Mitigating the risk from slopes lying outside the Network Rail boundary

Topics that the Presentation will cover

What brought the Project about?
What are the current NR Standards that relate to Outside Party Slopes?
How did we approached the problem?
What are the possible implications of fully implementing this project?
What are the types of landslide the NR asset is vulnerable to?
What are the susceptibility of areas to landslide?
What will this output look like?
What brought about this project?

“….In response to six landslips which occurred on Network Rail infrastructure between June 2012 and February 2013, the RAIB has undertaken a class investigation into earthwork issues related to land neighbouring the railway and to risk management during adverse weather…..”

“…. There is a lack of clarity about who should be carrying out visual checks for risks which can develop on neighbouring land between examinations which take place at intervals of up to ten years. The mandated process for collecting information about neighbouring land is, in parts, difficult to implement and not usually followed. Recent technological developments could offer means of improving the collection of this information…”

RAIB Report “Class investigation into landslips affecting Network Rail infrastructure between June 2012 and February 2013” published in April 2014
What brought about this project?

St Bees Derailment 30th August 2012

NR/L3/CIV/065 Examination of Earthworks

“…. This Standard covers all Earthworks within the Network Rail boundary, and where it is appropriate to do so, slopes outside the boundary that may affect Network Rail infrastructure…”

“…. This Standard applies to the following:

…. Outside Party Slopes (irrespective of their height) whose failure could pose an unacceptable risk to the safe operation or performance of railway infrastructure (Section 4.1 only applies). If application of this Standard is not appropriate to such slopes then a suitable bespoke system should be adopted to manage the risk.”
NR/L3/CIV/065 Examination of Earthworks (con’t)

“….For Outside Party Slopes where there is evidence or concern that the failure of the slope presents an unacceptable risk to the safe operation or performance of the railway the procedures described in NR/L2/CIV/086: Management of Earthworks relating to Outside Party Slopes shall be adopted, so far as reasonably practicable….”

“….Where the Outside Party is unable to provide a satisfactory management policy for the slope, or demonstrate by other means that it is being managed in a satisfactory manner, the slope shall, so far as is lawful, be subject to a Cyclical Examination…."

NR/L2/CIV/086 Management of Earthworks

“….The following requirements shall apply, so far as reasonably practicable, to Outside Party Slopes where there is evidence or concern that the Failure of the Slope presents an unacceptable risk to the safe operation or performance of the railway:

a) the location, identity and owner (including emergency contact details) of the Slope (where they can be ascertained),
b) the location of safety related records of the Slope shall be established (where reasonably practicable),
c) details of the management policy for the Slope shall be sought from its owner (where reasonably practicable),
d) the management policy shall be reviewed to determine whether or not it satisfies the principles of this Standard in respect of the safety and performance of railway operations. A Slope managed in accordance with current Highway Agency Standards shall be considered to satisfy these requirements….“
NR/L2/CIV/086 Management of Earthworks (con’t.)

“…. Details of the management policy for the Slope shall be documented and recorded for the life of the Slope.

Where the owner is unable to provide a satisfactory management policy for the Slope, or demonstrate by other means that it is being managed in a satisfactory manner, the Slope shall, so far as is lawful, be subject to a Cyclical Examination.

The owner of the Slope shall be advised of any Significant defects noted during an Examination, or brought to notice by any other means, and shall be requested to provide proposals to Network Rail for rectifying these defects.

Where necessary, mitigation measures shall be taken so that there is no unacceptable risk to the safe operation or performance of railway infrastructure....”

RAIB Recommendation

“…. Network Rail should review and improve its processes for managing earthworks related risk arising from neighbouring land, including associated drainage issues. This should provide a documented process which takes account of the extent to which it is practical and proportionate for Network Rail to review and/or rely on land management activities undertaken by neighbours....”

RAIB Report “Class investigation into landslips affecting Network Rail infrastructure between June 2012 and February 2013” published in April 2014
How we approached the problem

- The extent of Outside Party Slopes (OPSs) is likely to be significant, many of which will be difficult to access and inspect.
- The identification of OPSs which do present ‘...an unacceptable risk to the safe operation or performance of the railway...’ will require considerable resource and time.
- Only when an unacceptable OPS has been identified can the work required to gather the data required by NR’s Management of Earthworks (NR/L2/CIV/086) begin.
- To enable the requirements of the Management of Earthworks (NR/L2/CIV/086) to be achieved in a logical and defensible manner, an initial sift of such OPSs along the rail corridor is recommended to enable the initial resources to be focused on the OPSs of most concern.
- Such a sift could be undertaken using a landslide zoning methodology based on Geographic Information System (GIS) techniques and historical landslide inventories.

Possible implications?

- What is the size of the challenge that NR face?
- What are the legal ramifications for possible land value and any ongoing liabilities presented to third party landowners who may disagree with our assessment?
- Are NR funded to deal with such issues on third party land?
- Will changes made by third parties to their land that may affect the railway need to be managed by NR?
- Are the datasets available of such granularity that potential changes can be assessed and managed?
- What can be considered to be “…where reasonably practicable…?”
Types of Landslides Above Rail Infrastructure

Rotational Landslides

Folkestone Warren (1915)

Hatfield (2013)
Translational Landslides

Harbury (2015)

Chipping Sodbury (2008)

Earth Flows

Nethertown (2012)

Teignmouth 2012
Rock Falls

Landslide Susceptibility
Landslide Susceptibility
Network Rail Project

- Coffey and BGS are working together to utilise and develop GIS layers for different types of landslides which may occur along the LNW route.
- We are using the existing BGS GeoSure and Debris Flow layers and developing layers for Rock Falls and Earth Flows.
- These layers will be used within a scoring system to determine the landslide susceptibility rating of a particular area (area will be determined by catchment as below).

Figure shows an example location of the LNW route and the catchments along it.

Landslide Susceptibility
GeoSure

- GeoSure is BGS’s current GIS assessment of landslide hazard for the British Mainland.
- The GeoSure methodology was developed using expert judgement to assess and classify the hazard, and determine the likely causative factors of landsliding.
- The approach within GeoSure assesses the presence of the causative factors, giving each one a rating according to their relative importance in causing slope instability.
- After several iterations, three key factors were used - slope, geology and bedrock discontinuities.
**Landslide Susceptibility**

**GeoSure**

Site at Kitson Woods (near Todmorden)

GeoSure indicates high landslide susceptibility. Evidence on site of large historic failures and on-going slope instability.

**Landslide Susceptibility**

**Debris Flow**

BGS, in collaboration with the Transport Research Laboratory (TRL), created a Debris Flow GIS layer based upon the principles of GeoSure which considered the following 5 components:

- Availability of debris material
- Hydrogeological conditions
- Land use
- Proximity of stream channels
- Slope angle
Debris Flow layer indicates high debris flow susceptibility. Evidence on site of debris flows occurring in gully sides and on open hill slopes.

Two options for rock fall susceptibility have been produced using a combination of 3 factors:

- **Option 1**
  - Areas of moderate strength rock and above.
  - Slopes angles greater than or equal to 35°.
- **Option 2**
  - Presence of Top of Cliff line OS ornamentation.

Using a combination of the options allows us to identify where rock may be present at surface.
**Landslide Susceptibility**

**Rock Fall**

Site at Fair Hill (near Todmorden)

On site it was observed that there are 15m high rock crags above the railway which have the potential for rock fall failures. These correlate with the areas highlighted by the GIS.

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**Earth Flow (in Tills)**

Coffey and BGS scored the Till deposit domain map with regards to slope angle and material susceptibility (based on previous earth flow failures and material type) to account for the Till's susceptibility to earth flow.

<table>
<thead>
<tr>
<th>Component</th>
<th>Score 1</th>
<th>Score 3</th>
<th>Score 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susceptibility</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Slope Angle</td>
<td>10-20°</td>
<td>&gt;35°</td>
<td>20-35°</td>
</tr>
</tbody>
</table>

Whilst it is understood that earth flows occur in materials other than tills, these will have been assessed as part of GeoSure.
Landslide Susceptibility
Earth Flow

Site at Nethertown

The Earth Flow layer has correctly identified the areas which slipped in the Nethertown landslide and further down the coast at Coulderton.

Outputs

- Each catchment will be given a score and these will correlate with a susceptibility class.

<table>
<thead>
<tr>
<th>Total Class</th>
<th>Susceptibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low</td>
</tr>
<tr>
<td>2</td>
<td>Low to Moderate</td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td>4</td>
<td>High</td>
</tr>
<tr>
<td>5</td>
<td>Very High</td>
</tr>
</tbody>
</table>

- The Network Rail 5 chain lengths will overlay the catchments so each 5 chain length will also have a susceptibility class.
- All the layers along with the susceptibility scores will be viewable within Network Rail’s Geo-RIMN system.
Further Work

- The current project is solely based on susceptibility. Following this project further work can be undertaken focusing on hazard and risk assessment and risk management.

- A man made earthworks layer is being created as part of a different piece of work. It is anticipated that in future this can be assimilated into the scoring system for Network Rail.

Thank You

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