Rapid evaluation of an upland peat catchment for construction of a site access road

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Background

- Site access road required for a large hydro-electric scheme, running from existing access road (gravelled track) to planned dam site
- A first visit undertaken to identify primary geotechnical risks through non-intrusive walkover, and enable follow-up investigation to identify mitigation measures
- Second visit undertaken two weeks later:
  - to undertake visual assessment of peat cover
  - undertake preliminary logging of peat cover along proposed alignment
  - identify geotechnical issues and geohazards (particularly in relation to peat instability)

Site overview

- Existing access road terminates at the head of the valley and access track must ascend the sidewalls of a corrie, and cross an extensive area of peat
- Valley sidewalls are typically up to 30˚, and locally steeper

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Approach

- In order to identify geotechnical constraints and geohazards, the following tasks were planned:

  i. Characterisation of slope conditions, based on a NextMap digital elevation model (DEM)

  ii. Characterisation of terrain and historical and contemporary geomorphological processes, based on aerial photograph interpretation (API)

  iii. Characterisation of peat extent and depth along the route corridor, based on peat coring and logging at intervals along the proposed route

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Phasing of investigation

- Following the initial investigation, this work was undertaken in three phases:

i. Pre-site visit: desk study comprising data acquisition, processing and geomorphological interpretation in GIS

ii. Site visit: field verification of initial interpretation and additional geomorphological mapping + peat coring and logging exercise

iii. Post-site visit: route corridor assessment based on finalised geomorphological interpretation and peat extent and depth data, and recommendations

Assessment in GIS – Topography

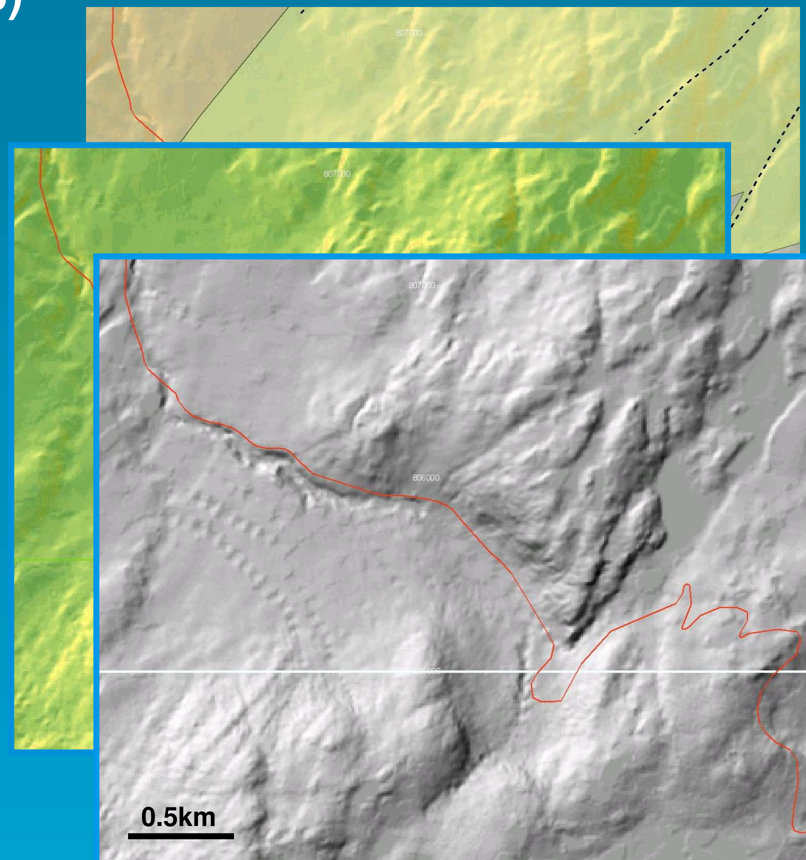
- Slope angle and elevation (relief) analysed in the ArcView geographical information system (GIS)

  - NextMap data provides DEM at 10m bins

  - ‘Hillshade’ created to visualise ruggedness of terrain

  - Slope angle map created to identify locally steepest slopes

  - Geological map rectified to provide overview of solid geology



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Assessment in GIS – Ground Conditions

- In order to undertake geomorphological mapping, aerial photographic data was required
- Google Earth data (freely available) insufficiently resolute for mapping
- Ordnance Survey B&W contact prints from 1998 used as an alternative:
  - Contact prints, subject to distortion at margins
  - Pronounced shadow obscured detail
  - Required geo-referencing (or 'fitting') to the spatially more accurate Ordnance Survey raster tiles
  - Rectification also problematic due to lack of 'static' features visible at 1:25,000 scale (no fence boundaries, sheepfolds or dwellings visible/present)
  - Good 'fit' at the centre of photographs, but poor at margins

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Assessment in GIS – Ground Conditions

- Mapping undertaken to delineate major drainage patterns, identify evidence of peat instability and any other geomorphological processes (e.g. gullying, cracking)

- Following 'terrain units' identified:
  - Areas of peat with 'diffuse' drainage & peat dissected by gullies
  - Areas of peat punctuated by rocky outcrops
  - Stream channels and lochs
  - However, no evidence of recent instability (e.g. exposed substrate, usually highly reflective light tones; run-out, dark lobate debris tracks)

- 1:25,000 scale photos insufficiently resolute to identify small scale instability features (e.g. cracks, compression ridges)

- Significance of light and dark tones for drainage conditions could not be validated without a field visit

Site Walkover & Peat Logging

- **Peat probing undertaken to capture depth of peat along route, and therefore, in combination with slope information, provide basis for stability assessment**
- **Once site walkover undertaken:**
  - Light, dendritic patterns confirmed as mossy flushes in topographic lows
  - Shadowed 'lumps' confirmed as rock outcrops
  - Geomorphological maps revised according to field validation

- **Gouge sampler used:**
  - Comparatively lightweight (relative to Russian sampler)
  - Sampled 1m sections easily and rapidly achieved in soft deposits
  - Penetration limited mainly by strength of coring team, but generally easy to 2m
  - Combined Von Post / BSSS standard methodology used to log samples

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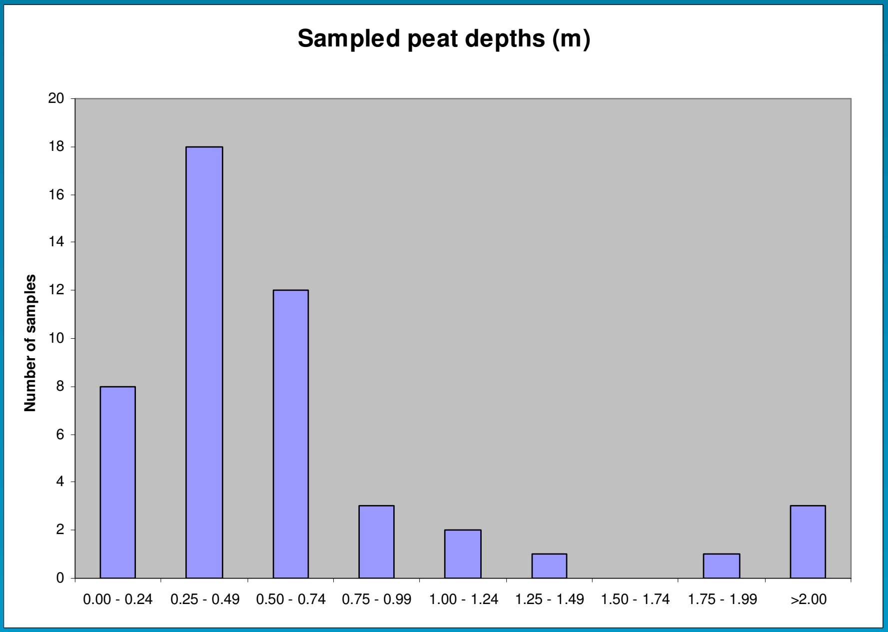
Peat Sampling

- In total 4km of route walked over in 2 days, despite poor weather conditions and comparatively few daylight hours
- 49 hand cored samples were assessed and logged in the field, comprising 23m of core material
- Only 2 of 49 samples experienced failed recovery due to high moisture content



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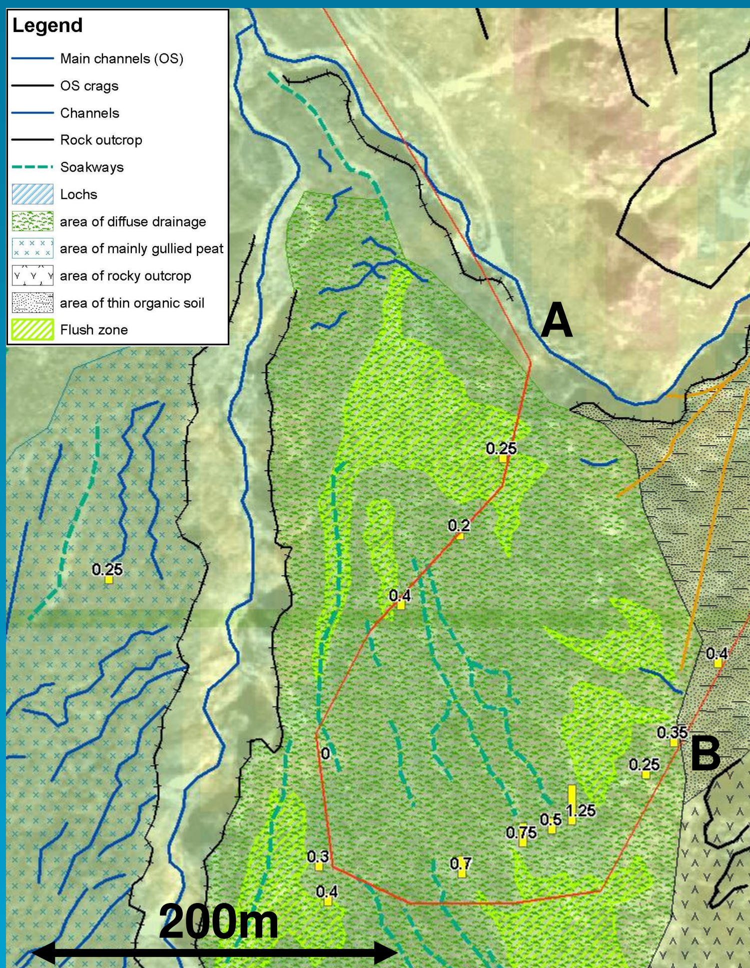
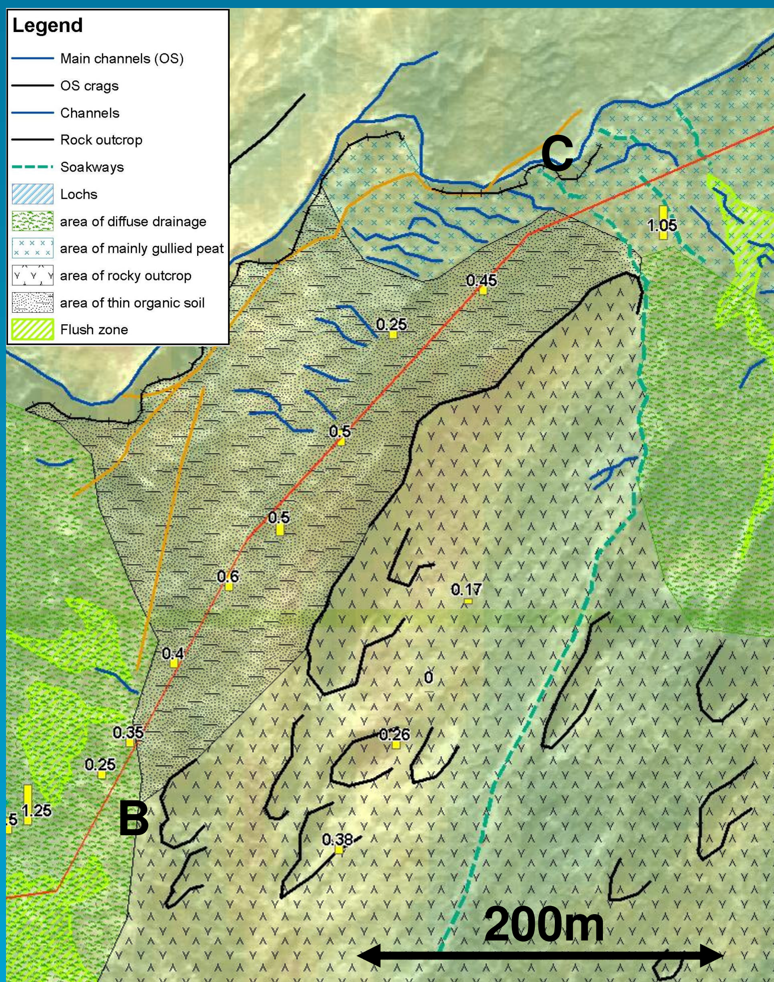
Tour of Access Road route – A to B



Points A to B

- Corrie floor with gentle slopes from 4 to 10˚
- Area of diffuse drainage – predominantly diffuse soakways and localised gullies
- Firm to fibrous texture with local woody fragments and small mineral inwashes; depths from 0.4 – 0.75m
- 7 to 8 on von Post humification scale
- No signs of instability

Tour of Access Road route – B to C



Points B to C

- Valley side traverse over steeper slopes 20˚ to 30˚
- Very shallow peat (0.4 to 0.5m) / organic soil
- Few clear drainage features visible on aerial photographs or on ground
- Despite steep slopes, no tension cracks or features of en masse instability
- Terracettes indicate slower creep processes dominate

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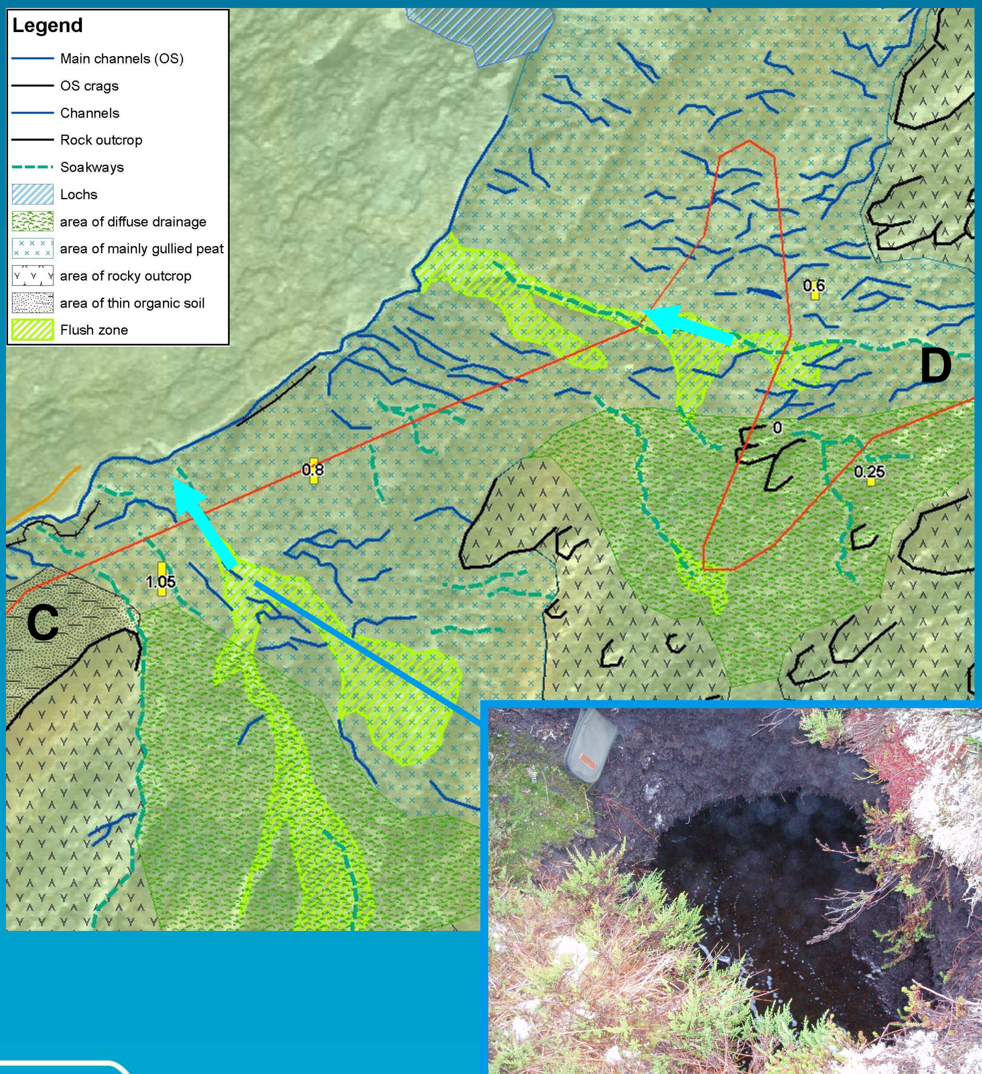
Tour of Access Road route – C to D



Points C to D

- Valley side traverse over steeper slopes 5 to 20˚
- Numerous gullies, groughs and haggs
- Two distinct soakways transfer water from the plateau to the valley bottom
- Peat depths from 0.5 – 1.05m, thinning upslope towards summit
- Extensive linear drainage and absence of extensive tracts of intact peat indicate low likelihood of peat instability

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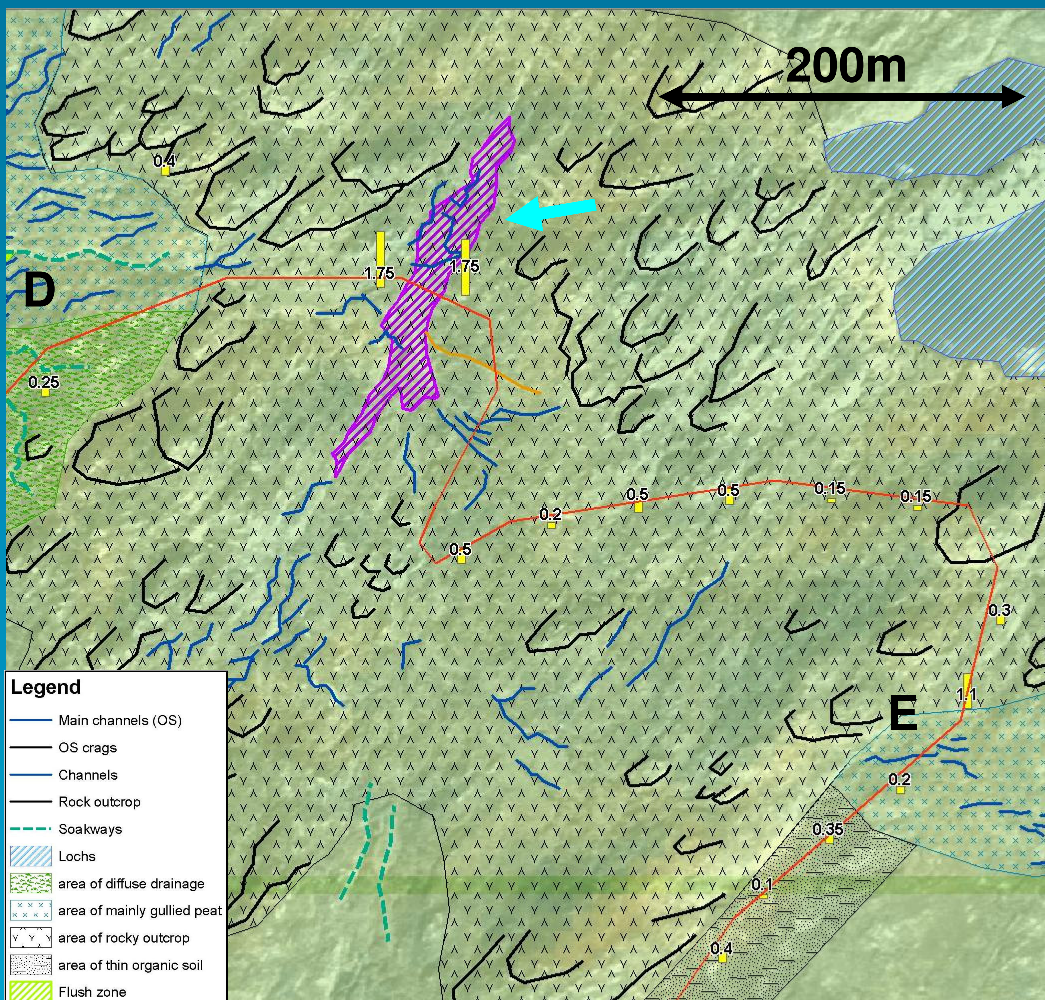
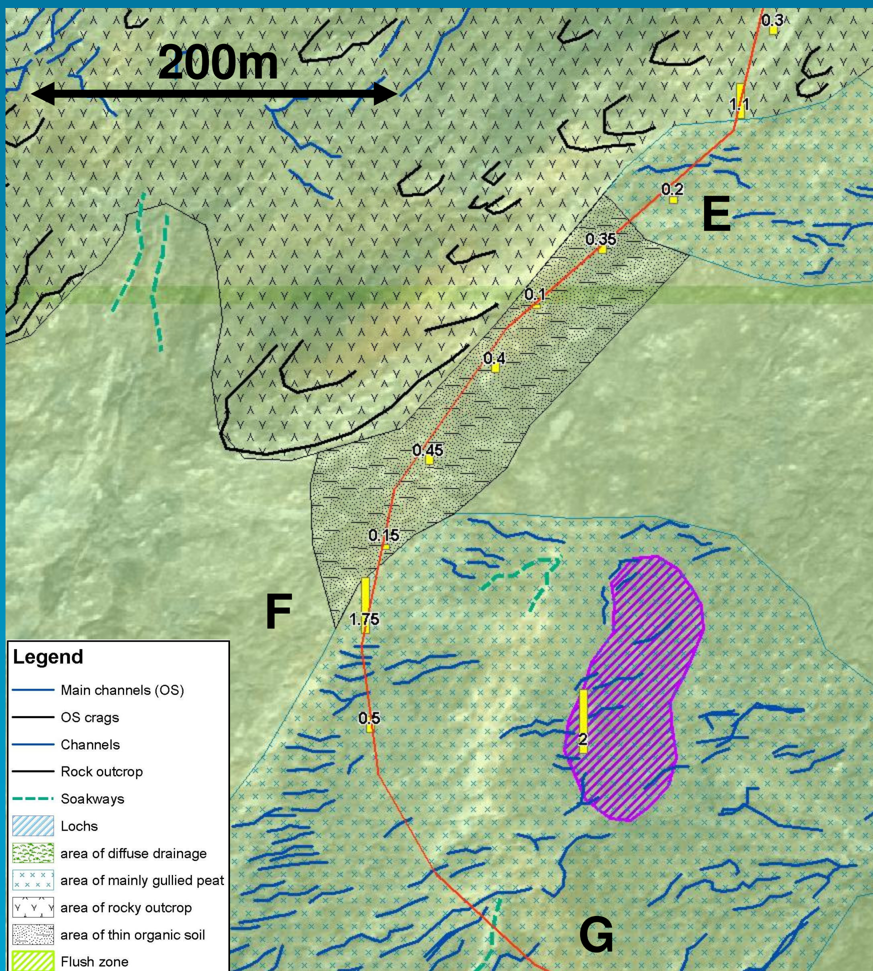
Tour of Access Road route – D to E



Points D to E

- Summit plateau with slopes 0 to 10˚ through area of rocky outcrops
- Very thin (<0.5m) to absent peat cover, numerous ponds
- One significant area of deep bog formed in a structural low, 15m wide, up to 200m long, >1.5m deep
- Wetness precluded retrieval below 1.5m depth
- Cutting for road construction (or impedance of drainage) may lead to local instability (or spreading) if not carefully managed

Tour of Access Road route – E to G



Points E to F

- Traverse of gentle slope running down from plateau, between 8 and 12˚
- Thin organic soil drapes hillside between localised rocky outcrops

Points F to G

- Moderately sloping valley side 5 to 25˚ and descending through 50m
- Drainage pattern converges in a deeper peat area (up to 2.0m) – peat firm and fibrous

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Evidence for geohazards

- Initial site walkover gave an impression of significant peat depths
- However, sampling indicated that peat was generally thin and patchy
- Morphological evidence indicates peat terrain generally gullied and dissected and not in keeping with planar continuously covered peat slopes more often associated with peat failures
- No significant tension cracking, compression features or relict failures observed on air photos – verified in field
- ‘Geohazards’ more likely to relate to adverse drainage conditions or artificially triggered failures than ongoing natural processes

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Key management issues

- Blockage of hillslope drainage system caused by unsympathetic road construction may result in:
    - Excess build up / ponding of water upslope of road
    - Increased lateral loading and possible failure
    - Need to ensure free drainage is maintained if gullies or flushes are crossed

- Peat catchments ‘flashy’ - under-road culverts should have sufficient capacity

- Use of cutting, drilling and blasting for road construction
    - May result in small scale hillslope failures through unloading of slope toes or through vibration induced failures
    - Close monitoring should be undertaken during road construction

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Lessons learned

- Access road was built successfully along route, despite initial concerns about peat instability
- Upland peat environments can appear ‘hostile’ to construction at first sight
- Simple and rapid (cost effective) reconnaissance methods can identify a majority of the major geohazard drivers and potential engineering issues in a short time period
- However, peat terrains can be deceptive – Interpretation from aerial photographs alone can be misleading
- Site reconnaissance (including sampling) must be conducted to ensure valid interpretation of site characteristics is made