

## **38 Geology, Contaminated Land and Groundwater**

**This chapter identifies and describes the existing geology, contaminated land and groundwater within the Fastlink study corridor. It assesses the impacts of the proposed scheme on these issues and outlines measures for avoiding or mitigating impacts wherever possible.**

**Based on a desk study, preliminary ground investigations and consultations, descriptions of drift and solid geology are provided. Data were collected on sites of potential contaminated land, groundwater flow and groundwater resources, including wells and springs, within the study corridor. No sites of geological importance were identified.**

**Groundwater flow and quality monitoring in selected areas, will enable the future development of site-specific mitigation if required. Private water supplies will be replaced if any major impairment is noted during construction and these will be further protected by the lining of drainage pipes during the operational phase.**

**Contaminated material will be treated or removed, if encountered during the earthworks required for construction of the proposed scheme, to avoid risks to construction workers and potential impacts upon groundwater and groundwater quality arising from disturbance to contaminated land will be assessed in further detail at a later stage.**

**The proposed scheme would result in a Negligible to Slight adverse overall impact for geology and groundwater and a Slight beneficial impact for contaminated land.**

### **38.1 Introduction**

- 38.1.1 This chapter assesses the effects of the proposed scheme on geology within the Fastlink study area, including contaminated land and local groundwater resources. The assessment includes solid (bedrock) geology and drift geological deposits such as peat, sands and gravels. Assessment of the value of local soils is limited to their agricultural capability and this issue is discussed in Chapter 37 (Land Use).
- 38.1.2 Both geology and soils play an important part in determining the environmental characteristics of a region. The underlying geology has a major influence on landform, and rocks provide the parent material from which soils are created. The nature of the rock helps to determine not just the nature and chemistry of the soil, but also the rate at which it forms. This in turn strongly affects the vegetation that will grow naturally and the type of agriculture or horticulture that can be sustained.
- 38.1.3 There are a variety of ways in which road developments can impact on geological resources. Road schemes may sterilise or remove soils associated with prime agricultural land, or sterilise underlying mineral resources. Excavating or masking exposures of rocks or drift geological deposits of scientific interest can represent a serious impact if the features of interest are not reproduced elsewhere in the area. Similarly, removal or modification of geomorphological features can affect their scientific value or the local landscape resource. Impacts can also affect the existing or potential future commercial exploitation of resources and ground conditions may impose constraints on a proposed road scheme, for example, where land has become unstable due to mining or has been contaminated by previous land uses.
- 38.1.4 Road schemes can have potential impacts on underlying groundwater aquifers both during construction and operation. For example, construction works which involve excavation can lead to dewatering of shallow aquifers. There is also a risk of spillage or leakage of fuel or oil from storage tanks or construction plant. Without suitable mitigation measures, these pollutants can enter the aquifers. Once a new road is opened, runoff from the surface may contain elevated concentrations of pollutants such as oils, suspended solids, metals (e.g. copper and zinc) and, in winter, salt and engine coolants (e.g. ethylene glycol). Consequently, without adequate design measures, highway drainage discharges can cause pollution to aquifers.

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38.1.5 This chapter presents baseline conditions, predicted impacts and any associated mitigation measures in relation to the solid strata, the covering drift deposits and the associated groundwaters. The assessment also focuses on current and historic mineral extraction and contaminated land, and considers impacts occurring both during construction and operation.

## 38.2 Approach and Methods

### Baseline Conditions

38.2.1 The study area for the assessment extends to approximately 250m either side of the proposed route. The assessment was undertaken by means of consultation, a desk study and ground investigations.

38.2.2 Consultations were undertaken with a number of statutory and non-statutory bodies holding records pertinent to the assessment. These include the following:

- Aberdeenshire Council, for records of Regionally Important Geological Sites (RIGS) and information on contaminated sites and private water supplies;
- British Geological Survey (BGS), for information on local geology, drift and borehole information; and
- Scottish Environment Protection Agency (SEPA), for listing of contaminated sites, waste disposal sites and industrial processes.

38.2.3 The desk-based studies followed the recommended scope of DMRB, Volume 11, Section, Part 11 Chapter 5, Geology and Soils (The Highways Agency, 1993).

38.2.4 A programme of additional consultation with landowners commenced in March 2007, following publication of the Environmental Statement in December 2006. This consultation focused on the confirmation of desk study identified private water supplies located partly or fully within the study area (i.e. 250m either side of the proposed scheme). This additional consultation is not complete and further detailed baseline information is yet to be determined.

### Impact Assessment

38.2.5 As described in Chapter 5 (Overview of Assessment Process), impact significance was determined with respect to the sensitivity of the baseline conditions and the magnitude of potential impact. This is described in detail below.

#### Sensitivity/Importance

38.2.6 The importance or sensitivity of the geological and groundwater interest of the study area was determined using the criteria set out in Tables 38.1 and 38.2.

**Table 38.1 – Sensitivity Criteria for Geology**

Sensitivity	Description	Examples of Receptors
High	Areas containing geological or geomorphological features considered to be of national interest.	Sites of Special Scientific Interest (SSSIs).
Medium	Areas containing features of designated regional importance considered worthy of protection for their educational, research, historic or aesthetic importance.	Regionally Important Geological Sites (RIGS).
Low	Features not currently protected and considered not to require specific protection.	n/a

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**Table 38.2 – Sensitivity Criteria for Groundwater**

Sensitivity	Description
<b>High</b>	Local groundwater aquifer(s) constitutes a valuable resource because of its high quality and yield, or extensive exploitation for public, private domestic, agricultural and/or industrial supply. Designated sites of nature conservation dependent on groundwater.
<b>Medium</b>	Local aquifer(s) of limited value because quality does not allow potable or other quality sensitive uses. Exploitation of local groundwater is not extensive. Local areas of nature conservation known to be sensitive to groundwater impacts.
<b>Low</b>	Poor groundwater quality and/or very low permeabilities make exploitation of the aquifer(s) unfeasible. Changes to groundwater not expected to have an impact on local ecology.

- 38.2.7 Specific criteria are not defined for the assessment of mineral extraction or contaminated land as these aspects primarily represent engineering considerations for the scheme construction and their extent, nature and required mitigation will be assessed by specific ground investigations undertaken by the Contractor prior to detailed design of the development. However, the occurrence and proposed management of these aspects has been considered, assessed qualitatively, and presented as part of this assessment.

#### Magnitude of Impact

- 38.2.8 The magnitude of predicted impact on geological and groundwater interests was determined in accordance with the criteria shown in Tables 38.3 and 38.4.

**Table 38.3 – Magnitude Criteria for Geology**

Magnitude	Description
<b>High</b>	Where there would be partial (greater than 50%) or total loss of a site, or where there would be complete severance of a site such as to significantly affect the value of the site.
<b>Medium</b>	Where there would be loss of part (between approximately 15% to 50%) of a site, major severance, major effects to the setting, or disturbance such that the value of the site would be affected, but not to a major extent.
<b>Low</b>	Where there would be a minimal effect on a site (up to 15%) or a medium effect on its setting, or where there would be a minor severance or disturbance such that the value of the site would not be affected.
<b>Negligible</b>	Very slight change from baseline condition. Change hardly discernible, approximating to a 'no change' conditions.

**Table 38.4 – Magnitude Criteria for Groundwater**

Magnitude	Description
<b>High</b>	Major permanent or long-term change to groundwater quality or available yield. Existing resource use is irreparably impacted upon. Changes to quality or water table level would have an impact upon local ecology.
<b>Medium</b>	Changes to the local groundwater regime are predicted to have an impact slightly on resource use but not rule out any existing supplies. Minor impacts on local ecology may result.
<b>Low</b>	Changes to groundwater quality, levels or yields do not represent a risk to existing resource use or ecology.
<b>Negligible</b>	Very slight change from groundwater baseline conditions approximating to a 'no change' situation.

#### Significance of Impact

- 38.2.9 The significance of impacts was then determined by reference to both the sensitivity of the site and the magnitude of impact, according to the matrix shown in Table 38.5.

**Table 38.5 – Significance of Impacts on Geology and Groundwater**

Magnitude	Sensitivity			
	High	Medium	Low	Negligible
High	Substantial	Moderate/Substantial	Moderate	Slight
Medium	Moderate/Substantial	Moderate	Slight/Moderate	Negligible/Slight
Low	Moderate	Slight/Moderate	Negligible/Slight	Negligible
Negligible	Slight	Negligible/Slight	Negligible	Negligible

**Limitations to Assessment**

- 38.2.10 The listing of wells and springs is based on information received from consultation with Aberdeenshire and Aberdeen City Council, from information gathered during hydrological surveys, and from current Ordnance Survey (OS) map data. Further private supplies were identified during landowner consultation and have therefore been included in the assessment. Wells and springs, which are not notified by the Councils, not identified during surveys or landowner discussions undertaken to date and are not recorded in current OS data are not assessed within the ES.
- 38.2.11 Available information obtained through the private water supply survey is presented within this chapter. However, it should be noted that detailed consultation and mitigation development is anticipated to continue as part of the pre-construction activities on the AWPR and as such the exact location of some springs and wells is yet to be determined.
- 38.2.12 Contour maps were produced for groundwater contours, rockhead elevation and drift thickness. These contours are solely based on ground investigation data available to date, which are mainly concentrated along the route of the proposed scheme and not on the wider area.

**38.3 Baseline Conditions**

**Designations**

- 38.3.1 No geological Sites of Special Scientific Interest (SSSIs), Regionally Important Geological Sites (RIGS) or other designated sites of geological value have been identified in the area, and no other features of special importance to geology have been identified.

**Geology**

- 38.3.2 The solid geological succession and drift deposits are described below, and provide context to the mineral extraction, contaminated land and groundwater assessments. The local solid geology is shown on Figure 38.4a, with key drift deposits (peat and river alluvium) highlighted on Figures 38.2a-f.

Solid Geological Succession

- 38.3.3 BGS geological maps indicate that along the route scheme, the bedrock is mainly composed of schist. The schist is part of the Glen Effock Schist Formation described as a dark grey to greenish semipelite. Other metasediments comprising psammites, semipelites and subsidiary pelites with very scarce calc-silicate ribs are also present. To the south of the Hill of Muchalls, the proposed scheme crosses a southwest-northeast trending fault associated with the Highland Boundary Fault. The Highland Boundary Fault is located near Cowie and borders the route corridor to the south.
- 38.3.4 To complement BGS published information, a preliminary ground investigation was carried out in May/June 2006. The ground investigation dominant geological units encountered are shown on Figure 38.4a and are summarised below.

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- 38.3.5 The preliminary ground investigation indicated that the proposed Fastlink route is characterised by a variety of metamorphic rocks and occasional granite, including the following successive occurrences from south to north:
- mixture of schists and psammites identified between Cowie (ch0) and Forester's Croft (ch1200);
  - band of granite in the vicinity of Forester's Croft (ch1200);
  - schist from north of Forester's Croft to Wyndford Farm (ch3000);
  - gneiss north of Wyndford Farm to Burnside (ch4400);
  - schist again as far as South Cookney/Meadowfield (ch5300);
  - granite from South Cookney to Cookney (ch6300);
  - schist from Cookney to just south of Stoneyhill (ch6400);
  - granite from Stoneyhill to Burnside of Newhall (ch7450);
  - schist from Burnside of Newhall to Stranog (ch9400); and
  - granite from Stranog to the Cleanhill Junction.
- 38.3.6 As there are no geological designations and the local geological strata are extensively represented elsewhere throughout the area, solid geology is considered to be of low sensitivity.

#### Rockhead Elevation

- 38.3.7 Based on the preliminary ground investigation, rockhead elevation contours have been produced (Figures 38.3a-f) indicating a variable rockhead surface.
- 38.3.8 The route of the proposed Fastlink is characterised by high rockhead levels between Burnside (ch4400) and Stranog (ch9400), from which rockhead falls gently towards the south to 90mAOD at Coneyhatch and more steeply to the north to 40mAOD at Cleanhill Junction (ch12000). From Cowie (ch0) to Coneyhatch (ch2000) rockhead rises at a relatively constant gradient from 20mAOD to 90mAOD.
- 38.3.9 These data indicate that rock generally follows the landform/topography.

#### Drift (Superficial) Deposits

- 38.3.10 Published geological maps indicate that the proposed Fastlink route is generally located above glacial till including significant meltwater deposits, which is consistent with the results of the ground investigations.

#### *Drift Composition*

- 38.3.11 The ground investigations identified the presence of river alluvium and both cohesive (clay/silt-rich) and granular (sand and gravel) glacial deposits, as described in Table 38.6 below.

**Table 38.6 – Drift Composition Present in the Proposed Fastlink Route**

Drift Material	Description
Glacial Deposits	Cohesive glacial (boulder clay) deposits – characterised by stiff, stony, sandy, clayey, diamicton with metamorphic and igneous clasts, typically massive, but stratified and more sandy locally
	Granular glacial (meltwater) deposits – described as unsorted, generally unstratified, clay, sandy clay, or sand, usually containing many pebbles and boulders.
River Alluvium	Loose to very dense deposits ranging from silty sands to coarse gravels.

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- 38.3.12 Alluvial deposits were encountered along the Burn of Muchalls, Limpet Burn and Crynoch Burn. These areas are shown on BGS maps to represent a potential resource for sand and gravel. However, these alluvial deposits are not designated as sites of geological value and are considered to be of low to medium sensitivity.
- 38.3.13 Granular and cohesive glacial deposits are often interbedded and where this occurs it is referred to in the ES collectively as glacial deposits, being mixtures of sandy gravels, gravelly clay, cobbles and boulders. Glacial deposits are the most abundant drift material in the area, underlying the majority of the route. These are considered to be of low sensitivity.
- 38.3.14 The preliminary ground investigation indicated the presence of granular glacial deposits at the following locations within the Fastlink study area:
- from the northern foothills of the Hill of Megray (ch400) to the south of Coneyhatch (ch2000);
  - from Burnside (ch4400) to Meadowfield (ch5300); and
  - from south of Stoneyhill (ch6300) to north of Rothnick (ch8400) and from Stranog (ch9400) to Polston (ch10900).
- 38.3.15 No made ground was encountered during the intrusive site investigation.
- 38.3.16 BGS maps indicate the presence of extensive peat deposits in numerous locations as shown on Figures 38.2a-f. The preliminary ground investigation did not encounter any peat deposits along the Fastlink study area and, although considered to be unlikely, their presence, particularly localised peat presence, cannot be ruled out.

#### *Drift Thickness*

- 38.3.17 Drift thicknesses have been plotted using the ground investigation results and are presented in Figures 38.1a-f.
- 38.3.18 At Cowie (ch0) the drift thickness is of 9m and then thins to 4m in the vicinity of Forester's Croft (ch600). Along the rest of the Fastlink study area, drift thickness fluctuates between 1m and 7m , with localised maxima of 4m to the north of Coneyhatch (ch3000), 4-5m near the burn of Muchalls (ch4350), 5m to the north of Cookney (ch7000) and 7m at the northern end of the section (ch10800).

#### **Mineral Extractions**

- 38.3.19 No mineworkings or shaft locations were identified along the route alignment during the desk study. An absence of mining is consistent with the geological strata in the area.
- 38.3.20 Sand and gravel quarries were, however, identified. These features are of interest in relation to potential past landfilling and associated contamination (identified in the following section) and to potential future sand and gravel exploitations.

#### **Contaminated Land**

- 38.3.21 Information relevant to contaminated land is based on a desk study review of historical maps and consultations. Potential contaminated land features are summarised in Table 38.7 and shown on Figure 38.5a-b.
- 38.3.22 The main evidence of potential contamination in the immediate vicinity of the Fastlink comprises the Council Site 1 (quarry) which may have been backfilled, Council Site 2 (located to the west) which is a potential former landfill of unknown extent and the Stoneyhill Quarry which may also have been backfilled. The preliminary Ground Investigation consisted of installing boreholes along the proposed route and none of the borehole logs indicated the presence of potential contaminated land. However, because the potential contaminated land features listed below are not exactly

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along the proposed route itself, the ground investigation has not confirmed the presence of any of these potentially contaminated sites.

- 38.3.23 Beyond the land-take required directly for the proposed scheme, but within the study area, Forester's Croft Quarry, Crossley Quarry and Wedderhill Quarry have all potentially been backfilled. However, the proposed scheme is not anticipated to affect, or be affected by, these areas.

**Table 38.7 – Potentially Contaminated Sites along the Proposed Fastlink Route**

Potential contaminated land & location	Chainage	Desk study evidence	Ground investigation and laboratory testing
Forester's Croft Quarry	West of ch700	The quarry was only evident in 1967 and is no longer indicated.	Not investigated
Series 3 of steep slope – Forester's Croft	Adjacent to ch1200	Steep slopes only indicated from 1967 onwards.	Not investigated
Kempstone Hill	ch2400	None	Acid pH (4.9)
Cantlayhills	ch2900 and ch3000	None	Acid pH (5.0 and 5.2)
Burnside made ground	East of ch4400	Made ground indicated in 1963 only.	Not investigated
Burnside	ch4500	None	Acid pH (4.9)
Elrick made ground	West of ch5000	Made ground indicated on 1967 map only.	Not investigated
Stoneyhill Quarry	Adjacent to ch6450	Quarry only shown on 1964 maps. No longer evident.	Not investigated
Stoneyhill tank	East of ch6550	Tank only indicated in 1964.	Not investigated
Council Site 1 Stoneyhill	Adjacent ch6300	The council has recorded this site as a former quarry. However, no historical information was found. The quarry is no longer evident and may have been backfilled.	Not investigated
Council site 2 Stoneyhill	West of ch6500	The council has identified this site as the East Moss Bank of Cairnhill (Moss Side of Cairnhill) Landfill. The council indicated that this landfill may not have been licensed and no information on the type of waste was found.	Not investigated
Crossley Quarry	West of ch9100	Quarry indicated in 1971 and no longer evident.	Not investigated
North Rothnick	ch8800	None	Slightly acid pH (5.8)
Stranog Hill	ch9450	None	Slightly acid pH (5.3)
Wedderhill Quarry	East of ch10000	Quarry only indicated in 1967.	Not investigated
Crynoch steep slope	Adjacent to ch10350	Only indicated on 1967 map.	Not investigated
Blaikiewell made ground	ch11300	This made ground was only indicated in 1967.	Yes: slightly acid pH (5.7).

### Groundwater

- 38.3.24 The metamorphic and crystalline igneous rocks present beneath the Fastlink study area do not have the capacity to store or transmit large volumes of water, although some limited potential may exist in cracks and joints opened by weathering close to rockhead.
- 38.3.25 The alluvial deposits around the major watercourses crossed by the proposed scheme and significant deposits of glacial sand and gravel deposits may represent shallow aquifers capable of producing small scale private supplies. Groundwater in local drift deposits may also support important ecological resources.

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##### Groundwater Resources

- 38.3.26 Historical maps show that numerous wells were present along the route and many of them remain in use today. Figures 38.2a-f show currently active wells based on information collected by means of consultation with the local authority, consultation with landowners and information gathered during hydrological walkovers. These are for domestic water supply and/or agricultural use. Although the study area for the assessment extends to approximately 250m either side of the proposed route, the wells have been listed within an approximate distance of 1km to identify potential areas of high well density. This list is given in Table 38.9.
- 38.3.27 No high well density area has been identified within the land take for the Fastlink, but several high well density areas are found in the close vicinity of the proposed scheme :
- Near Hillock, to the east of ch2900 to 4000;
  - Near Cookney, to the west of ch5500 to ch6200;
  - Near Stoneyhill, to west of ch7000; and
  - Near Polston, to the west of ch10000 to ch10800.
- 38.3.28 There is a series of springs emerging from the northern valley of Limpet Burn. A walkover inspection of the Limpet Burn was undertaken on 19 July 2006. It identified this burn as a narrow watercourse within a wider U-shaped valley. A series of springs were observed on the northern slope of the valley, characterised by clear changes in vegetations and locally wet ground conditions. It is anticipated that surface run-off on this slope would occur during the winter. It is therefore important to consider Limpet Burn as a surface water system which extends beyond the burn channel and supports a shallow groundwater system and deeper groundwater inflows.
- 38.3.29 Groundwater is generally considered to be of low sensitivity. However, where wells and ecological areas of interest supported by groundwater are in the vicinity of the route, sensitivity is considered to be moderate to high, as shown in Table 38.9.
- 38.3.30 Groundwater in many areas of the Fastlink is considered to be of medium to high sensitivity due to the presence of wells/springs. Sensitivities are listed in Table 38.9 of Section 38.4 (Potential Impacts).
- 38.3.31 Private water supply questionnaires completed in April/May 2007 as part of the ongoing landowner consultation and incorporated within this assessment are provided in Appendix A38.1.

##### Groundwater Pattern

- 38.3.32 Approximately 25 boreholes were installed for groundwater monitoring during the preliminary ground investigations. Groundwater levels recorded in these boreholes have allowed groundwater level contour plans to be produced (Figures 38.2a-f).
- 38.3.33 Groundwater flow is mostly influenced by the topography, flowing from high areas to low. Groundwater levels fluctuate between 40mAOD and 130mAOD along the proposed route.
- 38.3.34 Stranog Hill (ch9000) and Hill of Muchalls (ch4200) are the highest topographical areas. Consequently, groundwater generally flows northwards from Stranog Hill (130mAOD) to the River Dee and southwards from Hill of Muchalls (100mAOD) to Stonehaven Bay. The groundwater gradient is generally very gentle with some minor variations between Stranog Hill and Hill of Muchalls. Artesian conditions were encountered locally around Burn of Muchalls and Cookney.

##### Groundwater Supporting Sensitive Habitats

- 38.3.35 The proposed scheme passes on the eastern edge of Fisherymyre, ch3000 to ch3400, which is considered to be of ecological importance for water vole and other wetland species. Further details on habitats are given in Chapter 40 (Ecology and Nature Conservation). Fisherymyre Wetland is



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supported by groundwater and was indicated on historical maps as a wetland area and on BGS maps as partially covered by peat. A walkover took place on 26 March 2007 and indicated that Fishermyre has reached a water equilibrium.

- 38.3.36 The walkover indicated that the central, flat part of Fishermyre is saturated, with surface water likely to be present all year. The central area may act as a reservoir for the site, which probably extends in all directions in wet periods, and recedes in dry periods. Fishermyre is not solely rainfall dependent, but also receives water (via surface drainage and/or groundwater flow) from the surrounding area.
- 38.3.37 The exact extent of the catchment which drains towards the central area is unknown at present. However, the walkover indicated that this catchment is local but larger than Fishermyre site itself and appear to be delimited by the local topography. In particular, an inflow was noted from the western side of Fishermyre.
- 38.3.38 Green Burn and other minor surface water features originate from the central 'reservoir' at Fishermyre and flow towards the east. The ground in the vicinity of these water courses was wet underfoot and appeared to be hydraulically connected to the surface water sources. It is expected that this area would also flood in periods of prolonged rainfall.
- 38.3.39 Based on these observations, it is clear that shallow groundwater supports the water balance of Fishermyre and is therefore assessed as being of high sensitivity.

## 38.4 Potential Impacts

### Geology

#### Solid Geological Succession

- 38.4.1 Table 38.8 below details the excavations required for the proposed Fastlink scheme. This table indicates that several excavations are likely to reach the solid geology.

**Table 38.8 – Excavated Areas within the Fastlink**

Road cuttings	Chainage	Maximum Excavation depth (mbgl)	Average drift thickness (mbgl)	Excavation reaches Solid Geology
Hill of Megray	ch0-1300	18.9	3-9	Yes
Megray Wood	ch1550-2250	12.2	3-4	Yes
Hill of Muchalls	ch3450-4350	5.3	3-4	Yes
C12K overbridge	ch4850-5250	7.0	3-3.5	Yes
Cookney	ch6000-6400	7.8	1.5-3	Yes
Burnside of Newhall	ch6950-7300	7.1	5-5.5	Yes
C13K overbridge	ch8200-8700	9.74	2-3	Yes
Stranog Hill	ch9400-9950	13.6	2-4	Yes

- 38.4.2 The solid geology is considered to be of low sensitivity. The impact magnitude, given the extent of the same strata types across the area, is negligible, and the overall significance of impacts on solid geology is therefore assessed as Negligible.

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##### *Impact of Blasting*

- 38.4.3 It is anticipated that rock blasting may be required where cuttings extend into bedrock. Although no areas of geological interest have been identified, blasting may impact on the hydrogeological characteristics of the rock mass. The relevant impacts of blasting in terms of disruption are addressed in Chapter 48 (Disruption due to Construction).
- 38.4.4 There are three major mechanisms whereby rock blasting can impact on rock structure:
- generation of new fractures in previously intact rock;
  - dilation of existing joints and discontinuities by the action of high pressure explosive gases; and
  - promotion of slip along unfavourably oriented joints and fracture surfaces.
- 38.4.5 All three mechanisms are vibration controlled. The generation of new fractures in previously intact rock and the dilation of existing joints and discontinuities occur close to the blast zone (termed 'near-field' effects), and promotions of slippage along unfavourably oriented joints can occur several hundreds of metres from the blast (termed 'far-field' effects).
- 38.4.6 Blasting effects on rock mass as described above may result in consequential impacts on hydrogeology by creating or changing groundwater pathways. Potential impacts could therefore accrue if the contractor opts for the use of explosives in the excavation of the cuttings where there are sensitive receptors and potentially significantly contaminated sites in relatively close proximity. There are two locations at potential risk in the Fastlink; at Cookney cut where the existing water table (groundwater) is expected to be above the final base of the cuttings without mitigation (i.e. proposed road drainage design which will locally lower the water table to prevent flooding), several private water supplies are present, and Council sites 1 and 2 and Stoneyhill Quarry are located adjacent to the two cuttings as shown on Figures 38.2d and 38.5b. Consequently, this area is considered of medium to high sensitivity and the blasting magnitude of impact is considered as medium. The overall significance of impact is Moderate. In all other areas, the significance of impact of blasting on the rock mass is expected to be Slight to Negligible.
- 38.4.7 Utilities/services such as gas and water mains, power cables, and pylons may be subject to vibration impacts from blasting. Allowable vibration limits set by service providers/utility companies will be relatively low, typically 10-15mm/sec.
- 38.4.8 Further detail and identification of further studies required in the next phase of the development are described in Appendix A8.2 (Blasting Assessment).

##### Drift (Superficial) Deposits

- 38.4.9 Table 38.8 above indicates that excavations are likely to affect drift deposits, in some cases extensively. The sensitivity of drift deposits (dependant on the nature of the drift), and the magnitude of predicted impact (dependant on the depth of cutting and the drift deposit thickness) vary from one cutting to another and are considered further below.
- 38.4.10 Glacial deposits underlie the majority of the route and are of low sensitivity. The impact magnitude of excavating through glacial deposits is estimated to be negligible to low. The overall significance of impact is therefore assessed to be Negligible to Negligible/Slight.
- 38.4.11 Alluvial deposits present along the Burn of Muchalls, Limpet Burn and Crynoch Burn are of low to medium sensitivity because these deposits are classified by the BGS as potential sand and gravel resources. The magnitude of impact is estimated to be negligible to low and the overall significance of impact is therefore assessed to be Slight.

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##### **Mineral Extraction**

- 38.4.12 The only potential mineral extraction areas identified are for future sand and gravel extraction. Impacts related to potential future extraction (river alluvium) was discussed in the previous section and found to be Slight.
- 38.4.13 Impacts associated with former quarries and quarries used for infilling or landfill with potentially contaminated material are discussed in the following section.

##### **Contaminated Land**

- 38.4.14 Areas of contaminated land are not environmentally sensitive receptors. However, there is potential for contaminated land to impact on human health and other environmental receptors, particularly during the construction phase. This is dependant on the type of contamination present.
- 38.4.15 The proposed road scheme is not expected to have any direct interaction with the areas of contaminated land located away from the road, therefore assessment of direct human interaction with contaminated land focuses on areas of potential contamination encountered on or immediately adjacent to the proposed Fastlink scheme. Gross contamination (significant levels of contamination likely to cause harm to the environment and human health) was not identified during the preliminary ground investigation.
- 38.4.16 Although the preliminary ground investigation did not identify any pollution along the proposed scheme (gas or groundwater), the main potential areas of contamination at and adjacent to the proposed Fastlink scheme (Figure 38.5a-b) comprise the Stoneyhill quarry and Council Site 1 (quarry) which may have both been backfilled and 'Council Site 2' (potential former landfill of unknown extent). These represent a potential hazard. The exact extent of infilled material is unknown. Without remediation measures, site workers could be exposed to this material and associated gases during the construction phase.

##### **Groundwater**

- 38.4.17 The impacts on groundwater are considered in relation to the presence of private groundwater supplies and/or ecological receptors supported by groundwater, and their proximity to the proposed road scheme.

##### Groundwater Quality

- 38.4.18 A significant number of wells have been identified within the Fastlink study area. These wells are listed in Table 38.9, where they are shown in relation to the topography and to the proposed scheme.
- 38.4.19 Table 38.9 indicates that groundwater, due to the presence of wells, is of medium to high sensitivity in many areas.
- 38.4.20 In the event of an accidental road spillage, particularly during construction, contamination may either migrate through the unsaturated zone or discharge directly into groundwater in cuttings and derogate groundwater quality. The magnitude of impacts on groundwater quality is determined as moderate where embankments or grade sections are proposed, and determined as high in areas of proposed road cuttings.
- 38.4.21 As a result, Substantial to Moderate significance of impacts have been assessed in several localised areas as shown on Table 38.9, if no appropriate mitigation measures are taken. These areas include East Lodge, Hillocks, Burn of Muchalls, C12k Overbridge, Cookney, Burnside of Newhall cutting and Stranog.

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- 38.4.22 Similarly, groundwater quality in the vicinity of Fishermyme Wetland is of high Sensitivity and the magnitude of the impact is high in the event of accidental spillage. This results in a Substantial impact significance, if no appropriate mitigation measures are taken.
- 38.4.23 Shallow groundwater, mainly in areas covered by sand and gravel or peat deposits, is at risk from the same contaminated run-off and spillages as surface waters, as covered in detail in Chapter 39 (Water Environment). However, the potential impact is reduced because groundwater does not take direct discharge of surface water run-off from the road, unlike watercourses, and would only be impacted upon if the road drainage design was inadequate to collect all run-off and overspill onto adjacent land occurred. Any potential groundwater quality impacts are therefore predicted to be temporary and of low magnitude. Given the low sensitivity of groundwater in the study area, the overall impact has been assessed to be Negligible to Slight significance.
- 38.4.24 Table 38.9 provides a list of wells and springs, including those identified during results of the private water supply consultation obtained during April and May 2007, and a summary of the potential impacts on the groundwater quality in the absence of mitigation measures.

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**Table 38.9 – Well and Spring Details**

Well \ Spring Number	Well \ Spring Location	Well \ Spring Distance from AWPR (m)	Well \ Spring Sensitivity	Well \ Spring Elevation (mAOD)	Existing Elevation at Proposed Road (mAOD)/ direction of land gradient fall from AWPR	Proposed elevation of road (mAOD) Cutting/ Embankment	Significance of impact	Comments from landowners consultation
F1	Milton Croft	743m/to the South	Low	35	Stonehaven Junction/South		Negligible/Slight	N/A
F2	East Lodge	220m/to the Northwest	Medium	52	Stonehaven Junction/Southeast		Moderate	One well is used for domestic supply and the water never runs out. – The well supplies mainly the East Lodge property (domestic use). However the next door neighbour uses some of this water for irrigating the garden.
F3	No 2 Glithno Cotter Hse	909m/to the West	Negligible	112	120/Southwest	121/Cutting	Slight	N/A
F4	No 1 Glithno Cotter Hse	1074m/to the West	Negligible	112	116/Southwest	116/Embankment	Negligible/Slight	N/A
F5	West Port Cottage	1289m/to the East	Negligible	98	108/East	117/Embankment	Negligible/Slight	N/A
F6	The Cattlemans Cottage	1289m/to the West	Negligible	123	111/Southeast	114/Embankment	Negligible/Slight	N/A
F7	Glithno	1223m/to the West	Negligible	123	109/Southeast	114/Embankment	Negligible/Slight	N/A
F8	Wyndford	644m/to the East	Negligible	105	110/North	119/Embankment	Negligible/Slight	N/A

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Well \Spring Number	Well \Spring Location	Well \Spring Distance from AWPR (m)	Well \Spring Sensitivity	Well \Spring Elevation (mAOD)	Existing Elevation at Proposed Road (mAOD)/ direction of land gradient fall from AWPR	Proposed elevation of road (mAOD) Cutting/ Embankment	Significance of impact	Comments from landowners consultation
F9	Howieshill	463m/to the East	Low	116	111/North	118/ Embankment	Slight/Moderate	Properties discussed here are: Backhill Croft, North Cookney Farm, Bents and Meadowfields, all belonging to Aberdeen Endowments Trust, while Blackbutts belongs to a different owner. North Cookney and Bents are on a main supply. Backhill Croft, Meadowfields and Blackbutts are supplied by 2 springs and the water never runs out with a fairly constant volume of water through out the seasons. The water is used for domestic supply and for animals. Aberdeen Council undertake regular water quality analysis.
F10	West Of Hillocks	347m/East	Low	108	112/East	116/ Embankment	Slight/Moderate	Included in F9 comments
F11	West Allochie	1123m/to the West	Negligible	138	113/East	112/Cutting	Slight	N/A
F12	Allochie	909m/to the West	Negligible	122	111/East	111/ Embankment	Negligible/Slight	N/A
F13	Burnorrachie Croft	396m/to the East	Low	85	91/Northeast	98/Embankment	Slight/Moderate	Included in F9 comments
F14	No 3 Elrick Cottage	260m/to the West	Medium	107	107/Northeast	97/Cutting	Moderate/Substantial	There are two cottages in the property. Cottage No. 3 is supplied by a spring. The other cottage is supplied by mains water.
F15	Newbigging	1371m/to the West	Negligible	133	107/Northeast	106/Cutting	Slight	N/A
F16	Blackbutts	1190m/to the East	Negligible	90	106/Southeast	99/Cutting	Slight	N/A
F17	South Hilton	1322m/to the West	Negligible	119	88/Northeast	97/Embankment	Negligible/Slight	N/A
F18	West Blackbutts	991m/to the East	Negligible	100	105/North	105/ Embankment	Negligible/Slight	N/A

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Well \Spring Number	Well \Spring Location	Well \Spring Distance from AWPR (m)	Well \Spring Sensitivity	Well \Spring Elevation (mAOD)	Existing Elevation at Proposed Road (mAOD)/ direction of land gradient fall from AWPR	Proposed elevation of road (mAOD) Cutting/ Embankment	Significance of impact	Comments from landowners consultation
F19	South Cookney	727m/to the West	Negligible	120	108/Northwest	109/ Embankment	Negligible/Slight	N/A
F20	Cookney Garage	578m/to the West	Negligible	146	129/South	125/Cutting	Slight	One well supplies the farm and is 35 feet (10.7 m) deep. The water never runs out. The well only supplies this property and the quality has been tested in the past.
F21	Sawmill North Cookney Cottage	248m/to the East	Medium	124	130/Northeast	129/Cutting	Moderate/Substantial	No contact details available for this landowner. Unable to confirm location and use of this supply.
F22	Bentiehowe	578m/to the West	Negligible	125	127/Northeast	124/Cutting	Slight	There are three wells in the property: 2 active near house and 1 abandoned well about 400 yards east of the house. The water is used.
F23	West Stoneyhill	479m/to the West	Low	134	129/Northeast	123/Cutting	Moderate	No further data is available at this stage. A letter was sent and the consultation is on going.
F24	Berrytop Farm	1305m/to the West	Negligible	141	120/West	120/ Embankment	Negligible/Slight	N/A
F25	East Rothnick	545m/to the East	Negligible No private water supply	114	138/Southeast	127/Cutting	Slight	The property is on mains water.
F26	Caravan Westside	1074m/to the West	Negligible	106	134/North	129/Cutting	Slight	N/A
F27	Stranog	248m/to the West	Negligible Well no longer used	143	144/Southeast	134/Cutting	Negligible/Slight	This property is on mains supply. The well is no longer used.
F28	Wederhill Cottages	1091m/to the East	Negligible	136	133/Southeast	136/ Embankment	Negligible/Slight	N/A
F29	Greens Of Crynoch	83m/to the East	Negligible Well no longer used	98	99/Northwest	108/ Embankment	Negligible/Slight	Same as F27

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Well \Spring Number	Well \Spring Location	Well \Spring Distance from AWPR (m)	Well \Spring Sensitivity	Well \Spring Elevation (mAOD)	Existing Elevation at Proposed Road (mAOD)/ direction of land gradient fall from AWPR	Proposed elevation of road (mAOD) Cutting/ Embankment	Significance of impact	Comments from landowners consultation
F30	Mill Of Crynoch	826m/to the West	Negligible	85	88/Southeast	92/Embankment	Negligible/Slight	N/A
F31	Invercrynoch	909m/to the West	Negligible	85	93/Southeast	101/Embankment	Negligible/Slight	N/A
F32	Invercrynoch Cottage	1123m/to the West	Negligible	92	80/Southeast	86/Embankment	Negligible/Slight	N/A
F33	Craigentath	512m/to the East	Negligible Well no longer used	105	83/Northwest	87/Embankment	Negligible	This property is on mains supply.
F34	Swellhead	1090m/to the East	Negligible	107	80/Northwest	84/Embankment	Negligible/Slight	N/A
F35	Polston	909m/to the West	Negligible	97	80/Northeast	84/Embankment	Negligible/Slight	N/A
F36	Bentiehowe	800m/to the west	Negligible	123	126/East	124/Cutting	Slight	Included in comment for F22
F37	Bentiehowe	740m/to the west	Negligible	123	126/East	124/Cutting	Slight	Included in comment for F22
F38	Cookney	130m/to the West	High	145	136/East	128/Cutting	Substantial	Included in comment for F20.
F39	Hill of Megray	N/A	N/A	N/A	N/A	N/A	N/A	No further data is available at this stage. A letter was sent and the consultation is on going.

38.4.25 N/A: No landowner consultation was carried out for these properties because wells are distant from the proposed route scheme and will not be affected



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#### Groundwater Flow

- 38.4.26 Local groundwater flows and levels can be affected in areas of deep road cutting that extend below local groundwater levels. The resultant dewatering of the groundwater bodies into the road drainage and locally reduced groundwater levels can affect habitats sustained by groundwater (e.g. wetlands), groundwater abstractions and in extreme cases can significantly reduce low flows in watercourses.
- 38.4.27 Several cuttings along the Fastlink are likely to affect groundwater flow, as shown in Table 38.10. In the areas of cutting the potential impact on local groundwater level is considered to be of medium magnitude, as the scale of reduction is likely to cause localised dewatering. The highest impacts are expected at Hill of Megray, C12K overbridge, Cookney and Stranog Hill. The impact significance varies from Moderate to Moderate/Substantial.

**Table 38.10 – Potential Impact of Cuttings on Groundwater Flow**

Cuttings	Groundwater Parameters			Groundwater Affected by Cutting/impact Magnitude	Receptor(s)' Sensitivity	Significance
	Max depth of cutting (mbgl)	Local monitoring	Estimated elevation of groundwater mAOD/mbgl			
Hill of Megray	18.9	Yes	45-110 / 2.0-9	Yes: most of the excavation intercepts groundwater/ medium.	High: one well near East Lodge (well F2) and other potential wells\springs (F39) near to the proposed route	Moderate/ Substantial
Megray Wood	12.2	Yes	110-100 / 7.0-1.5	Yes: estimated groundwater level likely to be intercepted by excavation/ medium.	Medium: wells F3 and F4 are distant from the proposed scheme	Moderate
Hill of Muchalls	5.3	Yes	100-110 / 1.5-2	Yes: most of the excavation intercepts groundwater/ medium.	Medium: well F12 is distant from the proposed scheme	Moderate
C12K overbridge	7.0	Yes	107-112/0-1.5	Yes: estimated groundwater level likely to be intercepted by excavation/ medium.	High: spring (F14) in proximity of C12k overbridge cutting	Moderate/Substantial
Cookney	7.8	No	115/2	Yes: contours believed to be incorrect in this area due to lack of monitoring, but the cutting is deep and likely to intercept groundwater/ medium.	High: well F38 and F21 are close to Cookney cutting. Well F20 is distant	Moderate/ Substantial
Burnside of Newhall	7.1	Yes	115/2.8-3.4	Yes: most of the excavation intercepts groundwater/ medium.	Medium: wells F36, F37, F22 and F23 are distant	Moderate
Stranog Hill	13.6	No	100-120/ 1.5-2.2	Yes: estimated groundwater level likely to be intercepted by excavation/ medium.	High: one well is present in close vicinity (well F27)	Moderate/ Substantial

38.4.28 The springs noted along Limpet Burn, based on topographical contours and originating from groundwater flowing from Kempstone Hill towards the southwest, are thought to contribute significantly to Limpet Burn base flow. As a consequence, these springs are considered to be of medium sensitivity. Although these springs are located away from road cuttings, the Megray Wood cut, which is shown in the above table to intercept groundwater, may disturb the local groundwater pattern and affect spring flow. The impact magnitude has been assessed as medium and the significance of impact is assessed as Moderate.

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##### Groundwater Supporting Habitats

- 38.4.29 The Fastlink is proposed to run along the extreme eastern part of Fishermyre which has been described in the baseline (sections 38.3.35 to 38.3.37) as a site of ecological importance highly dependant on groundwater, and was assessed as highly sensitive.
- 38.4.30 Consequently, there is a potential for the road to alter the water balance in this site and impact on the water quality. The magnitude of impact on the water balance and water quality is considered to be low to medium and the overall impact assessed as moderate to substantial significance.

##### Groundwater Flow and Potential Contaminated land

- 38.4.31 There are areas along the Fastlink study area where the groundwater zone of influence of road cutting (i.e. disturbance of groundwater flow caused by dewatering) may reach areas of potentially significant contaminated land (i.e. landfills or backfilled quarries), which could result in contamination flowing towards groundwater receptors, namely private water supplies, but also towards human receptors (workers operating during the construction phase). Where this occurs, there is potential for humans to come into direct contact with contamination transported by groundwater and issuing from contaminated land located away from the proposed road. Those areas are discussed below.

##### *Forester's Croft Quarry*

- 38.4.32 Forester's Croft Quarry is located approximately 30m to the west of the Hill of Megray cutting. At present, groundwater flow is likely to be towards the southwest and groundwater is therefore expected to be significantly intercepted by the cutting, reversing groundwater flow pattern towards the east (medium magnitude). There is uncertainty regarding the exact location of a private water supply well (F39) within the immediate area of the cutting. Contaminant migration via groundwater to this well is considered to be a possibility. Given the uncertainty, the wells are therefore considered to be of high sensitivity. The impact significance for groundwater is estimated to be Substantial.

##### *Council Site 1 and Council Site 2 and Stoneyhill quarry*

- 38.4.33 Two Council sites and one quarry are located approximately 50m to the northwest, 260m to the northeast and on the western edge of the Cookney cutting respectively. At present, groundwater flow is likely to be east – northeast, away from the proposed road. The cutting is indicated in Table 38.10 to intercept groundwater (medium magnitude). A private water supply well is present in the immediate vicinity of the cutting, but 50m to the south of Council site 2. The well is therefore of medium sensitivity. Contaminant migration via groundwater to this well is considered to have a Moderate/Substantial adverse impact significance. Another private groundwater supply (F38) is located approximately 150 m to the south of Council Site 1 (low sensitivity) and 130m to the west of the Cookney cutting. Location of the well is shown in Figure 38.2d. At present the well does not appear to lie in between the potentially contaminated sites and Cookney cutting. In addition, based on the available hydrogeological information (Figure 38.2d), in the Cookney cutting area the piezometric level does not appear to be intercepted by the proposed route levels (Table 38.10). Therefore contamination migration via groundwater to this well is considered to have a Negligible adverse impact significance in relation to the proposed route.

##### *Wedderhill Quarry*

- 38.4.34 Wedderhill Quarry is located approximately 100m to the northeast of the Stranog Hill cutting. At present, groundwater flow is likely to be towards the north. Groundwater is likely to be intercepted by the cutting, potentially modifying groundwater flow direction (medium magnitude). A private water supply is present approximately 200m to the north of the quarry; hence new migration of contamination towards this well is unlikely to occur and the well is considered of low sensitivity. The resulting significance of impact is Slight. However, construction workers are at risk of contact with potentially contaminated groundwater.

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### **38.5 Mitigation**

38.5.1 The mitigation measures described below are proposed to minimise or eliminate the potential impacts on geology, contaminated land and groundwater arising from the Fastlink.

#### **Solid Geology**

38.5.2 The assessment indicates potentially Negligible impacts with respect to the local solid geology and therefore no mitigation measures are required.

#### Impact of Blasting

38.5.3 As noted in Section 38.4 (Potential Impacts), rock blasting has the potential to impact on the hydrogeology by creating or changing groundwater pathways, and on utilities/services due to vibration. In Cookney cut, identified potentially at risk in paragraph 38.4.8, mitigation measures during construction, should blasting be proposed, will include the use of technical methodologies such as use of low-explosive loading densities, following to current British Standards and regulations. These technical considerations are provided in Appendix A8.2 (Blasting Assessment).

#### **Drift Deposits**

38.5.4 As Negligible to Negligible/Slight impact significance is predicted for the drift deposits, no mitigation measures are required.

#### **Contaminated Land**

38.5.5 Any hazardous contaminated made ground/backfill encountered during the earthworks required for construction of the proposed scheme will be treated or removed to avoid risks to construction workers. This material is generally unsuitable for construction for geotechnical reasons. Areas where further investigation will be needed as part of the mitigation strategy are identified below.

38.5.6 The proposed scheme may cross a number of areas of suspected contaminated ground, as discussed in the previous sections. Although no areas of gross contamination, which may present significant human health or environmental risks, were identified during the preliminary ground investigation, additional investigation will be required in the areas of potential contamination prior to construction, to further define the contamination and to allow the design of any required remedial measures.

38.5.7 Further investigations are recommended to ensure that the required earthworks do not extend into the landfilled area at Council Site 2. Depending on the proximity and nature of contamination present, mitigation measures may be required.

38.5.8 Although not envisaged, the earthworks required for construction of the scheme may encounter other potentially contaminated ground, not currently identified. Should any contaminated land be encountered, its treatment and/or removal would be required as part of the Employer's Requirements for Construction.

38.5.9 For all contaminated areas, the Contractor will be required to prepare Method Statements, which will be submitted to the appropriate regulatory authorities for approval, with compliance monitored by the Employer's Representative. Potentially contaminated materials will be tested and removed if necessary in a controlled manner in accordance with the Duty of Care Regulations (The Environmental Protection (Duty of Care) Amendment (Scotland) Regulations, 2003).

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- 38.5.10 The Employer's Requirements will include measures to prevent any contaminated run-off or contaminated groundwater produced by the works from entering and polluting the local drainage system as further detailed in Table 38.11. Any contaminated waters produced will be removed for off-site disposal at an appropriate facility in accordance with waste management regulations, or treated on-site and discharged in compliance with a Consent to Discharge issued by SEPA. Further details on measures to avoid contamination of watercourses during construction are provided in Chapter 48 (Disruption due to Construction).

**Table 38.11 – Mitigation Measures for Contaminated Land**

Type of Measure	Description
<b>Prevent</b>	The adoption of procedures to deal with any hazardous ground and gas being encountered and the removal of potentially contaminated materials to prevent the release of contaminated materials into the environment. Removal and disposal off-site of any contaminated waters to prevent contaminated run-off or groundwater produced by the Works, entering and polluting the drainage system.
<b>Reduce</b>	Adoption of soil handling procedures during construction to contain contaminated soil and reduce potentially adverse impacts on soil quality and the potential for spread of contamination to impact workers, the public and adjacent land or controlled water.
<b>Offset</b>	Only remove contaminated soil from the development where there is a demonstrable need via environmental risk assessment for risk management. Otherwise where suitable, made ground or moderately contaminated soil may be contained within the construction.
<b>Enhance</b>	None

#### Mineral Extraction

- 38.5.11 No mitigation is required.

#### Groundwater

##### Groundwater Quality

- 38.5.12 Road drainage features along the Hillock area of high well density, identified in the baseline study, will be lined to prevent possible groundwater contamination. In addition, the sections of the route in the vicinity of wells where Substantial to Moderate impacts have been assessed should also be lined as summarised below:
- ch0 to ch600 near East Lodge and Hill of Megray (wells F2 and F39);
  - ch2900 to ch4000 near Hillock (F8, F9, F10);
  - ch4800 to ch5200 near to Elrick Farm (spring F14);
  - ch6000 to ch6550 near along Cookney cut (well F21 and F38);
  - ch6900 to ch7300 along Burnside of Newhall cut (wells F22 and F23);
  - ch9800 to ch9950 along Stranog Hill cut (well F27); and
  - ch1150 to ch1400 near Greens of Crynoch (well F29).
- 38.5.13 In addition, the section of the route in the vicinity of Fishermyle Wetland (ch2800 to 3600) will also be lined to protect the water quality of this ecological site.
- 38.5.14 Mitigation measures to prevent or minimise the potential for contamination of local groundwaters elsewhere during construction or operation are the same as those required for surface water protection and are detailed in Chapter 39 (Water Environment) and Chapter 48 (Disruption due to Construction).

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##### Groundwater Flow

- 38.5.15 The local impacts on groundwater levels associated with a number of proposed road cuttings within the Fastlink can be reduced slightly by optimising the drainage design. However, intercepting groundwater that would otherwise flood the road necessitates the reduction of the immediate groundwater level to the level of the road.
- 38.5.16 The data currently available, which includes private water supplies identified during the consultation undertaken in April and May 2007, suggest that impacts would be likely on groundwater levels adjacent to cuts, which may affect nearby groundwater supplies. A more extensive groundwater monitoring network will be installed in areas identified in Table 38.10, prior to construction, to clarify the level of impact and provide a better understanding of groundwater flow and groundwater quality. This will enable the potential impact on private groundwater supplies to be determined with more accuracy, and mitigation developed as appropriate.
- 38.5.17 Based on the groundwater monitoring and assessment available to date, further mitigation measures may be required in relation to specific groundwater supplies. It may be necessary to undertake monitoring of selected groundwater supply sources during construction and into the start of the operational phase to assess whether there has been any discernible effect on the supply. If yields of water supplies are shown to be reduced, mitigation measures would be likely to include an alternative or replacement supply.

##### Groundwater Supporting Sensitive habitats

- 38.5.18 The bottom sections of the road embankment (ch3000-3400m) running along Fishermyre will be constructed using permeable materials in order to allow shallow groundwater to flow towards the east and ensure that the road does not act as a barrier. Drains and surface water features flowing out of Fishermyre should be culverted beneath the Fastlink to minimise disturbances to the water balance of the site.
- 38.5.19 Piezometers (to monitor groundwater level and quality) will be installed in Fishermyre along the road line and adjacent areas of the site, prior to construction. The piezometers will be monitored before, during and after the construction of the proposed road scheme to define a baseline hydrogeological condition for the site, and to assess any change in water levels. These measures will complement hydrological mitigation measures detailed in Chapter 39 (Water Environment).

##### Groundwater Flow and Potential Contaminated Land

- 38.5.20 Changes in groundwater flow conditions and potential migration of contaminants towards cuttings may potentially impact on construction workers at Hill of Megray, Cookney and Stranog cuttings. There is also a potential impact on wells located near Cookney cutting because of the presence of Council 2 Site.
- 38.5.21 The measures proposed in paragraph 38.5.16 are also applicable here (monitoring network). The groundwater flow and quality monitoring data will provide the background information to determine the zone of influence of each cutting. If potentially contaminated land is within the zone of influence, a ground investigation will then be required to determine the exact nature of any contamination. If required, a risk assessment will be carried out and further measures will be proposed, as appropriate.
- 38.5.22 If groundwater becomes contaminated and is then intercepted by the road drainage, treatment will be required before the drainage can be discharged.

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#### **38.6 Residual Impacts**

38.6.1 Residual impacts are the impacts that remain once the mitigation measures described in section 38.5 have been implemented.

##### **Solid Geology**

###### Solid Geological Succession

38.6.2 The residual impact on local solid geology is anticipated to be Negligible.

###### *Blasting*

38.6.3 Mitigation measures have been proposed in paragraph 38.5.3 to reduce blasting impacts on the rock mass. If these measures are implemented, the residual impact at Cookney cut is assessed as Slight.

###### Drift (Superficial) Deposits

38.6.4 There are Negligible to Negligible/Slight anticipated residual impacts on local drift deposits.

##### **Contaminated Land**

38.6.5 The mitigation measures for the management of known or encountered occurrences of contaminated ground during construction will ensure that any human or environmental risks are appropriately addressed. At the same time, those mitigations may tackle in-situ ground contamination and may consequently improve the condition of those sites. The residual impacts may therefore be considered as Slight (beneficial) where any existing contaminated ground is treated or removed.

##### **Mineral Extraction**

38.6.6 Future quarries in drift deposits have been assessed in paragraph 38.6.4 (Negligible/Slight residual impacts) and past landfill issues discussed in paragraph 38.6.5 (Slight (beneficial) residual impacts).

##### **Groundwater**

###### Groundwater Quality

38.6.7 All drainage features in areas of high well density and where groundwater supports sites of ecological interest will require to be lined and in consequence residual impacts are considered Slight.

38.6.8 Potential impacts on shallow groundwater quality in sand and gravel aquifers are mitigated by the same management procedures as proposed for protection of surface waters. It is predicted that these measures will result in Negligible residual impacts.

###### Groundwater Flow

38.6.9 Groundwater levels will be lowered in the vicinity of road cuttings which extend below the water table. The only potential impact of significance associated with this effect is the impact on private groundwater supplies yields in the cutting areas. It is anticipated that the characterisation of the local groundwater conditions and supply details, followed by provision of alternative or replacement of the affected supplies if necessary, will appropriately mitigate impacts on private groundwater supplies. This will result in Negligible residual impacts.

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#### Groundwater Supporting Sensitive Habitats

- 38.6.10 The residual impact at Fishermyre is considered to be Slight. In addition, monitoring of the site will be conducted pre, post and during construction to ensure the effectiveness of mitigation and to provide further information regarding the hydrological and groundwater connectivity of the moss. Further information on the hydrological functioning of the moss can be found in Appendix A39.1 (Surface Water Hydrology).

#### Groundwater Flow and Potential Contaminated Land

- 38.6.11 Once monitoring, ground investigations, risk assessments and any other measures considered necessary have been undertaken, it is anticipated that residual impacts on both humans and private water supplies will be Negligible.

### **38.7 References**

BGS – British Geological Survey. Drift and Solid maps – Aberdeen – Sheet 67.

BGS – NJ80NE, NJ80SE, NO89NE, NO89SE and NO88NE drift & solid maps and associated borehole logs descriptions.

Historical maps of the area (First edition until current Ordnance Survey) at 1:10,000 and 1:2,500 scale.

Mouchel Parkman (2003) Western Peripheral Route (western leg) – Stage 2 Addendum Environmental Assessment/ Mouchel Parkman.