

## **Chapter 10: Hydrology**

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## Chapter 10: Hydrology

### 10.1 Introduction

This chapter assesses the impact on the hydrological environment of Herds Hill Wind Farm and lays out the likely effects resulting from the construction and operation of this Proposed Development. Mitigation measures will also be discussed in this section which can be put in place to reduce the impact.

- In summary, this chapter will cover the following:
- Summary of scoping consultation responses;
- Baseline of the Proposed Development and the surrounding environment;
- Flood risk;
- Private Water Supply Assessment; and
- Peat.

### 10.2 Scoping and Consultation

The scoping opinion from the Council’s Flood Risk Management Team Leader and the Environmental Health Officer are summarised below in Table 10.1.

**Table 10.1: Consultation responses relating to hydrology.**

Consultee	Response	Applicant Comment
Dumfries and Galloway Council Flood Risk Management Team Leader 12 March 2023	No Objection but recommend: a) management of surface runoff from the site during and after construction. b) consideration of the runoff rate and impact on downstream. c) hydrological assessment of culverts in terms of capacity. d) maintenance plan for drains and culverts. e) Access tracks should not act as a flow route for surface water.	a) A management plan regarding surface runoff during and after construction will be included in the Construction and Environmental Management Plan (CEMP), the submission of which will be secured with a planning condition. b) The runoff rate and impacts downstream is considered on pages 9 and 14 and mitigation measures will be offered in the CEMP. This will mainly consist of well-designed access tracks. c) Watercourse crossing and the use of culverts are discussed in Technical Appendix 10.1. d) The CEMP will include details regarding maintenance plan for drains and culverts. e) The placement of access tracks away from watercourses has ensured that

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		they will not act as flow route for surface water.
Dumfries and Galloway Council Environmental Health Officer 19 June 2023	No Objection but recommend: a) site specific impact assessment regarding the potential impact on private water supplies to enable them to comment fully. b) Applicant to ensure the development does not have an adverse effect on private water supplies or the quality of water from them. The Developer should produce a list of private water supplies in the area and quantify the risk to these. If any adverse impact is identified, the Developer should propose a programme of works to mitigate against these impacts.	Details regarding the assessment and potential impact on private water supplies are included in the Water Resources Section on Page 8 and also Table 10.5.

### 10.3 Baseline Conditions

#### Site Area

The Proposed Development is located within the administrative area of Dumfries and Galloway and lies 5.06km west of Sanquhar and 2.68km south of Kirkconnel. The site consists of open moorland and rough grazing.

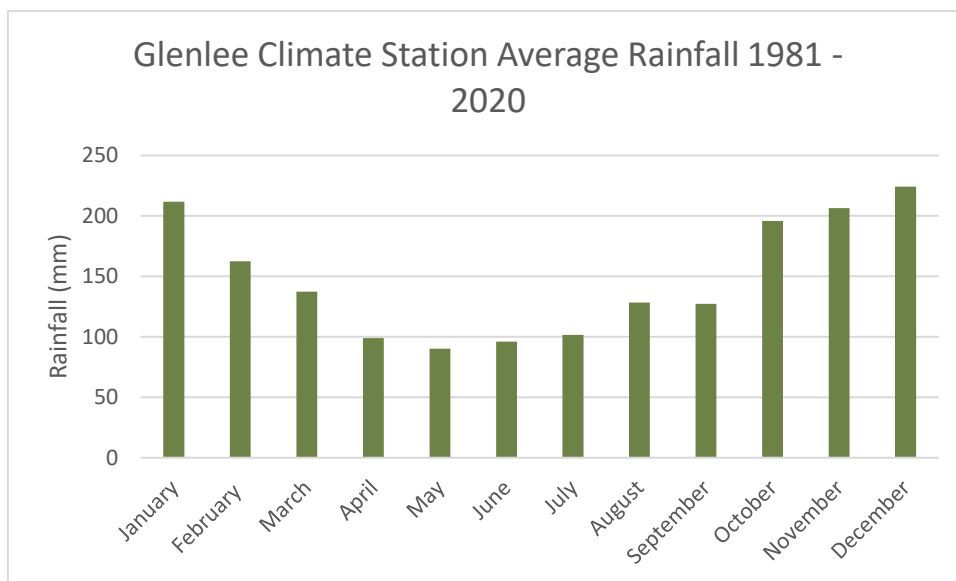
The topographic high is reached in the southwest of the site near Black Hill, where the Above Ordnance Datum (AOD) is 427m, however the section of site where infrastructure is located ranges between 243m and 342m AOD.

The hydrological study area incorporates the site boundary and surrounding areas. This is to ensure that the upper and lower reaches of the watercourse catchments present in the area are assessed. This is shown in Figure 10.1.

#### Climate

Glenlee Climate Station is the closest station to the Proposed Development, located 30km southwest from the turbines, at an elevation of 55m above mean sea level. The annual total rainfall at Glenlee is 1,780.61mm, however due to Herds Hill Wind Farm being situated at 340m AOD, it is considered that the rainfall experienced at the Proposed Development will be higher than that recorded at Glenlee climate station due to topographic influence.





**Graph 10.1: Glenlee Climate Station Average Rainfall 1981 - 2020**

Designated Sites

There are no designated sites within the Proposed Development boundary. Table 10.2 sets out designated areas within the vicinity of the site, the closest of which being the North Lowther Uplands SSSI which lies 2.5km to the north of the site.

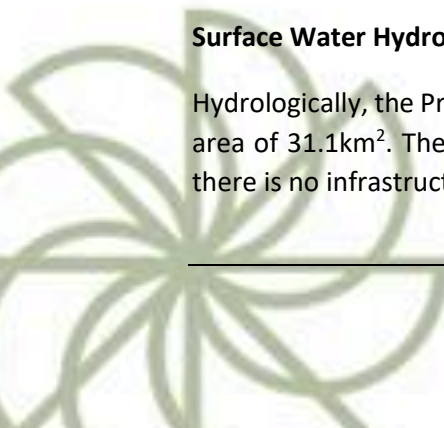
**Table 10.2: Environmental Designations surrounding the Proposed Development.**

Name	Type	Distance
North Lowther Uplands	SSSI & SPA	2.5km North
Back Wood	SSSI	4.3km Northeast
Mennock Water	SSSI	6.3km East
Polhote and Polneul Burns	SSSI	3.5km West
Lagrae Burn	SSSI	5km Northwest
Muirkirk Uplands	SSSI & SPA	8.5km Northwest
Upper Nirthsdale Woods	SPA	4.3km Northeast

None of the designated sites near the Proposed Development are hydrologically connected and can subsequently be scoped out, therefore designated sites have not been considered further in this chapter.

**Surface Water Hydrology**

Hydrologically, the Proposed Development lies within the Kello Water catchment which covers a total area of 31.1km<sup>2</sup>. The Euchan Water catchment lies within the south of the site boundary, however there is no infrastructure placed within this catchment.



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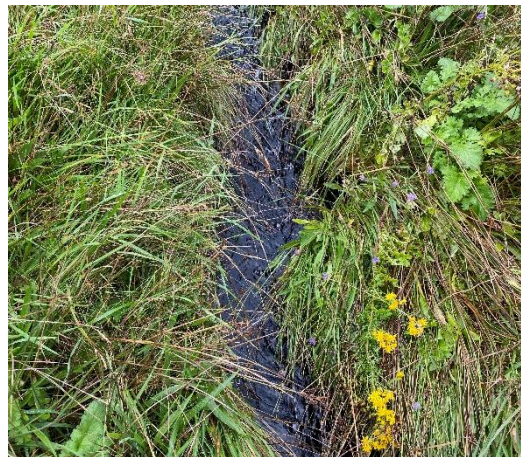
The watercourses that sit within the Proposed Development are all upland tributaries of the River Nith and these sub catchments are described below. The River Nith discharges into the Solway Firth at Glencaple.

### Kello Water

The Kello Water, approximately 13.8km in length, enters the River Nith at NS 74679 11630 draining predominately from an area of open moorland. The source of the Kello Water is from the northern slopes of Blacklorg Hill (681 m AOD) and the eastern slope of Greenlorg Hill (598 m AOD). The river flows north easterly joining the River Nith downstream at Kelloholm. A ridge exists between the Blacklorg Hill and Greenlorg Hill falling within the Kello Water catchment boundary.

The Proposed Development extends along the northeastern and eastern slopes of Brunt Rig, with Turbine 3 being located at the apex of this peak. Quintin's Burn is a tributary of the Kello Water with the water draining from the northeastern and eastern slopes of Brunt Rig. Thwarter Burn and Birk Burn also run through the Proposed Development and form part of the Kello Water catchment. Birk Burn runs along the eastern slopes of Brunt Rig, while Thwarter Burn's source is located on Black Hill and runs easterly from this peak.

### **Plate 10.1: Quintin's Burn and Thwarter Burn, a tributary of Kello Water.**



Quintin's Burn and Thwarter Burn meet to form one watercourse at NS 73354 08943. At this point the channel form is a shallow vee with stable banks. The bed material consisted of coarse gravels. Bankfull width is 0.65 m and bankfull height is 0.7m. During a site visit (19/09/2023), the water width was 0.65 m, while the depth measured 0.25m. The riparian corridor is approximately 50 m wide and comprised of fenced moorland with sparse native trees. The watercourse enters Kello Water at NS 73213 09930. A further site visit was carried out in October to conduct a watercourse crossing assessment which is detailed in Appendix 1.10 of this Chapter.

### Euchan Water

The Euchan Water, approximately 14.5km in length, enters the River Nith at NS 77997 09171 and drains both areas of forestry plantation and open moorland. The source of the Euchan Water is from the eastern slopes of Blacklorg Hill (681 m AOD), Littledodd Hill (600 m AOD) and Blackshoulder (558 m AOD). The river flows eastwards joining the River Nith at Sanquhar.

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Approximately 200m of Barr Burn is located within the south of the site boundary. This flows along the eastern slopes of Black Hill and joins Euchar Water at NS 77422 08926. Due to such a minor section of this watercourse being within the boundary of the Proposed Development and no infrastructure being placed within this catchment, no further assessment has been conducted on the Euchar Water catchment.

Both catchments are shown in Figure 10.1 alongside the site boundary and infrastructure for reference.

### Hydrological Regime

#### Effects of Forestry

The Proposed Development consists of moorland and rough grazing, with no areas of forestry within the site boundary. Given this, there is no requirement to fell any trees as part of the Proposed Development and therefore there will be no changes to runoff as there will be no alterations to forestry.

#### Flow Estimation

Peak flows (up to 200 year + climate change (CC)) have been estimated for the key catchments described above using the Flood Estimation Handbook Rainfall Runoff (FEH RR) method for a range of return periods, with the results presented in Table 10.3 below. Catchment descriptors were derived from the FEH Web Service and used for calculating peak flows for the identified catchments.

To ensure the estimated peak runoff data is accurate, peak flows have also been presented using the guidance from the Institute of Hydrology (IoH) Flood estimation for small catchments (1994). This technique calculates specific run-off rates for stated return periods but is specifically designed for smaller rural catchment areas. Catchment boundaries have been used in their entirety which allows for a more representative result.

**Table 10.3 Estimated peak runoff for site catchments calculated using the methodology prescribed by the FEH RR IoH Report No. 124.**

Estimated peak runoff (m <sup>3</sup> /s) for stated return period										
Catchment	Area (km <sup>2</sup> )	Method	2 (QMED)	5	10	25	50	100	200	200 + CC
Kello Water	30.93	FEH RR	27.51	40.26	48.72	60.95	71.68	82.09	94.76	113.712
		IHI24	29.40	35.86	45.87	58.47	58.80	70.10	84.96	123.28

Base Flow Index (BFI) and Standard Percentage Runoff (SPR) data was taken from the FEH Web Service. The BFI is a measure of the proportion of a catchment's long-term runoff that derives from stored sources, with the BFI ranging from 0.1 in relatively impermeable clay catchments to 0.99 in highly permeable catchments. The SPR values represent the percentage of rainfall that is likely to contribute to runoff.

Figure 10.2 provides information on the flow direction of the surface runoff within the area of the Proposed Development and clearly illustrates the influence of topography on the direction of surface water runoff across the Proposed Development.

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### Flood Risk – Fluvial Flooding Sources

Flood information available on the SEPA Flood Map (2015) indicates that the main stem of the Kello Water is at high – 0.5 % (1 in 200 year) likelihood of fluvial (watercourse) flooding in any given year. The areas indicated do not extend much beyond the river course itself (restricted to riparian corridor). No other tributaries of the catchments have been highlighted as being at a risk of fluvial flooding.

The overall fluvial derived flood risk within the Proposed Development area is considered to be low. A combination of relatively few headwater catchments within the site boundary and the size and scale of the Proposed Development has meant that there is a reduced risk of potential fluvial flooding impacts downstream.

### Flood Risk – Pluvial Flooding Sources

Still using the SEPA Flood Map (2015), sections of the headwater streams of the Kello Water have been highlighted as high likelihood of surface water flooding. This is specifically near Birk Burn but only relates to very small areas which coincide with areas likely to be hollows and depressions.

### Flood Risk – Coastal Flooding Sources

The Proposed Development is located approximately 50km from the nearest coast and due to this distance along with the topographical position, above 200 m AOD, the Proposed Development will not be affected by tidal flooding.

### Flood Risk – Groundwater Flooding Sources

Flood information available on the SEPA website does not indicate the likelihood of groundwater flooding however historical records do indicate in the lower catchment of the Nith that groundwater flooding was experienced following the cessation of mining activity.

### Cumulative Flood Risk

Kirkconnel has been identified as a Potentially Vulnerable Area (14/01) (SEPA, 2016) to flood risk, and it is approximately 3.5km downstream of the Proposed Development. The area identified is vulnerable from flooding from the River Nith and three of its tributaries including Kello Water. The presence of the proposed infrastructure to watercourses and the potential influence of this on existing runoff and flow regimes could, without appropriate drainage mitigation being installed, increase the flood risk to the downstream catchments.

## Water Quality

Kello Water has been classified under SEPA's River Basin Management Plans (RBMP) (SEPA, 2009 – 2015). The details of the watercourses that are within or downstream of the Proposed Development and are classified under the RBMP classification scheme are provided in Table 10.4 below.

**Table 10.4: RBMP classification of watercourses within the vicinity of the Proposed Development.**

River	Length (km)	Current Ecological Status (2020)	Reasons for classification
Kello Water	14.7	Good	Good overall ecology and high overall hydrology status.

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### Water Resources

The Proposed Development lies within an area designated as a Drinking Water Protection Area for Groundwater.

Two properties with Private Water Supplies (PWS) were identified by Dumfries and Galloway Council (extract from their Private Water Supplies Register) within a 3km buffer of the Proposed Development. Neither of these properties are located within the site boundary and are not hydraulically connected to any of the proposed works. Details of these are found below in Table 10.5 and are shown in Figures 10.1 and 10.3a and b in more detail.

**Table 10.5: Private Water Supplies within 3km of the Proposed Development.**

PWS ID	Property Name	Type of Supply	Within Site?	Hydrologically Connected?	Distance from Infrastructure (km)	Property Requires Further Assessment
1	Glenmaddie	Groundwater Spring	No	No	1.4	No – Up-gradient of infrastructure within a hydrologically separate sub catchment
2	Glenglass Cottage	Unconfirmed Groundwater Spring	No	No	2.45	No – Up-gradient of infrastructure within a hydrologically separate sub catchment

All private water supplies within the hydrological study area are topographically and hydrologically separated from the Proposed Development. Given this, PWS are not considered further in this chapter.

### Soil and Peat

The generalised soil type according to the National Soil Map of Scotland within the Proposed Development includes humus-iron podzols, mineral gleys, peaty gleys and peaty podzols. These are presented in Figure 10.4. Humus-iron podzols line the banks of the Kello Water, while the upper catchment of Thwarter Burn can be identified by peaty podzols. The wind turbines and associated infrastructure are mainly located on mineral gleys and peaty gleys.

Using the Carbon and Peatland 2016 map produced by the James Hutton Institute shown in Figure 10.5, it indicates that the site mainly consists of Class 3 peat (68.7%) and Class 0 peat (28.7%). The plan shows that there is 0.3 hectares of Class 1 peat located along the existing access track to the north. Turbines 1 and 3 are located on Class 3 peat, while Turbine 2 is sited on Class 0.

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### Geology

The following geological information has been obtained from digital data available from the British Geological Survey (BGS). This indicates that the bedrock geology of the Proposed Development is separated by vertical strips loosely following the catchment areas separated into; Kirkcolm Formation – Wacke (Afton Water and Kello Water), Clackmannan Group – Sedimentary Rock Cycles and Scottish Coal Measures Group – Mudstone, siltstone, coal and ironstone. The majority of the site is Kirkcolm Formation.

The superficial deposits within the Proposed Development comprise of peat and till. Large extents of the surrounding area have no superficial deposits recorded as shown on Figure 10.6.

### Hydrogeology

Groundwater information has been recorded using published data sources. The BGS map on superficial and bedrock aquifer and groundwater bodies (BGS, 2015) shows that the Proposed Development borders two bedrock aquifer groups. Carboniferous - extensively mined for coal to the north and Silurian-Ordovician to the south. The Carboniferous aquifer group is a sedimentary aquifer that is dominantly noncalcareous, of low permeability and of moderate productivity. Silurian – Ordovician is associated with low aquifer productivity and where present, water flow is predominantly through fractures and other discontinuities including surface weathered zones.

### Groundwater Dependant Terrestrial Ecosystems (GWDTE)

A review and assessment of Groundwater Dependant Terrestrial Ecosystems (GWDTE) of the Proposed Development has been undertaken by ecological consultants Starling Learning with details provided in Section 8: Ecology.

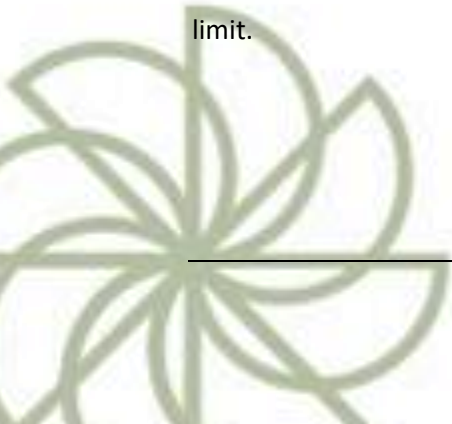
## 10.4 Identification and Evaluation of Key Impacts

The Proposed Development will introduce physical changes which have the potential to alter the hydrological characteristics within the Proposed Development. During the construction phase and to a lesser extent during the operational phase, potential sources of pollution will be present.

Typically, the construction phase will involve a period of earthworks inclusive of track construction and excavations for forming turbine bases. Following this, the turbine bases and infrastructure will be installed and finally the turbines will be transported to site and erected.

### Mitigation by Design

As the site consists of no Class 1 peat, this did not need to be accounted for when placing turbine infrastructure. All turbines are located out with the buffer limit of 50m. Distances were calculated using ArcGIS Pro by first identifying the watercourses as linear features and then applying a blanket buffer of 50m to these features. Table 10.6 confirms that all turbines are located outside this buffer limit.



**Table 10.6: Distance of turbines from identified hydrological features.**

<b>Turbine ID</b>	<b>Turbine distance from watercourse (inclusive of 50 m buffer)</b>
1	67.45m
2	118.16m
3	204.55m

The Proposed Development includes an existing borrow pit, which was used for the construction of Sanquhar Community Wind Farm (Borrow Pit E). This area was identified as it is located over 50m from a watercourse and is on flat ground to minimise surface water ingress. By utilising this area again, the risks are known, it stops further disturbance to the landscape, and it minimises the potential impact on the natural hydrological features. 2.29km of new track including hardstanding will be created to allow access to the turbines and to the substation and control room. These are all located out with the 50m of watercourses, except for tracks utilised for watercourse crossings. This is assessed in Technical Appendix 10.1 and mitigation opportunities will also be outlined in the CEMP. This will be prepared post consent as part of the conditions discharge process.

The temporary construction compound is located within the 50m watercourse buffer of Birk Burn. This has been sited on an existing hardstand area. By using this existing hard stand area, it minimises any further potential disturbance to the landscape, or watercourse. During the construction period, when this area will be utilised, mitigation measures will be put in place to ensure minimal impact to Birk Burn. These will be outlined in the CEMP.

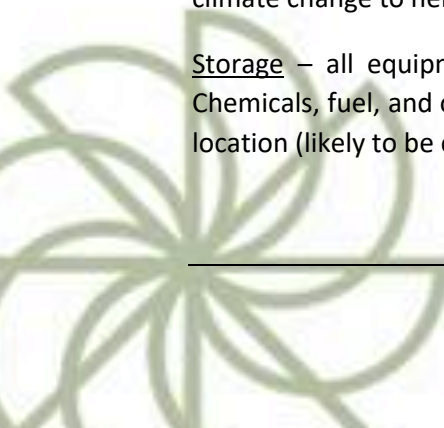
A summary of the general site pollution control measures which will be included within the CEMP are described below and have been assumed to be part of the proposals when the residual effects and their significance are reported. Several of the embedded mitigation measures described in the following paragraphs can also be adopted during the operational phase of the Proposed Development.

### General Site Pollution Control

A site-specific CEMP will ensure that industry good practice measures are put in place and activities carried out in such a manner as to prevent or minimise effects on the surface and groundwater environment. The CEMP will be prepared prior to commencement of construction, for approval by the local authority and SEPA, and it will include, but is not limited to, the following information:

Drainage – all runoff derived from construction activities and site infrastructure will not be allowed to directly enter the natural drainage network. All runoff will be adequately treated via a suitably designed drainage scheme with appropriate sediment and pollution management measures. The Proposed Development is situated in an upland hydrological area, and it is imperative that the drainage infrastructure is designed to accommodate storm flows based on a 1 in 200 year event plus climate change to help maintain the existing hydrological regime;

Storage – all equipment, materials and chemicals will be stored away from any watercourses. Chemicals, fuel, and oil stores will be sited on impervious bases with a secured bund at a designated location (likely to be construction compound on an area of existing hardstand);



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Vehicles and Refuelling – standing machinery will have drip trays placed underneath to prevent oil and fuel leaks causing pollution. Where practicable, refuelling of vehicles and machinery will be carried out in designated areas, on an impermeable surface, and away from any watercourses;

Maintenance – maintenance to construction plant will be carried out in designated zones, on an impermeable surface away from any watercourses or drainage, unless vehicles have broken down necessitating maintenance at the point of breakdown, where special precautions will be taken;

Welfare Facilities – on-site welfare facilities will be adequately designed and maintained to ensure all sewage is disposed of appropriately. This may take the form of an on-site septic tank with soakaway, or tankering and off-site disposal depending on the suitability of the Proposed Development for a soakaway. Any discharge requirements will comply with relevant requirements under SEPAs CAR;

Cement and Concrete – fresh concrete and cement are very alkaline and corrosive and can be lethal to aquatic life. The use of wet concrete in and around watercourses will be avoided and carefully controlled;

Monitoring Plan – all activities undertaken as part of the Proposed Development will be monitored throughout the construction phase. Such monitoring will be to ensure environmental compliance. Water quality monitoring will also occur throughout each phase of the Proposed Development and will help to maximise the effectiveness of embedded mitigation measures whilst monitoring effects on the hydrological environment.

Contingency Plans – a site specific Emergency Response Plan will be implemented to ensure plans are in place to manage a spill or other pollution incident. The plans will ensure that emergency response equipment is available on-site i.e. spill kits and absorbent materials, advice on action to be taken and who should be informed in the event of a pollution incident.

Training – All relevant staff personnel will be trained in both normal operating and emergency procedures and be made aware of sensitive areas on-site.

Further details regarding other mitigation measures to be adopted during the construction and operation of the Proposed Development will be included in the CEMP.

### **Predicted Construction Effects**

The potential for effects on the hydrological environment is greatest during the construction phase due to the elevated levels of activity on-site and when there is greatest change to the existing environment. The construction of the Proposed Development is discussed in the following paragraphs, and this information is considered in the mitigation and management measures outlined in the mitigation measure section below.

#### Pollution Incidents

During the construction phase, several potential pollutants will be present on-site, including oil, fuels, chemicals, unset concrete, waste and wastewater from construction activities, and staff welfare facilities. The majority of these potential pollutants will be located or stored within the temporary construction compound which is located within the Kello Water Catchment. Mitigation measures to limit and prevent pollution incidents will be outlined in the CEMP.

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### Erosion and Sedimentation

Soil and sediment generation may occur in areas where the ground has been disturbed, particularly where surface runoff has been concentrated.

### Increase in Runoff

Turbine bases, hardstand areas and access tracks will act as impermeable areas, restricting the natural movement of water within the hydrological environment, potentially resulting in increased rates of runoff. Localised increases could cause issues for downstream flood storage capacity and/or pollution incidents. Increases in the volume of runoff entering watercourses could also cause erosion and sedimentation.

### Modification of Surface Drainage Patterns

The Proposed Development infrastructure and associated drainage may disrupt the natural drainage regime of the area, concentrating flows and potentially diverting flows from one catchment to another. This may have implications on flood issues downstream of the Proposed Development.

PWS catchments, potential GWDTE and other surface water dependent habitats present a potential engineering constraint, and the necessary precautions should be taken.

Construction of the Proposed Development may have potential effects on the quantity and quality of groundwater supplying PWS sources and wetland habitats.

### Impediments to Surface Water Flow

The construction of watercourse crossings may restrict flow in the various channels and reduce hydraulic capacity, resulting in an increase in flood risk, and promotion of erosion and sedimentation. In addition, poorly designed watercourse crossings may impede the migration of fish and mammal movement in the riparian corridor. The construction of watercourse crossings are assessed in Technical Appendix 10.1.

### Modification of Groundwater flows and levels

Deep excavations, such as those required for the turbine foundations are likely to disrupt the shallow groundwater systems and bedrock geology. Surface water ingress will be minimised utilising up gradient cut-off drains or other drainage measures. The installation of cut-off drains has the potential to lower local groundwater levels within surrounding peat dominated soils.

Access tracks have the potential to disrupt flow pathways, such as interrupting shallow groundwater flow or altering the hydrological regime. The presence of existing tracks at the Proposed Development will minimise hydrogeological disturbance.

### Compaction of soils

The movement of construction traffic within the Proposed Development is likely to cause localised compaction of the ground surface, leading to changes in both the hydrological and hydrogeological regime. The impacts of compaction are likely to be highly localised but will damage the vegetation and result in a reduction in the soil permeability and rainfall infiltration, thereby increasing the potential for flood risk and erosion.

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### **Predicted Operational Effects**

The following paragraphs discuss the potential effects that are predicted to occur during the operational phase of the Proposed Development. These are expected to be substantially lower than during the operational phase.

#### Pollution Incidents

The potential risk of pollution is substantially lower during operation than during construction because of the decreased levels of activity in the operational phase. The majority of potential pollutants will have been removed when construction is complete; however, lubricants for turbine gearboxes, transformer oils and possible fuel leaks from maintenance vehicles will remain.

#### Erosion and Sedimentation

Levels of erosion and sedimentation during operation will be much lower than construction as there will be no excavations or exposed ground. Some erosion and sedimentation are still possible for the on-site tracks and drainage ditches as a result of scouring during extreme rainfall events. Similarly, there could be some erosion and sedimentation around new stream crossings as watercourses reach new equilibrium.

#### Modification of Surface Drainage Patterns

Modification of surface runoff will occur as a result of the construction of the new infrastructure associated with the Proposed Development. The operational effects are likely to result in changes to volume and/or changes to runoff rate.

Poorly designed on-site tracks and associated drainage could allow surface water to travel through a catchment much faster than if it were to travel as diffuse overland flow. This could result in an increase in runoff rates, peak flows and influence response times during storm events. The utilisation of many of the existing tracks reduces the magnitude of the changes expected to the drainage regime.

#### Impediments to Surface Water Flow

During the operational phase, impediments to flows can generally occur as a result from blockages to watercourse crossings, ditches and watercourses resulting from vegetation and erosion debris.

#### Modification of Groundwater flows and levels

Tracks and their drainage as well as turbine foundations and hardstands will potentially alter the water table within the upslope and downslope peat and upper bedrock aquifers, which can also have implications for the long-term functionality of peatland environments. Backfilled cable trenches can also provide preferential flow pathways for groundwater.

### **Predicted Cumulative Effects**

In the surrounding 5km area of the Proposed Development, the following wind farms are present:

- 5 existing,
  - 3 approved,
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- 2 in planning, and
- 2 in scoping.

Of these, Sanquhar Community Wind Farm and Hare Hill Wind Farm Extension are located within the Kello Water Catchment. The other wind farms are positioned within the wider catchment of the River Nith.

The construction and subsequent operation of the twelve schemes within the 5km radius as well as the Proposed Development has the potential to cumulatively affect the water quality, flooding and fisheries interests associated with Kello Water and the River Nith.

However, taking into account that some of these wind farms are already operational and others are in the very early planning stages and, that construction of these developments would not be concurrent and assuming the successful implementation of detailed mitigation (following industry good practice) and monitoring plans it is expected that any cumulative effects would be minor.

A programme of surface water quality monitoring will be finalised post consent, prior to construction. A breakdown of the suggested monitoring has been provided to take into account sensitivities of the on-site and downstream environments.

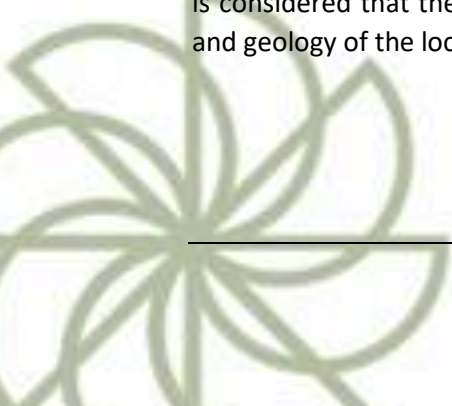
### 10.5 Summary

An assessment has been carried out of the likely impacts of the Proposed Development on the hydrological, hydrogeological and geological environment. The assessment has considered site preparation, construction and operation of the Proposed Development and considered the following impacts:

- Pollution incidents;
- Erosion and sedimentation;
- Changes to water resources;
- Modification to surface water and groundwater flows;
- Modification of natural drainage patterns;
- Impediments to flow and flood risk;
- Peat; and
- Compaction of soil.

After detailing these potential impacts and identifying the mitigation measures to be implemented, it is considered that the Proposed Development will have no unacceptable impacts on the hydrology and geology of the local area.

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### References

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## **Technical Appendix 10.1- Watercourse Crossing Assessment**

### **Introduction**

The Proposed Development will be located approximately 5.06km west of Sanquhar and 2.68km south of Kirkconnel within Dumfries and Galloway. Access is proposed from the C125n road, which is off the A76 between Kirkconnel and Sanquhar, and then uses the existing access road which leads to Sanquhar Community Wind Farm. The Proposed Development will be located on open moorland surrounded by rough grazing land.

The construction phase of the Proposed Development will utilise several elements of the existing infrastructure associated with the Sanquhar Community Wind Farm which is operational. This includes the main spine access track. However, short lengths of new track will be needed, which subsequently requires the construction of one new watercourse crossing, and the replacement of another existing watercourse crossing which is currently used by farm vehicles. A third crossing was identified using 1:25,000 scale mapping but proved to be non-existent following a site visit.

There are existing watercourse crossings which are located along the existing main spine access track which are used to access Sanquhar Wind Farm. These have been deemed acceptable crossing points and are therefore not considered further in this Technical Appendix.

This report forms a Technical Appendix to Section 10: Hydrology of the Herds Hill Wind Farm Report and should be read with reference to it.

The purpose of this report is to provide all the relevant information associated with watercourse crossings required as part of the Proposed Development and to assist with the design of these crossings. It is essential that all the watercourse crossings are designed to maintain hydrology as well as allowing the free passage of mammals and aquatic species.

### **Legislation**

The Water Framework Directive (2000/60/EC) (WFD) represents a significant piece of environmental legislation which has limited implications for the Proposed Development. The WFD has been transposed into Scottish legislation as the Water Environment and Water Services (Scotland) Act 2003 (or WEWS) and has given Scottish Ministers powers to introduce regulatory controls over activities to protect and improve Scotland's water environment. The water environment includes wetlands, rivers, lochs, transitional waters (estuaries), coastal waters and groundwater. These regulatory controls, known as The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) came into force on the 31<sup>st</sup> of March 2011 and were updated in 2022.

With respect to the watercourse crossings required for the Proposed Development, CAR requires that all 'engineering works in inland waters and wetlands' are subject to authorisation and allow for proportionate risk-based regulation. The authorisation process operates at three levels:

- General Binding Rules (GBR);
  - Registration; and
  - Licence (Simple or Complex).
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## Herds Hill Wind Farm

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GBR represent a set of mandatory rules which cover low risk activities. Activities complying with the mandatory rules do not require an application to be made to the Scottish Environment Protection Agency (SEPA), as compliance with a GBR is considered to be compliance under an authorisation.

These three levels cover activities with increasing levels of potential impact upon the hydrological environment. SEPA will only be required to provide authorisation for watercourse crossings shown on the 1:50,000 scale Ordnance Survey maps (Landranger series). All other watercourses are classed as a 'minor watercourse' and are exempt under CAR. Where appropriate, likely authorisations required for the surveyed crossings are described in this report but are expected to be covered under the GBR given their minor nature.

The information presented in this document is only intended to act as a guide. The actual design, construction and/or improvements to the crossings during construction will be the responsibility of the appointed Principal Contractor.

Following an update to CAR in 2018, all large construction projects, which exceed a certain aerial extent also require a Construction Site Licence (CSL), which must be obtained from SEPA prior to the initiation of construction. Whilst the design of watercourse crossings is in part related to the site's drainage and associated impacts (which is an integral element of the CSL), this document is associated with identifying the licensing requirement for engineering works within the water environment only. The 2022 update included a new table outlining the regulatory approach for maintenance, repair, removal and replacement works, changes to clarify authorisation levels and amendments to GBR5, GBR6, GBR8, GBR9, GBR14, GBR15 and GBR18.

### Limitations of Report

This report should be considered as a 'live' document meaning changes should be made if new information comes to light. The report endeavours to identify the watercourse crossings required as part of the construction associated with the Proposed Development, however, it is possible additional watercourse crossings which do not feature on either the Ordnance Survey (OS) mapping or were not encountered during the site visit could be identified within the Proposed Development area. Should the construction process identify additional crossings, then these should be surveyed immediately, and due consideration given to the legislation above to ensure compliance.

### Methodology

The methodology used to carry out the watercourse crossing surveys consisted of a desk study, a site visit and applying the information gathered to select the correct type of crossing.

#### Desk Study

The desk study consisted of a review of the information regarding the Proposed Development, principally involving an examination of the track layout and the identification of watercourses which will require crossings, including those marked on the 1:50,000 scale OS map which consequently would require licensing under CAR.

#### Site Visit

Following the desk study, a survey of the identified crossings was undertaken to obtain information specific to each watercourse crossing point. Photographs and detailed field notes were taken,

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## Herds Hill Wind Farm

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reporting the dimensions of the watercourse channel and flood channel (where apparent), the type of substrate and the crossing type.

The site survey was carried out on 24<sup>th</sup> October 2023. Weather conditions during the visit were cloudy with light rain.

### Water Crossing Selection Criteria

Information collected during the site visit has been used to inform crossing point selection. Construction of the Proposed Development will include stone access tracks, which will be required to cross natural watercourses.

### Watercourse Crossing Assessment

Three watercourse crossings have been identified, two of which were identified on OS 1:50,000 scale mapping and therefore requires authorisation under CAR. It is anticipated that a range of other small natural ephemeral channels, artificial drainage channels and flushes may be encountered during the detailed design stage prior to construction. These crossings will not require authorisation under CAR. The third watercourse crossing, (WX2) identified on the OS 1:25,000 scale mapping was also included in the assessment for completeness.

Table 2.1 provides a summary of the surveyed natural watercourses, including proposed crossing type and CAR authorisation required. A map showing the locations presented in the following table is provided in Figure 10.1. Again, it is important to note that crossing WX2 did not exist on the ground and is only included in the table for completeness.

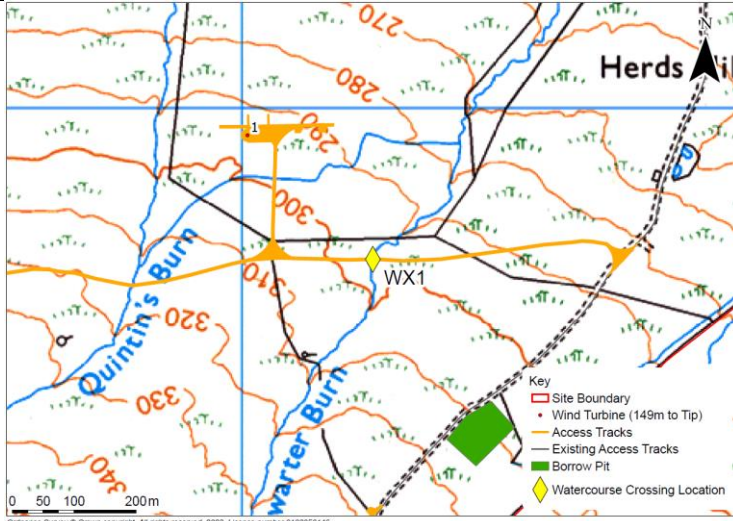
**Table 2.1: Summary of Watercourse Crossings**

ID	Easting	Northing	Type	Proposed Crossing Type	CAR Authorisation
WX1	273211	608756	New	Pipe Culvert	Registration
WX2	273052	608887	N/A	N/A	N/A
WX3	272830	608715	Existing	Pipe Culvert	Registration

More detailed information on each watercourse crossings is provided on the pages below, with the mapping used being OS 1:25,000 mapping.



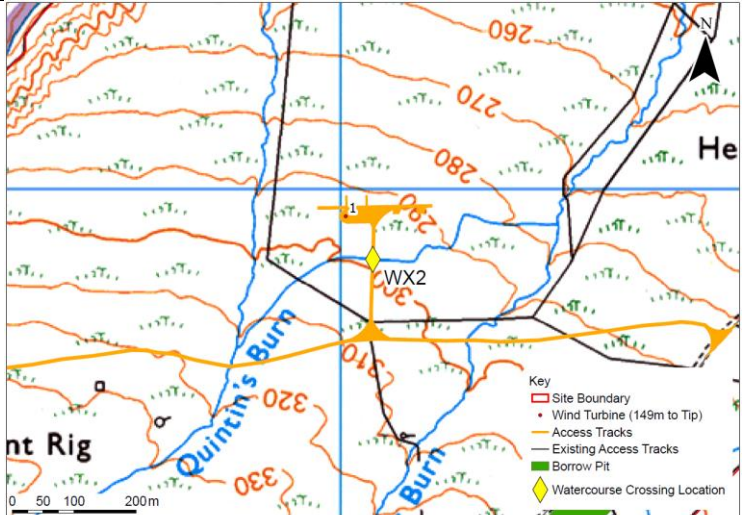
# Herds Hill Wind Farm

Crossing Location	WX1 (NS 73211 08756)	Crossing Description
 <p>Key</p> <ul style="list-style-type: none"> <li>Site Boundary</li> <li>Wind Turbine (149m to Tip)</li> <li>Access Tracks</li> <li>Existing Access Tracks</li> <li>Borrow Pit</li> <li>Watercourse Crossing Location</li> </ul> <p>0 50 100 200m</p> <p>Ordnance Survey © Crown copyright, All rights reserved. 2023. Licence number 0100050146.</p>	<ul style="list-style-type: none"> <li>Existing Crossing: No</li> <li>Channel: Meandering</li> <li>Gradient: Gentle</li> <li>Valley form: Shallow vee</li> <li>Bank Condition: Stable</li> <li>Bed Material: Course gravels</li> <li>Riparian Corridor: Open Moorland</li> <li>Flow Condition: Moderate</li> </ul>	<ul style="list-style-type: none"> <li>Water width (m): 1.31</li> <li>Water depth (m): 0.18</li> <li>Bankfull width (m): 1.43</li> <li>Bankfull height (m): 0.62</li> </ul>

## Crossing Photographs

Across	Upstream	Downstream
		

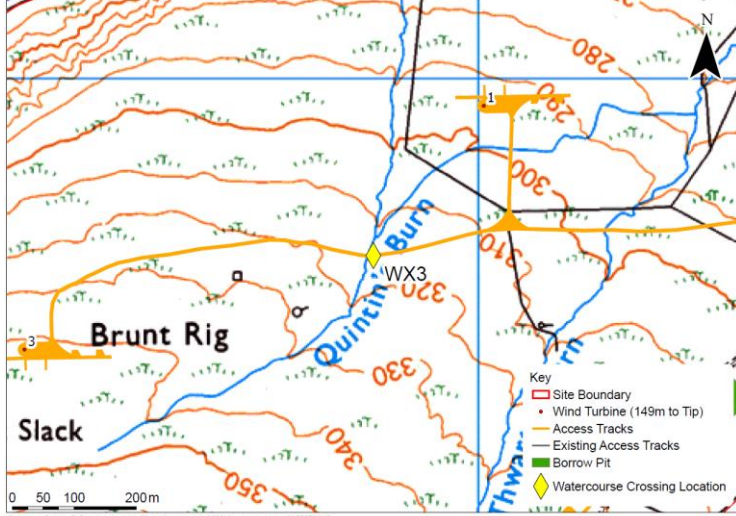
# Herds Hill Wind Farm

Crossing Location	WX2 (NS 73052 08887)	Crossing Description
 <p>Key</p> <ul style="list-style-type: none"> <li>Site Boundary</li> <li>Wind Turbine (149m to Tip)</li> <li>Access Tracks</li> <li>Existing Access Tracks</li> <li>Borrow Pit</li> <li>Watercourse Crossing Location</li> </ul> <p>0 50 100 200m</p> <p><small>Ordnance Survey © Crown copyright, All rights reserved. 2023. Licence number 0100050146</small></p>	<ul style="list-style-type: none"> <li>Existing Crossing: No</li> <li>Channel: Surface runoff/wetlands only</li> <li>Gradient: Gentle</li> <li>Valley form: No obvious valley sides</li> <li>Bank Condition: stable</li> <li>Bed Material: vegetation</li> <li>Riparian Corridor: Moorland</li> <li>Flow Condition: Stagnant</li> </ul>	<ul style="list-style-type: none"> <li>Water width (m):</li> <li>Water depth (m):</li> <li>Bankfull width (m):</li> <li>Bankfull height (m):</li> </ul> <p>Note: Watercourse is not mapped on 1:50,000 scale OS.</p>




## Crossing Photographs



# Herds Hill Wind Farm

Crossing Location	WX3 (NS 72830 08715)	Crossing Description
 <p>Key</p> <ul style="list-style-type: none"> <li>Site Boundary</li> <li>Wind Turbine (149m to Tip)</li> <li>Access Tracks</li> <li>Existing Access Tracks</li> <li>Borrow Pit</li> <li>Watercourse Crossing Location</li> </ul>	<ul style="list-style-type: none"> <li>Existing Crossing: Yes</li> <li>Channel: Meandering</li> <li>Gradient: Gentle</li> <li>Valley form: Shallow Vee</li> <li>Bank Condition: Stable</li> <li>Bed Material: Course Gravel</li> <li>Riparian Corridor: Open Moorland</li> <li>Flow Condition: Moderate</li> </ul>	<ul style="list-style-type: none"> <li>Water width (m): 1.63 at crossing point, 0.60 up and down stream</li> <li>Water depth (m): 0.10</li> <li>Bankfull width (m): 2.15</li> <li>Bankfull height (m): 0.53</li> </ul>

## Crossing Photographs

Across	Upstream	Downstream
		

Legend

- Site Boundary
  - Wind Turbine (149m to Tip)
  - Access Tracks
  - Cable Route
  - Existing Access Tracks
  - Substation & Control Room
  - Temporary Construction Compound
  - Borrow Pit
- Hydrological Considerations
- Hydrological Study Area
  - Watercourse
  - Watercourse Buffer (50m)
  - ▲ Private Water Supplies
  - ◆ Watercourse Crossing Locations
- River Catchments
- Euchan Water
  - Kello Water

Notes: N/A  
 Revisions: N/A  
 Layout: 397-220905-9005-C

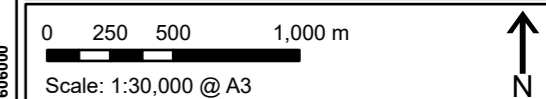
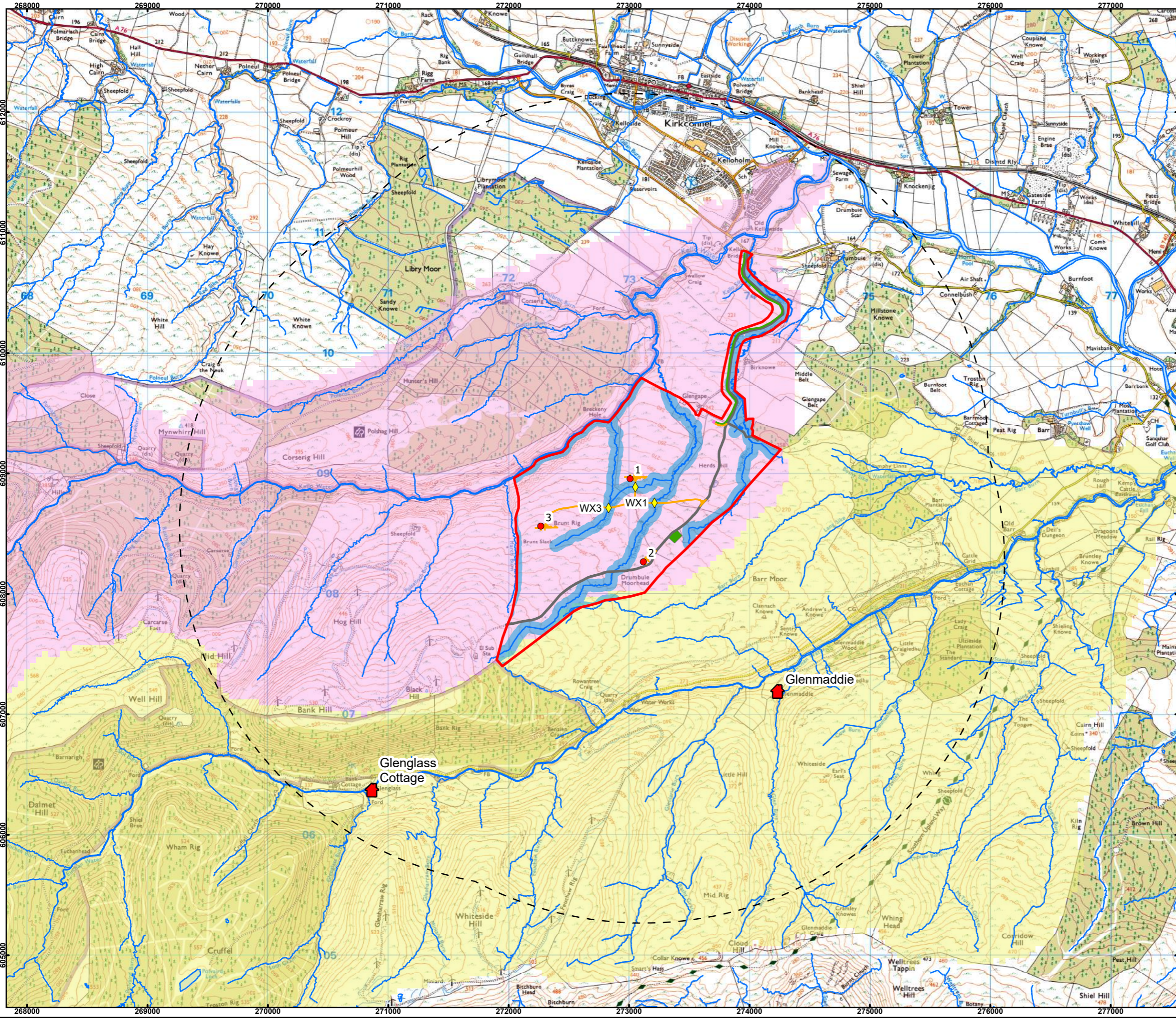


Figure 10.1  
 Hydrology Overview

Date: 07/11/2023 Ref: 397-230915-7063-A  
 Produced: DW Reviewed: RE Approved: GC

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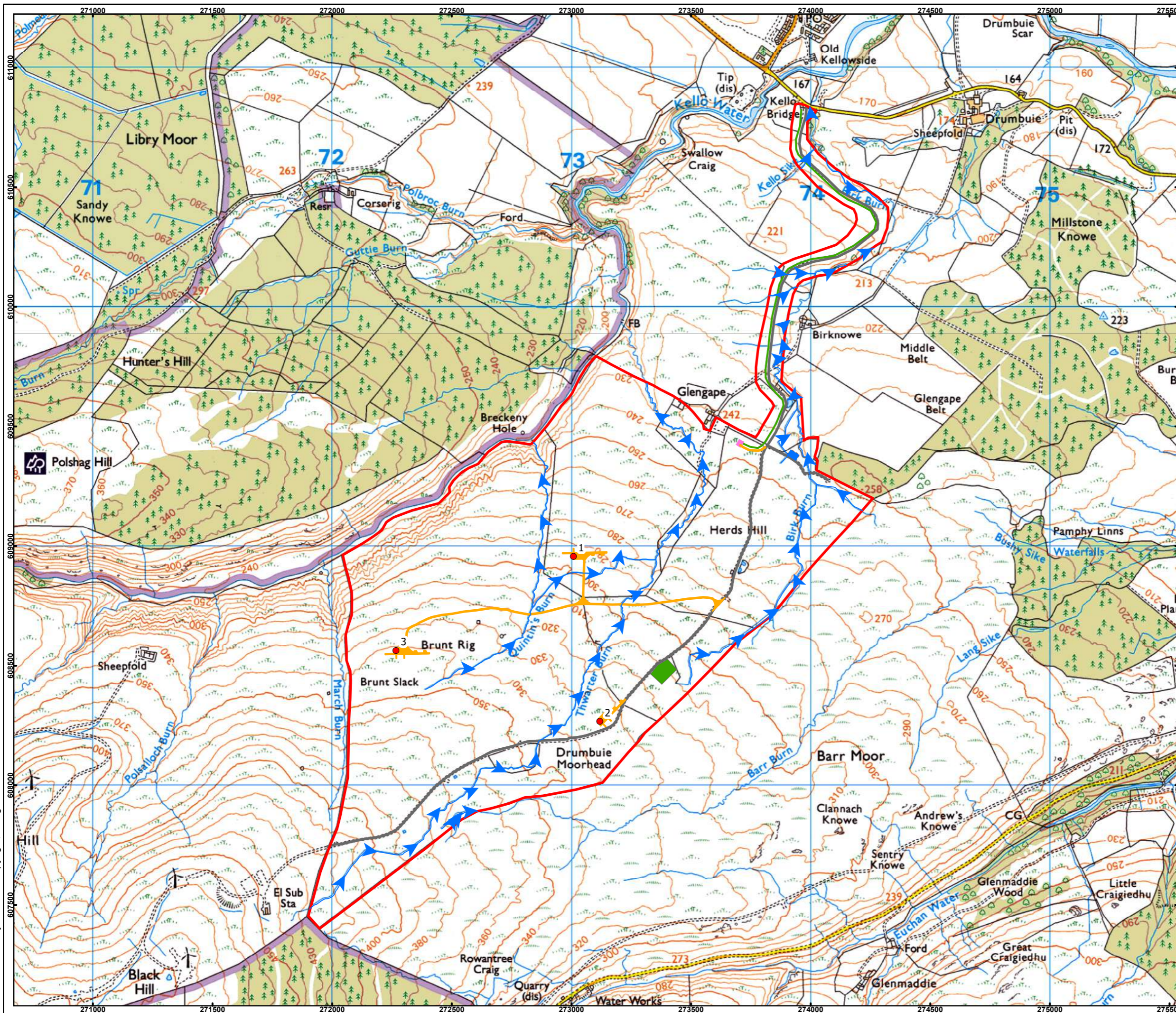
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 e: info@drumbuie.com



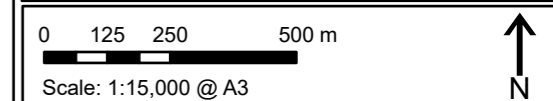
# 397 Herds Hill

## Legend

- Site Boundary
- Wind Turbine (149m to Tip)
- Access Tracks
- Cable Route
- Existing Access Tracks
- Substation & Control Room
- Temporary Construction Compound
- Borrow Pit
- Watercourse and Flow Direction



Notes: N/A  
 Revisions: N/A  
 Layout: 397-220905-9005-C




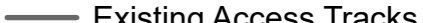




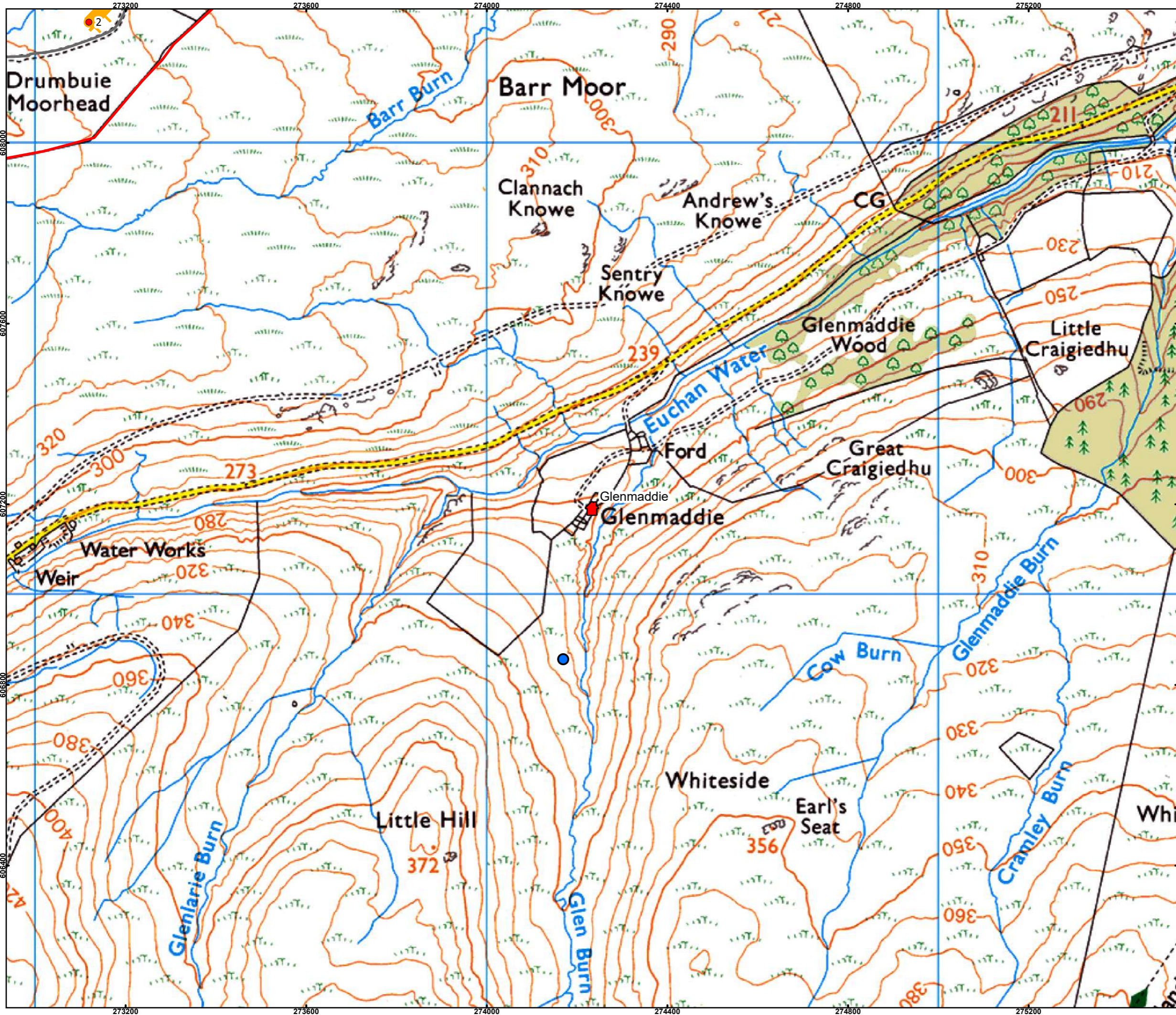
**Figure 10.2**  
**Flow Direction**

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 Produced: DW      Reviewed: RE      Approved: GC

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Legend

-  Site Boundary
-  Wind Turbine (149m to Tip)
-  Access Tracks
-  Existing Access Tracks
-  Property
-  Groundwater Spring



Notes: N/A  
 Revisions: N/A  
 Layout: 397-220905-9005-C

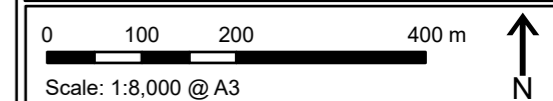


Figure 10.3a Glenmaddie Private Water Supply

Date: 07/11/2023 Ref: 397-230928-7071-A  
 Produced: DW Reviewed: RE Approved: GC

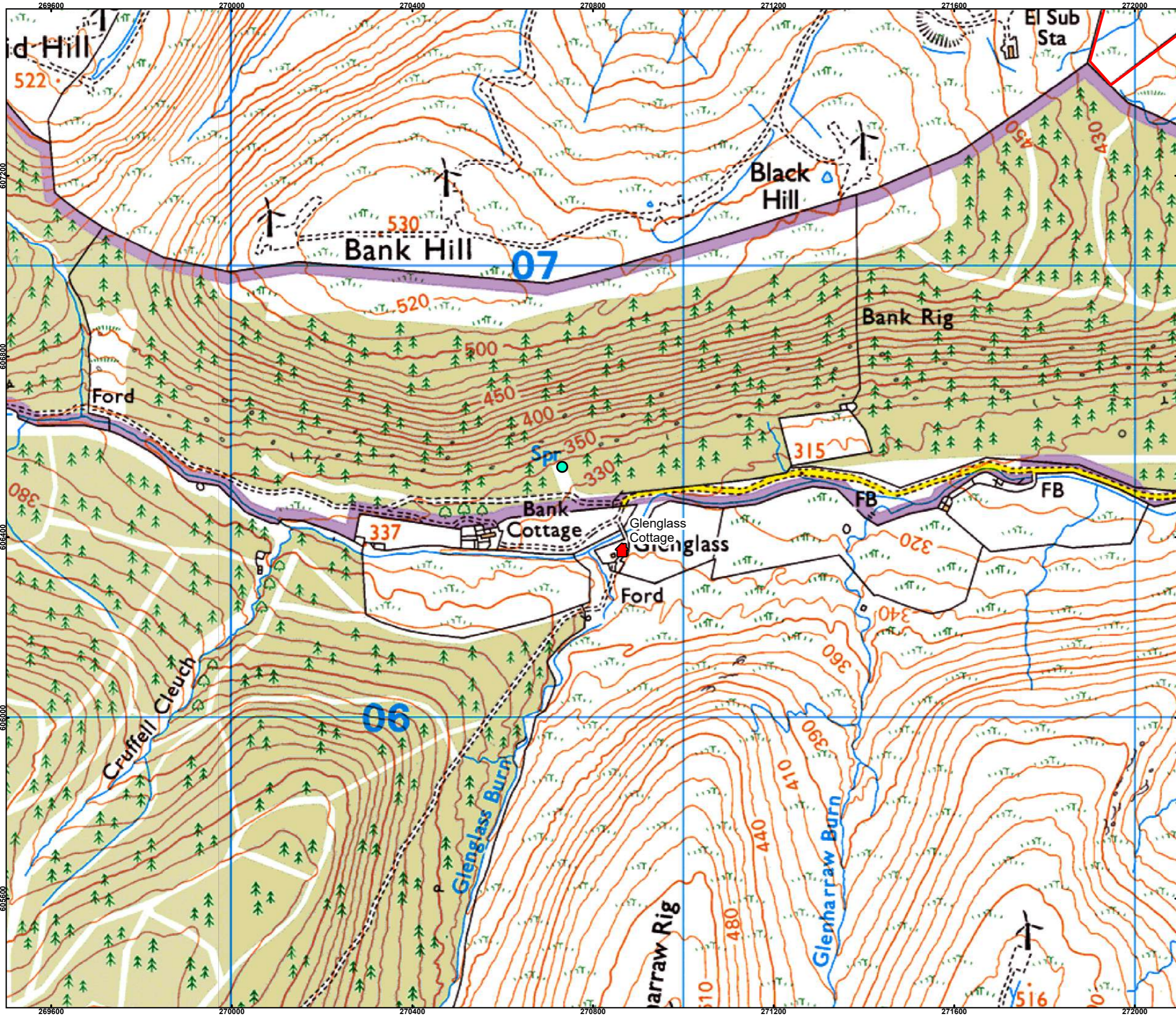


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Legend

- Site Boundary
- ▣ Property
- Unconfirmed Groundwater Spring



Notes: The nearest spring noted on OS mapping is located approximately 225 m to the northwest of the property at NGR NS 70720 06560. However, it is more likely that the PWS is gained from the stream southwest of the property.

Revisions: N/A  
Layout: 397-220905-9005-C

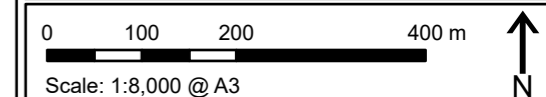


Figure 10.3b Glenglass Cottage Private Water Supply

Date: 07/11/2023 Ref: 397-231004-7074  
Produced: DW Reviewed: RE Approved: GC



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Legend

- Site Boundary
  - Wind Turbine (149m to Tip)
  - Access Tracks
  - Cable Route
  - Existing Access Tracks
  - Substation & Control Room
  - Temporary Construction Compound
  - Borrow Pit
- National Soil Map for Scotland:  
Generalised Soil Type
- Brown earths
  - Humus-iron podzols
  - Mineral gleys
  - Peat
  - Peaty gleys
  - Peaty podzols

Notes: N/A  
Revisions: N/A  
Layout: 397-220905-9005-C

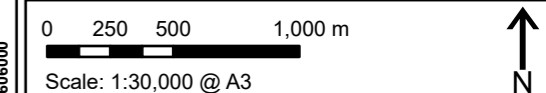
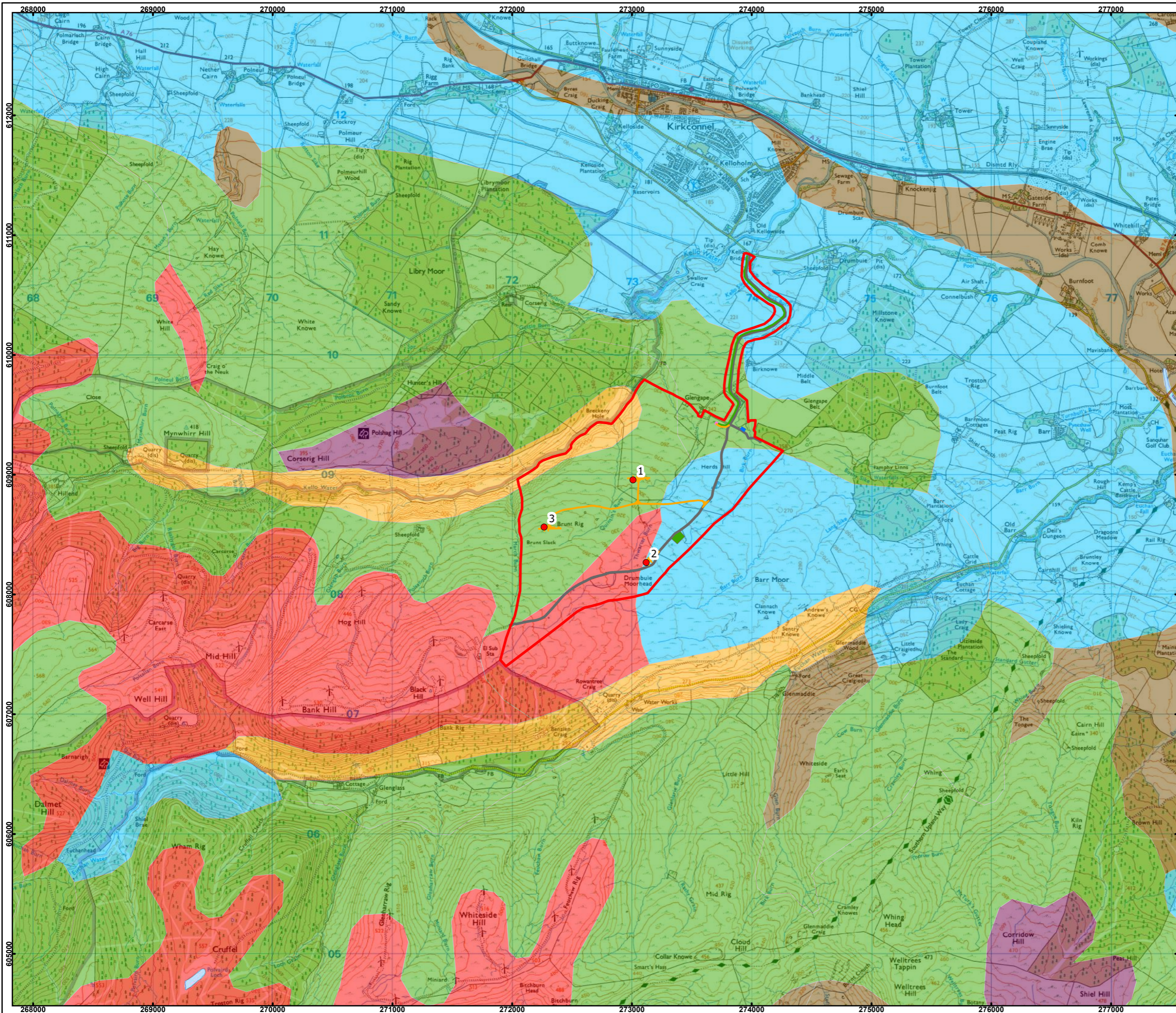


Figure 10.4  
Predominant Soils

Date: 07/11/2023 Ref: 397-230925-7068-A  
Produced: DW Reviewed: RE Approved: GC

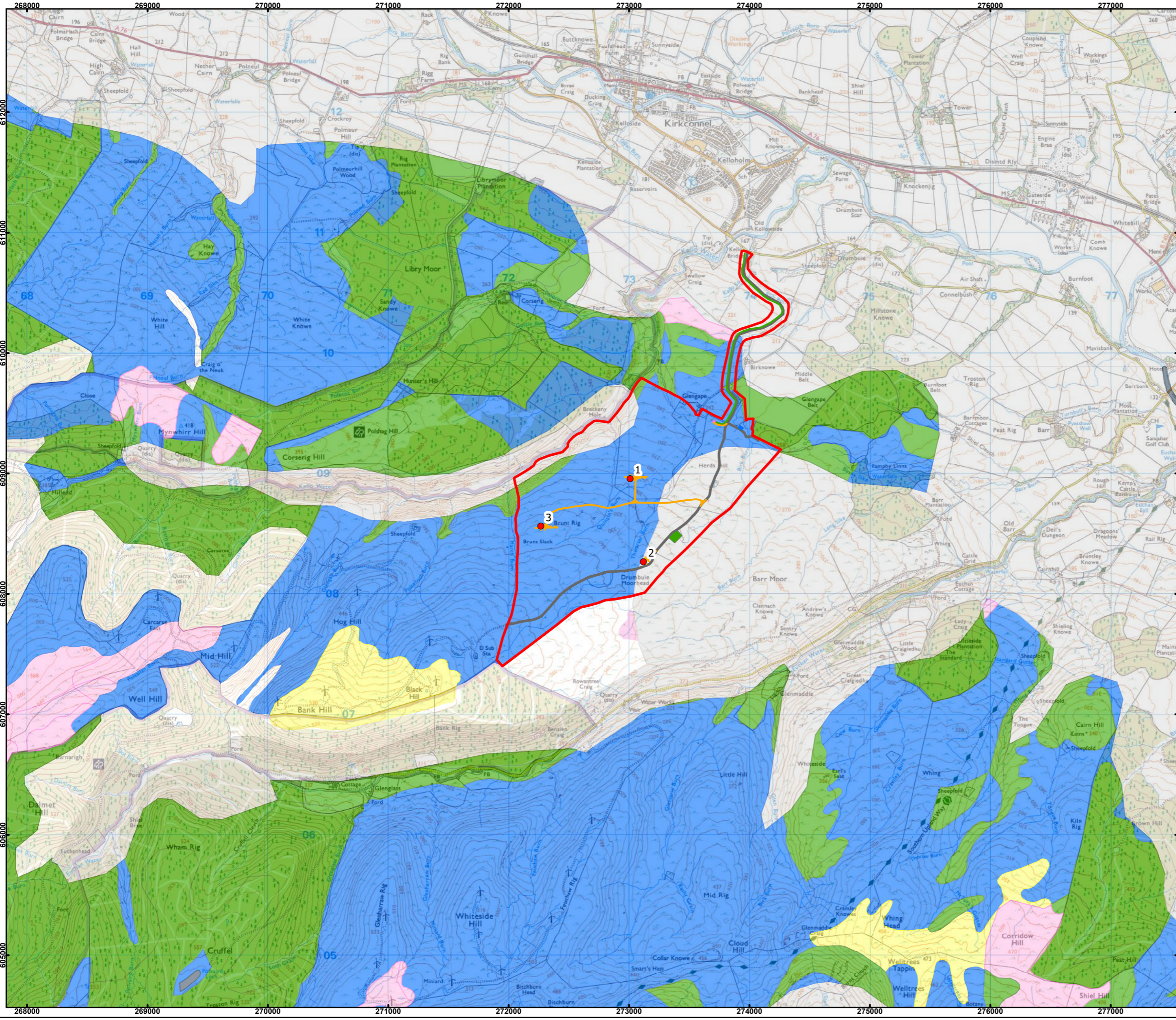
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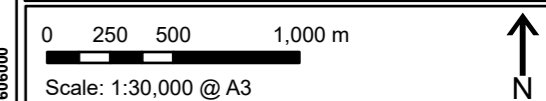
# 397 Herds Hill

## Legend

- Site Boundary
  - Wind Turbine (149m to Tip)
  - Access Tracks
  - Cable Route
  - Existing Access Tracks
  - Substation & Control Room
  - Temporary Construction Compound
  - Borrow Pit
- Carbon and Peatlands
- Soil Class
- Class 0: Mineral soils
  - Class 1
  - Class 2
  - Class 3
  - Class 4
  - Class 5
  - Class -2: Non-soil



**Notes:**  
 The Carbon and Peatland 2016 map is based on soil and land cover data produced by the James Hutton Institute.  
 Revisions: N/A  
 Layout: 397-220905-9005-C



**Figure 10.5**  
**Carbon and Peatlands**

Date: 07/11/2023      Ref: 397-230915-7064-A  
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# 397 Herds Hill

## Legend

- Site Boundary
  - Wind Turbine (149m to Tip)
  - Access Tracks
  - Cable Route
  - Existing Access Tracks
  - Substation & Control Room
  - Temporary Construction Compound
  - Borrow Pit
- Superficial Geology
- Till, Devensian – Diamicton Hummocky (moundy) Glacial
  - Glaciofluvial Deposits – Gravel, sand and silt
  - Alluvium – Silt, sand and gravel
  - Peat

Notes: N/A  
 Revisions: N/A  
 Layout: 397-220905-9005-C

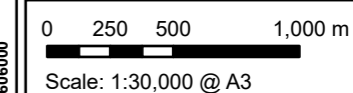
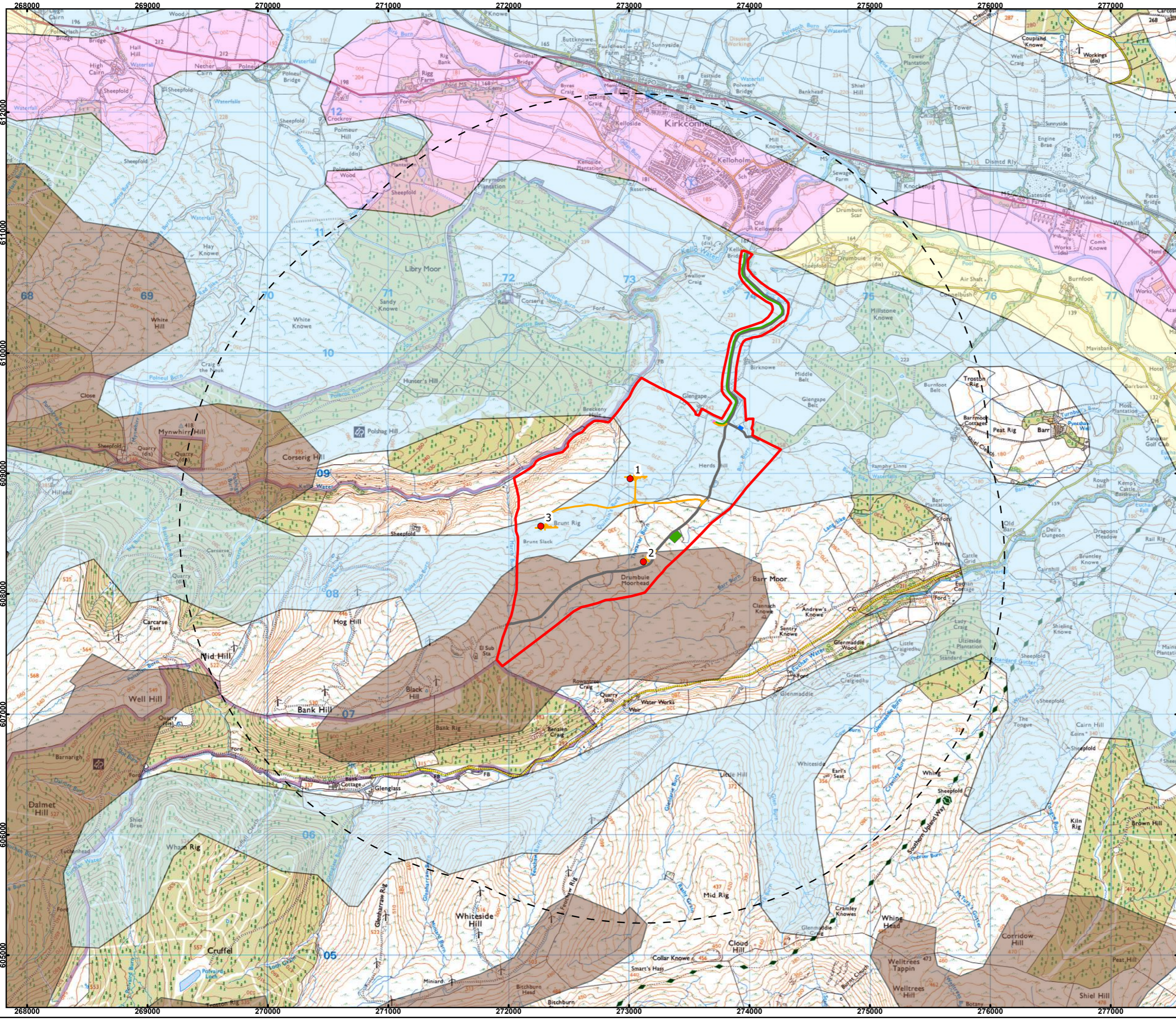


Figure 10.6  
 Superficial Geology

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