Appendix 13.A
Geology, Hydrology and Hydrogeology Terminology and Abbreviations

Table 13.A1 List of Terms and Abbreviations

Term or Abbreviation	Description
AEP	Annual Exceedance Probability
Aquifer	An aquifer comprises strata that hold an exploitable groundwater resource.
BFI	Baseflow Index
BGS	British Geological Survey
BS	British Standard
CAR	The Water Environment (Controlled Activities) (Scotland) Amendment Regulations 2011
Catchment	The area drained by a particular stream or river.
CEH	Centre for Ecology & Hydrology
CEMP	Construction Environmental Management Plan
CIRIA	Construction Industry Research and Information Association
CMS	Construction Method Statement
CVF	Carrick Volcanic Formation
DGC	Dumfries & Galloway Council
DMP	Drainage Management Plan
EAC	East Ayrshire Council
EC	Electrical conductivity
ECoW	Environmental Clerk of Works
EIA	Environmental Impact Assessment
EQS	Environmental Quality Standards
FC	Forestry Commission
FCS	Forestry Commission Scotland
FEH	Flood Estimation Handbook
GWDTE	A Groundwater Dependent Terrestrial Ecosystem is an ecosystem, such as a wetland or flush, whose integrity is critically dependent on the level, flow or quality of groundwater.
Ha	Hectares
HS	Historic Scotland
LCM	Lower Coal Measures
LUPSGU31	Land Use Planning System Guidance Note 31 (SEPA, 2014)
mAOD	Metres above Ordnance Datum
MAFF	Ministry of Agriculture, Fisheries and Food
mbgl	Metres below ground level
MCM	Middle Coal Measures
MSS	Marine Scotland Science
NDSFB	Nith District Salmon Fisheries Board
NGR	National Grid Reference
NPF3	National Planning Framework 3
NVC	National Vegetation Classification

Term or Abbreviation	Description
ORS	Old Red Sandstone
OS	Ordnance Survey
PAN	Planning Advice Note
PIRP	Pollution Incident Response Plan
PMP	Peat Management Plan
PPG	Pollution Prevention Guidance
PPP	Pollution Prevention Plan
PSHRA	Peat Slide Hazard Risk Assessment
PWS	Private water supply
RBMP	River Basin Management Plan
SAC	Special Area of Conservation
SEPA	Scottish Environment Protection Agency
SGt	Scottish Government
SNH	Scottish Natural Heritage
SNIFFER	Scotland and Northern Ireland Forum for Environmental Research
SPA	Special Protection Area
SPP	Scottish Planning Policy
SPR	Standard Percentage Runoff
SPZ	Source Protection Zone
SR	Scottish Renewables
SSSI	Site of Special Scientific Interest
SuDs	Sustainable Drainage System
WFD	Water Framework Directive
UCM	Upper Coal Measures
UKCP09	UK Climate Projections
ULF	Upper Limestone Formation
ZOC	Zone of Contribution

Appendix 13.B
GWDTE Assessment

Enoch Farm Wind Farm

Groundwater Dependent Terrestrial Ecosystems Assessment

August 2015

Amec Foster Wheeler Environment
& Infrastructure UK Limited

Report for

Simon Lejeune
E.ON Climate and Renewables UK Limited
Westwood Way
Westwood Business Park
Coventry
CV4 8LG

Main contributors

Dr Eleanor Haresign
Dr Shaun Salmon

Issued by

....
Dr Eleanor Haresign

Approved by

pp S.P. A...
Dr Shaun Salmon

Amec Foster Wheeler

Prospect House
32 Sovereign Street
Leeds LS1 4BJ
United Kingdom
Tel +44 (0)113 389 1100

Doc Ref. 32965\Rr113i1

Copyright and non-disclosure notice

Third-party disclaimer

Management systems

This document has been produced by Amec Foster Wheeler Environment & Infrastructure UK Limited in full compliance with the management systems, which have been certified to ISO 9001, ISO 14001 and OHSAS 18001 by LRQA.

Document revisions

No.	Details	Date
1	Draft for client comment	10/07/15
2	Final	20/08/2015

Contents

1. Introduction

This assessment forms an appendix to Chapter 13 of the Enoch Hill Wind Farm (the 'Proposed Development') Environmental Statement (ES). The ES is in support of a planning application made by E.ON Climate and Renewables UK Developments Ltd (E.ON) to install 19 wind turbines, with the associated infrastructure and ancillary development, including, for example, crane pad hardstanding areas, access tracks, electrical cabling, transformers, substation building, meteorological masts, temporary construction compounds and borrow pits. The Proposed Development is located between the settlements of New Cumnock and Dalmellington, approximately 5km to the south west of New Cumnock, and approximately 7km to the north east of Dalmellington, and is close to the boundary between East Ayrshire and Dumfries and Galloway (ES Figure 13.1).

The National Vegetation Classification (NVC) habitat survey of the Development Site, undertaken by Amec Foster Wheeler, has identified the presence of a number of potential groundwater dependent terrestrial ecosystems (GWDTEs). GWDTEs, which are types of wetland, are specifically protected under the Water Framework Directive (WFD, 2000/60/EC). The main objectives of WFD are to protect, enhance and restore Europe's waters, with the aim of achieving 'Good' status by 2015; establishing a baseline of no deterioration; and encouraging the sustainable use of water resources and the water environment.

As such, further assessment of the GWDTEs in the vicinity of the Proposed Development is merited. The aim of this report is, therefore, to firstly assess the groundwater dependency of each of the NVC communities that have been identified by survey at the Proposed Development. Secondly, those communities that have the potential to be of Moderate or High dependence on groundwater, in accordance with Scottish Environment Protection Agency (SEPA) Land Use Planning System Guidance Note 31 (LUPSGU31), have then been considered further, with the aim being to identify appropriate mitigation measures, where required, for those communities close to the Proposed Development, such that potential impacts from the wind farm are minimised.

2. Method of Assessment

LUPSGU31 stipulates that a hydrogeological assessment of the impacts upon potential GWDTEs is required where sensitive receptors lie within 100m of all excavations less than 1m in depth (typically new or upgraded access tracks or hardstanding), or within 250m of all excavations greater than 1m deep (typically turbine foundations or borrow pits). Based on a precautionary approach, all such habitats identified within the Proposed Development have been identified, and those considered by the LUPSGU31 as having Moderate and High potential groundwater dependence have been assessed further for 'actual' groundwater dependence[1].

The assessment presented in Section 3 determines the likelihood of actual groundwater dependency. The likelihood of groundwater dependency has been determined through identification of underlying geology and its hydraulic properties, the local topography, and the contribution of water to the habitat from surface water.

The nature of the underlying geology determines its porosity, permeability and groundwater through flow, which in turn will influence the water supply to wetland habitats. Groundwater flow within low permeability bedrock is limited to lines of faults and/or fractures and, thus, is only present where these features exist. Porous bedrock or superficial deposits are likely to support intergranular flow, which is the movement of water between grains. For the purposes of the GWDTE assessment, where the habitat is overlying and/or in the immediate vicinity of permeable or faulted geology, the likelihood of a groundwater contribution is deemed to be the same as the original SEPA designation in Appendix 4 of LUPSGU31.

Some NVC communities may be present due to a combination of contributions from surface water (which could be natural or artificially influenced), peat or by their location on flat terrain. These habitats are likely to be almost entirely fed by precipitation or very near-surface groundwater within shallow drift deposits and soils. It is considered that the groundwater component supporting these habitats therefore more resembles a surface (or near-surface) water regime, with very local and shallow rain-fed catchments for each GWDTE. For the purposes of the GWDTE assessment, these habitats are considered to have a Low dependency on groundwater.

Following the assessment of the actual groundwater dependence of each habitat, those habitats that remain with a Moderate or High dependency rating and which reside within LUPSGU31 buffer zones are assumed to be potentially affected by the construction and operation of the Proposed Development. In Section 4 an assessment of potential and residual (post-mitigation) effects of these PWSs is presented, following a slightly modified form of the significance assessment methodology described in ES Section 13.2.

The conclusions of the assessment are presented in Section 5.

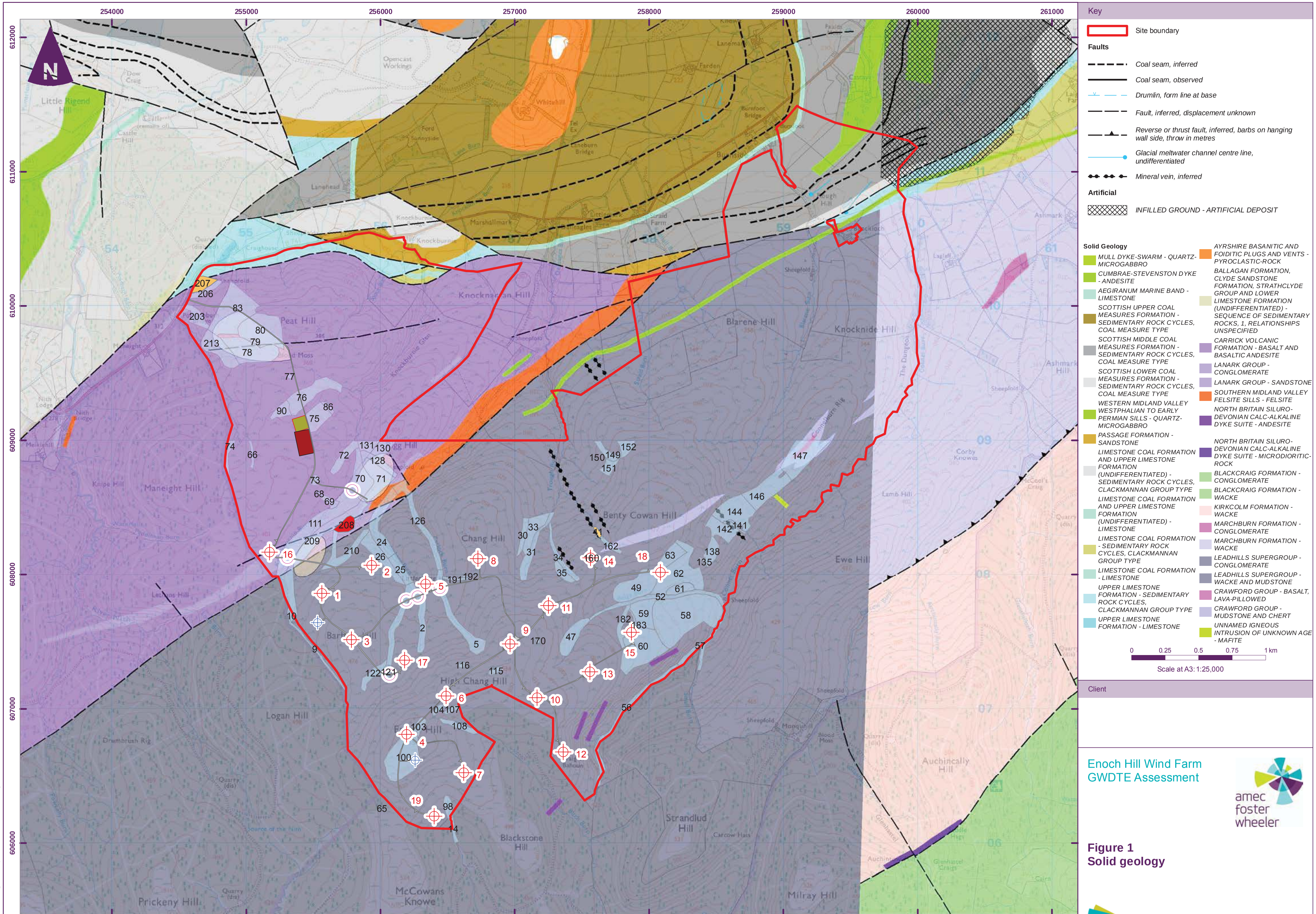
[1] Those habitats comprising multiple NVC communities which contain those of Low potential groundwater dependence have only been included within the assessment where the habitat is dominated by Moderate or High potential groundwater dependence NVC communities i.e. where the first listed NVC community within the mosaic is of Moderate or High potential groundwater dependence.

3. Assessment of Actual Groundwater Dependence

The locations of all potential High and Moderate groundwater dependence GWDTEs are illustrated in relation to the Proposed Development and the local solid geology (Figure 1), drift geology (Figure 2) and topography (Figure 3). Each of the 85 habitats has been numbered according to the habitat number referred to in the NVC survey (Chapter 11: Terrestrial Ecology), and then assessed for actual groundwater dependence in Appendix A.

The majority of the habitats identified as of potentially Moderate or High groundwater dependency have been assessed to be of Low actual groundwater dependence, based on their hydrogeological and topographical settings. For example, Habitat No. 74, which contains NVC community M23 and is therefore classified by SEPA as of High potential groundwater dependency, overlies superficial and solid geology of low hydraulic conductivity and permeability, and lies on a burn. Therefore, the presence of a significant groundwater component feeding the habitat is unlikely, and a surface water supply to the habitat is considered more probable. Such habitats are therefore not considered any further within this assessment, and are ‘scoped out’ from further assessment within the EIA.

Three habitats identified by SEPA as of potentially Moderate or High groundwater dependency have been confirmed by Amec Foster Wheeler to indeed be of this groundwater dependence. These are Habitats No. 41, 207 and 208, and all are associated with either faults or mineral vein outcrops. Of these, two (Habitats No. 41 and 208) have been identified as being within 250m of a turbine location or borrow pit search area, and one (Habitat No. 207) has been identified within 100m of an access track. These habitats are assessed further with respect to the construction and operation of the Proposed Development in Section 4 below, and retained in the EIA. A schematic flow map is provided in Appendix B for each of the three habitats, with green arrows indicating the likely indicative existing groundwater flow path/flow direction, and yellow arrows highlighting the predominant surface water flow direction. The LUPSGU31 100m and 250m buffers for the three GWDTEs are also shown on these maps.



Client

Enoch Hill Wind Farm
GWDTE Assessment

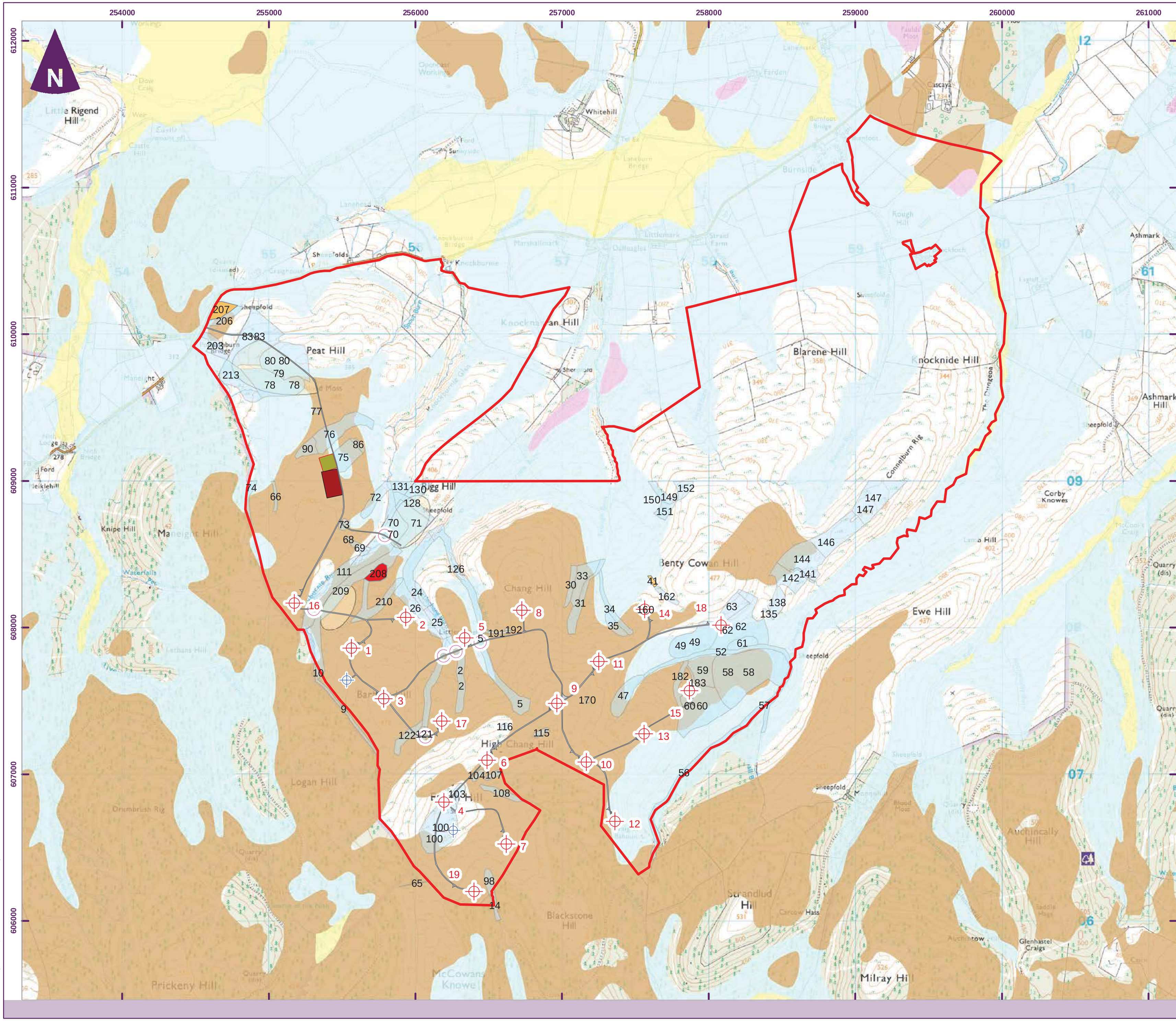
amec foster wheeler

Figure 1
Solid geology

July 2015 32965-Gla174c.mxd panng

Derived from 1:50K scale BGS Digital Data under licence 2013/3PDL/268717 British Geological Survey, © NERC

file: C:\Users\gwenda.pannu.GLOBAL\Desktop\Enoch ArcGIS\MXDs\32965-Gla174c.mxd



Key

- Site boundary
- Turbine location - LENOCH008
- Proposed on site tracks
- Crane pad
- SPEN and EON substation compound
- Temporary construction compound
- Watercourse crossing
- Borrow pit search area
- Permanent meteorological mast
- Potential GWDTEs
- Actual GWDTEs
  - High
  - Moderate

Drift Geology

- *ALLUVIUM - SILT, SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]*
- *TILL, DEVENSIAN - DIAMICTON*
- *GLACIOFLUVIAL DEPOSITS - GRAVEL, SAND AND SILT [UNLITHIFIED DEPOSITS CODING SCHEME]*
- *PEAT - PEAT [UNLITHIFIED DEPOSITS CODING SCHEME]*

0 0.25 0.5 0.75 1 km

Scale at A3: 1:25,000

Client

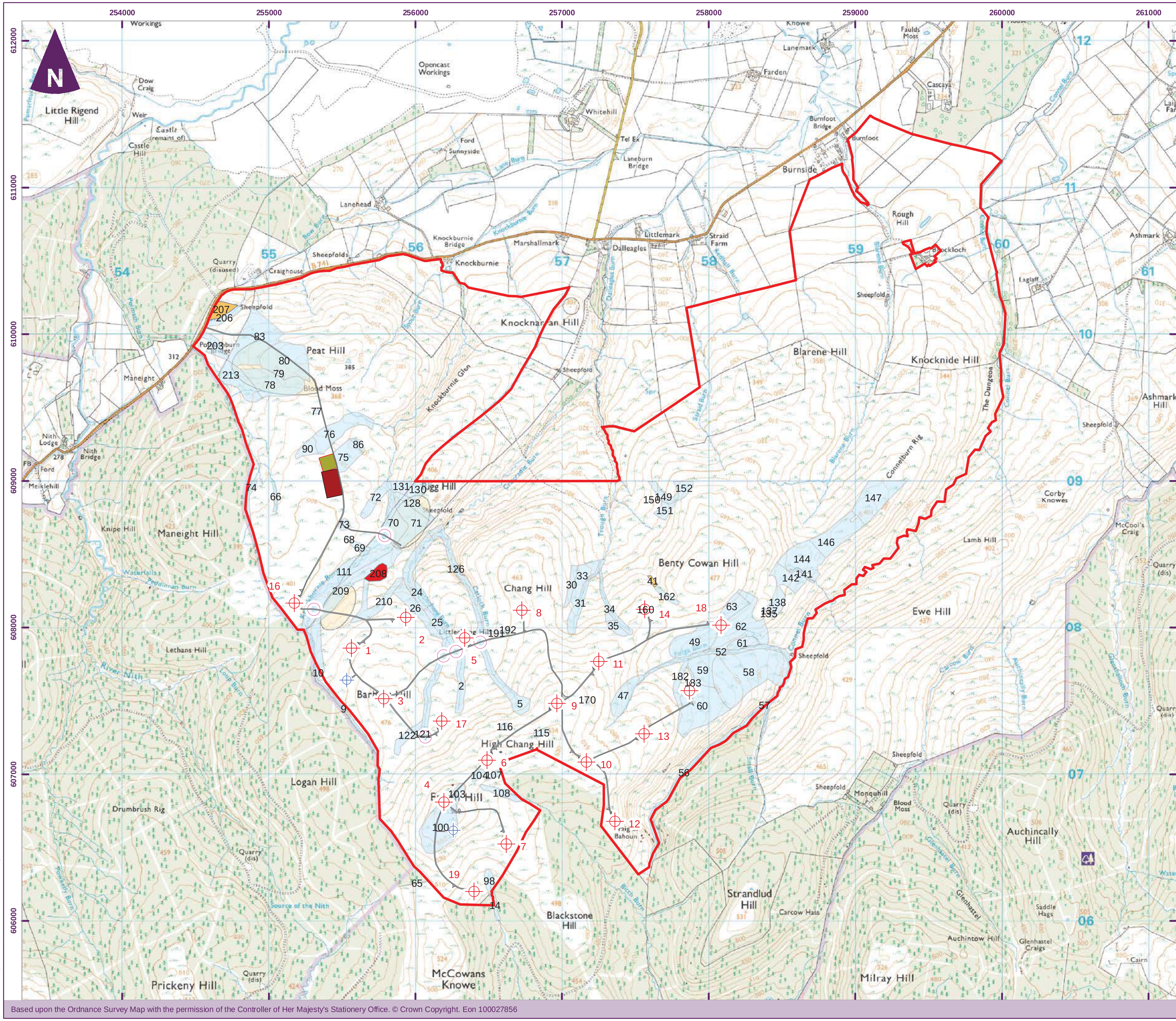
Enoch Hill Wind Farm
GWDTE Report

amec foster wheeler

Figure 2
Drift geology

July 2015 32965-Gla175c.mxd panng

file: C:\Users\gwenda.pannu.GLOBAL\Desktop\Enoch ArcGIS\MXDs\32965-Gla175c.mxd



Client

Enoch Hill Wind Farm
GWDTE Assessment

amec foster wheeler

Figure 3
Topography

July 2015 32965-Gla176c.mxd panng

file: C:\Users\gwenda.pannu.GLOBAL\Desktop\Enoch ArcGIS\MXDs\32965-Gla176c.mxd

4. GWDTE Assessment

4.1 Assessment Approach

Excavation and placement of soil and bedrock and/or active dewatering and pollution events during construction and operation of the Proposed Development could disrupt the quantity and/or quality of water supplying a nearby Moderate or High GWDTE. On this basis, it is considered that the three GWDTEs identified in Section 3 would potentially be affected by the Proposed Development, and require further assessment.

With respect to the effects in terms of groundwater flow to the GWDTEs, the estimated direct habitat loss, i.e. planned removal for wind farm infrastructure, and loss of the 'zone of contribution' (ZOC) i.e. groundwater catchment, for each of these GWDTEs as a result of the Proposed Development, is first considered. The ZOCs are also shown on the Appendix B maps, using a red outline. The categorisation for both 'direct habitat loss' and 'loss of ZOC' ranges from None (0%), through Slight (<10%) and Moderate (10-50%) to Substantial (>50%), and can be taken as broadly analogous to the negligible, low, medium and high magnitude classes of the main EIA (ES Chapter 13, Table 13.3).

The direct habitat loss is relatively easily determined by calculating the proportion of the habitat overlain by the proposed infrastructure. The loss of the ZOC is more difficult to determine, but can be calculated by comparing the location of the infrastructure with that of the ZOC and the supplying fault(s). This part of the assessment is based on the following considerations:

- The proportion of the ZOC that is potentially disrupted catchment (the part of the ZOC lying upgradient of an intersecting track, plus the additional habitat within 250m of a turbine or borrow pit, as a combined proportion of the ZOC); and
- The proportion of fault length within 250m of a turbine or borrow pit.

The overall percentage of loss of ZOC is whichever of these two proportions is the greatest. By considering the location of the relevant fault compared to the habitat, together with topographical considerations, this approach assumes the fault provides the primary source of groundwater to the vegetation species on the habitats, and is also precautionary.

The direct habitat loss, together with the ZOC loss and anticipated water quality effects (scored using the EIA magnitude criteria), are then combined to inform a qualitative assessment of the magnitude and significance of potential flow and quality effects, with the habitat sensitivity, overall magnitude of effect and significance of effect determined in accordance to the criteria of ES Tables 11.3 and 13.3-13.4, respectively. To facilitate this, the five ecological values (international/UK, Scottish, district, local, and less than local) are considered to broadly equate to the five water feature sensitivity classes (very high, high, medium, low and very low).

An assessment is then made of the residual, i.e. post-mitigation, flow and quality effects on the GWDTEs from the Proposed Development. This assessment takes account of the relevant mitigation measures that would be employed during the construction, operation and decommissioning of the Proposed Development (and which are outlined in Chapter 13: Geology, Hydrogeology and Hydrology of the ES) to minimise potential effects are considered for each habitat.

4.2 Findings of Assessment

Introduction

The outcomes of the assessment for each of the three GWDTEs are presented in Table 4.1, with the detailed evaluation for each habitat provided in the descriptions below.

GWDTE 41

This habitat is located downgradient of T14 including the associated crane pad and access track. Its SEPA 250m buffer intercepts T14, but the 100m buffer does not encounter the crane pad or any access track.

The habitat comprises M23, rush-pasture, vegetation of Moderate groundwater dependence. It lies along a mineral vein within the Leadhills Supergroup (conglomerate, wackes and mudstone; Figure 1 and Appendix B), which may provide a localised source of groundwater in a weathered 'contact' zone with the country rock. Nonetheless, given its position within a watercourse valley, a proportion of surface water is also likely to contribute some of the water to this habitat.

The construction of T14 is unlikely to lead to any direct loss of habitat, and the ZOC is unlikely to intercept T14, the crane pad or the access track running towards the turbine. The potential effect on the quality of the water supporting the GWDTE is considered low, leading to an overall (flow and quality) potential magnitude of change on this very low sensitivity receptor of low and not significant.

Mitigation would further reduce these limited effects. These measures include the use of appropriate track drainage design in the immediate vicinity of the habitat, including cross drains to allow water to travel downslope of the track. The mitigation measures employed during the construction, operation and decommissioning of the turbines and their crane pads, such as the use of settling ponds in the vicinity of the habitat, would also minimise the potential effect on groundwater flow and quality. The re-use of filtrated water from the settlement ponds could be used to provide a compensatory water source for the habitat by discharging to a vegetated surface just upgradient of the habitat, although this is unlikely to be necessary. Other mitigation measures throughout the life cycle of the Proposed Development are further detailed in the ES Chapter 13. As such, the assessed magnitude of residual change to this habitat is considered to be negligible and not significant. The same mitigation would also minimise disruption of the habitat's surface water supply.

GWDTE 207

This habitat is located immediately adjacent to, and downgradient, of the main site access track, close to the site entrance. Its SEPA 250m buffer does not intercept any turbines, although it lies close to the northernmost borrow pit, and whilst the 100m buffer does not encounter any crane pads, it does encounter the access track.

The habitat comprises M25, mire, vegetation of Moderate groundwater dependence. The habitat is likely to receive the majority of its groundwater supply from the fault that occurs at the interface of the Carrick Volcanic Formation (CVF, andesite and basalt) and the Upper Limestone Formation (ULF, Figure 1 and Appendix B). A weathered horizon at the top of the CVF upgradient of the habitat may also provide some groundwater, as well as a potential surface water input from the upgradient watercourse.

The construction of the access track is unlikely to lead to any direct loss of habitat, and the track does not intercept the fault, but as the ZOC may intercept the access track, a slight potential reduction in capture zone exists. The potential effect on the quality of the groundwater supporting the GWDTE is also considered low, leading to an overall (flow and quality) potential magnitude of change on this medium sensitivity receptor of low and not significant.

Although considered not significant, the potential impact to this habitat would nevertheless be further reduced through the use of appropriate track drainage design in the immediate vicinity of the habitat, including cross drains to allow water to travel downslope of the track. Other mitigation measures throughout the life cycle of the Proposed Development are further detailed in the ES Chapter 13. As such, the assessed magnitude of residual change to this habitat is considered to be negligible and not significant. The same mitigation would also minimise disruption of the habitat's surface water supply.

GWDTE 208

This habitat is located between two borrow pit search areas, with access tracks on three sides (north, west and south), and T2 and its associated crane pad to the south east. Its SEPA 250m buffer intercepts both borrow pit search areas, but not T2. The 100m buffer does not encounter any of the access tracks.

The habitat comprises M23, rush-pasture, vegetation of High groundwater dependence. The habitat is likely to receive the majority of its groundwater supply from the two nearby faults; a northern one that occurs within the CVF, and another at the interface of CVF and the Leadhills Supergroup (Figure 1 and Appendix B). A weathered horizon at the top of the Leadhills Supergroup, upgradient of the habitat but downgradient of the southernmost fault, may also provide some groundwater to the habitat.

The construction of the access tracks is unlikely to lead to any direct loss of habitat, but the proximity of the borrow pit search areas and their proximity (particularly the western borrow pit search area) to the two faults means that there is a substantial potential reduction in groundwater flow to the feature. The potential effect on the quality of the groundwater supporting the GWDTE is considered low, but based on the higher flow effect score, the overall (flow and quality) potential magnitude of change on this very low sensitivity receptor is considered high and not significant. It should be noted that the final borrow pit excavation areas are expected to comprise only a small proportion of these borrow pit search areas.

Although considered not significant, the potential effects to this habitat would nevertheless be reduced by micro-siting of the borrow pit excavations within the search areas such that the groundwater flow to the GWDTE is preserved. Other mitigation measures throughout the life cycle of the Proposed Development are further detailed in the ES Chapter 13. As such, the assessed magnitude of residual change to this habitat is considered to be low and not significant. The same mitigation would also minimise disruption of the habitat's surface water supply.

Table 4.1 GWDTE Impact Assessment

Habitat Number (NVC type)	Sensitivity of Habitat	Assessed Groundwater Dependency	Estimated Direct Loss of Habitat	Estimated Potential Reduction in Capture Zone	Potential Reduction in Water Quality	Overall Potential Magnitude of Change	Significance of Potential Effect	Specific Mitigation Required	Overall Residual Magnitude of Change	Significance of Residual Effect
41 (M23a)	Very Low	Moderate	None	None	Low	Low	Not Significant	Runoff and sediment control measures; Construction pollution prevention, water quality monitoring and emergency response plan; Track drainage design; and Re-use of filtered water from settlement ponds to support habitat	Negligible	Not Significant
207 (M25)	Medium	Moderate	None	Slight	Low	Low	Not Significant	Runoff and sediment control measures; Construction pollution prevention, water quality monitoring and emergency response plan; Track drainage design; and Re-use of filtered water from settlement ponds to support habitat	Negligible	Not Significant
208 (M23a)	Very Low	High	None	Substantial	Low	High	Not Significant	Micro-siting of borrow pit within search area away from GWDTE; Runoff and sediment control measures; Construction pollution prevention, water quality monitoring and emergency response plan; Track drainage design; and Re-use of filtered water from settlement ponds to support habitat	Low	Not Significant
	Very Low Low Medium High Very High	Low Moderate High	None (0%) Slight (<10%) Moderate (10-50%) Substantial (>50%)	None (0%) Slight (<10%) Moderate (10-50%) Substantial (>50%)	Negligible Low Medium High	Negligible Low Medium High	Not Significant Significant		Negligible Low Medium High	Not Significant Significant

5. Conclusions

Some 85 potential GWDTEs have been identified on the site of the Proposed Development but, of these, only three are considered to be likely to be truly groundwater dependent, and located within the SEPA LUPSGU31 buffers in relation to the Proposed Development. Mitigation measures have been proposed to ensure that any change to their groundwater supply, and to any surface water contribution, occurring as a result of the Proposed Development is minimised. As such, there are no significant residual effects from the Proposed Development on GWDTEs.

Appendix A
Assessment of Potential GWDTEs

NVC Number	NVC Community	Potential Groundwater Dependency	Geology	Surface Hydrology	Assessed Groundwater Dependency
2	M23-M6	High and high	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup, with some bedrock at surface	The site as a whole lies within the Littlechang Burn valley. As such, it is considered that the presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Littlechang Burn.	Low
3	M23b-M20	High and moderate	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
5	M23-M6	High	Peat and till, and low permeability wackes and mudstones of the Leadhills Supergroup	The site as a whole lies within the Catlock Burn valley. As such, it is considered that the presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Catlock Burn.	Low
9	M23a	High	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
10	M6-M23	High	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
14	M23a	High	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration, as well as from surface runoff within the Strathwiggan Burn.	Low
24	M6	high	Till, and low permeability wackes and mudstones of the Leadhills Supergroup, and felsite of the Southern Midlands group, with some bedrock at surface	Although faults run through the site, a major part of the site lies upgradient from these, and the site as a whole lies within the Littlechang Burn valley. As such, it is considered that the presence of till and low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Littlechang Burn.	Low
25	M6	high	Low permeability wackes and mudstones of the Leadhills Supergroup	The site as a whole lies within the Littlechang Burn valley. As such, it is considered that the presence of low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Littlechang Burn.	Low
26	M23 and minor M6	High and high	Peat and till, and low permeability wackes and mudstones of the Leadhills Supergroup with mostly bedrock exposed at surface	The site as a whole lies within the Littlechang Burn valley. As such, it is considered that the presence of peatand till, along with low permeability bedrock, ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Littlechang Burn.	Low
30	M25-M23	Moderate and High	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
31	M23 and minor M6	High and high	Peat and till, and low permeability wackes and mudstones of the Leadhills Supergroup	The site as a whole lies within the Trough Burn valley. As such, it is considered that the presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Trough Burn.	Low

NVC Number	NVC Community	Potential Groundwater Dependency	Geology	Surface Hydrology	Assessed Groundwater Dependency
33	M23 and U4	High and low	Peat and till, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat and till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
34	M23 and minor M6	High and high	Peat and till, and low permeability wackes and mudstones of the Leadhills Supergroup	Notwithstanding the presence of low permeability bedrock, an element of water supply to the habitat could originate by the upflow of groundwater via a fault within the vicinity of the habitat. However, site as a whole lies within the Trough Burn valley and it is more likely that any groundwater levels are local and perched with the majority of the supply coming instead from surface runoff in Trough Burn or other surface or very near-surface runoff/infiltration.	Low
35	M23 and U4	High and low	Peat and till, and low permeability wackes and mudstones of the Leadhills Supergroup	The site as a whole lies within the Trough Burn valley. As such, it is considered that the presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface o+F81r very near-surface runoff/infiltration and surface runoff in Trough Burn.	Low
41	M23a	High	Till and low permeability wackes and mudstones of the Leadhills Supergroup with some bedrock exposed at surface	Notwithstanding the presence of till and low permeability bedrock, an element of water supply to the habitat could originate by the upflow of groundwater via an outcropping mineral vein in the immediate vicinity of the habitat. However, site as a whole lies within the Trough Burn valley and it is more likely that any groundwater levels are local and perched with the majority of the supply coming instead from surface runoff in Trough Burn or other surface or very near-surface runoff/infiltration.	**Moderate**
47	M23 and minor M6	High and high	Peat and till, and low permeability wackes and mudstones of the Leadhills Supergroup	The site as a whole lies within the Connel Burn tributary valley. As such, it is considered that the presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Connel Burn tributary.	Low
49	M23a and U4	High and low	Till, and low permeability wackes and mudstones of the Leadhills Supergroup with some bedrock at surface	The presence of till and low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
52	M23 and M6	High and high	Till, and low permeability wackes and mudstones of the Leadhills Supergroup	The site as a whole lies within the Connel Burn tributary valley. As such, it is considered that the presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Connel Burn tributary.	Low
56	M25 and M23	Moderate and High	Till, and low permeability wackes and mudstones of the Leadhills Supergroup	The site as a whole lies within the Connel Burn valley. As such, it is considered that the presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Connel Burn.	Low
57	M23 and M6	High and high	Till, and low permeability wackes and mudstones of the Leadhills Supergroup	The site as a whole lies within the Connel Burn valley. As such, it is considered that the presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Connel Burn.	Low
58	M25 and M23	Moderate and High	Peat and till, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat and till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low

NVC Number	NVC Community	Potential Groundwater Dependency	Geology	Surface Hydrology	Assessed Groundwater Dependency
59	M25	Moderate	Peat and till, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat and till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
60	M25 and M17	Moderate and low	Peat and till, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat and till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
61	M23a and U4	High and low	Till, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
62	M23a and U4	High and low	Till, and low permeability wackes and mudstones of the Leadhills Supergroup with some bedrock at surface	The presence of till and low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
63	M25	Moderate	Low permeability wackes and mudstones of the Leadhills Supergroup	The presence of low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
65	M23b	High	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
68	M23a-minor M6	High and high	Peat, and low permeability volcanic rocks of the Lower ORS	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
69	M23a	High	Peat, and low permeability volcanic rocks of the Lower ORS with some bedrock at surface	The presence of till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration, and is also likely to be supported by surface runoff in the Knockburnie Burn.	Low
70	M23a	High	Till, and low permeability volcanic rocks of the Lower ORS	The presence of till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration, although the majority of the supply is more likely to be supported by surface runoff in the Knockburnie Burn.	Low
71	M25	Moderate	Till, and low permeability volcanic and conglomerate rocks of the Lower ORS, with some bedrock at surface	The presence of till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
72	M23a-minor M6	High and high	Peat and till, and low permeability volcanic rocks of the Lower ORS, with some bedrock at surface	The presence of till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration, although the majority of the supply is more likely to be supported by surface runoff in the Knockburnie Burn.	Low
73	M25	Moderate	Peat, and low permeability volcanic rocks of the Lower ORS	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low

NVC Number	NVC Community	Potential Groundwater Dependency	Geology	Surface Hydrology	Assessed Groundwater Dependency
74	M23	High	Till and peat, and low permeability volcanic rocks of the Lower ORS	The presence of till and peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration, as well as surface runoff in the Polmath Burn that dissects the habitat.	Low
75	M23a	High	Peat and till, and low permeability volcanic rocks of the Lower ORS	The presence of till and peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
66	M23	High	Peat, and low permeability volcanic rocks of the Lower ORS	The presence of till and peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration, as well as surface runoff in the Polmath Burn that dissects the habitat.	Low
76	M23a-minor M6 and M20	High, high and moderate	Till and peat, and low permeability volcanic rocks of the Lower ORS	The presence of till and peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration, as well as surface runoff in the unnamed watercourse that dissects the northern part of the habitat.	Low
77	U6	Moderate	Peat, and low permeability volcanic rocks of the Lower ORS	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
78	M23a-minor M6 and M25	High, high and moderate	Till and peat, and low permeability volcanic rocks of the Lower ORS with some bedrock at surface	Notwithstanding the presence of till and peat, an element of water supply to the habitat could originate by the upflow of groundwater via faults in the immediate vicinity of the habitat. However, a substantial portion of the habitat lies upgradient of this fault, and it is more likely that any groundwater levels are local and perched with the majority of the supply coming instead from surface or very near-surface runoff/infiltration, as well as surface runoff in the unnamed watercourse that dissects the habitat.	Low
79	M23	High	Till and low permeability volcanic rocks of the Lower ORS	Notwithstanding the presence of till, an element of water supply to the habitat could originate by the upflow of groundwater via faults in the immediate vicinity of the habitat. However, a substantial portion of the habitat lies upgradient of this fault, and it is more likely that any groundwater levels are local and perched with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
80	M25	Moderate	Till and peat, and low permeability volcanic rocks of the Lower ORS with some bedrock at surface	Notwithstanding the presence of till, an element of water supply to the habitat could originate by the upflow of groundwater via faults in the immediate vicinity of the habitat. However, a substantial portion of the habitat lies upgradient of this fault, and it is more likely that any groundwater levels are local and perched with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
83	M23-M25	High/moderate	Till and peat, and low permeability volcanic rocks of the Lower ORS with some bedrock at surface	The presence of low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
84	U5-M25	Low and Moderate	Till and peat, and low permeability volcanic rocks of the Lower ORS with some bedrock at surface	Notwithstanding the presence of till and peat, an element of water supply to the habitat could originate by the upflow of groundwater via faults in the immediate vicinity of the habitat. However, a substantial portion of the habitat lies upgradient of this fault, and it is more likely that any groundwater levels are local and perched with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
86	M23a	High	Peat, and low permeability volcanic rocks of the Lower ORS	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low

NVC Number	NVC Community	Potential Groundwater Dependency	Geology	Surface Hydrology	Assessed Groundwater Dependency
90	M23a	High	Peat, and low permeability volcanic rocks of the Lower ORS	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
98	M23a	High	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration, as well as from surface runoff within the Strathwiggan Burn.	Low
100	U6	Moderate	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup with some bedrock at surface	The presence of low permeability bedrock outcrop and peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
103	U6	Moderate	Low permeability wackes and mudstones of the Leadhills Supergroup	The presence of low permeability bedrock outcrop ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
104	U6	Moderate	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
107	U6	Moderate	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
108	M6 Je-M20-M17	High, moderate and moderate	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration, as well as from surface runoff within the Bitch Burn.	Low
111	M6-M23	High and high	Peat, and low permeability volcanic and conglomerate rocks of the Lower ORS, with some bedrock at surface	Although faults are present close by, the more likely source of water is that within the Knockburnie Burn, in whose valley the habitat lies. As such, they are unlikely to provide the main source of water as groundwater. Instead, the presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Knockburnie Burn.	Low
115	U6-U4	Moderate and Low	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
116	U6-U5	Moderate and Low	Low permeability wackes and mudstones of the Leadhills Supergroup	The presence of low permeability bedrock outcrop ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
121	M23-M6	High and high	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration, and surface runoff in Littlechang Burn.	Low
122	M6c	High	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low

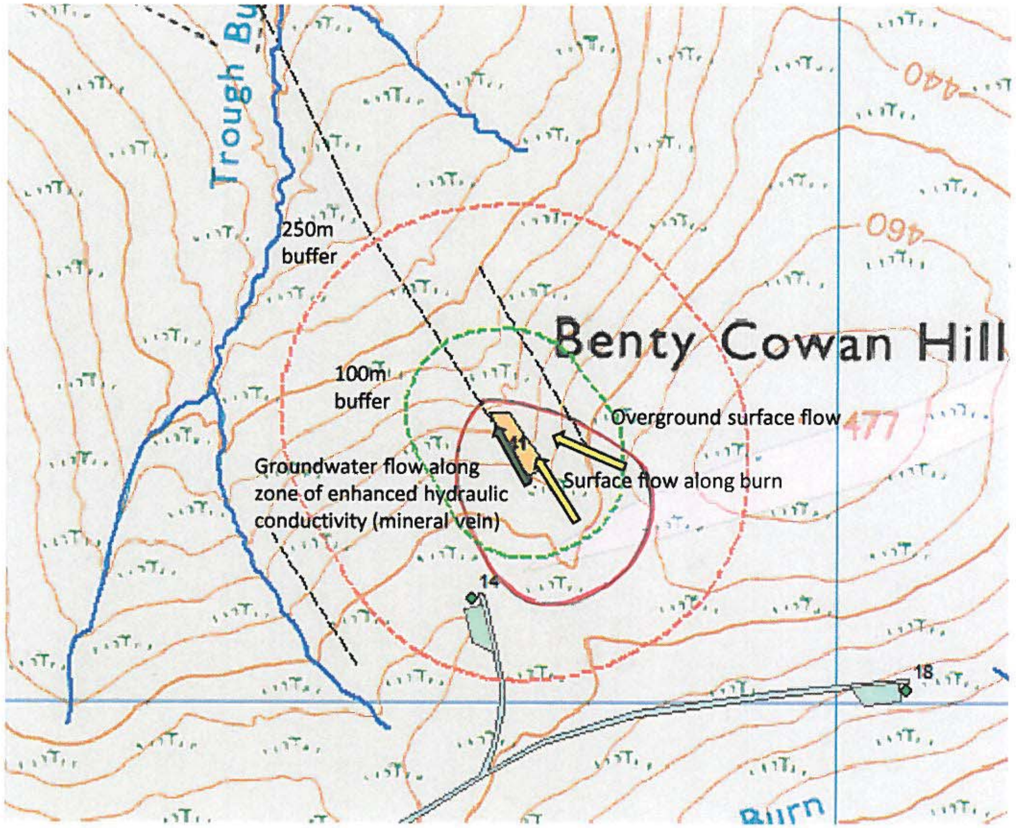
NVC Number	NVC Community	Potential Groundwater Dependency	Geology	Surface Hydrology	Assessed Groundwater Dependency
126	M6	High	Till, and low permeability wackes and mudstones of the Leadhills Supergroup, and felsite of the Southern Midlands group, with some bedrock at surface	Although faults run through the site, a major part of the site lies upgradient from these, and the site as a whole lies within the Catlock Burn valley. As such, it is considered that the presence of till and low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Catlock Burn.	Low
128	M25	Moderate	Till, and low permeability volcanic rocks of the Lower ORS, with some bedrock at surface	Although faults are present close by, they occur at the lateral edges of the habitat, and much of the habitat does not lie downgradient of the fault. As such, they are unlikely to provide the main source of water as groundwater. Instead, the presence of till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
130	M25	Moderate	Till, and low permeability volcanic rocks of the Lower ORS, with mostly bedrock at surface	Although faults are present close by, they occur beyond the downgradient extent of the habitat. As such, they are unlikely to provide the main source of water as groundwater. Instead, the presence of low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
131	M23-U4	Moderate and Low	Till, and low permeability volcanic rocks of the Lower ORS	The presence of till and peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
135	M6d	High	Till, and low permeability wackes and mudstones of the Leadhills Supergroup with mostly bedrock at surface	The presence of low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
137	M6d	High	Till, and low permeability wackes and mudstones of the Leadhills Supergroup with mostly bedrock at surface	The presence of low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
138	M25-M17	Moderate and low	Low permeability wackes and mudstones of the Leadhills Supergroup	The presence of low permeability bedrock outcrop ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
141	M23a	High	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup with some bedrock at surface	Although faults run through the site, the site lies within the valley of the unnamed tributary to the Connel Burn. As such, it is considered that the presence of peat and low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in the unnamed watercourse.	Low
142	M25-M17	Moderate and low	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup with some bedrock at surface	Notwithstanding the presence of till and peat, an element of water supply to the habitat could originate by the upflow of groundwater via a band of enhanced hydraulic conductivity (mineral vein) in the immediate vicinity of the habitat. However, a substantial portion of the habitat lies upgradient of the vein and it is more likely that any groundwater levels are local and perched with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low

NVC Number	NVC Community	Potential Groundwater Dependency	Geology	Surface Hydrology	Assessed Groundwater Dependency
144	M25-minor M17	Moderate and low	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup with some bedrock at surface	Notwithstanding the presence of till and peat, an element of water supply to the habitat could originate by the upflow of groundwater via a band of enhanced hydraulic conductivity (mineral vein) in the immediate vicinity of the habitat. However, only a small portion of the habitat is intersected by the vein. Therefore it is more likely that any groundwater levels are local and perched with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
146	M25-minor M17	Moderate and low	Low permeability wackes and mudstones of the Leadhills Supergroup	The presence of low permeability bedrock outcrop ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
147	M25	Moderate	Low permeability wackes and mudstones of the Leadhills Supergroup and Crawford Group	The presence of low permeability bedrock outcrop ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
149	M25	Moderate	Till, and low permeability wackes and mudstones of the Leadhills Supergroup with some bedrock at surface	The presence of till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
150	M23a-U5	High and low	Till, and low permeability wackes and mudstones of the Leadhills Supergroup with some bedrock at surface	The presence of till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
151	M25-M23	Moderate and high	Till, and low permeability wackes and mudstones of the Leadhills Supergroup with some bedrock at surface	The presence of till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
152	M25	Moderate	Low permeability wackes and mudstones of the Leadhills Supergroup	The presence of low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
160	U6	Moderate	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
162	M23a	High	Low permeability wackes and mudstones of the Leadhills Supergroup and Crawford Group	Notwithstanding the presence of low permeability bedrock, an element of water supply to the habitat could originate by the upflow of groundwater via a fault within the vicinity of the habitat. However, the fault lies downgradient from the habitat and it is more likely that any groundwater levels are local and perched with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
170	M6c	High	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
182	M23b	High	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low

NVC Number	NVC Community	Potential Groundwater Dependency	Geology	Surface Hydrology	Assessed Groundwater Dependency
183	M23b	High	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
191	M6c	High	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
192	U6	Moderate	Peat, and low permeability wackes and mudstones of the Leadhills Supergroup	The presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
203	M23a	High	Till and peat, and low permeability volcanic rocks of the Lower ORS with some bedrock at surface	The presence of peat and till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
206	M23a	High	Till and peat, and low permeability volcanic rocks of the Lower ORS	The presence of peat and till ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration. Furthermore, the majority of the supply instead likely to be supported by surface runoff in the Bow Burn.	Low
207	M25	Moderate	Till and peat, and low permeability volcanic rocks of the Lower ORS	Notwithstanding the presence of till, an element of water supply to the habitat could originate by the upflow of groundwater via faults at and immediately upgradient of the habitat.	**Moderate**
208	M23a	High	Peat, and low permeability volcanic and conglomerate rocks of the Lower ORS	Notwithstanding the presence of till, an element of water supply to the habitat could originate by the upflow of groundwater via faults in the immediate vicinity of the habitat.	**High**
209	M6-M23	High and high	Peat, and low permeability volcanic and conglomerate rocks of the Lower ORS as well as wackes and mudstones of the Leadhills Supergroup, with some bedrock at surface	Although faults run through the site, a major part of the site lies upgradient from these, and the site as a whole lies within the Knockburnie Burn valley, adjacent to habitat #47. As such, it is considered that the presence of peat ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff/infiltration and surface runoff in Knockburnie Burn.	Low
210	M6	High	Peat and till, and low permeability volcanic and conglomerate rocks of the Lower ORS as well as wackes and mudstones of the Leadhills Supergroup	Notwithstanding the presence of till and peat, an element of water supply to the habitat could originate by the upflow of groundwater via faults in the immediate vicinity of the habitat. However, a substantial portion of the habitat lies upgradient of this fault, and it is more likely that any groundwater levels are local and perched with the majority of the supply coming instead from surface or very near-surface runoff/infiltration.	Low
213	M25-M23	Moderate and High	Till and low permeability volcanic rocks of the Lower ORS with some bedrock at surface	Notwithstanding the presence of till, an element of water supply to the habitat could originate by the upflow of groundwater via faults in the immediate vicinity of the habitat. However, a substantial portion of the habitat lies upgradient of this fault, and it is more likely that any groundwater levels are local and perched with the majority of the supply coming instead from surface or very near-surface runoff/infiltration, as well as surface runoff in the unnamed watercourse that dissects the habitat.	Low

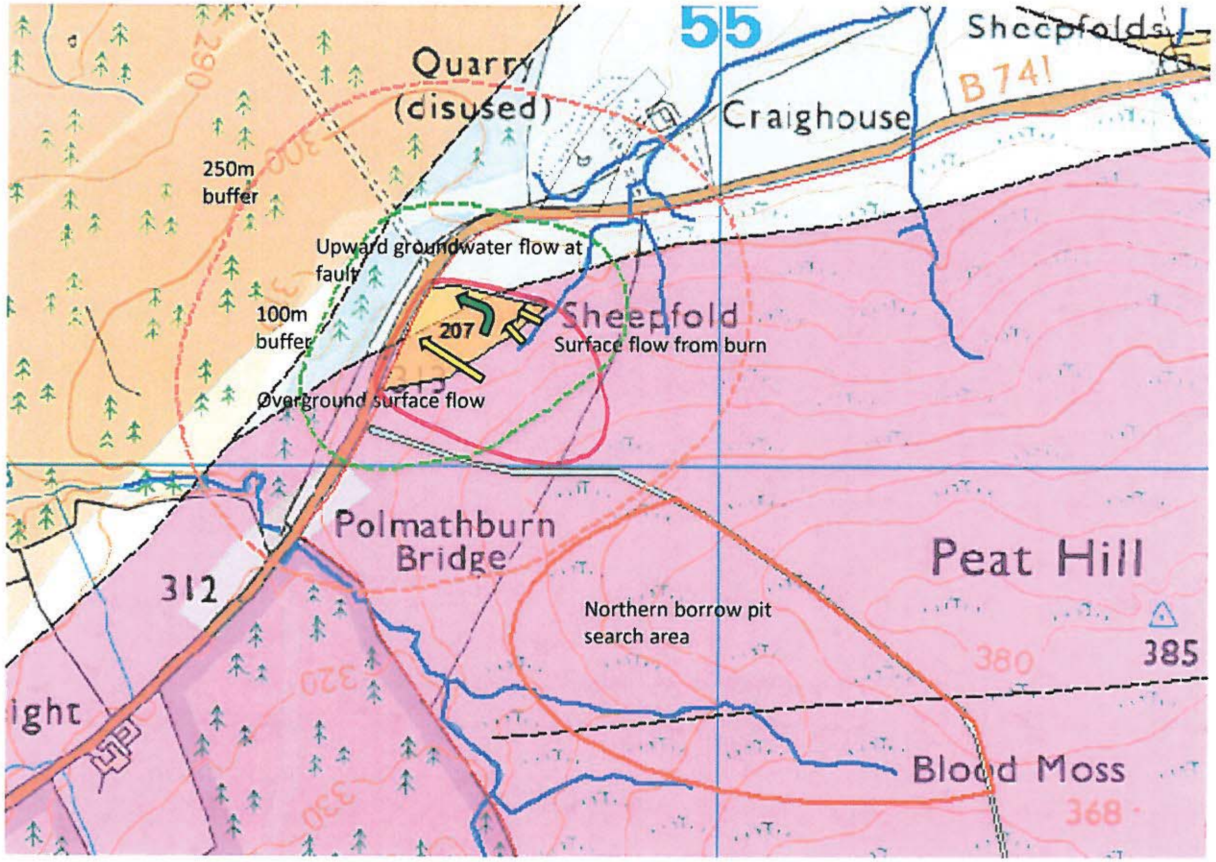
Appendix B
Assessment of Actual GWDTEs

GWDTE 41



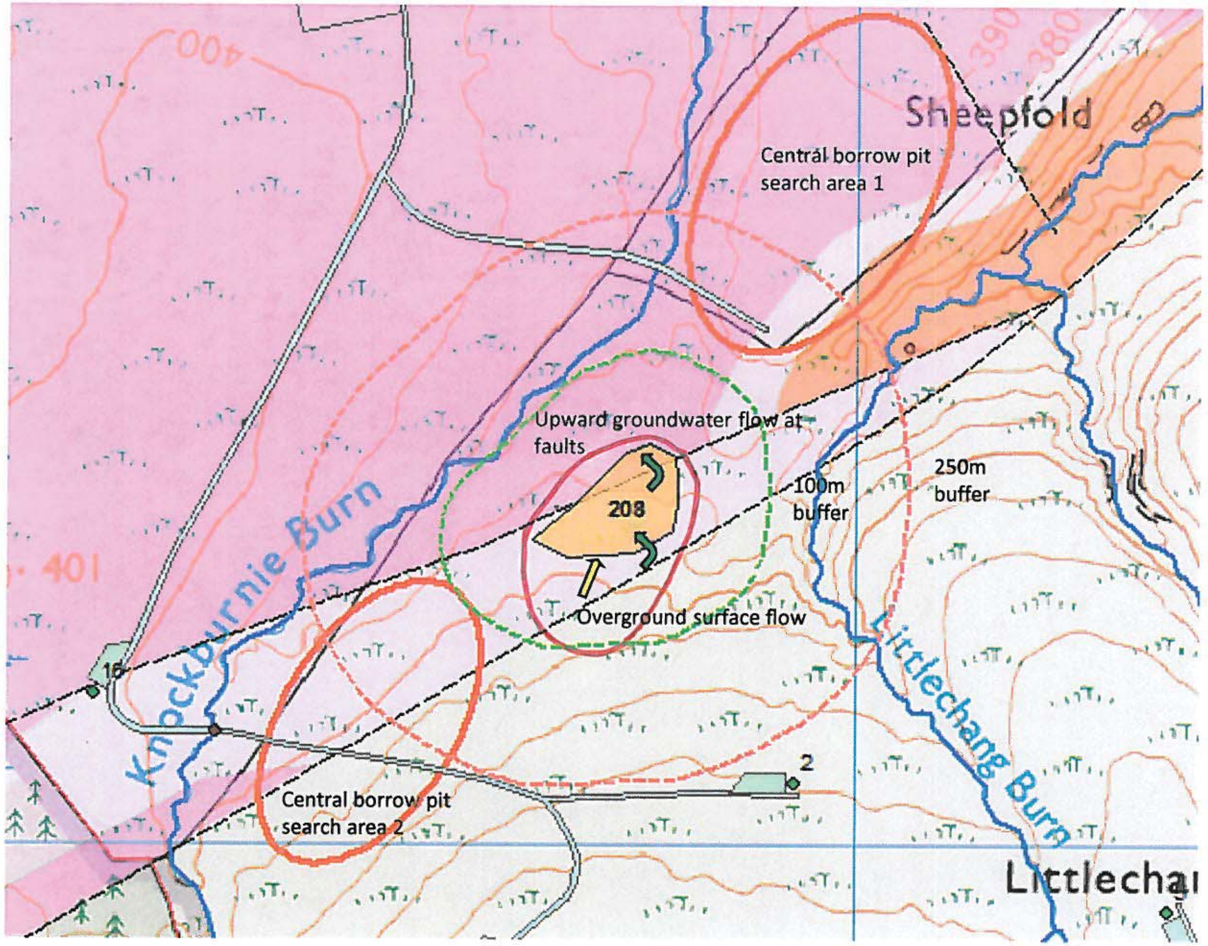
Trough Bu
250m
buffer
100m
buffer
Benty Cowan Hill
Overground surface flow
477
Surface flow along burn
Groundwater flow along
zone of enhanced hydraulic
conductivity (mineral vein)
440
460
14
18
Burn

GWDTE 207



55
Sheepfolds
B 741
Quarry
(disused)
Craighouse
250m
buffer
Upward groundwater flow at
fault
100m
buffer
207
Sheepfold
Surface flow from burn
Overground surface flow
Polmathburn
Bridge
312
Peat Hill
Northern borrow pit
search area
385
380
ight
Blood Moss
368
290
300
320
330

GWDTE 208


Sheepfold
Central borrow pit search area 1
Upward groundwater flow at faults
208
100m buffer
250m buffer
Overground surface flow
Knockburnie Burn
Littlechang Burn
Central borrow pit search area 2
Littlechal
400
401
390
380
16
2

Appendix 13.C
Private Water Supply Dataset

StartDate	EndDate	SiteRef	SourceName	GridReference - Eastings	GridReference - Northings	Classification	Regulation 3(1) status	TypeA Reason	Tourist Accommodation	Purpose Domestic	Within 5km
01/01/2011	31/12/2011	EAY187	Nith Lodge	253590	609290	B				yes	y
01/01/2011	31/12/2011	EAY175	Maneight Farm	254270	609620	B				yes	y
01/01/2011	31/12/2011	EAY177	Meikle Hill	255480	608850	B				yes	y
01/01/2011	31/12/2011	EAY155	Lanehead Farm	255720	610880	B				yes	y
01/01/2011	31/12/2011	EAY146	Knockburnie Farm	256200	610480	B				yes	y
01/01/2011	31/12/2011	EAY079	Moor Farm	256990	603640	B				yes	y
01/01/2011	31/12/2011	EAY083	Auchingee	257310	612150	B				yes	y
01/01/2011	31/12/2011	EAY092	Brockloch Farm	259510	610480	B				yes	y
01/01/2011	31/12/2011	EAY151	Laglaff Farm	260397	610095	B				yes	y1
01/01/2011	31/12/2011	EAY093	Broomhill	2	6	B				yes	
01/01/2011	31/12/2011	EAY213	Cauldstanes	2	6	B				yes	
01/01/2011	31/12/2011	EAY217	Crofthead of Gree	2	6	B				yes	
01/01/2011	31/12/2011	EAY053	Glaister	2		B				yes	
01/01/2011	31/12/2011	EAY215	High Polquirter	2	6	B				yes	
01/01/2011	31/12/2011	EAY149	Knowe Farm, Darvel	2	6	B				yes	
01/01/2011	31/12/2011	EAY170	Low Carlincraig	2	6	B				yes	
01/01/2011	31/12/2011	EAY184	Netherton	2	6	B				yes	
01/01/2011	31/12/2011	EAY076	North Glassock	2	6	B				yes	
01/01/2011	31/12/2011	EAY202	Underlaw	2	6	B				yes	
01/01/2011	31/12/2011	EAY211	Underlaw Cottages	2	6	B				yes	
01/01/2011	31/12/2011	EAY185	Newhouse, Auchencloigh	232150	654145	B				yes	
01/01/2011	31/12/2011	EAY058	Keirsmill	240400	611200	B				yes	
01/01/2011	31/12/2011	EAY006	Laigh Castleton	240646	644442	A1		Dairy Farm	no	yes	
01/01/2011	31/12/2011	EAY067	Shankston Farm	240700	611200	B				yes	
01/01/2011	31/12/2011	EAY038	Lochridge Hills	241534	651993	B				yes	
01/01/2011	31/12/2011	EAY002	West Tannacrieff	244219	642860	A1		Dairy Farm	yes	yes	
01/01/2011	31/12/2011	EAY214	Townend of Fullwood	244383	649919	B				yes	
01/01/2011	31/12/2011	EAY008	Keyshill Farm	244683	622419	A1		Dairy Farm	no	yes	
01/01/2011	31/12/2011	EAY056	High Fullwood	244755	650285	B				yes	
01/01/2011	31/12/2011	EAY009	Midhouse of Garbrockhill	245176	650970	A1		Dairy Farm	no	yes	
01/01/2011	31/12/2011	EAY084	Auldcraigoch	245322	604281	B				yes	
01/01/2011	31/12/2011	EAY012	Chipperlaggan	245693	620616	A1		Dairy Farm	no	yes	
01/01/2011	31/12/2011	EAY013	Treesmax	246068	618516	A1		Dairy Farm	no	yes	
01/01/2011	31/12/2011	EAY066	Ravenscroft Farm	246535	613890	B				yes	
01/01/2011	31/12/2011	EAY074	Ladeside	246684	646514	B				yes	
01/01/2011	31/12/2011	EAY206	Gree Cottage	246705	646663	B				yes	
01/01/2011	31/12/2011	EAY055	Townhead of Gree	246706	646662	B				yes	
01/01/2011	31/12/2011	EAY034	Auchenfail	247100	628800	B				yes	
01/01/2011	31/12/2011	EAY039	Warnockland	247663	644476	B				yes	
01/01/2011	31/12/2011	EAY036	Fleminghill Farm	247892	638905	B				yes	
01/01/2011	31/12/2011	EAY024	Harelaw Farm	248600	647200	B				yes	
01/01/2011	31/12/2011	EAY033	North Drumboy	249455	648826	B				yes	
01/01/2011	31/12/2011	EAY022	South Drumboy	249700	648500	B				yes	
01/01/2011	31/12/2011	EAY203	Best Friends Cottage	249732	647255	B				yes	
01/01/2011	31/12/2011	EAY042	Burnockstone	250185	618647	B				yes	
01/01/2011	31/12/2011	EAY136	Highfield Farm	250335	649624	B				yes	
01/01/2011	31/12/2011	EAY208	Highfield Cottage	250368	649594	B				yes	
01/01/2011	31/12/2011	EAY015	Howletburn	250500	638400	B				yes	
01/01/2011	31/12/2011	EAY007	Alton Farm	250607	639071	A1		Dairy Farm	no	yes	
			Clawfin Farm	250610	607250						y1
01/01/2011	31/12/2011	EAY041	Syke Farm	250666	624412	B				yes	
01/01/2011	31/12/2011	EAY027	Alton Muirhouse	250700	640600	B				yes	
01/01/2011	31/12/2011	EAY216	Kingswell	250877	658194	B				yes	
01/01/2011	31/12/2011	EAY037	Airtnoch	250989	644402	B				yes	
01/01/2011	31/12/2011	EAY017	Alton Lodge	251000	640200	B				yes	
01/01/2011	31/12/2011	EAY030	West Newton Farm	251400	639000	B				yes	
01/01/2011	31/12/2011	EAY031	Newton Lea	251500	639400	B				yes	
01/01/2011	31/12/2011	EAY032	Loudoun Lodge	251600	638500	B				yes	
01/01/2011	31/12/2011	EAY019	East Newton Farm	251700	639300	B				yes	
01/01/2011	31/12/2011	EAY003	Woodhead Farm	252030	637904	A1		Dairy Farm	no	yes	
01/01/2011	31/12/2011	EAY046	Cessnock Castle	252119	635314	B				yes	
01/01/2011	31/12/2011	EAY001	Langside	252604	633377	A1		Dairy Farm	no	yes	
01/01/2011	31/12/2011	EAY004	Loudoun Mains	252751	638962	A1			yes	yes	
01/01/2011	31/12/2011	EAY209	Cairnhill Farm	252777	634117	B				yes	
01/01/2011	31/12/2011	EAY139	Hillhouse	253546	634910	B				yes	
01/01/2011	31/12/2011	EAY160	Little Carleith	254129	632973	B				yes	
01/01/2011	31/12/2011	EAY040	Whatriggs	255215	640325	B				yes	
01/01/2011	31/12/2011	EAY020	Brocklees Farm	255300	641300	B				yes	
01/01/2011	31/12/2011	EAY005	Gamesland Farm	255344	638890	A1		Dairy Farm	no	yes	
01/01/2011	31/12/2011	EAY023	Templehill	255700	638600	B				yes	
01/01/2011	31/12/2011	EAY108	Dalgig Farm	255740	613225	B				yes	y
01/01/2011	31/12/2011	EAY051	Eastfield	255805	635092	B				yes	
01/01/2011	31/12/2011	EAY029	Greenfield Farm	255837	633892	B				yes	
01/01/2011	31/12/2011	EAY050	East Loudounhill	255866	635197	B				yes	
01/01/2011	31/12/2011	EAY059	Keiland Cottage	255866	635197	B				yes	
01/01/2011	31/12/2011	EAY153	Laigh Hapton	255941	641281	B				yes	
01/01/2011	31/12/2011	EAY129	High Carlincraig	255988	639919	B				yes	
01/01/2011	31/12/2011	EAY021	Carlinlees	256400	640100	B				yes	
01/01/2011	31/12/2011	EAY026	Gateside Farm	256800	640800	B				yes	
01/01/2011	31/12/2011	EAY018	Loudoun Moor Schoolhouse	256900	640900	B				yes	
01/01/2011	31/12/2011	EAY197	Richardton Farm	257077	636438	B				yes	
01/01/2011	31/12/2011	EAY060	Long Green	257505	640881	B				yes	
01/01/2011	31/12/2011	EAY152	Laigh Braidley	257636	240560	B				yes	
01/01/2011	31/12/2011	EAY063	Meikleglen	257693	639721	B				yes	
01/01/2011	31/12/2011	EAY016	Little Glen	257700	639400	B				yes	
01/01/2011	31/12/2011	EAY045	Byres of Bankhead	257804	638817	B				yes	
01/01/2011	31/12/2011	EAY052	Feoch	257893	639963	B				yes	
01/01/2011	31/12/2011	EAY044	Henryton Farm	257978	638622	B				yes	
01/01/2011	31/12/2011	EAY014	Low Overmoor Farm	258100	643200	B				yes	
01/01/2011	31/12/2011	EAY128	Tulloch	258132	635511	B				yes	
01/01/2011	31/12/2011	EAY164	Lochfield Farm	258418	641710	B				yes	
01/01/2011	31/12/2011	EAY221	Glenview	258831	626707	B				yes	
01/01/2011	31/12/2011	EAY071	Windshields	258874	639427	B				yes	
01/01/2011	31/12/2011	EAY025	Templandshaw Farm	259600	624900	B				yes	
01/01/2011	31/12/2011	EAY043	Auchenlongford Farm	259726	628497	B				yes	
01/01/2011	31/12/2011	EAY010	Watston Farm	259790	617695	A1		Dairy Farm	no	no	
01/01/2011	31/12/2011	EAY091	Borland Mains	259839	618505	B				yes	
01/01/2011	31/12/2011	EAY057	High Newton	259898	635626	B				yes	
01/01/2011	31/12/2011	EAY140	Holmside	259936	637681	B				yes	
01/01/2011	31/12/2011	EAY096	Calton	260611	616982	B				yes	
01/01/2011	31/12/2011	EAY109	Dalhanna farm	261996	610657	B				yes	
01/01/2011	31/12/2011	EAY119	Garpel Farm	262189	627702	B				yes	
01/01/2011	31/12/2011	EAY212	Lochbrowan	262375	609692	B				yes	
01/01/2011	31/12/2011	EAY201	Stonebriggs Farm	262472	623948	B				yes	
01/01/2011	31/12/2011	EAY087	Blackcraig Farm	263611	608168	B				yes	y1
01/01/2011	31/12/2011	EAY061	Meikle Garcleugh	264706	614775	B				yes	
01/01/2011	31/12/2011	EAY123	Greenockdyke	265644	628681	B				yes	
01/01/2011	31/12/2011	EAY120	Glen Farm	265940	614962	B				yes	
01/01/2011	31/12/2011	EAY069	Townhead of Greenock	266407	627208	B				yes	
01/01/2011	31/12/2011	EAY190	Over Cairn	266635	612833	B			No	yes	
01/01/2011	31/12/2011	EAY064	Midwellwood	266789	624999	B				yes	
01/01/2011	31/12/2011	EAY048	Upper Wellwood	267713	225525	B				yes	
01/01/2011	31/12/2011	EAY028	Middlefield Farm	268343	629821	B				yes	
01/01/2011	31/12/2011	EAY047	Crofthead Cottage	270006	627963	B				yes	
01/01/2011	31/12/2011	EAY204	Wee Darnhunch	274919	628208	B				yes	

01/01/2011	31/12/2011	EAY081 Allanton	B		yes
01/01/2011	31/12/2011	EAY082 Alton Muirhouse	B		yes
01/01/2011	31/12/2011	EAY221 Auchencloigh	B		yes
01/01/2011	31/12/2011	EAY085 Auldhouseburn	B		yes
01/01/2011	31/12/2011	EAY086 Avisyard	B		yes
01/01/2011	31/12/2011	EAY078 Bent	B		yes
01/01/2011	31/12/2011	EAY088 Blacklawhill	B		yes
01/01/2011	31/12/2011	EAY089 Blair	B		yes
01/01/2011	31/12/2011	EAY090 Boghead Farm	B		yes
01/01/2011	31/12/2011	EAY072 Burnanne House	B		yes
01/01/2011	31/12/2011	EAY094 Burnfoot Farm	B		yes
01/01/2011	31/12/2011	EAY097 Carcloot Farm	B		yes
01/01/2011	31/12/2011	EAY098 Castlemains Farm	B		yes
01/01/2011	31/12/2011	EAY099 Changue Farm	B		yes
01/01/2011	31/12/2011	EAY100 Chapelhouse	B		yes
01/01/2011	31/12/2011	EAY102 Corsehouse	B		yes
01/01/2011	31/12/2011	EAY103 Corsencon Cottage	B		yes
01/01/2011	31/12/2011	EAY104 Craigends	B		yes
01/01/2011	31/12/2011	EAY105 Croilburn	B		yes
01/01/2011	31/12/2011	EAY106 Cronberry Farm	B		yes
01/01/2011	31/12/2011	EAY107 Crossflat Farm	B		yes
01/01/2011	31/12/2011	EAY113 Dalblair Scholhouse	B		yes
01/01/2011	31/12/2011	EAY110 Dalvennan Farm	B		yes
01/01/2011	31/12/2011	EAY111 Darnhunch	B		yes
01/01/2011	31/12/2011	EAY112 Drumtee	B		yes
01/01/2011	31/12/2011	EAY114 Dyke Farm	B		yes
01/01/2011	31/12/2011	EAY049 Dykehead	B		yes
01/01/2011	31/12/2011	EAY115 East Blackbyre Farm	B		yes
01/01/2011	31/12/2011	EAY117 East Blacklaw Farm	B		yes
01/01/2011	31/12/2011	EAY095 East Burnhead	B		yes
01/01/2011	31/12/2011	EAY116 East Heads	B		yes
01/01/2011	31/12/2011	EAY118 Eastfield Farm	B		yes
01/01/2011	31/12/2011	EAY073 Glen Farm	B		yes
01/01/2011	31/12/2011	EAY077 Glen Muck Farm	B		yes
01/01/2011	31/12/2011	EAY054 Glendale	B		yes
01/01/2011	31/12/2011	EAY121 Glenmuck Farm	B		yes
01/01/2011	31/12/2011	EAY122 Glenouther	B		yes
01/01/2011	31/12/2011	EAY124 Greensland Farm	B		yes
01/01/2011	31/12/2011	EAY125 Guelt Farm	B		yes
01/01/2011	31/12/2011	EAY126 Gunshill	B		yes
01/01/2011	31/12/2011	EAY127 Hall of Auchincross	B		yes
01/01/2011	31/12/2011	EAY130 High Clunch	B		yes
01/01/2011	31/12/2011	EAY131 High Fullwood	B		yes
01/01/2011	31/12/2011	EAY132 High Glenmuir	B		yes
01/01/2011	31/12/2011	EAY133 High Overmuir	B		yes
01/01/2011	31/12/2011	EAY134 High Park Farm	B		yes
01/01/2011	31/12/2011	EAY135 High Polquheys Farm	B		yes
01/01/2011	31/12/2011	EAY075 Highside	B		yes
01/01/2011	31/12/2011	EAY137 Hill Farm, Cumnock	B		yes
01/01/2011	31/12/2011	EAY138 Hill Farm, Galston	B		yes
01/01/2011	31/12/2011	EAY141 Home Farm	B		yes
01/01/2011	31/12/2011	EAY142 Intax	B		yes
01/01/2011	31/12/2011	EAY143 Kennels Cottage	B		yes
01/01/2011	31/12/2011	EAY144 Kieland Farm	B		yes
01/01/2011	31/12/2011	EAY145 Knevocklaw Farm	B		yes
01/01/2011	31/12/2011	EAY218 Knockenlee	B		yes
01/01/2011	31/12/2011	EAY147 Knocknaib	B		yes
01/01/2011	31/12/2011	EAY148 Knockterra	B		yes
01/01/2011	31/12/2011	EAY150 Kyle Farm	B		yes
01/01/2011	31/12/2011	EAY154 Lamond House	B		yes
01/01/2011	31/12/2011	EAY156 Lanfine House	B		yes
01/01/2011	31/12/2011	EAY157 Lightshaw Farm	B		yes
01/01/2011	31/12/2011	EAY158 Linburn Farm	B		yes
01/01/2011	31/12/2011	EAY159 Lintbrae	B		yes
01/01/2011	31/12/2011	EAY161 Little Garcleugh	B		yes
01/01/2011	31/12/2011	EAY162 Little Glen	B		yes
01/01/2011	31/12/2011	EAY163 Loanfoot Farm	B		yes
01/01/2011	31/12/2011	EAY165 Lochgoin Farm	B		yes
01/01/2011	31/12/2011	EAY166 Lochhill Farm	B		yes
01/01/2011	31/12/2011	EAY167 Lochside Cottage	B		yes
01/01/2011	31/12/2011	EAY168 Loudoun Lodge	B		yes
01/01/2011	31/12/2011	EAY169 Loudounmoor Schoolhouse	B		yes
01/01/2011	31/12/2011	EAY171 Low Carston	B		yes
01/01/2011	31/12/2011	EAY219 Low Dalblair	B		yes
01/01/2011	31/12/2011	EAY210 Low Gameshill Farm	B		yes
01/01/2011	31/12/2011	EAY173 Low Polquheys	B		yes
01/01/2011	31/12/2011	EAY174 Lowes Farm	B		yes
01/01/2011	31/12/2011	EAY207 Marramead	B		yes
01/01/2011	31/12/2011	EAY176 Meadowhead	B		yes
01/01/2011	31/12/2011	EAY062 Meikle Auchengibbert	B		yes
01/01/2011	31/12/2011	EAY178 Meikle Westland	B		yes
01/01/2011	31/12/2011	EAY179 Mid Grange	B		yes
01/01/2011	31/12/2011	EAY180 Midhouse Farm, Muirkirk	B		yes
01/01/2011	31/12/2011	EAY181 Midton of Fullwood	B		yes
01/01/2011	31/12/2011	EAY080 Monquhil Farm	B		yes
01/01/2011	31/12/2011	EAY182 Nether Heilar	B		yes
01/01/2011	31/12/2011	EAY183 Nether Waistland	B		yes
01/01/2011	31/12/2011	EAY011 Netherwood	A1	no	yes
01/01/2011	31/12/2011	EAY186 Newton Lea	B		yes
01/01/2011	31/12/2011	EAY188 No.1 Mansfield Cottages	B		yes
01/01/2011	31/12/2011	EAY189 North Glassock	B		yes
01/01/2011	31/12/2011	EAY191 Pollick Farm	B		yes
01/01/2011	31/12/2011	EAY192 Polquhairn	B		yes
01/01/2011	31/12/2011	EAY193 Polshill	B		yes
01/01/2011	31/12/2011	EAY194 Priestland, Muirkirk	B		yes
01/01/2011	31/12/2011	EAY195 Rankinston Farm	B		yes
01/01/2011	31/12/2011	EAY196 Redding Farm	B		yes
01/01/2011	31/12/2011	EAY198 Rottenyard Farm	B		yes
01/01/2011	31/12/2011	EAY199 Schoolhouse, Lethanhill	B		yes
01/01/2011	31/12/2011	EAY200 Skerrington Farm, Hurlford	B		yes
01/01/2011	31/12/2011	EAY068 Sornbeg	B		yes
01/01/2011	31/12/2011	EAY220 Townend of Gabrochill	B		yes
01/01/2011	31/12/2011	EAY070 West Auchenlongford	B		yes
01/01/2011	31/12/2011	EAY205 Westoun Farm	B		yes

Information from DGC

Property	Easting	Northing	Supply Type
Brownhill	255861	602779	SW

Appendix 13.D
Private Water Supply Risk Assessment

Enoch Hill Wind Farm

Private Water Supply Risk Assessment

August 2015

Amec Foster Wheeler Environment
& Infrastructure UK Limited

Report for

Simon Lejeune
E.ON Climate and Renewables UK Limited
Westwood Way
Westwood Business Park
Coventry
CV4 8LG

Main contributors

Dr Eleanor Haresign
Dr Shaun Salmon

Issued by

....
Dr Eleanor Haresign

Approved by

pp S.P.A ....
Dr Shaun Salmon

Amec Foster Wheeler

Prospect House
32 Sovereign Street
Leeds LS1 4BJ
United Kingdom
Tel +44 (0)113 389 1100

Doc Ref.: 32965\Rr112i1

Copyright and non-disclosure notice

Third-party disclaimer

Management systems

This document has been produced by Amec Foster Wheeler Environment & Infrastructure UK Limited in full compliance with the management systems, which have been certified to ISO 9001, ISO 14001 and OHSAS 18001 by LRQA.

Document revisions

No.	Details	Date
1	Draft for client comment	10/07/2015
2	Final	20/08/2015

Contents

1. Introduction

The Environmental Statement (ES) for the proposed Enoch Hill Wind Farm includes an assessment of effects on the water environment (Chapter 13). This report informs that part of the assessment relating to private water supplies (PWSs).

This report first describes the hydrogeological character of the area in Section 2, before presenting information obtained regarding each of the key PWSs. Section 3 presents a risk assessment and assesses the appropriate mitigation measures required to ensure potential effects to each PWS are minimised, before further recommendations are made in Section 4.

2. Water Environment Setting

2.1 Local Area

The hydrological and hydrogeological setting of the Proposed Development has been set out in Chapter 13 of the ES. Within the ES baseline description, consideration has been given to which PWSs in the area (Figure 1) could potentially be affected by the Proposed Development, and the need for further assessment with respect to three PWSs has been identified, namely Craighouse Cottage and Lanehead and Knockburnie farms (Figure 2). These PWSs are all located on the north slope of Peat Hill, at ~250-350 metres Above Ordnance Datum (mAOD) within the catchment of the Lane Burn and its tributaries, draining into the River Nith.

The geology of the area is presented in the two maps that comprise Figure 13.2 of the ES Chapter 13, and in more detail around the PWSs in Figure 2. Underlying the northern foot of Peat Hill lies the Upper Limestone Formation (ULF) and Limestone Formation and, further north still, the sandstone Passage Formation and cyclical strata of the Scottish Lower and Middle Coal Measures (LCM and MCM, respectively). To the south under Peat Hill is basalt and andesite of the Carrick Volcanic Formation (CVF). The superficial deposits in the area predominantly comprise till (a tenacious brown or blue-grey clay with a variable sand content), but bedrock is occasionally at, or close to, ground surface.

A geological cross section is provided in Appendix A. Running left to right (from north to south), and intersecting the Development Site at Blarene Hill, approximately 3km east of Peat Hill, the cross section illustrates the gentle folding of the Limestone/Coal Measures basin to the north of the site, and the generally steep dip angle of the faults in the area. In the absence of further detailed geological data, it is assumed that the fault north of Peat Hill is inclined at a similar dip angle.

The CVF strata are considered to be of low productivity, although with occasional springs which may occur from systems of near-surface dilated joints. The Coal Measures constitute a locally important aquifer, in which flow is dominantly in fissures and other discontinuities.

Groundwater levels were inferred during the peat survey works for the Proposed Development, based on the location of the acrotelm/catotelm interface (ES Chapter 6; Appendix 6.B: Peat Slide Hazard and Risk Assessment [PSHRA]). The interface generally occurred across the site at between approximately 0.2m and 0.8m below ground level (mbgl). Given the lack of a main aquifer across the part of the site where peat survey took place, i.e. the area underlain by the CVF and the Leadhills Supergroup (conglomerate, wacke and mudstone) to the south (PSHRA, Appendix A Figure 10), it is anticipated that such groundwater constitutes shallow, 'perched' water within the peat itself. In addition, it is noted in the PSHRA that, due to the density of drainage ditches and the shallow peat depths, very few areas of the Proposed Development were noted to have standing water or wet, boggy ground. There are no known current SEPA groundwater monitoring locations close to the site.

The three PWSs are located within the catchment of the Water Framework Directive (WFD) Lane Burn Water Body (Water Body Reference 10613). This water body is classified as having a 'Good' overall and chemical status in the 2013 Scotland River Basin Management Plan (RBMP), with no identified pressures on the water body. Successive overall environmental objectives for this water body have been set to remain as 'Good'. The relevant groundwater body is that of the New Cumnock Bedrock and Localised Sands and Gravel Aquifers, and has 'Poor' overall and chemical status in the Scotland RBMP for 2008. It is not entirely clear which water body name replaces this in the new designations in 2013. However, the Upper Nith Valley Water Bodies are at 'Good' overall and chemical status.

The hydrogeological conceptual understanding of each key PWS is presented in more detail below. The PWSs were visited by Amec Foster Wheeler on November 28th 2014, and the owner of Knockburnie Farm (and also of Craighouse Cottage) was also questioned regarding the water supplies. Relevant photographs are presented in Appendix B.

2.2 Craighouse Cottage PWS

The information obtained for this PWS is presented in Table 2.1, and the PWS infrastructure is mapped on Figure 2.

Table 2.1 Craighouse Cottage PWS

Data Type	Details
Source Location	Spring at NGR 254892 610295 (~340m from the northernmost borrow pit search area, and 305 m from the access track).
Header Tank Location	NGR 254892 610295 – a buried catch-pot concrete chamber with grass grown over the top.
Properties Supplied	Craighouse Cottage via a buried pipe from header tank.
Water Use	Domestic supply and livestock.
Water Volumes	Flow rates not known. No water shortages reported. Dimensions not known – estimate from ground surface ~2.5 x~1. 5m, and ~1m deep.
Sanitary Protection	No fencing around source/header tank. Chamber not watertight. Drainage around the source to take any surface runoff away. Water not currently treated. No water quality issues reported. There is sometimes a brown peaty colour. Water quality measurements from the overflow pipe on 28/11/15: pH 8.2 T 10.1°C.

The PWS source lies near to, but not within, the confluence of the two burns which make up the headwaters of Bow Burn, according to the Ordnance Survey (OS) mapping and as shown on Figure 2. The photographs of the source area (Appendix B) indicate that the mapped watercourse appears as a linear depression within an area of vegetation type that suggests boggier ground in the vicinity of the spring, which is located separately from the watercourse. As such, it is considered that the source is indeed a spring, and that the PWS is not sourced from water within the burns.

The location of the spring indicates the source is located immediately downgradient of the mapped fault. The spring's location suggests several hypotheses regarding the source of the water. One is that the uppermost strata of the ULF (strata of moderate permeability) provide water to the spring directly. In this case, the zone of contribution (ZOC) to the spring would lie to the north of the spring, but this is contrary to the slope of the ground and the direction of surface water flow. A second possibility is that the Limestone/Coal Measures basin strata could provide water from depth via the nearby fault. This is possible, but the associated ZOC would be difficult to define and possibly quite distant from the Proposed Development. A third possibility is that the water originates in an upper weathered zone in the bedrock, or as 'perched'/near-surface groundwater flow in superficial deposits. It is not considered likely that superficial deposits provide the source of water, given their low permeability nature (till) and their sparsity in this area (Chapter 13; Figure 13.2). However, whilst the CVF beneath Peat Hill is likely to be of dominantly low permeability, the resulting 'worst case' (topographically defined) PWS ZOC up the northern flank of Peat Hill (Figure 2) towards the main access track and the northernmost borrow pit search area is also 'worst case' with respect to the Proposed Development, and has been assumed for the purposes of the risk assessment.

2.3 Lanehead Farm PWS

The information obtained is presented in Table 2.2, and the PWS infrastructure is mapped on Figure 2.

Table 2.2 Lanehead Farm PWS

Data Type	Details
Source Location	Spring at NGR 255600 610200 (~295m from the northernmost borrow pit search area, and 475m from the access track).
Header Tank Location	NGR 255681 610470 – a buried chamber with grass grown over the top.
Properties Supplied	Lanehead Farm via a buried pipe from header tank.
Water Use	Domestic supply, no agricultural use.
Water Volumes	Flow rates not known. Usage ~80l/d. No shortages experienced, although the water pressure can drop from time to time.
Sanitary Protection	No fencing around source/ header tank. Cover/watertight chamber/dimensions not known. Water not currently treated. No water quality issues reported. Water quality measurements from the overflow trough on 28/11/15: pH 8.2 T 8.7ºC.

The PWS source lies approximately 170m upgradient of the headwaters of an unnamed tributary of the Bow Burn, according to the OS mapping, as shown in Figure 2. Indeed, inspection of the OS 1:50,000 mapping shows the watercourse to extend further up the slopes of Peat Hill to approximately 350mAOD, much closer to the location of the spring. Nonetheless, the source is understood to comprise a spring supply. Lying approximately 220m upgradient of the fault between the ULF and the CVF, and in the absence of any superficial deposits, this PWS further supports the hypothesis that water is associated with a weathered horizon near the surface of the CVF. Based on topography alone, the 'worst case' ZOC potentially extends to the summit of Peat Hill, towards the main access track and the northernmost borrow pit search area, as mapped in Figure 2.

2.4 Knockburnie Farm PWS

The information obtained is presented in Table 2.3, and the PWS infrastructure is mapped on Figure 2.

Table 2.3 Knockburnie Farm PWS

Data Type	Details
Source Location	Spring at NGR 256024 610242 (~590m from the northermost borrow pit search area).
Header Tank Location	NGR 256073 610631 – a buried chamber with grass grown over the top.
Properties Supplied	Knockburnie Farm via a buried pipe from header tank.
Water Use	Domestic supply, no agricultural use.
Water Volumes	Flow rates not known. No water shortages reported. Dimensions not known – Estimate from ground surface ~2.5x~1.5m.
Sanitary Protection	No fencing around source/ header tank. Chamber not watertight. No secure cover. Drainage around the source to take any surface runoff away. Water not currently treated. No water quality issues reported. There is sometimes a brown peaty colour.

The PWS source lies close to the Spout Burn, according to the OS mapping and as shown on Figure 2. At this location, the spring lies almost directly above the fault between the CVF and the ULF, which suggests that, despite the proximity of the Spout Burn, the PWS is indeed a spring. As with Craighouse Cottage, whilst a deep groundwater source is possible, the 'worst case' assumption is that of an up-gradient weathered CVF origin, although in this case the Proposed Development infrastructure is some distance away.

3. Risk Assessment and Mitigation

3.1 Zone of Contribution

SEPA sets out guidelines on assessing the impacts of wind farm development proposals on groundwater abstractions within its Land Use Planning Guidance Note 31[1] (LUPSGU31). According to this guidance, where groundwater abstractions lie within 250m of proposed infrastructure requiring excavation greater than a depth of 1m, or within 100m of proposed infrastructure requiring excavation less than a depth of 1m, a site specific risk assessment is required. The SEPA buffers of the three PWSs are shown on Figure 2, and do not intercept the proposed site infrastructure. However, the Craighouse Cottage 'worst case' ZOC discussed earlier is shown on Figure 2 to be close to the main access track and the northernmost borrow pit , and on this basis a site specific risk assessment is indeed necessary. The Lanehead and Knockburnie Farm PWS 'worst case' ZOCs are seen to be some distance from the Proposed Development infrastructure, and so these PWSs do not require further assessment.

3.2 Significance of Effects

The process for the construction of the access tracks on the Proposed Development is outlined in Chapter 4 of the ES, including mitigation measures, with more details regarding the mitigation provided in Chapter 13 of the ES. With respect to the effect of the main access track construction on the Craighead Cottage ZOC, the track is on the very margins of the 'worst case' ZOC, and the magnitude of potential effects is therefore considered to be low in EIA terms, which for the low sensitivity PWS would translate into a not significant effect. With additional mitigation in place, the magnitude of the residual effect would be lower still, negligible, and again not significant.

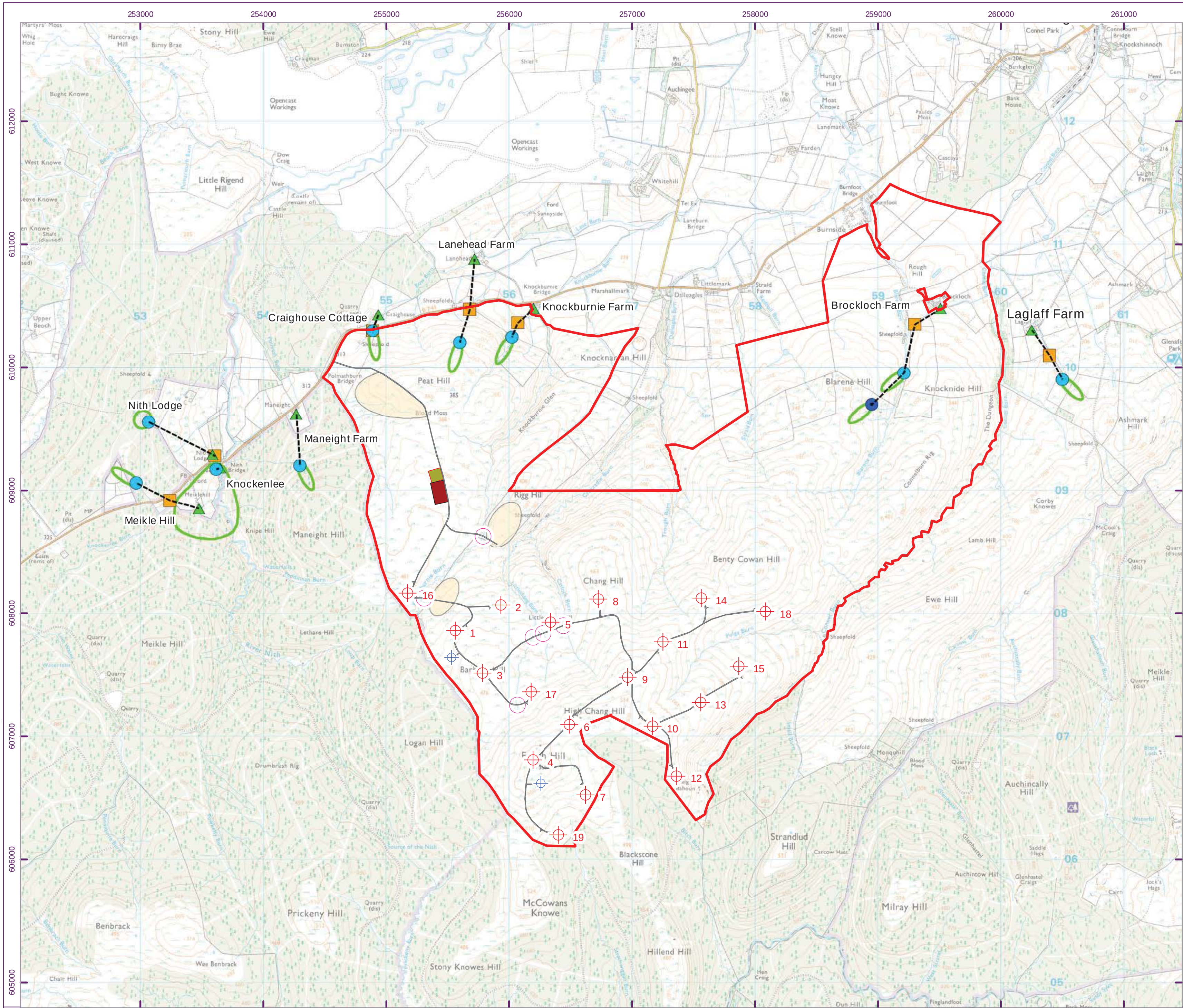
The assessment of the effects of the construction and operation of the northernmost borrow pit on both the Craigside Cottage PWSs is potentially more complex, because the borrow pit could itself be associated with groundwater abstraction and a 'zone of drawdown'. The borrow pit drawdown potentially allows it to derogate flows to the PWS, even though the borrow pit itself lies outside the PWS ZOC.

Whilst the borrow pit search area represents a far larger area than actually needed for the extraction of material, and therefore it might be possible to micro-site the excavation area to avoid effects on the Craigside Cottage PWS, the risk assessment has proceeded on the basis that the excavation area is instead located in the northern corner of the search area, closest to the PWS ZOC.

The borrow pit would preferentially dewater up the regional hydraulic gradient, i.e. south east towards the summit of Peat Hill, and the reduction in the PWS ZOC would be based on the assumption that in any downgradient direction, the borrow pit could only access groundwater above the deepest base elevation of the borrow pit. For an excavation within the northern corner of the proposed search area, this would be at ~345mAOD, which equates to an existing topographic surface of about 350mAOD (based on an estimated maximum 5m thick excavation and assuming an equivalent unsaturated zone thickness).

Even assuming an overly large ZOC and an overly large dewatering extent, Figure 2 indicates that none of the contributing area to the Craighouse Cottage PWS would potentially be lost, and would, therefore, not be expected to affect the more realistic likely small volumes of water used by the PWS. Therefore, in relation to Craighead Cottage PWS, the borrow pit dewatering during construction and operation is considered to represent a negligible magnitude of effect. Combined with the low sensitivity of this PWS, this is a not significant effect in EIA terms. With additional mitigation in place, such as the collection of sump water and its discharge up-gradient of the ZOC, the negligible magnitude of the residual effect would be lower still and, again, not significant.

[1] http://www.sepa.org.uk/media/143868/lupsgu31_planning_guidance_on_groundwater_abstractions.pdf



Key

- Site boundary
- Turbine location - LENOCH008
- Proposed onsite tracks
- Crane pad
- SPEN and EON substation compound
- Temporary construction compound
- Watercourse crossing
- Borrow pit search area
- Permanent meteorological mast
- Pipeline

Private Water Supplies (PWS)

- Source
- Secondary source
- Tank
- Property
- Estimated zone of contribution

0 0.5 1 1.5 km

Scale at A3: 1:30,000

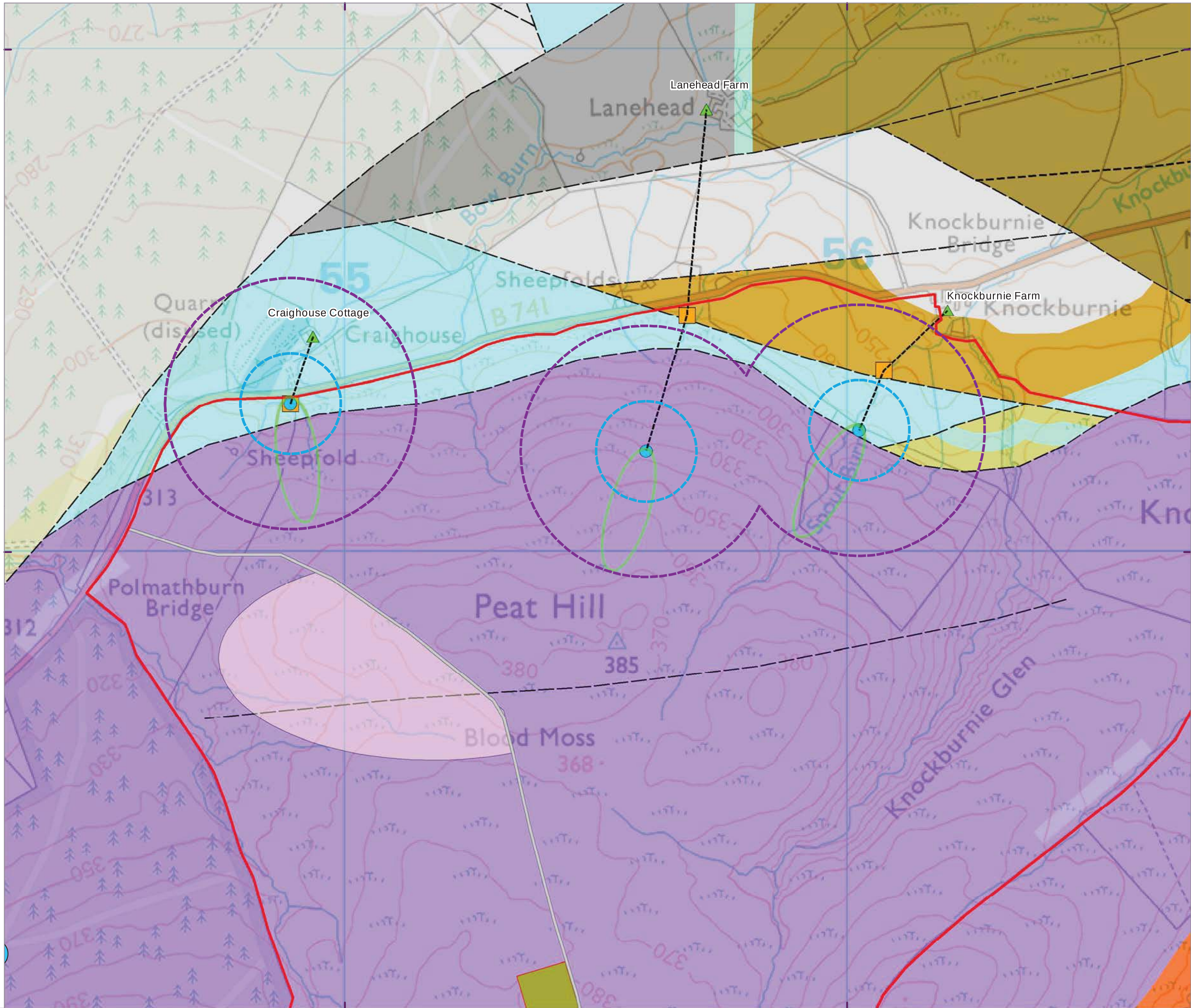
Client

Enoch hill Wind Farm
Private Water Supply
Risk Assessment

Figure 1
Location of private water supplies

July 2015 32965-Gla178c_PWS.mxd panng

file: N:\Projects\32965 - Enoch Hill Wind Farm EIA\D040\ArcGIS\MXDs\32965-Gla178c_PWS.mxd



Key

	Site boundary
	Proposed onsite tracks
	Temporary construction compound
	Borrow pit search area

Private Water Supplies (PWS)

	Source
	Tank
	Property
	Pipeline
	100 m buffer around PWS source
	250 m buffer around PWS source
	Estimated zone of contribution

Solid Geology

	Carrick Volcanic Formation - Basalt and Basaltic Andesite
	Upper Limestone Formation - Sedimentary Rock Cycles, Clackmannan Group Type
	Upper Limestone Formation - Limestone
	Scottish Upper Coal Measures Formation - Sedimentary Rock Cycles, Coal Measure Type
	Scottish Middle Coal Measures Formation - Sedimentary Rock Cycles, Clackmannan Group Type
	Scottish Lower Coal Measures Formation - Sedimentary Rock Cycles, Clackmannan Group Type
	Passage Formation - Sandstone
	Limestone Coal Formation - Sedimentary Rock Cycles, Clackmannan Group Type

Faults

Coal seam, inferred

Fault, inferred, displacement unknown

0 0.1 0.2 0.3 km

Scale at A3: 1:7,500

Client

Enoch Hill Wind Farm
Private Water Supply
Risk Assessment

amec foster wheeler

Figure 2
PWS Zone of Contribution

July 2015 32965-Gla353a_PWS.mxd panng

file: C:\Users\gwenda.pannu.GLOBAL\Desktop\Enoch ArcGIS\MXDs\32965-Gla353a_PWS.mxd

4. Further Recommendations

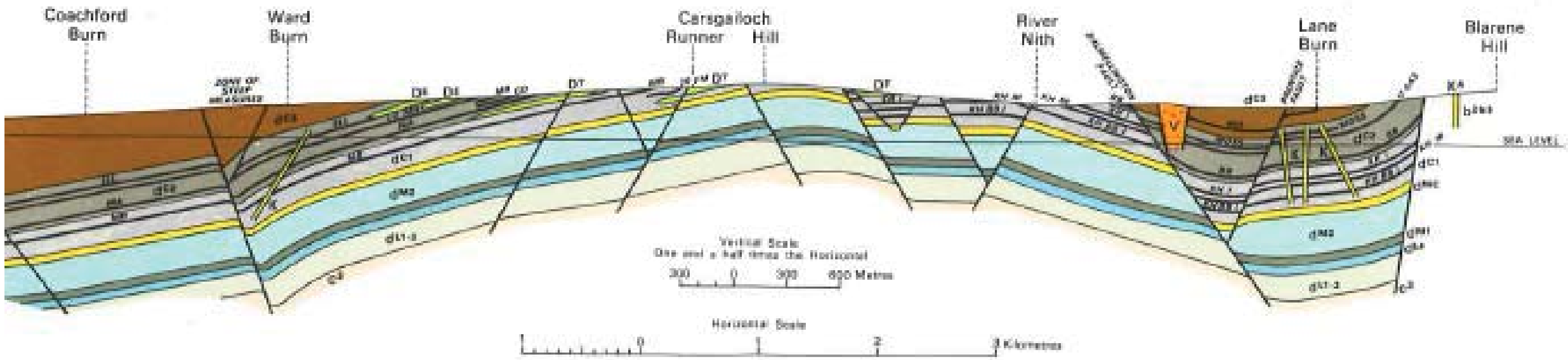
To further ensure that no adverse effects to the Craighouse Cottage PWS occur during the construction, operation and restoration of the proposed borrow pit, a monitoring programme is proposed via implementation of a planning condition. The monitoring would involve collecting water quality samples prior to commencement in order to establish baseline conditions, followed by sampling and analysis throughout the Peat Hill borrow pit construction and operation period. It is suggested that samples are collected from this property at a frequency and for a suite of parameters compliant with LUPSGU31 Appendix 5.

Appendix A
Geological Cross Section

Scale 1:50 000

Heights are in feet above Mean Sea Level   Contours are at 50 feet vertical intervals

SHOWING THE GENERAL RELATIONS OF THE ROCKS ALONG THE LINE DRAWN ON THE MAP



Appendix B
PWS Photos

Craighouse Cottage PWS

View south to Peat Hill

Top of chamber

Lanehead Farm PWS

Top of chamber

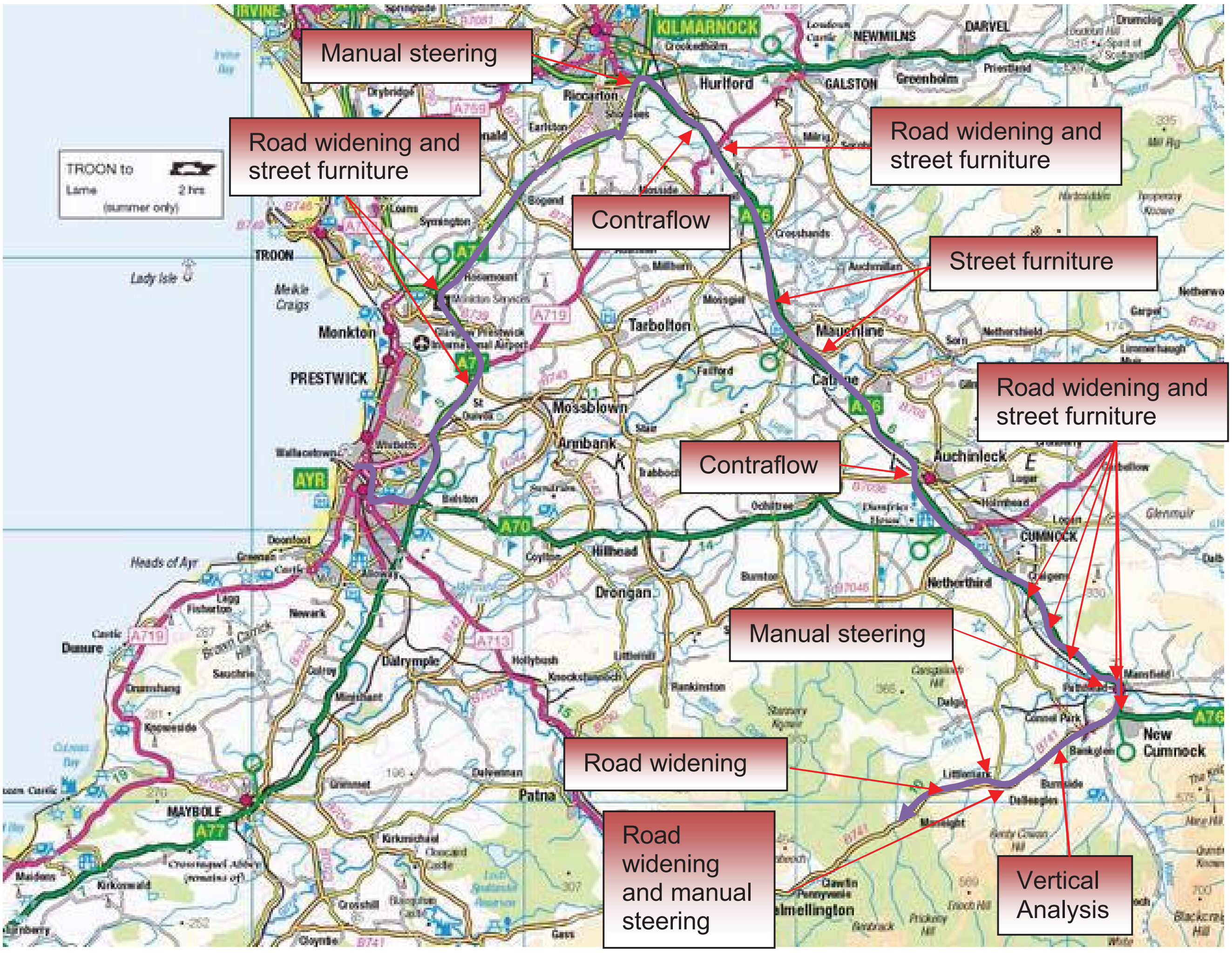
View south to Peat Hill
Overflow trough by road

Knockburnie Farm PWS

View south to Peat Hill

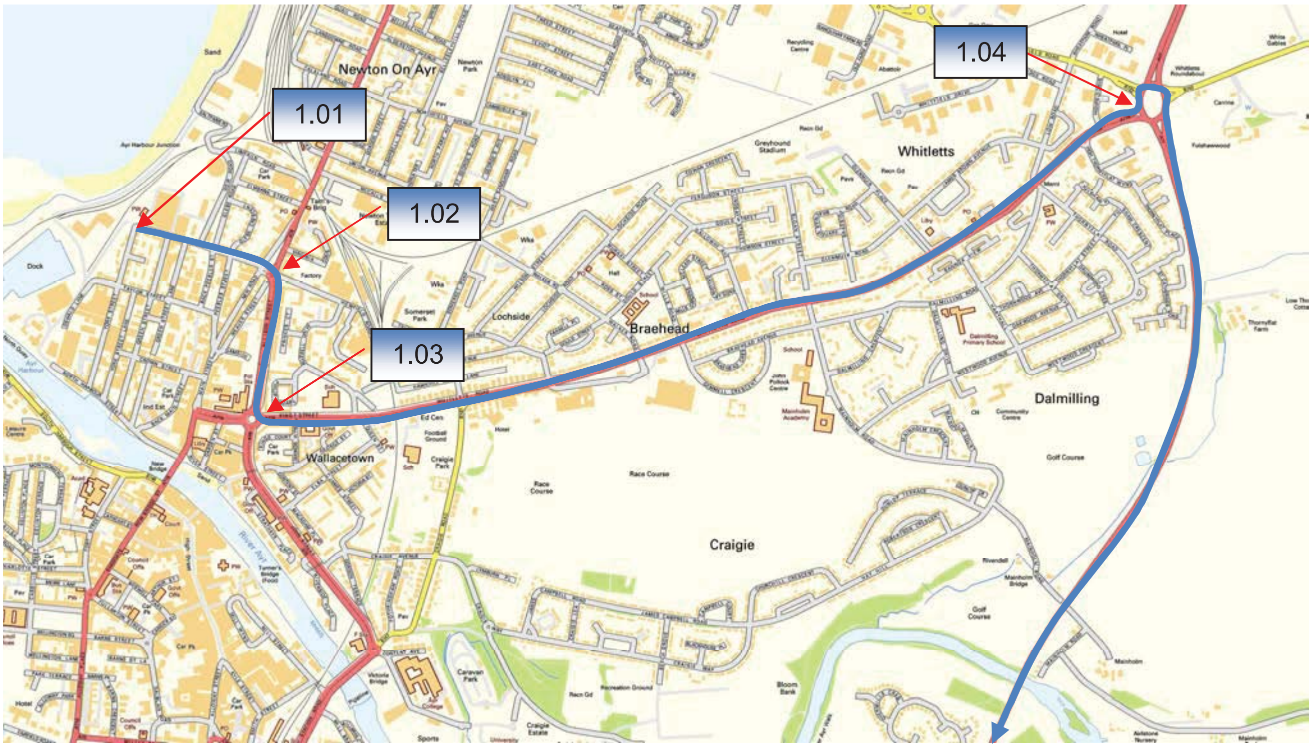
Appendix 14.A
Enoch Hill Extract From South Scotland Access Study

Route B – Enoch Hill Wind Farm

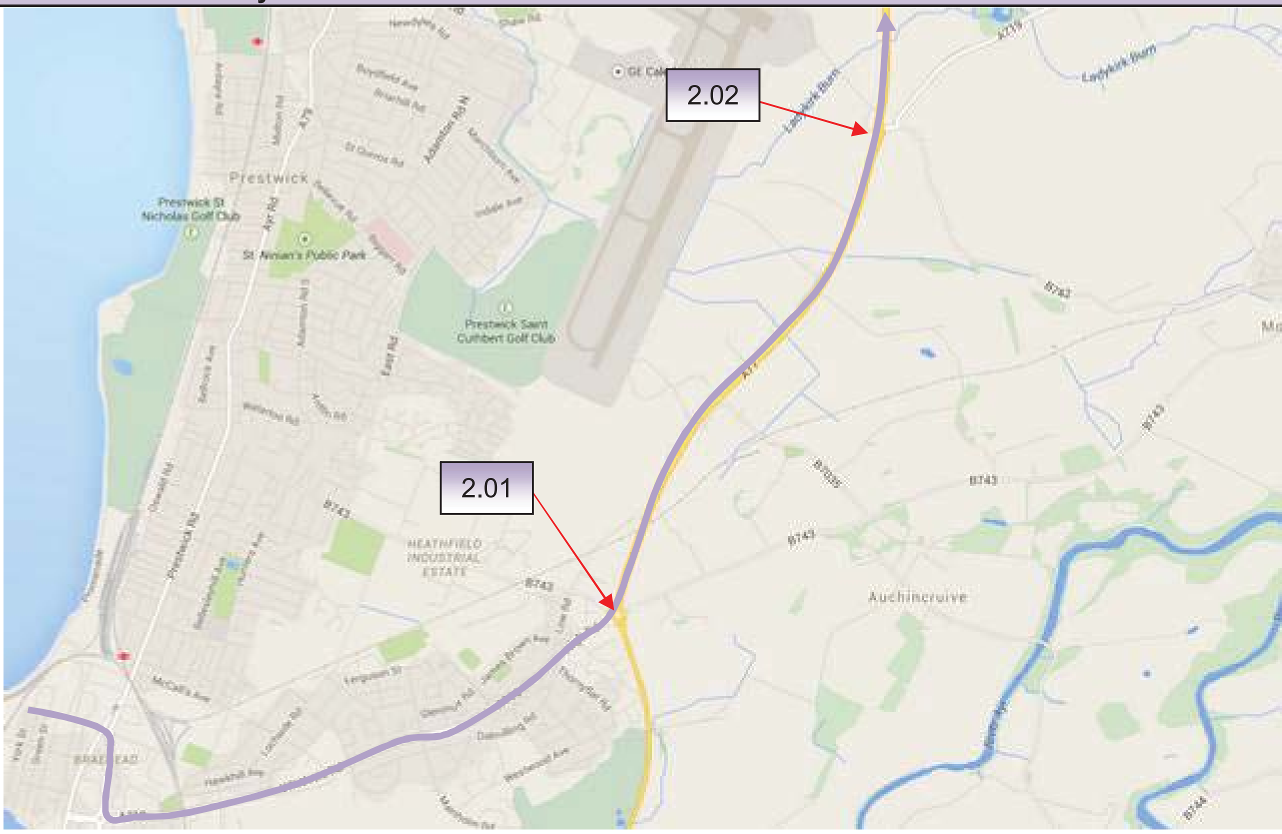


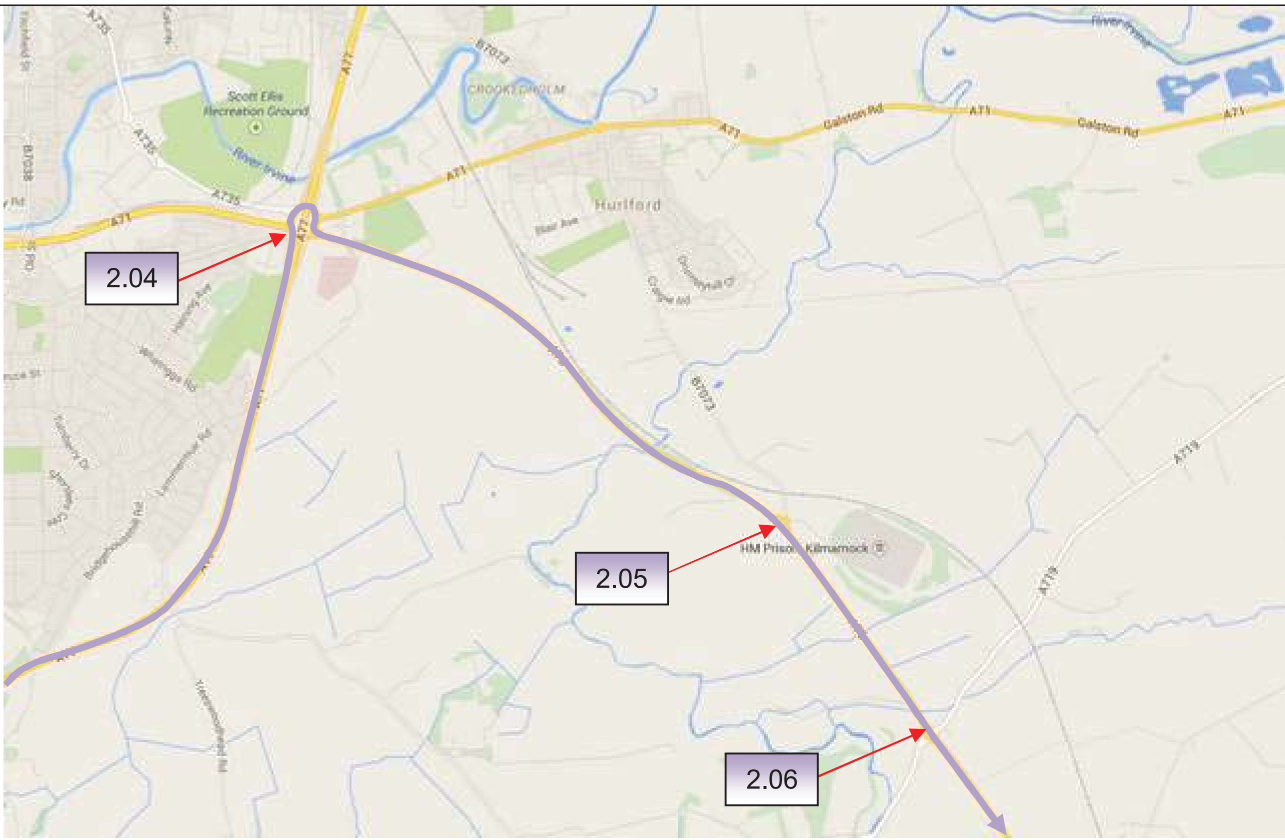
Survey Route A

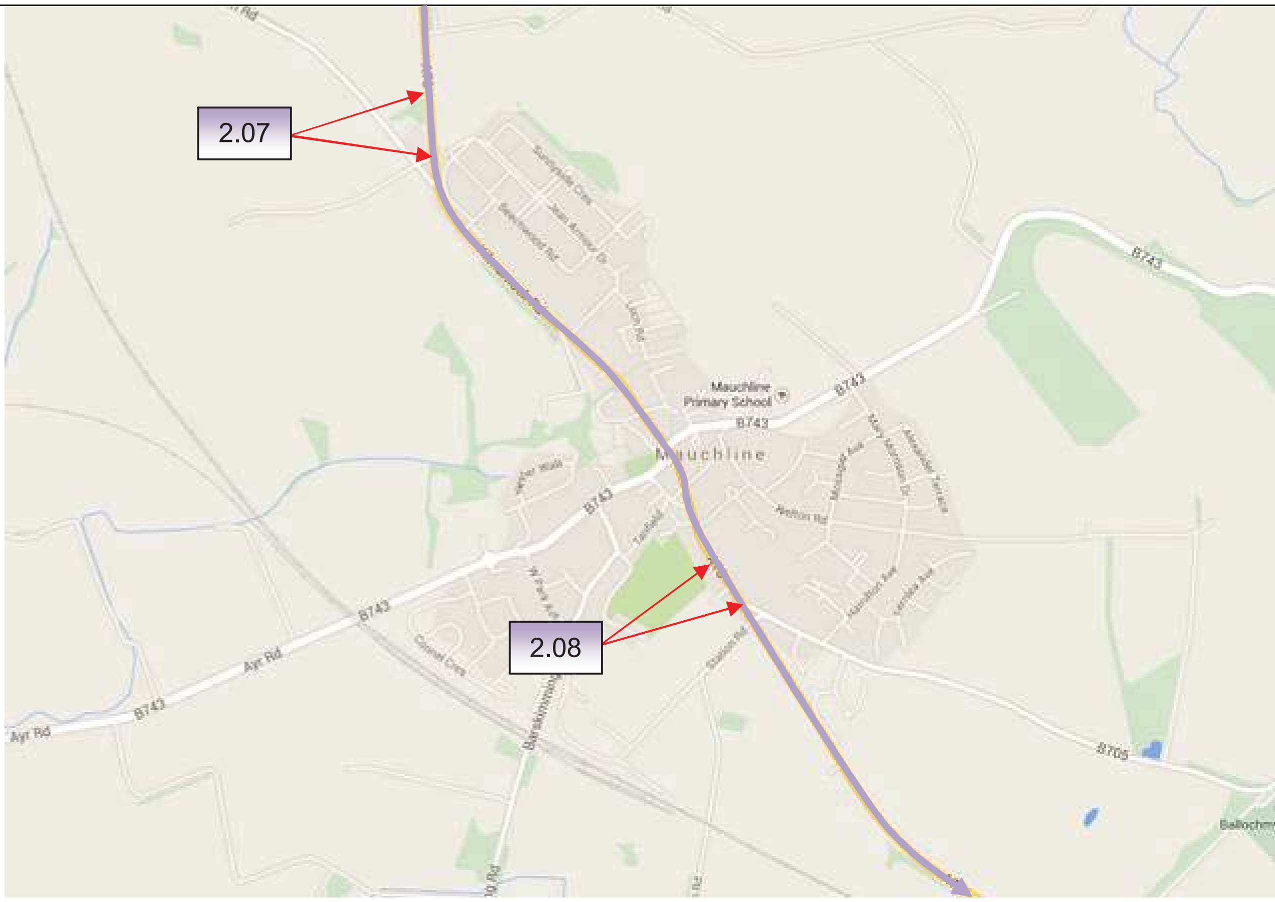
Route A Visual Survey Locations

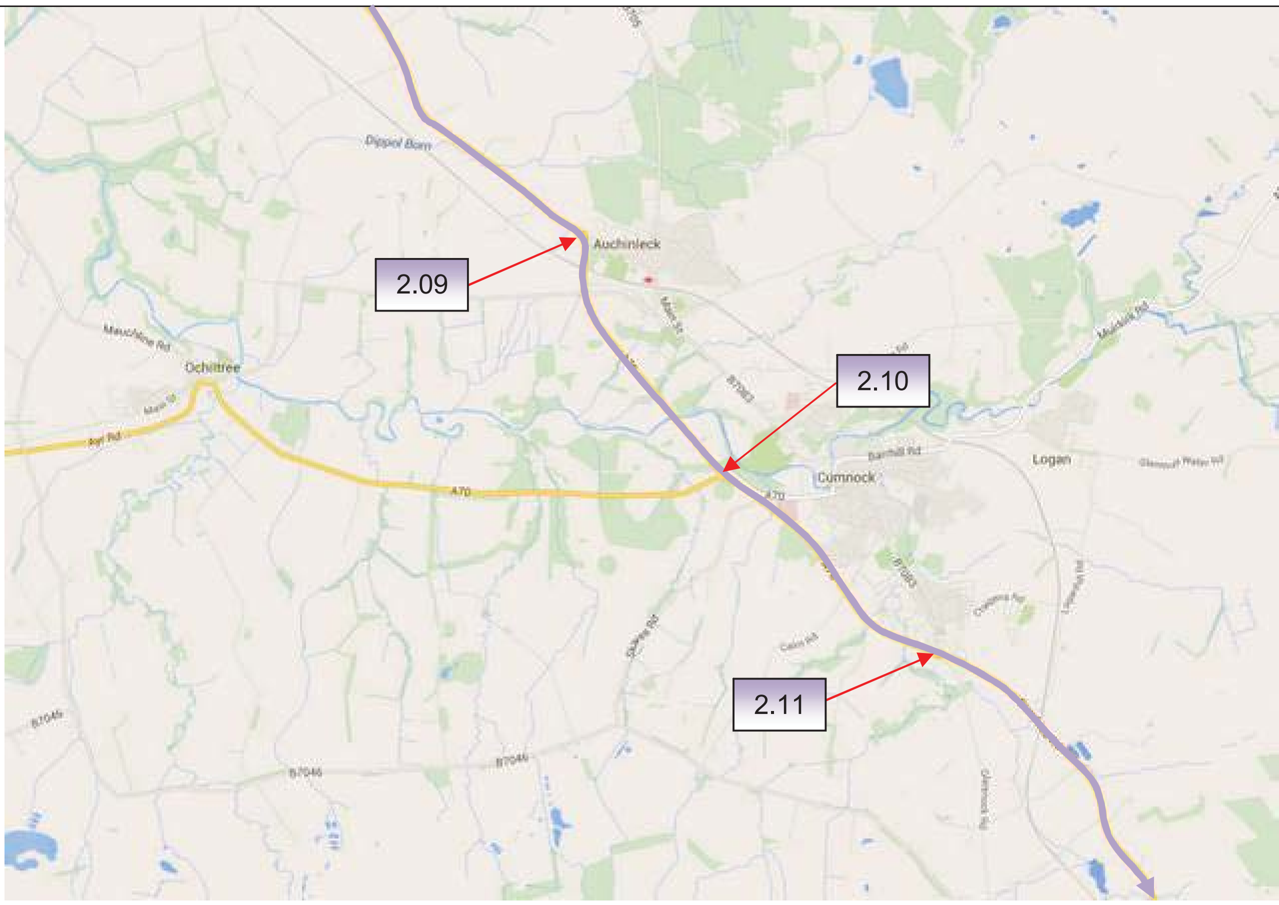


Survey Route B
Route B Visual Survey Locations



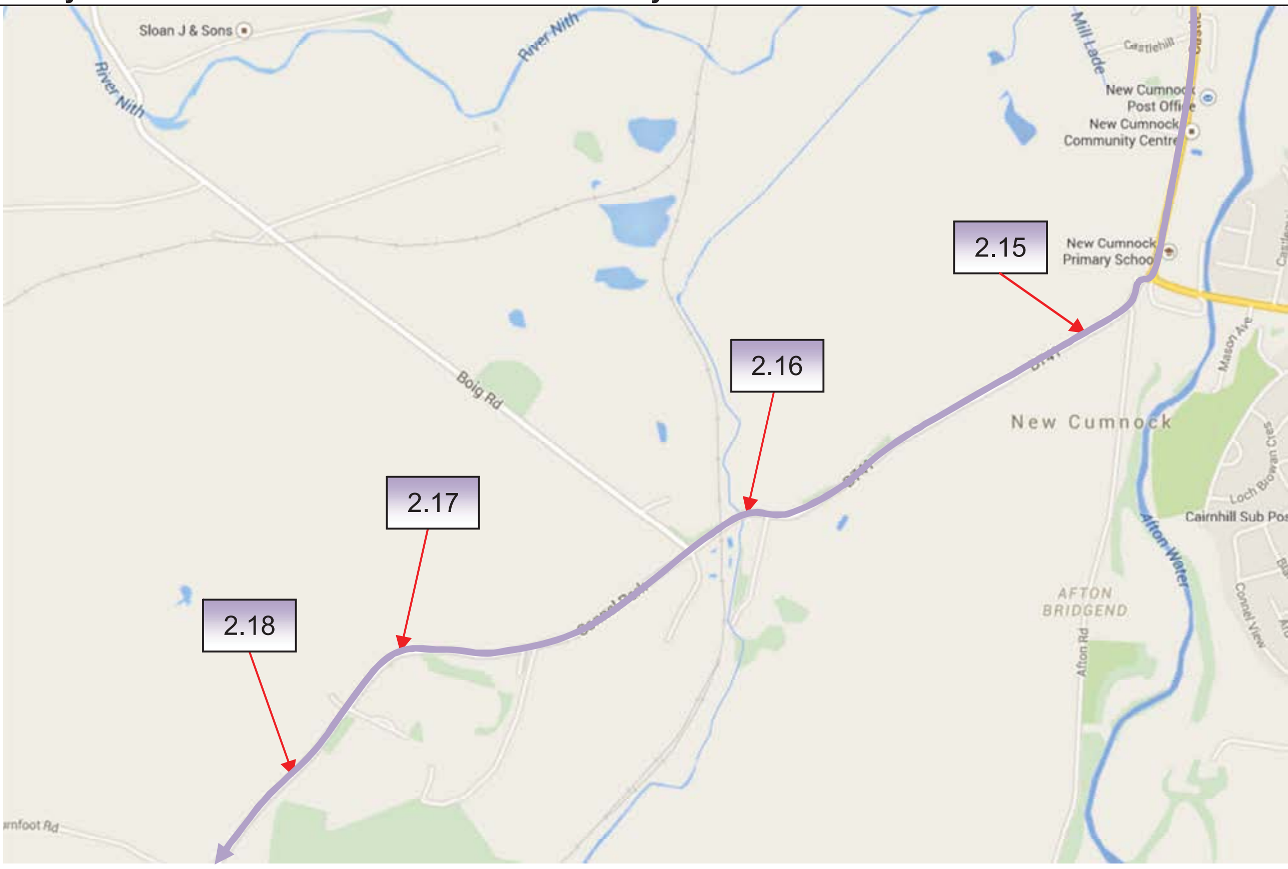

2.04
2.05
2.06
Scott Ellis Recreation Ground
River Irvine
Hurlford
HM Prison Kilmarnock
Galston Rd
A71
A77
A735
A719
B7073

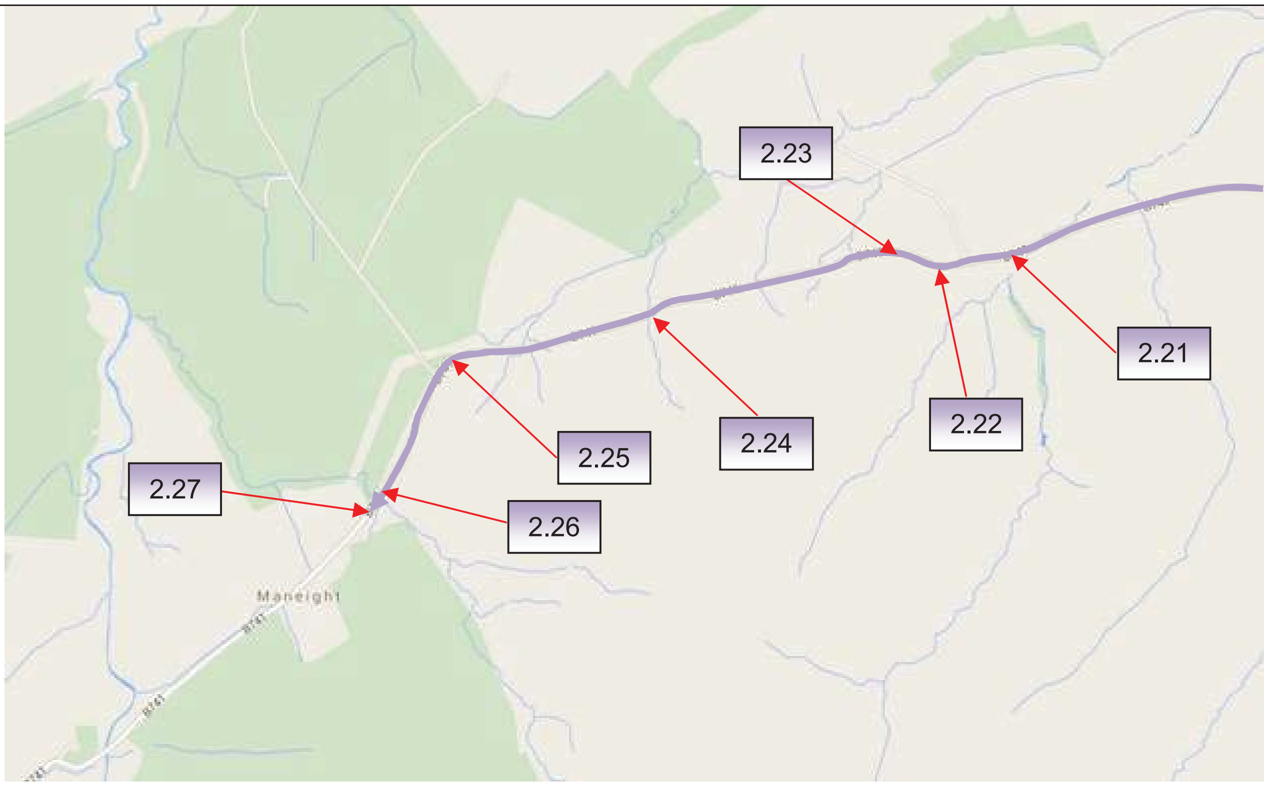

2.07
2.08
Mauchline
Mauchline Primary School
B743
Ayr Rd
B705

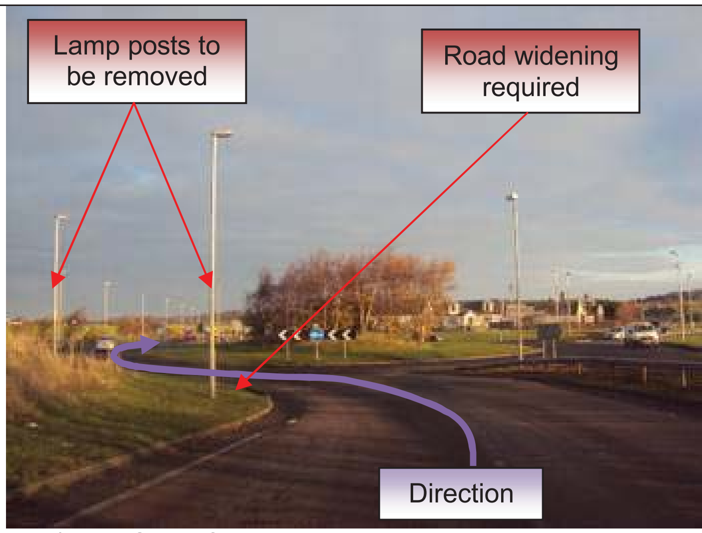
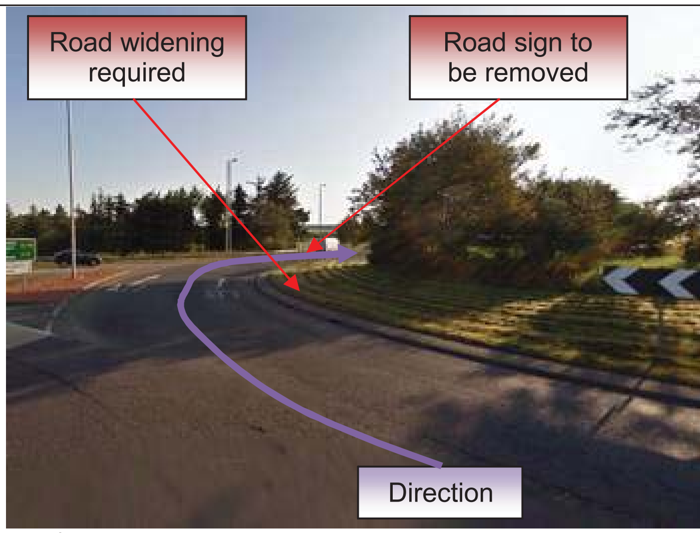

2.09
2.10
2.11
Auchinleck
Ochiltree
Cumnock
Logan
Dippol Burn
A70
B7046

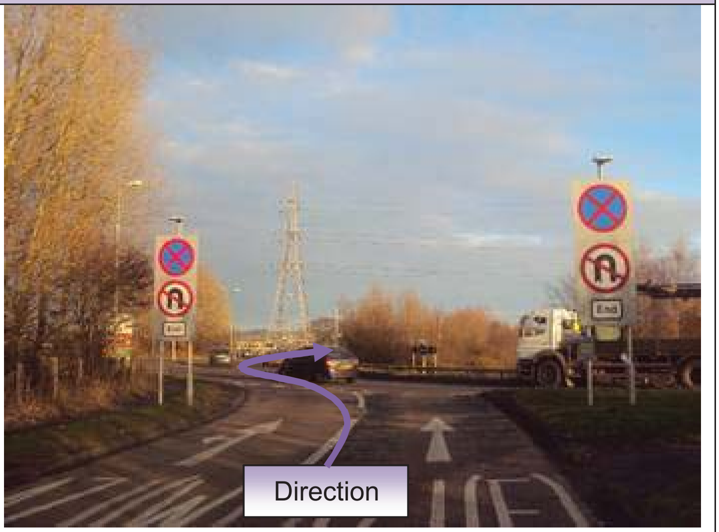
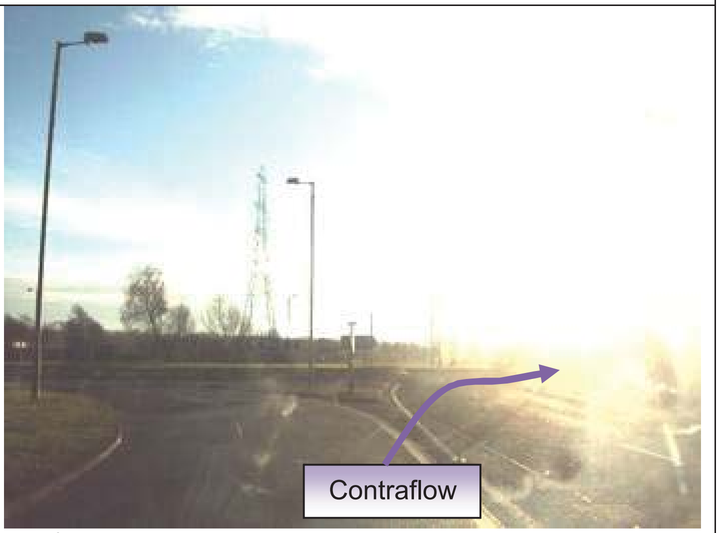
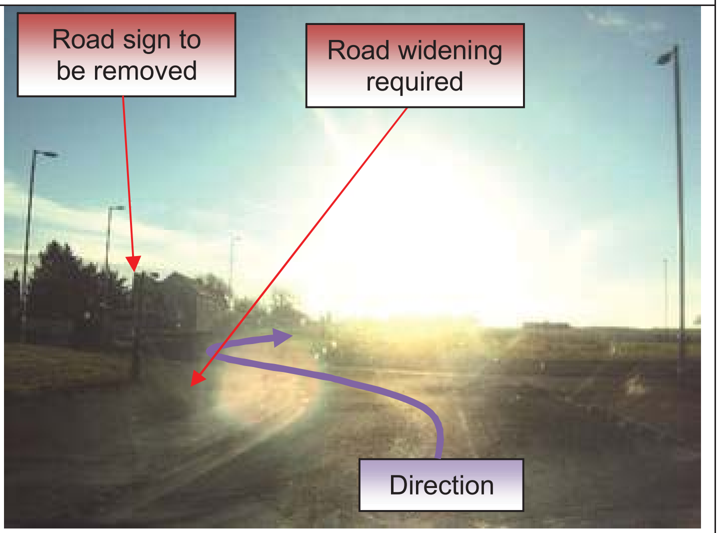

2.12
2.13
2.14
2.15
Lochside House
New Cumnock Golf Club
Loch O
Th Lowes
New Cumnock
Scottlandscapes
Mansfield Rd
River Nith
Glenafton Athletic F.C
Glenafton Athletic
Mill Lade
Keystor
New Cumnock
Community Centre
New Cumnock
Primary
Afton Bridgend
A76
Nithsdale Ave
Boig Rd
New Cumnock

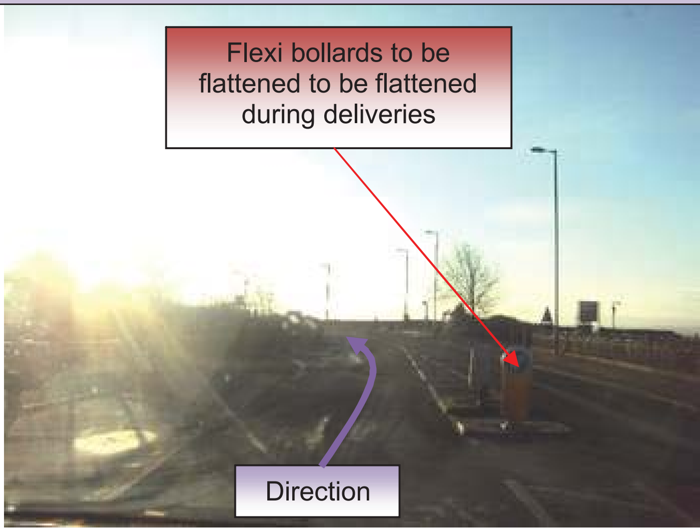
Survey locations relate to Enoch Hill Wind Farm Only

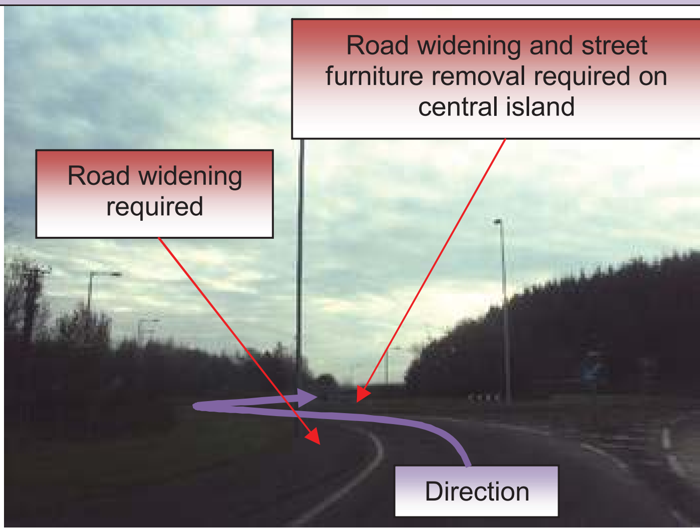
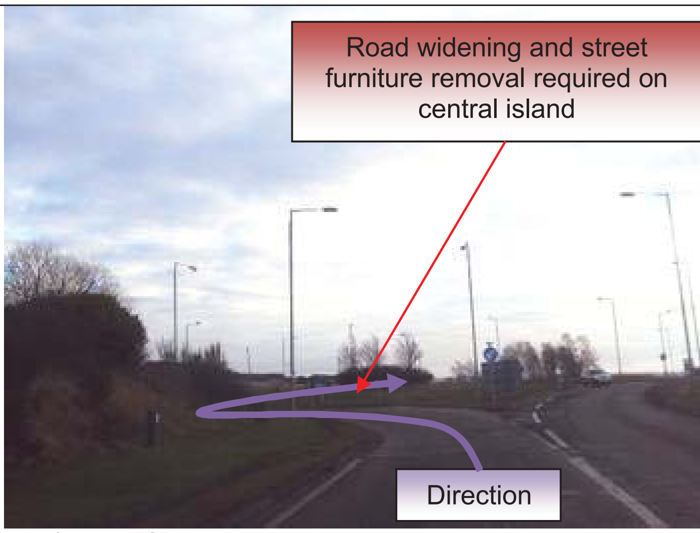


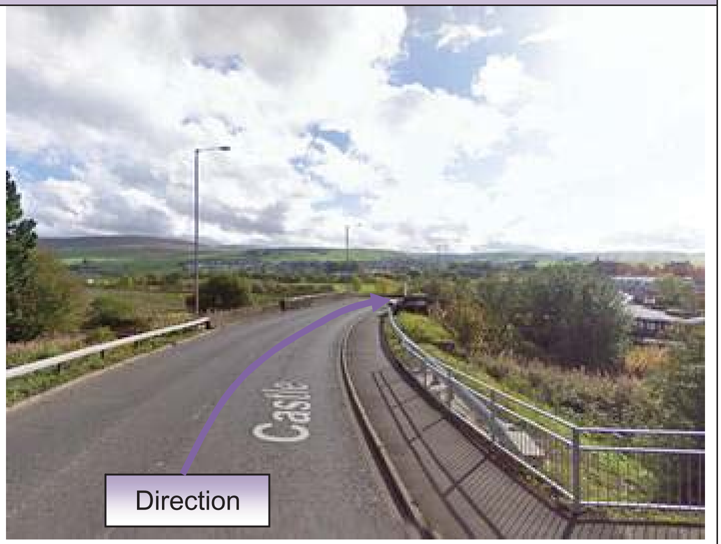

2.23
2.21
2.22
2.24
2.25
2.27
2.26
Maneight

ROUTE COMMENCES AS PER ROUTE A TO ITEM 1.03		
Item	**Details**	**Photograph**
2.01	Continue on A719 to Whitletts Roundabout at junction with A77 At roundabout, turn left onto A77. (OS Grid ref: NS 36626 23265) • Loaded components will navigate this roundabout without any issues.	 A719/A77 Whitletts Roundabout
2.02	Continue on A77 to Sandyford Toll Roundabout at junction with A719. At roundabout, continue straight on A77. (OS Grid ref: NS 38021 25652) ***Caution*** • Road widening required on the nearside of the entry onto the roundabout. • Lamp posts on the nearside to be removed due to oversail of the loaded components. • Further investigation is recommended to determine the swept path area of the loaded vehicles.	 A77/A719 Sandyford Toll Roundabout
2.03	Continue on A77 to Dutch House Roundabout at junction with A78. At roundabout, turn right onto A77. (OS Grid ref: NS 36609 28690) ***Caution*** • Road widening required on the central island of the roundabout. • Road sign on central island of the roundabout to allow for widening. • Further investigation is recommended to determine the swept path area of the loaded vehicles.	 A77/A78 Dutch House Roundabout

Item	Details	Photograph
2.04	Continue on A77 to junction for A71/A76. Exit A77 at junction to roundabout. At roundabout, turn right onto A76. (OS Grid ref: NS 44086 36515) ***Caution*** • Loaded components will navigate this roundabout utilising manual steering to avoid bridge parapets on the offside of the roundabout. • Further investigation is recommended to determine the swept path area of the loaded vehicles.	 A77/A71/A76 Roundabout
2.05	Continue on A76 to roundabout with B7073. At roundabout, continue straight on A76. (OS Grid ref: NS 46296 35018) ***Caution*** • The loaded components will navigate this roundabout using a contraflow manoeuvre. • Further investigation is recommended to determine the swept path area of the loaded vehicles.	 A76/B7073 Roundabout
2.06	Continue on A76 to Crossroads Roundabout at junction with A719. At roundabout, continue straight on A76. (OS Grid ref: NS 46962 34006) ***Caution*** • Road widening required on nearside kerb to avoid modifications on central island. • Road sign on the nearside to be removed due to rear projection of the blade component. • Further investigation is recommended to determine the swept path area of the loaded vehicles.	 A76/A719 Crossroads Roundabout

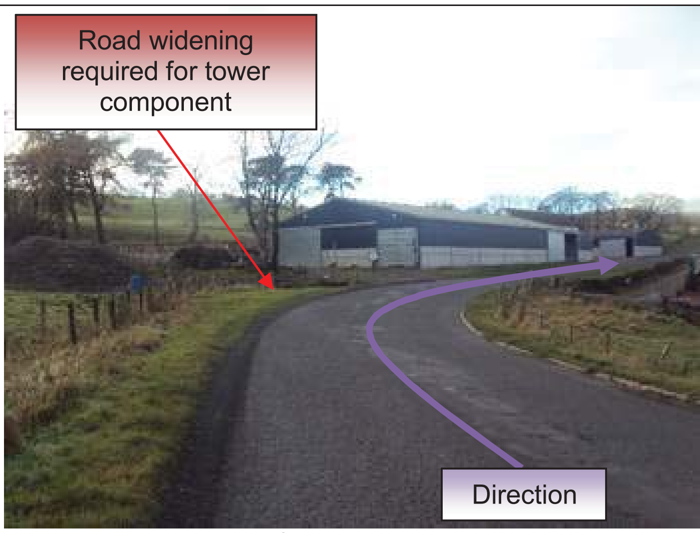
Item	Details	Photograph
2.07	Continue on A76 to splitter islands at entry to Mauchline. (OS Grid ref: NS 49344 28058) ***Caution*** • Flexi bollards to be flattened during deliveries of the tower components.	 Entry splitter islands at Mauchline
2.08	Continue A76 though Mauchline to splitter islands at exit from Mauchline. (OS Grid ref: NS 50021 26903) ***Caution*** • Street furniture on splitter islands to be removed to allow wider components to navigate.	 Exit splitter islands at Mauchline
2.09	Continue on A76 to Templeton Roundabout at junction with B7083. At roundabout, turn right onto A76. (OS Grid ref: NS 54401 22441) ***Caution*** • See drawing no: 274071-90A0.1/90B0.1 • The loaded components will navigate this roundabout using a contraflow manoeuvre.	 A76/B7083 Templeton Roundabout

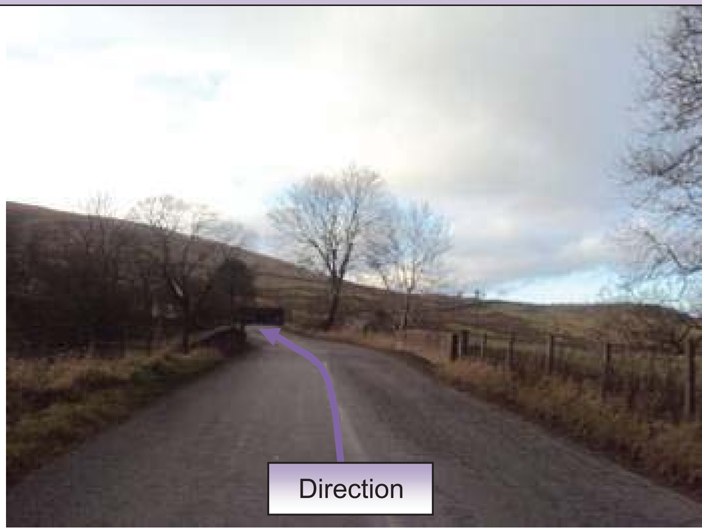
Item	Details	Photograph
2.10	Continue on A76 to Dettingen Roundabout at junction with A70. At roundabout, continue straight on A76. (OS Grid ref: NS 55647 20142) ***Caution*** • Road widening required on the nearside of both entry and exit from the roundabout and on the central island to allow loaded components to navigate. • Road sign on central island to be removed to allow for widening. • Further investigation is recommended to determine the swept path area of the loaded vehicles.	 A76/A70 Dettingen Roundabout
2.11	Continue on A76 to Skerrington Roundabout at junction with B7083. At roundabout, continue straight on A76. (OS Grid ref: NS 57624 18370) ***Caution*** • Road widening required on the central island of the roundabout to allow loaded components to navigate. • Road sign on central island to be removed to allow for widening. • Further investigation is recommended to determine the swept path area of the loaded vehicles.	 A76/B7083 Skerrington Roundabout
2.12	Continue on A76 to roundabout. At roundabout, continue straight on A76. (OS Grid ref: NS 61336 14581) ***Caution*** • Road widening required on the central island of the roundabout to allow loaded components to navigate. • Road sign on central island to be removed to allow for widening. • Further investigation is recommended to determine the swept path area of the loaded vehicles.	 A76 Roundabout

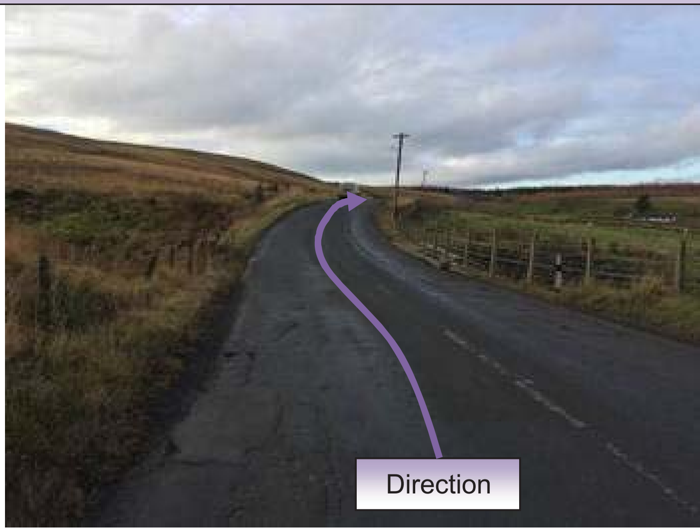
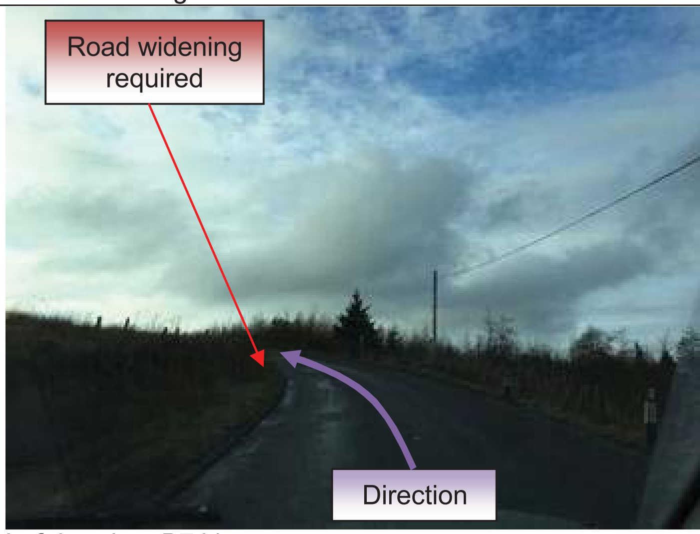
Item	Details	Photograph
2.13	Continue on A76 to right bend over railway bridge in New Cumnock. (OS Grid ref: NS 61943 14202) ***Caution*** • Loaded components will navigate this bend and bridge utilising manual steering. • Manual steering required to avoid third party land. • Further investigation is recommended to determine the swept path area of the loaded vehicles.	 A76/B741 Mini Roundabout in New Cumnock
2.14	Continue on A76 to mini roundabout at junction with B741 in New Cumnock. At mini roundabout, turn right onto B741. (OS Grid ref: NS 61707 13301) ***Caution*** • See drawing no: 274071-100A1.1/100B1.1 • Road widening required on the offside of the junction to allow loaded components to navigate. • Bollards and road sign on the offside to be removed. • Splitter island to be removed. • Railings on the nearside after junction to be removed. • Manual steering required to avoid third party land.	 A76/B741 Mini Roundabout in New Cumnock

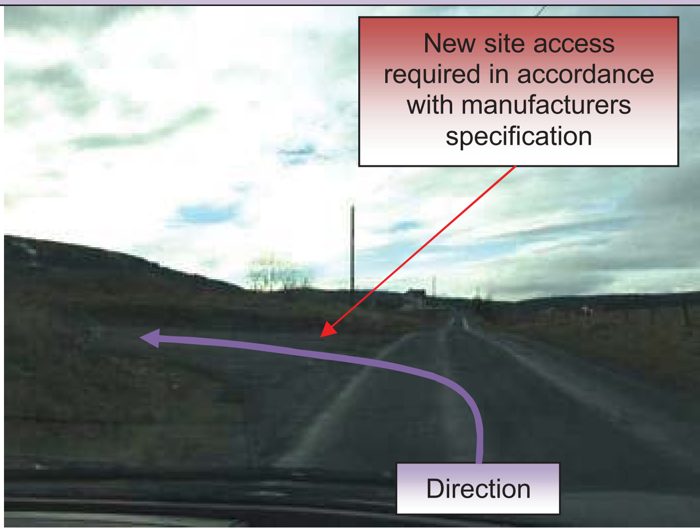
****After Item 2.14, the route separates to provides access to the Enoch Hill and Afton Wind Farm projects.****

The following items related to the Enoch Hill Wind Farm project only		
Item	**Details**	**Photograph**
2.15	*****From Item 2.14***** Continue on B741 for approx. 300m to vertical crest. (OS Grid ref: NS 61477 13135) ***Caution*** • Visual inspection indicates that vertical alignment issues may be present at this location. • Vertical analysis recommended on this structure to determine any issues that may be presented by the crest.	 Vertical crest on B741
2.16	Continue on B741 to left bend at Connel Burn. (OS Grid ref: NS 60815 12820) ***Caution*** • See drawing no: 274071-110A1.1/110B1.1 • Road widening required on footpath on the offside of the bend to allow navigation and avoid third party land/buildings at the bend. • Railings on the nearside to be removed. • Manual steering required to avoid third party land and buildings.	 Left bend on B741 at Connel Burn
2.17	Continue on B741 to left bend at Manse War Memorial. (OS Grid ref: NS 60059 12544) • See drawing no: 274071-120A0.1/120B0.1 • Loaded components will navigate this bend without any issues.	 Left bend on B741 at Manse War Memorial

Item	Details	Photograph
2.18	Continue on B741 for approx. 400m to vertical crest. (OS Grid ref: NS 59462 11903) ***Caution*** • Visual inspection indicates that vertical alignment issues may be present at this location. • Vertical analysis recommended on this structure to determine any issues that may be presented by the crest.	 Vertical crest on B741
2.19	Continue on B741 to right bend at farm. (OS Grid ref: NS 58007 10673) **Caution** • See drawing no: 274071-130A1.1/130B0.1 • Road widening required on the nearside of the bend for the tower component in order to avoid component oversailing third party land. • Manual steering required for the blade component to avoid third party land and modifications.	 Right bend on B741 at farm
2.20	Continue on B741 to Dalleagles Bridge. (OS Grid ref: NS 57365 10656) • See drawing no: 274071-140A1.1/140B0.1 • The loaded components will navigate this bridge without any issues.	 B741 Dalleagles Bridge

Item	Details	Photograph
2.21	Continue on B741 to Knockburnie Bridge. (OS Grid ref: NS 56339 10562) • The loaded components will navigate this bridge without any issues.	 B741 Knockburnie Bridge
2.22	Continue on B741 to right bend. (OS Grid ref: NS 56067 10502) • See drawing no: 274071-150A0.1/150B0.1 • The loaded components will navigate this bend without any issues.	 Right bend on B741
2.23	Continue on B741 to left bend. (OS Grid ref: NS 55930 10561) • See drawing no: 274071-160A0.1/160B0.1 • The loaded components will navigate this bend without any issues.	 Left bend on B741

Item	Details	Photograph
2.24	Continue on B741 to S-bend over bridge on B741. (OS Grid ref: NS 55244 10401) ***Caution*** • Visual inspection indicates that loaded components will navigate this S-bend utilising manual steering. • Further investigation is recommended to determine the swept path area of the loaded vehicles.	 S-bend at bridge on B741
2.25	Continue on B741 for approx. 500m to left bend. (OS Grid ref: NS 54706 10303) ***Caution*** • See drawing no: 274071-170A0.1/170B0.1 • Road widening required on the nearside to allow loaded component to navigate. • Ground to be prepared to accept suitable axle loadings. • The original OS data tile is highly inaccurate. Due to the inaccuracies, it is recommended that a topographical survey be carried out this location.	 Left bend on B741
2.26	Continue on B741 for approx. to Polmathburn Bridge. (OS Grid ref: NS 54482 09917) • See drawing no: 274071-180A0.1/180B0.1 • The loaded components will navigate this bridge without any issues.	 B741 Polmathburn Bridge

Item	Details	Photograph
2.27	Continue on B741 to proposed site access to Enoch Hill. (OS Grid ref: NS 54411 09835) ***Caution*** • New site entrance/access road to be constructed in accordance with the selected manufacturer's specification.	 Proposed site access to Enoch Hill Wind Farm

Important Notes

1. The recommendations in this report are made from a purely transport orientated view, and do not consider any political issues in terms of land ownership, or any other precincts raised that may otherwise be restrictive.

2. The information contained in this report is privileged and confidential and is for the exclusive use of the client nominated herein.

3. A Police escort or pilot car will be required for nacelle, towers and blade component trailers in order to assist with traffic control for the entire route surveyed.

4. Permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the blade and tower components. These permits are at the discretion of the Highways Agency (H.A). Therefore, approval of these permits by the H.A are a major consideration before any movements can be undertaken.

5. It is recommended to have adequate warning signs implemented to warn other road users at critical points.

6. All hedges, shrubs, bushes, trees and overhanging branches along the nominated routes must be trimmed to allow a minimum envelope on the road as stated in the selected manufacturers specification.

7. All street furniture, signage etc. along the nominated route must be removed to allow a minimum envelope on the road as stated in the selected manufacturers specification. Other specific street furniture has been nominated in this report to facilitate over-sailed and swept areas.

8. The turbine manufactures transport guidance notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this.

9. In areas where land take or road widening is required, the road construction must be formed to the minimum specification suitable for the transfer of axle loadings up to 16Te, the road construction must be formed to the minimum specification contained in the selected manufacturers transport and erection guidance notes.

10. The maximum gross vehicle weight anticipated for a 100m diameter rotor turbine could be the nacelle at over 100Te. Therefore, a full Route Access Survey (RAS) is recommended, in order to determine the acceptability of gross vehicle weights and axle loading issues, for bridges, culverts and structures for the entire route, the results of which have not been applied for in terms of the depth and level of reporting required for this report.

11. A test drive of the route with a 51.39m empty blade trailer, from the commencement point of this route to site entrance is recommended. This is in order to verify the facts contained in this report and proof test the requirements for road alterations horizontally and vertically. The test drive should be completed with an empty trailer, so that in an emergency or at the points where land take has been recommended, but not progressed, or in the case of vertical issues there is insufficient ground clearance, the trailer can be closed until it is past the hazard. The test drive should be attended by turbine manufacturers, project managers, Police, Highways & County Council representatives and other interested parties with responsibility for road alterations.

12. It should be noted that all assessments and inspections have been done so with the intention of producing information to highlight anticipated problems. This includes highlighting of potential land take requirements, possible street furniture implications, and highway alignment issues.

13. Land take is usually referred to when land is required from private land owners; road widening is usually referred to when land is required within highways boundaries. However the details of the nominated land take and road widening contained in this report are highlighting the expected areas of concern, and can only be confirmed by swept path analysis. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.

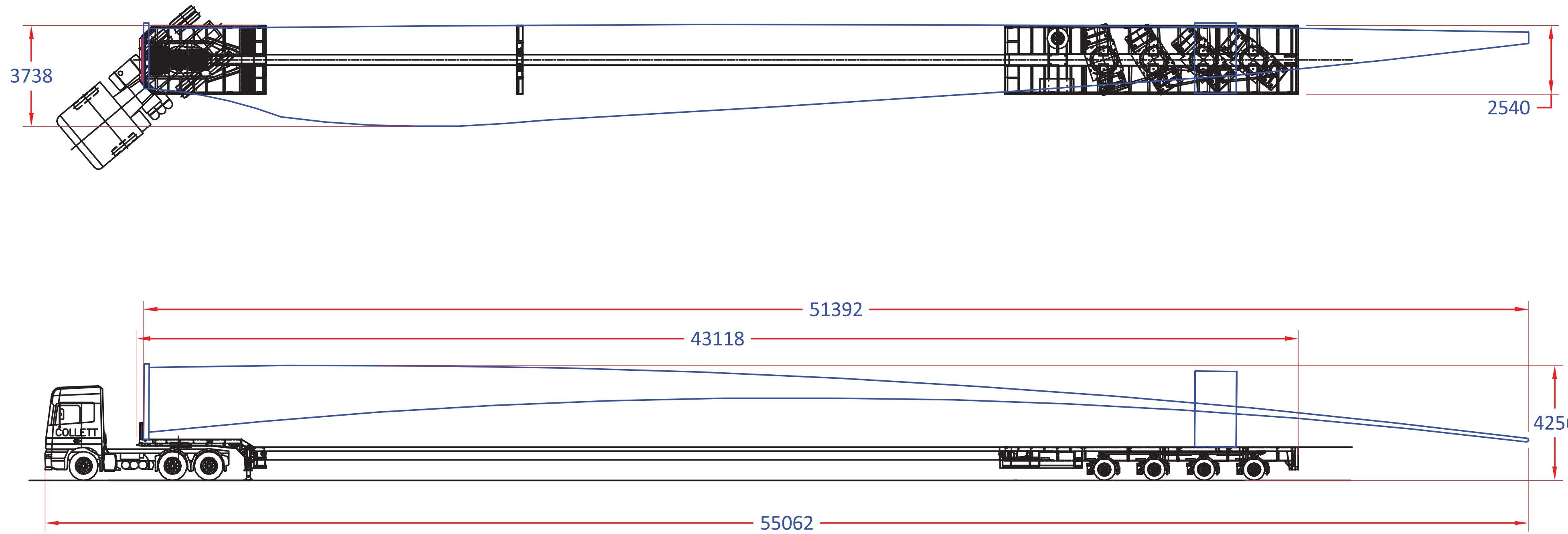
14. All inspections and assessments are made for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons trailer equipment.

15. All route inspections and assessments, and subsequent conclusions and recommendations are deemed accurate by Collett & Sons Limited at the date that this report is created. We cannot be held responsible for the development of future road schemes or alterations to the routes surveyed that may leave this report inaccurate.

16. This report is based solely on a preliminary visual inspection. Nothing in this report shall be construed in any way as committing Collett & Sons Limited to being able to deliver turbines to site using this route before a test drive has been undertaken, and any accommodation/remedial works undertaken which are to Collett & Sons satisfaction.

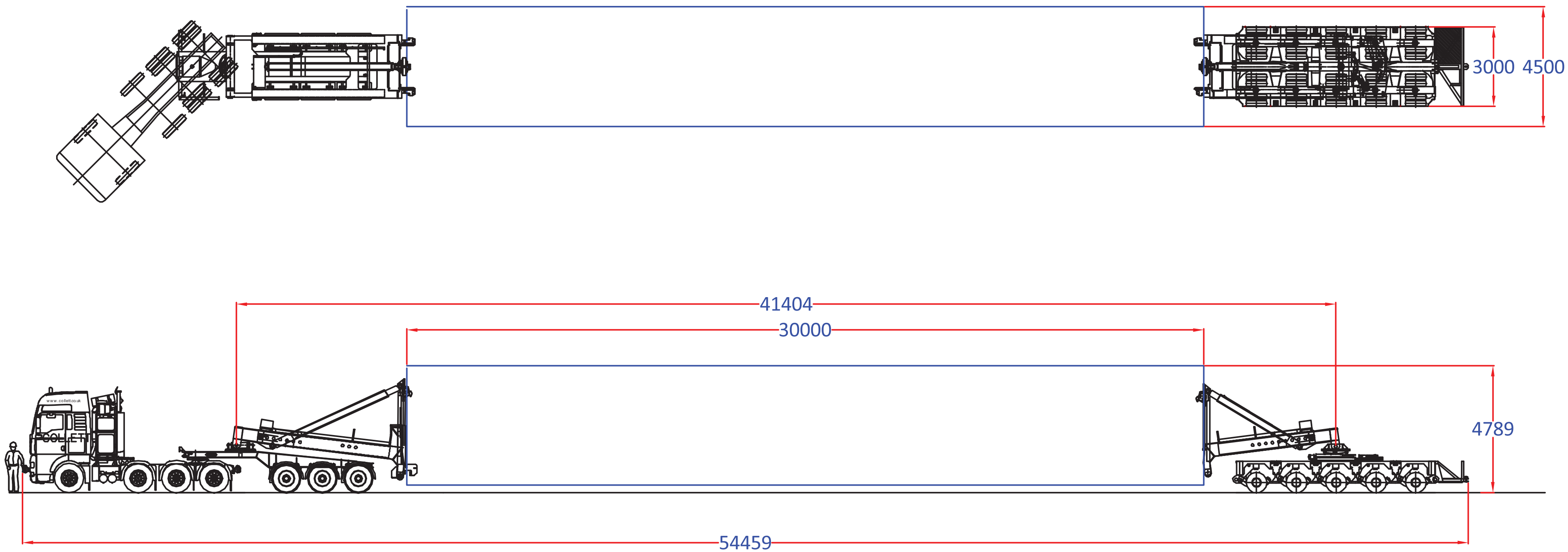
APPENDIX 1
LOADED COMPONENT DRAWINGS

DO NOT SCALE - IF IN DOUBT ASK



COLLETT & SONS LIMITED Victoria Terminal TEL: +44(0)8456 255288 Albert Road FAX: +44(0)8456 255244 Halifax, HX2 0DF WEB: www.collett.co.uk	DRAWN S.MANGHAM	TITLE GENERIC 51.39M BLADE	
	DATE 10/12/2014	SITE Enoch	
	SCALE 1:225 / SIZE A4	CUSTOMER E.ON	DRG No. 274071 - A

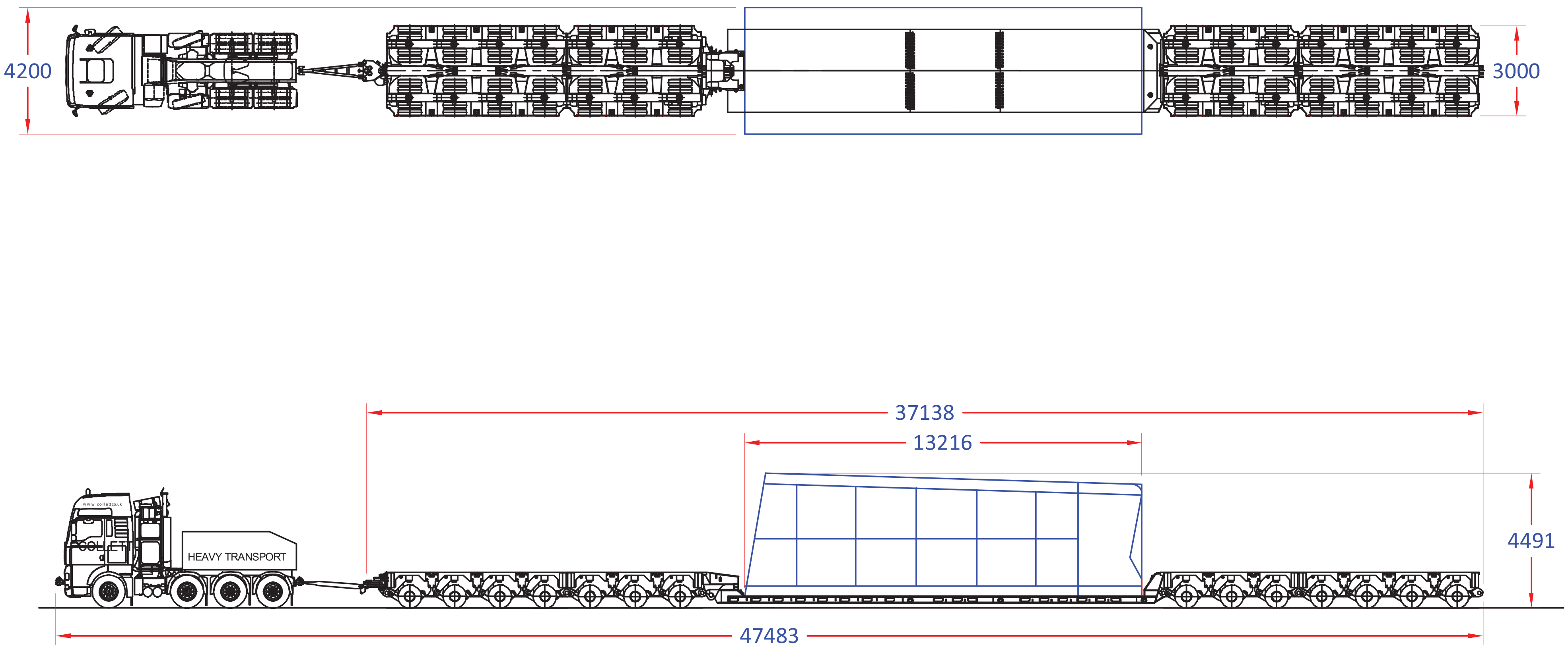
DO NOT SCALE - IF IN DOUBT ASK



COLLETT & SONS LIMITED Victoria Terminal TEL: +44(0)8456 255288 Albert Road FAX: +44(0)8456 255244 Halifax, HX2 0DF WEB: www.collett.co.uk	DRAWN S.MANGHAM	TITLE GENERIC 30M TOWER SECTION IN CLAMP	
	DATE 10/12/2014	SITE Enoch	
	SCALE 1:225 / SIZE A4	CUSTOMER E.ON	DRG No. 274071 - B

COLLETT
EXPERTS IN MOTION

DO NOT SCALE - IF IN DOUBT ASK

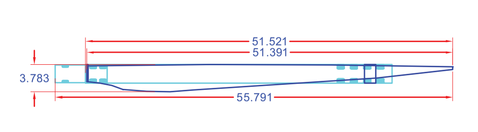


COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal
Albert Road
Halifax, HX2 0DF
TEL: +44(0)8456 255288
FAX: +44(0)8456 255244
WEB: www.collett.co.uk

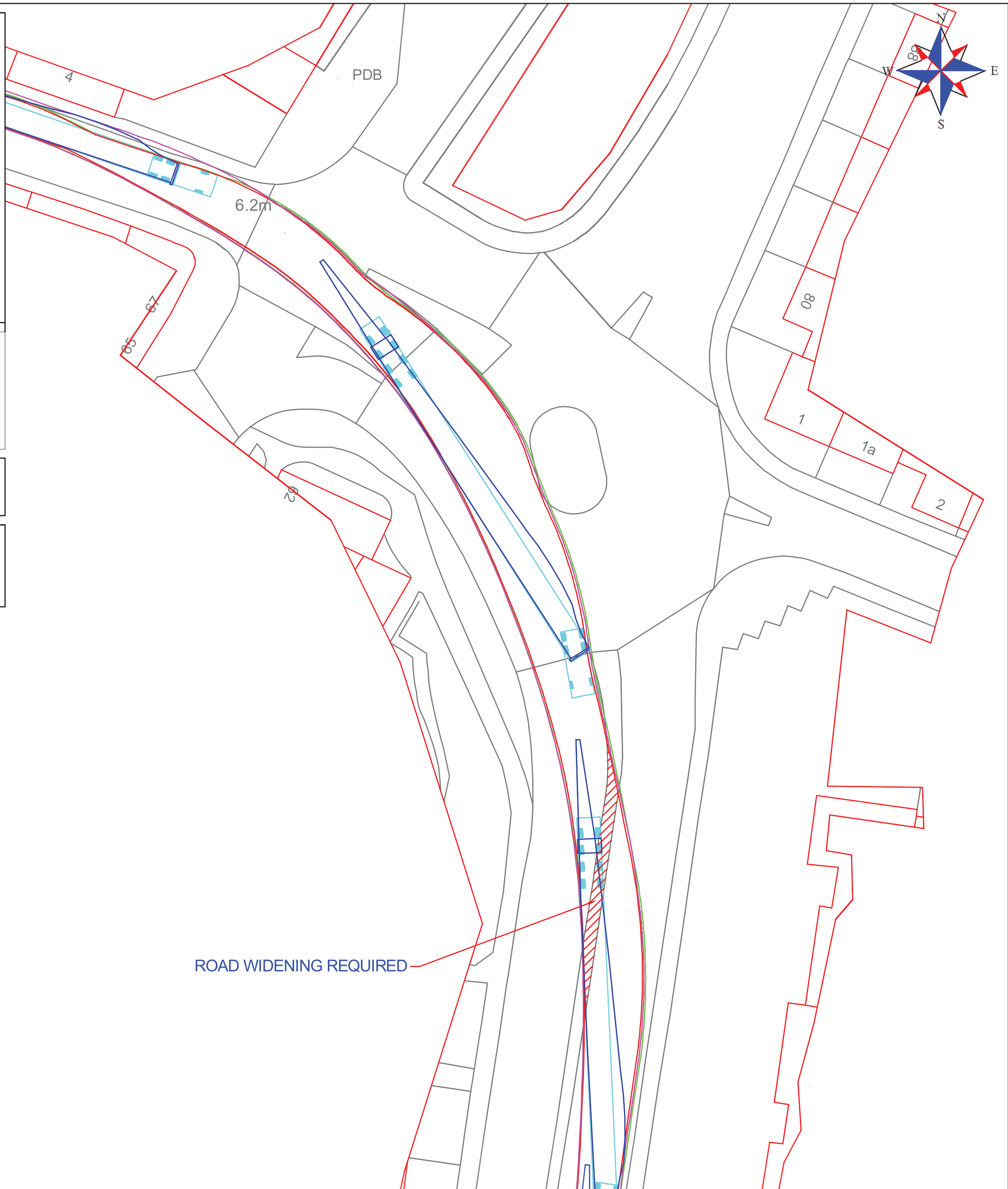
DRAWN S.MANGHAM		TITLE GENERIC NACELLE COMPONENT	
DATE 10/12/2014		SITE Enoch	
SCALE 1:200	SIZE A4	CUSTOMER E.ON	DRG No. 274071 - C

APPENDIX 2
EXISTING SWEPT PATH ANALYSIS



Swept Path indicates trailer utilising
AUTOMATIC steering

Generic 51.39m Blade Component
4 axle extendable trailer



Continue on Waggon Road to roundabout at junction with A79 Allison Street.
At roundabout, turn right onto A79 Alllison Street.

Caution

- Widening required to provide a useable road surface as indicated by the red hatching.
- Road widening required on splitter island to allow loaded component to contraflow this roundabout.
- Contraflow manoeuvre required in order to navigate this roundabout.
- Ground to be prepared to accept suitable axle loadings.

UK Grid Reference: NS 34043 22766

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

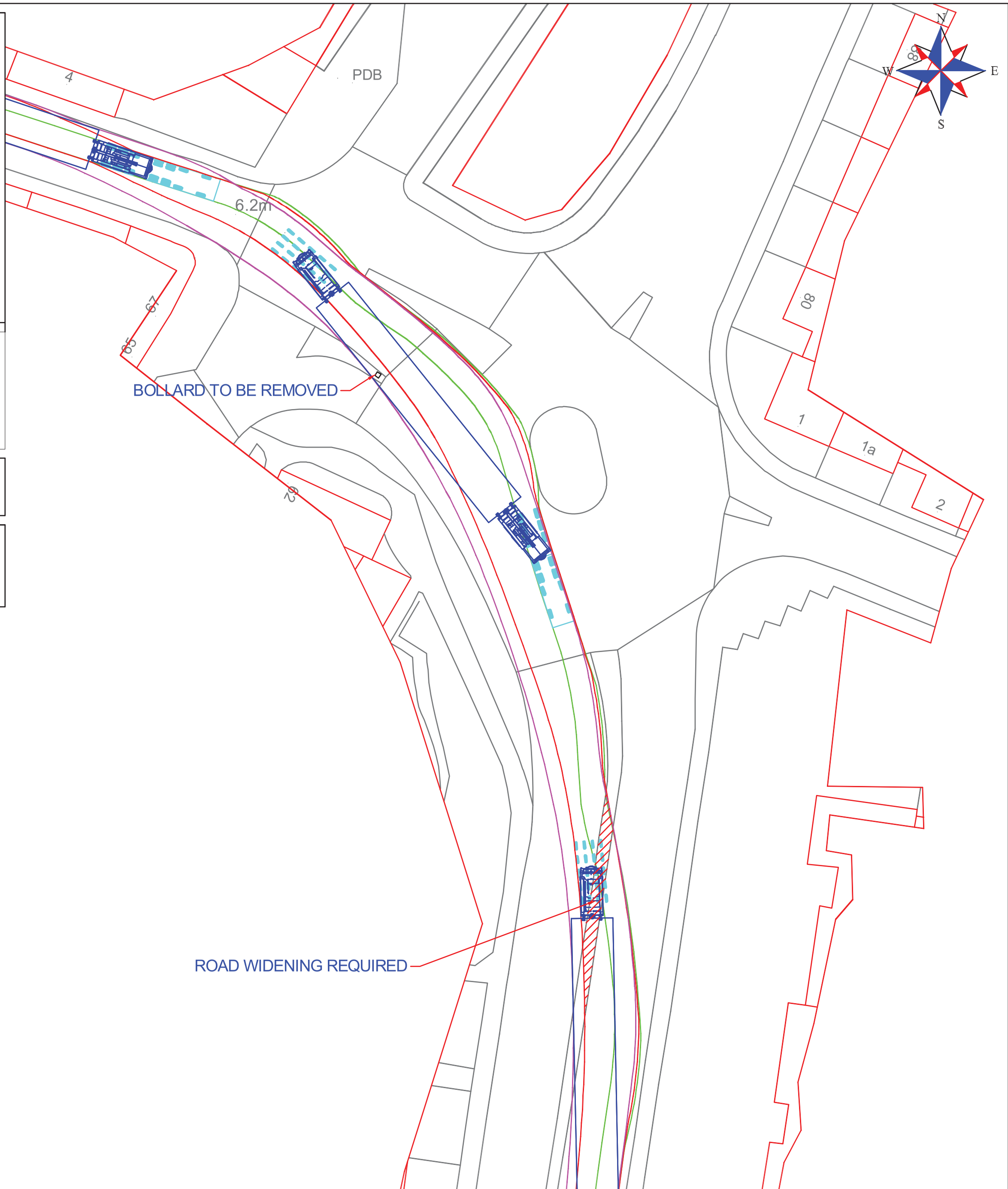
COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN	S.MANGHAM		TITLE	WAGGON ROAD/A79 ALLISON STREET ROUNDABOUT	
DATE	19/11/2014		MAPPING	ORDNANCE SURVEY Not Adjusted	CUSTOMER EON
SCALE 1:500	SIZE	A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch	DWG. NO. 274071-10A0.1

Swept Path indicates trailer utilising AUTOMATIC steering

Generic 30m - 4.5m dia. Bottom Tower Section Tower Transporter Trailer



Continue on Waggon Road to roundabout at junction with A79 Allison Street.
At roundabout, turn right onto A79 Alllison Street.

Caution

- Widening required to provide a useable road surface as indicated by the red hatching.
- Road widening required on splitter island to allow loaded component to contraflow this roundabout.
- Contraflow manoeuvre required in order to navigate this roundabout.
- Indicated bollard to be removed due to oversail of the loaded component.
- Ground to be prepared to accept suitable axle loadings.

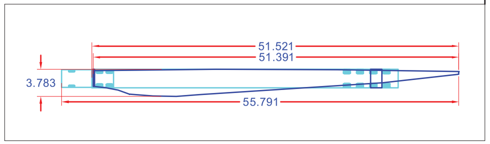
UK Grid Reference: NS 34043 22766

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Red line	Area within red outline will be swept by tractor and trailer axles
Red hatching	Hatched area within red outline to be levelled and prepared to accept axle loadings
Magenta line	Area within magenta outline will be oversailed by load and projections
Green line	Area within green outline will be oversailed by trailer body

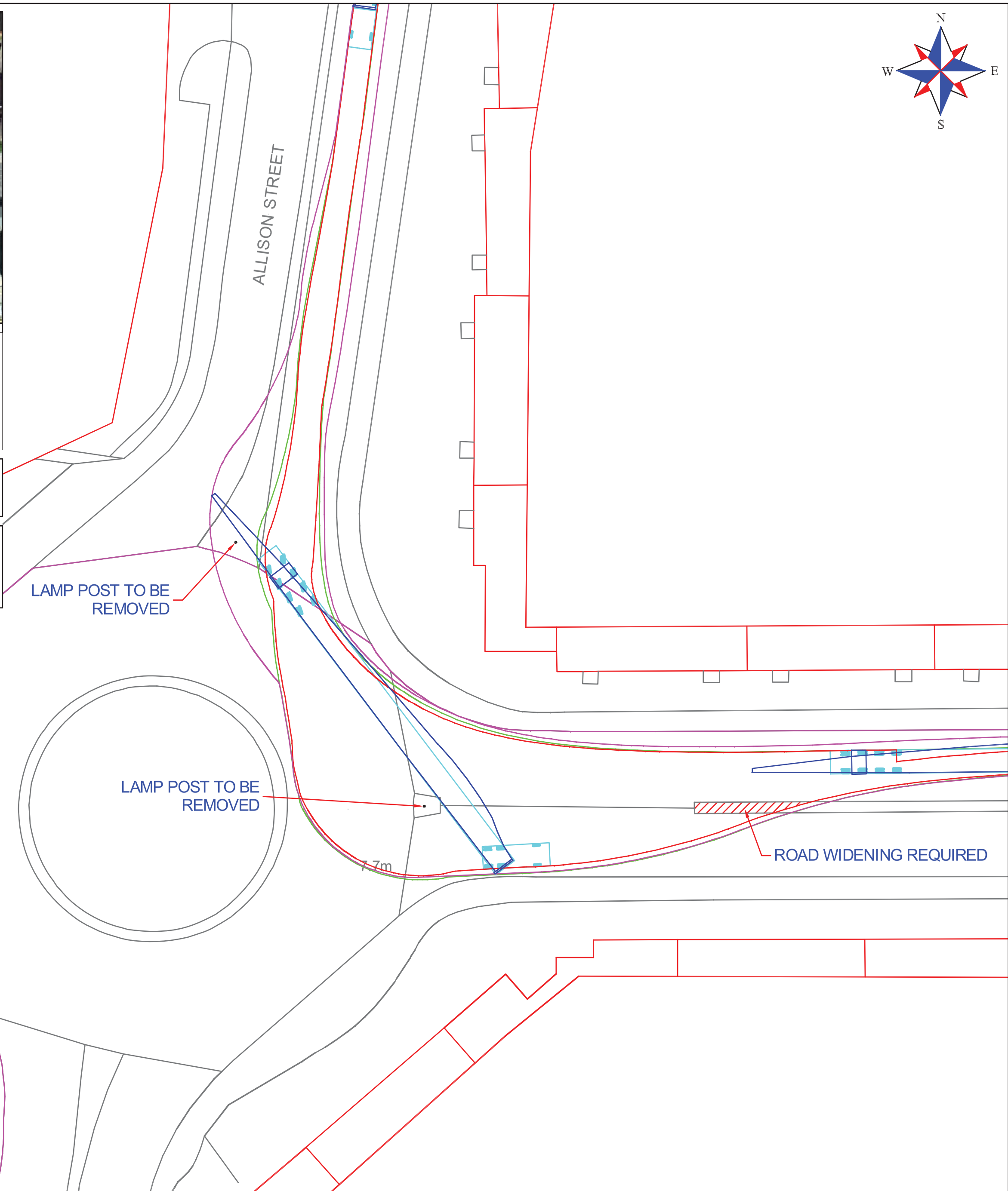
COLLETT
EXPERTS IN MOTION
COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN	S.MANGHAM		TITLE	WAGGON ROAD/A79 ALLISON STREET ROUNDABOUT	
DATE	19/11/2014		MAPPING	ORDNANCE SURVEY Not Adjusted	CUSTOMER EON
SCALE 1:500	SIZE A3		PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch	DWG. NO. 274071-10B0.1



Swept Path indicates trailer utilising AUTOMATIC steering

Generic 51.39m Blade Component
4 axle extendable trailer



Continue on A79 Allison Street to roundabout at junction with A719.
At roundabout, turn left onto A719.

Caution

- Widening required to provide a useable road surface as indicated by the red hatching.
- Road widening required on splitter island to allow loaded component to contraflow this roundabout.
- Lamp posts at entry and exit at roundabout to be removed due to oversail of the trailer and component.
- Ground to be prepared to accept suitable axle loadings.

UK Grid Reference: NS 34004 22360

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

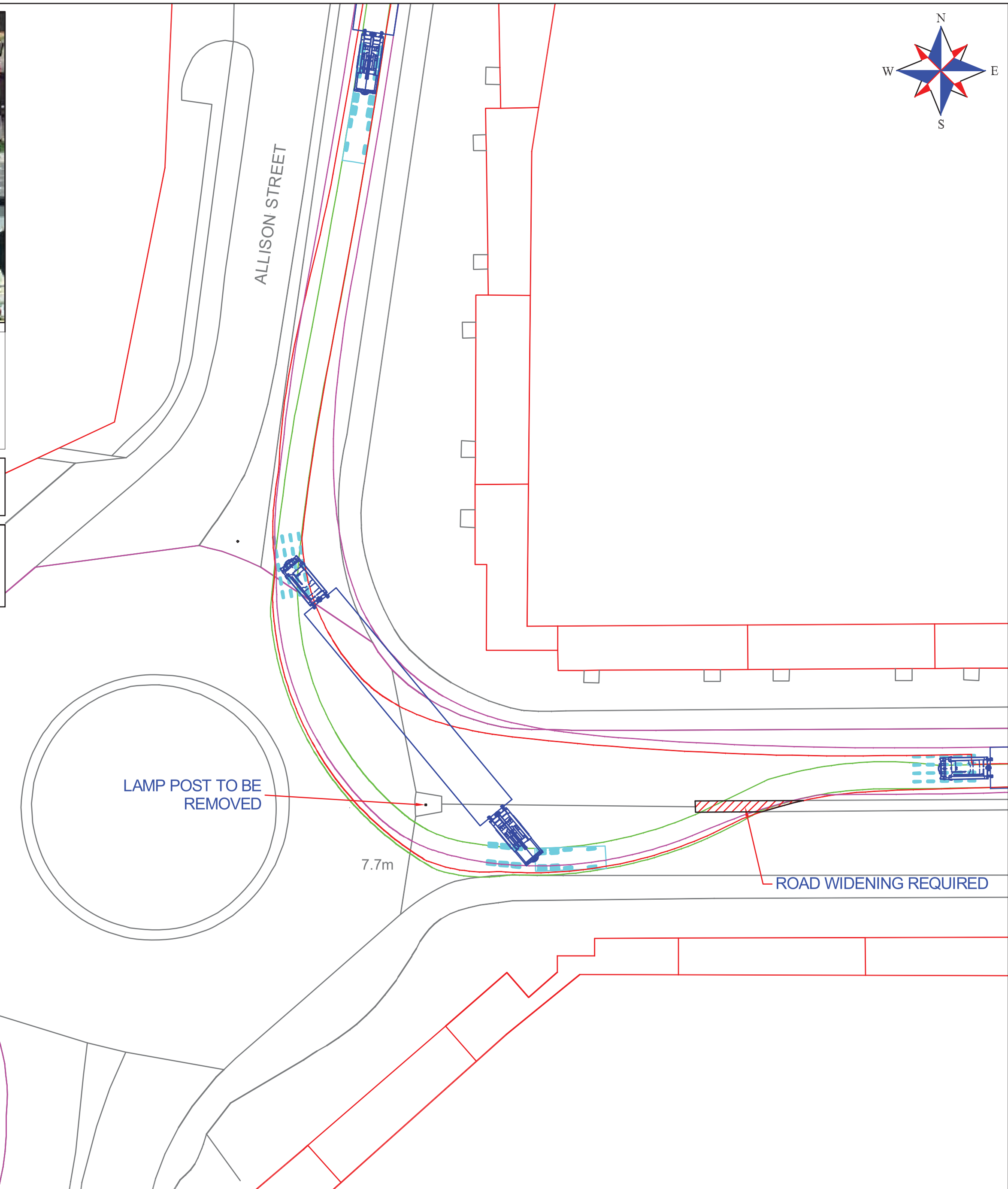
COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN	S.MANGHAM	TITLE	A79 ALLISON STREET/A719 ROUNDABOUT		
DATE	19/11/2014	MAPPING	ORDNANCE SURVEY Not Adjusted	CUSTOMER	EON
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY	CLIENT	SITE Enoch	DWG. NO. 274071-20A0.1

Swept Path indicates trailer utilising AUTOMATIC steering

Generic 30m - 4.5m dia. Bottom Tower Section Tower Transporter Trailer



Continue on A79 Allison Street to roundabout at junction with A719.
At roundabout, turn left onto A719.

Caution

- Widening required to provide a useable road surface as indicated by the red hatching.
- Road widening required on splitter island to allow loaded component to contraflow this roundabout.
- Lamp post at exit from roundabout to be removed due to oversail of the loaded component.
- Ground to be prepared to accept suitable axle loadings.

UK Grid Reference: NS 34004 22360

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

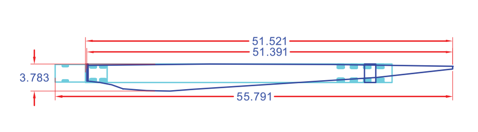
Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN S.MANGHAM		TITLE A79 ALLISON STREET/A719 ROUNDABOUT	
DATE 19/11/2014		MAPPING ORDNANCE SURVEY Not Adjusted	CUSTOMER EON
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch
			DWG. NO. 274071-20B0.1



Swept Path indicates trailer utilising AUTOMATIC steering

Generic 51.39m Blade Component
4 axle extendable trailer

Continue on A76 to Templeton Roundabout at junction with B7083.
At roundabout, turn right onto A76.

Caution

- Loaded component will navigate this roundabout utilising a contraflow manoeuvre.

UK Grid Reference: NS 54374 22446

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Red line	Area within red outline will be swept by tractor and trailer axles
Red hatching	Hatched area within red outline to be levelled and prepared to accept axle loadings
Magenta line	Area within magenta outline will be oversailed by load and projections
Green line	Area within green outline will be oversailed by trailer body

COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN	S.MANGHAM	TITLE	A76/B7083 TEMPLETON ROUNDABOUT
DATE	19/11/2014	MAPPING	ORDNANCE SURVEY Not Adjusted
SCALE	1:750	SIZE	A3
PINCH POINT IDENTIFIED BY	CLIENT	CUSTOMER	EON
SITE	Enoch	DWG. NO.	274071-90A0.1

Swept Path indicates trailer utilising AUTOMATIC steering

Generic 30m - 4.5m dia. Bottom Tower Section Tower Transporter Trailer

Continue on A76 to Templeton Roundabout at junction with B7083.
At roundabout, turn right onto A76.

Caution*

- Loaded component will navigate this roundabout utilising a contraflow manoeuvre.

UK Grid Reference: NS 54374 22446

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

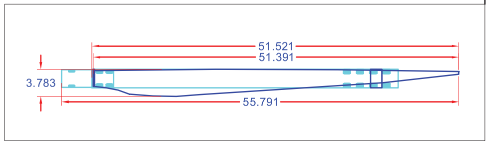
Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

COLLETT
EXPERTS IN MOTION

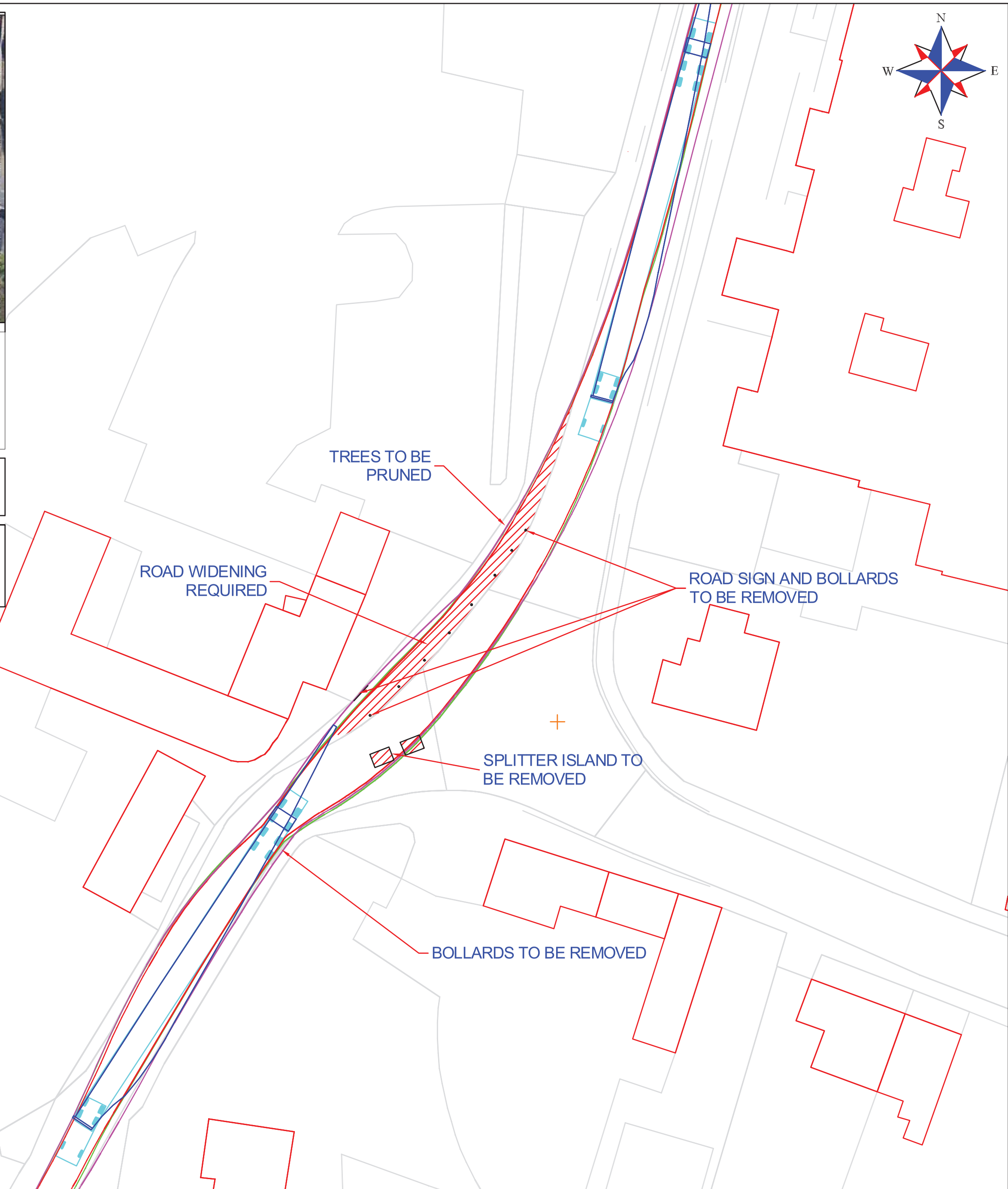
COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN S.MANGHAM		TITLE A76/B7083 TEMPLETON ROUNDABOUT	
DATE 19/11/2014		MAPPING ORDNANCE SURVEY Not Adjusted	CUSTOMER EON
SCALE 1:750	SIZE A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch / DWG. NO. 274071-90B0.1



Swept Path indicates trailer utilising MANUAL steering

Generic 51.39m Blade Component
4 axle extendable trailer



Continue on A76 to mini roundabout at junction with B741 at New Cumnock.
At roundabout, turn right onto B741.
Caution

- Widening required to provide a useable road surface as indicated by the red hatching.
- Road widening required on the offside of the junction to avoid third party land and buildings at the mini roundabout.
- Splitter island to be removed at exit from roundabout.
- Indicated road sign and bollards to be removed.
- Trees on the offside to be pruned.
- Ground to be prepared to accept suitable axle loadings.
- Due to close proximity to buildings and third party land, it is recommended that a topographical survey be undertaken at this junction.

UK Grid Reference: NS 61708 13307

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

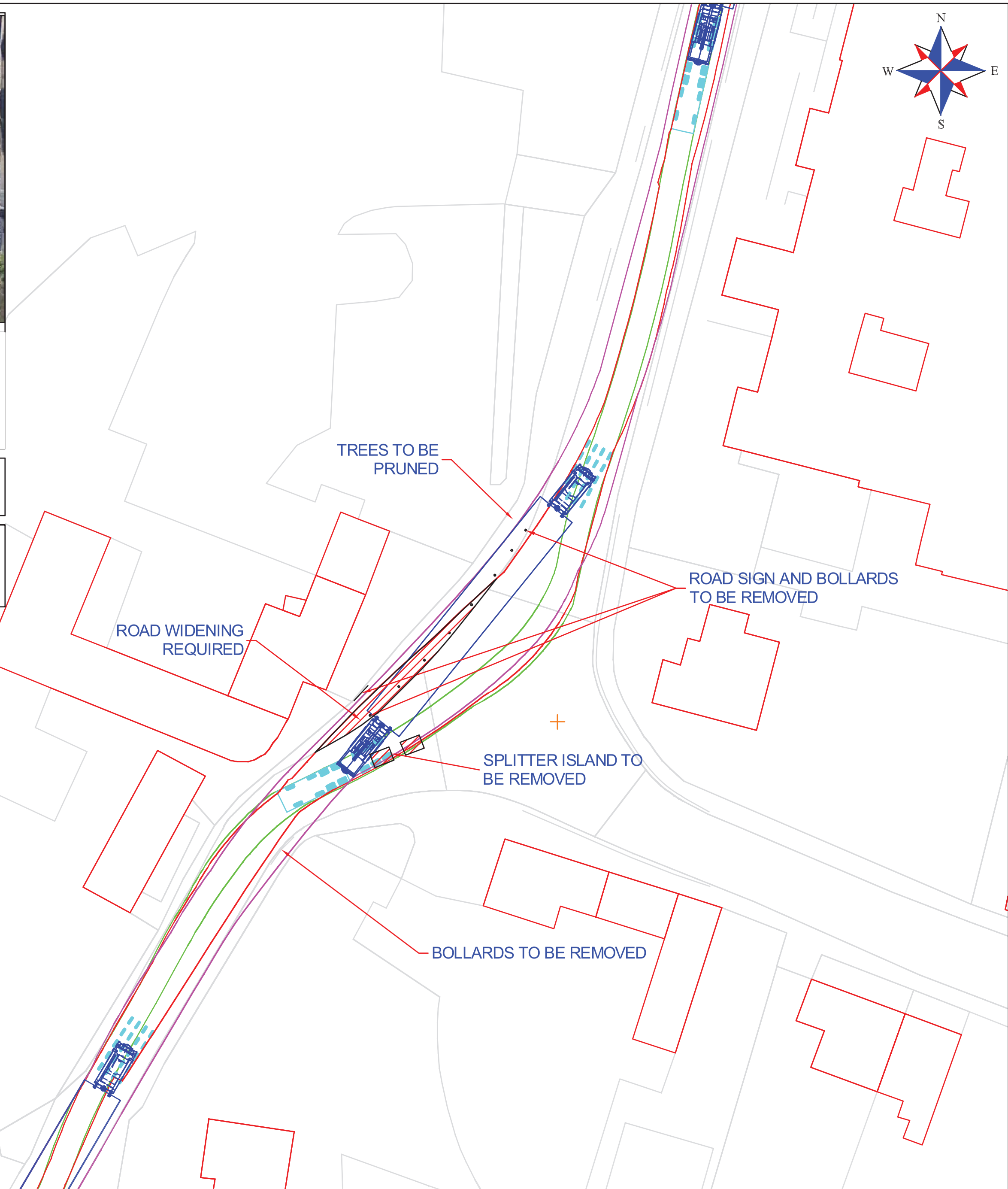
COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN	S.MANGHAM	TITLE	A76/B741 MINI ROUNDABOUT IN NEW CUMNOCK		
DATE	19/11/2014	MAPPING	ORDNANCE SURVEY Not Adjusted	CUSTOMER	EON
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY	CLIENT	SITE Enoch	DWG. NO 274071-100A1.1

Swept Path indicates trailer utilising MANUAL steering

Generic 30m - 4.5m dia. Bottom Tower Section Tower Transporter Trailer



Continue on A76 to mini roundabout at junction with B741 at New Cumnock.
At roundabout, turn right onto B741.
Caution

- Widening required to provide a useable road surface as indicated by the red hatching.
- Road widening required on the offside of the junction to avoid third party land and buildings at the mini roundabout.
- Splitter island to be removed at exit from roundabout.
- Indicated road sign and bollards to be removed.
- Trees on offside to be pruned.
- Ground to be prepared to accept suitable axle loadings.
- Due to close proximity to buildings and third party land, it is recommended that a topographical survey be undertaken at this junction.

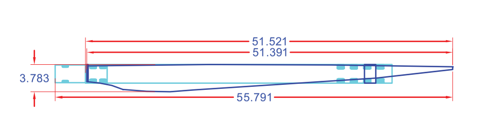
UK Grid Reference: NS 61708 13307

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Red line	Area within red outline will be swept by tractor and trailer axles
Red hatching	Hatched area within red outline to be levelled and prepared to accept axle loadings
Magenta line	Area within magenta outline will be oversailed by load and projections
Green line	Area within green outline will be oversailed by trailer body

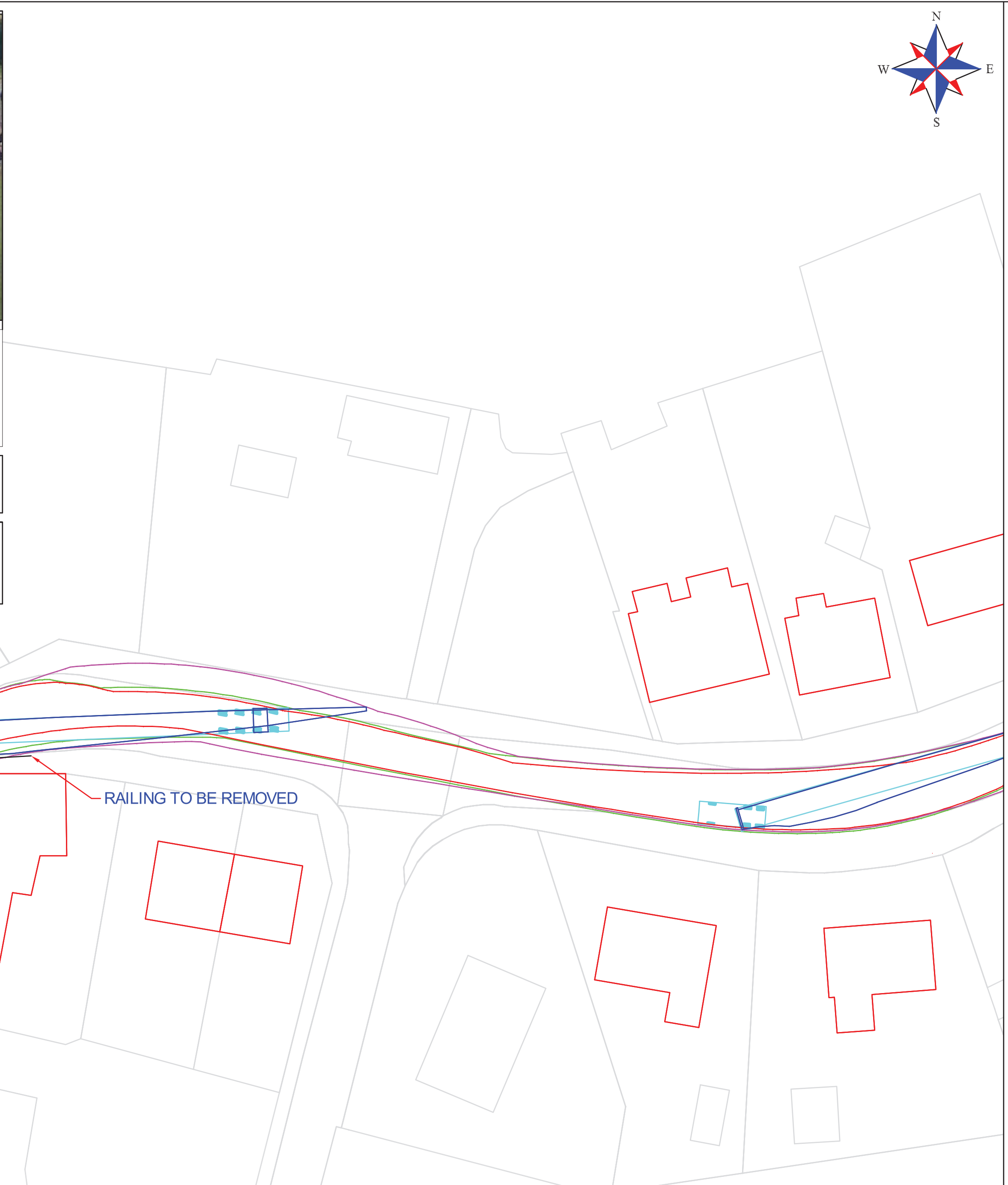
COLLETT
EXPERTS IN MOTION
COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN S.MANGHAM	TITLE A76/B741 MINI ROUNDABOUT IN NEW CUMNOCK		
DATE 19/11/2014	MAPPING ORDNANCE SURVEY Not Adjusted	CUSTOMER EON	
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch	DWG. NO 274071-100B1.1



Swept Path indicates trailer utilising MANUAL steering

Generic 51.39m Blade Component
4 axle extendable trailer



Continue on B741 to left bend on Connelllorn Bridge.

Caution

- Widening required to provide a useable road surface as indicated by the red hatching.
- Road widening required on the offside of the bend to avoid third party land and buildings.
- Railings on the nearside to be removed.
- Ground to be prepared to accept suitable axle loadings.
- Due to close proximity to buildings and third party land, it is recommended that a topographical survey be undertaken at this bend/bridge.

UK Grid Reference: NS 60817 12820

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

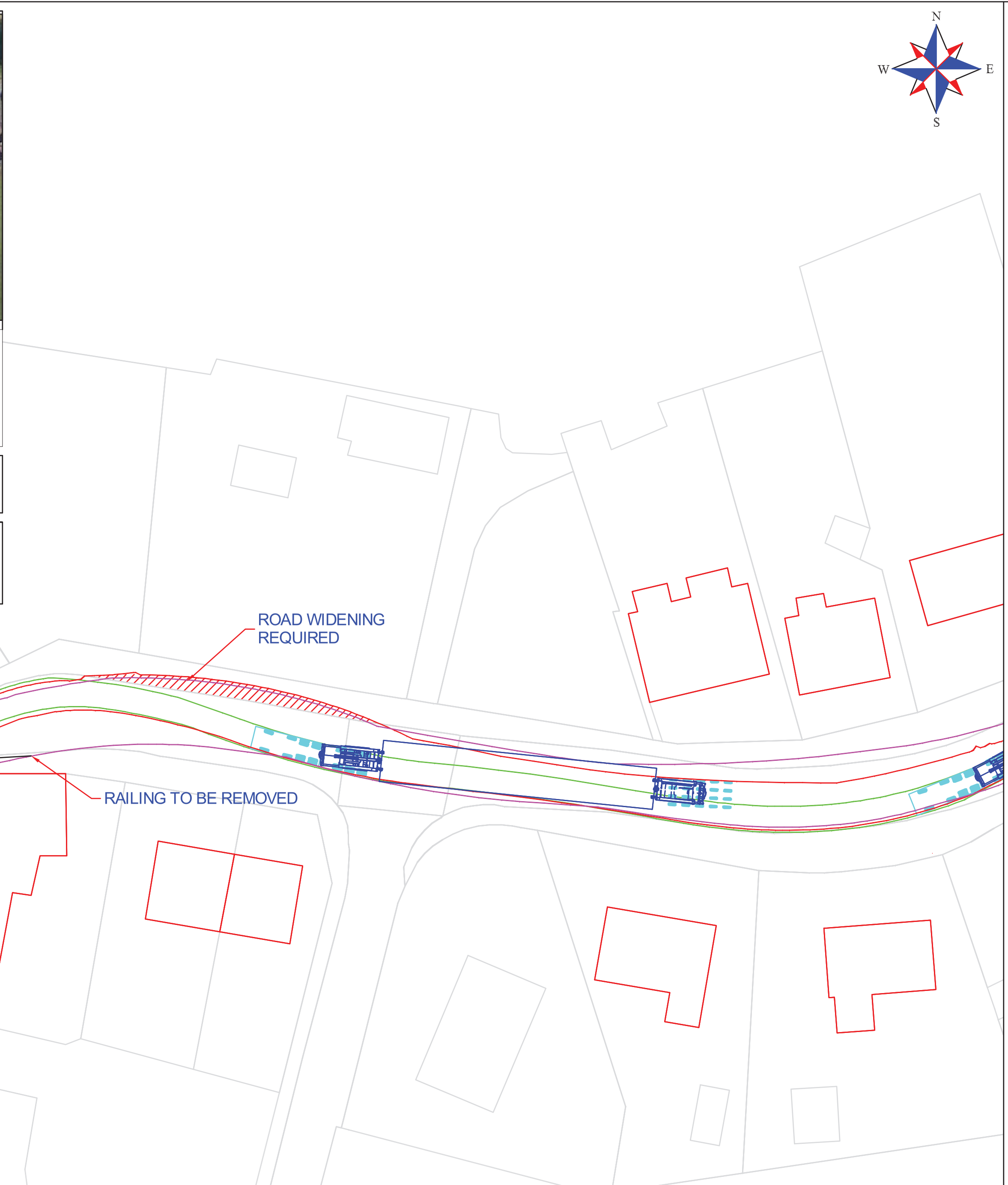
COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN S.MANGHAM	TITLE LEFT BEND ON B741 AT CONNELLLORN BRIDGE		
DATE 19/11/2014	MAPPING ORDNANCE SURVEY Not Adjusted	CUSTOMER EON	
SCALE 1:500 SIZE A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch	DWG. NO 274071-110A1.1

Swept Path indicates trailer utilising MANUAL steering

Generic 30m - 4.5m dia. Bottom Tower Section Tower Transporter Trailer



Continue on B741 to left bend on Connelllorn Bridge.

Caution

- Widening required to provide a useable road surface as indicated by the red hatching.
- Road widening required on the offside of the bend to avoid third party land and buildings.
- Railings on the nearside to be removed.
- Ground to be prepared to accept suitable axle loadings.
- Due to close proximity to buildings and third party land, it is recommended that a topographical survey be undertaken at this bend/bridge.

UK Grid Reference: NS 60817 12820

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

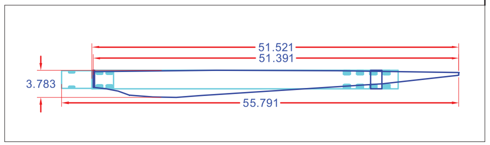
Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

COLLETT
EXPERTS IN MOTION

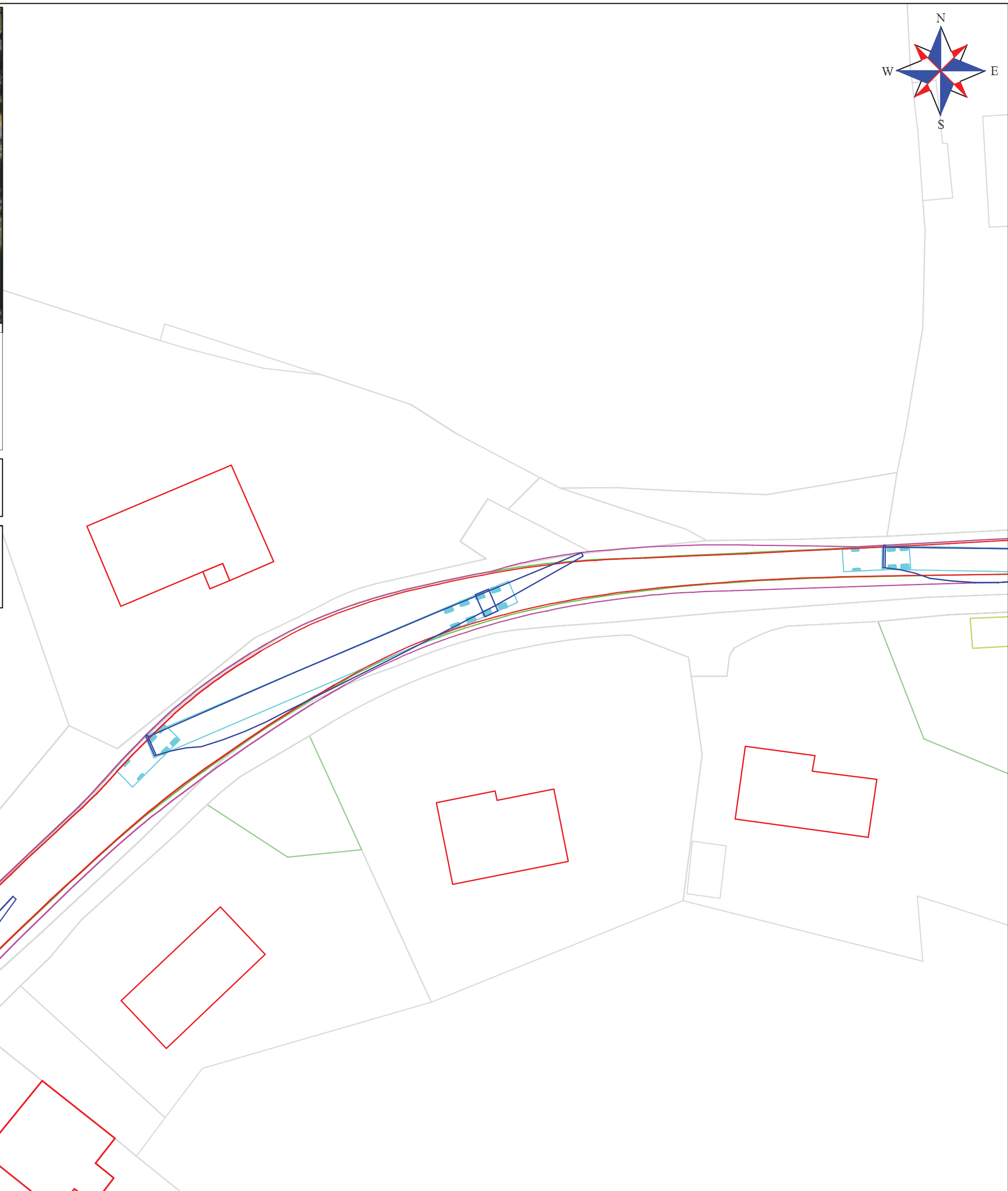
COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN S.MANGHAM		TITLE LEFT BEND ON B741 AT CONNELLLORN BRIDGE	
DATE 19/11/2014		MAPPING ORDNANCE SURVEY Not Adjusted	CUSTOMER EON
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch / DWG. NO 274071-110B1.1



Swept Path indicates trailer utilising AUTOMATIC steering

Generic 51.39m Blade Component
4 axle extendable trailer



Continue on B741 to left bend at Manse War Memorial.

Caution

- Loaded component will navigate this bend without any issues.

UK Grid Reference: NS 60059 12545

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
- © Crown copyright and database rights 2014. Ordnance Survey 0100031673

Red line	Area within red outline will be swept by tractor and trailer axles
Hatched red box	Hatched area within red outline to be levelled and prepared to accept axle loadings
Magenta line	Area within magenta outline will be oversailed by load and projections
Green line	Area within green outline will be oversailed by trailer body

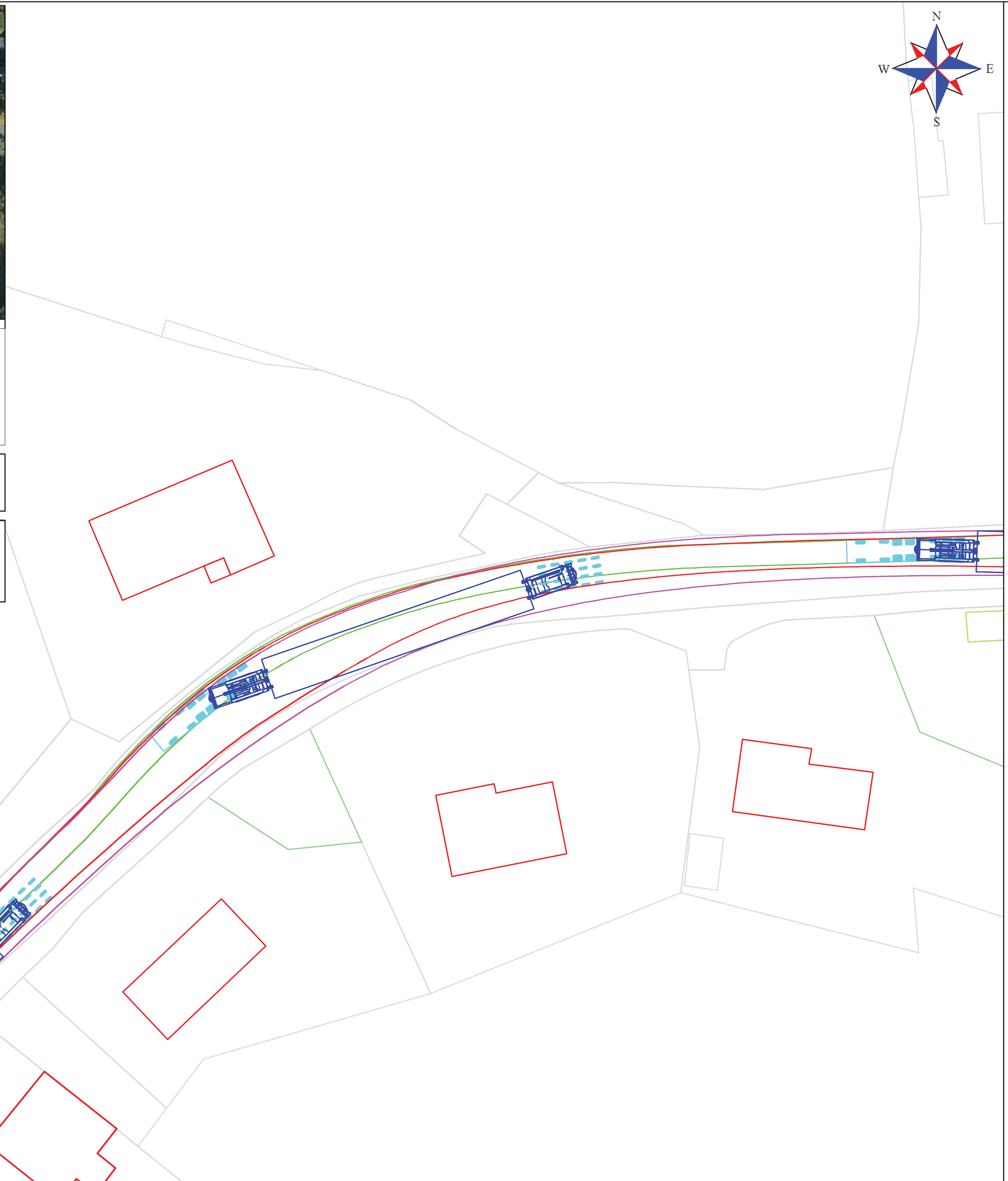
COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN	S.MANGHAM	TITLE	LEFT BEND ON B741 AT MANSE WAR MEMORIAL
DATE	19/11/2014	MAPPING	ORDNANCE SURVEY Not Adjusted
		CUSTOMER	EON
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY	CLIENT
		SITE	Enoch
		DWG. NO	274071-120A0.1

Swept Path indicates trailer utilising AUTOMATIC steering

Generic 30m - 4.5m dia. Bottom Tower Section Tower Transporter Trailer



Continue on B741 to left bend at Manse War Memorial.

Caution

- Loaded component will navigate this bend without any issues.

UK Grid Reference: NS 60059 12545

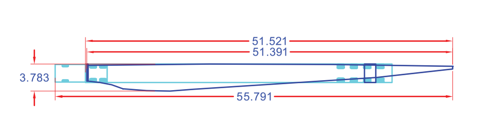
- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Red outline	Area within red outline will be swept by tractor and trailer axles
Red hatched	Hatched area within red outline to be levelled and prepared to accept axle loadings
Magenta outline	Area within magenta outline will be oversailed by load and projections
Green outline	Area within green outline will be oversailed by trailer body

COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN S.MANGHAM		TITLE LEFT BEND ON B741 AT MANSE WAR MEMORIAL	
DATE 19/11/2014		MAPPING ORDNANCE SURVEY Not Adjusted	CUSTOMER EON
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch / DWG. NO 274071-120B0.1



Swept Path indicates trailer utilising MANUAL steering

Generic 51.39m Blade Component
4 axle extendable trailer

Continue on B741 to right bend at Redhall Burn.

Caution

- Loaded component will navigate this bend utilising manual steering.

UK Grid Reference: NS 57998 10690

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

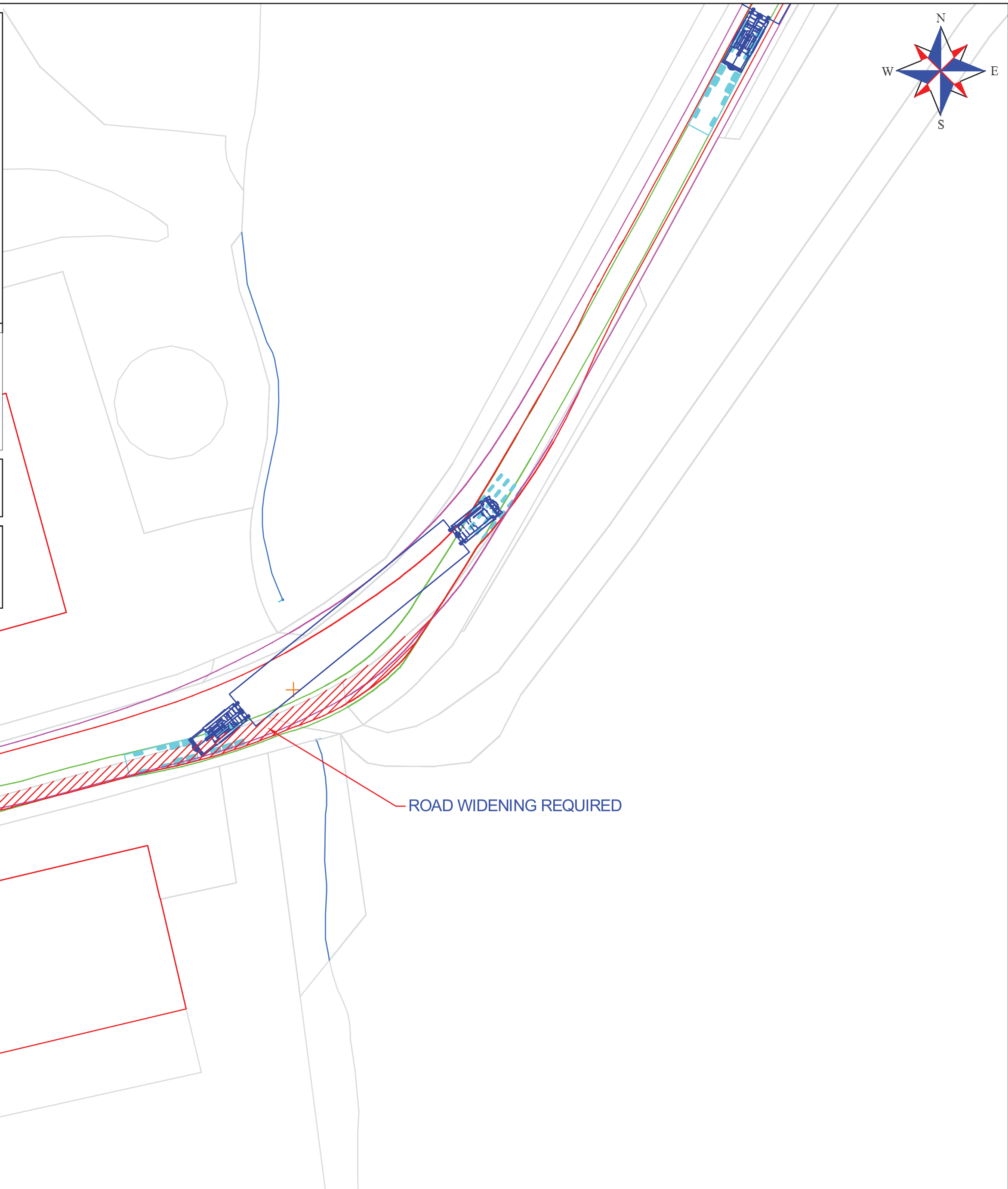
COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN S.MANGHAM	TITLE RIGHT BEND ON B741 AT REDHALL BURN		
DATE 19/11/2014	MAPPING ORDNANCE SURVEY Not Adjusted	CUSTOMER EON	
SCALE 1:500 / SIZE A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch	DWG. NO 274071-130A1.1

Swept Path indicates trailer utilising AUTOMATIC steering

Generic 30m - 4.5m dia. Bottom Tower Section Tower Transporter Trailer



Continue on B741 to right bend at Redhall Burn.

Caution

- Widening required to provide a useable road surface as indicated by the red hatching.
- Road widening required on the nearside of the bend to avoid third party land on the offside.
- Railings on the nearside to be removed.
- Ground to be prepared to accept suitable axle loadings.

UK Grid Reference: NS 57998 10690

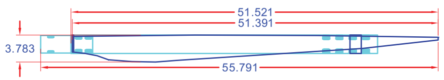
- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Red line	Area within red outline will be swept by tractor and trailer axles
Red hatching	Hatched area within red outline to be levelled and prepared to accept axle loadings
Magenta line	Area within magenta outline will be oversailed by load and projections
Green line	Area within green outline will be oversailed by trailer body

COLLETT
EXPERTS IN MOTION

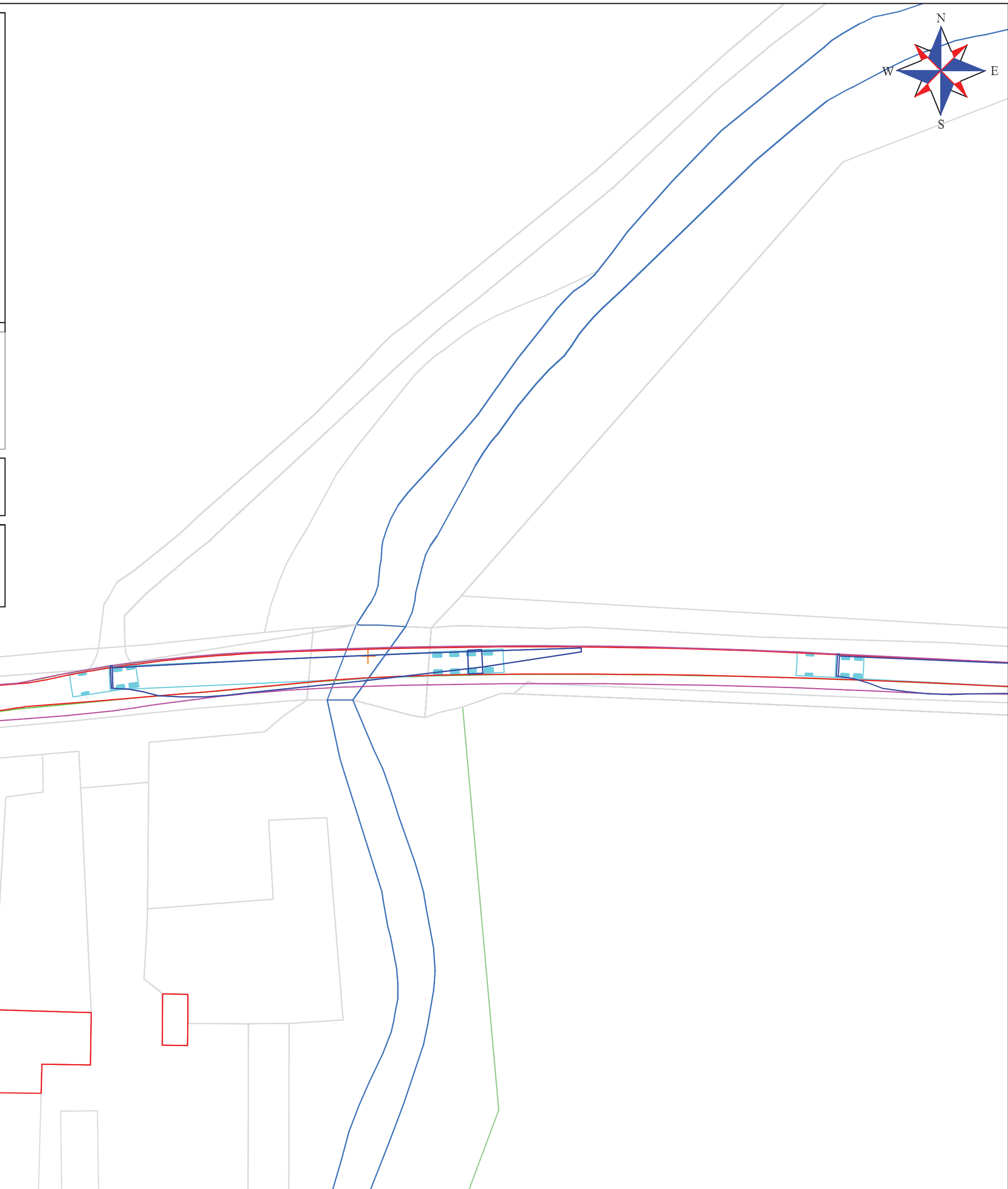
COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN S.MANGHAM	TITLE RIGHT BEND ON B741 AT REDHALL BURN		
DATE 19/11/2014	MAPPING ORDNANCE SURVEY Not Adjusted	CUSTOMER EON	
SCALE 1:500 / SIZE A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch	DWG. NO 274071-130B0.1



Swept Path indicates trailer utilising AUTOMATIC steering

Generic 51.39m Blade Component
4 axle extendable trailer



Continue on B741 to Dalleagles Bridge.

- Loaded component will navigate Dalleagles Bridge without any issues.

UK Grid Reference: NS 57351 10647

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

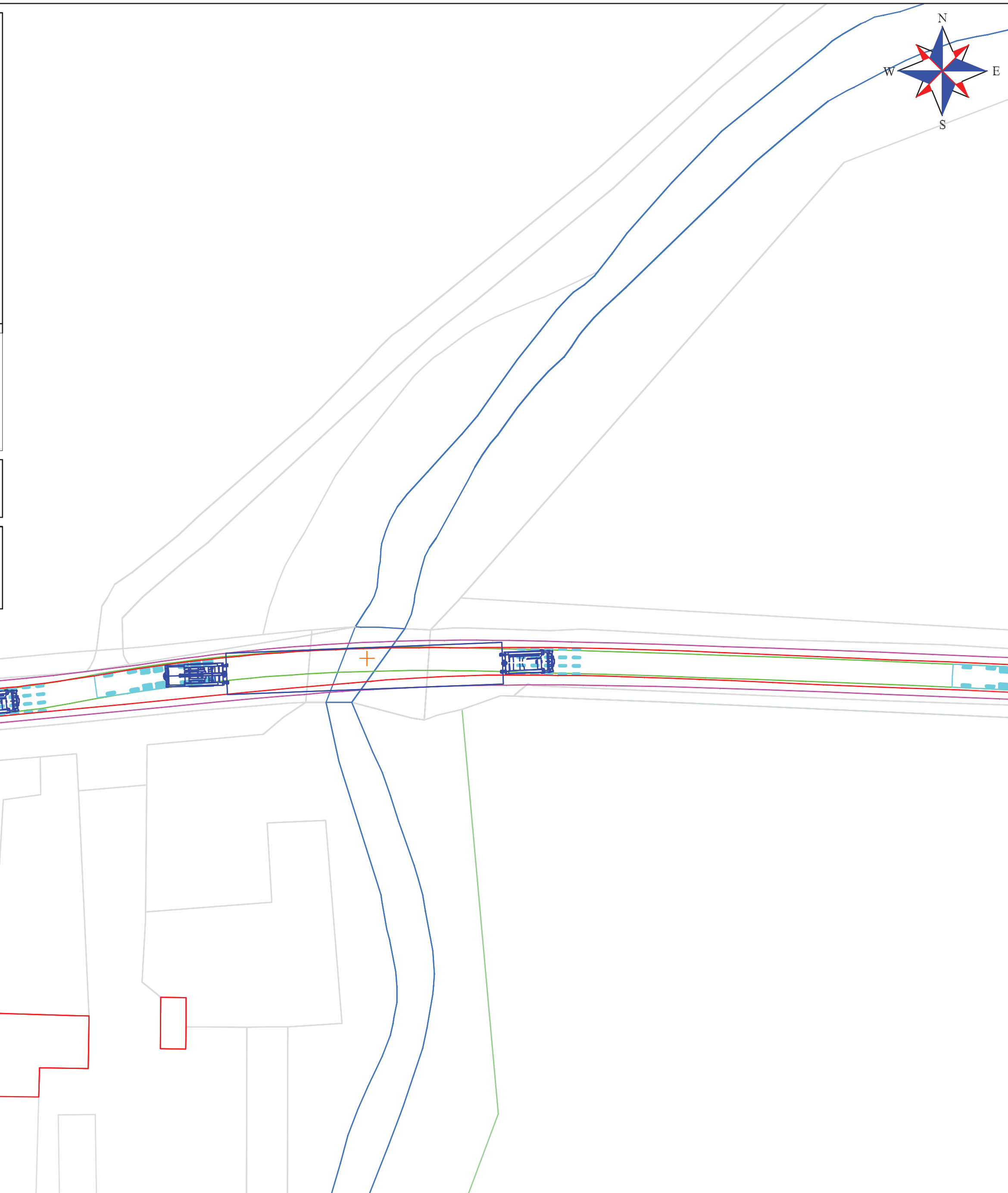
COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN	S.MANGHAM	TITLE	B741 DALLEAGLES BRIDGE		
DATE	19/11/2014	MAPPING	ORDNANCE SURVEY Not Adjusted	CUSTOMER	EON
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY	CLIENT	SITE Enoch	DWG. NO 274071-140A0.1

Swept Path indicates trailer utilising AUTOMATIC steering

Generic 30m - 4.5m dia. Bottom Tower Section Tower Transporter Trailer



Continue on B741 to Dalleagles Bridge.

- Loaded component will navigate Dalleagles Bridge without any issues.

UK Grid Reference: NS 57351 10647

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

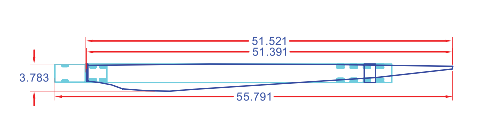
Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

COLLETT
EXPERTS IN MOTION

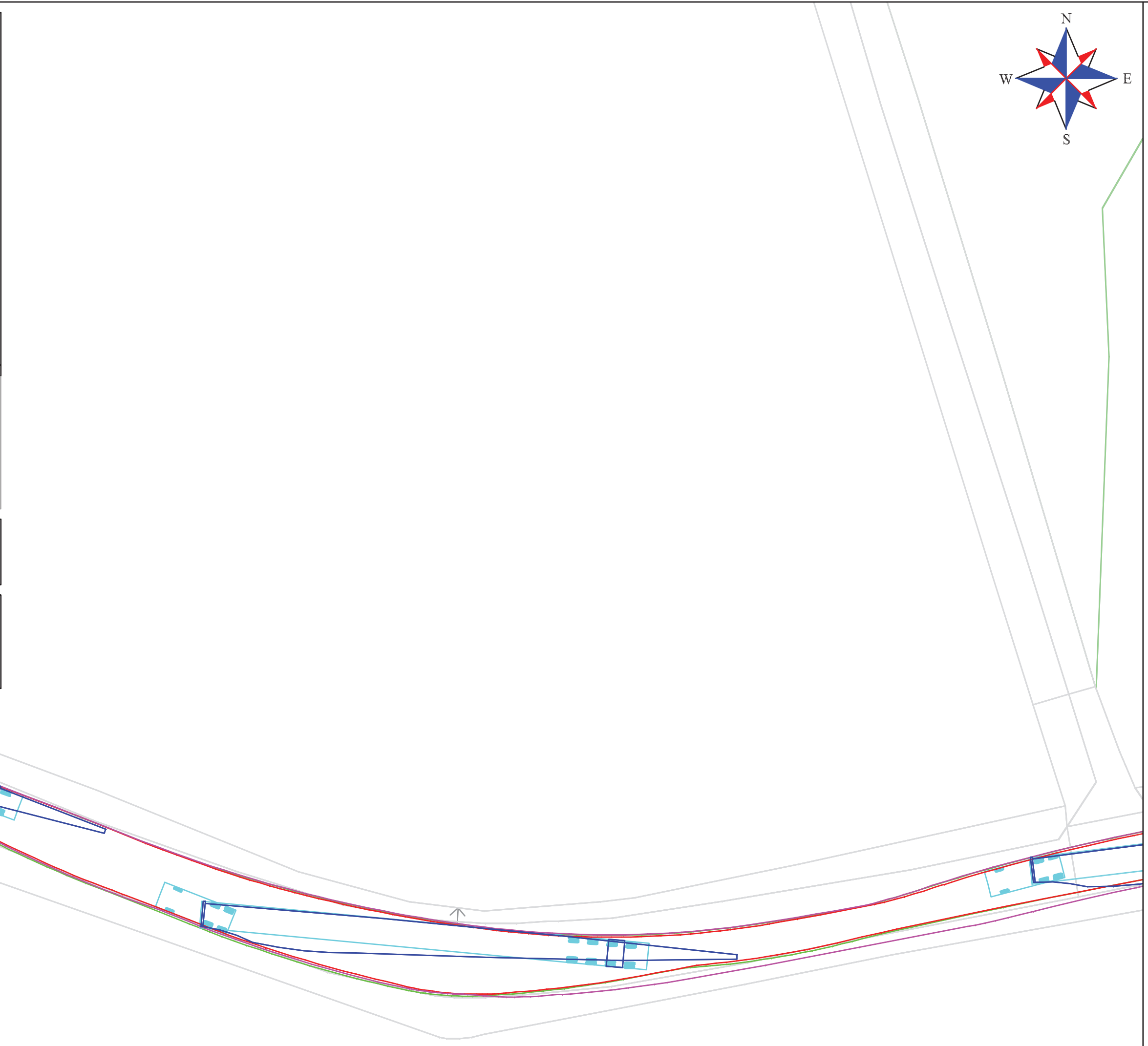
COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN	S.MANGHAM	TITLE	B741 DALLEAGLES BRIDGE		
DATE	19/11/2014	MAPPING	ORDNANCE SURVEY Not Adjusted	CUSTOMER	EON
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY	CLIENT	SITE Enoch	DWG. NO 274071-140B0.1



Swept Path indicates trailer utilising AUTOMATIC steering

Generic 51.39m Blade Component
4 axle extendable trailer



Continue on B741 to right bend.

- Loaded component will navigate this bend without any issues.

UK Grid Reference: NS 56061 10507

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Red line	Area within red outline will be swept by tractor and trailer axles
Red hatching	Hatched area within red outline to be levelled and prepared to accept axle loadings
Magenta line	Area within magenta outline will be oversailed by load and projections
Green line	Area within green outline will be oversailed by trailer body

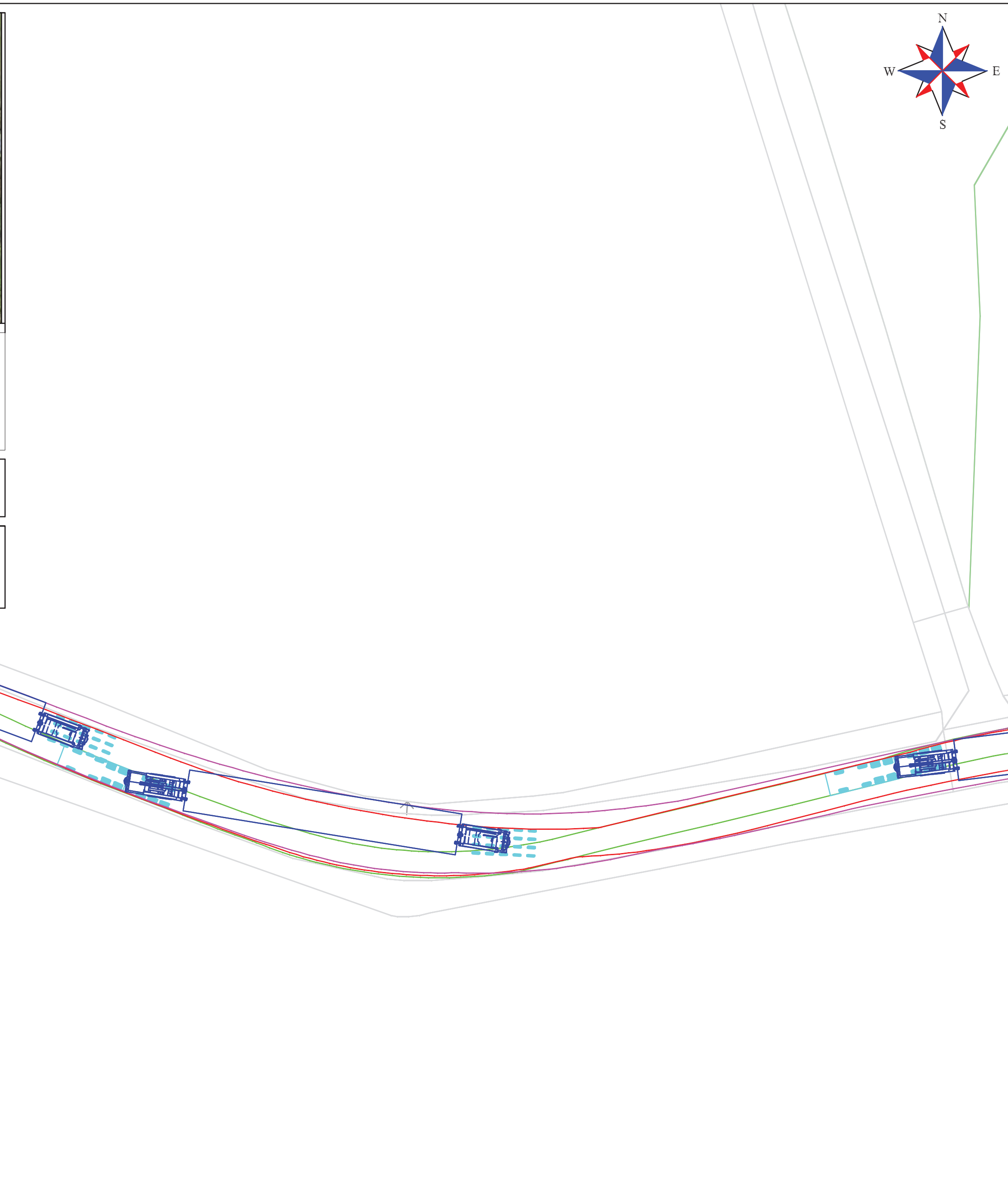
COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN S.MANGHAM	TITLE RIGHT BEND ON B741		
DATE 19/11/2014	MAPPING ORDNANCE SURVEY Not Adjusted	CUSTOMER EON	
SCALE 1:500 / SIZE A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch	DWG. NO 274071-150A0.1

Swept Path indicates trailer utilising AUTOMATIC steering

Generic 30m - 4.5m dia. Bottom Tower Section Tower Transporter Trailer



Continue on B741 to right bend.

- Loaded component will navigate this bend without any issues.

UK Grid Reference: NS 56061 10507

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

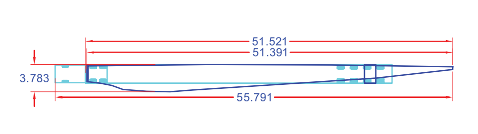
Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

COLLETT
EXPERTS IN MOTION

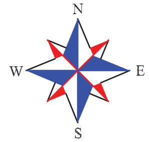
COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

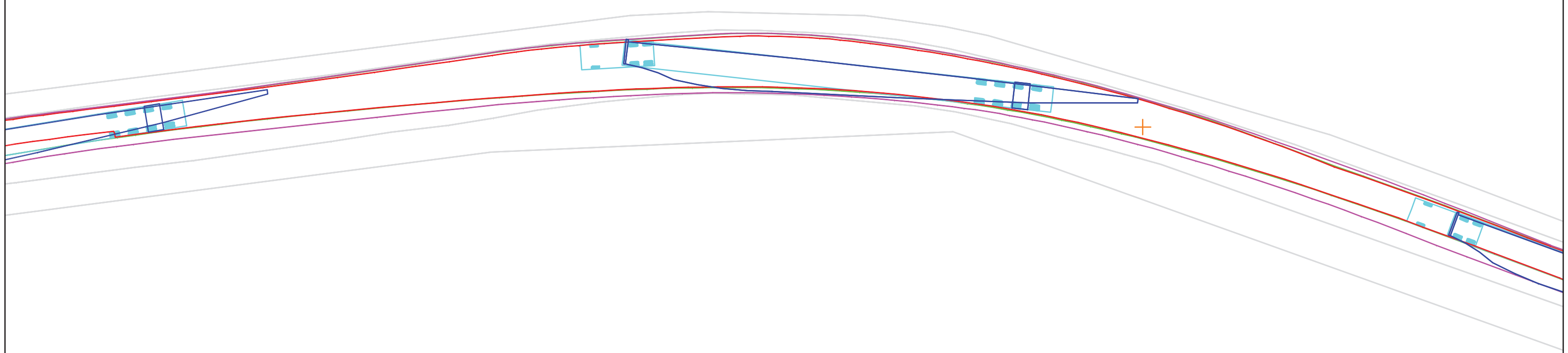
DRAWN	S.MANGHAM	TITLE	RIGHT BEND ON B741		
DATE	19/11/2014	MAPPING	ORDNANCE SURVEY Not Adjusted	CUSTOMER	EON
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY	CLIENT	SITE Enoch	DWG. NO 274071-150B0.1



Swept Path indicates trailer utilising AUTOMATIC steering

Generic 51.39m Blade Component
4 axle extendable trailer





Continue on B741 to left bend.

- Loaded component will navigate this bend without any issues.

UK Grid Reference: NS 55927 10553

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

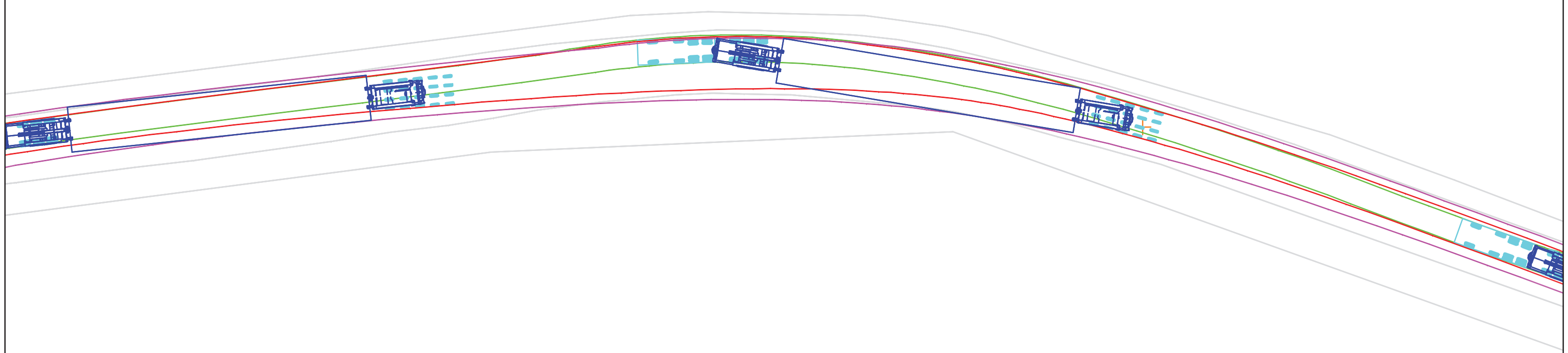
COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN S.MANGHAM		TITLE LEFT BEND ON B741	
DATE 19/11/2014		MAPPING ORDNANCE SURVEY Not Adjusted	CUSTOMER EON
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch / DWG. NO 274071-160A0.1

Swept Path indicates trailer utilising AUTOMATIC steering

Generic 30m - 4.5m dia. Bottom Tower Section Tower Transporter Trailer



Continue on B741 to left bend.

- Loaded component will navigate this bend without any issues.

UK Grid Reference: NS 55927 10553

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

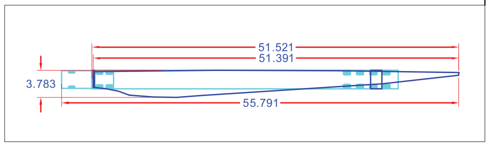
Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

COLLETT
EXPERTS IN MOTION

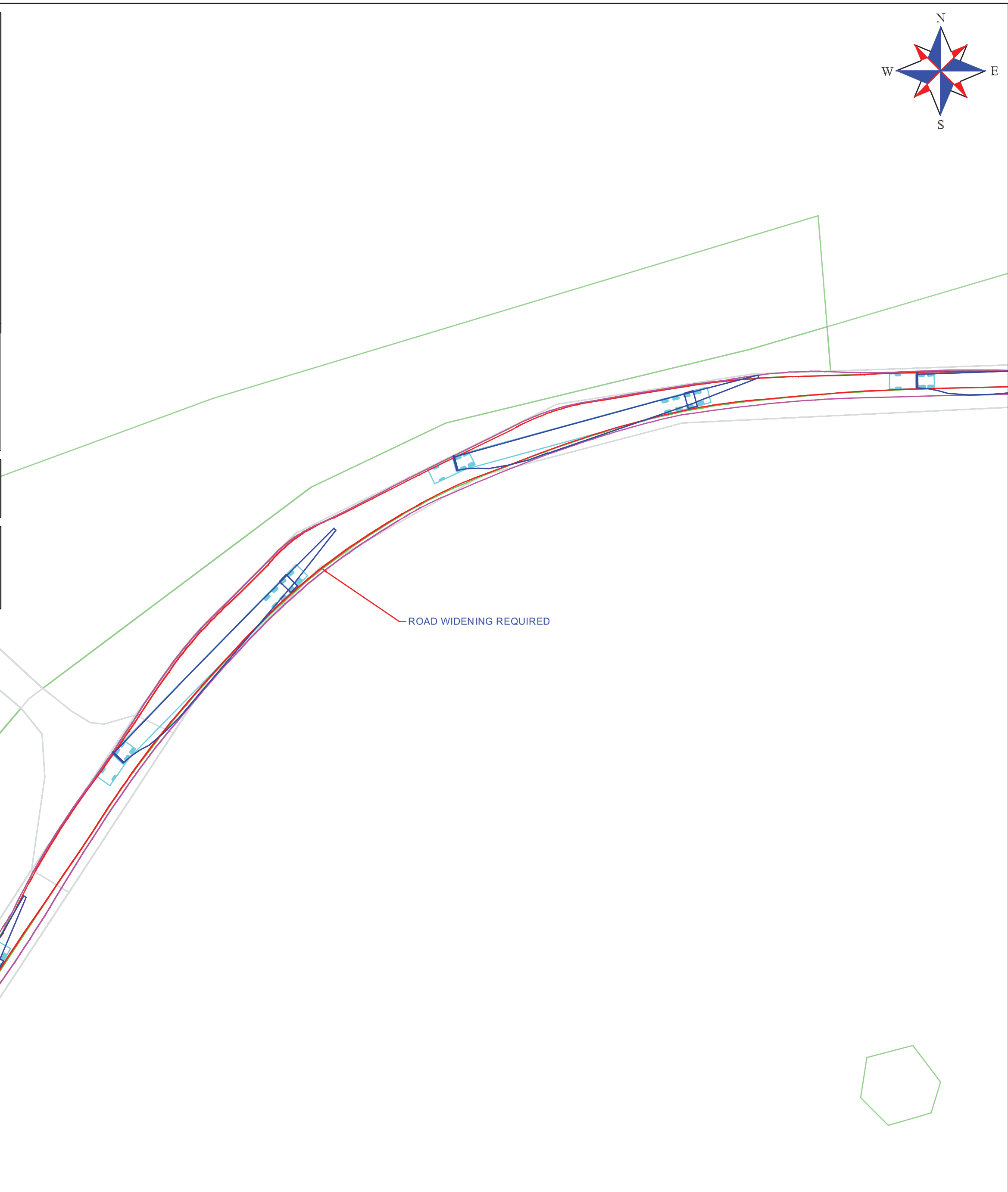
COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN S.MANGHAM		TITLE LEFT BEND ON B741	
DATE 19/11/2014		MAPPING ORDNANCE SURVEY Not Adjusted	CUSTOMER EON
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch	DWG. NO 274071-160B0.1



Swept Path indicates trailer utilising AUTOMATIC steering

Generic 51.39m Blade Component
4 axle extendable trailer



Continue on B741 to left bend.

Caution

- Widening required to provide a useable road surface as indicated by the red hatching.
- Road widening required on the nearside to allow loaded component to navigate.
- Ground to be prepared to accept suitable axle loadings.
- The original OS data tile is highly inaccurate. Due to the inaccuracies, it is recommended that a topographical survey be carried out this location.

UK Grid Reference: NS 54687 10291

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Legend:
- Area within red outline will be swept by tractor and trailer axles
- Hatched area within red outline to be levelled and prepared to accept axle loadings
- Area within magenta outline will be oversailed by load and projections
- Area within green outline will be oversailed by trailer body

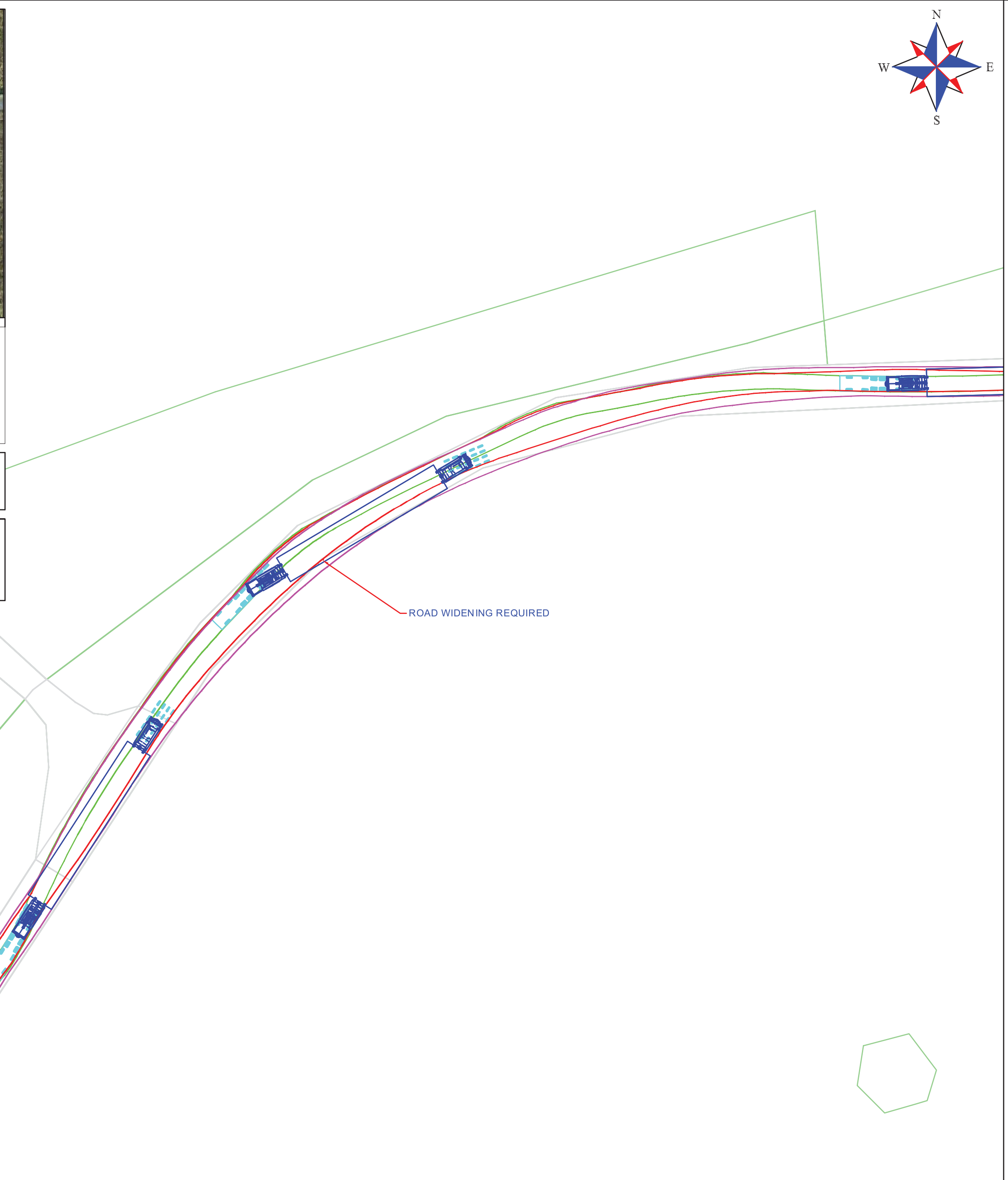
COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN	S.MANGHAM	TITLE	LEFT BEND ON B741		
DATE	19/11/2014	MAPPING	ORDNANCE SURVEY Not Adjusted	CUSTOMER	EON
SCALE 1:750	SIZE A3	PINCH POINT IDENTIFIED BY	CLIENT	SITE Enoch	DWG. NO 274071-170A0.1

Swept Path indicates trailer utilising AUTOMATIC steering

Generic 30m - 4.5m dia. Bottom Tower Section Tower Transporter Trailer



Continue on B741 to left bend.

Caution

- Widening required to provide a useable road surface as indicated by the red hatching.
- Road widening required on the nearside to allow loaded component to navigate.
- Ground to be prepared to accept suitable axle loadings.
- The OS data tile is highly inaccurate. Due to the inaccuracies, it is recommended that a topographical survey be carried out this location.

UK Grid Reference: NS 54687 10291

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

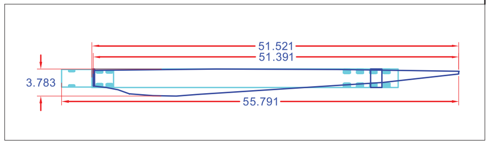
Area within magenta outline will be oversailed by load and projections

Area within green outline will be oversailed by trailer body

COLLETT
EXPERTS IN MOTION

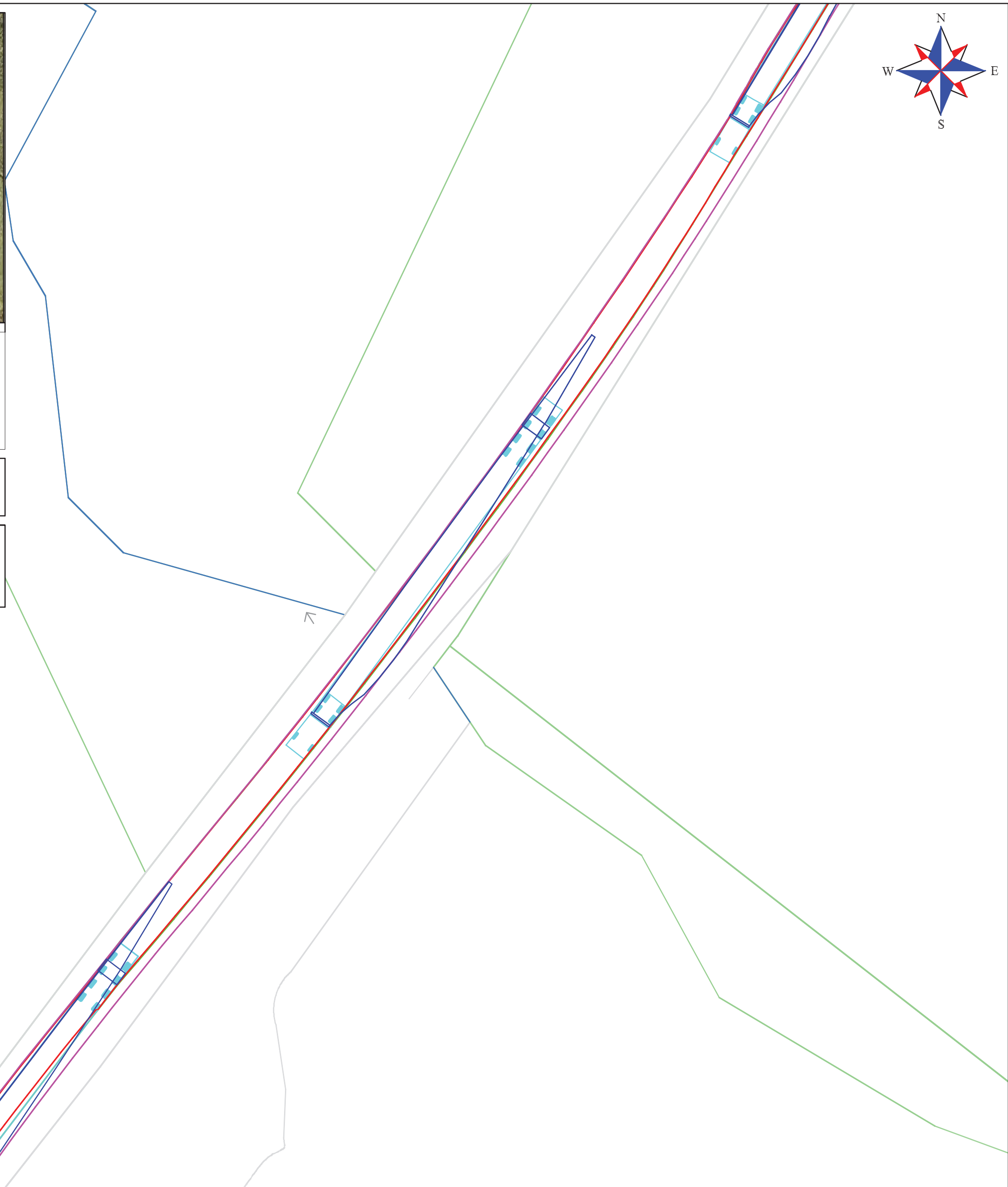
COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN	S.MANGHAM		TITLE	LEFT BEND ON B741			
DATE	19/11/2014		MAPPING	ORDNANCE SURVEY Not Adjusted	CUSTOMER	EON	
SCALE 1:750	SIZE	A3	PINCH POINT IDENTIFIED BY	CLIENT	SITE	Enoch	DWG. NO 274071-170B0.1



Swept Path indicates trailer utilising AUTOMATIC steering

Generic 51.39m Blade Component
4 axle extendable trailer



Continue on B741 to Polmathburn Bridge.

- Loaded component will navigate Polmathburn Bridge without any issues.

UK Grid Reference: NS 54477 09924

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

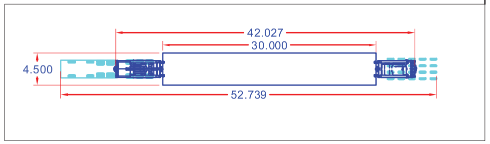
Area within red outline will be swept by tractor and trailer axles

Hatched area within red outline to be levelled and prepared to accept axle loadings

Area within magenta outline will be oversailed by load and projections

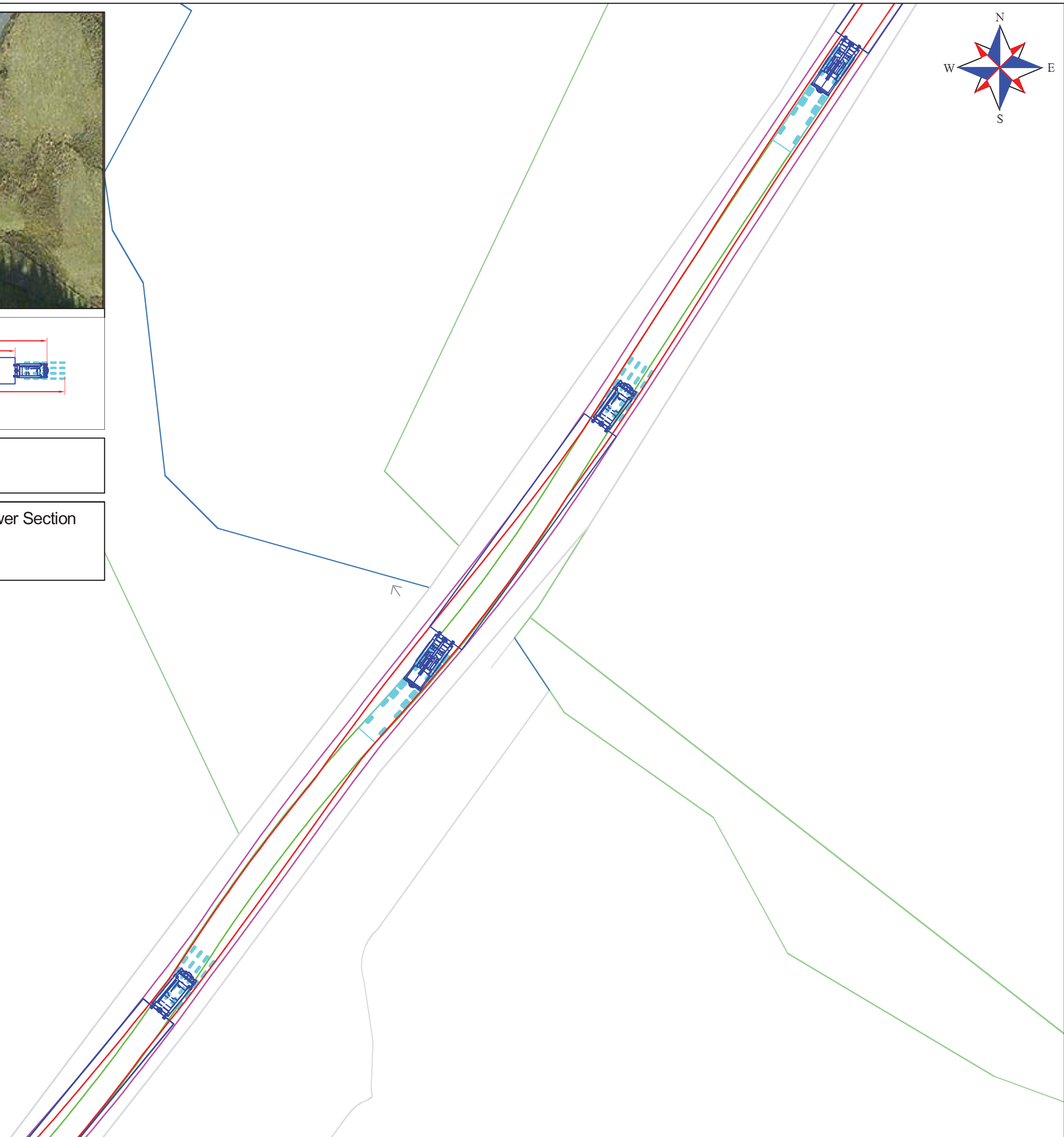
Area within green outline will be oversailed by trailer body

COLLETT EXPERTS IN MOTION	COLLETT & SONS LIMITED Victoria Terminal TEL: +44(0)8456 255288 Albert Road FAX: +44(0)8456 255244 Halifax, HX2 0DF WEB: www.collett.co.uk	DRAWN S.MANGHAM		TITLE B741 POLMATHBURN BRIDGE	
		DATE 19/11/2014		MAPPING ORDNANCE SURVEY Not Adjusted	CUSTOMER EON
		SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY CLIENT	SITE Enoch / DWG. NO 274071-180A0.1



Swept Path indicates trailer utilising AUTOMATIC steering

Generic 30m - 4.5m dia. Bottom Tower Section Tower Transporter Trailer



Continue on B741 to Polmathburn Bridge.

- Loaded component will navigate Polmathburn Bridge without any issues.

UK Grid Reference: NS 54477 09924

- The swept path analysis provided is produced from a purely transport orientated view, and does not consider any political issues in terms of land ownership, or any other precincts raised, that may otherwise be restrictive.
- The drawing has been produced from Ordnance Survey Data. A site visit has **not** been conducted to verify road widths or the presence of street furniture.
- All swept path diagrams and assessments are made and calculated for the road movement of loaded trailer equipment carrying Turbine components. These dimensions are based on the turning circles and specification of Collett & Sons Ltd trailer equipment.
- This SPA is a means of providing evidence of minimum requirements of any one vehicle as a footprint and there is no safety factor or margin included.
- Turbine delivery vehicles can be both left and right hand drive vehicles, therefore due to drivers perception it must be assumed that every vehicle will not follow the exact same line and so a margin of additional space should be allowed for.
- Land take is usually referred to when land is required from Private Land Owners; road widening is usually referred to when land is required within highways boundaries. The boundaries between private land and highways property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual boundaries between highways and private land are not substantiated in this report and can only be authenticated by carrying out land searches.
- Police escorts and permits will be required for the movement of all of the components. Form 'BE16' permits will also be required to undertake the movement of the vehicle shown in the swept path analysis. These permits are at the discretion of the Highway Agency (HA). Therefore, approval of these 'permits for movements' by the HA are a major consideration before the physical capability to deliver these components are undertaken.
- In critical areas, where modifications are required, the road construction must be formed to the minimum specification contained in the Turbine Manufactures Transport Guidance Notes.
- The Turbine Manufactures Transport Guidance Notes will state the minimum road width required for the transport of components. Any roads below this stated width will require widening to reflect this regardless of any swept path analysis not indicating modifications.
- The information is privileged and confidential and is for the exclusive use of the nominated client.
- All dimensions in meters
-

Red line	Area within red outline will be swept by tractor and trailer axles
Red hatching	Hatched area within red outline to be levelled and prepared to accept axle loadings
Magenta line	Area within magenta outline will be oversailed by load and projections
Green line	Area within green outline will be oversailed by trailer body

COLLETT
EXPERTS IN MOTION

COLLETT & SONS LIMITED
Victoria Terminal TEL: +44(0)8456 255288
Albert Road FAX: +44(0)8456 255244
Halifax, HX2 0DF WEB: www.collett.co.uk

DRAWN	S.MANGHAM	TITLE	B741 POLMATHBURN BRIDGE		
DATE	19/11/2014	MAPPING	ORDNANCE SURVEY Not Adjusted	CUSTOMER	EON
SCALE 1:500	SIZE A3	PINCH POINT IDENTIFIED BY	CLIENT	SITE Enoch	DWG. NO 274071-180B0.1

Appendix 15.A
Receptors from Tourism Assessment

Appendix 15.A Receptors from Tourism Assessment

Tourist receptors either located within 35km of the Development Site but with no theoretical visibility of the Proposed Development, or with some theoretical visibility of the Proposed Development but no predicted significant visual or cultural heritage effects (as assessed in Chapter 9 – LVIA and Chapter 10 – Cultural Heritage respectively), are listed below:

- ‘A’ class and Trunk roads: M77, A71, A77, A78, A719, A735, A759, A76 (Kilmarnock to Dumfries) and Burns Heritage Trail outwith 10km from Development Site, A70 (M74 to Ayr) outwith 10km from Development Site, A713 Galloway National Tourist Route outwith 10.5km from Development Site, A702, A712 and A762;
- Glasgow to Stranraer railway line via Ayr;
- Glasgow to Carlisle railway line via Kilmarnock and Dumfries;
- The River Ayr Way;
- Ayrshire Coastal Path;
- National Cycle Route (NCR) 7;
- NCR 74;
- Kirkpatrick Macmillan Cycle Trail (NCR 73) and NCR 73 within and beyond Kilmarnock;
- Robert the Bruce Trail;
- Galloway Red Kite Trail;
- Southern Upland Way;
- Scottish Hill Track 77a: Bargrennan to Dalmellington or Carsphairn / 78a: Glen Trool Village to Dalmellington by Tunskeen and the Loch Doon Heritage Path (both following the same route);
- Key Hills and Summits: Merrick (Corbett), Mullwharchar (Graham), Craignaw (Graham), Lamachan Hill (Graham) and Green Lowther (Graham);
- Garden and Designed Landscapes (GDL): Dumfries House GDL, Blairquhan GDL, Kilkerran GDL, Rozelle (La Rochelle) GDL, Loudon Castle GDL and Carnell GDL;
- Culzean Castle and Culzean Country Park;
- Dundonald Castle;
- Andy Goldsworthy's Striding Arches on top of Benbrack, Colt Hill and Bail Hill;
- Mabie Farm Park;
- Mabie Forest;
- Loch Doon Castle;
- Afton Reservoir;
- Skeldon House;
- Bargany;
- Caprington Castle;
- Drumlanrig Castle;
- Maxwelton (Glencairn Castle);

- Scot's Mining Company House;
- Lanfine;
- Burns National Heritage Park;
- Sanquhar Castle ruin;
- Clatteringshaws Visitor Centre;
- Glentrool Visitor Centre; and
- Golf Courses: Patna Golf Course (Doon Valley Golf Course), Royal Troon Golf Course, Turnberry Golf Resort, Roodlea Golf Course, Sanquhar Golf Course, Muirkirk Golf Course;, Leadhills Golf Course, Thornhill Golf Course, Woodhead Mine; and New Galloway Golf Course.

1.1.1 Owing to a lack of theoretical visibility or due to considerable intervening distances, these receptors would not experience significant landscape or visual effects from the Proposed Development (see Chapter 9 – LVIA for full details). Locations for sports such as quad biking and other recreational / tourist destinations where the focus of activity is indoors, for example museums (including the Dick Institute Museum in Kilmarnock and the Robert Burns Birthplace Museum), would also not experience significant visual effects. Consequently there is no possibility that any of these receptors could experience significant effects in terms of visitor attractiveness and tourism. On this basis all of these receptors have been excluded from the visitor attractiveness and tourism assessments provided in Chapter 15 of the ES. In addition, the Camlarg (No.147) and Glaisnock (No.83) Garden and Designed Landscapes are not open to the public; as such they are not considered to represent tourist receptors and have been scoped out of the tourism and recreation assessment provided in Chapter 15 – Socioeconomics, tourism and recreation.

Appendix 15.B
Public Attitudes to Renewable Energy & Wind Farm Development

Appendix 15.B Public Attitudes to Renewable Energy & Wind Farm Development

Introduction

1.1.1 This appendix supports Chapter 15 of the ES by providing an overview of surveys, polls and research regarding public and tourist attitudes towards the deployment of renewable energy technologies including wind farms.

1.1.2 A number of studies have been consulted to gather information on public attitudes towards wind farm development and in particular the potential effects of wind farm development on tourism. The following surveys and research studies have been reviewed as part of this assessment:

- DECC (August 2014) Public attitudes tracking survey: wave 10 - headline findings. Available at: https://www.gov.uk/government/statistics/public-attitudes-tracking-survey-wave-10;
- ComRes (August 2014) REG Windpower – On-shore Wind Public Survey. Available at: http://www.comres.co.uk/polls/REG_Windpower_Onshore_Wind_Public_Poll_Summer_2014.pdf;
- ComRes (July 2014) RenewableUK – Renewable Energy Survey. Available at: http://www.comres.co.uk/poll/1227/renewableuk-onshore-wind-poll.htm;
- YouGov (February 2013) YouGov/Scottish Renewables Survey Results. http://d25d2506sfb94s.cloudfront.net/cumulus_uploads/document/vj66wakgzm/YG-Scottish-Renewables-Archive-results-260213-renewable-energy.pdf;
- MORI. (April 2013) Renewable UK Wind Power omnibus research. http://www.ipsos-mori.com/Assets/Docs/Polls/renewable-uk-wind-power-topline-april.pdf;
- Demski, C., Spence, A. and Pidgeon, N. (2013) Transforming the UK Energy System: Public Values, Attitudes and Acceptability – Summary findings of a survey conducted August 2012. (UKERC: London). Available at: http://www.ukerc.ac.uk/support/tiki-download_file.php?fileId=3088;
- MORI. (September 2002) Tourist Attitudes towards Wind Farms. British Wind Energy Association and Scottish Renewable Forum;
- Moffat Centre. (March 2008) The Economic Impacts of Wind Farms on Scottish Tourism: A Report for the Scottish Government. Glasgow Caledonian University; and
- Visit Scotland. (2012) Wind Farm Consumer Research. Available at: http://www.visitscotland.org/pdf/Windfarm%20Consumer%20Research%20final_docUpdatedx.pdf.

1.1.3 This appendix is structured as follows:

1.1.4 Section 2 summarises recent polling and survey data regarding general public attitudes towards the deployment of renewable energy technologies, with a specific focus on attitudes towards onshore wind farm development.

1.1.5 Section 3 outlines recent surveys, polls and research regarding potential impacts from the construction and operation of onshore wind farms on tourism interests.

Section 2: Public Attitudes Towards Onshore Wind Farms

1.1.6 In early 2012 DECC set up a rolling tracking survey to monitor public attitudes regarding key departmental issues, including support for the deployment of renewable energy technologies. Surveys were conducted between 26th - 20th March 2014 (‘wave 9’) and 25th - 29th June 2014 using face-to-face in-home interviews with representative samples of 2,047 and 2,087 UK households respectively. The results from these surveys indicate that:

- 79% of people support the use of renewable energy sources to generate the UK's electricity, fuel and heat. This includes 26% of people who strongly support the deployment of renewable energy technologies. Just 4% of people oppose the deployment of renewables, including 1% of people who strongly oppose this.
- 70% of people agree that renewable energy industries and developments provide economic benefits to the UK, with 8% disagreeing.
- 59% of people would be happy to have a large scale renewable energy development in their area.
- 81% of people think that renewable energy developments should provide direct benefit to the communities in which they are located.
- 67% of people support the deployment of onshore wind farms whilst 11% of people oppose this. 18% of people strongly support the deployment of onshore wind farms whilst 3% of people strongly oppose this.

Polling Evidence

1.1.7 Relevant polling evidence is summarised below:

- A poll published on 18th August 2014 of 4051 people (conducted in July 2014) by ComRes found that 62% of all Britons and 55% of those living in rural areas would be happy to have an onshore wind development in their local area. 32% of rural dwelling Britons said they would oppose local onshore wind developments.
- Another poll (2065 people) conducted by ComRess in June 2014 on behalf of Renewable UK found that 48% of people consider the deployment of renewable energy as the number one priority to ensure the UK's future energy supply.
- In February 2013 YouGov conducted a survey for Scottish Renewables which revealed that 64% of the 1,003 people questioned across Scotland support the continued development of wind power as part of a mix of renewable and conventional forms of electricity generation. 62% of respondents stated that they would be "*generally for*" the development of large-scale wind farm projects being built in their local authority area, with 20% of people "*generally against*" such development. Furthermore, 69% of respondents stated that generally speaking their decision to visit an area would not be affected by the presence of a wind farm, while 26% of respondents thought that this decision would be affected by the presence of a wind farm.
- The results of the 2013 YouGov poll accord with the findings from a UK-wide MORI poll of 1009 adults published in April 2012. This survey indicated that 66% of respondents were in favour of the use of wind power, with 28% "*strongly in favour*". One in twelve (8%) of those surveyed were opposed, with 3% indicating that they are "strongly opposed" to the use of wind power. When asked to judge the general acceptability of the landscape impacts of wind farms on a 1-10 scale (with 1 being completely unacceptable and 10 being completely acceptable) the most common response (20% of respondents) was 10. Only 6% of respondents stated that the landscape impacts of wind farms are completely unacceptable.
- As part of the Transforming the UK Energy System: Public Values, Attitudes and Acceptability study funded by the UK Energy Research Centre, Demski et al (2013) report the results from a survey of 2,441 people across the UK conducted in August 2012. Generally speaking, renewable energy technologies were highly favoured by a majority of the respondents, and 75% of respondents were "*very/mainly favourable*" towards the use of wind energy in the UK.

1.1.8 Overall these survey results indicate a high level of general public support for the deployment of renewable energy technologies, including onshore wind farms, across Scotland and the UK. It must be noted that this baseline position relates to the social acceptability of wind farms in general rather than specifically in relation to the Proposed Development.

Section 3: Research regarding the Impact of Onshore Wind Farms on Tourism

1.1.9 A number of studies have specifically considered the impact of wind farms on tourism and tourists' attitudes towards wind farm developments. Within the aforementioned 2013 You Gov poll for Scottish Renewables, 69% of respondents stated that generally speaking their decision to visit an area would not be affected by the presence of a wind farm, while 26% of respondents thought that this decision would be affected by the presence of a wind farm. These results accord with the findings of previous studies including Visit Scotland's Wind Farm Consumer Research (2012), which found that 80% of UK residents and 83% of Scottish residents surveyed stated that the presence of a wind farm would not affect their decision about where to visit or stay on a UK holiday or short break.

The Moffat Report

1.1.10 In 2007 the Scottish Government commissioned Caledonian University to undertake a study to assess whether the Scottish Government's support for wind farms under its renewable energy targets would be likely to have an economic impact, positive or negative, on the Scottish tourism industry. The study conducted an intercept survey with 380 tourists, asking their opinion of eleven different types of structures in the landscape, in order to determine the associated effect on tourism. The research also involved a literature review of over 40 other studies considering the impact on tourism from wind farms in the UK, Ireland, and other countries with similar landscape characteristics to Scotland. In addition an internet survey of 700 people from both the UK and USA who had been, or were likely to go, to Scotland in the near future was carried out. The results from these research methods are detailed in 'the Moffat Report', which was published by the Moffat Centre for Travel and Tourism Business Development at Caledonian University in 2008.

1.1.11 The Moffat Report indicates that 39% of survey respondents felt that wind farms had a positive impact on the landscape, 36% had no opinion and 25% thought that wind farms had a negative impact on the landscape. The findings also show that tourist's attitudes were more negative towards pylons (49% of those surveyed), mobile telephone masts (36% of those surveyed) and power stations (26% of those surveyed) than wind turbines (25% of those surveyed). It should also be noted that overseas visitors showed a more positive attitude towards wind farms. In terms of the online survey, the results from this indicate that the youngest respondents (ages 16-25) in general thought that wind farms have less of an impact than potential visitors in other age ranges.

1.1.12 The Moffat Report further confirms that over 90% of those surveyed who have seen a wind farm stated that the experience would have no effect on their likelihood of returning to the location/Scotland, and for some it would increase the likelihood of return (Moffat Centre - Caledonian University, 2008). This confirms results of previous attitude surveys including MORI's Tourist Attitudes Towards Wind Farms (2002), where the results showed that 91% would visit the area again regardless of wind farms being located there (MORI, 2002).

1.1.13 Overall the findings of the Moffat Report demonstrate that the negative impact of wind farms on tourism at the national level is relatively minor and that the associated negative impact on employment numbers is less than the employment directly generated by the wind power industry. The study recommends that planning authorities seek the advice of local tourist agencies and consider the potential impacts on tourism "*where tourism is an important part of the local economy*". Consideration of the following topics is suggested: tourist numbers and routes; scale of tourism within the area; views from accommodation; positives associated with the development; and views of local tourist boards. The socio-economic, tourism and recreation assessment detailed in Chapter 15 of the ES responds to the recommendations within the Moffat Report by considering potential effects on tourism accommodation and assessing in detail the predicted effects of the Proposed Development on tourism and recreational receptors during the construction, operational and decommissioning phases.

Other Studies

1.1.14 Previous studies confirm that the Scottish tourism industry relies heavily on the countryside and landscape and the attraction this holds to tourists, with over 80% of those surveyed stating it as their 'main' reason for visiting (MORI, 2002). However, the results from a relatively recent Visit Scotland survey suggest that British tourists do not feel that wind farms spoil the look of the countryside, and the majority felt that wind farms do not currently ruin the tourism experience (Visit Scotland, 2012).

1.1.15 The 2002 MORI study also showed that 80% indicated they would be interested in visiting a wind farm if open to the public and with a visitor centre, with 54% 'very interested' in doing this. It should be noted that the visitor centre at Whitelee Wind Farm near Glasgow, which is managed by the Glasgow Science Centre, attracted over 120,000 visitors in its first 12 months after opening in September 2009 and by the summer of 2012 the visitors centre had attracted over 250,000 visitors. In addition it is estimated that to date least a further 100,000 people have directly accessed the wind farm's 90km of trails for recreational purposes such as jogging and cycling. In recognition of the fact that Whitelee Wind Farm has become an important tourist destination ScottishPower Renewables announced on 20th June 2012 that the wind farm would become the first wind energy project in Scotland to join the Association of Scottish Visitor Attractions (ScottishPower Renewables, 2013).

Conclusion

1.1.16 Overall, a review of studies and surveys suggests that whilst there are clearly different views on wind farms, there is no conclusive data that demonstrates tourism is generally adversely affected by wind farm developments. Indeed, in the final report of its inquiry into the achievability of the Scottish Government's 2020 renewable energy targets the Scottish Parliament's Economy, Energy and Tourism Committee concluded that "*no witness has provided the Committee with robust, empirical evidence, as opposed to anecdotal comment and opinion, that tourism is being negatively affected by the development of renewable projects*" (Scottish Parliament, 2012: 8). Nevertheless, it is necessary to consider the associated impacts of wind energy development on tourism and wider recreational activities as a result of impacts upon landscape and visual amenity. Potential effects on tourism and recreational activities and receptors are therefore considered in Sections 15.7-15.10 within chapter 15 of the ES.

Appendix 15.C
Assessment of Potential Effects on Galloway Dark Sky Park

The Impact of Infrared Aviation Warning Lights at the Proposed Enoch Hill Wind Farm on Galloway Dark Sky Park

Dr Stuart Lumsden

School of Physics and Astronomy

University of Leeds

(s.l.lumsden@leeds.ac.uk; 0113-343-6691)

Summary: This document considers the impact of military aviation lighting mounted on the wind turbines proposed by E.ON at the proposed Enoch Hill Wind Farm in East Ayrshire. The 19 turbines proposed will require aviation warning lights to satisfy MOD requirements. The MOD allow for the use of infrared LED military aviation warning lights where the total wind turbine height is less than 150m. Enoch Hill lies approximately 6 miles at closest approach from the boundary of the Galloway Forest Dark Sky Park, which has been awarded Gold Tier Status by the International Dark Skies Association. It similarly lies about 6 miles ENE from the Scottish Dark Sky Observatory. This report considers the direct and scattered light, from both the proposed aviation lights and other sources, which will be seen from the Dark Sky Park and the Scottish Dark Sky Observatory. Images are taken around the region to demonstrate the full effect expected using in-situ infrared lighting installed on meteorological masts.

The final conclusion is that there is no effect from the proposed aviation lights on the Gold Tier status of the Dark Sky Park as a whole. The Scottish Dark Sky Observatory will not be significantly affected for the main purpose of their work, namely facilitating viewing of the night sky for visitors and amateur astronomers. The direct line of sight to all but one of the lights is blocked by local topography. No quantitative astronomy is carried out within the first few degrees of the horizon because of the increased atmospheric opacity, so even the one remaining light lies outside a region that would normally be observed. There may be some minor impact on the general amenity for amateur astronomy from other locations within the Galloway Forest Park, but only for those possessing suitable equipment able to detect infrared radiation, and only from locations that are not designated as main viewing sites within the Park (mostly well away from any roads). Most night-time visitors to the Park would in general lack suitable detecting equipment, and therefore would not notice the infrared lights from any viewpoint. They would still experience the full benefit of the Dark Sky Park. Mitigation measures are discussed that would lower the already small impact even further, especially during the construction phase.

The Author: Stuart Lumsden is an Associate Professor in the School of Physics and Astronomy at the University of Leeds. He is an experienced observational astronomer at wavelengths including the infrared and optical. He has experience of the design of astronomical instruments for the infrared in particular, and worked for the Anglo-Australian Observatory (AAO: now called the Australian Astronomical Observatory) for six years. The AAO is a 4m telescope, and is the premier optical/infrared facility in Australia located at Siding Spring Mountain. He has experience with Charge Coupled Device-like (CCD) detector technology at both optical and infrared wavelengths, and is also experienced with photography using both film and digital cameras and the detectors used therein (and even has his own infrared digital camera). He is familiar with the criteria used by professional astronomers when seeking sites for new observing facilities, as well as those stated in Appendix A intended for the use of amateur observers in characterising their sites.

1. Background

Galloway Forest Park was awarded status as a Dark Sky Park by the International Dark Skies Association (IDA) on 16th November 2009 for an initial area wholly within the Galloway Forest Park. The boundary was subsequently extended to land to the north and east of the initial boundary, including an area outside Galloway Forest Park on 5th October 2012. This extension includes the new Scottish Dark Sky Observatory (SDSO) on the Craigengillan Estate, and runs as far north as the B741 Dalmellington-Straiton road. Currently the Dark Sky Park holds Gold Tier status, the highest available. Dumfries and Galloway, South and East Ayrshire Councils, as well as Forestry Commission Scotland, have been active in heavily promoting the Dark Sky Park and its Gold Tier status as a draw for tourists interested in astronomy (e.g. www.forestry.gov.uk/darkskygalloway).

In addition to restrictions on new lighting in developments within the Dark Sky Park, any development up to 10 miles from its boundary, or, if lesser, up to the edge of the nearest built-up area, also has to satisfy stringent conditions. The proposed Enoch Hill Wind Farm lies within 10 miles of the boundary in a direction where there is no substantial existing development between the boundary and the wind farm site, and is therefore subject to these lighting controls.

The MOD require that wind farm turbines are lit wherever low level flying may be present. However they allow infrared LEDs to be used if the total height of the wind turbine, from base to blade tip, is less than 150m. The infrared LEDs used are invisible to the naked eye but can be seen with night vision goggles, as used by MOD pilots.

This paper considers the impact of the proposed Enoch Hill Wind Farm on the Gold Tier status of the Dark Sky Park, and on the amateur astronomy and related tourism that the Dark Sky Park hopes to encourage, as well on the SDSO. In addition, it considers the cumulative impact that the proposed Enoch Hill Wind Farm will have if approved on top of other approved or proposed wind farms in the region.

The issue of the impact of Dersalloch Wind Farm on the Observatory was considered previously by myself, and independently by Professor Graham Woan, on behalf of South Ayrshire Council. The Scottish Government largely accepted the arguments laid out by myself and Professor Woan regarding the impact on astronomy in their reasons for approval. This advice now also appears to be officially accepted by all three councils that span the Dark Sky Park. The proposed Supplementary Guidance to the Local Development Plan from Dumfries and Galloway Council on "Dark Sky Park Friendly Lighting" contains in Appendix 1a conditions relating to windfarms, which states the use of infrared lighting at the highest practical point as being an example condition that would be placed if planning approval is granted. The same document notes that the guidance was prepared in collaboration with East Ayrshire Council, South Ayrshire Council and the Forestry Commission as the other statutory bodies with an interest in the Dark Sky Park.

This document will recap some of those previous arguments, but also presents direct evidence for the minimal impact that infrared wind farm lighting will have. The other planned or consented developments are briefly summarised in Section 2. The existing situation and regulations for the Dark Sky Park will be summarised first in Section 3, together with images obtained by the author to demonstrate the visible light pollution already present. This is followed by an analysis of the impact of infrared lights on amateur astronomy in Section 4, including images taken by the author in the infrared. Finally, in Section 5 the visibility of the proposed Enoch Hill Wind Farm, and the issue of diffuse infrared light in the wider area will be considered.

2. Approved and Planned Projects in this Region, and their Geographical Context

Dersalloch Wind Farm was approved in 2014. Dersalloch lies directly west of the SDSO, in the opposite direction to Enoch Hill. In addition, there are proposals for other developments at Keirs Hill (just north of Dersalloch: RES), South Kyle (just west of Enoch Hill: Vattenfall), Glenmount (south of the SDSO: RWE) and Benbrack (south east of SDSO; also E.ON) currently within the planning process. Slightly more distant consented windfarms lie at Windy Standard (RWE/Fred Olsen Renewables) and Windy Standard II (Fred Olsen Renewables: both lie approximately south of Enoch Hill), and there are also proposals for a further development at Windy Standard, part of which would lie just east of Benbrack, and also at Quantans Hill by E.ON, Shepherd's Rig (Infinergy) and Longburn (Burcote Wind) all of which are near Carsphairn. Of these, South Kyle, Benbrack and Windy Standard lie within a continuous 45^o arc as viewed from the SDSO. These comprise 50 turbines and 18 turbines of height 149.5m proposed for South Kyle and of 130m for Benbrack, 36 turbines of height 53.5m at Windy Standard, 18 turbines of height 120m and 12 turbines of height 100m at Windy Standard II, with up to a further 25 of height 100-150m at the proposed Windy Standard III extension. There is some degree of visibility from the SDSO of turbines at South Kyle, Benbrack and Windy Standard III.

The arc between Enoch Hill and Windy Standard III as viewed from the SDSO faces in the direction between the settlements of New Cumnock and Sanquhar. Enoch Hill in particular lies on the same line of sight as New Cumnock.

3. Overview of the IDA Guidelines on Light Sources, and Actual Practice in-situ

The Galloway Forest Dark Sky Park as proposed by Forestry Commission Scotland is composed of two zones, namely a Core and Buffer Zone. The award of status was largely dependent on the conditions within the Core Zone, but both regions are an integral part of the Dark Sky Park. The full conditions can be found in the documents attached in Appendix F, but Appendix A summarises the positions with regard to the award of status, and Appendix B provides an overview of the relevant lighting regulations. A brief overview of these regulations can be summarised as:

- *optical* lighting does not provide a distracting glare;
- diffuse scattered light is only visible on the sky near the horizon, with less than 10% increase in sky brightness at an angle 45 degrees above the horizon;
- any clouds overhead appear dark rather than bright due to reflected light;
- the site has a Bortle sky class within the range 1-3 (see Appendix A for details); and
- and new developments within the Buffer Zone of the Park, or external to it up to either ten miles distance, or the nearest built-up area if closer, should not have any new lighting that emits above the horizontal plane, and no new external lighting will be allowed in the Core Zone.

The original IDA specifications for a dark sky site are specified in terms of allowed intensity of visible light (as measured in lumens). The lumen is a unit which relates to visible light output as perceived by the human eye, which lies roughly between the wavelengths of 400 nanometres (nm) and 720nm (these are the approximate wavelengths where the eye's response drops to less than 0.1% of its peak response - by 850nm the human eye essentially has no response). Purely infrared lighting, which is invisible to the naked eye, typically refers to light emitted between 720nm and 1000nm.

As an example, a glass filter designed to transmit light at 800nm and beyond would appear black and opaque to our eyes - it is however completely transparent to these infrared wavelengths. A purely infrared lamp, *regardless of its power output,* by definition emits zero lumens. Therefore, the proposed infrared LEDs do not alter any of the conditions required and already achieved for Gold Tier Status, though care should be taken to minimise the visibility even of infrared lights to those in designated Dark Sky Park viewing areas or at the SDSO.

It is possible to examine the existing pattern of light pollution from night-time images acquired within and around the Dark Sky Park. These images were acquired on the night of 18 April 2014 from two locations (listed with grid references in Appendix G). Figure 1 shows a map of the region with the two marked viewing locations. These were chosen for convenience of access, and visibility of the existing Enoch Hill meteorological masts. Both masts have exactly the same infrared light source as a turbine would have, at the same height above local ground level. Individually they therefore act as a good test of the effect that will be seen from any lit turbine in the wind farm. In addition to the two Enoch Hill masts, location 1 also gives a view of one of the existing Benbrack masts, as well as the one that was installed at the Big Hill of Glenmount at that time (since removed). All four masts are marked on the map.

Figure 2 shows visual images taken from location 1 (on the Straiton-Newton Stewart Road) on the northern edge of the Core Zone. These are taken with a Canon EOS-6D, an ordinary digital SLR camera, insensitive to infrared light. It is clear the northern horizon is very poor with regard to stray light, and the Buffer Zone of the Park there suffers as a result (note this is where the SDSO is). There is also evidence even on northern edge of the Core Zone that clouds overhead are weakly illuminated by distant diffuse lighting. These images show clearly what any typical visitor would be able to see themselves. By contrast, the infrared lighting requires specialist equipment to see – for this report a modified Canon EOS-600D was used, that had been made sensitive to *only* infrared light (see Appendix E).

The rest of the Galloway Forest Park, especially in most of the Core Zone, has more limited light pollution. This is particularly true of its Southern edge, and more specifically those regions identified by the Forestry Commission Scotland as good viewing locations near the car parking facilities within the Galloway Forest Park, which generally are better shielded from the worst areas of light pollution in the north, as well as from the poor areas in the south around Dumfries and Stranraer. This can be seen from Figure 3, which is a summed set of images taken by the SUOMI NPP satellite.

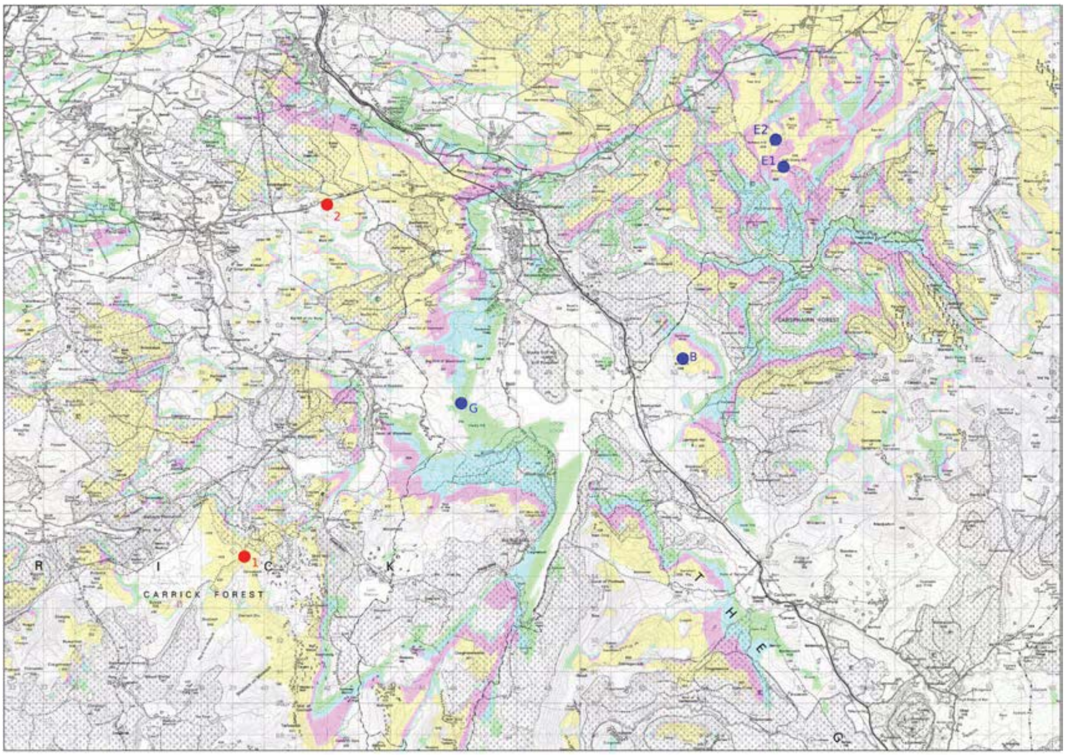


Figure 1: Extract from OS Landranger map showing the locations of the met mast at Benbrack, Glenmount and both those at Enoch Hill (blue dots labelled B, G, E1 and E2 respectively), and the two locations where the images were acquired (red dots). The locations are numbered in the chronological order in which the pictures were taken. Actual grid references are given in Appendix G. The colour shadings represent the Zone of Theoretical Visibility of the turbines at the wind farm, as discussed in more detail in Section 4. (Based upon the Ordnance Survey Landranger map 77 with permission of the controller of Her Majesty's Stationery Office, © Crown Copyright 100001776).

.

Figure 2: Normal visible images acquired from location 1 on the northern edge of the Core Zone. These face approximately NE (upper, file 1612) and SW (lower, file 1605). There is considerable light pollution present in both of these (Ayr, Dalmellington, Cumnock and New Cumnock in 1612, Stranraer and Cairnryan in 1605). Note the underlit cloud in file 1612 that extended almost overhead in this location (and was visible to the naked eye as well).

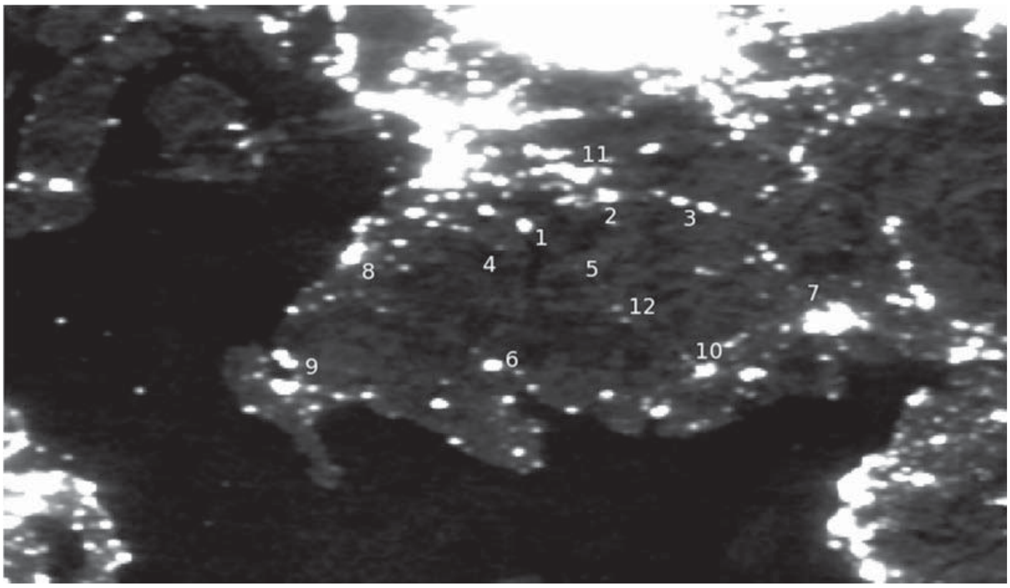


Figure 3: Suomi NPP VIIRS Day-Night Band image of SW Scotland, courtesy of the Earth Observation Group, NOAA National Geophysical Data Center. The DNB is sensitive between 500 and 900nm, and scans each portion of the globe twice a day. The image shown here is the product of multiple clear nights summed together. Seven separate observations acquired between 14/3/2015 and 10/4/2015 were used. The features marked are: 1 – Dalmellington/Bellsbank; 2 – New Cumnock; 3 – Sanquhar and Kirkconnel; 4 – Loch Bradan water works; 5 – Carsphairn; 6 – Newton Stewart; 7 – Dumfries; 8 -Girvan; 9 – Stranraer; 10 – Castle Douglas; 11 – Cumnock. Also clearly visible are the lights of Ayr, Irvine and Kilmarnock which merge into a continuous sequence on the coast, the central belt, and Belfast. No existing wind farm is visible in these images.

3. MOD Approved Infrared Lighting

3.1 Detectability of Infrared Lighting by a Casual Observer

The suggested military aviation lights for the proposed Enoch Hill Wind Farm are wholly infrared devices, with output peaking at 850nm, and effectively no emission shortwards of about 750nm. A detailed data sheet for the most commonly used approved device is made available in Appendix C, as are the specifications as laid out by the MOD for such lighting. The MOD has indicated it wishes all turbines to be lit.

These LEDs are invisible to the human eye, and as such emit zero lumens. The emitted wavelengths of the infrared LEDs are simply beyond the range of detectability of the human eye, and therefore the infrared LEDs have absolutely no impact on "naked eye" astronomy, whether unaided or through a telescope (see Figure E2, which demonstrates the approximate wavelength dependence of the human eye). The author's personal experience of photographing infrared lights around Galloway is in absolute agreement with this (e.g. the Benbrack and Glenmount lights were completely invisible to the naked eye at a distance of about one mile). Instead, it is the considerable optical lighting around the region that distracts, as summed up in Section 2.

As Figure 5 also shows, current generation digital cameras are also insensitive to the infrared lighting. Generally, modern digital cameras have a cut-off filter around 650nm which blocks all light with a longer wavelength than this. Different wavelengths of light come to a focus in the camera at slightly different points unless this is corrected for (chromatic aberration). For normal cameras the difference between minimum and maximum wavelength passed is about 50%, and the optics required to bring both ends of the range close to focus are relatively trivial. By comparison, for a full optical-infrared camera this difference is about 150% and the optics required to fully correct for the effect are complex and expensive. The filter stops the out of focus images by restricting the wavelength range. All digital cameras can be modified at cost (typically £250) by specialist dealers to create a camera capable of detecting infrared light. These vary from those that extend the range to 700nm whilst still being viable as a normal daytime camera as well, to those that have the filter completely removed, to those that have a new filter installed (see Appendix E) in order to only record infrared light. The former are commonly used in astrophotography, where the region between 650nm and 700nm is good for imaging the regions around young stars (this corresponds to an astronomical *R*-band filter). The amount of light from the LED that is emitted below 700nm is very much less than 1%, which reduces the impact of the lights to effectively zero. Cameras that have been modified to full infrared use can see the lights as Figures 4 and 5 show. However they are not generally used for astronomy, due to the focus issues raised earlier for those without any filter, and to the reduced sensitivity for those with an infrared long-pass filter installed (Appendix E).

In what follows therefore we consider only two cases, that an observer has either a telescope or camera with an infrared sensitive detector. Appendix C outlines how bright we might expect the infrared lights to be. In the rest of this document, and the calculations presented, I will assume a very conservative worst case scenario of 0.5W per turbine.

3.2 Observations with a Telescope and CCD, or Full Infrared-modified Camera

Amateur astronomers also use small, purpose designed, telescopes for their observations. If the telescope is used with an astronomical Charge Coupled Device (CCD) detector, as many now are, it is actually capable of detecting light in the 350nm to 950nm range without any modifications. These images can then be saved digitally and viewed on a computer. However the most common use by amateur astronomers still involves observations of the visible wavelength range from 400nm to 700nm, through the use of so called *RGB*+luminance filters (red, green, blue, and one covering the whole visible range). Since these filters lie in the same 400nm to 700nm wavelength range that can be seen by the human eye, they transmit none of the light from the LEDs. The astronomical *I* band spans the wavelength range that the infrared LEDs emit in, between about 750nm and 900nm. To date, amateur use of the *I*-band is relatively rare, partly for historical reasons (standard photographic film, the traditional recording medium, is not particularly sensitive at this wavelength) and partly because *I*-band observations are more challenging due to the intrinsically brighter natural night sky. Telescopes have a relatively small field of view (to maximise the angular resolution), typically about 1 degree maximum. Therefore the infrared LEDs could be detected using a normal telescope but only ***if*** it was fitted with a CCD detector ***and if*** the telescope was pointed almost ***directly*** at them.

Figure 4: infrared images of the infrared lights on the Glenmount, Benbrack and Enoch Hill meteorological masts. These are taken from location 1 (files 500 and 502). The direction is similar to that shown in Figure 2 (upper). There are small changes in the size of the field of view between the images here and in Figure 2 due to the nature of the cameras and lenses used. The “colour” of these images should be ignored, as the camera intrinsically is more sensitive to infrared light in its nominal blue channel (see Appendix E). Glenmount is the brightest of the lights (also by far the nearest); the Enoch Hill lights lie just above it, and the Benbrack light is on the far right of both images. The apparent brightness of the Benbrack and Enoch Hill lights is somewhat less than the conservative estimate from first principles by about a factor of 2, suggesting that the lights are even more directional than the analysis assumes. The upper image covers the full infrared (560nm-950nm), whereas the lower image covers the more restricted range passed by a B+W 093 filter (830-950nm). Diffuse light pollution is less at the longer wavelengths as expected, but is still present as the illumination of the cloud on the left hand edge of the image shows.

Figure 5 (a): infrared images of the infrared lights on the Enoch Hill meteorological masts taken from the B741 near Gass (location 2: files 509,504). The lower infrared image is taken with the B+W 093 filter, to enhance longer wavelengths. Dalmellington lies just right of the line of the road, and Bellsbank further right (the two obvious low glows in the visual image Figure 5(b)). New Cumnock is more distant and lies just left of the line of the road. The glow present on the left edge of the visual picture is due to Cumnock and surrounds. Note how the clouds are less obvious in the upper right image (since Rayleigh scattering is less important at these wavelengths), but the sky is still brighter along the horizon – this is partly due to diffuse emission from towns, but primarily from the bright atmospheric hydroxyl line emission discussed in Section 4.2.

Figure 5 (b): visual images of the infrared lights on the Enoch Hill meteorological masts taken from the B741 near Gass (location 2: file 1633). Dalmellington lies just right of the line of the road, and Bellsbank further right (the two obvious low glows in this image). New Cumnock is more distant and lies just left of the line of the road. The glow present on the left edge of the visual picture is due to Cumnock and surrounds.

Consider the conservative 0.5W detectable power output from the infrared LED on a single turbine. The typical turbine distance from the SDSO is ~6 miles. This means the flux seen is approximately $4x10^{-9}$ W/m^2 (adopting the fact that the light seen only illuminates ~1.2sr). Appendix C shows the characteristics of the LED. It emits approximately in a bandpass 100nm wide, so will not be detected by a detector that cuts off below 800nm. By comparison a bright star will emit across the whole range from 700 to 1000nm. For example a star with an astronomical *I*-band magnitude of *I*=0 has a total flux in the same band of approximately $4x10^{-9}$ W/m^2. Comparing the two gives an equivalent *I* magnitude for the light at this distance of *I*=0. The actual measured brightness from the images shown is about a factor of two less than this relatively simple analysis suggests. Clearly, if one of the lights were to be seen by the observatory in the infrared it would be an obvious source. However, these lights will lie on the horizon (eg Figures 4 and 5, and the discussion in Section 4). A telescope has a relatively small field of view as noted above. The camera images shown in this report span a much larger angular scale on the sky than a telescope would for example. There is therefore little reason to ever have one of the infrared lights in the field of view given the low elevation of the light. For the same reason, it is highly unlikely anyone would point the telescopes of the SDSO at other nearby static direct light sources.

An additional major source of intermittent infrared light pollution around the boundaries of the Dark Sky Park is car headlights. Professional observatories preclude the use of full beam headlamps for this very reason. It is not feasible that this is a condition that can be imposed on the public roads around Galloway Forest Park. The main A713 is mostly blocked from view at the SDSO. However, the access road to Loch Doon, which comes within 300m of the SDSO, is in direct line of sight. Car halogen lights emit significantly in the infrared. This road is on approximately the same line of sight as that to Enoch Hill.

The SDSO are keen to extend their current activities (in outreach and education) into supported research. Although the UK research council responsible for astronomy would not fund such an activity, there are areas of astronomy, including the study of bright variable stars, and exoplanet research, which are sponsored by private foundations overseas (and indeed even individuals). Care must be taken therefore not to compromise such opportunities, since such observations may be carried out in the infrared in the future. However the low elevation of any of the lights, where the atmosphere is almost opaque, mitigates against serious effects in this regard. Professional observations would never be made this close to the horizon simply because of the degradation in image quality and brightness due to the long path through the atmosphere that the light is passing.

4. Geographic Visibility of the Proposed Enoch Hill Wind Farm

4.1 Direct Light

An analysis based on gross landscape contours from Ordinance Survey data reveals that only one of the proposed Enoch Hill Wind Farm turbines is expected to directly visible from the SDSO (assuming the main 20 inch telescope is mounted 8m above local ground level), due to the topology of the intervening ground. This is illustrated by the wireframe given in Figure 6, where only one hub lies above the horizon. Local irregularities on scales less than the OS mapping information may mean that the actual number is slightly less or more than this. Only one other turbine however is close to visible.

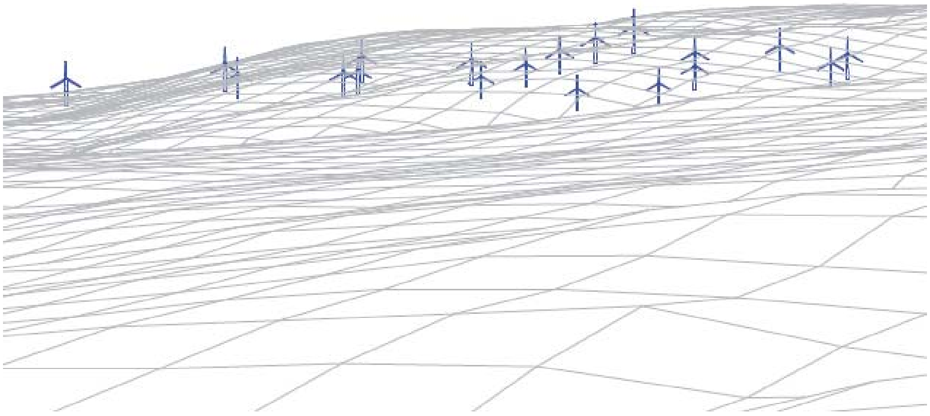


Figure 6: wireline from the perspective of the SDSO looking towards the proposed Enoch Hill Wind Farm. Only the most northerly turbine head is directly visible, and only one other is close enough that insensitivity to the “micro-topology” in OS data could mean that it is visible.

Enoch Hill is also partially visible from other parts of the Dark Sky Park as illustrated by Figure 1, where the Zone of Theoretical visibility for the wind farm is indicated by the colour scale (green represents up to 4 blade tips, blue 5 to 9, pink 10 to 14 and yellow 15 to 19). Note these are the tips of the blades rather than the hubs where the lights sit. The visibility of the lights will be less. Of particular interest are those car parks marked by the Forestry Commission Scotland as possible good viewing sites. Only the site at the southern end of Loch Doon has any visibility, and then very partial and likely to be of the blade tips only. The lights on the current meteorological masts are not visible from this location. Other areas will have visibility of the turbines and hence the lights but these tend to lie at high elevation. The only public vehicular access to such a location lies along the section of the Straiton-Newton Stewart road marked as location 1, where some of the images presented in this report were acquired.

4.2 Diffuse and Scattered Light

The major cause of most light pollution is not from being able to see a light directly, since the lights are all very low on the horizon. Instead, diffuse and scattered light can be a concern. This takes two forms: scattered light that creates a diffuse glow in the atmosphere well above the horizon; and scattered light from reflective surfaces near an observatory itself. Suitable baffling at the SDSO site should already be in place to minimise the latter for the permanently mounted telescopes, which are the ones most likely to be used for infrared observations. Therefore scattered light from reflective surfaces is discounted, and only those sources that can create a diffuse glow are considered. A full discussion of the analysis is given in Appendix D. A non-technical summary is given here.

There are two sources of particles that can scatter light, the normal molecules that make up the air we breathe, and the much larger molecules classed as aerosols. The latter include sources such as smoke, complex organic compounds such as pollen, water droplets etc. Scattering by aerosols (known as Mie scattering) is much more efficient in the red and infrared part of the spectrum when compared to the

Rayleigh scattering from single molecules (which gives rise to the blue colour of the daytime sky) by about a factor of 5-6. This is important since scattering of light from aerosols is generally seen preferentially in the forward and backwards direction. An example that may be more familiar to people is where a diffuse ring of light can appear round the sun, especially on partially cloudy days - the thin cloud acts as an aerosol. Therefore scattered light is visible largely around the direction of the light source, typically up to angles of 30 degrees away.

Finally at 850nm, the “dark sky” is not actually fully black even at a very good professional astronomical site such as those in the deserts of Chile. The night sky has a characteristic airglow, largely due to excitation of OH (hydroxyl) molecules in the upper atmosphere that emit strongly at all wavelengths from 800nm to 2000nm. This glow is evident in the longest wavelength infrared image shown in Figure 5. The glow tends to peak towards the horizon since the strength is determined by the length of path through the atmosphere which is greater at that elevation.

A significant fraction of distant urban “glow” actually occurs from downwards pointed lights reflected back from the ground, and not just from upwards pointing lights. The infrared LEDs at Enoch Hill are shielded and will emit only in the narrow range of angles between –15 degrees and +30 degrees from the horizontal. This also considerably reduces the glow, and essentially reduces any “light dome” effect present. The calculated sky brightness for all parts of the sky due to scattered light from the turbine LEDs lies more than a factor of 10 below the natural sky brightness in the I-band (750nm-900nm) at any distance between 2 and 20 miles from the wind farm. This is entirely consistent with the images presented in this report. There is absolutely no evidence seen for light domes around the existing meteorological mast in any of the images taken for this report (e.g. the images in Figures 4 and 5).

The detectable diffuse light at low elevations as evidenced from the images is dominated by the combined emission from surrounding towns and the intrinsic night sky airglow. The same analysis as used for the infrared lights can be applied to the towns as well. The model predicts significant scattered light from Ayr for example up to at least 20 degrees above the horizon, which is seen. This provides confidence in the analysis that the scattered light from the wind farm will not be seen. Even scattered light from a small village such as Carsphairn, just visible on the satellite image shown in Figure 3 (unlike any infrared lights in the region), is predicted to drop below the level of the natural sky background, again in agreement with the actual images acquired by the author. Figure 5 (image 504) shows for example that both Dalmellington and Bellsbank have little easily detectable diffuse emission at the longest wavelengths (note Cumnock lies off the edge of this image – it would otherwise be predicted to have a detectable diffuse emission).

4.3 Lighting from Construction and Other Site Activities

Two other aspects of light pollution require discussion. The completed wind farm will also contain ancillary buildings with lighting and security lighting. In addition, since construction will take place in part during winter-time, lighting will be required during that phase which must also be considered.

The first of these is relatively straightforward. Any on-site buildings will be well below the local horizon, given the tips of the turbines are only just visible. Despite this I would recommend that any lighting used should satisfy the E1 lighting standard described in Appendix B. That will ensure that any light pollution from the site as a whole is absolutely minimised. Building lights can be managed relatively straightforwardly under this restriction. Security lights could also utilise infrared technology, to even further minimise the impact, and should be shielded so that no light escapes above the horizontal.

The construction phase will be the main source of visible light pollution on the site. I would again recommend that as best practice, as far as practical within considerations of health and safety, this should conform to the E1 standard. Specifically lights should be shielded to not emit above the horizontal, and as far as possible should be located to illuminate in a direction facing away from the SDSO.

If these recommendations are followed the potential impact on the Dark Sky Park and the SDSO will be minimised.

5. Conclusions

The proposed infrared military aviation lights at the proposed Enoch Hill Wind Farm are unlikely to have a major impact on Galloway Forest Dark Sky Park. Visitors to the wider Galloway Forest Dark Sky Park would see them, from a few locations, as bright infrared light sources if suitably equipped with infrared cameras, but these are not traditionally used in astrophotography as outlined in Appendix E. In addition, for most of the part, the lights are actually below the local horizon. The areas in the park where all the lights are visible tend to be remote, and mostly relatively inaccessible high altitude sites which are unlikely to have night-time visitors. The main exception is the Straiton-Newton Stewart Road, as shown by Figure 4, but there are no designated parking areas on the section of the road where the lights are visible.

The proposed lights will not affect the Gold Tier status of the Park, since the lights are (i) infrared and (ii) allowed within the context of the regulations of the Dark Sky Association. Tourists passing through the area at night will not suffer any loss of amenity from the darkness of the sky in Galloway Forest Park and its surroundings, as they will not be able to see the lights.

Visitors to the SDSO will likely only see one of the military aviation lights directly as most of the turbine heads lie below the local horizon. No significant astronomy is carried out within the first few degrees of the horizon because of atmospheric opacity, so even the light which is visible is at worst a minor issue, especially when the small field of view of the telescopes is considered. The scattered light from Enoch Hill should also be below acceptable thresholds, as demonstrated by the photographs shown in this report, even if looking near the lights. The infrared LEDs will not be bright enough to have any impact whatsoever on observations when looking elsewhere in the night sky. I therefore conclude that the impact on the SDSO is also likely to be negligible.

The most significant impact that Enoch Hill could have on the local lighting environment is more likely to be during construction. The construction site will mostly be shielded from the Dark Sky Park and the SDSO by the existing forestry that surrounds the site on the west and southern flanks. Care should be taken to ensure that all works taking place outside daylight hours conform to the E1 lighting guidance in mitigation. In particular, all construction lighting should use shielded downwards pointing installations, and only limited lighting should be used at after twilight in winter if at all possible.

Appendix A – Dark Sky Parks

The International Dark Sky Association (IDA) *is a not-for-profit organisation whose mission statement "is to preserve and protect the nighttime environment and our heritage of dark skies through environmentally responsible outdoor lighting"*. As well as educational activities, it achieves this through the award of "Dark Sky Park" or "Dark Sky Reserve" status as part of its International Dark Sky Places Program. There are currently two Parks and two Reserves in the UK, with the parks in Galloway and Kielder having the highest Gold Tier status awarded. The primary aim is to allow the sky to be seen free from light pollution by anyone visiting these areas, but also to limit the impact on local wildlife of extensive external night-time lighting. The IDA do not regulate conditions around professional astronomical observatories in general – these tend to be controlled by specific government legislation instead. Indeed, in the UK, all the major optical research observatories now lie overseas, since other factors, such as lack of cloud, or how much the atmosphere distorts images (the "twinkling" seen in stars) are as crucial as light pollution. Generally to solve these problems the best professional sites nowadays lie at high altitude (above 7000 feet) in remote sub-tropical regions. For an *amateur* observatory, or a facility designed largely for tourism, the convenience of the site to its users is a primary factor. Therefore in this case the lack of light-pollution is a primary concern.

The International Dark Skies Association (IDA) publish criteria which optimise the conditions for the control of light pollution. They also award status to applicant organisations who show they can meet the stringent lighting conditions laid down, as well as having a site that is currently of sufficient quality in terms of sky darkness to be worth preserving.

The short version of the IDA criteria are:

(from http://www.darksky.org/night-sky-conservation/dark-sky-places/86-international-dark-sky-parks)

	Gold	**Silver**	**Bronze**
Artificial Light and Skyglow	Typical observer is not distracted by glary light sources. Light domes are only dim and restricted to sky close to horizon.	Point light sources and glary lights do not dominate nighttime scene. Light domes present around horizon bud do not stretch to zenith.	Areas with greater artificial light and skyglow than Silver, but where aspects of the natural sky are still visible.
Visual Limiting Magnitude	Equal or greater than 6.8 under clear skies and good seeing conditions	6.0 to 6.7 under clear skies and good conditions	5.0-5.9 under clear skies and good seeing conditions
Bortle Sky Class	1-3	3-5	5-6
Observable Sky Phenomena	The full array of visible sky phenomena can be viewed—e.g. aurora, airglow, Milky Way, zodiacal light, and faint meteors	Brighter sky phenomena can be regularly viewed, with fainter ones sometimes visible. Milky Way is visible in summer and winter.	Many sky phenomena cannot be seen. Milky Way is faintly seen when pointed out, as is Andromeda Galaxy.
Unihedron Sky Quality Meter	21.75 or above	21.00 or above	20.00 or above

Fuller details on these criteria can be found in the attachments of the original documents in Appendix C. Note these criteria are heavily skewed towards North America. It is hard because of our northern latitude to see the Milky Way in mid-summer for example. The basic principles however are sound.

These criteria, with the exception of the last, are highly subjective since they rely on the visual acuity of the observer. However the last is typically a measure of average sky brightness overhead, and hence does not measure light pollution well if it occupies only one horizon for example. The units used here are magnitudes per square arcseconds. Magnitudes are logarithmic units defined by

$$m = -2.5 \times \log_{10} (Flux) + constant$$

Hence an object which is magnitude 20 is 10^8 or 100,000,000 times fainter than an object which is magnitude 0, a typical value for the very brightest stars. Arcseconds are a measure of angular size on the sky – as an example, the planet Venus (the brightest evening or morning object apart from the Moon), extends across about 60 arcseconds when it is fully illuminated. These are difficult measurements to make, and should ideally be repeated many times on different nights, and always on a cloudless night. It also only measures the sky brightness in the visual range, since this is what the IDA uses to assess and re-assess the award of Dark Sky Park status. The specific device that must be used can be found at

http://unihedron.com/projects/sqm-l/

The meter is most sensitive to green light. It also has a blocking filter to exclude the infrared background. It has a beam diameter at half-power of 20 degrees. Therefore, even if used directly near the SDSO site and including the Enoch Hill Wind Farm LEDs in its field of view, it would not measure any additional excess. The proposed infrared lighting will have absolutely no effect on that measurement.

However, the easiest way for anyone to judge a site in a quick fashion is by examining the first, third and fourth criteria. The Bortle scale overlaps these to some extent. The original definition by John Bortle was published in Sky & Telescope magazine and the following is adapted from that:
(see http://www.skyandtelescope.com/resources/darksky/3304011.html?page=1&c=y):

Class 1: Excellent dark-sky site. The zodiacal light is visible, as is the galaxy M33, with the naked eye. The limiting magnitude is 7.6 to 8.0 without aid. Airglow around the horizon can be seen. Unlit features in your immediate vicinity should not be visible to you.

Class 2: Good dark site. As for class 1, though all astronomical objects are slightly harder to see. Clouds should appear black. The limiting naked-eye magnitude is as faint as 7.1 to 7.5.

Class 3: Rural sky. Light pollution may be present but only along the horizon. Clouds may appear illuminated near the horizon but are still black overhead. The typical objects seen in class 1 and 2 are still visible, though may require greater effort (especially M33). The naked-eye limiting magnitude is 6.6 to 7.0.

Class 4: Semi-rural. Light pollution is evident in more than one location. The zodiacal light will not stretch over large parts of the sky. M33 will be a difficult naked eye object. Clouds will be illuminated near the centres of light pollution but still remain dark overhead. Once dark adapted your surroundings will be faintly visible. The naked-eye limiting magnitude is 6.1 to 6.5.

Class 5: Suburban sky. Typically the clouds will look brighter than the background sky in most directions. M33 cannot be detected, and the zodiacal light will be very challenging, and only on the best nights. The naked-eye limit is around 5.6 to 6.0.

Class 6-9: Covers typical urban landscapes and are not of interest here.

These criteria can be compared to the photographs presented in the main body of this report.

Appendix B - Environmental Lighting Guidance

The Institute of Lighting Professionals provides guidance on lighting in the UK and Ireland, with a stated objective of "promoting excellence in all forms of lighting". This includes the issuance of a document on "Guidance Notes for the Reduction of Obtrusive Light" available at https://www.theilp.org.uk/documents/obtrusive-light/. The environmental lighting zones contained in this guidance have been adopted by Forestry Commission Scotland and Dumfries and Galloway Council as the basis for all proposed planning regulations with respect to the Dark Sky Park. The zones are also summarised in "Planning and Lighting Advisory Notes for Galloway Dark Sky Park" (see Appendix F). The ILP also suggests that councils adopt these zones into their Local Development Plans. These zones as defined by the ILP are:

E0: A protected zone in which new lighting developments should not be allowed. (In the context of Galloway Dark Sky Park, this is the Core Zone).

E1: An intrinsically dark region, such as a National Park or Area of Outstanding National Beauty etc. No light should emerge above the horizontal plane. (Again in the context of the Galloway Dark Sky Park this is the Buffer Zone *and* surrounding area).

E2: A rural or outer suburban area with some low level external lighting present. Carsphairn or Glentrool would be good examples locally. Only 2.5% of total exterior light should escape above the horizontal.

E3 and E4 refer to built-up areas and are therefore not important here (the centres of the neighbouring small towns and larger villages would fall under E3, the centre of Ayr under E4 as an example).

Note this guidance applies to visual lighting only – the only ILP reference to infrared light is in the context of discussing that light source output is measured in Lumens rather than Watts, i.e. light pollution is measured relative to visible light present. Generally it is accepted that infrared emission is suitable for security purposes for example. Forestry Commission Scotland note that these are permissible in their plan to protect the Dark Sky Park as published in their application (Appendix F). The only specific mention of wind turbines in the Forestry Commission document refers to those within the Dark Sky Park itself, which is not relevant here, though their "Good Design Practice – 20 Point Checklist" outlines measures that should be adhered to as best practice during any construction phase.

Note that the E1 zone is also adopted externally to the Dark Sky Park for a distance of up to 10 miles from the boundary, or the edge of any built-up area, whichever is closer, by both Forestry Commission Scotland and Dumfries and Galloway Council (see Section 2.4 of the original Dark Sky Park application). The bulk of the Dark Sky Park falls within the responsibility of Dumfries and Galloway Council. Dumfries and Galloway Council have therefore taken the lead, in consultation with Forestry Commission Scotland, East Ayrshire Council and South Ayrshire Council, in drawing up proposed guidelines for lighting developments within the Dark Sky Park. Their March 2015 proposed supplementary guidance to the Local Development Plan notes this in section 1.4, and it is expected that those councils will adopt similar plans. Appendix 1a of that document outlines the policy with regard to lighting on wind turbines as a whole:

Condition relating to Wind turbines /Meteorological Masts:

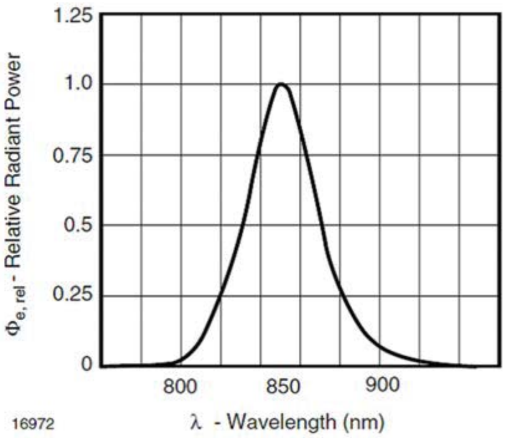
> That no development in respect of this planning permission shall take place unless and until precise details of aviation lighting to be installed on the mast have been submitted to and approved in writing by the Council as planning authority (in consultation with the Ministry of Defence). The said lighting shall be 25 candela equivalent brightness infra-red lighting at the highest practicable point. The mast hereby granted planning permission shall not be erected or brought into operation unless the required aviation lighting as so approved has been installed on the mast. Thereafter, the said lighting shall thereafter be retained in situ for the lifetime of the development in an effective operational condition. Reason: In order to ensure that external light(s) do not adversely impact upon the interests of the Dark Sky Park, whilst safeguarding aviation interests and public safety.

There is clearly a willingness to accept infrared lighting within this guidance.

Appendix C – Infrared Military Aviation Lights

The data sheet for the Contarnex CEL-infrared 850-024-CST unit can be found from the source in Appendix F as can the original MOD specification. This is approved for use on wind farms on-shore by the MOD. The 850nm LED used in the units has the following spectral profile:

There is no emission within the visual range above the 0.1% level, and it is likely to be considerably less



in practice.

The total steady power output of a single LED unit is typically 300milli-Watts/steradian (hereafter, mW/sr). The units in which the LEDs are mounted are made up of more than one hundred separate LEDs as shown in the data sheet. The unit is shielded so that the emitted light covers from -15 degrees to +30 degrees with respect to the horizontal plane, and 360 degrees around the sky (or about 4.8 steradians). The LEDs also cycle to give a “flashing” effect as is normal for military aviation lights. The preferred mode of operation for the MOD is to have 60 flashes per minute, with the “on-time” for each flash being 0.25 seconds. During the flash the output rises by a factor of about two on the steady power output. The specification allows for a 50% reduction in the total output for light emitted between -15 and -10 degrees with respect to the horizontal plane.

Long exposures are required to obtain astronomical images. Across the duration of these exposures therefore the LEDs effectively emit an average of 375mW/sr (the flashing itself has no impact). Finally less than about one quarter of the emitted light is actually visible from any given direction, since the individual LEDs from which the units are made are highly directional, and those on the opposite side to the viewer are obviously obscured by the central core of the unit (i.e. this is not the same as single light bulb which emits evenly in all directions). Therefore the perceived power output of a distant observer is, at most, 0.45Watts (hereafter W).

Appendix D – Scattering Model

We follow the standard analysis from the work of Garstang (1986, Publication of the Astronomical Society of the Pacific, vol 98, pp364-375) in order to give an estimate of the brightness of the diffuse scattered light source in the infrared. This paper considers the effect of light pollution on professional observatories around the world, and presents the accepted method for deriving estimates of the magnitude of the impact. The derived estimates agree well with actual observations from those professional observatories. The basic scattering model used here is the same as that outlined by Garstang, together with aspects of the follow up paper, Garstang (1989, Publications of the Astronomical Society of the Pacific, vol 101, pp 306-329).

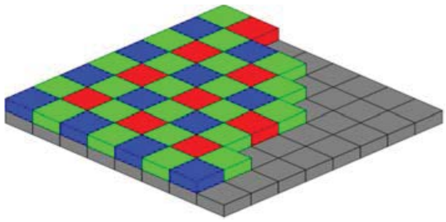
The typical external lighting for small towns is in the region of 500 lumens per person according to Garstang. Therefore Dalmellington will have a total external night illumination of about 500,000 lumens at visible wavelengths. Another way to look at this is to imagine one third of the population having an old fashioned 100W light bulb illuminating the external parts of their homes - of course in practice much of this lighting is actually street lighting etc, but it helps to show the net effect of a population centre nearby. More than 1% of the light emitted from Dalmellington could be in the infrared (a conservative lower limit – all existing street lights emit to some extent in the infrared ranging from low pressure sodium, which is perhaps only 5-10% as bright in the infrared as the visual, through high pressure sodium, metal halide and halogen which all emit essentially as much infrared as visual light). Dalmellington therefore is likely to emit more than 50W of infrared light, though spread over a larger region of sky than a single LED unit. The same is true for other larger and more distant towns. These towns and villages are significant sources of potential infrared light pollution around the northern fringes of the Dark Sky Park (and particularly the SDSO site).

The model assumes the following key aspects: an exponential scale height to the drop off of atmospheric molecules (i.e. air) and aerosols (a combination of any larger particles, such as water, soot, various complex bio-molecules etc.); a flat geometry (adequate for such small distances), though corrected to ensure the atmosphere behaves correctly when looking along the horizon (i.e. is finite); the Contarnex unit specification as a light source, with full cut-off towards the zenith and the ground immediately under the light unit; a standard aerosol/atmospheric mix; the corrected angular phase function for Mie scattering (Garstang quotes an incorrect normalisation) – using the “proper” Henyey-Greenstein phase function effectively gives the same results; the normal Rayleigh scattering phase function; adopting appropriate formula for dealing with extinction and scattering on sight-lines near the horizon, where the standard approximation that air-mass is simply 1/cos(zenith angle) breaks down. The final result is a diffuse scattered background an order of magnitude below the natural night sky.

The same results can be seen to be “reasonable” using a simple back of the envelope style calculation. First, consider only the simpler case of Rayleigh scattering. We can approximate the Rayleigh scattering as approximately isotropic. The mean path length before a photon scatters from a molecular of air at sea level is approximately 300 miles at 850nm (it is only ~50 miles in the visual band – though since this is greater than the scale height of the atmosphere it does mean we can actually see stars at night without their light being spread too much by air molecules!) The same simple argument can be turned round to show that only about 1% of all photons will scatter over a path length of 3.5 miles for light with wavelength 850nm due to Rayleigh scattering (it is about 8% for visual light). We can assume all the geometrical factors roughly cancel out in terms of which exact path a photon takes between light source and observer via the scatterer, so the 1% roughly holds true for all photons. Most of the scattering occurs on paths that lie between observer and the source, so this is reasonable. The probability of light scattering into the beam at the observer for an isotropic scatterer is $\sim 2\times10^{-11}/4\pi$ per square arcsecond. We can assume the light source that is scattered arises at the geometric midpoint, in order to give the correct order-of-magnitude drop-off in flux as the light propagates away from the source. This makes it about another factor of ten smaller. Applying this crude analysis gets within a factor of 10 of the full Garstang model, with an I band scattered light of ~27 magnitudes per square arcsecond. Therefore the excess scattered light from Rayleigh scattering is well below the natural night sky background, as the full model predicts. Mie scattering by comparison is strongly directional, and is only efficient near to “straight through” directions, having a scattering probability per steradian within 5 degrees of approximately 1. Mie scattering is relatively stronger as a function of wavelength at 850nm as well. Even so, the diffuse scattered light along a sight-line to one of the lights is still only about a factor of 4 magnitudes per square arcseconds brighter. Note this depends crucially on the actual aerosol composition (unlike Rayleigh scattering). Larger particulates will give a greater degree of scattering. The standard Garstang model assumes typical particle sizes of about 1 micron. Particles ten times this size will be common at times over rural Scotland. This crude "back-of-the-envelope" calculation ignores the fact the warning lights are partly shielded which again reduces the effect of diffuse scattered light-pollution. Clearly overall, the crude calculation predicts a sky brightness below the natural for Mie scattering, as does the full model. Mie scattering is actually beneficial in another way, since the additional scattering along the line of sight is actually representative of a dimming of the direct sight-line. The lights in practice may on some days be 1-2 magnitudes fainter than the worst-case scenario given in the main text.

Appendix E: Infrared Digital SLR Cameras Explained.

Images were acquired using a modified Canon EOS-600D Digital SLR (DSLR) camera. The modification, carried out by Advanced Camera Services, replaced the infrared blocking filter present in all DSLRs, with a long pass filter that blocked visual light. The filter installed allows light between 665 and 1000nm to be recorded by the camera, but blocks all light below about 650nm. In addition a set of pictures were taken at normal visual wavelengths (i.e. between about 400 and 650nm) using a Canon EOS-6D DSLR.



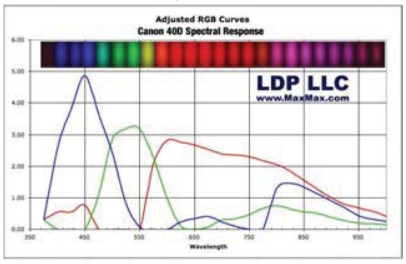


Figure E1: (left) schematic of the superposition of Bayer colour filter over a detector (taken from http://en.wikipedia.org/wiki/File:Bayer_pattern_on_sensor.svg). The individual filter elements allow the underlying detector to record colour information. The detector itself has no capability of analysing the colour of the light detected, and is sensitive to some extent to all light between 300 and 1000nm. The final image from a DSLR is a composite of the individual colour elements averaged together into a "fake" pixel twice as large (right). The spectral response of a typical Bayer filter in the infrared. The EOS-600D used had a blocking filter that lets all light above 665nm pass, but removes all the light at shorter wavelengths. Therefore the red elements in the Bayer filter actually pass more of the short wavelength emission recorded because they pass more light at 665-750nm than the other colours. The blue, by contrast, largely only passes light at higher wavelengths, above 800nm. The green response peaks in between these. All three colours pass light at 800nm and beyond, and therefore all detect the infrared warning LEDs. "False" colour infrared images are often constructed by swapping the red and blue channels in the processing, but for the purpose of this study the original colour information is unmodified. (Taken from http://www.maxmax.com/spectral_response.htm).

All digital SLRs use a Bayer filter to produce colour images. An example is shown in Figure E1. These filters still permit the passage of infrared light however, since they have significant light "leaks" red-ward of their normal wavelength. In ordinary SLR cameras this is not an issue since the infrared blocking filter eliminates this light. In the modified camera the "leaks" actually provide all the transmitted light. Figure E1 shows a plot of the spectral response of the Bayer filter in a Canon EOS-40D, an earlier camera than the 600D, but with essentially the same filter properties. The net result is that the camera records light such that the longest wavelength will come predominantly through the blue filter, and shortest through the red filter. However there is no entirely pure "colour" response in the same way that red/green/blue colours are acquired with a normal camera, as Figure E2 shows.

As should be clear from Figure E1, the amount of infrared light reaching the sensor in these cameras is less than the equivalent amount of optical light that would reach an identical but unmodified camera. Therefore full infrared modification leaves the camera less sensitive, reducing the likelihood of someone using such a camera for astrophotography.

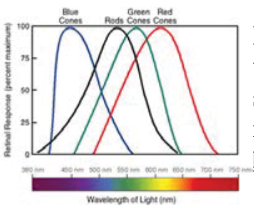


Figure E2: Response of the human eye by comparison. Even the shortest wavelength recorded by the modified DLSR appears to the human eye as very red, since it would only excite the red cones. The human eye has essentially no response at the wavelength of the infrared warning LEDs. (Taken from http://misclab.umeoce.maine.edu/boss/classes/SMS_491_2003/Week_10.htm)

Appendix F – Attachments Regarding Dark Sky Park Regulations

Forestry Commission/Dumfries and Galloway Council, Dark Sky Friendly Lighting Guide
http://www.forestry.gov.uk/pdf/PlanningLightadvisorynoteDGA.pdf/$FILE/PlanningLightadvisorynoteDGA.pdf
accessed 8th February, 2013.

Galloway Forest Dark Sky Park Application to the International Dark Sky Association
http://www.forestry.gov.uk/pdf/GallowayDarkySkyApp.pdf/$FILE/GallowayDarkySkyApp.pdf
accessed 8th February, 2013.

Galloway Forest Dark Sky Park Viewing Sites
http://www.forestry.gov.uk/pdf/Darkskiesparkboundaryandsites.pdf/$FILE/Darkskiesparkboundaryandsites.pdf
accessed 8th February, 2013.

International Dark Skies Association Guidelines
http://www.darksky.org/idsp/Guidelines/IDSP%20Guildelines%20Final-May13-BP.pdf

accessed 2nd November 2013.

Dumfries and Galloway Council: Local Development Plan: Consultation Draft Supplementary Guidance: Dark Sky Park Friendly Lightinghttp://www.dumgal.gov.uk/index.aspx?articleid=11943

accessed 16th June 2014.

MOD Specification for IR and Low Intensity Red Vertical Obstruction Lighting (AL 3), available from

http://www.renewableuk.com/en/our-work/aviation-and-radar/

accessed 23rd June 2014.

Appendix G: List of Images Acquired and Viewing Locations

All of the images presented in the text, as well as those made available only in digital format, were obtained from the following locations (all marked on the map on Figure 1).

	Location	Grid Reference	Dates
1	Newton-Stewart Rd, south of Loch Bradan	NX 23942 59478	18/4/2014
2	Passing place on B741 near Gass	NS 41952 05906	18/4/2014

The full list of images acquired for this work is given below – images 488 through 586 are infrared, acquired with the EOS 600D described in Appendix E, and 1601 through 1665 normal optical acquired with a Canon EOS 6D. The exposure time, f-ratio, focal length and time and location at which the image was acquired is listed as are notes on what can be seen in each. Only those images related to this particular work are described below. Infrared images with a focal length of 28mm were acquired through an external 820nm B+W 093 cut-off filter mounted on the lens (i.e. no light shorter than this reaches the detector). This helps to emphasise the infrared lights relative to other background sources.

Filename	Exp (s)	F number	Focal length (mm)	Time taken	Loc	Comments
IMG_0488	38	F8	28.0mm	10:08:41 PM	1	Missed the masts – looking SE
IMG_0489	63	F8	28.0mm	10:10:35 PM		Found all 4 - not quite enough sky to really get usable stars though
IMG_0492	15	F8	17.0mm	10:22:51 PM		Shortest exposure of the 4 met mast lights – Glenmount still anomalously bright
IMG_0493	113	F8	17.0mm	10:24:11 PM		Some car headlights on approach up from Loch Bradan – good view of all the diffuse emission
IMG_0494	119	F8	17.0mm	10:29:09 PM		Looking towards Cairnryan – clear glow
IMG_0495	120	F8	17.0mm	10:31:43 PM		Cf 1606 in terms of direction etc. Very obvious light pollution looking towards the coast from Ayr south
IMG_0496	120	F8	17.0mm	10:35:55 PM		Cf 1609 – Dumfries pollution obvious
IMG_0497	120	F8	17.0mm	10:40:34 PM		back to the met masts
IMG_0498	120	F8	17.0mm	10:42:55 PM		ditto
IMG_0499	120	F8	17.0mm	10:45:23 PM		ditto
IMG_0500	360	F8	17.0mm	10:48:00 PM		ditto but longer exposure
IMG_0501	30	F8	28.0mm	10:55:52 PM		Most reliable of the BW filter ones given more sky than 499
IMG_0502	360	F8	28.0mm	10:56:45 PM		And long exposure met mast using the BW filter – the tie-up with the optical give the masts at ~80 and 85 deg, consistent with known positions to 2 deg
IMG_0503	240	F8	28.0mm	11:28:47 PM	2	
IMG_0504	370	F8	28.0mm	11:34:41 PM		Looking ENE along the B741. Only the Enoch Hill masts are visible from here.
IMG_0505	270	F8	28.0mm	11:41:27 PM		Ditto
IMG_0506	120	F8	17.0mm	11:50:23 PM		Full IR in the same direction. There is an obvious track of an aircraft on approach to Prestwick.
IMG_0507	120	F8	17.0mm	11:52:54 PM		Looking approximately NW towards Loch Spallander. The light is on the met mast there for the proposed Keirs Hill Wind Farm. It is a far red, rather than infrared, light, as seen by

Filename	Exp (s)	F numbe r	Focal length (mm)	Time taken	Loc	Comments
						comparison with 0503 where it is invisible in the B+W 093 filter (so all emission is below 800nm).
IMG_0508	120	F8	17.0mm	11:55:27 PM		Looking south – this will be the site of the consented Dersalloch Wind Farm.
IMG_0509	240	F8	17.0mm	11:57:49 PM		As 0506, but longer exposure.

IMG_1601	34	F10	29.0mm	10:09:24 PM	1	Nice shot of the other camera...
IMG_1603	44	F10	26.0mm	10:23:01 PM		As prev, there is a direct light source corresponding to direction of Bellsbank/Dalmellington
IMG_1604	23	F10	26.0mm	10:23:48 PM		As prev + weak car headlight on NS road
IMG_1605	48	F10	26.0mm	10:27:50 PM		Looking SW. Procyon is the brightest star, and it sits at about 235 E of N, consistent with the brightest lights being Cairnryan
IMG_1606	32	F10	26.0mm	10:29:46 PM		Brightest star is Capella near top edge. Centre frame is about 2 deg W of NW. Right edge is about 12 deg W of N, so the strong light pollution is Ayr and getting weaker Maybole and Girvan moving right to left
IMG_1607	25	F10	26.0mm	10:30:32 PM		Similar to previous Ayr is even more prominent as we've swung a bit more North from NW.
IMG_1608	41	F10	26.0mm	10:31:16 PM		Sky shot roughly SW – Jupiter is bright object, Procyon nearer the centre of the frame – light pollution from Cairnryan
IMG_1609	34	F10	26.0mm	10:34:30 PM		Almost directly SE, Spica brightest, light pollution under mu Ser, (about 107 deg E of N), more about 125 deg (so Dumfries & Castle Douglas)
IMG_1610	43	F10	17.0mm	10:35:50 PM		Similar direction, sky view, bright objects Mars & Arcturus, Note the illuminated cloud overhead
IMG_1611	38	F10	17.0mm	10:39:02 PM		Sky view looking roughly NE (Vega is more or less centre at the bottom of the frame). Again note the illuminated high level cloud
IMG_1612	44	F11	17.0mm	10:40:11 PM		Vega is right of centre the left edge near due N, other features as 1602
IMG_1613	43	F11	17.0mm	10:41:26 PM		Vega just left of centre, mid frame circa 60 E of N, right edge about 110 E of N (latter catches Dumfries)
IMG_1614	55	F11	17.0mm	10:42:35 PM		Centre is about 5 deg E of N, stretching to NE on left edge, so Girvan through Ayr direction well represented
IMG_1615	38	F11	17.0mm	10:44:08 PM		Centre 150 deg E of N, Cairnryan obvious, right edge is about 285 (so should catch Girvan but Cairnryan is so bright it's hard to tell!)
IMG_1616	51	F11	17.0mm	10:45:19 PM		Mars is the bright object, centre about 160 E of N, left edge about 110, so Dumfries left edge, Castle Douglas sort of under Spica (below left Mars), Newton Stewart more right edge

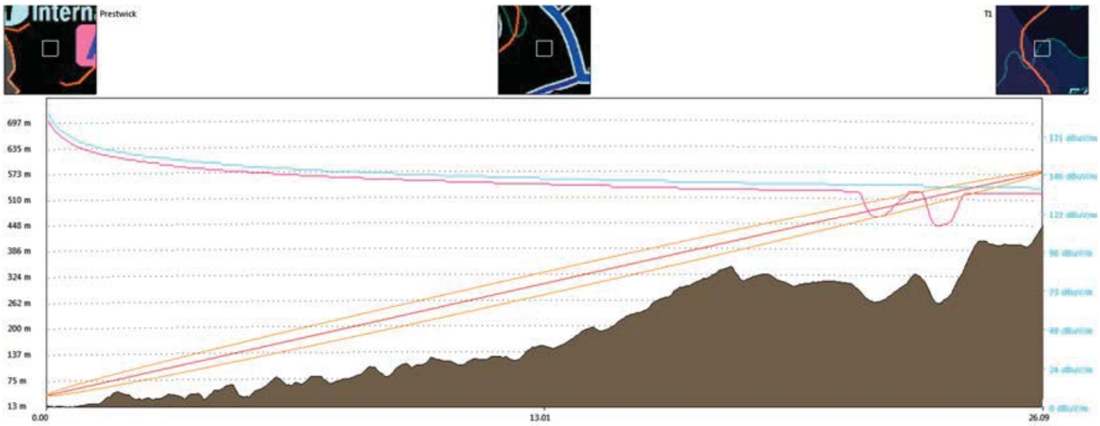
IMG_1617	67	F11	17.0mm	10:46:49 PM		Sky view – more or less N, (Plough is mid frame at a bit of a tilt). Again illuminated cloud
IMG_1618	44	F11	19.0mm	10:48:30 PM		Mars is the bright object. Looking about 148 E of N, brightest background more likely 130 so Castle Douglas
IMG_1619	67	F11	19.0mm	10:49:41 PM		Similar view to 1618, note the strong reflected background from the clouds in the E-S horizon
IMG_1620	102	F11	19.0mm	10:55:05 PM		Kappa Lyrae more or less centre so 55 deg E of N – see notes for 1602
IMG_1621	34	F11	19.0mm	11:23:42 PM	2	Looking ENE along B741
IMG_1622	48	F11	19.0mm	11:28:40 PM		Looking towards Loch Spallander and the visible red aircraft warning light discussed in 0507. Only true infrared lights would be completely acceptable for the Dark Sky Park as this image demonstrates.
IMG_1623	56	F11	21.0mm	11:30:12 PM		Ditto
1624-1629, 31						Junk – camera tests
IMG_1630	30	F8	17.0mm	11:42:56 PM		Looking along B741 ENE
IMG_1632	30	F8	19.0mm	11:51:49 PM		Ditto
IMG_1633	30	F8	19.0mm	11:52:41 PM		Ditto
IMG_1634	30	F8	19.0mm	11:54:12 PM		Looking south towards Dersalloch

Appendix 17.A
Glasgow Prestwick Airport Primary Survelliance Radar Line of Sight Analysis

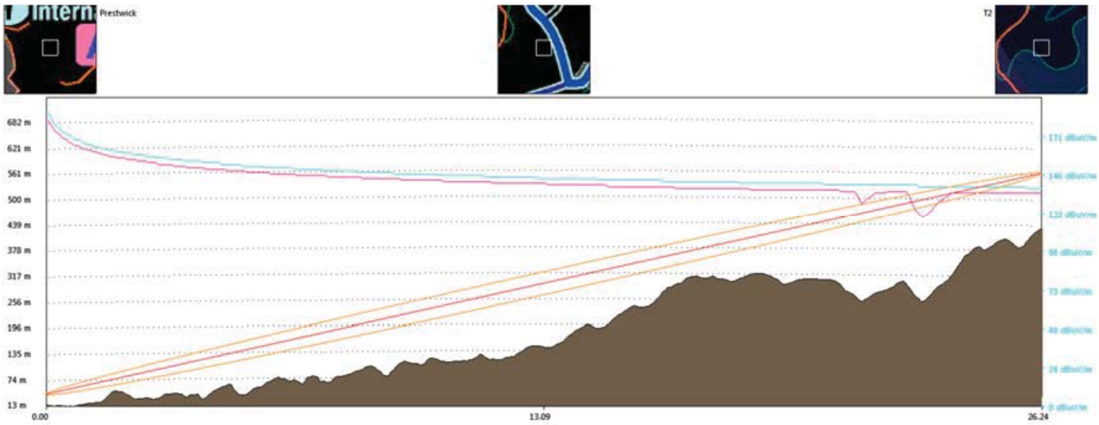
70511 004 01 Line of Sight Diagrams

Enoch Hill Wind Farm to the Glasgow Prestwick Airport Primary Surveillance Radar

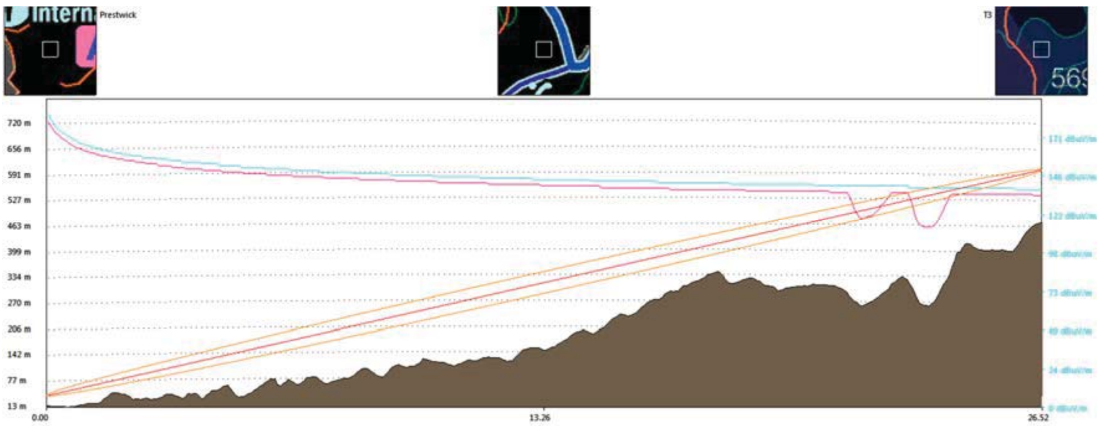
Turbine 1



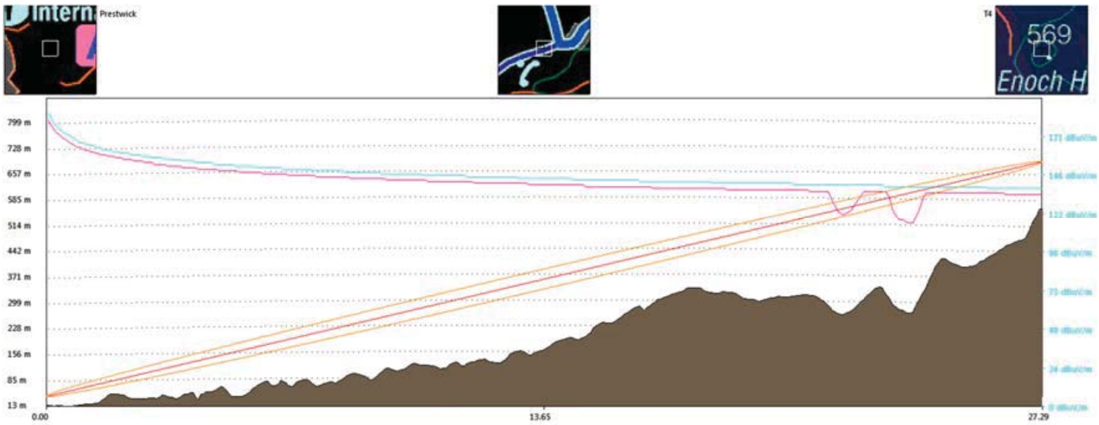
Turbine 2



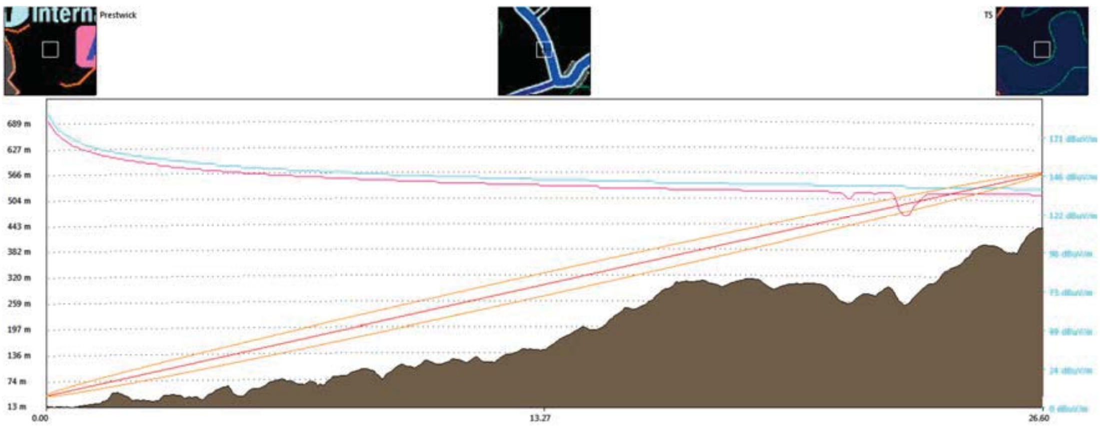
Turbine 3



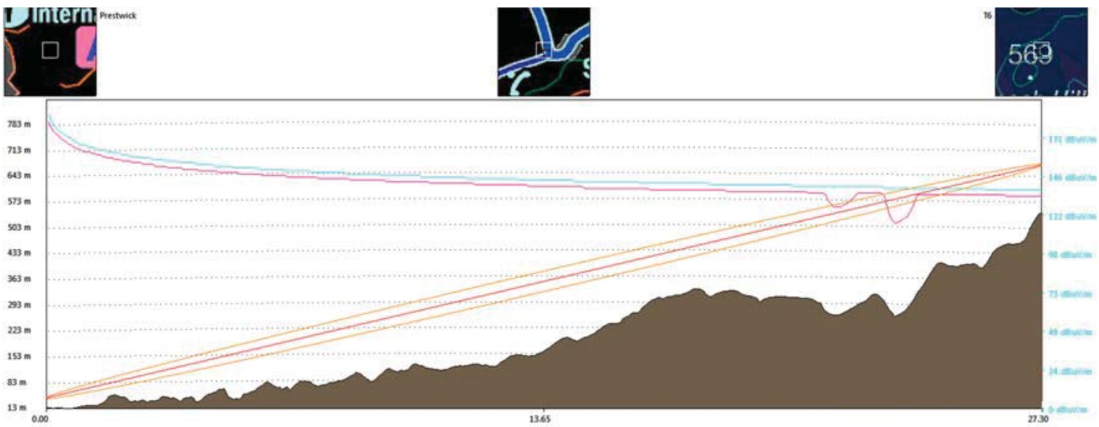
Turbine 4



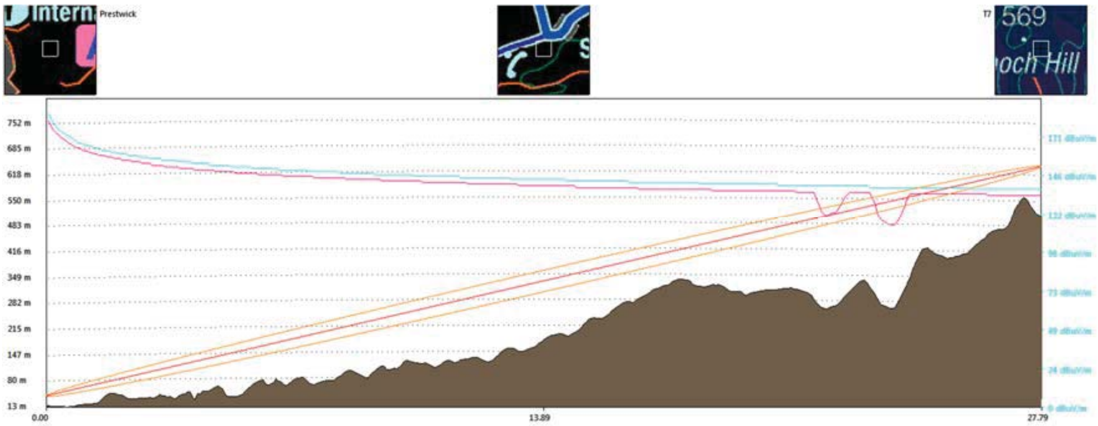
Turbine 5



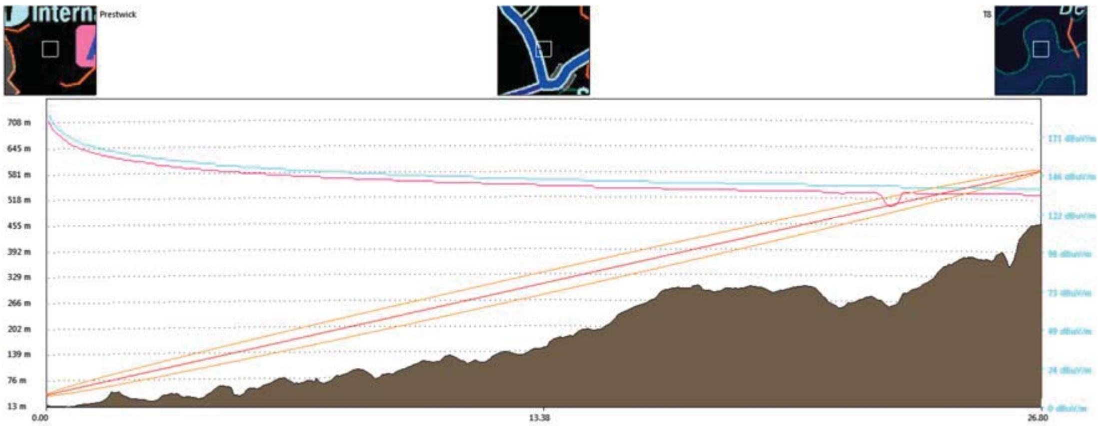
Turbine 6



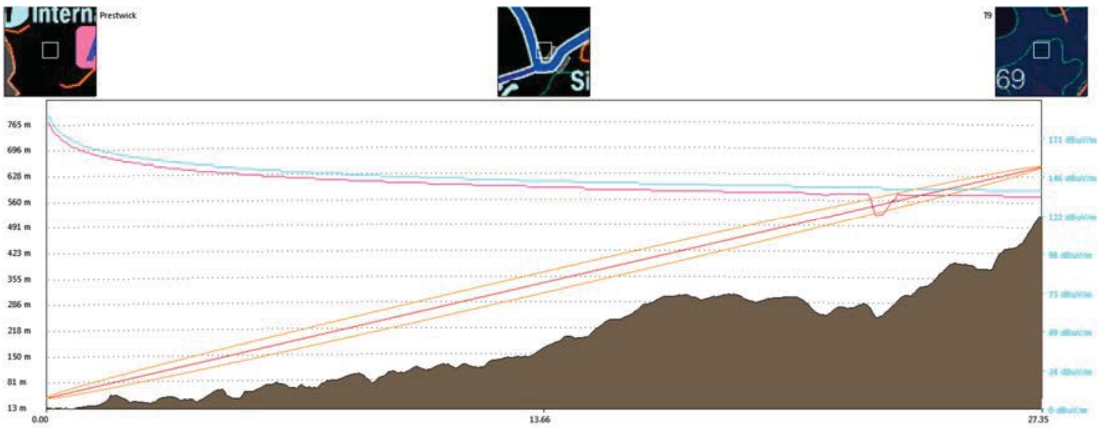
Turbine 7



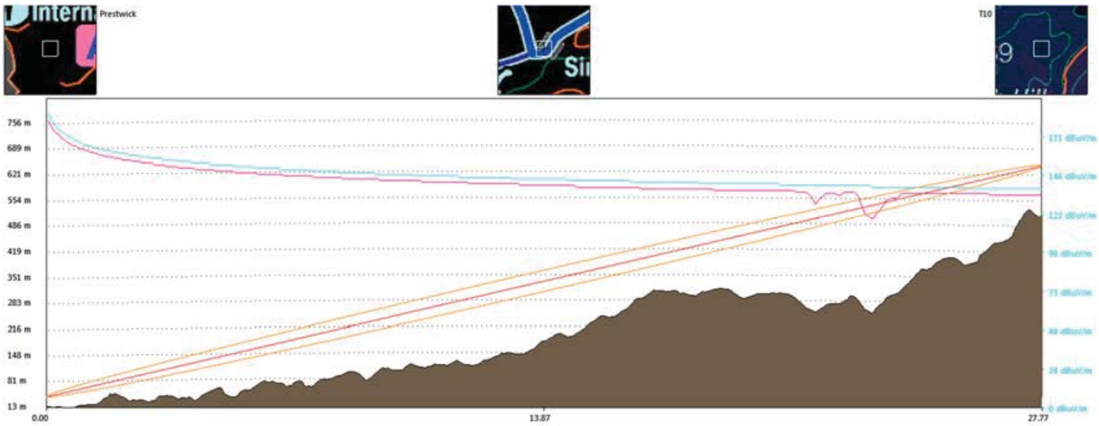
Turbine 8



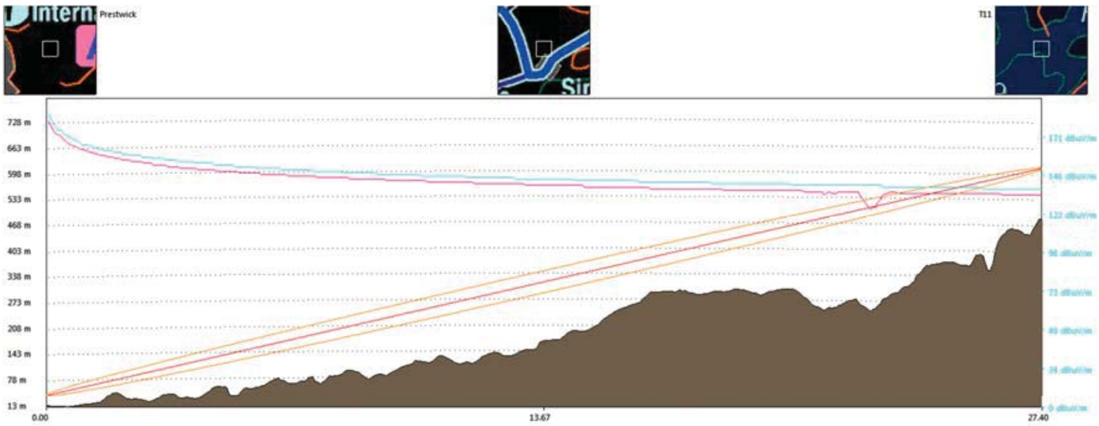
Turbine 9



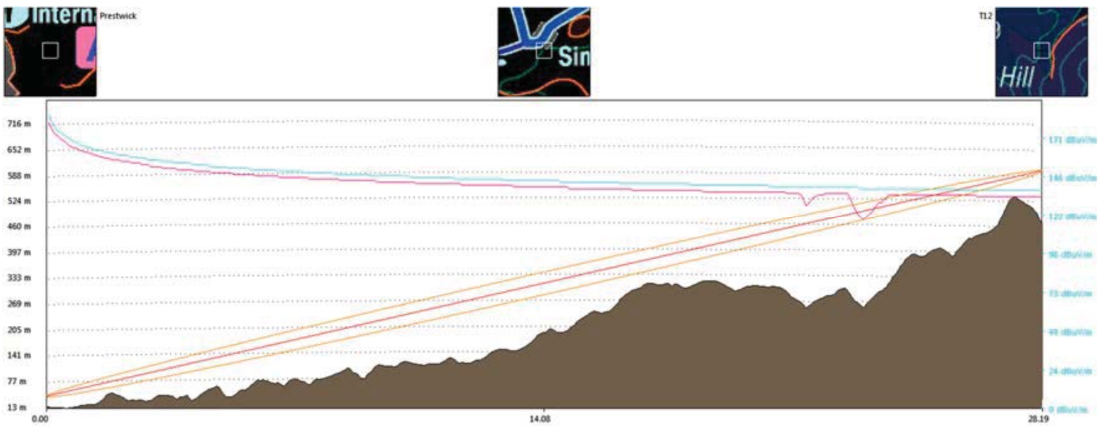
Turbine 10



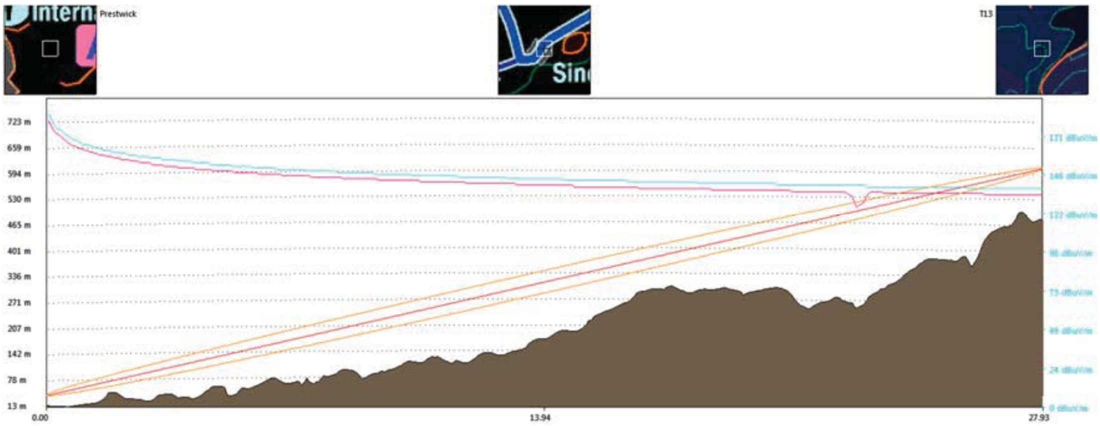
Turbine 11



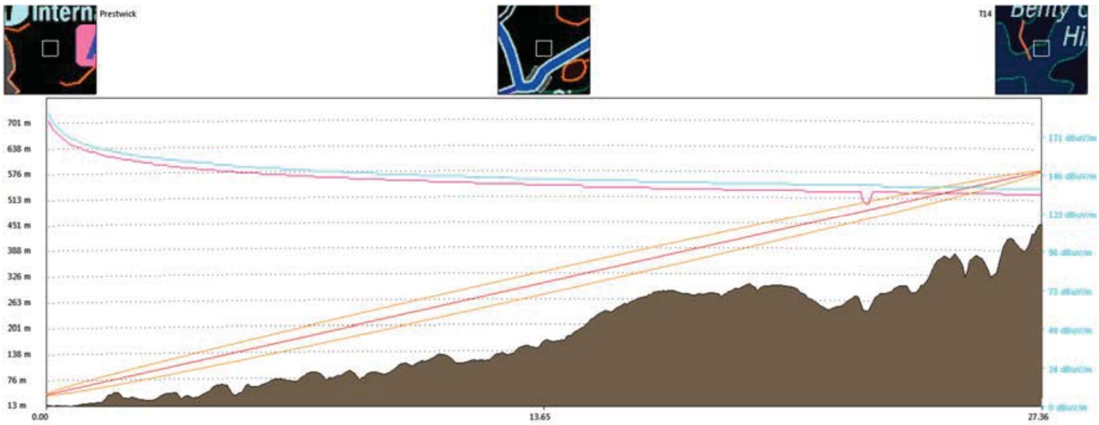
Turbine 12



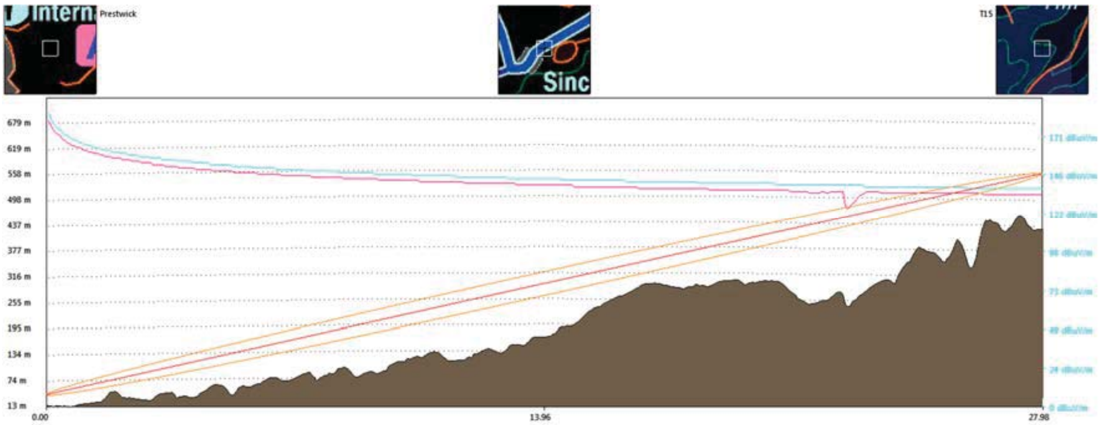
Turbine 13



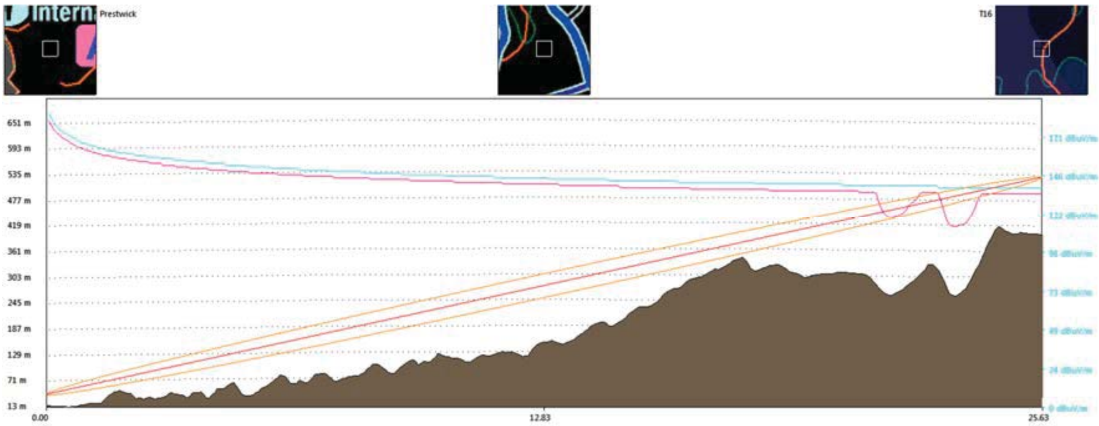
Turbine 14



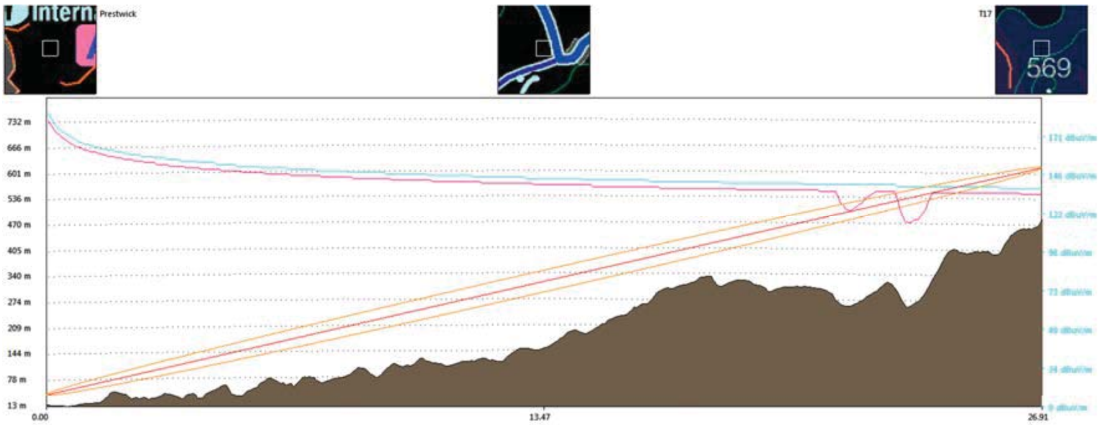
Turbine 15



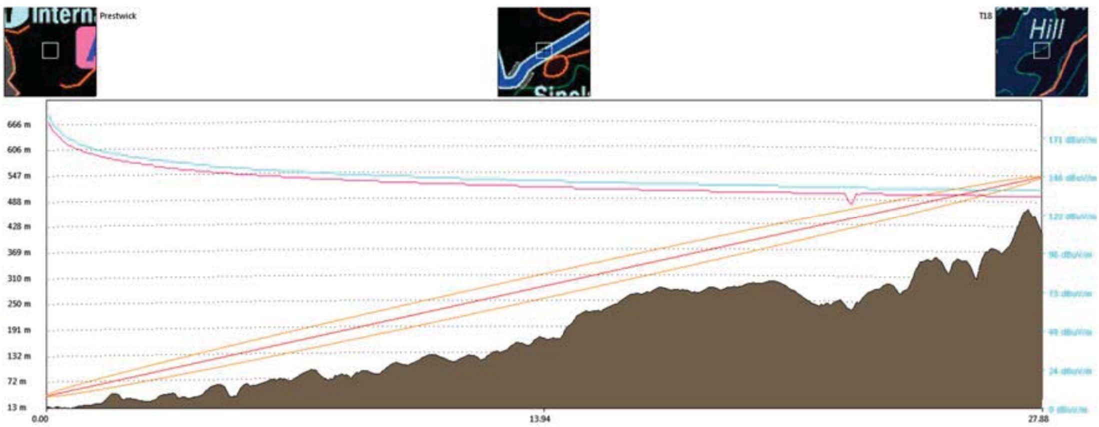
Turbine 16



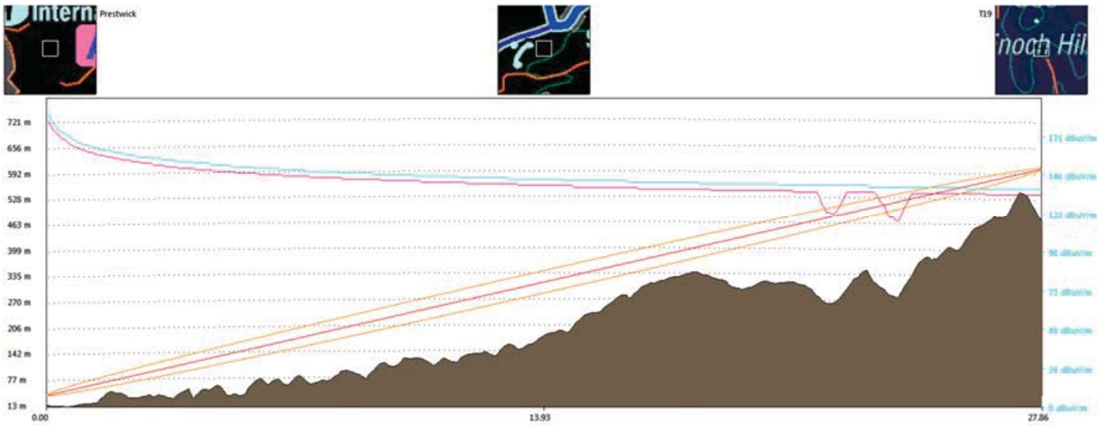
Turbine 17



Turbine 18



Turbine 19


Prestwick
T19
721 m
656 m
592 m
528 m
463 m
399 m
335 m
270 m
206 m
142 m
77 m
13 m
0.00
13.93
27.86

Appendix 17.B
Letter Withdrawing MOD Objection

Defence Infrastructure Organisation

Claire Duddy
Assistant Safeguarding Officer
Ministry of Defence
Safeguarding – Wind Energy
Kingston Road
Sutton Coldfield
West Midlands B75 7RL
United Kingdom

Telephone [MOD]: +44 (0)121 311 3714
Facsimile [MOD]: +44 (0)121 3112218
E-mail: DIO ODC-IPS SG2a1@mod.uk

Your Reference: Enoch Hill Wind Farm

Our Reference: DIO/SUT/43/10/1/10138

Ms Joyce Melrose
Energy Consents & Deployment Unit
The Scottish Government
Edinburgh
Scotland

13 November 2013

Dear Ms Melrose

Please quote in any correspondence: 10138

Site Name: Enoch Hill Wind Farm

Proposal: Erection of Wind Turbine(s)

Planning Application Number: N/A

Site Address: Between New Cumnock and Dalmellington, East Ayrshire

I refer to our letter dated 18 December 2012 in which the Ministry of Defence raised low flying objections to the above planning application.

I am writing to advise you that since that time the applicant has provided additional information in respect of the application, as a result of which we are able to withdraw our objection to the proposal.

The application is for 23 turbines at 150 metres to blade tip. This has been assessed using the grid references below as submitted in the planning application or in the developers' your pro-forma.

Turbine	100km Square Letter	Easting	Northing
1	NS	56239	08225
2	NS	55698	08069
3	NS	55320	08350
4	NS	55967	07759
5	NS	56867	07676
6	NS	56731	08042
7	NS	56359	07678
8	NS	55940	07313
9	NS	56239	08225

10	NS	55698	08069
11	NS	55320	08350
12	NS	55967	07759
13	NS	56867	07676
14	NS	56731	08042
15	NS	56359	07678
16	NS	57981	07492
17	NS	57522	07986
18	NS	57969	08287
19	NS	57835	07848
20	NS	58344	08177
21	NS	58388	07763
22	NS	58800	08449
23	NS	55542	08817

In the interests of air safety, the MOD requests that all turbines are fitted with 25 candela omni-directional red or infrared lighting with an optimised flash pattern of 60 flashes per minute of 200ms to 500ms duration at the highest practicable pointlighting at the highest practicable point.

The principal safeguarding concern of the MOD with respect to the development of wind turbines relates to their potential to create a physical obstruction to air traffic movements and cause interference to Air Traffic Control and Air Defence radar installations.

Defence Infrastructure Organisation Safeguarding wishes to be consulted and notified of the progression of planning applications and submissions relating to this proposal to verify that it will not adversely affect defence interests.

If planning permission is granted we would like to be advised of the following;

- the date construction starts and ends;
- the maximum height of construction equipment;
- the latitude and longitude of every turbine.

This information is vital as it will be plotted on flying charts to make sure that military aircraft avoid this area.

If the application is altered in any way we must be consulted again as even the slightest change could unacceptably affect us.

I hope this adequately explains our position on the matter. If you require further information or would like to discuss this matter further please do not hesitate to contact me.

Further information about the effects of wind turbines on MOD interests can be obtained from the following websites:

***MOD*:** http://www.mod.uk/DefenceInternet/MicroSite/DIO/WhatWeDo/Operations/ModSafeguarding.htm

Yours sincerely

Claire Duddy

Claire Duddy
Assistant Safeguarding Officer – Wind Energy
Defence Infrastructure Organisation

SAFEGUARDING SOLUTIONS TO DEFENCE NEEDS