Sources:
- 2018 survey of the barrier beach by LTVCA
- 1955 aerials provided by LTVCA

N
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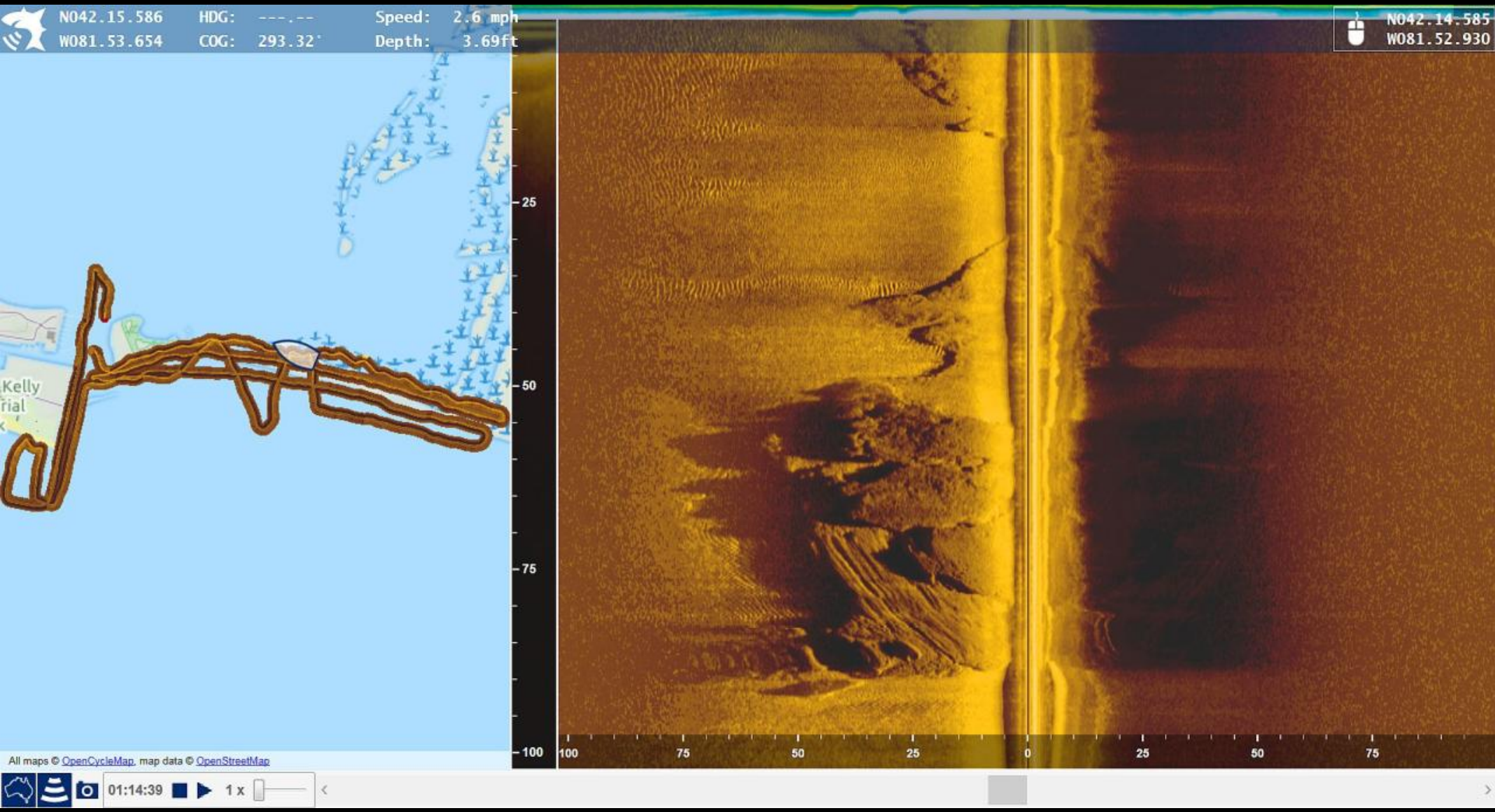
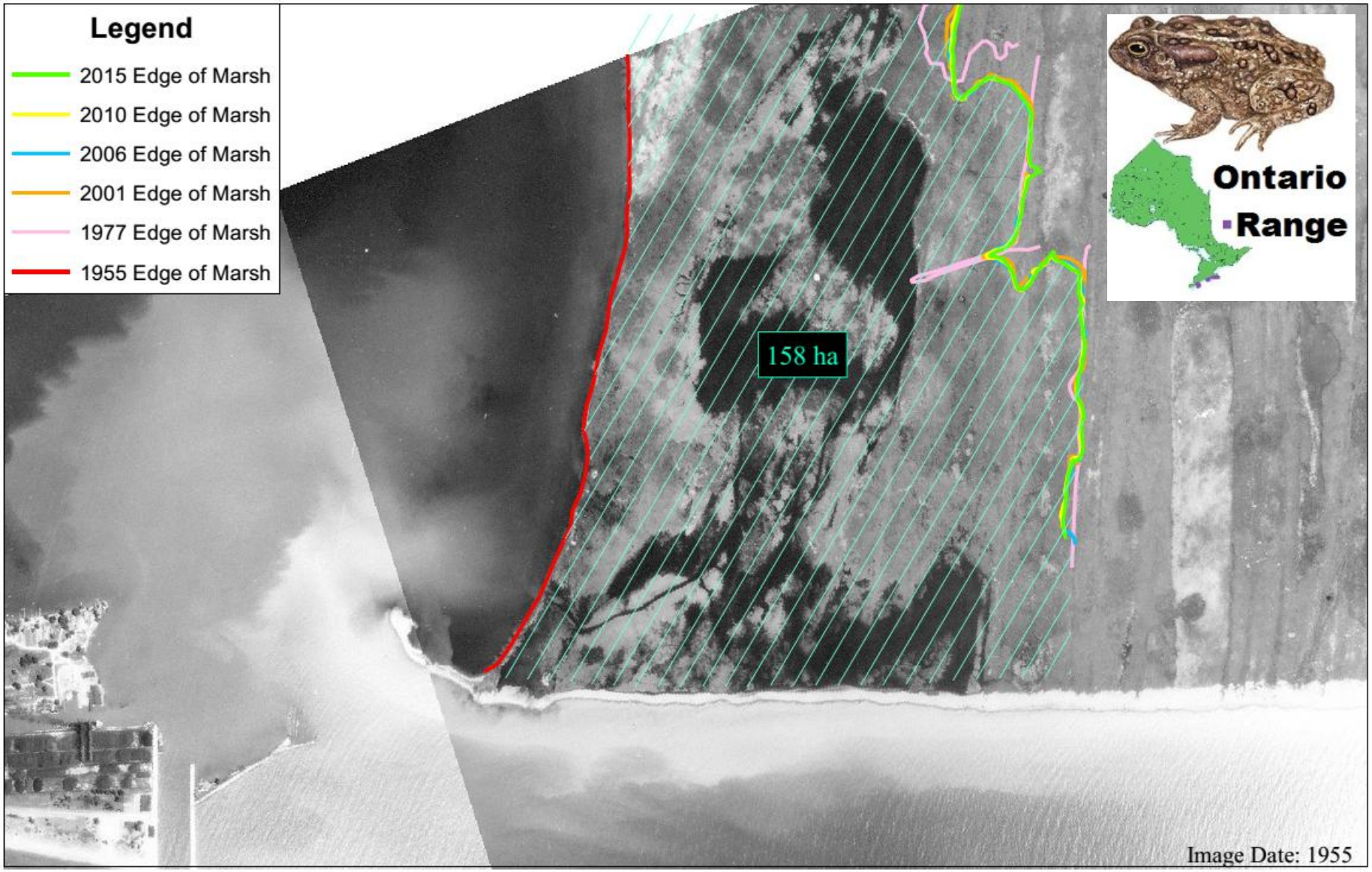
m

Peat Exposure on the Lake Bottom



Peat (not Pete) on the Beach



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Change in Marsh Edge at Rondeau Provincial Park 1955-2015

Data Sources:
1955 aerials provided by LTVCA

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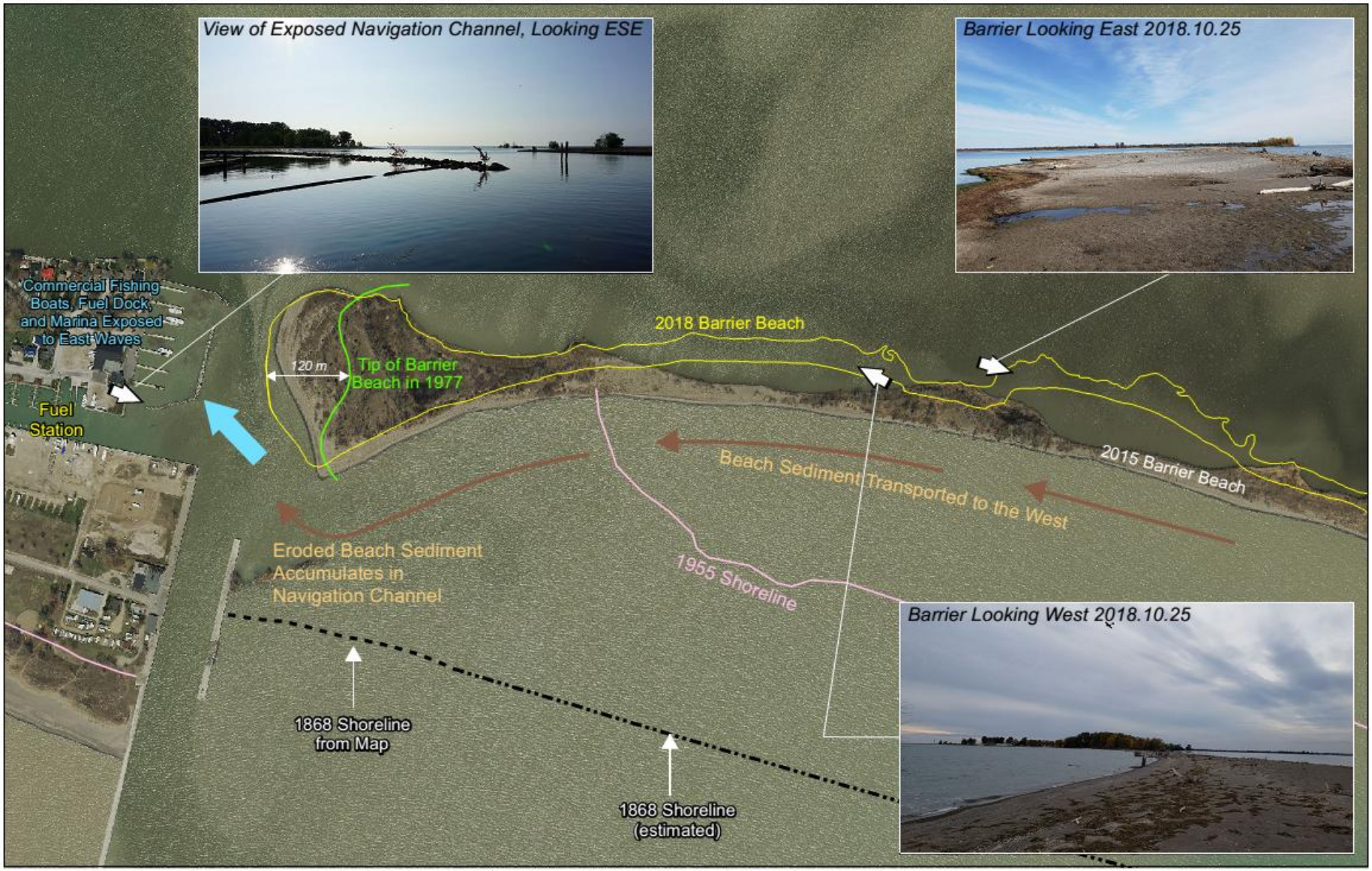
0 100 200 300
m



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Rondeau Bay Navigation Channel and Barrier Beach: 1868 to 2018 Evolution and Risk Exposure

2018-10-25 LTVCA Survey
1977 Shoreline
1955 Shoreline
1868 Shoreline

Data Sources:
- 2018 survey of the barrier beach by LTVCA
- 2015 orthophoto provided by ECCC

N
W E
S

0 100 200
m

Next Steps

- Public Engagement starts in early 2019 (one of the most challenging and important aspects of this study)
- Map erosion hazard with historical recession rates to assist with road planning and re-alignment studies
- Evaluate Stream 1 impacts on hazards, risks, and regulatory responsibilities of the CA and Municipality
- Co-develop adaptation strategies to reduce coastal risks and increase resilience
- Map erosion, flooding, and dynamic beach setbacks for future develop
- Address legacy development on hazardous lands

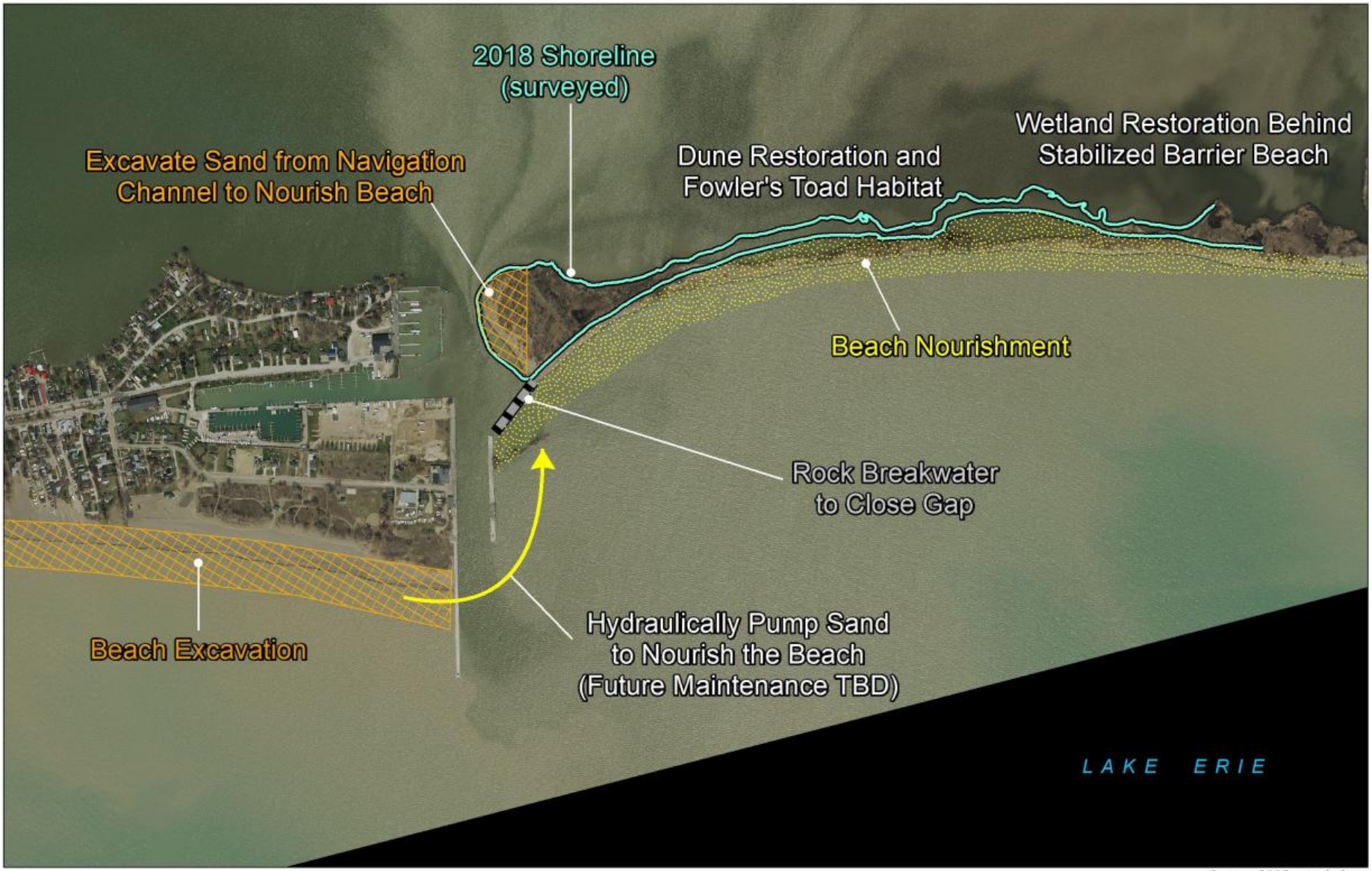

Image: 2015 aerial photo

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Draft Adaptation Plan

Data Sources:
- 2018 survey of the barrier beach by LTVCA
- 2015 aerials provided by ECCC

N E S W

0 100 200 300
m

IV – QUESTIONS