# 7 GEOLOGY AND SOILS

## 7.1 INTRODUCTION

This chapter considers the potential effects of the proposals on geological resources and soils. The project engineers have supplied all detailed geological and soils information.

## 7.2 SOURCES OF INFORMATION

The following sources of information have been used for this assessment:

- a previous ground investigation report for the project[78];
- a Detailed Geological Assessment Report[79] for the project commissioned from British Geological Survey (BGS), containing geological, hydrogeological, and groundwater vulnerability mapping information;
- an Envirocheck[80] report for the site, commissioned from Landmark Information Group Service Ltd, containing data from various sources including the SEPA, SNH and Stirling Council;
- a peat probing exercise[81];
- a peat landslide hazard and risk assessment[82];
- a ground investigation by Norwest Holst in 2008[83]; and
- observations made during a site reconnaissance of the study area.

The report from the BGS is contained in Appendix 7.1. The report on the peat probing exercise and the peat landslide hazard and risk assessment are contained in Appendix 7.2 and 7.3 respectively.

## 7.3 BASELINE

### 7.3.1 Designations and Important Resources

There are no geological Sites of Special Scientific Interest (SSSI)[84], Regionally Important Geological/Geomorphological Sites (RIGS)[85], prime agricultural land or known contaminated land within the area which would be directly affected by the proposals. There is extensive peat present on the site (see Figure 1 in Appendix 7.3).

### 7.3.2 Geology

The solid geology is composed of metasedimentary[86] rocks of Dalradian Age. These metamorphosed[87] sediments comprise the metamorphosed sedimentary rocks schistose semipelite to psammite, with more massive layers of psammite developed locally.

[78] Scottish Office (1995) Crianlarich Project Stage 3 Environmental Assessment Volume 2
[79] British Geological Service (2006) Geological Assessment – Detailed, client's reference: 115799
[80] Landmark Information Group Service Ltd (2006) Envirocheck Report, order number: 20525483
[81] Holequest Ltd (2008) A82 Crianlarich Bypass – peat probes
[82] Headley, A (2008) Peat landslide hazard and risk assessment
[83] Norwest Holst, 2009. Ground Investigation Report
[84] A SSSI is an area that has been notified as being of special interest due to its flora, fauna or geological or physiographical features under the Wildlife and Countryside Act 1981 and the Nature Conservation (Scotland) Act, 2004
[85] Regionally Important Geological and Geomorphological Sites (RIGS) are a non-statutory designation of the most important places for geology and geomorphology in the United Kingdom. RIGS are locally designated by geological groups
[86] Sediment or sedimentary rock that shows evidence of having been subjected to metamorphosis
[87] To change the form or nature of

**Table 7.1: Geological Resources in the Study Area**

| Geological Formation | General Description | Rock Types | Location |
|---|---|---|---|
| Southern Highland Group (Dalradian) | Metamorphosed sedimentary rocks | Semipelite and psammite | Southern part of the route corridor |
| | | Semipelite | Remainder of the route corridor |

### 7.3.3 Soils

Drift deposits are present over extensive areas, though locally thin or absent, and mainly comprise peat overlying glacial deposits. Other deposits may be found locally, including made ground[88] in association with the existing infrastructure development, and river terrace deposits associated with the main terrace of the River Fillan at the route's north tie–in.

The glacial soils occur principally as glacial moraine deposits, with glaciolacustrine[89] deposits. The glacial moraine deposits produce the mounded deposits and hummocky terrain. These are primarily silty to very silty sand containing gravel, cobbles and boulders in varying proportions, and pockets of sandy silt. They may grade downward into glacial till. The glaciolacustrine deposits are reworked morainic material found at some of the deeper channels between mounds in the form of bedded silt and sand. The glacial drift is rarely more than 5m thick, though may be up to 10m thick in the intervening hollows.

The surface along the corridor is generally saturated, often being waterlogged or ponded (see Photograph 6 Annex E). Groundwater may be anticipated at shallow depths within the peat, and as small, perched bodies of groundwater within the glacial deposits (see also Section 8.5.4).

The report on the original geotechnical investigation work that was carried out in 1994 identified the presence of peat along the route corridor[90]. The report on a subsequent peat probing investigation and recent ground investigation for the proposed development indicated that the type of material present was generally spongy to firm black fibrous peat (see Appendix 7.2).

The recent peat landslide risk assessment (see Appendix 7.3) included a survey of the peat deposits and found that there were thirteen areas of peat more than 0.5m deep along the route or immediately adjacent to the route of the proposed bypass, with a further three up to 200m upslope of the bypass within the forestry plantation. The areas of peat on the northern and western parts of the survey area were relatively shallow (typically between 0.2 and 1m deep) in flushed concave hollows immediately below the Ewich forestry plantation. In the southern part of the survey area the peat was largely present in basins between moraines and had deeper peat that was typically 0.4 to 1.5m thick. There is one particularly deep body of peat, at least 4m deep, immediately adjacent to the existing A82. The majority of the peat is a well-humified sedge peat, with significant quantities of silt and sometimes sand towards the base of the peat. The peat in most cases sits directly on top of bedrock or boulders.

The peat landslide hazard and risk assessment was carried out to further inform the environmental baseline and to determine whether the changes associated with

[88] Material placed or tipped, often as a result of previous industrial or mineral extraction activities
[89] Sediments deposited into lakes that have come from glaciers
[90] Scottish Office (1995) Crianlarich Project Stage 3 Environmental Assessment Volume 2

the proposals would impact on the areas of peat identified along the route. The assessment also considered whether such impacts could be associated with any significantly increased risk of peat landslide. The assessment report contains a number of recommendations for best practice during design and construction of the proposals and these have been incorporated into the mitigation measures set out in Section 7.6.

## 7.4 ASSESSMENT METHODOLOGY

A qualitative appraisal of the likely effects of the development following the methodology set out in Section 1.6.4 has been made taking account of potential impacts and agreed mitigation measures.

## 7.5 POTENTIAL IMPACTS

### 7.5.1 Permanent

Potential permanent impacts include:

- removal of *in situ* material which may be used in embankments and as fill but whose stratigraphy would be damaged and its geological and soils value largely lost;
- burial of sites and materials of geological interest (including fossils) e.g. under embankments or permanent structures;
- loss of access to mineral and aggregate resources beneath permanent structures;
- exposure of geological formations e.g. in cuttings which may benefit geological study;
- physical damage of soils;
- local but minor changes to the ground water regime as a result of earthworks and carriageway drainage which could affect soils; and
- creation of new and possibly steeper slopes than natural slopes and the creation of new rock exposures affecting drainage and aspect;
- construction of embankments that would infill and / or cover existing geomorphological features and could create breaks in peat bogs;
- the creation of unnatural breaks in the peat or peat slippage as a result of peat excavation;
- subsidence of the road surface and embankments to occur after construction as a result of buried peat decomposing and compressing;
- increased susceptibility of peat bodies to failure during or after construction, due to damage to the integrity of the vegetation or underlying peat caused by construction vehicles crossing bodies of deep peat that are not to be removed or buried by the proposed development;
- reduced stability of peat bodies due to potential effects of new cuttings and earthworks for the scheme;
- increased likelihood of peat bodies sliding on to the road during heavy rainfall events; and
- effects on the hydrology and, therefore stability, of the of the remaining peat bodies.

### 7.5.2 Construction

Potential construction impacts include:

- encountering locally contaminated land; and
- pollution of soils from spills.

### 7.5.3 Operational

Potential operational impacts include:

- pollution of soils by spillages or spray from the road.

## 7.6 MITIGATION MEASURES

The following mitigation measures would be implemented.

G1. The contractor would be required to implement best practice measures to ensure disturbance to local geology and soils is reduced to the minimum necessary for the safe implementation of the works.

G2. The effect of erosion of new soil slopes would be mitigated by earthworks, detailed drainage design and re-use of removed turfs or new planting.

G3. Existing watercourses would be culverted under the bypass at their current location. The drainage pattern would not be significantly altered.

G4. Where peat deposits are to be excavated, pumping of inflowing groundwater to detention basins would be implemented if required.

G5. Opportunities to create rock cuts of geological interest would be exploited where appropriate.

G6. Only minor rock cuts would be expected. Newly exposed rock would be left bare where practical.

G7. Large glacial boulders uncovered by the works which were considered by the site's environmental representative to be suitable for inclusion in landscaping works would be safeguarded and used.

G8. Scheme drainage measures would be designed to avoid significant disturbance of local drainage patterns.

G9. All soils disturbed by the works would be handled, stored and re–spread following best practice[91] to minimise adverse effects upon soil quality.

G10. The contractor would be required to produce a method statement identifying how best practice would be implemented to ensure soils were safeguarded.

G11. All fuel and other chemicals would be stored in accordance with best management practice within the site compounds. All oil and fuel storage facilities and small static plant would be well managed to minimise the risks of leaks to soil and groundwater.

G12. Plant and vehicles used for the construction works would be maintained on impermeable surfaces to contain oil spills.

G13. All earth bunds and soil storage areas would be well managed to minimise run–off and erosion.

G14. Soils removed, as part of the earthworks to facilitate construction would be re–used wherever possible in the final landforming of the road unless found to be unsuitable.

G15. Any peat that could not be re-used in the works would be disposed off-site in accordance with best practice.

G16. Any contaminated ground that is encountered would be dealt with according to best practice and contained in the works or disposed of following best practice to a suitably licensed disposal facility.

G17. Turfs removed from the peat surface would be re-used in restoration of the earthworks to help promote stability.

[91] For example see Ministry of Agriculture, Fisheries and Food, Good Practice Guide for Handling Soils http://webarchive.nationalarchives.gov.uk/20090306103114/http://www.defra.gov.uk/farm/environment/land-use/soilguid/index.htm

G18. During construction, peat bodies along the route of the bypass would have their peat removed in order to avoid the potential for subsidence of the road surface and embankments to occur after construction as a result of buried peat decomposing and compressing.

G19. Construction vehicles would avoid crossing bodies of deep peat that are not to be removed or buried by the proposed development, wherever possible, to avoid damage to the integrity of the vegetation or underlying peat (which would make the body of peat more susceptible to failure during or after construction).

G20. During construction the effects of any deep cuttings on bedrock and/or glacial deposits that retain remaining peat bodies identified as at risk from construction would be considered and appropriate mitigation defined if required.

G21. Gently sloping batters would be used (of less than 15 degrees) where it has been identified that cuttings could put peat at risk of sliding on to the road during heavy rainfall events.

G22. The effects of the proposals on the hydrology of any peat body identified as potentially unstable would be further investigated prior to the commencement of construction activities in order to determine whether the proposed design could reduce the stability of the peat body and whether further mitigation measures would be required.

## 7.7 RESIDUAL EFFECTS

### 7.7.1 Permanent

The site is not within an area that is designated for its geological interests and no locally important geological features, exposures or resources would be directly affected by the construction activities. No significant geological effects are therefore predicted. Some rock could be exposed during construction. These would be incorporated in the works and left exposed whenever feasible.

There would be disturbance to extensive areas of peat and soils during construction. The contractor would be required to remove peat from below the new road (some 133,800$m^3$ of material of which 35,800$m^3$ would be peat/soft soils). Some of the material which was removed would be re-used and buried in the earthworks for the scheme (some 65,000$m^3$) and some (anticipated to be some 68,800$m^3$) would be disposed of off–site (in accordance with best practice). Disturbance and loss would be reduced to the minimum necessary for the works and all best practice measures implemented to reduce impacts on peat and the quality of the remaining soils and peat. Tracking over peat by construction vehicles would be discouraged unless essential to avoid unnecessary compression of peat which would remain.

Site drainage would be designed to reduce impacts to local drainage patterns and wherever possible new slopes would seek to mimic natural slopes to avoid impacts in the longer term (see Section 8.8 and Figure 8.1). Turfs would be removed from the top layers of peat to be removed and used in restoration of the earthworks to give stability by preventing peat drying out and encouraging more rapid re-growth of stabilising vegetation.

The peat landslide risk assessment indicated that because, in most cases, the peat sits directly on top of bedrock or boulders (see Section 7.3) this would be likely to reduce the potential for a peat slide to occur. Other factors that would reduce the likelihood of peat slides occurring include the lack of peatpipes[92], the

[92] Naturally occurring watercourses within the body of the peat

lack of compression features or tension cracks in the peat, the presence of concave slopes, the fact that the majority of remaining peat deposits in proximity to the road are shallow, and the lack of any evidence of past debris flows or 'peat creep'.

The assessment also highlighted various specific issues.

- There is one particularly deep (at least 4m) body of peat (peat body E, see Figure 2 in Appendix 7.3), immediately adjacent to the current A82 that, presently, cannot fail because it is retained by the road's embankment. However, this area of peat, immediately downslope of the proposed bypass could be affected by changes to its hydrology through drying out of the peat. Although the hazard from this body of peat sliding downhill would be high, the probability of this event occurring was considered to be very low and therefore considered unlikely to occur. It was, however, recommended in Appendix 7.3 that the impact of the detailed proposals on hydrology, and therefore stability, of peat body E was established prior to construction taking place.
- For the southern basin of peat body K (see Figure 3 in Appendix 7.3), the proposed development would result in the remaining area of peat perched above the southern roundabout and road. This would reduce the stability of the peat and could make it susceptible to slumping on to the road. The cutting into the peat would increase the drying out of the peat body significantly during summer and potentially could give rise to cracking of the peat. It was recommended that gently sloping batters of less than 15 degrees should put in place around the cutting to the southern roundabout of the development to minimise the likelihood of peat within basin K sliding on to the road during heavy rainfall events.
- Although peat body N (see Figure 2 in Appendix 7.3) is currently very stable within its basin, it has the strong potential to flow downslope on to the proposed scheme if the mineral deposits or bedrock that currently hold it in place were removed or weakened by the construction works. This is because it is a relatively fluid mass of peat that will have very low effective cohesive strength. During construction care would need be taken to ensure that the bedrock and/or glacial deposits that retain peat body N were not affected by the deep cutting that is proposed immediately to the east and downslope of this peat body.

The summary of the peat risk assessment provided above has indicated some potential for peat slide risk and the contractor would be required to deliver the specific mitigation measures which were identified as necessary as part of the appraisal (see Section 7.6) . The contractor would also be required to make further checks of the final detailed design for additional peat slide risk and identify any further required mitigation. There would be no significant risk of subsidence due to the decomposition of buried peat because the contractor would be required to remove peat from below the new road line and provided all committed mitigation was successfully delivered there would be no risk of peat slides.

### 7.7.2 Construction

It is not anticipated that any significant areas of contaminated ground would be encountered during construction based on studies to date. Should any previously unidentified contaminated material be encountered the contractor would be required to make provision for appropriate investigation of the material and its safe handling and if necessary its disposal to a suitably licensed site.

The contractor would be required to implement all best practices to ensure that the risk of pollution of soils was reduced to a minimum and no significant effects are considered likely.

### 7.7.3 Operational

There may be some minor impacts to soils at the edge of adjoining land from salt spray off the road but effects are considered unlikely to be significant since a barrier would be created by the hard strips and verges at the edge of the road and associated planting.

## 7.8 SUMMARY

- No sites designated for their geological interest would be affected by the proposals.
- No geological resources of particular significance have been identified which would be affected by the works and no significant effects are predicted.
- No significant areas of contaminated land have been identified which could be affected by the works.
- There would be disturbance to extensive areas of peat and soils during construction. The contractor would be required to remove peat from below the new road (some 133,800$m^3$ of material of which 35,800$m^3$ would be peat/soft soils). Some of the material which was removed would be re-used and buried in the earthworks for the scheme (some 65,000$m^3$) and some (anticipated to be some 68,800$m^3$) would be disposed of off–site (in accordance with best practice).
- Disturbance and loss would be reduced to the minimum necessary for the works and all best practice measures implemented to reduce impacts on peat and the quality of the remaining soils and peat.
- Tracking over peat by construction vehicles would be discouraged unless essential to avoid unnecessary compression of peat which would remain *in situ*.
- Implementation of best management practices including the design of the works would ensure that any impacts to soils were minimised.
- Implementation of best management practices and the committed mitigation measures would ensure that the risk of subsidence of the new road due to the decomposition of buried peat would be avoided and the risk of peat slides avoided.