Rockland 1996 Landslide Assessment

City of Rockland

December 16, 2024

GEI Consultants

OUTLINE

- Background on 1996 Landslide
- Geology and Contributing Factors
- Current Assessment and Observations
- Additional Findings
- Summary and Recommendations

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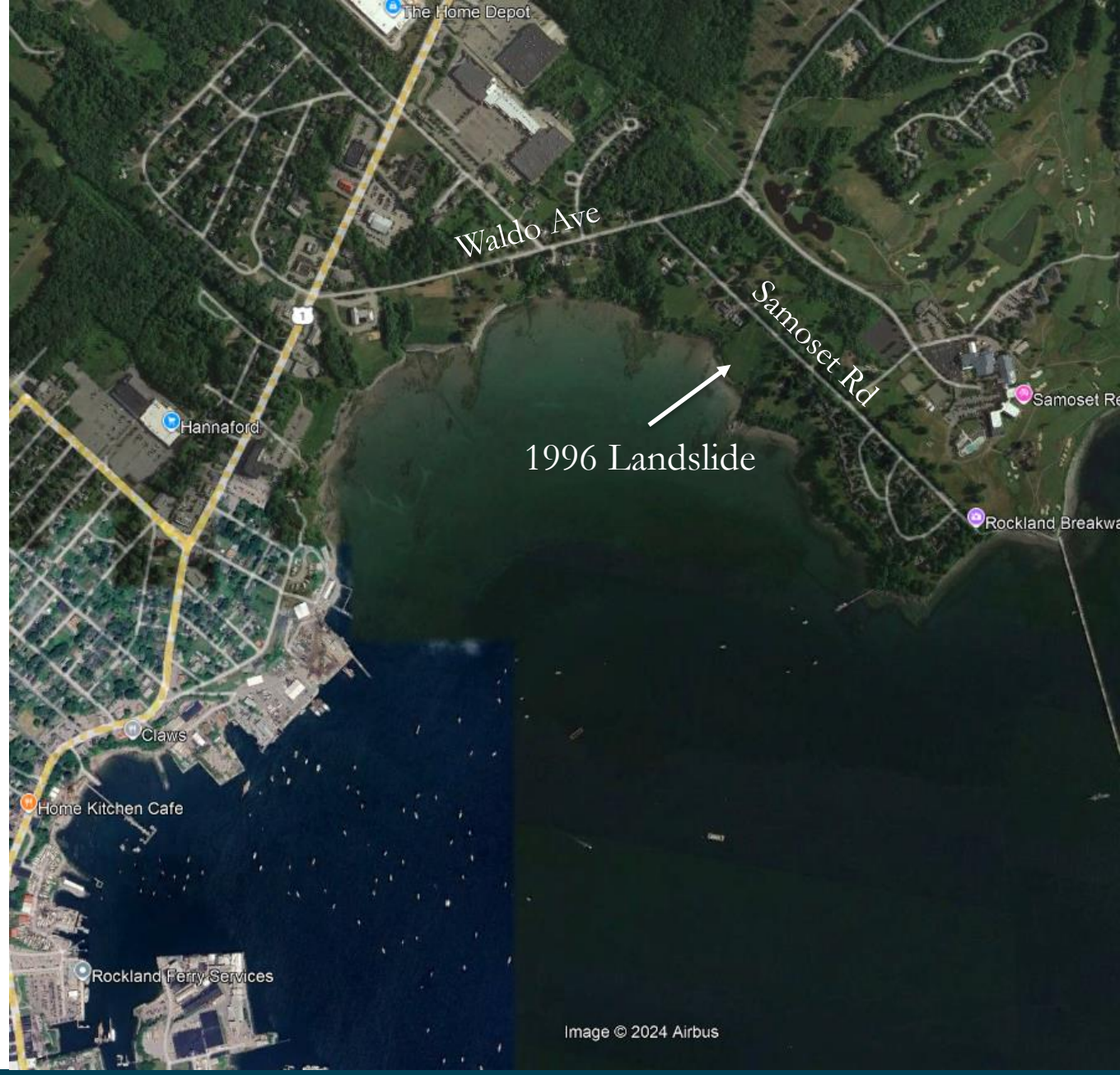
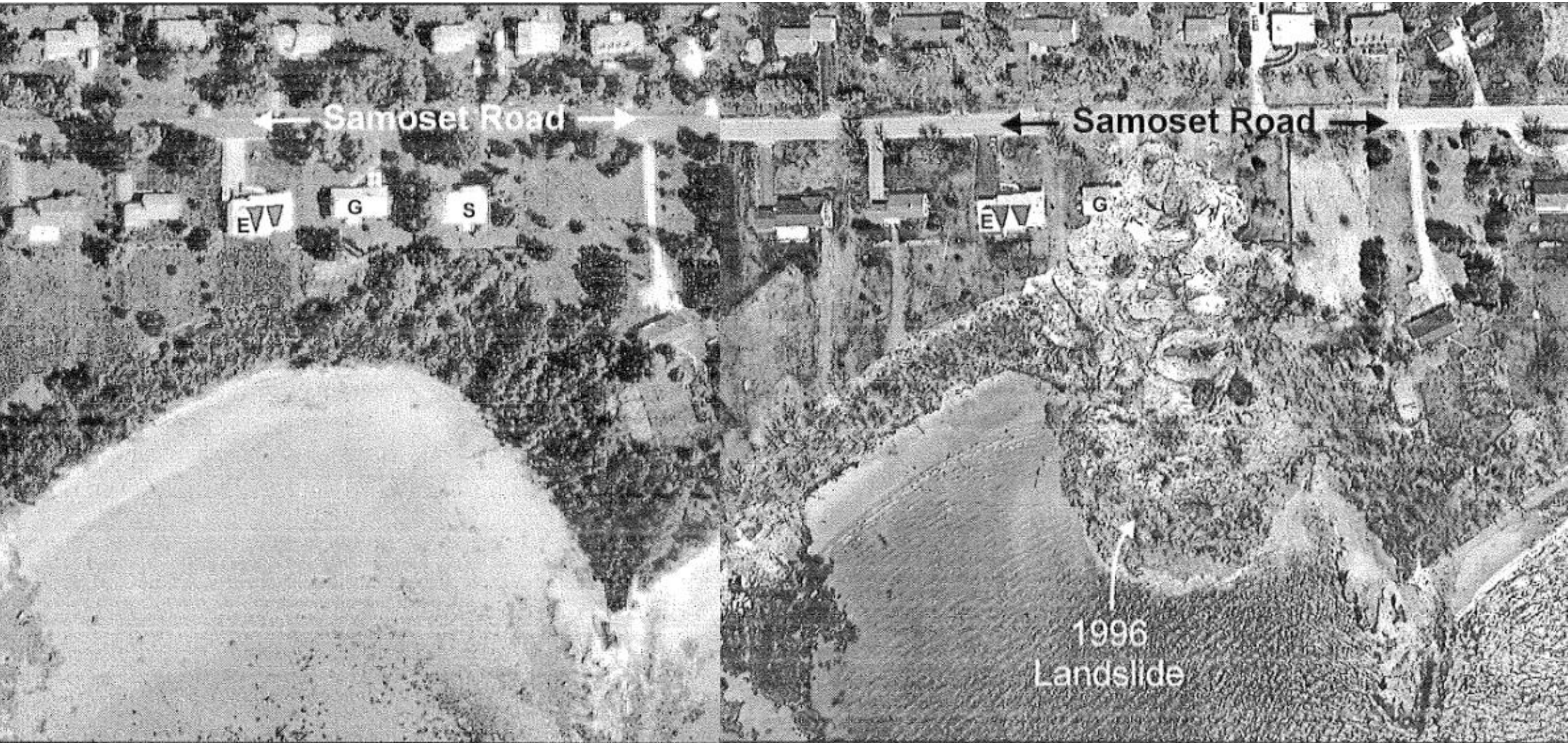
1996 Rockland Landslide

- Occurred April 16, 1996
- Bluff ~50 ft tall, 2H:1V
- Scarp ~200 ft landward of bluff crest
- Deposited soil/debris ~250 ft seaward of bluff toe
- 3.5 acres disturbed
- Two homes destroyed
- No casualties

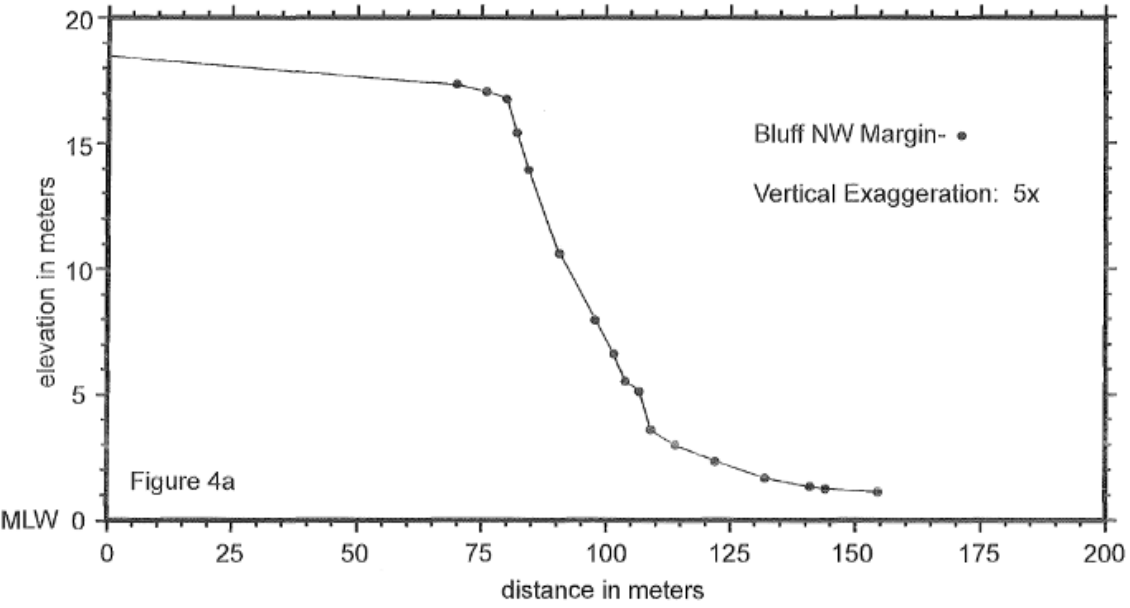


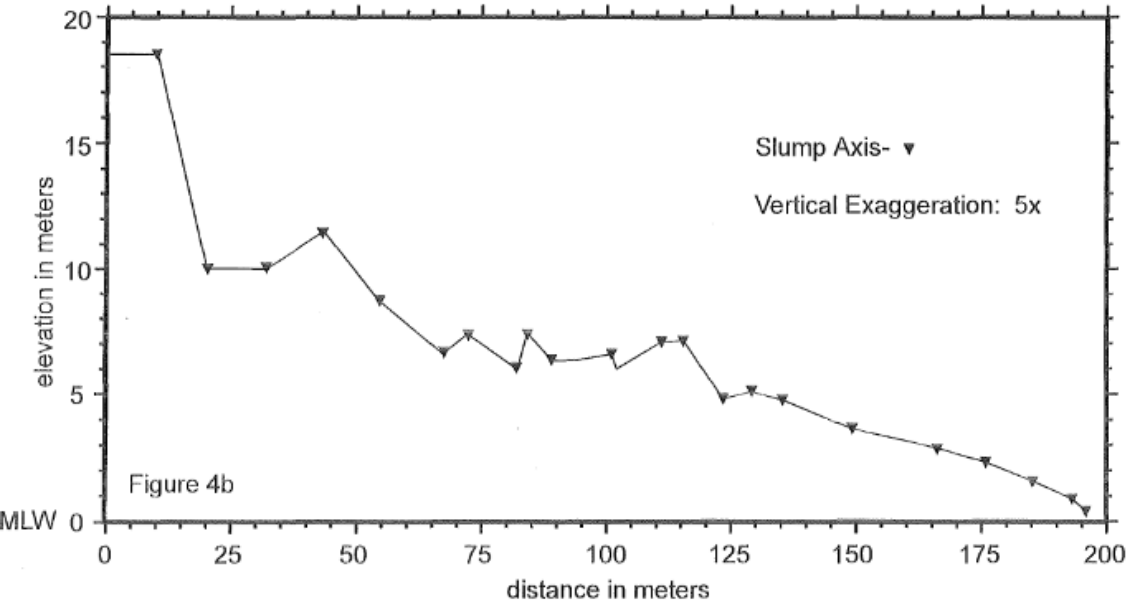
BEFORE

AFTER



MGS, 1996


20
15
10
5
MLW 0
elevation in meters
Bluff NW Margin- •
Vertical Exaggeration: 5x
Figure 4a
0
25
50
75
100
125
150
175
200
distance in meters

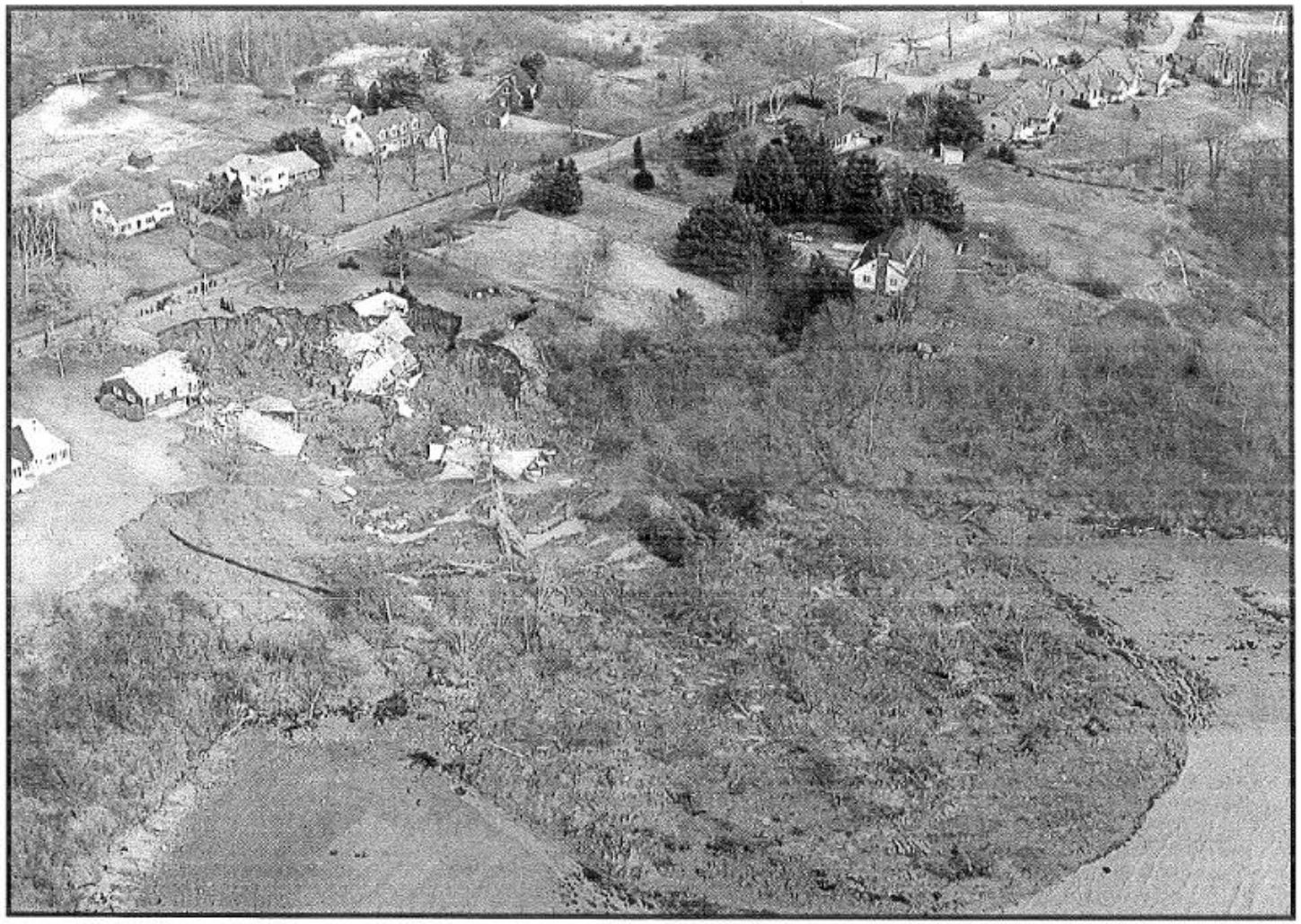

20
15
10
5
MLW 0
elevation in meters
Slump Axis- ▾
Vertical Exaggeration: 5x
Figure 4b
0
25
50
75
100
125
150
175
200
distance in meters

MGS, 1996

1996 Study

- MGS, NRIMC, UMaine, Gerber geologists
- Multiple visits to map the landslide and assess conditions
- Review of geology and landslide history
- Seismic refraction survey performed to estimate bedrock depth
- Three borings advanced behind head scarp, performed vane shear tests

The April 1996 Rockland Landslide



MGS, 1996

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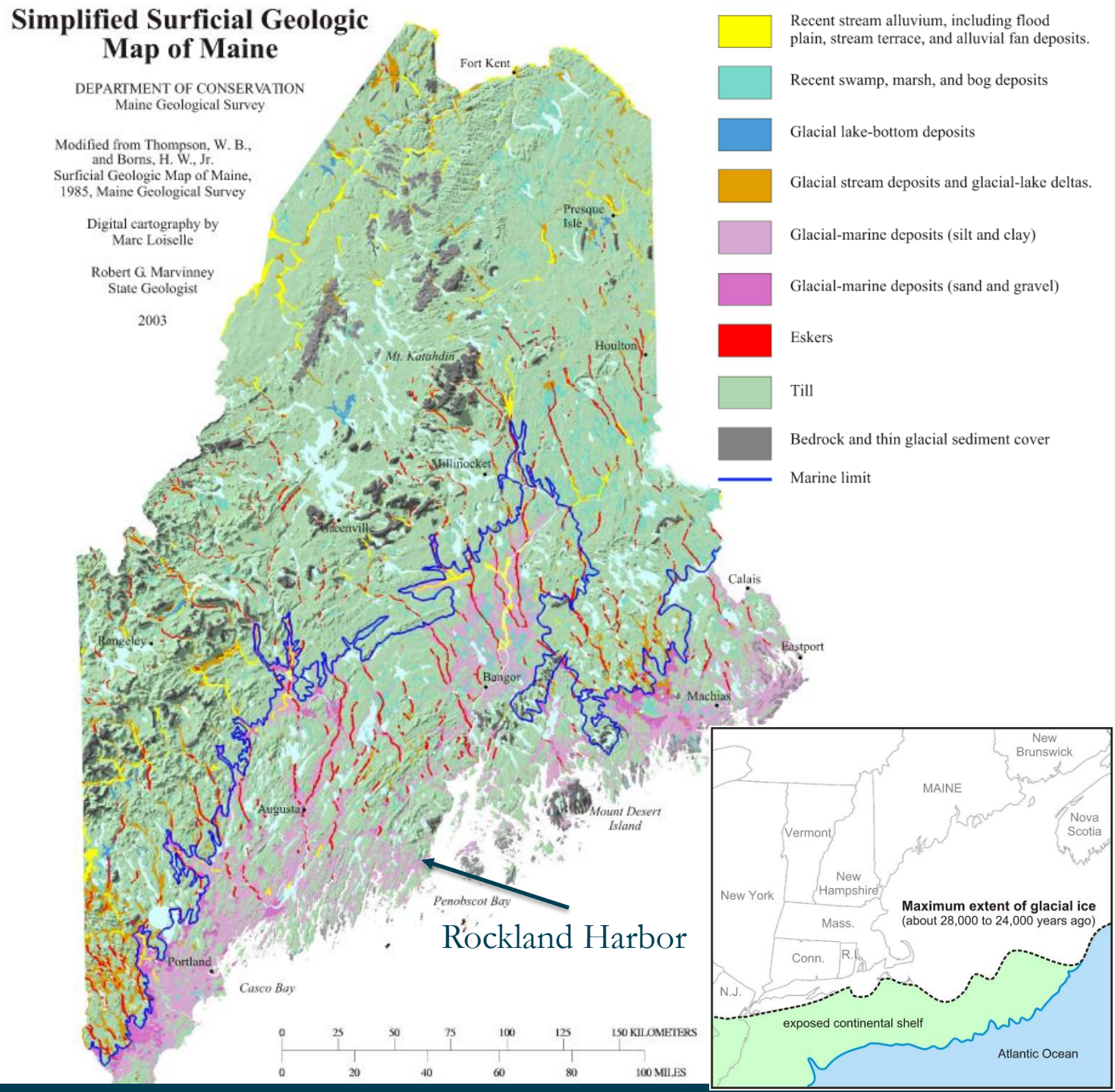
Geology

- Presumpscot Formation – glaciomarine silt, clay with sand lenses
- Glacial Till – sand, silt, gravel, rock debris, boulders deposited as glaciers advanced and retreated
- Bedrock – schist and gneiss



MGS, 2003

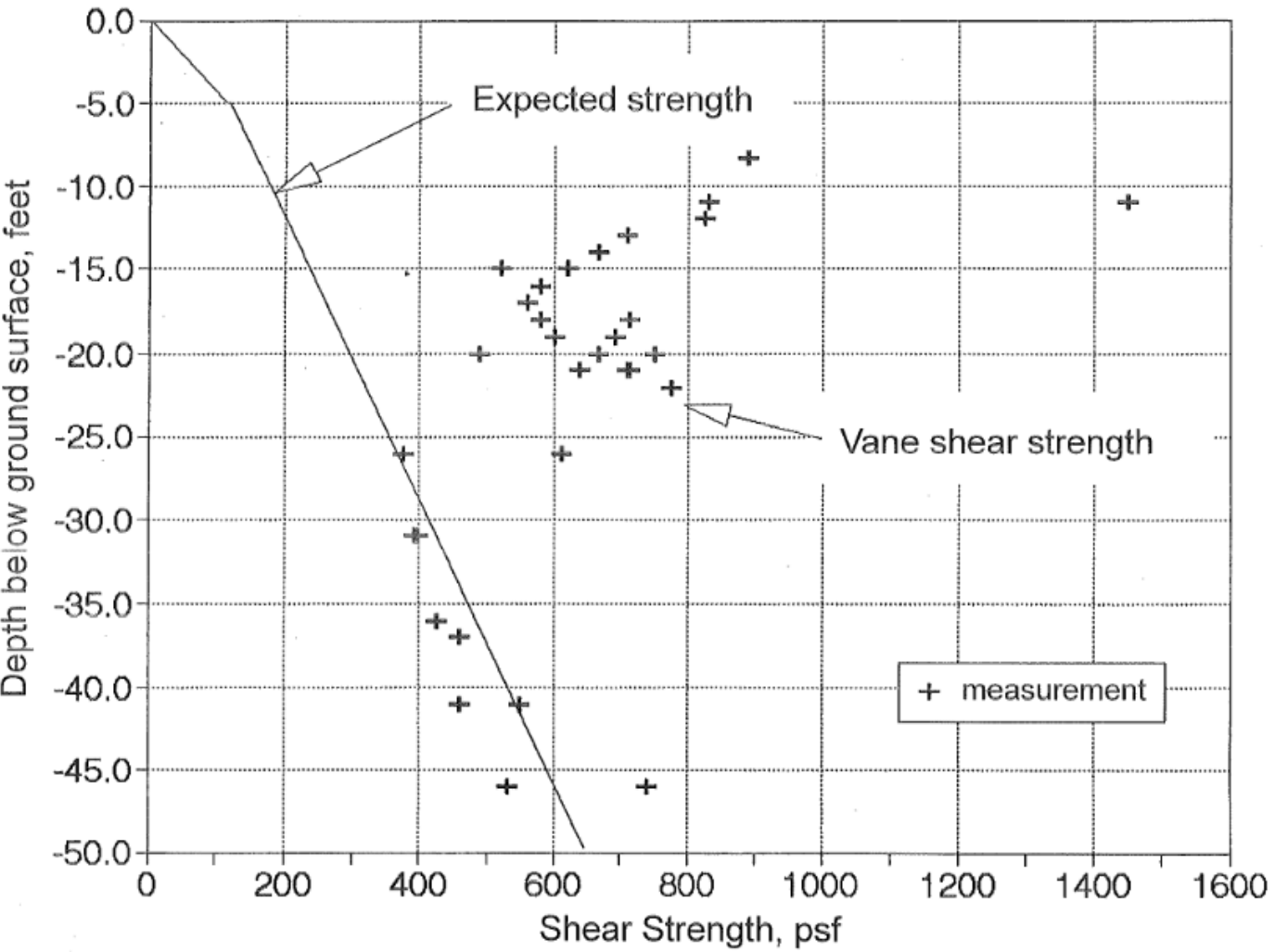
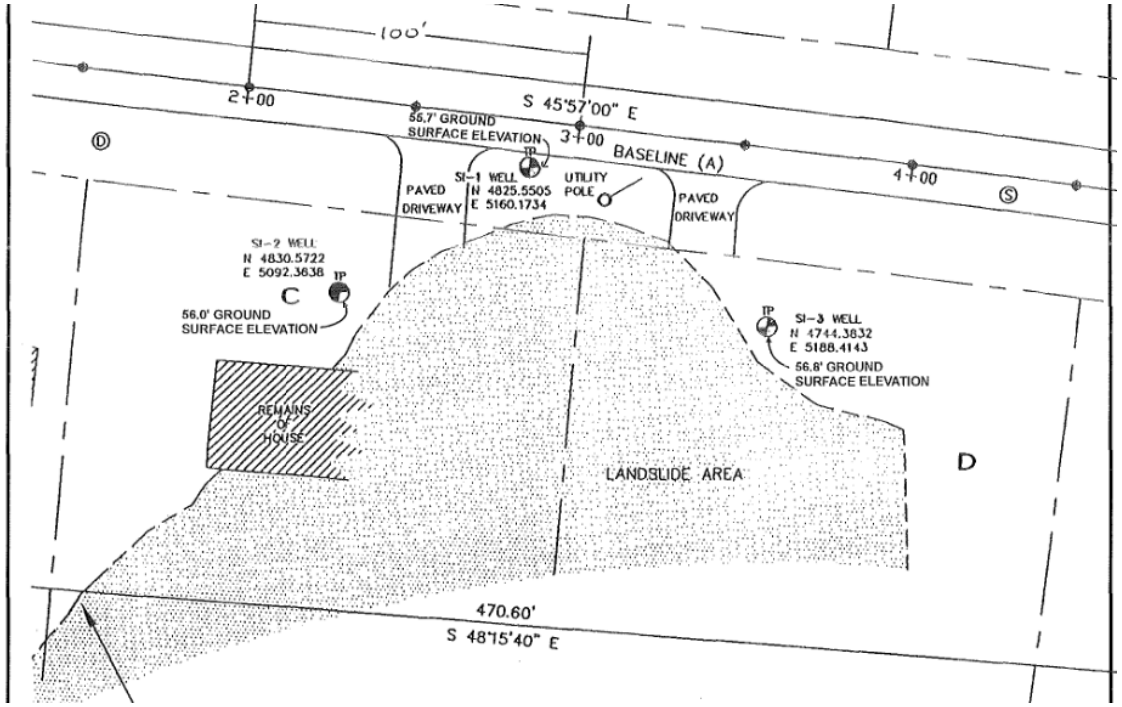
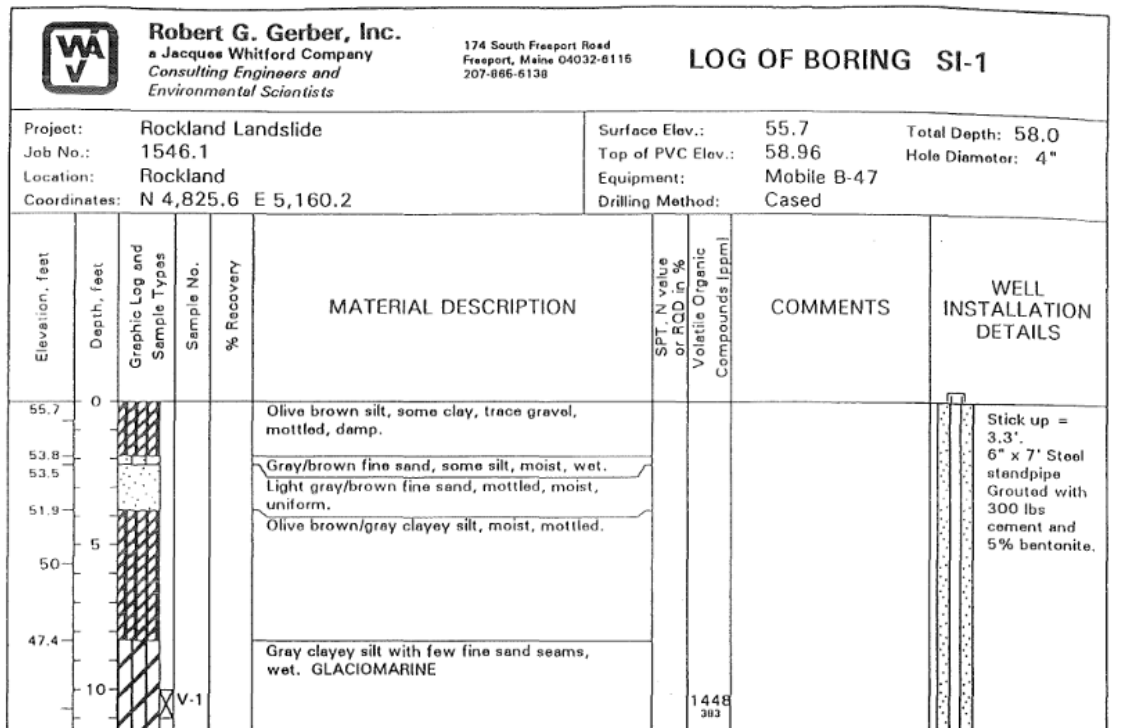


Figure 11. Diagram showing vane shear strength of the clay at various depths. Vane shear strength measurements of clay from boreholes at the 1996 Rockland landslide site are shown by "+" symbols. The line drawn on the diagram shows the expected strength of normally consolidated clay of the Presumpscot Formation.





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a Jacques Whitford Company
Consulting Engineers and Environmental Scientists
174 South Freeport Road
Freeport, Maine 04032-6116
207-865-6138

LOG OF BORING SI-1

Project:	Rockland Landslide	Surface Elev.:	55.7	Total Depth:	58.0
Job No.:	1546.1	Top of PVC Elev.:	58.96	Hole Diameter:	4"
Location:	Rockland	Equipment:	Mobile B-47		
Coordinates:	N 4,825.6 E 5,160.2	Drilling Method:	Cased		

Elevation, feet	Depth, feet	Graphic Log and Sample Types	Sample No.	% Recovery	MATERIAL DESCRIPTION	SPT, N value or RQD in %	Volatile Organic Compounds [ppm]	COMMENTS	WELL INSTALLATION DETAILS
55.7	0				Olive brown silt, some clay, trace gravel, mottled, damp.				Stick up = 3.3'. 6" x 7' Steel standpipe Grouted with 300 lbs cement and 5% bentonite.
53.8					Gray/brown fine sand, some silt, moist, wet.				
53.5					Light gray/brown fine sand, mottled, moist, uniform.				
51.9					Olive brown/gray clayey silt, moist, mottled.				
50	5								
47.4					Gray clayey silt with few fine sand seams, wet. GLACIOMARINE				
	10		V-1				1448 303		

MGS, 1996

Contributing Factors

- Thickness of weaker Presumpscot Formation
- Bluff height and steepness
- High groundwater
- Potential artesian conditions
- Large precipitation event and snow melt

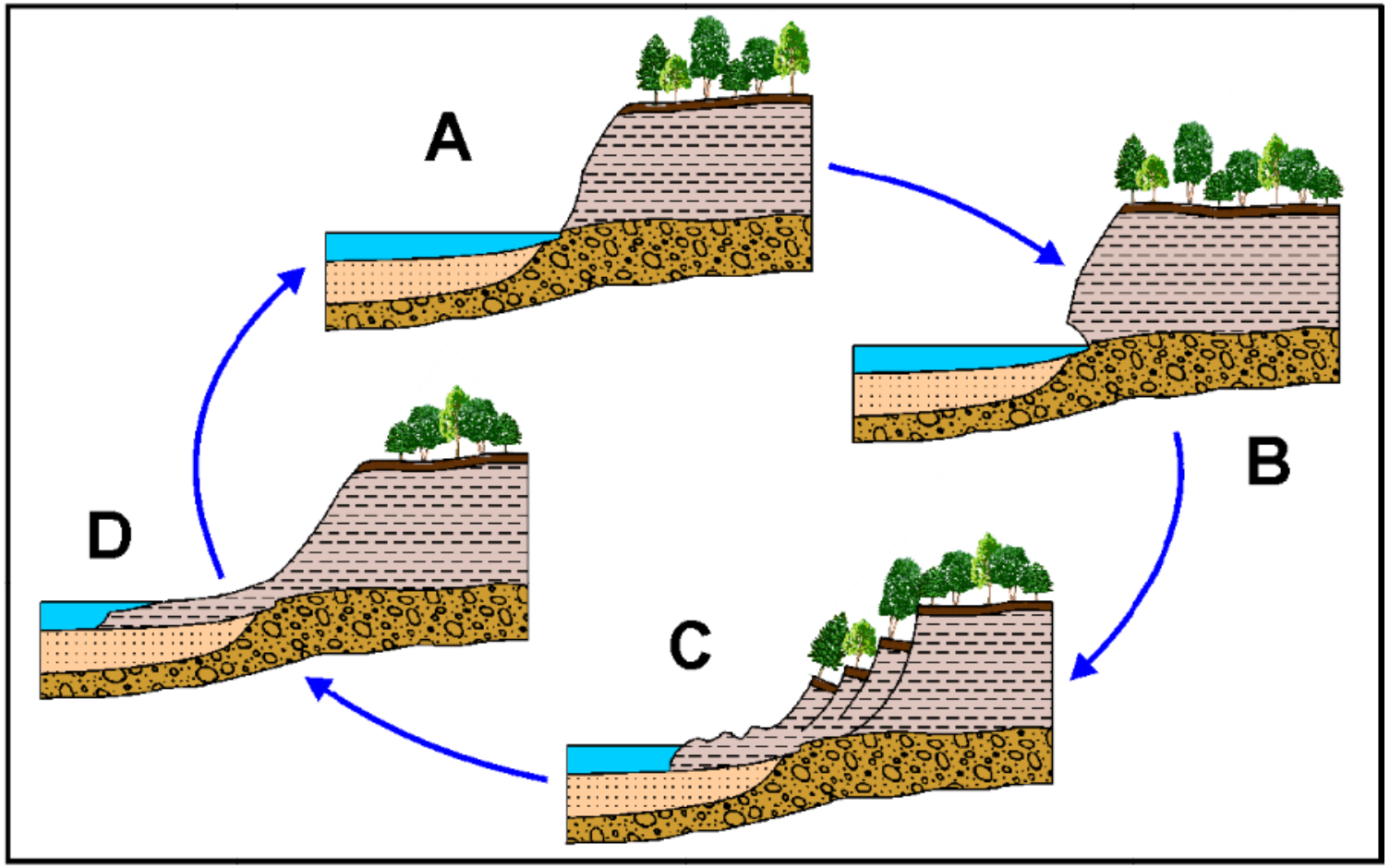
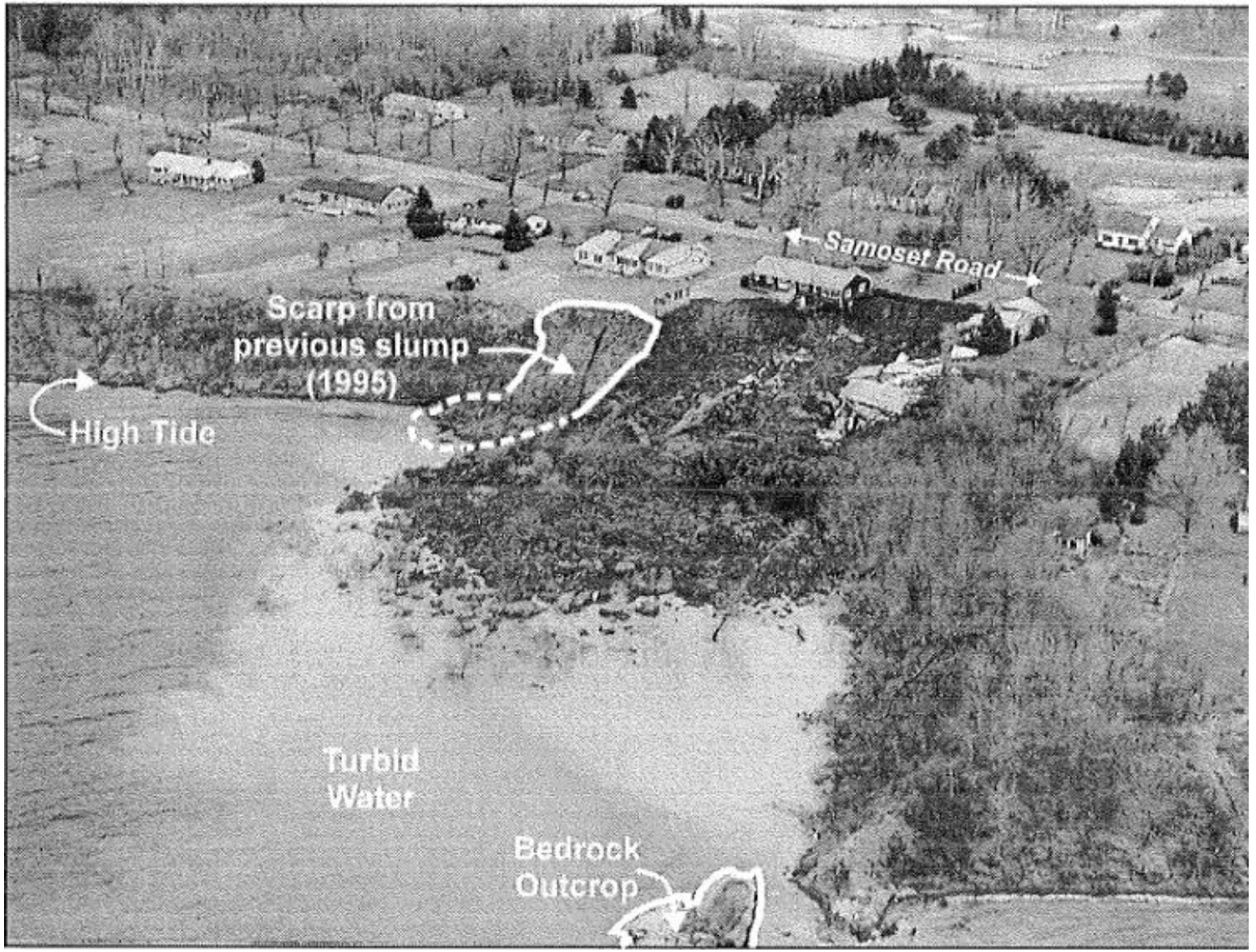


Figure 2. Life cycle of a landslide on a bluff composed of sediment (modified from Kelley and others, 1989).

1995 Slump

- Smaller slide (slump) did occur adjacent to 1996 slide in 1995
- May have reduced lateral support of the bluff that eventually failed in 1996



MGS, 1996

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Current Assessment

- Review of existing data and publicly available information
- Site visit to record observations and collect aerial and ground imagery
- Summary of findings


Interlocked riprap
1996 Slide Area
Looser riprap
Geotextile
Seepage
Toe Scarp
Riprap?
Interlocked riprap


Interlocked riprap
Looser riprap
1996 Slide


1996 Slide
Looser riprap
Interlocked riprap

MGS, 1996


Possible displaced riprap


Possible displaced riprap
Wet area


Hole with seepage exiting slope


Compromised geotextile

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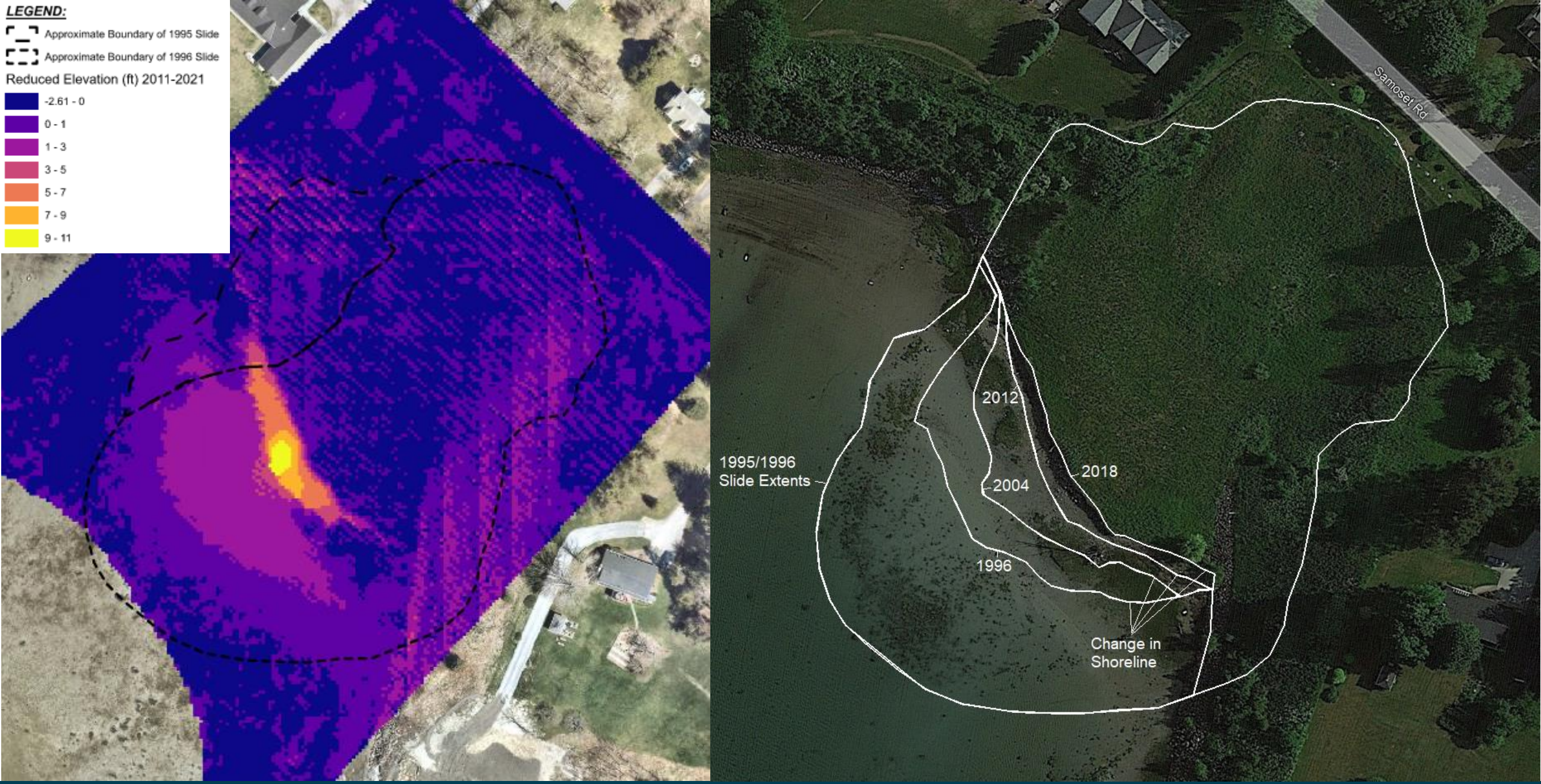

LEGEND:
Approximate Boundary of 1995 Slide
Approximate Boundary of 1996 Slide
Reduced Elevation (ft) 2011-2021
-2.61 - 0
0 - 1
1 - 3
3 - 5
5 - 7
7 - 9
9 - 11
Samoset Rd
2012
1995/1996
Slide Extents
2018
2004
1996
Change in
Shoreline

Table 1. Summary of Surface Area of Soil Loss at Toe of Landslide

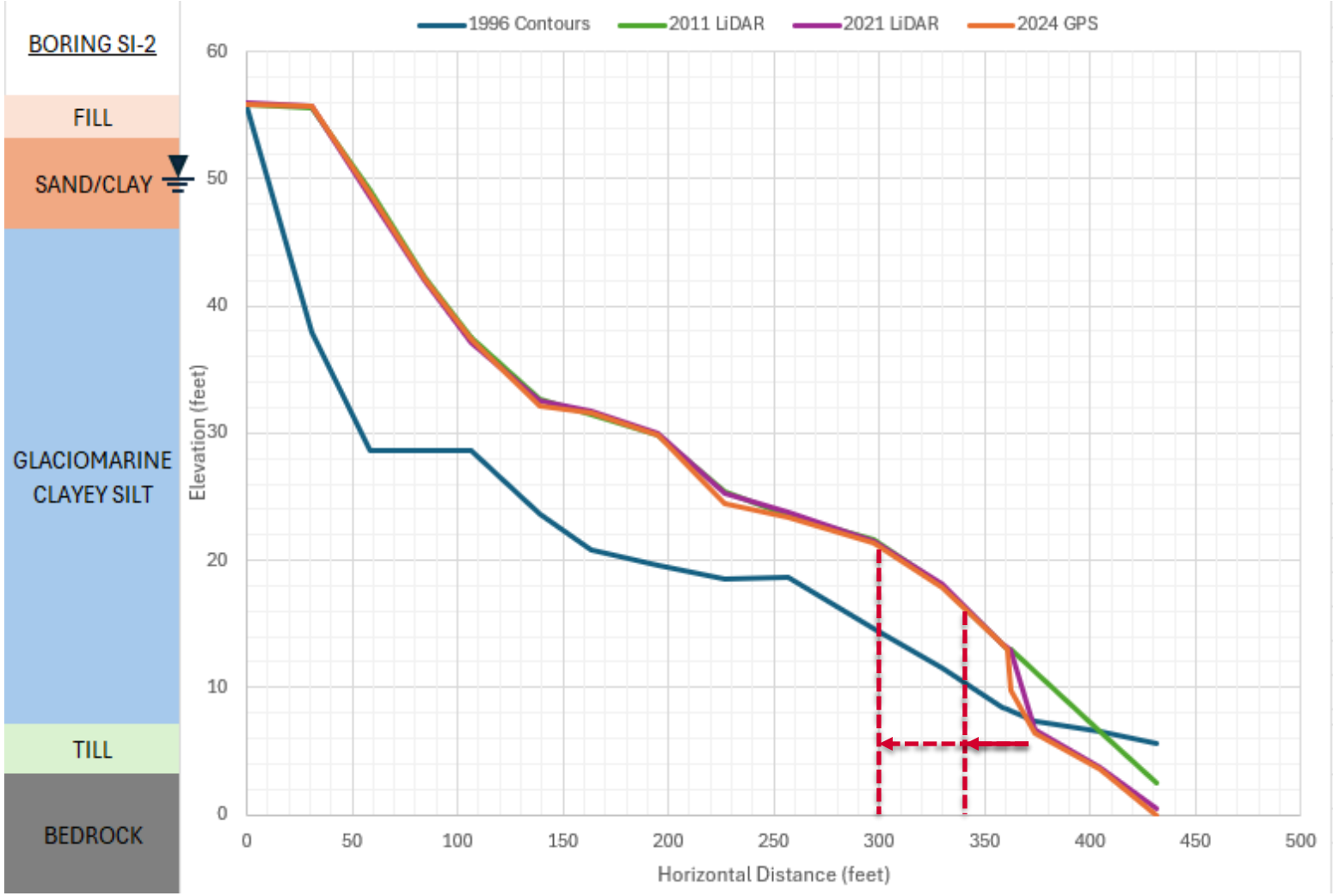
Years / Description	Surface Area[1] (square yards)	Rate of Loss (square yards / year)
1995/1996 Slide Extents	20,300	Not Applicable
1996 Tidal Zone Inundation Area	5,550	5,550 (relatively immediate)[2]
Loss From 1996 to 2004	1,290	161
Loss From 2004 to 2012	970	121
Loss From 2012 to 2018	511	85

Notes:

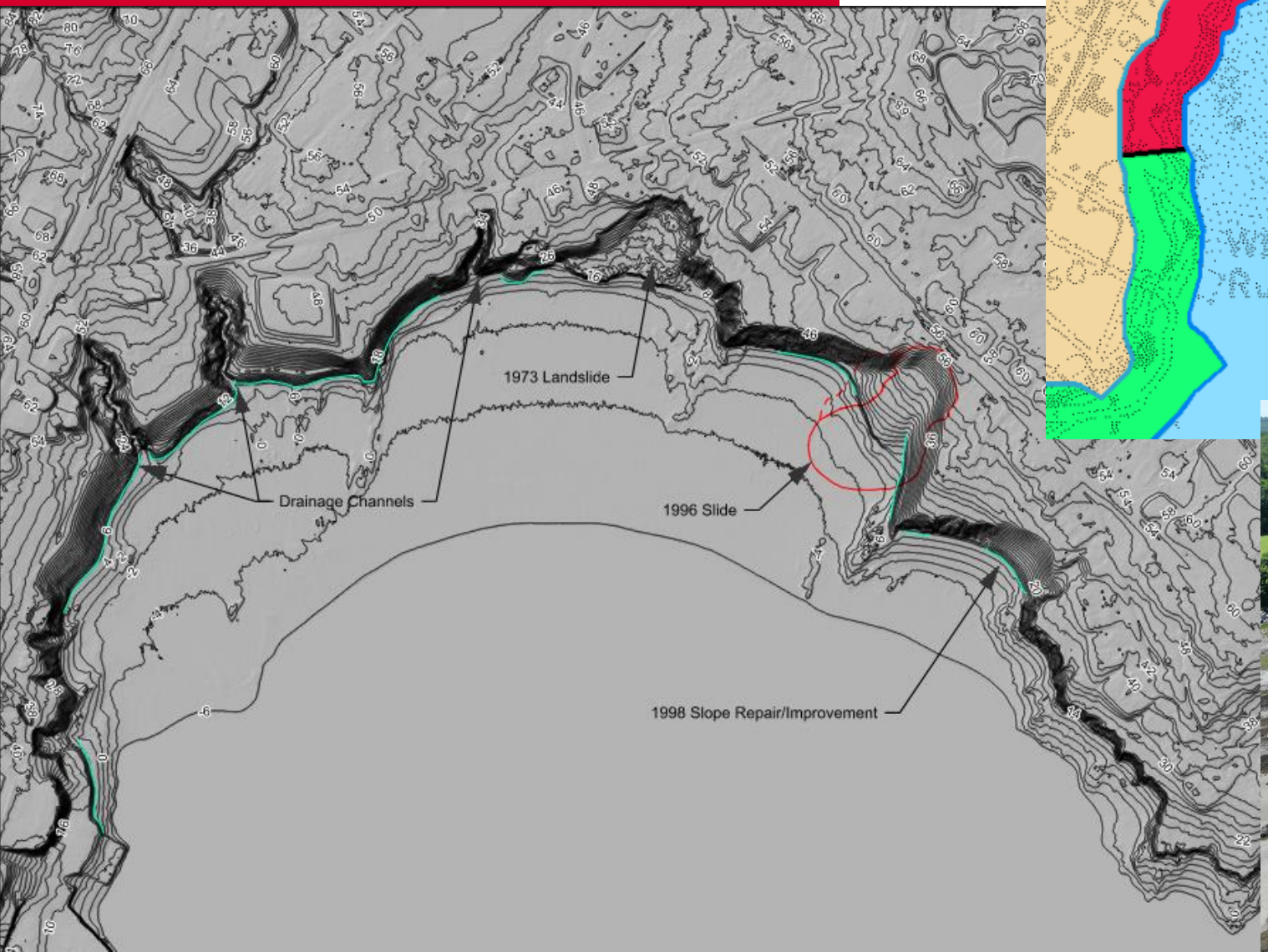
1. Surface area is approximated from Google Earth imagery and is based on a polygon clamped to the ground surface.
2. The landslide extended into the tidal zone so some soil within the extents of the slide was already beyond the shoreline. This value should not be directly compared to the rate of loss in subsequent years which are the result of erosive processes.

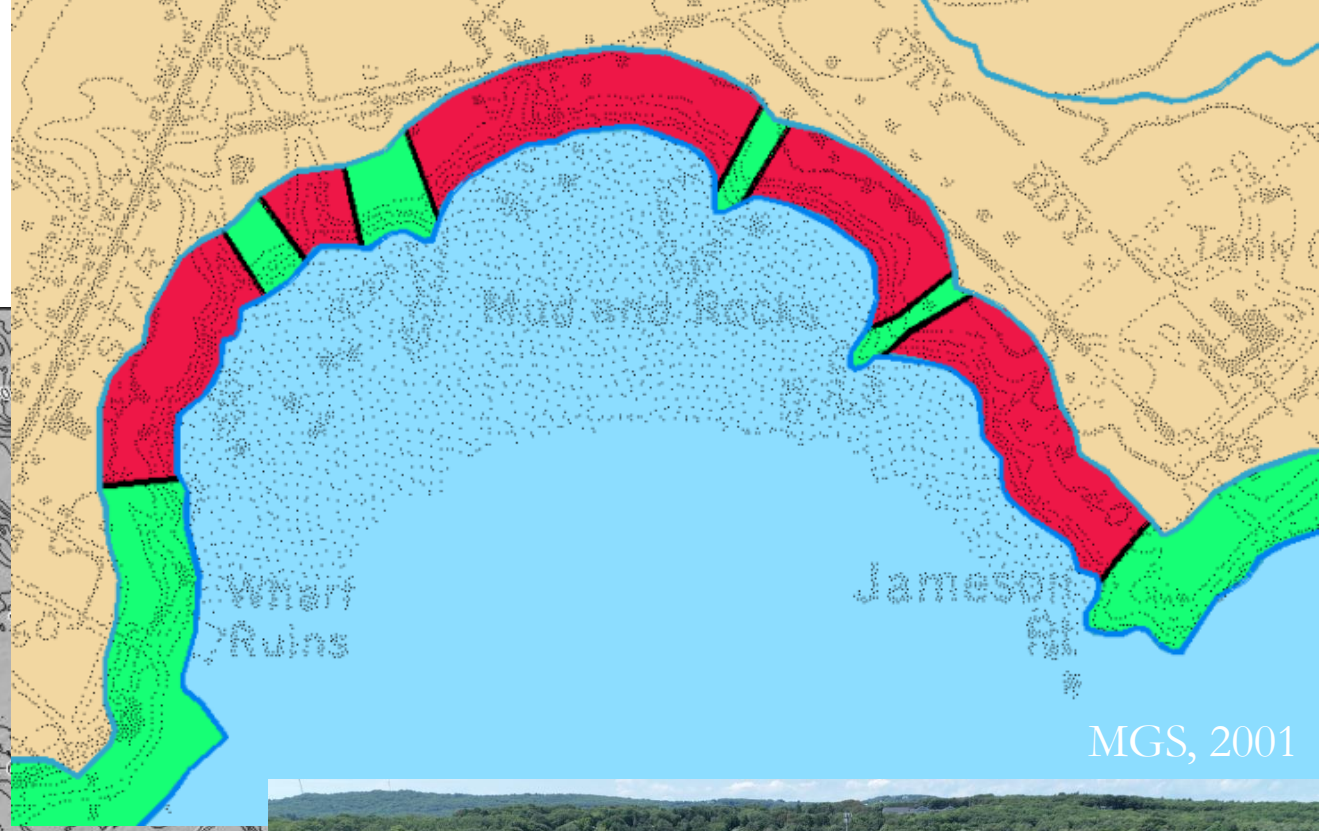
Erosion Rates

- Rate of erosion has slowed due to reach of tidal zone and neighboring armoring
- Estimate ~950 square yards of additional erosion in 10 years with current configuration
- Original embayment ~2,850 square yards of loss



North Rockland Harbor





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Summary

- Landslide not reactivated
- Toe has experienced erosion
- Seepage exiting slope
- Riprap armoring appears effective at limiting erosion if properly sized
- Erosion to continue if not armored, but has slowed
- Possible side slopes of neighboring properties could slump with enough recession of toe of 1996 slide

Recommendations

- Check state lidar and satellite imagery annually, utilize data to monitor changes to slide area.
- Clear low brush and mow slope annually to allow for better observation and collect drone imagery for better visual observation and change detection.
- Attempt to find observation wells noted in 1996 report. If found, take readings monthly for two years and then quarterly if readings stable.
- Attempt to find third inclinometer casing and start taking readings, monthly for first year and then quarterly or less if readings consistent.
- If movement detected, assess slope immediate mitigation or long-term solutions
- Attempt to locate records of construction / cleanup efforts
- Consider armoring toe of slide area
- Development not recommended without further study

Questions?