UNIVERSITY OF Southampton

Coastal landfills: long term effect on shoreline management plans

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NERC SCIENCE OF THE ENVIRONMENT

LANDSS Aftercare Forum Thursday 30th March 2017

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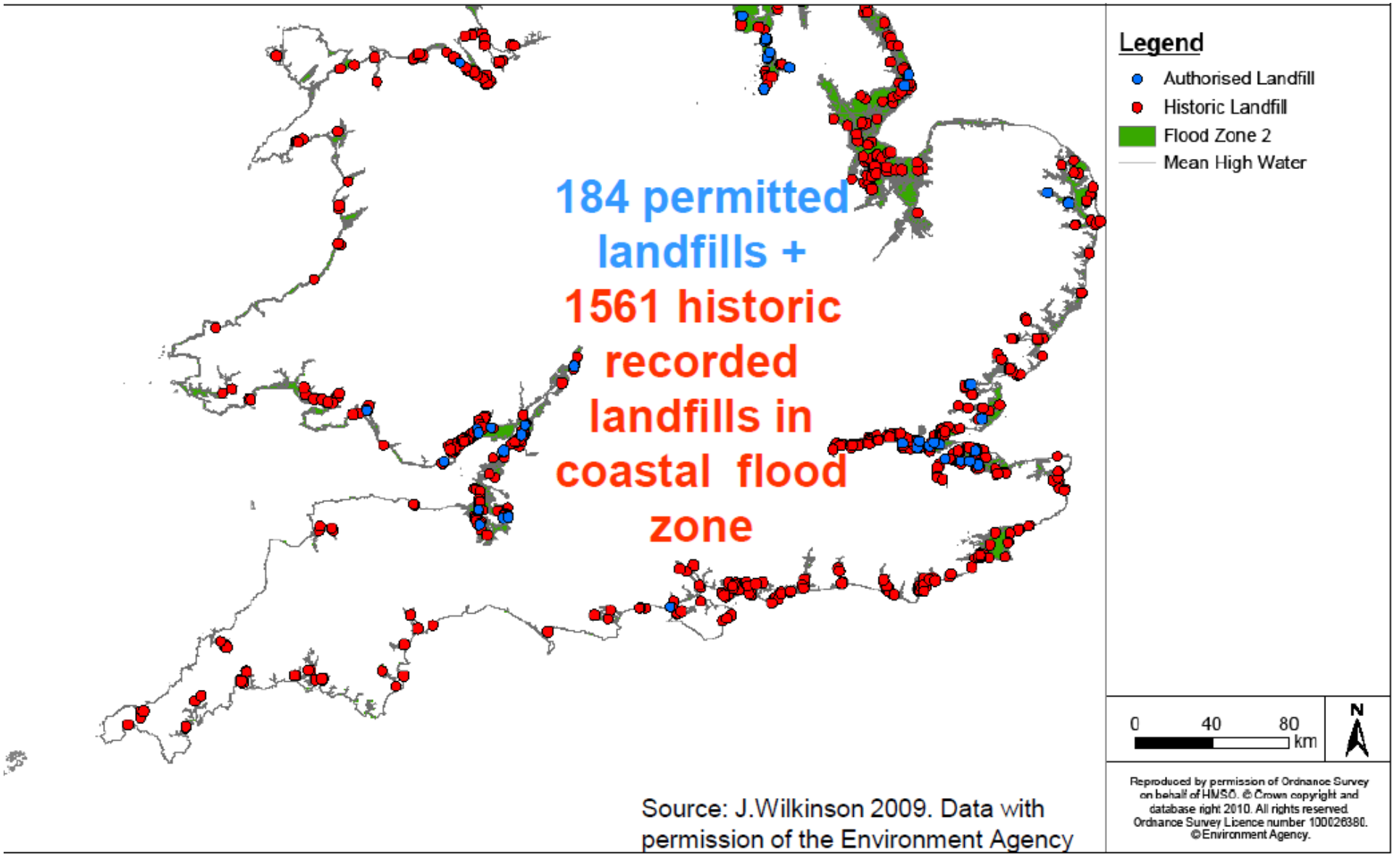
Shoreline Management Plans

- Produced by Local Authorities in conjunction with EA
- A Shoreline Management Plan (SMP) policy identifies the most sustainable approach to managing the flood and coastal erosion risks to the coast
  - No active intervention
  - Hold the (existing defence) line
  - Managed re-alignment (retreat)
  - Advance the line
- Funding the implementation of SMPs is not guaranteed

Landfills and Coastal Issues



Climate Change and Coastal Issues

- Legacy of historic coastal landfills:
  - Pose potential risks to the environment
  - Constrain (some) shoreline management plans
  - Coastal managers don't know what to do with them
- The risks of coastal erosion and flooding are growing due to changing:
  - Climatic factors, e.g., rising sea levels and changes in storm surge regimes
- Can coastal landfills be better managed?

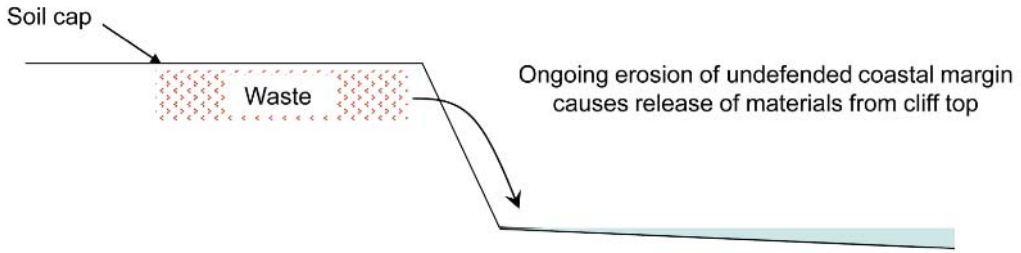
Guidance on the management of landfill sites and land contamination on eroding or low-lying coastlines

CIRIA report C718

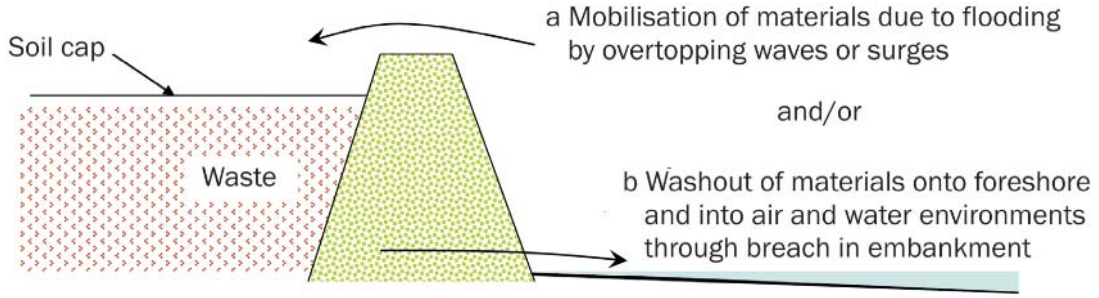
C718

Scenarios (CIRIA C718):

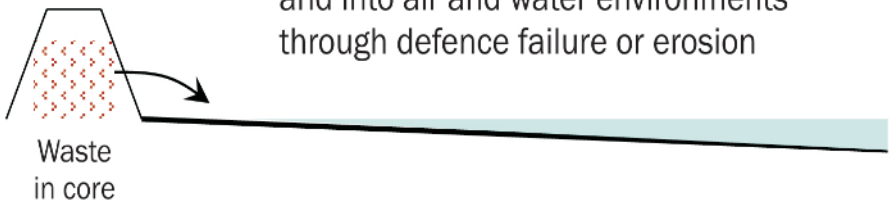
Scenario 1 material release on undefended shoreline



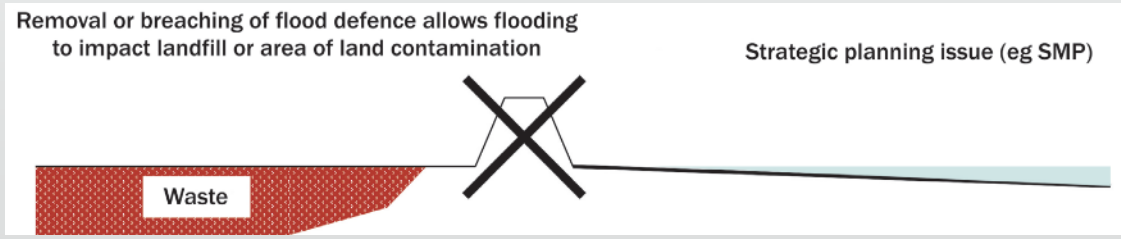
Scenario 2 material release on defended shoreline



Scenario 3 material release from coastal defence



Scenario 4 material constraining management options



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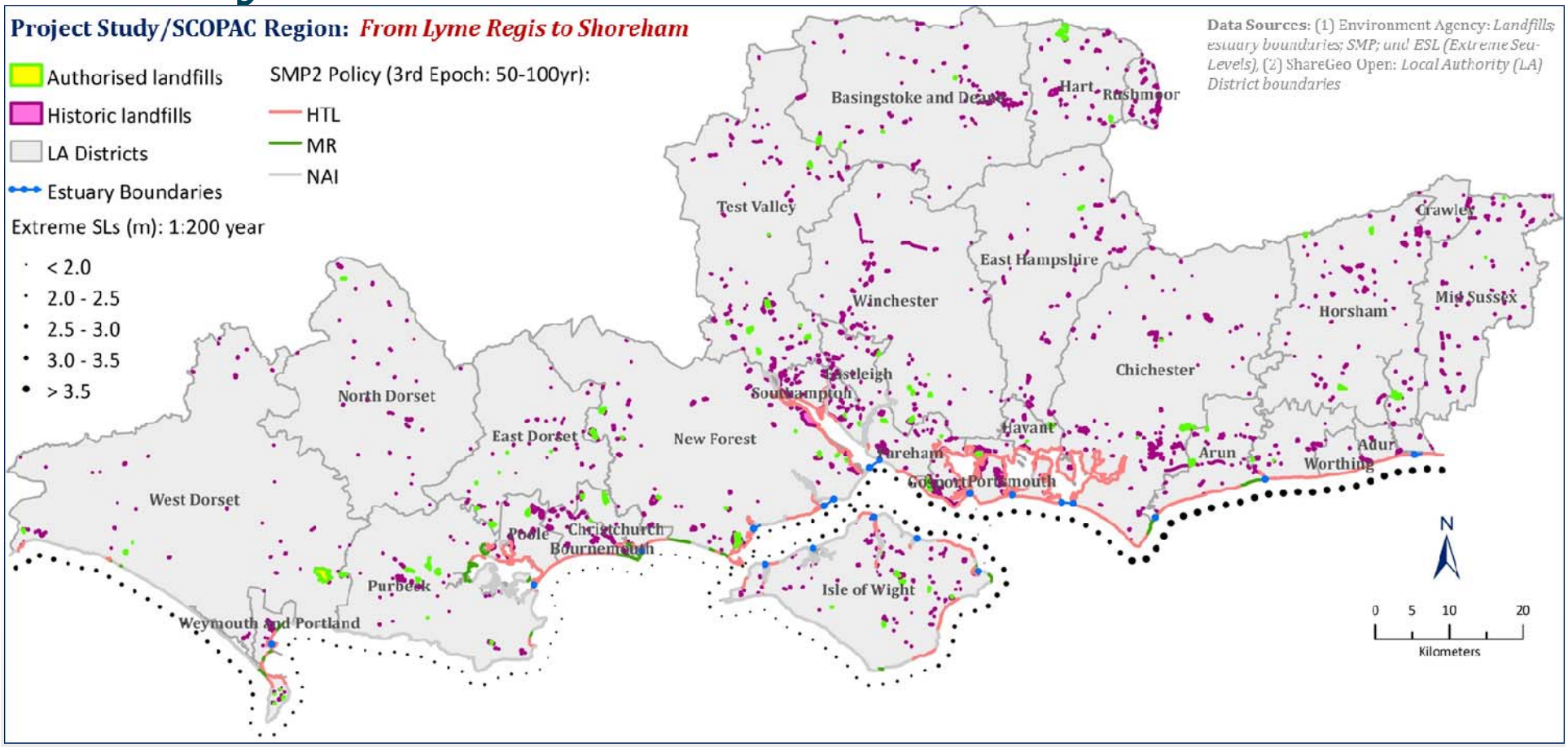
Study area



- 148 of the sites are within the 1 in 200 year tidal floodplain
- ~ 60 landfills are within 50-100 year erosion buffer zone

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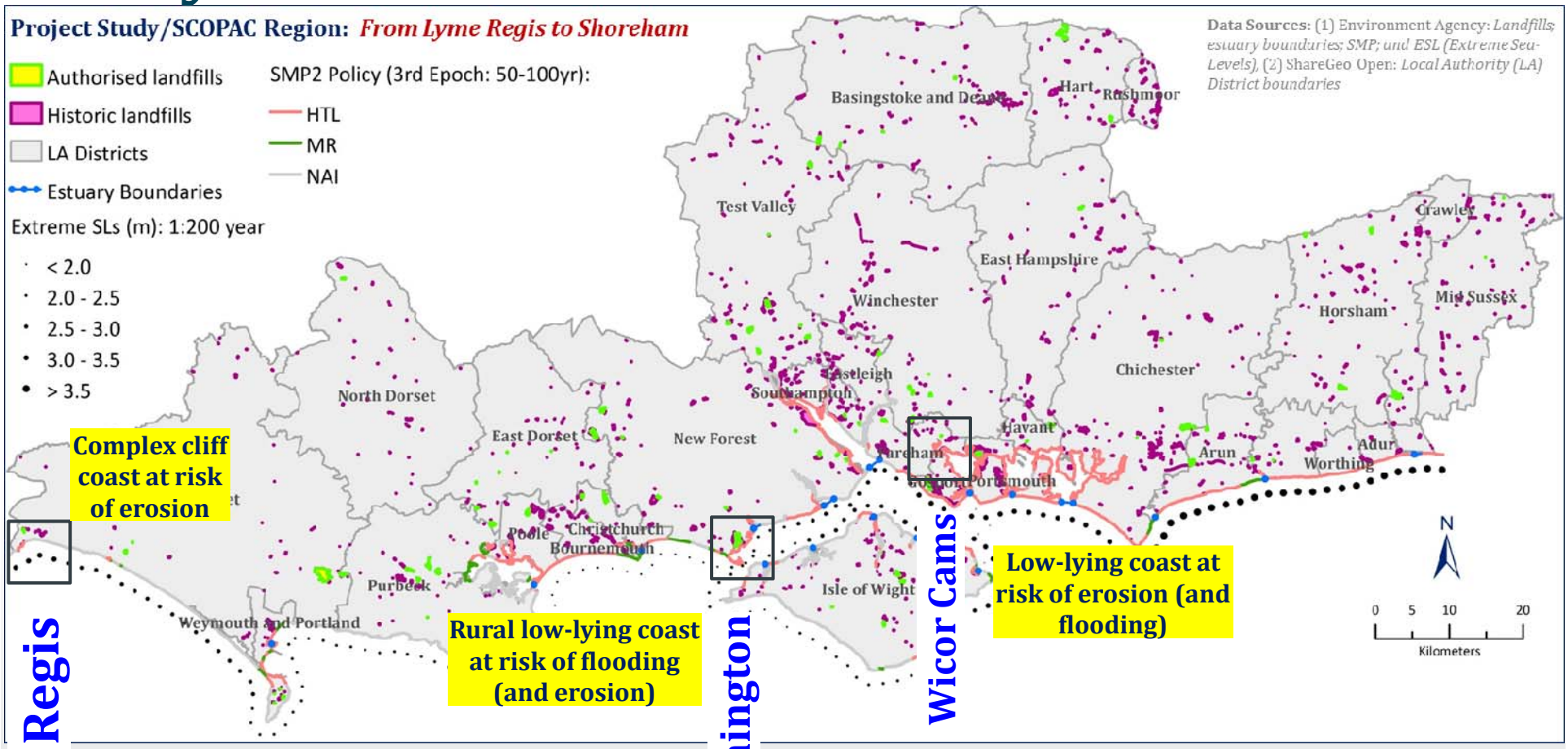
Study area



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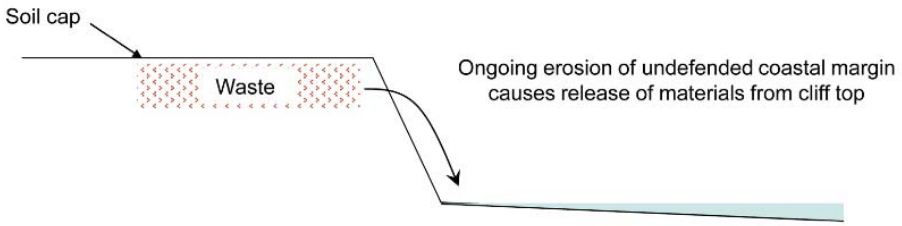
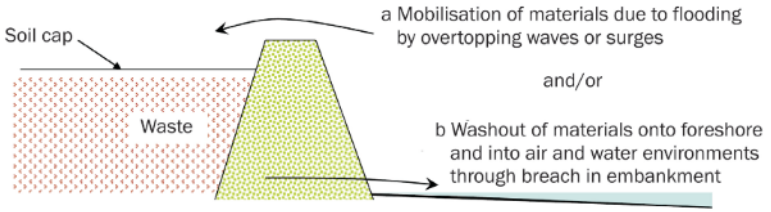
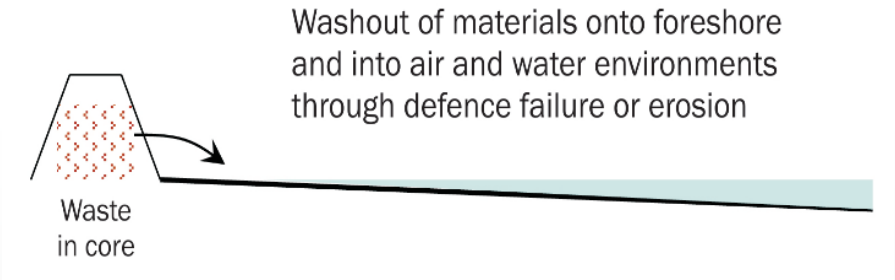
Scenario 1 material release on undefended shoreline



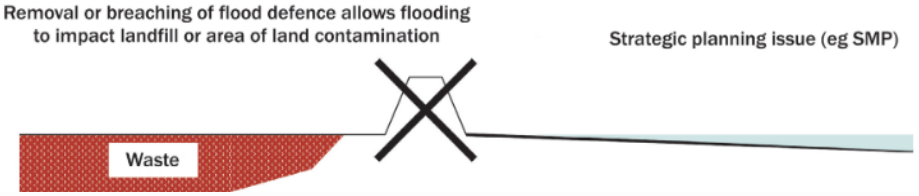
Scenario 2 material release on defended shoreline



Scenario 3 material release from coastal defence



Scenario 4 material constraining management options



Site	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Lyme Regis	✓			
Pennington		✓		✓
Wicor Cams	?	✓	?	?

Study Site: Lyme Regis

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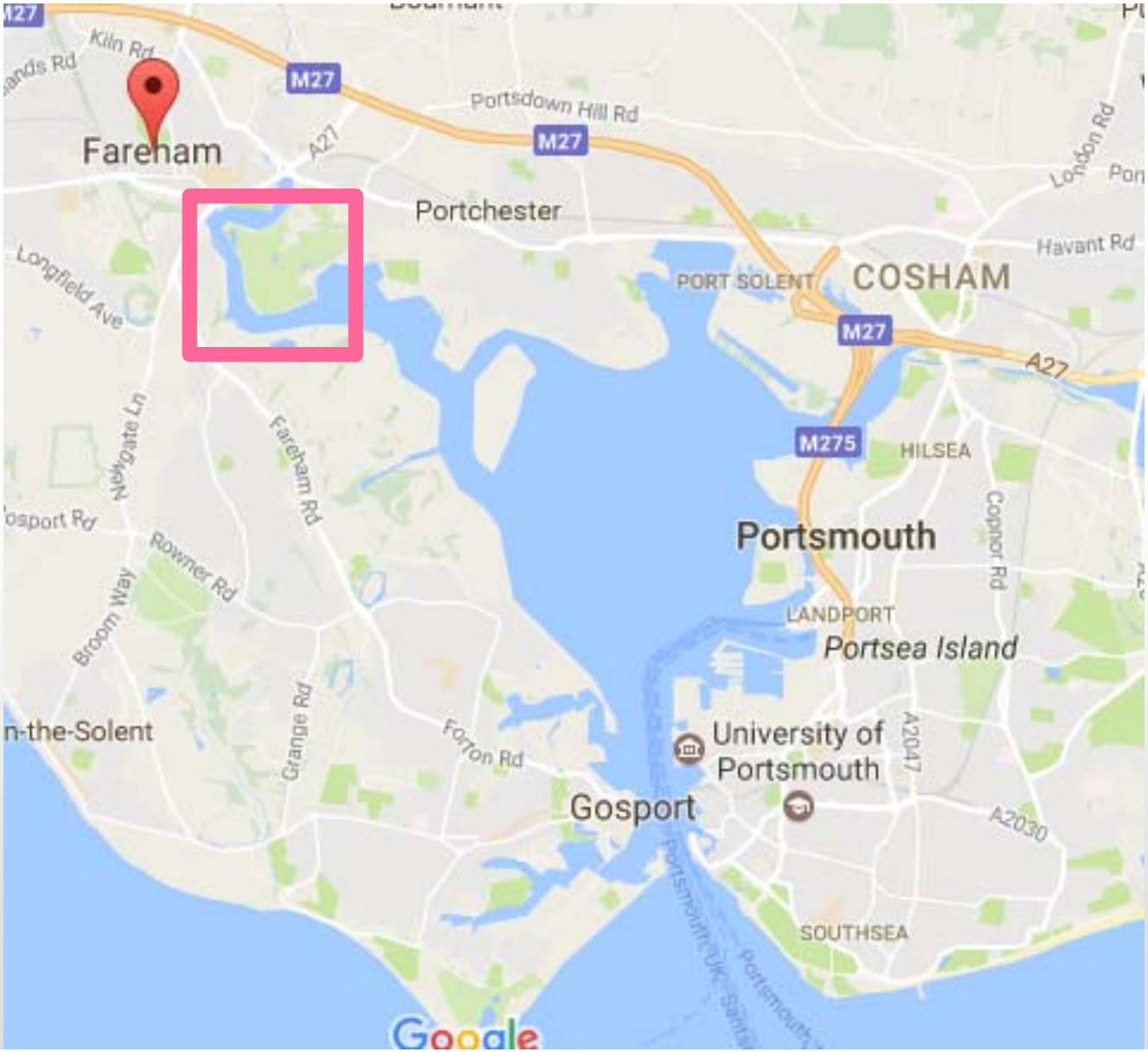
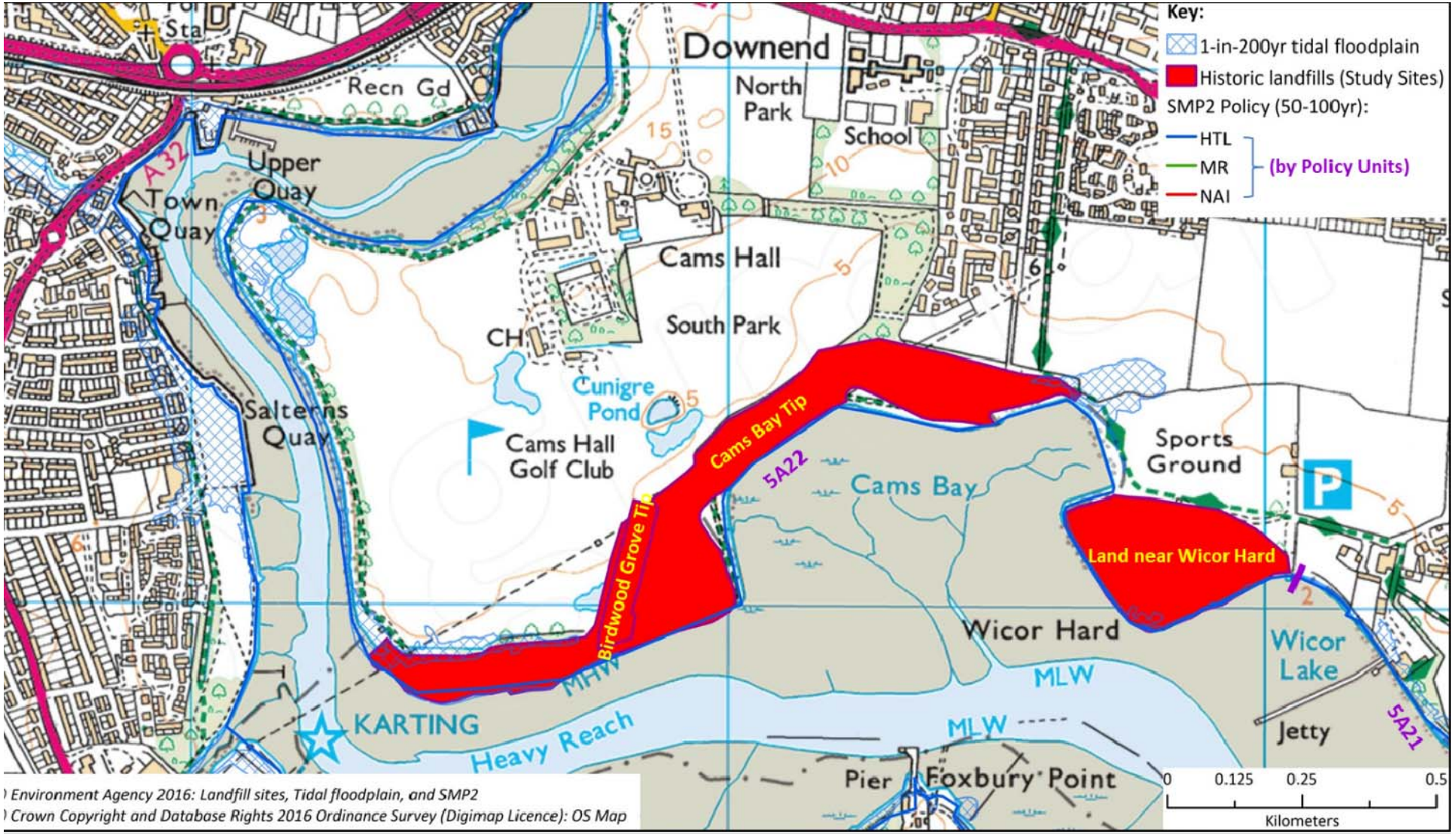
Study Site: Wicor Cams

Study Site: Wicor Cams



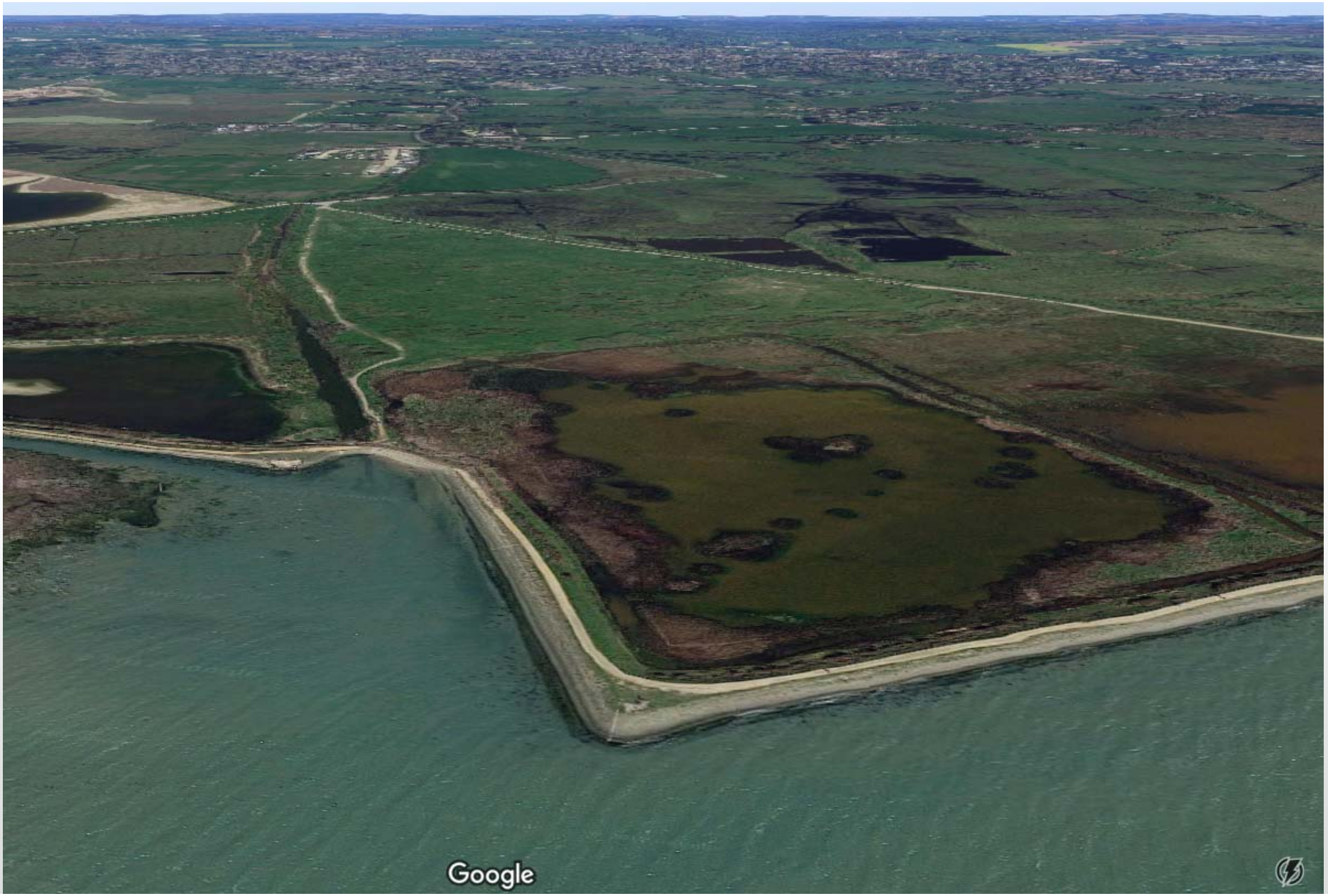
Overview: Geographic Location of Landfill Sites



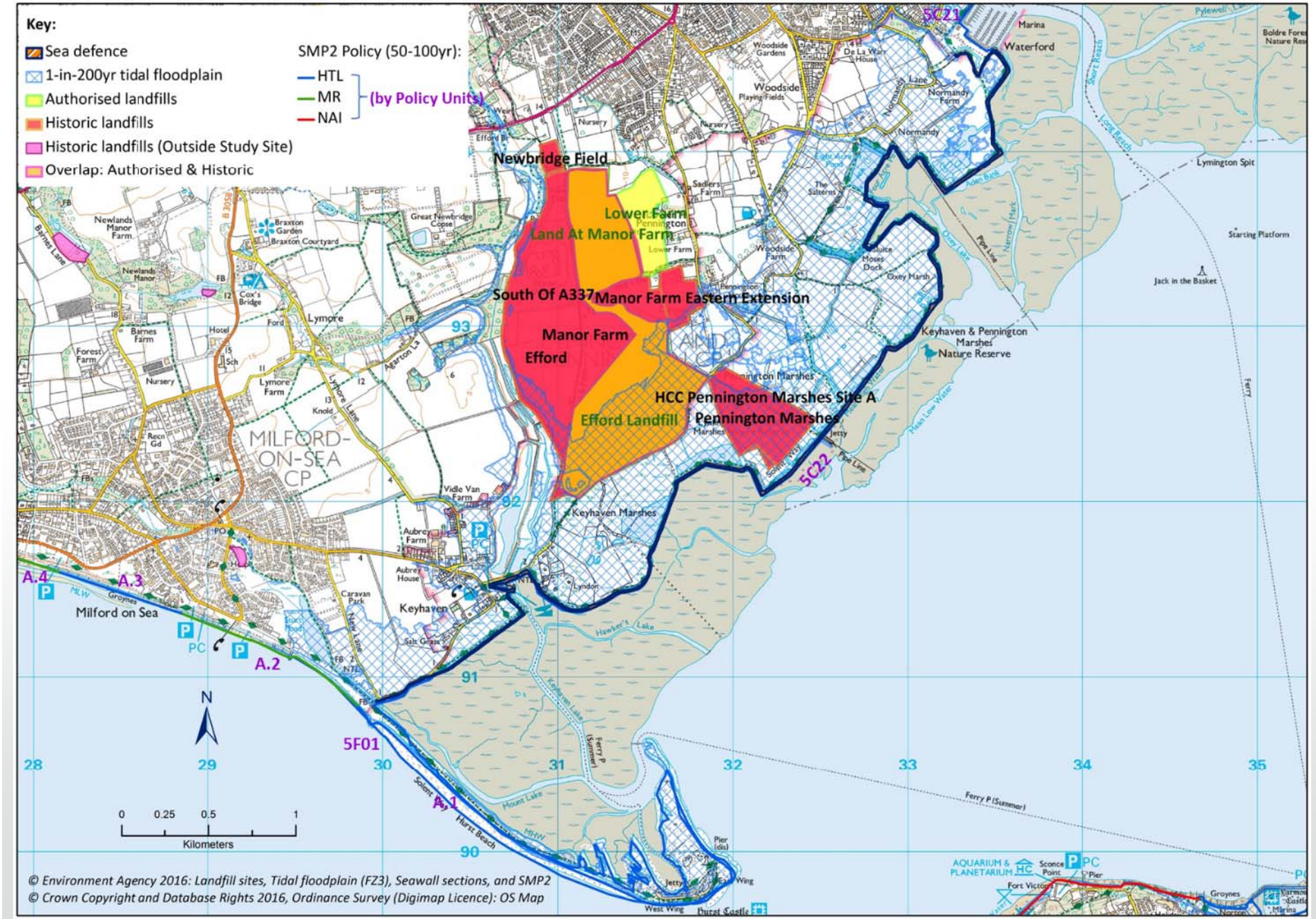
Wicor Cams

- Hold the Line policy at this location ONLY because of presence of the landfill
- Cost to relocate landfill £80m to £180m (largely landfill tax)

Study Site: Pennington



Overview: Geographic Location



Overview: Key Characteristics of the Site

❑ Coastal issues and SMP policies:

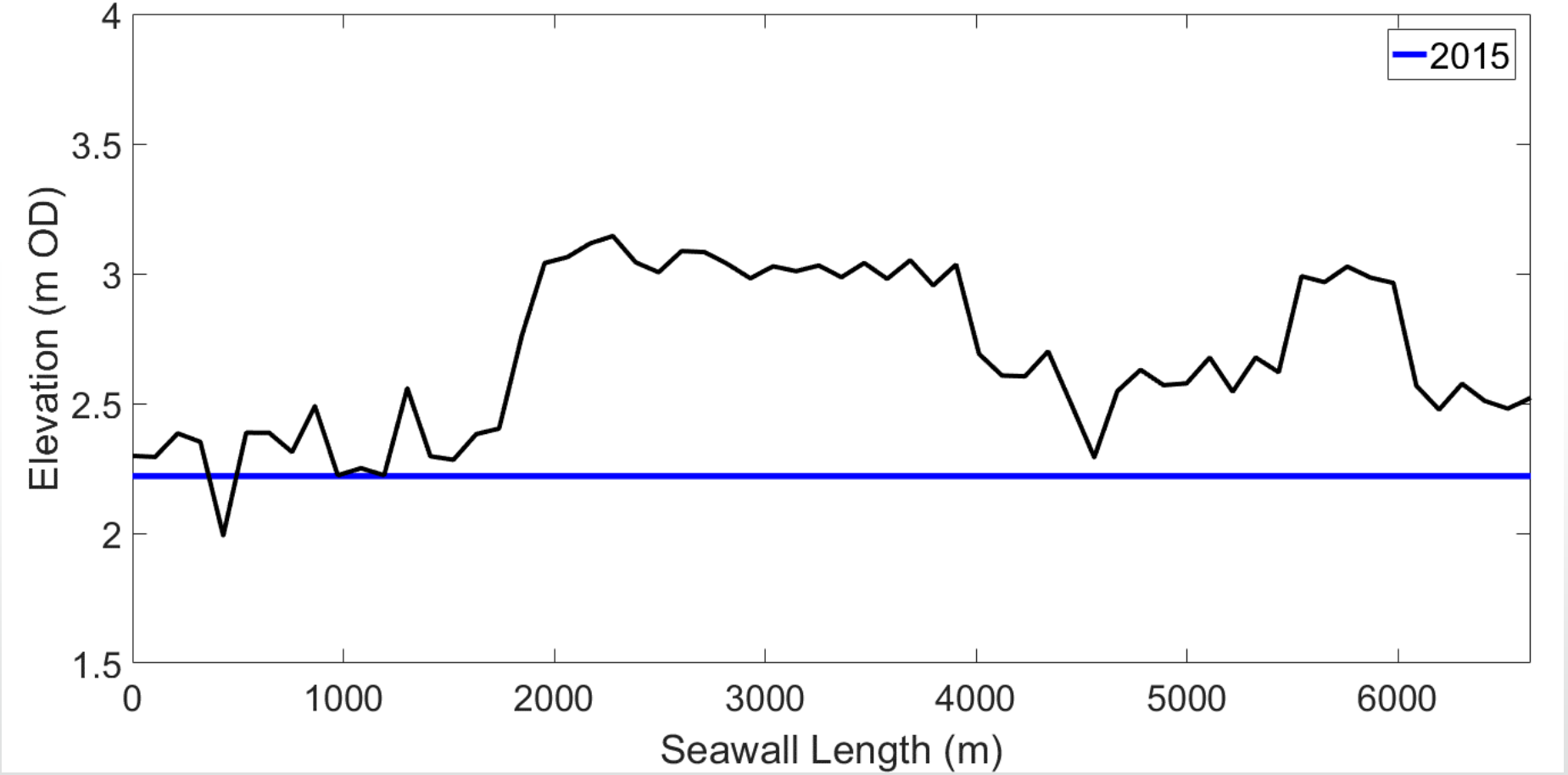
- ❖ Prone to coastal flooding and saltmarsh erosion, already experiencing dramatic changes due to rapid loss of saltmarshes (at a rate of 0.5–5 m/year)
- ❖ Future climate and sea-level rise could only exacerbate these issues
- ❖ The seawall, saltmarshes and Hurst Spit are the main coastal defence system
- ❖ SMP policies: *HTL (in all 3 epochs) for the coastline fronting the site*

Pennington Marshes Site A

- Waste characteristics :
  - 160,000 m^3 material
  - Household and construction waste deposited 1962-69
  - Trial pits identified mix of soils plastic, wood, paper, metals and fabrics
  - No asbestos identified
  - Hydrocarbon odour
- Leachate characteristics
  - Weak aged MSW type leachate (~5,000 m^3)
  - Minimal impact on saline groundwater
  - Likely minor impact on surrounding surface water systems

Impact of sea level rise on coastal defences

Current Day: 1-in-50 year extreme high water level event



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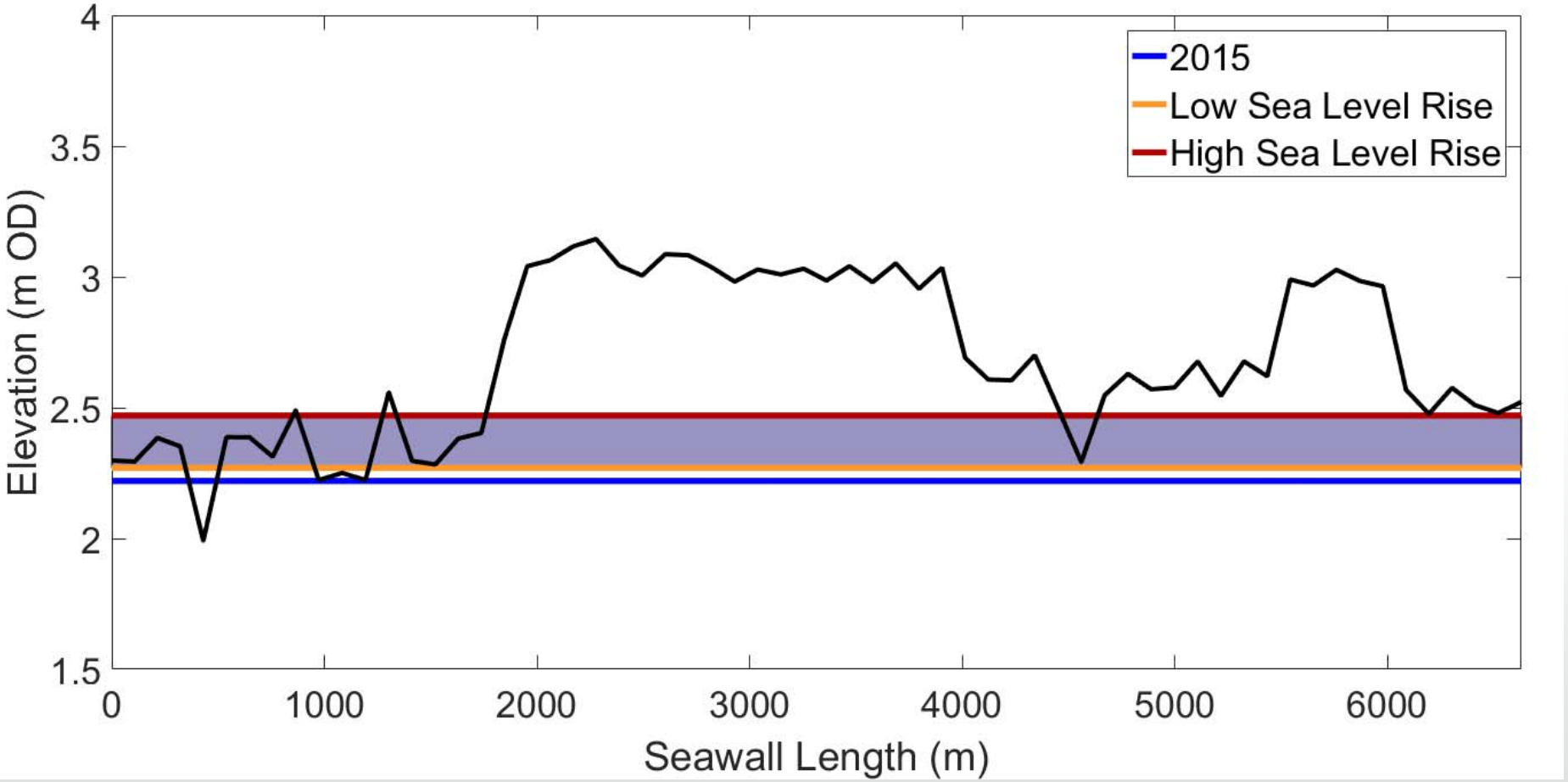
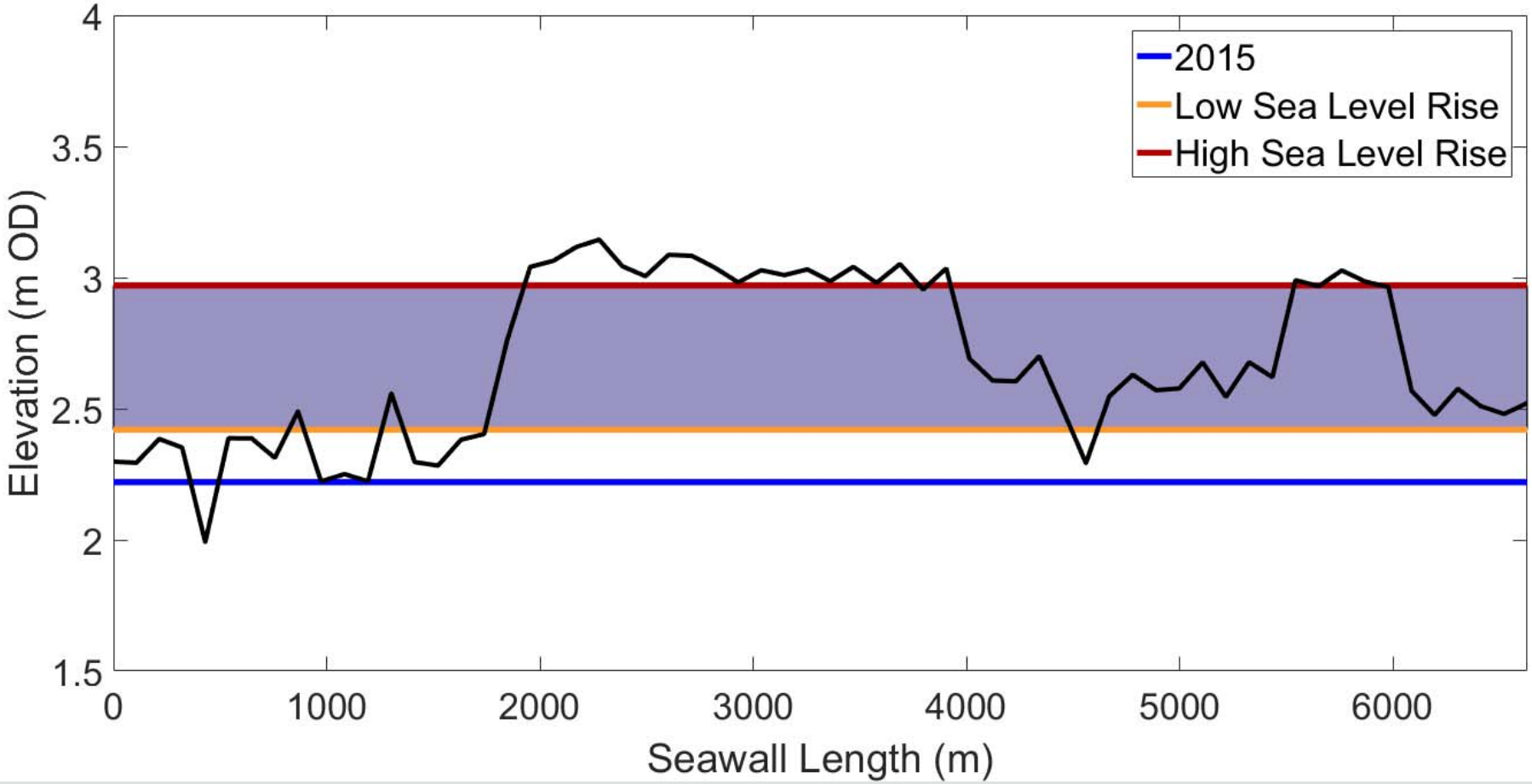
Impact of sea level rise on coastal defences

Year 2050: 1-in-50 year extreme high water level event



Impact of sea level rise on coastal defences

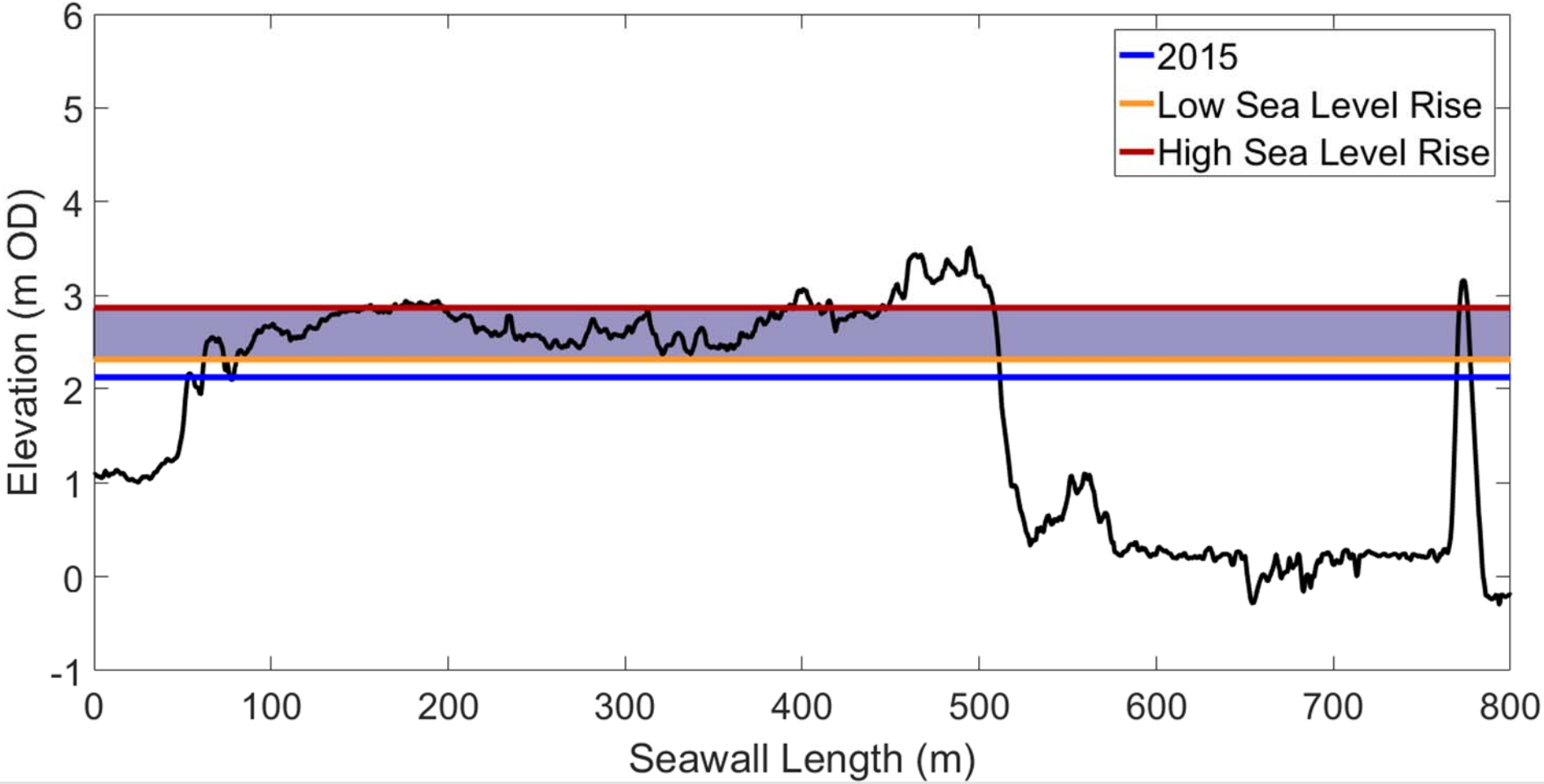
Year 2100: 1-in-50 year extreme high water level event



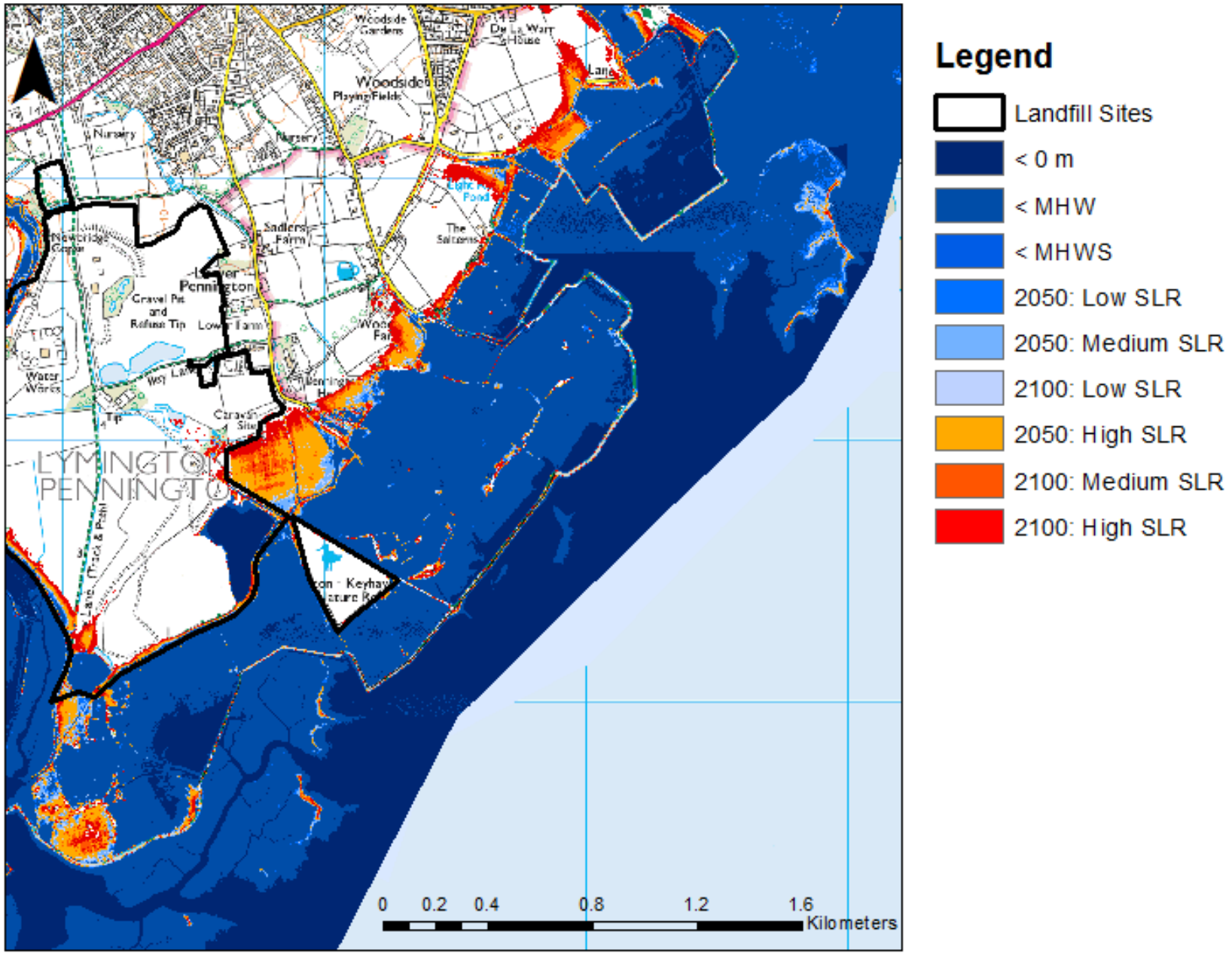
Overtopping will lead to damage and potentially to breaching

- Substantial investment will be required to raise and maintain sea wall in future
- Possible spend over next 50 years
  - £42 million for low sea level rise scenario
  - £100 million for high sea level rise

Impact of sea wall failure on landfills

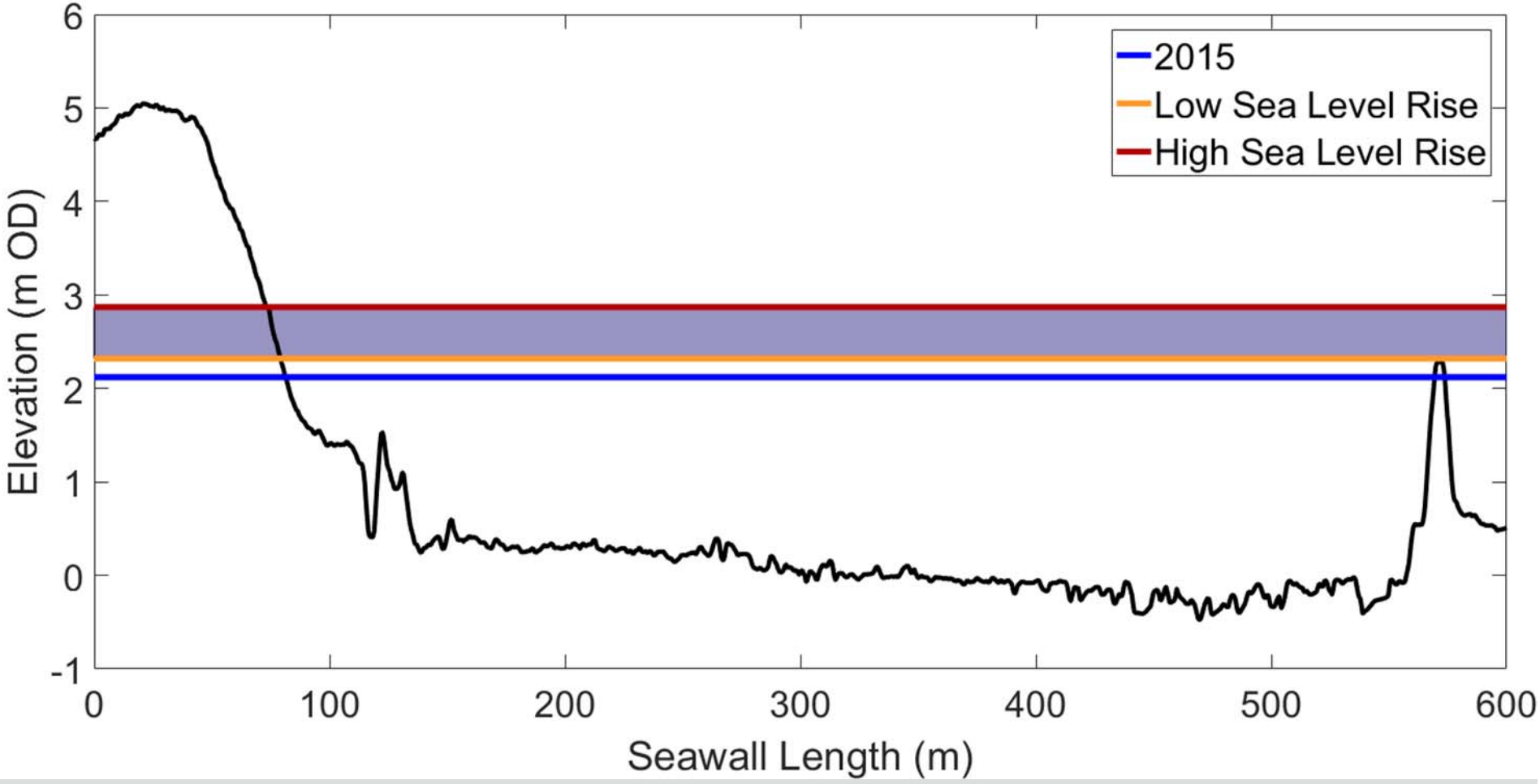


Flooding map in absence of sea wall

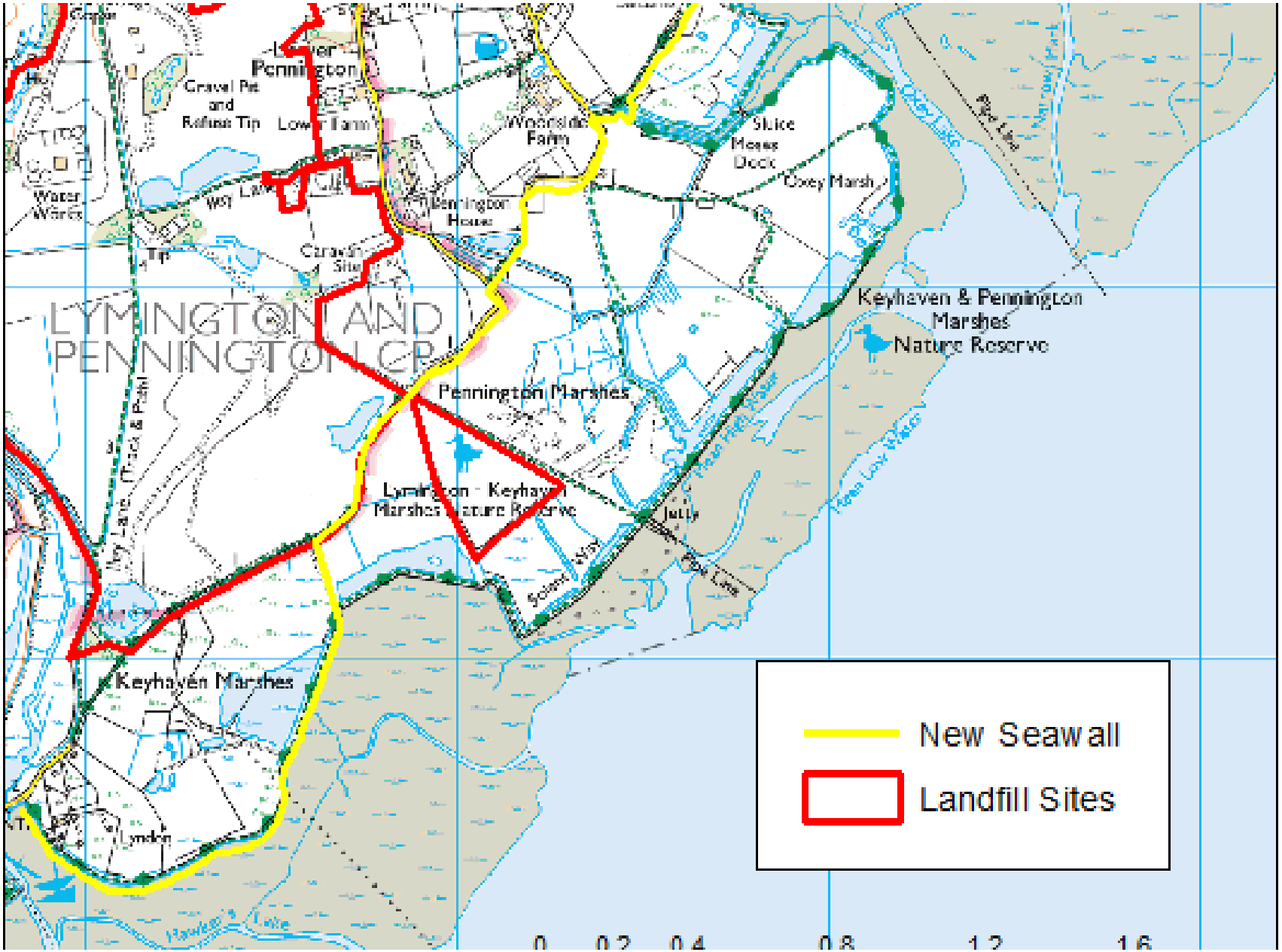


Impact of sea wall failure on landfills

Year 2100: Manor Farm/ Efford – 1 in 50 year extreme water level event



Potential cost savings for realigned sea wall



Cost comparison of MR and HTL options over next 50 years

	Sea Level Rise Scenario	Estimated Capital Cost (£ m)	Estimated Maintenance Costs		Total cost over 50 years (£ m)
			Annual (£ m/yr)	Over 50 year (£ m)	
Hold the Line	Low	28	0.28	14	42
	High	65	0.65	32.5	97.5

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Managed Realignment maintenance costs taken at 0.005% of capital costs, compared to hold the line costs of 0.01%.

Cost comparison of MR and HTL options over next 50 years

	Sea Level Rise Scenario	Estimated Capital Cost (£ m)	Estimated Maintenance Costs		Total cost over 50 years
			Annual (£ m/yr)	Over 50 year (£ m)	(£ m)
Hold the Line	Low	28	0.28	14	42
	High	65	0.65	32.5	97.5
Managed Realignment	Low	26.6	0.17	8.4	35
	High	46	0.27	13.6	60

- Possible £7m savings for managed realignment for low sea level rise
- Possible £37.5m savings for managed realignment for high sea level rise

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Managed Realignment maintenance costs taken at 0.005% of capital costs, compared to hold the line costs of 0.01%.

What about the landfill?

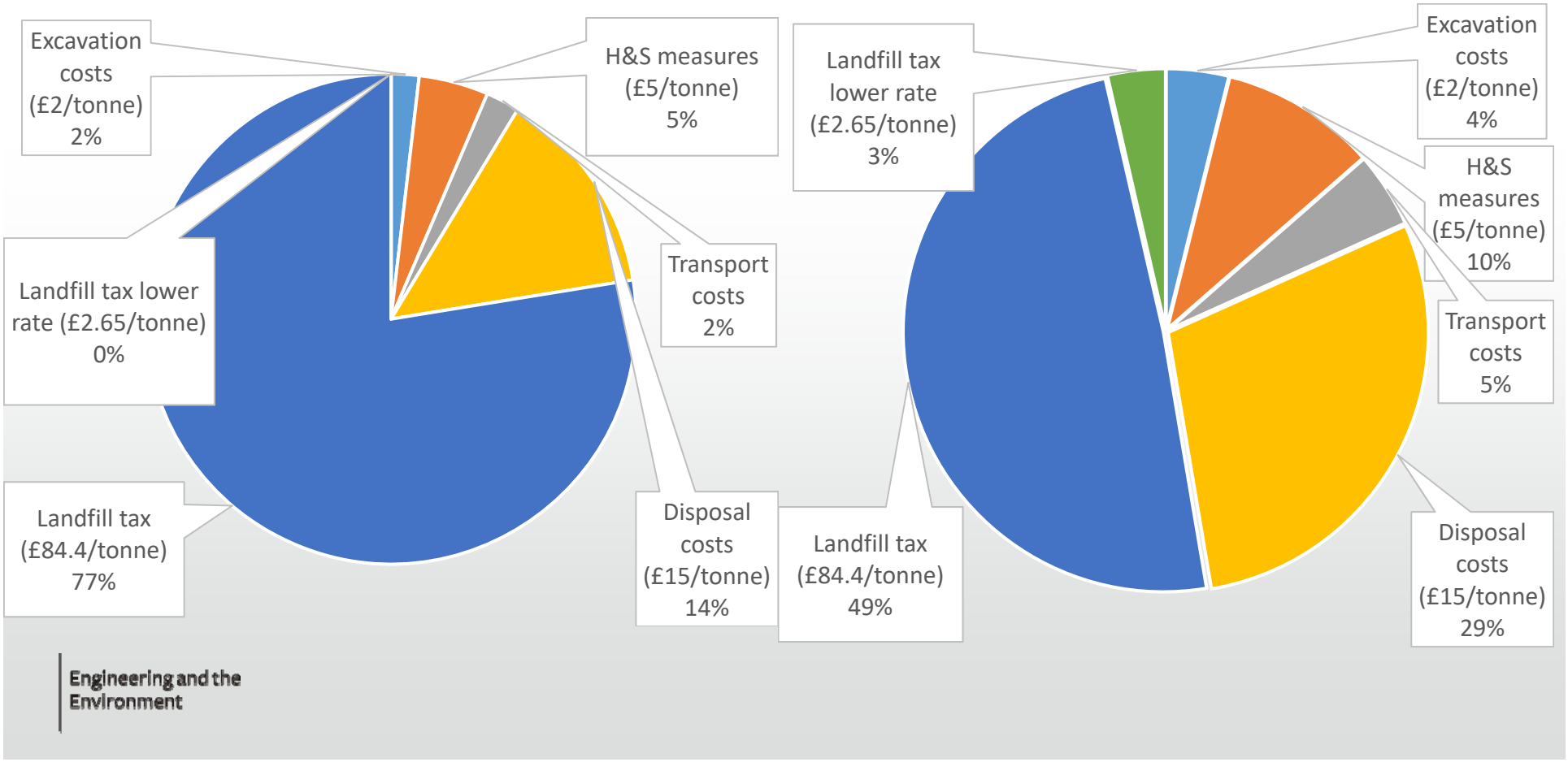
Options?

- Excavate and move to another landfill
- Allow to flood and erode into the sea
- Remediate *in-situ*
- Other?

Excavate and remove to another landfill

100% attracting top rate of landfill tax
Total Cost: £21 million

30% attracting top rate of landfill tax
Total Cost: £10 million



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Allow to erode!!!

- Generally unacceptable
- Direct offence under The Environmental Permitting (England and Wales) Regulations 2010
- Is it acceptable for different components of landfills to erode?
  - Soils?
  - Glass?
  - Wood?
  - Plastics?
  - Asbestos
  - Metals
  -

Pollution risk from over 1,000 old UK landfill sites due to coastal erosion

Storms and rising sea levels could break up old rubbish dumps in England and Wales releasing potentially toxic waste, study shows

Old landfill rubbish revealed by coastal erosion in sea cliffs on Walney Island, off Barrow in Furness. Photograph: Ashley Cooper/Global Warming Images/Alamy

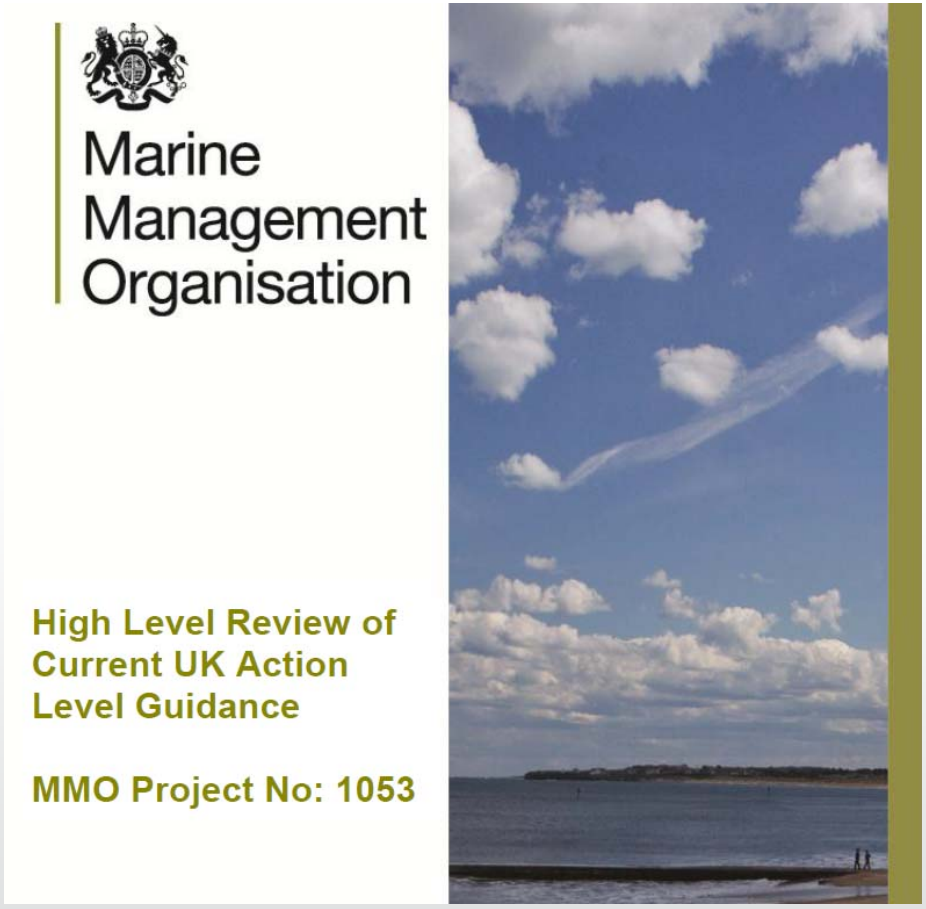
Over 1,000 old landfill sites on the coasts of England and Wales are at increasing risk of being breached by erosion, according to a new study, posing a serious pollution danger to wildlife and bathing waters.

Total metal concentrations from waste samples from study sites

	Solid Waste	
	Average	Max
Mercury	0.22	0.25
Arsenic	13.2	21.8
Cadmium	0.93	2.7
Copper	142.9	630
Chromium	13	22
Nickel	43.3	58
Lead	181.2	660
Zinc	391.9	1100
PAH Total	18.75	73
Benzo[a]pyrene	1.69	6.8

How to assess acceptability of solid waste discharges to sea

- Framework does not exist
- London Convention and Protocol: Action Levels for dredged material



Waste compared to CEFAS action levels

	Solid Waste		CEFAS	
	Average	Max	Action Level 1	Action Level 2
Mercury	0.22	0.25	0.3	3
Arsenic	13.2	21.8	20	100
Cadmium	0.93	2.7	0.4	5
Copper	142.9	630	40	400
Chromium	13	22	40	400
Nickel	43.3	58	20	200
Lead	181.2	660	50	500
Zinc	391.9	1100	130	800
PAH Total	18.75	73		
Benzo[a]pyrene	1.69	6.8		

The average total metal content in waste is less than CEFAS action level 2

British Geological Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

Normal background concentrations (NBCs) of contaminants in English soils: Final project report

Science Facilities Directorate

Commissioned Report CR/12/035[N]

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Waste compared to soil NBCs

	Solid Waste		CEFAS		BGS		
	Average	Max	Action 1	Action 2	Principal soil	Mineralised soil	Urban
Mercury	0.22	0.25	0.3	3	0.5		1.9
Arsenic	13.2	21.8	20	100	32	290	437
Cadmium	0.93	2.7	0.4	5	1	2.9-17	2.1
Copper	142.9	630	40	400	62	340	190
Chromium	13	22	40	400		13	13
Nickel	43.3	58	20	200	42	120-230	
Lead	181.2	660	50	500	180	2400	820
Zinc	391.9	1100	130	800			
PAH Total	18.75	73					
Benzo[a]pyrene	1.69	6.8			0.5		3.6

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Zinc	391.9	1100	130	800			
PAH Total	18.75	73					
Benzo[a]pyrene	1.69	6.8			0.5		3.6

Question

- What other characteristics of solid waste make it suitable/ unsuitable for erosion into marine environment?

Remediation

Example: Sandford Farm Landfill – Reading

Contractor: Vertase FLI

Costs: £12m for £240,000 m^3 waste (£50/m^3 ~ £40/tonne)

Source: http://darwinsplough.blogspot.co.uk

Remediation

Source segregation

- Only 600 tonnes material (metals) recovered off-site (0.25%)
- 4000 tonnes of waste materials removed off site (1.7%)

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Source: http://darwinsplough.blogspot.co.uk

How does remediation help in coastal landfill situation?

- Remediated landfill OK for housing - but could it be acceptable for any of it to erode into marine environment?
  - If so, could envisage processing seaward part of a landfill to create a buffer zone
- Is remediated landfill still a waste? End of waste protocol required

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Summary

- Landfills in coastal flood plains are constraining shoreline management plans
- Risks related to erosion more serious than from flooding
- Risks will increase with time, not decrease
- More proactive approach to managing erosion risks required
- Landfill tax major cost component in attempting to relocate landfills

Summary

- At present it is unacceptable for waste to erode into the marine environment
  - In the absence of a means to characterise the impact of individual waste components

Acknowledgements

Project funded by

Environmental Risks to Infrastructure Innovation Programme

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