

# Prediction of Earthworks Failure from Track Geometry Data

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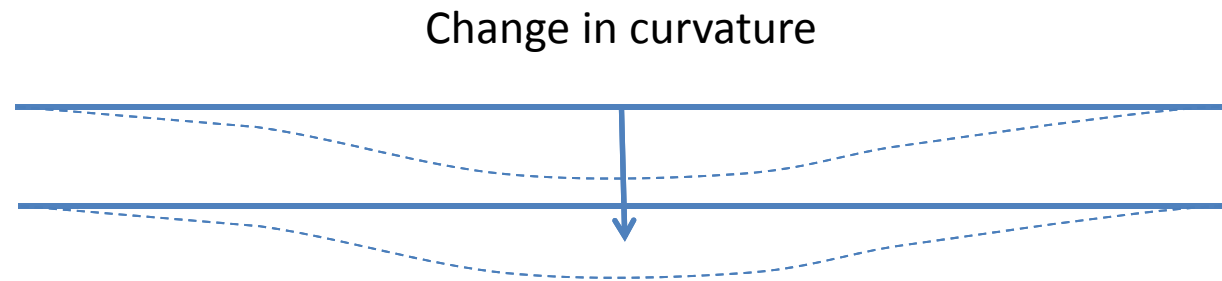
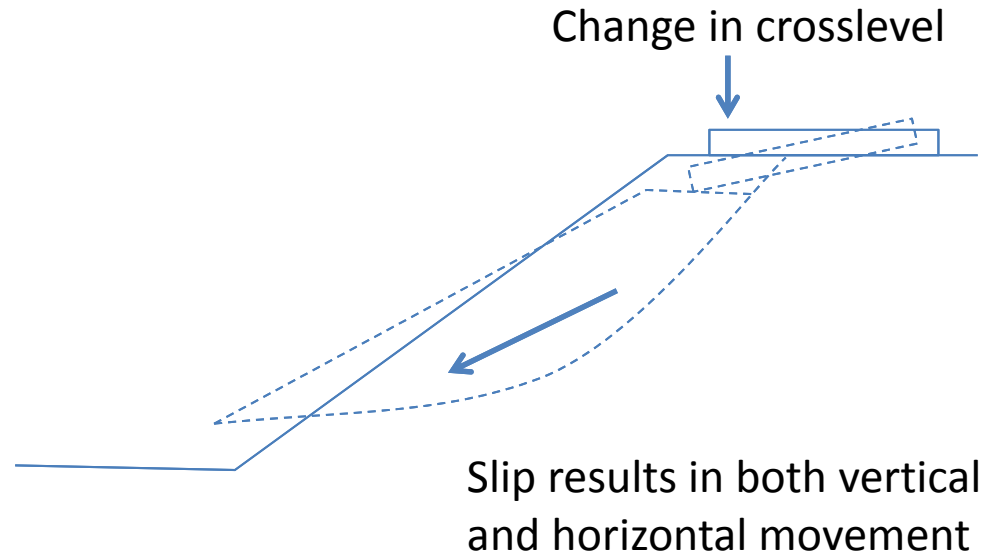
## EARTHWORK FAILURES

- UK Rail network largely constructed before 1880
- Poor knowledge of geotechnical engineering
- Areas of overconsolidated clays prone to embankment failure
- Frequent temporary speed restriction
- Too expensive to stabilise all at risk earthworks
- Difficult to predict when & where despite regular inspection



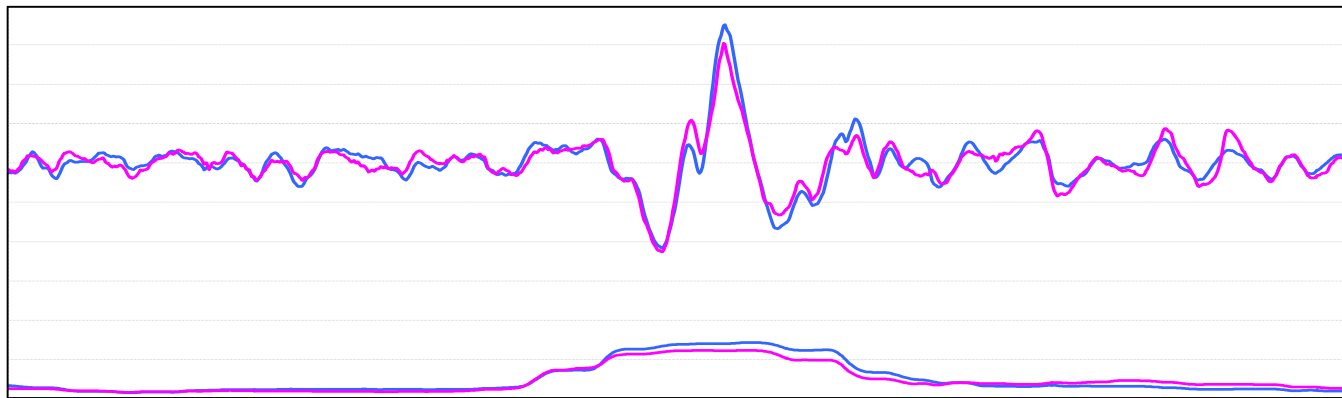
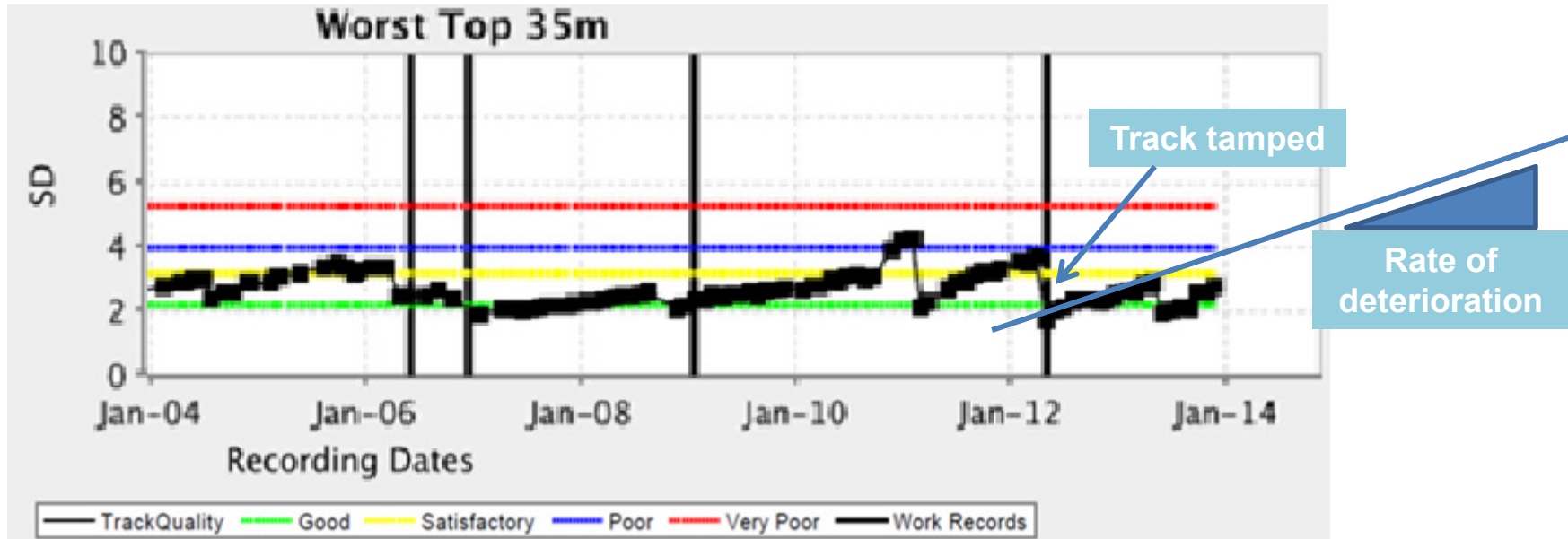
Typical Earthwork Failure  
Stewartby Way  
Midland Main Line

## Earthwork deformation affects track geometry





**Prediction of Earthworks Failure from Track Geometry Data**



**1/8<sup>th</sup> mile**

**Left and Right Top**

**36.6m rolling SD**

*Accurate alignment of Track Quality data is essential*

Accurate alignment of 39  
sequential runs of track  
geometry data

TAMP deterioration rate:

Deterioration rate —

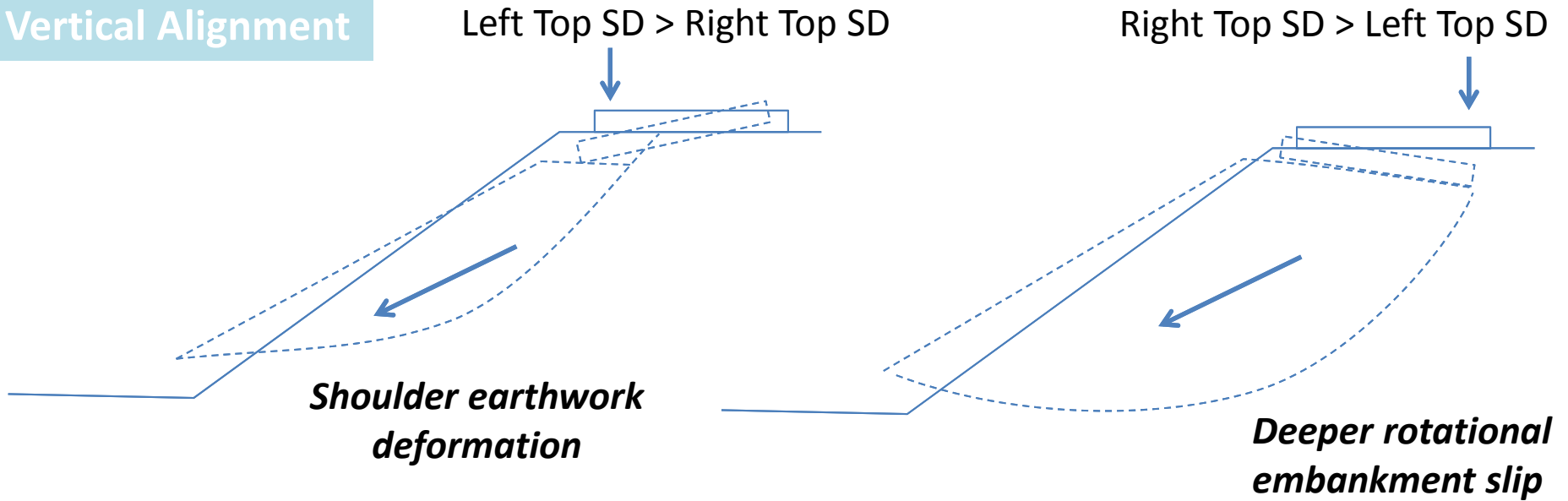
Intervention count ¶¶

Intervention effect —

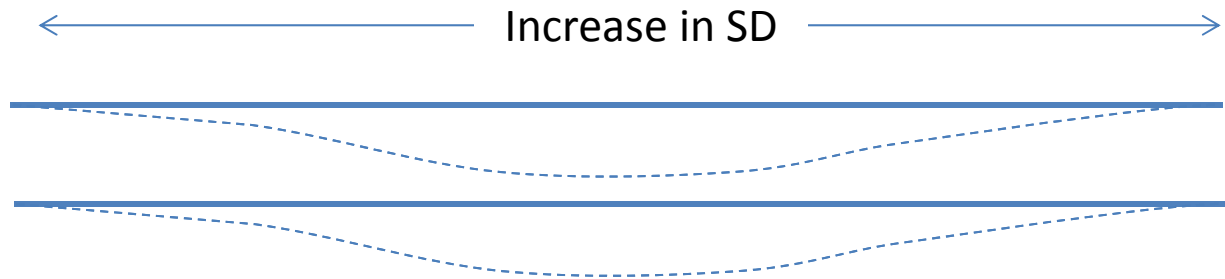
Previous standard approach:

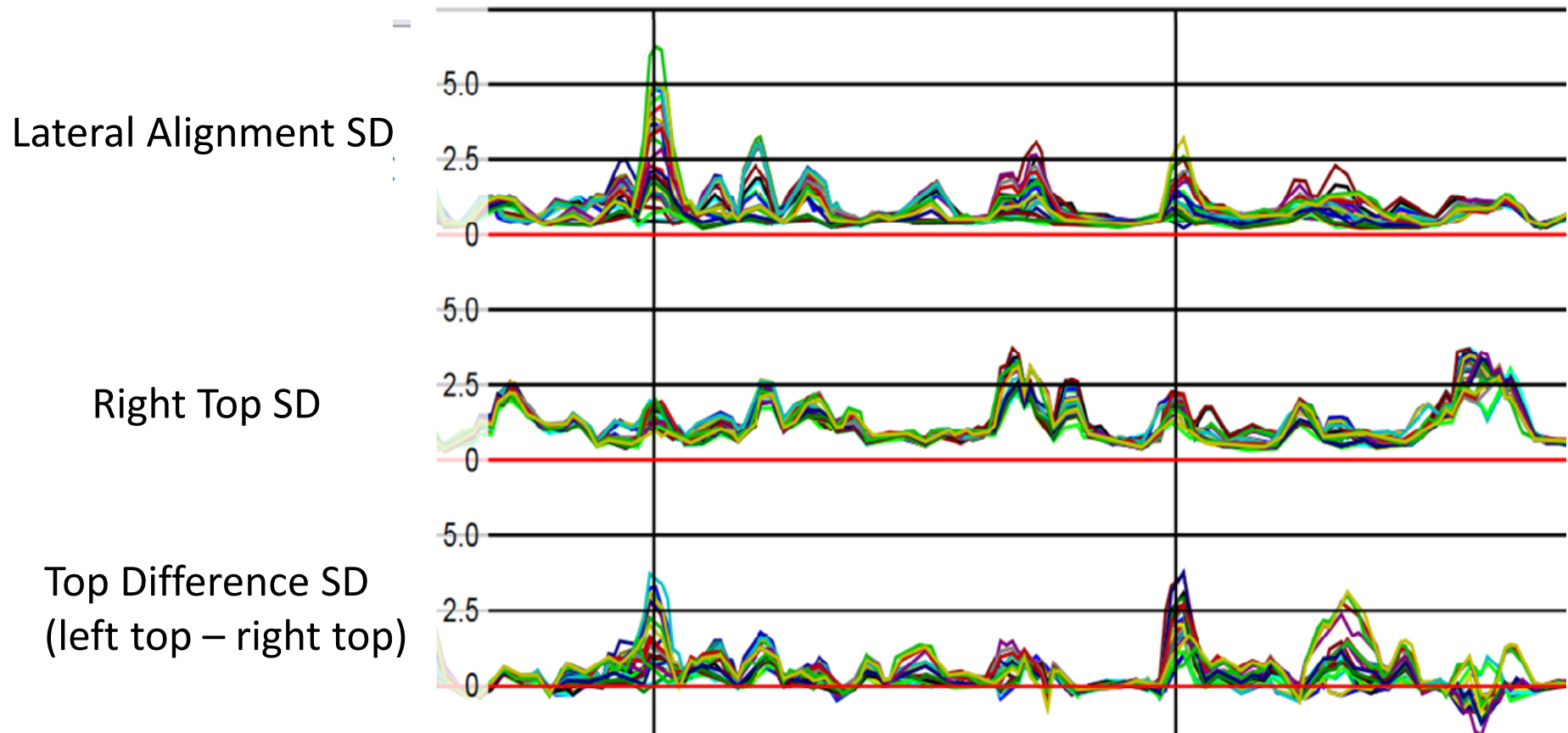
1/8<sup>th</sup> Mile Standard Deviation

**Vertical Alignment**



**Lateral Alignment**

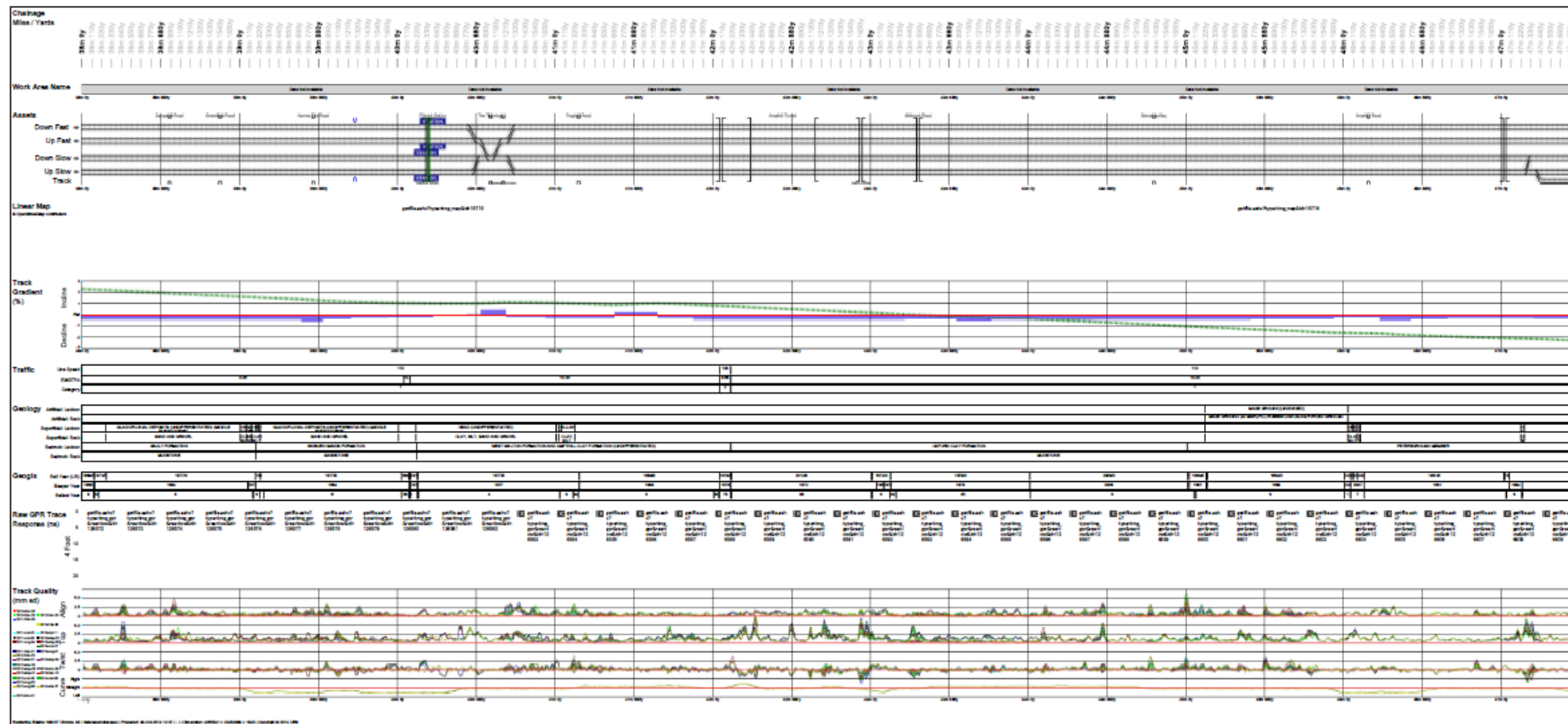




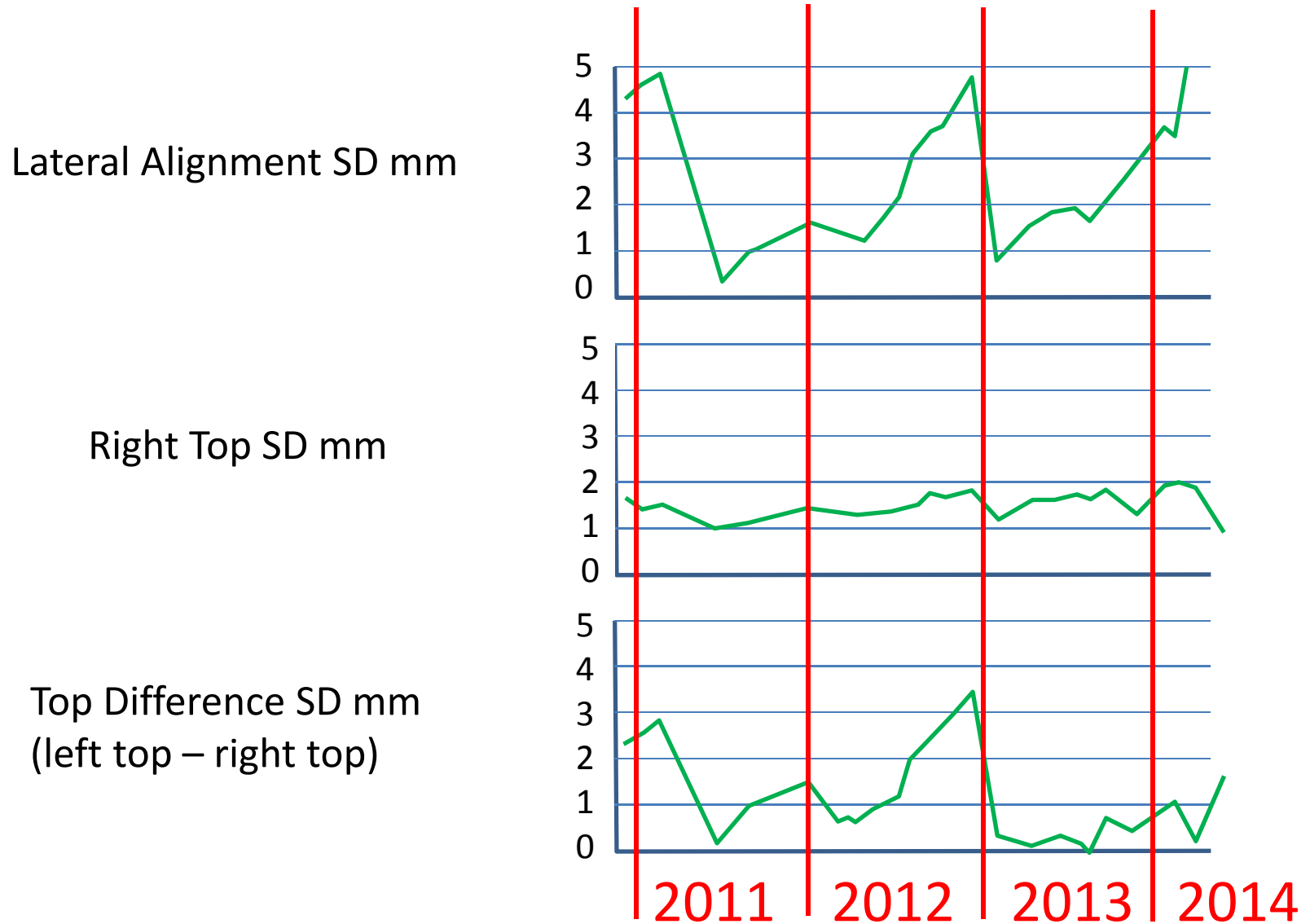


## Pilot Study - Data Collection

- Midland Main Line SPC1 38mp to 48mp
- 4 Track Railway 2 outer tracks investigated
- 40 runs collected for each line, Nov 2010 to May 2014

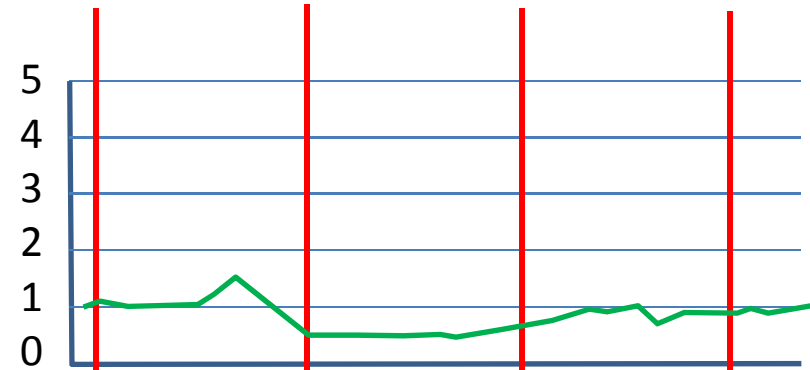


# Stewartby Way – Shoulder Earthwork Deformation



# Deeper rotational failure?

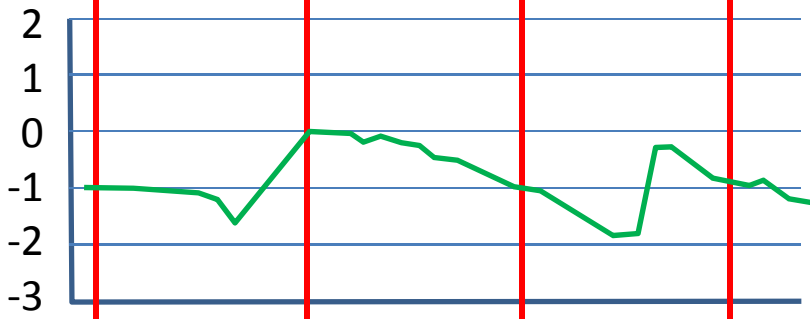
Lateral Alignment SD mm



Right Top SD mm



Top Difference SD mm  
(left top – right top)



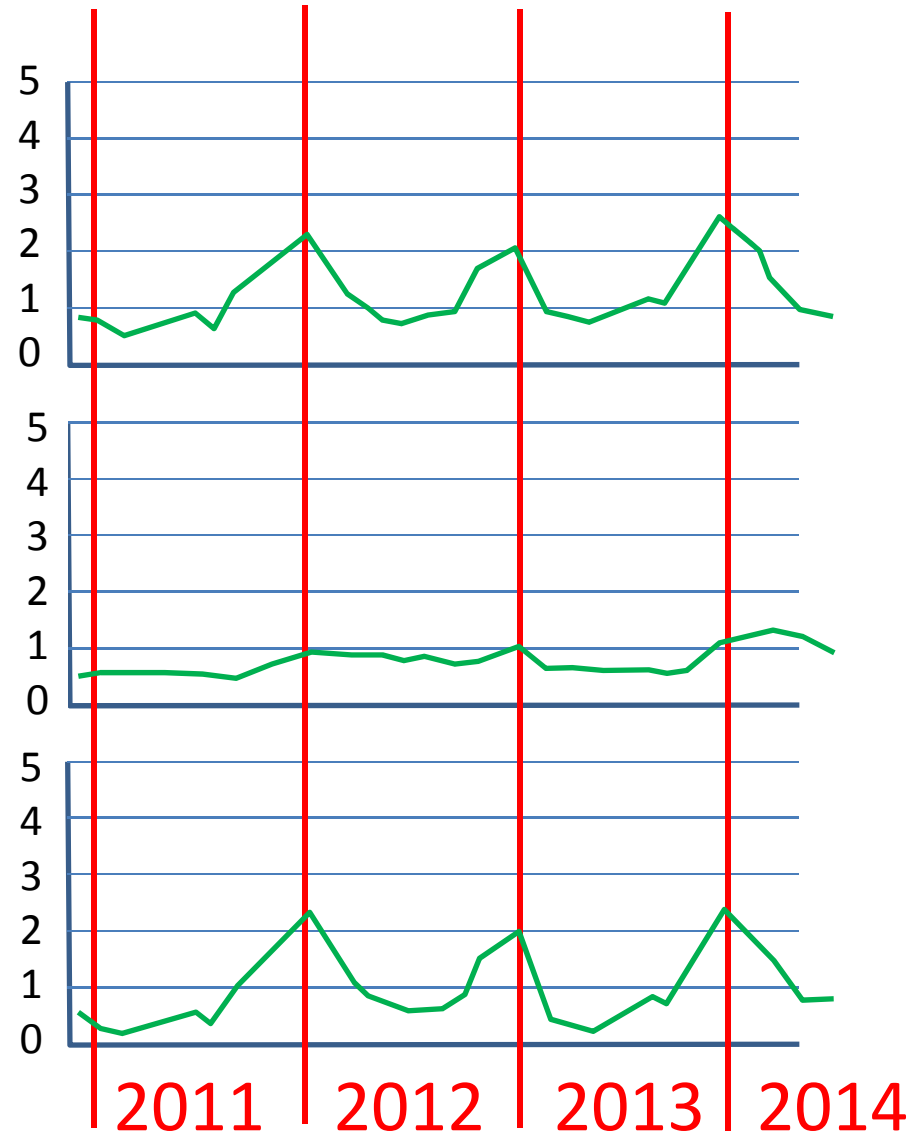
2011 | 2012 | 2013 | 2014

# Seasonal Behaviour - Evapotranspiration

Lateral Alignment SD mm

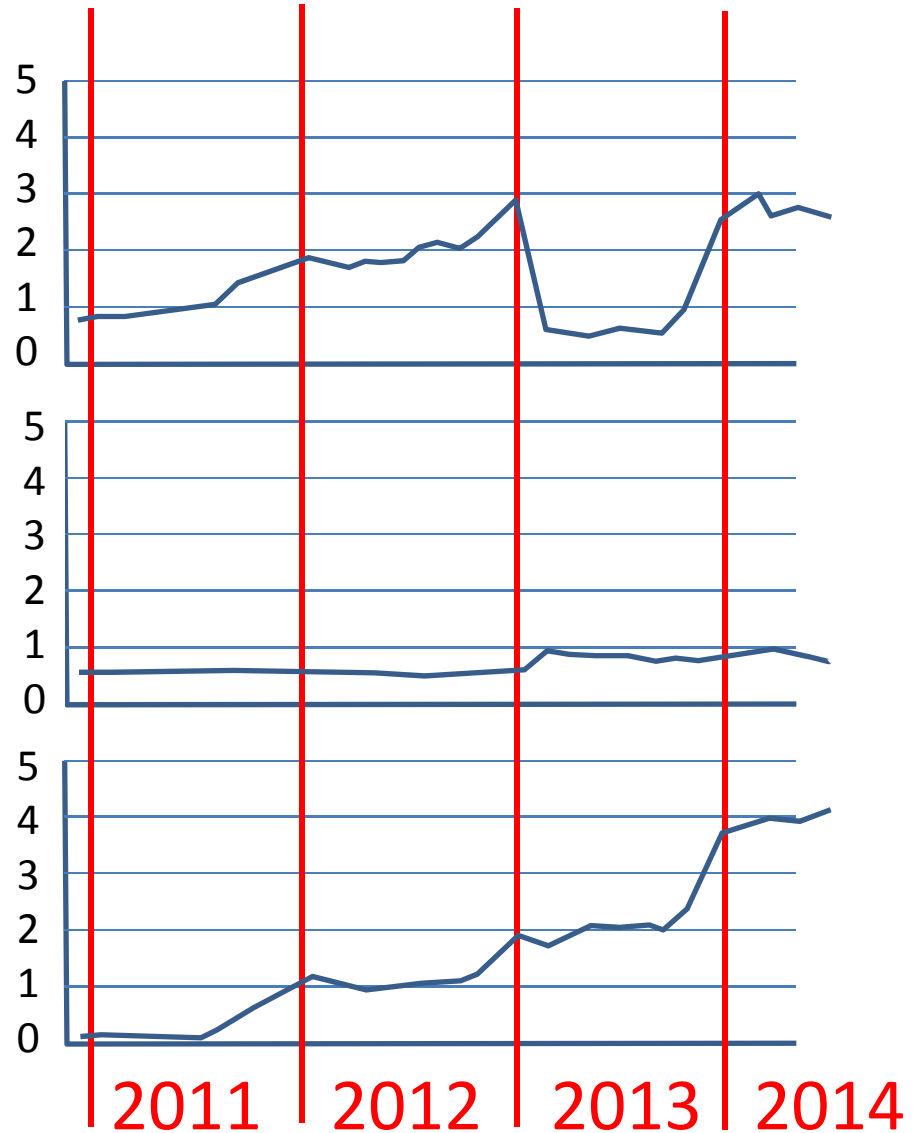
Right Top SD mm

Top Difference SD mm  
(left top – right top)



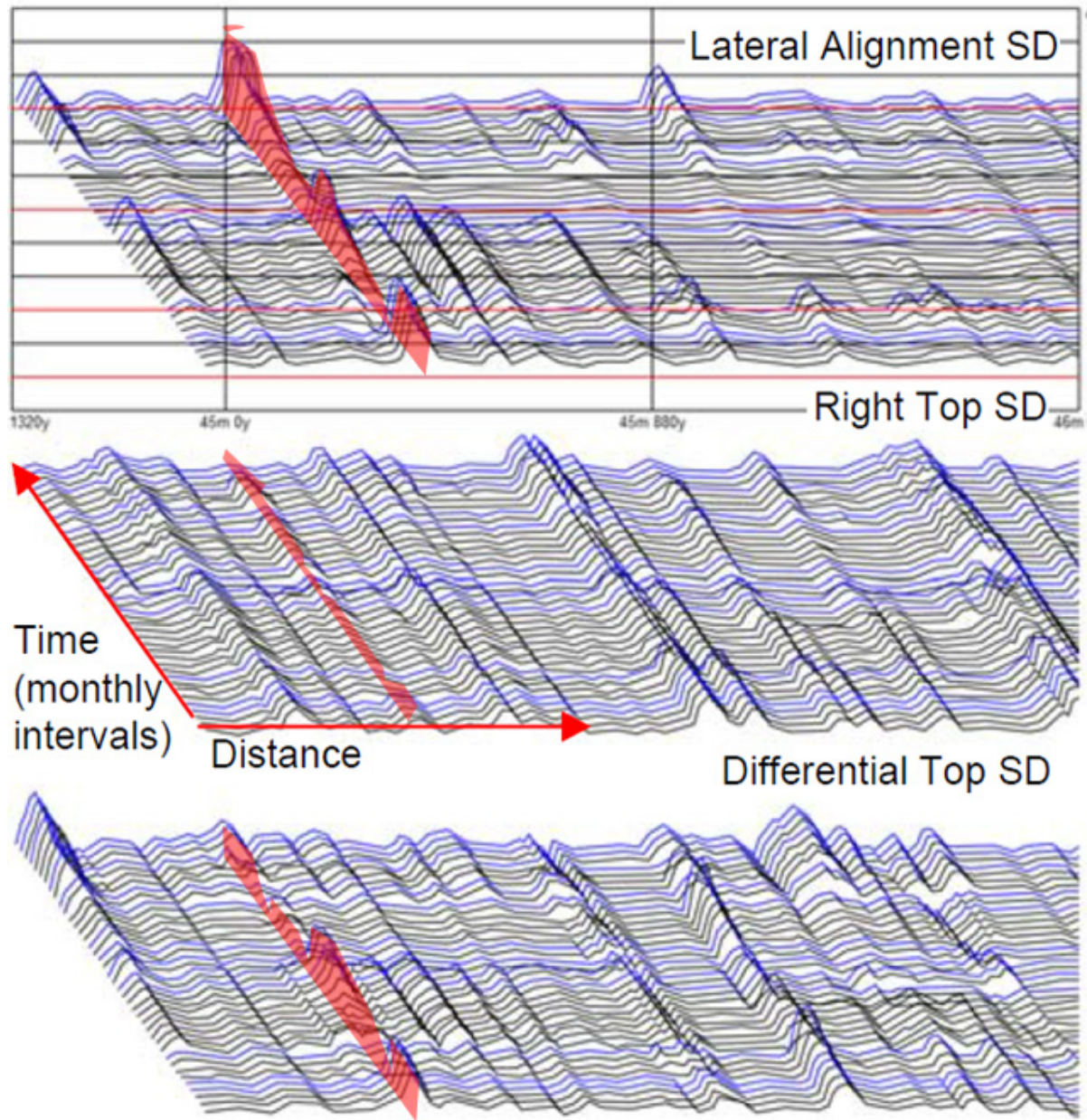
# Developing failure?

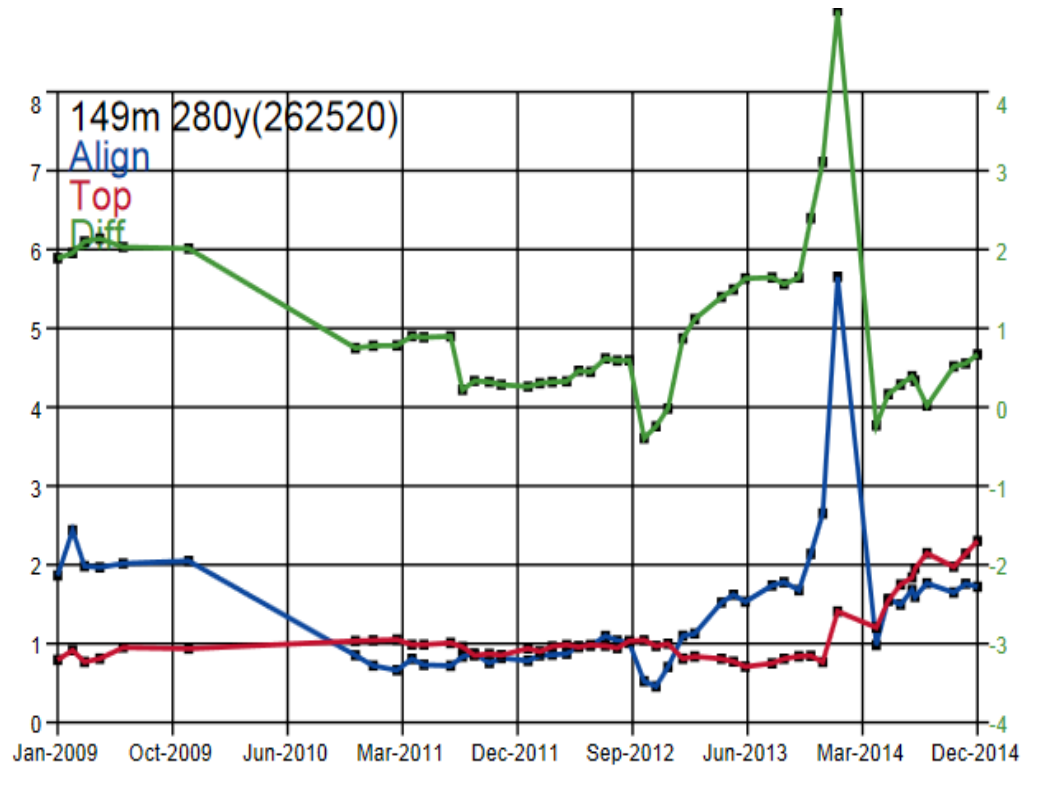
Lateral Alignment SD mm



Right Top SD mm

Top Difference SD mm  
(left top - right top)





Unstone Landslip



## *Characterisation of Behaviours*

Stable earthworks – regular deterioration pattern, no SD difference, no lateral movement

Shoulder earthwork deformation – Increase in Lateral SD, Left Top SD > Right Top SD

Deeper rotational slip – Increase in Lateral SD, Left Top SD < Right Top SD

Seasonal behaviour – As for shoulder earthwork, but with some recovery during wet periods

## *Severity of deterioration/Risk of Failure in next five years.*

< 1mm SD Diff deterioration/annum			- Low Risk
1 < 2mm	“	“	- Moderate Risk
2 < 4mm	“	“	- High Risk
> 4mm	“	“	- Deemed to have failed

## *Conclusion*

- Analysis of track geometry data can help predict where earthwork failures might occur
- In many cases we can predict where failure is most likely to occur
- Deterioration characteristics indicate likely modes of failure





Thank You