MetroWest

Portishead Branch Line (MetroWest Phase 1)

Planning Inspectorate Reference: TR040011

Applicant: North Somerset District Council

9.3.3 ExA.SoCG-EA.D3.V2 – Appendix 5 to Statement of Common Ground

Between

(1) North Somerset District Council;
(2) Network Rail Infrastructure Limited; and
(3) Environment Agency

Version: 2
Date: December 2020

MetroWest Phase 1: Flood Plan

1. Introduction

1.1 Project Background

MetroWest Phase 1 comprises the delivery of infrastructure to enable the reopening of the Portishead Branch Line to passenger traffic. Part of the route from Parson Street Junction to Portbury Dock is in operational use for freight traffic and is in Network Rail's ownership. The disused section of route from Portbury Junction to Portbury Station House is also owned by Network Rail and from there to Portishead is owned by North Somerset Council. Once construction works for the DCO Scheme are complete, the whole route will be absorbed into the national rail network under the ownership of Network Rail.

1.2 Scope and Purpose

The project is the subject of a Development Consent Order (DCO) application. If the DCO scheme is approved and constructed, the DCO scheme has the potential to be impacted by extreme weather events such as flooding during its period of operation. To discharge its duty under the Railway Operational Code, Network Rail has developed its own technical and operational Standards to manage disruptions resulting from weather hazards. Technical Standards specify how resilience should be built into railway infrastructure to mitigate climate change and extreme weather. Operational Standards form the response plan that is implemented in hazardous weather events. Both are frequently reviewed to reflect climate change patterns but also following critical incidents such as the derailment at Stonehaven in August 2020.

This document will provide an overview of the operational procedures that Network Rail will use to ensure the safety of passengers and personnel where flood events present a risk to the operation of the DCO scheme, including the steps taken by Network Rail to identify flood risk, how Network Rail will respond to and monitor flooding events, and how the scheme will be returned to operational status following the subsidence of flooding.

1.3 Exclusions

As part of the DCO submission, the applicant has provided a Master Construction Environmental Management Plan (CEMP) which pertains to construction stage of the scheme. The Master CEMP outlines the need for the construction contractor to produce Flood Plans for each relevant Works stage (as defined by the DCO) for approval by the relevant local authority prior to the commencement of the construction phase. Hence, consideration of the implications of flood planning during the construction stage of the scheme lies outside the scope of this document.

2. Reference Documents

This Flood Plan should be read in conjunction with the following appendices:

Network Rail Standards and Procedures:

Appendix A: National Operating Procedures, Weather Arrangements, Procedure 3.17, Issue 03, June 20

Appendix B: NR/L2/OPS/021, Weather – Managing the Operational Risks, 01 June 2019

Appendix C: NR/L3/OPS/021, Issue 01, Weather Management Index, March 2020 and the following modules contained within it:

- Appendix D: Module 12: Flooding – Management of Drainage
- Appendix E: Module 13: Managing the Weather – Extreme Weather Response Process

Appendix F: NR/L3/TRK/1010, Issue 02, Management of responses to extreme weather conditions at structures, earthworks and other key locations, August 2008

Appendix G: NR/L3/OPS/045, National Operating Procedures, Managing Stranded Passengers and Train Evacuation, Procedure 4.15, Issue 03, 5th December 2020.

Other Documents:

Appendix H: Western Route CP6 Weather Resilience and Climate Change Adaptation Plans

3. Risk

3.1 Existing Risks

The combination of Victorian era infrastructure and increasingly severe weather caused by climate change requires Network Rail to have a comprehensive understanding of risks and be well rehearsed to deal with incidents caused by hazardous weather conditions. The Western Route is unique in that it has 245 miles of coastal boundary. Previous incidents such as Dawlish in 2014 has ensured that the Network Rail has response plans in place both to ensure the safety of rail users and protect the infrastructure so that recovery of vital rail services is made as quickly as possible.

Costs related to damage of the infrastructure caused by weather can mount both from repairs to the infrastructure and compensation provided to train operators and passengers. Between 2006/07 and 2018/19 inland and coastal flood related incidents accounted for an average of 65,252 delay minutes and £3.42m in Schedule 8[1] costs per year.'

For a detailed assessment of known flooding risks across the Western Route and Network Rail's plan to manage this within the current control period (2019-2024) please refer to '*2019-2024 Western Route CP6 Weather Resilience and Climate Change Impact Report.*'

It should be noted that while the document lists the routes that are the most susceptible to flooding due to sea level rise, the current freight railway within the DCO scheme has not been highlighted as a current risk.

3.2 Flood Events on the Western Route in 2020

Table 1. provides details of the flood events experienced on Western Route in 2019/2020. The number of trains affected (reactionary train count) and corresponding delay minutes are given in the last two columns. The extent to which both are affected depends on the severity of flooding and number of trains using the line (with primary routes such as the Badminton Line being the main contributor to the reactionary train count and delay minutes).

[1] Schedule 8 is a mechanism enabling a train or freight operator to be compensated by Network Rail if they are delayed or forced to cancel a train service.

Table 1. Flood Events and knock on delays – Western Route 2019/2020

Incident Start Datetime	Incident Number	Incident Description	Incident Reason	Incident Reason Name	Section Name	Line	Delivery Unit Name	Reactionary Train Count	PfPI Minutes
19/07/2019	164251	UPHILLJ FLOODING	JK	FLOODING	Filton Abbey Wood	Down main	WESTERN CENTRAL	2	7
13/10/2019	408693	ASHJN PTBRLOP FLOODING	X2	SEV FLOOD	Bristol Temple Meads to Portbury Coal Terminal EWS	Portbury Single	WESTERN CENTRAL	6	19
14/10/2019	414078	MKM FLOODING	X2	SEV FLOOD	Thingley East Junction to Bradford Jn	Melksham Single	WESTERN WEST	2	6
26/10/2019	446846	XAY FLOODING	X2	SEV FLOOD	Abbotswood Jn to Ashchurch For Tewkesbury	Down Abbotswood Loop	WESTERN CENTRAL	4	32
26/10/2019	447520	LED GMV FLOODING	X2	SEV FLOOD	Ledbury to Great Malvern	Down (Entrance to Ledbury Tunnel)	WESTERN CENTRAL	60	806
30/10/2019	458988	3P18 VSTP WOS	X2	SEV FLOOD	Worcester Shrub Hill	Worcester & Hereford Single	WESTERN CENTRAL	1	3
30/10/2019	460250	PTBRCAL FLOODING	X2	SEV FLOOD	Portbury Coal Terml (FLHH)	Portbury Single	WESTERN CENTRAL	1	0
30/10/2019	461933	TRR FLOODING	X2	SEV FLOOD	Paignton to Newton Abbot	Up Torbay	WESTERN WEST	2	24
31/10/2019	463180	TOT NTA FLOODING	JK	FLOODING	Totnes to Newton Abbot	Up Main (Totnes side of Dainton Tunnel)	WESTERN WEST	2	12
03/11/2019	473120	CHPSDBY FLOODING	X2	SEV FLOOD	Westerleigh Jn to Hullavington	Up & Down Badminton	WESTERN CENTRAL	4	117
14/11/2019	510719	MIM TC FLR	X2	SEV FLOOD	Moreton-In-Marsh	Down Main	WESTERN CENTRAL	23	365
14/11/2019	510935	AWRE GCR FLOODING	X2	SEV FLOOD	Awre to Gloucester	Down Main at Newnham Tunnel	WESTERN CENTRAL	7	117
14/11/2019	510938	LED FLOODING	X2	SEV FLOOD	Ledbury	Worcester & Hereford Single	WESTERN CENTRAL	21	244
14/11/2019	511576	CHFIELD FLOODING	X2	SEV FLOOD	Charfield	Down Charfield	WESTERN CENTRAL	32	695
15/11/2019	514393	EVE FLOODING	X2	SEV FLOOD	Evesham	Up & Down Cotswolds	WESTERN CENTRAL	98	1,038
23/11/2019	540338	TRR NTA FLOODING	X2	SEV FLOOD	Newton Abbot	Up Main	WESTERN WEST	1	4
27/11/2019	552692	LSK LOO FLOODING	X2	SEV FLOOD	Liskeard	Looe single	WESTERN WEST	1	3
08/12/2019	589377	BTHMPTJ THNGLEJ FLOODING	JK	FLOODING	Bathampton Jn to Thingley East Junction		WESTERN CENTRAL	1	3

13/12/2019	606406	HLVNGTN WSTLGHJ FLOODING	X2	SEV FLOOD	Hullavington to Westerleigh Jn	Down Badminton	WESTERN CENTRAL	85	1,184
13/12/2019	608944	COP FLOODING	X2	SEV FLOOD	Crediton to Eggesford	North Devon line	WESTERN WEST	4	22
19/12/2019	627696	CDI FLOODING	X2	SEV FLOOD	Crediton	North Devon line	WESTERN WEST	6	59
20/12/2019	630425	HGHWTHJ FLOODING	X2	SEV FLOOD	Swindon	Highworth Single line	WESTERN CENTRAL	21	234
21/12/2019	633945	HEMERDN FLOODING	X2	SEV FLOOD	Hemerdon	Up Main	WESTERN WEST	1	4
22/12/2019	635085	OXF DIDCTNJ FLOODING	X2	SEV FLOOD	Oxford to Didcot North Jn	DCL	WESTERN CENTRAL	1	5
23/12/2019	637997	SDONCBY FLOODING	X2	SEV FLOOD	Swindon Cocklebury		WESTERN CENTRAL	3	12
27/12/2019	643307	SOMEVIA FLOODING	X2	SEV FLOOD	Athelney Crossing to Somerton Ground Frame	Up line	WESTERN WEST	2	11
10/01/2020	679343	STNDSHJ CHFIELD FLOODING	X2	SEV FLOOD	Standish Jn to Charfield	Down Charfield	WESTERN CENTRAL	2	12
14/01/2020	691388	HLVNGTN WSTLGHJ WATER ON TRACK	X2	SEV FLOOD	Hullavington to Westerleigh Jn	Down Badminton	WESTERN CENTRAL	358	5,440
15/01/2020	692867	LAVNGTN FLOODING	X2	SEV FLOOD	Lavington to Woodborough	Down Westbury	WESTERN WEST	2	23
15/01/2020	692998	WTNBSTJ CPM FLOODING	X2	SEV FLOOD	Wootton Bassett Jn to Chippenham	Down Main	WESTERN CENTRAL	24	436
15/01/2020	693141	NBY SCOTEJN FLOODING	X2	SEV FLOOD	Newbury to Southcote Jn	Up and Down Westbury	WESTERN EAST	11	149
16/01/2020	696048	HLVNGTN WSTLGHJ FLOODING	X2	SEV FLOOD	Hullavington to Westerleigh Jn	Up & Down Badminton	WESTERN CENTRAL	3	34
13/02/2020	776055	MIM AUW FLOODING	X2	SEV FLOOD	Moreton-In-Marsh to Ascott-Under-Wychwood	Up	WESTERN CENTRAL	1	6
15/02/2020	782653	NQY GNBARWJ FLOODING	X2	SEV FLOOD	Newquay to Goonbarrow Jn	Newquay Single	WESTERN WEST	3	15
15/02/2020	782922	STS SGM FA TRACK FLOODED	X2	SEV FLOOD	Saltash to St Germans	Up Main	WESTERN WEST	11	189
15/02/2020	783227	DAINTNT FLOODING	X2	SEV FLOOD	Newton Abbot to Totnes	Up Main	WESTERN WEST	1	10
15/02/2020	783140	PGN NTA HA TRACK FLOODED	X2	SEV FLOOD	Paignton to Newton Abbot	Up Torbay	WESTERN WEST	1	3
15/02/2020	783253	GCR AWRE FLOODING	X2	SEV FLOOD	Gloucester to Awre	Up & Down (Newham Tunnel)	WESTERN CENTRAL	38	590
16/02/2020	784428	LED FLOODING	X2	SEV FLOOD	Ledbury	Worcester & Hereford Single	WESTERN CENTRAL	2	16

16/02/2020	784684	WTNBSTJ CPM FLOODING	X2	SEV FLOOD	Wootton Bassett F.Y. to Chippenham	Up main	WESTERN CENTRAL	2	46
16/02/2020	784727	AISHXO TOT FLOODING	X2	SEV FLOOD	Aish Emergency Crossover to Totnes		WESTERN WEST	3	229
16/02/2020	784731	MIM FLOODING	X2	SEV FLOOD	Moreton-In-Marsh to Ascott-Under-Wychwood	Up & Down main	WESTERN CENTRAL	1	11
16/02/2020	785129	BTHMPTNJ THNGLYJ FLOODING	X2	SEV FLOOD	Bathampton Jn to Thingley East Junction		WESTERN CENTRAL	2	7
16/02/2020	785137	AMT FLOODING	X2	SEV FLOOD	Newbury to Southcote Jn	Down Westbury	WESTERN EAST	3	168
16/02/2020	785424	CHPSDBY FLOODING	X2	SEV FLOOD	Westerleigh Jn to Hullavington	Up & Down Badminton	WESTERN CENTRAL	118	1,999
28/02/2020	819443	SGM STS FLOODING	X2	SEV FLOOD	St Germans to Saltash	Up Main	WESTERN WEST	31	529
05/03/2020	835707	SGM STS FA TC FLR	X2	SEV FLOOD	St Germans to Saltash	Down Main	WESTERN WEST	21	204
13/03/2020	858624	SGM STS FA TC FLR FLOODING	JK	FLOODING	St Germans to Saltash		WESTERN WEST	7	100

3.3 Future Risks pertaining to the DCO Scheme

A brief precis of the key issues identified within the Flood Risk Assessment for the DCO scheme is presented below.

The DCO Scheme is considered to pass the NPPF Sequential Test as the DCO Scheme is identified in NSC Core Strategy, Adopted April 2012 and there are no other feasible locations for the DCO Scheme. The current resilience of the rail asset to flooding has been assessed as part of the assessments undertaken within the project FRA.

The FRA identified that the most significant flood risk to the DCO Scheme is River Avon tidal flood risk in the vicinity of Bower Ashton. For the present day (2015) scenario, modelling undertaken for the FRA indicates the proposed railway would flood once every 5 to 10 years on average near Bower Ashton, due to high tide/surge conditions.

For the future scenarios, due to projected future sea level rise, the railway will flood on average approximately two to three times a year by 2075 (which is the 60 year design life of the DCO) Scheme and approximately 8 times a year on average in 2115 (well beyond the design life of the DCO Scheme) near Bower Ashton. Whilst it is anticipated that there would be a strategic River Avon flood defence scheme in place by that time, due to the extensive increase in flood risk across Bristol, the adopted Extreme Weather Plan will detail flood warning procedures and actions to manage flood risks to the DCO Scheme and its users/personnel.

Coastal flood risk between Portishead and Pill is not regarded as significant for the present day (2015) and future (2075) scenarios as modelling undertaken for the FRA indicates flooding of the DCO Scheme occurs less than once every 1000 years on average. Modelling indicates that for the future (2115) scenario the DCO Scheme will experience coastal flooding once every 200 to 1000 years on average.

Portishead station and carpark are in the defended floodplain and the impact of flooding on access and egress is considered insignificant for the present day (2015) and future (2075) scenarios. For the future (2115) scenario, Portishead station and carparks are predicted to flood once every 200 to 1000 years on average. Pill station, carpark and adjacent roads are several metres higher than River Avon flood levels and so access/egress is considered safe from River Avon tidal flooding.

The FRA indicates that fluvial flooding in the Longmoor and Colliter's Brooks would result in flooding of the railway in the vicinity of the railway crossing of Longmoor Brook approximately once every 100 to 1000 years on average for the present day (2015) and every 50 to 75 years in 2075 and 2115.

Further to the above, the Environment Agency's surface water flood map indicates that there may be relatively small and localised areas in the vicinity of the DCO Scheme that could be vulnerable to surface water flooding during rainstorms.

The surface water drainage of the railway and stations/carparks has been designed in consultation with the EA, North Somerset Levels Internal Drainage Board (NSLIDB), North Somerset District Council (NSDC) and Bristol City Council (BCC), as appropriate, to ensure the DCO Scheme does not increase surface water flood risk elsewhere. The ground conditions at Portishead and Pill stations and carparks are not suitable for sustainable drainage systems (SuDS) based on infiltration, but the drainage designs include underground tanks where appropriate to maintain current discharges to outfalls.

A breach of the Sea Commissioner's Bank coastal flood defence during a tidal flood event would not affect the DCO Scheme for the present day (2015) scenario. The potential for a breach to impact the DCO Scheme increases for the future (2115) scenario, due to projected future sea level rise. The final Extreme Weather Plan which will be applicable to the operational DCO Scheme will specify operational procedures during high tide and surge levels (i.e. levels for which a breach would impact the railway services). This may include, for example, precautionary closure of the railway during (rare) high tide and surge level conditions.

The inland flood bund coastal flood defence (FRA, Appendix M) provided as part of a recent residential development has an unresolved structural issue. The EA requires this to be resolved before adopting and maintaining the structure. The EA is in discussion with the developer to resolve this outstanding issue. There is likely to be a strategic response to manage future increased coastal flood risk between Portishead and Pill and the inland bund is likely to remain a component of the strategic coastal flood risk management infrastructure in the future.

Significant culverts under the railway will continue to be managed by the NR, EA, NSLIDB, NSDC and BCC as appropriate to their ownership and responsibilities to minimise the risk of blocked culverts resulting in increased flooding locally during a flood event. Access will be maintained for third parties to maintain their assets as part of the DCO Scheme.

Overall, Network Rail is content that the DCO Scheme does not pose a serious flood risk to railway operations in the short to medium term.

4. Weather Forecasting

The actions that Network Rail will carry out in preparation and in response to weather and flooding are summarised in section 4 and 5. Full details can be found Appendix A - *National Operating Procedures, Weather Arrangements, Procedure 3.17, Issue 03, June 20*

4.1 Weather Forecast Arrangements

The contracted weather forecast provider supplies weather reports with a forecast for all weather areas.
The forecasts shall be provided by 03:00 hours each day with a forecast for the current day plus a four-day forecast. If forecasts are not received, then the Route Operations Control Manager (RCM) shall contact the forecast provider.
On receipt of the forecast the Route Operations Control shall:
a) send out alert status;
b) record alert status; and
c) liaise with the nominated senior manager if a conference is needed.

The Route Operations Control shall have a process to notify the colour alert status (see Table 1) to Train Operating Companies (TOCs) and Freight Operating Companies (FOCs), National Operations Centre (NOC) and other key stakeholders.

4.2 Weather Alert Status Table and Confidence

Table 1: Weather Alert Status Table

Weather Type	Alert Status
Normal	Green
Aware	Yellow
Adverse	Amber
Extreme	Red
Extreme weather affecting two or more Routes	Double Red (to be used only by NOC manager)

The forecast provider shall provide a confidence level of the weather expected, ranging from high to low. When a colour alert has been issued other than green, arrangements shall be made by the Route to discuss the operational integrity and preparedness. Every Route shall have a high-risk site register of weather susceptible locations, which might be of use.

When a yellow alert has been forecast within the four-day outlook, this might be reviewed with the forecast provider if felt necessary by the Route.
When an amber alert has been forecast within the four-day outlook, this shall be reviewed daily, or more frequently if felt necessary by the Route.
When a red alert has been forecast then this shall be reviewed daily.
Hazards are expected to be present in extreme form or a combination of adverse weather conditions giving a high degree of risk to the operational integrity of the network.

Extreme Weather Affecting Two or More Routes (Double Red):
When two or more Routes activate the Extreme Weather Response process, the status of the alert shall be referred to as Double Red. The RCMs of the Routes affected by the Double Red status shall be advised via the 0440 NOC conference call on days it is held or via e-mail outside of the 0440 conference call schedule. Those in receipt of email notification will be required to acknowledge receipt of the transmission.

High-Risk Register:
Route Operations Controls shall have a list of high-risk areas and assets which are weather that can operationally affect the running of trains and help become a factor in deciding on an alert status. High-risk registers shall be compiled by each Route.

4.3 Extreme Weather Action Teleconference (EWAT)
When weather conditions which might warrant a red alert status are expected within 3 days on the five-day forecast outlook, or the Route Operations Control has assigned red alert status to weather conditions which are expected within 2 days, preparation activities shall begin. This shall include a Delivery Unit (DU) conference to allocate DU and Asset Management resources prior to the EWAT). The EWAT utilises a templated script for each weather scenario. The EWAT for utilised for heavy rain and flooding can be found in Appendix E *NR/L3/OPS/021/13 Appendix B*

The purpose of the EWAT is:
a) to assess the impact of extreme weather on the infrastructure;
b) to determine mitigation, monitoring and contingency plans; and
c) to communicate actions and decisions.

The EWAT conference agenda shall include, but is not limited to:
a) confirmation of the forecast, affected locations and confidence in the forecast, which may be delivered by the weather forecast provider;
NOTE: The forecast provider shall be given four hours' notice of this.
b) declaration of the weather as extreme to allow Customer Account Teams to activate the force majeure procedure as outlined in NR/L2/OPS/021;
c) infrastructure risks and mitigation plans;
d) staff and equipment resource availability and deployment;
e) whether the Strategic Command / Tactical Command / Operational Command structure shall be activated (see NR/L2/OPS/250);
f) emergency timetable utilisation;
g) information provision to Network Rail and TOC managed stations;
h) confirmation of route-proving arrangements after the event; and
i) summary of actions and decisions.
The actions shall be shared with participants of the EWAT conference and the NOC.

5. Flood Procedure

5.1 Coding of Flood Warning
The National Coded Flood Warning Service provides a means whereby warnings of flooding can be transmitted with an indication of estimated severity. There are four types of flood warning in the Service. Each level of severity is associated with flooding forecast for a certain type of area and flood risk, as follows:

- Flood Alert;
  - Fast flowing and bank full rivers
  - Flooding on fields and minor roads
  - Surface water flooding
  - Spray/wave overtopping
  - Overland flow from rivers/watercourses
  - Flooding from ordinary watercourses
  - Potential property flooding

- Flood Warning (Including Updates);
  - Risk to life and property
  - Underground stations and lines vulnerable
  - Damage to defences
  - Risk to main road and railways
  - Significant wave/spray overtopping
  - Access Roads vulnerable
  - Severe floodplain inundation

- Severe Flood Warning;
  - Large numbers of people/property affected
  - Major incident/flood plan triggered
  - High risk to life
  - Civil disruption (traffic etc)
  - Major breaches of flood defences

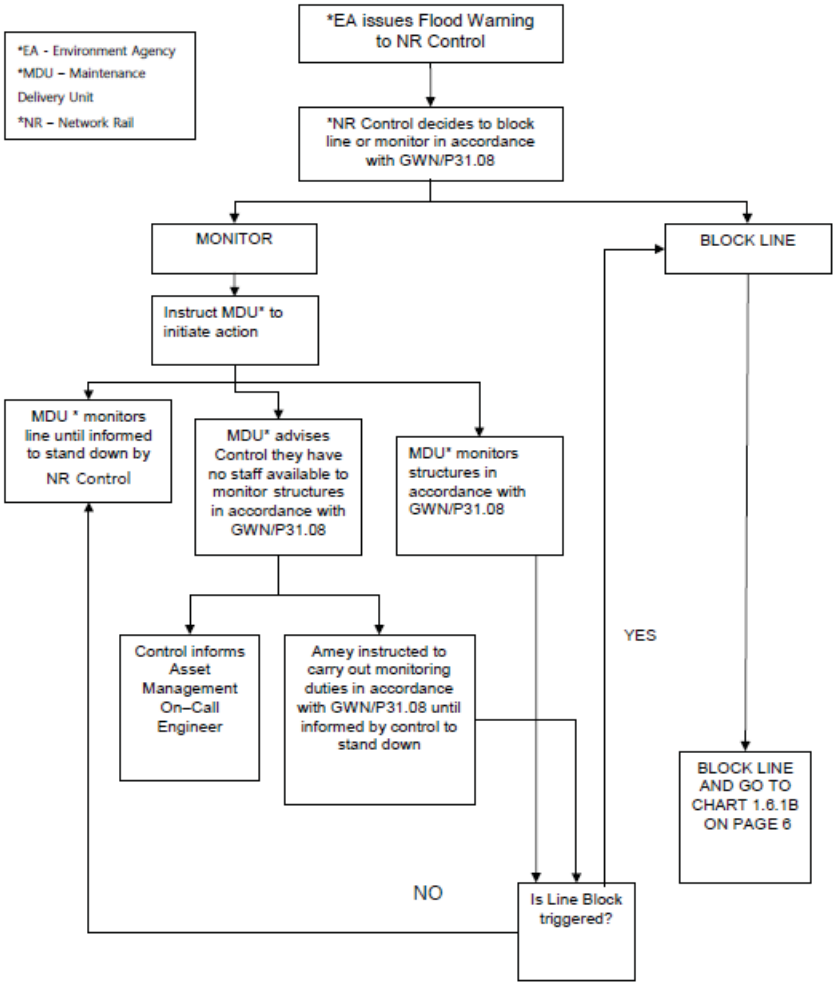
- Warning no longer in force Flood water receding;
  - Fall in water level with damage and destruction to be cleared up where flooding has occurred

5.2 General Flood Alert

Where there is a likelihood of flooding, warnings are issued by email, telephone or fax from the regional offices of the EA and electronically through the Flood Warning Database. Flood warnings are communicated to Network Rail Control by the EA. On receipt of a flood warning the Route Operations Control shall have procedures in place to communicate flood alerts, warnings and severe warnings to all relevant parties.

The Route shall maintain a list of national, regional and area offices of the relevant authorities. Mitigation plans shall be in place that shall include any actions for safeguarding railway operations, including, but not limited to:
a) procedures for implementation and subsequent removal of site monitoring; and
b) temporary or emergency speed restrictions and / or line closures.
The action plan shall also detail the circumstances which trigger the required actions.

Figure 2. provides a general illustration of the process for on-site monitoring to be followed on receipt of a flood warning



5.3 Conditions for Train Movement during Flooding

Following advice from the signaller to the Route Operations Control that train running has been suspended due to flood water being above the top of the rail head, operational staff may be requested to attend to establish the depth of the water. If the water is up to the top of the rail head, the signaller shall authorise trains to travel through the flood water at a maximum speed of 5 mph. Where flood water is above the top of the railhead or flood water is moving at any depth and is likely to dislodge or has dislodged ballast, Route Operations Control shall only authorise train movements through the flood water if the following conditions have been met:

a) the track and formation have been inspected by track maintenance or engineering staff and they have confirmed that it is safe for trains to travel through the affected area;

b) where the flood water is above the bottom of the rail head the movement is authorised at a maximum speed of 5 mph; and

c) where the flood water is more than 100mm above the top of the rail the movement is permitted by the train operator.

5.4 Response and Recovery

In the response phase, Route Operations Control shall

a) conduct further EWATs as appropriate;

b) provide updates to TOCs, Managed Stations and Media teams to keep the travelling public informed; and

c) initiate the Service and Performance Recovery Conference.

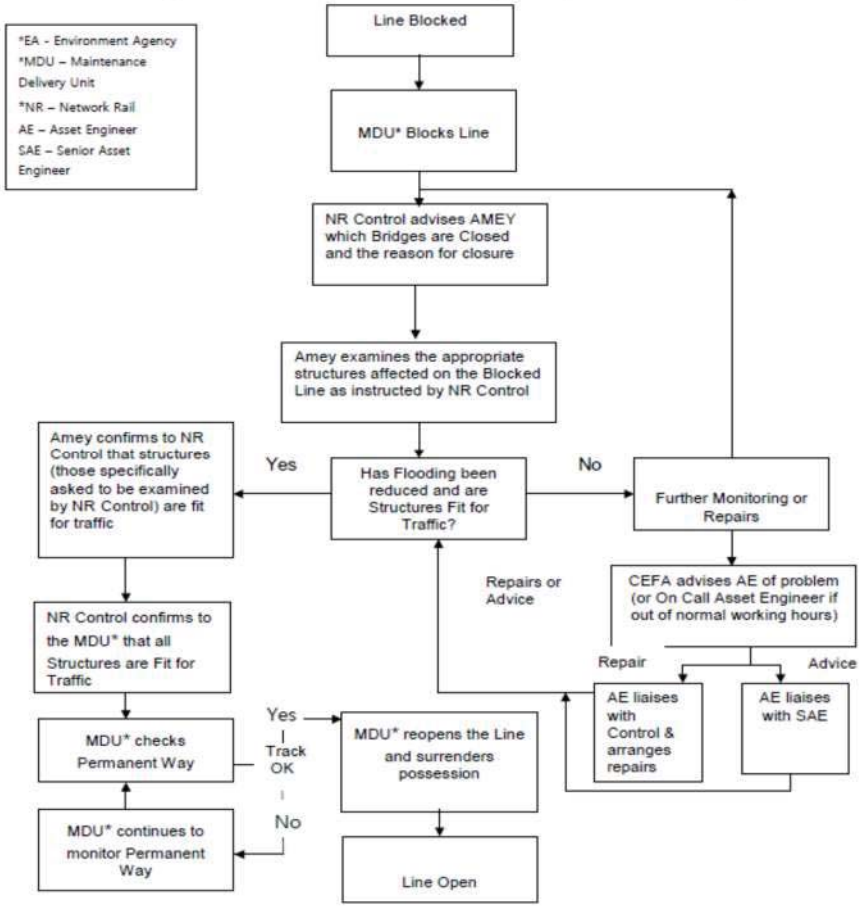
The Service and Performance Recovery Conference is the key component of the recovery phase. This shall normally be led by the COM or RCM.

The purpose of the conference is to:

a) establish the priorities and timescales for recovery of the network; and

b) understand the TOCs / FOCs priorities and timescales for service recovery.

Figure 3. An illustration of the process to be followed for reopening where flooding has affected structures



5.5 Timeframes for Reopening

As every flood incident is unique, a standard timeframe for reopening a line to traffic is difficult to establish and depends on the circumstances and type of flooding. Tidal flooding for example is expected to recede at the next period of low tide, as is often the case on the Loo branch line in Cornwall. Pluvial flooding caused by a storm on already saturated ground may affect railway operations for a longer extent.

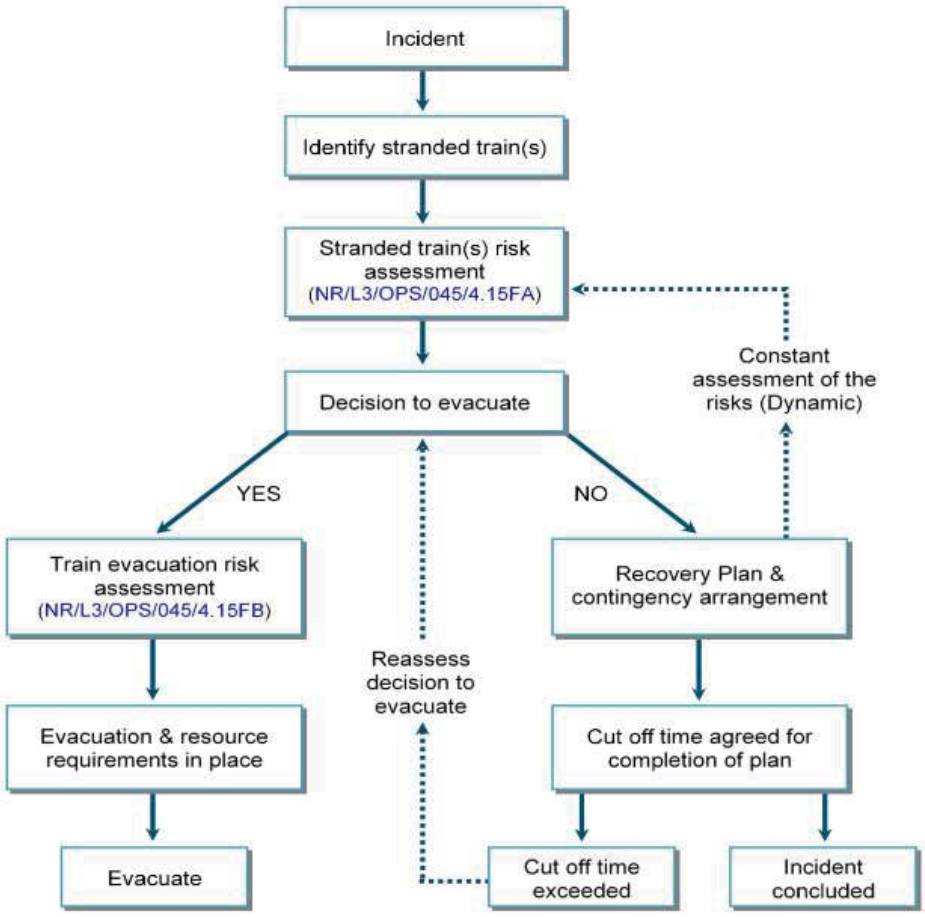
As a rule, the procedure set out in section *5.3 Conditions for Train Movement during Flooding* will be followed. It should be noted that the movement of trains is predicated on the assumption that other railway assets such as signalling has not been affected by flooding and are working in their normal working state.

Network Rail will always prioritise safety and in a flood event where water has damaged the railway infrastructure, a line will be closed until flood water recedes and repairs can be carried out. To release trains that are blocked by a flooded section or to minimise significant disruption, movement of trains may be permitted by Route Operations Control with continued monitoring and inspections in place on site. Detailed examinations and repairs will then be carried out overnight to minimise further disruption throughout the day.

5.6 Stranded Services and Evacuation

If a train service becomes stranded, a risk-based approach will be followed to maintain the safety and welfare of passengers. The procedure will be applied by Route Operations Control when dealing with the management of stranded trains and where trains are to be evacuated on Network Rail infrastructure. Full details of this plan can be found in Appendix G - *NR/L3/OPS/045, Procedure 4.15, Issue 03, 5th December 2020.*

Figure 4. Procedure following an incident where single or multiple trains are stranded



Should evacuation become necessary, NR and the TOC will cooperate and coordinate activities. The emergency services will be contacted and informed of the possible request for their assistance in the evacuation as soon as possible.

Evacuation of a train shall be decided using the following order of preference:

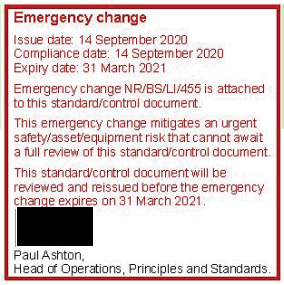
a) at a station platform;
b) at a disused platform;
c) by end-on transfer to another train brought up to one end of the train requiring evacuation (only possible if both trains have end gangways);
d) by side-to-side transfer to another train brought up alongside the train requiring evacuation (only possible on multiple track lines with standard clearances);
e) by escorting passengers along the track to another train; or
f) by escorting passengers along the track to a suitable access point for alternative road transport.

The TOC will hold the evacuation procedures relevant to the train type and is displayed throughout the passenger saloons.

6. Summary

This document presents a high level summary of the processes Network Rail utilises to manage flood risks. The material contained within this document draws upon Network Rail's assured Standards and Procedures which have been tried and tested over the course of time. Once construction works have been completed and the DCO Scheme is subsequently absorbed into Network Rail's asset base, these procedures will be implemented in accordance with the Railway Operational Code. It is recommnended that the appendices following this summary are read to provide full comprehension of the processes that will be implemeted for the DCO scheme as they are across the national rail network.

Appendix A: National Operating Procedures, Weather Arrangements, Procedure 3.17, Issue 03, June 20



1 PURPOSE

1.1 The purpose of this procedure is to outline the framework in which Route Operations Control manage weather events of floods, high winds, snow, high and low temperatures and respond to seasonal weather events by following the instructions contained in this instruction, NR/L2/OPS/021 and NR/L3/OPS/021.

1.2 In addition, this procedure provides instruction to operational staff when dealing with the management of floods and snow on the Network Rail managed infrastructure.

2 SCOPE

2.1 The scope of this document is designed to provide seasonal instructions, including non-operation of track circuits, using Route specific instructions.

2.2 This document will also provide direction to mitigate the risks from seasonal management of flooding, high winds, snow and high temperatures using forecast arrangements, actual weather data, utilisation of the Extreme Weather Response Process and Structured Expert Judgements (SEJs).

2.3 This instruction applies to the actions of frontline operational staff when responding to weather related incidents involving floods and snow

3 REFERENCE DOCUMENTATION

NR/L2/OPS/021	Weather Managing the Operational Risks
NR/L3/OPS/021/05	Weather Management Module 5 High Winds
NR/L3/OPS/021/01	Weather Management Module 1 Autumn
GE/RT8000	Rule Book Modules and Handbooks
NR/L2/OPS/021	Weather – Managing the Operational Risks
NR/L3/OPS/045/F3.17A	Failure to Operate Track Circuits Standard Operating Report Form
NR/L3/OPS/045/F3.17B	Failure to Operate Track Circuits – Report Form for Subsequent Incidents
NR/L3/OPS/045/F3.17C	Winter Mitigation Request Form
NR/L2/OPS/250	Network Rail National Emergency Plan
RIS-3708-TOM	Arrangements Concerning the Non-operation of Track Circuits During the Leaf Fall Contamination Period
Sectional Appendix	

4 DEFINITIONS

Actual Data	This is data which is available via weather stations, personnel on the ground or other sources.
Force Majeure Procedure	The happening of defined acts, events or omissions which could not be avoided through the exercise of due care. In extreme weather, Network Rail can be relieved of its obligations to indemnify the operator in respect of relevant losses sustained.
Forecast Data	This is the prediction of conditions and severity of weather, primarily over the next five days, supplied by our contracted weather forecast provider.
Structured Expert Judgement (SEJ)	An exercise carried out with appropriate industry members who are able to provide input to decision-making, using relevant actual data captured during extreme weather events to define network limits outside of those defined by existing thresholds.

5 RESPONSIBILITIES

R – **Responsible** is the person or people who are responsible for performing a certain task or action. **A** – An **Accountable** person is one who has overall accountability to make sure that a task or action is completed. **C** – **Consulted** people have an input into the task or action; this can be providing information, reviewing documents or attending workshops etc. **I** – **Informed** people are those who receive the output of a task or process. *Denotes option for delegation		Route Operations Control	NOC Manager	Current Operations Manager	Head of the National Operations Centre	Infrastructure Maintenance Delivery Manager	Operations Manager	Route Services Operations Duty Control Manager	Route Services Operations Infrastructure Test Train and Seasonal Delivery Controller	Seasons Delivery Specialist	Route Asset Manager
6.1	Forecast Process	R	I	A							
6.2	Weather Alert Status Table and Confidence	I	I								
6.3	Alert Status	R	I	A		I	I			I	I
6.4	Extreme Weather Affecting Two or More Routes (Double Red)	I	R	I	A						
6.5	High-Risk Registers	R		A							

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7.1	Extreme Weather Response Process Overview	I	I	I	I		I			I	I
7.2	Stage 1: Awareness	R	I	A		I	I			I	I
7.3.1	Stage 2: Preparation, General	I		I		R*A	I				C
7.3.2	Stage 2: Preparation, EWAT	I	I	R*A		C	C			C	C
7.4	Stage 3: Respond	R	I	A							
7.5	Stage 4: Recovery	I	I	R*A		C	I				C
7.6	Stage 5: Review	C		R*A		C	C			C	C
7.7	Short Notice and Out of Hours Extreme Weather Response	R	I	A	I	C	C			I	C
7.8	National EWAT	C	R	C	A	I	I			C	I
8.1	Imposition of a Blanket Emergency Speed Restriction	R	I	A		C	I				C
8.2	Advice to Drivers / Signallers / NOC	R	I	A							
9	Removal of Blanket Emergency Speed Restrictions	R	I	A		C	I				C
10.1	Structured Expert Judgement	I		C		R*A	C			I	C
10.2	SEJ Review	I		C		R*A	C			I	C
11	Flood Warnings	R		A		I	I			I	I
12	Conditions for Train Movements During Flooding	R		A		C	I				C
13.1	High Wind Forecasts	I	I	I		I	I			I	i
13.2	Trigger Table Using Forecast Data	I	I	R*A		I	I			I	I
13.3	High Wind Actual Data	I	I	R*A		I	I			I	I
13.4	Freight Wind Warning Process	I	R		A						

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14.1	Autumn Working Arrangements	I		A		I	I			R	I
14.2	Autumn Forecasting Arrangements	R	I	A		I	I			I	I
14.3	Leaf Fall Season	R		A		I	I			C	I
14.4	Arrangements for Railhead Treatment Fleet	R		A		I	I			C	I
14.5	Non-Activation of Track Circuits During the Leaf Fall Season	I	I	I		I	I			I	I
14.6	Route Operations Control Actions Upon Notification of Non-Operation of Track Circuit(s)	R	R* I	A		I	I			I	I
14.7	Introduction of Special Working Arrangements	R	I	A		I	I			I	I
14.8	Route Operations Control Actions – To Introduce Special Working Arrangements	R		A		C	I			I	
14.9	Route Operations Control Actions – To Withdraw Special Working Arrangements	I		I		C	R*A			I	C
14.10	Withdrawal of Special Working Arrangements	R		A			I			I	
15.1	Winter Weather Arrangements	I		A		I	I			R	I
15.2	Key Route Strategy	C		A		C	C			R	C
15.3	Fleet Considerations During Snow Events	R		A							
15.4	Snow Plough / Snow Blower	I		A		I	I			R	I
15.5	Miniature Snow Ploughs	I		I			R*A				

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15.6	Standby and Call Out Process for Snow Clearance (Snow Plough and Snow Blowers), Route Operations Control Responsibilities	R	I	A							
15.7	Standby and Call Out Process for Snow Clearance (Snow Plough and Snow Blowers), Route Services Responsibilities	I	I					A	R		
15.8	General	I	I					A	R		
15.9.1	Standby Request, Route Operations Control Responsibilities	R		A							
15.9.2	Standby Request, Route Services Responsibilities							A	R		
15.9.3	Winter Mitigation Request Form	R		I				I	A		
15.9.4	Liaise with TOCs	R		A					I		
15.10.1	Service Provision								C		
15.10.2	Prioritisation	I	R		A				C		
15.10.3	Actions Taken	I	I					A	R		
15.11	Standby Status	I	I					A	R		
15.12.1	Call Out	R							A		
15.12.2	Completion	I	I					A	R		
15.13	Train Running Suspended Due to Snow Accumulation	R		A		I	I				I
15.14	Lines Completely Blocked by Snow	R		A		I	I				I

NOTE: *This is a generic RACI and Route specific responsibilities may be used – Routes are responsible for briefing such changes to their users.*

6 WEATHER FORECAST ARRANGEMENTS

6.1 Forecast Process

The contracted weather forecast provider supplies weather reports with a forecast for all weather areas (see **Appendix A** Map of Forecast Areas).

The forecasts shall be provided by 03:00 hours each day with a forecast for the current day plus a four-day forecast.

If forecasts are not received then the Route Operations Control Manager (RCM) shall contact the forecast provider.

On receipt of the forecast the Route Operations Control shall:

a) send out alert status;

b) record alert status; and

c) liaise with the nominated senior manager if a conference is needed.

The Route Operations Control shall have a process to notify the colour alert status (see ***Table 1***) to Train Operating Companies (TOCs) and Freight Operating Companies (FOCs), National Operations Centre (NOC) and other key stakeholders.

6.2 Weather Alert Status Table and Confidence

Weather Type	Alert Status
Normal	Green
Aware	Yellow
Adverse	Amber
Extreme	Red
Extreme weather event affecting two or more Routes	Double Red (*to be used only by NOC Manager*)

Table 1: Weather Alert Status Table

The forecast provider shall provide a confidence level of the weather expected, ranging from high to low.

6.3 Alert Status

When a colour alert has been issued other than green, arrangements shall be made by the Route to discuss the operational integrity and preparedness.

Every Route shall have a high-risk site register of weather susceptible locations, which might be of use.

When a yellow alert has been forecast within the four-day outlook, this might be reviewed with the forecast provider if felt necessary by the Route.

When an amber alert has been forecast within the four-day outlook, this shall be reviewed daily, or more frequently if felt necessary by the Route.

When a red alert has been forecast then this shall be reviewed daily.

Hazards are expected to be present in extreme form or a combination of adverse weather conditions giving a high degree of risk to the operational integrity of the network.

6.4 Extreme Weather Affecting Two or More Routes (Double Red)

When two or more Routes activate the Extreme Weather Response process, the status of the alert shall be referred to as Double Red. The RCMs of the Routes affected by the Double Red status shall be advised via the 0440 NOC conference call on days it is held or via e-mail outside of the 0440 conference call schedule. Those in receipt of e-mail notification will be required to acknowledge receipt of the transmission.

6.5 High-Risk Register

Route Operations Controls shall have a list of high-risk areas and assets which are weather susceptible (see weather hazard identification in **Appendix B**) that can operationally affect the running of trains and help become a factor in deciding on an alert status. High-risk registers shall be compiled by each Route.

7 EXTREME WEATHER RESPONSE PROCESS

7.1 Process Overview

The extreme weather response process is a five stage process. These are:

Stage 1: Awareness

Stage 2: Preparation

Stage 3: Respond

Stage 4: Recovery

Stage 5: Review

7.2 Stage 1: Awareness

When weather conditions which might warrant a red alert status are 4 – 5 days out on the five day forecast outlook, the Route Operations Control shall outline the potential of these conditions to key stakeholders.

7.3 Stage 2: Preparation

7.3.1 General

When weather conditions which might warrant a red alert status are three days out on the five day forecast outlook or the Route Operations Control has assigned red alert status to weather conditions which are two days out, preparation activities shall begin. This shall include a Delivery Unit (DU) conference to allocate DU and Asset Management resources prior to the Extreme Weather Action Teleconference (EWAT). DU conferences are outlined in NR/L2/OPS/021.

7.3.2 EWAT

The Current Operations Manager (COM) shall convene an EWAT.

The purpose of the EWAT is:

a) to assess the impact of extreme weather on the infrastructure;

b) to determine mitigation, monitoring and contingency plans; and

c) to communicate actions and decisions.

The EWAT should normally be led by the COM or RCM and attendees should include staff from Route Operations, Delivery Units, Asset Management, Operational Planning and Communications.

The TOCs / FOCs shall be invited on to the EWAT to share their mitigation plans.

The EWAT conference agenda shall include, but is not limited to:

a) confirmation of the forecast, affected locations and confidence in the forecast, which may be delivered by the weather forecast provider;

NOTE: *The forecast provider shall be given four hours' notice of this.*

b) declaration of the weather as extreme to allow Customer Account Teams to activate the force majeure procedure as outlined in NR/L2/OPS/021;

c) infrastructure risks and mitigation plans;

d) staff and equipment resource availability and deployment;

e) whether the Strategic Command / Tactical Command / Operational Command structure shall be activated (see NR/L2/OPS/250);

f) emergency timetable utilisation;

g) information provision to Network Rail and TOC managed stations;

h) confirmation of route-proving arrangements after the event; and

i) summary of actions and decisions.

The actions shall be shared with participants of the EWAT conference and the NOC.

7.4 Stage 3: Respond

During an extreme weather event, Route Operations Control shall:

a) conduct further EWATs as appropriate;

b) provide updates to TOCs, Managed Stations and Media teams to keep the travelling public informed; and

c) initiate the Service and Performance Recovery Conference.

7.5 Stage 4: Recovery

The COM shall convene a Service and Performance Recovery Conference. This shall normally be led by the COM or RCM.

The purpose of the conference is to:

a) establish the priorities and timescales for recovery of the network; and

b) understand the TOCs / FOCs priorities and timescales for service recovery.

7.6 Stage 5: Review

A review conference shall be convened by the COM. This shall normally be led by the COM or RCM.

The purpose of the review conference is to:

a) review the preparation for and response to the weather event;

b) identify and capture good practice; and

c) identify, capture and create improvement plans for bad practice.

An invitation to the review conference shall be extended to all parties involved in the EWAT. The agenda for the review shall include, but is not limited to:

a) forecast accuracy throughout the outlook period;

b) Route Operations Control preparation activities;

c) DU preparation activities;

d) infrastructure performance and continued risks;

e) operator preparation, performance and continued risks;

f) what worked well; and

g) what did not work and how could this be improved.

7.7 Short Notice and Out of Hours Extreme Weather Response

If a weather forecast escalates to an extreme event with less than 24 hours' notice or outside of office hours, the RCM shall arrange for an EWAT to take place.

NOTE: *The EWAT should be arranged to take place as soon as practicable.*

The core attendees shall include:

a) the Strategic level Senior 'On Call' Manager;

b) the Route Asset Management (RAM) Senior Civils 'On Call' Manager or equivalent;

c) the Delivery Unit 'On Call' Senior Engineer;

d) the MetDesk weather forecaster; and

e) Level 2 Operations 'On Call'.

From this point, the processes outlined in clauses 7.4 – 7.6 shall be followed.

7.8 National EWAT

When a Double Red Status is declared, the Head of the National Operations Centre, NOC Manager and National Weather Team shall decide whether a National EWAT is required to prepare for and manage the weather event. The National EWAT shall be led by the NOC Manager and will require the attendance of either all Routes or those Routes affected dependent on the event.

8 IMPOSITION OF BLANKET EMERGENCY SPEED RESTRICTION

8.1 The actions to be considered are:

a) reduction in line speeds to reduce the likelihood and / or consequence of a train striking obstructions blown onto the line;

b) reduce the risk of damage to Overhead Line Electrification (OLE) and electric trains;

c) mitigation of the effects of wind related incidents and their effects on staff and passengers; and

d) engineering work, especially where cranes are involved.

8.2 Advice to Drivers / Signallers / NOC

Should the Route decide to impose a blanket speed restriction relevant details shall be published on the Late Notice Case at Traincrew Booking on Points. The time when this notice is published shall dictate whether further reactive advice to drivers and signallers is required. The NOC shall also be advised of the relevant details.

Train drivers shall be specially advised of the imposition of emergency speed restrictions by methods described below:

a) GSM-R; and

b) stopping of Trains at Signals to advise of the action required.

Route Operations Control shall check that signal boxes are advised if such restrictions are imposed.

Route Operations Control, or the signaller, shall receive positive confirmation from drivers in the affected area that they have received and understood the message and Route Operations Control shall note the time the blanket speed was introduced.

Any trains entering the blanket speed restriction area shall also be advised, stopping especially if necessary. Consideration shall be given to cross route trains and boundaries when imposing speed restrictions.

Where there is a conflict between different requirements, the most restrictive requirement shall be applied.

Speed restrictions are subject to any lower permanent or temporary speed restriction.

9 REMOVAL OF BLANKET EMERGENCY SPEED RESTRICTIONS

9.1 When a forecast indicating abatement from the conditions that forced the implementation of blanket emergency speed restrictions has been received and is confirmed by an actual reading from monitoring equipment (where available), the conditions shall be monitored for one hour ('weather related incident-free' period) after which the Route representatives may decide to remove the blanket emergency speed restriction. Considerations should be given to cross route trains and boundaries when removing speed restrictions.

9.2 During leaf fall season, the 'weather related incident-free' period shall be extended, as required, to allow for any effects of precipitation on embankments, weight of trees in full leaf.

Withdrawal shall be carried out using:

a) removal notice at booking on points.

b) GSM-R (where available); and

c) advice at manned stations.

9.3 If all services on a given Route section have been suspended, then a resumption of services at the normal or reduced speed shall be dependent on line proving being carried out, and shall be subject to consultation and agreement using a Structured Expert Judgement.

9.4 During line proving the driver shall proceed at a safe speed.

10 STRUCTURED EXPERT JUDGEMENT (SEJ)

10.1 When forming a SEJ, individuals shall consider all available information, including but not limited to:

a) local features to the area concerned i.e. lineside trees;

b) daylight / darkness;

c) wind speed and other weather conditions;

d) OLE / DC lines;

e) local environment i.e. flat moorland, mountainous area, embankments; and

f) assessment of reducing permissible line speed.

10.2 SEJ Review

SEJs shall be reviewed when weather conditions change. Updated actual data shall be used to review arrangements. If a SEJ has been used, the individual shall record why this action was taken and its outcomes. The record shall be stored in the Network Rail Weather Service library.

11 FLOOD WARNINGS

11.1 The Environment Agency has in place a system whereby flood warnings are advised to Route Operations Control via email, fax or telephone message.

11.2 On receipt of a flood warning the Route Operations Control shall have procedures in place to communicate flood alerts, warnings and severe warnings to all relevant parties.

11.3 The Route shall maintain a list of national, regional and area offices of the relevant authorities.

11.4 Mitigation plans shall be in place that shall include any actions for safeguarding railway operations, including, but not limited to:

a) procedures for implementation and subsequent removal of site monitoring; and

b) temporary or emergency speed restrictions and / or line closures.

11.5 The action plan shall also detail the circumstances which trigger the required actions.

12 CONDITIONS FOR TRAIN MOVEMENTS DURING FLOODING

12.1 Following advice from the signaller to the Route Operations Control that train running has been suspended due to flood water being above the top of the rail head, operational staff may be requested to attend to establish the depth of the water.

12.2 If the water is up to the top of the rail head, the signaller shall authorise trains to travel through the flood water at a maximum speed of 5 mph.

12.3 Where flood water is above the top of the railhead or flood water is moving at any depth and is likely to dislodge or has dislodged ballast, Route Operations Control shall only authorise train movements through the flood water if the following conditions have been met:

a) the track and formation have been inspected by track maintenance or engineering staff and they have confirmed that it is safe for trains to travel through the affected area;

b) where the flood water is above the bottom of the rail head the movement is authorised at a maximum speed of 5 mph; and

c) where the flood water is more than 100mm above the top of the rail the movement is permitted by the train operator.

13 HIGH WINDS

13.1 High Wind Forecasts

High Wind forecasts are advised through the normal weather forecasting arrangements. This advice is given when wind speeds are forecast in excess of predetermined values (mean and gust).

The definition of “High Winds” is when a forecast predicts wind speeds gusting in excess of 29 mph, or mean speeds in excess of 39 mph as shown in ***Table 2***.

13.2 Trigger Table Using Forecast Data

Plans should be made in advance for possible requirements for blanket speed restrictions along the guidelines shown in ***Table 2***.

A SEJ may take precedence over the guidelines and can be pre-defined by a Route.

Wind Speed	Action	Element
Forecast of gusts up to 39 mph Forecast of mean wind speeds of up to 29 mph	No action	**Normal**
Forecast of gusts from 40 – 49 mph Forecast of mean wind speeds of 30 – 39 mph	Be aware of the possibility of higher speeds being reached	**Aware**
Forecast of gusts from 50 – 59 mph Forecast of mean wind speeds of 40 – 49 mph	Be aware of the possibility of higher speeds being reached	**Adverse**
Forecast of gusts 60 mph or over Forecast of mean wind speeds of 50 mph or over	50 mph speed restriction for all trains in the affected Weather Forecast Area	**Extreme**
Forecast gusts 90 mph or over	All services suspended in the affected Weather Forecast Area	**Extreme**

Table 2: Weather Trigger Table

Where the existing line, or train speed, is lower than 50 mph, then no restrictions are required except the suspension of services when gusts of 90 mph or over are encountered.

NOTE: *Also refer to clauses 7.3.2 and 8 of this procedure.*

13.3 High Wind Actual Data

If actual data (as opposed to forecast data) is available via weather stations, personnel on the ground or other sources, the forecast information in this clause regarding wind forecasting and mitigations may be used as guidance during the SEJ process.

13.4 Freight Wind Warning Process

The forecast provider supplies a wind forecast specifically for freight FEA wagons conveying empty containers for a 48 hour period.

In the event of the forecast provider issuing a forecast with wind gusts in excess of 40 mph the NOC shall send a 'Rail Freight Wind Warning' to all FOCs with an instruction that states:

"*Any trains which include FEA(B), FEA(E) or FEA(S) vehicles conveying empty containers shall not enter traffic without first having empty containers either removed from the train, mechanically locked to the wagons or changed to wagons with UIC compliant spigots.*"

FOCs shall be required to acknowledge receipt of this instruction within 30 minutes, by email, and to confirm that appropriate action has been carried out. If receipt has not been acknowledged the NOC shall seek verbal confirmation.

If advice is received that actual wind gusts have exceeded 40 mph (and are less than 50 mph) which has not been previously forecasted and a 'Rail Freight Wind Warning' and had not been sent by the NOC and acknowledgement received by the FOCs, then immediate contact shall be made with each FOC to determine which services in traffic are conveying the FEA(B), FEA(E) or FEA(S) type wagons with empty containers not locked mechanically to the wagons. These services may continue to destination unrestricted unless further advice is received that wind gusts have exceeded 50 mph.

If advice is received that actual wind gusts have exceeded 50 mph which has not been previously forecasted and a 'Rail Freight Wind Warning' had not been sent by the NOC and acknowledgement received by the FOCs, then immediate contact shall be made with each FOC to determine which services in traffic are conveying the FEA(B), FEA(E) or FEA(S) type wagons with empty containers not locked mechanically to the wagons. Once the specific services have been identified the Route Operations Control affected shall be immediately advised.

Trains which have yet to proceed through the area shall be recessed prior to arrival in the area concerned.

Trains that are already in the forecast area or trains which have no point of recess available shall be managed appropriately between Network Rail Route Operations Control and the affected FOC. Agreement shall be reached as to how each train is to be managed through the forecast area with high winds predicted. This agreement shall take into account:

a) Actual wind speed measured;

b) Location and suitability of nearest point of recess;

c) Speed of train if allowed to continue;

d) Restriction of train running on adjacent lines.

If advised that actual wind gusts have exceeded the 40 mph threshold then the NOC shall determine from the forecast provider how long the conditions are expected to last and a 'Rail Freight Wind Warning' shall be sent once all Route Operations Controls have been immediately contacted.

14 AUTUMN

14.1 Autumn Working Arrangements

Network Rail, and its customers and suppliers, have agreed arrangements that shall apply in the event of weather conditions affecting the Route's ability to run train services. These arrangements shall be published in response to NR/L3/OPS/021/01 and are reviewed and updated annually.

14.2 Autumn Forecasting Arrangements

During the autumn period, the forecast provider shall supply a forecast of adhesion conditions. The adhesion index numbers provided by the forecaster are described in ***Table 3***.

Adhesion Index	Description
0 to 2	**Good adhesion conditions expected** Leaf contamination unlikely except in very prone locations. Rails generally dry or briefly damp.
3	**Wet railhead expected** Rails damp or wet, generally devoid of leaf contamination away from prone spots, but sufficient to reduce adhesion between the wheel and rail, potentially leading to wheel slippage.
4 to 5	**Moderate adhesion conditions** Moderate leaf fall risk with dry conditions. Slight contamination with damp rail. Some disruption to the network could be expected, especially in cuttings or densely vegetated areas.
6 to 8	**Poor adhesion conditions** High leaf fall risk with dry conditions. moderate leaf fall contamination with damp rail conditions. Disruption to the network likely if treatment not completed.
9 to 10	**Very poor adhesion to extreme leaf fall conditions** Very high contamination of the railhead due to leaf fall. High to very high contamination of the railhead due to leaf fall and damp rail conditions. Very high risk of disruption to the network.

Table 3: Low Adhesion Index

14.3 Leaf Fall Season

During the leaf fall season a railhead treatment programme to mitigate the potential effects of leaf fall on the operation of the Network is undertaken.

Details of changes to the agreed treatment programme and any additional track access shall be recorded daily and communicated to those affected as defined by the Route.

Any incidents occurring as a result of leaf fall shall be dealt with through agreed mechanisms.

14.4 Arrangements for Railhead Treatment Fleet

The principles for the use of railhead treatment fleet are:

a) Network Rail has the responsibility to provide and work railhead treatment trains on agreed Routes and at agreed frequencies; and

b) any necessary decisions on prioritisation of railhead treatment circuits (resource provision shortfall / possession conflicts) shall be made by the Route Operations Control.

14.5 Non-Activation of Track Circuits During the Leaf Fall Season

The purpose is to provide effective management of all incidents of non-operation of track circuits by vehicles during the leaf fall contamination period and provide for the safe passage of trains during that period. This period is defined in Group Standard RIS-3708-TOM as being between 01 October and 13 December each year. These dates may be extended either earlier or later if necessary.

If a train fails to operate a track circuit during the leaf fall period then the procedures detailed in the remainder of this clause shall be followed together with any Route specific instructions relating to special working arrangements for track circuits fitted with remote condition monitoring equipment.

14.6 Route Operations Control Actions Upon Notification of Non-operation of Track Circuit(s)

On receipt of notification of non-operation of a track circuit(s), Route Operations Control shall:

a) complete either of the following:

- failure to Operate Track Circuits Standard Operating Report Form (see form NR/L3/OPS/045/F3.17A) in respect of the first instance of non-operation of a track circuit, or
- failure to Operate Track Circuits – Report Form for Subsequent Incidents (see form NR/L3/OPS/045/F3.17B) for subsequent incidents in respect of subsequent instance of non-operation of that track circuit.

b) advise or arrange attendance at site by competent Route / Regional staff;

d) instruct the Train Operator to have the affected wheel sets examined by a competent person;

e) ascertain if the Track Circuit Assister Interference Detector (TCAID) (where fitted) was working. A list of track circuits fitted with TCAID equipment are listed in the relevant Route Appendix;

f) advise the NOC immediately and then send a copy of either:

- Form NR/L3/OPS/045/F3.17A – Failure to Operate Track Circuits Standard Operating Report Form, advising the NOC of the details of questions 20 and 21 within six hours; or
- Form NR/L3/OPS/045/F3.17B – Failure to Operate Track Circuits – Report Form for Subsequent Incidents as appropriate.

g) enter the necessary details into CCIL or equivalent logging system. Send a copy of the form to the TOC / FOC concerned; if, following the site inspection, it is established that the cause of the incident is due to leaf fall contamination, or 'not known, but likely to be due to leaf fall contamination' then the special working instructions shall be introduced in respect of the location concerned.

When more than two incidents involving the non-activation of track circuits by a train occur in a single geographical area within seven days as defined in the Geographical Block Working (GBW) map, the RCM shall liaise with the NOC.

NOTE: *An example of a GBW map is attached as* ***Appendix C****; for the current GBW map, contact your Route Seasons Delivery Specialist.*

The NOC Manager shall instruct the RCM to implement the special working instruction at all of the locations previously identified as being high risk locations within that single geographical block working area. The NOC may also require the implementation of special working arrangements at other high risk locations in light of the national situation and shall instruct the RCM(s) accordingly. On receipt of these instructions, the RCM shall advise other affected parties as required.

Special working arrangements shall be withdrawn on a location by location basis until all locations on that single geographical block working area have been withdrawn and normal working shall then apply to that single geographical block working area.

When more than two new incidents involving the non-activation of track circuits by a train occur within seven days at a location where special working arrangements have been withdrawn and before all locations on that single geographical block working area have been restored to normal working, the RCM shall liaise with the NOC. The NOC Manager shall instruct the RCM to re-implement the special working instruction at all of the locations previously identified as being high risk locations on that single geographical block working area.

14.7 Introduction of Special Working Arrangements

Special working arrangements have been devised to enable trains to continue to run safely through the affected section of line with the minimum impact on performance.

If it is ascertained by site inspection that the failure was either:

a) 'caused by leaf fall contamination', or

b) 'not known – but likely to be caused by leaf fall contamination'

then the RCM shall implement the special working arrangements contained in supplementary instructions, but only in respect of the affected location.

GE/RT8000 instructions shall remain in operation until the special working instructions are in place.

14.8 Route Operations Control Actions – To Introduce Special Working Arrangements

The Route Operations Control shall contact each signal box concerned (within the defined area of responsibility) and instruct the signaller that the special working arrangements apply forthwith. The extent of, and the line(s) to which the arrangements apply shall be specified, as detailed in the Route Produced Weather Mitigation Plans.

The signaller shall be instructed to make a suitable entry in the Train Register Book and complete the form Record of Special Working Arrangements in Connection with Failures to Operate Track Circuits due to Leaf Fall Contamination (see Route Autumn Working Arrangements).

The Route Operations Control shall record the details in the form Record of Wrong Side Track Circuit Failures. A sequential authority number shall be allocated to each conversation between the signaller and the Route Operations Control imposing the special working arrangements. Each authority number shall comprise of the day / month / sequential number for authorities issued that day i.e. 05/12/03 (05 December and the third authority number issued that day).

The Route Operations Control shall maintain records of all occasions when the special working instructions are implemented. The Route Operations Control shall brief their relief on the arrangements in force.

If a failure occurs in an area not previously identified then the instructions in GE/RT8000 shall be observed, pending the issue of supplementary special instructions being issued to the signal boxes concerned.

The railhead shall be inspected at periods defined by the Infrastructure Maintenance Delivery Manager to minimise the time that the special working arrangements shall be in force. Where they have been imposed, after no more than 14 days the railhead shall be inspected as per the instructions in this procedure (above) to establish whether normal working can be safely resumed.

14.9 Route Operations Control Actions – To Withdraw Special Working Arrangements

The only person who shall authorise the resumption of normal working is the Operations Manager (OM) or designated 'on call' manager outside of normal working hours.

Once the special working arrangements have been implemented then normal working shall not be resumed until it has been established that there is no imminent danger of a track circuit failing to operate during the passage of a train. Considerations shall be given to the commercial aspects of Network Rail's business. Safety shall always remain the overriding consideration.

The OM who has responsibility for the line concerned shall arrange a daily site meeting with competent persons from the Infrastructure Maintainer, representing Civil Engineering and S&T disciplines. The OM shall either attend in person or be represented at the meeting.

The OM or representative shall complete the site inspection form and obtain signatures from both the Infrastructure Maintainer's representatives present for each site inspection.

The site inspection form is found in the Route Autumn Working Arrangements.

If all those attending agree that the risk from leaf fall has subsided and there is no contamination present, nor evidence of further imminent contamination, then a site inspection form shall be completed to this effect and signed by the Infrastructure Maintainer's representatives present and the OM or representative

Once completed the OM or representative shall send the form to the appropriate Route Operations Control who shall request the OMs authority to withdraw the special working arrangements.

If the risk from leaf fall is still present, or there is evidence of further imminent contamination then a site inspection form shall be completed to this effect and signed by the Infrastructure Maintainer's representatives present and the OM or representative.

14.10 Withdrawal of Special Working Arrangements

When the OM has agreed to the withdrawal of special working, the appropriate Route Operations Control shall contact each individual signal box and instruct the signaller to make a suitable entry in the Train Register Book and complete the Record of Special Working Arrangements in Connection with Failures to Operate Track Circuits due to Leaf Fall Contamination Form which is found in the Route Autumn Working Arrangements.

Once special working arrangements have been withdrawn at all locations on a single geographical block working (GBW) area the RCM shall advise the NOC by completing and returning the Withdrawal of Special Working Arrangements form attached to the initial notice to implement special working arrangements from the NOC.

The NOC, on receipt of the Withdrawal of Special Working Arrangements form shall reset the weekly count on the affected GBW to zero.

15 WINTER

15.1 Winter Weather Arrangements

Network Rail, and its customers and suppliers, have agreed arrangements that shall apply in the event of extreme weather conditions affecting the Route's ability to run train services.

These arrangements are published in the 365 Weather Management Modules and Route Appendices, which are reviewed and updated annually.

Snow ploughs shall be dealt with in accordance with the GE/RT8000 and the Sectional Appendix.

15.2 Key Route Strategy

The Key Route Strategy prioritises Routes and sections of lines throughout the Route where effort shall be directed during periods of heavy snow.

Details shall be contained in the Route produced weather mitigation plans along with information in relation to any additional resources that may be required.

15.3 Fleet Considerations During Snow Events

Routes shall liaise with TOCs and FOCs to understand the possible need to impose train speed reductions relating to specific rolling stock and operating requirements during snow events.

15.4 Snow Plough / Snow Blower

Details of location and call out procedures for snow ploughs and the snow blower are contained within the Route produced weather mitigation plans.

15.5 Miniature Snow Ploughs

Many locomotives are fitted with miniature snow ploughs (MSPs). Where it is necessary to use these resources, the nearest suitably equipped locomotives may be found by conducting TOPS procedure 'e3121'.

Mini slow ploughs shall be dealt with in accordance with the GE/RT8000.

There shall be an assessment of the risk of an accumulation of snow being left on or close to the line as a result of prolonged use of miniature snow ploughs to clear lines of snow, particularly with regards accumulated snow where it could directly contact components on the bogies of rolling stock.

A SEJ may be used for this consideration (see clause 10 – Structured Expert Judgement)

15.6 Standby and Call Out Process for Snow Clearance (Snow Plough and Snow Blowers) Route Operations Control Responsibilities

Route Operations Control shall:

a) issue of standby request;

b) issue of standby status instructions; and

c) call out instructions.

15.7 Standby and Call Out Process for Snow Clearance (Snow Plough and Snow Blowers) Route Services Responsibilities

Network Rail Route Services Control Manager shall confirm:

a) receipt, recording and forwarding of Standby and Call Out Requests from Route Operations Control to Supplier;

b) receipt, recording and forwarding of Supplier's responses to NOC; and

c) completion of Period and Daily Records.

The Route Services Duty Manager shall:

a) acknowledge the Standby Request;

b) confirm the standby status; and

c) confirm the Call Out Instructions.

The NOC shall be advised by Route Operations Control of a request made to Route Services, and Route Services shall advise the NOC of their response to the Route.

15.8 General

Communications shall be carried out verbally. Route Services shall action and confirm through the communication NR/L3/OPS/045/F3.17C form. The flow chart in **Appendix D** depicts the process.

15.9 Standby Requests

15.9.1 Standby Request, Route Operations Control Responsibilities

On receipt of notification of the snow weather forecast, the RCM shall make a decision regarding the Route's requirement for snow clearance equipment.

Route Operations Control shall make a request to Route Services Control requesting one of the following snow clearance services:

a) Miniature Snow Plough (MSP) fitted traction;

b) large independent drift snow plough (not included in this contract); and

c) Beilhack snow plough.

Route Operations Control shall clearly identify the Route that requires assistance and the time that stand-by status is required from, providing a minimum of 48 hours' notice. Route Operations Control shall advise the NOC of the request.

15.9.2 Standby Request, Route Services Responsibilities

Route Services shall make a call to the appropriate supplier requesting the requirements of Route Operations Control.

15.9.3 Winter Mitigation Request Form

Route Operations Control shall verbally complete the Winter Mitigation Request Form (see form NR/L3/OPS/045/F3.17C) with Route Services who shall, in turn, forward the request form to the supplier.

15.9.4 Liaise with TOCs

At the time of a request for the services of a drift / Beilhack plough or snow blower Route Operations Control shall liaise with the relevant train operator to make arrangements to provide a competent person to meet the machine / train.

15.10 Services Being Provided

15.10.1 Service Provision

The supplier shall inform Route Services which resources are being provided.

15.10.2 Prioritisation

In the event that insufficient resources are available to meet all winter mitigation requests, the NOC shall prioritise which Routes are to be cleared. The NOC shall liaise with Route Services for such information.

15.10.3 Actions Taken

Route Services shall inform Route Operations Control of actions being taken regarding their request and will also advise the NOC.

15.11 Standby Status

At the time that the snow clearance equipment is required to be on standby, the supplier shall confirm that standby status has been achieved to Route Services by telephone and the returning of the appropriate completed request form. Route Services shall inform Route Operations Control of this and advise the NOC.

In the event that a request has been made for standby status to be achieved in a shorter timescale that the required response times detailed in Schedule 4, the supplier shall notify Route Services as soon as standby status has been achieved by telephone and the returning of the appropriate completed request form. Route Services shall inform Route Operations Control of this and advise the NOC.

15.12 Call Out and Completion

15.12.1 Standby Status

Once standby status is reached, the snow clearance equipment shall be in a position to leave the depot boundary within thirty minutes of a call out request.

15.12.2 Call Out

On receipt of a new request from the Route Operations Control, Route Services shall progress the standby status by instructing the supplier to either stand down or implement the call out requirement. This is to be confirmed by the completion of the request form.

15.12.3 Completion

The supplier shall complete the standby / call out box confirming stand-by, stand down or call out status including time and date of arrival at exit signal. The supplier shall transmit the completed request form back to Route Services. Route Services shall inform Route Operations Control of this, and advise the NOC.

15.13 Train Running Suspended Due to Snow Accumulation

If the signaller advises that snow is deeper than 200mm (8 inches) above the top of the rail the normal running of trains shall be suspended and further movement of trains other than snow clearing trains may only be authorised as follows:

a) where snow depth is between 200m (8 inches) and 300mm (12 inches) above the top of the rail trains fitted with miniature snow ploughs may operate normally and other trains may operate only in accordance with existing control instructions;

b) where snow depth is between 300m (12 inches) and 450mm (18 inches) above the top of the rail only trains fitted with miniature snow ploughs may operate. This shall only be done in accordance with the decision criteria for restricted operation as now;

c) where snow depth is between 450mm (18 inches) and 1.8m (6 feet) above the top of the rail only Beilhack snow ploughs and independent ploughs may operate; and

d) where snow depth is above 1.8m (6 feet) only independent snow ploughs may operate.

NOTE: *This information in this clause is to be read in conjunction with the 365 Weather Management Winter Module and Route Appendix.*

15.14 Lines Completely Blocked by Snow

On receipt of information from the signaller that the line is blocked due to snow, adhere to the instructions within clause 15 of this procedure.

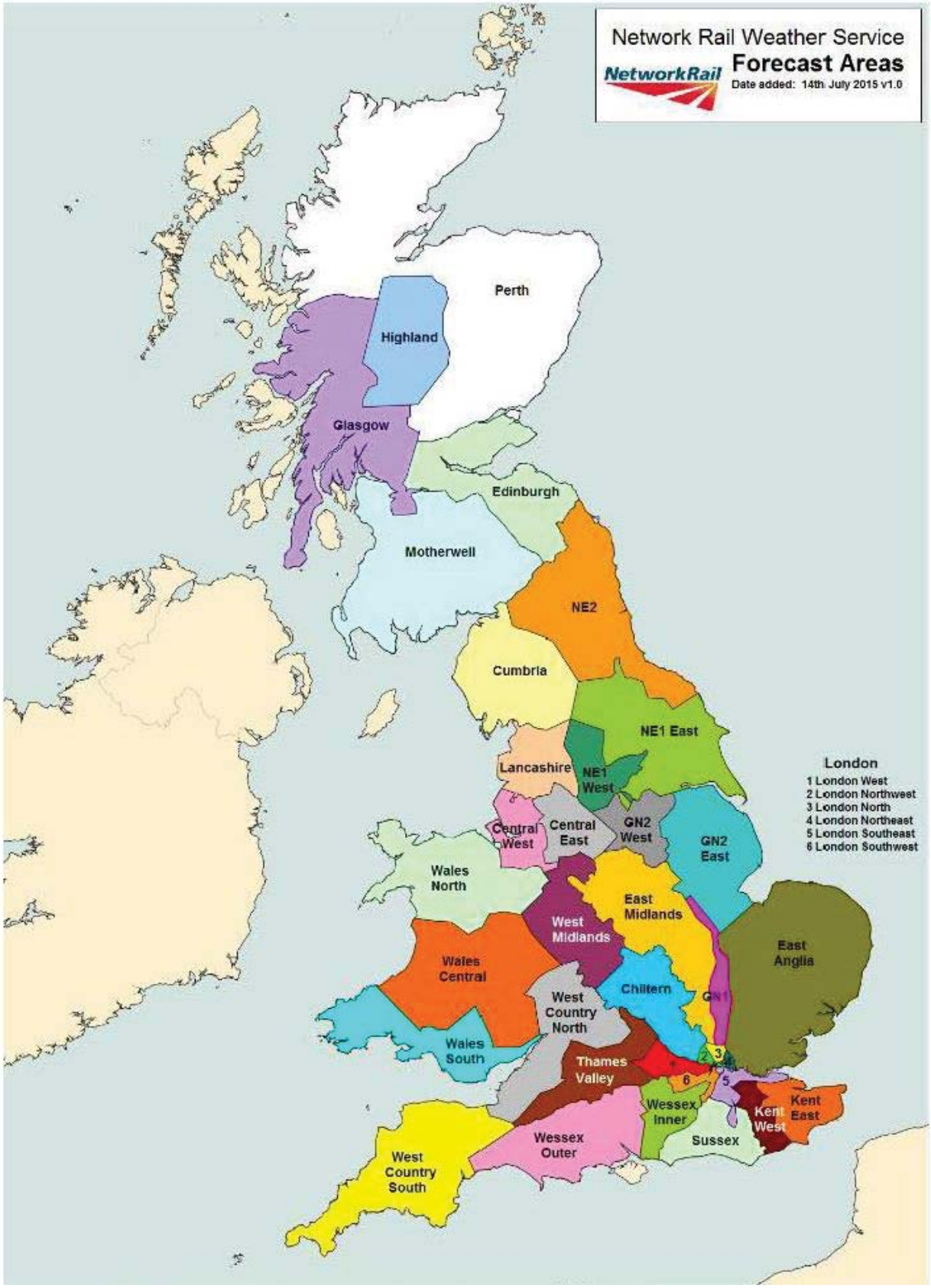
Arrange for the electrical traction system to be switched off and isolated where possible if:

a) conductor rails are covered by snow and it is to be removed by hand digging; and

b) personnel need to stand on vehicles under or next to overhead line equipment to remove drifting snow.

APPENDIX A

NETWORK RAIL FORECAST AREAS



APPENDIX B

TERMINOLOGY USED FOR NETWORK RAIL WEATHER ADVICE AND HAZARD IDENTIFICATION

Weather Hotspot	A weather hotspot is a line-side geographical area that is at a higher risk to one or more weather hazards.

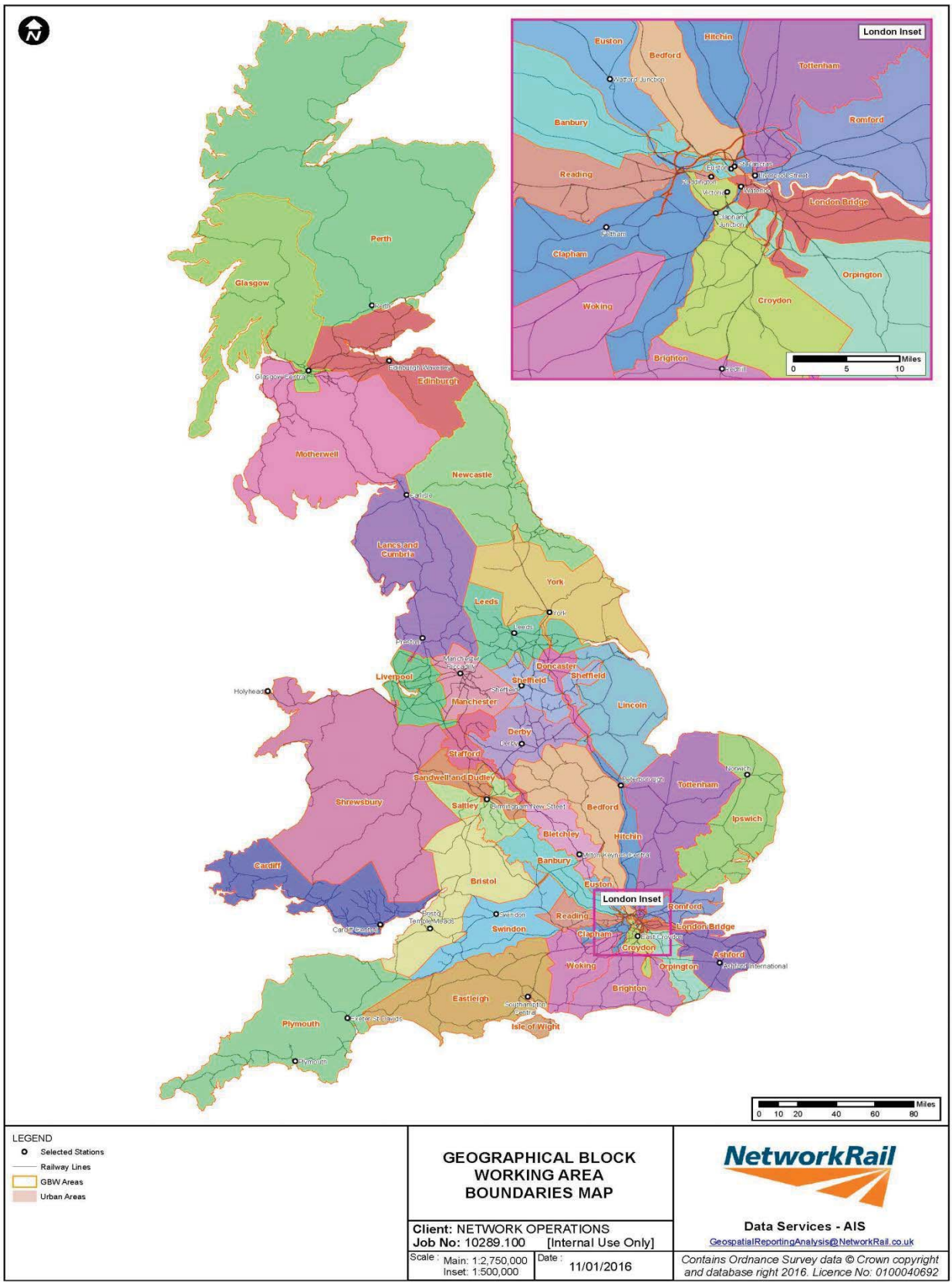
National Table				
Wind				
Category	**Normal**	**Aware / Level 1**	**Adverse / Level 2**	**Extreme / Level 3**
Sustained (mph)	29 or less	30 to 39.9	40 to 49.9	50 mph or more
Hourly Gusts (mph)	39 or less	40 to 49.9	50 to 59.9	60 mph or more
Rain				
Category	**Normal**	**Aware / Level 1**	**Adverse / Level 2**	**Extreme / Level 3**
Hourly (mm)				
3 Hourly (mm)	less than 3mm	3 to 4.9mm	5 to 9.9 mm	10mm or more
12-hour	less than 15mm	15 to 19.9mm	20 to 24.9 mm	25mm or more
12-hour on 100% Wet Soil (mm)	less than 5mm	5 to 7.9 mm	8 to 10 mm	10mm or more
Daily (mm)	less than 30mm	30 to 39.9	40 to 49.9	50 or more
Daily on 100% Wet Soil (mm)	less than 10mm	10 to 14.9 mm	15 to 19.9 mm	20mm or more
15 Daily (mm)	less than 70mm	70 to 99.9 mm	100 to 149.9 mm	150mm or more
Temperature				
Category	**Normal**	**Aware / Level 1**	**Adverse / Level 2**	**Extreme / Level 3**
Heat (°C)	less than 20 C	20 to 24.9	25 to 28.9	29 or more
Cold (°C)	warmer than -0	0 to -2.9	-3 to -7	-7 or colder
Frost (°C) (Minimum air temperature - wind >12 mph)	warmer than -0	-0 to -0.9	-1 to -2.9	-3 or colder
1 Day Diurnal Cycle (°C)	less than 13 C	13 to 15.9	16 to 17.9	18 or more
Snow				
Category	**Normal**	**Aware / Level 1**	**Adverse / Level 2**	**Extreme / Level 3**
Daily Snowfall (cm)	1.9 or less	2 to 4.9	5 to 14.9	15 or more
Accumulation	TBD	TBD	TBD	TBD
Drifting Risk	None	Low	Medium	High

APPENDIX B (Continued)

Forecast Data	
Hazard Category	**Forecast**
Temperature	
Min Air Morning	Minimum air temperature this morning, between 06:00 hrs and 12:00 hrs
Max Air Today	Maximum air temperature between 06:00 hrs and 18:00 hrs
Min Air Tonight	Minimum air temperature tonight, between 18:00 hrs and 06:00 hrs
Min Ground	Minimum ground temperature tonight, between 18:00 hrs and 06:00 hrs
Cold Accumulation	No consecutive days below 0
Ice Day	Air temperature is not expected to reach or exceed zero deg Celsius
Cold Accumulation	No consecutive days below 0
Freezing Fog	Fog is expected to form with air temperatures below freezing and fog droplets freeze on contact with surfaces and structures.
Rain	
Freezing Rain	Rain is expected to fall onto surfaces already below freezing and freezes

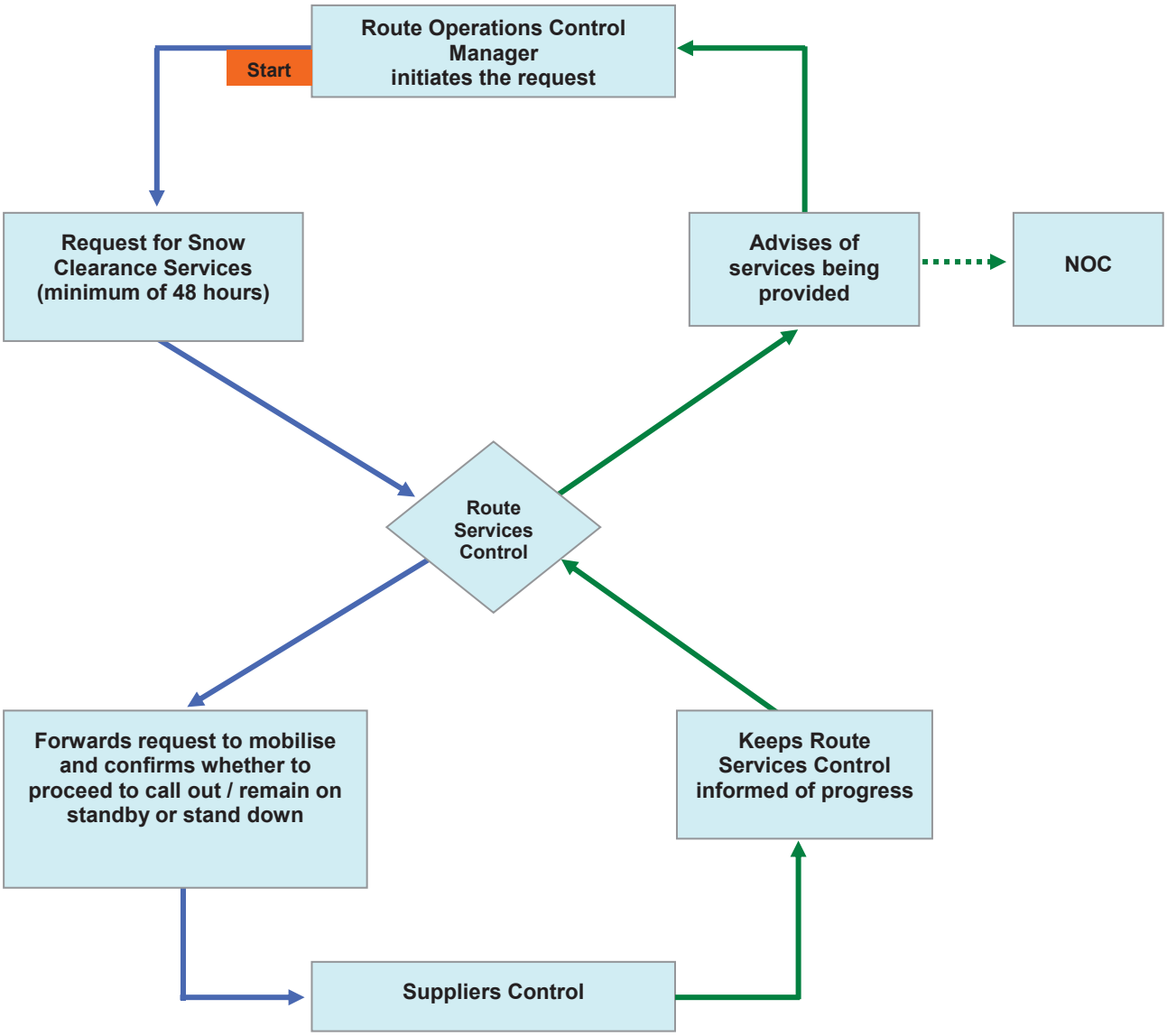
APPENDIX C

EXAMPLE OF GEOGRAPHICAL BLOCK WORKING MAP



APPENDIX D

WINTER WEATHER ARRANGEMENTS: CALL OUT PROCESS FOR SNOW PLOUGHS AND BLOWERS



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Compliance date:	14 September 2020
Expiry date:	31 March 2021

Emergency change: NR/BS/LI/455

Standard/control document affected: NR/L3/OPS/045/3.17 Weather Arrangements (Issue 03)

The affected standard/control document will be reviewed and up-issued before this emergency change expires 31 March 2021.

For further information contact: Paul Ashton, Head of Operations Principles & Standards [redacted].

1 Reason for issue

As a result of recent events there is an urgent need to reaffirm our approach to the risk from extreme rainfall and the effect it has on our infrastructure specifically around extreme weather response processing and to consistently apply the current framework. This emergency change is intended as a short-term change and will be supplemented or amended by the introduction of better forecasting technology or procedural improvements.

This brief is intended to allow each route to take action based on the advice given in this emergency change.

2 Scope

This emergency change is applicable to the RAM Geotechnical and each Route Control and any other roles accountable for the management of extreme weather response process. It has been developed to coincide with the publication of the new rules (GE/RT8000, Module 3 Sections 7.1-7.4, Module G1 Section 3, Handbook 1 Section 8).

3 Changes

Clause/sub-clause	Change
New Clause 16, 17, 18, 19, 20 & 21	Added see below

Reference Documentation

NR/L3/OPS/021 Weather and Seasonal Management Modules1-01 to 1-09
NR/L2/CIV/086 Management of Earthworks.
NR/L3/OPS/045/3.17 Weather Arrangements
NR/L3/OPS/250 Network Rail's National Emergency Plan

Published and Issued by Network Rail, 2nd Floor, One Eversholt Street, London, NW1 2DN.

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NR/L3/TRK/1010 Management of Responses to Extreme Weather Conditions at Structures, Earthworks and Other Key Locations
NR/L2/CIV/086 Management of Earthworks – Module 8 & Module 7

16. Operational Route Sections and Associated Risk Levels for Rainfall

16.1 Operational Route Sections

The Route/Region Operations team shall decide on how the railway is divided into smaller Operational Route Sections.

Operational Route Sections will allow the Route Control to apply any safety restrictions required (such as speed restrictions) to specific geographic areas, based on the risk profile from the relevant Route Engineer.

The Operational Route Sections shall start and finish at clearly distinguishable points for Signallers and Drivers (e.g. Junction to Junction, Line of Route, station to station etc).

This will allow any restrictions to be applied safely and appropriately.

These Operational Route Sections may initially be full lines of route but can be broken down as the detailed weather forecasting and knowledge of earthwork risks becomes more mature. Changes to the Operational Route Section length should be agreed through a suitable risk assessment and consultation with the relevant Route Engineer.

16.2 Determining the specific risk to Operational Route Sections

The Route/Region Operations team shall work with the relevant Route Engineer in each discipline to determine the risk level for structures/earthworks in the Operational Route Sections. Once the Operational Route Sections and risk level are determined this information shall be shared with the Meteorological supplier to formulate a co-ordinated response.

Operational Route Sections and their associated risk levels should be distributed locally by relevant Route Engineers and / or Route Weather Specialists. The table in NR/L3/OPS/045/F3.17F could be used to make reference to individual high / medium / low risk sites specific for the Operational Route Section concerned.

This format and detail of the table shall be locally determined by the relevant Route Engineer and Route/Region Operations Team.

16.3 Operational Route Section risk assessment

The risk level associated with Operational Risk Sections shall be determined through risk assessment.

The following roles should be involved in the risk assessment as subject matter experts:

- Senior Route Control Representative.
- Route Engineer (Geotech / Structures / Drainage / delegate)
- Seasons Delivery Specialist or equivalent
- Operations Manager (OM) or equivalent for the area concerned

- Operations Risk Advisor (ORA) or representative

Some of the items that might be considered when completing the risk assessment are:

a) the typical weather conditions

b) the number of risk sites on the line of route;

c) communications;

d) condition of drainage in the vicinity and any additional resources required;

e) single vs multi track;

f) rolling stock in use.

17. Rainfall Accumulation

17.1 Route Rainfall Accumulation Table

Where significant rainfall accumulation is expected, monitoring of the forecast might be required and implementation of a speed restriction over the affected area might be necessary.

The following table provides guidance on rainfall accumulations and should be considered by the Routes for their specific Operational Route Sections. Routes will set the thresholds for the Precipitation Analysis Tool (PAT) for the time period, accumulation of rainfall and Soil Moisture Index (SMI) based on direction from the relevant Route Engineer.

It should be noted that the PAT thresholds are different to the five-day forecast.

The five-day forecast shall be reviewed to determine whether thresholds could be met and therefore indicate if further action is taken e.g. convening a Route EWAT.

Where the PAT Alert Level is “Normal”, no action is required.

Where the PAT Alert Level is “Adverse” for one or more Operational Route Sections, the PAT shall be monitored regularly until the weather system has passed.

A speed restriction should be considered and implemented on any affected Operational Route Section or line of route if the risk profile for that section requires it.

Where the PAT Alert Level is “Extreme” for one or more Operational Route Sections, the PAT shall be monitored regularly until the weather system has passed. A speed restriction shall be implemented on all affected Operational Route Sections or line of route during the relevant period.

If significant areas of the Route or Region are not included on the PAT as a result of there being no high risk sites within that area, and there is a concern the Extreme PAT Alert Level may be breached, arrangements shall be made to monitor the PAT Map (radar) within the Network Rail Weather Service (NRWS).

The monitoring and engagement with the Duty Weather Forecaster will help to determine the time and location of potential breaches. A speed restriction should be considered and implemented on the area concerned when the ‘Extreme’ PAT threshold is breached.

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At a Route level the threshold and alert levels in the PAT shall align with the trigger levels and Operational Route Sections defined by the Route. An assessment of the locations within PAT is required to allow for them to align with Operational Route Sections and threshold levels.

Rainfall & Soil Moisture Levels	PAT Alert Level	Response
*hr rainfall ≥**mm AND SMI≥**	Normal	No action required.
*hr rainfall ≥**mm AND SMI≥**	Adverse	Review forecast regularly. Prepare to manage train speed and service.
*hr rainfall ≥**mm AND SMI≥**	Extreme	Reduce speed of trains appropriately in the affected location (see 20.2)

***NOTE 1**: * Each Routes must determine the time period for the rainfall levels.*

***NOTE 2**: ** Each Route is responsible for determining the levels within the table for rainfall volumes and SMI. To achieve this each Route may review the thresholds for particular lines of route and introduce new values but consideration must be given to cross border areas.*

***NOTE 3**: SMI is Soil Moisture Index.*

17.2 Localised EWAT during the event

Additional localised EWAT call can be convened during the rainfall event.

During these EWAT conferences, the Route Control shall use the EWAT Heavy Rainfall agenda in **NR/L3/OPS/021/13 – Appendix B** and take into account structures and earthwork sites or the risk level for Operational Route Sections when there is a forecast of Adverse or Extreme rainfall. Each Route shall agree any local changes in the thresholds for rainfall volumes for Operational Route Sections or lines of route that would require a different operational response.

The rainfall and soil moisture index should be used as a guide and adjusted according to the saturation levels of the ground and the levels of rainfall experienced in the days leading up to the event.

Route Control shall inform the signaller when the rainfall threshold is breached and inform them what restriction(s) or method of degraded working will be imposed.

17.3 Decision making with limited information

Ordinarily, a weather event will be forecasted and a Route EWAT will be convened as required, which will include a requirement to discuss appropriate mitigations as per the risk profile of affected Operational Route Sections. However, there may be occasions where late-notice forecast changes deteriorate the rainfall hazard quickly and without warning.

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On these occasions, every effort should be made to engage the on-call Route Engineer and forecasters to determine the best course of action.

Where this proves impossible, the Route Control Manager should consider implementing a speed restriction as per the below thresholds for the affected areas.

5 Day Weather Forecast Threshold	***Enter Operational Route Sections / Line of Route e.g. Settle & Carlisle***
Extreme	Implement a blanket speed or caution through the affected area (see 20.2).
Adverse	Consider an emergency or blanket speed restriction within the affected area.
Aware	Locally Monitored
Normal	No Action Required

***NOTE**: Consideration should also be given to the local weather conditions using Network Rail Weather Service (NRWS) and NOT only the forecast.*

18. Convective Rainfall

18.1 National Convective Rainfall Thresholds Table

The following table provides guidance on levels of convective rainfall. Each Operational Route Section risk profile shall detail any mitigating action required should the below thresholds be breached.

Where the PAT Alert Level is “Normal”, no action is required.

Where the PAT Alert Level is “Adverse” for one or more Operational Route Sections, the PAT shall be monitored regularly until the weather system has passed.

A speed restriction will be considered and implemented on any affected Operational Route Section if the risk profile for that section requires it.

Where the PAT Alert Level is “Extreme” for one or more Operational Route Sections, the PAT shall be monitored regularly until the weather system has passed.

A speed restriction will be implemented on all affected Operational Route Sections during the relevant period.

If significant areas of the Route or Region are not included on the PAT as a result of there being no high risk sites within that area, and there is a concern the Extreme PAT Alert Level might be breached, arrangements shall be made to monitor the PAT Map (radar) within the Network Rail Weather Service (NRWS). The monitoring and engagement with the Duty Weather Forecaster will help to determine the time and location of potential

breaches. A speed restriction should be considered and implemented on the area concerned when the 'Extreme' PAT threshold is breached.

Threshold	Alert Level	Response
3 hour: <30mm convection rainfall	Normal	No action required
3 hour: 30mm – 39.9mm convection rainfall	Adverse	Review forecast continuously. Prepare to manage train speed and service.
3 hour: ≥40mm convection rainfall	Extreme	Reduce speed of trains appropriately (see 20.2).

***NOTE**: Each Route may review the thresholds and response for particular lines of route and introduce new values but consideration must be given to cross border areas.*

19. Report of actual or potential damage to structures and earthworks above or below the line

19.1 Report of damage to structure or earthworks above or below the line

When a report of damage to structure or earthworks above or below the line is received, the following items shall be discussed and the details recorded:

a) name of the person who reported the incident and contact details;

b) where is the incident location (mileage / signal number etc.);

c) what lines (if any) are affected;

d) are any structures / earthworks damaged above or below the line i.e.:

1) landslips;

2) washouts (dislodged ballast / severely disrupted track bed, etc)

3) embankment failures;

4) retaining wall failures.

Where damage to structure or earthworks above or below the line is reported, GE/RT8000, Module M3, Section 7 will be applied by the signaller.

19.2 Report of conditions that has the potential to damage to structures or earthworks above or below the line

When a report of conditions that has the potential to damage to structures or earthworks above or below the line is received, the following items shall be discussed and the details recorded:

a) name of the person who reported the incident and contact details;

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b) where is the incident location (mileage / signal number etc.);

c) what lines (if any) are affected;

d) is there flowing or pooling water with the potential to damage structures or earthworks i.e.:

1) water rising up from the track or cess;

2) unusual amount of water pooling on the track or cess; or

3) water flowing down or pouring out of the sides of embankments or cuttings.

Where flooding is reported, GE/RT8000, Module M3, Section 4 will be applied by the signaller.

Where potential damage to structure or earthworks above or below the line due to other water related events is reported, GE/RT8000, Module M3, Section 7 will be applied by the signaller.

19.3 Actions following a report in 19.1 and 19.2

Once all of the information has been gathered, take the following actions:

a) confirm with the signaller that immediate action has been taken in accordance with Rule Book module M3;

b) assign / contact relevant available staff to attend the location for the purposes of monitoring the structure or earthwork and assessing potential damage;

NOTE: *i.e. Mobile Operations Manager (MOM), Route Engineer (Relevant Discipline), P-way as appropriate.*

c) consult the weather report from the EWAT to obtain the weather alert description (Normal, Adverse or Extreme);

d) cross reference the weather report with the Operational Route Sections or line of route risk level where available;

e) assess any localised weather variations by contacting on-site staff or local operating location, signal boxes, stations, etc;

f) based on the information provided, Operational Route Sections or Lines of Route may be reduced in length by identifying an area using geographical locations or infrastructure, however these should be areas that are easily identifiable to drivers i.e. junction to junction and station to station. The areas identified could be constrained by GSM-R cell distance; and

g) where the appropriate operational response is not immediately clear, conduct a dynamic risk- assessment based on all the above information to come to an operating decision on how train running will be achieved referring to immediate actions (16.3.)

19.4 Confirmed damage to the structures or earthworks above or below the line

Ref:	**NR/BS/LI/455**
Issue date:	14 September 2020
Compliance date:	14 September 2020
Expiry date:	31 March 2021

Where it has been confirmed that there is damage to a structure, track, track bed or adjoining earthworks that may affects the passage of trains, the relevant Route Engineer shall be consulted prior to authorising train movements at any speed.

When making a decision through a dynamic risk assessment, a rules and regulations qualified representative e.g. Operations Manager (OM) and relevant Route Engineer shall be consulted when determining the speeds and resulting actions needed during adverse / extreme weather.

20. Operational Response Guidance

20.1 Examination of the line

When examination of the line is required, signallers will examine the line(s) in accordance with GE/RT8000, Module TS1, Regulation 20. If the initial examination is conducted on-foot there is no requirement to use a train to examine the line.

NOTE: *A train cannot be used to examine a line where it is confirmed to be affected.*

Where appropriate and/or deemed necessary, an examination of the line should take place either by train or on foot prior to authorising speeds.

Following the examination of the line, train movements may be permitted in accordance with guidance from the relevant Route Engineer.

Control may instruct signallers where it is not clear if the line is affected, they can authorise the line to be examined from an adjacent line:

a) where a driver has examined from the unaffected line, and advised that they do not deem the damage to the earthwork to be a danger to trains on the affected line, then Control may advise the Signaller to permit a train to examine the affected line at no more than 5mph;

b) if the driver of the examining train on the affected line reports that the earthwork damage is not deemed to be a danger to trains, then subsequent trains may be cautioned over the affected line at no more than 20mph;

c) this will continue until the line is examined by relevant Route Engineer, when further instruction will be provided.

20.2 Speeds and Advice

A 20mph speed restriction is a cautionary speed at which it is deemed a train can safely stop before striking an obstruction. A 20mph speed restriction is more like likely to be used where there is actual damage but the line is safe for the passage of trains.

A 40mph speed restriction is a speed at which it is proven that should a train strike an obstruction; it is scientifically proven (see RSSB T201) that it is most likely to remain upright. Higher speeds could potentially present a much greater risk of derailment or worse, a roll over event occurring. A 40mph speed restriction is more likely to be used as a preventative measure due to a live or forecast ‘Extreme’ rainfall event .

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NOTE: *All speeds contained in section 20 are advisory and can be adjusted locally if suitably risk assessed or approved by P-way / relevant Route Engineer / Operations but will be specific to Operational route sections or lines of route.*

20.3 Additional instructions where adjacent lines may not be affected

In addition to the above guidance, in areas where one line is unlikely to be affected by an obstruction (landslip / structures above or below the line etc) on another line (such as a 4-track railway with a 10ft+), line speed or higher speeds may be authorised on the unaffected line(s) subject to the following conditions:

a) an on-site or remote (where available) examination has taken place to the location by relevant Route Engineer, as appropriate, giving an assurance it is currently safe for the passage of trains;

b) the site will be monitored by a competent person i.e. watchman;

c) there is no other extreme weather at the location; and

d) the situation should be regularly monitored using the forecast tool and reports from site and where appropriate, the site is re-examined by the relevant Route Engineer.

NOTE: *To assist the relevant Route Engineer in making a decision for remote locations, on-site photographs / video may be useful and / or FF CCTV where an on-site inspection would take considerable time.*

20.4 Single Lines

Where the Operational Route Section or line of route includes sections of single line, the Route Control shall confirm the arrangements to operate over the single line during from the report received from the signaller.

The Route Control will consider whether the line can be examined by a train through a dynamic risk assessment with the Route Operations Manager (OM) or equivalent and relevant Route Engineer.

20.5 Wrong Direction Movements

Following the closure of the line and when a train is required to make a wrong direction movement from the obstruction, the condition of the line behind the train shall be assessed.

Upon returning to right direction of travel, the Signaller shall be advised of the conditions under which the movement will take place. Options are to reduce the speed of the train in accordance with the prevailing conditions. The signaller shall also be advised of the distance the train must travel at a reduced speed, taking into account the Operational Route Sections and weather conditions.

The conditions under which movements are made upon returning to the right direct can be determined through a dynamic risk assessment.

20.6 Rainfall based Blanket speed restriction

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Where there is a risk to earthworks/structures from a forecast of adverse weather, the EWAT team may determine that as a precautionary measure, a blanket speed restriction may be imposed as follows:

a) blanket speed restriction will be pre advised to Drivers through the appropriate means;

b) advise the signaller of the section of route at risk;

c) signaller will setup a GSMR Weather Alert Broadcast;

d) this method of work will continue until you advise the signaller that there is no longer a requirement to impose the speed restriction.

20.7 Resumption of normal working

After the weather alert has expired or the convective rainfall has ceased, the Route Control may authorise normal working to resume however, consider local weather reports and/or conditions. Additional or prolonged restrictions might be required.

Where there has been damage to structures or earthworks above or below the line the relevant Route Engineer for the affected asset shall confirm the safety of the asset. The track handback shall then be completed as per relevant standard(s).

21. Additional Guidance for Route Control

21.1 Initial Considerations (Immediate response)

The following should be considered prior to making any operating decisions:

a) check the weather forecast;

b) contact relevant Route Engineer for advice;

c) are there any other high-risk assets in the vicinity;

d) trains should not return to line speed without authorisation from the relevant Route Engineer; and

e) consider blanket speed restrictions for the wider area / GSM-R notifications as per clause 20.5.

21.2 Primary considerations (1st hour)

The following should be considered within the first hour:

a) the rescue of any stranded trains;

NOTE 1: *i.e. How are these trains going to be recovered - working in wrong direction moves, setting back, cautioning, etc.*

b) prompt recovery of passengers from stranded trains;

c) maintain service operations where possible;

NOTE 2: *e.g. alternative / diversionary routes, unaffected lines etc.*

d) consideration to Passenger Information During Disruption (PIDD);

e) begin process of arranging Strategic Command structure;

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f) commence a tactical conference to include Maintenance, relevant Route Engineer and Railway undertakings;

g) consider how long the incident may last and resourcing this both in site and in Route Control; and

h) consider evacuation / safety of staff on site if flooding is severe.

21.3 Secondary considerations (2-4 hours)

The following should be considered within two to four hours:

a) obtain regular updates from site – Is the flooding increasing or receding?

b) is the situation deteriorating?

c) a Route strategy conference by the RCM / Incident Officer (IO) with relevant the Executive, NOC and relevant Route Engineer to agree suitable mitigations to maintain (or closure) of the operational railway;

d) thinning of service to assist in service recovery; and

e) consider amended WTT (A for B) for following day where required.

21.4 Tertiary considerations (6hr+)

The following should be considered after six hours:

a) update with NOC, Railway Undertakings and Route Directors;

b) actions from Strategic Command; and

c) consider internal and external resource for site recovery and infrastructure repair.

21.5 Additional considerations

If the threshold is breached on Operational Route Sections or lines of route listed as high-risk, some mitigations may include a suitable speed restriction, with clear detail on when the speed restriction can be removed.

The need to review any proactive measures that are required (visual examination of known sites, staff attendance at sites until rainfall ceases, trains cautioned past sites) and the need to involve the relevant Route Engineer.

Where the rainfall threshold is breached overnight when no trains have been operating, consider how the first train in the morning will operate, including the need to travel at caution, specific speed or to examine the line as per guidance.

21.6 DC Lines

If you become aware that the line is flooded above sleeper level, you shall report this to the ECO. You shall report the state and extent of the flooding to the ECO along with any change to the extent of the flooding.

21.7 AC Lines/Power sources

Identify:

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a) any overhead line equipment that might be affected by excessive rainfall, particularly where power sources are at ground level;

b) other electrically powered equipment such as point motors, location cabinets, axle counters which might be affected by localised flooding.

21.8 Extreme rainfall accumulation forecast or convective rainfall events

If there is extreme rainfall accumulation forecast or convective rainfall events, local monitoring shall be implemented to suitably assess longer term risk to the infrastructure and subsequent train running.

Consider if there is likely to be signalling faults that may require TBW / ESW or working to / from the point of obstruction and associated staff requirements.

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Approval of Standard and Control Document Owner

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John Winnifrith, Acting Principal Rules, Standards and Controls Manager

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4 Recipients

Name	**Post**
Eliska Burrows	Route Director, Anglia
James Dean	Route Director, West Coast Mainline South
Michael Gallop	Route Director, Western
Philip James	Route Director, North West
William Kelly	Route Director, Wales
Mark Killick	Route Director, Wessex
Shaun King	Route Director, Sussex
David Penney	Route Director, Central
Matthew Rice	Route Director, North East
Paul Rutter	Route Director, East Coast
Liam Sumpter	Route Director, Scotland
Fiona Taylor	Route Director, Kent
Gary Walsh	Route Director, East Midlands
Philip Barnes	Head of Operations Delivery, NW & Central
Martin Colmey	Head of Operations Delivery, NW & Central
Mark Corney	Head of Operations Delivery (Telecoms)
David Davidson	Head of Operations Delivery, Eastern
Christopher Fuoco	Head of Operations Delivery, Wales & Western
Christopher Gee	Head of Operations Delivery, Eastern
Neil Henry	Head of Operations Delivery, Eastern
Richard Horobin	Head of Operations Delivery, North West & Central
Clyde Howarth	Head of Operations Delivery, Southern
Timothy Leighton	Head of Operations Delivery, Southern
Gunnar Lindahl	Head of Operations Delivery, Southern
Jim Mansfield	Head of Operations Delivery, East Mids
Daniel Matthews	Head of Operations Delivery, Southern
Ross Moran	Head of Operations Delivery, Scotland
Mike Paterson	Head of Operations Delivery, Southern
Chris Pearce	Head of Operations Delivery, Wales & Western
Martin Ball	Head of Maintenance Delivery, North West & Central
Mark Budden	Head of Maintenance Delivery, Eastern
Robert Coulson	Head of Maintenance Delivery, Southern

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Royston Evans	Head of Maintenance Delivery, North West & Central
Timothy Flower	Professional Head of Maintenance
Ian Griffiths	Professional Head of Maintenance
Paul Jenkins	Head of Maintenance Delivery, Wales & Western
Ivan Kimble	Head of Maintenance Delivery, Southern
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Richard Owens	Head of Maintenance Delivery, Eastern
Ian Puckrin	Head of Maintenance Delivery, Eastern
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Terence Strickland	Head of Maintenance Delivery, North West & Central
Martin Taylor	Head of Maintenance Delivery, Wales & Western
Charlie Usher	Head of Maintenance Delivery, Southern
Andrew Murray	Director Engineering & Asset Management, Eastern
Jane Austin	Director Engineering & Asset Management, Wales & Western
Joan Heery	Director Engineering & Asset Management, Track
Kamini Edgeley	Director Engineering & Asset Management, North West & Central

5 Details of briefing or cascade communication process

Re-brief – Each Route to develop briefing process to cascade the following (realising each Route has differing roles now)

Weather - managing the operational risks - **NR/L2/OPS/021**
Weather Management Modules – **NR/L3/OPS/021 13 (EWRP)**

Process owner (Route specific) to brief on the importance and content of EWAT and to include the above clarifications.

Appendix B: NR/L2/OPS/021 Weather – Managing the Operational Risks, 01 June 2019

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Date:	01 June 2019
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NR/L2/OPS/021

Level 2

Business Process

Weather – Managing the Operational Risks

Approvals

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NetworkRail

Ref:	NR/L2/OPS/021
Issue:	8
Date:	01 June 2019
Compliance date:	07 September 2019

User information

This Network Rail document contains colour-coding according to the following Red–Amber–Green classification.

Red requirements – *no variations permitted*

- Red requirements are to be complied with and achieved at all times.
- Red requirements are presented in a red box.
- Red requirements are monitored for compliance.
- Non-compliances will be investigated and corrective actions enforced.

Amber requirements – *variations permitted subject to approved risk analysis and mitigation*

- Amber requirements are to be complied with unless an approved variation is in place.
- Amber requirements are presented with an amber sidebar.
- Amber requirements are monitored for compliance.
- Variations can only be approved through the national variations process.
- Non-approved variations will be investigated and corrective actions enforced.

Green guidance – *to be used unless alternative solutions are followed*

- Guidance should be followed unless an alternative solution produces a better result.
- Guidance is presented with a dotted green sidebar.
- Guidance is not monitored for compliance.
- Alternative solutions should be documented to demonstrate effective control.

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Compliance date:	07 September 2019

Compliance

This Network Rail standard/control document is mandatory and shall be complied with by Network Rail Infrastructure Limited and its contractors if applicable from 07 September 2019.

Where it is considered not reasonably practicable[1] to comply with the requirements in this standard/control document, permission to comply with a specified alternative should be sought in accordance with the Network Rail standards and controls process, or with the Railway Group Standards Code if applicable.

If this standard/control document contains requirements that are designed to demonstrate compliance with legislation they shall be complied with irrespective of a project's Governance for Railway Investment Projects (GRIP) stage. In all other circumstances, projects that have formally completed GRIP Stage 3 (Option Selection) may continue to comply with any relevant Network Rail standards/control documents that were current when GRIP Stage 3 was completed.

NOTE 1: *Legislation includes Technical Specifications for Interoperability (TSIs).*

NOTE 2: *The relationship of this standard/control document with legislation and/or external standards is described in the purpose of this standard.*

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Issue record

[1] *This can include gross proportionate project costs with the agreement of the Network Rail Assurance Panel (NRAP).*

Ref:	NR/L2/OPS/021
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Issue	Date	Comments
1	August 2003	Original issue
2	October 2004	Amended to reflect organisational change
3	March 2010	Organisational changes within Network Rail to Job Titles and to capture the change of Weather information supplier to Network Rail and the benefits
4	March 2011	Changed to OCS standard Clause 5.7 reference to www.smtleaffall.co.uk removed (clause number changed to 4.7 due to re-pagination
5	June 2011	Correction to cross references within standard
6	March 2015	Changed to OPS standard Inclusion of SEJs and autumn-specific forecasts. Amendment to reflect the changes introduced by the revised extreme weather response process
7	September 2017	Inclusion of Short Notice and Out of Hours Arrangements Additional clarity over ownership within Delivery Unit Conferences
8	June 2019	Safety recommendations from Lamington and derailments at Watford and Loch Eilt. Recognise changes in weather and incorporate weather modules into one standard.

Reference documentation

NR/L3/OPS/021	Weather and Seasonal Management Modules 1-01 to 1-09
NR/L2/CIV/086	Management of Earthworks.
NR/L3/OPS/045/3.17	Weather Arrangements
NR/L3/OPS/250	Network Rail's National Emergency Plan
NR/L3/TRK/1010	Management of Responses to Extreme Weather Conditions at Structures, Earthworks and Other Key Locations
Railway Operational Code	Part C – Arrangements for Provision of Equipment to deal with Adverse Weather Conditions; and the preparation for and response to Seasonal Disruptions

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Contents

1 Purpose

This document together with NR/L3/OPS/021 mandates how Network Rail:

a) prepares, manages and responds to operational risks arising from adverse and extreme weather events;

b) prepares for, mitigates and manages seasonal weather-related activities.

In addition, it provides guidance to train and freight operators on their actions to manage weather hazards.

This business process supports the rail industry in managing its response to weather. It enhances industry safety, reduces operational risk and minimises the impact of weather hazards on passengers and the public.

2 Scope

The Railway Operational Code outlines the industry requirements to:

a) sustain the operation of train services on the network in accordance with the working timetable;

b) restore operations following a disruption in accordance with the working timetable, taking into account:

- the interests of safety and security;
- the needs of passengers and freight customers; and
- the efficient and economical operation of the network and of trains operating on it.

In order to meet these requirements, the Railway Operational Code directs Network Rail to provide an integrated weather management plan at Route level to manage the operational disruptions resulting from weather hazards.

This business process has been put in place to meet this obligation. This document applies to these activities:

a) forecasting of weather to manage:

- routine preparation, planning and response to weather hazards;
- seasonal weather preparation and its management; and
- near real-time monitoring of weather hazards.

b) recovery and lessons learnt from weather hazard responses;

c) weather hazard contingency planning, plan rehearsal and exercising; and

d) vulnerable asset response planning.

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3 Definitions

For the purpose of this standard the definitions shown in **Table 1** apply:

Adverse / Extreme Weather	A period of weather that is outside the normal range that includes periods of prolonged and / or intense rainfall, prolonged dry and / or hot periods and periods of repeated freezing and thawing. These events can result in scour, storms, flooding, high tides, desiccation or high groundwater levels, increasing the likelihood that an asset may fail, suffer performance loss or experience accelerated degradation.
Adverse / Extreme Weather Plan (A/EWP)	A procedure produced in accordance with the relevant company standards covering the actions to be taken in the event of Adverse / Extreme Weather. The plan includes registering of assets that are assessed as vulnerable to failure, performance loss or to experience accelerated degradation in the event of Adverse / Extreme Weather.
Adverse Weather (amber status)	Weather conditions which, while not extreme, are known to be challenging to reliable operations. However, with effective maintenance, timely delivery of seasonal preparation and robust deployment of mitigation measures, the full timetable can be delivered with acceptable reliability.
Autumn	Commences 01 October, concludes 13 December.
Aware Weather (yellow status)	Weather conditions which have breached the normal threshold however the Rail Industry continues to operate effectively and reliably.
Extreme Weather (red status)	Weather conditions which are so severe that consideration has to be given as to the level of service which can be safely operated. These conditions may require a reduced timetable, some form of Key Route Strategy implementation, possible speed restrictions and significant redeployment of resources. Safely meeting the immediate needs of customers and providing essential communication links will take precedence in decision making, potentially to the detriment of measured PPM.
Extreme Weather (double red status)	Extreme weather conditions, as defined above, applying over two or more Routes.
Extreme Weather Response Process	A six-stage process that complies with regulatory requirements that covers how Network Rail will prepare for, respond to, and recover from the impact of an extreme weather event.
Force Majeure	Is the happening of defined act, events or omissions which could not have been anticipated or are beyond reasonable control.

Joint Train Service Contingency and Service Recovery Plan	An agreed plan based on the anticipated number of train paths available over a restricted railway developed by Network Rail Routes and their customers, which describes the actions to be taken and the managerial arrangements which will apply when an event, or events, disrupts normal timetable operation.
Key Route Strategy (KRS)	A planned reduction in managing the availability of the infrastructure and the need to reduce levels and / or suspend train services as a result of extreme weather which could, or is, severely affecting a Route.
Normal Weather (green status)	The range of weather parameters within which the Rail Industry operates effectively and reliably.
Red Day Assessment	A Red Day is declared when one of the following applies: a) if the forecast that an Extreme Weather Threshold will be breached; b) if the forecast that Multiple Adverse Weather Thresholds will be breached; c) an actual Extreme Weather Threshold has been breached; and d) actual Multiple Adverse Weather Thresholds have breached.
Route, Delivery Unit and Local Area Forecasts	Forecasts supplied daily to Route Operations Controls and the National Operations Centre covering the range of weather parameters within which the Rail Industry operates effectively and reliably.
Seasonal Calendar	A Network Rail annual process map that contains the planning arrangements and the measurements of activity of preparedness for seasonal conditions.
Seasonal Arrangements	A set of instructions documenting preparations for Summer, Autumn and Winter.
Summer	Commences 01 April, concludes 30 September.
Weather Hazards	The definitions agreed with the forecast provider to be included in local area weather forecasts.
Winter	Commences 01 October, concludes 31 March.

Table 1 – Definitions

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4 Response, Accountability, Consulted and Informed Matrix

A list of roles and responsibilities relating to this document are shown in **Table 2**.

R – **Responsible** is the person or people who are responsible for performing a certain task or action. **A** – An **Accountable** person is one who has overall accountability to make sure that a task or action is completed. **C** – **Consulted** people have an input into the task or action, this can be providing information, reviewing documents or attending workshops etc. **I** – **Informed** people are those who receive the output of a task or process. * Denotes option for delegation		Director, Route Asset Management	Infrastructure Maintenance Delivery Manager	Chief Operating Officer[1]	Current Operations Manager[2]	Seasons Delivery Specialist	Route Control Manager	Operations Manager	Head of National Operations Centre	NOC Duty Controller	National Weather Specialist	Train / Freight Operators	Head of Operations Delivery	Head of Maintenance Delivery
5.1	Forecast Process			I	A	I	R		I	C	I	I	I	I
5.2	Alert Status	I	I	I	A	C	R		I	C	I	I	I	I
6	Integrated Weather Management Plan	C	C	A	C	R	I	I	I	I	I	I	C	C
7.2	Stage 1: Awareness	I	I	I	A	I	R	I	I	I	I	I	I	I
7.3	Stage 2: Preparation	I	I	I	A	I	R	I	I	I	I	I	I	I
7.3.2	Delivery Unit Conferences	C	R*A		I	I	I							C
7.3.3	Extreme Weather Action Teleconference	C	C	I	R*A	C	I	C	I	I	I	C	C	C
7.4.1	Front Line Staff	A	R				I	R					C	C
7.4.2	Route Operations Control Staff				A	I	R			I		I		
7.4.3	Incident Command			R*A										
7.5	Stage 4: Recovery	C	C	I	R*A	I	I	C		I		C	C	C
7.6.1	Review Conference	C	C	I	R*A	C	C	C		I	I	C	C	C
7.6.2	Lessons Learnt	I	I	I	A	R	I	I			I	I	I	I

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7.7	Short Notice and Out of Hours Extreme Weather Response	C	C	I	A	I	R	C	I	I		I	I	I
7.8	Short Notice Extreme Weather Response during office hours	C	C	C	A	I	R	C	I	I		I	C	C
7.9	Force Majeure				C	I						I		
7.10	Engineering Work	C	C	I	A	C	R			I	I	C	C	C
8	Contingency Planning and Rehearsal	C	C	I	A	C	I	C			I	C	C	C
9	Provision for Amended Working Timetables in Contingency Plans			C	A	I	C	I				C	C	C
10.1	Network Readiness Conference						C		A	R				
10.2	Double Red Weather Status						R		C	A				
10.3	National EWAT	I	I		I	I	I	I	A	R	I	I		
11	Structured Expert Judgement	C	C	R*A	C	I	C	C	I		I	C	C	C
11.1	SEJ Records	I	I	A	I	R	I	I	I		I	I	I	I

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12.1	Implementation of Seasonal Arrangements	C	C	A	C	R		I			I	C	C	C
12.2	Seasonal, Timetabling and Communication Calendars	I	I	I	C	R	I	I			A	C	I	I
12.3.1	Variation to Seasonal Dates	I	I	R*A	I	I	I	I	I	I	I	I	I	I
12.3.2	Extension of the Autumn Season	I	C	R*A	C	C	C	C		I	I	C	C	C
12.3.3	Early Cessation of the Autumn Season	I	C	R*A	C	C	C	C		I	I	C	C	C

[1] The role of Chief Operating Officer is undertaken by the Infrastructure Director in Scotland

[2] The role of Current Operations Manager is undertaken by the Head of Integrated Control in Scotland

Table 2 – Roles and responsibilities

5 Weather Forecast Arrangements

5.1 Forecast Process

The contracted weather forecast provider supplies weather reports with a forecast for all weather areas by 03:00 hours. The forecast is for current day and four day forecast.

The Route Control Manager (RCM) shall:

a) confirm that the forecasts are received;

b) send out alert status for the day ahead and the following day;

c) record alert status for the day ahead and the following day; and

d) liaise with the relevant senior Route and asset managers if a conference is needed.

The Network Rail RCM shall have a process to notify the colour alert status (see **Table 3**) to Train Operating Companies (TOCs) and Freight Operating Companies (FOCs), National Operations Centre (NOC) and other key stakeholders.

Weather Type	Alert Status
Normal	Green
Aware	Yellow
Adverse	Amber
Extreme	Red

Table 3 - Weather type and colour alert status

The forecast provider shall provide a confidence level of the weather expected, ranging from high to low.

5.2 Alert Status

When a colour alert has been issued other than green, arrangements shall be made by the Route to discuss the operational integrity and preparedness.

Every Route shall have an Integrated Weather Management Plan as detailed in Clause 6.

6 Integrated Weather Management Plan

The Integrated Weather Management Plan (IWMP) is a collation of seasonal arrangements to be applied during the applicable period and functional information and arrangements to be applied during periods of adverse or extreme weather. The information required within the IWMP is captured within the L3 modules to this standard.

7 Extreme Weather Response

7.1 Process

The extreme weather response process is a five-stage process. These are:

a) Stage 0: Normal forecast and business as usual
b) Stage 1: Awareness
c) Stage 2: Preparation
d) Stage 3: Respond
e) Stage 4: Recovery
f) Stage 5: Review

Figure 1 outlines the process.

Ref:	**NR/L2/OPS/021**
Issue:	8
Date:	01 June 2019
Compliance date:	07 September 2019

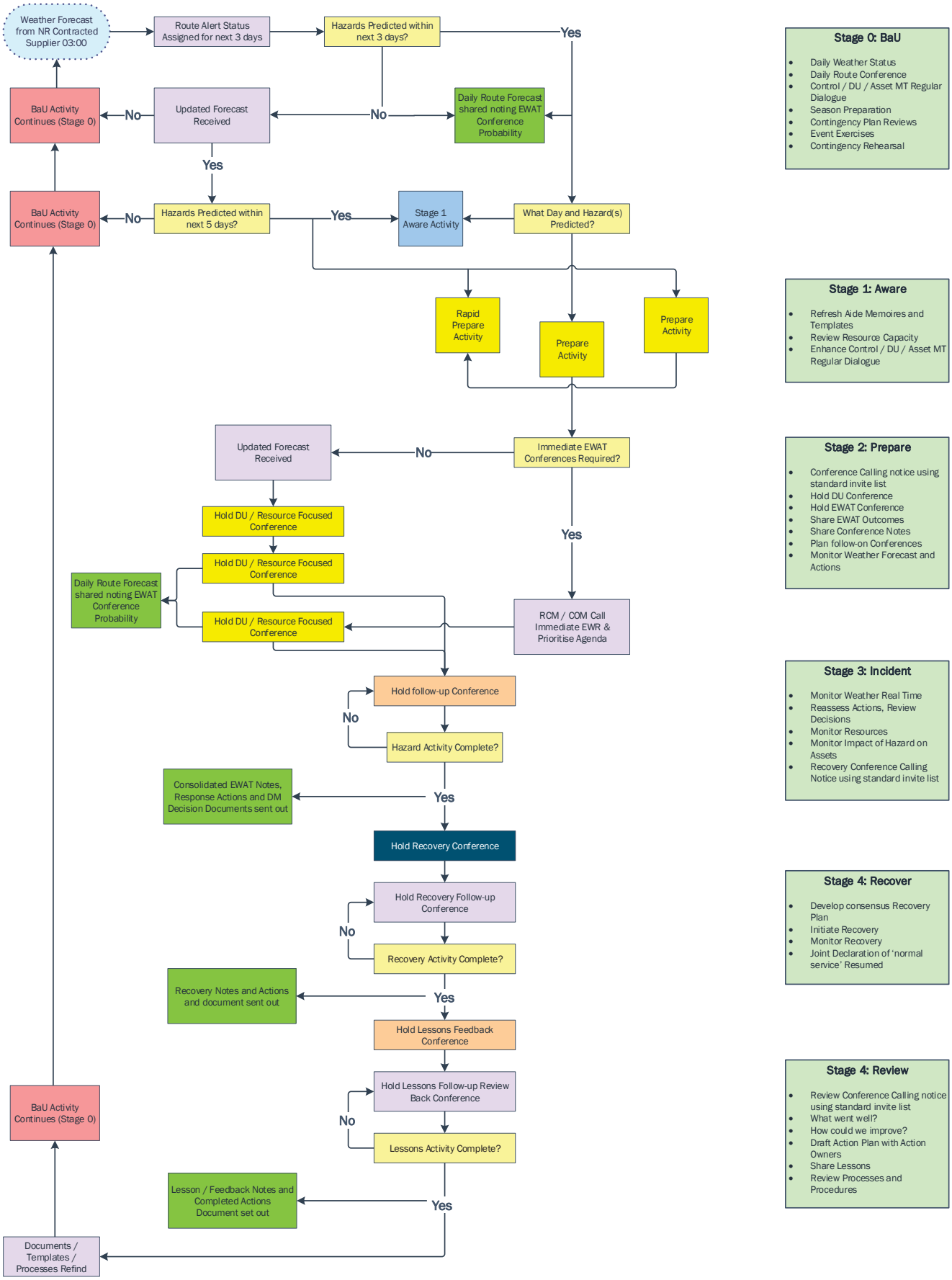

Figure 1 - Extreme Weather Response Process Flow Chart

7.2 Stage 1: Awareness

When there are weather conditions which might warrant a red alert status on day four or day five, the RCM shall outline the potential of these conditions to key stakeholders.

7.3 Stage 2: Preparation

7.3.1 General

When weather conditions which warrant a red alert status on day three or the RCM has assigned red alert status to weather conditions on day two, the preparation activities described in 7.3.2 and 7.3.3 shall begin.

7.3.2 Delivery Unit Conferences

The Delivery Unit (DU) shall convene a conference to outline the impact of the impending weather conditions, and to allocate resources accordingly. As well as DU staff, the conference shall involve Asset Management staff as required.

Structures and Earthworks teams should arrange to undertake appropriate actions detailed in their A/EWP, as outlined in NR/L3/TRK/1010 and NR/L2/CIV/086. Other Asset Management and DU staff should follow the processes outlined in their asset-specific company standards and local policies.

The conference agenda shall include, but is not limited to:

a) current weather forecast conditions and confidence;

b) risks and actions identified in the integrated weather management plan;

c) staff and equipment deployment, which may include changes to rosters, postponement of works and the mobilisation of additional staff;

d) potential timetable alterations;

e) the impact of alternative working arrangements on other roles;

f) the necessity of route-proving after the event; and

g) summary of actions from the conference which shall be shared with the RCM.

7.3.3 Extreme Weather Action Teleconference EWAT

The Current Operations Manager (COM) shall convene an (EWAT).

NOTE: *An EWAT may also be convened by other regional route representatives i.e. Route Asset Manager (RAM), RCM or Incident Officer (IO).*

The purpose of the EWAT is to:

a) assess the impact of extreme weather on the infrastructure;

b) agree appropriate mitigation, monitoring and contingency plans as detailed in the integrated weather management plan; and

c) communicate actions and decisions.

The EWAT shall be led by the COM or RCM and attendees shall include staff from:

a) Operations Management i.e. Local Operations Managers (LOMs), Mobile Operations Managers (MOMs), etc.

b) Delivery Units.

c) Route Asset Management (from required discipline);

d) Operational Planning and Communications; and

e) Supply Chain Operations.

TOCs and FOCs shall be invited on to the EWAT conference to share their mitigation plans.

The EWAT conference agenda shall include, but is not limited to:

a) confirmation of the forecast, affected locations and confidence in the forecast, which may be delivered by the weather forecast provider;

b) declaration by the COM of the weather as extreme to allow Customer Account Teams to activate the force majeure procedure (see 7.9);

c) risks and mitigation plans as detailed in the integrated weather management plan;

d) staff and equipment resource availability and deployment;

e) whether the Strategic / Tactical / Operational Command structure shall be activated;

f) Emergency Timetable utilisation;

g) information provision to Network Rail and TOC managed stations;

h) confirmation of route-proving arrangements after the event; and

i) summary of actions and decisions.

The actions shall be shared with participants of the EWAT conference and the NOC.

7.4 Stage 3: Respond

7.4.1 Front Line Staff

During an extreme weather event front-line staff (e.g. MOM and Pway staff) shall be deployed to monitor conditions on the ground and asset performance, feeding back this information to Route Operations Control.

7.4.2 Route Operations Control Staff

During an extreme weather event, Route Operations Control staff shall:

a) conduct further EWAT conferences as appropriate; and

b) provide updates to TOCs, Managed Stations and Media teams to keep the travelling public informed;

7.4.3 Incident Command

During an extreme weather event a decision at route level will be made as to whether the incident command structure will be implemented in line with NR/L2/OPS/250.

7.5 Stage 4: Recovery

The COM shall convene a Service and Performance Recovery Conference.

NOTE: *The conference may also be convened by the RAM, RCM, or Incident Officer (IO).*

The objective of this conference is to:

a) establish the priorities and timescales for recovery of the network; and

b) understand TOC / FOC priorities and timescales for service recovery.

7.6 Stage 5: Review

7.6.1 Review Conference

A review conference shall be convened by the COM within 14 days of the event.

NOTE 1: *The conference may also be convened by the RAM, RCM, IO or Senior Incident Officer (SIO).*

NOTE 2: *The conference may be schedules to include several adverse and extreme events in one review.*

The purpose of the review conference is to:

a) review the preparation for and response to the weather event;

b) identify and capture good practice; and

c) identify, capture and create improvement plans.

An invitation to the review conference shall be extended to all parties involved in the EWAT. The agenda for the review shall include, but is not limited to:

a) forecast accuracy throughout the outlook period;

b) review actions planned;

c) review actions implemented including identifying any deviation from the integrated weather management plan and the reason for this deviation; and

d) infrastructure performance and continued risks;

- Operator preparation, performance and continued risks;
- areas of good practice; and
- areas for development and how these could be improved.

7.6.2 Lessons Learnt

The Seasons Delivery Specialist (SDS) shall be responsible for:

a) collating lessons learnt;

b) capturing the elements of the process which worked well and which did not work well; and

c) sharing this information nationally at the Seasons Management Team meeting; and

d) Incorporating the lessons learnt into future weather and seasonal preparations where required.

7.7 Short Notice Out of Hours Extreme Weather Response

If a weather forecast escalates to an extreme event with less than 24 hours notice or outside of office hours, the RCM shall arrange for an EWAT to take place.

NOTE: *The EWAT should be arranged to take place as soon as practicable.*

The core attendees shall include:

a) the Strategic level Senior 'On Call' Manager;

b) the Route Asset Management (RAM) Senior Civils 'On Call' Manager or equivalent;

c) the Delivery Unit 'On Call' Senior Engineer;

d) the Met Desk weather forecaster; and

e) The operations 'On Call' manager.

From this point, the process outlined in 7.4 to 7.6 shall be followed.

7.8 Short Notice Extreme Weather Response during office hours

If a weather forecast escalates to an extreme event with less than 24 hours notice during office hours the process outlined in 7.4 to 7.6 shall be followed.

NOTE: *The EWAT should be arranged to take place as soon as practicable.*

7.9 Force Majeure

In extreme weather, Network Rail can be relieved of its obligations to indemnify the operator in respect of relevant losses sustained.

Customer Account Teams are responsible for applying a force majeure and each extreme weather event is judged on a case by case basis.

7.10 Engineering Work

The planning process for all engineering work shall take into account the impact of weather on the programme, including seasonal conditions and the possibility of an extreme weather event.

On receipt of weather forecast information, Network Rail Route Operations Control shall discuss the potential impact on engineering work with the relevant parties.

If a forecast of extreme weather conditions is received during the defined autumn period the provision of railhead treatment or other autumn mitigation measures shall, in the interests of operational safety, be considered over other operational activities.

8 Contingency Planning and Rehearsal

COMs shall be accountable for the development of joint train service contingency and service recovery plans.

The plans shall be developed based on the anticipated number of available train paths but shall not prioritise individual operators' services.

The plan(s) shall:

a) describe the actions to take and the managerial arrangements to apply in the event of disruption to normal timetable operation;

b) contain details of diversionary routes; and

c) indicate anticipated available paths if emergency special working or temporary block working or single line working is introduced.

If short term planning or very short term planning freight services are scheduled, the FOCs shall establish their priorities and agree a strategy for the working of freight traffic with Network Rail's Route Operations Control.

As a minimum, contingency plans shall be reviewed and updated:

a) following long term changes to the availability of the railway infrastructure;

b) at six and 18 month intervals via electronic media; and

c) at 12 and 24 month intervals at formal meetings.

Updates and rehearsals of contingency plans shall be recorded along with details of any lessons learned.

If an extreme weather event has occurred within the previous six months which has exercised these contingency plans, this shall negate the requirement for a further review via electronic media.

9 Provision for Amended Working Timetables in Contingency Plans

Network Rail shall prepare and regularly review a contingency plan with each TOC.

Network Rail shall decide whether the contingency plans should include:

a) amendments to the working timetable that might be needed;

b) procedures or criteria to help affected parties decide when and how to apply timetable amendments prepared in advance; and

c) procedures or criteria to help affected parties establish timetable amendments not prepared in advance.

10 Extreme Weather Affecting Two or More Routes

10.1 Network Readiness Conference

As part of the normal process, weather is discussed on the daily (Monday to Friday) Network Readiness Conference between the NOC and the Routes. Over the weekend the three day weather forecast provided and reviewed to highlight any issues.

Each Route will declare its weather status for the next two days.

Should a hazard be present over the outlook period, this shall also be discussed.

10.2 Double Red Weather Status

When two or more Routes activate the Extreme Weather Response process for a weather event, the NOC shall notify the Head of National Operations Centre or nominated deputy and all other relevant personnel and co-ordinate responses across the affected parts of the network. The status of alert shall be referred to as double red.

On being notified by the NOC of a double red weather status, the Network Rail RCMs of the Routes involved shall then reflect this revised status in their own reporting arrangements.

10.3 National EWAT

When double red status is declared, the Head of National Operations Centre or nominated deputy shall decide whether a national EWAT is required to prepare for and manage the weather event. The national EWAT shall be led by the NOC Duty Controller and shall involve all affected Routes and TOCs / FOCs.

11 Structured Expert Judgement (SEJ)

A SEJ is an exercise carried out with appropriate industry members who are able to provide input to decision-making, using relevant actual data captured during extreme weather events to define network limits outside of those defined by existing thresholds.

When forming a SEJ individuals shall take into account all available information, including but not limited to:

a) local features to the area concerned i.e. lineside trees;

b) daylight / darkness;

c) wind speed and other weather conditions;

d) OLE / DC lines;

e) local environment i.e. flat moorland, mountainous area, embankments; and

f) consideration of reducing permissible line speed.

SEJs shall be reviewed when weather conditions change. Updated actual data shall be used to review arrangements.

11.1 SEJ Records

The SDS is responsible for recording the SEJ.

If a SEJ has been used, the individual shall record why this action was taken and its outcomes. The record shall be sent to the National Weather Team for archiving

12 Seasonal Planning and Implementation

12.1 Implementation of Seasonal Management Arrangements

The arrangements for seasonal management shall be included in the seasonal working arrangement documents. The documents shall be issued as controlled documents a minimum of two weeks before the arrangements are due to commence. The arrangements for each season shall be reviewed and re-issued at least annually.

Routes should encourage access parties to follow joint procedures in the seasonal arrangements for the response to seasonal weather conditions. These procedures might include weather hazards.

Weather hazards can occur outside the season they would normally be expected. If this is forecast or happens, apply the seasonal arrangements to address the weather hazard if possible.

12.2 Seasonal, Timetabling and Communication Calendars

Routes shall define the:

a) content;

b) requirements; and

c) operation

of their seasonal, timetabling and communication calendars. This shall be done with the other access parties.

Access parties should make every effort to populate the revised seasonal calendar with seasonal precautionary measures and progress with activities.

The Routes shall use the seasonal calendar to plan, implement and review how they will manage seasonal and weather conditions. This shall include the content, preparation arrangements and timescales to implement the seasonal working arrangements for:

a) Autumn.

b) Winter.

c) Summer.

12.3 Seasonal Dates

12.3.1 Variation to Seasonal Dates

The start and end dates of seasons are set out in **Table 4:**

Summer	Starts 01 April, ends 30 September
Autumn	Starts 01 October, ends 13 December
Winter	Starts 01 October, ends 31 March

Table 4 – Start and end dates of seasons

The dates of the summer and winter seasons will not normally change, however, the arrangements employed during these seasons shall be used where weather conditions indicate this need.

The dates for the start of the leaf fall season will change and may fifer from the official start of autumn.

12.3.2 Extension of the Autumn Season

The Chief Operating Officer (COO) may, where conditions dictate, extend the Route autumn working arrangements, including railhead treatment trains, beyond those dates previously planned.

Network Rail shall gather and assess the following information to establish whether the autumn railhead treatment programme can be extended:

a) actual proposed dates for when the treatment trains are planned to be cancelled;

b) confirmation that the general weather forecast for the proposed extension dates contains extreme weather warnings;

c) confirmation that there are black or red leaf fall days forecast for the proposed dates;

d) confirmation that less than 90% of leaves are down, autumn to date;

e) confirmation that more than 12 drivers' reports of low rail adhesion per line of route or circuit have been reported in the preceding week prior to the proposed extension dates;

f) confirmation that there has been no decrease in safety KPIs (Overruns, SPAD, WSTCF) reported in the preceding week prior to the proposed extension dates to the 'peak' autumn weeks that are directly attributable to Autumn; and

g) confirmation that locally identified personnel have been carried out at high risk sites for low rail adhesion and deemed to be either high risk or contamination found. This will be based on the judgement and expertise of the MOM at the time.

After this information has been established or reviewed, a representative of Network Rail shall inform SCO Seasonal Control, Route Operations Control and the relevant TOCs / FOCs of the decision. Extensions shall be made on a circuit-by-circuit basis.

12.3.3 Early Cessation of the Autumn Season

The COO shall, where conditions dictate, reduce or terminate the Route autumn working arrangements, including railhead treatment trains, earlier than previously planned.

Network Rail shall gather and assess the following information to establish whether the autumn railhead treatment programme can be reduced or terminated:

a) actual proposed dates for when the treatment trains are planned to be cancelled;

b) confirmation that the general weather forecast for the proposed cancellation dates does not contain extreme weather warnings;

c) confirmation that there are no black or red leaf fall days forecast for the proposed dates;

d) more than 90% of leaves are down, autumn to date;

e) no more than 12 drivers' reports of low rail adhesion per line of route or circuit shall have been reported in the preceding week prior to the proposed curtailment dates;

f) there have been no safety KPIs (Overruns, SPAD, WSTCF) reported in the preceding week prior to the proposed curtailment dates that are directly attributable to Autumn; and

g) Inspections by locally identified personnel have been carried out high risk sites of low rail adhesion and deemed to be either low risk or no contamination found. This will be based on the judgement and expertise of the party carrying out the inspection at the time.

After this information has been established or reviewed, a representative of Network Rail shall inform SCO Seasonal Control, Route Operations Control and the relevant train and freight operators of the decision. Cancellations shall be made on a circuit-by-circuit basis.

Appendix A - Weather Hazard Consequences

The potential consequences of weather related hazards are listed in **Table A.1**.

Specific procedures to manage, mitigate and respond to these hazards are contained in the referenced documentation which includes Network Rail's NR/L3/OPS/045/3.17, the NR/L3/OPS/021 modules and in the IWMP.

NOTE: *The list of weather related hazards is not exhaustive.*

Flooding / High Seas (Topping) / Heavy Rain	a) Obstructions on the line. b) Scour action. c) Land-slide, slope failure or washout. d) Inundation (flooding), including equipment failure. e) Sea spray. f) Erosion.
Ground Saturation	a) Surface water flooding. b) Land-slide, slope failure or washout. c) Erosion.
High Wind Speeds	a) Overhead line damage. b) Structural damage, including station roofs and canopies. c) Fallen trees (or parts thereof). d) Leaf fall (includes railhead contamination and loss of track circuit detection [wrong side failures]). e) Debris. f) Shifted load or loose sheeting.
Railhead Contamination	a) Category A SPAD. b) Station over-run. c) Low rail adhesion. d) Loss of Track Circuit Detection (wrong side failures). e) Rail / wheel defects.

Extremes of Temperature	a) Rail buckles. b) Track circuit failures. c) Point failures through loss of detection, especially switch diamonds. d) Overhead line sag. e) Overheating relay rooms. f) Swing bridge expansion. g) Rock-fall resulting from prolonged periods of cold weather.
Thunderstorms / Lightning	a) Failure of electrical and electronic equipment. b) Structural / tree damage. c) Lineside fires.
Fog / Mist / Low Level Cloud Cover	a) Signal Passed At Danger. b) Level crossing collision.
Snow / Hail / Ice / Frost, including Freezing Rain and Freezing Fog	a) Points failures. b) Signal failure. c) Structural / tree damage. d) Ground heave during extended periods of low temperatures. e) Icing of electrical supply equipment, including conductor rails and OLE. f) Icicles, including in tunnels. g) Signal passed at danger. h) Level crossing collision. i) Platforms and walkways covered by snow or ice. j) Track circuit failures at level crossings caused by applications of road salt.
Long Periods of Dry Weather	a) Desiccation (shrinkage) of sensitive clay embankment from moisture removal leading to serviceability issues with formation and track. b) Lineside fires: - Fires on land / premises adjoining the railway. - Fires resulting from the operation of steam locomotives.

Table 1 – Potential consequences of weather related hazards

Standard and control document briefing note

Ref: *NR/L2/OPS/021*	**Issue:** *08*
Title: *Weather: Managing the Operational Risks*	
Publication date: *01 June 2019*	**Compliance Date:** *07 September 2019*
Standard/Control Document Owner: *Operational Weather Resilience Manager*	
Non-compliance rep (Approver of TRACKER applications): *National Weather Specialist*	
Technical lead/contact for briefings: *Peter McCreery, National Weather Specialist*	**Tel:** [redacted]

Purpose:

This document together with NR/L3/OPS/021 mandates how Network Rail:

a) prepares, manages and responds to operational risks arising from adverse and extreme weather events;

b) prepares for, mitigates and manages seasonal weather-related activities.

In addition, it provides guidance to train and freight operators on their actions to manage weather hazards.

This business process supports the rail industry in managing its response to weather. It enhances industry safety, reduces operational risk and minimises the impact of weather hazards on passengers and the public.

Scope:

The Railway Operational Code outlines the industry requirements to:

a) sustain the operation of train services on the network in accordance with the working timetable;

b) restore operations following a disruption in accordance with the working timetable, taking into account:

- the interests of safety and security;
- the needs of passengers and freight customers; and
- the efficient and economical operation of the network and of trains operating on it.

In order to meet these requirements, the Railway Operational Code directs Network Rail to provide an integrated weather management plan at Route level to manage the operational disruptions resulting from weather hazards.

This business process has been put in place to meet this obligation. This document applies to these activities:

a) forecasting of weather to manage:

- routine preparation, planning and response to weather hazards;
- seasonal weather preparation and its management; and
- near real-time monitoring of weather hazards.

b) recovery and lessons learnt from weather hazard responses;

c) weather hazard contingency planning, plan rehearsal and exercising; and

d) vulnerable asset response planning.

Overview of change

This version of NR/L2/OPS/021 introduces the concept of the integrated weather management plan, a new requirement, the detail of which is explained in the new NR/L3/OPS/021 modules.

The 365 Weather Management modules have been withdrawn and are replaced by NR/L3/OPS/021 modules.

Detail of change

Section(s)/clause(s)	**Summary of changes**
6.	Explanation of the integrated weather management plan, a new requirement
7.4.3.	Additional detail around incident command during weather events
11.1	Clarification on dealing with records of structured expert judgements
9	365 documents references removed as these have been superseded by NR/L3/OPS/021 modules

Reasons for change

The integrated weather management plan is a recommendation made following the Watford Embankment Failure.

Affected documents:

Reference	*Impact*
NR/L2/OPS/021 ISSUE 07	Superseded

Briefing requirements:

Will Briefing Management System be used to deliver the briefing to posts listed below? No

Technical briefings are given to those who have specific responsibilities within this standard/control document.

Awareness briefings are given to those who might be affected by the content but have no specific responsibilities within the standard/control document.

Details of the briefing arrangements are included in the associated briefing programme.

All posts identified for briefing must be as described in OrgPlus.

Roles are directly briefed and do not cascade briefings.

Briefing *(A-Awareness/ T-Technical)*	**Post**	**Function**	**Responsible for cascade briefing? Y/N**
T	Director, Route Asset Management	Route Businesses	Y
T	Infrastructure Maintenance Delivery Manager		N
T	Chief Operations Officer		N
T	Current Operations Manager		Y
T	Seasons Delivery Specialist		N
T	Route Control Manager		N
T	Head of National Operations Centre		Y
T	National Operations Centre Manager		Y
T	NOC Duty Controller		N
T	National Weather Specialist		N
T	Head of Operations Delivery		N
T	Head of Maintenance Delivery		N
T	Incident Officer		N
T	Operational Weather Resilience Manager		N
A	Head of Operations Principles and Standards	Safety, Technical and Engineering	N
A	Operations Principles and Standards Expert		N
A	Corporate Investigation and Assurance Manager (Audit)		N
A	Head of Geotechnical		Y
A	Environmental Strategy Manager		N
A	Chief Health Safety and Quality		N
A	Weather Resilience and Climate Change Adaptation Strategy Manager		Y
A	Climate Change Adaptation Manager		N
A	Professional Head of Structures		Y
A	Chief Track, Switches and Crossings Engineer		Y
A	Capacity Planning Manager	System Operator	N
A	Train / Freight Operating Companies	External	Y
A	Section Managers	Maintenance	N

Briefing *(A-Awareness/ T-Technical)*	**Role**	**Function**

NOTE: *Contractors are responsible for arranging and undertaking their own Technical and Awareness Briefings in accordance with their own processes and procedures.*

Appendix C: NR/L3/OPS/021, Issue 01, Weather Management Index, March 2020 and the following modules contained with it:

- Appendix D: Module 12: Flooding – Management of Drainage
- Appendix E: Module 13: Managing the Weather – Extreme Weather Response Process

Ref:	NR/L3/OPS/021
Issue:	5
Date:	05 September 2020
Compliance date:	05 December 2020

Level 3

Manual

Weather Management Index

Emergency change

Issue date: 18 August 2020
Compliance date: 18 August 2020
Expiry date: 17 November 2020

Emergency change NR/BS/LI/453 is attached to this standard/control document and affects module 8.

This standard/control document will be reviewed and reissued before the emergency change expires on 17 November 2020.

[redacted]

Paul Ashton,
Head of Operations, Principles & Standards.

Emergency change

Issue date: 14 September 2020
Compliance date: 14 September 2020
Expiry date: 31 March 2021

Emergency change NR/BS/LI/454 is attached to this standard/control document.

This emergency change mitigates an urgent safety/asset/equipment risk that cannot await a full review of this standard/control document.

This standard/control document will be reviewed and reissued before the emergency change expires on 31 March 2021.

[redacted]

Paul Ashton,
Head of Operations, Principles & Standards.

Approvals

Content approved by:

[redacted]

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Technical Lead

Content approved by:

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NetworkRail

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Issue:	5
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User information

This Network Rail document contains colour-coding according to the following Red–Amber–Green classification.

Red requirements – *no variations permitted*

- Red requirements are to be complied with and achieved at all times.
- Red requirements are presented in a red box.
- Red requirements are monitored for compliance.
- Non-compliances will be investigated and corrective actions enforced.

Amber requirements – *variations permitted subject to approved risk analysis and mitigation*

- Amber requirements are to be complied with unless an approved variation is in place.
- Amber requirements are presented with an amber sidebar.
- Amber requirements are monitored for compliance.
- Variations can only be approved through the national variations process.
- Non-approved variations will be investigated and corrective actions enforced.

Green guidance – *to be used unless alternative solutions are followed*

- Guidance should be followed unless an alternative solution produces a better result.
- Guidance is presented with a dotted green sidebar.
- Guidance is not monitored for compliance.
- Alternative solutions should be documented to demonstrate effective control.

Ref:	NR/L3/OPS/021
Issue:	5
Date:	05 September 2020
Compliance date:	05 December 2020

Compliance

This Network Rail standard/control document is mandatory and shall be complied with by Network Rail Infrastructure Limited and its contractors if applicable from 05 December 2020.

Where it is considered not reasonably practicable[1] to comply with the requirements in this standard/control document, permission to comply with a specified alternative should be sought in accordance with the Network Rail standards and controls process, or with the Railway Group Standards Code if applicable.

If this standard/control document contains requirements that are designed to demonstrate compliance with legislation they shall be complied with irrespective of a project's Governance for Railway Investment Projects (GRIP) stage. In all other circumstances, projects that have formally completed GRIP Stage 3 (Option Selection) may continue to comply with any relevant Network Rail standards/control documents that were current when GRIP Stage 3 was completed.

NOTE 1: *Legislation includes Technical Specifications for Interoperability (TSIs).*

NOTE 2: *The relationship of this standard/control document with legislation and/or external standards is described in the purpose of this standard.*

Disclaimer

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[1] *This can include gross proportionate project costs with the agreement of the Network Rail Assurance Panel (NRAP).*

Ref:	NR/L3/OPS/021
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Issue record

Issue	Date	Comments
1	June 2019	Original issue. New manual and associated procedures replacing elements of the 365 Weather Management Modules.
2	September 2019	Module 10 Joint Seasons Management Plan published.
3	December 2019	Module 05 High Winds, Module 02 Winter and Module 13 Extreme Weather Reporting Process Published.
4	June 2020	Module 07 Tree Management Published
5	September 2020	02 Summer Management Published, 12 Drainage & Flooding Published, 11 Seasonal Calendar Published

Ref:	NR/L3/OPS/021
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Contents

OFFICIAL

Ref:	**NR/L3/OPS/021**
Issue:	5
Date:	05 September 2020
Compliance date:	05 December 2020

1 Purpose

This manual is an index of the weather management modules which manage the risk associated with adverse, extreme and seasonal weather conditions and forecasts.

NOTE: *Risk mitigations are contained in the individual modules.*

2 Scope

The manual set out how Network Rail:

a) prepares, manages and responds to operational risks arising from adverse and extreme weather events; and

b) prepares for, mitigates and manages seasonal weather-related activities.

The manual provides guidance to train and freight operators in their actions to manage weather hazards.

This manual applies to:

a) forecasting of weather to manage:

- routine preparation, planning and response to weather hazards;
- seasonal weather preparation and its management; and
- near real-time monitoring of weather hazards.

b) recovery and lessons learnt from weather hazard responses;

c) weather hazard contingency planning, plan rehearsal and exercising; and

d) vulnerable asset response planning.

OFFICIAL

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3 Index of the Weather Management Manual modules and associated forms

MODULES	Weather Management Modules	Issue No.	Publication / Withdrawal Date
01	**Autumn Management** *Previously Module D – 365 Weather Management*	01	01/06/2019
02	**Summer Management** *Previously Module F – 365 Weather Management*	01	05/09/2020
03	**Winter Management** *Previously Module E – 365 Weather Management*	01	07/12/2019
04	**Stage Gate Process**		
05	**High Winds** *Previously Module G – 365 Weather Management*	01	07/12/2019
06	**Not in use**		
07	**Tree Management** *Previously Module J (Vegetation Management) – 365 Weather Management*	01	07/12/2019
08	**Earthworks**	01	01/06/2019
09	**Management of Structures during Adverse and Extreme Weather**	01	01/06/2019
10	**Joint Seasons Management Groups** *Previously Module K – 365 Weather Management*	01	07/09/2019
11	**Seasonal Calendars**	01	05/09/2020
12	**Drainage and Flooding**	01	05/09/2020
13	**Extreme Weather Reporting Process**	01	07/12/2019

Standard and control document briefing note

Ref: *NR/L3/OPS/021*	**Issue:** 5
Title: *Weather Management Index*	
Publication date: 0*5 September 2020*	**Compliance Date:** 05 December 2020
Standard/Control Document Owner: Paul Ashton, *Head of Operations Principles & Standards*	
Technical lead/contact for briefings: *Peter McCreery, National Weather Specialist*	**Tel:** [redacted]

Purpose:

This manual is an index of the weather management modules which manage the risk associated with adverse, extreme and seasonal weather conditions and forecasts.

NOTE: Risk mitigations are contained in the individual modules.

Scope:

The manual set out how Network Rail:

a) prepares, manages and responds to operational risks arising from adverse and extreme weather events; and

b) prepares for, mitigates and manages seasonal weather-related activities.

The manual provides guidance to train and freight operators in their actions to manage weather hazards.

This manual applies to:

a) forecasting of weather to manage:

- routine preparation, planning and response to weather hazards;
- seasonal weather preparation and its management; and
- near real-time monitoring of weather hazards.

b) recovery and lessons learnt from weather hazard responses;

c) weather hazard contingency planning, plan rehearsal and exercising; and

d) vulnerable asset response planning. .

Overview of change

NR/L3/OPS/021/12 is a new module. It details the preparations and mitigations managed by Network Rail relating to flooding and drainage, to enable teams across the Route to understand their role in preparing for responsibilities to assets which could be affected by flooding.

NR/L3/OPS/021/11 is a new module. It details the contents, review process and publication of seasonal calendars at a local and national level, managed by Network Rail

NR/L3/OPS/021/02 is a new module. It details the preparations and mitigations managed by Network Rail relating to summer, to enable teams across the Route to understand their role in preparing for responsibilities to assets which could be affected by heat.

The 365 Weather Management modules have been withdrawn and are replaced by NR/L3/OPS/021 modules.

Reasons for change

NR/L3/OPS/021 weather management modules are designed to pull various sources of information on weather together into one document.

NR/L3/OPS/021/12 captures new flooding thresholds based on latest risk management guidance.

NR/L3/OPS/021/11 supports the Railway Operational Code requirement with a designed process.

NR/L3/OPS/021/02 collates existing guidance on summer management into a single document.

Affected documents:

Reference	*Impact*
NR/L3/OPS/021 ISSUE 4	Superseded
NR/L3/OPS/021/12 ISSUE 1	New
NR/L3/OPS/021/11 ISSUE 1	New
NR/L3/OPS/021/02 ISSUE 1	New

Briefing requirements:

Will Briefing Management System be used to deliver the briefing to posts listed below? No

Technical briefings are given to those who have specific responsibilities within this standard/control document.

Awareness briefings are given to those who might be affected by the content but have no specific responsibilities within the standard/control document.

Details of the briefing arrangements are included in the associated briefing programme.

All posts identified for briefing must be as described in OrgPlus.

Roles are directly briefed and do not cascade briefings.

Briefing *(A-Awareness/ T-Technical)*	Post	Function	Responsible for cascade briefing? Y/N
T	Director, Route Asset Management	Regions	N
T	Head of Maintenance Delivery	Regions	N
T	Route Director	Regions	N
T	Current Operations Manager	Regions	N
T	Seasons Delivery Specialist	Regions	Y
T	Route Control Manager	Regions	N
T	Head of National Operations Centre	Network Services	N
T	National Operations Centre Manager	Network Services	Y
T	NOC Duty Controller	Network Services	N
T	National Weather Specialist	Network Services	N
T	Head of Operations Delivery	Regions	N
T	Infrastructure Maintenance Delivery Manager	Regions	Y
T	Incident Officer	Regions	N
T	Operational Weather Resilience Manager	Network Services	N
T	Route Asset Manager [Drainage and Off-Track]	Regions	N
T	Route Asset Manager [Signalling]	Regions	N
T	Electrification and Plant Maintenance Engineer	Regions	N
T	Route Level Crossings Manager	Regions	N
T	Senior Asset Engineer [Drainage and Off-Track]	Regions	N
T	Infrastructure Maintenance Engineer	Regions	Y
T	Track Maintenance Engineer	Regions	Y
A	Head of Operations Principles and Standards	Network Services	N
A	Operations Principles and Standards Expert	Network Services	N
A	Corporate Investigation and Assurance Manager (Audit)	Technical Authority	N
A	Professional Head of Geotechnical	Technical Authority	Y
A	Environmental Strategy Manager	Technical Authority	N
A	Chief Health Safety and Quality	Technical Authority	Y
A	Weather Resilience and Climate Change Adaptation Strategy Manager	Technical Authority	Y
A	Climate Change Adaptation Manager	Technical Authority	N
A	Professional Head of Structures	Technical Authority	Y
A	Chief Track, Switches and Crossings Engineer	Regions	N
A	Capacity Planning Manager	System Operator	N
A	Senior Incident Officer	Regions	N
A	Section Manager (Maintenance)	Regions	N
Briefing		**Function**	

(A-Awareness/ T-Technical)		
A	Train / Freight Operating Companies	External

NOTE: *Contractors are responsible for arranging and undertaking their own Technical and Awareness Briefings in accordance with their own processes and procedures.*

Ref:	**NR/BS/LI/453**
Issue date:	18 August 2020
Compliance date:	18 August 2020
Expiry date:	17 November 2020

Emergency change: NR/BS/LI/453

Standard/control document affected: NR/L3/OPS/021 Module 8 Managing The Weather - Earthworks (Issue 01),

The affected standard/control document will be reviewed and up-issued before this emergency change expires on 17th November 2020

For further information contact: Paul Ashton, Head of Operations Principles & Standards

[redacted]

1 Reason for issue

With the recent tragic events in Scotland there is a need to reaffirm our approach to the risk from extreme rainfall and the effect it has on our infrastructure specifically around earthworks, and to consistently apply the current framework. This emergency change is intended as short term change and will be supplemented or amended by the introduction of better forecasting technology or procedural improvements.

This note is intended to brief the following such that this advice can be enacted within each Route from Tuesday 18th August 2020.

2 Scope

This emergency change is applicable to the RAM Geotechnical and each Route Control and any other roles accountable for the management of earthworks

The guidance within the **Weather Management Modules – NR/L3/OPS/021 Module 8 (Earthworks)** of our control framework recognise very heavy rainfall and that this can introduce a risk of overwhelming the infrastructure and initiate incidents that are hard to predict in both location, nature and asset condition.

To maintain the safe operation of trains in these circumstances additional mitigating actions shall be considered in a structured manner. These mitigations should include the consideration of reducing operational hazard, whether that be by withdrawing services or reducing the speed of trains on sections of the infrastructure where risk is identified.

Clause 5.4 introduces a structured approach to the risk of rainfall on earthworks

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Ref:	**NR/BS/LI/453**
Issue date:	18 August 2020
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3 Changes

Clause/sub-clause	Change
5.4	Delete Note 2 Add d) The susceptibility of earthwork infrastructure requires a risk-based approach to operational management. At times of significantly heightened rainfall intensity (i.e. levels well above asset thresholds) increased proportions of the network may become susceptible to failure. The Route Director shall arrange for the dynamic assessment of the risk to operational management, regardless of whether there are any cutting slopes or embankments in the documented IWMP for the geographical area under threat. *NOTE 2: This activity should now be undertaken irrespective of the presence of at-risk assets* e) Each Route's adverse weather procedures shall be reviewed by the Route Director. This should recognise this requirement and specifically consider the establishment of a structured and syndicated dynamic risk assessment, which considers the whole operational impact – involving asset (geotechnical, drainage and structures) , operational and maintenance teams, along with the needs and impacts on other Rail Undertakings (Train operators). f) Due to the variation across the network, Routes should consider their clear definition and application of – "significantly heightened rainfall" – and how this reflects appropriately local abnormal levels. g) Routes shall confirm that during the period of severe weather that regular reviews are undertaken to confirm that the planned mitigations remain suitable for the emerging situation. h) The senior person appointed to lead the implementation of the arrangements (e.g. Control Manager, Incident Officer) should confirm that information is available to identify weather conditions in real time. i) If the events exceed that which had been expected in the risk assessment, in volume or severity, additional measures shall be

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	taken to confirm safety of passengers and employees. This shall explicitly assess the need for additional resources to support the operational control centres and the decisions required to control emerging risks. This should form part of EWAT and Control conference calls over the next few weeks whilst more widespread amendments to our processes and introduction of improved weather forecasting tools are considered.

Approval of Standard and Control Document Owner

Approved by:

[redacted]

Paul Ashton, Head of Operations Principles & Standards

Approval of Delivery Function Authority

Approved by:

[redacted]

Oliver Bratton, Director Network Strategy and Operations

Approval of Standards and Controls Management Team

Approved for publication by:

[redacted]

John Winnifrith, Acting PrincipalRules, Standards andControls Manager

Ref:	**NR/BS/LI/453**
Issue date:	18 August 2020
Compliance date:	18 August 2020
Expiry date:	17 November 2020

4 Recipients

Name	**Post**
Eliska Burrows	Route Director, Anglia
James Dean	Route Director, West Coast Mainline South
Michael Gallop	Route Director, Western
Philip James	Route Director, North West
William Kelly	Route Director, Wales
Mark Killick	Route Director, Wessex
Shaun King	Route Director, Sussex
David Penney	Route Director, Central
Matthew Rice	Route Director, North East
Paul Rutter	Route Director, East Coast
Liam Sumpter	Route Director, Scotland
Fiona Taylor	Route Director, Kent
Gary Walsh	Route Director, East Midlands
Philip Barnes	Head of Operations Delivery, NW & Central
Martin Colmey	Head of Operations Delivery, NW & Central
Mark Corney	Head of Operations Delivery (Telecoms)
David Davidson	Head of Operations Delivery, Eastern
Christopher Fuoco	Head of Operations Delivery, Wales & Western
Christopher Gee	Head of Operations Delivery, Eastern
Neil Henry	Head of Operations Delivery, Eastern
Richard Horobin	Head of Operations Delivery, North West & Central
Clyde Howarth	Head of Operations Delivery, Southern
Timothy Leighton	Head of Operations Delivery, Southern
Gunnar Lindahl	Head of Operations Delivery, Southern
Jim Mansfield	Head of Operations Delivery, East Mids
Daniel Matthews	Head of Operations Delivery, Southern
Ross Moran	Head of Operations Delivery, Scotland
Mike Paterson	Head of Operations Delivery, Southern
Chris Pearce	Head of Operations Delivery, Wales & Western
Martin Ball	Head of Maintenance Delivery, North West & Central
Mark Budden	Head of Maintenance Delivery, Eastern

Ref:	**NR/BS/LI/453**
Issue date:	18 August 2020
Compliance date:	18 August 2020
Expiry date:	17 November 2020

Robert Coulson	Head of Maintenance Delivery, Southern
Royston Evans	Head of Maintenance Delivery, North West & Central
Timothy Flower	Professional Head of Maintenance
Ian Griffiths	Professional Head of Maintenance
Paul Jenkins	Head of Maintenance Delivery, Wales & Western
Ivan Kimble	Head of Maintenance Delivery, Southern
Tom McNamee	Head of Maintenance Delivery, Southern
Richard Owens	Head of Maintenance Delivery, Eastern
Ian Puckrin	Head of Maintenance Delivery, Eastern
Lindsay Saddler	Head of Maintenance Delivery, Scotland
Terence Strickland	Head of Maintenance Delivery, North West & Central
Martin Taylor	Head of Maintenance Delivery, Wales & Western
Charlie Usher	Head of Maintenance Delivery, Southern
Andrew Murray	Director Engineering & Asset Management, Eastern
Jane Austin	Director Engineering & Asset Management, Wales & Western
Joan Heery	Director Engineering & Asset Management, Track
Kamini Edgeley	Director Engineering & Asset Management, North West & Central

5 Details of briefing or cascade communication process

Re-brief – Each Route to develop briefing process to cascade the following (realising each Route has differing roles now)

Weather - managing the operational risks - **NR/L2/OPS/021**
Weather Management Modules – **NR/L3/OPS/021 08 (Earthworks)**

Process owner (Route specific) to brief on the importance and content of EWAT and to include the above clarifications.

Ref:	**NR/BS/LI/454**
Issue date:	14 September 2020
Compliance date:	14 September 2020
Expiry date:	31 March 2021

Emergency change: NR/BS/LI/454

Standard/control document affected: NR/L3/OPS/021 Module 13 Managing the Weather – Extreme Weather Response Process (Issue 01),

The affected standard/control document will be reviewed and up-issued before this emergency change expires on 31 March 2021

For further information contact: Paul Ashton, Head of Operations Principles & Standards [redacted]).

1 Reason for issue

As a result of recent events there is an urgent need to reaffirm our approach to the risk from extreme rainfall and the effect it has on our infrastructure specifically around extreme weather response processing and to consistently apply the current framework. This emergency change is intended as a short-term change and will be supplemented or amended by the introduction of better forecasting technology or procedural improvements.

This brief is intended to allow each route to take action based on the advice given in this emergency change.

2 Scope

This emergency change is applicable to the RAM Geotechnical and each Route Control and any other roles accountable for the management of extreme weather response process. It has been developed to coincide with the publication of the new rules (GE/RT8000, Module 3 Sections 7.1-7.4, Module G1 Section 3, Handbook 1 Section 8).

3 Changes

Clause/sub-clause	Change
Appendix B – EWAT Heavy Rain Agenda	*Changed:* As a result of feedback from the Routes, tick boxes have been added to the agenda together with other minor formatting changes (see attached). The content remains unchanged.

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Ref:	**NR/BS/LI/454**
Issue date:	14 September 2020
Compliance date:	14 September 2020
Expiry date:	31 March 2021

NR/L3/OPS/021/13 – Appendix B

EWAT Agenda for Heavy Rain				
No.	**Item**	**Completed / Applicable?**		
1	**Roll Call**	**Y**	**N**	**NA**
•	List of Attendees			
•	Confirm the chairperson and secretary			
•	Confirm how EWAT notes will be distributed and by when			
2	**Forecast Update**	**Y**	**N**	**NA**
•	Confirm affected forecast areas and geographical boundaries			
•	Confirm the forecasted start and finish time of the heavy rain			
•	Confirm the time the risk is expected to be at its worst			
•	What is the maximum rainfall intensity and volume?			
•	How does it compare to normal average totals?			
•	What will be the impact of precursor conditions?			
•	What is the confidence level in the forecast?			
•	Is it likely to be a prolonged event?			
•	Have any EA flood warnings or alerts been published?			
•	When will the next update be available?			
•	Any further questions for the forecaster?			
•	If lightning is a risk associated with this event, consider using the additional guidance in Appendix A			

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3	Declaration	Y	N	NA
•	Have the thresholds for a heavy rain event been met? If so declare this as an extreme weather event.			
4	**Risk Assessment and Mitigation Plans**	**Y**	**N**	**NA**
•	Are assets at risk due to heavy rainfall / flooding?			
•	Are resources and evacuation plans available to manage stranded trains?			
•	Are there any managed stations or TOC operated stations at risk?			
•	Consideration for overcrowding at stations and management of passenger flow at stations			
•	Confirmation that drainage at high risk sites has been inspected			
•	Are sufficient resources and competent staff available? (For example, staff to attend at flooding locations and at earthwork risk locations etc.)			
•	Do we need to stagger resources?			
•	Confirm that appropriate risk assessments are in place for employee activities			
•	Where are pumps available? Confirm that these are in position and have sufficient fuel supplies?			
•	Are temporary flood defences available?			
•	Are there any managed stations or TOC operated stations at risk?			
•	Are there any route or location specific risks that need to be considered for example implementation of site specific response plans?			
•	If lightning is a risk associated with this event, consider using the additional guidance in Appendix A			
5	**Command and Control**	**Y**	**N**	**NA**
•	Do we need to establish a Strategic / Tactical / Operational command structure?			
•	If so detail the arrangements as outlined in NR…			
•	Define and agree the communication arrangements with emergency services and the Environment Agency			

Ref:	**NR/BS/LI/454**
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• Is additional support required for route control or trust delay attribution?			
6 Communication	**Y**	**N**	**NA**
• Define and agree customer information protocols			
• Identify stakeholders (for example, customer account teams, property teams) and agree communication protocols			
7 Service Recovery	**Y**	**N**	**NA**
• Are emergency timetables to be deployed?			
• Is the VSTP team likely to need assistance?			
• Confirmation of route proving arrangements after the event			
8 AOB	**Y**	**N**	**NA**
• Summary of actions and decisions			
• Confirm time of next meeting if required			
• AOB			
• Reiterate how and when notes from meeting will be distributed			
• Meeting Close			

Ref:	**NR/BS/LI/454**
Issue date:	14 September 2020
Compliance date:	14 September 2020
Expiry date:	31 March 2021

Approval of Standard and Control Document Owner

Approved by:

[redacted]

Paul Ashton, Head of Operations Principles & Standards

Approval of

Delivery Function Authority

Approved by:

[redacted]

Mark Killick, Route Director,

Approval of Standards and Controls Management Team

Approved for publication by:

[redacted]

John Winnifrith, Senior Standards & Controls Specialist

Ref:	**NR/BS/LI/454**
Issue date:	14 September 2020
Compliance date:	14 September 2020
Expiry date:	31 March 2021

4 Recipients

Name	**Post**
Eliska Burrows	Route Director, Anglia
James Dean	Route Director, West Coast Mainline South
Michael Gallop	Route Director, Western
Philip James	Route Director, North West
William Kelly	Route Director, Wales
Mark Killick	Route Director, Wessex
Shaun King	Route Director, Sussex
David Penney	Route Director, Central
Matthew Rice	Route Director, North East
Paul Rutter	Route Director, East Coast
Liam Sumpter	Route Director, Scotland
Fiona Taylor	Route Director, Kent
Gary Walsh	Route Director, East Midlands
Philip Barnes	Head of Operations Delivery, NW & Central
Martin Colmey	Head of Operations Delivery, NW & Central
Mark Corney	Head of Operations Delivery (Telecoms)
David Davidson	Head of Operations Delivery, Eastern
Christopher Fuoco	Head of Operations Delivery, Wales & Western
Christopher Gee	Head of Operations Delivery, Eastern
Neil Henry	Head of Operations Delivery, Eastern
Richard Horobin	Head of Operations Delivery, North West & Central
Clyde Howarth	Head of Operations Delivery, Southern
Timothy Leighton	Head of Operations Delivery, Southern
Gunnar Lindahl	Head of Operations Delivery, Southern
Jim Mansfield	Head of Operations Delivery, East Mids
Daniel Matthews	Head of Operations Delivery, Southern
Ross Moran	Head of Operations Delivery, Scotland
Mike Paterson	Head of Operations Delivery, Southern
Chris Pearce	Head of Operations Delivery, Wales & Western
Martin Ball	Head of Maintenance Delivery, North West & Central
Mark Budden	Head of Maintenance Delivery, Eastern
Robert Coulson	Head of Maintenance Delivery, Southern
Royston Evans	Head of Maintenance Delivery, North West & Central
Timothy Flower	Professional Head of Maintenance

Ref:	**NR/BS/LI/454**
Issue date:	14 September 2020
Compliance date:	14 September 2020
Expiry date:	31 March 2021

Ian Griffiths	Professional Head of Maintenance
Paul Jenkins	Head of Maintenance Delivery, Wales & Western
Ivan Kimble	Head of Maintenance Delivery, Southern
Tom McNamee	Head of Maintenance Delivery, Southern
Richard Owens	Head of Maintenance Delivery, Eastern
Ian Puckrin	Head of Maintenance Delivery, Eastern
Lindsay Saddler	Head of Maintenance Delivery, Scotland
Terence Strickland	Head of Maintenance Delivery, North West & Central
Martin Taylor	Head of Maintenance Delivery, Wales & Western
Charlie Usher	Head of Maintenance Delivery, Southern
Andrew Murray	Director Engineering & Asset Management, Eastern
Jane Austin	Director Engineering & Asset Management, Wales & Western
Joan Heery	Director Engineering & Asset Management, Track
Kamini Edgeley	Director Engineering & Asset Management, North West & Central

5 Details of briefing or cascade communication process

Re-brief – Each Route to develop briefing process to cascade the following (realising each Route has differing roles now)

Weather - Managing the Operational Risks - NR/L2/OPS/021
Weather Management Modules – NR/L3/OPS/021 13 (EWRP)

Process owner (Route specific) to brief on the importance and content of EWAT and to include the above clarifications.

Ref:	NR/L3/OPS/021/12
Issue:	01
Date:	05 September 2020
Compliance date:	05 September 2020

NR/L3/OPS/021

Module 12

Flooding- Management of Drainage

Published and Issued by Network Rail, 2nd Floor, One Eversholt Street, London, NW1 2DN.

User information

This Network Rail document contains colour-coding according to the following Red–Amber–Green classification.

Red requirements – *no variations permitted*

- Red requirements are to be complied with and achieved at all times.
- Red requirements are presented in a red box.
- Red requirements are monitored for compliance.
- Non-compliances will be investigated and corrective actions enforced.

Amber requirements – *variations permitted subject to approved risk analysis and mitigation*

- Amber requirements are to be complied with unless an approved variation is in place.
- Amber requirements are presented with an amber sidebar.
- Amber requirements are monitored for compliance.
- Variations can only be approved through the national variations process.
- Non-approved variations will be investigated and corrective actions enforced.

Green guidance – *to be used unless alternative solutions are followed*

- Guidance should be followed unless an alternative solution produces a better result.
- Guidance is presented with a dotted green sidebar.
- Guidance is not monitored for compliance.
- Alternative solutions should be documented to demonstrate effective control.

Compliance

This Network Rail standard/control document is mandatory and shall be complied with by Network Rail Infrastructure Limited and its contractors if applicable from 05 September 2020

Where it is considered not reasonably practicable[1] to comply with the requirements in this standard/control document, permission to comply with a specified alternative should be sought in accordance with the Network Rail standards and controls process, or with the Railway Group Standards Code if applicable.

If this standard/control document contains requirements that are designed to demonstrate compliance with legislation they shall be complied with irrespective of a project's Governance for Railway Investment Projects (GRIP) stage. In all other circumstances, projects that have formally completed GRIP Stage 3 (Option Selection) may continue to comply with any relevant Network Rail standards/control documents that were current when GRIP Stage 3 was completed.

NOTE 1: *Legislation includes Technical Specifications for Interoperability (TSIs).*

NOTE 2: *The relationship of this standard/control document with legislation and/or external standards is described in the purpose of this standard.*

Disclaimer

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[1] *This can include gross proportionate project costs with the agreement of the Network Rail Assurance Panel (NRAP).*

Issue record

Issue	Date	Comments
01	September 2020	Initial Document

Reference documentation

NR/L2/OPS/021	Weather Management Plan

Contents

1 Purpose

This module describes the operational requirements for management of drainage during Adverse/Extreme Weather (A/EW).

This procedure manages the control, ‘weather – managing operational risk’, by mitigating the risk of flooding.

2 Scope

This module contains the business process to manage drainage during A/EW by:

a) selecting high risk drainage systems as identified in the Route Drainage Management Plans (RDMP) for inclusion in the Integrated Weather Management Plan (IWMP);
b) identifying the actions to be taken during A/EW weather events to maintain levels of safety and performance;
c) developing, reviewing and updating the record of the drainage systems contained within the relevant sections of the IWMP; and
d) implementing measures documented in the IWMP for drainage.

This module applies to all drainage systems within the network rail boundary, and drainage assets outside the boundary which have the potential to affect Network Rail infrastructure.

3 Roles and Responsibilities

R – Responsible is the person or people who are responsible for performing a certain task or action. **A – An Accountable** person is one who has overall accountability to make sure that a task or action is completed. **C – Consulted** people have an input into the task or action, this can be providing information, reviewing documents or attending workshops etc. **I – Informed** people are those who receive the output of a task or process. * Denotes option for delegation		Route Asset Manager (Drainage) RAM (Drainage)	Senior Asset Engineer (Drainage) SAE (Drainage)	Seasons Delivery Specialist (SDS)	Current Operations Manager (COM)	Route Control Manager (RCM)	Chief Operating Officer
5.2	Conduct Review	A/R	R	I	I	I	I
5.3	Create/Update Drainage System Requirements	A/R	R	I	I	I	I
5.4	Incorporation into IWMP	I	I	R	I	I	A
5.5	Implementation of risk mitigation measures	A	I	I	R	R	A
6.1	Records	A	I	I	R	R	A

Table 1 –RACI chart

NOTE: *Where no RAM (Drainage) in Route, these will transfer to RAM (Geotech) or to Senior Asset Engineer (Drainage).*

4 Definitions and Abbreviations

For this module the definitions shown in **Table 2** apply.

Term	Definition
Adverse/Extreme Weather	A period of weather that is outside the normal range that can result in scour, storms, flooding, high tides, desiccation or high groundwater levels, increasing the likelihood that an earthwork asset may fail, suffer performance loss or experience accelerated degradation. It includes periods of prolonged and / or intense rainfall, prolonged dry and / or hot periods, and periods of repeated freezing and thawing.
Integrated Weather Management Plan	A complete route-wide plan for the mitigation of weather-related risks and the associated requirements of company standards to adequately manage risk across the infrastructure.
Route Drainage Management Plan	Documents the overall strategy for managing the drainage assets and owned by the Route Asset Manager (Drainage)

Table 2 – Terms and definitions

For this module the definitions shown in **Table 3** apply.

Term	Definition
A/EW	Adverse / Extreme Weather
EWAT	Extreme Weather Action Teleconference
IWMP	Integrated Weather Management Plan
RDMP	Route Drainage Management Plan

Table 3 – Abbreviations

5 Procedure

5.1 Procedural Steps

The procedural steps set out below define the requirements in the management of weather-related threats against drainage systems. Detailed management procedures including specific risk assessments are contained with the RDMP.

5.2 Conduct Review

The RAM (Drainage) shall review the list of drainage systems at high risk from A/EW at least annually and update the RDMP accordingly.

5.3 Create/Update Drainage System Requirements

The RDMP shall include a list of drainage systems that are at risk, and the mitigation measures required to manage the risks.

The SAE (Drainage) shall annually review the drainage systems contained within the RDMP and record the justification for drainage systems which were added or removed from the RDMP.

The SAE (Drainage) shall define in the RDMP (for subsequent inclusion into the IWMP):

a) the weather warning system and any other monitoring systems to be adopted e.g. river level alarms;
b) threshold trigger levels for the notification of a forecast of flood, tidal surge, adverse / extreme rainfall or any other monitored parameter;
c) the maximum level to which water can rise before the stability or use of the earthworks, track or associated infrastructure will be jeopardised;
d) specific actions to be taken, dependent on the level of the water and / or flow conditions;
e) procedures (such as a rapid response or special examination) to validate informal reports of flooding or high water levels.
f) actions to be taken following the notification, including actions for safeguarding railway operations;
g) circumstances that require closure of a line, imposition of an emergency speed restriction or any other operational restriction and the procedures to be followed in such cases;
h) procedures for reopening a line to rail traffic, or the removal of an emergency speed restriction or any other operational restriction imposed to mitigate the risk;
i) identification of those responsible for carrying out the tasks; and
j) arrangements for contact and liaison with an outside party.

5.4 Incorporation into IWMP

The Seasons Delivery Specialist (SDS) shall request from the RAM (Drainage) at the end of the financial year (March) a list of sites contained within the RDMP that are susceptible to flooding from A/EW.

The requirements of the RDMP shall be incorporated into the IWMP and included in the company weather warning system for implementation

5.5 Implementation of risk mitigation measures

The RAM (Drainage) or nominated representative(s) shall be invited to participate in operational planning discussions and EWATs:

a) as and when rainfall levels do or are expected to exceed those specified in the IWMP;
b) in the build up to and during rainfall events of significantly heightened intensity that are forecast to occur in geographical areas where no drainage systems are documented within the IWMP. Appropriate engineering input from the RAM (Drainage) team shall be sought to provide a technical view on risk exposure, supported by a dynamic risk assessment; and
c) as and when there are heightened concerns from hazards that may materialise from rapid snowmelt and ground thaw.

6 Records

Decisions made, and actions taken to manage risks of A/EW, flooding and water action shall be recorded and retained for the life of the drainage systems to enable subsequent analysis of control effectiveness.

Ref:	NR/L3/OPS/021/13
Issue:	01
Date:	07 December 2019
Compliance date:	07 March 2020

NR/L3/OPS/021

Module 13

Extreme Weather Response Process

Emergency change

Issue date: 14 September 2020
Compliance date: 14 September 2020
Expiry date: 31 March 2021

Emergency change NR/BS/LI/454 is attached to this standard/control document.

This emergency change mitigates an urgent safety/asset/equipment risk that cannot await a full review of this standard/control document.

This standard/control document will be reviewed and reissued before the emergency change expires on 31 March 2021.

[redacted]
Paul Ashton,
Head of Operations, Principles & Standards.

Published and Issued by Network Rail, 2nd Floor, One Eversholt Street, London, NW1 2DN.

Ref:	**NR/L3/OPS/021/13**
Issue:	01
Date:	07 December 2019
Compliance date:	07 March 2020

User information

This Network Rail document contains colour-coding according to the following Red–Amber–Green classification.

Red requirements – *no variations permitted*

- Red requirements are to be complied with and achieved at all times.
- Red requirements are presented in a red box.
- Red requirements are monitored for compliance.
- Non-compliances will be investigated and corrective actions enforced.

Amber requirements – *variations permitted subject to approved risk analysis and mitigation*

- Amber requirements are to be complied with unless an approved variation is in place.
- Amber requirements are presented with an amber sidebar.
- Amber requirements are monitored for compliance.
- Variations can only be approved through the national variations process.
- Non-approved variations will be investigated and corrective actions enforced.

Green guidance – *to be used unless alternative solutions are followed*

- Guidance should be followed unless an alternative solution produces a better result.
- Guidance is presented with a dotted green sidebar.
- Guidance is not monitored for compliance.
- Alternative solutions should be documented to demonstrate effective control.

Ref:	NR/L3/OPS/021/13
Issue:	01
Date:	07 December 2019
Compliance date:	07 March 2020

Compliance

This Network Rail standard/control document is mandatory and shall be complied with by Network Rail Infrastructure Limited and its contractors if applicable from 07 March 2020.

Where it is considered not reasonably practicable[1] to comply with the requirements in this standard/control document, permission to comply with a specified alternative should be sought in accordance with the Network Rail standards and controls process, or with the Railway Group Standards Code if applicable.

If this standard/control document contains requirements that are designed to demonstrate compliance with legislation they shall be complied with irrespective of a project's Governance for Railway Investment Projects (GRIP) stage. In all other circumstances, projects that have formally completed GRIP Stage 3 (Option Selection) may continue to comply with any relevant Network Rail standards/control documents that were current when GRIP Stage 3 was completed.

NOTE 1: *Legislation includes Technical Specifications for Interoperability (TSIs).*

NOTE 2: *The relationship of this standard/control document with legislation and/or external standards is described in the purpose of this standard.*

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[1] *This can include gross proportionate project costs with the agreement of the Network Rail Assurance Panel (NRAP).*

Ref:	NR/L3/OPS/021/13
Issue:	01
Date:	07 December 2019
Compliance date:	07 March 2020

Issue record

Issue	Date	Comments
01	September 2019	First issue

Reference documentation

NR/L3/OPS/045/3.17	Weather Arrangements

Legislation

No legislation has been identified that is applicable to the content of this standard/control document.

Ref:	**NR/BS/LI/454**
Issue date:	14 September 2020
Compliance date:	14 September 2020
Expiry date:	31 March 2021

Emergency change: NR/BS/LI/454

Standard/control document affected: NR/L3/OPS/021 Module 13 Managing the Weather – Extreme Weather Response Process (Issue 01),

The affected standard/control document will be reviewed and up-issued before this emergency change expires on 31 March 2021

For further information contact: Paul Ashton, Head of Operations Principles & Standards
[redacted]

1 Reason for issue

As a result of recent events there is an urgent need to reaffirm our approach to the risk from extreme rainfall and the effect it has on our infrastructure specifically around extreme weather response processing and to consistently apply the current framework. This emergency change is intended as a short-term change and will be supplemented or amended by the introduction of better forecasting technology or procedural improvements.

This brief is intended to allow each route to take action based on the advice given in this emergency change.

2 Scope

This emergency change is applicable to the RAM Geotechnical and each Route Control and any other roles accountable for the management of extreme weather response process. It has been developed to coincide with the publication of the new rules (GE/RT8000, Module 3 Sections 7.1-7.4, Module G1 Section 3, Handbook 1 Section 8).

3 Changes

Clause/sub-clause	Change
Appendix B – EWAT Heavy Rain Agenda	*Changed:* As a result of feedback from the Routes, tick boxes have been added to the agenda together with other minor formatting changes (see attached). The content remains unchanged.

Published and Issued by Network Rail, 2nd Floor, One Eversholt Street, London, NW1 2DN.

Ref:	**NR/BS/LI/454**
Issue date:	14 September 2020
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NR/L3/OPS/021/13 – Appendix B

EWAT Agenda for Heavy Rain				
No.	**Item**	**Completed / Applicable?**		
1	**Roll Call**	**Y**	**N**	**NA**
•	List of Attendees			
•	Confirm the chairperson and secretary			
•	Confirm how EWAT notes will be distributed and by when			
2	**Forecast Update**	**Y**	**N**	**NA**
•	Confirm affected forecast areas and geographical boundaries			
•	Confirm the forecasted start and finish time of the heavy rain			
•	Confirm the time the risk is expected to be at its worst			
•	What is the maximum rainfall intensity and volume?			
•	How does it compare to normal average totals?			
•	What will be the impact of precursor conditions?			
•	What is the confidence level in the forecast?			
•	Is it likely to be a prolonged event?			
•	Have any EA flood warnings or alerts been published?			
•	When will the next update be available?			
•	Any further questions for the forecaster?			
•	If lightning is a risk associated with this event, consider using the additional guidance in Appendix A			

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3	Declaration	Y	N	NA
•	Have the thresholds for a heavy rain event been met? If so declare this as an extreme weather event.			
4	**Risk Assessment and Mitigation Plans**	**Y**	**N**	**NA**
•	Are assets at risk due to heavy rainfall / flooding?			
•	Are resources and evacuation plans available to manage stranded trains?			
•	Are there any managed stations or TOC operated stations at risk?			
•	Consideration for overcrowding at stations and management of passenger flow at stations			
•	Confirmation that drainage at high risk sites has been inspected			
•	Are sufficient resources and competent staff available? (For example, staff to attend at flooding locations and at earthwork risk locations etc.)			
•	Do we need to stagger resources?			
•	Confirm that appropriate risk assessments are in place for employee activities			
•	Where are pumps available? Confirm that these are in position and have sufficient fuel supplies?			
•	Are temporary flood defences available?			
•	Are there any managed stations or TOC operated stations at risk?			
•	Are there any route or location specific risks that need to be considered for example implementation of site specific response plans?			
•	If lightning is a risk associated with this event, consider using the additional guidance in Appendix A			
5	**Command and Control**	**Y**	**N**	**NA**
•	Do we need to establish a Strategic / Tactical / Operational command structure?			
•	If so detail the arrangements as outlined in NR…			
•	Define and agree the communication arrangements with emergency services and the Environment Agency			

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• Is additional support required for route control or trust delay attribution?			
6 Communication	**Y**	**N**	**NA**
• Define and agree customer information protocols			
• Identify stakeholders (for example, customer account teams, property teams) and agree communication protocols			
7 Service Recovery	**Y**	**N**	**NA**
• Are emergency timetables to be deployed?			
• Is the VSTP team likely to need assistance?			
• Confirmation of route proving arrangements after the event			
8 AOB	**Y**	**N**	**NA**
• Summary of actions and decisions			
• Confirm time of next meeting if required			
• AOB			
• Reiterate how and when notes from meeting will be distributed			
• Meeting Close			

Ref:	**NR/BS/LI/454**
Issue date:	14 September 2020
Compliance date:	14 September 2020
Expiry date:	31 March 2021

Approval of Standard and Control Document Owner

Approved by:

[redacted]

Paul Ashton, Head of Operations Principles & Standards

Approval of

Delivery Function Authority

Approved by:

[redacted]

Mark Killick, Route Director,

Approval of Standards and Controls Management Team

Approved for publication by:

[redacted]

John Winnifrith, Senior Standards & Controls Specialist

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4 Recipients

Name	**Post**
Eliska Burrows	Route Director, Anglia
James Dean	Route Director, West Coast Mainline South
Michael Gallop	Route Director, Western
Philip James	Route Director, North West
William Kelly	Route Director, Wales
Mark Killick	Route Director, Wessex
Shaun King	Route Director, Sussex
David Penney	Route Director, Central
Matthew Rice	Route Director, North East
Paul Rutter	Route Director, East Coast
Liam Sumpter	Route Director, Scotland
Fiona Taylor	Route Director, Kent
Gary Walsh	Route Director, East Midlands
Philip Barnes	Head of Operations Delivery, NW & Central
Martin Colmey	Head of Operations Delivery, NW & Central
Mark Corney	Head of Operations Delivery (Telecoms)
David Davidson	Head of Operations Delivery, Eastern
Christopher Fuoco	Head of Operations Delivery, Wales & Western
Christopher Gee	Head of Operations Delivery, Eastern
Neil Henry	Head of Operations Delivery, Eastern
Richard Horobin	Head of Operations Delivery, North West & Central
Clyde Howarth	Head of Operations Delivery, Southern
Timothy Leighton	Head of Operations Delivery, Southern
Gunnar Lindahl	Head of Operations Delivery, Southern
Jim Mansfield	Head of Operations Delivery, East Mids
Daniel Matthews	Head of Operations Delivery, Southern
Ross Moran	Head of Operations Delivery, Scotland
Mike Paterson	Head of Operations Delivery, Southern
Chris Pearce	Head of Operations Delivery, Wales & Western
Martin Ball	Head of Maintenance Delivery, North West & Central
Mark Budden	Head of Maintenance Delivery, Eastern
Robert Coulson	Head of Maintenance Delivery, Southern
Royston Evans	Head of Maintenance Delivery, North West & Central
Timothy Flower	Professional Head of Maintenance

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Ian Griffiths	Professional Head of Maintenance
Paul Jenkins	Head of Maintenance Delivery, Wales & Western
Ivan Kimble	Head of Maintenance Delivery, Southern
Tom McNamee	Head of Maintenance Delivery, Southern
Richard Owens	Head of Maintenance Delivery, Eastern
Ian Puckrin	Head of Maintenance Delivery, Eastern
Lindsay Saddler	Head of Maintenance Delivery, Scotland
Terence Strickland	Head of Maintenance Delivery, North West & Central
Martin Taylor	Head of Maintenance Delivery, Wales & Western
Charlie Usher	Head of Maintenance Delivery, Southern
Andrew Murray	Director Engineering & Asset Management, Eastern
Jane Austin	Director Engineering & Asset Management, Wales & Western
Joan Heery	Director Engineering & Asset Management, Track
Kamini Edgeley	Director Engineering & Asset Management, North West & Central

5 Details of briefing or cascade communication process

Re-brief – Each Route to develop briefing process to cascade the following (realising each Route has differing roles now)

Weather - Managing the Operational Risks - NR/L2/OPS/021
Weather Management Modules – NR/L3/OPS/021 13 (EWRP)

Process owner (Route specific) to brief on the importance and content of EWAT and to include the above clarifications.

Appendix F: NR/L3/TRK/1010, Issue 02, Management of responses to extreme weather conditions at structures, earthworks and other key locations, August 2008

Ref:	NR/L3/TRK/1010
Issue:	2
Date:	26 August 2008
Compliance date:	26 August 2008

Level 3

Management of responses to extreme weather conditions at structures, earthworks and other key locations

Endorsement and Authorisation

Endorsed by:

[redacted]

C Hawley, Working Group Chair

Authorised by:

[redacted]

pp E R Cummings, Steering Group Chair

Accepted for issue by:

[redacted]

M McManus, National Standards Manager

Published and Issued by Network Rail, 40 Melton Street, London NW1 2EE.

Network Rail

Issue record

Issue	Date	Comments
1.0	October 07	Initial issue
2.0	August 2008	Re issue to incorporate changes as a result of Maintenance and Engineering (Track and Civil) reorganisation. Additionally document renumbered from NR/L3/MTC/TK0167 to align with Track Engineering document numbering system

Compliance

This Network Rail standard is mandatory and shall be complied with by Network Rail and its contractors if applicable from 26 August 2008.

When this standard is implemented, it is permissible for all projects that have formally completed GRIP Stage 4 to continue to comply with the Issue of any relevant Network Rail Standards current when GRIP Stage 4 was reached and not to comply with requirements contained herein, unless the designated Standard Owner has stipulated otherwise in the accompanying Briefing Note.

Reference documentation

NR/L2/TRK/001	*Inspection and Maintenance of Permanent Way*
NR/SP/CTM/011	*Competence and Training in Track Engineering*
NR/CS/CIV/032	*Managing Existing Structures*
NR/GN/TRK/7001/TWI2B014	*How to carry out flood warning inspections*
NR/L3/TRK/002/A08	*Flood warning inspection*
NR/L3/TRK/1013	*Maintenance of track assets*

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Contents

1 Purpose

This process outlines the roles and responsibilities for the maintenance organisation to manage the necessary actions in order to protect the line as a result of extreme weather conditions including water action (including flooding, storm, wave action, scour) at structures, earthworks and other key locations.

2 Scope

This process applies to all maintenance staff whose duties include track maintenance and inspection.

This procedure does not cover structures maintenance teams who will have their own procedure.

SMP applies to:	Infrastructure Maintenance	Operational Property	Overhead Line Condition Renewals	Contractors
	✓			✓

3 Roles and responsibilities

3.1 RACI

RACI DETAILS	KEY CONTROL ACTIVITY	TME Track Maintenance Engineer	IME Infrastructure Maintenance Engineer	IMDM Infrastructure Maintenance Delivery Manager	TSE Territory Structures Engineer	TGE Territory Geotechnical Engineer	TCE Territory Civil Engineer	ICC Integrated Control Centre	ROC Route Operations Control	SM[T] Section Manager [Track]	CP Competent Person	Sig Signaller	ISM Infrastructure Services Manager
Process Task													
6.1		Details contained within clause											
6.2		R	C	A				C		I			
6.3		I			I	I		A/R	I				
6.4		R		A						C			
7.1		A						I		R	R	I	
7.2		A						I		R	R	I	
7.3		A						I		R	R	I	
8.1		A								R	I		
8.2								I		A	R	I	
8.3								A/R	I				
8.4					I	I			A/R				
9.1		I			R	R	A						
9.2		A/R						C		C		C	
9.3										A/R	C/R		
9.3.1		C								A/R			C
9.4								I		A/I	R	I	
end RACI													

RACI is a means of linking process steps to roles as follows:

- R – Responsible: the individual(s) who perform an activity – responsible for action/implementation – although usually only one, Rs can be shared
- A – Accountable: the individual who is ultimately accountable including yes/no decision and power of veto – only one ‘A’ can be assigned
- C – Consulted: the individual(s) to be consulted prior to a final decision being made or action taken – two-way communication.
- I – Informed: the individual(s) who need to be informed after a decision is made or action is taken – one-way communication.

4 Abbreviations and definitions

4.1 Abbreviations

CP	Competent Person
EA	Environment Agency
EWP	Extreme Weather Plan
ICC	Integrated Control Centre
IMDM	Infrastructure Maintenance Delivery Manager
IME	Infrastructure Maintenance Engineer
ISM	Infrastructure Services Manager
ROC	Route Operations Control
SEPA	Scottish Environment Protection Agency
SM[T]	Section Manager [Track]
TCE	Territory Civil Engineer
TGE	Territory Geotechnical Engineer
TME	Track Maintenance Engineer
TSE	Territory Structures Engineer

4.2 Definitions

All Clear

EA Definition ~ There are no Flood Watches or Flood Warnings currently in force in the area covered by the message

Flood Warning

EA Definition ~ Flooding of homes, businesses and main roads is expected in the area covered by the message, act now

Flood Watch

EA Definition ~ Flooding is possible in the area covered by the message – be aware, be prepared, watch out

Severe Flood Warning

EA Definition ~ Severe flooding is expected in the area covered by the message – there is imminent danger to life and property

Survey

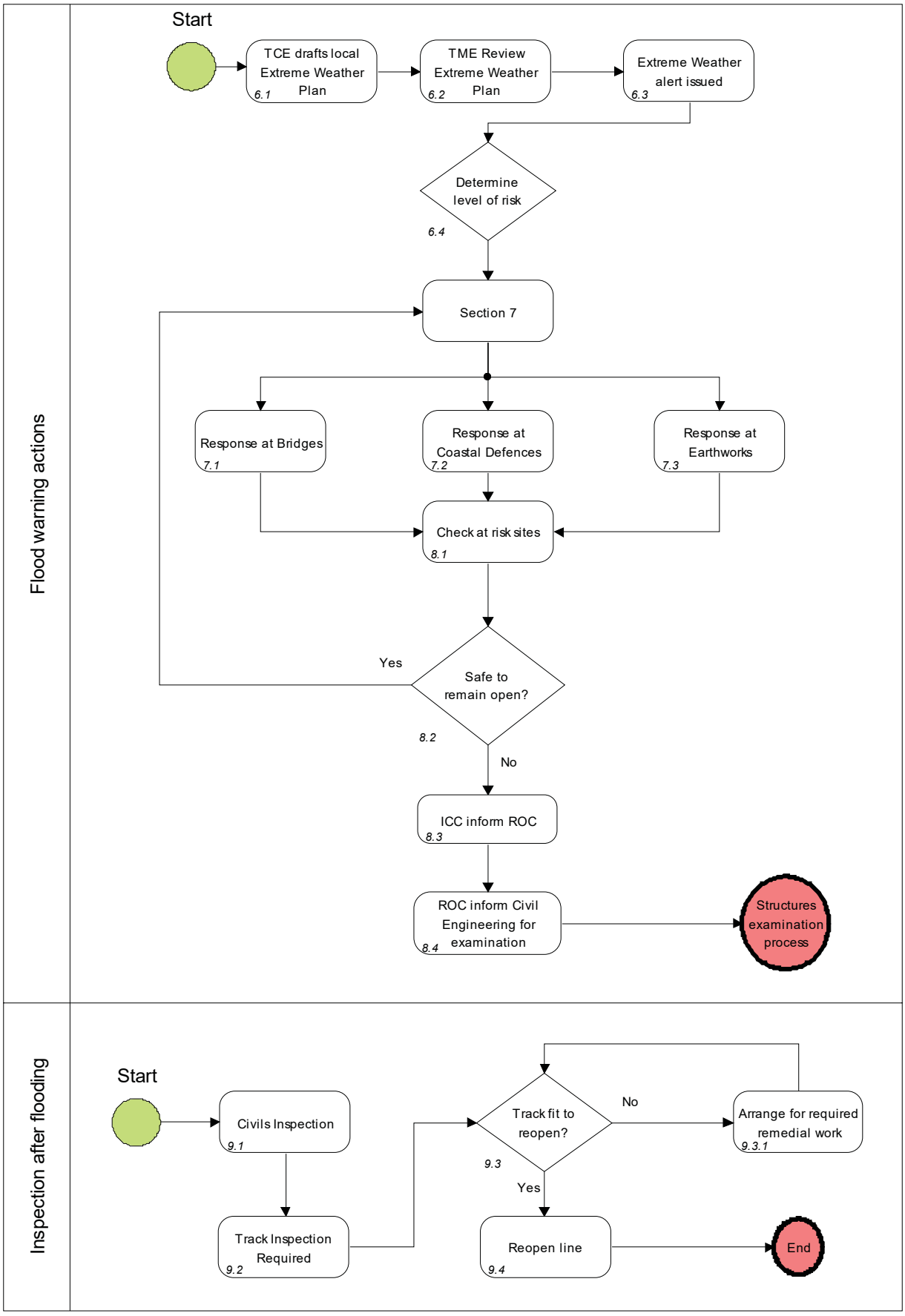
Data collection from site which may include methodologies such as:

- hallade
- line and level collection (dumpy level survey)
- Platform clearances

WAIF

Work Arising Identification Form

5 Flow chart


Flood warning actions
Start
TCE drafts local Extreme Weather Plan
6.1
TME Review Extreme Weather Plan
6.2
Extreme Weather alert issued
6.3
Determine level of risk
6.4
Section 7
Response at Bridges
7.1
Response at Coastal Defences
7.2
Response at Earthworks
7.3
Check at risk sites
8.1
Yes
Safe to remain open?
8.2
No
ICC inform ROC
8.3
ROC inform Civil Engineering for examination
8.4
Structures examination process
Inspection after flooding
Start
Civils Inspection
9.1
Track Inspection Required
9.2
Track fit to reopen?
9.3
No
Arrange for required remedial work
9.3.1
Yes
Reopen line
9.4
End

6 Initial reporting

6.1 TCE drafts local Extreme Weather Plan (EWP)

The Territory Civil Engineer (TCE) shall produce a local procedure (Extreme Weather Plan (EWP)) in accordance with NR/CS/CIV/032 Management of Existing Structures covering actions to be taken in the event of scour, storms, flooding or high tides. This plan includes a register of structures, earthworks other key locations (such as location cabinets and cuttings) at risk of damage from water and where sea water may affect the operation of traffic.

The following table shows individual Territory posts that have accountability for producing the Extreme weather Plans:

Territory	Bridges	Earthworks	Coastal Estuarine Defences
LNW	TSE	TGE	TGE
LNE	TSE	TGE	TGE
W	TSE	TGE	TSE
SE	TSE	TGE	TGE
Sc	TSE	TGE	TGE

TSE = Territory Structures Engineer

TGE = Territory Geotechnical Engineer

The register of at risk assets shall contain as a minimum the following information for each structure:

- ELR
- Track ID
- Mileage
- Geographical Location Map reference or GPS co-ordinates
- Number of structure if applicable
- Name of structure if applicable
- Form of construction
- Element at risk/type of risk
- Details of the lines of communications and interactions between the Territory Civil Engineering staff, Infrastructure Maintenance Delivery Manager (IMDM), Infrastucture Maintenance Engineer, (IME), and the Environment Agency (EA) or the Scottish Environment Protection Agency (SEPA).

The TCE shall forward the EWP to the relevant IME.

6.2 TME review Extreme Weather Plan

The Track Maintenance Engineer (TME) shall in consultation with IME review the EWP and identify precautions, intervention levels and actions for which the need for

response may arise. These shall be documented locally and briefed to all staff involved with extreme weather management and reviewed at least annually.

The TME shall review the requirements of the EWP with the IMDM and the Section Manager [Track] (SM[T]) to confirm that there are appropriate resources at each depot to enable inspections or suitable mitigation should the adverse weather require it.

6.3 Extreme Weather alert issued

Information on extreme weather conditions such as flooding may come to the Integrated Control Centre, (ICC), in a number of ways which include but are not limited to:

- Route Operations Control (ROC)
- Environment Agency
- Water Authority
- Meteorological Office
- Maintenance Organisation
- Police
- Local Authority
- Public report

On receipt of an extreme weather report, ICC shall follow the instructions set out in the EWP which can involve informing the following of the affected area of this information:

- ROC
- TSE
- TGE
- TME
- SM[T]
- On Call representatives for any of the above

At present in some cases, the Route Operations Control (ROC) may specify actions to be taken under the EWP.

6.4 Determine level of risk

The TME in consultation with the SM[T] shall review the details of the Extreme Weather alert against the EWP and action accordingly.

Reports of Extreme Weather may be received from other sources as well as ICC such as those listed in 6.3.

For actions regarding:

- Bridges proceed to clause 7.1
- Coastal (and Estuarine) Defences proceed to clause 7.2
- Earthworks proceed to clause 7.3

7 "At Risk" Sites

7.1 Flood response at Bridges

Bridges that are at risk during a flood normally have 'maximum water level marks' painted on them.

When flood conditions are such that the procedure triggers a response, the SM[T] shall arrange for a Competent Person to routinely visit or remain at an affected bridge if safe to do so. The Competent Person will be equipped with suitable means of contact with ICC. The Competent Person must report on arrival at site to their line manager and ICC as applicable and every 15 minutes to a point of contact agreed with the SM[T], whilst they remain at the site. ICC and line manager should also be informed on departure form site or relief by another member of staff.

Track maintenance staff competency shall be in accordance with NR/SP/CTM/011 Competence and Training in Track Engineering (module TR16).

Should the water level reach the water level mark, the traffic must be stopped immediately; the line blocked in accordance with the Rule Book requirements.

In additions to watching river levels the Competent Person is to observe the bridge for:-

- Visible structural damage, caused by impact of trees, ice floes etc.
- Excessive accumulation of tree trunks and/or other large debris against the bridge.
- Abnormal changes in turbulence at the piers or abutments.
- Water overtopping or penetrating behind the wing walls.

Should any of the above potentially dangerous conditions be observed then the line must be blocked to traffic immediately.

Should it not be possible to access a structure which requires monitoring, it must be assumed that the railway is in danger and therefore the line must be blocked to traffic until such time as an examination can be carried out.

If there is no water level mark on an 'At Risk' structure which is experiencing flooding then the Line must be closed to traffic should any of the following conditions be noted;

- River levels approaching the soffit of girder bridges or springing level of arch bridges.
- Visible structural damage, caused by impact of trees, ice floes etc.
- Excessive accumulation of tree trunks and/or other large debris against the bridge.
- Abnormal changes in turbulence at the piers or abutments.
- Water overtopping or penetrating behind the wing walls

Should any of the above conditions occur the line must be blocked and ICC informed

7.2 Extreme Weather Response at Coastal Defences

Coastal and Estuarine Defences that are at risk during a storm or high tides are subject to bespoke procedures. These procedures normally involve a two or three staged response, escalating where worsening conditions warrant.

When storm and tide conditions are such that the procedure triggers a response, the SM[T] shall arrange for a Competent Person to visit routinely or remain at an affected defence if safe to do so. The Competent Person will be equipped with suitable means of contact with ICC. In some instances arrangements have been made for the Competent Person to ride in the cab of successive trains along the affected line.

The Competent Person will observe sea conditions and their effects on the defence, track and trains and other infrastructure.

Track maintenance staff competency shall be in accordance with NR/SP/CTM/011 Competence and Training in Track Engineering (module TR16).

When overtopping waves are likely to, or have caused, damage to the track system or the train, the traffic must be stopped immediately; the line blocked in accordance with the Rule Book requirements and reopening of the line permitted when conditions have abated and any damage has been rectified.

In addition to observing the sea conditions the Competent Person is to observe the defence for:-

- Structural damage to the sea wall
- Large gaps appearing in any rock armour protection or other secondary defence

Should any structural damage or effects on secondary defences be observed the line must be blocked and the Signaller and ICC informed. ICC will then contact the Territory representative for Civil Engineering to arrange a structural inspection prior to reopening the line.

Should it not be possible to access a Defence which requires monitoring, it must be assumed that the railway is in danger and therefore the line must be blocked to traffic until such time as an examination can be carried out.

7.3 Extreme Weather Response at Earthworks

When the amount of rainfall or river levels are such that the procedure triggers a response, the SM[T] shall arrange for a Competent Person to visit Earthworks on the ‘At Risk Register’ for the affected route sections.

Track maintenance staff competency shall be in accordance with NR/SP/CTM/011 Competence and Training in Track Engineering (module TR16).

From a safe location, clear of the affected earthwork but within sight of it, the Competent Person will observe effects of scour, washout of soil or flow of soil or rock fall together with the functioning of drains and culverts and the effects on the earthwork, track, trains and other infrastructure.

Should any scour, washout of soil or flow of soil or rock fall occur towards the track or embankment material supporting the track washed away then the appropriate

measures shall be taken to protect traffic. This may include blocking the line. The Competent person shall inform the Signaller, ICC and line manager of actions taken. ICC will then contact the Territory representative for Civil Engineering to arrange an earthwork examination prior to reopening or restoring the line to linespeed.

Should it not be possible to access an earthwork due to water levels, it must be assumed that the railway is in danger and therefore the line must be blocked to traffic until such time as an examination can be carried out.

8 Responses

8.1 Check at risk sites

The SM[T] shall arrange for the inspection of the required sites.

The SM[T] shall liaise with the TME to check that any sites under the control of renewals or other outside contractors have suitable arrangements in place.

The SM[T] shall appoint a Competent Person to carry out and record details of this inspection.

Track maintenance staff competency shall be in accordance with NR/SP/CTM/011 Competence and Training in Track Engineering.

8.2 Safe to remain open

The Competent Person shall inspect the site including the line in accordance with the EWP and the details in section 7.

If the line is safe to remain open, the Competent Person shall continue to monitor the site in accordance with section 7.

Where the line is not safe to remain open, the CP shall block the line and inform the Signaller and ICC accordingly and proceed to clause 8.3.

8.3 ICC inform ROC

ICC shall inform ROC that the line has been blocked and attendance is required by Civil Engineering for examination of the structure or earthwork.

8.4 ROC contacts Civil Engineering for examination

ROC shall contact the TSE or TGE, as appropriate, or Civil Engineering on call representative to arrange that the structure or earthwork is inspected prior to any decision to reopen the line.

9 Inspection after flooding

9.1 Civils inspection

Where the line has been blocked, there will be a subsequent requirement for Civil Engineering department to carry out their inspection of their asset. On completion of this inspection, if they deem the structure to be fit for traffic, the TGE or TSE as appropriate shall contact the SM[T] and TME (via ICC) to confirm the state of the infrastructure and arrange for a track inspection of the site to be carried out.

9.2 Track inspection required

The TME shall liaise with the Signaller and ICC to confirm they are informed of the process being undertaken and consult with the SM[T] for the inspection to be carried out.

9.3 Determine if track is fit to open

The SM[T] shall appoint a Competent Person to attend the site to carry out the inspection of the track in accordance with NR/L2/TRK/001.

Where the line is not fit to reopen, the CP shall inform the SM[T] and continue to clause 9.3.1.

Where the line is fit to reopen, proceed to clause 9.4.

9.3.1 Arrange for required remedial work

The SM[T] shall in consultation with the TME and Infrastructure Services Manager arrange that suitable corrective works are planned and carried out, in accordance with NR/L3/TRK/1013 Maintenance of track assets, before a further re-examination of the line is carried out.

When corrective works have been carried out return to clause 9.3.

9.4 Reopen line

The CP shall reopen the line and inform ICC, the signaller and the SM[T] accordingly.

Standards Briefing Note

Ref: NR/L3/TRK/1010	Issue: 2	Publication Date: 26 August 08	Compliance Date: 26 August 08
Title: Management of responses to extreme weather conditions at structures, earthworks and other key locations			
Standard Owner: Track Engineering			
Non-Compliance rep (NRNC): Principal Maintenance Support Engineer [Track]			

Purpose: This process outlines the roles and responsibilities for the maintenance organisation to manage the necessary actions in order to protect the line as a result of extreme weather conditions including water action (including flooding, storm, wave action, scour) at structures, earthworks and other key locations.

Scope: This process applies to all maintenance staff whose duties include track maintenance and inspection.

This procedure does not cover structures maintenance teams who will have their own procedure.

What's New/Changed: Document reissued as a result of Engineering and Maintenance re-organisations. As a result post titles amended accordingly but process mapped within the procedure not altered.

Affected documents:

Reference	*Impact*
NR/L3/MTC/TK0167	Superseded

Implementation requirements:

The following posts have specific responsibilities within this standard and shall receive technical briefing as part of the Implementation Programme:

Section Manager [Track]

Track Maintenance Engineer

Territory Structures Engineer

Territory Geotechnical Engineer

For further information contact:
Name: Charlton Hawley
Contact number: [redacted]
Email: Charlton.hawley@networkrail.co.uk

The following teams require awareness briefing:

- Executive Management Group ☐
- Commercial Property ☐
- Contracts and Procurement ☐
- Strategic Change ☐
- CTRL ☐

Engineering

- Asset Management ☐
- Civil Engineering ☒
- E&P Engineering ☐
- Enhancements Engineering ☐
- Ergonomics ☐
- Future Railway Programme ☐
- Ops Principles & Standards ☐
- Rail Vehicle Engineering ☐
- Railway Systems ☐
- Telecoms Engineering ☐
- Track Engineering ☒
- Signal Engineering ☐

- Finance ☐
- Funding ☐
- Govt & Corp Affairs ☐
- Human Resources ☐
- Information Management ☐

Infrastructure Investment

- Crossrail ☐
- Track ☐
- Programme Management ☐
- Contracts & Procurement ☐
- HSQE ☐
- Sig. Power & Comms ☐
- WCRM ☐
- Construction ☐
- FTN/GSM-R ☐
- Thameslink ☐
- Enhancements ☐

Infrastructure Maintenance

- Maintenance Areas ☒
- Operational Property ☐
- Overhead Condition Renewals ☐

- Legal Services ☐
- National Delivery Service ☐
- Network Development ☐
- Operations & Customer Services ☐
- Planning & Regulation ☐
- Safety and Compliance ☐
- Westwood ☐

Network Rail, Kings Place, 90 York Way, London. N1 9AG.

Letter of Instruction: NR/BS/LI/292

Issue date: 18 July 2013
Compliance date: 30 November 2013
Expiry date: Pending standard change
Contact details: Richard Frost: [redacted]

Standard affected: NR/L3/TRK/1010 (Issue 2), *Management of responses to extreme weather conditions at structures, earthworks and other key locations*

1 Reason for issue

Following the derailment of a train within Summit Tunnel in December 2010 due to an ice fall from a shaft, this Letter of Instruction is updating Track standard NR/L3/TRK/1010 (Issue 2) to include enhanced extreme weather management processes in order to prevent future loss of performance and possible injury to workforce.

The changes will improve the identification of actions required by the maintenance organisation following extreme cold weather events and subsequent thaw conditions.

2 Scope

Currently, extreme cold weather events are not included in Standard NR/L3/TRK/1010. This Letter of Instruction mandates the inclusion of extreme cold weather within Local Extreme Weather Plans.

The extreme weather responses have been updated to include tunnels and the risks associated with ice formation and subsequent thaw conditions.

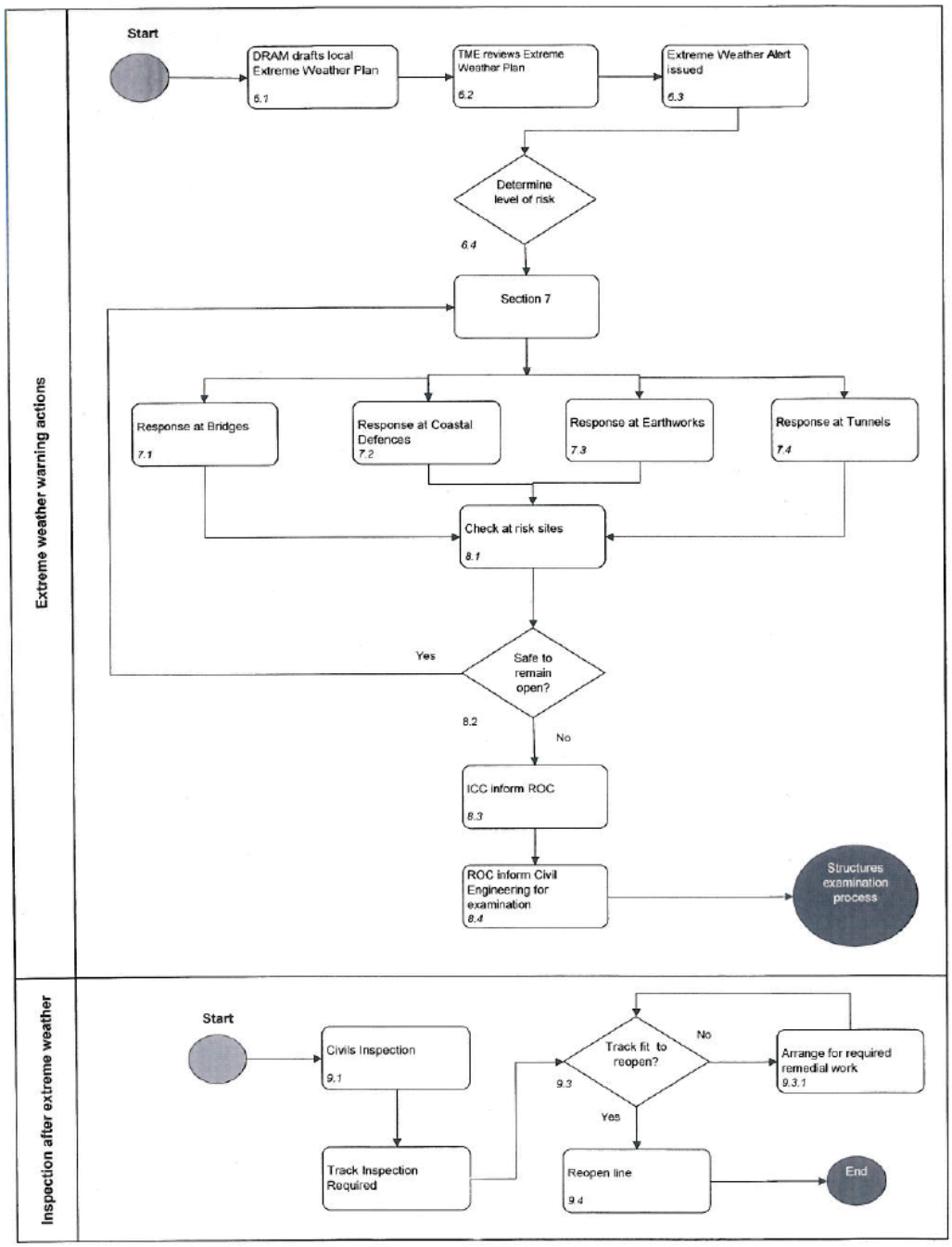
Following devolution, the Roles and Responsibilities have been updated to reflect current posts.

3 Changes

Clause/sub clause	Change
General	Throughout the document replace “Territory” with “Route” and replace TCE with DRAM, TGE with RAM (GEO) and TSE with RAM (STR).
3.1 RACI	**Replace the RACI chart with the following chart where the changes are shown in red.**

RACI DETAILS	KEY CONTROL ACTIVITY	TME Track Maintenance Engineer	IME Infrastructure Maintenance Engineer	IMDM Infrastructure Maintenance Delivery Manager	RAM (STR) Route Asset Manager (Structures)	RAM (GEO) Route Asset Manager (Geotechnical)	DRAM Director Route Asset Management	ICC Integrated Control Centre	ROC Route Operations Control	SM(T) Section Manager (Track)	CP Competent Person	Sig Signaller	ISM Infrastructure Services Manager
Process Task													
6.1		Details contained within clause											
6.2		R	C	A				C		I			
6.3		I			I	I		A/R	I				
6.4		R		A						C			
7.1		A						I		R	R	I	
7.2		A						I		R	R	I	
7.3		A						I		R	R	I	
8.1		A								R	I		
8.2								I		A	R	I	
8.3								A/R	I				
8.4					I	I			A/R				
9.1		I			R	R	A						
9.2		A/R						C		C		C	
9.3										A/R	C/R		
9.3.1		C								A/R			C
9.4								I		A/I	R	I	
End RACI													

4.1 Abbreviations	**Delete** TCE, TGE and TSE. **Add the following to the table of abbreviations:** • DRAM Director of Route Asset Management • RAM (GEO) Route Asset Manager (Geotechnical) • RAM (STR) Route Asset Manager (Structures)

Clause/sub clause	Change
5 Flow Chart	**Replace the flowchart in Clause 5 with the following showing updated roles and adds a stage for response at tunnels.** 
6.1 RAM drafts local Extreme Weather Plan (EWP)	**Replace 6.1 with the following:** The RAM shall produce a Local Extreme Weather Plan (EWP) in accordance with NR/L1/CIV/032 Management of Existing Structures covering actions to be taken in the event of scour, storms, flooding or high tides and extreme cold weather events. This

	plan includes a register of structures, earthworks and other key locations (such as location cabinets and cuttings) at risk from rainfall, meltwater, sea water, high winds, lightning, heat, extreme cold, snowfall and ice including subsequent thaw conditions which may affect the operation of traffic. The RAM (STR) produces the extreme weather plan for bridges, and the RAM (GEO) produces those for earthworks and coastal estuarine defences. For tunnels, consult the Tunnel Management Strategy to establish if the tunnel is susceptible to extreme weather events and to identify the actions to be taken following an extreme weather event. The DRAM will have accountability for producing Local Extreme Weather Plans. The register of at risk assets shall contain as a minimum the following information for each structure: • ELR • Track ID • Mileage • Geographical Location Map reference of GPS co-ordinates • Number of structure if applicable • Name of structure if applicable • Form of construction • Element at risk/type of risk • Details of the lines of communications and interactions between the Route structures engineers, Infrastructure Maintenance Delivery Manager, (IMDM), Infrastructure Maintenance Engineer, (IME), the Environment Agency, (EA) or the Scottish Environment Protection Agency, (SEPA). For tunnels, consult the national tunnel ice risk assessment to identify 'at-risk' assets. The RAM shall forward the EWP to the relevant IME.
6.3	**Add the following to the end of sub-clause 6.3:** A Red alert status shall be assigned to any period in the four-day outlook where weather conditions are expected to be 'Extreme'. When the forecast indicates a likelihood of an extreme weather event the Route Control Manager for the Route involved shall activate the Extreme Weather Management process in accordance with standard NR/L2/OCS/021: • An 'Extreme Weather Action Team' (EWAT) shall be formed of responsible senior managers drawn from the operations, engineering, commercial and communications functions • The EWAT shall normally be led by the senior 'On-call' operations manager for the relevant Route / Area. Additional maintenance actions may arise from the EWAT.
6.4 Determine level of risk	**Add the following to the bullet point list:** • For actions regarding tunnels proceed to clause 7.4
7 "at risk" sites	**Add the following sub-clause:** **7.4 Extreme Weather Response at Tunnels** When temperatures are such that the EWP triggers a response the SM[T] shall arrange for a Competent Person to visit tunnels on the 'At-Risk Register' for the

	affected route sections. Track maintenance staff competency shall be in accordance with NR/SP/CTM/011 Competence and Training in Track Engineering (module TR16). The competent person will carry out tunnel inspections as required by the EWP. Additional maintenance actions may arise from EWAT meetings
8.1 Check at risk sites	**Add the following paragraph to the end of sub-clause 8.1:** When an ice patrol is completed as required by the EWP or EWAT meeting, records of what ice was found and what actions were taken are to be submitted to the structures team and stored within the appropriate asset management system.

Network Rail, Kings Place, 90 York Way, London. N1 9AG.

Authorisation of Standard Owner

Authorised by [redacted]

Andy Jones, Professional Head [Track]

Authorisation of appropriate Delivery Function authority

Authorised by [redacted]

Richard Frost, Professional Head [Structures]

4 Recipients

Name	Post
Andy Jones	Professional Head (Track)
Richard Frost	Professional Head (Structures)
Colin Sims	Principal Engineer (Tunnels)
Sharon Lee, Derek Butcher, Mark Norman, Neil Jones, Andrew Anderson, Mark Huband, Andy Cross, Nick Tedstone, Michael Smith	Route Asset Managers

5 Details of briefing or cascade communication process

The above recipients shall inform the relevant members of their team that this letter of instruction has been issued.

Queries and clarifications on the requirements of this Letter of Instruction should be directed to the Professional Head (Structures) or their representative.

Appendix G: NR/L3/OPS/045, National Operating Procedures, Managing Stranded Passengers and Train Evacuation, Procedure 4.15, Issue 03, 5th December 2020.

NATIONAL OPERATING PROCEDURES

MANAGING STRANDED PASSENGERS AND TRAIN EVACUATION

Procedure: 4.15
Issue: 03
Date: 05/12/20

1 PURPOSE

This procedure provides a risk-based approach to maintain the safety and welfare of passengers when a train is stranded based on the relative risks. It minimises the risk involved in this type of incident and sets out how to develop plans to deal with such incidents.

2 SCOPE

This procedure provides the approach to be applied by Route Control when dealing with the management of stranded passengers and where trains are to be evacuated on Network Rail infrastructure.

3 REFERENCE DOCUMENTATION

ATOC/ACOP014	Provision of Customer Information
ATOC/ACOP015	Passenger Information During Disruption (PIDD)
GE/RT8000	Rule Book Modules and Handbooks
Local instructions for the management of stranded trains	
NR/L3/OPS/045/4.15FA	Stranded Passengers Risk Assessment
NR/L3/OPS/045/4.15FB	Train Evacuation Risk Assessment
NR/L3/OPS/045/4.15FC	Example Template for Managing Multiple Trains Being Stranded by an Incident
RDG-GN-OPS-049	RDG / Network Rail guidance – Meeting the needs of passengers on stranded trains
Train Operating Company (TOC) Policy	

4 DEFINITIONS

For the purpose of this procedure the definitions shown in **Table 1** apply.

Load Shedding	Where necessary, in the event of a loss of power to the unit*, the load on the batteries can be reduced by systematically shutting down individual functions of the train e.g. air conditioning, toilets etc. This is in order to prevent a complete shutdown of the system and to provide basic functions such as cab radio, Public Address system (PA) and limited / emergency lighting. ***NOTE:*** **i.e. Overhead Line Equipment (OLE), third rail or diesel engine shut down.*

Stranded Train	The train is stationary other than as scheduled and it is established with reasonable certainty that it will not resume its journey within a reasonable time (10 – 15) minutes, or where it is expected to resume its journey but only after an unacceptable length of time (30 minutes). Train Operating Company (TOC) Policy may dictate the length of time, although this and the suggested times above should only be used as guidance.
Multiple Trains	Three or more trains affected by the same incident.

Table 1 – Definitions

5 RESPONSIBILITIES

A list of roles and responsibilities relating to this procedure are shown in **Table 2**.

R – **Responsible** is the person or people who are responsible for performing a certain task or action. **A** – An **Accountable** person is one who has overall accountability to make sure that a task or action is completed. **C** – **Consulted** people have an input into the task or action; this can be providing information, reviewing documents or attending workshops etc. **I** – **Informed** people are those who receive the output of a task or process.		Route Control	Train Operating Company	National Operations Centre
6	Actions to be Taken in the Event of up to Two Trains Being Stranded by an Incident	RA	RA	I
7	Actions to be Taken in the Event of Multiple Trains Being Stranded by an Incident	RA	C	I
8	Considerations for All Stranded Events	R	R	I
9	Passenger Information During Disruption (PIDD)	RA	RA	I
10	Decision Whether to Evacuate	RA	C	I
11	Train Evacuation	RA	RA	I
12	Prolonged Incidents	RA	R	I
13	Recording of Information	RA	C	I

NOTE: *This is a generic RACI and Route specific responsibilities may be used – Routes are responsible for briefing such changes to their users.*

Table 2 – Roles and responsibilities

6 ACTIONS TO BE TAKEN IN THE EVENT OF UP TO TWO TRAINS BEING STRANDED BY AN INCIDENT

6.1 If trains become stranded, Network Rail shall take into account the needs of the passengers using the principles shown in **Appendix B** and follow the flow chart in **Figure 1**.

6.2 As soon as a train(s) is confirmed to be stranded, Route Control shall decide the appropriate actions by completing the form NR/L3/OPS/045/4.15FA. This shall be completed in consultation with the relevant TOC(s)

6.3 Clear timescales shall be worked out using the suggested timescales as shown in **Appendix A**. A count up clock shall be started to monitor key milestones.

6.4 If load shedding and hot / cold weather factors are present, the protocols in **Table 3** shall be followed.

6.5 Upload or enter all completed risk assessments into Control Centre Incident Log (CCIL) for any stranding event.

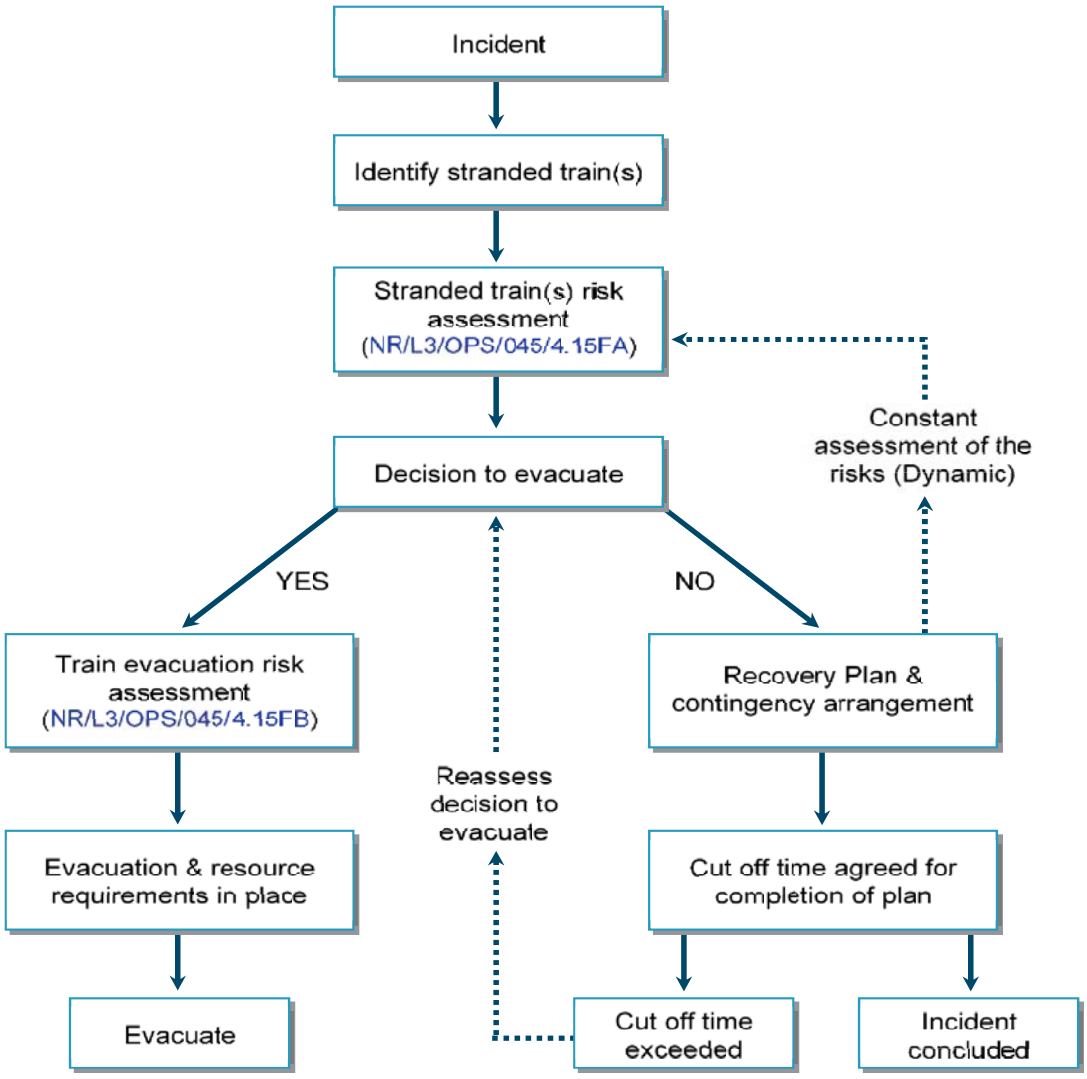


Figure 1 – Procedure following an incident which results in a single train or multiple trains being stranded

FACTOR	PROTOCOL
Load Shedding	Understand what functions would be lost or expected timeframes for further loss of systems. Facilities such as cab secure radio, PA systems, lighting, air conditioning, toilet door functionality and train heating systems can all be lost. Based on the unit type and characteristics it may prompt a quicker response than those incidents where trains still have traction power.
Cold Weather	Do not consider evacuation unless passengers can be safely relocated or a bus is at the nearest access point and the passengers can reach these relatively quickly, safely and have suitable clothing. Hypothermia can set in quickly and any wind chill factor may considerably reduce the safe time that people can be outside. There are likely to be additional safety and welfare issues with trains stranded in cold weather. As this is likely to be a winter scenario, anticipate the need for additional lighting, both on the train and along any likely evacuation route. Look for sources of support in situ e.g. Mobile Operations Managers (MOMs), station staff P-way / S&T. This may prevent the situation worsening and also make certain of additional visible support on site. Consider vulnerable passengers who may be more susceptible. Alcohol consumption can also reduce a person's resistance to the effects of the cold weather. Consider providing support to the passengers on the train, such as contacting the local authorities and emergency services for assistance by the use of thermal blankets, hot drinks and expertise in dealing with those people exposed to the cold. Consider contacting the Local Resilience Forums for support beyond that of the emergency services blue light response. All local authorities have designated reception centres and these can be established within once the request has been made, although they may take time to set up (requests shall be agreed between Network Rail and TOC as costs may need to be agreed). TOCs may also have facilities of their own which may be used in these circumstances.
Hot Weather	There are likely to be additional safety and welfare issues with trains stranded in hot weather (i.e. when the temperature exceeds or is forecast to exceed 27 C). The environment on a stranded train without air conditioning in hot weather can deteriorate very quickly from one which is simply unpleasant where people feel uncomfortable to one which is potentially hazardous in that it presents significant medical risks. The most immediate risks are dehydration and heat exhaustion, to which children and the elderly may be particularly susceptible and which potentially could require medical assistance. In extreme cases heatstroke may follow, resulting in unconsciousness and requiring urgent removal to hospital. Consider allowing the train crew to open an appropriate number of exterior doors to promote a flow of fresh air. (This can only be done with the agreement with the driver and with the permission of the signaller). Loss of air conditioning (sometimes as a characteristic of load shedding) may also result in increased humidity levels. They impact on the ability of sweat to evaporate from the skin, which is the main method of heat control in humans, thus increasing the risk of heat exhaustion. Evacuation of train(s) stranded without air conditioning in hot weather, particularly if in direct sunlight, could be a better option than might otherwise be the case. Consider pre-emptive advice to the local ambulance service should passengers be detained on-board a train in hot weather for an excessive length of time.

Table 3 – Protocols for load shedding, cold weather and hot weather

7 ACTIONS TO BE TAKEN IN THE EVENT OF MULTIPLE TRAINS BEING STRANDED BY AN INCIDENT

7.1 For the purpose of this procedure a multiple train scenario shall be considered when there are three or more trains affected by the same incident.

7.2 Incidents involving multiple stranded trains can quickly overstretch available response resources, therefore assistance from the emergency services will be vital and shall be requested as soon as practicable.

7.3 A Rail Incident Commander (RIC) shall be appointed.

7.4 A command structure and emergency services liaison shall be set up with consideration given to each train having its own separate response team and plan to resolve the situation.

7.5 All trains and decisions shall be recorded using the templated example NR/L3/OPS/045/4.15FC.

7.6 If load shedding and hot / cold weather factors are present, the protocols in **Table 3** shall be followed.

7.7 Evidence shall be recorded when decisions are made and uploaded as evidence in accordance with Clause 13.

7.8 It shall not be necessary to complete form NR/L3/OPS/045/4.15FA for all trains; however, it shall be used as guidance to help identify and mitigate the risks.

8 CONSIDERATIONS FOR ALL STRANDING EVENTS

8.1 In the event of one or more trains becoming stranded, our response as “the railway” needs to be guided by the following:

a) Preventing the situation becoming worse – this includes responding to situational awareness by taking immediate action to prevent or limit any escalation*. This should include application of rules or through dynamic risk assessment;

NOTE 1: ** e.g. by holding other trains back at stations outside the affected area rather than allowing them to approach or diverting them to an alternative route.*

b) British Transport Police (BTP) shall be contacted where there is an incident involving train(s) which are stranded outside of stations and are likely to remain there for any length of time where passengers might take upon themselves to self-evacuate;

c) Incidents of this nature can become time critical quickly, with effective decisions needed quickly and communicated with those involved. The timings and urgency of these decisions will be based upon the risk associated with each incident, and as such any suggested timescales are only guidance and may be reduced in certain circumstances; and

NOTE 2: *e.g. hot / cold weather or trains relying solely on battery power.*

d) In determining the course of action when a train(s) become stranded input from the train crew and the TOC Control is key. In the initial stages they will be the primary source of information from site – the number, type and mood of passengers, on-train environmental conditions and local conditions outside the train.

NOTE 3: *This decision should be based on the identified risks both current and potential. NR/L3/OPS/045/4.15FA should be completed in consultation with the relevant TOC(s).*

8.2 The management of stranded train(s) is a co-operative activity between Network Rail and TOCs. Each TOC has their own instructions on the management of stranded trains. The details of the TOC policy(s) should be taken into account and their assistance sought when completing the RA process and concluding on whether to and how to evacuate trains, this process may involve multiple TOCs.

8.3 The train crew shall check that communication flow between themselves and the passengers is robust to try and mitigate the risk of self-evacuation.

9 PASSENGER INFORMATION DURING DISRUPTION (PIDD)

9.1 The single biggest need for stranded passengers, at least initially, is information – even if the information is not good news. It should be provided proactively and follow the good practices defined in the appropriate PIDD guidance. In addition to the actual factual content (which may be fairly minimal, at least in the early stages), provision of information on a regular basis is also a very powerful means of providing reassurance to passengers that 'the railway' remains in control and is actively engaged in attempting to resolve the problem, thus dissuading them from taking matters into their own hands.

NOTE: *e.g. self evacuation.*

9.2 All Network Rail Route Controls shall check that information is given prominence during disruption of this type in accordance with ATOC/ACOP014 and ATOC/ACOP015. Public address calls directly to the passengers may be given using the GSM-R fixed terminal.

9.3 Where it has been decided to use the GSM-R PA system for a stranded train an update shall be given at 15 minute intervals or whenever an update is available.

10 DECISION WHETHER TO EVACUATE

10.1 If the decision is made not to evacuate the train:

a) a review of the decision shall be made as a minimum every 15 minutes; and

b) two or more contingency plans shall be agreed and be ran concurrently.

NOTE: *For example, plan 'A' and plan 'B' for recovering a service, particularly if plan 'A' is vulnerable to any setbacks such as fault transfer or emergency coupling problems. This means that should the initial plan fail the second contingency can be implemented immediately. If a second contingency plan is deemed necessary, agree a cut off time for implementation of the backup plan.*

10.2 The decision to evacuate a train shall be made by the Network Rail person in charge of managing the incident, which may be the Rail Incident Commander (RIC) if appointed. The decision shall be made in consultation with the Train Operations Liaison Officer (TOLO) if appointed, and shall be based upon the onboard conditions of the train(s) involved as reported by the TOLO.

10.3 If the decision is made to evacuate the train, a Rail Incident Officer (RIO) shall be appointed.

10.4 A Train Evacuation Risk Assessment in NR/L3/OPS/045/4.15FB shall be completed in conjunction with the relevant TOC(s).

NOTE: *This will determine all identified risks that need to be considered and clarify how each evacuation is to be managed.*

11 TRAIN EVACUATION

11.1 The method of evacuation shall be decided using this order of preference:

a) at a station platform;

b) at a disused platform;

c) by end-on transfer to another train brought up to one end of the train requiring evacuation (only possible if both trains have end gangways);

d) by side-to-side transfer to another train brought up alongside the train requiring evacuation (only possible on multiple track lines with standard clearances);

e) by escorting passengers along the track to another train; or

f) by escorting passengers along the track to a suitable access point for alternative road transport.

11.2 The evacuation arrangements set out in **Table 4** shall be followed.

11.3 Any evacuation of a passenger train shall be a co-operative venture between Network Rail and the relevant TOCs.

11.4 The assistance of the emergency services may be required to evacuate passengers where this is beyond the abilities of the rail industry personnel available (this can include non-operations staff who are competent to assist). Emergency services should be informed of the possible request for their assistance in the evacuation as soon as possible.

NOTE: *Different means of evacuation will require differing levels of attendance and involvement by Network Rail and the TOCs concerned.*

METHOD	REQUIREMENTS
Evacuation at a Station Platform	May be achieved by means of a wrong direction movement, permissive working or emergency permissive working.
Evacuation at a Disused Platform	Check: a) The platform is reasonably free of hazards and obstructions; b) There is a means of exit from the platform to alternative transport. Network Rail and TOC staff will be required to: a) Check the suitability of the platform; b) Confirm there is an exit available and assist passengers.
Evacuation by End-On Transfer	Both trains involved in the transfer should be equipped with end gangways, but do not need to be compatible or have compatible couplings. The train to which passengers are to be transferred should be positioned as close as possible to the end of the train being evacuated and the end gangway doors opened. Network Rail or TOC staff should be positioned close to the opened gangway doors to make certain of a safe transfer between trains. ***NOTE 1:*** *Some TOCs have portable emergency bridges available for this purpose.*

Evacuation by Side to Side Transfer	On a multiple-track railway with standard track spacing, an evacuation can be carried out onto a rescue train brought alongside the train to be evacuated. Transfer of passengers is undertaken at one door of each train only, using a suitable "bridge". TOC staff on-board will determine whether the correct equipment is on the train or is required to be transported to site. ***NOTE 2:*** *Large track spacing will not permit the safe use of such a "bridge". Network Rail or TOC staff should be positioned at each door and "hand" passengers from one train to the other.* *Network Rail staff in DC electrified areas should consider the positioning of third rails (cess side, 6ft side) in relation to the evacuation. Where the 3rd rails are present in the 6ft and would be otherwise 'live' under the evacuation bridge – Network Rail staff should consider an appropriate traction current discharge.*
Evacuation Onto and Along the Track	Stop all movements on adjoining lines and isolate 3rd / 4th rail traction current supplies. The most expedient and safe route should be used in normal circumstances. This should be decided upon before evacuating passengers. This decision should take into account available lighting and tripping hazards and, if the route to be followed is on an embankment, the risks of falling or slipping down the embankment. Network Rail staff should be on site to conduct groups of passengers from the train to a place of safety clear of the track. This place of safety may be another train, a station platform, or an access point to a road or track (from where alternative transport or appropriate shelter will be available). If the route includes an unavoidable hazard, a member of railway staff or emergency services personnel should be positioned at that location to warn and assist passengers. TOC staff should be available at the reception site to organise the onwards journeys of the passengers in an orderly manner. Consideration should be given to using other means of moving passengers, particularly those who are disabled, those with mobility problems and the elderly. Such methods may include the use of P-way trolleys.
Evacuation from a Train in a Tunnel	Set up suitable and sufficient lighting. Consider the difficulties that could be caused by evacuation in a tunnel. Consider support from the emergency services in these circumstances.

Table 4 – Evacuation arrangements

12 PROLONGED INCIDENTS

If it proves impossible to either move the train or evacuate passengers, you shall escalate this within the railway and emergency services.

You should check what supplies are available to be taken to the train* and what resources are available to take them to site.

NOTE: **Including water, lighting, blankets and train door barriers.*

13 RECORDING OF INFORMATION

In recording the decisions made in managing passengers stranded on trains, stranded passenger incidents are liable to trigger extensive investigations, potentially including legal inquiries.

All those in decision making roles shall confirm that a record is kept of all significant decisions.

NOTE: *Including the information known at the time and any risk assessments undertaken.*

Appendix A – Suggested timelines from when it is confirmed that a train is stranded

Within	Signaller	Driver (Guard)	Incident Controller	MOM / RIO	On Call Ops Mgr / TOLO	On Call Customer Service Manager	Information Coordinator
10 Minutes	Identify stranded train(s) and tell Route Control. Attempt to get stranded train into platform. Hold other trains at platforms; and hold trains back	Contact Signaller.	Call out MOM. Write prioritised plan. Appoint RIO. Call out TOLO.	Start to make way to trapped train. Become RIO.	Start to make way to nearest station or access point.	Check supplies of water / food.	Issue holding message. Confirm NRCC is updated.
20 Minutes	Work through above options with RIO. Maintain contact with the driver.	Once aware that train is stranded focus on continuing reassurance / care of passengers.	Lead prioritised plan.	Liaise with Signaller / Incident Controller/ Traincrew. Work with TOLO.	Start to make way to stranded train to support RIO and become TOLO.	Confirm staff available with supplies at where customers likely to detrain. Monitor messages put out by NRCC and via social media.	Communicate with guard(s) on stranded train/s. Confirm NRCC is updated.
30 Minutes	Continue as above.	Work with Signaller / RIO on options.	Support Network Rail Route Control Manager by taking responsibility for options.	Work through options with signaller.	Support RIO with options, particularly with regard to passenger care on the train.	Be prepared to greet customers and arrange alternative transport. Monitor messages put out by NRCC and via social media.	Issue CSL2 message. Confirm NRCC is updated.
Target 1 hour	**Commence evacuation / assistance**						
Target 2 hours	**Complete evacuation / assistance (depending on location and numbers involved)**						

NOTE: *The above timescales are indicative only and will be subject to risk assessment of conditions on the day.*

Appendix B - Stranded Passengers Principles (Extract from RDG-GN-OPS-049)

Stranded Passengers Principles used by the GB Rail Industry are:

1	**Passenger welfare is the priority when dealing with one or more stranded trains**
	The key cultural change for the industry is that the situation for passengers on trains must be the priority and 'think passenger needs'. This is usually best served by moving the train but may require a prompt evacuation of the train.
2	**Event, emergency and contingency planning will include the risks to passengers on stranded trains**
	Preplanning to prevent stranded customers is needed and should be part of the EWAT process.
3	**Prevent stranded trains incidents from escalating**
	Preventing the situation becoming worse – this includes taking immediate action to prevent or limit any escalation*. This should include application of rules or through dynamic risk assessment. ***NOTE:*** ** e.g. by holding other trains back at stations outside the affected area rather than allowing them to approach or diverting them to an alternative route.*
4	**Understanding the situation on the train(s) and undertake a risk assessment which is updated when more information is known**
	The decision on what needs to be informed by a risk assessment, but very rarely will all relevant facts be known so there will also need to be an element of judgement and updating of the assessment. Sources of data include staff on train, train management system, CCTV and social media. The risk assessment this should take into account such factors as the number and type of toilets, on train environmental control systems or lack thereof, ability to open external windows, provision of refreshments, etc.
5	**Taking control of the situation**
	An Industry Single Point of Contact should be appointed to oversee the response to stranded train incidents. It is better to initiate an early full activation of the response plan and subsequently stand down resources than it is to ramp up the response as a degraded situation evolves into a crisis.
6	**Incident management protocols will be followed in good time to allow quick and efficient decision making**
	The aim is to not have customers stranded on a train for more than 60 minutes with a reduced time for crowded trains and during hot weather. This could be longer if trains have power and catering. There are also often logistical items which would extend this. How best to meet the needs and expectations of the passengers on board – broadly the choice here is likely to be between a) holding passengers on the train until the situation has improved or b) the evacuation of the train if the situation is unlikely to improve. Clear timescales including a count-up clock in control should be used.

7	**Plans for evacuation, repairing infrastructure, rescuing trains and moving trains will be developed concurrently**
	Plans should be developed in parallel to make sure that if the first plan does not work then resources are in place for another options.
8	**Where possible the correct resources are deployed to each stranded train**
	Additional staff will be required to support a stranded train in most circumstances via on call or other response staff dependent. DOO(P) trains will need resources provided faster than trains manned with on board staff. A MOM or on call OM should also be used a key resource.
9	**Accurate and meaningful information will be communicated to passengers quickly and at regular intervals**
	Information is key and is important to how to gain / maintain control of the situation – by demonstrating care, empathy, competence and confidence. Information provision with clear update on progress are key especially in preventing the risk of self-evacuation. Detailed and structured communications plan should be in place with our customers and staff in line with PIDD.
10	**Willing to evacuate trains rather than leave passengers on the train**
	Customers should not be left on a train ideally for more than 60 minutes which may require train evacuation. However, in may circumstances the customers are better remaining on the train and logistically getting staff to site to evacuate a train may take much longer.
11	**Staff are trained and refreshed to deal with stranded and evacuated trains**
	Competence and particularly experience – Instances of significant numbers of passengers being stranded on trains are comparatively rare. In the absence of first-hand experience, adequate testing and exercising of operational scenarios involving stranded passengers become essential to developing and maintaining competence.
12	**Understanding when additional help is required with multiple trains being stranded**
	Number of trains involved – it is recommended that Railway Undertakings and Network Rail identify a ‘worst case scenario’ in terms of the number of trains that could plausibly become stranded by a credible failure (such as a widespread power or signalling system outage) and then review their response plans to check the adequacy of these for addressing such a scenario.

Appendix H: Western Route CP6 Weather Resilience and Climate Change Adaptation Plans

2019 – 2024

Western

Route CP6 Weather Resilience and Climate Change Adaptation Plans

Contents

Purpose of this document

This document defines the Western Route Weather Resilience and Climate Change Adaptation (WRCCA) Plan for CP6 and reviews progress against the WRCCA Plan published for CP5. This is supported by an evaluation of the resilience of rail infrastructure to historical weather events and an awareness of potential impacts from regional climate change projections. The resilience of the rolling stock operating within the Route is not specifically assessed.

Western Route Weather Resilience and Climate Change Adaptation Plan – Version 1 – September 2020.

Director of Route Asset Management statement

Over the last decade Western Route has faced periods of major service disruption and infrastructure damage at multiple locations resulting from the effects of extreme weather.

The vulnerability of the Route to weather-induced disruption continues to be at an elevated status and weather-related issues at locations such as Dawlish and the Somerset Levels have become nationally totemic symbols of the vulnerability of the rail network to weather-related issues.

Following a programme of major resilience works in CP5, the start of CP6 sees Western Route continue to be focused on delivering significant and long-term improvements in infrastructure resilience and service recovery in response to both extreme weather events and the strategic changes brought about by climate change. Several long-term programmes, including work to increase the resilience of the railway between Dawlish and Teignmouth, continue to be developed and implemented. However, the primary strategic approach adopted in CP6 is to ensure that consideration of weather resilience is incorporated into the remit of all projects is being delivered across the Route.

The following report documents the effects of extreme weather and climate change on Network Rail infrastructure and demonstrates the close working relationships Network Rail has made to manage extreme weather and climate change risks with the Environment Agency and Local Government organisations in the Thames Valley, the West Country and the South West Peninsula.

Tim Laverye
Director of Route Asset Management – Western Route – November 2019

Executive summary

Adverse and extreme weather events can cause significant damage to rail infrastructure, the effects of which can cause major disruption to the operation of train services.

The UK Climate Change Projections 2018 (UKCP18) indicates the continuation of the shift to a warmer climate, significant changes in sea level and an increase in intensity of precipitation across the year. The frequency and intensity of adverse and extreme weather events are expected to increase causing additional stress to our infrastructure.

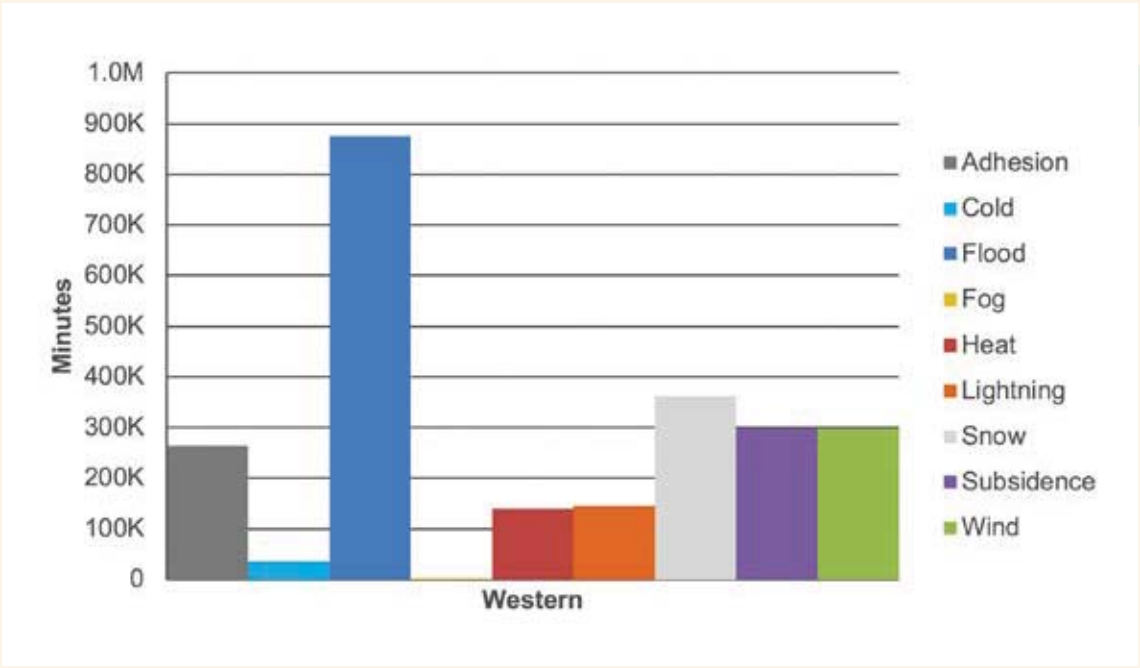
With a renewed focus on train performance and passenger experience through the 'Putting passengers and freight first' initiative, it is critical that the vulnerabilities of rail assets to weather events and potential impacts from climate changes are understood and addressed in order to maintain a performing and resilient railway system; as such, Western Route is fully and firmly committed to delivering our weather and climate change adaptation action plan through CP6 and beyond.

The CP5 WRCCA plan saw successful development and implementation of weather resilience and climate change adaptation schemes, including:

- Large scale flood resilience projects,
- Network Rail Weather System (NRWS),
- Training and equipment provision for maintenance teams,
- Increased use of suitable technology including Remote Condition Monitoring (RCM) in earthworks and track monitoring, and
- Strengthening of relationships with the Environment Agency and other 3rd party bodies.

We have developed an understanding of our risks by assessing our weather-related vulnerabilities (Figure 1) and identified root causes of historical performance impacts.

Figure 1
Western Route weather attributed delay minutes 2006/07 – 2018/19



Western Route's CP6 WRCCA plan will build on the development of the CP5 plan noting a fundamental change of delivering the majority of actions through 'Business As Usual' (BAU) activities. Using the predictions of UKCP18, focus will be given to improving and updating vulnerability assessments and the delivery of appropriate works – including vulnerability of structures to coastal and estuarine scour; earthworks to high and persistent rainfall in addition to heat and prolonged dry periods, and trees and consequential tree strike from high winds. This updated plan reports our CP5 progress, sets out our plan for CP6 and beyond, and updates our vulnerability and impact assessments to account for changes in Network Rail WRCCA strategy and guidance.

Although the actions taken in CP5 improved aspects of our resilience, weather events continue to impact our operations. Western Route is committed to addressing the risks through the timely, cost efficient and safe delivery of this Route WRCCA Plan.

Introduction

The railway routinely operates in a wide range of weather conditions, however adverse and extreme weather can cause significant disruption to our network.

Weather events such as extreme rainfall, wind, snow and high temperatures reveal the vulnerability of the rail network and the severe impact these weaknesses in resilience has on train services and our resources as detailed throughout this report.

The impact of weather on the rail network is monitored using performance data. Schedule 8 costs, the compensation payments to train and freight operators for network disruption, are used as a proxy for weather impacts due to greater granularity of root cause reporting. Incidents are recorded under 9 categories as follows:

- Adhesion – line contamination leading to traction loss, e.g. leaf fall, moisture, oils,
- Cold – e.g. ice accumulations on conductor rails, points and in tunnels,
- Flooding – standing or flowing water leading to asset damage or preventing trains from accessing the track,
- Fog – reduced visibility obscuring signals,
- Heat – high temperature impacts e.g. rail buckles, Temporary Speed Restrictions (TSRs), overheated electrical components,
- Lightning strike – e.g. track circuit and signaling damage or power system failure,
- Snow – e.g. blocked lines and points failures,
- Subsidence – the impacts of landslips, rockfalls and sinkholes, and
- Wind – e.g. trees and other items blown onto the track and into the Overhead Line Equipment (OLE) or TSRs.

Weather-related costs can also be captured within Schedule 4 payments, compensation to train and freight operators for Network Rail's possession of the network, and capital expenditure required to reinstate the asset.

In the past 13 years (2006/07 to 2018/19) the average annual number of delay minutes attributed to weather for the Western Route network was 176,923.

The impacts of severe weather events on the Western Route can be clearly seen in Figure 2, for example:

- Snowfalls of 2009 through to 2011 and 2017/18,
- Wind in a number of years, but particularly 2013/14,
- Severe flooding in 2007/08, 2012/13 and 2013/14,
- Subsidence in events in 2012/13, and
- Heat impact in 2018/19.

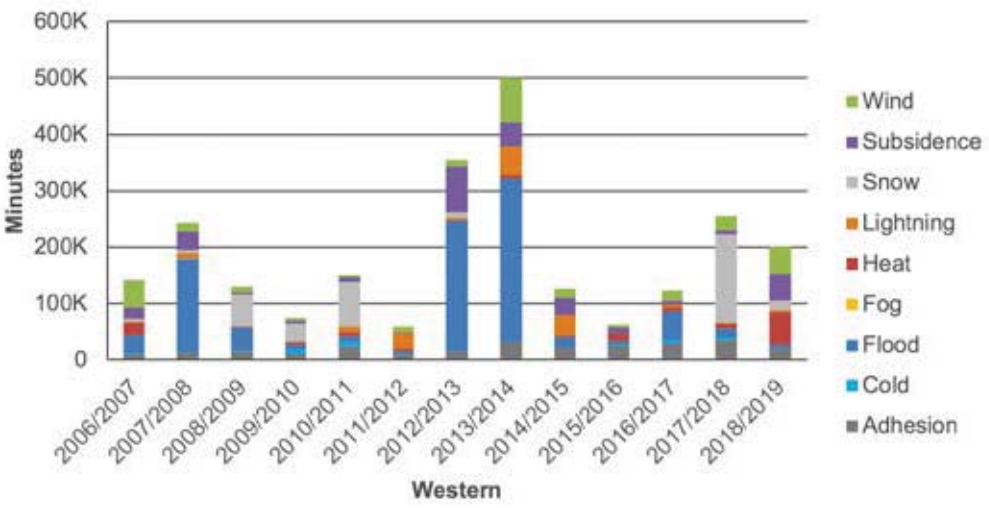


Figure 2
Delay minutes across 13 years (2006/07 – 2018/19) with relation to weather type

The costs, in addition to the wider socio-economic impacts, justify Network Rail's enhanced investments to increase weather resilience. The interdependencies within transport and infrastructure systems similarly justifies Network Rail's continued efforts to improve collaborative understanding of the wider impacts of weather-related events and our role in supporting regional and national resilience.

Trends in the UK climate, and the UKCP18 data, indicate that there has, and will continue to be a shift to a warmer climate. Figure 3 illustrates the projected changes in frequency and severity of Atlantic winter storms.

Historical temperature records indicate that a significant, relatively recent shift in climate has occurred. The Hadley Centre Central England Temperature (HadCET) dataset is the longest instrumental record of temperature in the world, Figure 4 clearly shows a rising trend in temperature over the past century.

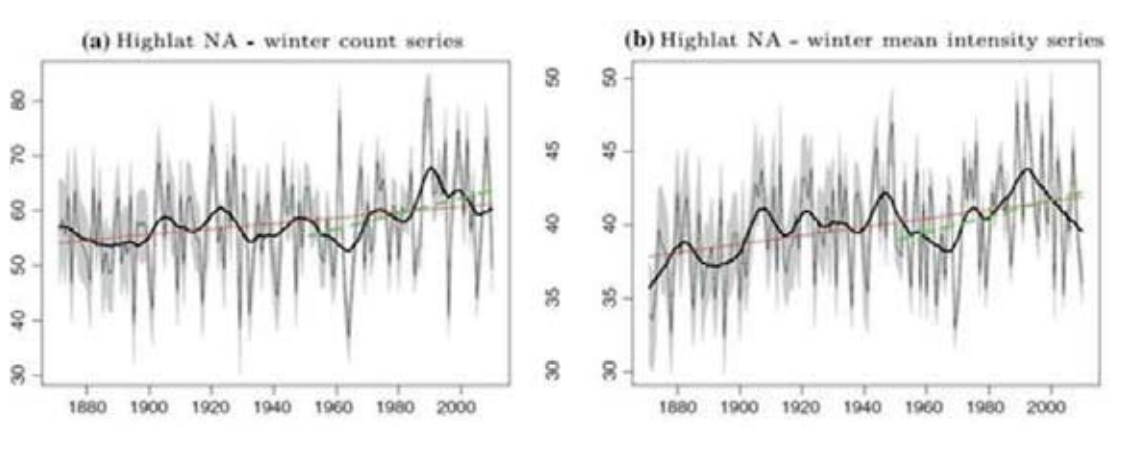


Figure 3
Intensity and frequency of high latitude Atlantic winter storms[1]

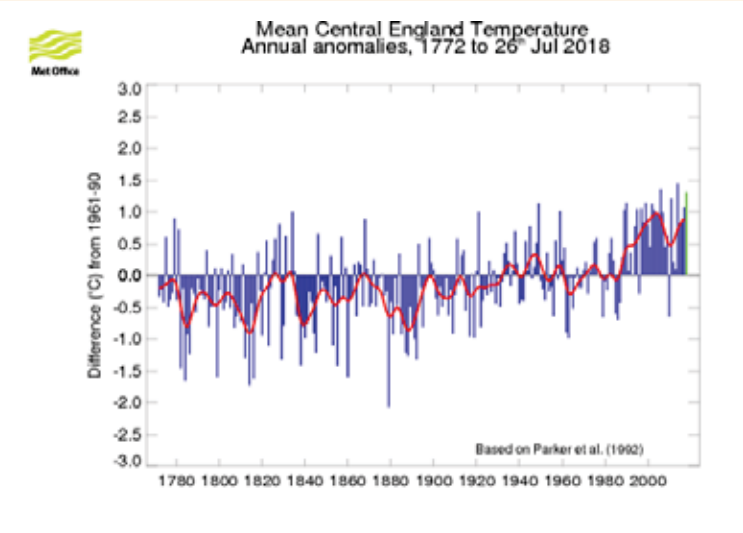


Figure 4
Mean Central England Temperature record[2]

[1]Xiaolan L. Wang, Y. Feng, G.P. Compo, V.R. Swail, F.W. Zwiers, R.J. Allan, P.D. Sardeshmukh. 2012. Trends and low frequency variability of extra-tropical cyclone activity in the ensemble of twentieth century reanalysis.

[2]Parker, D.E., T.P. Legg and C.K. Folland. 1992. A new daily Central England Temperature Series, 1772-1992. Int. J. Clim., Vol12, pp 317-342.

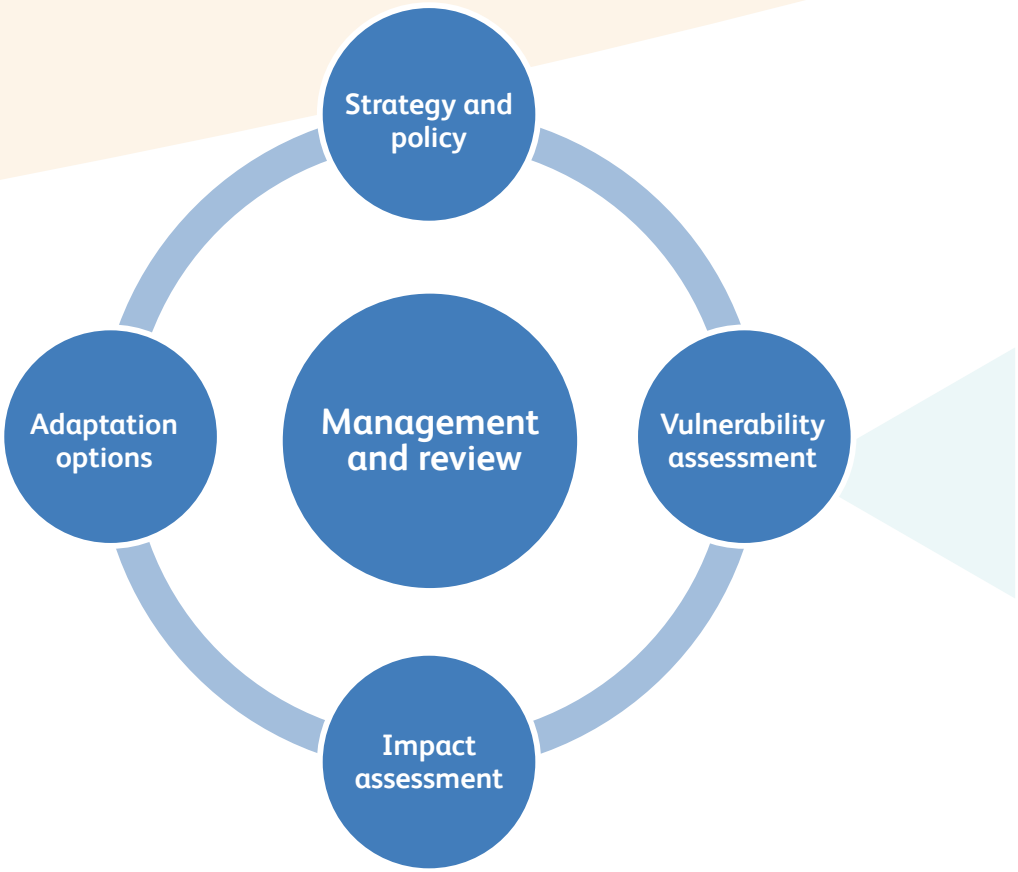
Introduction continued

To ensure a consistent approach to WRCCA consideration and action across Network Rail an iterative framework of key management stages is used (see Figure 5). The same framework has been applied to develop this Route WRCCA plan.

Network Rail will take a range of soft (changes to processes, standards, specifications and knowledge and skill base) and hard (engineered solutions to increase resilience) WRCCA actions tailored to the level of risk and the strength of evidence for it.

The following sections provide findings from the updated Western Route vulnerability and impact assessments, and detail progress on the CP5 resilience actions, actions planned for CP6 and additional actions for future consideration.

Figure 5
Weather resilience and climate change adaptation framework



Climate change projections

UKCP18 projects an overall shift towards warmer climates with drier summers and wetter winters for the whole of the UK, although the level of change will vary across the regions.

Examples of the changes are shown in Figure 6 for the mean daily maximum summer temperature and Figure 7 for winter precipitation.

Figure 6
Change in mean daily maximum summer temperature (°C) (left to right; 2030s, 2050s and 2070s) based on a 1981-2000 baseline[3]

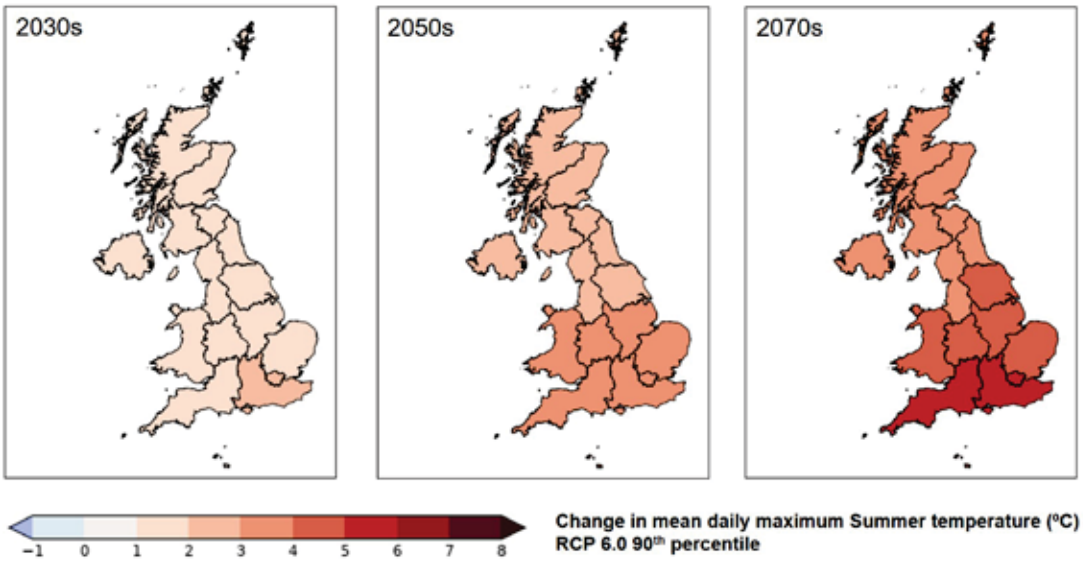
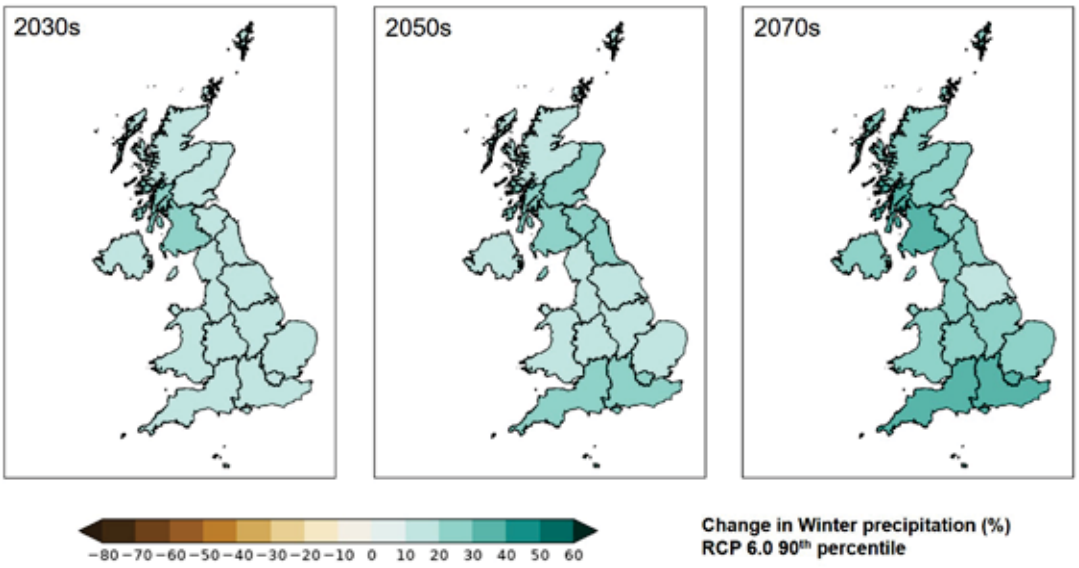


Figure 7
Change in winter precipitation (%) (left to right; 2030s, 2050s and 2070s) based on a 1981-2000 baseline[4]



[3]© UK Climate Projections, 2018.
[4]© UK Climate Projections, 2018.

Climate change projections continued

The 2015 Paris Agreement unites nearly every nation in a common cause to undertake ambitious efforts to combat climate change and adapt to its effects. The central aim is for a strong global response to the threat that keeps the global temperature rise this century to well below 2˚C above pre-industrial levels and to pursue efforts to limit it to 1.5˚C.

The Department for the Environment, Food and Rural Affairs (Defra) provides national climate change guidance in a number of ways to enable the assessment of future climate risks and the planning of adaptation actions to maintain and improve resilience. Of these the most critical to Network Rail and the Western Route are:

- The UK Climate Projection data sets which are produced by the Met Office Hadley Centre, and
- The National Adaptation Programme (NAP).

The UK Climate Projection data sets are produced for use in assessing the future risk and impacts of the possible climate projections for the UK. They are used by government to conduct the 5 yearly UK Climate Change Risk Assessments (UKCCRA) and by individual organisations to understand and plan for their specific risks.

For the 2014 Route WRCCA Plans Network Rail's national guidance was to use the UKCP09 High scenario, 50th percentile probability projections as an appropriate benchmark on which to base evaluations and decisions. In 2017 Network rail commissioned a review of its guidance considering the Paris Agreement, advances in climate science and additional years of climate observations and the then pending release of the UKCP18 dataset.

The conclusions of the review[5] were that as a safety critical focused organisation and major UK infrastructure manager the most appropriate UKCP projections to use are:

- UKCP18 – RCP 6.0 90th percentile probability as the baseline scenario for evaluation and decisions, and
- RCP 8.5 90th percentile as the sensitivity test on assets with a lifespan beyond 2050.

Analysis in this report has been updated using the UKCP18 projections where available. It should be noted that some UKCP09 parameters have not been updated in UKCP18. Where this is the case, the UKCP09 data has been used and this is clearly indicated in the report.

The NAP is based upon the UKCCRA and is published by Defra every 5 years. It contains a summary of the impacts expected for each sector of the UK economy and tables detailing adaptation actions that the UK Government requires those sectors to undertake to ensure the continuing resilience of the UK economy. The sectorial actions are apportioned to key stakeholders such as regulators and national infrastructure operators. Details of the Transport Sector actions in the NAP 2018 that are apportioned to Network Rail, and hence the Western Route, are included in the Western Route WRCCA Actions section of this Plan.

It must be noted that climate change projections include inherent uncertainties, associated with natural climate variability, climate modelling and future emissions, and these uncertainties increase with downscaling to local levels; however, the projections can be used by Network Rail to provide a direction of where the UK climate is heading, and the Route Weather Resilience and Climate Change Plan (WRCCA) uses these projections to support the prioritisation of weather resilience actions.

[5]Identifying a climate change planning scenario, JBA Consulting 22/02/18.

Future climate change vulnerability

The relationship between weather events and climate is complex, Network Rail must therefore, use the climate projections to understand the risks from future weather and make informed strategic decisions to weather resilience.

UKCP18 provides regional climate change projections across 13 administrative regions in Great Britain, Figure 8. The South West England region of UKCP18 is predominantly representative of Western Route but the London 'Thames Valley' end of the Route falls within the South East England region. Projections for these two areas are considered to be representative of the future climate changes within the Route.

In the 2014 Plan charts were generated using the UKCP09 High emission 50th percentile probability scenario for the two regions to show the projected changes in temperature and precipitation from the 2020s to the 2080s relative to the baseline climate of the 1970s (1961-1990). For this report the charts and associated narrative have been updated to match the current Network Rail climate change planning projections. that uses the updated climate projections (UKCP18) where available. UKCP18 moves to a new 1981-2000 baseline and new future 20-year average time periods (2030s, 2050s, 2070s) with comparable climate scenarios RCP 6.0 for Network Rail's Primary Climate Change Scenario and RCP 8.5 for the Higher scenario for temperature and precipitation variables, For UKCP18 sea level rise data, RCP 4.5 and RCP 8.5 are used as Network Rail Climate Change Scenarios Primary and Higher respectively. RCP 4.5 is used in place of RCP 6.0 (which is not available) and the future time periods are shown as up to that year (e.g. by 2050) rather than 20-year averages. Sea level rise (in cm) is expressed as the 95th percentile that shows the higher end of the range projected for each location.

Figure 8
Map of UK administrative regions used in UKCP18[6]

[6]Source: Met Office © Crown Copyright 2019 [available from UKCP18 Guidance: Data availability, access and formats: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-guidance-data-availability-access-and-formats.pdf]

Climate change projections continued

Mean Daily Maximum Temperature change

The mean daily maximum temperature for both regions is projected to increase in every month of the year, with greatest increases expected in the summer months. This increase becomes larger across the century.

South East England

The highest mean daily maximum summer temperatures are expected to be in August for both the 2050s and 2070s, with increases of 4.6˚C to 26.4˚C and 6.3˚C to 28.1˚C respectively. In winter the highest mean temperatures will be seen in December, with increases of 2.1˚C to 10.1˚C and 2.9˚C to 10.9˚C respectively.

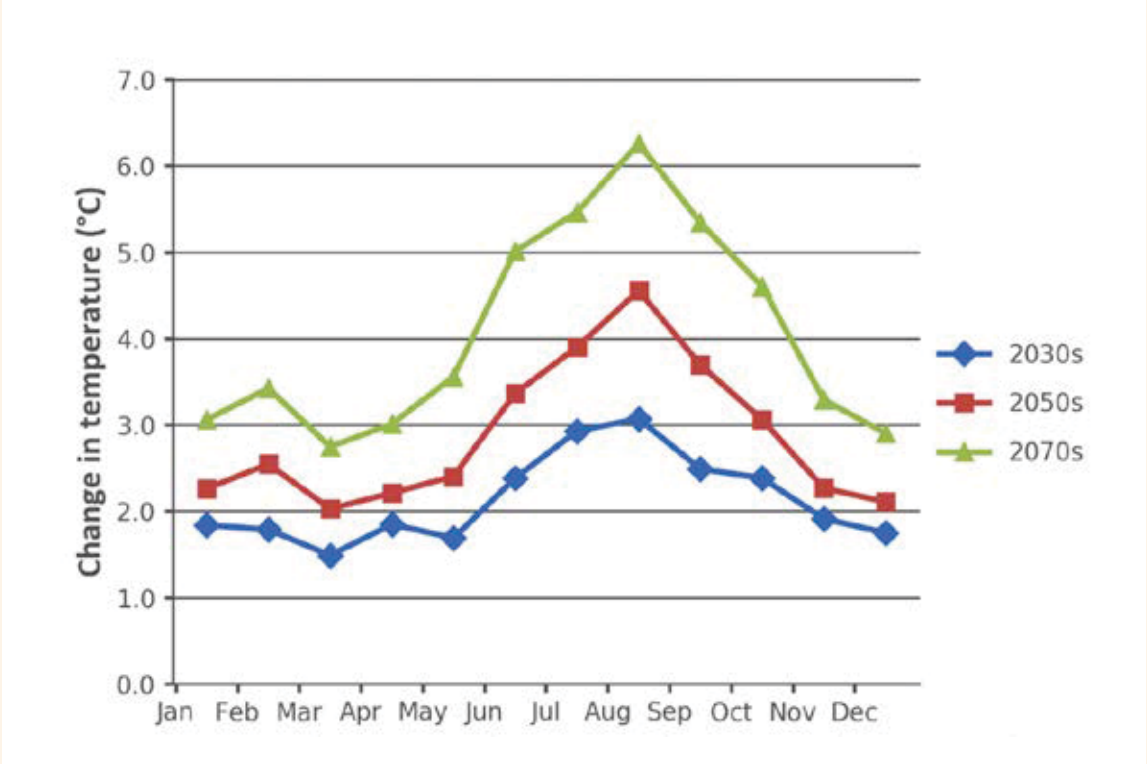
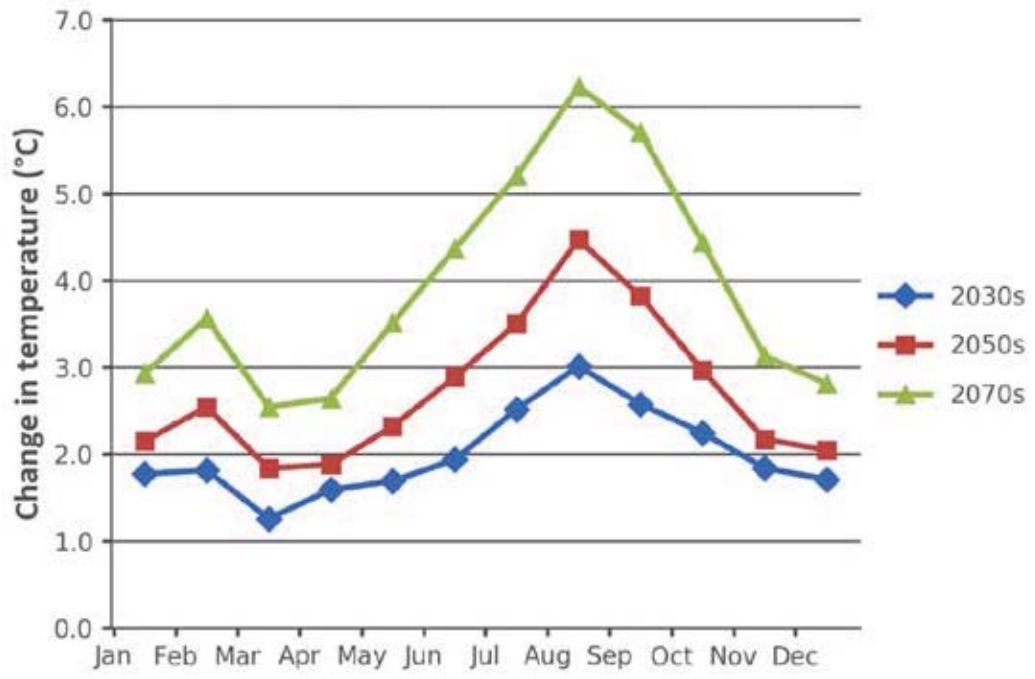


Figure 9
South East England, mean daily maximum temperature change (˚C), (RCP 6.0 90th percentile)

South West England

The highest mean daily maximum summer temperatures are expected to be in August for both the 2050s and 2070s, with increases of 4.5˚C to 25.0˚C and 6.2˚C to 26.8˚C respectively. In winter the highest mean temperatures will be seen in December for the 2050s, with increases of 2.0˚C to 10.4˚C and February by the 2070s with increases of 3.6˚C to 11.3˚C respectively.

Figure 10
South West England, mean daily maximum temperature change (˚C), (RCP 6.0 90th percentile)



Climate change projections continued

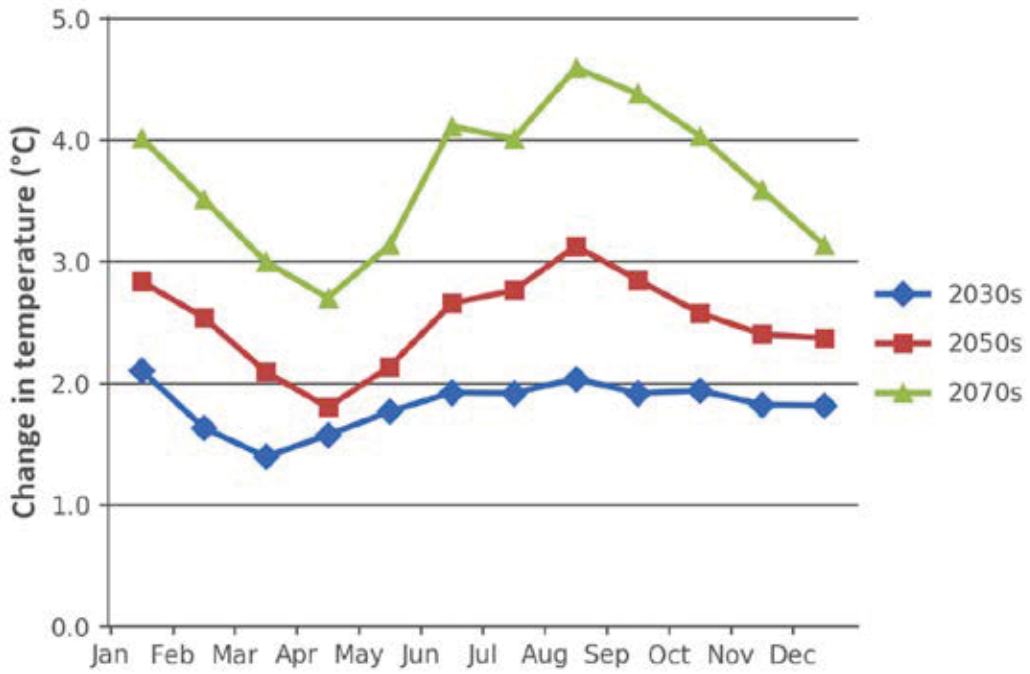
Mean Daily Minimum Temperature change

The mean daily minimum temperature for the regions is also projected to show increases throughout the year with the highest in summer. The level of increase is expected to become higher across the century.

South East England

The highest mean daily minimum temperatures for summer are expected to be in August, with an increase of 3.1˚C to 15.0˚C by the 2050s and increase of 4.6˚C to 16.5˚C by the 2070s. The lowest mean minimum temperatures will still occur in February with expected increases being 2.5˚C to 3.6˚C by the 2050s, and by 3.5˚C by the 2070s to 4.5˚C.

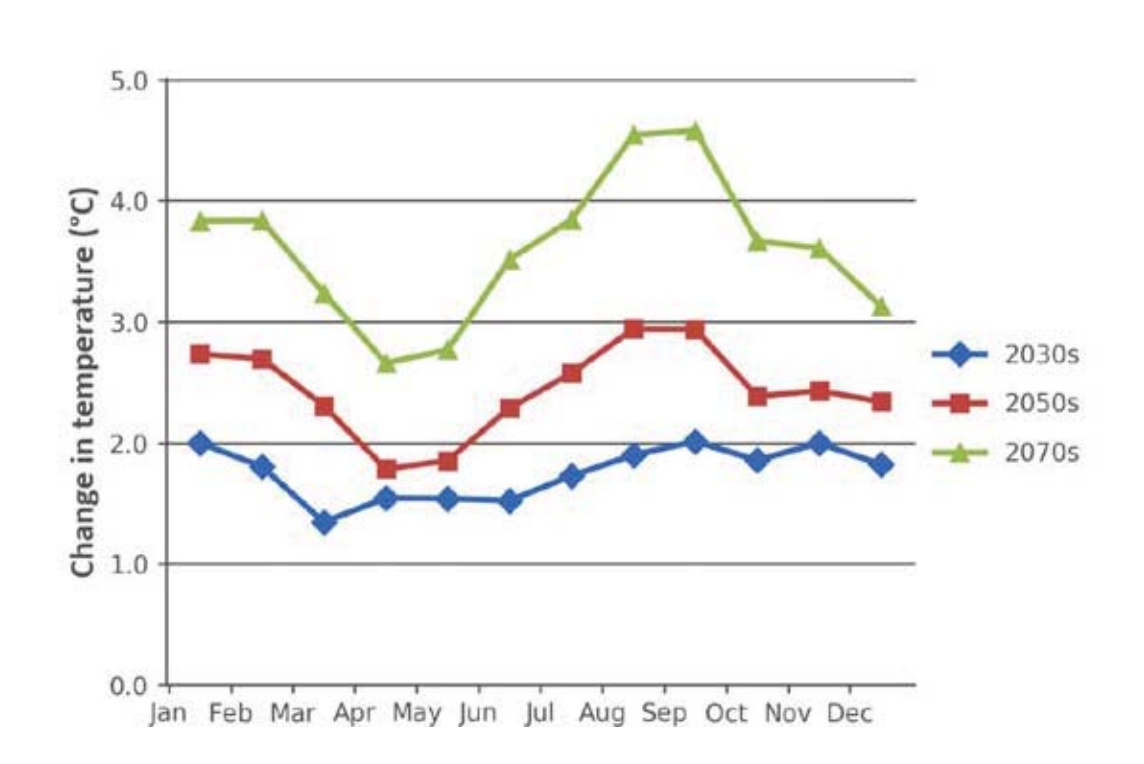
Figure 11
South East England, mean daily minimum temperature change (˚C), (RCP 6.0 90th percentile)



South West England

The highest mean daily minimum temperatures for summer are expected to be in August, with increases of 2.9˚C to 14.7˚C by the 2050s and an increase of 4.5˚C to 16.3˚C by the 2070s. The lowest mean minimum temperatures will still occur in February with expected increases being 2.7˚C to 4.3˚C by the 2050s, and 3.8˚C by the 2070s to 5.5˚C.

Figure 12
South West England, mean daily minimum temperature change (˚C), (RCP 6.0 90th percentile)



Climate change projections continued

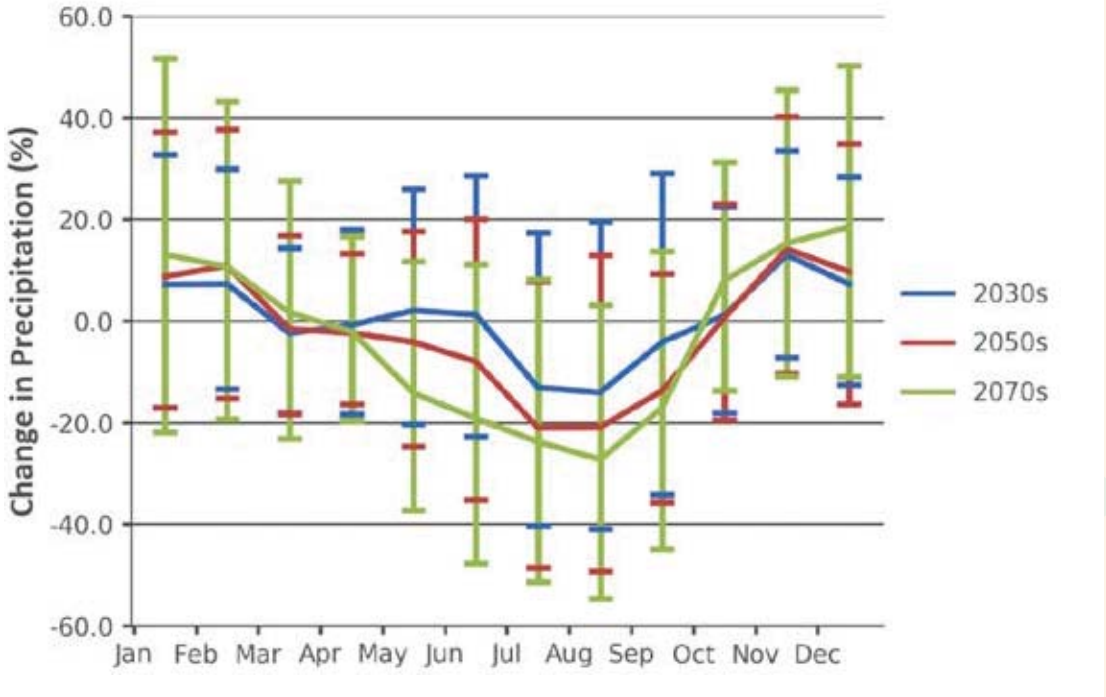
Mean daily precipitation

The UKCP18 narrative for mean daily precipitation in the regions is of significantly wetter winters and drier summers. Network Rail's chosen climate change planning scenario (RCP 6.0 90th percentile) shows the upper range of winter rainfall increases, but it does not illustrate the highest potential summer rainfall reductions. These are best represented by the RCP 6.0 10th percentile projections Figures 13 and 14 therefore plot the RCP 6.0 50th percentile projections with error bars that indicate the wider range of change associated with the 10th and 90th percentiles.

South East England

In the 2050s and 2070s December will be the wettest month with mean daily rainfall increases of 34.8 % to 3.8mm/day and 50.3 % to 4.2mm/day respectively. The driest month will be July showing decreases of 48.6 % to 0.8mm/day by the 2050s and 51.3 % to 0.7mm/day by the 2070s.

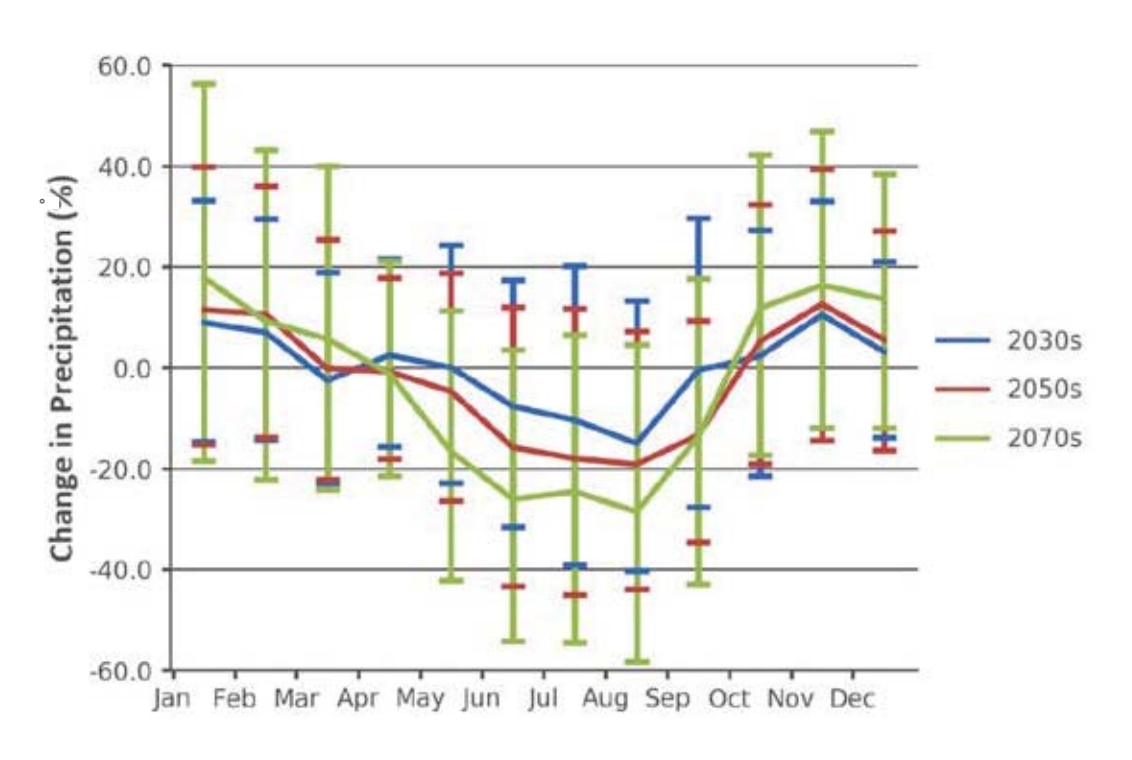
Figure 13
South East England, mean daily precipitation change (%), (RCP 6.0 50th percentile with the wider range showing the 10th and 90th percentiles)



South West England

In the 2050s and 2070s December will be the wettest month with daily rainfall increases of 27.2 % to 5.4mm/day and 38.4 % to 5.8mm/day respectively. The driest month will be July showing decreases of 45.1 % to 1.0mm/day by the 2050s and 54.5 % to 0.8mm/day by the 2070s.

Figure 14
South West England, mean daily precipitation change (%) (RCP 6.0 50th percentile with the wider range showing the 10th and 90th percentiles)



Climate change projections continued

Storm intensity and river flows

In addition to changes in total rainfall, climate change is also expected to increase the frequency and severity of river flooding events and individual rainstorm events, summer rainstorms show the largest increases.

The Environment Agency produces guidance on the rainstorm intensity and river flow uplifts that should be used to account for climate change. This guidance is being reviewed due to the release of UKCP18 climate change data, however, at the time of publishing this plan the guidance is still based on the UKCP09 Medium emissions scenario.

This recommends that rainstorm intensities for the Western Route area should be increased by 10 % for the 2050s and 20 % for the 2080s. Climate uplifts[7] for river flows are provided by river basin and those relevant to the Western Route are shown in Table 1.

Table 1
River flow uplifts (UKCP09)

River basin	2050s uplift	2080s uplift
Thames	25 %	35 %
South West England	30 %	40 %

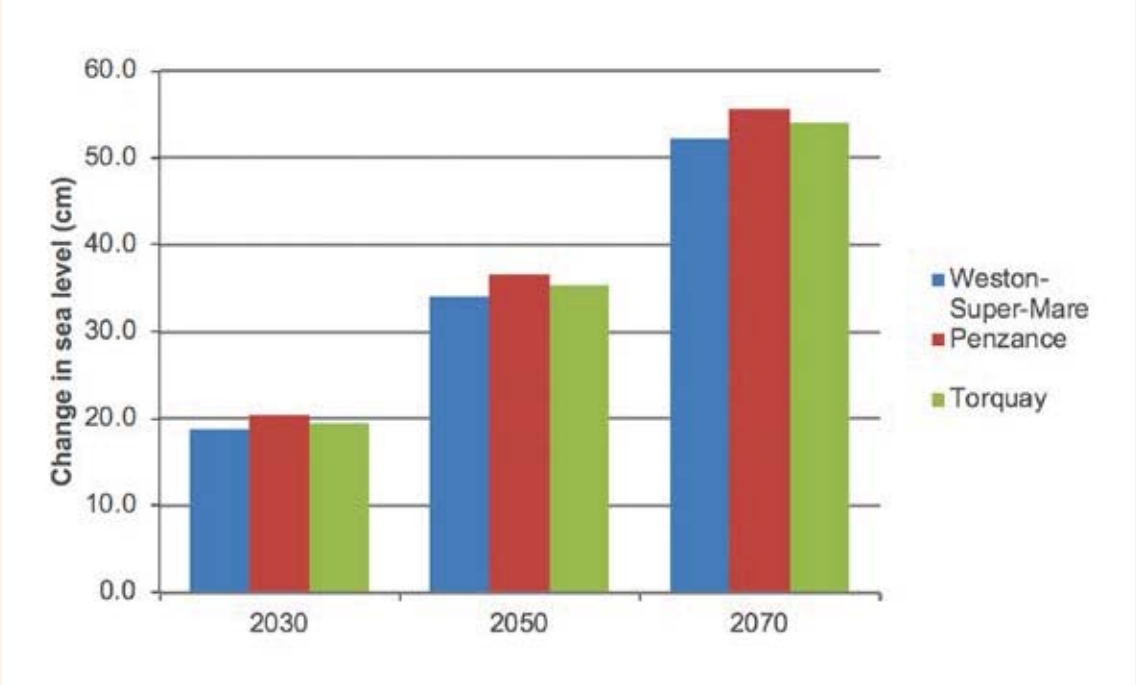
Sea level rise

Sea level varies around the coast which will also affects the degree of sea level rise. UKCP18 projections have been obtained for coastal locations covered by the Western Route[8].

South West England

Penzance will see the highest rises by 2050 and 2070 of 36.5cm and 55.6cm respectively and Weston-Super-Mare will see the lowest at 34.1cm and 52.2cm.

Figure 15
Sea level rise projections for South West England (cm) (RCP 4.5 95th percentile)



[7]Environment Agency higher central climate change estimate as the most comparable to Network Rail's climate change planning scenario.
[8]Sea level rise data in UKCP18 is not available for RCP 6.0, instead RCP 4.5 is used as a proxy on the recommendation of the Met Office. This is the most compatible with the Network Rail Primary planning scenario.

Western Route vulnerability assessment

Network-wide weather vulnerability

The rail network and its component assets are sensitive to the effects of several weather types. These manifest as either primary events (one weather type) or secondary events which are the result of these and/or a combination of weather types – Figure 16.

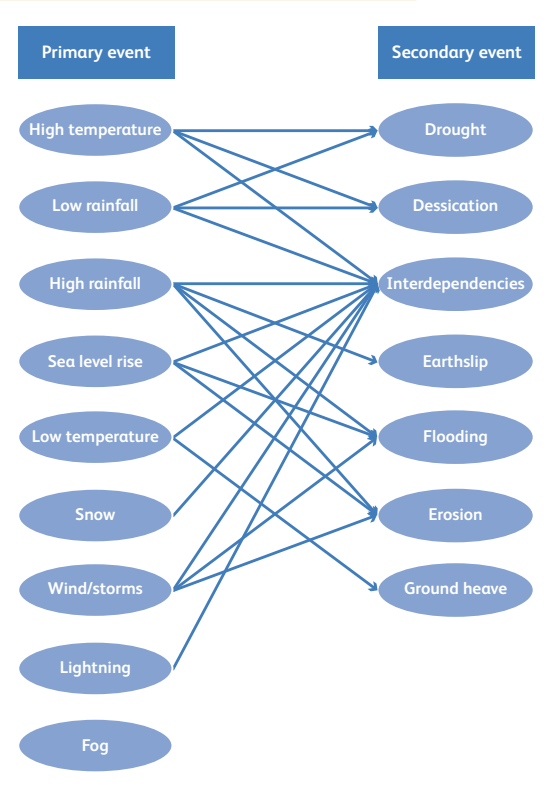


Figure 16
Diagram showing the link between primary weather events and secondary event consequences

Managing an intricate array of assets of varying ages, condition and weather vulnerabilities across a wide range of bio-geographic regions in a variety of climates is a complex challenge for Network Rail, additionally so when considering interdependencies with other infrastructure sectors e.g. power and telecoms.

Understanding current weather impacts is essential for assessing the probable effects of climate change and for the planning and implementation of appropriate resilience investments to adapt the network to the future impacts.

We have monitored the impact of weather on the performance of our network and analysed this data to understand:

- The characteristics of weather-events that trigger failures,
- The thresholds at which failure rates significantly change, and
- Trends in the failures of assets and the performance of the network.

Western Route vulnerability assessment continued

Performance impacts

The key findings of this work were that earthworks were the asset most affected by rainfall, OLE was most sensitive to wind and that temperature impacted the widest range of assets. We continue to monitor and analyse this data and we now have a 13-year series increasing our capacity to discern trends in failures and performance.

Rail asset and weather impact relationships are complex, as demonstrated in the case of OLE where many wind-related failures are a result of vegetation incursion and not direct wind gusts as the primary impact; therefore, any analysis of rail assets and weather vulnerability requires deeper understanding of root causes to identify cost effective resilience actions.

Figure 17
Network wide potential consequences of weather-related hazards (NR/L2/OPS/021, 2019)

Flooding/High seas (Topping)/Heavy Rain	a) Obstructions on the line b) Scour action c) Land-slide, slope failure or washout d) Inundation (flooding), including equipment failure e) Sea spray f) Erosion
Ground Saturation	a) Surface water flooding b) Land-slide, slope failure or washout c) Erosion
High Wind Speeds	a) Overhead line damage b) Structural damage, including station roofs and canopies c) Fallen trees (or parts therof) d) Leaf fall (includes railhead contamination and loss of Track Circuit Detection [wrong side failures]) e) Debris f) Shifted load or loose sheeting
Railhead Contamination	a) Category A SPAD b) Station over-run c) Low rail adhesion d) Loss or Track Circuit Detection (wrong side failures) e) Rail/wheel defects
Extremes of temperature	a) Rail buckles b) Track circuit failures c) Point failures through loss of detection, especially switch diamonds d) Overhead line sag e) Overheating relay rooms f) Swing bridge expansion g) Rock-fall resulting from prolonged periods of cold weather
Thunderstorms/ lightning	a) Failure of electrical and electronic equipment b) Structural/tree damage c) Lineside fires
Fog/Mist/Low Level Ground Cover	a) Signal passed at danger b) Level crossing collision
Snow/Hail/Ice/ Frost, including Freezing Rain and Freezing Fog	a) Points failure b) Signal failure c) Structural/tree damage d) Ground heave during extended periods of low temperatures e) Icing of electrical equipment, including conductor rails and OLE f) Icicles, including in tunnels g) Signal passed at danger h) Level crossing collision i) Platforms or walkways covered by snow or ice j) Track circuit failures at level crossings caused by applications of road salt
Long Periods of Dry Weather	a) Desiccation (shrinkage) of sensitive clay embankment from moisture removal leading to serviceability issues with formation and track b) Lineside fires – Fires on land/premises adjoining the railway – Fires resulting from the operation of steam locomotives

Route weather vulnerability

Western Route, along with the rest of the UK has experienced a number of significant weather events since publishing the CP5 Weather Resilience and Climate Change Adaptation action plan. Following several years of extreme winters involving the largest average winter rainfall for over a hundred years, the annual rainfall in the previous 3 years throughout the UK has been below the 1981-2010 average. CP5 ended with one of the hottest summers on record with a mean temperature of 15.75˚C across the UK.

UK – Mean temperature – summer

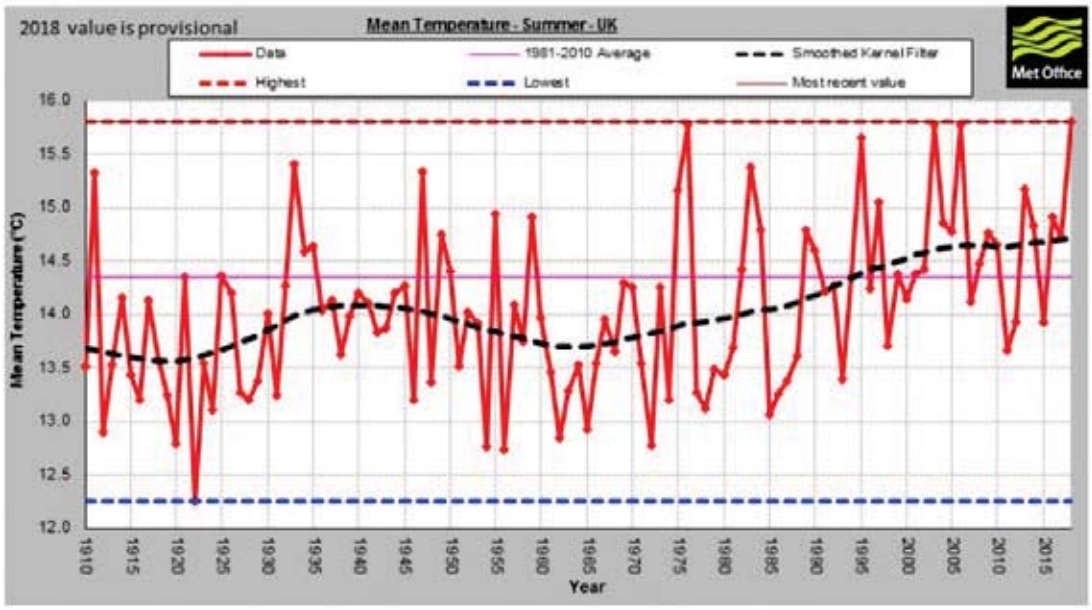


Figure 18
Graph showing the change in mean temperature in the UK during the summer months 1910–2018[9]

[9]Met Office, 2019, Climate graph, https://www.metoffice.gov.uk/datapoint

Western Route vulnerability assessment continued

Prior to CP5, flooding was by far the Route's primary weather vulnerability; however, over the last 5 years, the effect of flooding has been considerably less. In terms of delay minutes, snow has been the greatest vulnerability of the Route between 2014/15 and 2018/19, with over 100,000 minutes in 2017/18 alone, attributed mainly to the 'Beast from the east'. The record-breaking summer of 2018 showed the challenges faced by prolonged hot temperatures and dry periods causing stress on rail and high Soil Moisture Deficit (SMD) leading to shrinkage of embankments and subsequent speed restrictions being instigated across the Route.

Operational restrictions are often instigated preemptively when extreme weather conditions are expected. Figure 19 shows the thresholds for weather conditions to be considered Adverse and Extreme and where operational restrictions would be considered.

The variation of extreme weather throughout CP5 is evidence of the increasing challenges that Western Route must deal with to ensure a resilient railway. Below highlights some of the issues faced over the past control period due to adverse weather.

Figure 19
Table highlighting the national weather hazard identification (NR/L3/OPS/045/3. 17, 2017)

National Table				
Wind				
Category	**Normal**	**Aware / Level 1**	**Adverse / Level 2**	**Extreme / Level 3**
Sustained (mph)	29 or less	30 to 39.9	40 to 49.9	50 mph or more
Hourly Gusts (mph)	39 or less	40 to 49.9	50 to 59.9	60 mph or more
Rain				
Category	**Normal**	**Aware / Level 1**	**Adverse / Level 2**	**Extreme / Level 3**
Hourly (mm)				
3 Hourly (mm)	less than 3mm	3 to 4.9mm	5 to 9.9 mm	10mm or more
12-hour	less than 15mm	15 to 19.9mm	20 to 24.9 mm	25mm or more
12-hour on 100% Wet Soil (mm)	less than 5mm	5 to 7.9 mm	8 to 10 mm	10mm or more
Daily (mm)	less than 30mm	30 to 39.9	40 to 49.9	50 or more
Daily on 100% Wet Soil (mm)	less than 10mm	10 to 14.9 mm	15 to 19.9 mm	20mm or more
15 Daily (mm)	less than 70mm	70 to 99.9 mm	100 to 149.9 mm	150mm or more
Temperature				
Category	**Normal**	**Aware / Level 1**	**Adverse / Level 2**	**Extreme / Level 3**
Heat (°C)	less than 20 C	20 to 24.9	25 to 28.9	29 or more
Cold (°C)	warmer than -0	0 to -2.9	-3 to -7	-7 or colder
Frost (°C) (Minimum air temperature - wind >12 mph)	warmer than -0	-0 to -0.9	-1 to -2.9	-3 or colder
1 Day Diurnal Cycle (°C)	less than 13 C	13 to 15.9	16 to 17.9	18 or more
Snow				
Category	**Normal**	**Aware / Level 1**	**Adverse / Level 2**	**Extreme / Level 3**
Daily Snowfall (cm)	1.9 or less	2 to 4.9	5 to 14.9	15 or more
Accumulation	TBD	TBD	TBD	TBD
Drifting Risk	None	Low	Medium	High

Summer 2018 heatwave

The summer of 2018 proved to be the joint hottest summer on record for the UK as a whole and the hottest ever for England, experiencing twice as many days over 21˚C as the previous year (98 versus 47). The heat caused numerous issues to a variation of assets, including track, earthworks, signalling and Electrification and Plant (E&P).

Points failures formed the most significant proportion of disruptive incidents. No single failure mode stood out as the most common root cause, however, 34 % of points related failures were classified 'No Cause Found'. Overheating Cyclon cell batteries were responsible for one major failure at Bristol East Junction, and three other points failures, making this the highest attributed failure mode for points failures. Train detection also experienced a number of failures at high temperatures above 21˚C – although it should be noted that there are a number of other issues that may have contributed to the axel counter failures.

Figure 20
Scrap rail left within 2m of heads (left) and poor installation of axel counter (right)

Overheating electrical assets was a critical underlying factor in many service affecting failures during the summer, including major datalink and battery failures. Much of the current air-con provision is specified by the area of the building being cooled rather than the heat generated by the equipment it houses.

The track itself is vulnerable to high temperatures as compressive forces which develop in rails expanding in hot weather can cause the rail to buckle, resulting in a short but severe misalignment. The incident shown in Figure 21 at Oxford resulted in emergency works being required and associated train delays.

Figure 21
Track buckle at Oxford, May 2018

Western Route vulnerability assessment continued

The long period of hot and dry weather lead to desiccation on clay cored embankments throughout Western Route, but notably in the Thames Valley and West Country (north) areas.

This was exacerbated by the dry and hot summer following a wet winter causing a significant differentiation in SMD from winter to summer.

Figure 22
Example of SMD tracking, updated weekly for TSR board

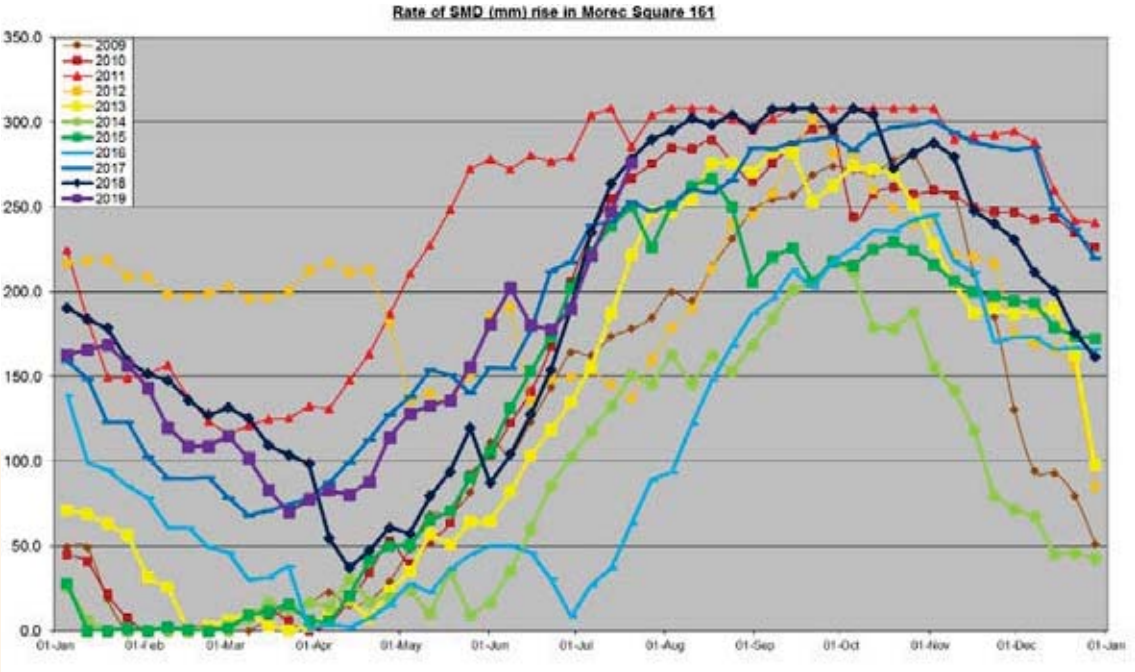


Figure 23
Image showing track alignment issues when transitioning to underbridge

Shrinkage in the embankment and subsequent movement of the track above led to a number of track alignment issues, especially on transition to underbridges and other underlying hardstandings. The track issues were exacerbated further by the very low levels of track maintenance undertaken due to the exceptionally high track temperatures and the risk of track buckling if disturbed – a total of 10 no. Temporary Speed Restrictions (TSRs) were imposed due to underlying desiccation issues.

Southall Uninterruptible Power Supply (UPS) (2015)

During hot weather in August 2015 all Signaling was lost in the Southall area due to a power failure. The train service in and out of Paddington station was severely affected with over 8000 minutes delay attributed to the event. The UPS at Southall had overheated and shutdown. The overheating was due to a complete failure of the air conditioning in the equipment room and technicians attending the fault stated the room was initially too hot to enter. The UPS batteries expanded in the excessive heat and all had to be scrapped. This incident prompted a change in cooling philosophy in UPS rooms and new installations are now cooled by forced air cooling which is more reliable than air conditioning.

Figure 24
Overheated batteries, Southall UPS, August 2015

Winter storms

A number of storms have hit the Route during CP5, the most damaging of which occurred in 2016 – notably, Storm Katie (March 2016), Storm Imogen (Feb 2016) and Storm Angus (Nov 2016). All caused significant damage to infrastructure and train delays due to issues such as flooding, washouts and fallen trees.

Storm Imogen struck the West Country area of Western Route (0700hrs 8th February 2016) with estimated wind speeds in excess of 70mph and heavy rainfall showers. Disruption to service was experienced and a number of weather-related incidents occurred. As summary of the incidents and associated disruption is listed below.

Figure 25
Fallen tree at Bodmin and damage to Voyager

Western Route vulnerability assessment continued

Table 2
Summary of incidents directly associated with Storm Imogen (Feb 2016)

Incident location	Incident description	Short term mitigations	Medium term mitigations	PfPI minutes	PfPI costs
Bodmin	1S47 disabled after striking fallen tree. Tree was from 3rd party (National Trust) land. Both lines blocked. Train was evacuated.	Pway removed fallen tree. Single line working introduced. Train removed under own power.	N/A	638	£91,961.00
Pilning to Patchway	Patchway – Flowing water from adjacent bank potentially eroding ballast.	Pway visited site and reported that water was not disturbing ballast.	Investigation to be completed to determine whether the drainage measures currently in place are adequate and serviceable.	593	£40,925.24
Gunnislake Branch	Fallen tree on the Gunnislake Branch line	Pway removed fallen tree.	N/A	0	£0.00
Tiverton	Closure of line due to overhanging 3rd party tree at risk of falling onto track.	Tree removed and normal service resumed.	N/A	392	£79,525.12
Par	Train stuck fallen tree.	Pway removed fallen tree and temporary repair to fence.	N/A	7	£611.00
Yate	Very large bush brushing side of trains.	Off-track cut back branches.	N/A	12	£1,086.00
Chenson	Low branch striking front of train.	Trains were run at caution until tree was cleared.	N/A	0	£0.00
Charfield	Small tree online approaching Charfield.	Driver removed tree.	N/A	0	£0.00
Bristol DU	Flooding causing multiple Track Circuit Failures.	Flood waters to be allowed to recede. S&T Maintenance mobilised to rectify fault.	Investigation to be completed to determine whether the drainage measures currently in place are adequate and serviceable.	7065	£849,745.29
Plymouth DU	Flooding causing multiple Track Circuit Failures.	Flood waters to be allowed to recede. S&T Maintenance mobilised to rectify fault.	Investigation to be completed to determine whether the drainage measures currently in place are adequate and serviceable.	3276	£422,756.98

Storm Emma and other unnamed storms in the winter of 2018 caused damage to the Dawlish Wall. The damage was mainly damage to the walkway, missing and dislodged copings and the loss of fencing adjacent to King Harry's Walk. There were no major defects to the fabric of the wall through CP5.

Figure 26
Image showing effects from storms at Dawlish during the winter of 2018

In the winter of 2018, severe snow and cold hit Western Route in addition to the majority of the UK – this storm was known as the 'Beast from the East'. The storm caused significant disruption due to the snow drifts on the line and closure of railway platforms. The deep snow covered the rail head stopping the Train Operating Companies (TOCs) and Freight Operating Companies (FOCs) running their fleet until snow ploughs could be deployed to clear the paths and to enable the safe running of the railway.

Figure 27
Snow fall covering the rails during the 'Beast from the East' (2018)

Western Route impact assessment

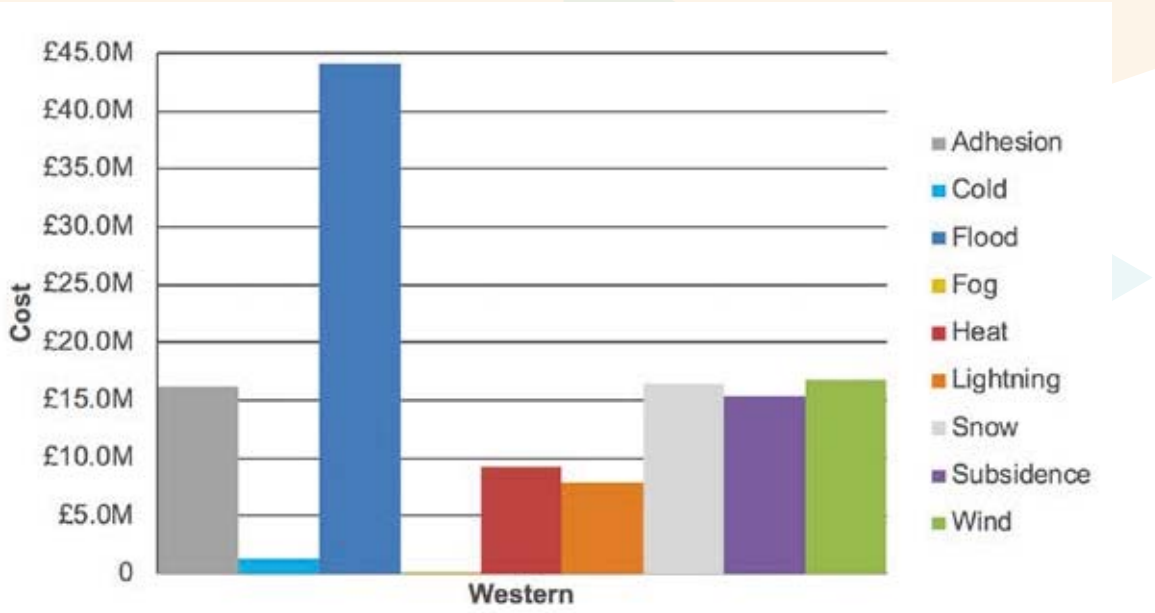
This section provides an update to Western Route's weather impact assessment findings published in the 2014 Western Route WRCCA action plan, including annual performance impacts and identification of higher impact locations on the Route.

Performance impacts

The impact of weather events on our network's performance is monitored using delay minutes and Schedule 8 (APL – average passenger lateness) compensation costs as proxies. As this data includes the duration and location of each disruption, and attributes cause, it provides a high degree of granularity for use in analysing weather impacts and trends.

Compensation costs for the past 13 financial years for Western Route have been analysed to provide an assessment of weather impacts, see Figure 28.

Figure 28
Western Route weather attributed Schedule 8 costs 2006/07 – 2018/19



The updated analysis shows that, with a cost of £44.7m over the last 13 years, flooding remains the greatest impact by far. Wind and adhesion are next with individual costs of roughly one third of those for flooding; however, both of these impacts have shown a marked growth in cost over the last 4 years relative to the remainder of the impact types.

Climate modelling cannot provide future weather forecasts, but it does give us projections for the trends in future weather patterns. Combining these trends with our analysis of current weather impacts allows us to understand the future vulnerability and possible impacts on the Western Route.

From early review of UKCP18, there is a high degree of confidence in the projections for temperature, rainfall and sea level rise, but lower levels of confidence for wind, lightning and snow fall. Planning for the latter parameters should still be undertaken, but outputs should be more flexible to acknowledge the higher possibility of alternative climate outcomes.

The combined analysis of current weather impacts and UKCP data (UKCP09 for wind, lightning and snow and UKCP18 for temperature, precipitation and sea level rise) will be used in the prioritisation of resilience actions as summarised in Table 3 – Prioritisation of weather-related impacts on Western Route.

Table 3
Prioritisation of weather-related impacts on Western Route

Impact	Compensation costs per year[10]	Climate projection[11]	Prioritisation
Wind	Average £1.09m Highest £3.96m	Changes difficult to project, however generally expected to increase.	High
Adhesion	Average £1.22m Highest £2.51m	Complex relationship between multiple causes and their climate projections.	High
Snow	Average £1.26m Highest £9.21m	Changes difficult to project, but increases in autumn, winter and spring minimum temperatures suggest reduced snow days.	Medium
Lightning	Average £0.63m Highest £3.21m	Changes in storms difficult to project, however generally expected to increase.	Medium
Cold	Average £0.11m Highest £0.44m	Increases in mean daily minimum temperatures across the regions in autumn, winter and spring ranging from 1.8°C in April to 2.9°C in September for the 2050s and 2.7°C in April to 4.6°C in September for the 2070s.	Low
Earthwork Failure / Landslip	Average £0.96m Highest £3.51m	Increases in mean daily rainfall across the regions for late autumn, winter and early spring months, for example; 17.8% in April and 39.8% in January by the 2050s becoming 21.2% in April and 56.3% in January by the 2070s. Increased frequency and intensity of winter and summer storms. Decreases in mean daily rainfall for late spring through to early autumn, for example; 26.3% in May and 43.9% in August by the 2050s becoming 42.2% in May and 58.4% in August by the 2070s.	High
Heat	Average £0.43m Highest £1.48m	Increases in mean daily maximum temperatures across the regions range from 2.0°C to 2.5°C (winter) and 2.9°C to 4.5°C (summer) by the 2050s. In the 2070s this becomes 2.8°C to 3.6°C and 4.4°C to 6.2°C respectively.	High
Flooding	Average £3.65m Highest £15.26m	Increases in mean daily rainfall for late autumn through to early spring and increased intensity and frequency of winter and summer storms (see Earthwork Failure/Landslip)	High
Sea level rise	Average (schedule 8 effect not currently known)	Sea level rise ranges from 34.1cm (Weston-Super-Mare) to 36.5cm (Penzance) in the 2050s and 52.2cm to 55.6cm in the 2080s. This and increases in storminess raise the risk of overtopping and erosion[12].	High
Fog	Average <£0.01m Highest £0.04m	This is a complex picture with low confidence[13],however possible seasonal changes across the regions for the 2080s have been indicated as: winter -+7% to -+4%, spring -40% to -42%, summer -69% to -70% and autumn -28% to -31%.	Low

It should be noted that the compensation cost rate charged for Schedule 8 delays increased in 2015, as such, costs associated with CP5 are augmented in comparison with pre-CP5 events.

Identification of higher risk locations

Throughout CP5, Western Route has continued to experience extreme weather events that have challenged weaknesses in our assets and operations. More frequent and intense extreme weather events are projected due to climate change; understanding the impacts of current and future events is critical to investment decision making.

Western Route has identified potential future risks and resilience actions based on climate change projections and Route knowledge but is also supported by data captured, via the schedule 8 compensation cost data.

Combining these findings allows us to proactively identify potential investments that would address current weaknesses and mitigate and/or enable the mitigation of future risks. This approach is critical creating a railway that is safer and more resilient to weather impacts now and in the future.

[10]Based on Schedule 8 costs per year over the last 13 years from 2006/07 to 2018/19.
[11]UKCP09 projections still used for wind, snow, lightning and fog as UKCP18 does not contain updates.
[12]UKCP18 RCP 4.5 95th percentile.
[13]Probabilistic data is not available from the UKCP09 data sets, this has been sourced from a supplementary UKCP09 report and represents the average of 11 models run using the Medium Emissions Scenario.

Western Route impact assessment continued

Weather impact assessments

Understanding the impact of adverse weather and the effects it has on the infrastructure is vital for preparation for the projected changes in climate. Temperatures will become hotter on average in all seasons. Spring will move earlier, and autumn will move later. Winter will be shorter. Average and daily maximum temperatures will increase, and heatwaves will become more frequent, longer and more severe and droughts will become more common. This will lead to a decline in frost and snow days and the likelihood of severe winters will decrease, but current levels of severity will remain possible. Winters are, however, expected to become significantly wetter, and the frequency and intensity of summer storms are expected to markedly increase.

Summer storm rainfall will be more severe than in winter. Intense summer rainfall after droughts/dry periods will increase the surface run-off and flash flood risks as well as an increase in peak river flows. Due to climate change sea level rise along the Western Route coast is expected with small variations depending on location. Storm intensity and frequency is all expected to increase, growing the risk of coastal erosion and sea defence overtopping causing difficulties in discharging to estuaries and the coast.

Earthwork impact assessment

Within the Western Route boundary there are long sections of earthworks known to be vulnerable to adverse weather, and where earthwork failures or proactive safety measures have restricted the running of trains.

Landslips & washout failures

The vulnerability of earthwork assets to adverse weather events can be linked to the type of underlying geological material cut through or used to fill during the construction of the railway. Weathering and the resultant reduction in the strength of the soils and rock forming the earthworks over the c.180 years since construction has left certain slopes susceptible to intense and/or sustained rainfall.

Earthwork failures are often triggered by water. This can be by direct rainfall and saturation of the earthwork, a failure of a drainage system at the crest or the toe of the earthwork, third party inflows or groundwater level changes.

Network Rail's steep soil cuttings, often cut into steep and large catchments, will always be at risk of failures in adverse or extreme rainfall as the high moisture content can reduce the soil's shear strength, and/or lubricate pre-existing slip surfaces within the slopes. Western Route contains a high percentage of high plasticity clays which are particularly susceptible to weakening in high moisture content.

Due to the relatively drier weather in CP5 in comparison to other control periods, in addition to targeted earthwork drainage enhancements over the last control period, there were fewer earthwork failures in total with no failures similar to the magnitude of which occurred in Teignmouth in CP5. Numerous smaller scale washouts and slope failures have occurred as a result of heavy and prolonged rainfall, including the slope washout at Chipping Sodbury Aqueduct and washout at level crossings in the Golden Valley, near Stroud.

Continued delivery of earthwork stability and drainage schemes is required to ensure resilience to adverse and extreme rainfall throughout CP6 and the projected increase rainfall magnitude and intensity due to climate change.

Figure 29
Washout failure and adjacent field at Chipping Sodbury Aqueduct (SWB 103m 74ch Dn)

Rockfalls

Rock cutting failures can occur quickly with very little warning (known as brittle failure) and can have catastrophic circumstances. During CP5 there were a number of these incidents on the Western Route. Freeze-thaw within rock cuttings can cause issues, by increasing the dilation of the joints which can in turn lead to failure. Below shows evidence of the damage that can be caused by just a light rain and a prolonged period of temperatures below zero.

There was also a large presence of vegetation on the rock face causing root jacking to occur which will have contributed to the planar failure.

Figure 30
Rockfall failure occurring on MLN3 in 2018

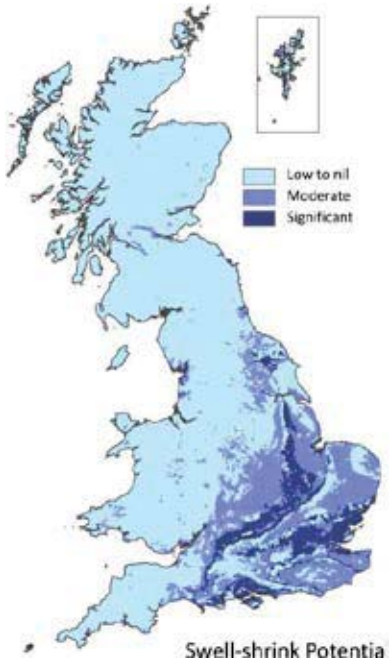
Western Route impact assessment continued

Dry weather impact to embankments and track quality

The CP5 WRCCA plan focused heavily on rainfall and storm events following the, at the time recent, damage caused at Dawlish and Teignmouth in addition to the large schedule 8 payments attributed to rainfall throughout CP4. In contrast, 2018 saw a prolonged period of very warm weather with highs of 35˚C making it the joint hottest summer in the UK since records began. Much of the Route's embankments are formed of clay material which in periods of hot and dry weather lead to shrinkage, known as desiccation. Where there is an embankment made up of predominantly clay material then there is potential for volume change when the moisture content changes.

Clay material is susceptible to both shrinkage and swelling and embankments with a high proportion of expansive clay minerals are most likely to experience the greatest volume change. The movement of the embankment causes a consequential movement of the track above and differential shrinkage in the embankment can contribute to significant track misalignment, especially on transition to underbridges and other underlying hardstandings. Additionally, the continued and increasing shrink/swell process can lead to a reduction in strength of the embankment and ultimately lead to an earthwork failure.

Figure 31
UK shrink-swell potential map and a table of Western Route earthwork 5 chain lengths with high potential



MLN1	WEY	SAL	DCL	SWB		BAG2
7.1100	104.1210	110.1540	55.0990	84.0220	88.0990	80.0770
51.1320	107.1320	110.1650	57.0660	84.0330	88.1100	84.0330
51.1430	107.1430	111.0000		84.0440	88.1210	91.1100
83.1430	108.0000	111.0110	OWW	84.0550	88.1540	
84.1650	108.0110		79.0990	84.1320	88.1650	SWM1
90.0330	108.1210	SWY	92.1540	84.1430	89.0000	86.0660
	108.1320	84.0550	98.0880	84.1540	89.0110	88.0330
ANL	108.1430	84.0770	98.1100	84.1650	89.0220	105.0000
6.0000	112.0770	84.0880		85.0000	89.0330	105.0440
	112.0990	84.0990		85.0110	89.0440	
BRB	112.1100	85.0000		85.0220	89.0550	BGL2
1.1320	117.0660	85.0110		85.0330	89.0660	96.0440
	117.0770	86.0110		86.0000	89.0770	96.0550
	117.1100	86.0220		86.0110	89.0880	97.1540
	117.1210	86.0330		86.0660	90.0440	101.1650
	118.1430			86.0770	90.0550	104.1320
	119.0000			86.0880	90.0660	106.0660
	119.0110			86.0990	90.0880	106.1540
	119.1100			87.0220	90.1100	106.1650
	124.1540			87.0330	90.1210	
				87.0440	91.0330	
				87.1650	91.1430	
				88.0880		

https://www.bgs.ac.uk/products/geosure/shrink_swell.html

The best indicator for desiccation occurring is Soil Moisture Deficit (SMD) which is the measure of how much water the ground can absorb before becoming saturated. As a rule, once the SMD levels exceed 200mm, impacts from clay shrinkage are expected to materialise in the track formation. In 2018 all susceptible areas along the Western Route went above the 200mm limit with some nearly reaching 300mm and most for prolonged periods of time.

Many Emergency and Temporary Speed Restrictions (ESRs) and TSRs were required due to the extreme heat and dry weather experiences in the summer 2018.

It is impractical to totally remove shrinkage from embankments, however preventative techniques such as planning an active high frequency track maintenance programme to manage the changes to the track geometry; and early targeted tree removal to reduce the increase and differential in SMD, can be used to lessen the symptoms.

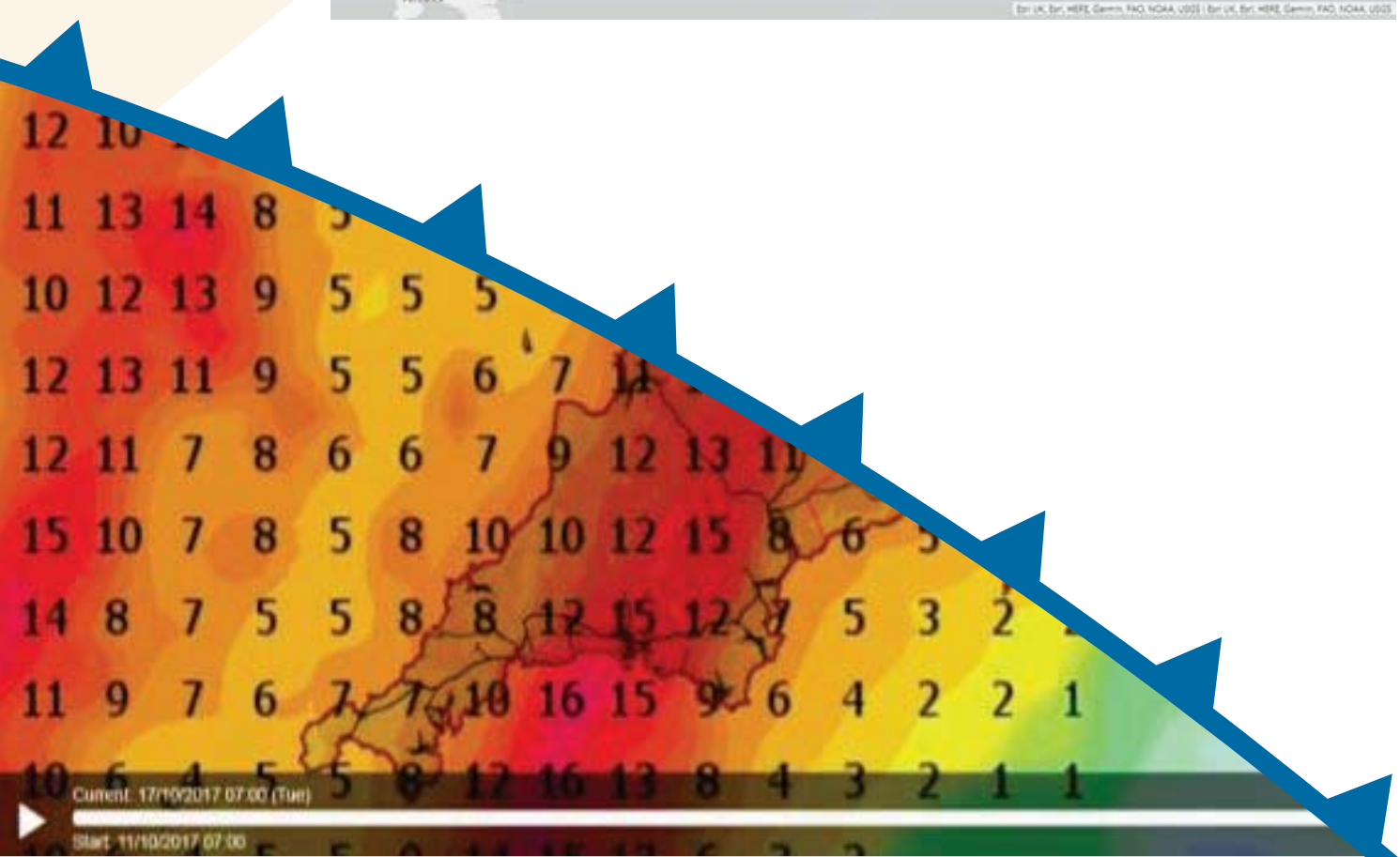
Generally, only rainfall can truly mitigate shrinkage through natural swelling in the embankment. Customarily this occurs in the winter, however due to the exceptionally high SMD in the summer months and relatively dry winters in recent years, earthworks have been remaining in a moisture deficit all year round. UKCP18 projections that winters will be wetter and summers will be hotter, drier and longer suggests that large differentials in SMD between winter and summer seasons will become the norm.

Western Route impact assessment continued

Heat impact assessment

Between 2006/07 and 2018/19 heat related incidents accounted for an average of 11,965 delay minutes and £0.786m in Schedule 8 costs per year.

Figure 32
Heat related incidents in CP5 (2014/15 – 2018/19)



Track

The rails are vulnerable to the effects of heat as the rail expands and induces additional forces into the track system.

The expansion of steel rails in hot weather is accommodated either through gaps at the end of jointed rails or through a pre-tensioning or stressing of continuously welded rail. Both scenarios are closely managed with any deficiencies corrected in the spring.

Where possible, normal maintenance activities such as packing of ballast to correct poor track geometry are avoided at very high temperatures as this can reduce the stability of track. If delaying the works is not possible, additional risk controls are applied which can include reducing the speed of trains over the affected area. Prolonged periods of hot weather can be particularly difficult due to this issue, with potential for a backlog of work to develop. This is being addressed through an increase in preventative work.

Certain track assets are inherently less resilient to the effects of heat, an example being point work at junctions constructed using hardwood timber bearers. Renewal with modern prestressed concrete bearers is more reliable in hot weather and has been gradually installed on main lines. The last principal main line junction to be relayed between London and Bristol is at Southall East where works will be completed in CP6.

Figure 33
Poor track geometry due to heat impact

Western Route impact assessment continued

Points

Currently, in conjunction with the Critical Rail Temperature (CRT) mitigations, the movement of points is minimised during hot weather to reduce the risk of failure. A Key Route Strategy (KRS) is applied to enable through traffic to pass without delay from point failures. The general track mitigations for heat stated above are also being considered for points and the immediately adjacent sections to reduce the need for restricted points operations.

Vegetation (off track failure, fences etc.)

During hot and dry weather, high water demand trees, such as Oak, Hawthorn and Willow can cause additional reduction of moisture in embankments. The differential shrinkage can cause localised track misalignment if support for the track is reduced, especially where the embankment crest to track stand-off is narrow. Although high water demand trees can be easily identified, determining which trees are likely to cause shrinkage issues prior to the differential shrinkage occurring is difficult and as such, felling of issue trees generally only occurs reactively.

Buildings

Heat causes problems and train disruption at all three of the managed stations on the Western Route.

Expansion of coping stones can cause damage to structures and eventually dislodge; this is principally due to the historic stones not having sufficient expansion joints, which would now be required under standard specification. The masonry walls and concrete flat roofs also expand in the heat creating a ratchet effect which directly damages the asset and creates a risk of subsequent issues such as water ingress and structural failure; this is a reactive issue requiring monitoring to identify.

Issues also arise when using containerised REBs (relocateable equipment buildings) that in certain operational conditions, can increase the likelihood of overheating and failure of critical equipment; this can lead to the need for artificial cooling which in turn creates a maintenance and energy liability. Management options can include colour, shading or compartmentation of heat generating equipment e.g. batteries from heat sensitive equipment.

Electrification and Plant (E&P)

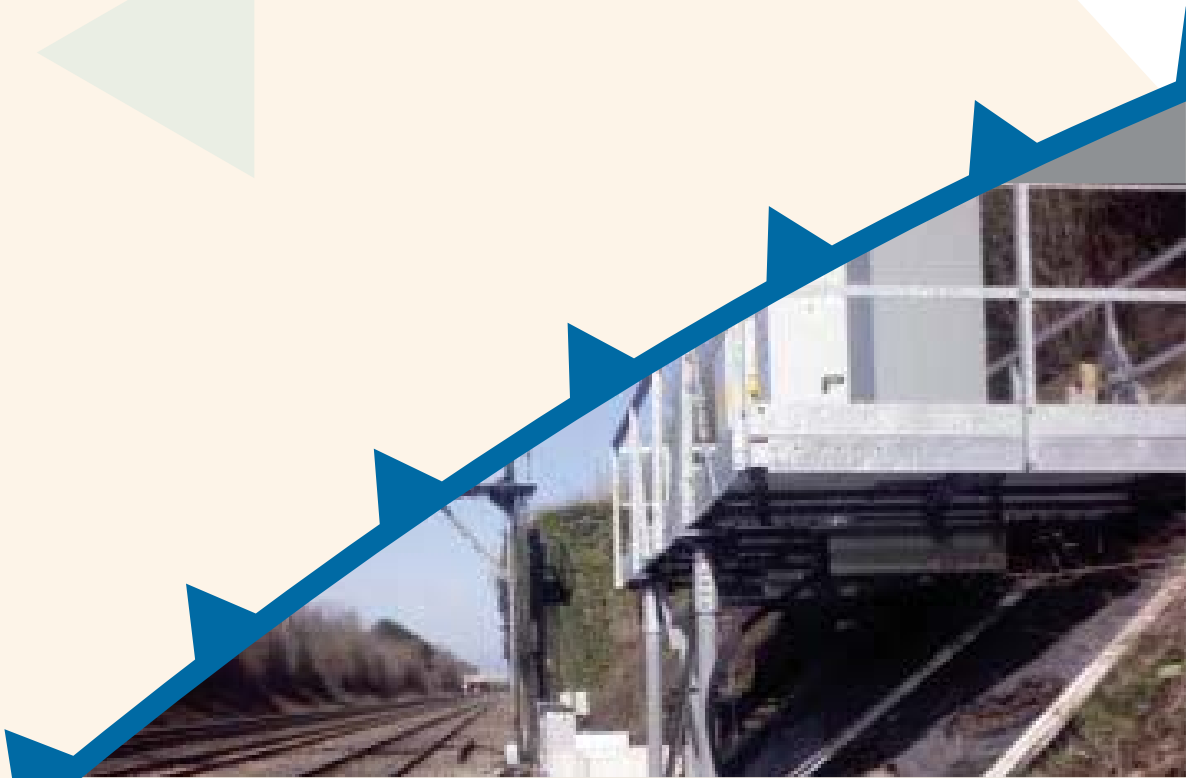
Most E&P assets are relatively unaffected by heat. Long lengths of OLE do expand and contract with temperature variation but the new OLE system is fitted with the latest automatic tensioning devices which manage this and keep the contact wire from drooping excessively. Additional checks of older balance weight tensioners in 0-12 mile take place during periods of high temperatures. Current OLE design allows for ambient temperatures of up to 40˚C.

Figure 34
PSP roof painted with reflective paint to reduce solar gain

Uninterruptable Power Supplies (UPS) batteries are susceptible to heat; ideally, they should be kept at a steady 20˚C and historically they have been kept in air-conditioned environments. Current policy however for Principal Power Supplies (PSPs) supplying signaling power to lineside equipment is to rely on forced air cooling. This relies on air at ambient outdoor temperature to cool equipment rooms and during the warmer months temperatures within these rooms are inevitably higher than ideal. The effects of heat on batteries is to reduce their operational life. The warmer the environment they are kept in the sooner they will need to be replaced. All battery rooms are fitted with high temperature alarms. We are experimenting with painting equipment room roofs with reflective paint to reduce solar gain and fitting full remote temperature monitoring to better respond to high temperature incidents.

Structures

Expansion of structures in high temperature can cause damage to structures where the expansion joints are insufficient or ineffective; in the case of overbridges, subsequent damage to road surfacing above can occur e.g. the damage at Ranelagh bridge.



Western Route impact assessment continued

Cold and snow impact assessment

Between 2006/07 and 2018/19 cold and snow related incidents accounted for an average of 26,756 delay minutes and £1.147m in Schedule 8 costs per year.

With climate change, South West England is predicted to experience less snow and cold overall and a general increase in daily winter temperatures, however natural variability, the complexity of the UK weather system mean that severe cold weather events cannot be ruled out. As such, Network Rail will still need to invest, maintain and prepare vulnerable assets for cold weather conditions.

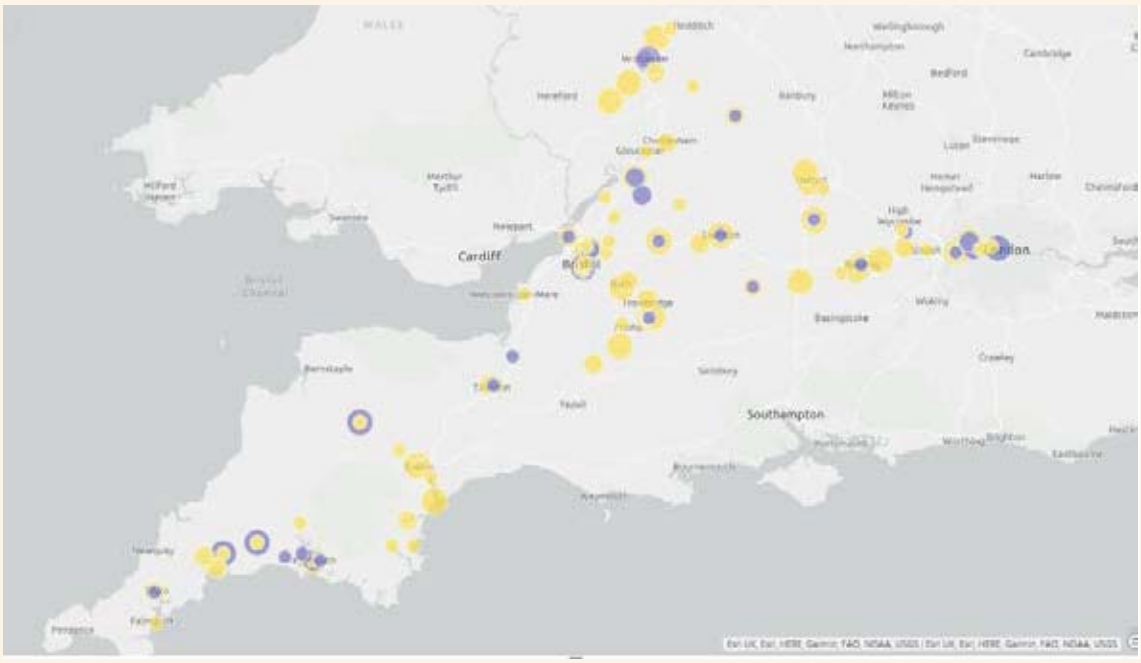


Figure 35
All cold (yellow) and snow (blue) related incidents in CP5 (2014/15 – 2018/19)

Buildings

Typically, low temperatures cause embrittlement of materials and icing of surfaces. while ice formation around or within a material can cause freeze/thaw action. This is a significant cause of stonework erosion and failure leading to objects falling from height. Cold combined with poor or historic design can also create 'cold bridging' resulting in higher fuel bills, and surface or interstitial condensation.

Surface condensation can be a significant issue, either promoting mold growth, or creating slip hazards on smooth paving surfaces, while interstitial condensation in the wall can cause building defects in concealed areas that can lead to structural failure.

Snow in the UK generally is denser and wetter than other countries. Suitable snow loading is required to be considered in the design of structures.

Snow has also been responsible for the closing of several stations due to the slipping hazard and other health and safety implications. Even though the use of salt or 'ice melt' can be used to remove the snow, the chemicals can cause corrosion within the structure, particularly to steel and concrete without careful management. The partial thawing and refreezing can create icicles and ice plugs that block the building's drainage.

Points

One of the Route's primary cold weather weaknesses is the failure of points. There are several failure modes for points: compacted snow between the switch rail and the stock rail; frozen point ends due to failed points heating; and frozen Points Operating Equipment (POE).

With potentially wetter winters and the continued risk of severe cold and snow events, it is imperative that points are reliable to maintain an operational railway. Reliability is currently monitored; the root cause of failures is established to improve asset knowledge and there is an appropriate action plan.

Snow compacted into point ends is cleared by maintenance when snowfall is predicted to overwhelm the points heating capability.

Points heating may fail due to detachment from the temperature sensor, detachment from the rail, or no power supply. The power supply is monitored remotely which allows for prompt maintenance if cold weather is expected.

Currently during snowfall or freezing events, Key Route Strategy (KRS) is implemented to reduce the movements of points and minimize service disruption. Points are maintained in a position for through traffic to minimise delay to main Routes, as points moved during snowfall fail more easily due to compacted snow or ice. Robust, reliable and powerful points-heating is essential to maintain performance regardless of the KRS. The Route is planning to specify these robust minimum design features for all new and renewed points.

Electric points heating is fitted to most main line S&C (Switches and Crossings) to keep them clear of snow and ice.

Track

Cold weather can lead to broken rail as the rail contracts. The Route will continue to mitigate the risk through normal maintenance and inspection

Electrification and Plant (E&P)

Automatic OLE tensioning also accounts for contraction in cold weather; current design allows for ambient temperatures down to -18°C. Icicles tend to form around the OLE at tunnel portals which can damage pantographs, as such maintenance teams must be sent out to knock these down in cold weather.

All lineside cabinets and equipment rooms are fitted with anti-frost and condensation heaters which protect against the effects of cold.

Figure 36
Icicles formed around OLE equipment,
(note –picture not on Western Route)

Western Route impact assessment continued

Structures

In wet tunnels, ice can form. Formation of ice in tunnel shafts results in large sections of ice suspended over the railway, which can and have fallen resulting in a train striking the dislodged ice and derailing in the tunnel.

Table 4
Tunnels with known issues of ice formation

Name	Location
Luxulyan Tunnel	NEW 285m 44.5ch
Box Tunnel	MLN1 99m 12ch
Rainbow Hill Tunnel (Worcester Hill)	OWW 120m 78.25ch
(Chipping) Campden Tunnel	OWW 97m 47ch
Sapperton Long Tunnel	SWM1 94m 70ch

Table 5
Shafts with known issues of ice formation

Name	Location
Wickwar Tunnel	BGL 115m 28.25ch
Patchway New Tunnel	BSW 6m 56ch
Somerton Tunnel	CCL 126m 58.5ch
Clifton Down Tunnel	CNX 4m 7ch
Box Tunnel	MLN1 99m 12ch
St Annes No.3 Tunnel	MLN1 115m 58.5ch
Chipping Sodbury Tunnel	SWB 101m 6.5ch
Sapperton Long Tunnel	SWM1 94m 70ch
Colwall New Tunnel	WAH 130m 48ch
Ledbury Tunnel	WAH 135m 15ch

Sea level rise and flooding impact assessment

Sea level rise

Sea level will rise along the Western Route coast with small variations depending on the location (see climate data). Storm intensity and frequency will increase. The risk of coastal erosion and defence overtopping will increase and discharges to estuaries and the coast will become more difficult.

Western Route has experienced a number of high-profile coastal flooding events; however, with sea levels due to rise by the end of century, relative to 1990 levels (based on UKCP18), water inundation will become more prevalent within coastal sections of the Route.

Western Route has 245 miles of coastal boundary, which accounts for 41 % of the Route boundary miles. With sea level rise, there are numerous branch lines to coastal resorts that are inherently more vulnerable to more flooding, coastal erosion and loss of the railway.

There are main lines that are susceptible to more frequent and more extensive flooding as the sea level rises:

- Penzance,
- Par and Lostwithiel,
- Exeter to Teignmouth (Powderham Banks to Newton Abbot),
- Bristol to Bridgwater (Highbridge & Burnham on Sea), and
- Severn Tunnel approach (from Bristol to Wales Route).

There are also branch lines at risk from sea level rise, namely:

- St Ives (Lelant),
- Falmouth,
- Fowey Docks,
- Looe,
- Torquay,
- Newquay,
- Clifton Down – Avonmouth,
- Exmouth Branch (Lympstone on East Exe Estuary), and
- Bere Ferrers (Gunnislake Branch).

In recognition of the potential risks that sea level rise will bring to connectivity West of Exeter, works are ongoing to improve resilience at Dawlish and Teignmouth. These works will examine the short-term impact of storm surge and flooding and long-term impact of sea level rise for the Route from Exeter St Davids to Newton Abbot.

In CP5 the initial asset management plans for Western Coastal, Estuarine and River Defences (CERDs) was produced (excluding Dawlish – Teignmouth a separate plan for this area is being developed under the South West Rail Resilience Project (SWRRP)). These plans looked at the current condition of the asset, defects on the asset, risk of over topping and the effects of predicated sea level rise. In CP6 an update of the management plans will be undertaken and hosted on an internet platform.

Western Route impact assessment continued

Flooding

Between 2006/07 and 2018/19 inland and coastal flood related incidents accounted for an average of 65,252 delay minutes and £3.42m in Schedule 8 costs per year.

Winters are expected to become significantly wetter on average and the frequency and intensity of winter storms will increase. Summers will become significantly drier, but the intensity and frequency of summer storms is expected to increase markedly. Summer storm rainfall will be more severe than in winter. Intense summer rainfall after droughts/dry periods will increase the surface/flash flood risk and peak river flows will increase (see climate data).

Figure 37
All flooding related incidents in CP5 (2014/15 – 2018/19)

It is important to analyse the water source of the flooding in order to develop the appropriate mitigations. Flooding affecting the railway takes a number of forms:

- Pluvial – directly resulting from rainwater overwhelming local drainage systems,
- Fluvial – from rivers or streams adjacent to or crossing the railway reaching 'bank full' or leaving their normal course – for the purpose of this report, this will include flood plains,
- Groundwater – groundwater levels rise on to the railway, usually over an extended length, of track and for an extended period,
- Estuarine – where natural periodic tidal variation and rainfall combine into a flood event, and
- Storm surge – on coastal sections, where the combined effects of tide and wind form unusually large waves.

Cuttings: pluvial flooding and groundwater flooding

Railway cuttings are naturally vulnerable as 'low points' attracting both groundwater flooding (dependent on the geology) and pluvial flooding (many drainage systems direct rainwater into cuttings).

Many flood resilience schemes have been successfully delivered throughout CP5 based on analysis undertaken as part of Western Route's Geo-Environmental Resilience Study, including drainage upgrades at Curry Road, and Whiteball cutting, and a signalling renewal with increased aquifer monitoring at White Waltham.

Chipping Sodbury, between Bristol Parkway and Swindon, has been Western Route's most frequently flooded cutting. Ongoing flood resilience works including construction of a flood alleviation lagoon is due for completion in early CP6. Other high-risk sites will be developed to detailed design stage which can be delivered if funding is granted.

There are widespread locations across the network where intense rainfall can overwhelm track drainage systems or, more often, their outfall to other watercourses or off-track systems. These sites are presently tracked and addressed on a case-by-case basis when flooding occurs, or damage/defects are found during inspection.

River valleys or flood plains: fluvial flooding

A number of lines across the Route follow river valleys, these often being level, and therefore cost-effective, Routes for railway construction. Similarly to pluvial and groundwater flooding, a number of the highest priority fluvial flooding schemes were developed and delivered in CP5 including Hinksey and Cowley Bridge Junction culvert enhancements.

Hele and Bradninch and Staffords bund flood prevention schemes will be developed and are planned for delivery in CP6.

Figure 38
Moreton in Marsh (Storm Katie 2016)

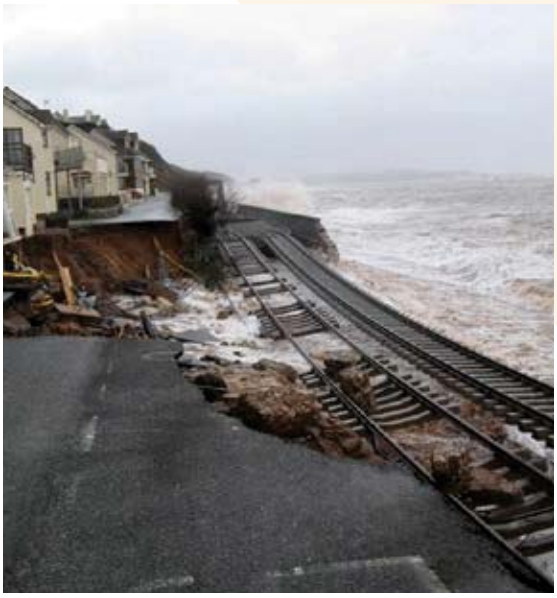
Western Route impact assessment continued

Estuaries: estuarine flooding

Estuarine flooding typically causes less damage to rail infrastructure than fluvial flooding as larger areas are submerged and peak flow rates at individual points are lower. However, persistent estuarine flooding can still cause significant disruption to rail services through damage to earthworks and trackside equipment e.g. signalling equipment.

Flooding on the Somerset Levels in 2014 was extensive and, as reported in press coverage during the event, long-lasting with the duration hard to predict. A section of the two-track line from Bristol to Taunton was submerged for a month, with damage to signalling further disrupting services for a second month. Although no similar events of this scale have been experienced in recent years, the sea level rises and more intense rainfall events projected due to climate change, we expect that similar levels of flooding will reoccur in the future.

Figure 39
Damage caused by the storms in 2014 in Dawlish



Coastal railway: storm surge

Sea defences can be adversely affected by wave damage and potential overtopping, a risk that is expected to increase due to the rising sea levels projected due to climate change.

Dawlish sea wall was overtopped in 2014, causing water to wash out fill and the wall to fail resulting in loss of support to the track and numerous areas of damage to the coping stones and boundary wall. New vulnerabilities are likely to develop due to the projected sea level rise.

Ongoing sea wall resilience works are ongoing at Dawlish with further resilience works being developed as part of the South West Rail Resilience Project (SWRRP).

Figure 40
Flooding at Didcot Station

Buildings

In Paddington, the rise in the water table causes water to ingress into the basement area, believed to be mainly caused by the retirement of historical pumps as well as the increase of sub surface structures such as Crossrail. In such cases, consideration must be given to the risk of water contamination and sewage etc.

When considering risk to Buildings, the decision is required whether to manage the risk through resistance measures or resilience is most effective.

Electrification and Plant (E&P)

Lineside flooding can affect cable routes and equipment cabinets. If a power cabinet is flooded, then we would normally isolate it for safety reasons which would affect operational/signaling equipment. There were some notable incidents in CP4 included in the last report.

Cable routes can become waterlogged and old rubber insulated cables can become saturated over time, reducing the cable insulation resistance until eventually power cables fail in service. There is an E&P renewal project in CP6 to replace our oldest 650V power cables.

Structures

During flood conditions river levels rise to an extent where the openings of bridges and culverts run at full bore – this can give rise to dangers. Particularly at risk are metal bridge decks that may be displaced by the force of the water itself or debris carried downstream. When enclosed culverts run at full bore, the water can be put under pressure and hydraulic capacity can be reached. This can lead to water backing up, causing further flooding upstream with attendant dangers.

Figure 41
Debris washed up against a metal bridge deck

Rainfall

Winters are expected to become significantly wetter on average and the frequency and intensity of winter storms will increase. Whilst summers will become significantly drier the intensity and frequency of summer storms is expected to increase markedly. Summer storm rainfall will be more severe than in winter.

Buildings

The projected increase in average rainfall and the intensity of severe events associated with climate change is a significant concern. Overwhelming of existing historic roof drainage systems can result in water ingress to buildings through overtopping of gutters and flashings, downpipe joints being placed under increased pressure and water taking routes to ground level that were not designed to do. Large quantities of water taking these routes at stations also creates problems for electrified lines as it can cause arcing. Even moderate water can cause problems for certain material specifications; e.g. at Bristol Temple Meads and Reading stations, where the polished limestone platform surfaces become slick when wet resulting in slips and falls.

Structures

Increased water percolation through structures, particularly where ageing profile of the structure has resulted in failure of the waterproofing or protective paint systems. This results in an increased rate of deterioration to both metallic elements (formation of rust and eventual loss of section, particularly around water traps, e.g. truss bridges) and masonry bridges (loss of mortar, open joints).

Western Route impact assessment continued

Wind impact assessment

Between 2006/07 and 2018/19 wind related incidents accounted for an average of 22,864 delay minutes and £1.32m in Schedule 8 costs per year.

Figure 42
All wind-based incidents throughout CP5 (2014/15 – 2018/19)

Buildings

The brute force of wind can cause structural damage to buildings through overturning, uplift etc. Wind can also create positive or negative wind pressure causing slight lifting of roof slates or bowing of finishes allowing water ingress. It can also contribute to and exaggerate problems from all the other weather types, such as wind chill; moving of water across a surface away from a drain or onto OLE; snow drifting and storm surges.

Vegetation

The impact of wind on vegetation can affect the running of railways in different ways. One of the most common causes is through leaves being blown onto the line, whether it be from trees within the Network Rail boundary or from third party land, this persistently causes a significant percentage of annual delay minutes. Another is a more serious and direct risk to safety due to potential derailment; the force that wind can create when acting on a tree could cause it to collapse onto the line, which, if not detected in time, could lead to a collision and derailment. Fallen trees can damage or destroy boundary fences raising opportunity for trespass – notably from livestock.

Figure 43
3rd party tree obstructing the LOO Line, June 2019

Electrification and Plant (E&P)

Lineside vegetation is a problem in OLE areas; storms and high wind events can damage trees which can fall on to the OLE equipment. Inadequate vegetation management is a risk in CP6. The Series One OLE itself is of a lightweight, wind resistant design and structure spacing and contact wire stagger is designed to reduce pantograph blow off in high winds in accordance with BS EN 1991-1-4 and BS EN 50119.

External DNO power supplies are also affected by high winds and storm events leading to short duration interruptions to Low Voltage Network Rail supplies. Critical operational equipment is backed up by standby generators and UPS systems to mitigate against this.

Structures

Although not a direct impact to structures, during construction works wind can be particularly disruptive. Where crane use is required, this can be delayed by high winds with implications to cost and programme. Where bridges are encapsulated to facilitate paint removal and reapplication, sheeting can act as a sail and impose significant loads on a structure. A safe wind level must be determined and contingency measures, such as slashing sheeting, put in place to ensure the safety of the structure.

Seawater spray

The south west coast can be significantly impacted by spray caused be wind over the sea. For Western Route, this is primarily the Dawlish and Teignmouth stretch of line. Spray can affect signaling and train fleet reliability; special operation arrangements are invoked when this risk is identified which lead to train delays and cancellations.

An industry weakness with regards to seawater spray is that some rolling stock is more unreliable in these conditions, particularly the class 220 and 221. With climate change, increased winds and potentially more forceful sea spray, modern rolling stock fleets must themselves become more resilient to these conditions in order to operate without restriction.

Western Route impact assessment continued

Lightning impact assessment

Between 2006/07 and 2018/19 lightning related incidents accounted for an average of 10,972 delay minutes and £0.603m in Schedule 8 costs per year.

The Route experiences a high number of lightning incidents in comparison to other Routes. Cornwall is particularly prevalent for lightning strikes, accounting for 50 per cent of the lightning strikes in the Route over the past eight years, primarily due to the granite-based geology and extremely high soil resistivity. Climate change projections are not available for lightning strikes, however as storm events are likely to increase in intensity and frequency, lightning will also potentially increase; however, this remains unpredictable.

Figure 44
All lightening related incidents throughout CP5 (2014/15 – 2018/19)

Buildings

Lightning strikes cause power surges or fires if the infrastructure is not sufficiently protected. All buildings should be risk assessed and have lighting protection installed and maintained as necessary.

Vegetation

Trees adjacent to the track are often the tallest point in the local area; this increases the risk of a lightning strike during a storm. Such a strike could lead to the tree collapsing onto the railway or for it to catch fire, which in turn could set fire to other adjacent vegetation.

Electrification and Plant (E&P)

OLE bonding has been sufficiently designed to dissipate lightning strikes down to earth.

Lineside power PSP equipment is all fitted with lightning protection devices. These are very high impedance connections to earth which are designed to short to earth if the equipment is struck by lightning, dissipating the energy.

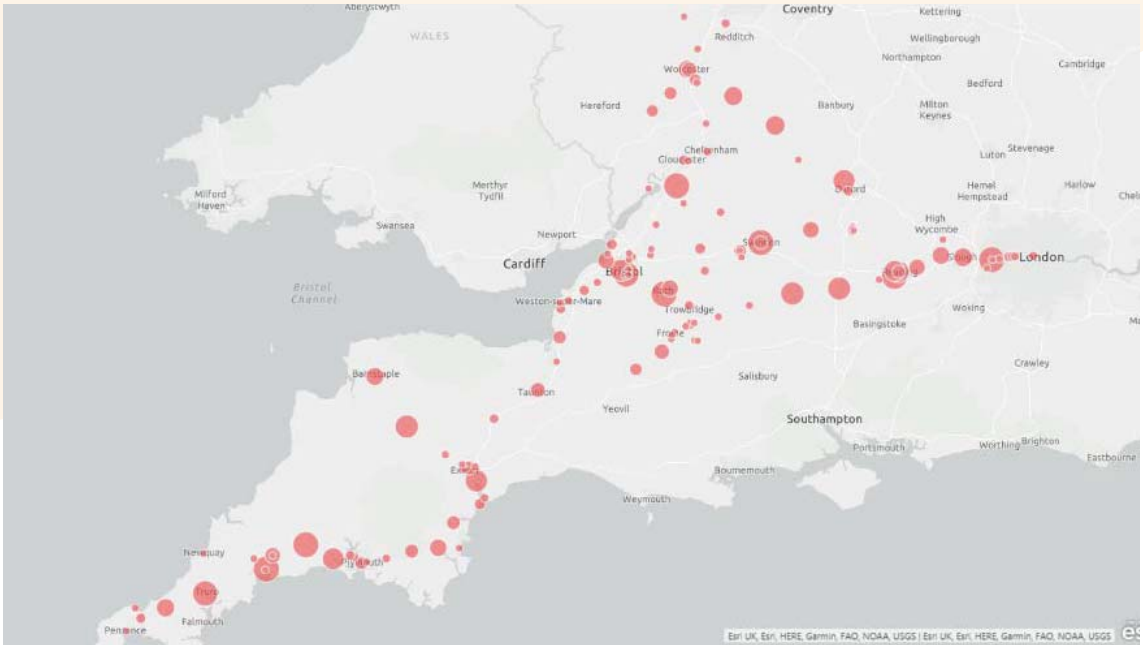
Adhesion impact assessment

Between 2006/07 and 2018/19 adhesion related incidents accounted for an average of 20,286 delay minutes and £1.23m in Schedule 8 costs per year.

Vegetation

As stated in Wind, leaves being blown onto the line, whether it be from trees within the Network Rail boundary or from third party land persistently causes a significant percentage of annual delay minutes. An adhesion assessment is undertaken annually.

Figure 45
All incidents regarding adhesion in CP5 (2014/15 – 2018/19)



Fog impact assessment

Between 2006/07 and 2018/19 fog related incidents accounted for an average of 166 delay minutes and less than £10,000 in Schedule 8 costs per year.

Signalling

The Worcester area is still predominantly signalled by semaphore signals and therefore can still be significantly affected by foggy conditions. The resignalling of the Worcester area is programmed for CP6, which will reduce the impact of fog on the Route.

Figure 46
Fog in South Devon (Feb 2017)

Western Route impact assessment continued

Subsidence

Buildings

Any buildings on vulnerable geology, both natural and re-worked, have the potential to suffer subsidence e.g. the platforms in Bristol Temple Meads. That is increased by other issues such as the local ground conditions and presence of high water demand trees; it needs to be managed on a risk assessment basis with problems pre-empted or dealt with reactively.

Vegetation

As stated in heat, during hot and dry weather, high water demand trees, such as Oak, Hawthorn and Willow can cause additional reduction of moisture in embankments. The differential shrinkage can cause localised track misalignment if support for the track is reduced or to building and structures when founded on clay material. Although high water demand trees can be easily identified, determining which trees are likely to cause shrinkage issues prior to the differential shrinkage occurring is difficult and as such, felling of issue trees generally only occurs reactively.

Weather Resilient Rolling Stock

Rolling stock equipped to handle poor weather is becoming increasingly valuable as it reduces the requirement for operatives to work on or near the line. It can also perform more efficiently, covering larger distances and with a higher output. Due to the unpredictability of weather some of the rolling stock isn't mobilised unless needed however some is planned in seasonally for near daily time slots due to the known risk to the running of the network.

Autumn

Leaves on the line is a constant problem in the autumn months, with the leaves falling from surrounding vegetation and landing on the rail heads to then be crushed by the passing trains. This creates a gelatinous like film over the head of the rail leading to poorer traction between the rail head and the wheel of the train. This can lead to delays as well as creating a safety risk.

Rail Head Treatment Trains (RHTT) are used on the Western Route between the autumn months (late September to early December) to help reduce the risks of leaves on the line. RHTTs work by jetting high pressured treated water to clean the rails, improving the wheel-rail adhesion and the track circuit activation. Operating out of four separate depots over the Western Route the RHTTs operate every night of the week within the autumn apart from Saturday, covering all the Route as well as some of Wales.

As part of moving forward and improving the RHTT's service to the Route, there are several potential advancements to its operation during CP6, such as the way treatment is reported. Moving towards a more real time digital system would aid this heavily with the likes of digital tick sheets so that Routes are advised quickly about missed treatment; live GPS tracking showing which sites have/haven't been treated and other useful stats such as the percentage of the circuit treated; as well as producing reports later to accurately reflect the previous night's circuits once all the data has been collated.

The improvement in availability and planning of the RHTTs will reduce the inefficiency of the treatment plans which currently rely on one replacement water pump module nationally.

Planning of treatment is also to be improved within CP6 with more robust pre, mid and post season plans in order to provide a better service. Chlorophyll sensors will potentially be fitted to the RHTTs in order to trigger treatment based on the presence of leaf contamination as well as generating heat maps of the worst locations, so that sites can be located for which additional mitigations might be beneficial.

Winter

Winter is normally when the more reactive side of the fleet responds, such as when having to deal with ice and snow. When deep snowfall covers the rail head, the TOCs and FOCs cannot run their fleet, in these circumstances, the snow plough from the fleet is deployed to clear the paths and to enable the safe running of the railway.

With the recent completion of the Great Western Electrification Programme (GWEP) within the Western Route OLE is now a concern in the winter due to it icing up and not allowing the pantograph to connect properly or even damaging it. It is proposed that the TOCs operate ghost trains and icebreakers to keep the OLE clear of ice or to safely remove ice from the OLE, this method is proposed to prevent incidences of trapped trains and the inherent risk to the travelling public.

Summer

During the summer months Supply Chain Operations (SCO) runs weed spraying throughout the network including hand weed spraying of the more complex track layouts e.g. between platforms, to control the vegetation which grows at a rapid rate during these months. The challenge of dealing with weed growth is likely to increase as weather becomes wetter and warmer.

Western Route WRCCA Plan

Western Route's CP5 WRCCA plan saw successful development and implementation of weather resilience and climate change adaptation schemes, including large scale flood resilience schemes, the implementation of NRWS (Network Rail Weather Service), training and equipment provision for maintenance teams, the increased use of suitable technology including RCM in earthworks and track monitoring, and the strengthening of relationships with the Environment Agency and other 3rd party bodies – notably the creation of an Environment Agency/Network Rail liaison officer.

Western Route's CP6 WRCCA plan will build on the development of the CP5 plan noting a fundamental change of delivering the majority of actions through BAU and renewal activities.

Examples include the continuation of strategic vegetation management programs, structural scour and earthwork adverse/extreme weather schemes. Using UKCP18, focus will be given to improving and updating vulnerability assessments and the delivery of appropriate works – including:

- Vulnerability of structures to coastal and estuarine scour,
- Earthworks to high and persistent rainfall in addition to heat and prolonged dry periods, and
- Trees and consequential tree strike during high winds.

These schemes have been referenced in the Route Strategic Plan with specific funding allocated to their delivery.

Weather resilience schemes that were not included within the CP5 plan will also be developed as BAU throughout CP6, including building lightening resilience into renewal designs for buildings and S&T equipment.

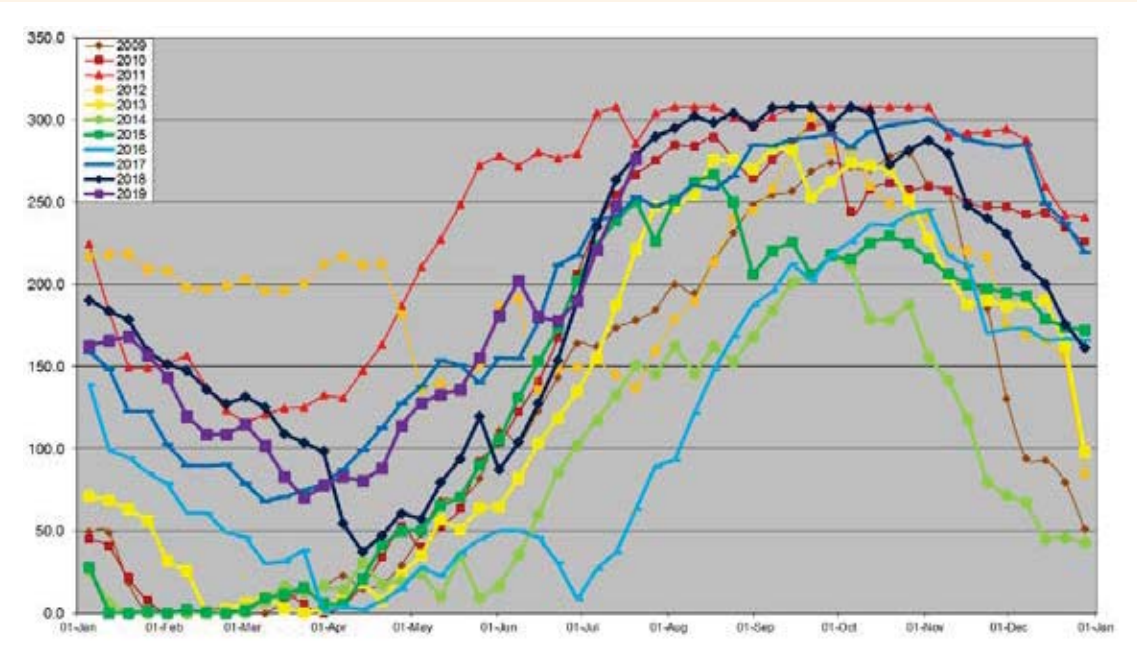


Figure 47
Example of SMD[14] analysis currently undertaken in the Route

[14]SMD is a measure of how much water the ground can absorb before reaching it maximum field capacity, the higher the calculated number the drier the soil profile. SMD is calculated by the Met Office at 40km^2 grids and considers a range of factors that include rainfall, solar intensity, wind exposure and vegetation cover.

An increased focus will be put on climate change adaptation in the CP6 plan. We intend to create a climate change vulnerability heat map based on UKCP18 and use the results to determine potential studies and schemes for CP7 and beyond.

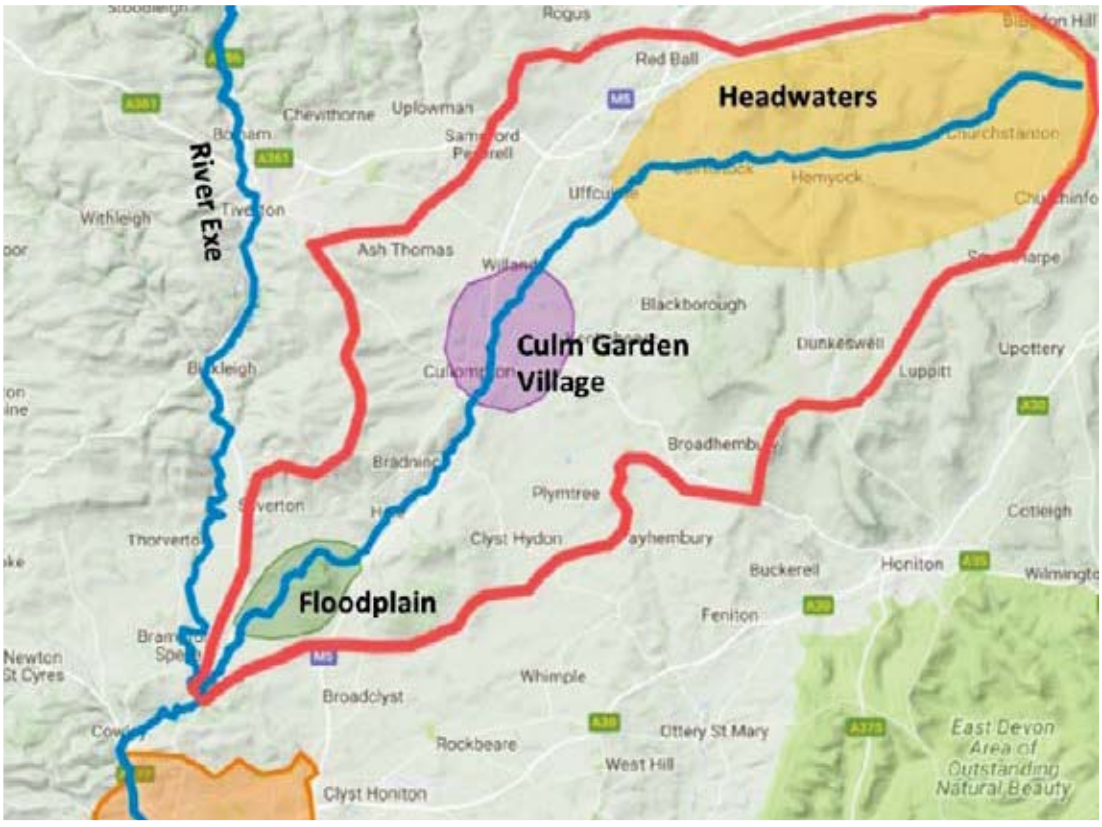
The requirements of the Environment and Social Responsibility standard will be implemented in CP6 for all applicable enhancement and renewal schemes delivered by IP and Works Delivery.

Additional flood resilience funding received in CP5 allowed a number of schemes to be developed and delivered within the control period (e.g. Cowley Bridge Junction and Hinksey) however; without similar funding in CP6 it is not proposed to develop as many such schemes (with the exception of works undertaken as part of the South West Rail Resilience Programme) as part of this plan. As such, and in line with Department for Transport (DfT) and Defra aspirations, Western Route will seek to engage with other statuary bodies and communities in order to deliver mutually beneficial schemes; this will include provision of expertise, information and when appropriate, funding.

We are actively working with Somerset Council on the early stages of 'Adaptation Pathways in Somerset (APIS): Climate Adaptation Planning for Flooding in Somerset'; and are collaborating with the East Devon Catchment Partnership in the Connecting the Culm scheme, including sharing of drainage mapping and the intention to share flood modelling of the Culm and Exe rivers that was undertaken as part of the CP5 flood resilience schemes.

Resilience of the railway between Dawlish and Teignmouth, accounting for climate change and latest sea level rise predictions will be developed in sections, in line with specific DfT granted enhancement funding through CP6.

Figure 48
Image showing extent of Connecting the Culm



Western Route WRCCA Plan continued

Vegetation Management

Lineside vegetation has been neglected over several decades with very little proactive removal undertaken. The failures and associated delay minutes, in addition to damage to infrastructure and rolling stock, has led to a serious evaluation of the adverse effect that poor vegetation management can have on performance and safety of the rail network.

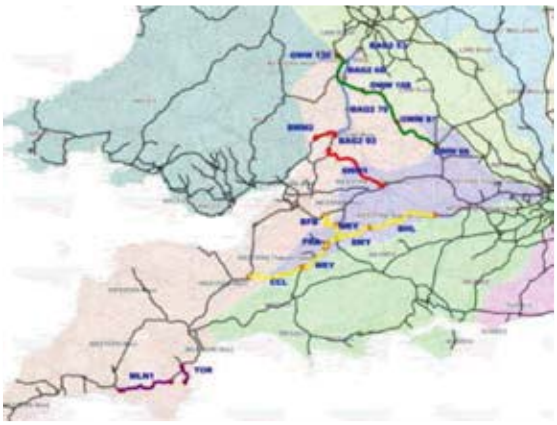


Figure 49
Map showing CP6 vegetation removal extents

In CP5, vegetation management began with the focus predominantly on the cutting back and maintaining of the vegetation adjacent to the soon to be electrified areas of the railway. Western Route authorised £12m of funds for lineside vegetation management in order to return the asset to a compliant standard – this was primarily driven by the introduction of the new hybrid IETs on the Route, to accommodate the installation of OLE installation, and for Crossrail. In total, 250 miles of vegetation was cleared to a compliant standard. In addition, a further 280 miles of vegetation was cleared beyond compliance due to the risk to the pantographs on the new fleet where OLE is not present.

The Varley report was conducted in CP5 and released in early 2019. The report considered the way Network Rail conducted its management of vegetation and produced 6 different recommendations, outlining Network Rail's responsibilities as a land owner as well as stating that Network Rail should lead cultural change for valuing nature across the organisation.

Alongside the Varley report, the new lineside vegetation management standard (NR/L2OTK/5201) was released in March 2019, outlining a 'new way to manage vegetation', including guidance on protecting OLE. The new standard has removed the previous 'blanket distance from the rail' approach and instead considers the danger of falling trees reaching the track, OLE and other critical equipment, as shown in Figure 50, where in addition to the standard 6m clearance from the cess rail, an 'infinite' clearance above 45° from the end of the sleeper is also required.

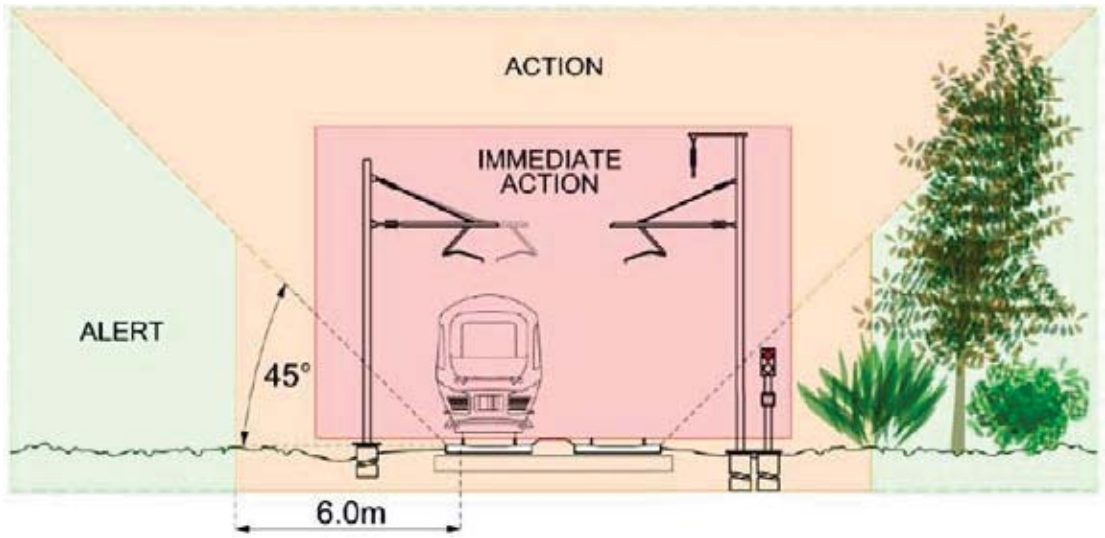


Figure 50
New lineside vegetation management standard (NR/L2/OTK/5201) – clearance cross section profiles

In CP6, the Route is funding a further £23m of vegetation management in order to increase compliance percentage against the updated standards, focusing on the mainline areas of the Route west of Swindon and into Cornwall. Funding has also been included within the CP6 Strategic Business Plan for a vegetation LiDAR survey. A Route wide tree survey on high criticality ELRs, where priority will be given to areas where major vegetation clearances haven't been completed, will be undertaken within Year 1 and Year 2 of CP6 at an estimated cost of £1m.

Figure 51 below shows the 250 Route miles of vegetation to be cleared to compliance with the standard (NR/L2/OTK/5201) throughout CP6 in addition to a maintenance regime implemented to maintain clearance on all previously de-vegetated areas.

Figure 51
CP6 Vegetation Clearance Sites

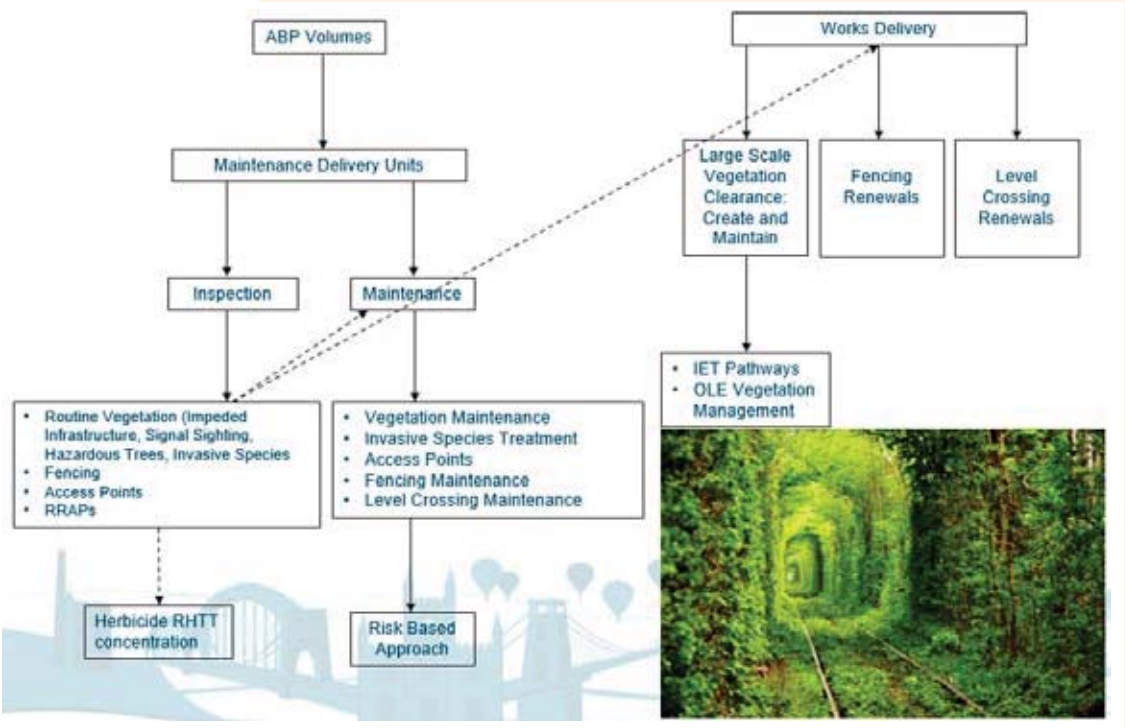
Western Route WRCCA Plan continued

The Route will continue improving the competence of maintenance Delivery Unit (DU) staff through continued tree awareness workshops and engaging with Safety, Technical and Engineering (STE) department on the competence matrix update for Off-Track Competences. Resourcing and OPEX spend within the maintenance organisation will increase in CP6 with increased staffing to deliver a more robust and sustainable approach to the off-track inspection and maintenance activities.

The CP6 strategic plan for Off Track is illustrated in Figure 52, including detailing the approach for all Activity Base Planning (ABP) volumes that will assist with maintaining general branch line vegetation, signal sightings and Service Requests, faults etc.

Vegetation clearance will play a significant part in reducing the risk to the running railway as well as the reduction of schedule 8 compensation payments and will provide a vital step in reducing the risk from adverse weather.

Figure 52
Off Track CP6 ABP Volume Strategic Plan



South West Rail Resilience Project (SWRRP)

The destruction of the Dawlish sea wall and the failure of the sea-cliffs at Teignmouth in the winter of 2014 brought the attention of the Nation to the severe risks posed from adverse weather. UKCP18 has predicted several weather changes, with 1 in 100 storms trending towards becoming 1 in 50 and the winters becoming wetter, more events comparable to the extreme weather experienced prior to the Dawlish and Teignmouth incidents are expected. Planning for the projected increase in intensity and frequency of such weather events, is vital.

Through CP5 and into CP6 and beyond, the South West Rail Resilience Project (SWRRP) is tasked with increasing resilience of the railway between Exeter and Newton Abbot to current and projected climates over the next 100 years. The scheme is currently focused on 4 main areas – Cliff Behaviour Unit 17 (CBU17), Parsons Tunnel to Teignmouth, Marine Parade and Colonnade to Coast Guards which will be developed in CP6.

Figure 53
Current image of the CBU17 and Parsons Tunnel portal (left) and Mock-up of rock fall shelter solution at CBU17 (right)

CBU17 covers the cliffs around the low mileage entrance into Parsons tunnel where there is substantial risk of rock slope failure due to its natural fall towards the railway, the formation of a gully around the tunnel portal and the risk of erosion of the cliff face in large storms. The proposed resilience scheme is to construct a rock fall shelter which will protrude for 85m out of Parsons Tunnel running along the base of the cliff face, accompanied by soil nailing and netting of the upper.

Parsons Tunnel to Teignmouth runs along the coast line until the railway moves inland towards Teignmouth station and encompasses the area of sea-cliff known as 'Woodlands' where in 2014 an extreme failure occurred. Large sections of the cliffs here are deemed high risk, with numerous largescale failures the past 20 years.

The proposed development for this section of the railway is one of the biggest railway engineering projects conducted by Network Rail. It will require land reclamation into the sea in order to move the railway away from the cliffs, a mix of sea wall and revetment to optimise the coastal protection as well as retaining as much of the beach running along that area as possible.

The repositioning of the track away from the cliffs will allow for a series of buttresses to be constructed at (CBU 4,6,8,10 and 12) to reinforce the high-risk cliffs situated behind them. Other areas will be strengthened by large dowels to prevent a large wedge failure and a rock fall shelter will be installed to the high mile (west) of Parsons tunnel to protect the line from the cliffs around the portal.

Figure 54
Extent of Parsons Tunnel to Teignmouth Site (Arcadis, 2019)

Western Route WRCCA Plan continued

Marine Parade and Colonnade to Coastguards covers the main sections through Dawlish with Colonnade underpass being the separator between the two schemes. The proposed solution will consider the predicted sea level rise over the next 100 years to protect the town from sea level rise and to prevent a similar failure to that experienced in 2014.

The section known as Marine Parade is split into three sections; Town Gateway which covers the Colonnade underpass, Marine Parade Promenade, and Boat Cove, which is at the far end of the section providing protection to Kennaway tunnel portal.

There have been three main areas of focus which have been considered throughout the design process; improving resilience, safety and amenity. The proposed design encompasses all of these with the height of the sea wall being raised by 5m, creating a 90% reduction in the volume of water reaching the railway. Due to the increased height it allows for a 1.1m high parapet along the edge of the promenade to prevent members of the pubic falling as well as an upstand between the walkway and the railway preventing vehicle incursion in the event of collision. Finally, the public amenity along the promenade has been increased, with textured concrete and colour finishes adding interest and a 1m wide amenity strip at the back of the promenade provides space for seating.

The whole of the SWRRP is focused on maintaining the safe and reliable running of the railway into Cornwall.

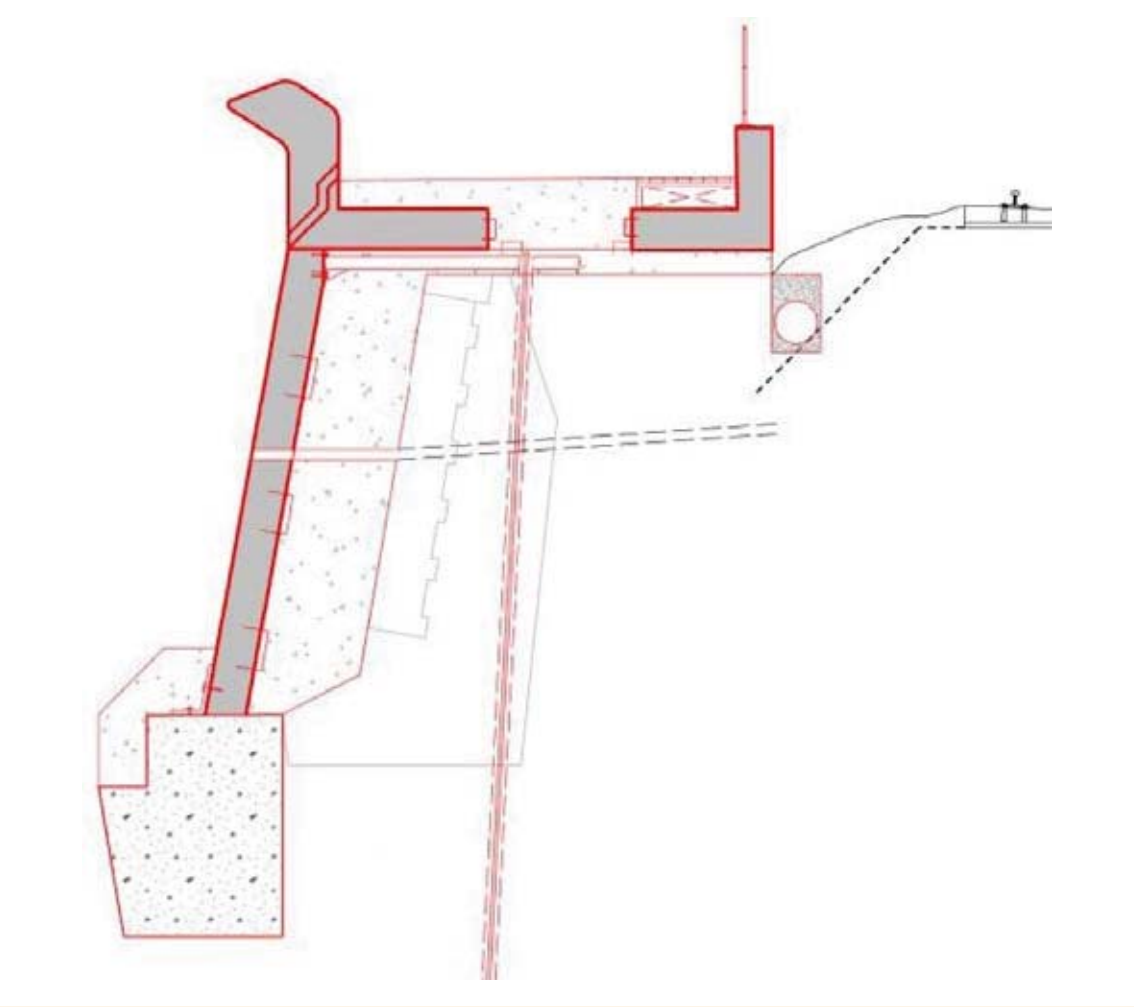


Figure 55
Form 001 Design of the new promenade at Dawlish

Western Route WRCCA actions

Western Route is committed to reacting to the challenges of climate change to ensure the long-term resilience and sustainability of all assets.

The tables below summarise the WRCCA actions undertaken by Western Route in CP5 and their current status, followed by the actions that planned and agreed for CP6, and potential additional actions that have been identified as potential actions to deliver in CP6, but which are not funded in the current CP6 business plan.

The final table details actions that have been apportioned to Network Rail, in the Defra NAP. Some of these will align with CP6 planned and funded actions.

CP5 WRCCA Plan CP5 actions – Review

Table 6
CP5 WRCCA Plan CP5 actions – Review

Action name	Target completion date	Actual completion date	Comments
All impacts			
Staff trained to use and supplied with appropriate equipment, e.g. life vests for flooding events, seasonal PPE	Continually Reviewed	Ongoing through BAU activity	Staff have been supplied and trained to use appropriate equipment. Specialist equipment and training can be limited to specific locations e.g. Inflatable dam and Cowley Bridge – Exeter
Include clear requirements for climatic conditions and resilience levels in Route Requirements Documents	December 2014	Not completed	Not completed in CP5 – action to be addressed in CP6 through the Environment and Social performance policy
Weather information			
Use real-time Met Office weather data to confirm actual weather conditions and assess asset vulnerability	August 2014	August 2014	Met desk weather has replaced Met Office as weather service provider for Network Rail. The NRWS provides a 1 stop shop system for weather and specific asset risk information (such as rainfall, Soil Moisture index (SMI) and lightning risk)
Flooding			
Provision of water safety equipment (lifejackets, lifesaving rings) at repeat flood sites which require staff attendance	October 2014	October 2014	Water safety equipment at repeat flood sites are now provided
Staff who respond to flooding and assess flood risk to receive Water Awareness Training	End 2014	End 2014	Training was provided and completed for required maintenance personnel
Strengthen relationship with the Environment Agency through setting up of a Local Liaison Group on flood risk management to share information and resolve issues	March 2014	March 2014	Steering group and working group have been set up and are attended quarterly
Engage with Local Flood Resilience Forums	March 2015	March 2015	Achieved through strategic approach from Environment Agency/ Network Rail Liaison Officer and Senior Asset Engineer – Drainage
Appoint a shared, co-funded member of staff between the Environment Agency in the South West and Network Rail Western Route to facilitate closer working	End 2014	End 2014	Network Rail/Environment Agency Liaison Officer has been employed – role currently as secondment
Flooding			
Deliver the major projects identified in the 2013 Flood Resilience Study and funded in February 2014	Three-year programme with staged completion 2014, 2015 and 2016	See comments	Whiteball scheme – completed CP5 Year 1 Patchway Tunnel Up – completed CP5 Year 2 Hinksey – completed CP5 Year 2 Exe and Culme Study – Completed Study P1 July 2014 – Completed Study P2 April 2015 Athelney – Cogload – On hold Hele & Bradninch – Deferred CP6 Flax Bourton – Progressing to GRIP 5 in CP6 Catchment Monitoring – Deferred CP6 Cowley Bridge Weirs – Cancelled Cowley Bridge Culverts – Completed CP5 Year 5 Chipping Sodbury Lagoon – Ongoing – Expected completed date May 2020
Review new flood sites and prioritise them for design development and remedial works	End 2014	End 2014	Initial action has been completed and priority sites determined based on 12/13 season flood data. The RAM Geotechnics, Drainage and Off-Track (GDO-T) team will continue to review and develop flood resilience sites based on flooding events and climate change projections
Install Remote Condition Monitoring (RCM)	End 2014	End 2014	Western Route will continue when deemed necessary, to enhance the frequency of preventative maintenance at high risk drainage locations considered for RCM fitment; such that a proactive risk management philosophy is adopted
Review latest flood risk projections against updated rail network elevation model	End 2015	End 2015	Western Route has been mapped onto ArcGIS and superimposed onto various data maps. The following data is available to view: • BGS Geosure Slope Instability – Landslides (Categorised from E to A – find attached guidance to categories), • BGS Geosure Shrink-swell – Subsidence (Categorised from D to A– find attached guidance to categories), • ESI Groundwater flooding (Categorised from High to Negligible Risk – with 'other' not being at any risk), • NaFRA River & Coastal flooding (Categorised from High to very low – with 'other' not being at any risk), and • Environment Agency surface water flooding 1in 30, 1 in 100 and 1 in 1000-year flooding (categorised into 'Yes' or 'No' if at risk of flooding)
Install RCM on the most frequently monitored bridge structures in the 'flood plan' to reduce requirement for staff response	Potential addition	N/A	Structures team working in accordance with STE guidelines to manage risk, profile and compliance of their vulnerable assets

Table 6
CP5 WRCCA Plan CP5 actions – Review

Action name	Target completion date	Actual completion date	Comments
Earthworks			
Actively monitor Met Office rainfall data to implement an Adverse Weather Earthworks Plan and ensure safety. Continuously revise the plan to take into account earthwork condition	Strategy completion autumn 2014 Implementation 2015-2017	Strategy completion autumn 2014 Implementation 2015-2017	Adverse weather sites are determined based on the Earthwork Hazard Category (EHC), Risk and Earthwork Asset Criticality Band (EACB) of each 5-chain length and supplied to the earthworks RAM team. Through risk assessment of the 'Very High Risk' sites by the earthworks RAM team, a decision was taken whether an ESR would be required during adverse weather. Where ESRs were deemed necessary, the sites were added to the Earthwork Adverse Weather Implementation plan, detailing the location and type of speed restriction to be used, and under what conditions the ESR would be implemented. The earthworks included in the Adverse Weather Plan are updated annually following a risk assessment of all earthworks, undertaken by the earthworks RAM team
Remediate the highest risk earthworks as planned within the renewals work bank	March 2017	March 2017	Intervention works have been delivered or are planned for a number of the highest risk earthworks in CP5. Enhanced monitoring and Adverse Weather ESRs are implemented on high-risk sites that have been deferred until CP6 due to budget constraints
Install RCM on select high-risk earthworks	End 2017	End 2017	RCM installed at the following suitable high-risk earthworks: • Teignmouth Sea Cliffs Early Warning System, and • Smugglers to Woodlands Catchfence accelerometer and cliff Inclinometers Earthwork Detection Failure (EDF) installed at 102 5ch lengths at 33 no. sites: • Intelligent Infrastructure led Pilot scheme – 65 5ch lengths at 22 no. sites, and • Western Route funded scheme – 37 5ch lengths at 11 no. sites
Prioritise and include adverse weather sites in the Civils Adjustment Mechanism (CAM) submission, for remediation in Years 3-5 CP5	March 2015	March 2015	Adverse weather sites were prioritised and included in CAM submission
Remediate additional earthworks at adverse weather sites	Potential addition	Ongoing delivery	Earthwork drainage refurbishment and maintenance work bank was developed by the earthwork and drainage RAM teams to improve the resilience of earthworks and reduce risk of failure in adverse weather. Locations of the works have been prioritised based on risk to track, risk to Network Rail personnel (that currently have to manually erect ESR boards) and potential disruption to the effective running of TOC timetables
Heat			
Install RCM of rail temperature on some of the high-risk, highest delay impact locations	Potential addition	N/A	CoRCM units are thermometers set across the Route and are controlled by Delivery Units (DUs). Critical Rail Temperature (CRT) is set for each unit by Asset Management (track) or Maintenance team. When the CRT is reached an 'alarm' (email) is sent to Maintenance and Asset teams. Although the units continually measure temperatures, an alarm will only be sent in units that are set to do so; track temperatures may not be deemed an issue if the sleepers are heavy (concrete) and in good condition, and a full ballast shoulder is in place, restricting movement of the track itself. When an alarm is sent, a TSR will be put in place, the severity of the TSR is dependent on the extent the temperature has passed the CRT. Watchmen will be put in place, for the duration of the TSRs, to check for buckling of rail. comments required
Coastal and estuarine			
Support regional resilience proposals developed by Somerset County Council and the Environment Agency	Ongoing	Ongoing	Support is provided and coordinated by Environment Agency/ Network Rail Liaison Officer
Develop and publish proposals for increasing the resilience of the coastal railway at Dawlish	End 2015	End 2015	Multi-control period resilience programme estimated to cost up to £600m over 20 years. The Exeter to Newton Abbot resilience scheme shall be developed through CP5-CP8. Meetings to be held with DfT to determine funding and programme

CP5 WRCCA Plan CP5 actions – Review continued

Table 6
CP5 WRCCA Plan CP5 actions – Review

Action name	Target completion date	Actual completion date	Comments
Coastal and estuarine			
Develop individual Asset Management Plans for Coastal Estuarine and River Defences (CERDs) which detail vulnerable coastal assets and their management plan for inspection, maintenance, renewal and upgrade	March 2019	March 2019	JBA will develop and deliver CERD analysis. JBA surveying assets as part of development of the database
Combined with Cornwall Signalling Renewal, relocate signalling equipment into storm resilient cases and buildings	Potential addition	N/A	Action delivered as part of Cornwall Signalling Renewal
Following the development of proposals by end 2015, consider investing in a rolling programme of resilience improvement work for Powderham Banks – Dawlish – Teignmouth over a 4 Control Period cycle (mid CP5 to end CP8)	Potential addition	N/A	Exeter to Newton Abbot (EX2NA) resilience study is ongoing. Ground Investigation (GI) of Teignmouth sea cliff has been completed. Intervention options report completed, preferred option selected
Wind			
Review and catalogue the results of the national LIDAR survey	End Q1 2015	End 2020	Survey release date was delayed to CP6 – Analysis ongoing with Airbus to allow pertinent information to be obtained from LiDAR survey data
Undertake autumn 2014 tree clearance programme (£5m)	End 2014	End 2014	Completed during the autumn 2014 season
Series 1 (overhead line system to be installed in Western Route) has improved design parameters for wind loading compared to previous high-speed overhead line systems	N/A	Series 1 Reference Design signed off June 2014	Series 1 OHL installed on electrified areas of Western Route
Vegetation clearance as part of Great Western Electrification Programme (GWEP)	Staged completion 2014-2018	Ongoing	GWEP de-vegetation was completed under extended license. Volume targets were revised and change controlled. Revised volume targets were met
Maintain new reduced levels of vegetation (following clearance during 2014 and the Electrification Programme)	Potential addition	N/A	Great Western Route Modernisation (GWRM) continued to maintain de-vegetation levels until hand back to RAM team following competition of GWRM. De-vegetation extents and volumes were reported to RAM. Maintenance teams to maintain vegetation and upload data to ELIPSE, allowing detailed records to be kept on time and location of de-vegetation
Cold and snow			
On extreme snow/cold days, consider running a maintenance train ahead of the first passenger trains to clear icicles, or other mitigation	Potential Addition	N/A	In extreme cold, Control shall contact the TOCs to request a 'Ghost' train be sent prior to any passenger trains. Process delivered through Disruptive Management Conference (DMC)
Inspect and monitor wet structures/tunnels for icicle growth	Potential Addition	N/A	Inspection and monitoring of wet structures/tunnels for icicle growth is being completed by control through Disruptive Management Conference (DMC)
Increase the number of Points Operating Equipment (POE) with internal heating as part of the renewals process	Potential Addition	N/A	Only a very few POEs do not have internal heating. Upgrade to be completed as part of BAU renewal process
Use train borne monitoring where possible. Review inspection frequencies during winter preparation	Potential Addition	No further works currently planned	Discussion held with Asset Information at STE concerning how the very large amounts of data that would be gathered by the cameras will be collected and processed. Funding for R&D required – no single product available. Investigation required to determine if the standard of the current on-board camera is sufficient to assess the heating strips. Potential that RCM technique – measuring current induction within the heating strips – would be more effective system of detecting detached heating strips. No further works to progress as this stage

Table 6
CP5 WRCCA Plan CP5 actions – Review

Action name	Target completion date	Actual completion date	Comments
Adhesion			
Undertake autumn 2014 tree clearance programme (£5m) – as noted in Wind	Undertake autumn 2015 tree clearance	End 2014	The Western Route Season Delivery Specialist (SDS) completed assessments of rail adhesion sites - updating the Hazard Directory, and the TGA's sandite and RHTT treatment programme accordingly.
Improved management of adhesion and development of autumn timetables	Ongoing	Ongoing – continual improvement	The autumn timetable for 2015 included many successful treatments that were trialled during 2014; mainly MLN3 WCS, where the RHTT was slowed and treated in shorter more intense bursts, this reduced the number of low adhesion reports that were received.
Lightning			
Include lightning risk in the business case for the proposed accelerated Cornwall Signalling Renewal and install lightning protection measures in the new signalling system	Potential addition	N/A	Lightning protection measures have been included in the Cornwall Signalling renewal

Planned WRCCA actions for CP6 (2019 – 2024)

Table 7
Planned WRCCA actions for CP6 (2019 – 2024)

Vulnerability	Location	Action to be taken	Cost of action	Funding source/ action lead	Expected benefit	Target completion date	NAP action reference
All impacts							
General	N/A	Compliance with the Environment and Social minimum requirements standard for all Infrastructure Projects and Works Delivery schemes	N/A	RAM/ Sponsor	Improve Network Rail's environment and social performance through the mitigation of risks and the improved delivery of environment and social management to leave a sustainable legacy for future generations.	December 2019	-
Earthworks							
Earthworks are at increased risk from failure in heavy and persistent rainfall	Various locations across the Route – determined through assessment of earthwork condition and risk following heavy rainfall	Undertake (minimum) annual adverse weather (rainfall) risk assessment to determine highly vulnerable sites to heavy and/or persistent rainfall that require operational restriction during adverse/ extreme rainfall	Time spent only	RAM GDO-T	Reduction of risk to rolling stock and passengers in case of earthworks failure in adverse/extreme rainfall	CP6 Yr1 – October 2019 CP6 Yr2 – October 2020 CP6 Yr3 – October 2021 CP6 Yr4 – October 2022 CP6 Yr5 – October 2023	NRNAP1
		Implement adverse weather (rain) protocol when pre-defined trigger levels of rainfall and SMI are met	Schedule 8 costs acquired per event			BAU activity	NRNAP1
		Enhance earthwork drainage at Adverse Weather sites	£9 million			Delivered as per programme in CP6 Business Plan	NRNAP5
		Remediate the highest risk earthworks as planned in the renewal workbank	£45 million				NRNAP5
		Increase coverage of Earthwork Detection Failure (EDF) in the Route	£200k	RAM Geotechnics	Near real-time detection of earthwork failure allowing operational restrictions to be put in place	March 2021	NRNAP4

Planned WRCCA actions for CP6 (2019 – 2024) continued

Table 7
Planned WRCCA actions for CP6 (2019 – 2024)

Vulnerability	Location	Action to be taken	Cost of action	Funding source/action lead	Expected benefit	Target completion date	NAP action reference
Earthworks							
Earthworks are at increased risk from failure in heavy and persistent rainfall	Bath Road cutting	Earthwork drainage enhancement at Bath Road cutting	£1.5m	RAM GDO-T	Increased resilience to surface and sub-surface water flow and removal of ESR in adverse weather (rain)	March 2021	NRNAP5
	Sites at risk from failures on 3rd party land	Undertake 3rd party slope risk evaluations making use of 'Classification of Hazards on Outside Party Slopes' (CHOPS) assessment	Time spent only	RAM Geotechnics	Reduction of risk to rolling stock and passengers in case of earthworks failure in adverse/extreme rainfall	March 2021	NRNAP1
Clay cored embankments susceptible to desiccation following dry and hot periods	Various – determined through earthwork assessments and track performance issues	Develop high risk desiccation embankment register and monitor	Time spent only	RAM GDO-T	Targeted track and vegetation management during dry and hot periods (high SMD)	March 2020	-
		Removal of high water demand trees on clay embankments that are particularly susceptible to desiccation	As required		Reduce effect of desiccation on track performance	BAU activity	-
		Undertake ground investigations and install inclinometers and piezometers at embankments known to be susceptible to shrink/swell	£2m	RAM Geotechnics	Develop early warning system using monitoring information to undertake targeted track maintenance regime and earthwork interventions	March 2020	-
		Develop cyclic tamping strategy with ringfenced shifts to take place twice a year	TBC – predicted costs to be determined as part of development of strategy	Head of Maintenance	Tamping shifts in spring time aimed at preventing issues occurring by tamping to a fixed design tamping shifts in autumn available to recover track position if it has dropped during the summer		-
Flooding							
Lineside E&P equipment within flood zones	Westbury – Castle Cary (WEY); Castle Cary – Taunton (CCL, MLN1), Totnes – Liskeard (MLN1&2), and Penzance (MLN4)	Renew old rubber 650V power cables showing signs of significant insulation degradation. Assess position of lineside equipment cabinets and raise them onto platforms in high flood risk areas	£21.5 million	RAM E&P	Prevention of signal power cables failing in service, reduction in train delays	End of CP6	NRNAP3
Major repeat flood sites	Staffords Bund	Repair and enhancement of flood bund at Staffords Bridge	£800k	Western Route flood resilience – enhancement	Reduction of flow through Cowley Bridge culvert in flood conditions	October 2019	NRNAP3
	Hele and Bradninch flood resilience scheme	Track lift through level crossing and highway. Flood plain landscaping.	£8.0m		Increased resilience and reduction in frequency of flood events	March 2021	

Table 7
Planned WRCCA actions for CP6 (2019 – 2024)

Vulnerability	Location	Action to be taken	Cost of action	Funding source/action lead	Expected benefit	Target completion date	NAP action reference
Flooding							
Major repeat flood sites	Flax Bourton flood resilience scheme	New crest drain to intercept runoff flows, new cross drains and possible enhancement to track drainage – Develop scheme to GRIP5 – Detailed design	TBC	-	Increased resilience and reduction in frequency of flood events – reduction in return flood period to be confirmed in detail design	March 2021	-
	Catchment monitoring	Installing telemetry at Exeter and Chipping Sodbury and improving the Exeter flood warning model	£365k		Improve flood warning for both sites leading to shortened periods of railway closure	March 2020	-
	Cowley Junction Demountable Barrier	Construction of demountable barrier – completion of Cowley Bridge flood resilience scheme to tie in with Environment Agency flood defence	TBC	RAM GDO-T	Protection of assets at Cowley Junction and along rail corridor to Exeter St. David's station	March 2020	-
Embankment damage from flood water	Athelney Embankment	Refurbishment and increased resilience of embankment damaged by flooding	£500k	RAM Geotechnics	Repair of damage caused by extreme flooding in 2014 and increased resilience to future flood events	March 2021	NRNAP5
Culvert can become overwhelmed in flood conditions	Various – determined through structures condition assessments	Renewals of prioritised high risk culverts	£4m	RAM Structures	Improved capacity of high criticality culverts allowing for increased flooding events due to climate change	March 2024 (End CP6)	-
Scour							
Damage caused to bridge structures from scour	River Cherwell	Undertake assessment and where required intervention works to reduce scour risk score to low	£230k	RAM Structures	Reduction in risk of scour damage during flood events	-	-
	Wharncliffe Viaduct		£250k				
	River Colne		£300k				
	Maidenhead Viaduct		£600k				
	St.James – R.Avon & towpaths		£280k				
	RBE UW: Huntspill Viaduct		£200k				
	RBE UW: Huntspill Viaduct 2		£200k				
	Huntspill Viaduct 3		£200k				
	River Dart		£300k				
	Liskeard Viaduct		£275k				
	Tregargle Viaduct		£275k				
	Truro Viaduct		£275k				

Planned WRCCA actions for CP6 (2019 – 2024) continued

Table 7
Planned WRCCA actions for CP6 (2019 – 2024)

Vulnerability	Location	Action to be taken	Cost of action	Funding source/action lead	Expected benefit	Target completion date	NAP action reference
Scour							
Damage caused to bridge structures from scour	Yeo River – No.26	Undertake assessment and where required intervention works to reduce scour risk score to low	£200k	RAM Structures	Reduction in risk of scour damage during flood events	-	-
	Dart Bridge		£330k				
	Railway over R.Taw Downside		£150k				
	Weir Marsh Viaduct 63		£250k				
	Black Bridge 77		£360k				
	Pill – No.93 Over river		£300k				
	RBE UW: Rock Mill Viaduct		£250k				
	River Evenlode/ Fawler Manor Farm		£155k				
	River Avon		£675k				
	Pump House – River Severn		£250k				
	Blackpool Brook/ Cinderford Brook		£110k				
	Lavignton Viaduct		£200k				
	Lavignton Viaduct		£660k				
	Bourne End Viaduct		£400k				
	Sheep House		£300k				
Earthwork Scour	Various high-risk locations across the Route – determined by RAM-Geotech through examination/ evaluation process	Scour prevention and repair at high risk sites	£2.9m	RAM Geotechnics	Repair of existing scour damage and increased scour resilience at high risk and criticality sites	March 2024 (End CP6)	-
Heat							
Track vulnerable to buckling in high temperatures	Southall East Junction	Renewal involving replacement of timber bearers with concrete bearers	£2.5m	Track renewals provision	Improved stability in hot weather	Jan 2020	-
Uninterruptible Power Supply (UPS) batteries are susceptible to heat	PSP buildings	Fit full remote temperature monitoring of battery rooms and painting of equipment room roofs with reflective paint	£200k	RAM E&P	Reduction in thermal solar gain and more efficient maintenance response to high temperature alarms	Completed through BAU	-

Table 7
Planned WRCCA actions for CP6 (2019 – 2024)

Vulnerability	Location	Action to be taken	Cost of action	Funding source/action lead	Expected benefit	Target completion date	NAP action reference
Coastal and estuarine							
Damage to infrastructure from storms	Exmouth Sea Defences	Repair and reinstate sea defences in Exmouth area with consideration given to projected increase in sea levels	£850k	RAM Structures	Increased sea defence resilience	March 2024 (End CP6)	-
	Lostwithiel to Fowey Sea Defences	Repair and reinstate sea defences	£1.2m	RAM Structures	Sea defence resilience	March 2024 (End CP6)	-
Damage from waves, storm surge and subsequent cliff instability	Exeter to Newton Abbot	South West Rail Resilience Programme – Exeter to Newton Abbot resilience – Works to keep the Route open during extreme weather including the following CP6 schemes:	£286.2m (total)	South West Rail Resilience Project	120-year design life and enhanced resilience to climate changes	Rolling programme of resilience improvement work for Powderham Banks – Dawlish – Teignmouth over a 4 Control Period Cycle (mid CP5 to end CP8) – subject to DfT funding	NRNAP5
		Rock fall shelter	£10m				
		Seawall strengthening	£26.2m				
		Cliff face remediation, track realignment and beach reclamation	£250m				
Structures at risk from flooding and damage from storms due to sea level rise	Various vulnerable coastal locations	Manage Asset Management Plans for Coastal Estuarine and River Defences (CERDS) which detail vulnerable coastal assets and their management plan for inspection, maintenance, renewal and upgrade	TBC	RAM Structures	Targeted increase in CERD resilience	March 2024 (End CP6)	-
	(ELR:) FOY & EMT	A series of major works are planned for the CERDs on the FOY and EMT. These works are a combination of repair works and enhancements	£4m				
3rd party engagement							
Improve relationships and increase liaison with 3rd party and other government organisations	Connecting the Culm	Sharing of flood modelling undertaken for the Cowley Weirs and Hele and Bradninch flood resilience schemes	N/A (modelling undertaken through CP5 flood resilience schemes)	WRCCA lead	Reduction of flooding in Cowley Bridge area	June 2019	-
	Somerset County Council	We are actively working with Somerset Council on the early stages of Adaptation Pathways in Somerset: Climate Adaptation Planning for Flooding in Somerset'	N/A	WRCCA lead	Improved flood resilience in Somerset levels	March 2021	-
	N/A	Continue local liaison group with Environment Agency	N/A	Environment Agency/ Network Rail liaison officer	Allow liaison on flood risk management to share information and resolve issues	Active	-

Planned WRCCA actions for CP6 (2019 – 2024) continued

Table 7
Planned WRCCA actions for CP6 (2019 – 2024)

Vulnerability	Location	Action to be taken	Cost of action	Funding source/action lead	Expected benefit	Target completion date	NAP action reference
Cold and snow							
Formation of ice on OLE not allowing the pantograph to connect properly	OLE	Formalising the process of TOCs operating 'ghost trains' and icebreakers to keep the OLE clear of ice or to safely remove ice from the OLE	To be agreed with TOC	SDS	This method is proposed to prevent incidences of trapped trains and the inherent risk to the travelling public	September 2020	-
Freeze thaw in rock cuttings causing rock slope failures	Various locations across the Route – determined through assessment of earthwork condition and risk	Targeted and appropriate interventions at the highest risk and criticality sites – including scaling and installation of netting, and maintenance of existing netting	£17.4m	RAM Geotechnics	Increased resilience to failures due to freeze-thaw	March 2024 (End CP6)	-
Wind							
Trees falling onto the line causing risk to safety and performance	Focusing on mainline areas to the west of Swindon	Undertake additional vegetation management to increase compliance to standard NR/L2OTK/5201	£23m	RAM GDO-T	Increased resilience to falling vegetation from Network Rail and adjacent 3rd party land	Compliance by end of CP7	-
	Route wide	Undertake vegetation LIDAR survey	£1m			March 2021	-
		Review and catalogue the results of the national LIDAR survey	N/A	RAM GDO-T		March 2021	-
	N/A	Continue improving the competence of maintenance DU staff through continued tree awareness workshops and engaging with STE on the competence matrix update	N/A	N/A	Improved competence of maintenance DU staff to recognise and mitigate risk from falling trees	Continued improvement	-
Cables can become detached from OLE gantries in strong winds	OLE zones within the Route	Use train borne cameras to detect potential or active OLE failure	£500k	DfT/GWR/ Paul Barnes lead	Reduction in OLE failures	July 2021	-
Lightning							
Lightning can cause significant damage to S&T equipment		Build lightning resilience into renewal designs for buildings and S&T equipment	BAU	N/A	Increased resilience of S&T equipment and buildings against lightning	Completed through BAU	-
Lightning strikes cause power surges or fires if the infrastructure is not sufficiently protected	Route wide	All buildings will be risk assessed and, if necessary, have lighting protection installed and maintained	As required subject to risk assessment output	RAM Buildings	Reduced power surges, blackouts and fires	March 2024 (End CP6)	-
Trees can be struck by lightning causing trees to collapse and ignite	Various	Undertake vegetation management to increase compliance to standard NR/L2OTK/5201	£23m	RAM GDO-T	Reduction of hazard from trees during lightning event	March 2024 (End CP6)	-

Table 7
Planned WRCCA actions for CP6 (2019 – 2024)

Vulnerability	Location	Action to be taken	Cost of action	Funding source/action lead	Expected benefit	Target completion date	NAP action reference
Adhesion							
Leaves on the line, especially in the autumn, cause performance issues due to loss of adhesion between rail and train	Route wide	Rail Head Treatment Trains will be used on the Western Route in the autumn months (late September to early December). Operating out of four separate depots over the Western Route the RHTTs operate every night of the week within the autumn apart from Saturday	£14.7m	SCO/SDS	Reduce the risks of leaves on the line and subsequent performance issues	Ongoing through BAU	-
		Improved planning of treatment through undertaking robust pre, mid and post season plans	TBC	SDS	Reduce the risks of leaves on the line and subsequent performance issues through targeted treatment	Autumn 2019	-

High Priority WRCCA actions not funded in CP6

Table 8
High priority WRCCA actions not funded in CP6

Vulnerability	Location	Potential action	Action lead	Predicted benefit	Target completion date	NAP action reference
Climate change						
Understanding the potential effects of modal change of behaviour on transport infrastructure due to climate change	Various	Assessment to determine vulnerabilities and effect of modal shift due to climate change and create a climate change vulnerability heat map based on UKCP18	Western Route Environment Specialist	Use the results to determine potential studies and schemes for CP7 and beyond	March 2024	-
Earthworks						
Earthworks are at increased risk from failure in heavy and persistent rainfall	Sites within Adverse Weather Risk Register	Install geo-physics based RCM on high risk earthworks	RAM – Geotechnics	Increase understanding of high-risk earthwork behaviour and detect movement in real-time	October 2020	NRNAP1
Clay cored embankments susceptible to desiccation following dry and hot periods	Sites known to be vulnerable to desiccation	Soil moisture probes to be installed into embankments to determine accurate in-situ SMI		Targeted track maintenance	N/A	NRNAP1
Flooding						
Major repeat flood sites	Athelney-Cogload	Completion of cross-track drain at Lyng Overbridge (3rd party inflow) and flood risk study through Somerset Levels (£2.6m)	Western Route flood resilience-enhancement	Reduction of flood risk at site location – flood return period reduction to be confirmed during design	N/A	NRNAP4
	Flax Bourton	Development to GRIP 8 – Installation of new crest drain, cross drains and enhancement to track drainage (£2.2m)				
	Berkley Road Junction	Proactive heavy drainage maintenance to ensure that existing systems can accommodate increased volume during extreme weather events; and track lift to bring running rails above expected floodwater levels (£1.0m)				
	Plympton	Upsize the existing components within the 6ft track drainage system to deal with greater volumes of water (£0.5m)				

High Priority WRCCA actions not funded in CP6 continued

Table 8
High priority WRCCA actions not funded in CP6

Vulnerability	Location	Potential action	Action lead	Predicted benefit	Target completion date	NAP action reference
Flooding						
Major repeat flood sites	Chipping Sodbury – Track drainage	Track drainage clearance in Up and Down cess through Chipping Sodbury cutting from the west portal to the lagoon. 6ft carrier drain requires clearing and CCTV survey to prove condition and capacity (£4.0m)	Western Route flood resilience-enhancement	Reduction of flood risk at site location – flood return period reduction to be confirmed during design	N/A	NRNAP4
	Lawes Road	Jetting and CCTV work to existing piped drainage system through bridge and retaining wall section and potential replacement of piped system with new components and upsizing of pipe diameters (£0.5m)				
Scour						
Flood and scour damage to structures	All sites risk rated medium/ high scour risk	Scour protection works to reduce risk to low	RAM – Structures	Reduction in risk of closing railway during and after flood events	CP8	-
Coastal and estuarine						
Sea Level Rises	Various sea defences	Improved/repaired sea defences	RAM – Structures	Resilience to sea level changes	CP9	-
Damage from waves, storm surge and subsequent cliff instability	Exeter to Newton Abbot	Rolling programme of resilience improvement work for Powderham Banks – Dawlish – Teignmouth over a 3 Control Period cycle (CP6 to CP8)	South West Rail Resilience Project (SWRRP)	Enhance resilience to extreme weather and climate change	CP6-8	-
Adhesion						
Leaves on the line, especially in the autumn, cause performance issues due to loss of adhesion between rail and train	Route wide	Chlorophyll sensors to be fitted to the RHTTs	SCO	Treatment will based on the presence of leaf contamination as well as generation of heat maps showing the worst locations, so that sites can be located for additional and specific mitigation	March 2024 (End CP6)	-

NAP actions

Table 9
NAP actions

Objective	Action	Timing	Network Rail NAP action reference	Monitoring and metrics
Climate change				
Network Rail will continue to address flood risk across its network by:	Ongoing monitoring of adverse weather through visual and thermal imaging	CP6	NRNAP1	Network Rail report on performance on a quarterly basis. This includes a running performance of each operator and the punctuality of its services. These are summarised in annual reports each year, allowing for yearly comparisons.
	Building pumping stations in flood-prone locations	CP6	NRNAP2	
	Building in measures to address flood risk in new lines installing equipment at higher levels to avoid flooding	CP6	NRNAP3	
Network rail will continue to comprehensively manage its assets against geotechnical faults as part of its Asset Management Excellence Model (AMEM), this will include:	Ongoing identification of sites vulnerable to landslips with use of Light Detection and Ranging surveys, in-place motion sensors, CCTV and ground investigations	CP6	NRNAP4	
	Slope stabilisation management via drainage, or steel rods, soil nails or slope re-profiling	CP6	NRNAP5	
	Service continuity management by rerouting services which are likely to be affected by embankment failure (via CCTV monitoring)	CP6	NRNAP6	
	Ongoing engagement with academia to research possible slope stabilisation techniques, in addition to modelling the response of slopes under different meteorological conditions	CP6	NRNAP7	
Transport interdependencies	Network Rail's STE Horizon Scanning Group will continue to identify, assess and manage external risks to Network Rail throughout their regional Strategic Business Plans for Control Period 6	CP6	NRNAP8	

Management and review

Governance and review

Successfully implementing WRCCA across the whole of Network Rail requires a long-term commitment to the regular review and management of the process at all levels of the business. This will ensure the timely delivery of the technical and cultural changes necessary to develop cost-effective WRCCA strategies and actions which will avoid unacceptable increases in safety risk, system unreliability or the compromising of downstream risk mitigation strategies.

Network Rail is committed to ensuring that we will appropriately govern and assure implementation of these plans. Although we are going through a reorganisation and the future governance structure is unclear, the Route WRCCA Plans are owned by the respective Director of Route Asset Management and the Office of Rail and Road (ORR – Network Rail's regulator) will monitor each Route's progress in implementation during CP6.

Effective governance of the wider WRCCA programme including Route WRCCA Plans will be embedded within the new governance structure. Based on existing structures, the following high-level management, review and reporting will be undertaken:

- Routes will provide updates on implementation of their WRCCA Plans to ORR and the central WRCCA Team twice a year (at the end of Periods 6 and 13),
- A report combining progress from all Routes will be presented to the National Asset Management Review Group and Quality, Health, Safety and Environment Integration Group (or future equivalents) twice a year,
- Progress in implementing milestones will be included in regular WRCCA reviews by the Network Rail Executive Leadership Team and the National Safety, Health and Environment Periodic Report (or future equivalent),
- Route WRCCA Plans form a key control in managing Network Rail's Enterprise Risk relating to weather related impacts on the railway which is managed through Route and National level Business Assurance Committees (or future equivalent),
- The WRCCA Working Group will review progress and identify any improvements which would be approved by the National Asset Management Review Group and Quality, Health, Safety and Environment Integration Group (or future equivalents) or Executive Leadership Team as appropriate, and
- The central WRCCA Team will use the information in the Route Reports to inform the next UKCCRA being compiled by the Committee on Climate Change and as part of its Adaptation Report under the Climate Change Act which is due to be submitted to Defra by 2021.

Western Route management and review

The projects and schemes included within the Western Route CP6 WRCCA plan have been agreed by the Director of Route Asset Management following detailed review of asset requirements by the individual Route Asset Managers and included within Western Route's CP6 business plan. To ensure that a tight control of delivery cost and volume is maintained a comprehensive governance process has been put in place to manage scheme delivery, deferral and scheme and business plan scope change with a rigid and peer reviewed change control process.

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