



On Track For A Resilient Rail Network

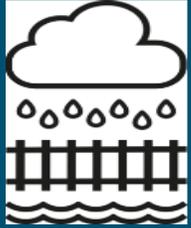
**Dafydd Thomas-Project Manager
(Climate Resilience and Adaptation)**

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Introduction to the Wales and Western region

- Wales and Borders route
 - Western route
 - 115.9 million passengers served per year
 - 26 million tonnes of freight moved every year
 - 5150 employees
 - 3418 signals operated
 - 3352 miles of railway
 - 3540 daily passenger and freight services
- 
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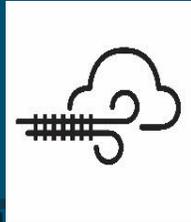
Weather Resilience and Climate Change Adaption: The Wales and Western Region CP6 Weather Events



Flood

Schedule 8: £90.73mn

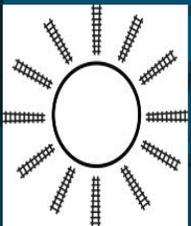
Delay Minutes: 1.7mn



Wind

Schedule 8: £44.9mn

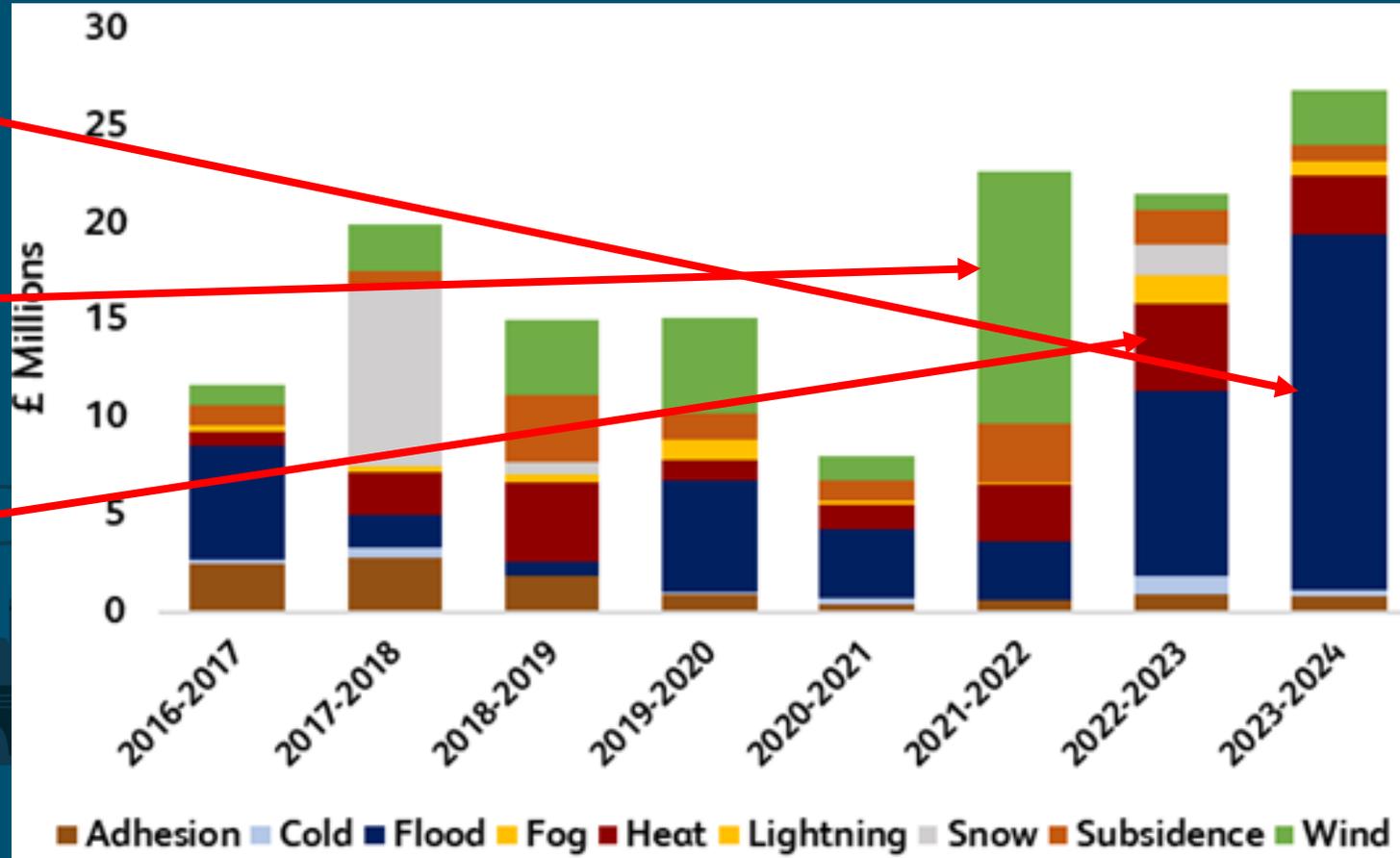
Delay Minutes: 0.87mn



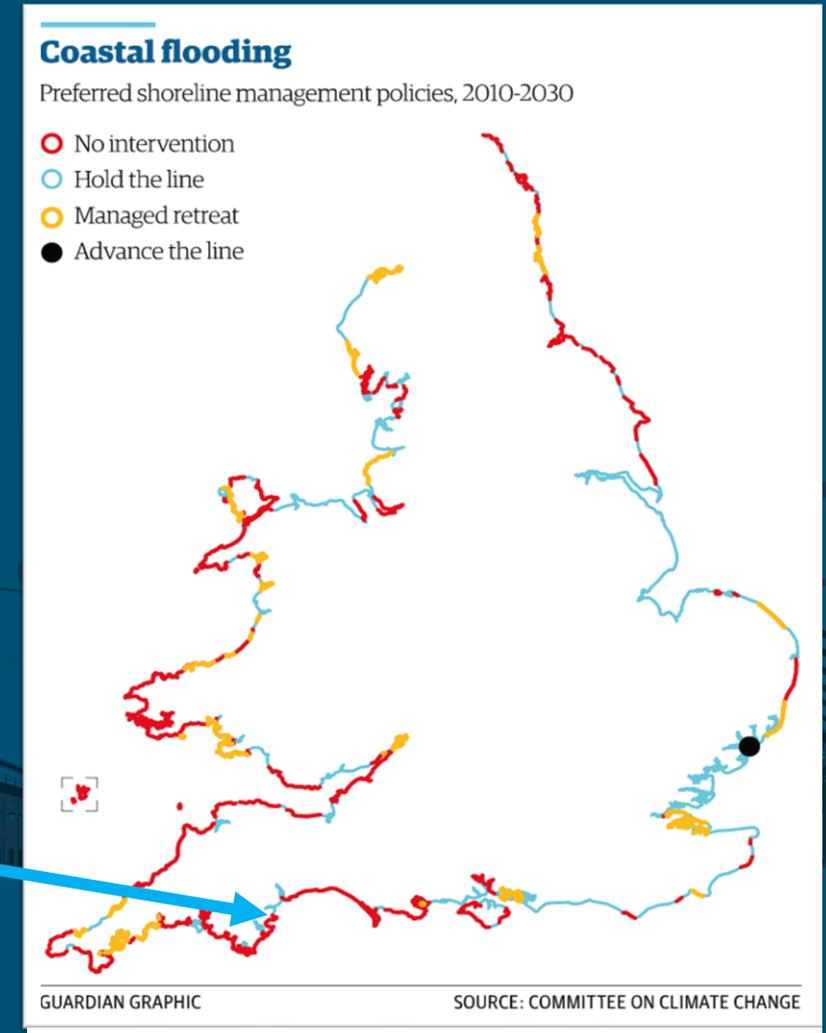
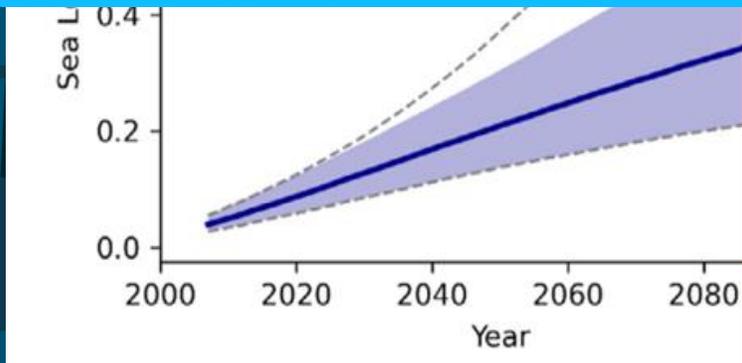
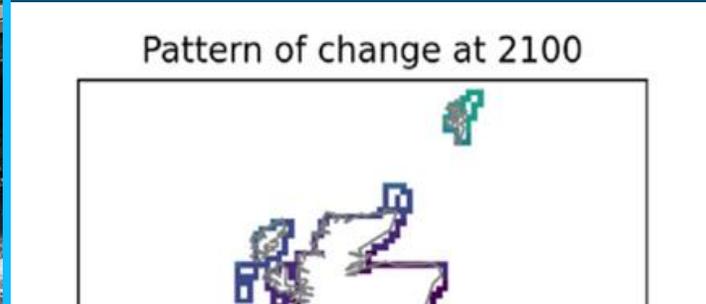
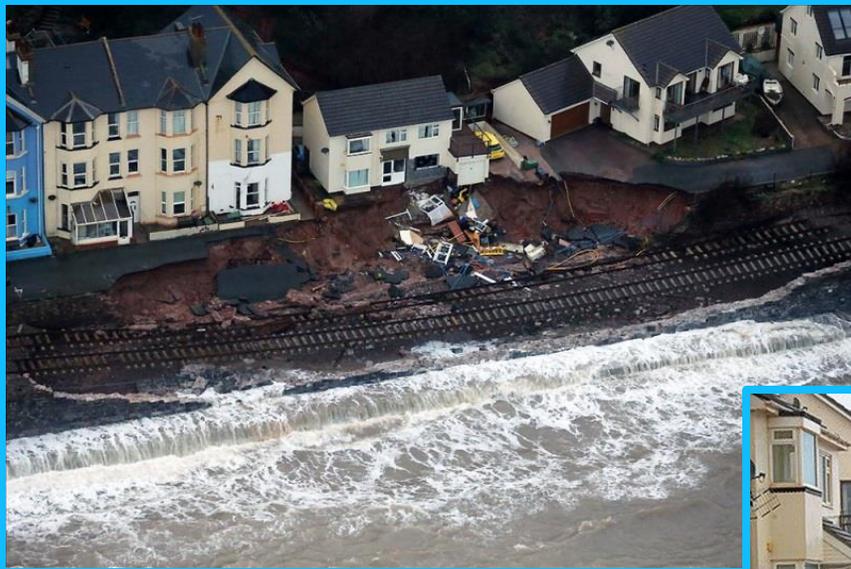
Heat

Schedule 8: £24.3mn

Delay Minutes: 0.35mn



Climate Change Adaptation: Climate Change Risks – Sea Level Rise



GUARDIAN GRAPHIC

SOURCE: COMMITTEE ON CLIMATE CHANGE

Network Rail Climate Change Adaption News:

W&W has the most coastal railway in the UK. Sea levels are expected to rise by 3mm per year.

Climate Adaptation: Climate Change Risks – Changing Precipitation Patterns

2030s



-80 -70 -60 -50



Fluvial (river) and pluvial (surface water) flooding

- **Drainage**
Flood defences challenged and overwhelmed
- **Tunnels**
Flooding and scour in tunnels
- **Platforms and subways**
Flooding of platforms and subways
- **Power distribution**
Disruption to power supplies
- **Geotechnical**
Re-activation of sinkholes
- **Structures**
Scour, loading from high water volume



High and low soil moisture

- **Track**
Destabilised track and poor track quality causing speed restrictions or line closure
- **Vegetation**
mortality due to drought



Intense and heavy rainfall

- **Drainage**
Exceedance of design capacity, pump failure
- **Buildings**
Building drainage overwhelmed
- **Track**
Sudden track failure
- **Vegetation**
Washout resulting in loss of root anchorage
- **Geotechnical**
Increase in likelihood of asset failure as the ground becomes saturated



Snow and ice

- **Tunnels**
Ice formation within shafts and pores leading to disruption to train operation
- **Rail operation**
Slippery conditions posing a risk to staff and passengers
- **Structures**
Weathering of structures and materials
- **Geotechnical**
Degradation from freeze thaw and snowmelt

Network Rail Climate Change Adaption News:

Prolonged & intense rainfall is expected to become more common leading to long wet winters.

Climate Adaptation: Climate Change Risks – Temperature Range



Network Rail Climate Change Adaption News:

*Long **HOT** summers will cause significant issues to track, electrification and earthwork assets.*

Adaptation Pathways Programme overview

The adaptation pathways programme aims to enable flexible, evidence-based investment planning that identifies, prioritises, and sequences adaptation interventions at 'high-risk/impact' locations. See this video for an introduction to [Adaptation Pathways](#)

STRATEGIC



'Rapid' screening of our network at Strategic Route Section scale to identify a longlist of locations vulnerable to adverse and extreme weather and changes in climate.

LOCAL



Desk-based optioneering assessment undertaken for a sub-set of the locations identified in the 'strategic phase'. This also includes more focussed workshop sessions and a further triage of locations to identify those we believe to be most suitable for deeper analysis

FULL



Detailed, costed adaptation pathways developed for the locations that would most benefit from full application of the methodology. This includes social, environmental and economic appraisal of options and wider stakeholder engagement (e.g., with funders)

Adaptation Pathways: Progress to date

OFFICIAL



Route	Climate Adaptation Sections	Strategic RAPA	Progress to Local APA?	Number of Local APA sections identified		Full APA	Full APA Sites	
Western	Cornwall	Completed	Yes	[Progress bar]		TBC	TBC	
Western	Devon	Completed	Yes	[Progress bar]		Yes	Exe Estuary (EA)	
Western	Sommerset Levels	Completed	Yes	[Progress bar]		TBC	TBC	
Western	Bristol Area	Completed	Yes	[Progress bar]		Yes	Chipping Sodbury	
Western	Paddington to Westbury	Completed	Yes	[Progress bar]		TBC	TBC	
Western	Cotswolds Line	Completed	Yes	[Progress bar]		TBC	TBC	
Wales	South Wales Main East	Completed	Yes	[Progress bar]		TBC	TBC	
Wales	Cardiff & Vale of Glamorgan Line	Completed	Yes	[Progress bar]		TBC	TBC	
Wales	South Wales Main West & Heart of Wales	Completed	Yes	[Progress bar]		TBC	TBC	
Wales	Marches Line	Completed	Yes	[Progress bar]		TBC	TBC	
Wales	Cambrian	Completed	Yes	[Progress bar]		Yes	Pwllheli - Porthmadog	
Wales	North Wales Coast & Conwy Valley	Completed	Yes	[Progress bar]		Yes	North Wales Coast	
		100% Complete		Outstanding	Complete		Progress	0%

Phase 1 S-RAPA

Phase 2 L-APA

Phase 3 F-APA

Complete Nov 2025

Complete March 2027

Complete March 2029



Wales and Borders



Adaptation Pathways input to the FP1 process

Each stage of the process provides key insights to guide prioritisation of investment in operations, maintenance and renewals to proactively build the resilience of rail infrastructure to extreme weather and climate change

STRATEGIC



- High-level, rapid assessment of adaptation requirements along strategic lines of route
- Defines ambition for future resilience levels along lines of route
- Identifies priority locations for further analysis and some initial adaptation interventions at key sites
- Initial outputs due by March - June 2026
- Will feed into June 2026 paper to DfT on FP1 scenarios

LOCAL



- Explores adaptation requirements at vulnerable locations in more detail
- Aims to identify BAU maintenance & renewals as well as transformational projects requiring further investigation in Full AP assessment
- List of OMR interventions needed in FP1 to guide SBP and delivery plan development
- Outputs for high priority locations due by December 2026
- Will feed into initial submission and IBP

FULL



- In depth investigation of adaptation requirements at high-risk locations including business case and costs
- Maps out timing of intervention in short, medium and long term
- Identifies locations where feasibility studies and early works required in FP1
- List of OMR and enhancement interventions needed in FP1 and beyond to guide IBP development
- Likely to be funded by enhancements budgets

Resilience Sites for FP1

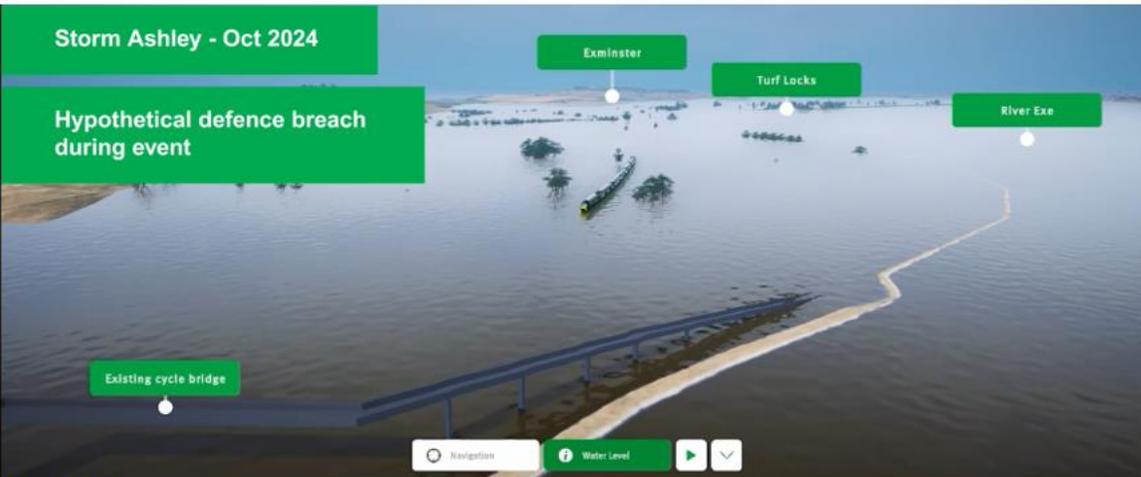
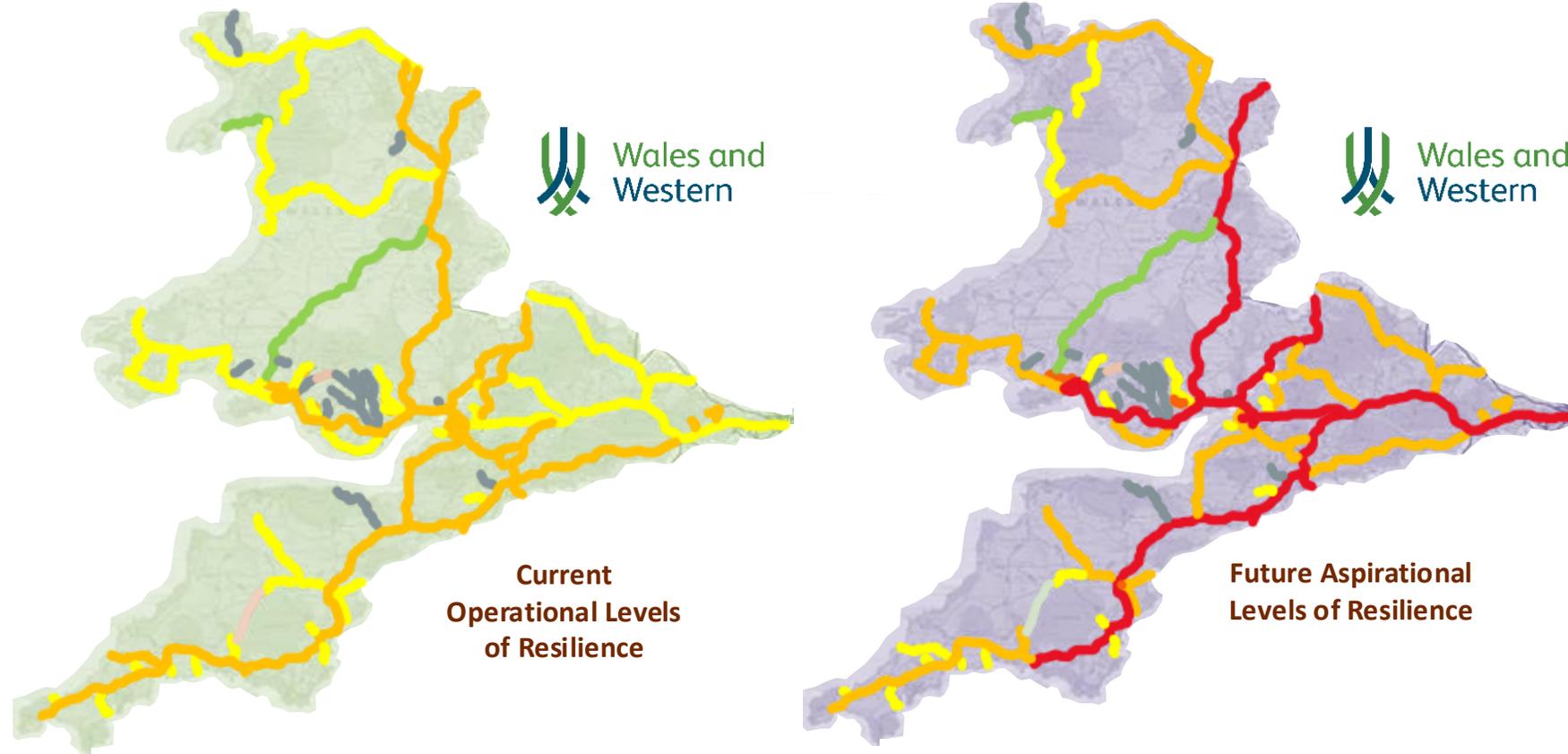


Figure 3: Visualisation showing a full breach at Powderham Banks for recent tide levels (October 2024) - urgent works were undertaken during this event to prevent a breach from occurring.



Resilience Gap Maps of Current Levels of Resilience Versus Future Aspirational Levels of Resilience



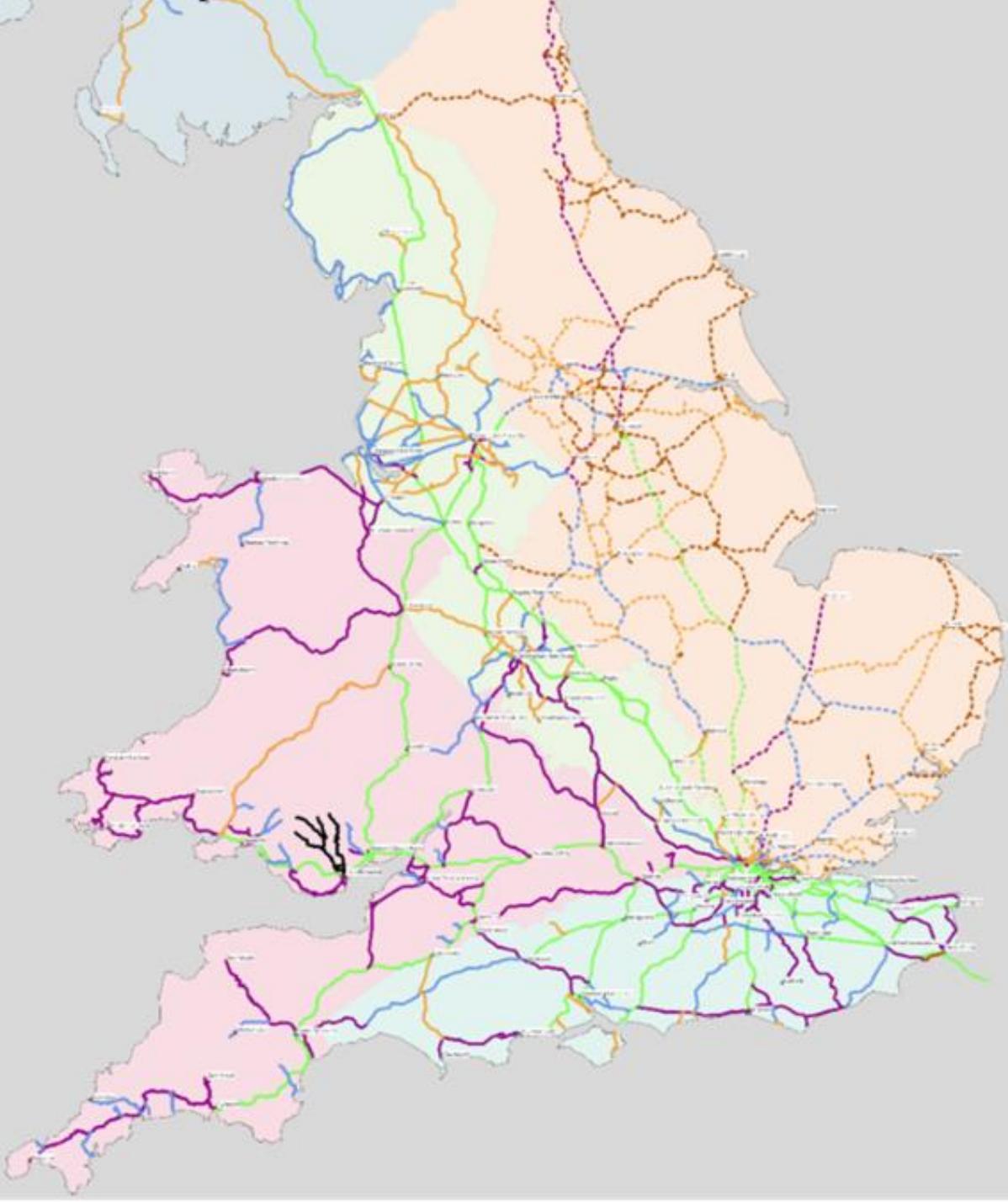
Resilience Category	Definition
Resist	the railway system in this part of the network must be able to resist shocks and stresses to prevent an impact on infrastructure and services
Rapid recovery	the railway system in this part of the network must be able to absorb shocks and stresses to minimise the impact on services and quickly recover from the event to restore expected levels of service (within 24 hours)
Bounce Back	the railway system in this part of the network could accept a short term interruption to services but must be able to bounce back to operations quickly after repairs have been carried out following incidents (up to a week)
Repair	the railway system in this part of the network could accept an interruption to services while repairs are carried out following incidents (weeks to months)
Close or alternative transport modes	the railway system in this part of the network could be abandoned if extreme weather and climate change make it impossible to maintain services.

Through the observation of operational recovery from Storm Bert (which was a 1 in 100year event) we have mapped out our current LoR.

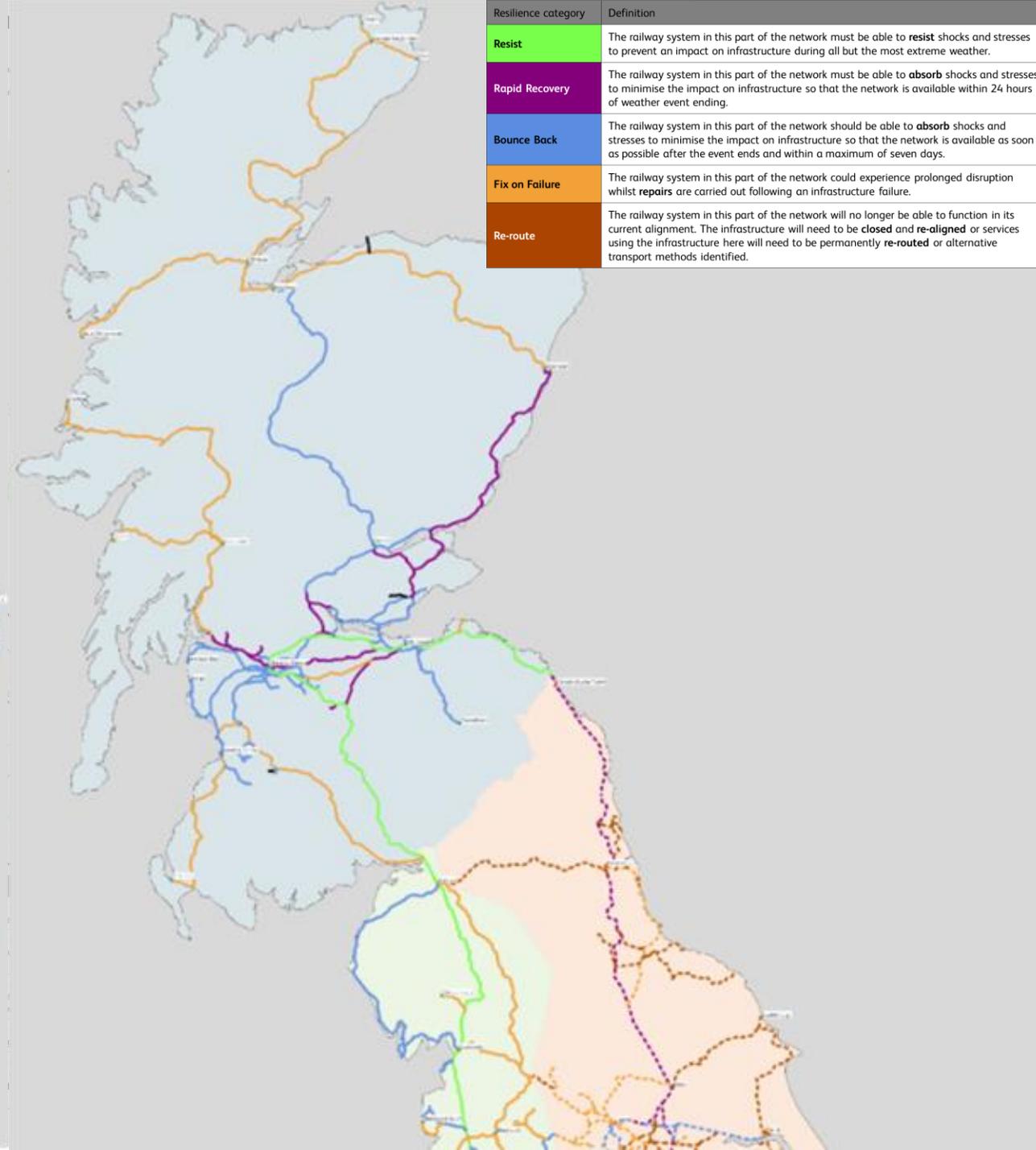
Where the current LoR matches the future LoR it is likely that there is still a need for adaptation to deal with the changing climate.

A Storm Bert style event is likely to become more frequent, making way for more extreme extremes. To recover or resist these events, there is going to be significant adaptation required.

Our Adaptation Pathways are currently mapping out adaptation options to meet our future aspirational levels of resilience. These options will be time bound and sequential, based on real time monitoring and climate projections to ensure the right level of adaptation is applied at the right time.



Resilience category	Definition
Resist	The railway system in this part of the network must be able to resist shocks and stresses to prevent an impact on infrastructure during all but the most extreme weather.
Rapid Recovery	The railway system in this part of the network must be able to absorb shocks and stresses to minimise the impact on infrastructure so that the network is available within 24 hours of weather event ending.
Bounce Back	The railway system in this part of the network should be able to absorb shocks and stresses to minimise the impact on infrastructure so that the network is available as soon as possible after the event ends and within a maximum of seven days.
Fix on Failure	The railway system in this part of the network could experience prolonged disruption whilst repairs are carried out following an infrastructure failure.
Re-route	The railway system in this part of the network will no longer be able to function in its current alignment. The infrastructure will need to be closed and re-aligned or services using the infrastructure here will need to be permanently re-routed or alternative transport methods identified.



Conwy Valley Bounce Back: Tuesday 9th April 2024 Washout

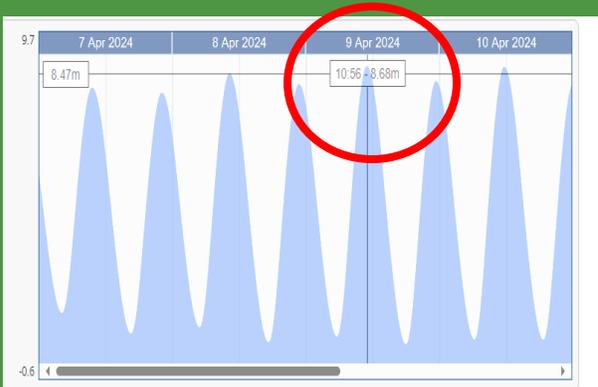
Tuesday 9th April

Wednesday 10th April

Thursday 11th April

Friday 12th April

Saturday 13th April



The railway line between Llandudno Junction and Blaenau Ffestiniog is expected to reopen on Saturday 13th April after emergency repairs. The line was forced to close on Tuesday this week (9th April 2024) after flooding washed away ballast near Dolgarrog station. 10 Apr 2024



RailAdvent
<https://www.railadvent.co.uk> > Infrastructure

North Wales railway set to reopen after flooding left tracks ...

Heavy Rain Accum.		Convective Rainfall Intensity	
Hazard	Conf.	Hazard	Conf.
Adverse	Medium	Low	Low
Aware	Medium	Aware	Low
Aware	Low	High	High
Low	Low	High	High
Low	Low	High	High



Early Day Motions

UK Parliament > Early Day Motions > Re-opening of the Conwy Valley Line

Re-opening of the Conwy Valley Line

EDM 620: tabled on 16 April 2024

Tabled in the 2023-24 session.

This motion has been signed by 4 Members. It has not yet had any amendments submitted.

Motion text

That this House congratulates Network Rail for the swift re-opening of the Conwy Valley Line on 13 April 2024; notes that the line was closed in the afternoon of 9 April 2024 when river flooding washed away ballast that supports the track near Dolgarrog station; further notes the hard work of the Network Rail team to install over 200 tonnes of new ballast which resulted in the resumption of services between Llandudno Junction and Blaenau Ffestiniog; also notes that the latest incident was 0.5 miles from previous resilience work carried out in 2020 and that these works held firm and had they not taken place this latest flooding incident would likely have closed the line for a period of up to four months; and congratulates the team at Network Rail for the vital work they do in operating and maintaining railways for public use in north Wales.



PLANNING

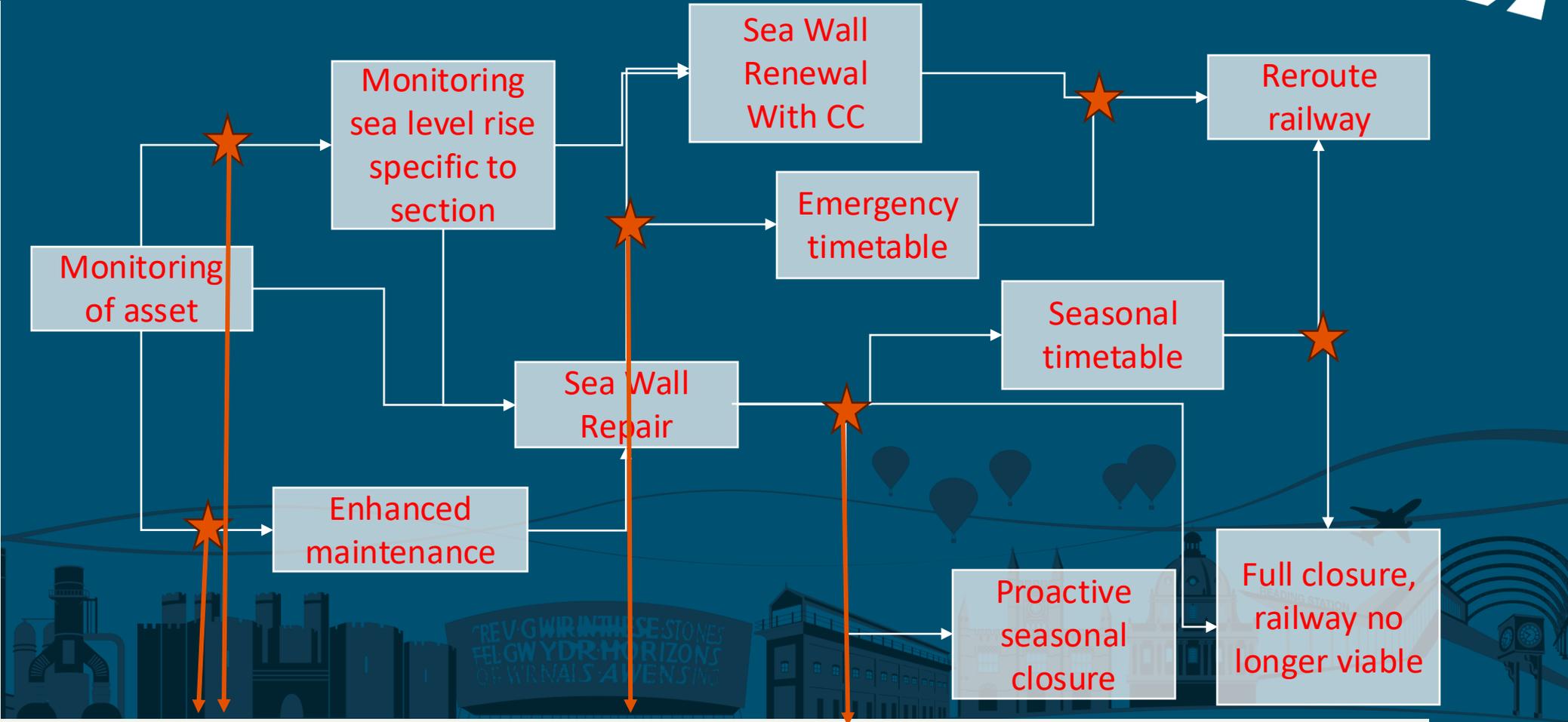
Resist

Rapid recovery

BounceBack

Repair

Close



Wales and Western

TIME, CLIMATE RISK & IMPACT
RCP8.5 (worst case)

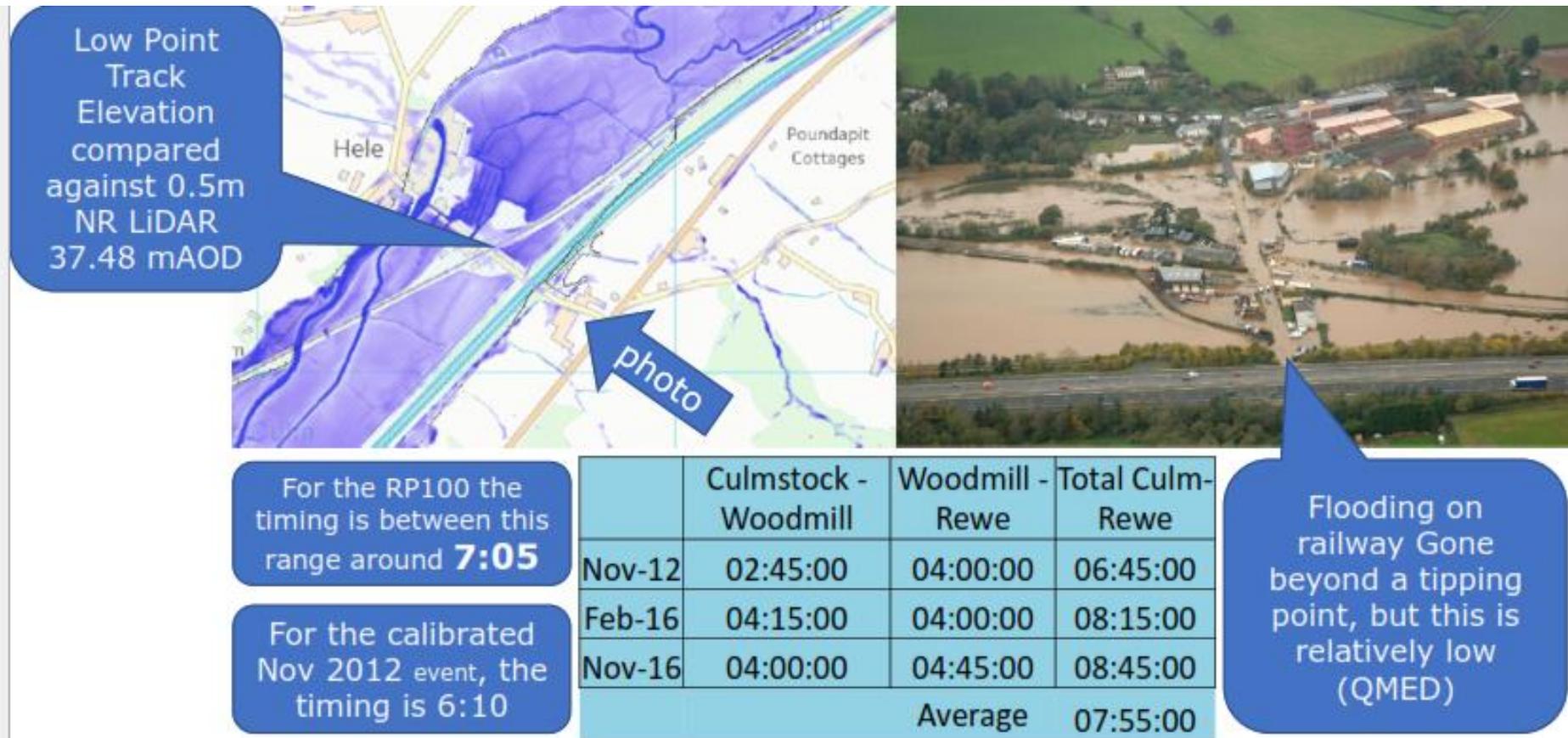
For a Greater Railway

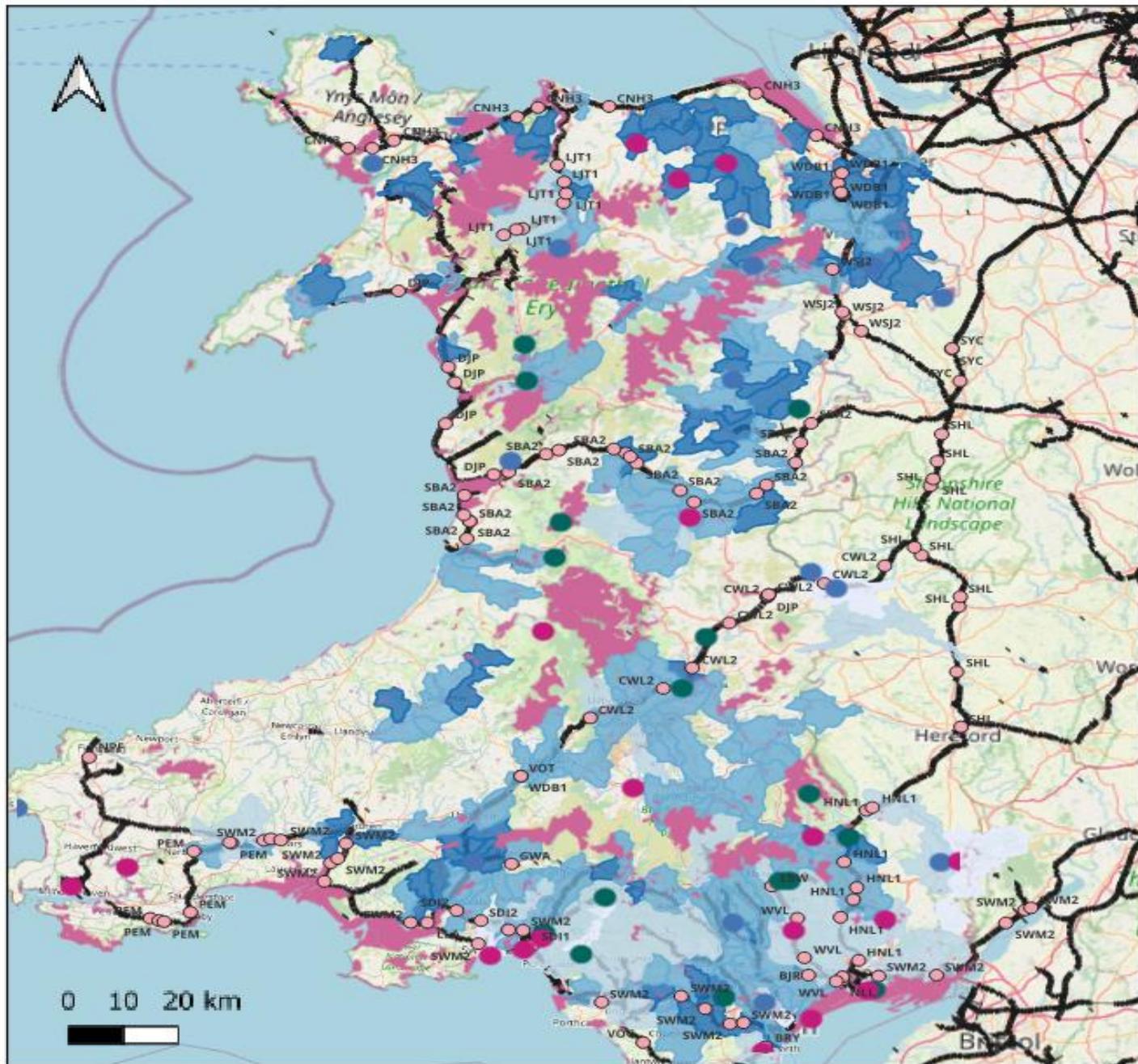
Wetland Creation



Culm/Hele

- CP6/7 2 delay events totalling **506** delay minutes
- Flooding occurs at 6-day consecutive rainfall of **47mm**
- At Hele crossing, implementation of the NBS measures is modelled to reduce peak flood flow by 16-21% and flood durations by between 5-10hrs.





status_report_for_nfm

- Concept / Feasibility
- Design / Construction
- Implemented / Monitoring
- Not Visible at this Scale

○ Flood sites. QGIS layer

NRW_SSSI

■

pmfnfm_large_catchments

- < 10%
- 10% - 25%
- 25% - 50%
- > 50%

OS Vector Map (District) - Railway Lines

↗

OpenStreetMap

PROBLEM STATEMENT

- The Swindon – Bristol Parkway main line, built 1902, was cut directly through an aquifer, creating Chipping Sodbury tunnel (over 2.5 miles long) and cuttings either side
- Flooding is caused by three different mechanisms:
- Groundwater flooding (e.g. springs erupting through tunnel)
- Surface-water flooding (run-off from surrounding land into cutting)
- Fluvial flooding from a number of water courses that flow from south to north across the railway

Cost to Network Rail for flooding incidents at Chipping Sodbury 2018-2024

£10,232,381.09

Start Date	Yr/Peri	Control Peri	IncidentDescription	Minute	cost
24/01/2018	2017/11		5 CHPSDBY FLOODING	797	102336.43
03/11/2019	2019/ 8		6 CHPSDBY FLOODING	117	21691.07
21/01/2021	2021/11		6 CHPSDBY FLOODING	316	48694.5
12/01/2023	2023/11		6 CHPSODBY FLOODING	16605.5	3344814.11
01/04/2023	2023/ 1		6 CHPSDBY FLOODING	7554	1689621.52
21/10/2023	2023/ 8		6 BADMTN CHPSDBY FLOODING	1168.5	269542.53
04/12/2023	2023/ 9		6 CHPSDBY FLOODING	5118	966097.9
31/12/2023	2023/10		6 CHPSDBY FLOODING	11646	2635280.63
08/01/2024	2024/11		6 CHPSDBY FLOOD 08/01/24	112	28743.32
08/02/2024	2024/12		6 CHPSDBY FLOODING	8	2516
09/02/2024	2024/12		6 CHPSDBY FLOODS	4134	898959.93
18/02/2024	2024/12		6 CHPSDBY FLOODING	654.5	185702.51
02/03/2024	2024/12		6 WSTLGHJ CHPSDBY FLOODING	242	55574.91
17/03/2024	2024/13		6 FLOODING CHPSDBY	310	42891.33
28/03/2024	2024/13		6 CHPSDBY FLOODING	1685.5	403625.51
				50468	£10,696,092.20

The Problem Statement:



Chipping Sodbury flood mitigation: Phase 0 works (Autumn 2024)

OFFICIAL



- Install widespread **monitoring** of flow, water levels, pumping status across the site
- **Clear vegetation from upper stream** to allow greater flow over aqueduct (within statutory allowance)
- **Connect** outflow from upper pond into down cess drainage, reducing pooling on track
- **Jet and survey entire track drainage system** in western cutting to maximise capacity and input into modelling for Phase 1 (35 tonnes of material removed)
- Risk assessment for running through floodwater completed
 - ✓ Rule Book allows for running through water that is moving provided allowed by Route Control
 - ✓ Risk assessment undertaken: known flooding mechanisms at the site with none of the flooding leading to wash-out
 - ✓ Removes the risk of stranded trains



Known Flooding Site Risk Assessment					
Region	Route	TME	SMT	LOR	LOR Description
W&W	Western	Central		SWB	Swindon to Bristol Parkway
Location	ELR(s)	TID(s)	From (mile/chains)	To (mile/chains)	Linespeed
Chipping Sodbury	SWB		103m50ch	104m15ch	
The purpose of this risk assessment is to ensure a consistent approach is taken to running trains through floodwater. The risk assessment does not replace the rule book requirements and is to be used in areas of known/repeat flood locations where the water level is up to 100mm above the head of the rail. This risk assessment excludes DC electrified lines.					
Questions:					Answers (Yes, No, N/A)
Is the site a known flooding location?					Yes
If yes, over the last 3 flood events has the site suffered from a loss of ballast leading to intervention work prior to re-opening?					No
Does the site have water level depth markers or an alternative method capable of establishing if the water level is up to 100mm above the head of the rail?					Yes
Specify the method: Depth markers					
Is there an effective method for establishing the depth of water (eg Driver report or CCTV)?					Yes
What is the preferred method? CCTV					
If the site contains S&C, is the signaller capable of detecting and maintaining the points in the desired position?					Yes
Are there any structures within the flooded area which would prevent applying this RA (acceptable to withstand flooding up to the head of the rail, but not up to 100mm above)?					No
Are there any earthworks within the flooded area which would prevent applying this RA (acceptable to withstand flooding up to the head of the rail, but not up to 100mm above)?					No
Are there any unrepaired Intervention Limit (IL) or Immediate Action Limit (IAL) twist faults within the flooded location?					No
Additional comments/brief description of flooding event: Chipping Sodbury tunnel and cutting floods regularly because of rising groundwater levels following rainfall as well as local runoff into the cutting. The railway is in a deep cutting throughout the section. Water rises up from the ground or runs off from the cutting sides and ends up flowing down the track. This mechanism is not consistent with wash-out of ballast and in the last 5 years over 26 flooding incidents, not once has any track remediation work been required following the incident. This risk assessment in conjunction with the monitoring from cameras on site provides the evidence needed for Operations Control to authorise train movements at depths of up to 100mm above the railhead.					
If the answers are all coded green the site is fit for running at 5mph. Note: only one train to pass through the flood water at a time.					
If any of the cells are red, the train movements must be stopped when the water level is above the head of the rail.					



New telemetry



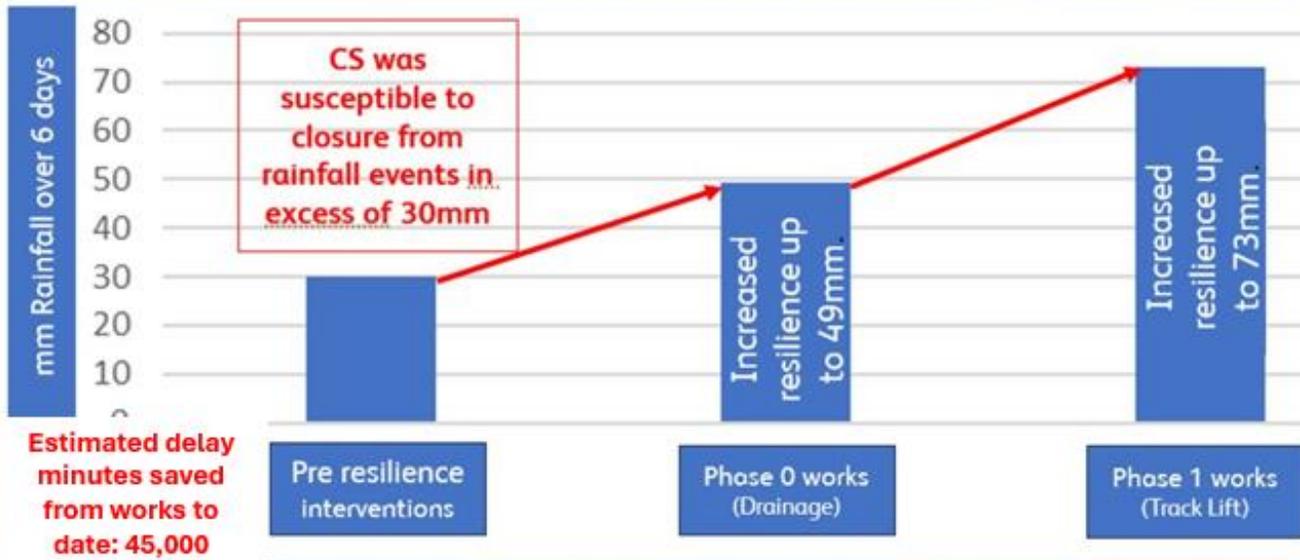
Chipping Sodbury flood mitigation: Phase 1 works (Summer 2025)

- **Raised track** over a distance of 850m by up to 250mm
 - This is in the area under the aqueduct where the track was lowered when the Overhead Line Equipment was installed during the Great Western Electrification Programme (GWEP)
 - The gauging was reviewed and clearances challenged given the flood risk in this location
- Western portal **pumps refurbished** to increase the water pumped out of the cutting in this location
- Water course that flows over aqueduct **de-silted in the area upstream**, increasing flow over railway
- **De-silting the balancing pond** that functions to reduce the amount of water going over the aqueduct
- The **lower resilience lagoon (installed in 2018)** was also **de-silted** as part of these works.



Increase in resilience for volume of rainfall totals at Chipping Sodbury.

Graph depicts the increasing rainfall totals that the railway is resilient to, meaning that fewer and fewer events will lead to performance-impacting flooding.



- The threshold above which the railway at Chipping Sodbury floods has been more than doubled by the resilience works
- This has saved an estimated 45,000 minutes of delay in reduced closure time and even some potential flooding events that were completely averted by the works
- However both Storm Bert (Nov 2024) and Storm Claudia (Nov 2025) brought in excess of 70mm of rainfall over 5 days at the site
- With climate change we need to carry out work to further increase the resilience

Infrastructure Systems Resilience at Chipping Sodbury

Cost to Network Rail for flooding incidents at Chipping Sodbury 2018-2024

£10,232,381.09

AVOIDED cost to Network Rail for flooding incidents at Chipping Sodbury 2024-2026

£9,123,744.74

Total Spent to date: £1.9m

