

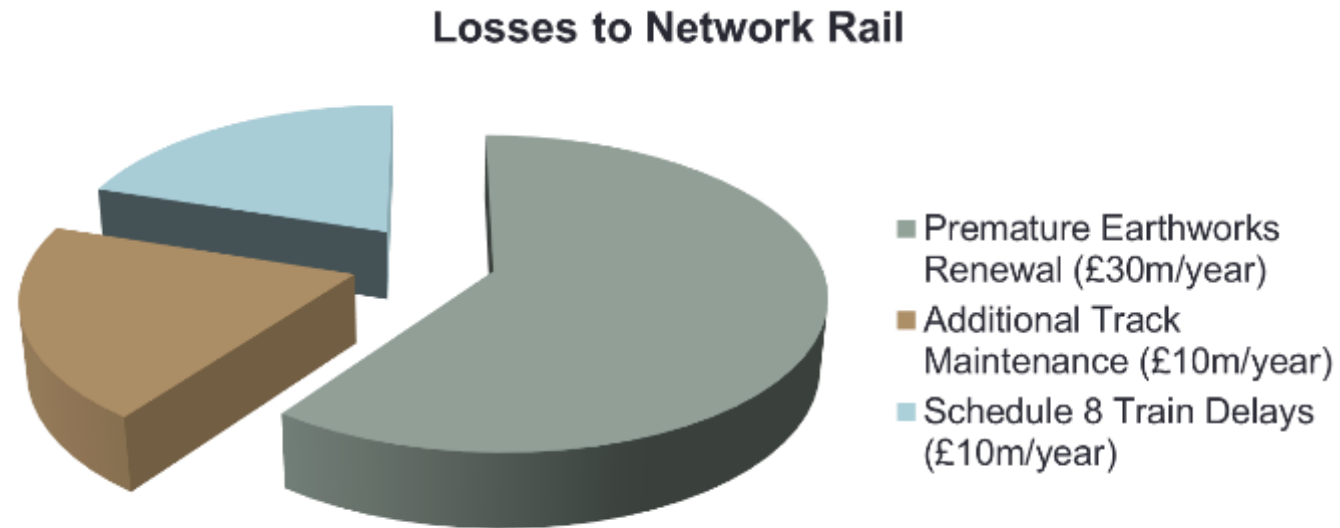
Drainage resilience

Application of technology to mitigate risk



Poor and ineffective drainage was identified as a key contributory factor in major incidents at:

- Gillingham in 2009
- Marks Tey in 2008
- Kemble in 2007
- Clarborough in 2012
- Baildon in 2012, 2016 and 2017
- Carmont in 2020

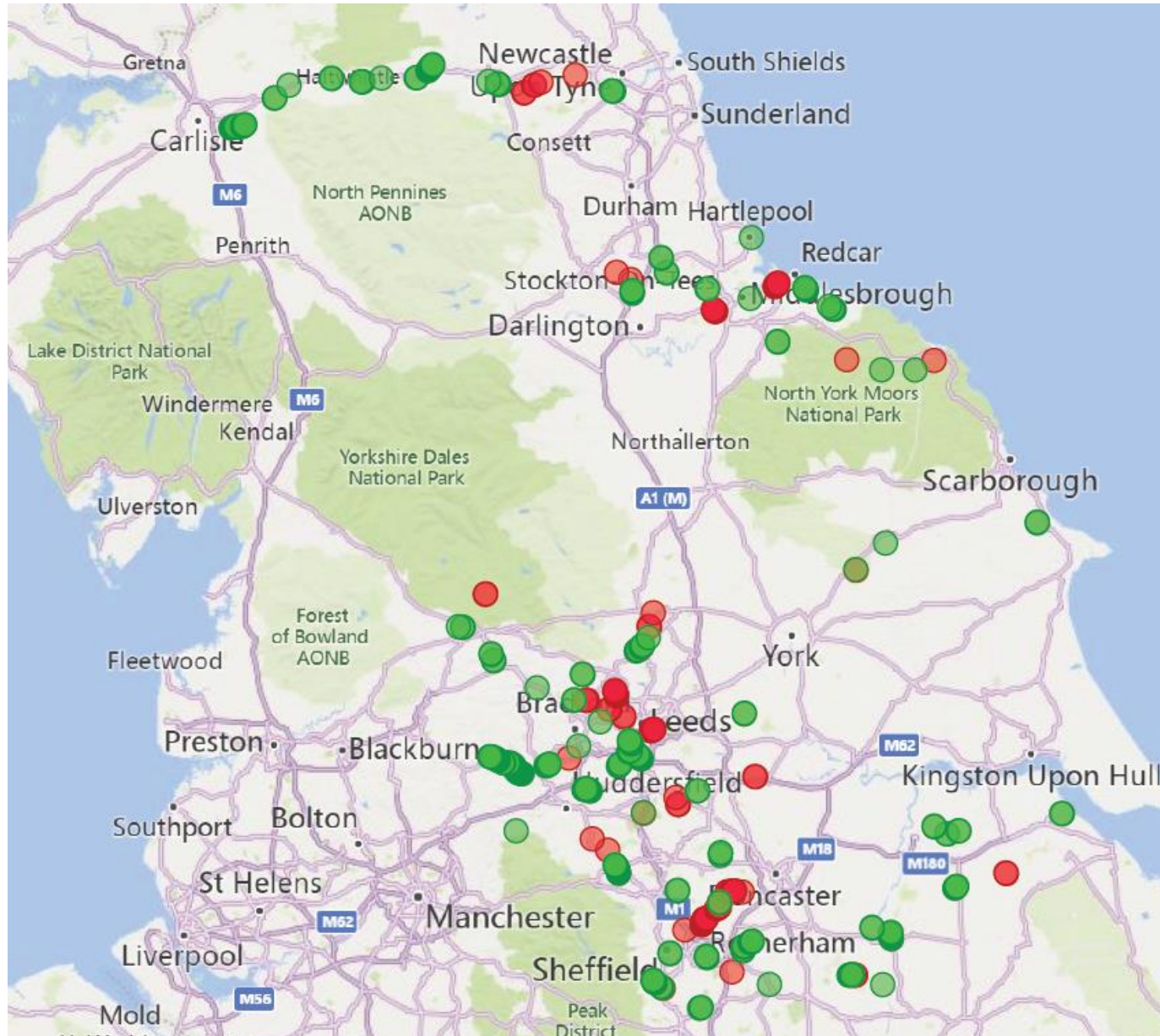


SITES WITH POOR DRAINAGE HAVE:

1.8 times more track faults
6 times more wet beds per mile
50% more twist faults

SITES WITH POOR DRAINAGE NEED:

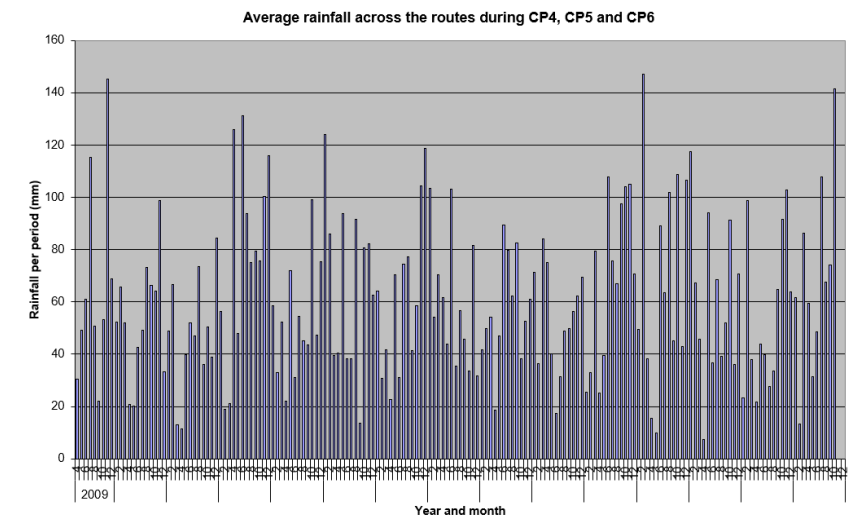
Three times more tamping or stoneblowing
Twice as much manual lifting and packing
Four times more money spending on it



Impact of STORM BABET 27th October 2023

Green: sites of historic flooding
unaffected by Storm Babet

Red: sites of flooding during storm
Babet



Named storms

Weather Event	Date	East Coast	East Midlands	North and East	Grand Total
		Minutes	Minutes	Minutes	Minutes
Babet	2023/24 P08	9336	9857	6236	25429
Christophe	2020/21 P11	569	1160	5834	7563
Angus	2016/17 P09	3079	2080	1853	7012
Darcy	2020/21 P11	1280	48	4668	5996
Bella	2020/21 P10	4839	444	660	5943
Dennis	2019/20 P12	1237	1043	2340	4620
Lorenzo	2019/20 P07	0	1754	2685	4439
Franklin	2021/22 P12	0	0	4192	4192
Elsa	2019/20 P10	0	1551	2011	3562
Desmond	2015/16 P09	22	0	3291	3313
Ciara	2019/20 P12	0	528	2486	3014
Alex	2020/21 P07	1009	1761	0	2770
Abigail	2015/16 P08	0	0	2630	2630
Eva	2015/16 P10	8	0	1613	1621
Miguel	2019/20 P03	521	818	40	1379
Helene	2018/19 P07	0	0	1353	1353
Jake	2015/16 P12	36	297	862	1195
Katie	2015/16 P13	0	914	64	978
Gareth	2018/19 P13	0	48	586	634

How do we reduce flood risk on the railway?

Inspection, maintenance and rapid response

- Risk-based inspection and maintenance
- Proactive maintenance
- Jetting and CCTV
- Incident management and risk mitigation

Physical work: refurbishment, renewal and new build

- Feasibility, design and implementation

Remote condition monitoring

- CCTV and telemetry (in-house and 3rd party)

Evaluation, analysis and modelling

- Catchment studies, upsizing of components and future-proofing at a system level

Drainage Management Plans

- Joint Maintenance/Asset management risk assessment and delivery plans

Drainage Inventory Completion

- Identification of missing assets and upload to Ellipse and accessible mapping platform

Standard Operating Procedures

- Site-specific processes to anticipate and mitigate risk of flooding.

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Distribution of fixed CCTV cameras



Distribution of remote condition monitoring

Monitoring of flood risk sites by fixed CCTV

METEOR DATA CLOUD

Navigation icons: [Grid] [Full Screen] [Zoom In] [Zoom Out] [Previous View] [Next View] [Previous Frame] [Next Frame] [Previous Day] [Next Day] [Previous Week] [Next Week] [Previous Month] [Next Month] [Previous Year] [Next Year] [Home] [Search] [Settings] [Help] [Logout]

15/08/2023 [start today] 14:29:25 GMT

BAILDON FRS 13/09/2023, 12:03:06	ECM1_STOKE_JUNCTION_SYPHO	IMMINGHAM FRS IMAGE THUMB	MVN2 WOOD LANE 13/09/2023, 11:05:29 GMT	TJC3_HARPERS_BRIDGE 13/09/2023, 11:29:20	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
BAILDON FRS 13/09/2023, 12:03:06 GMT	ECM1_STOKE_JUNCTION SYPHON OVERFLOW	KILLINGWORTH FRS 13/09/2023, 11:04:45 GMT	MVN2 WOOD LANE 13/09/2023, 11:05:29 GMT	TJC3_HARPERS_BRIDGE 13/09/2023, 11:29:20	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
ARDSLEY_TUNNEL_NORTH_FRS	ECM7_SCREMERSTON 11/09/2023	KILLINGWORTH FRS 13/09/2023, 11:04:45 GMT	PELAW FRS 13/09/2023, 11:43:57 GMT	DOW_STANTON_ORE_LC 13/09/2023, 11:09:33	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
ARDSLEY_TUNNEL_NORTH_FRS 13/09/2023, 11:47:37	ECM7_SCREMERSTON 11/09/2023, 18:06:25 GMT	KILLINGWORTH FRS 13/09/2023, 11:04:45 GMT	PELAW FRS 13/09/2023, 11:43:57 GMT	DOW_STANTON_ORE_LC 13/09/2023, 11:09:33	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
BOWLING_TUNNEL_FRS 13/09/2023, 11:47:37	ERYHOLME NORTH FRS 13/09/2023, 11:33:28	KIRK SANDALL BRIDGE FRS 13/09/2023, 11:33:28	PELAW AND MONKTON 13/09/2023, 11:28:34	ALCONBURY_AQUEDUCT 13/09/2023, 11:06:3	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
BOWLING_TUNNEL_FRS 13/09/2023, 11:47:37	ERYHOLME NORTH FRS 13/09/2023, 11:33:28	KIRK SANDALL BRIDGE FRS 13/09/2023, 11:33:28	PELAW AND MONKTON 13/09/2023, 11:28:34	ALCONBURY_AQUEDUCT 13/09/2023, 11:06:3	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
BRADWAY NORTH IMAGE THUMB	ERYHOLME SOUTH FRS 13/09/2023, 11:47:33	KIRK SANDALL CATCH PITS FRS 1	SKELTON_DRIVE_CULVERT 13/09/2023, 11:58:20 GMT	ALCONBURY_AQUEDUCT 13/09/2023, 11:06:3	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
BRADWAY NORTH IMAGE THUMB	ERYHOLME SOUTH FRS 13/09/2023, 11:47:33	KIRK SANDALL CATCH PITS FRS 1	SKELTON_DRIVE_CULVERT 13/09/2023, 11:58:20 GMT	ALCONBURY_AQUEDUCT 13/09/2023, 11:06:3	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
03/09/2023 [start today] 23:10:30 GMT	ERYHOLME SOUTH FRS 13/09/2023, 11:47:33	KIRK SANDALL CATCH PITS FRS 1	SKELTON_DRIVE_CULVERT 13/09/2023, 11:58:20 GMT	ALCONBURY_AQUEDUCT 13/09/2023, 11:06:3	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
CALVERLEY 13/09/2023, 11:13:26 GMT	FORGE_WAY_FRS 13/09/2023, 12:04:32 GMT	KIRKSTALL FRS 13/09/2023, 11:55:52 GMT	SOUTHSIDE FRS 13/09/2023, 11:29:43 GMT	ERYHOLME NORTH FRS 13/09/2023, 11:33:28	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
CALVERLEY 13/09/2023, 11:13:26 GMT	FORGE_WAY_FRS 13/09/2023, 12:04:32 GMT	KIRKSTALL FRS 13/09/2023, 11:55:52 GMT	SOUTHSIDE FRS 13/09/2023, 11:29:43 GMT	ERYHOLME NORTH FRS 13/09/2023, 11:33:28	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
ECM1_ALEXANDRA PALACE NORTH	HARE_PARK_CASCADE 08/09/2023, 19:06:17 GMT	KIVERTON BRIDGE FRS 13/09/2023, 11:56:30 GMT	STOKE JUNCTION FRS 13/09/2023, 12:00:36 GMT	MVN2_HORSEHOLD_WOOD_CASCADE 13/09/2023, 11:47:19 GMT	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
ECM1_ALEXANDRA PALACE NORTH	HARE_PARK_CASCADE 08/09/2023, 19:06:17 GMT	KIVERTON BRIDGE FRS 13/09/2023, 11:56:30 GMT	STOKE JUNCTION FRS 13/09/2023, 12:00:36 GMT	MVN2_HORSEHOLD_WOOD_CASCADE 13/09/2023, 11:47:19 GMT	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
ECM1_NEW BARNET TUNNEL 13/09/2023, 10:39:45	HONLEY FRS 13/09/2023, 10:39:45	MORLEY SOUTH FRS 13/09/2023, 11:56:30 GMT	TJC3_CALVERLEY CUTTING 13/09/2023, 11:56:20 GMT	ECM1_POTTERS_BAR_SOUTH_C	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
ECM1_NEW BARNET TUNNEL 13/09/2023, 10:39:45	HONLEY FRS 13/09/2023, 10:39:45	MORLEY SOUTH FRS 13/09/2023, 11:56:30 GMT	TJC3_CALVERLEY CUTTING 13/09/2023, 11:56:20 GMT	ECM1_POTTERS_BAR_SOUTH_C	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
CLAYTON STOTFORD ROAD 13/09/2023, 11:47:19 GMT	HONLEY FRS 13/09/2023, 10:39:45	MORLEY SOUTH FRS 13/09/2023, 11:56:30 GMT	TJC3_CALVERLEY CUTTING 13/09/2023, 11:56:20 GMT	ECM1_POTTERS_BAR_SOUTH_C	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
CLAYTON STOTFORD ROAD 13/09/2023, 11:47:19 GMT	HONLEY FRS 13/09/2023, 10:39:45	MORLEY SOUTH FRS 13/09/2023, 11:56:30 GMT	TJC3_CALVERLEY CUTTING 13/09/2023, 11:56:20 GMT	ECM1_POTTERS_BAR_SOUTH_C	MEADOWHALL_CASCADE 13/09/2023, 11:06:3
CLAYTON STOTFORD ROAD 13/09/2023, 11:47:19 GMT	HONLEY FRS 13/09/2023, 10:39:45	MORLEY SOUTH FRS 13/09/2023, 11:56:30 GMT	TJC3_CALVERLEY CUTTING 13/09/2023, 11:56:20 GMT	ECM1_POTTERS_BAR_SOUTH_C	MEADOWHALL_CASCADE 13/09/2023, 11:06:3

Monitoring of flood risk sites by fixed CCTV

Wood Lane
ELR MVN2



Harpers Bridge
ELR TJC3



Monitoring of flood risk sites by telemetry

Timeview Telemetry :: Logger Call x +

Not secure | www.timeview2.net/logger_calls/index

Timeview Telemetry

receiving and forwarding time series data and alarms

Network Rail Admin [Logout](#) [Change Password](#) [User Guide](#) Nov 07 2023 13:06 GMT

View

- List Latest
- Map View
- Alarms
- List Stations
- Timeview DBi

Alarm Configuration

- Groups and Recipients
- Message Contents

Logger Search

Overdue Checkins

User Management

Account Settings

List Stations - Network Rail All Groups 5 Days Sort by Latest Checkin 100 Items per Page Icon Display Yes

Group	5 Days	Group	5 Days
DERBY	SPC1_MILL_HILL_NORTH_CHAM Level 28.78mm (0.426V) 2023-11-03 00:00:00 2023-11-07 12:08:36 i7.1V e0.0V 0.9mA m23 cs98%	YORK	MVN2_HORSEHOLD_WOOD Level 0mm (0.393V) 2023-11-03 00:00:00 2023-11-07 12:07:45 i7.1V e0.0V 0.6mA m15 cs99%
YORK	LEH1_HORSEFORTH_MOSELEY_BE mAO 127.303m (0.506V) 2023-11-03 00:00:00 2023-11-07 12:07:22 i3.9V e0.0V 1.5mA h3.7V m9 cs92%	YORK	ECM5_ERYHOLME_DOWN_INLET level 115mm (0.445V) 2023-11-03 00:00:00 2023-11-07 12:07:46 i3.8V e0.0V 1.2mA h3.6V m31 cs94%
DERBY	SPC6_DRAYCOTT_OUTFALL level 357mm (0.537V) 2023-11-03 00:00:00 2023-11-07 12:07:50 i3.8V e0.0V 1.2mA h3.6V m14 cs92%	YORK	ECM5_ERYHOLME_OUTFALL_DOWN level 2mm (0.398V) 2023-11-03 00:00:00 2023-11-07 12:07:10 i3.9V e0.0V 4.9mA h3.6V m12 cs90%
YORK	TJC1_ABBEY_BROOK_SCREEN Level 154mm (0.456V) 2023-11-03 00:00:00 2023-11-07 12:10:16 i3.7V e0.0V 8.4mA h3.4V m20 cs99%	DERBY	SPC4_SKELTON_CHAMBER Level 63mm (0.405V) 2023-11-03 00:00:00 2023-11-07 12:09:16 i7.1V e0.0V 0.6mA m23 cs100%
YORK	ECM5_THIRSK_OUTFALL Level 210mm 2023-11-03 00:00:00 2023-11-07 12:06:46 i3.8V e0.0V 5.4mA h3.7V m5 cs93%	YORK	ECM7_KILLINGWORTH_1 Level 121mm (0.423V) 2023-11-03 00:00:00 2023-11-07 12:07:39 i7.1V e0.0V 0.8mA m17 cs100%
DERBY	SPC6_DRAYCOTT_SIPHON_DOWN Level 0.827m (0.879V) 2023-11-03 00:00:00 2023-11-07 12:01:10 i3.8V e0.0V 1.7mA h3.5V m23 cs95%	YORK	LEH3_HORNBEAM_PARK Level 568mm (0.58V) 2023-11-03 00:00:00 2023-11-07 12:06:17 i7.1V e0.0V 0.6mA m14 cs95%
YORK	ECM5_ERYHOLME_OUTFALL_UP level -2mm (0.401V) 2023-11-03 00:00:00 2023-11-07 12:08:08 i3.8V e0.0V 1.0mA h3.6V m9 cs90%	YORK	TJC3_HUNSLET_STA_JNC Level 316mm (0.406V) 2023-11-03 00:00:00 2023-11-07 12:08:07 i7.0V e0.0V 1.2mA m13 cs99%
YORK	ECM5_ERYHOLME_SIPHON_DOWN DRUCK 399mm 2023-11-03 00:00:00 2023-11-07 12:08:08 i7.1V e0.0V 0.8mA m14 cs99%	YORK	DOL2_ARDSLEY_TUNNEL_RCM DRUCK 225mm 2023-11-03 00:00:00 2023-11-07 12:08:08 i7.1V e0.0V 0.5mA m14 cs99%

13:08 07/11/2023 20

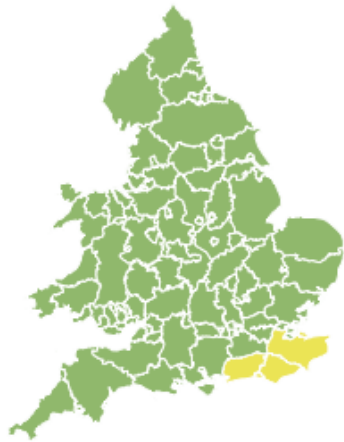
Management of flood risk through use of Flood Guidance Statements

Flood Guidance Statement

10:30hrs Monday 06 November 2023

**FLOOD
FORECASTING
CENTRE**

A working partnership between



Monday

6 Nov 2023 10:30-23:59

Trend since last FGS

Increased



Tuesday

7 Nov 2023

Steady



Wednesday

8 Nov 2023

Increased



Thursday

9 Nov 2023

Steady



Friday

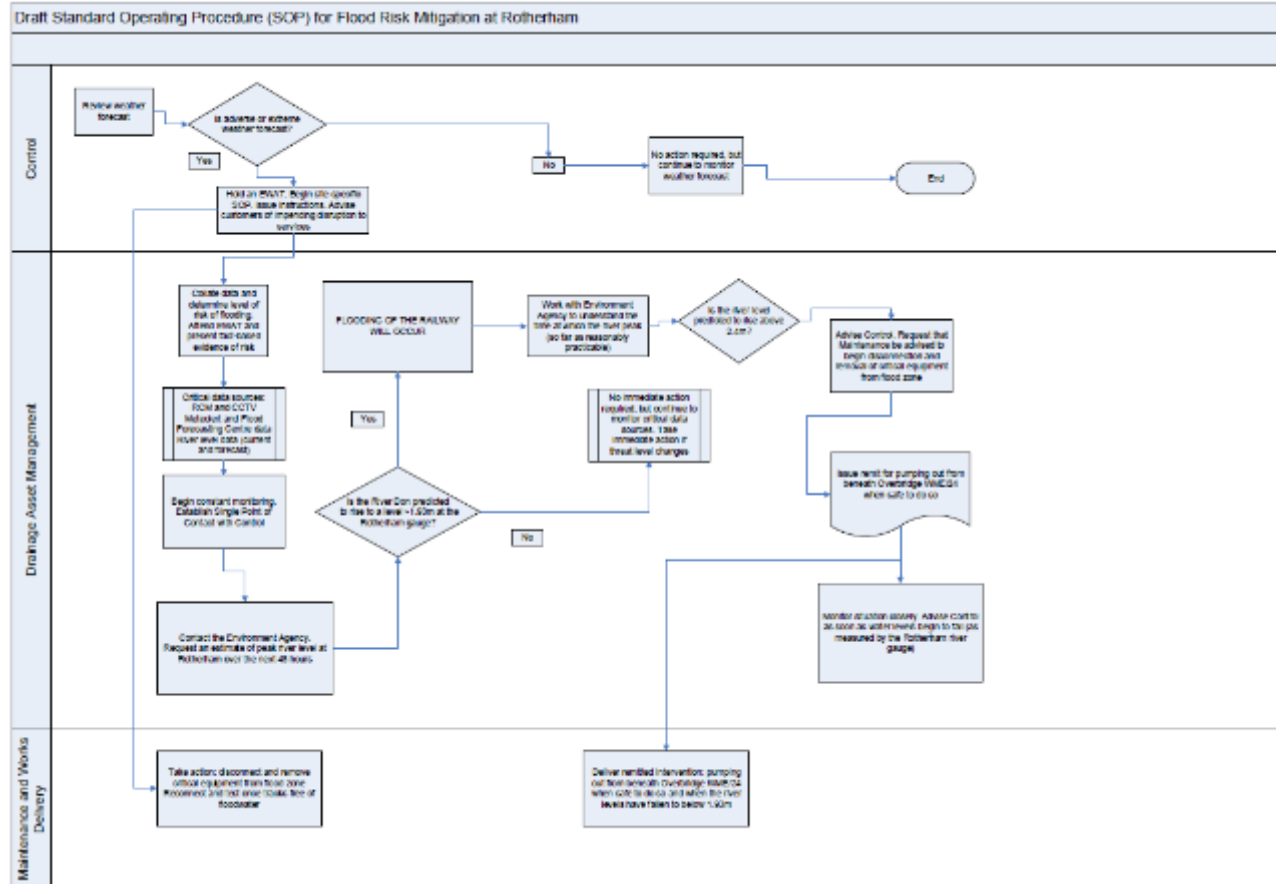
10 Nov 2023

Steady



Minor surface water flooding impacts are possible today (Monday) in the North West of England. Ongoing minor river flooding impacts in the South East of England and parts of Norfolk today. The overall flood risk is LOW.

Management of flood risk through use of Standard Operating Procedures



Flowchart No.	Activity	Responsibility
1	TRIGGER STAGE: review available data • Meteolert warnings • Flood Forecasting Centre forecasts • MetDesk forecasts • Precipitation Analysis Tool daily forecasts • Met Office weather warnings • River level gauge data • Antecedent rainfall levels • Environment Agency river level forecasts • EWAT forecasts • CCTV and Remote Condition Monitoring • Evidence from recent site visits • Current confidence in the resilience/condition of the drainage system and drainage assets	Drainage Asset Management
2	Determine level of flood risk based on available fact-based evidence • Red: will flood • Amber: may flood: continuous monitoring required • Green: will not flood	Drainage Asset Management
3	Communicate outputs from asset management risk review to Control (Senior Network Delivery Manager) either during an EWAT or by telephone	Drainage Asset Management
4	Assess fact-based evidence available and (in conjunction with asset management, maintenance and operations colleagues) determine a course of action to mitigate risk	Control
5	Mobilise S&T to disconnect and remove critical equipment (a minimum of 6 hour's notice is required). Give advance warning to customers that flooding is imminent and that the route will be closed for a period.	Control

CASE STUDIES

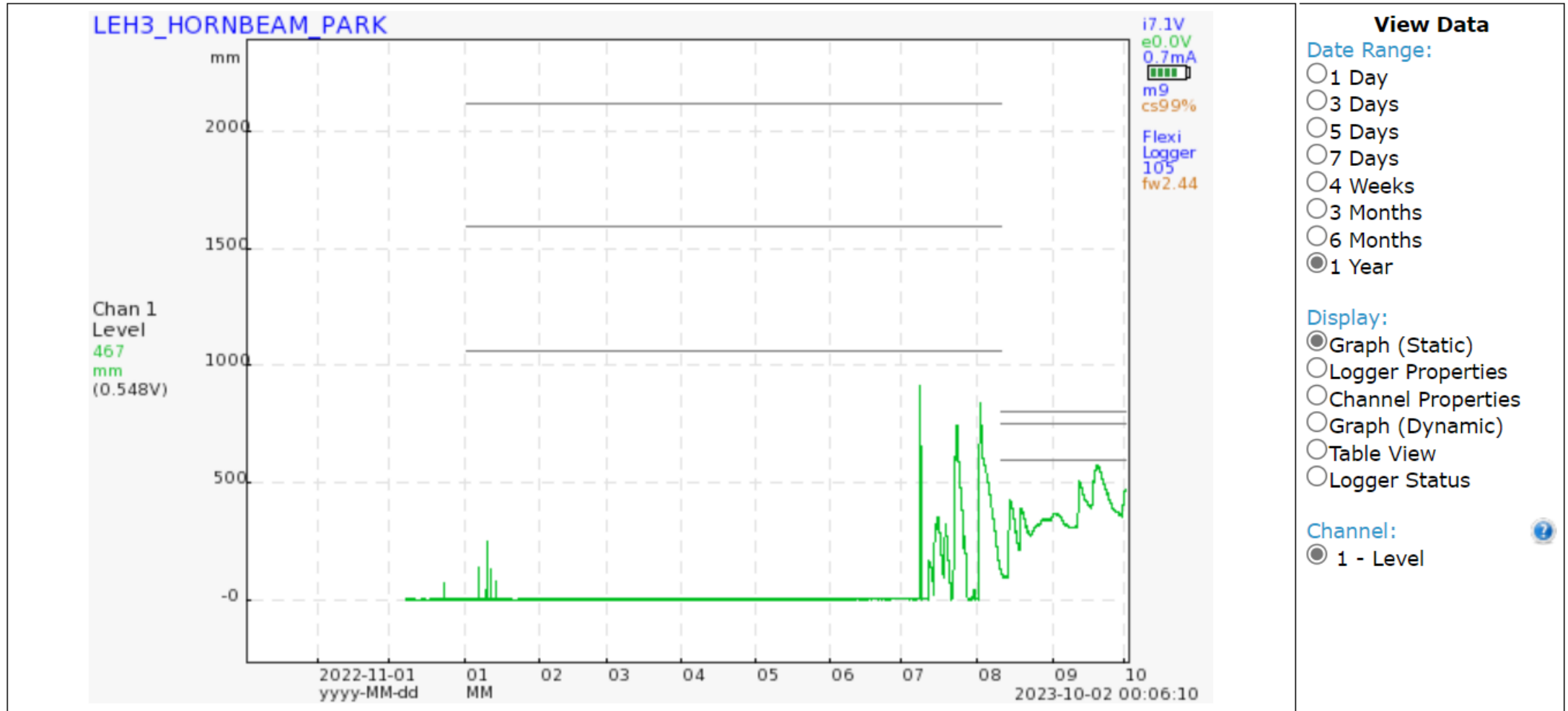
Telemetry application CASE STUDY

Hornbeam Park (LEH3)

Logger Profile Checkin Every 12 Hours



Configuration



Telemetry application CASE STUDY

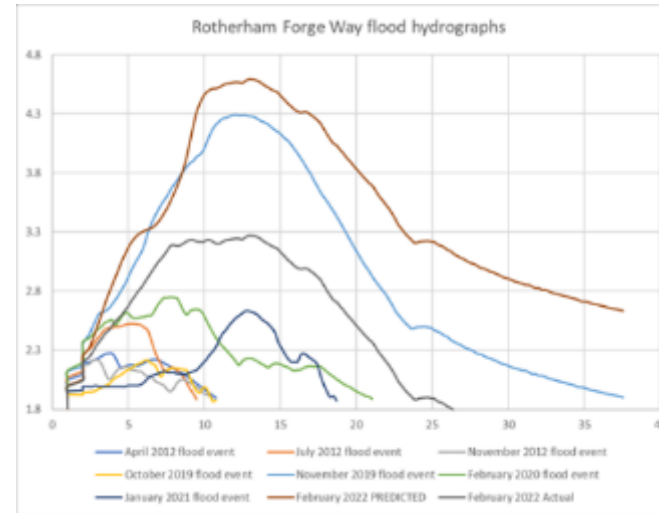
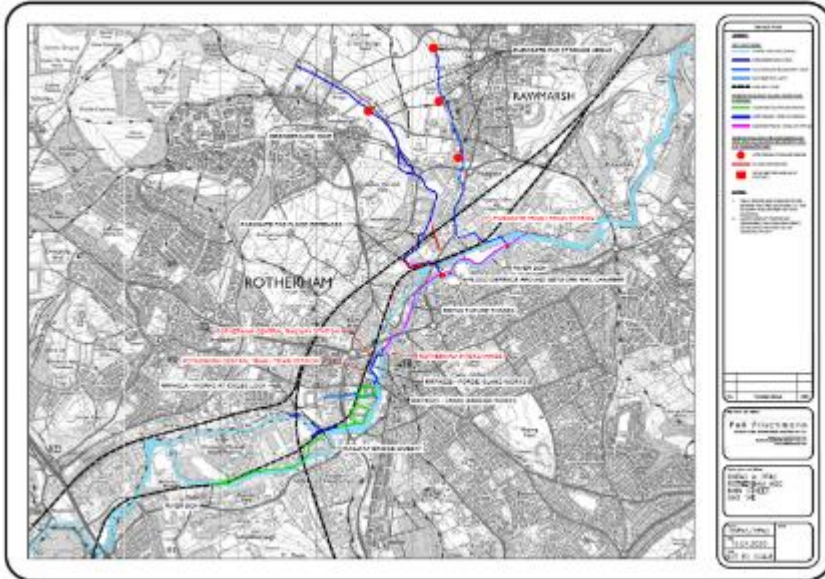
Hornbeam Park (LEH3)

Logger Profile Checkin Every 12 Hours



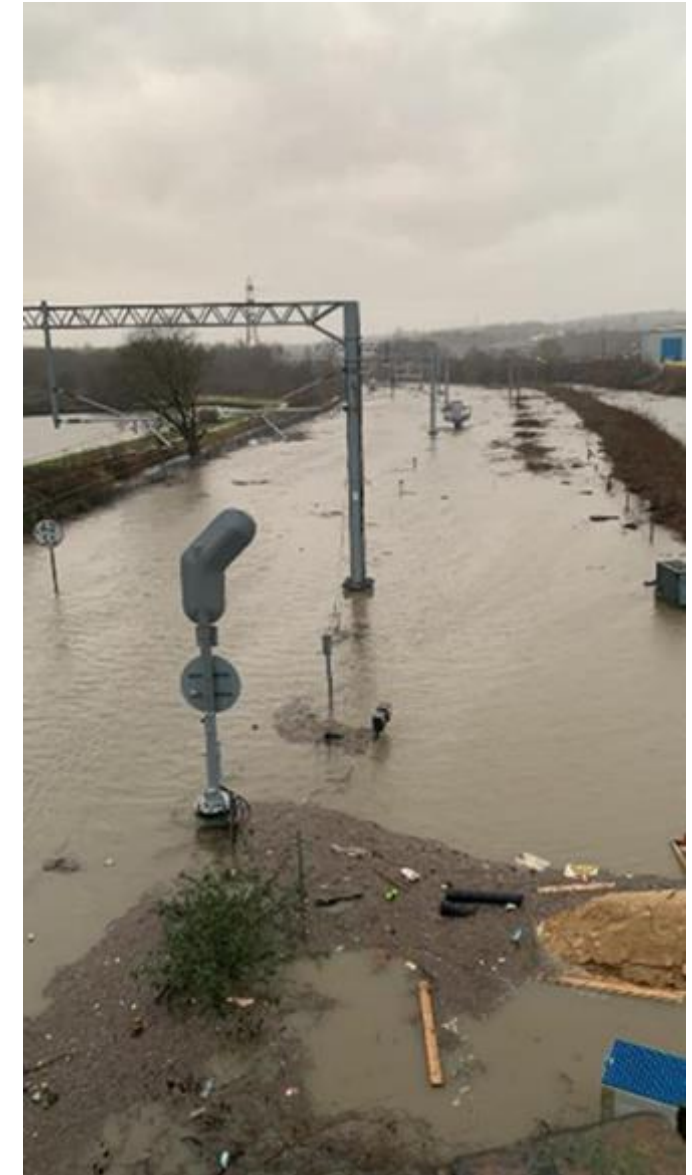
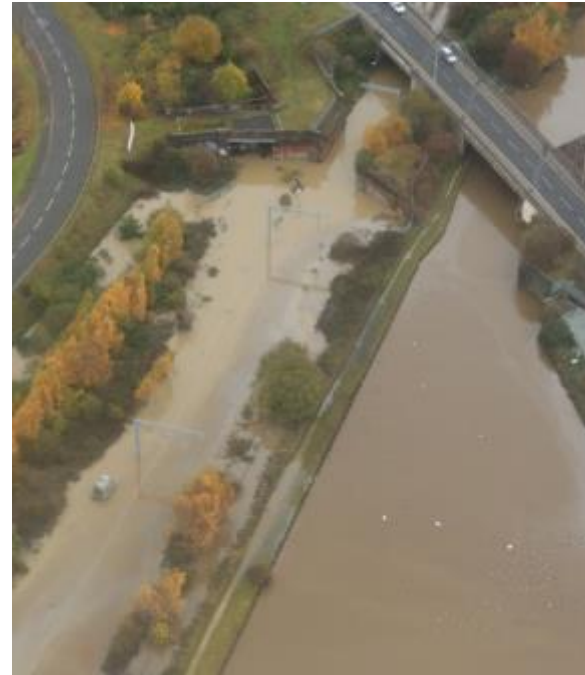
Configuration





ROTHERHAM FLOOD RISK SITE

- High flood risk: 30% annual Exceedance Probability
- Root cause: high levels of River Don and Greasborough Dyke
- Cannot be solved in isolation: complex and extensive catchments
- Network Rail is working closely with Rotherham MBC to deliver a joint FAS
- Combination of hard solutions and natural flood management planned to deliver a level of protection to 1 in 100



River Don level at Rotherham Forge Island

[Map](#) [Upstream](#) [Downstream](#) [Nearby levels](#)

Latest at 11:30am on 23 October ^④

Height
0.68m ^④

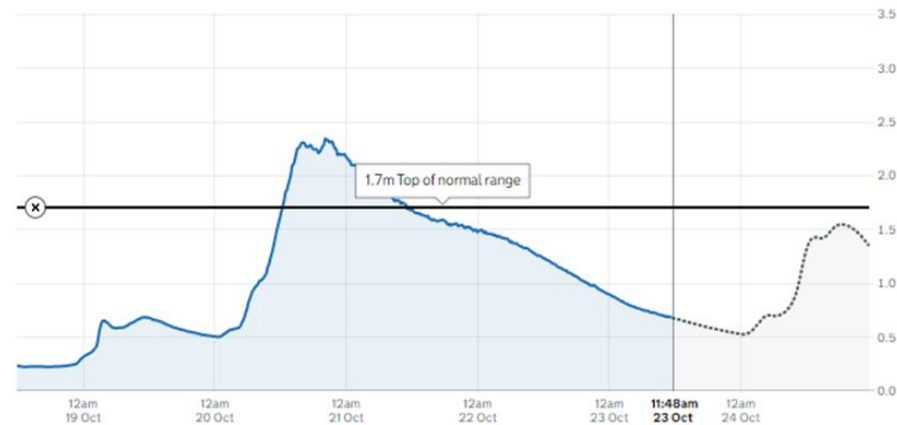
Trend
Steady ^④

State
Normal ^④

Normal range 0.23m to 1.70m

Height in metres over the last 5 days and up to 36 hour forecast

^③ This station includes an automated model which you should consider alongside other factors. The highest level in the model is 1.54m at 24 October at 6:15pm.



[Download data CSV \(16KB\)](#)

How levels here could affect nearby areas

3.32m	Water reaches the highest level recorded at this measuring station (recorded on 8 November 2019)	Show on chart
2.20m	Property flooding is possible above this level. One or more flood warnings may be issued	Show on chart
1.70m	This is the top of the normal range	Show on chart
0.68m	Latest level	



Rotherham Forge Way Downside

