Development of a Global Stability and Resilience Appraisal for Network Rail earthwork assets

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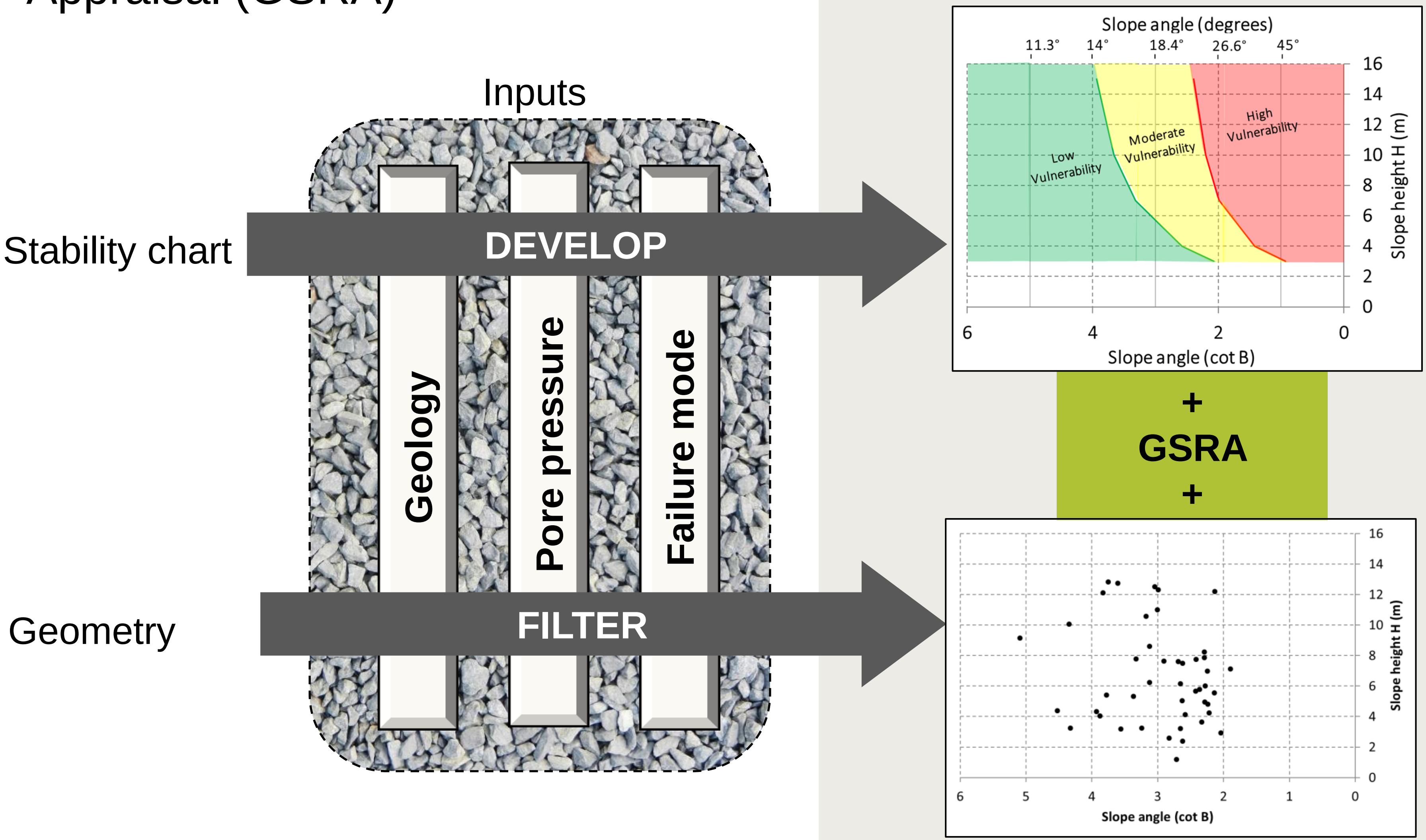
Introduction



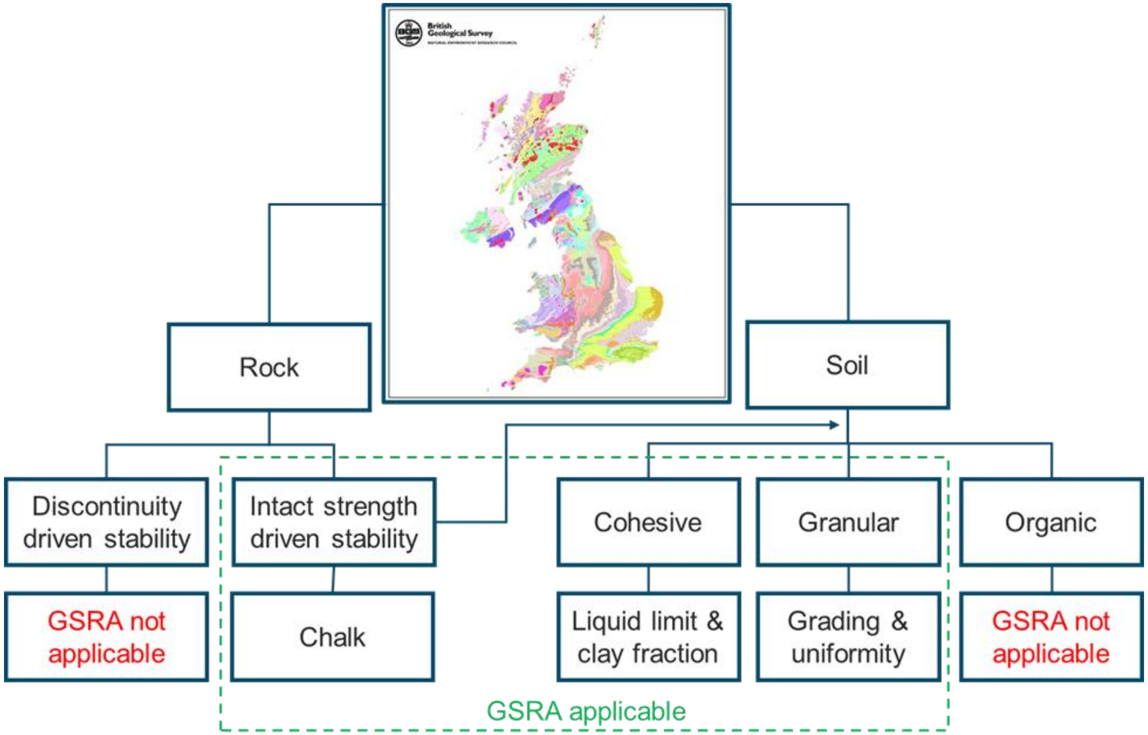



Global Stability and Resilience Appraisal (GSRA)

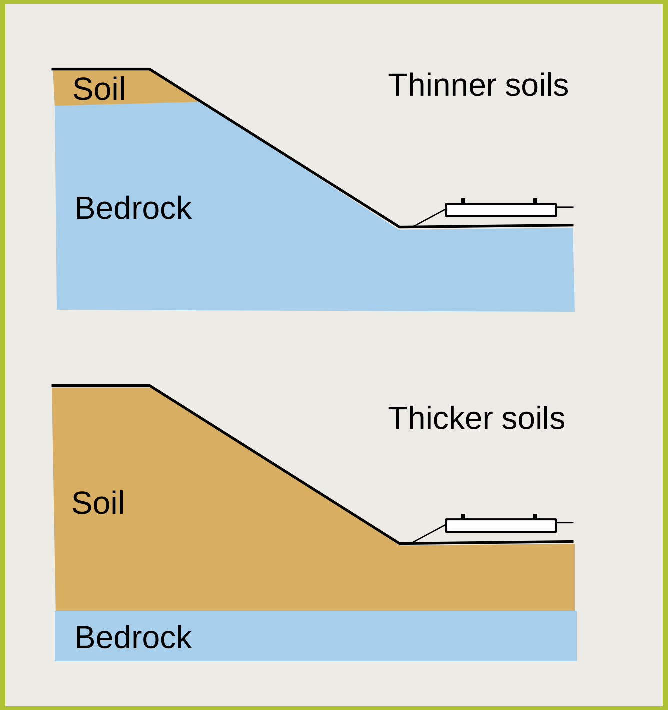


Inputs – earthwork geology

- GSRA uses BGS DigiMap 1:50k bedrock and soils mapping

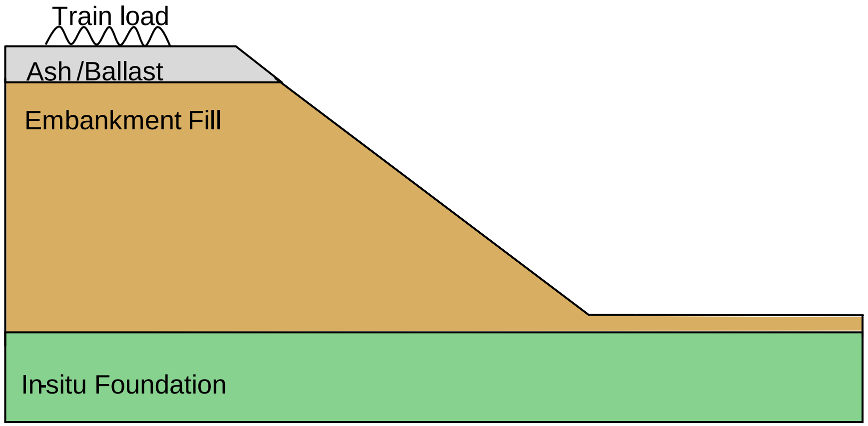


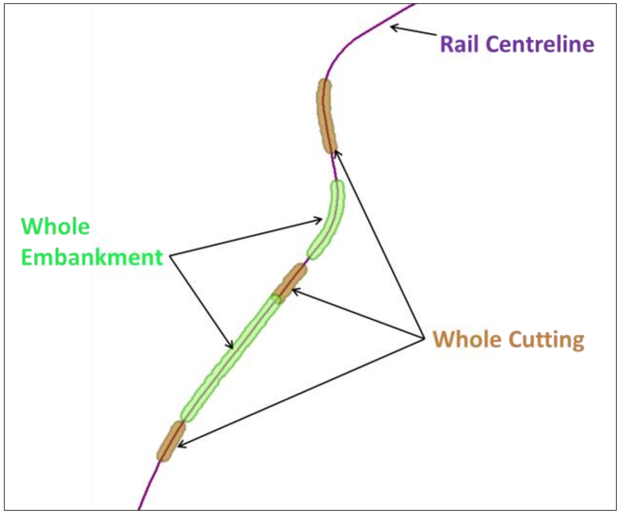
Also uses soil thickness from BGS Superficial Thickness Model

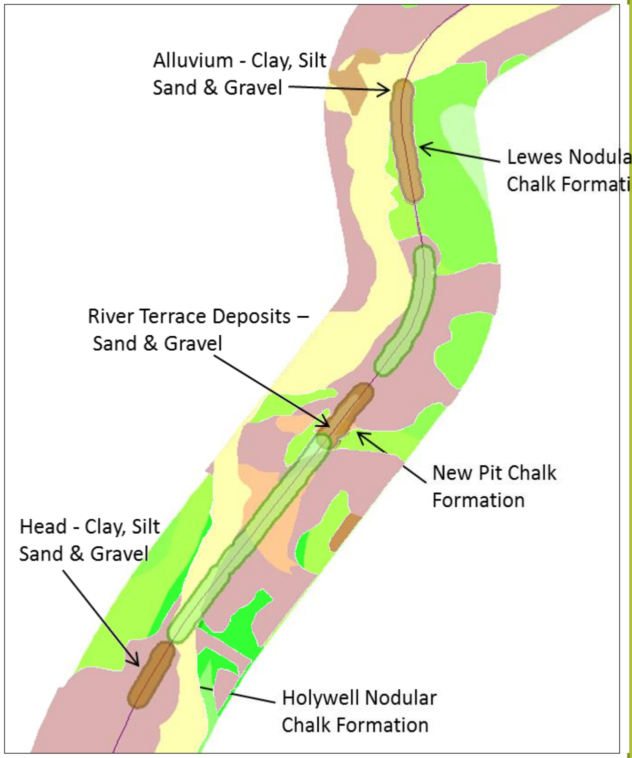


Inputs – earthwork geology

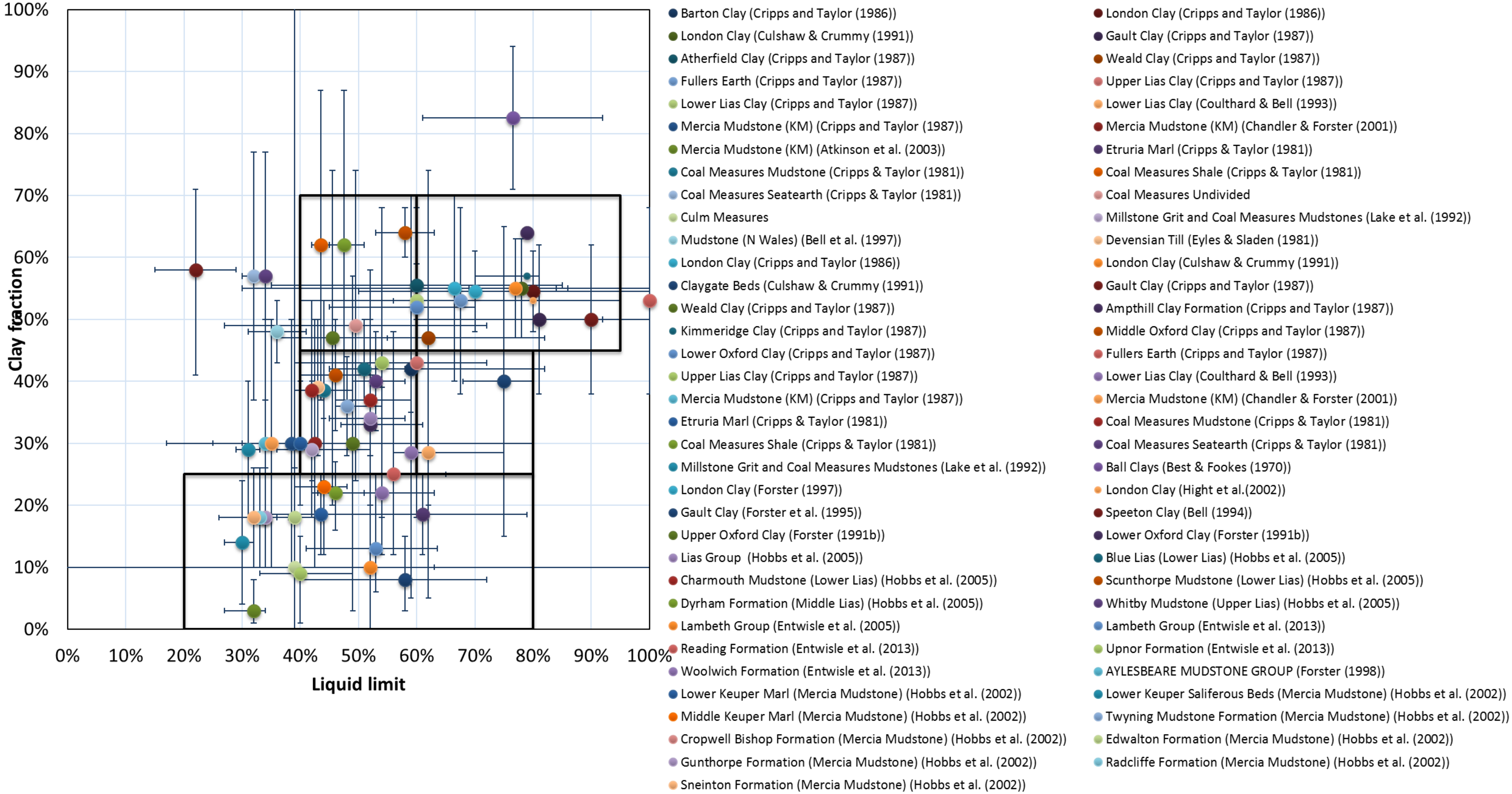
Embankments



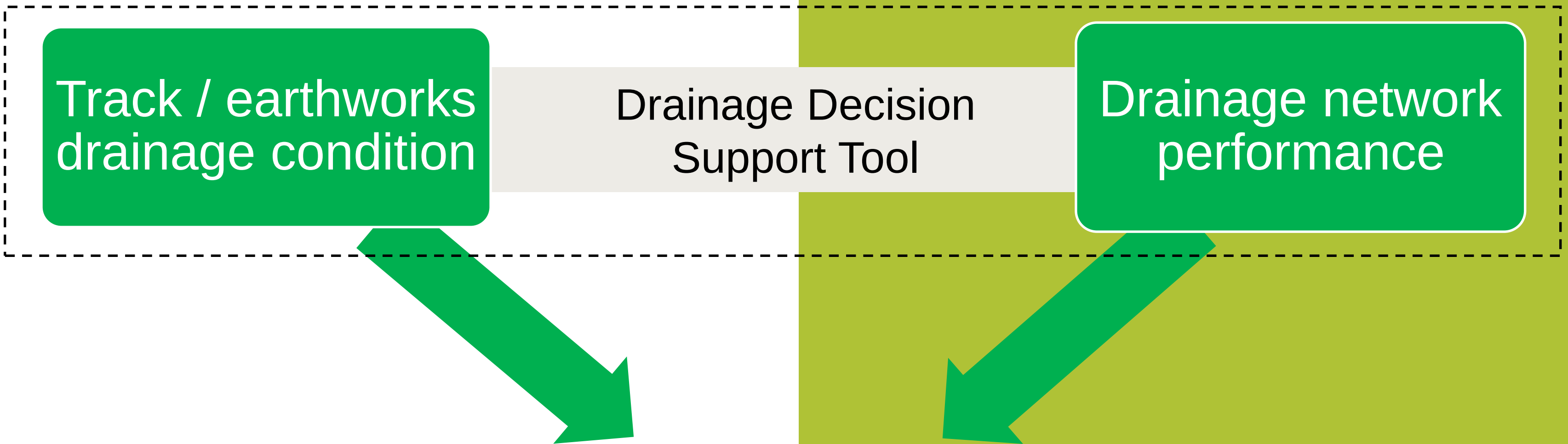




Inputs – Geological grouping

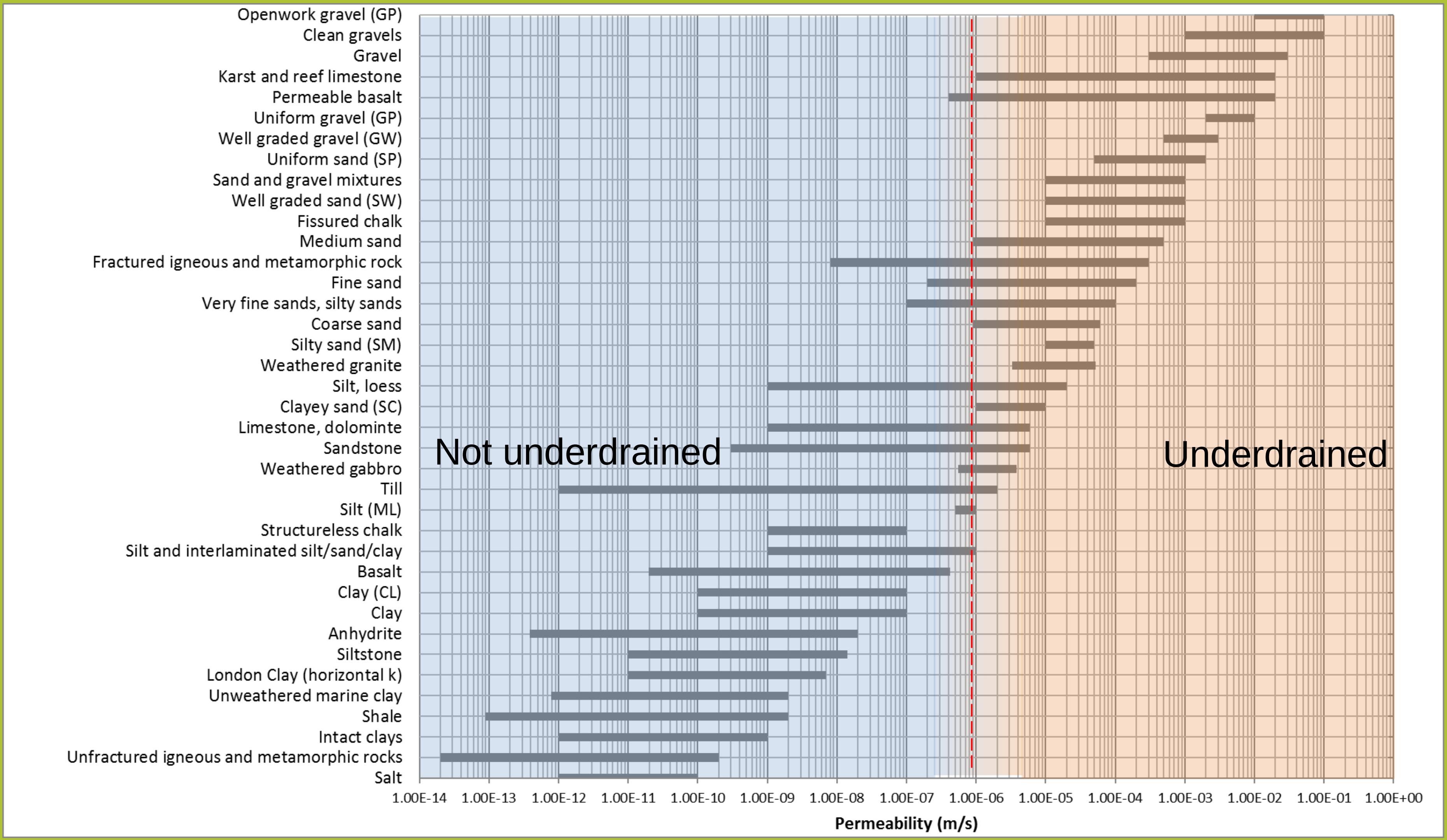


Inputs – pore pressure (cuttings)

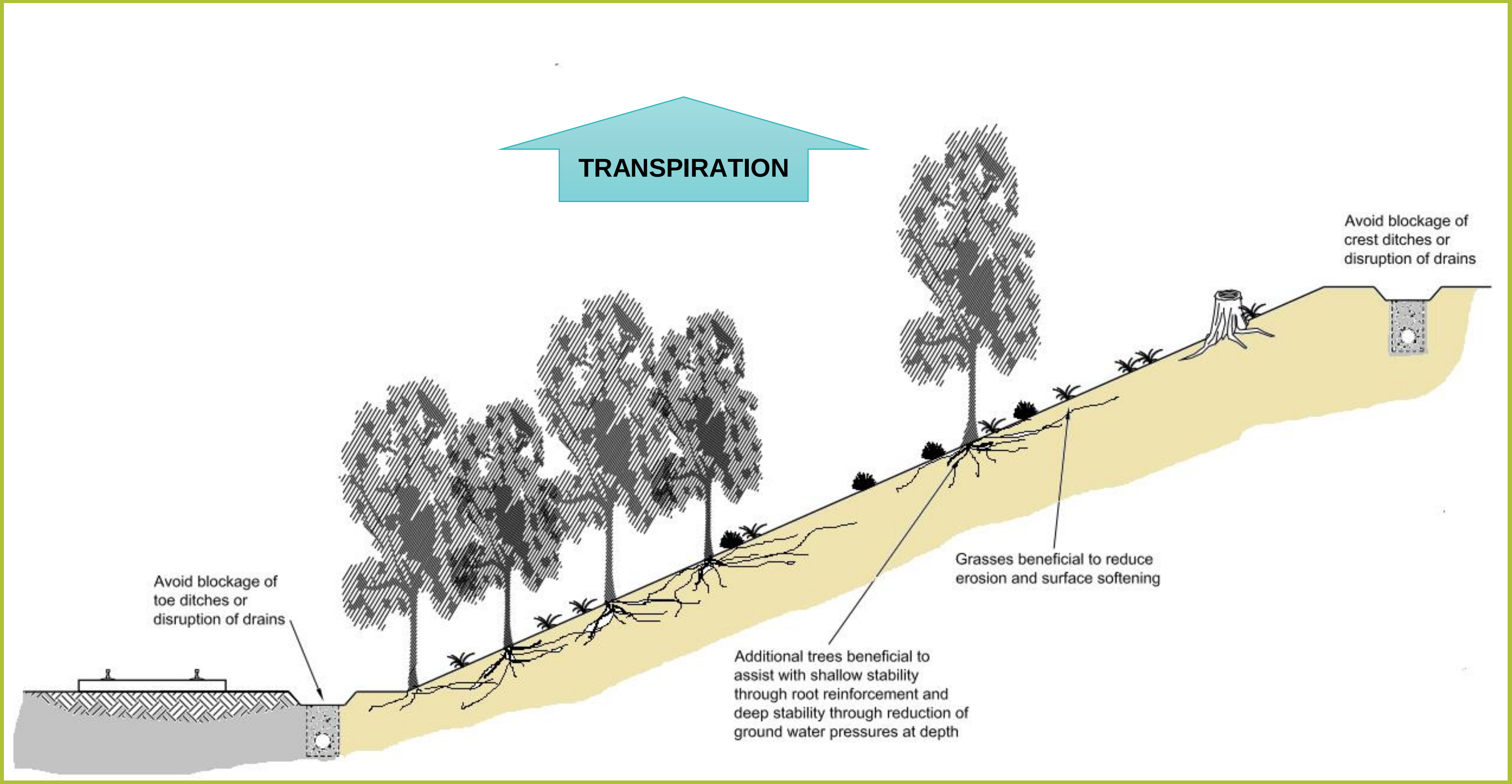


Drainage performance category	Track, earthworks or other asset condition (related to drainage)		
	Serviceable	Marginal	Poor
Serviceable	Lowest risk	Slight risk	High risk
Marginal	Slight risk	Moderate risk	High risk
Poor (including under capacity)	Moderate risk	High risk	Highest risk
Absent	Slight risk	Moderate risk	Highest risk

Inputs – pore pressure (embankments)

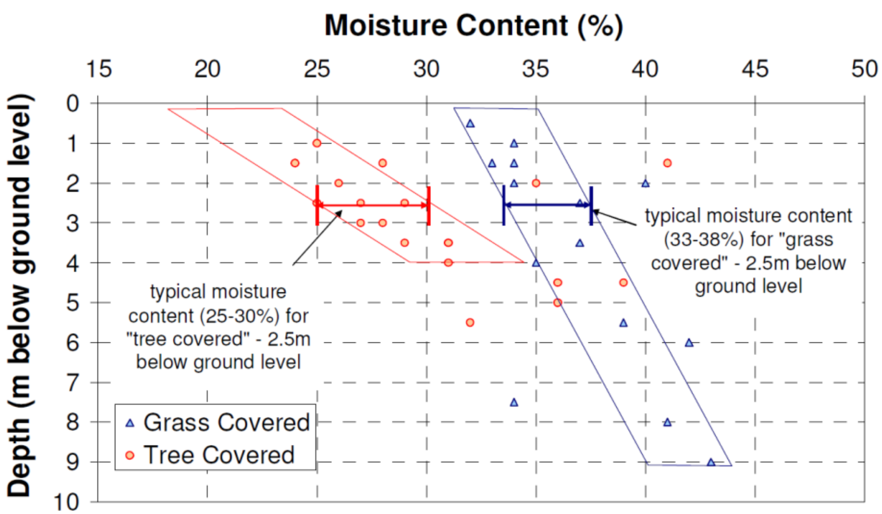


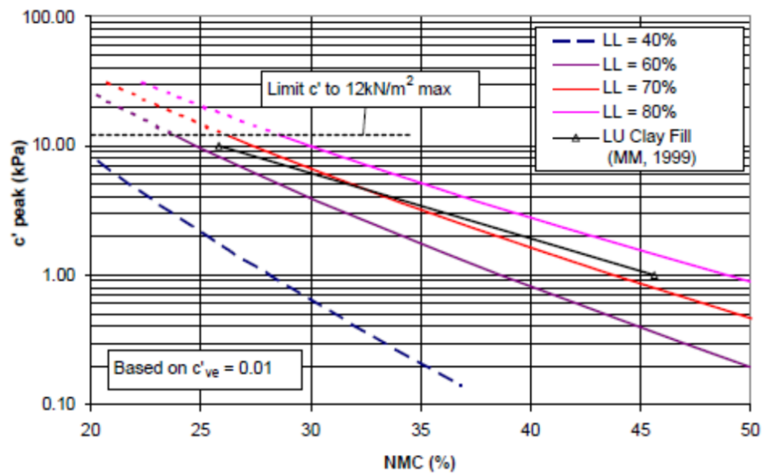
Inputs – pore pressure (vegetation)



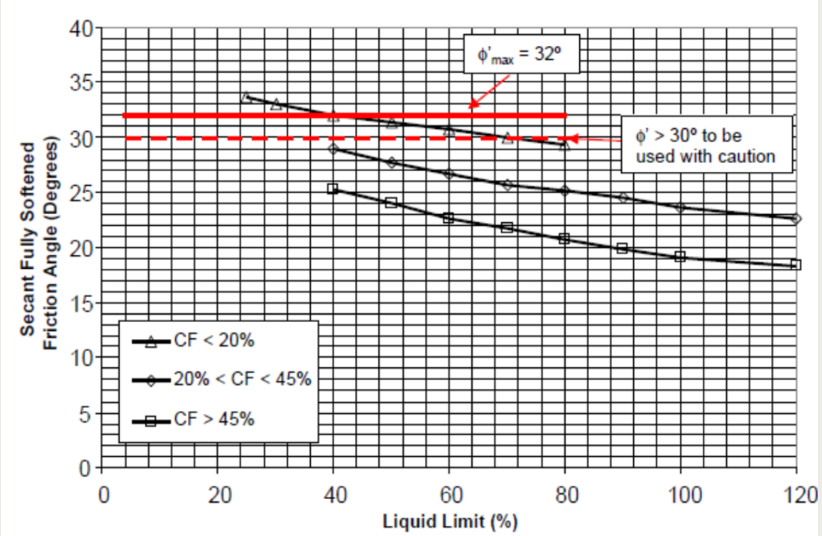
Analysis – derivation of parameters

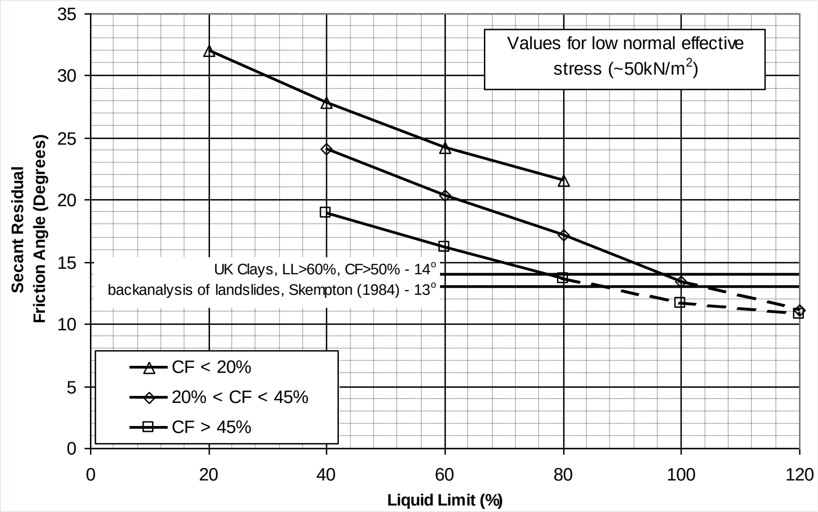
Cohesion – from m% and LL%



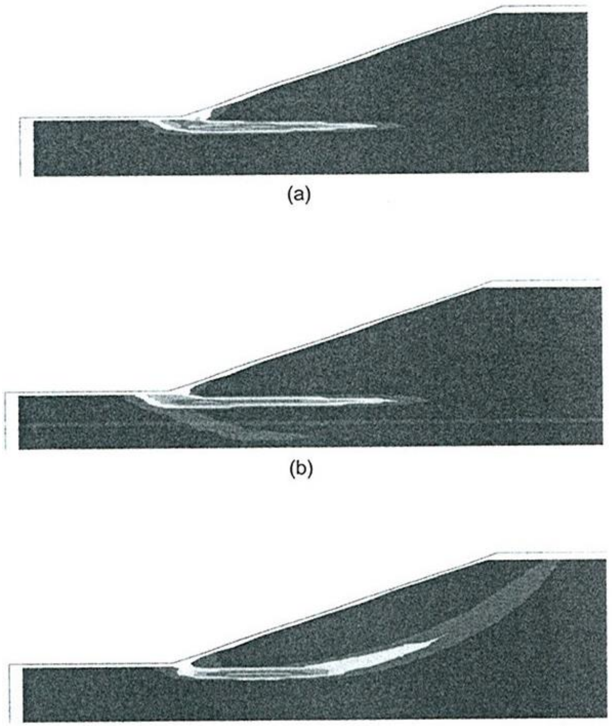


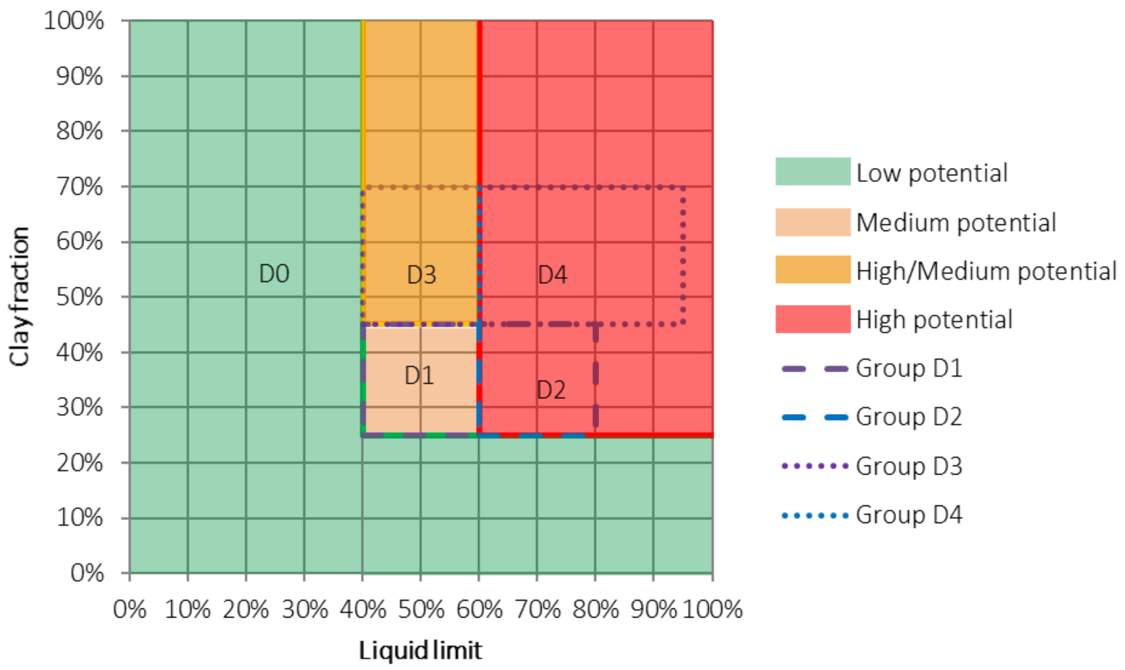
Friction Angle – from cF and LL%



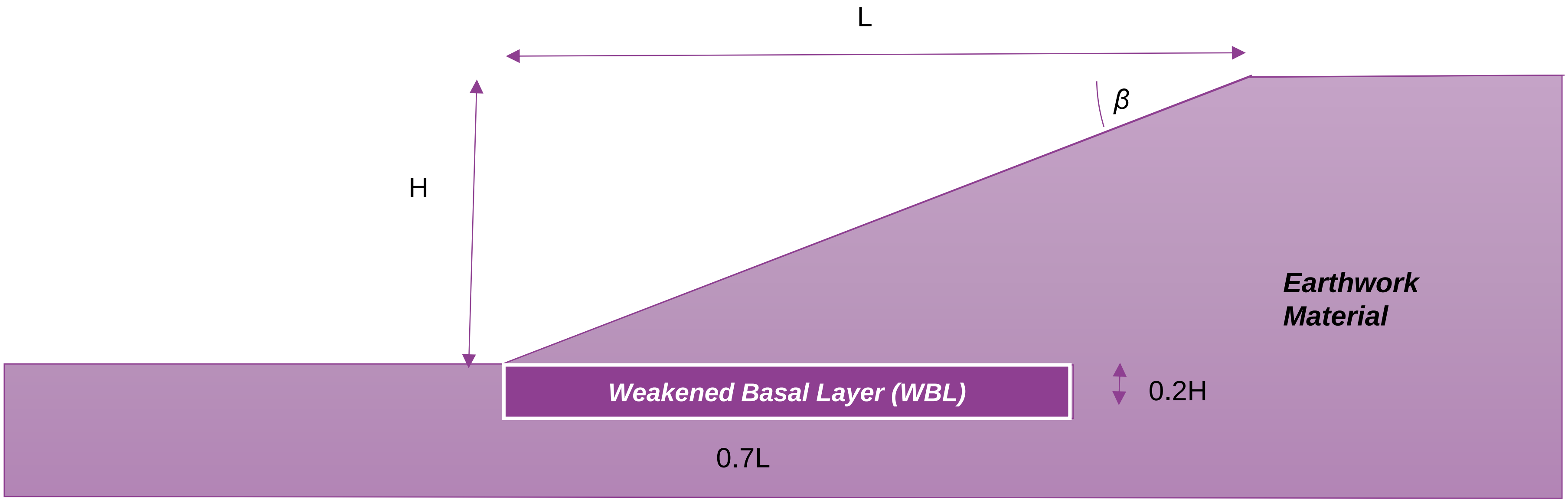


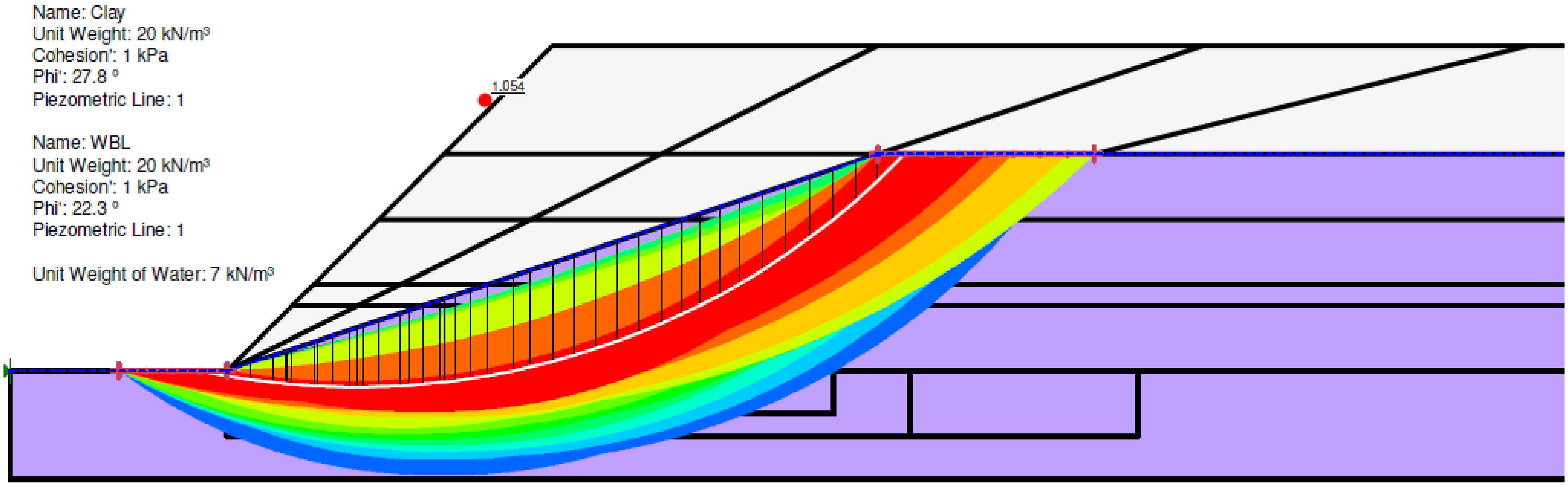
Analysis – progressive instability



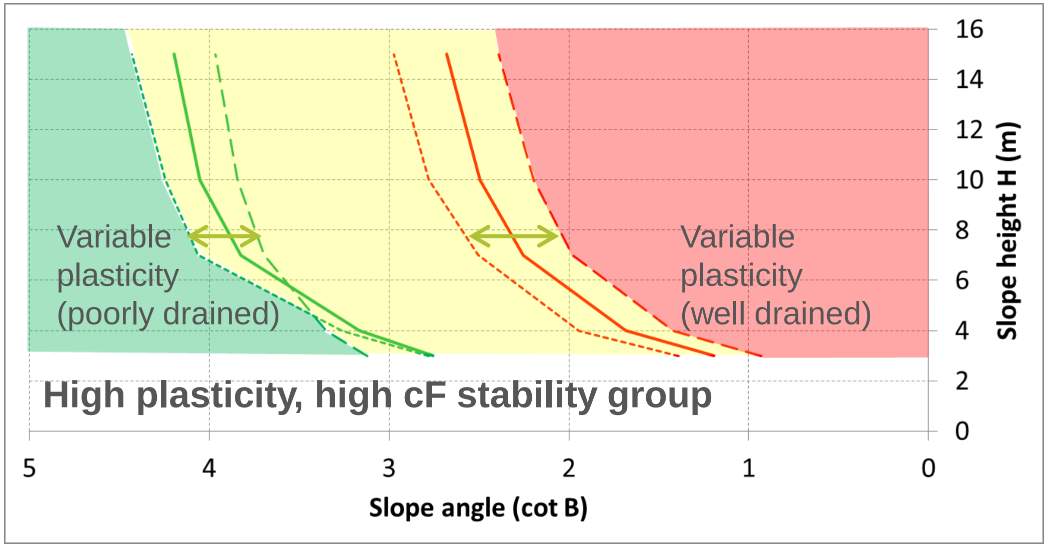


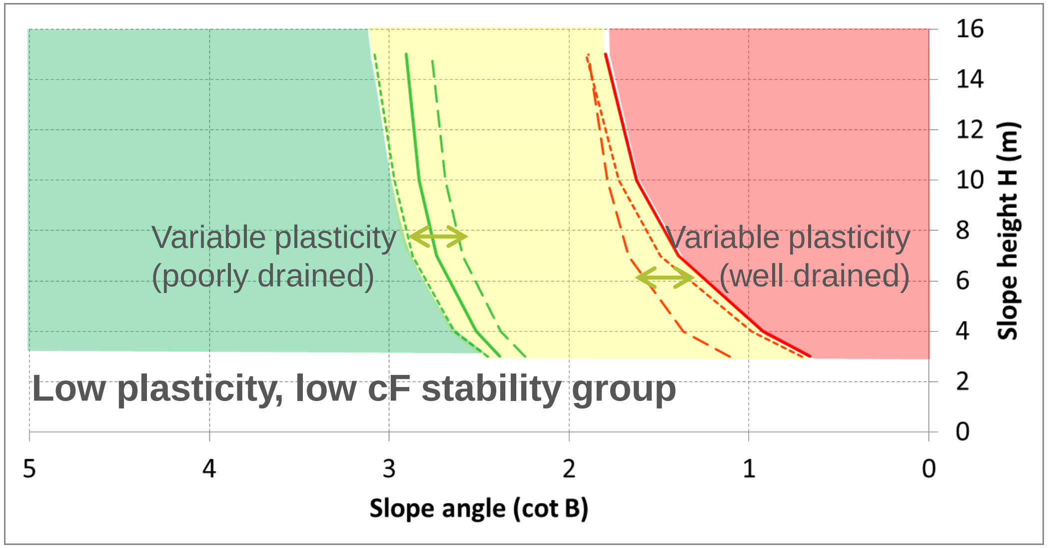
Analysis – Deep stability





Analysis – Deep stability





Each line on the chart reflects an analysis at FOS = 1;

- For a given earthwork type (embankment / cutting);
  - and a given stability group;
    - at a particular strength;
    - and a particular pore pressure.

Analysis parameters mutually supportive and consistent

Envelope is curved to reflect that stability depends on both height and angle

Analysis – Shallow stability

Infinite slope analysis

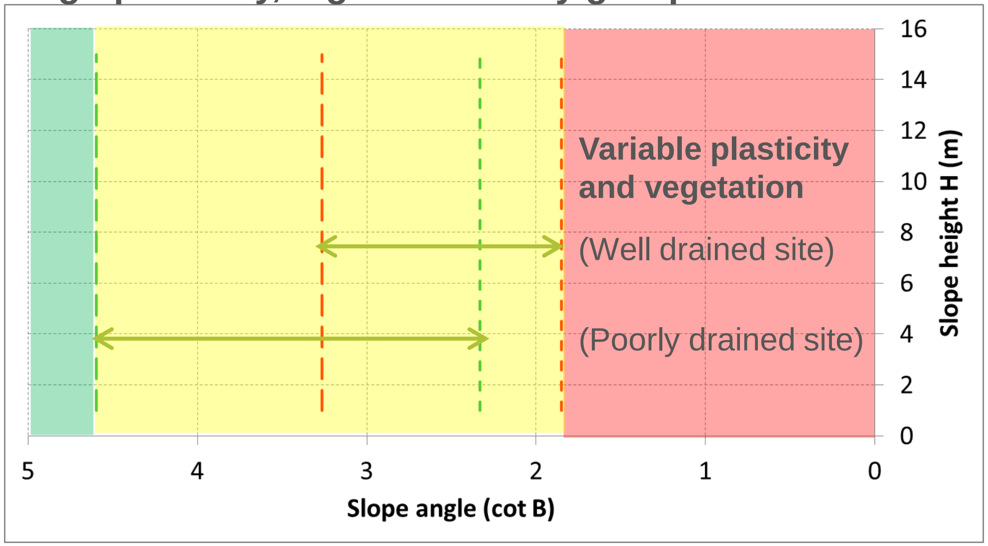
Based on similar material parameters to deep stability

Each line on the chart reflects an analysis at FOS = 1;

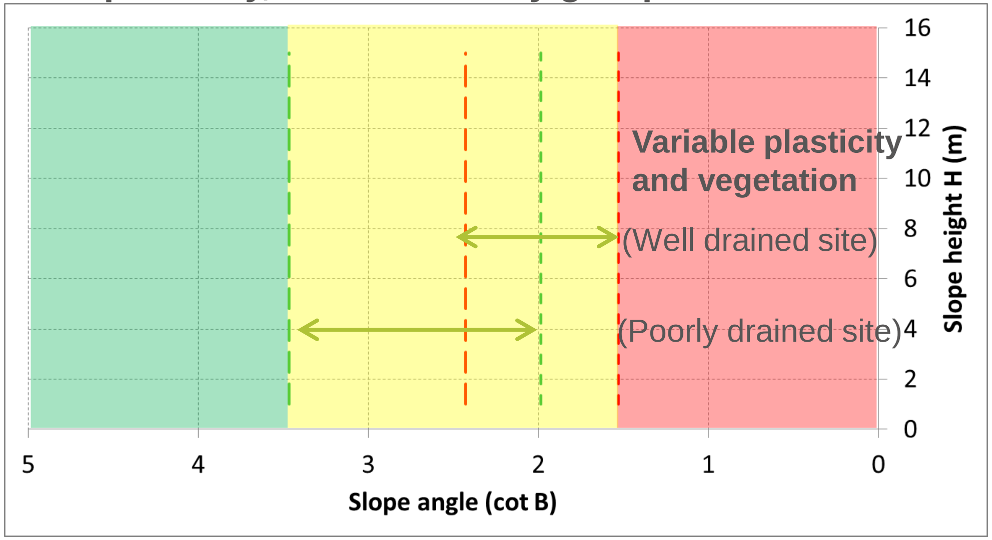
- For a given earthwork type;
  - And a given stability group;
    - Particular strength case; and
    - Particular pore pressure
    - Vegetation root cohesion.

Vertical to reflect that stability is dependent on angle only and irrespective of height

High plasticity, high cF stability group



Low plasticity, low cF stability group



Observation – Ravelling weak rock

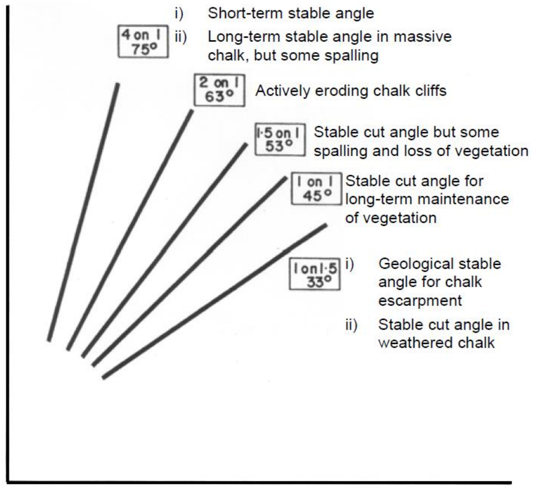
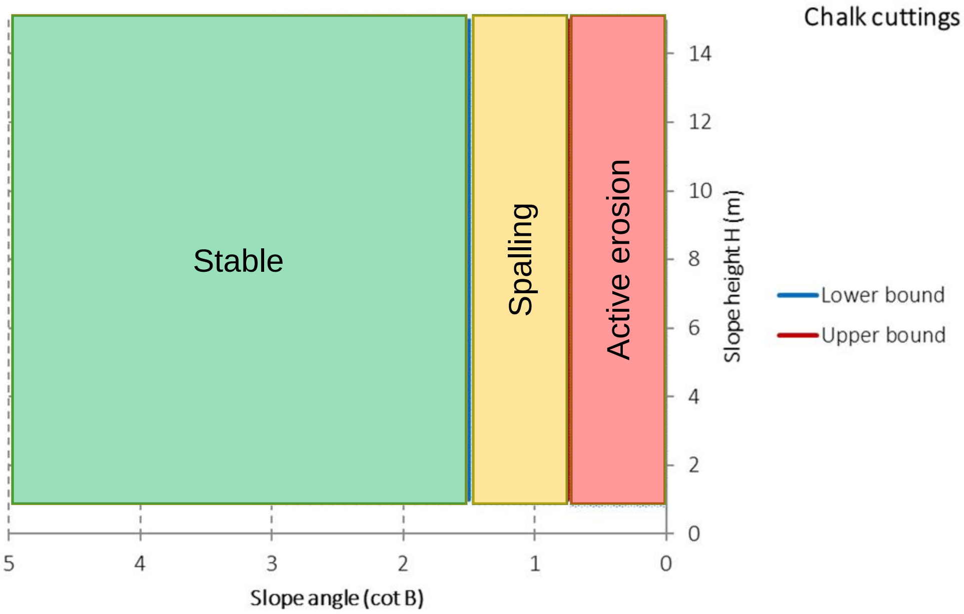


Figure 6.2 *Performance of chalk slopes in southern England (after Williams, 1990)*



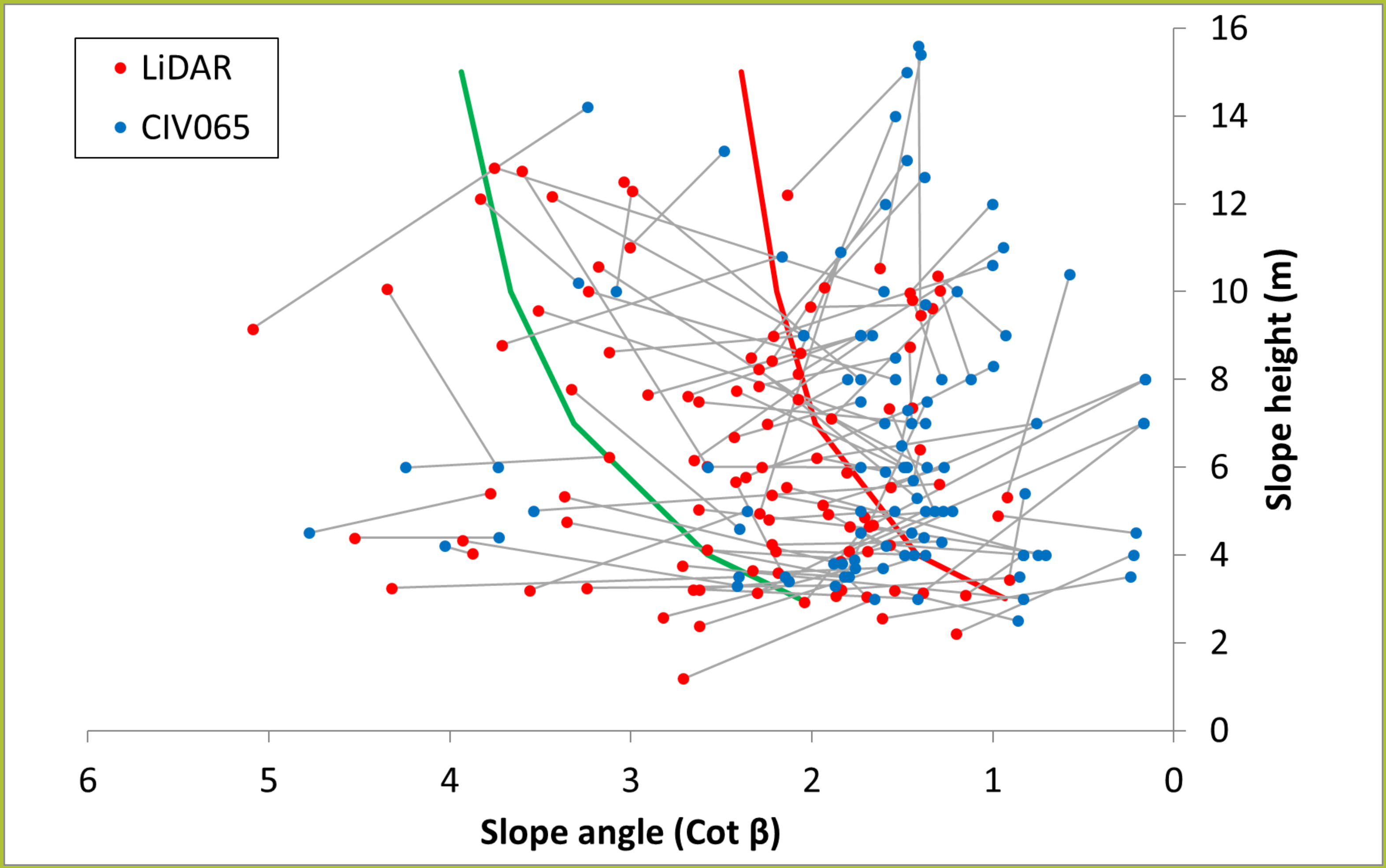
Empirical observation rather than from analytical design

Based on relationships for Chalk – weakest and therefore endpoint for similar weak rock materials

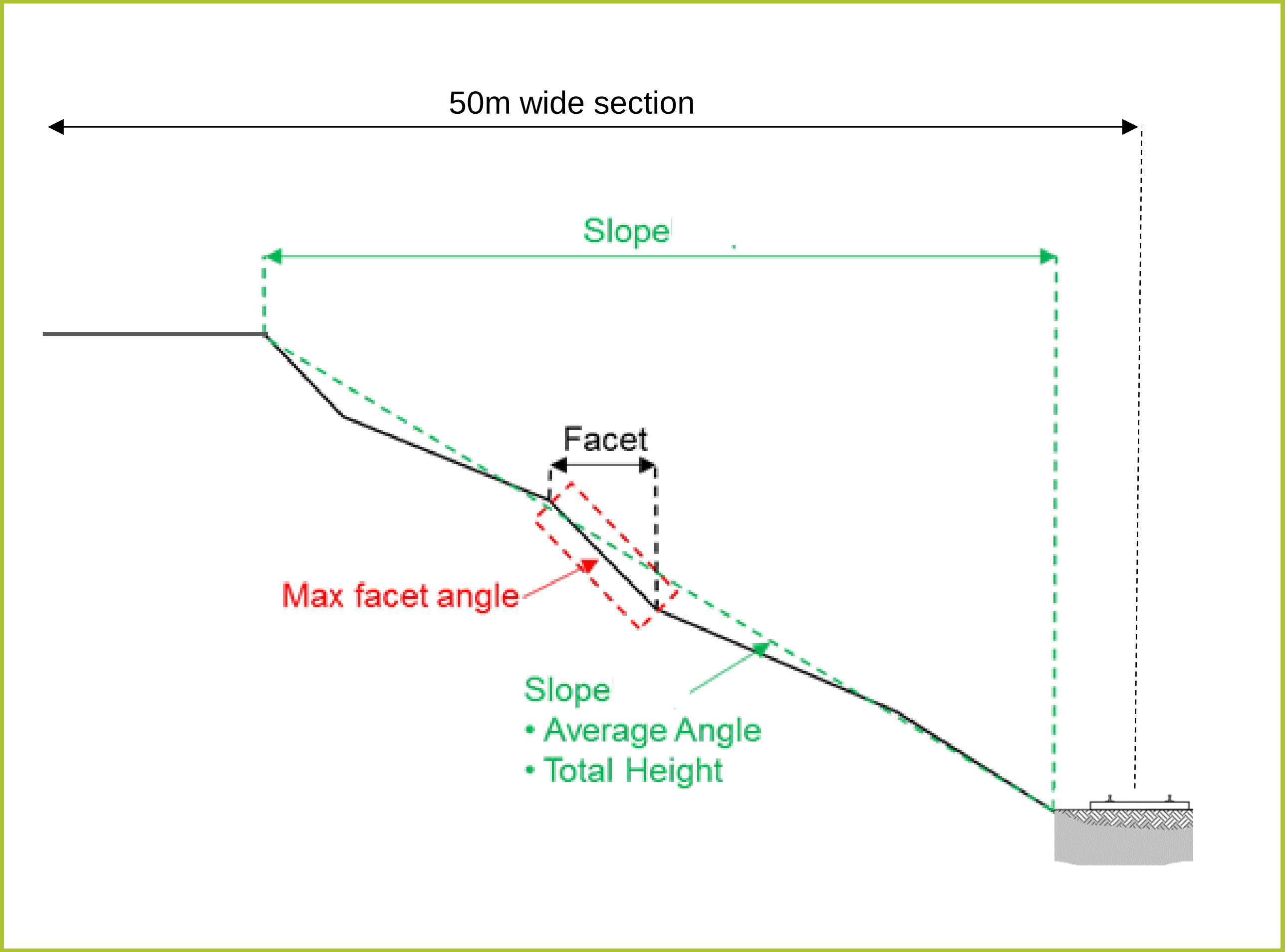
Recommendations attributed to vulnerability zone

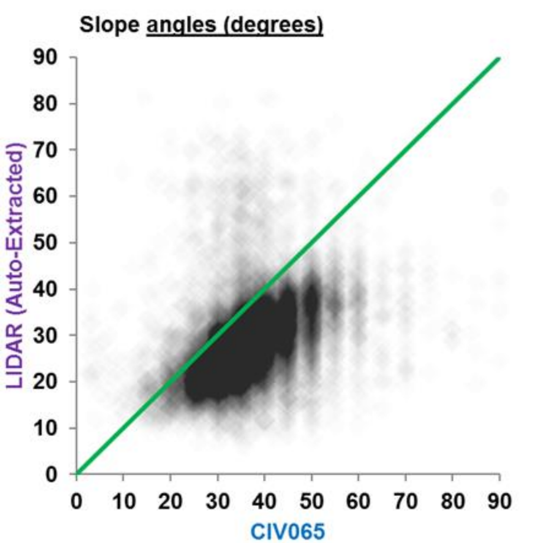
Vertical to reflect that stability is dependent on angle only and irrespective of height

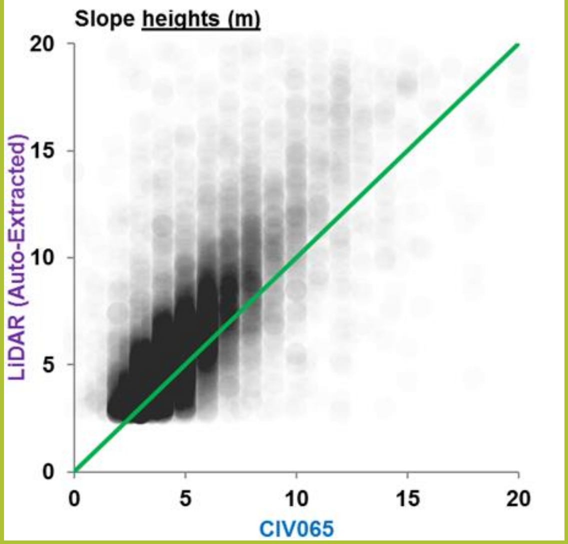
Inputs – earthwork geometry



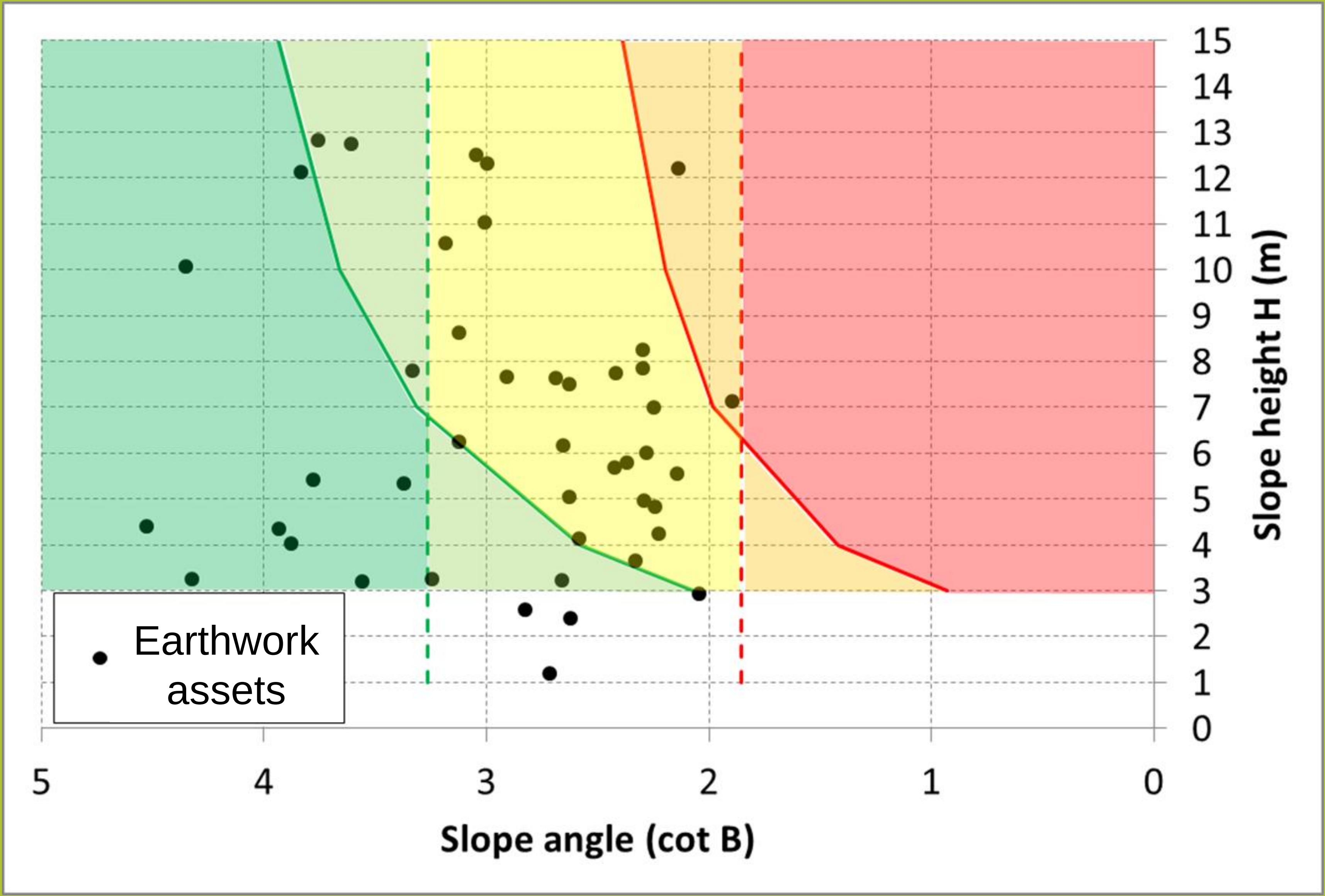
Inputs – earthwork geometry



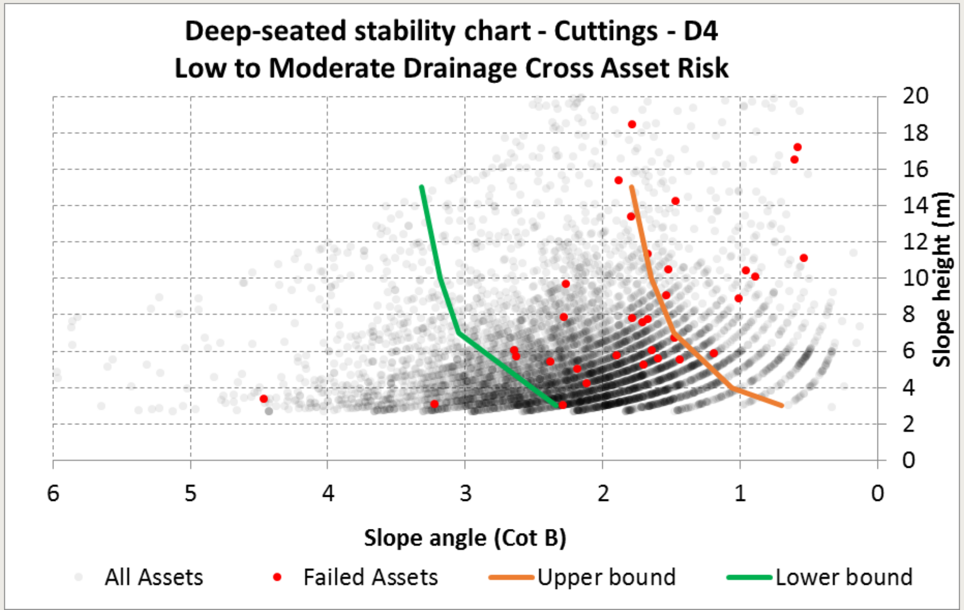


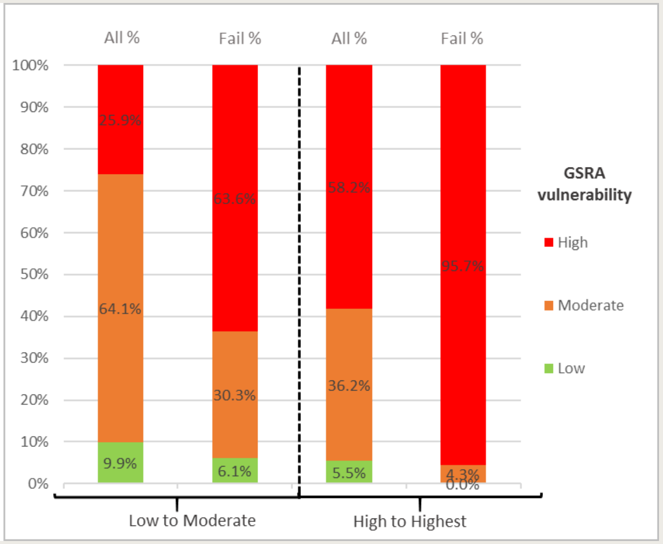


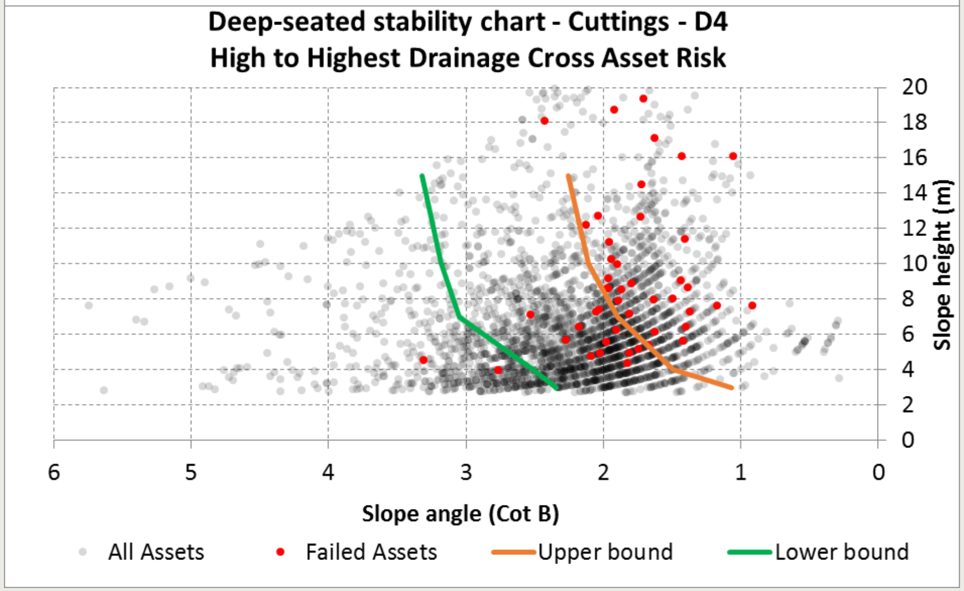
Results – combined

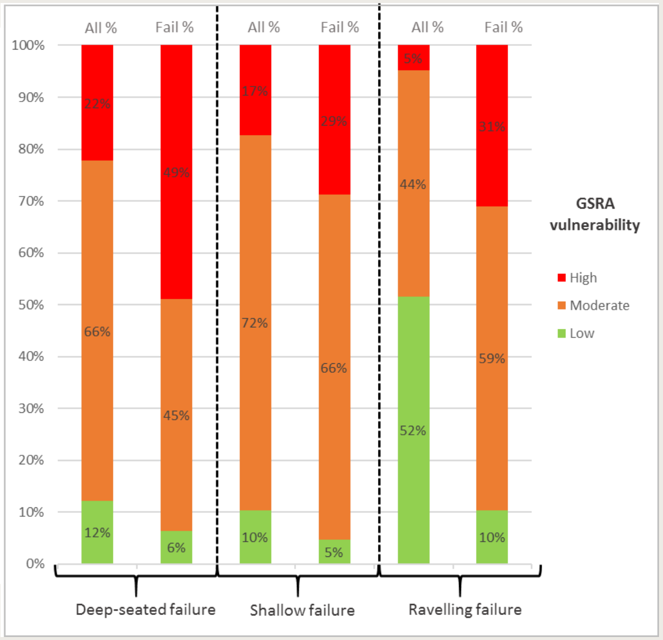


Results - Visualisation









Summary

Global Stability and Resilience Appraisal

- GSRA has for the first time quantified the vulnerability of Network Rail's legacy earthwork assets;
- Based on soil engineering principals, knowledge of the asset base and published information;
- Further work will be required to incorporate GSRA into the existing processes for management of the earthworks asset.

Thank you