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Peat Stability – Risk and Hazard Assessment

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What goes into a Peat Stability Risk Assessment?

You will need:

- An understanding of what peat is – it is not an engineering soil
- How it is formed, and
- What are the influences on Peat stability?

The big question

Can we determine the shear strength of peat with any certainty?

You may consider:

- Assume very weak peat throughout
- Avoid quoting specific factors of safety for slope stability
- Assess the potential for instability by looking at the field indicators

What does Peat instability look like?

Typical of what might be expected when working on peat.

This is a bearing capacity failure not slope instability

Derrybrien Peat Slide Oct 2003

- Volume – certainly in excess of 200,000 m^3
- Distance – up to 2.5km
- Effects – up to 20km in water courses
- Delay – ?? years
- Impact on subsequent schemes - significant

Image courtesy R Lindsay UEL

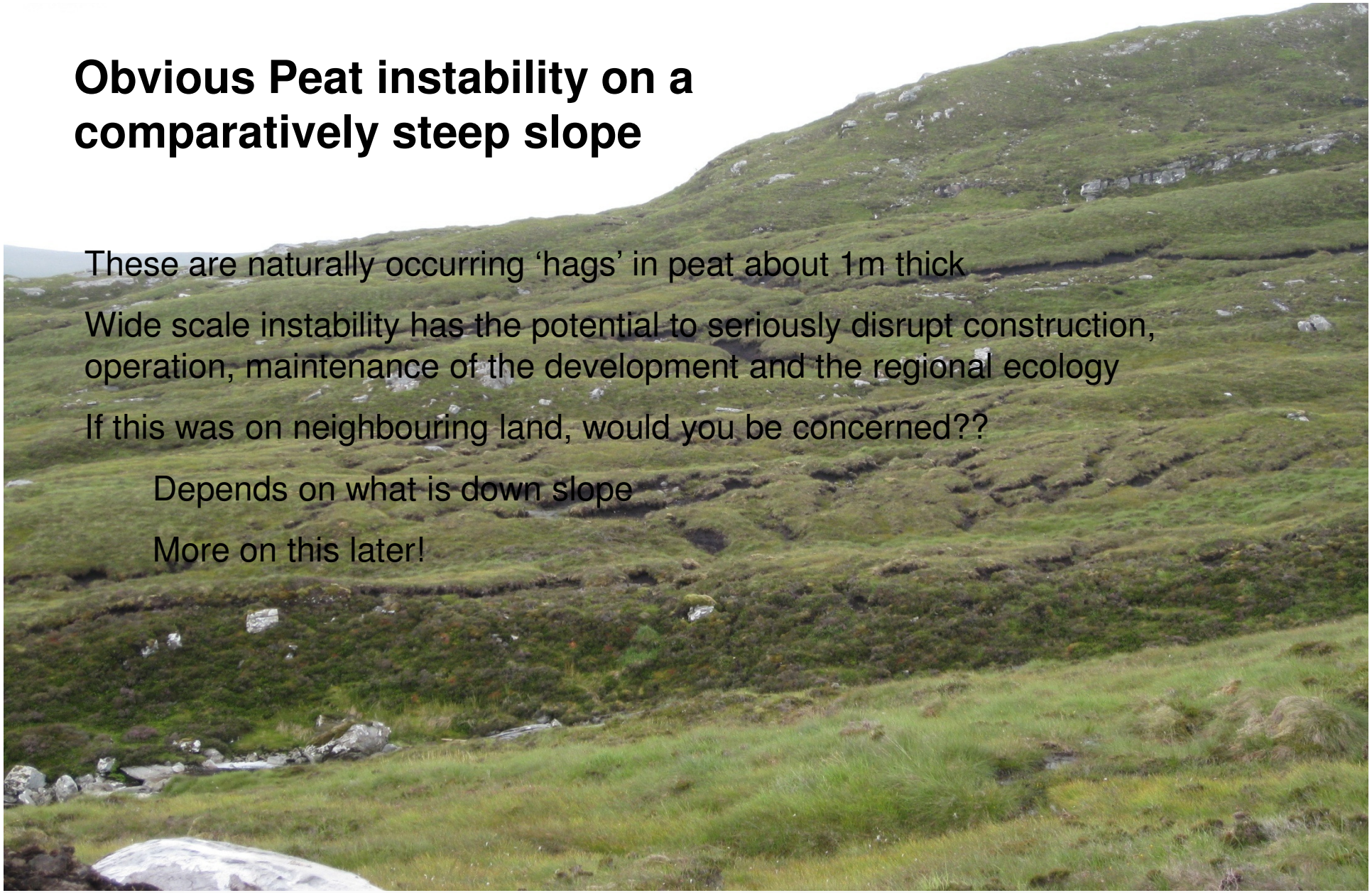
More instability

Forest clearing for drainage run and access track

- Drainage ditch was originally straight
- Would a stability analysis predict this situation?
- What is the residual stability for the slope?
- What are the construction implications?
- Would you drive a 150 tonne crane down the track?

Image courtesy O.M.Bragg, Dundee University

Obvious Peat instability on a comparatively steep slope



These are naturally occurring ‘hags’ in peat about 1m thick

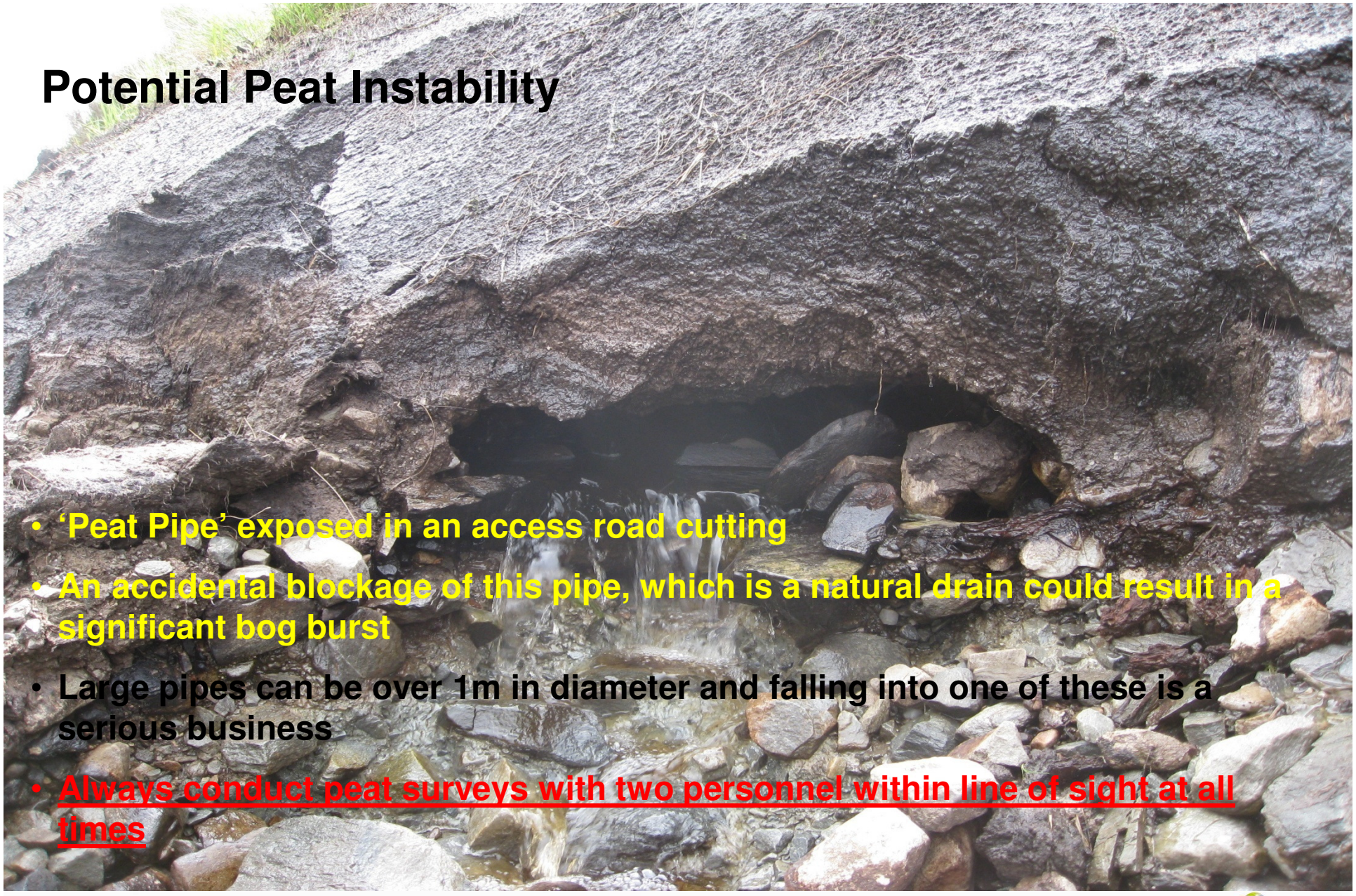
Wide scale instability has the potential to seriously disrupt construction, operation, maintenance of the development and the regional ecology

If this was on neighbouring land, would you be concerned??

Depends on what is down slope

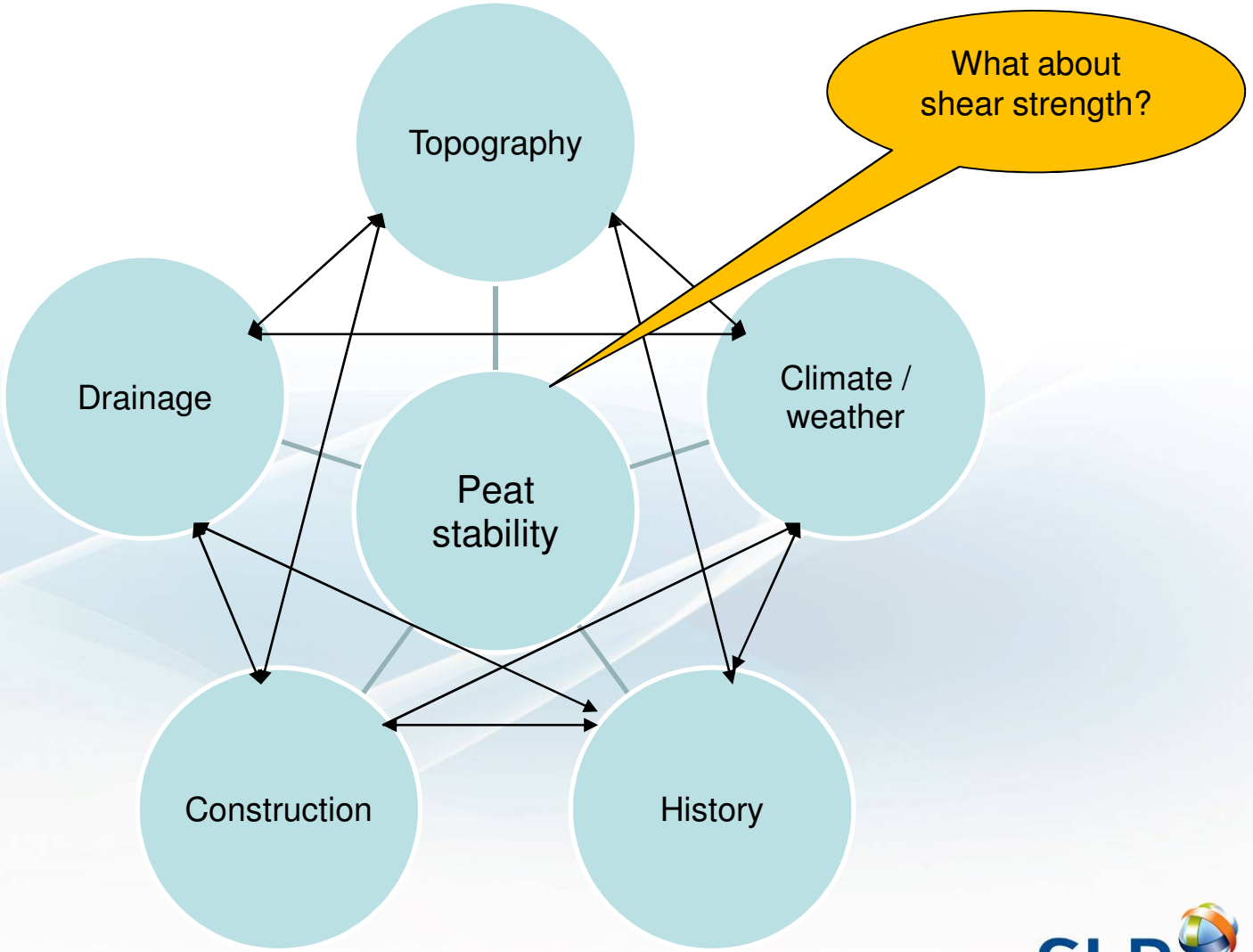
More on this later!

Potential Peat Instability

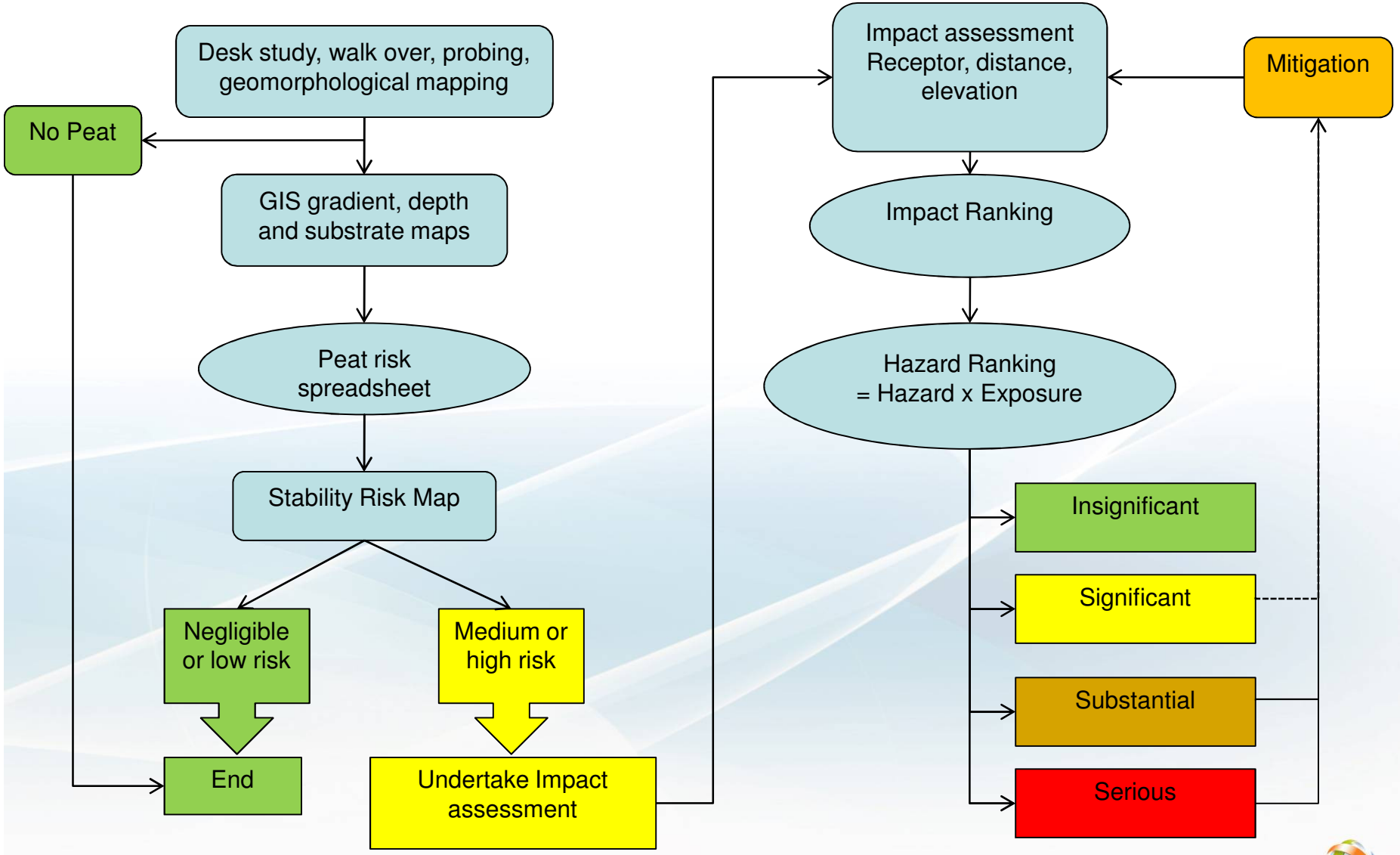


- 'Peat Pipe' exposed in an access road cutting
- An accidental blockage of this pipe, which is a natural drain could result in a significant bog burst
- Large pipes can be over 1m in diameter and falling into one of these is a serious business
- Always conduct peat surveys with two personnel within line of sight at all times

Inter-relationships that influence Peat Stability



Risk and Hazard Assessment Flow Chart

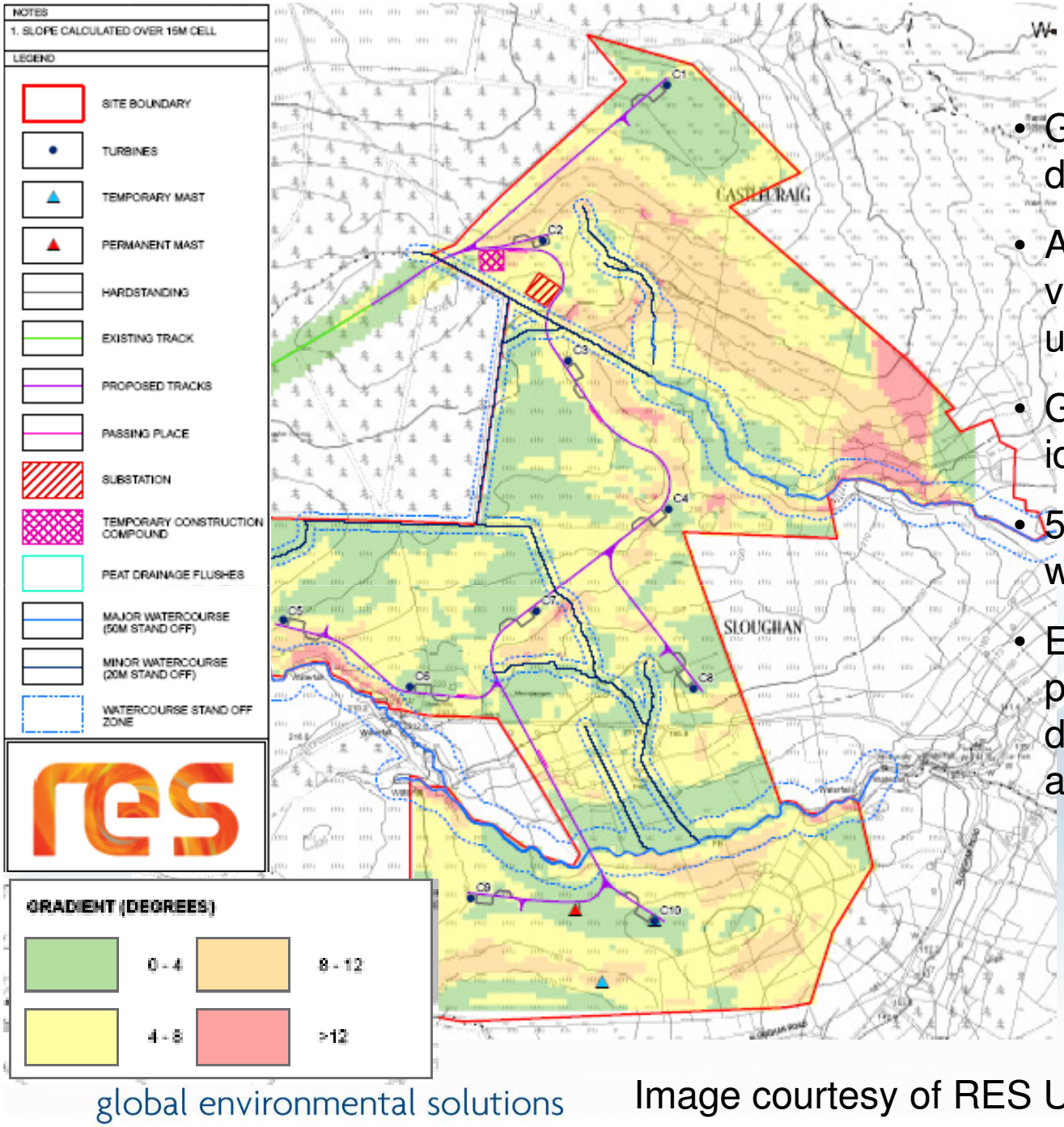


Desk Study

Sources of information for a desk study:

- Aerial Photographs
- Land use records
- Regional geological maps
- Newspaper articles
- Landowner or tenant farmer
- Preliminary walk-over survey
- Ecology survey to identify peat areas
- Development layout if available
- Digital terrain model (DTM) recommend 1:5 000 or 1:10 000 and produce a gradient map

Gradient Map



- Gradients determined from data in DTM
- Assessment grid can be varied from 5 to 50m (15m used here)
- Gives clear and definitive identification of steep slopes
- 50m stand-off to all mapped water courses
- Extract gradient data and plug into Risk Spreadsheet; develop coefficients for appropriate gradient ranges

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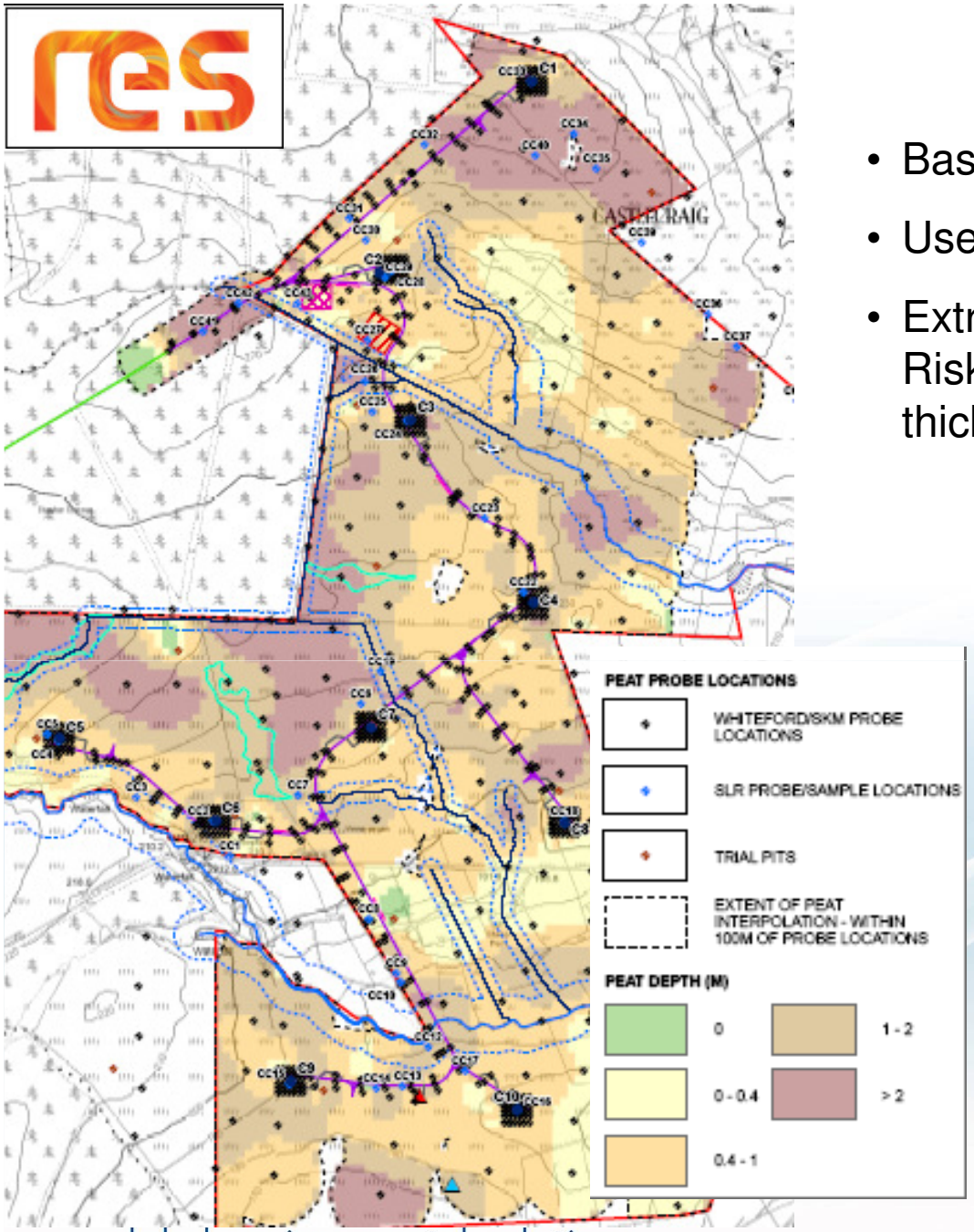
Image courtesy of RES UK Ltd

SLR

Peat Thickness

- Base data from probing
- Use GIS to interpolate between positions
- Extract thickness data and insert into the Risk Spreadsheet; develop appropriate thickness coefficients



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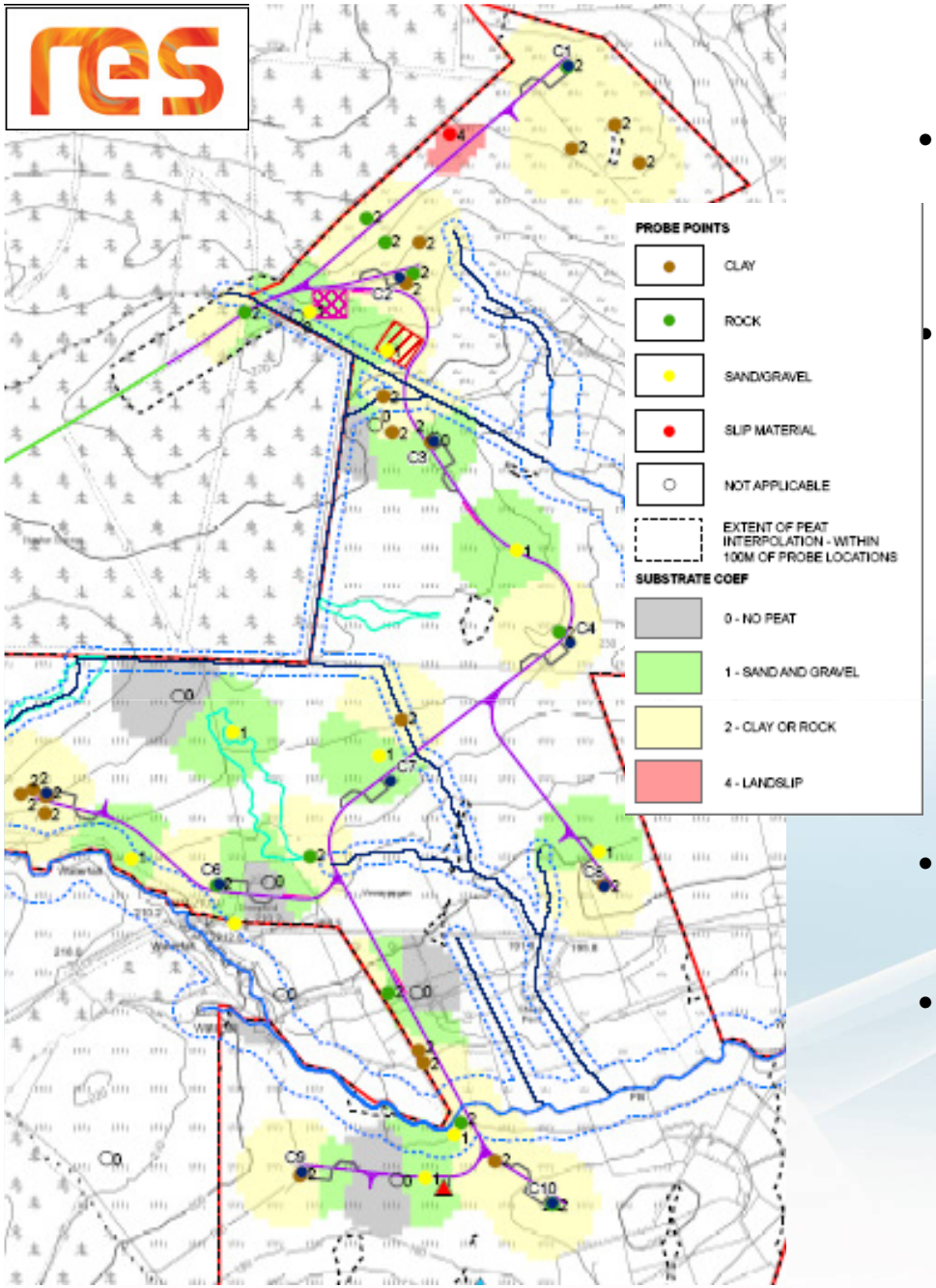


Interpretation of Substrate

- Substrate can be determined from, probing, trial pits, hand borings and boreholes
- Interpretation from probing:
  - Hard stop – rock or boulder
  - Progressive or abrupt stop (no noise) – stiff clay
  - Progressive or abrupt stop (grinding noise) – sand or gravel
  - Gradual stop – soft clay
- Input substrate data in GIS to produce map
- Input data to Risk Spreadsheet with suitable coefficients

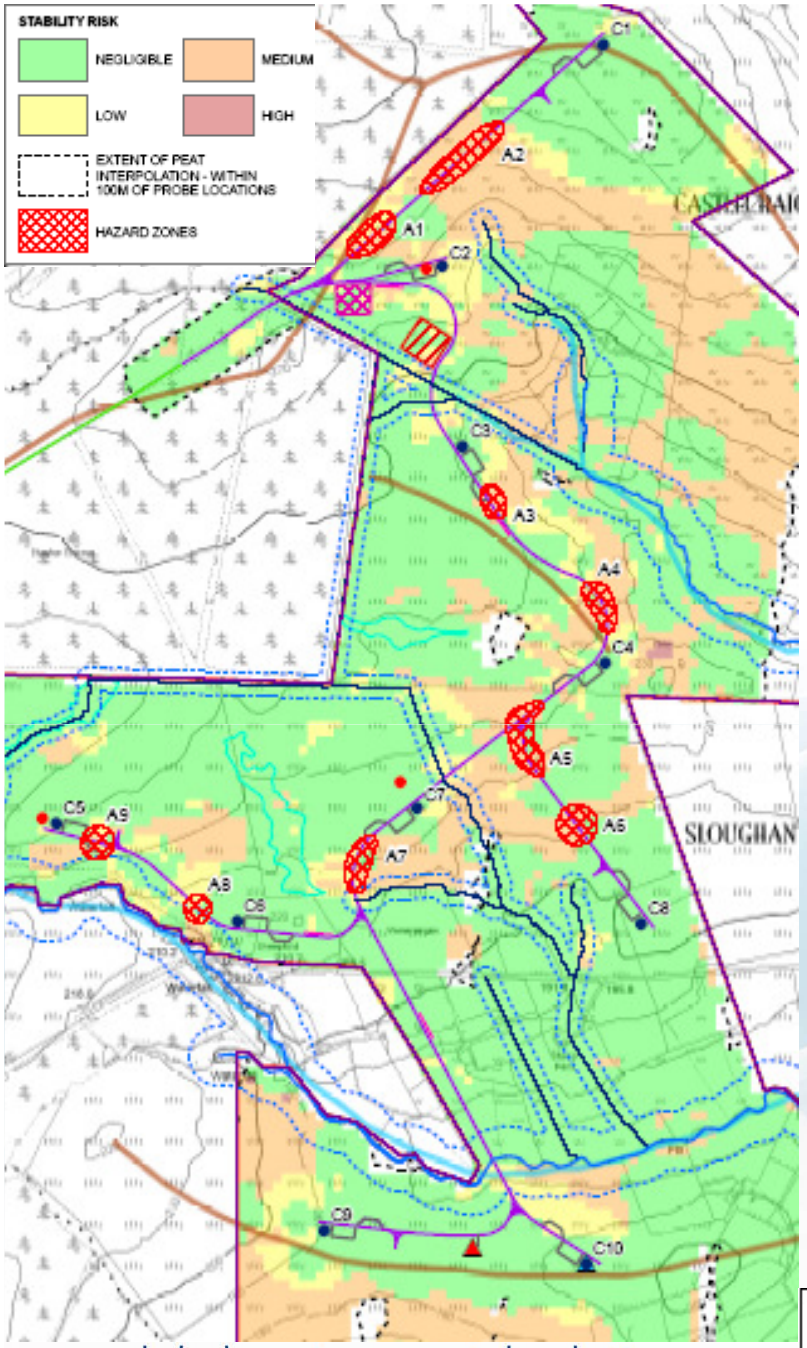
Example Stability Risk Assessment Spread Sheet

Input data				Coefficients			Risk Rating	
Peat Thickness (m)	**Slope Angle (°)**	**Inferred Substrate**	**Peat Category**	**Slope Coeff**	**Peat Coeff**	**Substrate Coeff**	**Risk Coeff**	**Potential Instability**
1.60	7.4	Rock	Thin Peat	3	3	2	18	Low
1.20	8.4	Sand/Gravel	Thin Peat	4	3	1	12	Low
	2.3	N/A	No Peat	0	N/A	N/A	N/A	N/A
1.00	3.6	Clay	Thin Peat	0	3	2	0	Insignificant
2.00	4.3	Clay	Thick Peat	1	2	2	4	Insignificant
1.70	3.8	Rock	Thin Peat	0	3	2	0	Insignificant
0.70	7.5	Clay	Thin Peat	3	3	2	18	Low
1.30	5.5	Clay	Thin Peat	3	3	2	18	Low
3.30	3.9	Clay	Thick Peat	0	2	2	0	Insignificant
1.80	6.8	Sand/Gravel	Thin Peat	3	3	1	9	Insignificant
0.50	4.5	Clay	Peaty Soil	1	0	2	0	Insignificant
0.49	9.8	Sand/Gravel	Peaty Soil	4	0	2	0	Insignificant
0.50	9.9	Rock	Peaty Soil	4	0	2	0	Insignificant
1.60	6.4	Rock	Thin Peat	3	3	2	18	Low
1.80	5.2	Slip material	Thin Peat	3	3	4	36	Medium
1.20	2.1	Rock	Thin Peat	0	3	2	0	Insignificant
2.2	5.0	Clay	Thick Peat	3	2	2	12	Low
2.6	5.0	Clay	Thick Peat				12	Low

No significant risk – no further action required

Impact assessment required

Stability Risk Map



Risk map - stability coefficients and GIS interpolation to produce four categories of risk.

Risk	Coefficient	Action
Negligible	<10	No mitigation required although slide management and monitoring shall be developed including a site specific construction and peat management plan
Low	11 – 20	Plus further assessment to consider mitigation such as micro-siting
Medium	21 – 50	Plus **Impact Assessment** to consider potential receptors
High	>51	Unacceptable, avoid these areas. If this is not possible, further detailed investigation quantitative assessment with long term monitoring

Coefficient ranges need to be set and then 'truth checked' against site observations of peat conditions.

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Impact Assessment

If the risk of instability is negligible or low, no further action is required.

If we can demonstrate that the **impact** of any instability is low, there may be no Hazard

(Note that the impact of instability could be from peat on the development or visa versa and receptors outside the immediate development should be considered).

How to assess the Impact of instability; consider:

1. Receptor vulnerability – non-critical, critical, sub-communities, community
2. Proximity – Distance and difference in elevation between the source and receptor
3. Calculate an Impact rating – based on the cost of remediation relative to development cost and the disruption to external receptors
4. Use coefficients for each to give a HAZARD RANKING (stability risk rating x impact rating)

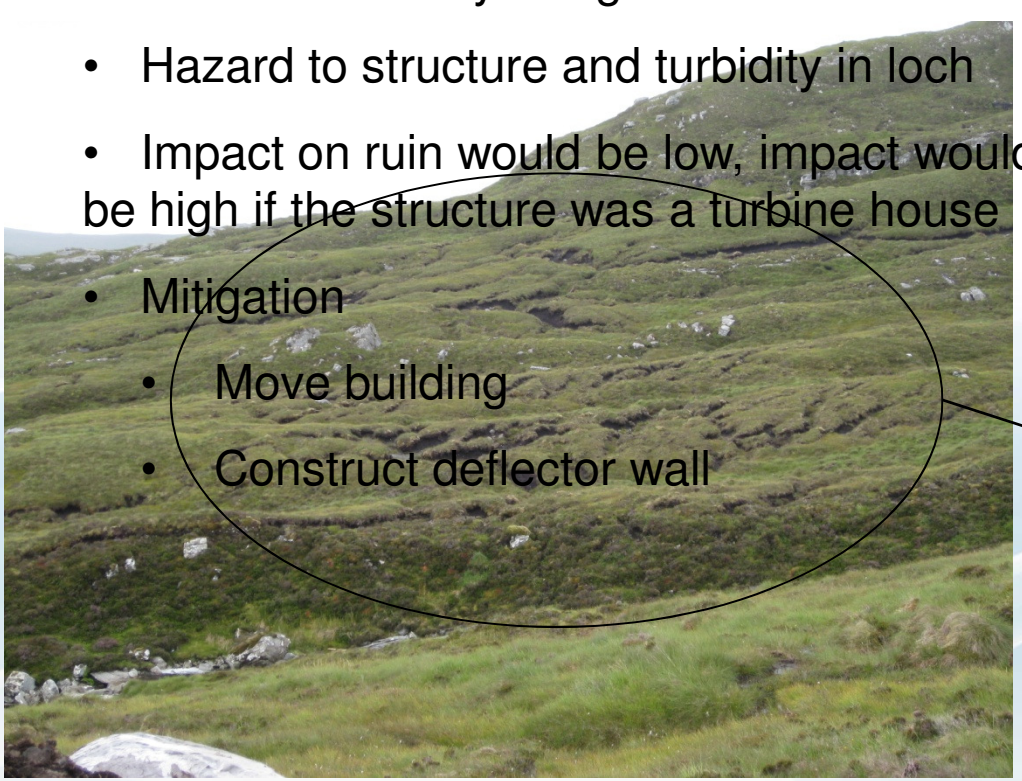
Hazard Ranking

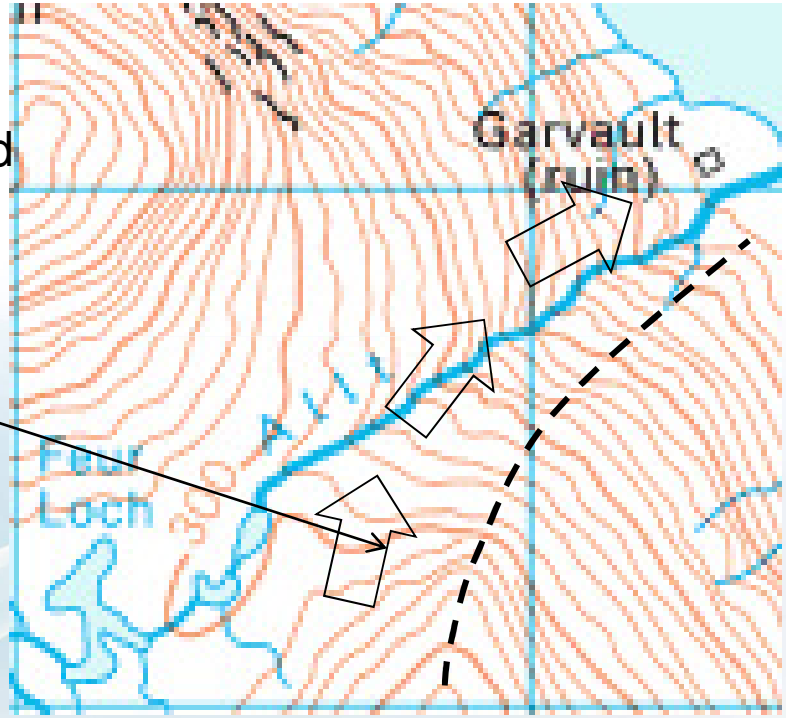
HAZARD RANKING	HAZARD RANKING ZONE	ACTION *(based on Scottish Executive guidance)*
<4	INSIGNIFICANT	No mitigation action required although slide management and monitoring shall be employed. Slide management shall include the development of a site specific construction plan for peat areas.
5 - 10	SIGNIFICANT	As for Insignificant condition plus Further investigation to refine the assessment combined with detailed quantitative risk assessment to determine appropriate mitigation through relocation or re-design.
11 - 16	SUBSTANTIAL	Consideration of avoiding project development in these areas should be made unless hazard mitigation can be put in place without significant environmental effect.
17-25	SERIOUS	Unacceptable level of hazard; part or all of the development should be avoided.

Note that completion of the risk and hazard assessment does not guarantee that all of the development is viable, there simply may not be an acceptable mitigation measure.

Risk, Hazard Impact and Mitigation

- Risk of instability is high
- Hazard to structure and turbidity in loch
- Impact on ruin would be low, impact would be high if the structure was a turbine house
- Mitigation
  - Move building
  - Construct deflector wall





Thank you