Appendix 6.1 Natural Heritage Desk Study

Natural Heritage Information Desk Study for Shetland Space Centre

Alba Ecology Ltd.

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Introduction

A proposal for a satellite launch facility has been made by the Applicant in north Unst, Shetland - known as the 'Shetland Space Centre' (SSC). As part of this proposal, Alba Ecology Ltd. was commissioned to conduct a natural heritage desk study to identify biological records within the potential zones of influence and to locate conservation designated sites within a 10km radius of the Site.

The SSC Proposed Development comprises of work in three discrete areas: (i) a Proposed Launch Site at Lamba Ness, (ii) a Proposed Launch and Range Control Centre Site, and (iii) a Proposed New Section of Access Road at Northdale. This report considers all three of these areas.

The Search Area for the Desk Study comprised of the Proposed Development plus a 1km buffer. The zone of influence from Proposed Launch Site was considered potentially greater than this for certain taxa, therefore a 4km buffer was considered a suitable Search Area for birds and mammal species. A location map can be seen in Appendix 7.1 Drawing 1[1] with the 1km Search Area and the additional 4km bird and mammal Search Area shown.

A search of biological records was conducted in 2020 using data obtained from the Shetland Biological Records Centre, from the NatureScot (formerly Scottish Natural Heritage; SNH) SiteLink Website and other relevant web-based sources such as the Shetland Island Council web pages, designated site citations and the National Biodiversity Network (NBN) Atlas.

A previous desk study was written in 2017 (to help inform potential surveys) for this proposal based on a wider search area as the design layout had not be finalised at that time. The previous desk study is superseded by this more up to date report and associated spreadsheets.

This desk study aims to identify records of species and habitats of conservation importance within the Search Area, using the relevant potential zones of influence, and designated sites within 10km of the Site.

Study methods

The data search for this desk study follows the Chartered Institute of Ecology and Environmental Management (CIEEM) best practice guidelines (CIEEM, 2016; CIEEM, 2017). The background data aims to provide the following information:

- Designated site information;
- Existing records of protected/priority/notable species for the Site;
- Existing records of protected/priority/notable species for the surrounding area; and

[1] Drawing 1 is provided within this report document, but a higher resolution version is provided separately as a PDF.

- Habitat information where available.

Designated site information

Sites with biological conservation designations located within 10km of the Application Boundary were identified using the NatureScot SiteLink Website (2020). These included Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), Special Protection Areas (SPA), Marine Protection Areas (MPA) and Ramsar sites. The local nature conservation sites were identified using the Shetland Island Development Plan Local Nature Conservation Site guidance (SIC, 2015).

Existing species records for the Search Area

Species records were obtained by commissioning data searches from the local biological records centre, as per CIEEM best practice guidelines. The Shetland Biological Records Centre was commissioned to search for biological records within the Search Area. Provision of the data by the recorders is neutral and should not be regarded, either explicitly or implicitly, as approving or opposing any project informed by the data provided.

As with all desk studies, the data collected are only as good as the data supplied to the recording schemes. The recording schemes and recorders provide disclaimers in relation to the quality and quantity of the data they provide and these should be considered when examining the outputs of this desk study. No attempt has been made to verify these records. Common (vernacular) names are used where they have been provided by the recorder.

All biological records within the Search Area were searched for on the NBN Atlas. The CIEEM (2016) guidance stipulated avoiding the use of the NBN for commercial purposes due to constraints to the licence of the data. However, the Guidance notes that there is a "*general trend, supported by governments, towards Open Data to increase access to data for all stakeholders and the situation is likely to change significantly in the coming years"*. Due to the updated and explicit guidance on the use of the Open Data for commercial purposes on the NBN Atlas website, the CIEEM guidance is deviated from on this point, but it is considered to be in keeping with its aims and expectations.

All records for the Proposed Development plus a 1km buffer, were downloaded on the NBN Atlas website in August 2020. As per NBN Atlas guidance for commercial use, only the records which have an Open Data licence (coded CCO, CC-BY and OGL) have been considered and presented here. These data "*can be used for any purpose*" (NBN Atlas, 2020). Those data with a non-commercial licence (CC-BY-NC) were not included and were not inspected or considered. This is accordance with the NBN Atlas terms and conditions for commercial use (NBN Atlas, 2020).

It should be noted that the Data Provider, Original Recorder [where identified], and the NBN Trust bear no responsibility for any further analysis or interpretation of that material, data and/or information.

Relevant literature sources, including Living Shetland LBAP documents, nearby designated site citations and relevant literature sources such as Rare Plants of Shetland (Scott, *et al.* 2002) were considered for species that could potentially be present within the Search Area.

All records, from all sources, were compared against the Scottish Biodiversity List and the Local Biodiversity Action Plan (LBAP) list of important species.

Existing habitat records for the Search Area and surrounding area

Relevant sources, such as the Living Shetland LBAP documents, the nearby designated site citation and relevant literature sources were considered in relation to the habitats likely to be present within and around the Search Area.

Results

Designated site information

A total of 10 designated sites with ecological qualifying features within a 10km radius of the Proposed Development have been identified (Table 1). The closest was Norwick Meadows SSSI, which is between the Proposed New Section of Access Road at Northdale and the Proposed Launch and Range Control Centre Site. There are a number of Local Nature Conservation Sites on Unst. These are listed in Table 2.

Designated site	Designation type	Area (ha)	Distance (km) and direction from Proposed Development	Biological Qualifying features
Hermaness, Saxa Vord and Villa Field	SPA	6,832ha	1.5km, West	Breeding birds: • Fulmar (*Fulmarus glacialis*) • Gannet (*Morus bassanus*) • Great skua (*Stercorarius skua*) • Guillemot (*Uria aalge*) • Kittiwake (*Rissa tridactyla*) • Puffin (*Fratercula arctica*) • Red-throated diver (*Gavia stellata*) • Shag (*Phalacrocorax aristotelis*) Breeding bird assemblages
Keen of Hamar	SAC	40ha	3.2km, South	Upland habitats: • Base rich scree • Dry heath Grasslands on soils rich in heavy metals
Keen of Hamar	SSSI	50ha	3.2km, South	Calaminarian grassland and serpentine heath

Designated site	Designation type	Area (ha)	Distance (km) and direction from Proposed Development	Biological Qualifying features
				Vascular plant assemblages
Hill of Colvadale and Sobul	SSSI	809ha	5.7km, South	Arctic sandwort (*Arenaria norvegica*) Breeding birds: • Arctic skua (*Stercorarius parasiticus*) • Whimbrel (*Numenius phaeopus*) Breeding bird assemblages Calaminarian grassland and serpentine heath
Valla Field	SSSI	629ha	4.2km, Southwest	Breeding birds: • Great skua • Red-throated diver
Crussa Field and Heogs	SSSI	469ha	2.0km, South	Breeding birds: • Arctic skua • Whimbrel Breeding bird assemblages Vascular plant assemblages Calaminarian grassland and serpentine heath
Hermaness	SSSI	978ha	2.9km, West	Breeding birds: • Fulmar • Gannet • Great skua • Guillemot • Puffin Breeding seabird colony
Saxa Vord	SSSI	56ha	2.3km, West	Breeding birds: • Fulmar • Guillemot Breeding seabird colony
Norwick Meadows	SSSI	25ha	0.1km, South and North	Sand dune habitats Valley fen wetlands
Fetlar to Haroldswick	MPA	216000ha	0.9km, South	Aggregation of breeding birds: • Black guillemot (*Cepphus grylle*) Horse mussel beds Circalittoral sand and coarse sediment communities Kelp and seaweed communities on sublittoral sediment

Table 1: Biological Designated Sites within 10km of the Site.

Local Conservation Sites on Unst	Primary Interest	Justification for Local Conservation Site
Baltasound	Species	Glasswort (*Salicornia europea*) and annual sea-blite (*Suaeda maritima*).
Burn of Mailand	Species	Rare plants. Lesser tussock sedge (*Carex diandra*) and small bur-reed (*Sparganium natans*) are found nowhere else in Shetland. Rich bryophyte flora.
Haroldswick mires	Species	Schedule 1 bird species. The pool at Haroldswick is attractive to migrant birds. The base-rich mire vegetation is unusual in Shetland.
Lochs of Bordastubble and Stourhoull	Species	These water bodies are on the Unst serpentine; they are nutrient rich and support a variety of aquatic species. Breeding Schedule 1 bird species.
Skeo Taing	Species	The herb-rich turf with base-rich shell sand provides habitat for a diverse range of plants. The nationally rare autumn gentian (*Gentianella amarelle septentrionalis*) is found on site. This is the only site in Shetland where harebell (*Campanula rotundifolia*) may still occur.
Wick of Skaw	Geology	Easily identifiable exposure of a granite intrusion contact zone.
Belmont Quarry	Geology	Rock exposures across a major shear zone/ophiolite thrust. Part of the Shetland Ophiolite Suite.
Clibberswick Cross Geo	Geology	Part of the Shetland Ophiolite suite.
Hill of Clibberswick	Species	Two nationally scarce plant species are present on-site, Arctic sandwort and northern rock cress (*Arabis petraea*)

Table 2: The Local Nature Conservation Sites on Unst with their features of primary interest and the justification as specified in the Shetland Island Development Plan Local Nature Conservation Site guidance (SIC, 2015).

Existing species records for the Search Area

Shetland Biological Records Centre data

The Shetland Biological Records Centre searched for all biological records within the Search Area. Due to the large number of data the search on birds was limited to post 2000 records and the search on all other taxa was limited to post 1990 records. The search provided a total of 4,392 bird records with a total of 105 species and a further 2,719 species records for other taxa, including 782 different species. Many of these records were beyond the 1km buffer of the Study. The full list of species and SBL species can be seen in Annex 1: Desk Study Data Sheet - Shetland Biological Records Centre Search.

Table 3 provides a summary of data by taxonomic groups.

Order/Class/Group	Notes (includes)	No' of species recorded
Amphibian		1 Species
Arachnids	Spiders & mites	58 Species
Birds		105 Species
Coleoptera	Beetles	50 Species
Diptera	Two-winged or true flies	36 Species
Hemiptera	True bugs	1 Species
Hymenoptera	Bees, wasps, ants & sawflies	5 Species
Lepidoptera	Butterflies & moths	132 Species
Lichen		130 Species
Mammals		17 Species
Mosses and liverworts		76 Species
Vascular plants		276 Species

Table 3: Summary of biological records provided by Shetland Biological Records Centre (search conducted in 2020).

A total of 56 species recorded from the Shetland Biological Records Centre are on the Scottish Biodiversity List (Annex 1). These include two mammals, 13 insects, five plants, six lichens and 30 birds (Annex 1; Table 4). The list of species recorded as part of the Shetland Biological Records Centre data search on the SBL can be seen in Annex 1.

The two terrestrial mammal species recorded within the Search Area from the Shetland Biological Records Centre which are on the SBL were otter (*Lutra lutra*) and Nathusius's pipistrelle (*Pipistrellus nathusii*). Nathusius's pipistrelle is a long-distance migrant and most UK records are for solitary individuals. Fewer than ten maternity colonies have been discovered in Britain and all from the east coast; Kent, Norfolk and Northumberland (Crawley *et al.,* 2020). Consequently, this Unst record is considered likely to be from a continental migrant as bats are not known to breed in Shetland. Otters have been recorded around Norwick on numerous occasions. Appendix 7.3 Otter Survey Report provides detail of the otter surveys conducted as part of the EIAR. Marine mammals are considered in EIAR Chapter 13: Marine and Transboundary Effects. Birds are considered in EIAR Chapter 6: Ornithology.

The insects that are on the SBL and are recorded as part of the Shetland Biological Records Centre data search are all within the "*watching brief only"* category of the SBL. Four species were recorded within the vicinity of the Proposed Development. Haworth's minor (*Celaena haworthii*) is "*mainly a moorland species, occurring most commonly in northern England, Wales and Scotland… Cotton-grass (*Eriphorium *spp.) is the main foodplant, the larvae feeding internally on the stems*" (UK Moths, 2020). Autumnal rustic (*Eugnorisma glareosa*) inhabits "*woodland fringes, moorland and sandy or chalky soils, it is widely distributed, though not always common, throughout Britain. The adults fly in August and September, and the caterpillars are polyphagous, living on a wide variety of plants and grasses*" (UK Moths, 2020). Ghost moth (*Hepialus humuli*) is considered a "*common species over much of Britain… The adults fly during June and July. The larvae feed underground on the roots of grasses and small plants* (UK Moths, 2020). Red carpet (*Xanthorhoe decoloraria*) is "*a locally common species in northern Britain, occurring from Shropshire and Staffordshire northwards, into Scotland, where a local subspecies* hethlandica *occurs on the Shetland Isles… The favoured habitat is rocky moorland,*

where the larvae feed on lady's mantle Alchemilla spp., possibly also on other low plants (UK Moths, 2020).

The lichens that are on the SBL and were recorded as part of the Shetland Biological Records Centre data search are all within the "*watching brief only*" category of the SBL. Although three of the lichen species have EU obligations and four of the lichen species are considered rare in Scotland (SBL, 2013, Annex 1). Four of the lichen species were recorded on Lamba Ness. These include two that have international obligations and three that are considered nationally rare (SBL, 2013). The lichen *Caloplaca britannica* "*is found on coastal rocks, in the spray zone and is undoubtedly under-recorded*" (Images of British Lichens, 2013). In Shetland it is known to be located in "*sheltered crevices in landward-facing rock face*" (Dalby and Dalby, 2005). The lichen *Leptogium britannicum* is found on coastal rocks (Images of British Lichens, 2013). In Shetland it is known to be located amongst mosses in salt marshes and on cliffs (Dalby and Dalby, 2005). The lichen *Opegrapha areniseda* is found on "*slightly acid or neutral soft rocks near the seashore (schists) and mainly on old walls, notably of chapels*" (Maritime Lichens, 2020). No information was found on the UK habitat requirements of the lichen *Thelenella muscorum var. octospora*.

Of the five vascular plants on the SBL, chicory (*Cichorium intybus*) and wild pansy (*Viola tricolor*) are in the "*conservation action needed*" category and field gentian (*Gentianella campestris*) and frog orchid (*Coeloglossum viride*) are considered to be vulnerable in Scotland. All five species were recorded >700m away from the Proposed Development.

Species name	Common name	Number of records	Closest record to Proposed Development
Lutra lutra	Otter	5	>700m, Norwick
Pipistrellus nathusii	Nathusius's pipistrelle	5	>600m, Norwick
Bombus (Thoracombus) muscorum	Moss carder-bee	3	150m, Houlanbrindy
Apamea remissa	Dusky brocade	3	150m, Houlanbrindy
Arctia caja	Garden tiger	1	>1km, SW of Saxa Vord
Celaena haworthii	**Haworth's minor**	**6**	**1 in Saxa Vord, 1 150m, Houlanbrindy**
Celaena leucostigma	Crescent	1	150m, Houlanbrindy
Dasypolia templi	Brindled ochre	6	150m, Houlanbrindy
Diarsia rubi	Small square-spot	3	150m, Houlanbrindy
Entephria caesiata	Grey mountain carpet	2	>500m, Norwick
Eugnorisma glareosa	**Autumnal rustic**	**1**	**Within Saxa Vord**
Hepialus humuli	**Ghost moth**	**5**	**Near Northdale**
Hydraecia micacea	Rosy rustic	4	>600m, Norwick
Xanthorhoe decoloraria	**Red carpet**	**1**	**Within Saxa Vord**
Monocephalus castaneipes	Broad groove-head spider	2	>900m, Norwick
Cichorium intybus	Chicory	1	>700m, Millfield
Coeloglossum viride	Frog orchid	1	>1.2km, beyond Skaw
Gentianella campestris	Field gentian	1	>1km, beyond Skaw
Lathyrus japonicus	Sea pea	7	>700m, Norwick
Viola tricolor	Wild pansy	1	>950m, Ward of Norwick
Brigantiaea fuscolutea	A lichen	2	>1km, Hill of Cibberswick
Caloplaca britannica	**A lichen**	**1**	**Lamba Ness**
Leptogium britannicum	**A lichen**	**2**	**Lamba Ness**
Lobaria virens	Green satin lichen	1	>1km, Hill of Cibberswick
Opegrapha areniseda	**A lichen**	**1**	**Lamba Ness**
Thelenella muscorum var. octospora	**A lichen**	**1**	**Lamba Ness**

Table 4: Species from the Shetland Biological Records Centre data search, within the Search Area, which are listed on the SBL (except birds). Bold indicates close proximity to Proposed Development.

Additional information, courtesy of Paul Harvey of the Shetland Biological Records Centre, provides details of species in the data search which are considered to be rare, scarce, or threatened in Shetland (Harvey, *pers comm*, May 2020).

Bryophytes

- Lindberg's bog-moss (*Sphagnum lindbergii*) is considered Nationally Scarce and this is the only location known in Shetland. This species was recorded >2km northwest of the Proposed Launch Site on Saxa Vord hill (not the Saxa Vord Resort).
- Dwarf streak-moss (*Rhabdoweisa fugax*) is considered rare in Shetland on current knowledge. This was recorded >2km northwest of the Proposed Launch Site at Ritten Hamar.

Vascular plants

- Wilson's filmy-fern (*Hymenophyllum wilsonii*) is considered Near Threatened and is scarce in Shetland. This species was recorded >2km northwest of the Proposed Launch Site on Saxa Vord hill (not the Saxa Vord Resort).
- White sedge (*Carex curta*) is scarce in Shetland. This species was recorded along the Burn of Norwick, likely within the Norwick Meadows SSSI, approximately 330m from the Proposed Launch and Range Control Centre.
- Bog sedge (*Carex limosa*) is scarce in Shetland. This species was recorded along the Burn of Norwick, likely within the Norwick Meadows SSSI, approximately 330m from the Proposed Launch and Range Control Centre.
- Frog orchid (*Coeloglossum (Dactylorhiza) viride*) is considered Vulnerable nationally. This species was recorded >1km north of the Proposed Launch Site.
- Oysterplant (*Mertensia maritima*) is considered Near Threatened and Nationally Scarce and scarce in Shetland. This was recorded in Inner Skaw in July 2019 as well as some locations north of the Proposed Launch Site.
- Arctic sandwort is considered Vulnerable nationally and rare in Shetland. This species was recorded >1.5km south west of the Proposed Launch and Range Control Centre at Hill of Cibberwick.
- Sea kale (*Crambe maritima*) is rare in Shetland. This species was recorded ca. 850m north of the Proposed Launch Site.
- Northern rock-cress is considered Vulnerable nationally and Nationally Scarce and scarce in Shetland. This species was recorded >1.5km south west of the Proposed Launch and Range Control Centre near Hill of Cibberwick.
- Corn spurry (*Spergula arvensis*) considered as Vulnerable nationally. This species as recorded at Northdale, near the New Section of Access Road at Northdale and near the Proposed Launch and Range Control Centre.
- Sea pea (*Lathyrus japonica*) is now extinct at this site. This species was historically recorded at Norwick.
- Long-headed poppy (*Papaver dubium*) is scarce in Shetland. This species was recorded in Norwick cemetery.

Corn spurry and oysterplant are of most relevance as they have both been recorded near the Proposed Development. Corn spurry was recorded at Northdale and near the Proposed Launch and Range Control Centre. Oysterplant was recorded in Inner Skaw which is within the vicinity of the Proposed Launch Site.

NBN Atlas data

The NBN Atlas data search provided a total of 793 records for the Search Area from a variety of taxa and from freely available data sources. The total number of species was 531. Species which were already considered as part of the Shetland Biological Records Centre search were removed. This left 288 additional species for the Search Area. These are presented in Annex 2 Desk Study Data Sheet – NBN Atlas Search.

Table 5 provides a summary of the additional species found using the NBN Atlas (listed by taxonomic group).

Order/Class/Group	Notes (includes)	No' of species recorded
Actinopterygii	Fish	5
Algae		8
Annelida	Earthworm	1
Birds		8
Chromista		3
Coleoptera	Beetles	7
Diptera	Two-winged or true flies	5
Lichen and fungi		80
Mammal		2
Mollusca	Mussels	4
Mosses and liverworts		120
Neuroptera	Net-winged insects, e.g. lacewings	1
Plants		27
Plecoptera	Stoneflies	2
Sessilia	Barnacles	2
Trichoptera	Caddisflies	13

Table 5: Summary of biological records provided by the NBN Atlas (search conducted August 2020).

The full list of additional species is provided in the accompanying Annex 2.

A total of 10 species recorded from the NBN Atlas data search are on the SBL (Annex 2). These include three fish, five birds and two lichens (Annex 2; Table 6). The list of species recorded as part of the NBN Atlas data search on the SBL can be seen in Annex 2.

The three fish species are all of conservation importance, but as they are non-terrestrial species they are not considered further.

The two lichen species are both within the "*watching brief only*" category of the SBL. *Caloplaca dichroa* "*occurs on sunny, exposed limestone rocks*" (Dorset Nature, 2020) and was recorded at Haroldswick Methodist Church. Little information on habitat was found for the species *Gyalecta foveolaris* which was recorded within the 10km grid square on Unst in the 1960s.

Species name	Common name	Number of records	Closest record to Proposed Development
Anguilla anguilla	Eel	1	Sea
Salmo salar	Atlantic salmon	1	Sea
Salmo trutta	Sea/brown trout	1	Sea
Caloplaca dichroa	A lichen	1	Haroldswick - Methodist Church
Gyalecta foveolaris	A lichen	1	No details (record from 1960)

Table 6: Species listed in the NBN Atlas dataset from the Search Area which are on the SBL (except birds).

LBAPs – Species Action Plans

There are number of Species Action Plans, as part of the Living Shetland LBAP (SIC, 2020). These include:

- Arable Birds;
    - Twite (*Carduelis flavirostris*), house sparrow (*Passer domesticus*), skylark (*Alauda arvensis*), meadow pipit (*Anthus pratensis*), starling (*Sturnus vulgaris*), and rock dove (*Columba livia*) (Ellis, 2004).
- Arable Plants;
    - Knotgrass (*Polygonum aviculare*): restricted to Fair Isle.
    - Lesser trefoil (*Trifolium dubium*): always restricted to southernmost south Mainland where it was once well established, but not seen since 1982.
    - Henbit dead-nettle (*Lamium amplexicaule*): occurred occasionally in south Mainland, but last recorded in 1987.
    - Common cornsalad (*Valerianella locusta*): formerly found in two sandy arable areas at the north of Unst and southernmost south Mainland, but not seen since 1966.
    - Wood burdock (*Arctium nemorosum*): always restricted to southernmost South Mainland, with just 20 plants counted in 2000.
    - Long-headed poppy: formerly a widespread but scarce weed of arable ground, now restricted to a handful of locations, the majority of which are in the south Mainland.
    - Field pansy (*Viola arvensis*): formerly a regular arable weed in north Unst, north Yell and southern south Mainland, but only occasional sightings in south Mainland since 1997.
    - Slender parsley-piert (*Aphanes australis*): although always having a localised distribution it was last seen in 1982.
    - Sun spurge (*Euphorbia helioscopia*): formerly found on arable ground on Unst, Fetlar, Yell and the limestone of central Mainland, but since 1990 almost confined to the southern South Mainland.
    - Dove's-foot crane's-bill (*Geranium molle*): always a localised distribution but in recent years rarely seen and now restricted to North Yell, South Mainland and a holm off Vementry.
    - Red bartsia (*Odontites vernus*): formerly used to grow along the edges of cornfields but now restricted to sandy pastures at four sites in Shetland.
    - Corn marigold (*Chrysanthemum segetum*): once scattered amongst oats or potatoes in various parts of Shetland (Harvey, 2004).
- Arctic char (*Salvelinus alpinus*).
- Breeding Waders;
    - Oystercatcher (*Haematopus ostralegus*), ringed plover (*Charadrius hiaticula*), golden plover (*Pluvialis apricaria*), lapwing (*Vanellus vanellus*), dunlin (*Calidris alpina*), snipe (*Gallinago gallinago*), whimbrel (*Numenius phaeopus*), curlew (*Numenius arquata*), redshank (*Tringa totanus*), greenshank (*Tringa nebularia*) and common sandpiper (*Actitis hypoleucos*) (Ellis, 2004).

- Bumblebees (*Bombus spp*.).
- Eider (*Somateria mollissima*).
- Harbour porpoise (*Phocoena phocoena*).
- Hawkweeds (*Hieracium* spp.).
- Merlin (*Falco columbarius*).
- Oysterplant.
- Red-necked phalarope (*Phalaropus lobatus*).
- Red-throated diver.
- Skylark.

Only oysterplant, of the LBAP plant species, have recently been recorded in the Search Area. Many of the LBAP bird species are known to use the Proposed Development Area.

Existing habitat records for the Search Area and surrounding area

Few records of existing habitat surveys within the Search Area were located. The main two were;

- Norwick Meadows SSSI citation (NatureScot, 2020);
- A draft NVC survey of Norwick Meadows SSSI (Smedley and Uttley, 1994, provided by Johnathan Swale of SNH in June 2018); and
- Sand Dune Vegetation Survey of Scotland (Dargie, 1998), which included the sand dunes at Inner Skaw.

There were some additional, more general published resources for habitats in Shetland such as coastal grassland management guide and the Habitat Action Plans for Shetland. Habitats around the Proposed Development are detailed in Appendix 7.2: Phase 1 Habitat, NVC and Groundwater Dependent Terrestrial Ecosystems report.

SSSI citation data

Norwick Meadows SSSI is also very close to the Proposed New Section of Access Road at Northdale (ca. 200m south), Proposed Launch and Range Control Centre (ca. 230m north) and near to the Proposed Launch Site (ca. 600m south). Norwick Meadows SSSI is designated for its valley fen wetlands and sand dunes (NatureScot, 2020).

The SSSI citation for Norwick Meadows describes the habitats as "*On the eastern end of Norwick Meadows SSSI between the marsh and the sea, there is a small but floristically rich sand dune system with marram grass* Ammophila arenaria*, sand couch* Elymus farctus*, yarrow* Achillea millefolium*, tufted vetch* Vicia cracca *and meadow vetchling* Lathyrus pratensis*. The nationally scarce and locally rare sea pea* Lathyrus japonicus subsp. maritimus*, internationally rare and locally scarce autumn gentian* Gentianella amarella subsp. septentrionalis *and nationally scarce curved sedge* Carex maritima *have been recorded from the site. Norwick Meadows SSSI provides one of the best and most extensive examples of mesotrophic (moderately nutrient-rich) marsh in Shetland. The meadows are species-rich with much of the*

area dominated by bottle sedge Carex rostrata *with bogbean* Menyanthes trifoliata*, marsh cinquefoil* Potentilla palustris *and amphibious bistort* Persicaria amphibiaalso *present. It is the most important site in Shetland for the locally rare white sedge* Carex curta*. The wettest parts of the marsh support the largest beds of mare's-tail* Hippuris vulgaris *in Shetland*".

Norwick Meadows NVC Survey data

The draft 1994 NVC survey of Norwick Meadows SSSI provides relatively detailed data on the SSSI (Smedley and Uttley, 1994, provided by Johnathan Swale of SNH in June 2018). It describes Norwick Meadows as: "*Norwick Meadows, along the Burn of Norwick, from Norwick Meadow to Northdale, consists of a valley fen, mainly* Carex rostrata – Potentilla palustris *tall-herb fen (S27) with localised development of mire communities, both poor- and rich-fen, including* Carex rostrata – Sphagnum squarrosum *mire (M5) and* Carex rostra – Calliergon cuspidatum/giganteum mire *(M9)."*

It goes on to describe the NVC communities:

- S27 *Carex rostrata – Potentilla palustris* tall-herb fen;
- M5 *Carex rostrata – Sphagnum squarrosum* mire;
- M6bi *Carex nigra – Sphagnum palustre/fallax; and*
- M9 *Carex rostra – Calliergon cuspidatum/giganteum.*

The report mentions the presence of MG8 *Cynosurus cristatus – Caltha palustris* grassland, S10 *Equisetetum fluviatile* swamp, S19 *Eleocharis palustris* swamp, S28 *Phalaris arundinacea* tall-herb fen, M28 *Iris pseudacorus – Filipendula ulmaria mire*, U6 *Juncus squarrosus – Festuca ovina* grassland, M25 *Molinia caerulea – Potentilla erecta* and MG12 *Festuca arundinacea* grassland within the SSSI boundary.

Sand Dune Vegetation Survey of Scotland

Inner Skaw, Wick of Skaw and Norwick formed part of the Shetland report of the Sand Dune Vegetation Survey of Scotland (SDVSS, Dargie, 1998a, 1998b, 1998c).

Inner Skaw is within the Proposed Launch Site boundary. The SDVSS survey reported a combination of SD4 *Elytrigia juncea* fore-dune community and SD8d *Festuca rubra – Galium verum* fixed dune grassland *Bellis perennis - Ranunculus acris* sub-community at Inner Skaw. SD8d was reported as the most common of the fixed dune grassland in Shetland and was considered to be generally species poor (Dargie, 1998a). MC8 *Festuca rubra – Holcus lanatus* maritime grassland was also recorded as the dune habitats transitioned to grassland.

Dargie (1998b) stated that "*The nature conservation interest of the site* [Inner Skaw] *is low due to small site area and limited range of vegetation*".

Similar NVC communities were reported at Wick of Skaw and Norwick, including:

- SD2 *Honkenya peploides – Cakile maritima* strandline community;

- SD4 *Elytrigia juncea* fore-dune community;
- SD8d *Festuca rubra – Galium verum* fixed dune grassland;
- MC8 *Festuca rubra – Holcus lanatus* maritime grassland;
- MG7 *Lolium perenne – Plantago lanceolata* community; and
- MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community.

Habitats in Shetland

In general, habitats in Shetland are reported to be "*strongly influenced by the islands' climate together with the nature of the terrain and underlying rocks*" as well as "*human influence on the natural heritage have been, and remain, strong*" (SNH, 2002). Habitats found across Shetland are discussed in a variety of published sources including the Habitat Actions Plans for freshwater (Hardy, 2004), strandlines (Davies and Gillham, 2004), ungrazed areas (Swale, 2004) and woodlands (McKenzie, Johnson, and Davies 2004); Scottish saltmarsh survey national report (Haynes, 2016) and Plantlife documents including "*A management Guide to Coastal grasslands*" (PlantLife, 2014).

Discussion

This desk study has identified several records of important ecological sensitivities within the Search Area, as far as existing and freely available data allows. Desk-based studies of this nature have limitations, such as the reliability of third-party records, the coverage of reported studies and the age of some records.

There was a relatively high number of records for some taxonomic groups e.g. birds, lichens, bryophytes and vascular plants for the Search Area, indicating a good base level of knowledge for these groups. However, there was a relatively paucity of biological records available for other taxonomic groups, such as Hymenoptera indicating either that there was a low of biodiversity within the Search Area and/or a low level of invertebrate biological recording.

There was some historic record of the habitats in and around the Search Area and general information available in relation to habitats found in Shetland.

It is important to understand that a lack of information for a species (or indeed Class/Order) does not necessarily mean absence and previous historical occurrence does not necessarily mean current presence.

References

Chartered Institute of Ecology and Environmental Management (CIEEM). 2016. *UK Guidelines for Accessing and Using Biodiversity Data.* CIEEM.

CIEEM. 2017. *Guidelines for Preliminary Ecological Appraisal*. CIEEM.

Crawley, D., Coomber, F., Kubasiewicz, L., Harrower, C., Evans, P., Waggit, J., Smith, B. and Mathews, F. 2020. *Atlas of Mammals of Great Britain and Northern Ireland*. Pelagic Publishing.

Dalby, K, and Dalby C (2005) Shetland Lichens. Shetland Amenity Trust.

Dargie, T. 1998a. *Sand dune vegetation survey of Scotland: Shetland*. *Volume 1: Main report*. Scottish Natural Heritage (SNH) Research, Survey and Monitoring Report No. 122 (Volume 1 of 3).

Dargie, T. 1998b. *Sand dune vegetation survey of Scotland: Shetland*. *Volume 2: Site report*. SNH Research, Survey and Monitoring Report No. 122 (Volume 2 of 3).

Dargie, T. 1998c. *Sand dune vegetation survey of Scotland: Shetland*. *Volume 3: NVC maps*. SNH Research, Survey and Monitoring Report No. 122 (Volume 3 of 3).

Davies, N. and Gillham, K. 2004. Living Shetland Biodiversity Action Plan. *Habitat Action Plan – Strandlines*.

Dorset Nature. 2020. http://www.dorsetnature.co.uk/pages-lichen/lch-257.html. Accessed August 2020.

Ellis, P. 2004. Living Shetland Biodiversity Action Plan *Grouped Species Action Plan - Arable birds*.

Ellis, P. 2004. Living Shetland Biodiversity Action Plan *Grouped Species Action Plan – breeding waders*.

Hardy, D. 2004. Living Shetland Biodiversity Action Plan. *Habitat Action Plan – Freshwater*.

Harvey, P. 2004. Living Shetland Biodiversity Action Plan *Grouped Species Action Plan -Arable associated* plants.

Haynes, T.A. 2016. *Scottish saltmarsh survey national report*. SNH Commissioned Report No. 786.

Images of British Lichens, 2020. http://www.lichens.lastdragon.org/. Accessed August 2020.

Maritime Lichens, 2020. http://www.lichensmaritimes.org/index.php?task=fiche&lichen=85&lang=en. Accessed August 2020.

McKenzie, J., Johnson, A., and Davies, N. 2004. Living Shetland Biodiversity Action Plan. *Habitat Action Plan – Woodlands*.

National Biodiversity Network (NBN) Atlas, 2020. https://nbnatlas.org/.

NatureScot. 2020. Sitelink. https://sitelink.nature.scot/home Accessed in April and August 2020.

NBN Atlas occurrence download at NBN Atlas accessed on Tues 11 August 2020.

PlantLife. 2014. Coastal grasslands, a management guide. https://www.plantlife.org.uk/application/files/4714/8155/7847/Coastal_grasslands_FINAL.pdf.

Scott, W., Harvey, P., Riddington, R. and Fisher, M. 2002. Rare Plants of Shetland. Shetland Amenity Trust.

Scottish Biodiversity List (SBL). 2013. https://www.webarchive.org.uk/wayback/archive/20160402063428/http://www.gov.scot/Topics/Environment/Wildlife-Habitats/16118/Biodiversitylist/SBL.

Scottish Natural Heritage (SNH). 2002. Natural Heritage Futures: Shetland.

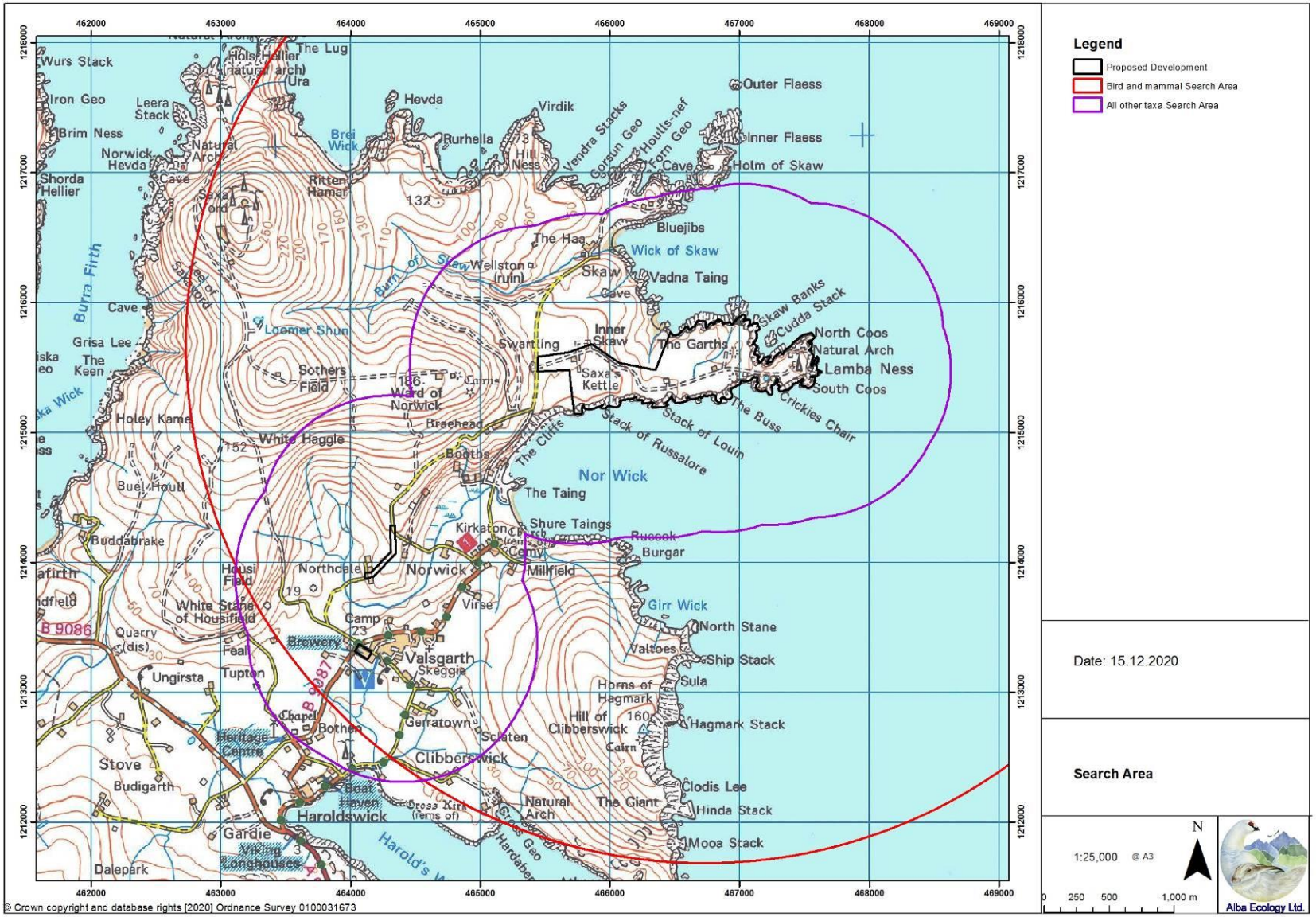
Shetland Island Council (SIC). 2015. *Shetland Local Development Plan, Supplementary Guidance Local Nature Conservation Sites*, 2014, Adopted 2015.

Smedley, M.D., and Uttley, J. 1994. Draft Norwick Meadows SSSI NVC survey. Provided by Johnathan Swale of SNH in June 2018.

Swale, J. 2004. Living Shetland Biodiversity Action Plan. *Habitat Action Plan – Ungrazed Areas*.

UK Moths. 2020. https://ukmoths.org.uk/species/celaena-haworthii. Accessed August 2020.

Appendix 7.1 Drawing 1: Desk Study Search Area



Species	Common Name	Reference(s)
Lutra lutra	European Otter	Shetland Biological Records Centre, 2002-2011
Rattus norvegicus	Brown Rat	Shetland Biological Records Centre, 1997-2004
Oryctolagus cuniculus	European Rabbit	Shetland Biological Records Centre, 2003
Cetorhinus maximus	Basking Shark	Shetland Biological Records Centre, 2011-2019
Cytophora cristata	Hooded Seal	Shetland Biological Records Centre, 2013
Balaenoptera acutorostrata	Minke Whale	Shetland Biological Records Centre, 2001-2019
Megaptera novaeangliae	Humpback Whale	Shetland Biological Records Centre, 2017
Globicephala melas	Long-finned Pilot Whale	Shetland Biological Records Centre, 2017
Grampus griseus	Risso's Dolphin	Shetland Biological Records Centre, 1991-2017
Lagenorhynchus acutus	Atlantic White-sided Dolphin	Shetland Biological Records Centre, 2001-2009
Lagenorhynchus albirostris	White-beaked Dolphin	Shetland Biological Records Centre, 2000-2003
Orcinus orca	Killer Whale	Shetland Biological Records Centre, 1990-2019
Phocoena phocoena	Common Porpoise	Shetland Biological Records Centre, 2002-2006
Erinaceus europaeus	West European Hedgehog	Shetland Biological Records Centre, 2002-2009
Chiroptera	Bats	Shetland Biological Records Centre, 2011-2015
Pipistrellus nathusii	Nathusius's Pipistrelle	Shetland Biological Records Centre, 1996-2011
Vespertilio murinus	Parti-coloured Bat	Shetland Biological Records Centre, 2003

Species	Common Name	Reference(s)
Cygnus olor	Mute Swan	Shetland Biological Records Centre, 2001-2019
Cygnus cygnus	Whooper Swan	
Anser fabalis	Bean Goose	
Anser fabalis subsp. rossicus	Tundra Bean Goose	
Anser brachyrhynchus	Pink-footed Goose	
Anser albifrons subsp. albifrons	European Greater White-fronted G	
Anser anser	Greylag Goose	
Branta canadensis	Canada Goose	
Branta leucopsis	Barnacle Goose	
Branta bernicla subsp. hrota	Light-bellied Brent Goose	
Tadorna tadorna	Shelduck	
Anas penelope	Wigeon	
Anas crecca	Teal	
Anas platyrhynchos	Mallard	
Anas acuta	Pintail	
Aythya ferina	Pochard	
Aythya fuligula	Tufted Duck	
Somateria mollissima	Eider	
Clangula hyemalis	Long-tailed Duck	
Melanitta nigra	Common Scoter	
Melanitta perspicillata	Surf Scoter	
Melanitta fusca	Velvet Scoter	
Bucephala clangula	Goldeneye	
Mergus cucullatus	Hooded Merganser	
Mergus serrator	Red-breasted Merganser	
Mergus merganser	Goosander	
Coturnix coturnix	Quail	
Gavia stellata	Red-throated Diver	
Gavia immer	Great Northern Diver	
Fulmarus glacialis	Fulmar	
Fulmarus glacialis subsp. glacialis	Fulmarus glacialis subsp. glacialis	
Phalacrocorax carbo	Cormorant	
Phalacrocorax aristotelis	Shag	
Ardea cinerea	Grey Heron	
Tachybaptus ruficollis	Little Grebe	
Podiceps auritus	Slavonian Grebe	
Rallus aquaticus	Water Rail	
Porzana porzana	Spotted Crake	
Crex crex	Corncrake	
Gallinula chloropus	Moorhen	
Fulica atra	Coot	
Grus grus	Crane	
Haematopus ostralegus	Oystercatcher	
Pluvialis apricaria	Golden Plover	
Vanellus vanellus	Lapwing	
Charadrius dubius	Little Ringed Plover	
Charadrius hiaticula	Ringed Plover	
Charadrius morinellus	Dotterel	
Numenius phaeopus	Whimbrel	
Numenius arquata	Curlew	
Limosa limosa	Black-tailed Godwit	
Arenaria interpres	Turnstone	
Calidris canutus	Knot	
Philomachus pugnax	Ruff	
Calidris ferruginea	Curlew Sandpiper	
Calidris alba	Sanderling	

Calidris alpina	Dunlin
Calidris maritima	Purple Sandpiper
Phalaropus lobatus	Red-necked Phalarope
Tringa nebularia	Greenshank
Tringa totanus	Redshank
Lymnocryptes minimus	Jack Snipe
Scolopax rusticola	Woodcock
Gallinago gallinago	Snipe
Stercorarius parasiticus	Arctic Skua
Fratercula arctica	Puffin
Cepphus grylle	Black Guillemot
Alca torda	Razorbill
Uria aalge	Guillemot
Sterna hirundo	Common Tern
Sterna paradisaea	Arctic Tern
Rissa tridactyla	Kittiwake
Chroicocephalus ridibundus	Black-headed Gull
Larus canus	Common Gull
Larus fuscus	Lesser Black-backed Gull
Larus fuscus subsp. graellsii	British Lesser Black-Backed Gull
Larus argentatus	Herring Gull
Larus glaucoides	Iceland Gull
Larus hyperboreus	Glaucous Gull
Larus marinus	Great Black-backed Gull
Columba palumbus	Woodpigeon
Falco columbarius	Merlin
Falco peregrinus	Peregrine
Corvus corone subsp. cornix	Hooded Crow
Alauda arvensis	Skylark
Hirundo rustica	Swallow
Delichon urbica	House Martin
Phylloscopus collybita	Chiffchaff
Hippolais icterina	Icterine Warbler
Acrocephalus palustris	Marsh Warbler
Troglodytes troglodytes	Wren
Sturnus vulgaris	Starling
Turdus merula	Blackbird
Turdus pilaris	Fieldfare
Turdus iliacus	Redwing
Oenanthe oenanthe	Wheatear
Passer domesticus	House Sparrow
Passer montanus	Tree Sparrow
Motacilla cinerea	Grey Wagtail
Motacilla alba subsp. yarrellii	Pied Wagtail
Motacilla alba subsp. alba	White Wagtail
Anthus pratensis	Meadow Pipit
Anthus petrosus	Rock Pipit
Actitis hypoleucos	Common Sandpiper
Stercorarius skua	Great Skua

Species	Common Name	Reference(s)
Rana temporaria	Common Frog	Shetland Biological records 1999

Species	Common Name	Reference(s)
Huperzia selago	Fir Clubmoss	Shetland Biological Records Centre, 1991-2018
Selaginella selaginoides	Lesser Clubmoss	
Equisetum arvense	Field Horsetail	
Equisetum fluviatile	Water Horsetail	
Equisetum palustre	Marsh Horsetail	
Polypodium vulgare agg.	Polypody	
Asplenium adiantum-nigrum	Black Spleenwort	
Blechnum spicant	Hard-fern	
Dryopteris dilatata	Broad Buckler-fern	
Hymenophyllum wilsonii	Wilson's Filmy-fern	
Botrychium lunaria	Moonwort	
Ophioglossum azoricum	Small Adder's-tongue	
Dryopteris filix-mas agg.	Male Fern	
Poa pratensis	Smooth Meadow-Grass	
Trichophorum cespitosum subsp. germanicum	Deergrass	
Callitriche stagnalis	Common Water-Starwort	
Trichophorum cespitosum	Deergrass	
Elytrigia repens subsp. repens	Common Couch	
Callitriche hamulata	Intermediate Water-Starwort	
Carex arenaria	Sand Sedge	
Carex bigelowii	Stiff Sedge	
Carex binervis	Green-ribbed Sedge	
Carex curta	White Sedge	
Carex echinata	Star Sedge	
Carex flacca	Glaucous Sedge	
Carex hostiana x viridula = C. x fulva	Sedge	
Carex limosa	Bog-sedge	
Carex nigra	Common Sedge	
Carex ovalis	Oval Sedge	
Carex panicea	Carnation Sedge	
Carex paniculata	Greater Tussock-sedge	
Carex pilulifera	Pill Sedge	
Carex pulicaris	Flea Sedge	
Carex rostrata	Bottle Sedge	
Carex viridula subsp. oedocarpa	Common Yellow-sedge	
Eleocharis palustris	Common Spike-rush	
Eriophorum angustifolium	Common Cottongrass	
Eriophorum vaginatum	Hare's-tail Cottongrass	
Crocosmia pottsii x aurea = C. x crocosmiiflora	Montbretia	
Iris pseudacorus	Yellow Iris	
Juncus articulatus	Jointed Rush	
Juncus bufonius	Toad Rush	
Juncus bulbosus	Bulbous Rush	
Juncus conglomeratus	Compact Rush	
Juncus effusus	Soft-rush	
Juncus squarrosus	Heath Rush	
Luzula campestris	Field Wood-rush	
Luzula multiflora	Heath Wood-rush	
Luzula multiflora subsp. congesta	Heath Wood-Rush	
Luzula multiflora subsp. multiflora	Heath Wood-Rush	
Luzula sylvatica	Great Wood-rush	
Triglochin palustre	Marsh Arrowgrass	
Hyacinthoides non-scripta x hispanica = H. x massartiana	Bluebell	
Narthecium ossifragum	Bog Asphodel	
Scilla verna	Spring Squill	
Coeloglossum viride	Frog Orchid	
Dactylorhiza	Marsh-Orchid	
Dactylorhiza fuchsii x purpurella = D. x venusta	Marsh-Orchid	
Dactylorhiza incarnata subsp. pulchella	Early Marsh-Orchid	
Dactylorhiza maculata	Heath Spotted-orchid	
Dactylorhiza purpurella	Northern Marsh-orchid	
Listera cordata	Lesser Twayblade	
Agrostis canina	Velvet Bent	
Agrostis capillaris	Common Bent	
Agrostis stolonifera	Creeping Bent	
Agrostis vinealis	Brown Bent	
Aira praecox	Early Hair-grass	
Atriplex prostrata agg.	Atriplex prostrata agg.	
Alopecurus geniculatus	Marsh Foxtail	
Alopecurus pratensis	Meadow Foxtail	
Ammophila arenaria	Marram	
Lychnis flos-cuculi	Ragged-Robin	
Anthoxanthum odoratum	Sweet Vernal-grass	
Arrhenatherum elatius	False Oat-grass	
Cochlearia officinalis agg.	Common Scurvygrass	
Bromus hordeaceus	Lesser Soft-Brome	
Cynosurus cristatus	Crested Dog's-tail	
Dactylis glomerata	Cock's-foot	
Deschampsia cespitosa	Tufted Hair-Grass	
Deschampsia flexuosa	Wavy Hair-grass	
Elytrigia juncea subsp. boreoatlantica	Sand Couch	
Elytrigia repens	Common Couch	
Festuca arundinacea	Tall Fescue	
Festuca rubra	Red Fescue	
Festuca rubra subsp. arctica	Red Fescue	
Festuca rubra subsp. rubra	Red Fescue	
Festuca vivipara	Viviparous Sheep's-fescue	
Glyceria fluitans	Floating Sweet-grass	
Holcus lanatus	Yorkshire-fog	
Leymus arenarius	Lyme-grass	
Lolium perenne	Perennial Rye-grass	
Molinia caerulea	Purple Moor-grass	

Nardus stricta	Mat-grass
Phalaris arundinacea	Reed Canary-grass
Poa annua	Annual Meadow-grass
Poa humilis	Spreading Meadow-grass
Poa trivialis	Rough Meadow-grass
Puccinellia distans	Reflexed Saltmarsh-Grass
Potamogeton	Pondweed
Potamogeton polygonifolius	Bog Pondweed
Typha latifolia	Bulrush
Angelica sylvestris	Wild Angelica
Anthriscus sylvestris	Cow Parsley
Conopodium majus	Pignut
Heracleum sphondylium	Hogweed
Heracleum sphondylium subsp. sphondylium	Hogweed
Hydrocotyle vulgaris	Marsh Pennywort
Ligusticum scoticum	Scots Lovage
Achillea millefolium	Yarrow
Achillea ptarmica	Sneezewort
Artemisia vulgaris	Mugwort
Aster novi-belgii	Confused Michaelmas-daisy
Bellis perennis	Daisy
Centaurea montana	Perennial Cornflower
Cichorium intybus	Chicory
Cirsium arvense	Creeping Thistle
Cirsium vulgare	Spear Thistle
Hypochaeris radicata	Cat's-ear
Leontodon autumnalis	Autumn Hawkbit
Matricaria discoidea	Pineappleweed
Petasites albus	White Butterbur
Senecio aquaticus	Marsh Ragwort
Senecio jacobaea	Common Ragwort
Senecio vulgaris	Groundsel
Solidago virgaurea	Goldenrod
Sonchus arvensis	Perennial Sow-thistle
Tanacetum vulgare	Tansy
Taraxacum	Dandelion Agg.
Taraxacum faeroense	Dandelion
Taraxacum officinale agg.	Dandelion
Tripleurospermum inodorum	Scentless Mayweed
Tripleurospermum maritimum	Sea Mayweed
Anchusa arvensis	Bugloss
Borago officinalis	Borage
Mertensia maritima	Oysterplant
Myosotis arvensis	Field Forget-me-not
Myosotis discolor	Changing Forget-me-not
Myosotis laxa	Tufted Forget-me-not
Myosotis scorpioides	Water Forget-me-not
Myosotis secunda	Creeping Forget-me-not
Arabis petraea	Northern Rock-cress
Cakile maritima	Sea Rocket
Cakile maritima subsp. integrifolia	Cakile maritima subsp. integrifolia
Capsella bursa-pastoris	Shepherd's-purse
Cardamine hirsuta	Hairy Bitter-cress
Cardamine pratensis	Cuckooflower
Cochlearia officinalis	Common Scurvygrass
Cochlearia officinalis subsp. officinalis	Scurvygrass
Crambe maritima	Sea-kale
Callitriche	Water-Starwort
Jasione montana	Sheep's-bit
Arenaria norvegica subsp. norvegica	Arctic Sandwort
Cerastium diffusum	Sea Mouse-ear
Cerastium fontanum	Common Mouse-ear
Cerastium fontanum subsp. holosteoides	Common Mouse-Ear
Cerastium glomeratum	Sticky Mouse-ear
Honckenya peploides	Sea Sandwort
Sagina maritima	Sea Pearlwort
Sagina procumbens	Procumbent Pearlwort
Silene acaulis	Moss Campion
Silene dioica	Red Campion
Silene uniflora	Sea Campion
Spergula arvensis	Corn Spurrey
Stellaria alsine	Bog Stitchwort
Stellaria uliginosa	Bog Stitchwort
Stellaria media	Common Chickweed
Atriplex glabriuscula	Babington's Orache
Atriplex prostrata	Spear-leaved Orache
Chenopodium album	Fat-hen
Convolvulus arvensis	Field Bindweed
Sedum rosea	Roseroot
Succisa pratensis	Devil's-bit Scabious
Drosera rotundifolia	Round-leaved Sundew
Empetrum nigrum	Crowberry agg.
Empetrum nigrum subsp. nigrum	Crowberry
Calluna vulgaris	Heather
Erica cinerea	Bell Heather
Erica tetralix	Cross-leaved Heath
Vaccinium myrtillus	Bilberry
Vaccinium uliginosum	Bog Bilberry
Vaccinium vitis-idaea	Cowberry
Anthyllis vulneraria	Kidney Vetch
Lathyrus japonicus	Sea Pea
Lathyrus pratensis	Meadow Vetchling
Lotus corniculatus	Common Bird's-foot-trefoil
Trifolium pratense	Red Clover

Trifolium repens	White Clover
Ulex europaeus	Gorse
Vicia cracca	Tufted Vetch
Vicia sepium	Bush Vetch
Gentianella campestris	Field Gentian
Geranium psilostemon	Armenian Crane's-bill
Geranium robertianum	Herb-Robert
Hippuris vulgaris	Mare's-tail
Lamium confertum	Northern Dead-nettle
Lamium purpureum	Red Dead-nettle
Mentha spicata	Spear Mint
Prunella vulgaris	Selfheal
Thymus polytrichus	Thymus polytrichus
Pinguicula vulgaris	Common Butterwort
Linum catharticum	Fairy Flax
Menyanthes trifoliata	Bogbean
Epilobium brunnescens	New Zealand Willowherb
Epilobium montanum	Broad-leaved Willowherb
Epilobium palustre	Marsh Willowherb
Papaver dubium	Long-headed Poppy
Plantago coronopus	Buck's-horn Plantain
Plantago lanceolata	Ribwort Plantain
Plantago major	Greater Plantain
Plantago major subsp. major	Greater Plantain
Plantago maritima	Sea Plantain
Armeria maritima subsp. maritima	Thrift
Polygala serpyllifolia	Heath Milkwort
Polygala vulgaris	Common Milkwort
Persicaria amphibia	Amphibious Bistort
Persicaria bistorta	Common Bistort
Persicaria maculosa	Redshank
Polygonum aviculare	Knotgrass
Polygonum boreale	Northern Knotgrass
Rheum palmatum x rhaponticum = R. x hybridum	Rhubarb
Rumex acetosa	Common Sorrel
Rumex acetosa subsp. acetosa	Common Sorrel
Rumex acetosella	Sheep's Sorrel
Rumex acetosella subsp. acetosella	Sheep's Sorrel
Rumex crispus	Curled Dock
Rumex crispus subsp. littoreus	Curled Dock
Rumex crispus x obtusifolius = R. x pratensis	Dock
Rumex longifolius	Northern Dock
Rumex obtusifolius	Broad-leaved Dock
Claytonia perfoliata	Springbeauty
Montia fontana	Blinks
Montia fontana subsp. fontana	Blinks
Anagallis tenella	Bog Pimpernel
Caltha palustris	Marsh-marigold
Ranunculus acris	Meadow Buttercup
Ranunculus ficaria	Lesser Celandine
Ranunculus ficaria subsp. ficaria	Lesser Celandine
Ranunculus flammula	Lesser Spearwort
Ranunculus flammula subsp. flammula	Lesser Spearwort
Ranunculus repens	Creeping Buttercup
Alchemilla glabra	Smooth Lady's-mantle
Potentilla erecta	Tormentil
Potentilla erecta subsp. erecta	Tormentil
Potentilla palustris	Marsh Cinquefoil
Rosa rugosa	Japanese Rose
Rubus idaeus	Raspberry
Galium aparine	Cleavers
Galium palustre	Marsh-bedstraw
Galium palustre subsp. palustre	Common Marsh-bedstraw
Galium saxatile	Heath Bedstraw
Galium verum	Lady's Bedstraw
Salix cinerea x phylicifolia = S. x laurina	Laurel-leaved Willow
Euphrasia	Eyebright
Euphrasia arctica	an Eyebright
Euphrasia micrantha	Eyebright
Euphrasia nemorosa	Eyebright
Euphrasia officinalis agg.	Eyebright
Hebe elliptica x speciosa = H. x franciscana	Hedge Veronica
Mimulus guttatus	Monkeyflower
Pedicularis palustris	Marsh Lousewort
Pedicularis sylvatica	Lousewort
Rhinanthus minor	Yellow-rattle
Rhinanthus minor subsp. stenophyllus	Yellow-Rattle
Scrophularia nodosa	Common Figwort
Veronica scutellata	Marsh Speedwell
Veronica serpyllifolia	Thyme-leaved Speedwell
Veronica serpyllifolia subsp. serpyllifolia	Thyme-Leaved Speedwell
Urtica dioica	Common Nettle
Viola arvensis	Field Pansy
Viola palustris	Marsh Violet
Viola palustris subsp. palustris	Marsh Violet
Viola riviniana	Common Dog-violet
Viola tricolor	Wild Pansy
Armeria maritima	Sea Pink
Potentilla anserina	Silverweed
Polypodium vulgare	Polypody

Species	Common Name	Liverwort/Moss	Reference
Aneura pinguis	Greasewort	Liverwort	Shetland Biological records 2008
Blepharostoma trichophyllum	Hairy Threadwort	Liverwort	Shetland Biological records 2008
Calypogeia fissa	Common Pouchwort	Liverwort	Shetland Biological records 2008
Calypogeia muelleriana	Mueller's Pouchwort	Liverwort	Shetland Biological records 2008
Cephalozia bicuspidata	Two-horned Pincerwort	Liverwort	Shetland Biological records 2008
Cephalozia leucantha	Pale Pincerwort	Liverwort	Shetland Biological records 2008
Cephaloziella divaricata	Common Threadwort	Liverwort	Shetland Biological records 2008
Cephaloziella hampeana	Hampe's Threadwort	Liverwort	Shetland Biological records 2008
Diplophyllum albicans	White Earwort	Liverwort	Shetland Biological records 2008
Kurzia trichoclados	Heath Fingerwort	Liverwort	Shetland Biological records 2008
Lepidozia reptans	Creeping Fingerwort	Liverwort	Shetland Biological records 2008
Lophocolea bidentata	Bifid Crestwort	Liverwort	Shetland Biological records 2008
Lophozia incisa	Jagged Notchwort	Liverwort	Shetland Biological records 2008
Lophozia ventricosa	Tumid Notchwort	Liverwort	Shetland Biological records 2001-2008
Lunularia cruciata	Crescent-cup Liverwort	Liverwort	Shetland Biological records 2008
Mylia anomala	Anomalous Flapwort	Liverwort	Shetland Biological records 2008
Mylia taylori	Taylor's Flapwort	Liverwort	Shetland Biological records 2001-2008
Nardia compressa	Compressed Flapwort	Liverwort	Shetland Biological records 2001
Pellia epiphylla	Overleaf Pellia	Liverwort	Shetland Biological records 2001-2008
Pellia neesiana	Nees' Pellia	Liverwort	Shetland Biological records 2001-2008
Ptilidium ciliare	Ciliated Fringewort	Liverwort	Shetland Biological records 2008
Riccardia latifrons	Bog Germanderwort	Liverwort	Shetland Biological records 2008
Scapania gracilis	Western Earwort	Liverwort	Shetland Biological records 2001-2008
Scapania undulata	Water Earwort	Liverwort	Shetland Biological records 2008
Tritomaria exsectiformis	Larger Cut Notchwort	Liverwort	Shetland Biological records 2008
Sphagnum	Bog Moss	Moss	Shetland Biological records 1991-2015
Aulacomnium palustre	Bog Groove-moss	Moss	Shetland Biological records 1991-2016
Barbula convoluta var. convoluta	Lesser Bird's-claw Beard-moss	Moss	Shetland Biological records 1991-2017
Barbula unguiculata	Bird's-claw Beard-moss	Moss	Shetland Biological records 1991-2018
Brachythecium rutabulum	Rough-stalked Feather-moss	Moss	Shetland Biological records 1991-2019
Bryum capillare	Capillary Thread-moss	Moss	Shetland Biological records 1991-2020
Bryum pseudotriquetrum	Marsh Bryum	Moss	Shetland Biological records 1991-2021
Calliergon giganteum	Giant Spear-moss	Moss	Shetland Biological records 1991-2022
Calliergon cuspidatum	Pointed Spear-moss	Moss	Shetland Biological records 1991-2023
Campylopus paradoxus	Rusty Swan-neck Moss	Moss	Shetland Biological records 1991-2024
Cratoneuron filicinum	Fern-leaved Hook-moss	Moss	Shetland Biological records 1991-2025
Dicranella varia	Variable Forklet-moss	Moss	Shetland Biological records 1991-2026
Dicranum bonjeanii	Crisped Fork-moss	Moss	Shetland Biological records 1991-2027
Dicranum fuscescens	Dusky Fork-moss	Moss	Shetland Biological records 1991-2028
Dicranum majus	Greater Fork-moss	Moss	Shetland Biological records 1991-2029
Dicranum scoparium	Broom Fork-moss	Moss	Shetland Biological records 1991-2030
Barbula fallax	Fallacious Beard-moss	Moss	Shetland Biological records 1991-2031
Barbula cylindrica	Cylindric Beard-moss	Moss	Shetland Biological records 1991-2032
Barbula rigidula	Rigid Beard-moss	Moss	Shetland Biological records 1991-2033
Drepanocladus revolvens	Rusty Hook-moss	Moss	Shetland Biological records 1991-2034
Eurhynchium praelongum	Common Feather-moss	Moss	Shetland Biological records 1991-2035
Homalothecium sericeum	Silky Wall Feather-moss	Moss	Shetland Biological records 1991-2036
Hylocomium splendens	Glittering Wood-moss	Moss	Shetland Biological records 1991-2037
Hypnum jutlandicum	Heath Plait-moss	Moss	Shetland Biological records 1991-2038
Isothecium myosuroides var. brach	Isothecium myosuroides var. brachythecioides	Moss	Shetland Biological records 1991-2039
Mnium hornum	Swan's-neck Thyme-moss	Moss	Shetland Biological records 1991-2040
Plagiomnium undulatum	Hart's-tongue Thyme-moss	Moss	Shetland Biological records 1991-2041
Polytrichum commune	Common Haircap	Moss	Shetland Biological records 1991-2042
Polytrichum commune var. commu	Polytrichum commune var. commune	Moss	Shetland Biological records 1991-2043
Polytrichum juniperinum	Juniper Haircap	Moss	Shetland Biological records 1991-2044
Polytrichum alpestre	Strict Haircap	Moss	Shetland Biological records 1991-2045
Barbula hornschuchiana	Hornschuch's Beard-moss	Moss	Shetland Biological records 1991-2046
Racomitrium lanuginosum	Woolly Fringe-moss	Moss	Shetland Biological records 1991-2047
Rhabdoweisia fugax	Dwarf Streak-moss	Moss	Shetland Biological records 1991-2048
Rhizomnium punctatum	Dotted Thyme-moss	Moss	Shetland Biological records 1991-2049
Rhytidiadelphus loreus	Little Shaggy-moss	Moss	Shetland Biological records 1991-2050
Rhytidiadelphus squarrosus	Springy Turf-moss	Moss	Shetland Biological records 1991-2051
Schistidium maritimum	Seaside Grimmia	Moss	Shetland Biological records 1991-2052
Sphagnum capillifolium	Red Bog-moss	Moss	Shetland Biological records 1991-2053
Sphagnum cuspidatum	Feathery Bog-moss	Moss	Shetland Biological records 1991-2054
Sphagnum recurvum var. mucronat	Flat-topped Bog-moss	Moss	Shetland Biological records 1991-2055
Sphagnum lindbergii	Lindberg's Bog-moss	Moss	Shetland Biological records 1991-2056
Sphagnum palustre	Blunt-leaved Bog-moss	Moss	Shetland Biological records 1991-2057
Sphagnum papillosum	Papillose Bog-moss	Moss	Shetland Biological records 1991-2058
Sphagnum squarrosum	Spiky Bog-moss	Moss	Shetland Biological records 1991-2059
Sphagnum subnitens	Lustrous Bog-moss	Moss	Shetland Biological records 1991-2060
Sphagnum tenellum	Soft Bog-moss	Moss	Shetland Biological records 1991-2061
Tortula muralis	Wall Screw-moss	Moss	Shetland Biological records 1991-2062
Drepanocladus fluitans	Floating Hook-moss	Moss	Shetland Biological records 1991-2063
Bryum bicolor	Bryum bicolor	Moss	Shetland Biological records 1991-2064
Hypnum cupressiforme	Hypnum cupressiforme	Moss	Shetland Biological records 1991-2065

Species	Common Name	Reference(s)
Acarospora fuscata		Shetland Biological Records Centre, 1990-2018
Agonimia tristicula		
Amandinea punctata		
Anaptychia runcinata		
Arthonia phaeobaea		
Arthonia varians		
Aspicilia caesiocinerea		
Aspicilia leprosescens		
Bacidia carneoglauca		
Bacidia scopulicola		
Baeomyces rufus		
Brigantiaea fuscolutea		
Caloplaca britannica		
Caloplaca ceracea		
Caloplaca crenularia		
Caloplaca crenulatella		
Caloplaca littorea		
Caloplaca marina	Orange Sea Lichen	
Caloplaca microthallina		
Caloplaca saxicola		
Caloplaca thallincola		
Caloplaca verruculifera	Orange Sea Star	
Candelariella vitellina		
Catapyrenium cinereum		
Cetraria aculeata		
Cetraria muricata		
Cladonia arbuscula subsp. squarrosa		
Cladonia bellidiflora		
Cladonia cervicornis subsp. cervicornis		
Cladonia ciliata var. tenuis		
Cladonia floerkeana		
Cladonia foliacea		
Cladonia gracilis		
Cladonia portentosa	Reindeer Moss	
Cladonia pyxidata		
Cladonia rangiformis		
Cladonia squamosa var. subsquamosa		
Cladonia subcervicornis		
Cladonia uncialis subsp. biuncialis		
Cliostomum griffithii		
Cliostomum tenerum		
Coccotrema citrinescens		
Evernia prunastri	Oak Moss	
Fuscidea cyathoides var. cyathoides		
Halecania ralfsii		
Hydropunctaria maura	Tar Lichen	
Hypogymnia physodes	Dark Crottle	
Ionaspis lacustris		
Lecania baeomma		
Lecanora albescens		
Lecanora confusa		
Lecanora expallens		
Lecanora farinaria		
Lecanora gangaleoides		
Lecanora helicopis		
Lecanora poliophaea		
Lecanora polytropa		
Lecanora pulicaris		
Lecanora rupicola var. rupicola		
Lecanora saligna		
Lecanora sulphurea		
Lecanora symmicta		
Lecanora umbrina		
Lecidea hypnorum		
Lecidea lactea		

Lecidella asema	
Lecidella meiococca	
Lecidella prasinula	
Lecidella scabra	
Lecidella stigmatea	
Leptogium britannicum	
Leptogium gelatinosum	
Lichenomphalia hudsoniana	
Lichina confinis	
Lichina pygmaea	Black Lichen
Lobaria virens	
Micarea lignaria	
Micarea peliocarpa	
Ochrolechia frigida	
Ochrolechia parella	Parelle
Opegrapha areniseda	
Opegrapha atra	
Opegrapha cesareensis	
Opegrapha multipuncta	
Pannaria pezizoides	
Parmelia omphalodes	
Parmelia saxatilis	Netted Shield Lichen
Parmelia sulcata	
Parmotrema chinense	
Parmotrema crinitum	Dog Lichen
Parmotrema perlatum	
Peltigera canina	
Peltigera hymenina	
Peltigera leucophlebia	
Peltigera membranacea	
Pertusaria albescens var. corallina	
Phaeophyscia orbicularis	
Physcia tenella	
Polyblastia cupularis	
Porina chlorotica f. chlorotica	
Porpidia macrocarpa	
Porpidia macrocarpa f. macrocarpa	
Porpidia platycarpoides	
Porpidia tuberculosa	
Protopannaria pezizoides	
Psoroma hypnorum	
Ramalina cuspidata	
Ramalina farinacea	Sea Ivory
Ramalina siliquosa	
Ramalina subfarinacea	
Rhizocarpon richardii	
Rinodina confragosa	
Rinodina oleae	
Roselliniopsis tartaricola	
Solorina spongiosa	
Sphaerophorus globosus	
Tephromela atra	
Tephromela grumosa	
Thelenella muscorum var. muscorum	
Thelenella muscorum var. octospora	
Toninia aromatica	
Trapelia coarctata	
Trapeliopsis pseudogranulosa	
Verrucaria fusconigrescens	Tar Lichen
Verrucaria maura	
Verrucaria nigrescens	
Violella fucata	Common Orange Lichen
Xanthoria aureola	
Xanthoria parietina	
Opegrapha calcarea	

Species	Common Name	Reference(s)
Dicymbium brevisetosum		Shetland Biologcal Records Centre 1991-2014
Hilaira frigida		
Lepthyphantes tenuis		
Lepthyphantes zimmermanni		
Lepthyphantes ericaeus		
Lepthyphantes mengei		
Latithorax faustus		
Meioneta beata		
Robertus lividus		
Ceratinella brevipes		
Walckenaeria clavicornis		
Walckenaeria nudipalpis		
Walckenaeria acuminata		
Dicymbium tibiale		
Hypomma bituberculatum		
Metopobactrus prominulus		
Gonatium rubens		
Peponocranium ludicrum		
Oedothorax gibbosus		
Oedothorax fuscus		
Silometopus elegans		
Cnephalocotes obscurus		
Tiso vagans		
Monocephalus castaneipes	Broad Groove-head Spider	
Lophomma punctatum		
Erigonella hiemalis		
Savignia frontata		
Diplocephalus permixtus		
Araeoncus crassiceps		
Scotinotylus evansi		
Pocadicnemis pumila		
Erigone arctica		
Erigone atra		
Erigone promiscua		
Leptorhoptrum robustum		
Micrargus herbigradus		
Agyneta decora		
Agyneta olivacea		
Centromerus prudens		
Meioneta saxatilis		
Centromerita bicolor		
Centromerita concinna		
Oreonetides vaginatus		
Saaristoa abnormis		
Bathyphantes gracilis		
Poeciloneta variegata		
Microlinyphia pusilla		
Allomengea scopigera		
Pardosa pullata		
Trochosa terricola		
Pirata piraticus		
Cryphoeca silvicola		
Amaurobius fenestralis		
Clubiona trivialis		

Xysticus cristatus
Ozyptila trux
Nemastoma bimaculatum
Mitopus morio

Species	Common Name	Reference(s)
Calathus melanocephalus		Shetland Biological Records Centre, 1991 - 2007
Agabus bipustulatus		Shetland Biological Records Centre, 2001
Agabus guttatus		Shetland Biological Records Centre, 2001
Hydroporus erythrocephalus		Shetland Biological Records Centre, 2001
Cychrus caraboides	Snail Hunter	Shetland Biological Records Centre, 2001 - 2007
Leistus rufescens		Shetland Biological Records Centre, 2004 - 2007
Nebria brevicollis		Shetland Biological Records Centre, 2001
Notiophilus palustris		Shetland Biological Records Centre, 2001
Loricera pilicornis		Shetland Biological Records Centre, 2001 - 2007
Trechus obtusus		Shetland Biological Records Centre, 2001 - 2007
Bembidion tetracolum		Shetland Biological Records Centre, 2001
Patrobus assimilis		Shetland Biological Records Centre, 2001 - 2007
Pterostichus oblongopunctatus		Shetland Biological Records Centre, 2001 - 2007
Pterostichus melanarius		Shetland Biological Records Centre, 2001
Pterostichus rhaeticus		Shetland Biological Records Centre, 2001 - 2007
Pterostichus strenuus		Shetland Biological Records Centre, 2001 - 2007
Calathus fuscipes		Shetland Biological Records Centre, 2001 - 2007
Agonum fuliginosum		Shetland Biological Records Centre, 2001 - 2007
Cercyon unipunctatus		Shetland Biological Records Centre, 2001
Megasternum obscurum		Shetland Biological Records Centre, 2001 - 2007
Leiodes obesa		Shetland Biological Records Centre, 2001 - 2007
Agathidium laevigatum		Shetland Biological Records Centre, 2001 - 2007
Olophrum piceum		Shetland Biological Records Centre, 2005 - 2007
Bryaxis bulbifer		Shetland Biological Records Centre, 2001
Tachinus signatus		Shetland Biological Records Centre, 2001 - 2007
Tachyporus dispar		Shetland Biological Records Centre, 2001 - 2007
Atheta graminicola		Shetland Biological Records Centre, 2001 - 2007
Boreophilia eremita		Shetland Biological Records Centre, 2001 - 2007
Geostiba circellaris		Shetland Biological Records Centre, 2001
Atheta fungi		Shetland Biological Records Centre, 2001
Anotylus rugosus		Shetland Biological Records Centre, 2001 - 2007
Stenus impressus		Shetland Biological Records Centre, 2001 - 2007
Stenus juno		Shetland Biological Records Centre, 2001 - 2007
Stenus brunnipes		Shetland Biological Records Centre, 2001
Lathrobium fulvipenne		Shetland Biological Records Centre, 2005 - 2007
Philonthus decorus		Shetland Biological Records Centre, 2001 - 2007
Quedius fuliginosus		Shetland Biological Records Centre, 2001
Quedius molochinus		Shetland Biological Records Centre, 2001 - 2007
Quedius umbrinus		Shetland Biological Records Centre, 2001 - 2007
Othius angustus		Shetland Biological Records Centre, 2001 - 2007
Byrrhus pilula	Pill Beetle	Shetland Biological Records Centre, 2005
Hypnoidus riparius		Shetland Biological Records Centre, 2001 - 2007
Dalopius marginatus		Shetland Biological Records Centre, 2001 - 2007
Anatis ocellata	Eyed Ladybird	Shetland Biological Records Centre, 1994 - 2009
Apion frumentarium		Shetland Biological Records Centre, 2004
Holotrichapion aethiops		Shetland Biological Records Centre, 2001 - 2005
Protapion assimile	Clover Seed Weevil	Shetland Biological Records Centre, 2005 - 2007
Barynotus squamosus		Shetland Biological Records Centre, 1991 - 2007
Otiorhynchus arcticus		Shetland Biological Records Centre, 1991 - 2007
Otiorhynchus singularis	Clay-coloured Weevil	Shetland Biological Records Centre, 2005 - 2007

Species	Common Name	Reference(s)
Pieris brassicae	Large White	Shetland Biological Records Centre, 1990-2017
Vanessa atalanta	Red Admiral	
Cynthia cardui	Painted Lady	
Aglais urticae	Small Tortoiseshell	
Inachis io	Peacock	
Paradiarsia glareosa subsp. glareosa	Autumnal Rustic	
Cydia succedana	Grey Gorse Piercer	
Hepialus humuli	Ghost Moth	
Zygaena filipendulae	Six-spot Burnet	
Anthophila fabriciana	Common Nettle-tap	
Glyphipterix thrasonella	Speckled Fanner	
Yponomeuta evonymella	Bird-cherry Ermine	
Plutella xylostella	Diamond-back Moth	
Rhigognostis senilella	Rock-cress Smudge	
Rhigognostis annulatella	Coast Smudge	
Elachista argentella	Swan-feather Dwarf	
Hofmannophila pseudospretella	Brown House-moth	
Endrosis sarcitrella	White-shouldered House-moth	
Depressaria badiella	False Brown Flat-body	
Agonopterix heracliana	Common Flat-body	
Bryotropha terrella	Cinerous Groundling	
Scrobipalpa samadensis subsp. plantaginella		
Aethes smeathmanniana	Yarrow Conch	
Eupoecilia angustana	Marbled Conch	
Syndemis musculana	Dark-barred Twist	
Clepsis senecionana	Obscure Twist	
Timandra griseata	Blood-Vein	
Eana osseana	Dotted Shade	
Eana penziana	Large Mottled Shade	
Eana penziana subsp. colquhounana		
Acleris sparsana	Ashy Button	
Acleris aspersana	Ginger Button	
Olethreutes lacunana	Common Marble	
Lobesia abscisana	Smoky-barred Marble	
Lobesia littoralis	Shore Marble	
Bactra lancealana	Rush Marble	
Epinotia mercuriana	Moorland Bell	
Rhopobota naevana	Holly Tortrix	
Eucosma cana	Hoary Belle	
Dichrorampha montanana	Spike-marked Drill	
Crambus lathoniellus	Hook-streak Grass-veneer	
Agriphila straminella	Straw Grass-veneer	
Agriphila tristella	Common Grass-veneer	
Scoparia subfusca	Large Grey	
Scoparia ambigualis	Common Grey	
Eudonia alpina	Highland Grey	
Eudonia angustea	Narrow-winged Grey	
Udea lutealis	Pale Straw Pearl	
Nomophila noctuella	Rush Veneer	
Pleuroptya ruralis	Mother of Pearl	
Dioryctria abietella	Dark Pine Knot-horn	
Scopula imitaria	Small Blood-vein	
Xanthorhoe munitata	Red Carpet	
Xanthorhoe decoloraria	Red Carpet	
Xanthorhoe montanata	Silver-ground Carpet	
Xanthorhoe fluctuata	Garden Carpet	
Entephria caesiata	Grey Mountain Carpet	
Eulithis testata	Chevron	
Eulithis populata	Northern Spinach	
Chloroclysta miata	Autumn Green Carpet	
Chloroclysta citrata	Dark Marbled Carpet	
Hydriomena furcata	July Highflyer	
Operophtera brumata	Winter Moth	
Perizoma albulata	Grass Rivulet	
Perizoma didymata	Twin-spot Carpet	
Eupithecia venosata	Netted Pug	
Eupithecia satyrata	Satyr Pug	
Eupithecia assimilata	Currant Pug	
Eupithecia pusillata	Juniper Pug	

Gymnoscelis rufifasciata	Double-striped Pug
Agrius convolvuli	Convolvulus Hawk-moth
Macroglossum stellatarum	Humming-bird Hawk-moth
Hyles galii	Bedstraw Hawk-moth
Arctia caja	Garden Tiger
Agrotis ipsilon	Dark Sword-grass
Standfussiana lucernea	Northern Rustic
Noctua pronuba	Large Yellow Underwing
Noctua fimbriata	Broad-bordered Yellow Underwing
Noctua janthe	Lesser Broad-bordered Yellow Underwing
Eugnorisma glareosa	Autumnal Rustic
Paradiarsia glareosa subsp. edda	Autumnal Rustic
Lycophotia porphyrea	True Lover's Knot
Diarsia mendica	Ingrailed Clay
Diarsia mendica subsp. thulei	Ingrailed Clay
Diarsia brunnea	Purple Clay
Diarsia rubi	Small Square-spot
Xestia c-nigrum	Setaceous Hebrew Character
Xestia baja	Dotted Clay
Xestia xanthographa	Square-spot Rustic
Eurois occulta	Great Brocade
Discestra trifolii	Nutmeg
Hada plebeja	Shears
Lacanobia suasa	Dog's Tooth
Lacanobia oleracea	Bright-Line Brown-Eye
Hadena confusa	Marbled Coronet
Hadena bicruris	Lychnis
Cerapteryx graminis	Antler Moth
Orthosia gothica	Hebrew Character
Mythimna pallens	Common Wainscot
Dasypolia templi	Brindled Ochre
Xylena vetusta	Red Sword-grass
Mniotype adusta	Dark Brocade
Eupsilia transversa	Satellite
Agrochola circellaris	Brick
Phlogophora meticulosa	Angle Shades
Enargia paleacea	Angle-striped Sallow
Parastichtis suspecta	Suspected
Cosmia trapezina	Dun-bar
Hepialus fusconebulosa	Map-winged Swift
Apamea monoglypha	Dark Arches
Apamea zeta	Exile
Apamea oblonga	Crescent Striped
Apamea crenata	Clouded-bordered Brindle
Apamea lateritia	Scarce Brindle
Apamea furva subsp. britannica	Confused
Apamea remissa	Dusky Brocade
Apamea ophiogramma	Double Lobed
Oligia fasciuncula	Middle-barred Minor
Mesapamea secalis	Common Rustic
Mesapamea didyma	Lesser Common Rustic
Photedes pygmina	Small Wainscot
Chortodes pygmina	Small Wainscot
Luperina testacea	Flounced Rustic
Amphipoea lucens	Large Ear
Amphipoea fucosa subsp. paludis	Saltern Ear
Hydraecia micacea	Rosy Rustic
Celaena haworthii	Haworth's Minor
Celaena leucostigma	Crescent
Plusia festucae	Gold Spot
Autographa gamma	Silver Y
Autographa pulchrina	Beautiful Golden Y
Syngrapha interrogationis	Scarce Silver Y

Species	Common Name	Reference(s)
Tipula varipennis		Shetland Biological Records Centre, 2014
Tipula paludosa		Shetland Biological Records Centre, 2008
Tipula lateralis		Shetland Biological Records Centre, 2008 - 2014
Erioptera trivialis		Shetland Biological Records Centre, 2008
Platycheirus clypeatus agg.	Platycheirus clypeatus agg.	Shetland Biological Records Centre, 2001
Empis tessellata		Shetland Biological Records Centre, 1983 - 2014
Empis trigramma		Shetland Biological Records Centre, 1983 - 2014
Episyrphus balteatus	Marmalade Hoverfly	Shetland Biological Records Centre, 1995 - 2016
Eristalis arbustorum		Shetland Biological Records Centre, 1990 - 2016
Eristalis intricarius		Shetland Biological Records Centre, 1990 - 2016
Eristalis pertinax		Shetland Biological Records Centre, 1995 - 2016
Eupeodes corollae		Shetland Biological Records Centre, 1894 - 2016
Eupeodes luniger		Shetland Biological Records Centre, 1995
Helophilus pendulus		Shetland Biological Records Centre, 1991 - 2016
Lejogaster metallina		Shetland Biological Records Centre, 1991 - 1996
Chrysogaster hirtella		Shetland Biological Records Centre, 1991 - 2014
Melanogaster hirtella		Shetland Biological Records Centre, 2014 - 2016
Melanostoma mellinum		Shetland Biological Records Centre, 1995 - 2015
Melanostoma scalare		Shetland Biological Records Centre, 1995 - 2016
Meliscaeva auricollis		Shetland Biological Records Centre, 1997 - 2014
Platycheirus albimanus		Shetland Biological Records Centre, 1995 - 2016
Platycheirus clypeatus		Shetland Biological Records Centre, 1996 - 2016
Platycheirus manicatus		Shetland Biological Records Centre, 1991 - 2016
Rhingia campestris		Shetland Biological Records Centre, 1991 - 2006
Scaeva pyrastri		Shetland Biological Records Centre, 1994 - 2016
Scaeva selenitica		Shetland Biological Records Centre, 1991- 2013
Sericomyia silentis		Shetland Biological Records Centre, 1991 - 2016
Syritta pipiens		Shetland Biological Records Centre, 1995 - 2014
Syrphus ribesii		Shetland Biological Records Centre, 1995 - 2016
Syrphus torvus		Shetland Biological Records Centre, 1995 - 2000
Xanthandrus comtus		Shetland Biological Records Centre, 2000 - 2015
Dioxyna bidentis		Shetland Biological Records Centre, 2015
Scathophaga stercoraria		Shetland Biological Records Centre, 1991 - 2014
Calliphora uralensis		Shetland Biological Records Centre, 1991 - 2014
Syrphus spp.		Shetland Biological Records Centre, 1995 - 2016
Melanostoma spp.		Shetland Biological Records Centre, 1995 - 2015

Species	Common Name	Reference(s)
Bombus muscorum	Moss Carder-bee	Shetland Biological Records Centre, 1991 - 2016
Bombus magnus	Northern White-tailed Bumblebee	Shetland Biological Records Centre, 1992 - 2016
Bombus hortorum	Small Garden Bumble Bee	Shetland Biological Records Centre, 1992 - 2014
Tenthredopsis coquebertii		Shetland Biological Records Centre, 2014
Bombus (Bombus) terrestris	Buff-Tailed Bumble Bee	Shetland Biological Records Centre, 2017-18

Species	Common Name	Reference(s)
Elasmostethus interstinctus	Birch Shieldbug	Shetland Biological Records Centre, 2002 - 2006

Licence	Rightsholder	Scientific Name	Common Name	Date	Data Provider	Institution Code	Kingdom	Phylum	Class	Order	Family	Genus
OGL		*Oligochaeta*	Earthworm	2005	Scottish Environment Protection Agency		Animalia	Annelida	Oligochaeta			
CC-BY		*Atomaria nitidula*		1960	Biological Records Centre	Biological Records Centre	Animalia	Arthropoda	Insecta	Coleoptera	Cryptophagidae	Atomaria
CC-BY		*Atomaria fuscipes*		1960	Biological Records Centre	Biological Records Centre	Animalia	Arthropoda	Insecta	Coleoptera	Cryptophagidae	Atomaria
CC0		*Boreonectes multilineatus*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Boreonectes
CC0		*Hydroporus obscurus*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporus
CC0		*Hydroporus tristis*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporus
CC0		*Hydroporus pubescens*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporus
CC0		*Rhantus suturellus*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Rhantus
CC-BY	Highland Biological Recording Group	*Calliphora vicina*	Common Bluebottle	1983	Highland Biological Recording Group	HBRG	Animalia	Arthropoda	Insecta	Diptera	Calliphoridae	Calliphora
OGL		*Chironomidae*	Non-biting midges	2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Diptera	Chironomidae	
OGL		*Empididae*		2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Diptera	Empididae	
OGL		*Psychodidae*	Indet. Mothfly	2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Diptera	Psychodidae	
OGL		*Tipulidae*	Cranefly	2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Diptera	Tipulidae	
CC-BY		*Wesmaelius (Kimminsia) subnebulosus*		1808	Biological Records Centre	Biological Records Centre	Animalia	Arthropoda	Insecta	Neuroptera	Hemerobiidae	Wesmaelius
OGL		*Chloroperlidae*		2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Plecoptera	Chloroperlidae	
OGL		*Leuctridae*	Needle or willow stoneflies	2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Plecoptera	Leuctridae	
CC-BY	UK Caddisfly Recording Scheme	*Lepidostoma hirtum*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Lepidostomatidae	Lepidostoma
CC-BY	UK Caddisfly Recording Scheme	*Athripsodes cinereus*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Leptoceridae	Athripsodes
CC-BY	UK Caddisfly Recording Scheme	*Ceraclea fulva*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Leptoceridae	Ceraclea
CC-BY	UK Caddisfly Recording Scheme	*Mystacides azurea*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Leptoceridae	Mystacides
CC-BY	UK Caddisfly Recording Scheme	*Limnephilus incisus*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilus
CC-BY	UK Caddisfly Recording Scheme	*Limnephilus lunatus*		1895	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilus
CC-BY	UK Caddisfly Recording Scheme	*Limnephilus rhombicus*		1895	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilus
CC-BY	UK Caddisfly Recording Scheme	*Mesophylax impunctatus*		1895	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Mesophylax
CC-BY	UK Caddisfly Recording Scheme	*Micropterna sequax*		1895	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Micropterna
OGL		*Limnephilidae*		2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	
CC-BY	UK Caddisfly Recording Scheme	*Polycentropus flavomaculatus*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Polycentropodidae	Polycentropus
OGL		*Polycentropodidae*		2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Trichoptera	Polycentropodidae	
CC-BY	UK Caddisfly Recording Scheme	*Tinodes waeneri*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Psychomyiidae	Tinodes
OGL		*Semibalanus balanoides*	Acorn Barnacle	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Arthropoda	Maxillopoda	Sessilia	Archaeobalanidae	Semibalanus
OGL		*Chthamalus stellatus*	Poli's Stellate Barnacle	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Arthropoda	Maxillopoda	Sessilia	Chthamalidae	Chthamalus
CC-BY		*Anguilla anguilla*	European Eel	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Anguilliformes	Anguillidae	Anguilla
CC-BY		*Gasterosteus aculeatus*	Three-spined Stickleback	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Gasterosteiformes	Gasterosteidae	Gasterosteus
CC-BY		*Platichthys flesus*	Flounder	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Pleuronectiformes	Pleuronectidae	Platichthys
CC-BY		*Salmo salar*	Atlantic Salmon	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Salmoniformes	Salmonidae	Salmo
CC-BY		*Salmo trutta*	Brown/Sea Trout	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Salmoniformes	Salmonidae	Salmo
CC-BY		*Vanellus vanellus*	Lapwing	2005	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Charadriiformes	Charadriidae	Vanellus
CC-BY		*Gallinago gallinago*	Snipe	2006	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Charadriiformes	Scolopacidae	Gallinago
CC-BY		*Tringa totanus*	Redshank	2006	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Charadriiformes	Scolopacidae	Tringa
CC-BY		*Numenius arquata*	Curlew	2006	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Charadriiformes	Scolopacidae	Numenius
CC-BY		*Haliaeetus albicilla*	White-tailed Eagle	1983	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Falconiformes	Accipitridae	Haliaeetus
CC-BY		*Gavia stellata*	Red-throated Diver	1994	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Gaviiformes	Gaviidae	Gavia
CC-BY		*Crex crex*	Corncrake	2004	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Gruiformes	Rallidae	Crex
CC-BY		*Linaria flavirostris*	Twite	2006	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Passeriformes	Fringillidae	Linaria
CC-BY		*Phoca vitulina*	Harbour Seal	1970	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Mammalia	Carnivora	Phocidae	Phoca
CC-BY		*Halichoerus grypus*	Grey Seal	1970	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Mammalia	Carnivora	Phocidae	Halichoerus
OGL		*Mytilus edulis*	Blue Mussel	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Mollusca	Bivalvia	Mytiloida	Mytilidae	Mytilus
OGL		*Littorina saxatilis/arcana*	Rough Periwinkle	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Mollusca	Gastropoda	Littorinimorpha	Littorinidae	Littorina
OGL		*Nucella lapillus*	Dog Whelk	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Mollusca	Gastropoda	Neogastropoda	Muricidae	Nucella
OGL		*Patella vulgata*	Common Limpet	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Mollusca	Gastropoda		Patellidae	Patella
OGL		*Himanthalia elongata*	Thongweed	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Chromista	Ochrophyta	Phaeophyceae	Fucales	Himanthaliaceae	Himanthalia
OGL		*Alaria esculenta*	Dabberlocks	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Chromista	Ochrophyta	Phaeophyceae	Laminariales	Alariaceae	Alaria
OGL		*Laminaria digitata*	Oarweed	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Chromista	Ochrophyta	Phaeophyceae	Laminariales	Laminariaceae	Laminaria
CC-BY		*Arthonia radiata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Arthoniomycetes	Arthoniales	Arthoniaceae	Arthonia
CC-BY		*Acrocordia macrospora*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Dothideomycetes	Monoblastiales	Monoblastiaceae	Acrocordia
CC-BY		*Collemopsidium foveolatum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Dothideomycetes	Pyrenulales	Xanthopyreniaceae	Collemopsidium
CC-BY		*Verrucaria mucosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Verrucaria viridula*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Verrucaria hochstetteri*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Verrucaria muralis*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Verrucaria striatula*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
OGL		*Verrucaria*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Polysporina simplex*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Acarosporales	Acarosporaceae	Polysporina
CC-BY		*Myriospora scabrida*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Acarosporales	Acarosporaceae	Myriospora
CC-BY		*Placynthiella uliginosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Baeomycetales	Trapeliaceae	Placynthiella
CC-BY		*Trapeliopsis granulosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Baeomycetales	Trapeliaceae	Trapeliopsis
CC-BY		*Candelariella aurella f. aurella*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Candelariales	Candelariaceae	Candelariella
CC-BY		*Candelariella vitellina f. vitellina*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Candelariales	Candelariaceae	Candelariella
CC-BY		*Cladonia diversa*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia cervicornis*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia coccifera s. lat.*	Scarlet-Cup Lichen	1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia firma*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia ramulosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia furcata subsp. furcata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia verticillata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia chlorophaea s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia pocillum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Myriolecis albescens*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Myriolecis
CC-BY		*Myriolecis dispersa*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Myriolecis
CC-BY		*Lecidella elaeochroma f. elaeochroma*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Lecidella
CC-BY		*Lecanora campestris subsp. campestris*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Lecanora
CC-BY		*Myriolecis actophila*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Myriolecis
CC-BY		*Myriolecis zosterae*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Myriolecis
CC-BY		*Megalaria grossa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Megalariaceae	Megalaria
CC-BY		*Tephromela atra var. atra*	Black Shields	2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Mycoblastaceae	Tephromela
CC-BY		*Hypogymnia tubulosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Hypogymnia
CC-BY		*Parmelia saxatilis s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Parmelia
CC-BY		*Melanelixia fuliginosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Melanelixia
CC-BY		*Platismatia glauca*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Platismatia
CC-BY		*Pseudevernia furfuracea s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Pseudevernia
CC-BY		*Tuckermannopsis chlorophylla*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Tuckermannopsis
CC-BY		*Bryoria fuscescens*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Bryoria
CC-BY		*Micarea lignaria var. lignaria*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Pilocarpaceae	Micarea
CC-BY		*Protoblastenia rupestris*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Psoraceae	Protoblastenia
CC-BY		*Lecania erysibe s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Ramalinaceae	Lecania

CC-BY		*Scoliciosporum umbrinum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Scoliciosporaceae	Scoliciosporum
CC-BY		*Lepraria finkii*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Stereocaulaceae	Lepraria
CC-BY		*Lepraria incana s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Stereocaulaceae	Lepraria
CC-BY		*Porpidia speirea*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecideales	Lecideaceae	Porpidia
CC-BY		*Lecidea berengeriana*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecideales	Lecideaceae	Lecidea
CC-BY		*Clauzadea monticola*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecideales	Lecideaceae	Clauzadea
CC-BY		*Porpidia crustulata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecideales	Lecideaceae	Porpidia
CC-BY		*Gyalecta foveolaris*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Ostropales	Gyalectaceae	Gyalecta
CC-BY		*Porina multipuncta*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Ostropales	Porinaceae	Porina
CC-BY		*Collema crispum var. crispum*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Collema
CC-BY		*Collema furfuraceum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Collema
CC-BY		*Leptogium lichenoides*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Leptogium
CC-BY		*Leptogium teretiusculum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Leptogium
CC-BY		*Collema tenax var. tenax*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Collema
CC-BY		*Leptogium pulvinatum*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Leptogium
CC-BY		*Pectenia plumbea s. lat.*	Bladder Stalks	1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Pannariaceae	Pectenia
CC-BY		*Peltigera rufescens*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Peltigeraceae	Peltigera
CC-BY		*Vahliella atlantica*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Vahliellaceae	Vahliella
CC-BY		*Aspicilia contorta subsp. contorta*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Megasporaceae	Aspicilia
CC-BY		*Varicellaria lactea*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Ochrolechiaceae	Varicellaria
CC-BY		*Ochrolechia tartarea*	Cudbear	1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Ochrolechiaceae	Ochrolechia
CC-BY		*Ochrolechia androgyna*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Ochrolechiaceae	Ochrolechia
CC-BY		*Ochrolechia frigida f. frigida*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Ochrolechiaceae	Ochrolechia
CC-BY		*Pertusaria pseudocorallina*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Pertusariaceae	Pertusaria
CC-BY		*Catillaria chalybeia var. chalybeia*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Rhizocarpales	Catillariaceae	Catillaria
CC-BY		*Rhizocarpon reductum*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Rhizocarpales	Rhizocarpaceae	Rhizocarpon
CC-BY		*Buellia stellulata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Caliciaceae	Buellia
CC-BY		*Physcia adscendens*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Physciaceae	Physcia
CC-BY		*Caloplaca dichroa*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Caloplaca oasis*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Xanthoria ucrainica*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Xanthoria
CC-BY		*Caloplaca limonia*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Caloplaca holocarpa s. str.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Xanthoria candelaria s. str.*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Xanthoria
CC-BY		*Caloplaca sorediella*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
OGL		*Caloplaca*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Fuscidea lygaea*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes		Fuscideaceae	Fuscidea
CC-BY	Highland Biological Recording Group	*Puccinia urticata*	Cawod Goch Danadl	2014	Highland Biological Recording Group	HBRG	Fungi	Basidiomycota	Pucciniomycetes	Pucciniales	Pucciniaceae	Puccinia
CC-BY	British Bryological Society	*Archidium alternifolium*	Clay Earth-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Archidiales	Archidiaceae	Archidium
CC-BY	British Bryological Society	*Breutelia chrysocoma*	Golden-head Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bartramiaceae	Breutelia
CC-BY	British Bryological Society	*Philonotis fontana*	Fountain Apple-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bartramiaceae	Philonotis
CC-BY	British Bryological Society	*Bryum dichotomum*		2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Bryum
CC-BY	British Bryological Society	*Anomobryum julaceum*			British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Anomobryum
CC-BY	British Bryological Society	*Bryum pallens*	Pale Thread-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Bryum
CC-BY	British Bryological Society	*Bryum argenteum*	Silver-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Bryum
CC-BY	British Bryological Society	*Bryum alpinum*	Alpine Thread-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Bryum
CC-BY	British Bryological Society	*Pohlia camptotrachela*	Crookneck Nodding-moss	1969	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Mielichhoferiaceae	Pohlia
CC-BY	British Bryological Society	*Pohlia nutans*	Nodding Thread-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Mielichhoferiaceae	Pohlia
CC-BY	British Bryological Society	*Pohlia annotina*	Pale-fruited Thread-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Mielichhoferiaceae	Pohlia
CC-BY	British Bryological Society	*Dicranum elongatum*	Dense Fork-moss	1907	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Dicranaceae	Dicranum
CC-BY	British Bryological Society	*Dicranella heteromalla*	Silky Forklet-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Dicranaceae	Dicranella
CC-BY	British Bryological Society	*Dicranella subulata*	Awl-leaved Forklet-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Dicranaceae	Dicranella
CC-BY	British Bryological Society	*Distichium capillaceum*	Fine Distichium		British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Ditrichaceae	Distichium
CC-BY	British Bryological Society	*Pseudephemerum nitidum*	Delicate Earth-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Ditrichaceae	Pseudephemerum
CC-BY	British Bryological Society	*Ceratodon purpureus*	Redshank	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Ditrichaceae	Ceratodon
CC-BY	British Bryological Society	*Fissidens osmundoides*	Purple-stalked Pocket-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Fissidentaceae	Fissidens
CC-BY	British Bryological Society	*Fissidens adianthoides*	Maidenhair Pocket-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Fissidentaceae	Fissidens
CC-BY	British Bryological Society	*Campylopus schimperi*	Schimper's Swan-neck Moss	1878	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Campylopus brevipilus*	Compact Swan-neck Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Campylopus fragilis*	Brittle Swan-neck Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Leucobryum glaucum*	Large White-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Leucobryum
CC-BY	British Bryological Society	*Campylopus pyriformis*	Dwarf Swan-neck Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Campylopus flexuosus*	Rusty Swan-neck Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Dichodontium pellucidum*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Rhabdoweisiaceae	Dichodontium
CC-BY	British Bryological Society	*Dichodontium palustre*	Marsh Forklet-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Rhabdoweisiaceae	Dichodontium
CC-BY	British Bryological Society	*Entosthodon obtusus*	Blunt Cord-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Funariales	Funariaceae	Entosthodon
CC-BY	British Bryological Society	*Racomitrium fasciculare*	Green Mountain Fringe-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Racomitrium
CC-BY	British Bryological Society	*Racomitrium canescens*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Racomitrium
CC-BY	British Bryological Society	*Racomitrium aciculare*	Yellow Fringe-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Racomitrium
CC-BY	British Bryological Society	*Grimmia pulvinata*	Grey-cushioned Grimmia	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Grimmia
CC-BY	British Bryological Society	*Schistidium apocarpum*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Schistidium
CC-BY	British Bryological Society	*Hookeria lucens*	Shining Hookeria	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hookeriales	Hookeriaceae	Hookeria
CC-BY	British Bryological Society	*Campylium stellatum*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Amblystegiaceae	Campylium
CC-BY	British Bryological Society	*Hygrohypnum ochraceum*	Claw Brook-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Amblystegiaceae	Hygrohypnum
CC-BY	British Bryological Society	*Kindbergia praelonga*	Common Feather-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Brachytheciaceae	Kindbergia
CC-BY	British Bryological Society	*Brachythecium albicans*	Whitish Feather-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Brachytheciaceae	Brachythecium
CC-BY	British Bryological Society	*Pseudoscleropodium purum*	Neat Feather-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Brachytheciaceae	Pseudoscleropodium
CC-BY	British Bryological Society	*Scorpidium cossonii*	Intermediate Hook-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Scorpidium
CC-BY	British Bryological Society	*Sarmentypnum exannulatum*	Ringless Hook-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Sarmentypnum
CC-BY	British Bryological Society	*Calliergon cordifolium*	Heart-leaved Spear-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Calliergon
CC-BY	British Bryological Society	*Scorpidium scorpioides*	Hooked Scorpion-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Scorpidium
CC-BY	British Bryological Society	*Warnstorfia fluitans*	Floating Hook-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Warnstorfia
CC-BY	British Bryological Society	*Scorpidium revolvens*	Rusty Hook-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Scorpidium
CC-BY	British Bryological Society	*Fontinalis antipyretica*	Greater Water-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Fontinalaceae	Fontinalis
CC-BY	British Bryological Society	*Rhytidiadelphus triquetrus*	Big Shaggy-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hylocomiaceae	Rhytidiadelphus
CC-BY	British Bryological Society	*Pleurozium schreberi*	Red-stemmed Feather-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hylocomiaceae	Pleurozium
CC-BY	British Bryological Society	*Calliergonella cuspidata*	Pointed Spear-moss	1996	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hypnaceae	Calliergonella
CC-BY	British Bryological Society	*Hypnum cupressiforme var. resupinatum*	Supine Plait-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hypnaceae	Hypnum
CC-BY	British Bryological Society	*Hypnum cupressiforme var. lacunosum*	Great Plait-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hypnaceae	Hypnum
CC-BY	British Bryological Society	*Ctenidium molluscum*	Chalk Comb-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hypnaceae	Ctenidium
CC-BY	British Bryological Society	*Isothecium myosuroides*	Slender Mouse-tail Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Lembophyllaceae	Isothecium
CC-BY	British Bryological Society	*Antitrichia curtipendula*	Pendulous Wing-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Leucodontaceae	Antitrichia
CC-BY	British Bryological Society	*Thamnobryum alopecurum*	Fox-tail Feather-moss	1907	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Neckeraceae	Thamnobryum
CC-BY	British Bryological Society	*Plagiothecium undulatum*	Waved Silk-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Plagiotheciaceae	Plagiothecium
CC-BY	British Bryological Society	*Thuidium tamariscinum*	Common Tamarisk-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Thuidiaceae	Thuidium
CC-BY	British Bryological Society	*Ulota phyllantha*	Frizzled Pincushion	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Orthotrichales	Orthotrichaceae	Ulota

CC-BY	British Bryological Society	*Zygodon viridissimus var. viridissimus*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Orthotrichales	Orthotrichaceae	Zygodon
CC-BY	British Bryological Society	*Didymodon rigidulus*	Rigid Beard-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Didymodon
CC-BY	British Bryological Society	*Pseudocrossidium hornschuchianum*	Hornschuch's Beard-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Pseudocrossidium
CC-BY	British Bryological Society	*Barbula convoluta*		2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Barbula
CC-BY	British Bryological Society	*Didymodon insulanus*	Cylindric Beard-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Didymodon
CC-BY	British Bryological Society	*Didymodon fallax*	Fallacious Beard-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Didymodon
CC-BY	British Bryological Society	*Hymenostylium recurvirostrum*	Hook-beak Tufa-moss		British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Hymenostylium
CC-BY	British Bryological Society	*Tortula subulata*	Awl-leaved Screw-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Tortula
CC-BY	British Bryological Society	*Tortella tortuosa*	Frizzled Crisp-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Tortella
CC-BY	British Bryological Society	*Didymodon tophaceus*	Olive Beard-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Didymodon
CC-BY	British Bryological Society	*Trichostomum brachydontium*	Variable Crisp-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Trichostomum
CC-BY	British Bryological Society	*Bryoerythrophyllum recurvirostrum*	Red Beard-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Bryoerythrophyllum
CC-BY	British Bryological Society	*Weissia brachycarpa*	Small-mouthed Beardless-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Weissia
CC-BY	British Bryological Society	*Oligotrichum hercynicum*	Hercynian Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Oligotrichum
CC-BY	British Bryological Society	*Pogonatum aloides*	Aloe Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Pogonatum
CC-BY	British Bryological Society	*Pogonatum urnigerum*	Urn Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Pogonatum
CC-BY	British Bryological Society	*Polytrichastrum alpinum*	Alpine Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Polytrichastrum
CC-BY	British Bryological Society	*Polytrichum piliferum*	Bristly Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Polytrichum
CC-BY	British Bryological Society	*Polytrichum strictum*	Strict Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Polytrichum
CC-BY	British Bryological Society	*Sphagnum teres*	Rigid Bog-moss		British Bryological Society	BBS	Plantae	Bryophyta	Sphagnopsida	Sphagnales	Sphagnaceae	Sphagnum
CC-BY	British Bryological Society	*Sphagnum fimbriatum*	Fringed Bog-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Sphagnopsida	Sphagnales	Sphagnaceae	Sphagnum
CC-BY	British Bryological Society	*Sphagnum denticulatum*	Cow-horn Bog-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Sphagnopsida	Sphagnales	Sphagnaceae	Sphagnum
CC-BY	British Bryological Society	*Sphagnum recurvum*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Sphagnopsida	Sphagnales	Sphagnaceae	Sphagnum
OGL		*Cladophora*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Chlorophyta	Ulvophyceae	Cladophorales	Cladophoraceae	Cladophora
OGL		*Enteromorpha*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Chlorophyta	Ulvophyceae	Ulvales	Ulvaceae	Enteromorpha
CC-BY	British Bryological Society	*Fossombronia incurva*	Weedy Frillwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Fossombroniales	Fossombroniaceae	Fossombronia
CC-BY	British Bryological Society	*Calypogeia sphagnicola*	Bog Pouchwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Calypogeiaceae	Calypogeia
CC-BY	British Bryological Society	*Hygrobiella laxifolia*	Lax Notchwort		British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Cephaloziaceae	Hygrobiella
CC-BY	British Bryological Society	*Cephalozia loitlesbergeri*	Scissors Pincerwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Cephaloziaceae	Cephalozia
CC-BY	British Bryological Society	*Harpanthus flotovianus*	Great Mountain Flapwort		British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Geocalycaceae	Harpanthus
CC-BY	British Bryological Society	*Harpanthus scutatus*	Stipular Flapwort	1878	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Geocalycaceae	Harpanthus
CC-BY	British Bryological Society	*Saccogyna viticulosa*	Straggling Pouchwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Geocalycaceae	Saccogyna
CC-BY	British Bryological Society	*Marsupella emarginata*	Notched Rustwort	1878	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Gymnomitriaceae	Marsupella
CC-BY	British Bryological Society	*Marsupella emarginata var. emarginata*		1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Gymnomitriaceae	Marsupella
CC-BY	British Bryological Society	*Herbertus stramineus*	Straw Prongwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Herbertaceae	Herbertus
CC-BY	British Bryological Society	*Nardia scalaris*	Ladder Flapwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Jungermanniaceae	Nardia
CC-BY	British Bryological Society	*Solenostoma paroicum*	Round-fruited Flapwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Jungermanniaceae	Solenostoma
CC-BY	British Bryological Society	*Solenostoma gracillimum*	Crenulated Flapwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Jungermanniaceae	Solenostoma
CC-BY	British Bryological Society	*Kurzia pauciflora*	Bristly Fingerwort		British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Lepidoziaceae	Kurzia
CC-BY	British Bryological Society	*Bazzania tricrenata*	Lesser Whipwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Lepidoziaceae	Bazzania
CC-BY	British Bryological Society	*Chiloscyphus pallescens*	St Winifrid's Other Moss		British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Lophocoleaceae	Chiloscyphus
CC-BY	British Bryological Society	*Mylia taylorii*	Taylor's Flapwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Myliaceae	Mylia
CC-BY	British Bryological Society	*Plagiochila punctata*	Spotty Featherwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Plagiochilaceae	Plagiochila
CC-BY	British Bryological Society	*Plagiochila porelloides*	Lesser Featherwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Plagiochilaceae	Plagiochila
CC-BY	British Bryological Society	*Lophozia sudetica*	Hill Notchwort	1907	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Lophozia
CC-BY	British Bryological Society	*Diplophyllum obtusifolium*	Blunt-leaved Earwort	1843	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Diplophyllum
CC-BY	British Bryological Society	*Gymnocolea inflata*	Inflated Notchwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Gymnocolea
CC-BY	British Bryological Society	*Scapania scandica*	Norwegian Earwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Scapania
CC-BY	British Bryological Society	*Scapania irrigua*	Heath Earwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Scapania
CC-BY	British Bryological Society	*Tritomaria quinquedentata*	Lyon's Notchwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Tritomaria
CC-BY	British Bryological Society	*Scapania degenii*	Degen's Earwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Scapania
CC-BY	British Bryological Society	*Riccardia multifida*	Delicate Germanderwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Metzgeriales	Aneuraceae	Riccardia
CC-BY	British Bryological Society	*Metzgeria furcata*	Forked Veilwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Metzgeriales	Metzgeriaceae	Metzgeria
CC-BY	British Bryological Society	*Pellia endiviifolia*	Endive Pellia	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Pelliales	Pelliaceae	Pellia
CC-BY	British Bryological Society	*Frullania teneriffae*	Sea Scalewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Frullaniaceae	Frullania
CC-BY	British Bryological Society	*Frullania tamarisci*	Tamarisk Scalewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Frullaniaceae	Frullania
CC-BY	British Bryological Society	*Frullania dilatata*	Dilated Scalewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Frullaniaceae	Frullania
CC-BY	British Bryological Society	*Lejeunea patens*	Pearl Pouncewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Lejeuneaceae	Lejeunea
CC-BY	British Bryological Society	*Radula complanata*	Even Scalewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Radulaceae	Radula
CC-BY	British Bryological Society	*Blasia pusilla*	Common Kettlewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Marchantiopsida	Blasiales	Blasiaceae	Blasia
CC-BY	British Bryological Society	*Marchantia polymorpha subsp. montivagans*		1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Marchantiopsida	Marchantiales	Marchantiaceae	Marchantia
CC-BY	British Bryological Society	*Marchantia polymorpha*	Common Liverwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Marchantiopsida	Marchantiales	Marchantiaceae	Marchantia
OGL		*Porphyra*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Bangiophyceae	Bangiales	Bangiaceae	Porphyra
OGL		*Ceramium*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Ceramium
OGL		*Membranoptera alata*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Ceramiales	Delesseriaceae	Membranoptera
OGL		*Corallina officinalis*	Coral Weed	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Corallinales	Corallinaceae	Corallina
OGL		*Lithothamnion*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Corallinales	Hapalidiaceae	Lithothamnion
OGL		*Mastocarpus stellatus*	False Irish Moss	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Gigartinales	Phyllophoraceae	Mastocarpus
OGL		*Rhodymenia*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Rhodymeniales	Rhodymeniaceae	Rhodymenia
OGL		*Rhodophyta*	Dark red crusts	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta				
CC0	BSBI	*Aegopodium podagraria*	Ground-elder	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Apiales	Apiaceae	Aegopodium
CC0	BSBI	*Allium moly*	Yellow Garlic	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asparagales	Amaryllidaceae	Allium
CC0	BSBI	*Crocosmia paniculata*	Aunt-Eliza	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asparagales	Iridaceae	Crocosmia
CC0	BSBI	*Kniphofia uvaria*	Red-hot-poker	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asparagales	Xanthorrhoeaceae	Kniphofia
CC0	BSBI	*Artemisia abrotanum*	Southernwood	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asterales	Asteraceae	Artemisia
CC0	BSBI	*Calendula officinalis*	Pot Marigold	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asterales	Asteraceae	Calendula
CC0	BSBI	*Aster novi-belgii x lanceolatus = A. x salignus*	Common Michaelmas-daisy	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asterales	Asteraceae	Aster
CC0	BSBI	*Hesperis matronalis*	Dame's-violet	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Brassicales	Brassicaceae	Hesperis
CC0	BSBI	*Sambucus nigra*	Elder	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Dipsacales	Adoxaceae	Sambucus
CC0	BSBI	*Symphoricarpos albus*	Snowberry	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Dipsacales	Caprifoliaceae	Symphoricarpos
CC0	BSBI	*Lonicera periclymenum*	Honeysuckle	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Dipsacales	Caprifoliaceae	Lonicera
CC0	BSBI	*Lysimachia punctata*	Dotted Loosestrife	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Ericales	Primulaceae	Lysimachia
CC0	BSBI	*Lupinus arboreus x polyphyllus = L. x regalis*	Russell Lupin	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Fabales	Fabaceae	Lupinus
CC0	BSBI	*Alnus viridis*	Green Alder	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Fagales	Betulaceae	Alnus
CC0	BSBI	*Geranium pratense*	Meadow Crane's-bill	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Geraniales	Geraniaceae	Geranium
CC0	BSBI	*Salix hookeriana*		2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Malpighiales	Salicaceae	Salix
CC0	BSBI	*Sidalcea*		2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Malvales	Malvaceae	Sidalcea
CC0	BSBI	*Chamerion angustifolium*	Rosebay Willowherb	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Myrtales	Onagraceae	Chamerion
CC0	BSBI	*Fuchsia magellanica*	Ffiwsia	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Myrtales	Onagraceae	Fuchsia
CC0	BSBI	*Meconopsis cambrica*	Welsh Poppy	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Ranunculales	Papaveraceae	Meconopsis
CC0	BSBI	*Papaver pseudoorientale*	Oriental Poppy	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Ranunculales	Papaveraceae	Papaver
CC0	BSBI	*Thalictrum minus*	Lesser Meadow-rue	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Ranunculales	Ranunculaceae	Thalictrum
CC0	BSBI	*Geum*		2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Rosales	Rosaceae	Geum
CC0	BSBI	*Sedum spectabile*	Butterfly Stonecrop	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Saxifragales	Crassulaceae	Sedum
CC0	BSBI	*Paeonia officinalis*	Garden Peony	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Saxifragales	Paeoniaceae	Paeonia
CC0	BSBI	*Saxifraga umbrosa x spathularis = S. x urbium*	Londonpride	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Saxifragales	Saxifragaceae	Saxifraga

Appendix 6.2 Phase 1 Habitat, NVC and Potential GWDTE Survey Report

Phase 1 Habitat, National Vegetation Classification and Groundwater Dependent Terrestrial Ecosystems Survey Report for the Shetland Space Centre, Unst

August 2020, updated December 2020

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Summary

A proposal for a space centre has been made by the Applicant in north Unst, Shetland. As part of this proposal, Alba Ecology Ltd. was commissioned to survey and map the habitats and plant communities within the boundary of the proposed development plus appropriate buffer zones. The proposal comprises of work in three discrete areas: (i) a proposed New Section of Access Road at Northdale, (ii) a proposed Launch and Range Control Centre (LRCC) Site, and (iii) a proposed Launch Site. This report considers all three of these areas.

Field survey work was undertaken in July 2018 and updated in July 2020. Fieldwork included an extended Phase 1 Habitat survey, a National Vegetation Classification (NVC) survey and an assessment of wetland habitats. Habitats and community types were described and mapped, species lists were compiled and target notes made. From this, an assessment of potential Groundwater Dependent Terrestrial Ecosystems (GWDTE) was made and is reported on.

The Proposed Launch Site Habitat Study Area held a variety of habitats and communities, the most common of which were wet modified bog, wet modified bog/wet heath and coastal grassland. Appendix 7.2 Drawing 2 displays all the Phase 1 Habitats found in the Proposed Launch Site Habitat Study Area and Table 3 lists the Phase 1 Habitats and the total area of each habitat mapped. Appendix 7.2 Drawing 3 displays the NVC communities that were described and mapped in the Study Area.

The wet modified bog, wet modified bog/wet heath, dry dwarf shrub heath, blanket bog, sand dune, coastal grassland, acid flush and some water margin vegetation habitats were evaluated as approaching or being equivalent to the descriptions of the Scottish Biodiversity List (SBL) habitats and/or Annex 1 habitat descriptions. The sand dunes and a water margin habitat were assessed as being of regional importance. The other habitats were evaluated as being of local importance due to a combination of factors including condition, size and the widespread nature of the habitat types in Shetland. Several habitats, including wet modified bog and neutral grassland, were assessed as being potentially moderately groundwater dependent. The acid flush habitat (NVC community M6) was assessed as being a potentially highly GWDTE.

The LRCC Habitat Study Area held a small number of habitats and communities, all of which are common in and around built-up areas and agricultural land. These included frequently mown amenity grassland, improved grassland, buildings and roads and small patches of neutral grassland. None of these habitats were considered to have particular ecological importance or sensitivities. Japanese knotweed, a non-native invasive species, is known to be present on Unst, including a patch near the LRCC Habitat Study Area, and so a watching brief should be kept for this species.

The New Section of Access Road at Northdale Habitat Study Area held a small number of habitats, which were considered to be typical of Shetland. These included dry dwarf shrub heath, acid grassland, improved grassland and small patches of neutral grassland mapped as a mosaic with the acid grassland and improved grassland. The dry dwarf shrub heath was evaluated as being of local importance.

The very small amount of MG9 and MG10 grassland in the New Section of Access Road at Northdale Habitat Study Area was assessed as being potentially moderately groundwater dependent. It was assessed as being potentially hydrologically connected to the nationally important, designated wetland habitats in Norwick Meadows SSSI. Care should be taken to ensure there are no direct or indirect impacts on the potentially sensitive habitats and the adjacent designated site.

Introduction

A proposal for a space centre has been made by the Applicant in north Unst, Shetland. As part of this proposal, Alba Ecology Ltd. was commissioned to survey and map the habitats and plant communities within the boundary of the proposed development plus appropriate buffer zones which together form the Study Area. Alba Ecology Ltd. was commissioned by the developer to conduct a Phase 1 Habitat and National Vegetation Classification (NVC) survey and to report on Groundwater Dependent Terrestrial Ecosystems (GWDTE). The proposal comprises of work in three discrete areas: (i) a proposed New Section of Access Road, (ii) a proposed Launch and Range Control Centre (LRCC) Site, and (iii) a proposed Launch Site. This report considers all three of these areas.

This document reports the findings of the Phase 1 Habitat and NVC survey and GWDTE assessment of the three Study Areas that was undertaken by Alba Ecology Ltd. in July 2018 and updated in July 2020.

Aims and Objectives

The objectives for this survey and report are:

- To identify, map and describe Phase 1 Habitats and NVC communities in the three Study Areas;
- To identify any particularly important habitats and species in the three Study Areas;
- To identify if any wetland habitats present are potential GWDTEs; and
- To evaluate the vegetation identified, with an appraisal of implications for the proposed Shetland Space Centre according to Ecological Impact Assessment (EcIA) guidelines (CIEEM, 2018).

Study Area

The proposal comprises of work in three discrete Study Areas: the proposed Launch Site Habitat Study Area, LRCC Habitat Study Area and the New Section of Access Road at Northdale Habitat Study Area (Appendix 7.2 Drawings 1 and 2).

Proposed Launch Site Habitat Study Area

The centre of the Proposed Launch Site Habitat Study Area is situated at approximate OS Grid reference HP660155, north to the village of Norwick in northeast Unst (Appendix 7.2 Drawing 1). The Proposed Launch Site Habitat Study Area comprised of the proposed boundary, plus a ca. 250m buffer. It extended from the eastward tip of Lamba Ness, to west of the road at Swartling. This gives an area of 137ha (1.37km^2). A location map can be seen in Appendix 7.2 Drawing 1 with this Proposed Launch Site Habitat Study Area indicated with a black outline.

The Proposed Launch Site Habitat Study Area includes the sea cliffs of Lamba Ness with maritime grassland habitats. Further to the west the habitats transition into more upland heath and blanket bog habitats. Current and historic land uses were evident across the Proposed

Launch Site Habitat Study Area. There are a series of old, derelict, military buildings, roads and foundations from World War II. Currently the area is grazed by sheep and has a series of artificial drainage ditches on it.

LRCC Habitat Study Area

The centre of the LRCC Habitat Study Area is situated at approximate OS Grid reference HP641133, at the Saxa Vord Resort, south of the village of Norwick in northeast Unst (Appendix 7.2 Drawing 2).

The LRCC Habitat Study Area comprises of the boundary around the distillery, plus a 100m buffer. This gives an area of 17.4ha (0.17km^2). A location map can be seen in Appendix 7.2 Drawing 2 with this LRCC Habitat Study Area indicated with a pink outline.

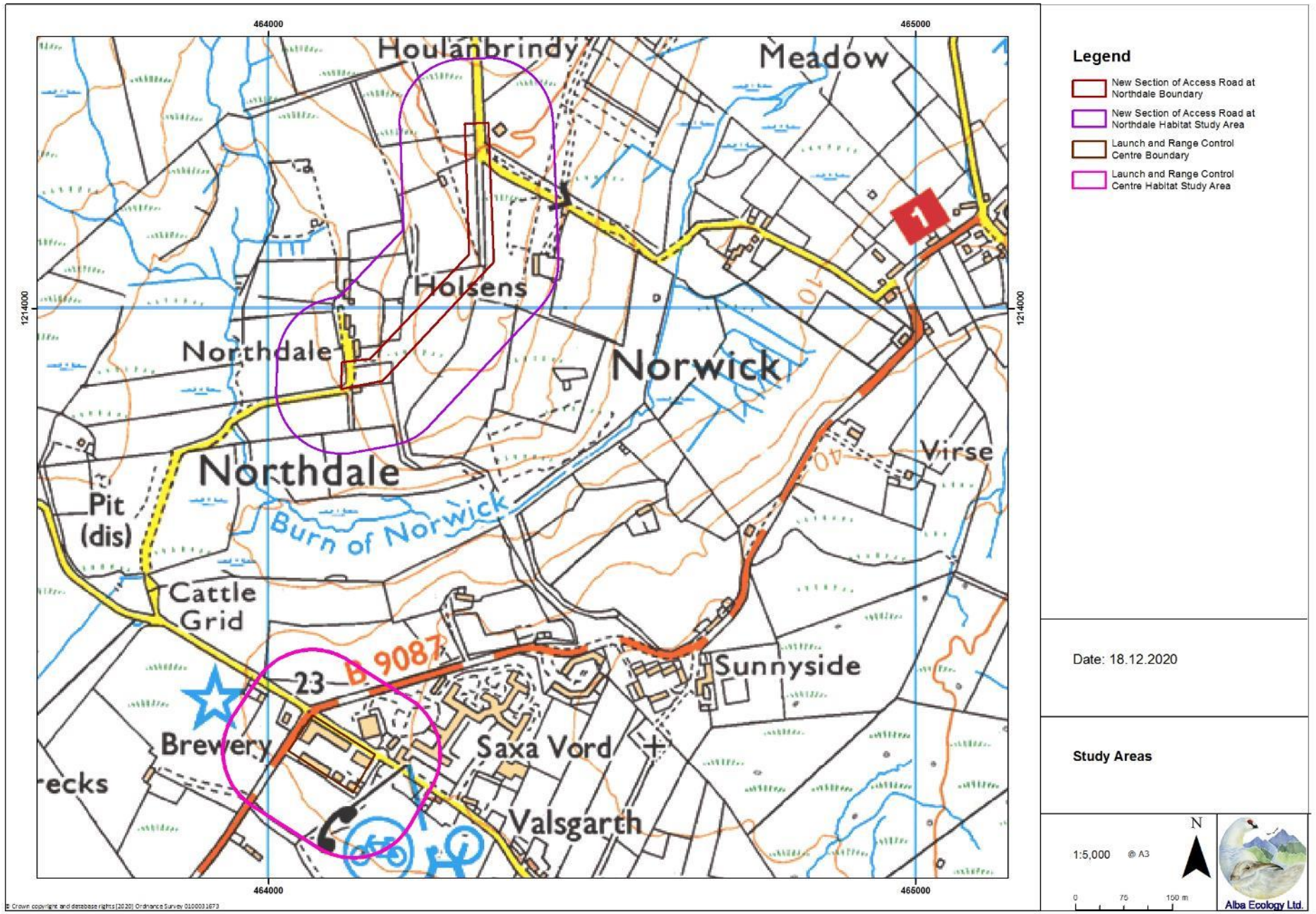
The term 'Saxa Vord Resort' is used in this report to describe the buildings at the centre of the LRCC Habitat Study Area including the restaurant, youth hostel and other accommodation. The LRCC Habitat Study Area also includes the distillery building, roads, amenity grassland and sheep grazed fields.

New Section of Access Road at Northdale Habitat Study Area

A short section of connecting road is required between Northdale and Houlanbrindy. This New Section of Access Road at Northdale Habitat Study Area is situated at approximate OS Grid reference HP643140, west of the village of Norwick in northeast Unst (Appendix 7.2 Drawing 2). The New Section of Access Road at Northdale Habitat Study Area was comprised of the proposed boundary, plus a 100m buffer which gives an area of 16.0ha (0.16km^2). A location map can be seen in Appendix 7.2 Drawing 2 with this New Section of Access Road at Northdale Habitat Study Area indicated with a purple outline.

The New Section of Access Road at Northdale Habitat Study Area includes sections of roads at Northdale and Houlanbrindy and the surrounding vegetation which was mostly sheep grazed grassland and dry dwarf shrub heath.

Appendix 7.2 Drawing 1: Proposed Launch Site Habitat Study Area



Appendix 7.2 Drawing 2: LRCC Habitat Study Area and New Section of Access Road at Northdale Habitat Study Area

Considerations of Rare Plants

The geological and climatic extremes and isolation of Shetland have resulted in the islands having a wide range of vascular plants including at least 23 endemic species and a large number of rare and scarce species (Scott *et al.,* 2002). A notable botanical feature on Unst is the presence of some of these rare and endemic plant species. For example, the Keen of Hamar SSSI and SAC are designated for Shetland mouse-ear/Edmondston's chickweed; (*Cerastium nigrescens*); nationally rare Scottish sandwort (*Arenaria norvegica ssp. Norvegica*) and nationally scarce northern rock-cress (*Arabis petraea*) (NatureScot, 2020).

During initial Pre-application correspondence with SNH, Alba Ecology suggested conducting a rare/endemic species survey of the initial Application Boundary (a larger area than is considered in this report, including the Proposed Launch Site, Launch and Range Control Centre, the New Section of Access Road and also area an around Unst airport). Johnathan Swale of SNH responded on 16/02/2018. In his correspondence he recommended that a rare species survey should be limited to the area around Unst airport due to the ultrabasic "serpentine" bedrock that occurs at that location. This area was subsequently dropped from the Application Boundary and so a rare/endemic plant species survey is not included within this report, although a watching brief for rare/endemic plant species was kept during Phase 1 Habitat and NVC surveys.

Soil and Geology

Soil and geological information can provide insight into the vegetation expected in the Study Areas and can inform decisions regarding Phase 1 Habitats categories and GWDTEs (McMullan, 2020). Therefore, the British Geological Society's (BGS) hydrogeological and geological mapping and the Scotland's Soils (2017) carbon and peatlands maps have been consulted to inform this survey report.

The carbon and peatland map describes the area of Lamba Ness and The Garths as having peaty soils with no peaty vegetation (Category 5 soils). It describes a small section of the northwest of the Proposed Launch Site Habitat Study Area as having peatland with peatland vegetation (Category 1). The rest of the Proposed Launch Site Habitat Study Area, including Saxa's Kettle and Inner Skaw, towards Swartling is classed as predominantly mineral soils with some peaty soils. The vegetation for this area is described as heath with some peatland vegetation (Category 4; Scotland's Soils. 2017).

The BGS open mapping data describes the superficial deposits over the majority of the Proposed Launch Site Habitat Study Area as "*till and Morainic deposits (undifferentiated) – Diamicton*" and provides information on these as such "*these sedimentary deposits are glacigenic in origin. They are detrital, created by the action of ice and meltwater, they can form a wide range of deposits and geomorphologies associated with glacial and inter-glacial periods*" (BGS, 2020a). There were also some superficial deposits, within the centre the Proposed Launch Site Habitat Study Area, near Inner Skaw, described as 'Blown Sands' with further information describing the soil in this area as "*These sedimentary deposits are aeolian in origin. They are detrital, comprising medium- to fine- grained materials, forming lenses, beds (and locally) dunes*" (BGS, 2020a).

Site specific Surveys in 2020 demonstrated that there was peaty soils and deep peat within the Proposed Launch Site Habitat Study Area (Appendix 12.3).

The bedrock for the majority of the Proposed Launch Site Habitat Study Area is described by the BGS as the "*Skaw Intrusion - Microgranite, Porphyritic. Igneous Bedrock formed approximately 359 to 444 million years ago in the Devonian and Silurian Periods*". It goes on to describe these as "*These igneous rocks are magmatic (intrusive) in origin. Rich in silica, they form intruded batholiths, plutons, dykes and sills*" (BGS, 2020a). The hydrogeological maps describe this bedrock as a "*low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures; rare springs*" (BGS, 2020b).

There is a change in the geology, which coincides with the road running north to south in the far west of the Proposed Launch Site Habitat Study Area. To the west of the road the bedrock is described as "*Hevda Phyllite Formation - Pelite, Phyllitic. Metamorphic bedrock formed approximately 541 to 1000 million years ago in the Period. Originally sedimentary rocks. Later altered by low-grade metamorphism*" (BGS, 2020a). The hydrogeological maps described this bedrock as a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures*" (BGS, 2020b).

Details regarding the soils, bedrock, and hydrogeology at the LRCC Habitat Study Area and the New Section of Access Road at Northdale Habitat Study Area are shown in Table 1.

	LRCC Habitat Study Area	New Section of Access Road at Northdale Habitat Study Area
Carbon and peatland maps	Peaty soils with no peatland vegetation (Category 5)	Mineral soils with no peaty vegetation (Category 0)
BGS – superficial deposits	Till and Morainic Deposits (undifferentiated) - Diamicton. Superficial Deposits formed up to 3 million years ago in the Quaternary Period. Local environment previously dominated by ice age conditions. These sedimentary deposits are glacigenic in origin. They are detrital, created by the action of ice and meltwater, they can form a wide range of deposits and geomorphologies associated with glacial and inter-glacial periods during the Quaternary.	Till and Morainic Deposits (undifferentiated) - Diamicton. Superficial Deposits formed up to 3 million years ago in the Quaternary Period. Local environment previously dominated by ice age conditions. These sedimentary deposits are glacigenic in origin. They are detrital, created by the action of ice and meltwater, they can form a wide range of deposits and geomorphologies associated with glacial and inter-glacial periods during the Quaternary.
BGS – bedrock	Gruting Greenschist Formation - Metalava and Metatuff. Metamorphic Bedrock formed approximately 419 to 485 million years ago in the Silurian and Ordovician Periods. Originally igneous rocks formed by eruptions of magma. Later altered by low-grade metamorphism. Setting: Originally igneous rocks formed by eruptions of magma. These rocks were igneous in origin, possibly formed as volcanic (extrusive) flows of lava but have subsequently undergone metamorphism.	Norwick Phyllite Formation - Pelite, Phyllitic. Metamorphic Bedrock formed approximately 419 to 485 million years ago in the Silurian and Ordovician Periods. Originally sedimentary rocks formed in shallow seas. Later altered by low-grade metamorphism. Setting: Originally sedimentary rocks formed in shallow seas. These rocks were sedimentary in origin, possibly shallow-marine (siliciclastic units), but have subsequently undergone metamorphism.
BGS - hydrogeological maps	Low productivity aquifer with small amounts of groundwater in near surface weathered zone and secondary fractures.	Low productivity aquifer with small amounts of groundwater in near surface weathered zone and secondary fractures.

Table 1: Summary descriptions of the soils, bedrock, and hydrogeology at the LRCC Habitat Study Area and the New Section of Access Road at Northdale Habitat Study Area (BGS, 2020a; BGS, 2020b; Scotland's Soils, 2017)

Methods

The vegetation surveys were conducted using 1:25,000 Ordnance Survey maps and aerial photographs with a resolution of 25cm that were taken in June 2016 purchased from emapsite. The Phase 1 Habitat survey and the NVC survey were conducted at a scale of 1:2,500 for the Satellite Launch Facility and LRCC Habitat Study Area and 1:5,000 for the New Section of Access Road at Northdale Habitat Study Area using the Ordnance Survey maps and aerial photographs.

Habitat Surveys

Two standard methodologies were used to survey the vegetation within the three Study Areas: the Phase 1 Habitat survey (JNCC, 2010; revised 2016 and JNCC, 2012) and the NVC (Rodwell, 2006). Phase 1 Habitat surveys are a standard national classification scheme of

broad habitat types and are based on plant species presence and some abiotic indicators such as soil type. The NVC is a more detailed survey of plant communities using plant species abundance as well as presence and often using quadrat data. More than one NVC community may be present within a single Phase 1 Habitat category, and visa-versa. GWDTE were determined from the NVC survey results and from the Functional Wetland Typology (FWT) guidance (SNIFFER, 2009a). The FWT was designed to enable a basic identification of wetland habitats in Scotland and Northern Ireland using landscape features and field indicators. The FWT data and NVC communities were compared with the published table to assess whether wetlands were potential GWDTE (SEPA, 2017).

Some of the habitats within the Study Areas were identified as peatlands. Therefore, the Peatland Condition Assessment (PCA) was consulted during the surveys and consideration given to the condition of the peatland based on this guide (Peatland Action, 2016). CIEEM provide no specific guidance on use of PCA in EcIA but given both the advisory and regulatory roles NatureScot (formerly SNH) have, PCA is considered a guidance support tool and is used as such.

The surveys that were conducted at and around LRCC Habitat Study Area and the New Section of Access Road at Northdale Habitat Study Area were completed from publicly accessible roads and viewpoints. The surveyors did not enter any of the gardens or fields to complete the survey as public access was not clear or assumed.

Phase 1 Habitat Survey

A Phase 1 Habitat survey was conducted by Dr Kate Massey and Dr Fergus Massey of Alba Ecology Ltd. in July 2018. The vegetation was described and mapped following the methods described in the Joint Nature Conservation Committee (JNCC) Handbook for Phase 1 Habitat surveys (JNCC, 2010; revised 2016, and JNCC, 2012).

All three Study Areas were walked at a slow pace to accurately map all the habitats present. Plant species were identified and habitat types assigned and mapped in the field. The Phase 1 Habitat survey was extended to include plant species lists for each habitat type and an assessment of each species' overall abundance using the DAFOR scale (Dominant, Abundant, Frequent, Occasional and Rare). The smallest habitat size mapped was approximately 10m×10m. For smaller features, target notes were made, including a 10-digit grid reference taken using a hand-held Garmin geographical positioning system (GPS) unit.

In July 2020, the three Study Areas were revisited by Dr Kate Massey, as per best practice guidance (CIEEM, 2019). The habitats were considered for any changes since the 2018 field surveys, and any updates made as necessary.

National Vegetation Classification (NVC) Survey

An NVC survey was conducted in July 2018 by Dr Kate Massey and Dr Fergus Massey of Alba Ecology Ltd. The vegetation was classified and mapped following the methods described in the JNCC National Vegetation Classification User's Handbook (JNCC, 2006).

All three Study Areas were walked at a slow pace, ensuring comprehensive coverage to accurately describe and map all communities and sub-communities. Each NVC community and sub-community type was assigned in the field by an experienced surveyor with the use of NVC field guides (e.g. Elkington *et al.*, 2001; Cooper, 1997). These data were subsequently compared with the published NVC communities using the definitions and the floristic tables (Rodwell, 1991; Rodwell, 1992; Rodwell, 1995; Rodwell, 2001; Averis *et al.*, 2004; Dargie, 1998a).

Quadrat data were taken where deemed appropriate particularly if, in the surveyor's professional judgment, the vegetation did not obviously fall into an existing published NVC community, or combination of communities. Standard NVC methodology does not require quadrats to be taken in each stand of vegetation (Rodwell, 2006). Where quadrat data was taken, the quadrats were 2×2m in size. All higher plants and common mosses were identified and their percentage cover assessed. The data was tabulated into consistency tables and compared to the published NVC communities using the keys and the floristic tables (Rodwell, 1991; Rodwell, 1992; Rodwell, 1995; Rodwell, 2001). In addition, the new version of TABLEFIT (Marrs *et al.,* 2020) was used for comparison. TABLEFIT calculates the top five community types that the data fits and provides a co-efficient of best-fit. The NVC community was then judged by comparing the results of these two approaches and using the author's professional experience and judgment.

The minimum size of vegetation mapped was approximately 10m×10m. Smaller stands were described as target notes, located with 10-digit grid reference using a GPS. Target notes were also made of any unusual features, rare species, management activities or other points of particular interest.

In July 2020 the three Study Areas were revisited by Dr Kate Massey, as per best practice guidance (CIEEM, 2019). The communities were considered for any changes since the 2018 field surveys, and any updates made as necessary.

Groundwater Dependant Terrestrial Ecosystems (GWDTE)

Wetland habitats were identified in the field using the FWT (SNIFFER, 2009a and 2009b). Where a wetland was noted, a grid reference, and target note was made and sample photographs were taken. SNIFFER (2009a) cross-mapped the wetland typology with Phase 1 Habitats and NVC vegetation types to allow comparison. Therefore, the Phase 1 and NVC communities were used to inform wetlands categorisation. Where wetlands were identified, an assessment was made as to whether they were potentially GWDTEs as defined in SEPA Guidance Note LUPS-GU31 Version 3 (SEPA, 2017).

Peatland Condition Assessment (PCA)

As some of the habitats within the three Study Areas were classed as peatlands, the Peatland Condition Assessment (PCA) was consulted. PCA bases the condition of peatlands on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). The PCA recognises four broad categories of peatland condition:

1. Near natural - peat forming bog-mosses dominant, with no recent fires, little or no grazing pressure and little or no bare peat, heather is not dominant.
2. Modified – bare peat is in small patches, fires may be recent, grazing impacts are evident, bog-mosses are absent or rare, extensive cover of heather or purple moor-grass.
3. Drained – within 30m either side of an artificial drain or a revegetated hagg or gully system.
4. Actively eroding – actively eroding hagg/gully system, extensive continuous bare peat surfaces.

At least one category from the PCA was assigned to each area mapped as the Phase 1 Habitat category 'bog'.

The PCA Support Tool also gives descriptions of peatlands as being in 'good, intermediate or bad condition' (Glenk *et al*., 2017). The criteria for these are shown in Table 2.

Signs	Good condition	Intermediate condition	Bad condition
Water	Plenty of water, visible on the surface	Surface water is rarely visible	Deep gullies have formed from wind and water erosion
Vegetation	Small grasses, bog-mosses (*Sphagnum spp*.) common and very wet	Taller plants, such as cottongrasses (*Eriophorum spp*.) and heather	Rarely any plants grow on the areas that are exposed. Patches of grasses or heather are still found on 'islands' in between exposed bare peat
Bare peat	Little to no bare peat patches	Bare peat patches are occasional, burning may occur	Bare peat areas will continue to expand, leaving less plant cover as protection on the surface. Peat will continue to be lost until the solid rock is exposed
Water quality	Water flowing from good quality peatland is clear	Water flowing from peatland likely to be slightly brown, especially after heavy rainfall	Bad quality, it can be dark brown from the peat content
Wildlife	Good for wildlife	Wildlife less abundant than in good condition	Home to little wildlife
Resultant activity level	Active	Stopped growing, inactive	Inactive

Table 2: Peatland Condition Assessment Support Tool categories of good, intermediate and bad peatland (Glenk et al., 2017).

Nomenclature

Both common and binomial scientific names are given the first time a species is mentioned within this report. Thereafter, common names only are used. Nomenclature follows Streeter (2016) for higher plant species, and Atherton *et al*., (2010) for bryophyte species.

Habitat and Species Evaluation

Evaluation of the species and habitats identified during the survey was completed using the best practice guidance (CIEEM, 2018). This considered a number of facets, including (but not necessarily limited to):

- Naturalness.
- Animal or plant species, sub-species or varieties that are rare or uncommon, either internationally, nationally or more locally, including those that may be seasonally transient.
- Ecosystems and their component parts, which provide the habitats required by important species, populations and/or assemblages.
- Endemic species or locally distinct sub-populations of a species.
- Habitats that are rare or uncommon.
- Habitats that are effectively irreplaceable.
- Habitat diversity.
- Size of habitat or species population.
- Habitat connectivity and/or synergistic associations.
- Habitats and species in decline.
- Rich assemblages of plants and animals.
- Large populations of species or concentrations of species considered uncommon or threatened in a wider context.
- Plant communities (and their associated animals) that are considered to be typical of valued natural/semi-natural vegetation types, including examples of naturally species-poor communities.
- Species or habitats on the edge of their range, particularly where their distribution is changing as a result of global trends and climate change.
- Geographical context (range/abundance when considered against known extent at various levels, local, regional, national etc.).
- Rarity listing and legal protection status.
- Presence on the Scottish Biodiversity Lists (SBL)
- Annex 1 habitat and species lists.

The SBL is a list of animals, plants and habitats that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland under the Nature Conservation (Scotland) Act 2004 (NatureScot, 2020). The UK BAP list of species and habitats has been superseded by the SBL (CIEEM, 2017). However, the classification system used for habitats within the SBL is the UK BAP priority habitats (Scottish Government, 2013). Therefore, UK BAP habitat descriptions are referred to within the habitat evaluation sections of this report.

For the avoidance of doubt, CIEEM EcIA guidance (2018) makes it clear that species and habitats which appear on national lists e.g. Schedule 1 of the Wildlife and Countryside Act (1981 as amended) are not necessarily evaluated as nationally important simply by appearing on such a list. Importance evaluation must consider the number of individuals of species within

a geographical context/scale, i.e. how many of a particular species are likely to be affected by the Proposed Development and what proportion of the local/regional/national population does this constitute. Legal listing/protection is a separate but important consideration.

Habitat categories and the 'condition' of these categories are human (or artificial) constructs and, therefore, to a degree are subjective and a matter of professional judgement. Furthermore, different conditions can co-exist in an area of habitat (e.g. through drainage, preferential grazing, trampling etc.) and so it is not appropriate to assume an entire area of habitat is in one condition or another. Under these circumstances, it is usually reported that the habitat is approaching a particular condition. This is fully recognised in Phase 1 Habitat and NVC assessments and consequently it is not always possible to be unequivocal when making judgements such as whether a particular habitat is classified under one condition or another. Where these have occurred with vegetation communities, they have been noted and explained.

Limitations

Standard sampling methods were followed, and any biases or limitations associated with these methods could potentially affect the results collected. Furthermore, while every effort was made to provide a full assessment and comprehensive description of the three Study Areas, it is unlikely that one survey can achieve full characterisation due to variations that occur with time. This survey report should be considered as a snapshot in time, specifically July 2018 and July 2020.

As with all Phase 1 Habitat and NVC surveys, the intention of the survey work was not to create a full inventory of the botanical species in the three Study Areas, but to map and describe the habitats and communities present. Species were recorded when they were encountered, but it is likely that additional species, not listed, are present within the Study Areas, particular as species presence and visibility varies throughout the growing season. Additionally, some of the habitats within the Study Areas, particularly within the Proposed Launch Site Habitat Study Area, were particularly heavily grazed by sheep rendering some plant identification more challenging. In these instances, professional judgement was applied. These are recognised limitations common to all Phase 1 Habitat and NVC surveys but were minimised by conducting the survey within the optimal survey period during two different growing seasons.

Similarly, the walkover surveys are not intended to count all individuals of any particular species. When a count of a particular species is mentioned within the report or target notes, it is visual estimate only, based on what was easily seen at the time of survey. Where precise locations are provided for a particular species, it is to provide an example location. It is highly unlikely that every individual, of any species, was located during the walkover survey.

Plant species occurrence and visibility change both temporally and spatially. This is particularly true for colonising and invasive species. The data provided by habitat surveys is a snapshot in time (specifically July 2018 and July 2020 for this survey) and cannot account for changes that occur outwith this time period. Non-native invasive species can be prolific colonisers. For example, Japanese knotweed (*Fallopia japonica*) spreads from rhizomes,

rhizome fragments, as well as stem and crown fragments. Spread is usually a result of human intervention, such as spreading fragments in tyre treads (Fennell *et al.,* 2018). Additionally, at different times of year (e.g. winter) or life-stage (e.g. early colonisation) the identification of non-native invasive species can be challenging. Therefore, although non-native invasive species were considered during field surveys and field surveys were conducted at the optimal time of year, it is possible for non-native invasive species to be present within the Study Areas.

The Phase 1 Habitat, NVC and GWDTE maps are only indicative of the habitat boundaries of the Study Areas. It is challenging to map the area to a higher degree of accuracy because there is often no clear boundary between vegetation types, there being instead a gradual gradation. Also, many of the NVC communities in the Study Areas contained a similar assemblage of species and were often at a transitional stage between two community types. This is a recognised limitation of all vegetation mapping. Surveying in Scotland as a whole, and even more so for Shetland, has the added limitation that the NVC community descriptions were often derived from work carried out in England. Therefore, the fit of the communities to the published accounts are often imperfect and the closest approximation of the communities is described.

Estimating peat depth can be an important component for determining some Phase 1 Habitat types and FWT types. However, it is important to note that measuring peat depth was outside the scope of these vegetation surveys. Apparent peat depth as discussed in this report is estimated based on visual assessments only.

Results – Proposed Launch Site Habitat Study Area

The Phase 1 Habitat survey map for the Proposed Launch Site Habitat Study Area is shown in Appendix 7.2 Drawing 3 and a list of habitat types are displayed in Table 3. The NVC survey map of the Proposed Launch Site Habitat Study Area is shown in Appendix 7.2 Drawing 4 with the potential GWDTE and PCA maps in Appendix 7.2 Drawing 5 and 6 respectively[1]. These drawings are supported with list a of target notes (Annex 1, Appendix 7.2 Drawing 7). Photographs of the habitats and interesting features are shown in Annex 2.

Overview

The Proposed Launch Site Habitat Study Area included distinctive maritime grassland in the east, on Lamba Ness, which had a range of pools and damp grassland. This transitioned into an area of wet modified bog dominated by purple moor-grass (*Molinia caerulea*). More westerly in the Proposed Launch Site Habitat Study Area the habitats were made up of wet modified bog/wet heath habitat, which was dominated by heather (*Calluna vulgaris*) and common cottongrass (*Eriophorum angustifolium*). The most westward side of the Proposed Launch Site Habitat Study Area transitioned into blanket bog habitats.

There were small areas of other habitats, including standing water, marginal vegetation at the edge of pools and saltmarsh perched within the coastal vegetation. The old military buildings and roads and other infrastructure were also mapped across the Proposed Launch Site Habitat Study Area and often had distinct vegetation around them, enriched from the sheep that sheltered in them.

All the habitats within the Proposed Launch Site Habitat Study Area had clearly been subject to modification through current and historic management practices including sheep grazing and drainage. Sheep were evident across the Proposed Launch Site Habitat Study Area and the impacts of fertilisation, grazing and sheep lay-down areas were recorded. Drainage ditches, both very recently cut, and older, were also recorded in the wet modified bog and wet modified bog/wet heath habitats. There were areas of naturally occurring haggs, within the blanket bog, which were likely to be exacerbated by sheep.

[1] Drawings are provided within this report document for ease of reference, but higher resolution versions are provided separately as PDFs.

Phase 1 Habitats	Area (ha)	% of Proposed Launch Site Habitat Study Area
Wet modified bog/wet heath	30.5	26.1
Wet modified bog	28.2	24.2
Coastal grassland	19.7	16.8
Semi-improved acid grassland	16.3	14.0
Unimproved acid grassland	7.3	6.2
Wet modified bog/wet heath/dry heath	6.5	5.6
Buildings and roads	1.8	1.5
Fen	1.5	1.3
Blanket bog/bare peat	1.5	1.3
Blanket bog	1.1	1.0
Dry dwarf shrub heath	0.7	0.6
Saltmarsh	0.4	0.3
Wet modified bog/wet heath/bare peat	0.3	0.2
Sand dunes	0.3	0.2
Marginal and inundation	0.2	0.2
Wet modified bog/wet heath/acid flush	0.2	0.2
Bare ground	0.1	<0.1
Acid flush	0.1	<0.1
Bare peat	0.1	<0.1
Neutral grassland	0.1	<0.1
Standing water	<0.1	<0.1
Open vegetation	Too small to map separately	N/A
Water courses and drains	Mapped as lines	N/A
Total	***116.9***	***100.0***

Table 3: The area of each of the Phase 1 Habitats found in the Proposed Launch Site Habitat Study Area.

Habitat and Community Descriptions

The habitats and communities that were found within the three Study Areas are described in the following manner: firstly a Phase 1 Habitat description, followed secondly by the corresponding NVC community(ies) and finally a comment on the FWT category and potential groundwater dependency where relevant.

Coastal grassland

Coastal grassland was mapped for much of the cliff tops of Lamba Ness and The Garths in the east of the Proposed Launch Site Habitat Study Area. The coastal grasslands were dominated by red fescue (*Festuca rubra*) with a variety of maritime species such as thrift (*Armeria maritima*), maritime plantain (*Plantago maritima*) and buck's-horn plantain (*Plantago coronopus*).

Lamba Ness was a military base during WWII and the associated abandoned infrastructure was evident across the peninsula. However, the main landuse at the time of surveying was sheep grazing which was evident and influential in the coastal grassland habitat. Many of the military buildings were used as shelter by the livestock resulting in localised fertilisation.

The coastal grassland was short (3-10cm) and tightly entwined, with cushions of thrift and mats of plantains. They were wind swept and had dung and fleece evident from the sheep. There were areas where sheep laydown and used as shelter within the coastal grassland. These areas often showed signs of localised enrichment. Some areas, where sheep clearly found shelter, the soil profile was revealed showing a thin richer (peaty soil) layer, followed by sands and gravels.

There were four coastal NVC communities mapped and described.

MC8d *Festuca rubra* – *Holcus lanatus* maritime grassland, *Holcus lanatus* sub-community

The MC8d maritime grassland community was dominated by red fescue with thrift abundant and conspicuous in the sward. Yorkshire fog (*Holcus lanatus*) was variable in cover, but generally quite abundant. It was a closed, thick, low sward of approximately 5-10cm on what appeared to be shallow peaty soil over sand. This community showed signs of extensive grazing by sheep.

There were a variety of species that were common throughout the sward including abundant white clover (*Trifolium repens*), creeping buttercup *(Ranunculus repens*) and maritime plantain along with the appearance of species such as ribwort plantain (*Plantago lanceolata*) and common bent (*Agrostis capillaris*).

Less abundant forbs included red clover (*Trifolium pratense*), daisy (*Bellis perennis*), ragged robin (*Lychnis flos-cuculi*), bird's-foot trefoil (*Lotus corniculatus*), squill (*Scilla spp.*) and common mouse-ear (*Cerastium fontanum*).

Other graminoids present at lower abundances included smooth meadow-grass (*Poa pratensis*), mat grass (*Nardus stricta*), sheep's fescue (*Festuca ovina*) and sweet vernal grass (*Anthoxanthum odoratum*). In wetter patches sedges became more apparent including carnation sedge (*Carex panacea*) and common sedge (*Carex nigra*).

In patches where the sheep lay in hollows, within the MC8d grassland, there were small patches of sheep's fescue with common chickweed (*Stellaria media*). These areas were too small to map separately, although some were target noted.

MC10a *Festuca rubra* - *Plantago spp*. maritime grassland, *Armeria maritima* sub-community

The red fescue – plantain grassland, thrift sub-community, MC10a, was described most extensively on the point of Lamba Ness. The grassland was generally less species rich than the other coastal grassland communities. It was close cropped by sheep grazing. Sea plantain was dominant, with thrift, red fescue, and some ribwort and buck's-horn plantain all abundant and constant in the sward. No other species had any prominence on these sea cliff grasslands, although there was a little autumn hawkbit (*Scorzoneroides autumnalis*), bird's-foot trefoil, sheep's fescue, sweet vernal grass and creeping buttercup.

There were small areas of MC10a grassland on the banks of some military buildings. Red fescues, plantains and thrift were all abundant, but there were a variety of other grasses including sheep's fescue, wavy hair-grass (*Deschampsia flexuosa*), Yorkshire fog and sweet vernal grass. There was also a little common bent and creeping bent (*Agrostis stolonifera)*. There was frequent creeping buttercup and white clover with occasional mouse ear, heath bedstraw (*Galium saxatile*), and daisy in these areas.

MC10b *Festuca rubra* - *Plantago spp*. maritime grassland, *Carex panacea* sub-community

The red fescue – plantain grassland was commonly found on the seaward facing slopes of Lamba Ness. The grassland was generally close cropped by sheep grazing. Red fescue was abundant along with sheep's fescue and mat grass. The plantain species, including maritime, ribwort and buck's-horn were all very common and constant in the sward. Thrift was apparent and abundant as were some of the sedge species, particularly carnation sedge, but also common sedge and sometime common yellow sedge (*Carex viridula ssp. oedocarpa*). In some stands of this grassland common sedge was the dominant species. Other forb species present included bird's-foot trefoil, autumn hawkbit, ragged robin, eyebright and creeping buttercup. In wetter patches lesser spearwort (*Ranunculus flammula*) was seen.

Graminoids that were recorded at lower frequencies included smooth meadow-grass, Yorkshire fog and jointed-rush (*Juncus articulatus*).

MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community

MG11 is a community which is associated with improved vegetation with coastal influences. Due to the cliff top location and clear maritime influence the MC11 grassland has been included in the coastal grassland category, as per the Saltmarsh Survey of Scotland, rather than as a saltmarsh where it is often included (Haynes, 2016). The MG11 community appeared to best describe some of the very small (often <5m wide) bright green grasslands around the old military buildings on Lamba Ness where sheep sheltered and grazed heavily and so enriched the vegetation.

Red fescue, creeping bent and Yorkshire fog were the most abundant grasses, although some stands had a high abundance of perennial rye grass (*Lolium perenne*). These areas have obvious associations with the MG11a sub-community and also included white clover and creeping buttercup. Other grasses in the MG11 community included smooth meadow-grass, Yorkshire fog, and sheep's fescue, but these were generally all at low abundances.

Silverweed (*Potentilla anserina*) was abundant in most stands, but had a more occasional presents, or absence in other stands. There were patches in some stands where common chickweed was abundant to dominant. Thrift, plantains, sheep's sorrel and autumn hawkbit were all present in low frequencies.

The MG11 community was closely cropped, but there were occasional taller patches of soft rush (*Juncus effusus*), nettles (*Urtica dioica*) and marsh thistle (*Cirsium palustre*) and rarely spear thistle (*Cirsium vulgare*).

Wet grassland

The coastal grasslands MC8 and MC10 are not considered to be wetlands in the FWT and are not listed as potentially GWDTE. MG11 is considered to be a wet grassland in the FWT and is listed as potentially moderately GWDTE depending on the hydrological setting by SEPA guidance.

Saltmarsh

There were several very small areas of perched saltmarsh recorded on the cliff tops of Lamba Ness. Perched saltmarshes can form on sea cliffs where shallow sediment develops in the wave splash-zone or from sea spray (Haynes, 2016). There was one saltmarsh NVC community recorded which was dominated by saltmarsh rush.

The Scottish Saltmarsh Survey recorded the most northerly saltmarsh in the UK in Baltasound (ca. 6km south of the Proposed Launch Site Habitat Study Area (Haynes, 2016)). However, the very small perched saltmarsh communities found in the Proposed Launch Site Habitat Study Area were likely smaller than the smallest mappable unit considered in the large scale Saltmarsh Survey of Scotland (Haynes, 2016).

SM16b *Festuca rubra* salt-marsh community, *Juncus gerardii* dominant sub-community

There were several small peaty channels on Lamba Ness which were dry at the time of the survey but clearly had periods where they were inundated and impacted by sea spray. They were ca. 2-3m wide and likely to be old ditch channels. These areas were dominated by saltmarsh rush, sometimes overwhelmingly so. These areas were mapped as SM16b which is one of the few sub-communities found on perched sites where thin layers of sediment develop in the sea splash zone (Haynes, 2016).

The other constant species in the SM16b community were red fescue and sea plantain with additionally species being more patchily distributed. In one stand, lesser spearwort was conspicuous with common sedge and carnation sedge abundant. Other species recorded were sweet vernal grass, eyebright and jointed rush.

There was a very small patch (ca. 6m×3m) of a seepage line in which sea arrowgrass (*Triglochin maritimum*) was the most notable species. There was also thrift, red fescue and sea plantain. There may have been association with the perched saltmarsh community SM19 although, given the very limited size and the proximity to the SM16 community it has been included as part of the SM16.

Saltmarsh is included as a wetland within the FWT. However, SM16 and SM19 are not listed as potentially GWDTEs by SEPA guidance (SEPA, 2017).

Sand dunes

There was a small area of sand dune, including open dune and dune grassland vegetation, at a small inlet at Inner Skaw, in the north of the Proposed Launch Site Habitat Study Area. There was an accumulation of bare sand in the inlet which formed a small beach. There was ca. 20m wide, stretch of open dune (SD4), followed by a ca. 20m wide stretch of dune grassland (SD8d), although they transitioned into one another. Inner Skaw formed part of the Shetland report of the Sand Dune Vegetation Survey of Scotland (SDVSS, Dargie, 1998a, 1998b, 1998c). The mapping and descriptions from the 1998 SDVSS coincide closely with this report, although, the NVC data are not identical. This would be expected as the surveys were conducted in different years and likely at different times of year. There would also variation in the surveyor's use of the NVC and their professional judgement. This between surveyor variation is a well-known and understood limitation to NVC surveying (e.g. Hearn *et al.* 2011).

SD4 *Elytrigia juncea* fore-dune community

The SD4 vegetation fore-dune was sparsely vegetated on wind-blown bare sand. It was made up of sand couch (*Elytrigia juncea*), with occasional lyme grass (*Leymus arenarius*) with a little ribwort plantain and sea sandwort (*Honckenya peploides*). Oysterplant (*Mertensia maritima*) was occasional in this community. This is consistent with the descriptions of SD4 within the Shetland report of the SDVSS where it describes sand couch as the only consistent species in SD4 in Shetland, and that it is a species poor community (Dargie, 1998a).

SD8d *Festuca rubra – Galium verum* fixed dune grassland *Bellis perennis - Ranunculus acris* sub-community

The SD8d vegetation was more species rich and made up a higher proportion of the ground cover than the SD4, although there were still areas where there was 20-30% bare sand. It was a narrow section of dune grassland which had influences from both the maritime grassland and the fore-dune vegetation. Red fescue was the most common species, with ribwort plantain abundant. Daisy, white clover, creeping buttercup were constant but with low frequencies. Eyebright (*Euphrasia spp.*) and mouse-ear were more rarely seen. Species associated with the maritime grassland communities were more common on the landward side, such as thrift and sea plantain. Lyme grass and sand couch were more frequent as it transitioned into the fore-dune.

SD8d is reportedly the most common of the SD8 grasslands in Shetland and was considered to be generally species poor (Dargie, 1998a).

The sand dune communities SD4 and SD8 are not considered to be wetlands in the FWT and are not listed as potentially GWDTE.

Semi-improved acid grassland

The semi-improved acid grassland was found in the more inland areas of the Proposed Launch Site Habitat Study Area in areas around Inner Skaw and Skaw. It was mapped in several large fields and some smaller areas beside buildings, road verges, tracks and old borrow pits.

The semi-improved acid grassland habitat was sheep grazed and likely to be on shallow peaty soils. It often formed part of a mosaic with other grassland types or wet modified bog/wet heath, although it usually made up the largest portion of the habitat mosaic present.

One semi-improved acid grassland NVC community type was described, U4b, although this was split into two types. One type was more improved than the other, evidenced by the high proportion of perennial rye grass.

U4b *Festuca ovina – Agrostis capillaris – Galium saxatile* grassland, *Holcus lanatus – Trifolium repens* sub-community

The U4b grassland was usually highly grazed, to 2-3cm, although it could have a rougher appearance with taller tussocks of less palatable species.

There was a mixture of abundant grasses, particularly red fescue, sheep's-fescue, common bent and Yorkshire fog. Other grasses were present at low abundances including smooth meadow-grass, sweet vernal grass, brown bent (*Agrostis vinealis*) and creeping bent. The grassland was forb rich, although most of these forbs were patchily distributed in the grassland, with none having a high prominence except perhaps white clover and ribwort plantain. Other forbs present included yarrow (*Achillea millefolium*), eyebright, sheep's sorrel (*Rumex acetosella*), creeping buttercup, spring squill (*Scilla verna*), dandelion (*Taraxacum agg.*), autumn hawkbit, selfheal (*Prunella vulgaris*), St. John's wort (*Hypericum spp.*) and heath spotted orchid (*Dactylorhiza maculata*) to name but a few. Where U4b was found in borrow pits and there were exposed rocks there was occasionally some thyme (*Thymus polytrichus*) present.

Some stands of U4b grassland had a high portion of perennial rye grass and showed signs of improvement. In these stands daisy and white clover tended to have a high-very high abundance. These stands had affinity to MG7, although, the species richness, and other grasses, particularly fescues and bent-grasses, placed it into the U4b community. To distinguish this more improved U4b type from the less improved U4b grassland it was mapped as U4b (MG7).

The semi-improved acid grassland U4 is not included in the FWT and is not a GWDTE.

Unimproved acid grassland

The unimproved acid grassland was generally recorded on the lower slopes of the hill side, and as part of the dry dwarf shrub heath mosaic.

Unimproved acid grasslands are generally unenclosed hill-grazed land and are relatively species poor (JNCC, 2010 revised 2016). The unimproved acid grassland within the Proposed Launch Site Habitat Study Area was generally dominated by either mat grass or heath rush (*Juncus squarrosus*). Heath bedstraw was the most common forb species. Grazing by sheep was apparent.

A total of three unimproved acid grassland NVC sub-communities were described in the Proposed Launch Site Habitat Study Area.

U5a *Nardus stricta – Galium saxatile* grassland, species poor sub-community

The U5a acid grassland community was a rough grassland mainly found in small patches around The Garths. It was strongly dominated by mat grass with tormentil abundant and conspicuous in the vegetation. It included a variety of other grass species at low abundances such as Yorkshire fog, sweet vernal grass, common bent, red fescue, smooth meadow-grass

and a little purple moor-grass. Forbs were restricted to selfheal, common dog violet (*Viola riviniana*) and rarely mouse ear and ragged robin.

There was a little heath wood-rush (*Luzula multiflora*) present. The moss layer was not well developed.

U5b *Nardus stricta – Galium saxatile* grassland, *Agrostis canina – Polytrichum commune* sub-community

The U5b grassland was well defined, with mat grass dominant, but not overwhelmingly so, and a variety of other grass had some prominence, including red fescue, sweet vernal grass and wavy hair-grass. Tormentil was the most abundant forb. There was occasional heath spotted orchid and eyebright. The moss layer was much more developed than the U5a sub-community with common haircap (*Polytrichum commune*), red bog-moss (*Sphagnum capillifolium*) and red-stemmed feather-moss (*Pleurozium schreberi*) all being present with varying abundances.

This community was found as a mosaic with the heath rush dominated grassland U6, particularly to the southwest of the Proposed Launch Site Habitat Study Area, but also in small patches (sometimes too small to map). In these areas U5 was generally the most common grassland community, with U6 making up small patches.

U6 *Juncus squarrosus – Festuca ovina* grassland community

There were small patches of the U6 heath rush dominated grassland across the Proposed Launch Site Habitat Study Area. Heath rush was dominant although mat grass could be very abundant in some stands, making it difficult to distinguish between U5 mat grass grassland and U6 heath rush grassland in some locations. However, where heath rush was considered to be dominant, and mat grass subordinate, it was assigned the U6 grassland category. There were also patches where heath rush dominated, but with purple moor-grass abundant. These were mapped as M25b, but the association with U6 was obvious.

The U6 grassland community was found in flushes and at transitions between grassland and heath and bog. It included heath bedstraw, but more frequently tormentil. There were a variety of other graminoids present including wavy hair-grass, sweet vernal grass and heath wood-rush which were occasional. Forbs that were seen, but only rarely, in the U6 grassland included sheep's-bit (*Jasione montana*) and sheep's sorrel.

The ground layer was usually dominated by common haircap, although there were hypnum mosses present too.

Montane grassland

Montane grasslands, as defined by the FWT, are wet areas of very short dense vegetation which may include some of the unimproved acid grassland Phase 1 Habitats and NVC communities (SNIFFER, 2009b). The NVC community U5 is not considered GWDTE (SEPA, 2017). However, the U6 community is classified as potentially moderately groundwater dependant depending on the hydrogeological setting (SEPA, 2017).

Neutral grassland

The Phase 1 Habitat category neutral grassland includes species-poor wet grasslands where soft rush and Yorkshire fog are abundant. The neutral grassland within the Proposed Launch Site Habitat Study Area was dominated by soft rush. A single NVC community was described.

MG10a *Holcus lanatus – Juncus effusus* rush-pasture, typical sub-community

There were some small patches of MG10a rush pasture. These were damp swards where soft rush stood out amongst the other grassland and heath vegetation. Yorkshire fog was abundant below the rushes. The MG10a community was species poor, although occasional species such as white clover and marsh willow herb were present. Several small patches were mapped within the Proposed Launch Site Habitat Study Area including within ditches. However, much of this community type was mapped as part of a mosaic as it appeared as small patches within other acid grasslands.

Marshy grassland

Marshy grassland, as described by the FWT, includes vegetation dominated by tussock forming grasses and rushes in damp soils. This includes the Phase 1 Habitat neutral grassland and NVC community MG10. The NVC communities MG10 is considered potentially moderately groundwater dependant depending on the hydrological setting (SEPA, 2017).

Blanket bog

The bog within the Proposed Launch Site Habitat Study Area was considered to be on peat which appeared deeper than 0.5m. In Phase 1 Habitat surveys bog-moss abundance is an indicator of whether bog should be classified as modified or unmodified, with '*sphagnum-rich vegetation'*, or '*abundant sphagnum'* indicating unmodified, and *'little to no sphagnum'* indicating modified bog (JNCC, 2010; Revised 2016).

All the bog within the Proposed Launch Site Habitat Study Area had clearly been subject to modification through current and historic management practices including sheep grazing and drainage. There were areas of naturally occurring haggs, which occurred within the peatlands, and were likely to have been exacerbated by sheep. However, there were bog-mosses present, not always forming a carpet, but more frequent than *'little to no sphagnum'.* Therefore, the blanket bog has not been described as modified using Phase 1 Habitat terminology.

The PCA bases the condition of blanket bog on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). Given that the bog habitat within the Proposed Launch Site Habitat Study Area was clearly grazed and drained and there were patches of bare peat, using PCA terminology, the blanket bog was considered to be modified and some areas drained. Using the PCA Support Tool, the blanket bog would be considered of intermediate condition.

Three NVC communities were described, including one bog pool community.

M2b *Sphagnum cuspidatum/fallax* bog pool, *Sphagnum fallax* sub-community

There were several small M2b bog pools in within the blanket bog and wet modified bog habitats. M2b bog pools were easily visible as bright green mats of flat-topped bog-moss (*Sphagnum fallax*). The carpet of flat-topped bog-moss was generally quite thin over peat. This community formed in the bases of peat haggs and in bog pool complexes usually with M3 pools. There were often few vascular plants within it including common sedge, common cottongrass and bent-grasses.

These bog pool communities were usually small or very small. Several M2b bog pools were mapped within the wet modified bog in the southwest of the Proposed Launch Site Habitat

Study Area. However, some were too small to mark on the map and examples are target noted.

M19 *Calluna vulgaris – Eriophorum vaginatum* blanket mire community

M19 blanket mire community is common in northern areas and tolerates drier peat than other NVC mire communities (Averis *et al.,* 2004).

It was dominated by heather with hare's-tail cottongrass (*Eriophorum vaginatum*) and common cottongrass both abundant. Crowberry (*Empetrum nigrum*) was a frequent dwarf shrub growing as a mat below the heather. There were a few occasional other graminoids but none formed any bulk of the vegetation, these included wavy hair-grass and heath rush. Tormentil was the commonest forb species.

Below the vascular plants, red bog-moss was abundant and constant, although its cover was patchy. Glittering wood-moss (*Hylocomium splendens*) was highly abundant and red-stemmed feather-moss was also frequent.

The M19 community was on a flat area in the north of the survey area which appeared to be waterlogged. It had some M2 and M3 bog pools present with damp patches of feathery bog-moss.

Although this community was distinctively M19, it did not show any of the described sub-communities characteristics and so it has been mapped as M19 and not given a sub-community.

M18 *Erica tetralix - Sphagnum papillosum* raised and blanket mire

There was a small area in the southwest of the Proposed Launch Site Habitat Study Area that had a higher abundance of papillose bog-moss (*Sphagnum papillosum*) than the surrounding areas. Common cottongrass was dominant with hare's-tail cottongrass also more frequent than the surrounding area. Heather, cross-leaved heath (*Erica tetralix*) and crowberry were present as low, open dwarf shrub layer. Tormentil was abundant in the vegetation and there were several other forb species present including lousewort (*Pedicularis sylvatica*), heath spotted orchid, devil's-bit scabious (*Succisa pratensis*), bog asphodel (*Narthecium ossifragum*) and heath speedwell (*Veronica officials*). There were a series of M2a bog pools present.

Peat bog (peatland setting)

In the FWT peat bog is defined as wet peat, which is generally thicker than 0.5m, with heather, cottongrasses and some small sedge species (SNIFFER, 2009b). The Phase 1 Habitat blanket bog fits into this peat bog category and the NVC communities M2, M18 and M19 are within this FWT category. They are not considered to be potential GWDTE (SEPA, 2017).

Wet modified bog/wet heath

There was a large area in the west of the Proposed Launch Site Habitat Study Area that was made up of wet heath vegetation usually dominated by heather with deergrass (*Trichophorum germanicum*), purple moor-grass and common cottongrass. There was less frequent crowberry, cross-leaved heath and bell heather (*Erica cinerea*).

In Phase 1 Habitat surveys, the classification of heath requires there to be greater than 25% cover of dwarf shrub and peat less than 0.5m deep or mineral soil (JNCC, 2010; Revised 2016; JNCC, 2012). Wet modified bog is defined as "*modified bog vegetation with little or no Sphagnum, often with bare peat and patches of* Trichophorum cespitosum *and/*or Molina

Caerulea*. Ericoids may be abundant, sparse or absent. This vegetation is mainly found on drying and degraded blanket bogs … It may resemble wet heath, but is distinguished by having a peat depth greater than 0.5m"* (JNCC, 2010; Revised 2016; JNCC, 2012)*.*

This demonstrates that where there is wet heath vegetation the key diagnostic feature classifying it, for Phase 1 Habitat purposes, is peat depth, with <0.5m being wet heath and >0.5m being wet modified bog (JNCC 2010, Revised 2016).

A peat depth survey was undertaken and demonstrated that a section of the wet heath vegetation was on peaty soils/peat between ca. 30cm and 65cm deep (Appendix 12.3). Which is at the transition point of these two Phase 1 Habitat types. Therefore, this vegetation type has been mapped as a transition of wet modified bog/wet heath. It was thought that some areas within the wet heath vegetation were likely to be on areas of deeper peat particularly around the M3 pools, and so would technically be wet modified bog. Nevertheless, some was clearly on shallower soils (meaning some areas were technically wet heath). Given the variation in peat depth the areas considered to be wet heath vegetation were defined as wet modified bog/wet heath.

It should be noted that this habitat survey does not constitute a formal peat depth survey. Visual clues from e.g. ditches, haggs, bedrock exposure and pushing a walking pole into the ground as well as professional judgement are used for habitat survey purposes. The peat depth survey data provides site specific evidence for peat depth in some parts of the Proposed Launch Site Habitat Study Area (Appendix 12.3).

The PCA bases the condition of bog on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). Given that the wet modified bog/wet heath habitat within the Proposed Launch Site Habitat Study Area was clearly grazed and drained using PCA terminology, the blanket bog was considered to be modified and some areas drained. Using the PCA Support Tool, the wet modified bog/wet heath would be considered of intermediate condition.

Two NVC communities were described as wet modified bog/wet heath, M15d and M15.

M15d *Trichophorum germanicum – Erica tetralix* wet heath, *Vaccinium myrtillus* sub-community

The M15d varied in its appearance across the Proposed Launch Site Habitat Study Area with some locations having a taller, more apparent dwarf shrub layer. In other areas the graminoids, particularly cottongrass, were more apparent, with dwarf shrubs short or less conspicuous below. These differences are likely to be attributable to differing grazing regimes areas across the Proposed Launch Site Habitat Study Area. The M15d community was drained and experienced grazing pressure from sheep.

There was a mixture of dwarf shrubs, including heather, crowberry and more occasionally cross-leaved heath and bell heather. Bilberry (*Vaccinium myrtillus*) was sparsely represented. The dwarf shrubs were usually short and over topped by grasses and sedges which is a common feature of this sub-community. Purple moor-grass, deergrass, heath rush, common cottongrass and mat grass were present too. Common cottongrass could be very abundant similar to the M15 community. Heath rush was often very conspicuous and, combined with the mat grass, some areas had some affinity with U6 grassland. There was a variety of other graminoids present including viviparous sheep's fescue (*Festuca vivipara*), wavy hair-grass and heath wood-rush.

Tormentil was generally the most common forb, but there were a variety of occasional other species including devil's-bit scabious, common butterwort (*Pinguicula vulgaris*), lousewort, round-leaved sundew (*Drosera rotundifolia*) and bog asphodel. The moss layer was not well developed but included patches of red bog-moss and more occasionally woolly fringe moss (*Racomitrium lanuginosum*).

There were occasional patches of hare's-tail cottongrass and there was a patch of M15d community in the north of the Proposed Launch Site Habitat Study Area in which bog asphodel and devil's-bit scabious were highly abundant. Sheep's-bit was present, but only rarely and there was a record of goldenrod (*Solidago virgaurea*).

Pools were present within the M15d community. These were described as M2a and M3 bog pools. M3 were generally the most common.

M15 *Trichophorum germanicum – Erica tetralix* wet heath community

There were some small (too small to map), and one large area (forming a mosaic with other communities) in which the vegetation was strongly dominated by common cottongrass. Dwarf shrubs (heather and crowberry) were present, but below a common cottongrass carpet. This community was defined as M15, without an associated sub-community. It appeared to form a transitional habitat type, between the M3x and more distinct M15d.

Wet modified bog

In Phase 1 Habitat surveys, wet modified bog is defined as "*modified bog vegetation with little or no Sphagnum, often with bare peat and patches of* Trichophorum cespitosum *and/*or Molina Caerulea*. Ericoids may be abundant, sparse or absent. This vegetation is mainly found on drying and degraded blanket bogs … It may resemble wet heath, but is distinguished by having a peat depth greater than 0.5m.* Molina *dominated vegetation on deep peat is included in this category, rather than in marshy grassland"* (JNCC, 2010; Revised 2016; JNCC, 2012).

In the central part of the Proposed Launch Site Habitat Study Area there were large areas of purple moor-grass dominated vegetation which was determined, as part of a subsequent site specific survey, to be on peat >0.5m (Appendix 12.3). As per Phase 1 Habitat classification this area has also been defined as wet modified bog, with marshy grassland vegetation over the peat.

The wet modified bog has been subjected to current and historic management practices including the grazing regimes and drainage as well as the extensive impact from historic military buildings and associated military uses.

It is considered possible that some areas, described as wet modified bog, are on shallower peat and/or sandy soils and so technically marshy grassland. However, on balance of the evidence, it has all been described as wet modified bog. It should be noted again that this habitat survey does not constitute a formal peat depth survey or soils survey. The peat depth survey data provides site specific evidence for deep peat (Appendix 12.3).

The PCA bases the condition of blanket bog on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). Given that the wet modified bog habitat within the Proposed Launch Site Habitat Study Area was clearly grazed and drained using PCA terminology, the blanket bog was considered to be modified and some areas drained. Using the PCA Support Tool, the blanket bog would be considered of intermediate condition.

Two NVC communities were described as wet modified bog, M25b which was purple moor-grass dominated and M3x which was common cottongrass dominated.

M25b *Molinia caerulea – Potentilla erecta* mire, *Anthoxanthum odoratum* sub-community

The centre of Lamba Ness had a large area mapped as M25b. This area was heavily drained and sheep grazed. The drainage ditches were ca. 1m wide and 50-60cm deep, some were recently dug, with the spoil still evident beside them. They were not flowing with water at the time of the survey but were likely to be active drains in wetter times of the year. Draining and grazing are considered important in maintaining this particular sub-community of M25 (Rodwell, 1991).

The vegetation was 10-20cm tall and fairly variable but was dominated by purple moor-grass with mat grass abundant in places. Sweet vernal grass had lower abundance but was constant. There was also sheep's fescue and smooth meadow-grass frequently present. Common cottongrass could be very abundant in some places with common sedge and carnation sedge. Below these taller graminoids, tormentil was creeping through the vegetation with occasional creeping buttercup, devil's-bit scabious, ragged robin, white clover, common dog violet and selfheal occasionally present. Rarer forb species included dandelion, tufted vetch (*Vicia cracca*), mouse-ear, spring squill, sheep's-bit and heath spotted orchid. Common butterwort and bog asphodel were found, but only rarely, in the M25b community.

Bog-mosses were generally absent in the M25b community with only very occasionally red bog-moss. Dwarf shrubs were also generally absent, although small sprigs of heather were present in some stands.

Some small stands of M25b had an abundance of heath rush showing some affinity to U6 grassland, but in other respects were similar to that of the M25b community as a whole.

Within some stands of M25b there were open water pools, generally 2m×2m in size, but varying up to about 5m×5m in size. The pools were either bulbous rush dominated (NVC community A24) or common spike-rush dominated with lesser spearwort (NVC community S19a). Bent-grasses appeared to be common to all these pools. These communities were also found in drainage ditches and were common in some areas of M25b.

The M25b vegetation was set between coastal grassland and bog habitat. As the coastal grassland gave way to the M25b vegetation there was a period of transition between the habitat types.

M3x *Eriophorum angustifolium* community

There were areas dominated by common cottongrass that did not fit well within the NVC community descriptions as they appeared to be well developed. They clearly had affinity with the M3 community. However, the vegetation was usually a full cover, particularly of common cottongrass, rather than an establishing/stabilising community on exposed or redistributed peat as M3 usually is. Therefore, it has been denoted as M3x.

There were some small patches of M3x on Lamba Ness in old peaty channels, ditches and in some shallow hollows. These were dominated by common cottongrass, sometimes overwhelmingly so. Other species represented were tormentil, purple moor-grass, common yellow sedge and a little red bog-moss. However, there were also species related to the surrounding habitats, such as lesser spearwort, carnation sedge, ribwort plantain, marsh

arrowgrass (*Triglochin palustre*), marsh pennywort (*Hydrocotyle vulgaris*), devils-bit scabious and marsh willowherb (*Epilobium palustre*).

There were some larger expanses of M3x within the M15d community in which common cottongrass was strongly dominant. Common cottongrass made up to 80-90% of the vegetation cover, and there was little dwarf shrub below it (<25% of the ground cover). However, there were generally a variety of other species, particularly tormentil but also devil's bit scabious, lousewort, heath spotted orchid and common dog violet. It is thought that these areas, mapped as M3x, represent a transitional point between M3 and M15. It is possible that some areas may have been on shallower peaty soils.

Peat bog (peatland setting)

In the FWT peat bog is defined as wet peat, which is generally deeper than 0.5m, with heather, cottongrasses and some small sedge species (SNIFFER, 2009b). Peat bogs are generally considered rainwater fed, and not considered to be potential GWDTE (SEPA, 2017). However, the NVC community M25 is considered potentially moderately groundwater dependant depending on the hydrological setting (SEPA, 2017). M3 is not considered to be a potential GWDTE in SEPA guidance.

Bare peat

Bare peat was mapped where there were extensive areas of bare peat within the Proposed Launch Site Habitat Study Area with common cottongrass was the main colonising species. This was seen as part of the hagging within the blanket bog and as bare peat areas in wet modified bog/wet heath. These may have been pools in wetter months.

The PCA bases the condition of peatlands on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). In PCA terminology the bare peat was considered to be both modified and actively eroding. Using the PCA Support Tool, the blanket bog would be considered of bad condition.

One NVC community was mapped within the bare peat classification.

M3 *Eriophorum angustifolium* bog pool community

Areas that had a high proportion of bare peat with common cottongrass were mapped as the NVC community M3.

M3 is a species poor community, generally made up of common cottongrass on redistributed peat or areas where the peat bog has been lost. Within the Proposed Launch Site Habitat Study Area, the majority of the M3 community was found in hagg fields, or bare peat areas within wet modified bog/wet heath.

In the hagg fields the M3 bare peat could be filled with water or as bare peat pans with little vegetation. In these areas common cottongrass with perhaps a little feathery bog-moss (*Sphagnum cuspidatum*) and/or flat-topped bog-moss were present.

Peat bog (peatland setting)

In the FWT peat bog is defined as wet peat, which is generally deeper than 0.5m, with heather, cottongrasses and some small sedge species (SNIFFER, 2009b). The Phase 1 Habitat bare peat could fit into this peat bog category (although some areas were not considered to be on

peat >0.5m) and the NVC community M3 is within this FWT category. M3 is not considered to be potential GWDTE (SEPA, 2017).

Fen

Fens are defined as minerotrophic mires usually over deep peat. The fen community was dominated by common sedge. A single NVC community was described.

Mxd *Carex nigra* provisional fen, *Molinia caerulea* sub-community

Dargie (1998a, 1998d) describes a provisional fen community that was not included in the original NVC publications. It is described as a rich fen, dominated by common sedge, developing in areas which are very wet, and poorly drained, but not inundated for long periods.

Within the Proposed Launch Site Habitat Study Area there were several locations where the species composition best fit this provision NVC community descriptions. These areas were generally in damp hollows and seepage lines. Common sedge was dominant with purple moor-grass abundant. Sweet vernal grass and Yorkshire fog were also frequently present. Tormentil was the only forb with any prominence, although there were small amounts of bog asphodel, marsh willowherb and common dog violet.

Fen

In the FWT fen is defined as tall herb vegetation, including flowering plants, reeds, sedges and rushes (SNIFFER, 2009b). The NVC community Mxd was found in seepage lines and hollows and may fit within this FWT category. Mxd is not included in SEPA guidance (SEPA, 2017).

Dry dwarf shrub heath

Dry dwarf shrub heath was recorded within the Proposed Launch Site Habitat Study Area. It was dominated by heather, with crowberry and bell heather both prominent. The dry dwarf shrub heath was found on steep slopes and on dry, raised patches within the blanket bog habitat in the north of the Proposed Launch Site Habitat Study Area and within the wet modified bog/wet heath to the west of the Proposed Launch Site Habitat Study Area. It was formed on peat which was apparently less than 0.5m deep, although it is possible some of the dry heath that was mapped was actually on dry (and degraded) deeper peat, with no visible indication of the peat depth.

There was a single dry heath NVC community described within the Proposed Launch Site Habitat Study Area.

H10b *Calluna vulgaris – Erica cinerea* heath, *Racomitrium lanuginosum* sub-community

The H10b heath community was dominated by heather although the heather was grazed short giving an open structure. Bell heather and crowberry were both present, with crowberry abundant and a preferential for this sub-community along with the woolly fringe moss and lichens (*Cladonia spp.*). Mat grass and heath rush were common, as was purple moor-grass. Tormentil was a common forb along with devil's-bit scabious in some stands. There was occasionally heath wood-rush and common sedge present.

Dry heath communities are not considered to be wetland habitats in the FWT and are not potential GWDTE.

Acid flush

There was a small flush running downhill in the west of the Proposed Launch Site Habitat Study Area. The flush was bog-moss dominated, with a variety of mosses, including flat-topped bog-moss. Common sedge and bulbous rush were the most common species, although they were sparse. It was mapped as a mosaic with the heath rush dominated acid grassland (U6) and as it became more diffuse on the lower slopes it was mapped as a mosaic with wet modified bog/wet heath (M15d) and acid grassland.

M6b *Carex echinata – Sphagnum fallax* mire, *Carex nigra – Nardus stricta* sub-community

The M6b sub-community was dominated by bog-mosses, particularly flat-topped bog-moss. Common haircap was occasional. The community was species poor, and sparsely vegetated over with common sedge and bulbous rush most common. Mat grass and heath rush were occasional, more at the transition with the U6 grassland than in the M6 community itself.

Seepage/Flush (slope settings)

In the FWT seepage/flushes are defined as variable vegetation associated with diffuse springs on hill slopes. This is similar to the Phase 1 Habitat acid flush and the NVC community M6. This category is defined as a potentially highly GWDTE (SEPA, 2017). According to the BGS geological maps the M6 was located in close proximity to the intersection between two different bedrock types, with the Saxa Vord Pelite Formation to the west and Skaw Intrusion to the east. This indicates a fault line (or some geological change), which can cause groundwater to discharge. It is, therefore, considered possible or even likely that the M6 flush was associated with groundwater.

Open vegetation

There were small patches of nettles, which fit the NVC community OV25. These were not mapped separately but formed very small stands within the acid grasslands.

OV25 *Urtica dioica – Cirsium arvense* community

There were occasionally, usually small, patches of nettles and/or creeping thistle (*Cirsium arvense*) across the Proposed Launch Site Habitat Study Area, usually associated with the buildings and surrounding enriched grasslands.

This dominated community is not considered a wetland and is not a potential GWDTE.

Standing water

There were several small standing water pools within the Proposed Launch Site Habitat Study Area. Most were dry, or partially dry at the time of survey. On Lamba Ness the marginal vegetation was often (but not exclusively) brackish in nature, while inland pools were more regularly dystrophic. Where there was marginal, emergent or inundation vegetation they were described separately.

Water margin and inundation vegetation

This habitat type comprises of emergent or frequently inundated vegetation. There were a number of small vegetated, or partly vegetated pools, and pool margins within the Proposed Launch Site Habitat Study Area, particularly on Lamba Ness, with a variety of vegetation types

within them. They were generally very small, being just a few meters in size. Some were mapped, and some target noted. A total of four water margin and inundation NVC communities were described:

- The pools dominated by common spiked-rush (*Eleocharis palustris*) were classed as NVC community S19a.
- Species poor marginal vegetation dominated by shoreweed was classed as NVC community A22a.
- Species poor marginal vegetation dominated by bulbous rush was classed as NVC community A24.
- A single area dominated by creeping bent and creeping buttercup was classed as NVC community OV28.

S19a *Eleocharis palustris swamp, Eleocharis palustris* sub-community

The S19a community was found in wet hollows on Lamba Ness. These areas were dominated by common spiked-rush standing in damp to wet ground at the time of the survey. Lesser spearwort was common in some stands but it was generally very species poor with limited records of common sedge and jointed rush. In one stand marsh pennywort was apparent and there was also occasional velvet bent, common chickweed and bulbous rush. This particular patch had some affinities with the S19c descriptions.

A22a *Littorella uniflora - Lobelia dortmanna* community, *Littorella uniflora* sub-community

There were two small areas where shoreweed dominated. One area was where peaty-sandy soil had been cut away in the past leaving a pool with shoreweed around the edges. The other area was over the foundations of an old building. Shoreweed formed a dense, species poor mat, where it was dominant with few other species recorded at the time of survey.

The pool had several large rocks within it and the water was smelly with thick algae growth.

A24 *Juncus bulbosus* community

There were some dry (at the time of survey) pools, with bare, cracked peaty soil which was poached by sheep. In these dried pools there was approximately 50% bare peaty soil and 50% bulbous rush, with some velvet bent also present. These areas were clearly water filled at certain times of the year.

OV28 *Agrostis stolonifera – Ranunculus repens* community

Creeping bent and creeping buttercup were found where a small stream met a small, sheltered beach. The stolons and runners were growing across a wet sandy surface substrate with a small 30cm wide stream running through the middle. There was also common chickweed, cuckooflower (*Cardamine pratensis*) and marsh willowherb occasionally present.

Swamp

Despite the association with pools, the water margins and inundation communities A22, A24, and OV28 are not considered to be wetlands in the FWT and are not listed as potentially GWDTE. S19 is considered as part of the swamp category in the FWT but is not listed as a potential GWDTE.

Watercourses and drains

There were a number of small watercourses across the Proposed Launch Site Habitat Study Area (defined using the OS 1:25,000 maps), which were subject to artificial management and so were often straight and well defined. Drains were also mapped across the Proposed Launch Site Habitat Study Area. These were generally associated with the wet modified bog and wet modified bog/wet heath. Some of the drains were target noted. They were usually about 1m wide and 50-60cm deep (but some were up to ca. 1m deep). A total of ca. 2.3km were mapped as watercourses with an additional ca. 2.2km mapped as ditches.

Bare ground

Some small areas were mapped as bare ground. These were either areas of bare sand or of exposed peaty-mineral soils.

Buildings and roads

Lamba Ness was previously a military base during the wars with associated infrastructure evident across the peninsula. Many of the military buildings were derelict and used as shelter by the livestock resulting in localised fertilisation. There were also some areas that were ruined, with only foundations remaining. Roads and tracks were mapped across the Proposed Launch Site Habitat Study Area. These included the road that links Norwick and Skaw and the track that leads to the head of Lamba Ness.

Results – LRCC and New Section of Access Road at Northdale Habitat Study Area

The Phase 1 Habitat survey map for the LRCC Habitat Study Area and the New Section of Access Road at Northdale Habitat Study Area is shown in Appendix 7.2 Drawing 8 and a list of habitat types are displayed in Table 4. The NVC survey map of the LRCC and New Section of Access Road at Northdale Habitat Study Area is shown in Appendix 7.2 Drawing 9 with the potential GWDTE shown in Appendix 7.2 Drawing 10[2]. These drawings are supported with a list of target notes (Annex 1, Appendix 7.2 Drawing 11). Photographs of the habitats and interesting features are provided in Annex 2.

Overview

The centre of the LRCC Habitat Study Area was largely made up of improved grassland and buildings, roads and car parking spaces. The grassland around some of the buildings and roads was frequently mown amenity grassland with perennial rye grass and daisy. The most common habitat surrounding the buildings and roads was improved grassland which was subject to varying intensities of sheep grazing. There were small patches of semi-improved neutral grassland along road verges and in discrete, less intensively managed locations.

The New Section of Access Road at Northdale Habitat Study Area was largely made up of improved grassland. There were also habitats that were consistent with those described in the Proposed Launch Site Habitat Study Area including dry dwarf shrub heath and acid grassland. There were some small patches of neutral grassland most of which were mapped as a mosaic with the acid grassland and improved grassland.

[2] Drawings are provided within this document for ease of reference and higher resolution versions are provided separately as PDFs.

Study Area	Phase 1 Habitats	Area (ha)	% of Study Area
LRCC Habitat Study Area	Improved grassland	4.6	61.2
	Buildings and roads	2.1	27.6
	Neutral grassland	0.6	7.6
	Amenity grassland	0.3	3.6
	Total	***7.6***	***100***
New Section of Access Road at Northdale Habitat Study Area	Improved grassland	6.6	41.4
	Acid grassland	3.4	21.3
	Dry dwarf shrub heath	3.2	20.3
	Acid grassland: neutral grassland	1.7	10.4
	Buildings and roads	0.5	3.2
	Neutral grassland	0.4	2.3
	Dry heath: acid grassland	0.1	0.7
	Neutral grassland: scrub	0.1	0.4
	Total	***16.0***	***100***

Table 4: The area of each of the Phase 1 Habitats found in the LRCC Habitat Study Area and the New Section of Access Road at Northdale Habitat Study Area.

Habitat and Community Descriptions

Buildings and roads

The building and roads category includes the buildings and their gardens, roads, tracks, carparks and play courts. In the LRCC Habitat Study Area the buildings included the distillery building, some buildings within Saxa Vord Resort and surrounding roads and parking spaces. In the New Section of Access Road at Northdale Habitat Study Area there were small sections of the existing road and some buildings. There is no associated NVC community.

Amenity grassland

Amenity grassland incudes intensively managed grassland which is regularly mown. It is typical of lawns and playing fields. Amenity grassland was common at Saxa Vord Resort. It contained a usual assemblage of species including perennial rye grass with daisy, white clover and creeping buttercup. There were occasional records of common sorrel (*Rumex acetosa*), red clover (*Trifolium pratense*), hogweed (*Heracleum sphondylium*), selfheal, bird's-foot trefoil and rarely heath spotted orchid.

The associated NVC community for this habitat is **MG7e *Lolium perenne – Plantago lanceolata* community** which is characteristic of verges and lawns which are regularly mown.

Amenity grassland is not considered to be a wetland and MG7 is not considered to be a GWDTE in SEPA's guidance.

Improved grassland

There was much improved grassland in the LRCC Habitat Study Area and the New Section of Access Road at Northdale Habitat Study Area which experienced a range of grazing intensity from sheep. Perennial rye grass was dominant in much of the improved grassland. In species

poor fields the improved grassland was restricted to perennial rye grass, white clover with some Yorkshire fog, common sorrel and occasional bent grasses. In other fields a greater variety of grasses could be more prominent including Yorkshire fog, bent grasses and fescues. Sheep's sorrel, white clover and creeping buttercup were common forbs. In the fields surrounding the New Section of Access Road at Northdale Habitat Study Area autumn hawkbit was prominent.

The associated NVC community for this habitat is **MG7 *Lolium perenne* leys**. Sub-communities ***MG7a Lolium perenne - Trifolium repens*** leys and **MG7b *Lolium perenne – Poa trivialis*** were both represented in the LRCC and New Section of Access Road at Northdale Habitat Study Area. The MG7b could be fairly forb rich with red clover, white clover, autumn hawkbit, tormentil and lesser stitchwort all frequent in some stands, indicating that these fields receive light, or minimal, improvement.

There were occasional patches of creeping thistle in the improved grassland.

Improved grassland is not considered to be a wetland and MG7 is not considered to be a GWDTE in SEPA's guidance.

Neutral grassland

The Phase 1 Habitat category neutral grassland includes grasslands dominated by false oat-grass (*Arrhenatherum elatius*) and species-poor wet grasslands where soft rush and Yorkshire fog are abundant. The neutral grassland within the LRCC Habitat Study Area and New Section of Access Road at Northdale Habitat Study Area included three NVC communities **MG1a *Arrhenatherum elatius* grassland, *Festuca rubra* sub-community, MG9 *Holcus lanatus – Deschampsia cespitosa* grassland** and **MG10a *Holcus lanatus – Juncus effusus* rush-pasture, typical sub-community.**

MG1a was recorded along some road verges and in a patch around the Saxa Vord Resort. False oat-grass was generally overwhelmingly dominant.

A small, rough grassland in the New Section of Access Road at Northdale Habitat Study Area was dominated by creeping soft-grass (*Holcus mollis*) with red fescue and sweet vernal grass. Pignut was the most common forb, with common sorrel and creeping buttercup. This was a very poor fit to the MG9 community.

There were occasional small patches of MG10a in the damp, hollows of grassland field where soft rush stood out amongst the other grassland and heath vegetation.

Marshy grassland, as described by the FWT, includes vegetation dominated by tussock forming grasses and rushes in damp soils. This includes the Phase 1 Habitat neutral grassland and NVC community MG10. The NVC communities MG10 is considered potentially moderately groundwater dependant depending on the hydrological setting (SEPA, 2017).

Unimproved acid grassland

The mat grass dominated acid grassland in the New Section of Access Road at Northdale Habitat Study Area was consistent with that of the Proposed Launch Site Habitat Study Area and descriptions are not repeated here. The associated NVC community was **U5b *Nardus stricta – Galium saxatile* grassland, *Agrostis canina – Polytrichum commune* sub-**

community. This acid grassland is also defined as a montane grassland in the FWT. U5 is not considered a potential GWDTE.

Where the existing footpath goes between farmland fields, there was a mosaic of dry dwarf shrub heath and acid grassland. This was similar to the **U4b *Festuca ovina – Agrostis capillaris – Galium saxatile* grassland, *Holcus lanatus – Trifolium repens* sub-community** descriptions form the Proposed Launch Site Habitat Study Area descriptions, although was not grazed. Common bent, red fescue, sweet vernal grass and Yorkshire fog were frequent to dominant. There were a variety of forbs including creeping buttercup, autumn hawkbit, white clover and tormentil (NVC community U4b).

Along the current road verge, at Houlanbrindy in the north of the New Section of Access Road at Northdale Habitat Study Area there was an abundance of wild flowers in the U4b grassland, including thyme, bird's-foot trefoil, selfheal, autumn hawkwbit and sheep's-bit. These were usually 1-3m along the road verge, too small to map and were generally present with exposed bedrock showing though. This likely best fit the **U4b** grassland NVC community, although with some base enrichment from the exposed bedrock.

Dry dwarf shrub heath

The heather dominated dry dwarf shrub heath in the New Section of Access Road at Northdale Habitat Study Area was consistent with that of the Proposed Launch Site Habitat Study Area and descriptions. The associated NVC community was ***H10b Calluna vulgaris – Erica cinerea heath, Racomitrium lanuginosum sub-community***. The H10b community was of short heather with crowberry, bell heather and tormentil. Wavy hair-grass, sweet vernal grass, mat grass and common sedge were occasional to frequent. Several field gentian (*Gentianella campestris*) were recorded along the trackway at the transition of dry heath and semi-improved grassland

Dry heath communities are not considered to be wetland habitats in the FWT and are not potential GWDTE.

Scrub

There was a small patch of Japanese rose (*Rosa rugosa*) in the New Section of Access Road at Northdale Habitat Study Area. It was ca. 2m tall and was found along the existing road edge and in old, ruined buildings.

Evaluation

Habitat evaluation

No parts of the three Study Areas formed part of a site designated for biological features. There are several designated sites on Unst with features that are nationally or internationally important. The closest nationally designated site is Norwick SSSI which is adjacent to the Proposed Launch Site Habitat Study Area to the southwest. It is designated for its geological features (NatureScot, 2020). A section of ca. 85m of this geological SSSI is within the Study Area, at the cliffs in southwestern edge (Appendix 7.2 Drawing 12).

Norwick Meadows SSSI is also very close to the New Section of Access Road at Northdale Habitat Study Area (ca. 60m south) and relatively near to the Proposed Launch Site Habitat Study Area (ca. 600m south) (Appendix 7.2 Drawing 12). Norwick Meadows SSSI is designated for its valley fen wetlands and sand dunes (NatureScot, 2020). The New Section of Access Road at Northdale Habitat Study Area is particularly close to the Norwick Meadows SSSI. Improved grassland is the main habitat type between the road and the SSSI, with a small area mapped as marshy grassland and acid grassland mosaic. These communities do not form part of the designated feature of the SSSI.

The other designated sites on Unst are designated for bird species and/or for calaminarian grassland and serpentine heath (e.g. Keen of Hamar SSSI and SAC and Crussa Field and the Heogs SSSI) (NatureScot, 2020).

There are also several Local Nature Conservation Sites on Unst. These are listed in Table 5.

Unst Local Nature Conservation Sites	Primary Interest	Justification for Local Nature Conservation Site
Baltasound	Species	Glasswort (*Salicornia europea*) and annual sea-blite (*Suaeda maritima*).
Burn of Mailand	Species	Rare plants. Lesser tussock sedge (*Carex diandra*) and small bur-reed (*Sparganium natans*) are found nowhere else in Shetland. Rich bryophyte flora.
Haroldswick mires	Species	Schedule 1 bird species. The pool at Haroldswick is attractive to migrant birds. The base-rich mire vegetation is unusual in Shetland.
Lochs of Bordastubble and Stourhoull	Species	These water bodies are on the Unst serpentine; they are nutrient rich and support a variety of aquatic species. Breeding Schedule 1 bird species.
Skeo Taing	Species	The herb-rich turf with base-rich shell sand provides habitat for a diverse range of plants. The nationally rare autumn gentian (*Gentianella amarelle septentrionalis*) is found on site. This is the only site in Shetland where harebell (*Campanula rotundifolia*) may still occur.
Wick of Skaw	Geology	Easily identifiable exposure of a granite intrusion contact zone.
Belmont Quarry	Geology	Rock exposures across a major shear zone/ophiolite thrust. Part of the Shetland Ophiolite Suite.
Clibberswick Cross Geo	Geology	Part of the Shetland Ophiolite suite.
Hill of Clibberswick	Species	Two nationally scarce plant species are present on-site, Norwegian sandwort (*Arenaria norvegica*) and northern rock cress (*Arabis petraea*)

Table 5: The Local Nature Conservation Sites on Unst with their features of primary interest and the justification as specified in the Shetland Island Development Plan Local Nature Conservation Site guidance (SIC, 2015).

Some of the habitats described within the Proposed Launch Site Habitat Study Area are similar to, or approaching descriptions for, Annex 1 habitats and/or SBL habitats. These include:

- Coastal grasslands;
- Saltmarsh;
- Sand dunes;
- Wet modified bog;
- Blanket bog;
- Wet modified bog/wet heath
- Fen;
- Dry dwarf shrub heath;
- Acid flush; and
- Water margin vegetation.

Dry dwarf shrub heath was also recorded in the New Section of Access Road at Northdale Habitat Study Area and may have been similar to, or approaching, Annex 1 habitats and/or SBL habitats descriptions.

Coastal grassland

The Annex 1 habitats vegetated sea cliffs of the Atlantic and Baltic coasts are described as "*vegetated sea cliffs are steep slopes fringing hard or soft coasts, created by past or present marine erosion, and supporting a wide diversity of vegetation types with variable maritime influence*" and "*The most exposed areas support maritime vegetation dominated by a range of salt-tolerant plants*". The description of Annex 1 habitat vegetated sea cliffs includes the NVC communities MC8 and MC10 (EC, 2013). The coastal grassland communities within the Proposed Launch Site Habitat Study Area meet these descriptions. The coastal grasslands in the Proposed Launch Site Habitat Study Area also meet the description of the UK BAP habitat maritime cliffs and slopes which is a SBL habitat.

No clear published account of the total area of coastal grassland in Shetland was found. There is an estimated 12,000ha (120km^2) of coastal grasslands in Scotland and 22,138ha (221.38km^2) in the UK (JNCC, 2020). There was a total of 19.7ha of coastal grassland recorded within the Proposed Launch Site Habitat Study Area (0.16% of the Scottish total). Given that Shetland has much grazed grassland around its extensive coastline it is not considered likely to be a particularly rare habitat type in Shetland, although it is considered to be potentially species rich and ecological valuable habitat (PlantLife, 2014). The sheep grazed coastal grassland within the Proposed Launch Site Habitat Study Area was relatively species rich and contained a good assemblage of species. The area is grazed throughout the summer period, which may limit species richness (PlantLife, 2014). No particular Shetland rarities were recorded in the coastal grassland and it has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with coastal grasslands as a citation feature (NatureScot, 2020; SIC, 2015). Following due consideration of the range of factors listed in the guidance (CIEEM, 2018) the coastal grasslands within the Proposed Launch Site Habitat Study Area were considered to be of local importance.

Sand dune

The sand dune habitats within the Proposed Launch Site Habitat Study Area are similar to the Annex 1 habitats descriptions for embryonic shifting dunes, which includes the NVC community SD4, and fixed dune vegetation, which includes NVC community SD8. The Annex 1 habitat description for embryonic shifting dunes states that "*Embryonic shifting dunes vegetation exists in a highly dynamic state and is dependent on the continued operation of physical processes at the dune/beach interface. It is the first type of vegetation to colonise areas of incipient dune formation at the top of a beach*." It goes on to say "*Embryonic shifting dunes are inherently species-poor and have a limited range of floristic variation. The predominant plants are strandline species such as sea rocket* Cakile maritima *and the two salt-tolerant, sand-binding grasses: lyme-grass* Leymus arenarius *and sand couch* Elytrigia juncea" (JNCC, 2020). The SD4 sand dune community described in the Proposed Launch Site Habitat Study Area is considered to meet these descriptions.

The Annex 1 habitat description for fixed dune vegetation states that "*Fixed dune vegetation occurs mainly on the largest dune systems, being those that have the width to allow it to develop. It typically occurs inland of the zone dominated by marram* Ammophila arenaria *on coastal dunes, and represents the vegetation that replaces marram as the dune stabilises and the organic content of the sand increases*. This description does not closely match what was

seen in the Proposed Launch Site Habitat Study Area and what habitat was present was a very small example of sand dune and dune grassland.

The sand dunes in the Proposed Launch Site Habitat Study Area meet the description of the UK BAP Habitat coastal sand dunes which is a SBL habitat. There was a total of 0.3ha of sand dunes mapped within the Proposed Launch Site Habitat Study Area. There is estimated to be 1,040ha (10.4km^2) of sand dune vegetation in Shetland including 3.4ha of embryonic dunes and 239.3ha of fixed dunes (Dargie, 1998a). There is an estimated 50,000ha (500km^2) of sand dunes in Scotland (70,000ha (700km^2) in the UK) (JNCC, 2020). The Scottish total for embryonic dunes is 90ha (295ha for the UK), whereas the fixed dune vegetation is much more common with an estimated 14,800ha (148km^2) in Scotland (22,400ha (224km^2) in the UK) (JNCC, 2020).

Dargie (1998b) states that "*The nature conservation interest of the site [Inner Skaw] is low due to small site area and limited range of vegetation*". This 2018 survey supports this statement, as the vegetation is sparse, generally species poor with limited examples of dune vegetation and is small in size. The embryonic dunes make up ca. 9% of the regional total and 0.3% of the Scottish total. Much of it was bare sand, and it has been considered to be of low conservation interest due to its limited size and range of vegetation. However, it is nearby to a SSSI designated for the sand dune features, namely Norwick Meadows SSSI. Therefore, on balance, the value of the sand dune vegetation within the Proposed Launch Site Habitat Study Area is elevated and considered to be of regional importance.

Saltmarsh

Saltmarsh is included in the Annex 1 habitat Atlantic salt meadows which includes the NVC community SM16. The description of Annex 1 habitat Atlantic salt meadows states that Atlantic salt meadows "*develop when halophytic vegetation colonises soft intertidal sediments of mud and sand in areas protected from strong wave action. This vegetation forms the middle and upper reaches of saltmarshes, where tidal inundation still occurs but with decreasing frequency and duration*". The description of Annex 1 habitat Atlantic salt meadows does not include perched saltmarshes and the description does not fit closely to the type of saltmarsh community found within the Proposed Launch Site Habitat Study Area and so does not meet this criteria. Saltmarsh habitats are on the SBL. Using the UK BAP habitat definitions saltmarsh is also restricted to intertidal areas with the upper limit being one metre above the level of highest astronomical tides (Maddock, 2011). These do not take into account perched saltmarsh as found in the Proposed Launch Site Habitat Study Area.

Perched saltmarsh is a relatively rare (and likely under-recorded) habitat type in Scotland and across the UK (Haynes, 2016). The saltmarsh survey of Scotland describes perched saltmarshes as "*often very small or present as short saltmarsh turf on cliff tops, which makes them difficult to map. These marshes are likely recorded more frequently as part of cliff vegetation surveys and may be interpreted as being closely associated with maritime cliff vegetation, rather than saltmarsh*" (Haynes, 2016). A total of 0.4ha of perched saltmarsh was recorded within the Proposed Launch Site Habitat Study Area with additional areas too small to map. No area metric for perched saltmarsh is given in the saltmarsh survey of Scotland. Nevertheless, the saltmarsh recorded in this 2018 survey appears to be the most northerly recorded in the UK. However, it was generally species poor with saltmarsh rush sometimes

the overwhelmingly dominant species present. The Proposed Launch Site Habitat Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site. Baltasound, which is ca. 6km away is a Local Conservation Site with the saltmarsh species glasswort (*Salicornia europea*) and annual sea-blite (*Suaeda maritima*) a justification citation feature. (SIC, 2015). These species were not found in the Proposed Launch Site Habitat Study Area and the type of saltmarsh, specifically perched saltmarsh, is not a feature of designated sites.

The perched saltmarsh in the Proposed Launch Site Habitat Study Area could be considered to be of regional importance because it is a relatively rare habitat in the UK and it appears to be the most northerly saltmarsh in the UK. However, the area of perched saltmarsh in the Proposed Launch Site Habitat Study Area is tiny and species poor. It is not an Annex 1 or SBL habitat and it is likely under-recorded in the UK. Taking all these aspects into consideration the small area of perched saltmarsh is considered to be of local importance.

This survey supports Haynes (2016) who states that "*It is likely that there is more perched saltmarsh present across Scotland than is currently recorded. The vegetation is strongly associated with the 'MC' classification and further research into the vegetation of maritime cliffs is required*".

Blanket bog

The blanket bog (M18, M19), wet modified bog (M25, M3) and wet modified bog/wet heath (M15) transition are all considered within this section.

All blanket bog, regardless of condition, is listed by European legislation, under Annex 1 of the Habitats Directive (Directive on the Conservation of Natural Habitats and Wild Fauna and Flora EC/92/43). This includes wet heath, M15, but not M25 (European Commission, 2013). Active, peat forming blanket bog has a priority status. 'Active' blanket bog is defined as "*supporting a significant area of vegetation that is normally peat-forming. Typical species include the important peat-forming species, such as bog-mosses* Sphagnum *spp. and cottongrasses* Eriophorum *spp., or purple moor-grass* Molinia caerulea *in certain circumstances, together with heather* Calluna vulgaris *and other ericaceous species*. *Thus sites, particularly those at higher altitude, characterised by extensive erosion features, may still be classed as 'active' if they otherwise support extensive areas of typical bog vegetation, and especially if the erosion gullies show signs of recolonisation*" (JNCC, 2019).

Blanket bog, including degraded blanket bog with wet heath vegetation (M15) and purple-moorgrass (M25) is listed as a SBL habitat.

The blanket bog habitat in the Proposed Launch Site Habitat Study Area had an abundance of common cottongrass with heather and other ericaceous species such as cross-leaved heath and crowberry. Bog-mosses were present, but not generally as a continuous carpet. Erosion and grazing pressures were evident.

A PCA of the blanket bog in the Proposed Launch Site Habitat Study Area was undertaken during the Phase 1 Habitat and NVC survey. All of the blanket bog in the Proposed Launch Site Habitat Study Area was considered to be modified through grazing. Some of the blanket bog (degraded areas of M3) was also considered likely to be actively eroding with erosion

features and bare peat present. This has been displayed in Appendix 7.2 Drawing 6. Using the 'PCA support tool' the blanket bog in the Proposed Launch Site Habitat Study Area was considered to be of intermediate condition, with areas of bad quality where the erosion was most pronounced (areas of M3).

The blanket bog considered to be in best ecological condition, specifically for the Proposed Launch Site Habitat Study Area, was considered to be the M18 and M19 communities.

Using the evidence provided here, and the 'PCA Support Tool', the blanket bog within the Proposed Launch Site Habitat Study Area could be judged as inactive and likely to be an atmospheric carbon source, rather than a carbon sink. However, this is a rough, subjective tool, and doesn't take into account subtleties and variation within the bog. Certainly, the eroding blanket bog is thought to be a carbon source rather than a sink and so unlikely to be active. But, given the northern location of the Proposed Launch Site Habitat Study Area, and the reasonable quality of at least some of the blanket bog there is a degree of uncertainty as to its activity status or not. Therefore, it is considered that the M18 blanket bog may be active/partially active and the M19 blanket bog in the Proposed Launch Site Habitat Study Area is likely to be mostly inactive but may have some areas that are still partially active. Therefore, the blanket bog in the Proposed Launch Site Habitat Study Area is considered to be approaching Annex 1 priority habitat definitions.

The PCA considered that the areas of wet modified bog and wet modified bog/wet heath transition in the Proposed Launch Site Habitat Study Area to be modified through grazing with some areas drained (Appendix 7.2 Drawing 6). Using the 'PCA Support Tool' the wet modified bog and wet modified bog/wet heath transition in the Proposed Launch Site Habitat Study Area were considered to be of intermediate condition and unlikely to be normally active.

There is an estimated 2,224,104ha (22,241km^2) of blanket bog in the UK (JNCC, 2020) and 1,759,000ha (17,590km^2) in Scotland (JNCC, 2020). Blanket bog (in a variety of conditions) is a widespread and common habitat across Shetland. There is an estimated 53,430ha (534.3km^2) of peatland (which in Shetland is considered synonymous with blanket bog as there is little e.g. fen habitat) with additional areas also mapped as a mosaic with peatland (19km^2) (The Macaulay Institute, 1993).

The Proposed Launch Site Habitat Study Area had 2.6ha of blanket bog habitat (including matrix with bare peat). Although some of the blanket bog met UK BAP and Annex 1 habitat definitions and may have been approaching Annex 1 priority habitat definition, there is considerably less than 1% of the national and regional total (0.0001% and 0.005% respectively). Therefore, the quantity, size and condition present is not considered to be of national or regional importance.

The Proposed Launch Site Habitat Study Area had a further 37.5ha of wet modified bog/wet heath transitional habitat (including matrixes). This is considerably less than 1% of the national and regional total of blanket bog (0.002% and 0.07% respectively). Therefore, the quantity, size and condition of wet modified bog/wet heath habitat is not considered to be of national or regional importance.

The Proposed Launch Site Habitat Study Area had a further 28.2ha of wet modified bog habitat. Again, this is considerably less than 1% of the national and regional total of blanket

bog (0.001% and 0.05% respectively). Therefore, the quantity, size and condition present is not considered to be of national or regional importance.

The Proposed Launch Site Habitat Study Area had a combined total of 68.3ha of bog habitats (including blanket bog, wet modified bog and wet modified bog/wet heath). The total of these habitat types is considerably less than 1% of the national and regional total (0.004% and 0.1% respectively). Therefore, the quantity, size and condition present is not considered to be of national or regional importance.

Furthermore, the Proposed Launch Site Habitat Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site. The area is not near site designated for conservation importance with blanket bog as a citation feature or justification feature (NatureScot, 2020; SIC, 2015), although Haroldwick mires, which are ca. 3.8km away, has base-rich mire vegetation which is unusual in Shetland (SIC, 2015). Therefore, the blanket bog within the Proposed Launch Site Habitat Study Area does not form an important wildlife corridor or link between important designated blanket bog patches.

The carbon and peatland maps show a small section of the northwest of the Proposed Launch Site Habitat Study Area as having peatland with peatland vegetation (Category 1), which is consistent with the location of much of the blanket bog habitat mapped in the Proposed Launch Site Habitat Study Area and with the areas of pools in the wet modified bog/wet heath transition. Class 1 is described as "*Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas likely to be of high conservation value*" (Scotland's Soils, 2017). The areas depicted as wet modified bog is mapped as Class 5 peat soils with no peatland vegetation, and the area mapped as wet modified bog/wet heath transition is mostly mapped as Class 4 - predominantly mineral soil with some peat soil with the vegetation described as heath with some peatlands.

Following due consideration of these the size, quality and condition of the blanket bog, and considering the widespread nature of blanket bog (in various conditions) in Shetland and on Unst, the blanket bog within the Proposed Launch Site Habitat Study Area was considered to be of local importance. The wet modified bog/wet heath transitional habitat was considered to be of local importance. The wet modified bog was considered to be, at best, of local importance.

Wet modified bog/wet heath

The wet modified bog/wet heath has been assessed as both wet heath and wet modified bog within the blanket bog evaluation.

Wet dwarf shrub heath is included in the upland heath SBL habitat. Using the UK BAP definitions for this habitat in favourable condition is defined as "*dominated by a mixture of cross-leaved heath, deergrass, heather and purple moor-grass over an understory of bog-moss*" (Maddock, 2011). Annex 1 Northern Atlantic wet heath includes M15 wet heath (JNCC, 2020). There is an estimated 467,714ha (4,677km^2) of wet dwarf shrub heath in the UK and 370,000ha (3,700km^2) in Scotland (JNCC, 2020). There is an estimated 16,500ha (165km^2) of heather moorland in Shetland, with additional areas of mosaics making a further 37,400ha (374km^2; The Macaulay Institute, 1993). There was 37.5ha of wet modified bog/wet dwarf

shrub heath within the Proposed Launch Site Habitat Study Area, (including mosaics). The combined total is much less than 1% (0.2%) of the Shetland total.

The wet modified bog/wet heath has been subjected to current and historic management practices of grazing and draining. It was fairly species poor, with common cottongrass often a dominant component. The Proposed Launch Site Habitat Study Area is not designated as a SSSI or Local Nature Conservation Site for wet dwarf shrub heath. There is no nearby designated site with wet dwarf shrub heath as a citation or justification feature (NatureScot, 2020; SIC, 2015). Therefore, the wet modified bog/wet heath within the Proposed Launch Site Habitat Study Area does not form an important wildlife corridor or link between important designated blanket bog patches. The wet modified bog/wet heath in the Proposed Launch Site Habitat Study Area was not considered to be of particularly high ecological value but may have some restoration potential. Following due consideration of these factors, and also those listed in the best practice guidance (CIEEM, 2018), the wet dwarf shrub heath was evaluated as being of local importance.

Dry heath

Dry dwarf shrub heath is included in the upland heath SBL habitat. Using the UK BAP definitions for this habitat in favourable condition it is defined as being "*dominated by dwarf shrubs such as heather, bilberry, crowberry, and bell heather*" (Maddock, 2011). Annex 1 European dry heath includes dwarf shrub dominated vegetation with heather, bilberry and bell heather (JNCC, 2020). Some of the dry dwarf shrub heath may have been approaching these definitions, but it was found in small patches, within a mosaic of blanket bog. There is an estimated 893,540ha (8,935km^2) of dry dwarf shrub heath in the UK and 479,000ha (4,790km^2) in Scotland (JNCC, 2020). There is an estimated 16,500ha (165km^2) of heather moorland in Shetland, with additional areas of mosaics making a further 37,400ha (374km^2; The Macaulay Institute, 1993). There was 0.7ha of dry dwarf shrub heath within the Proposed Launch Site Habitat Study Area with an additional 6.5ha mapped as a mosaic. There was a further 3.3ha (including mosaics) mapped within the New Section of Access Road at Northdale Habitat Study Area. The combined total is considerably less than 1% (0.06%) of the total in Shetland. The Proposed Launch Site Habitat Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with dry dwarf shrub heath as a citation feature or justification feature (NatureScot, 2020; SIC, 2015). Therefore, the dry heath within the Proposed Launch Site Habitat Study Area does not form an important wildlife corridor or link between important designated dry heath patches. Consequently, the dry dwarf shrub heath was not considered to be of sufficient quantity or quality to be nationally or regionally important and was evaluated as being of local importance.

Acid flush

Acid flush is listed as a SBL habitat categorised. Using the UK BAP habitat definitions upland flush is defined as 'peat or mineral-based terrestrial wetlands in upland situations, which receive water and nutrients from surface and/or groundwater sources as well as rainfall. It is a varied habitat category but is typically dominated by sedges and their allies, rushes, grasses and occasionally wetland herbs and/or a carpet of bryophytes' (Maddock, 2011). The flush habitat (NVC community M6) within the Proposed Launch Site Habitat Study Area is equivalent to this definition. Upland flush UK BAP habitat is widespread but local throughout

the uplands of Scotland (Maddock, 2011). The extent has not been recorded as it has not been comprehensively surveyed in many areas and tends to occur in small, sometimes numerous stands (Maddock, 2011). There was a single flush habitat in the Proposed Launch Site Habitat Study Area making up just 0.3ha of acid flush recorded (including mosaics). This habitat type is widespread across Scotland. The quantity of this habitat within the Proposed Launch Site Habitat Study Area was small and unconnected to other areas of this habitat type. The Proposed Launch Site Habitat Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with acid flush as a citation feature or justification feature (NatureScot, 2020; SIC, 2015). Following due consideration of not only these factors, but also others listed in the guidance (CIEEM, 2018), the upland flush habitat was considered to be of local importance (but see GWDTE evaluation).

Water margin vegetation

The Annex 1 habitat oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*) is described as "*This type of waterbody is restricted to sandy plains that are acidic and low in nutrients, and are therefore very scarce. The water is typically very clear and moderately acid*". The description goes on to say "*The habitat type is characterised by the presence of Littorelletalia-type vegetation. Such vegetation is characterised by the presence of water lobelia* Lobelia dortmanna, *shoreweed* Littorella uniflora, *or quillwort* Isoetes lacustris. *Only one species needs to be present to conform with the definition of this Annex I type and typically the vegetation consists of zones in which the individual species form submerged, monospecific lawns*" (JNCC, 2020). This habitat type is considered rare (JNCC, 2020). The SBL habitat oligotrophic and dystrophic lakes also includes the shoreweed community A22 (Maddock, 2011). The shoreweed community A22 within the Study Area is similar to these descriptions, particularly the pool which was on a peaty-sandy soil and species poor with shoreweed forming a carpet around the edge of a pool, although the pool was smelly with thick algae growth at the time of the survey. The pool in the Proposed Launch Site Habitat Study Area was very small, with a small patch of the community on one edge. The Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with acid flush as a citation feature or justification feature (NatureScot, 2020; SIC, 2015). Following due consideration of not only these factors, but also others listed in the guidance (CIEEM, 2018), the marginal vegetation habitat, specifically the NVC community A22, was considered to be of potentially regional importance due to its relative rarity.

Upland grassland

The upland grassland communities *Juncus squarrosus – Festuca ovina* grassland and *Nardus stricta – Galium saxatile* grassland are on the SBL. There are no descriptions for these in the UK BAP habitat descriptions (as they were not UK BAP habitats), but they correspond to the NVC communities U5 and U6. These are widespread community types in Scotland and Shetland (Scottish Government, 2013). They are also considered to require a '*watching brief only*' within the SBL. The Proposed Launch Site Habitat Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with upland grasslands as a citation feature or justification feature (NatureScot, 2020; SIC, 2015). Following due consideration of not only these factors,

but also others listed in the guidance (CIEEM, 2018), these upland grassland communities are considered to be, at best, of local importance.

Fen

A variety of fens are Annex 1 habitats and SBL habitats. The small amount of common sedge dominated community did not correspond well to these descriptions. Consequently the 'fen' habitat was considered to be of site importance.

Species evaluation

Only one of the plant species recorded during field surveys in 2018 was identified as being on the SBL. This was field gentian which was recorded along the trackway in the New Section of Access Road at Northdale Habitat Study Area.

Oysterplant, which was recorded in the fore-dune community, is an LBAP species and considered Near Threatened and Nationally Scarce and scarce in Shetland.

No other vascular species recorded during field surveys of the three Study Areas in 2018 were identified as an LBAP species or in the lists of rare and scarce species for Shetland (Scott *et al.,* 2002). Considerations of previous records within and near the three Study Areas are provided separately within the Shetland Space Centre Natural Heritage Desk Study.

There was no evidence of any notifiable non-native invasive species (e.g. Japanese knotweed) within the three Study Areas during walkover surveys. It should be noted that species distribution varies temporarily and spatially. The non-native invasive species Japanese knotweed is known to occur on Unst, including near Saxa Vord Resort (NBN Atlas, 2020) and so a watching brief should be kept for this species.

Groundwater dependant terrestrial ecosystems evaluation

GWDTE are defined as '*A terrestrial ecosystem of importance [at Member State level] that are directly dependent on the water level in or flow of water from a groundwater body (that is, in or from the saturated zone)*' (UKTAG, 2003). UKTAG defines pressures on GWDTE as '*being important when there is, or likely to be, significant damage on a GWDTE*' (UKTAG, 2005). Significant damage is defined as:

- '*the degree of damage occurring to a GWDTE (caused by groundwater related factors); and*
- the significance or conservation value of the ecosystem.' (UKTAG, 2005).

It has been suggested that non-statutory sites should be judged as significantly damaged if any groundwater-dependent ecosystem which is a UK BAP priority habitat is judged as damaged or declining for reasons of inadequate groundwater quality or quantity (UKTAG 2005).

SEPA's Guidance Note (2017) recommends that the listed NVC communities should be treated as GWDTE unless information can be provided to demonstrate they are not dependent

on groundwater. SEPA (2017) does recognise that some of these communities are common across Scotland and that these communities may be considered GWDTEs only in certain hydrogeological settings or may have limited dependency on groundwater in certain hydrogeological settings.

NVC communities recorded in the three Study Areas that are considered in the guidance (SEPA, 2017) to be potentially groundwater dependent include:

- M6 *Carex echinata – Sphagnum fallax* mire;
- M15 *Trichophorum cespitosum – Erica tetralix* wet dwarf shrub heath;
- M25 *Molinia caerulea – Potentilla erecta* mire;
- MG9 *Holcus lanatus – Deschampsia cespitosa* grassland;
- MG10 *Holcus lanatus – Juncus effusus* rush-pasture;
- MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community; and
- U6 *Juncus squarrosus – Festuca ovina* grassland.

One NVC community that is not in the SEPA guidance, which was considered to be a potentially GWDTE (due to the association with similar/related communities that are listed as a potentially GWDTE), is:

- Mxd *Carex nigra* provisional fen, *Molinia caerulea* sub-community; and

Of these, only M6 is considered to be potentially highly groundwater dependent, depending on the hydrological setting (SEPA, 2017). All the other communities are considered potentially moderately groundwater dependent, depending on the hydrological setting (SEPA, 2017). All mosaics of habitat were allocated their GWDTE category according to the NVC community with the highest potentially GWDTE.

The bedrock for the majority of the Proposed Launch Site Habitat Study Area was the Skaw Intrusion which was describe as a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures; rare springs*" (BGS, 2020b). To the far west of the Proposed Launch Site Habitat Study Area the bedrock is *Hevda Phyllite Formation which was also* described a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures*" (BGS, 2020b). Therefore, the majority of the potentially GWDTE are considered most likely to be present due to waterlogged conditions sustained by high rainfall in the region, rather than groundwater for their maintenance.

The M6 community was located at the transition between the two bedrock types in the Proposed Launch Site Habitat Study Area. This can be a source location for GWDTE, where groundwater is released at a spring or seepage line (McMullen, 2020). It is, therefore, considered that the M6 community may be an actual GWDTE.

In the LRCC and New Section of Access Road at Northdale Habitat Study Areas there were some habitats that were mapped as mosaics with MG10 and MG9, which are considered potentially moderately groundwater dependent depending upon the hydrological setting. The bedrock was Gruting Greenschist Formation for the LRCC Habitat Study Area and Norwick

Phyllite Formation for New Section of Access Road at Northdale Habitat Study Area. Both of which were described as a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures*" (BGS, 2020b). These areas of MG9 and MG10 may also be sustained by high rainfall in the region, rather than groundwater for their maintenance. However, the sensitive, nationally important, SSSI wetland habitats downhill of these potential GWDTEs should be considered in relation to the LRCC and New Section of Access Road development, particularly as there may be some interconnection through ground or surface water.

A qualified hydrologist should be consulted to determine if the potential GWDTEs identified within this report are actual GWDTEs.

Table 6 displays the relationship between NVC communities, Phase 1 Habitats, FWT categories and the groundwater dependency as stated by SEPA (2017).

Phase 1 Habitat	NVC Community	FWT Category	Guidance potential GWDTE	Setting	Comment on setting	Comment on potential GWDTE
Wet modified bog/wet heath	M15	Peat bog	Potentially moderately GWDTE	Lower slopes and westward side of the Proposed Launch Site Habitat Study Area	Set on peat with the bedrock classed as a low productive aquifer	Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region
Wet modified bog	M25	Peat bog	Potentially moderately GWDTE	Centre of Lamba Ness peninsula	Set on peat with the bedrock classed as a low productive aquifer	Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region
Fen	Mxd	Fen	Not included	Centre of Lamba Ness peninsula	In seepage lines and hollow	Potentially GWDTE, but likely that most influence is from the heavy rainfall and surface water movement – assigned moderate
Blanket bog	M19,	Peat bog	Not a GWDTE	Peat bog	Ombrotrophic	Not a GWDTE
Bare peat	M3	Peat bog	Not a GWDTE	Peat bog	Ombrotrophic	Not a GWDTE
Dry dwarf shrub heath	H10	Not a wetland	Not a GWDTE			Not a GWDTE
Acid flush	M6	Flush	Potentially highly GWDTE	Hill slope	Located at/near a change in the bedrock type	Potentially highly GWDTE
Acid grassland	U5 U6	Montane grassland Montane grassland	Not a GWDTE Potentially Moderately GWDTE	 With wet heath and other acid grasslands	 Set on peaty-sandy soils with the bedrock classed as a low productive aquifer	Not a GWDTE Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region
Coastal grassland	MC8, MC10 MG11	Not a wetland Wet grassland	Not a GWDTE Potentially Moderately GWDTE	 Lamba Ness peninsula	 Set on thin peaty-sandy soils with the bedrock classed as a low productive aquifer	 Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region
Saltmarsh	SM16	Saltmarsh	Not a GWDTE			Not a GWDTE

Phase 1 Habitat	NVC Community	FWT Category	Guidance potential GWDTE	Setting	Comment on setting	Comment on potential GWDTE
Sand dunes	SD4, SD8		Not a GWDTE			Not a GWDTE
Neutral grassland	MG9 and MG10	Marshy grassland	Potentially Moderately GWDTE	In ditches and as part of a mosaic within acid grasslands MG9 and mosaic of MG10 with acid and improved grassland in the New Section of Access Road at Northdale Habitat Study Area	The MG10 community found in ditches is likely to be influenced mostly from the surface water rather than groundwater. Where it was associated with other grassland it was on thin peaty-sandy soils with the bedrock classed as a low productive aquifer Some was uphill of SSSI designated wetland habitats	Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region Potential for connection with SSSI habitats
Water margins and inundation	S19 A22 A24 OV28	Swamp Not a wetland (standing water) Not a wetland (standing water) Not a wetland	None classed as GWDTE			None classed as GWDTE

Table 6: The relationship between Phase 1 Habitats, NVC communities, FWT categories and the GWDTE category defined by SEPA (2017).

Discussion

Proposed Launch Site Habitat Study Area

There were a wide variety of habitat and plant communities described within the relatively small Proposed Launch Site Habitat Study Area, with a total of 18 Phase 1 Habitats mapped and described using standard methods, plus a further three Phase 1 Habitat mapped as mosaics. A total of 28 NVC communities were found and described using standard survey methods. Many of these habitats were typical of Shetland, including wet modified bog, wet modified bog/wet heath, blanket bog, coastal grassland and acid grassland. There were also areas of sand dunes and pools with marginal vegetation.

Of the habitats present in the Proposed Launch Site Habitat Study Area wet modified bog/wet heath was the most common (26% of the Proposed Launch Site Habitat Study Area) closely followed by wet modified bog (24% of the Proposed Launch Site Habitat Study Area) and coastal grassland (17% of the Proposed Launch Site Habitat Study Area).

The dry dwarf shrub heath, blanket bog, wet modified bog, wet modified bog/wet heath, dune grassland, coastal grassland, acid flush and water margin vegetation habitats were evaluated as being approaching or equivalent to the descriptions of the SBL habitat and/or Annex 1 habitat descriptions, with blanket bog approaching Annex 1 priority habitat descriptions. The sand dune habitat and a water margin habitat were assessed as being of regional importance. The other habitats were evaluated as being of local importance due to a combination of factors including condition, size and the widespread nature of the habitat in Shetland.

Several habitats in the Proposed Launch Site Habitat Study Area, including wet modified bog and neutral grassland, were assessed as being potentially moderately groundwater dependent. The acid flush habitat (NVC community M6) was assessed as potentially highly GWDTE.

When assessing the potential impact of the proposed development, the presence and importance of the habitats present should be considered and special attention paid to the sand dune and the water margin (specifically the A22 community) habitats in the Proposed Launch Site Habitat Study Area, as well as the potentially GWDTE, particularly the potentially highly GWDTE acid flush (NVC community M6).

LRCC Habitat Study Area

The LRCC Habitat Study Area held a small number of habitats and communities, all of which are common in and around built-up areas and agricultural land. These included frequently mown amenity grassland, improved grassland, buildings and roads and small patches of neutral grassland along road verges and in less intensively managed locations.

None of these habitats were considered to have particular ecological importance or sensitivities. The non-native invasive species Japanese knotweed is known to be present on Unst, including a patch near the LRCC Habitat Study Area and so a watching brief should be kept for this species.

When assessing the potential impact of the proposed development, the presence and importance of the habitats present should be considered.

New Section of Access Road at Northdale Habitat Study Area

The New Section of Access Road at Northdale Habitat Study Area had a small number of habitats present, which were considered to be typical of Shetland. These included dry dwarf shrub heath, acid grassland, improved grassland and small patches of neutral grassland most of which were mapped as a mosaic with the acid grassland and improved grassland.

The dry dwarf shrub heath was evaluated as being approaching the descriptions of the SBL habitat and Annex 1 habitat descriptions. It was assessed as being of local importance.

The MG9 and MG10 grassland in the New Section of Access Road at Northdale Habitat Study Area, was assessed as being potentially moderately groundwater dependent. It was assessed as potentially being hydrologically connected to the nationally important, SSSI designated wetland habitats in Norwick Meadows. Care should be taken to ensure there are no direct or indirect impacts on these potentially sensitive habitats and the adjacent designated site.

When assessing the potential impact of the proposed development, the presence and importance of the habitats present should be considered and special attention paid to the nearby SSSI designated site and the potential for hydrological connectivity of wetland habitats within the New Section of Access Road at Northdale Habitat Study Area.

References

Athliserton, I., Bosanquet, S. and Lawley, M. 2010. *Moss and liverworts of Britain and Ireland: a field guide*. British Bryological Society, Plymouth.

Averis, A., Averis, B., Birks, J., Horsfield, D., Thompson, D. and Yeo, M. 2004. *An illustrated guide to British upland vegetation*. JNCC, Peterborough.

Botanæco. 2019. GWDTE decision tool. https://drive.google.com/file/d/1LOKvFmt1UOpd9DvXlGQoMbzxOY1rSHNl/view.

British Geology Society (BGS). 2020a. Geology of Britain Viewer. http://mapapps.bgs.ac.uk/geologyofbritain/home.html. Accessed April and May 2020.

BGS. 2020b. GeoIndex Onshore. http://mapapps2.bgs.ac.uk/geoindex/home.html?layer=BGSHydroMap. Accessed April and May 2020.

Chartered Institute of Ecology and Environmental Management (CIEEM), 2017. Guidelines for Preliminary Ecological Appraisal. CIEEM Guidance.

CIEEM. 2018. *Guidelines for Ecological Impact Assessment in the United Kingdom and Ireland, Terrestrial, freshwater, coastal and marine*, 3rd Edition. Version 1.1 (2019).

CIEEM. 2019. *On the lifespan of ecological reports and surveys*. CIEEM Guidance.

Cooper, E.A. 1997. *Summary descriptions of national vegetation classification grassland and montane communities*. JNCC, Peterborough.

Dargie, T. 1998a. *Sand dune vegetation survey of Scotland: Shetland*. *Volume 1: Main report*. Scottish Natural Heritage (SNH) Research, Survey and Monitoring Report No. 122 (Volume 1 of 3).

Dargie, T. 1998b. *Sand dune vegetation survey of Scotland: Shetland*. *Volume 2: Site report*. SNH Research, Survey and Monitoring Report No. 122 (Volume 2 of 3).

Dargie, T. 1998c. *Sand dune vegetation survey of Scotland: Shetland*. *Volume 3: NVC maps*. SNH Research, Survey and Monitoring Report No. 122 (Volume 3 of 3).

Dargie, T. 1998d. *Sand dune vegetation survey of Scotland: Western Isles*. *Volume 1: Main report*. SNH Research, Survey and Monitoring Report No. 122 (Volume 1 of 3).

Elkington, Dayton, N., Jackson, D.L. and Strachan, I.M. 2001. *National vegetation classification field guide to mires and heaths*. JNCC, Peterborough.

European Commission. 2013. *Interpretation Manual of European Union Habitats. European Commission DG Environment*. https://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf.

Fennell, M., Jones, L. and Wade, M. 2018. *Practical management of invasive non-native weeds in Britain and Ireland*. Property Care association.

Glenk, K., Martin-Ortega, J., Byg, A. 2017. *Online Condition Assessment Support Tool. Peatland Action*, SNH Commissioned Report.

Harvey, P. 2004. *Grouped Species Action Plan 'Arable associated* plants'. Living Shetland Biodiversity Action Plan.

Haynes, T.A. 2016. *Scottish saltmarsh survey national report*. SNH Commissioned Report No. 786.

Hearn, S. M.; Healey, J. R.; McDonald, M. A.; Turner, A. J.; Wong, J. L. G.; Stewart, G. B. 2011. The repeatability of vegetation classification and mapping. Journal of Environmental Management 92, pp. 1174-1184.

Joint Nature Conservation Committee (JNCC). 2010. *Handbook for Phase 1 habitat survey – a technique for environmental audit*, JNCC, Peterborough, Revised 2016.

JNCC. 2012. *Handbook for Phase 1 Habitat Survey, a technique for environmental audit Field Manual*. Revised Reprint.

JNCC. 2020. Joint Nature Conservancy Council. www.jncc.gov.uk Accessed April 2020.

Maddock, A. (ed.) 2011. *UK Biodiversity Action Plan; Priority Habitat Descriptions*. Updated from 2008. BRIG.

Marrs, R.H., Smart, S.M, Jones, M. and Hill, M.O. 2020. *TABLEFIT v. 3.0 & v.4, programs for the identification of vegetation types according to the British National Vegetation Classification*. Tablefit version 4.

McMullen, A. 2020. *GWDTE: Go With the Flow on Surveys*. https://botanaeco.co.uk/botan%C3%A6co-blog/f/gwdte-i-go-with-the-flow-on-survey?blogcategory=GWDTE.

National Biodiversity Network (NBN) Atlas, 2020. https://nbnatlas.org/. Accessed April and May 2020.

Peatland Action, 2016. Peatland Condition Assessment Guide. https://www.nature.scot/sites/default/files/2017-10/Guidance-Peatland-Action-Peatland-Condition-Assessment-Guide-A1916874.pdf.

PlantLife. 2014. *Coastal grasslands, a management guide*. https://www.plantlife.org.uk/application/files/4714/8155/7847/Coastal_grasslands_FINAL.pdf

Rodwell, J.S. (ed.) 1991. *British Plant Communities volume 2 Mires and Heaths*. Cambridge University Press, Cambridge.

Rodwell, J.S. (ed.) 1992. *British Plant Communities volume 3 Grassland and Montane Communities*. Cambridge University Press, Cambridge.

Rodwell, J.S. (ed.) 1995. *British Plant Communities volume 4 Aquatic Communities, Swamps and Tall-herb Fens*. Cambridge University Press, Cambridge.

Rodwell, J.S. (ed.) 2001. *British Plant Communities volume 5 Maritime communities and vegetation of open habitats*. Cambridge University Press, Cambridge.

Rodwell, J.S. 2006. *National Vegetation Classification Users' Handbook*. JNCC, Peterborough.

Scotland's Soils. 2017. *Carbon and Peatland Maps 2016*. https://soils.environment.gov.scot/maps/thematic-maps/carbon-and-peatland-2016-map/ Last updated May 2017. Accessd April 2020.

Scott, W., Harvey, P., Riddington, R. and Fisher, M. 2002. Rare Plants of Shetland. Shetland Amenity Trust.

Scottish Environment Protection Agency (SEPA), 2017. *Land-use planning system SEPA guidance note 31: Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems*. LUPG-GU31 Version 3.

Scottish Government. 2013. Scottish Biodiversity List. https://www.webarchive.org.uk/wayback/archive/20160402063428/http://www.gov.scot/Topics/Environment/Wildlife-Habitats/16118/Biodiversitylist/SBL.

Shetland Island Council (SIC). 2015. *Shetland Local Development Plan, Supplementary Guidance Local Nature Conservation Sites*, 2014, Adopted 2015.

NatureScot. 2020. Sitelink. https://sitelink.nature.scot/home Accessed in April 2020.

SNIFFER. 2009a. WFD95: *A Functional Wetland Typology for Scotland – Project Report.*

SNIFFER. 2009b. WFD95: *A Functional Wetland Typology for Scotland – Field Survey Manual*. Version 1.

Streeter, D., Hart-Davis, C., Hardcastle, A., Cole, F. and Harper, L. 2016. *Collins Flower Guide* 2nd Edition. Collins.

The Macaulay Institute. 1993. *The Land Use of Scotland, 1988, Executive Summary*. The Macaulay Landuse Research Institute.

UK Technical Advisory Group (TAG). 2005. *Draft protocol for determining 'significant damage' to a groundwater dependent terrestrial ecosystem v9.6 PR1 4-10-05*. http://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Determining%20significant%20damage%20to%20a%20groundwater%20dependent%20terrestrial%20ecosystem_Draft_011205.pdf.

Annex 1: Target Notes

TG no.	Grid reference	Note
1	HP 66382 15287	An example of coastal grassland (NVC community MC8d) dominated by red fescue with white clover and thrift.
2	HP 66457 15310	An example of a hollow within the MC8d grassland where sheep lie and fertilise. There was sheep's fescue, common chickweed and rough meadow-grass.
3	HP 66480 15304	An exposed profile of soil demonstrating a thin richer (peaty soil) layer at the top, followed by a sandy-humus layer quickly changing into a thin gravel layer then a layer of finer sand below. The sheep clearly use this for shelter as there is evidence of dunging and wool left on the edge.
4	HP 66549 15241	An example of coastal grassland (NVC community MC10b), which had an abundance of sedges.
5	HP 66570 15314	There was a small flow of water running to the cliff edge and an old, dry ditch channel which was dominated by saltmarsh rush with lesser spearwort (NVC community SM16b).
6	HP 66572 15335	Part of an old ditch which was dominated by common cottongrass (NVC community M3x).
7	HP 66568 15362	There was a ca. 8m×5m area dominated by common spike-rush (NVC community S19a).
8	HP 66557 15361	A patch of sedge dominated coastal grassland (NVC community MC10d) where common sedge and carnation sedge were of very high abundance.
9	HP 66573 15407	Drainage ditches were present across the entre of Lamba Ness, within the wet modified bog (NVC community M25b). This target note is an example of a ditch which was approximately 50cm deep and 75cm wide. It was dry during the survey. There was occasionally Pyrenean scurvygrass (*Cochlearia pyrenaica*) in the ditches.
10	HP 66525 15384	An example of wet modified bog (NVC community M25b), a common habitat in the centre of Lamba Ness. It was dominated purple moor-grass, with common cottongrass and mat grass.
11	HP 66526 15384	Heath spotted orchids were found within the wet modified bog at this location.
12	HP 66843 15475	There were bright green patches of grassland (NVC community MG11) surrounding the old military buildings. These areas were nutrient rich and heavily grazed from sheep congregating around them for shelter.
13	HP 66856 15414	There were a series of dry pools, bare peat cracked and poached by sheep. There was approximately 50% bare peat and 50% bulbous rush, with some velvet bent also present. These areas were likely to be water filled at certain times of the year. There was a ditch than went to the road, which had the same dried pool community (NVC community A24).
14	HP 66863 15341	There was a wide, open water pool at this location. Clearly an area where peaty soils had been removed. The pool had several large rocks, peat stained water and was smelly with algae growth. At the edges there were mats of shoreweed (NVC community A22a).
15	HP 66863 15341	An example of improved coastal grassland, (NVC community MG11) around a military building. There was about 3m wide strip of this nutrient enriched grassland. It was dominated by perennial rye grass with buttercup and common chickweed.
16	HP 66876 15345	An example of coastal grassland (NVC community MC8d) with thrift and plantains abundant.
17	HP 66706 15298	An example of a sheep laying area with the coastal grassland. There was an increased abundance of common chickweed.
18	HP 66675 15311	An old ditch channel which was dominated by saltmarsh rush (NVC community SM16b).
19	HP 66653 15368	An example of vegetation dominated by common spiked-rush (NVC community S19a). There was bare peat around it at the time of the survey, with bulbous rush and velvet bent. The common spiked-rush was in deeper channels.
20	HP 66595 15370	Shoreweed and velvet bent dominated area (NVC community A22a) on damp peaty soil on an old building foundation. At the time of survey it was damp, but likely to be a pool during wetter times of year.

TG no.	Grid reference	Note
21	HP 66581 15366	There was an old embankment/wall going northwards across Lamba Ness. The vegetation was coastal grassland (NVC community MC10d), but the graminoids were taller than the surrounding grassland.
22	HP 66593 15298	There was an abundance of silverweed within the coastal grassland (NVC community MC8d) at this location.
23	HP 66642 15297	There was a 50cm×50cm ditch at this location 50% filled with vegetation. There was a combination of velvet bent, sea plantain, ribwort plantain, buckhorn plantain, red fescue, thrift, saltmarsh rush and arrowgrass.
24	HP 66719 15383	There were a series of dried out pools within the wet modified bog (NVC community M25b). They were either bulbous rush dominated (NVC community A24) or common spike-rush dominated, with velvet bent common (NVC community S19a). The area was mapped as a matrix of M25b:A24:S19a at a ratio of approximately 80:10:10.
25	HP 66749 15306	There was a 2-3m wide patch, within a seepage line, with abundant sea arrowgrass. Red fescue, common cottongrass and purple moor-grass were all abundant with frequent sea plantain, and occasional chickweed, and Yorkshire fog. The surrounding part of this seepage line was made up of NVC community M3x, S19a, SM16 and A24.
26	HP 66857 15481	An example of a small shallow pool (dry at the time of survey) within the wet modified bog (NVC community M25) habitat. The dominant species in this pool was velvet bent.
27	HP 66892 15511	An example of the community S19a, dominated by common spike-rush. Marsh pennywort was common was abundant in this stand.
28	HP 66894 15518	There was a little red bog-moss in the wet modified bog (NVC community M25b) at this location. It was with some heather on the side of a ditch.
29	HP 66896 15601	An embankment around a military building had maritime grassland (NVC community MC10a) with the more nutrient rich maritime grassland (NVC community MG11a) surrounding the base.
30	HP 66896 15601	There was a patch of maritime grassland (NVC community MC8d) which appeared to be over a concrete of gravel surface. Thrift and daisy were more common in this patch.
31	HP 66838 15556	There was a dry ditch at this location with a spoil pile beside it. The ditch was straight, 1m wide and 60cm deep. There was a little velvet bent along the base. The spoil line was 1.5m wide and was drier than the surrounding vegetation.
32	HP 66836 15576	There was a wet ditch at this location with a little bog pondweed within it. There was also lesser spearwort, velvet bent, common cottongrass and bulbous rush occasionally present.
33	HP 66782 15567	There were two, man-made, circular pools at this location. They were made up of common spiked rush (NVC community S19a) with a bog pondweed surrounding it. Other species located here were marsh willowherb, marsh cinquefoil, cuckooflower and bog asphodel.
34	HP 66783 15574	There was a small patch of soft rush dominated area within the wet modified bog (NVC community M25b). It had an increase of some wetland species such as marsh marigold, marsh pennywort and marsh willowherb, and was moving towards an M23 community, although the abundance of purple moor-grass and common cottongrass resulted in it being part of the M25b community.
35	HP 67178 15407	There was a mostly dried out, un-vegetated, pool at this location. The base was of gravel and sands with some cobbles.
36	HP 67166 15350	There was a small (1m×3m) patch of saltmarsh rush dominated habitat (NVC community SM16b) in this location on a sandy substrate.
37	HP 67216 15375	An example of less species rich coastal grassland (NVC community MC10a).
38	HP 67249 15419	A small (5m×5m) dry, un-vegetated area with gravel and sand substrate. This may well be a pool at wetter times of year.
39	HP 67360 15396	A small wet pool, 4m×4m in size, with boulders and a sand/gravel substrate. There were some very small patches of saltmarsh rush (NVC community SM16b) around it.
40	HP 67487 15500	The coastal grassland (NVC community MC10b) at this location was more species poor than previously noted with fewer forbs. Sedges were still common in the grassland (giving the MC10b sub-community).

TG no.	Grid reference	Note
41	HP 67457 15500	The improved coastal grassland (NVC community MG11) at this location lacked any perennial rye grass.
42	HP 67433 15500	The improved coastal grassland (NVC community MG11) at this location included marsh thistle, and silverweed was highly abundant.
43	HP 67407 15600	An example of the coastal grassland (NVC community MC10a) where sea plantain was the dominant species.
44	HP 67167 15497	There was a steep cliff edge at this location that had been used as a rubbish dump. There was a large pile of glass, metal, plastic debris.
52	HP 67096 15536	There was a small, shallow, draining channel at this location, dominated by salt-marsh rush (NVC community SM16b) with an orangey brown muddy substrate below.
53	HP 67070 15528	There was a small bowl, shaped hollow dug out of the rock at this location. It was mostly grassed over with coastal grassland (NVC communities MC10a and MC10b). There was also a small dug out dry pool next to this location which had a sand and mud base.
54	HP 66600 15411	There were many dug out ditches within the wet modified bog (NVC community M25b) along this location with the fresh spoil along the side, which appeared sandy.
55	HP 66719 15547	There was an area dominated by well-established common cottongrass (NVC community M3x) either side of a ditch. The ditch had pondweed and marsh pennywort within it.
56	HP 66727 15563	A patch of fen (NVC community Mxd) where common sedge was dominant.
57	HP 66764 15760	There was a patch of mat grass dominated unimproved acid grassland (NVC community U5a) at this location.
58	HP 66755 15749	A patch of fen (NVC community Mxd) where common sedge was dominant.
59	HP 66664 15758	There was a patch of heath rush dominated U6 vegetation at this location.
60	HP 66615 15716	There was a historic wall or dyke at this location, located under the vegetation, but slightly raised within the wet modified bog (NVC community M25b). The vegetation on top was drier as the ground was free draining. It was about 2m across.
61	HP 66505 15701	The semi-improved acid grassland (NVC community U4b) at this location was highly grazed and quite tussocky. There were signs of a historic enclosure or terracing.
62	HP 66425 15416	There was a dried, scorched area of grassland (unidentified NVC community) at this location which had grown over an old tarmac road.
63	HP 66311 15732	There was fore-dune vegetation (NVC community SD4) at this location going to a small, sheltered beach.
64	HP 66309 15763	There was a narrow section of dune grassland (NVC community SD8d) at this location.
65	HP 66307 15754	There was a small, sheltered beach at this location.
66	HP 66305 15773	There was a flush of vegetation (NVC community OV28) at this location with running water meeting the sea.
67	HP 66281 15712	The semi-improved acid grassland (NVC community U4b) at this location was heavily sheep grazed. Daisy and perennial rye grass was abundant showing a strong affinity with more improved grassland types (MG7).
68	HP 66289 15549	There was a small seepage line of NVC community Mxd at this location, draining downhill towards the beach. It was dominated by common sedge with marsh pennywort, lesser spearwort and marsh willowherb.
69	HP 66090 15491	There was a 0.5-2m wide stripe of semi-improved acid grassland (NVC community U4b). There were a variety of forbs along the road verge and there were small patches where species such as silverweed were prominent.
70	HP 66063 15465	There was a dug out area at this location, with an old foundation. There were rock faces. The vegetation was fairly nutrient enriched with a combination of improved coastal grassland (NVC community MG11) and semi-improved acid grassland (NVC community U4b) and some small patches of nettle (NVC community OV25).
71	HP 66047 15400	There were large areas of wet modified bog/wet heath (NVC community M15d) in this location.
72	HP 65968 15301	There were a series of retaining walls with common sedge the most abundant species in the wet modified bog (NVC community M25b) along the top. These appeared to be holding back water with bog pools present behind it.

TG no.	Grid reference	Note
73	HP 65877 15277	There were several bog pools at this location. They were relatively wet, and filled with bog-moss, common sedge and common cottongrass (NVC community M2b).
74	HP 65877 15272	There were some large areas around this location which were mapped as the NVC community M3x. They had 100% cover of vegetation, with common cottongrass making up 80-90% of the vegetation. Dwarf shrubs were generally absent.
75	HP 65851 15328	There were small patches of NVC community M15d within the NVC community M3x vegetation. These were usually small (5m×5m) It was slightly raised and distinguished by the dwarf shrubs and heath rush.
76	HP 65826 15372	There were areas of wet modified bog that were between NVC communities M3x and M15d where common cottongrass were highly abundant, but dwarf shrubs were present below. Tormentil was highly abundant in these stands.
77	HP 65840 15385	There was a ca. 2m deep, 8m wide hole at this location. Heath rush dominated acid grassland (NVC community U6) was along the sides and there was semi-improved acid grassland (NVC community U4b) at the base.
78	HP 65835 15464	There was often a mixture of communities within the wet modified bog/wet heath with acid grassland habitats present in low proportions. (NVC communities M15, M3x, M15b and U6. At this location it was in a ratio of 60:20:10:10).
79	HP 65776 15549	This perennial rye grass and daisy semi-improved acid grassland (NVC community U4b with affinities to MG7) had patches of marsh, spear and creeping thistle. There were occasional tussocks of soft rush and heath rush.
80	HP 65919 15580	There was a mixture of highly grazed semi-improved acid grassland (NVC community U4b) with perennial rye grass and daisy, patches of mat grass dominated unimproved acid grassland (NVC community U5b) and patches of neutral grassland (NVC community MG10a) where soft rush was the dominant species.
81	HP 65824 15703	There were lots of small patches of soft rush dominated neutral grassland (NVC community MG10a) within the semi-improved acid grassland (NVC community U4b). It was dominated by soft rush, with Yorkshire fog.
82	HP 65792 15665	There was a dense patch of marsh thistle at this location around the foundations of an old military building.
83	HP 65827 15789	An example of wet modified bog/wet heath (NVC community M15d).
84	HP 65906 15865	There was round-leaved sundew within the wet modified bog/wet heath (NVC community M15d) at this location.
85	HP 65917 15876	There was a circular hole in the ground here (borrow pit perhaps), approximately 8m in diameter and 2m deep. There was a mixture of semi improved acid grassland and neutral grassland (NVC communities U4b and MG10a) within it. It was used as shelter by sheep. Thyme was recorded here. A drystone wall was nearby.
86	HP 66172 15782	There was a cutting at this location through the wet modified bog/wet heath (NVC community M15d). It was a straight line, 2-3m wide and long. It was vegetated down the sides and there was no water in it at the time of the survey.
87	HP 66150 15731	The acid grassland (NVC community U6) at this location had patches in which heath rush was highly abundant.
88	HP65457 15176	There was semi-improved acid grassland (NVC community U4b) at this location with patches of heath rush dominated acid grassland (NVC community U6).
89	HP 65532 15169	At the fence to the sea cliffs there was a 2-5m wide stripe of ungrazed semi-improved acid grassland (NVC community U4b). It was tall with fescues and bent-grasses, sheep's sorrel, tormentil and creeping buttercup.
90	HP 65598 15221	There was a flushed area rich in common sedge and lesser spearwort.
91	HP 65600 15267	The blanket bog (M18) at this location was dominated by common cottongrass over a patchy layer of papillose and red bog-moss. Cross-leaved heath, heather and crowberry were all evident under the common cottongrass layer.
92	HP 65447 15317	The wet modified bog/wet heath (NVC community M15d) around this location was characterised by an undulating ground. On the drier tops heather, deergrass, common cottongrass and heath rush were common. In the hollows red bog-moss, common cottongrass, bog asphodel and tormentil were more common.

TG no.	Grid reference	Note
93	HP 65495 15517	There was a patch of semi-improved acid grassland (NVC community U4b) with perennial rye grass and daisy. Clearly frequented by sheep and consequently enriched. There were also patches of soft rush, marsh thistle and nettles.
94	HP 65479 15502	There was a large borrow pit at this location, ca. 5m deep. It was filled with semi-improved acid grassland (NVC community U4b) with small patches of soft rush and heath rush.
95	HP 65545 15487	There was a common sedge dominated flush (NVC community Mxd) at this location with an area of exposed peat with common cottongrass the main species present (NVC community M3).
96	HP 65631 15538	The wet modified bog/wet heath (NVC community M15d) at this location was highly grazed and trampled. Red bog-moss was hummocky at this location.
97	HP 65582 15546	There was a small area beside a ditch that was dominated by common sedge with tormentil (NVC community Mxd).
98	HP 65418 15898	There were extensive areas of hagging in the blanket bog (NVC community M19) with bog pools (NVC communities M2a and M3) and areas of bare peat.
99	HP 65393 15896	There was a complex within the blanket bog habitat with blanket bog (NVC community M19), bog pools (mostly NVC community M3) and dry dwarf shrub heath (NVC community H10b). The ratio was approximately 50:40:10. There were extensive areas of hagging in the blanket bog. An M2 pool was located here with common sedge and flat-topped bog-moss.
100	HP 65400 15901	The blanket bog (NVC community M19) at this location was relatively wet, with the water table just below the surface.
101	HP 65402 15903	The blanket bog complex included areas of dry dwarf shrub heath (NVC community H10b), these were on drier hummocks within the blanket bog.
102	HP 65504 15722	There was another complex of bog pools (including NVC communities M3 and M2a) and bare peat within the wet modified bog/wet heath (NVC community M15d) at this location. There was some chickweed, floating sweet-grass and bent-grasses with the blunt-leaved bog-moss and common sedge. Bulbous rush was also present.
103	HP 65522 15721	There were large bog pools at this location (30m×40m). They were mostly exposed bare peat at the time of survey, but likely to be water filled in wetter months.
104	HP 65476 15653	There was an area of blanket bog (NVC community M19) at this location, with hare's-tail cottongrass was prominent.
105	HP 65296 15707	There was a patch of acid grassland (NVC community U6) along a steep bank near a military building at this location.
106	HP 65300 15687	There was a view of the Proposed Launch Site Habitat Study Area at this location.
107	HP 65212 15751	Potential GWDTE. There was a bog-moss dominated flush (NVC community M6) running downhill at this location. Bog-mosses dominated with occasional common sedge and bulbous rush over the bog-moss layer. On slightly raised ground heath rush dominated acid grassland (NVC community U6).
108	HP 65342 15461	An example of heath rush dominated acid grassland (NVC community U6).
109	HP 65396 15464	There was a borrow pit cut into the rock besides the road. It as vegetated with a white clover rich form of semi-improved acid grassland (NVC community U4b).
110	HP 65413 15464	In the semi-improved acid grassland (NVC community U4b) at this location, within a borrow pit, the grassland was short (<5cm), with a variety of forbs including selfheal and daisy. Thyme was occasional on drier patches. Yorkshire fog was abundant here. Wavy hair-grass was more common on the slopes of the borrow pit.
111	HP 65175 15324	The dry dwarf shrub heath (NVC community H10b) here had abundant crowberry and woolly fringe moss.
112	HP 65251 15326	There was a patch of highly grazed heath rush dominated acid grassland (NVC community U6). Heath rush was dominant throughout, but in wetter areas, in hollows common cottongrass and bog asphodel were abundant, in drier areas mat grass and tormentil were more abundant.
113	HP 64122 13405	The improved grassland at this location included perennial rye grass, creeping buttercup, white clover, common sorrel, hogweed, Yorkshire fog and occasionally yellow rattle.
114	HP 64115 13388	There was a dense stand of creeping thistle at this location.
115	HP 64401 13136	Japanese knotweed was located here.

TG no.	Grid reference	Note
116	HP 64317 14267	This was an area of dry dwarf shrub heath dominated by short heather with crowberry, bell heather and tormentil. Wavy hair-grass, sweet vernal grass and mat grass were occasional.
117	HP 64316 14329	The road verge along here was forb rich with sheep's-bit, thyme, bird's-foot trefoil. The grasses included red fescue, common bent and sweet vernal grass.
118	HP 64327 14337	The improved grassland field was dominated by sweet vernal grass and Yorkshire fog. There was occasional cock's-foot, bent grasses, perennial rye grass and Timothy. It was fairly forb rich, particularly noticeable was autumn hawkbit. There was also white clover, red clover, tormentil, lesser stitchwort and more rarely eyebright. The improved grassland field is likely to have had relatively little improvement in recent times.
119	HP 64349 14230	There was a ruderal area at this location with pineapple weed and broad-leaved dock.
120	HP 64424 14193	There was an overgrown dyke, or boundary wall, within the grassland at this location. There were occasional patches of soft rush in the grazed field.
121	HP 64396 14180	The improved grassland at this location included Yorkshire fog and sweet vernal grass. Daisy was very abundant. There was also heath wood-rush and autumn hawkbit. It was heavily grazed by sheep.
122	HP 64400 14184	The road verge was species rich, with autumn hawkbit, sheep's-bit, thyme, heather, bird's-foot trefoil, selfheal and eyebright.
123	HP 64328 14232	There was a ruderal area at this location, including a spoil heap with silverweed growing on it.
1124	HP 64326 14218	Around the gate of this improved grassland field pineapple weed was dominant.
125	HP 64321 14211	Dry dwarf shrub heath made up the vegetation on one side of the trackway whilst semi-improved grassland U4b made up the other side of the trackway. The dry heath similar to other areas (NVC community H10b). The grassland appeared unmanaged, with common bent, red fescue, sweet vernal grass and a variety of forbs (NVC community U4b).
126	HP 64328 14201	The field on the east side of the track was heavily grazed with white cover and daisy prominent.
127	HP 64323 14148	The west side of the track the grassland was grazed but was dominated by mat grass with tormentil, Autumn hawkbit as prominent. There were several orchid spikes, but they had senesced. They were likely to be heath-spotted orchid or a marsh orchid.
128	HP 64324 14056	There were several field gentians at this location, at the transition of dry heath and semi-improved grassland.
129	HP 64298 14021	The dry heath at this location was on flatter ground than the surrounding dry heath. It was fairly grassy with wavy hair-grass and common bent.
130	HP 64269 14021	Bird's foot-trefoil was common on the track at this location. The surrounding dry heath included common sedge, woolly fringe moss and lichens.
131	HP 64197 13945	This MG7b field was recently grazed by sheep. It included sweet vernal grass, Yorkshire fog, perennial rye grass white clover and autumn hawkbit.
132	HP 64166 13918	This field was similar to other rich MG7b, with no recent improvements, and grazing low at during this season. Yorkshire fog and sweet vernal grass were dominant. White clover and mouse ear were frequent.
133	HP 64171 13901	This area of rough grassland was made up of soft meadow grass, sweet vernal grass, red fescue and pignut. Common sorrel was also frequent. There was much senesced material below, indicating that it was not grazed recently.
134	HP 64118 13912	The road verges along here were dominated by false oat-grass (NVC community MG1).
135	HP 64119 13913	The improved grassland fields along this area were recently cut. They appeared to have been dominated by perennial rye-grass with Timothy (MG7a).
136	HP 64114 13960	There was Japanese rose scrub along the roadside here, besides a tumbled down wall. There was also honey suckle, elder and false oat-grass.
137	HP 64111 13986	The Japanese rose scrub along the side of the road at this location. False oat-grass was dominant along the verge. There was a garden escapee at this location too.
138	HP 64105 13992	There was a strip of semi-improved neutral grassland (NVC community MG1) at this location rich in dock, common sorrel and creeping buttercup.

TG no.	Grid reference	Note
139	HP 64118 13872	The road verges were semi-improved neutral grassland (NVC community MG1) at this location.

Annex 2: Photographs

Photo 1: MC8d Red fescue – thrift grassland (TG1).

Photo 2: MC10b Red fescue – plantain spp. grassland (TG4).

Photo 3: Saltmarsh rush (SM16b) in an old, peaty, ditch/cutting (TG5).

Photo 4: M3x dominated by common cottongrass on Lamba Ness (TG6).

Photo 5: An example of a dry ditch on Lamba Ness at OS grid reference HP 66573 15407 (TG9).

Photo 6: Wet modified bog (M25b) on Lamba Ness (TG10).

Photo 7: Bright green improved coastal grassland (MG11) around old military buildings (TG12).

Photo 8: An example of a seasonally dry pool on Lamba Ness (TG13).

Photo 9: Shoreweed (A22a) growing as a mat on the edge of a man-made pool (TG14).

Photo 10: Common spiked-rush (S19a) within a channel on Lamba Ness (TG19).

Photo 11: Shoreweed dominated community (A22a) growing in in the foundations of an old building (TG20).

Photo 12: An example of MC10a maritime grassland (TG37). It was dominated by sea plantain with thrift and fescues.

Photo 13: An example of MG11 around military buildings. Silverweed is prominent at this location (TG42).

Photo 14: A rubbish dump over the edge of the cliff at Lamba Ness (TG44).

Photo 15: A recently dug ditch with the fresh sandy spoil on the side (TG54).

Photo 16: Well-established M3x common cottongrass dominated vegetation beside ditch. (TG 55).

Photo 17: Sand dune vegetation at a sheltered beach (TG63-65).

Photo 18: Perennial rye grass and daisy were abundant in the highly grazed U4b grassland at this location. (TG 67).

Photo 19: Common cottongrass was dominant, with few shrub shrubs present in the M3x community (TG 74).

Photo 20: Common cottongrass was dominant over heather in the wet modified bog/wet heath (NVC community M15) (TG 76).

Photo 21: Soft rush was dominant in the MG10a neutral grassland (TG 81).

Photo 22: Round-leaved sundew in wet dwarf shrub heath (NVC community M15d) (TG 84).

Photo 23: The blanekt bog at this location was rich in pappilose bog-moss (NVC community M18) (TG 91).

Photo 24: There were extensive areas of hagging in the blanket bog (NVC community M19) *(TG 98).*

Photo 25: The blanket bog complex included areas of dry dwarf shrub heath (NVC community H10b), these were on drier hummocks within the blanket bog (TG101).

Photo 26: There were large bog pools at this location (30m×40m). They were mostly exposed bare peat at the time of survey, but likely to be water filled in wetter months (TG103).

Photo 27: A view of an extensive area of wet modified bog/wet heath (TG106).

Photo 28: A Potential GWDTE. There was a bog-moss dominated flush (NVC community M6) running downhill. On slightly raised ground heath rush dominated acid grassland (NVC community U6) (TG107).

Photo 29: Improved grassland in the LRCC Habitat Study Area (TG13).

Photo 30: Japenses knotweed just outside LRCC Habitat Study Area (TG116).

Photo 31: Species rich imporved grassland in the New Section of Access Road at Northdale Habitat Study Area (TG118).

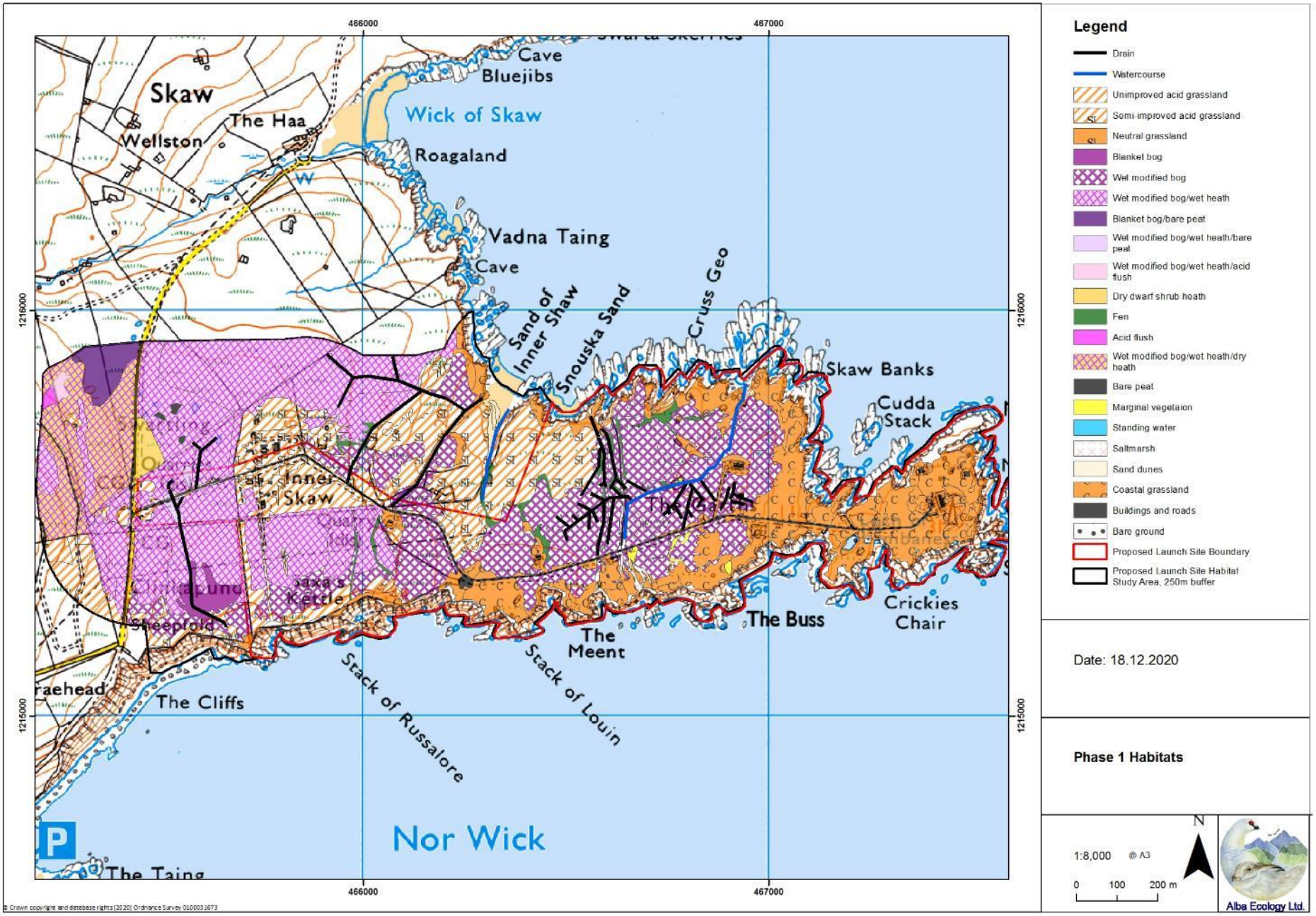
Photo 32: The road verge was species rich with thyme, sheep's-bit, autumn hawkbit and bird's-foot trefoil (TG122).

Photo 33: The track way was made up of dry dwarf shrub heath and acid grassland (TG125).

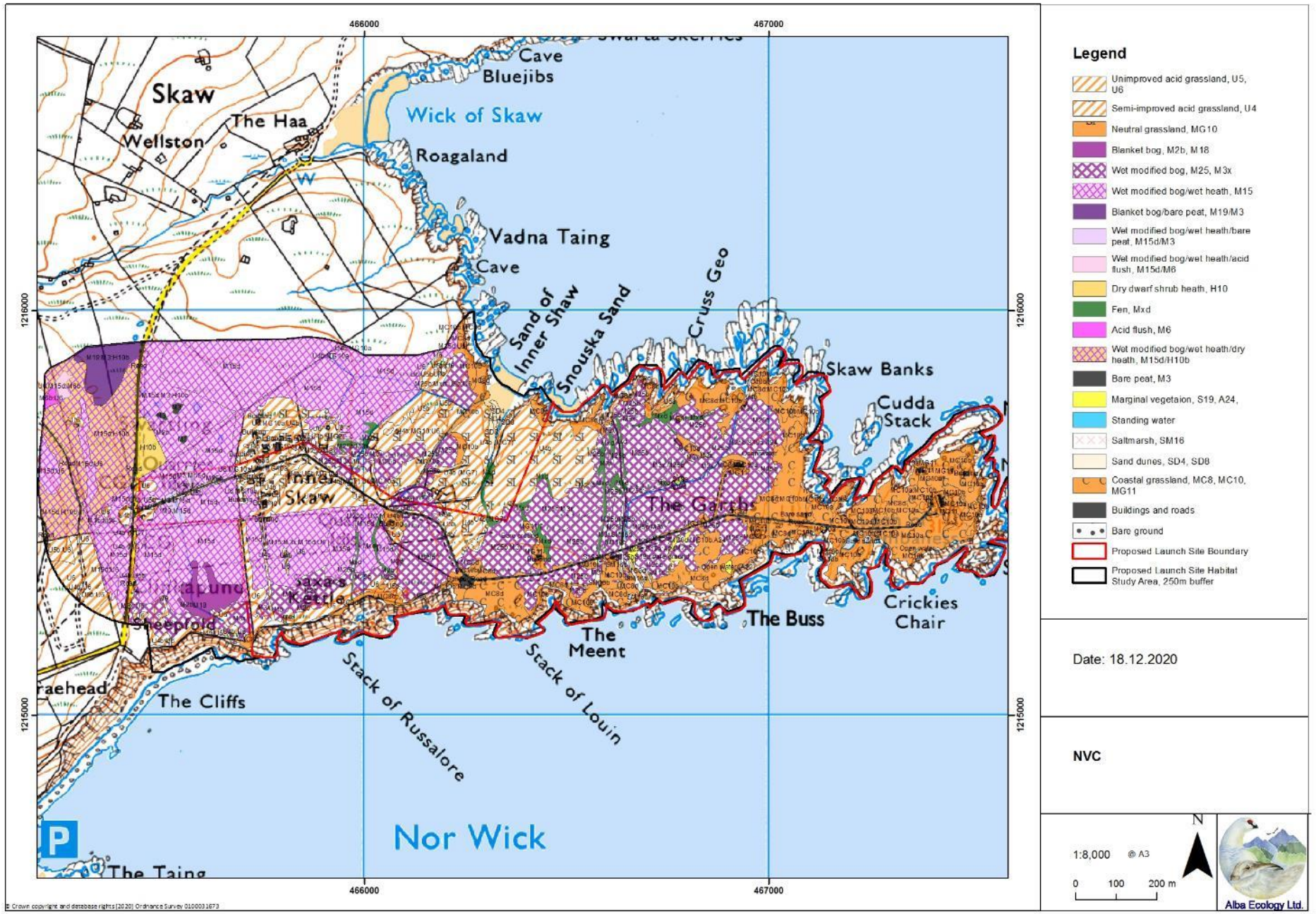
Photo 34: Field gentian (TG128).

Photo 35: The track way goes across dry dwarf shrub heath.

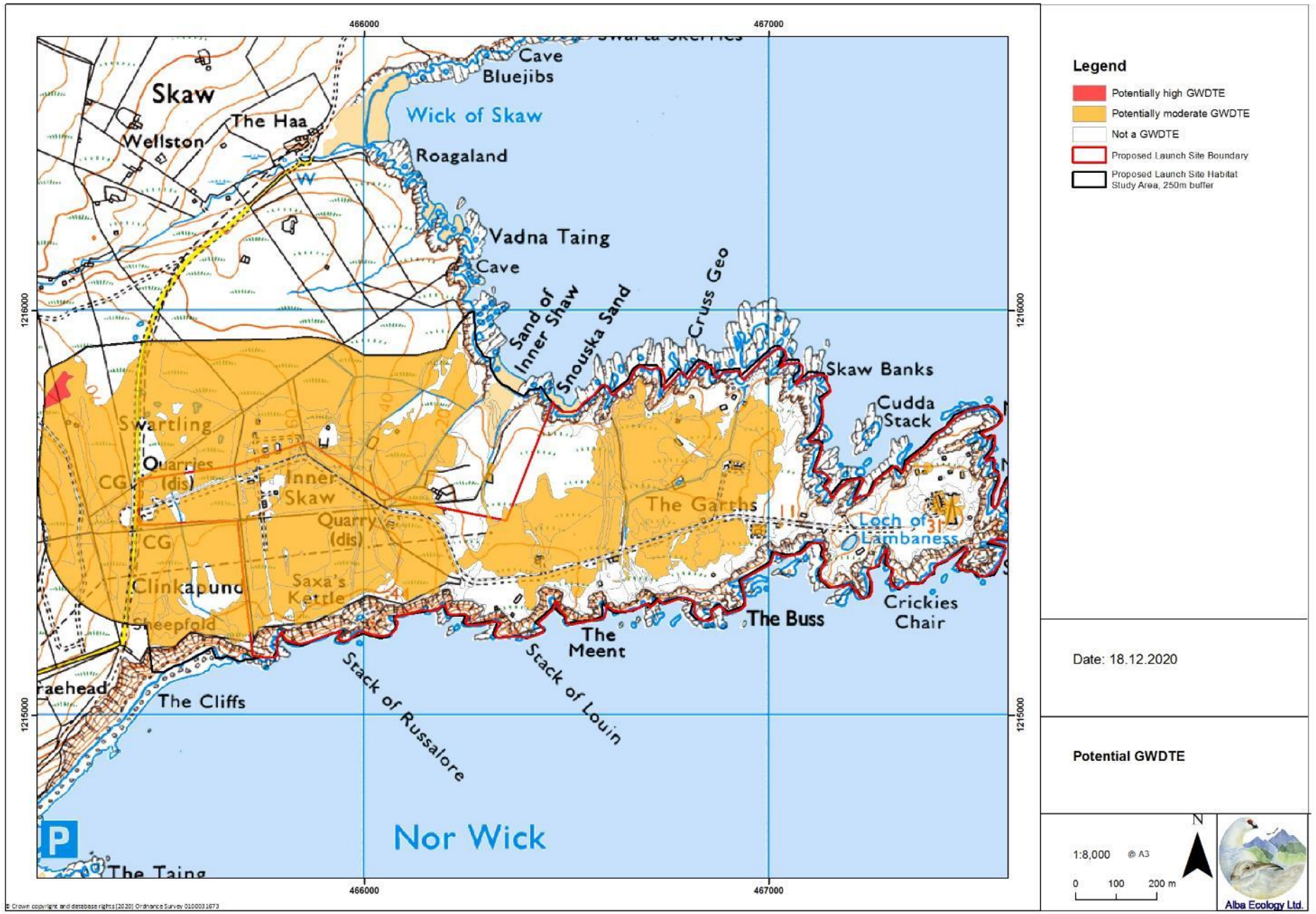
Photo 36: A rough neutral grassland within the New Section of Access Road at Northdale Habitat Study Area.



Appendix 7.2 Drawing 3: Phase 1 Habitat Survey at the Proposed Launch Site Habitat Study Area

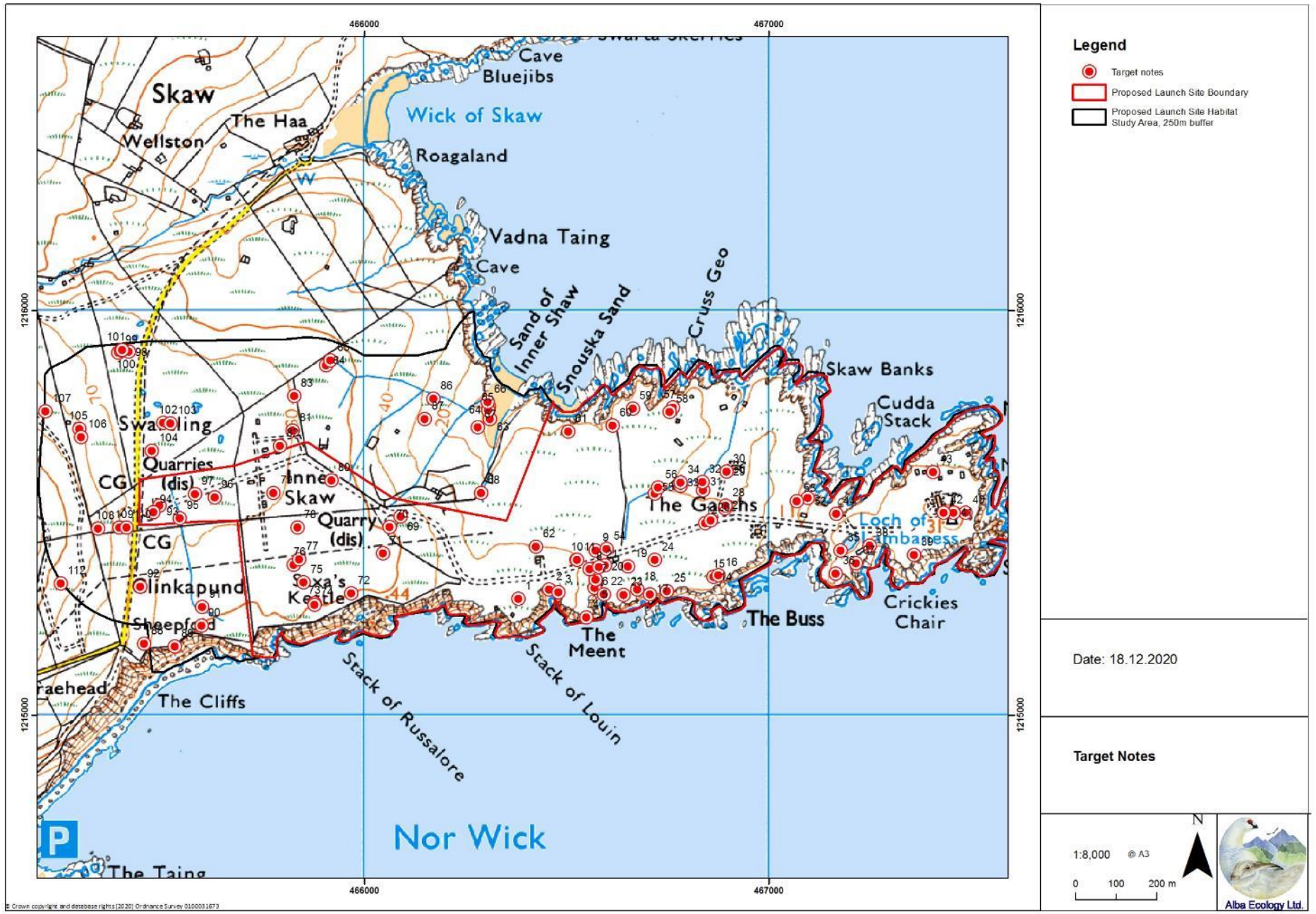


Appendix 7.2 Drawing 4: NVC communities at the Proposed Launch Site Habitat Study Area

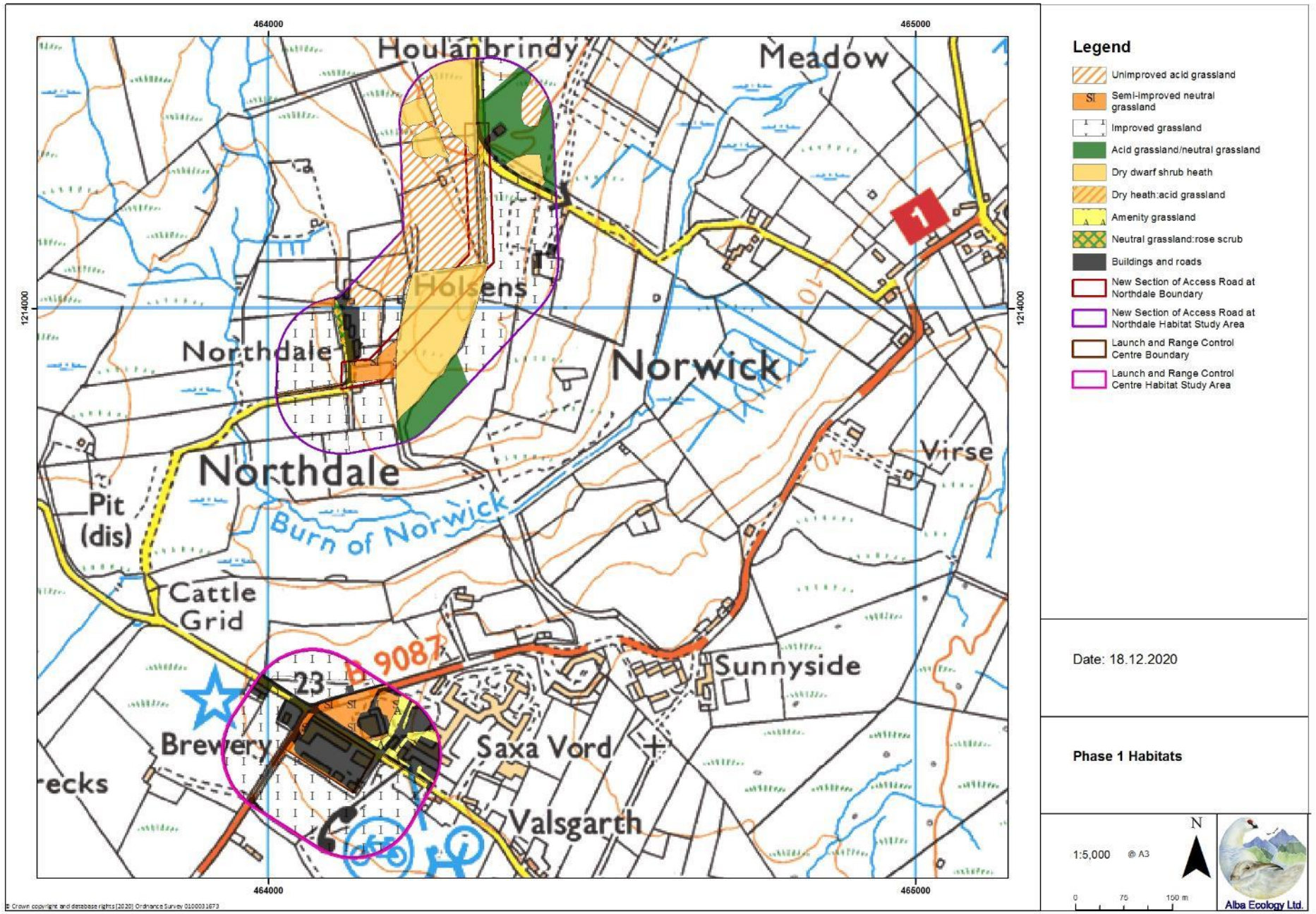


Appendix 7.2 Drawing 5: Potential GWDTEs at the Proposed Launch Site Habitat Study Area

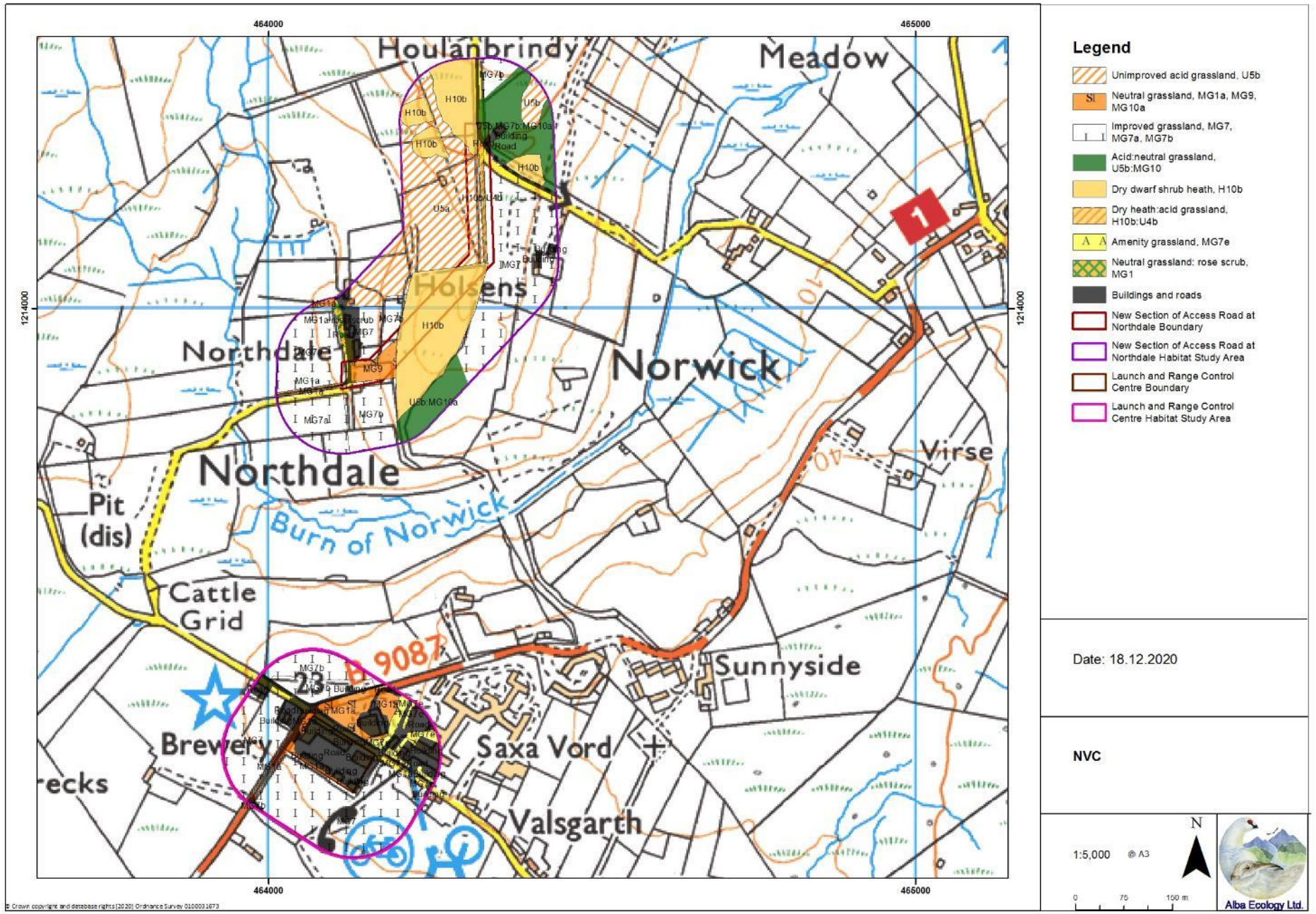
Appendix 7.2 Drawing 6: Peatland Condition at the Proposed Launch Site Habitat Study Area



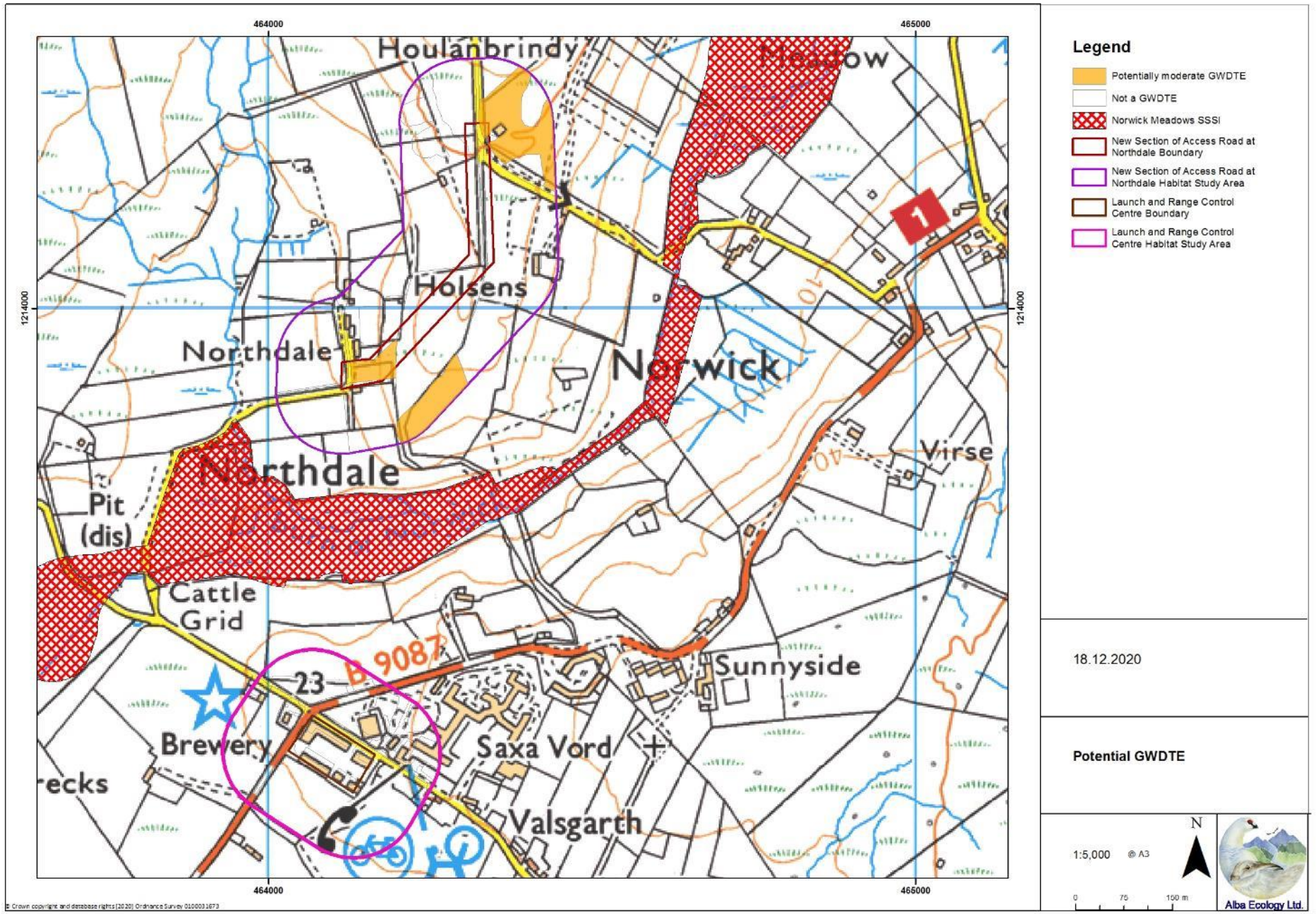
Appendix 7.2 Drawing 7: Target Note Locations at the Proposed Launch Site Habitat Study Area



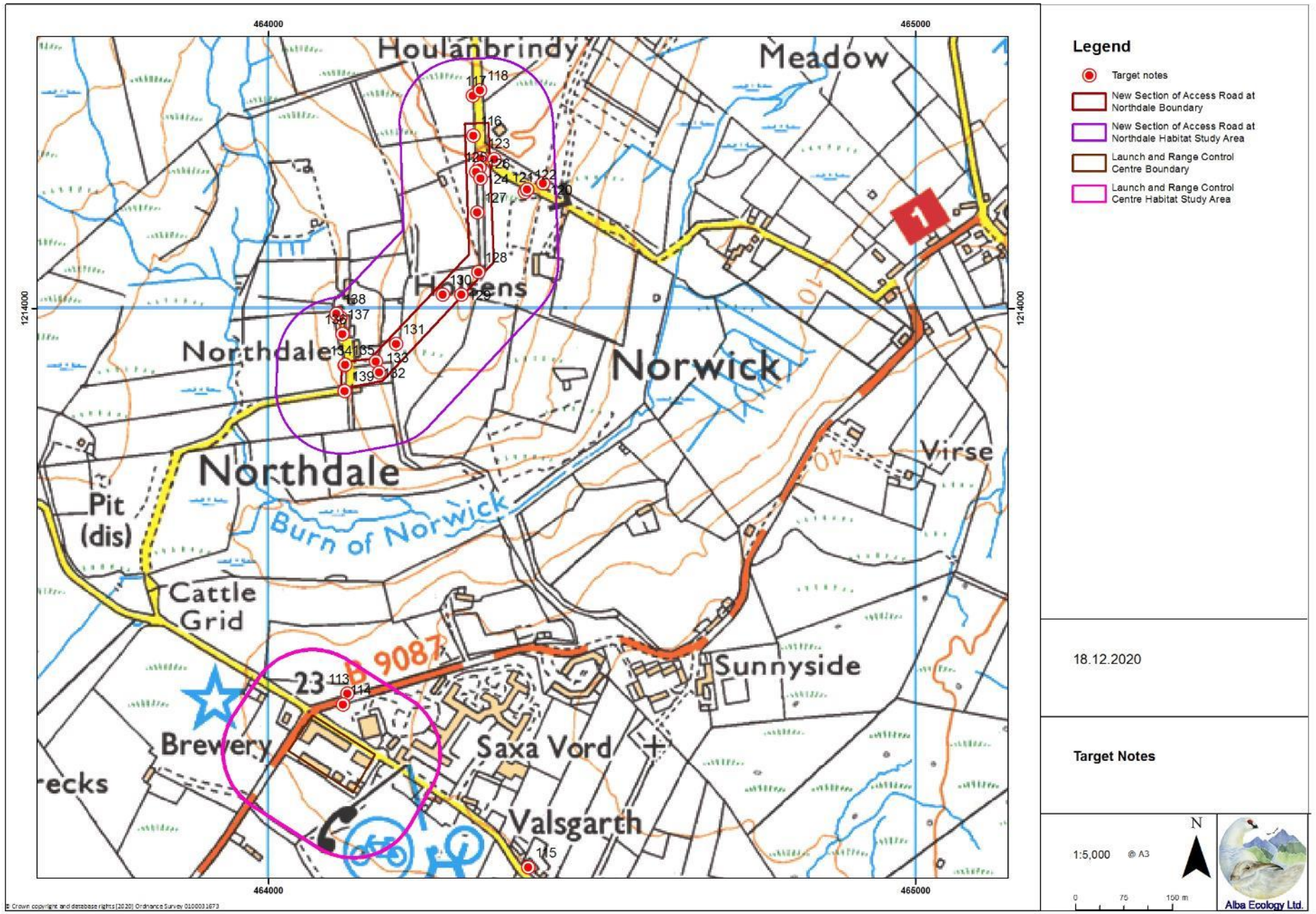
Appendix 7.2 Drawing 8: Phase 1 Habitat Survey at the LRCC Habitat Study Area and New Section of Access Road at Northdale Habitat Study Area



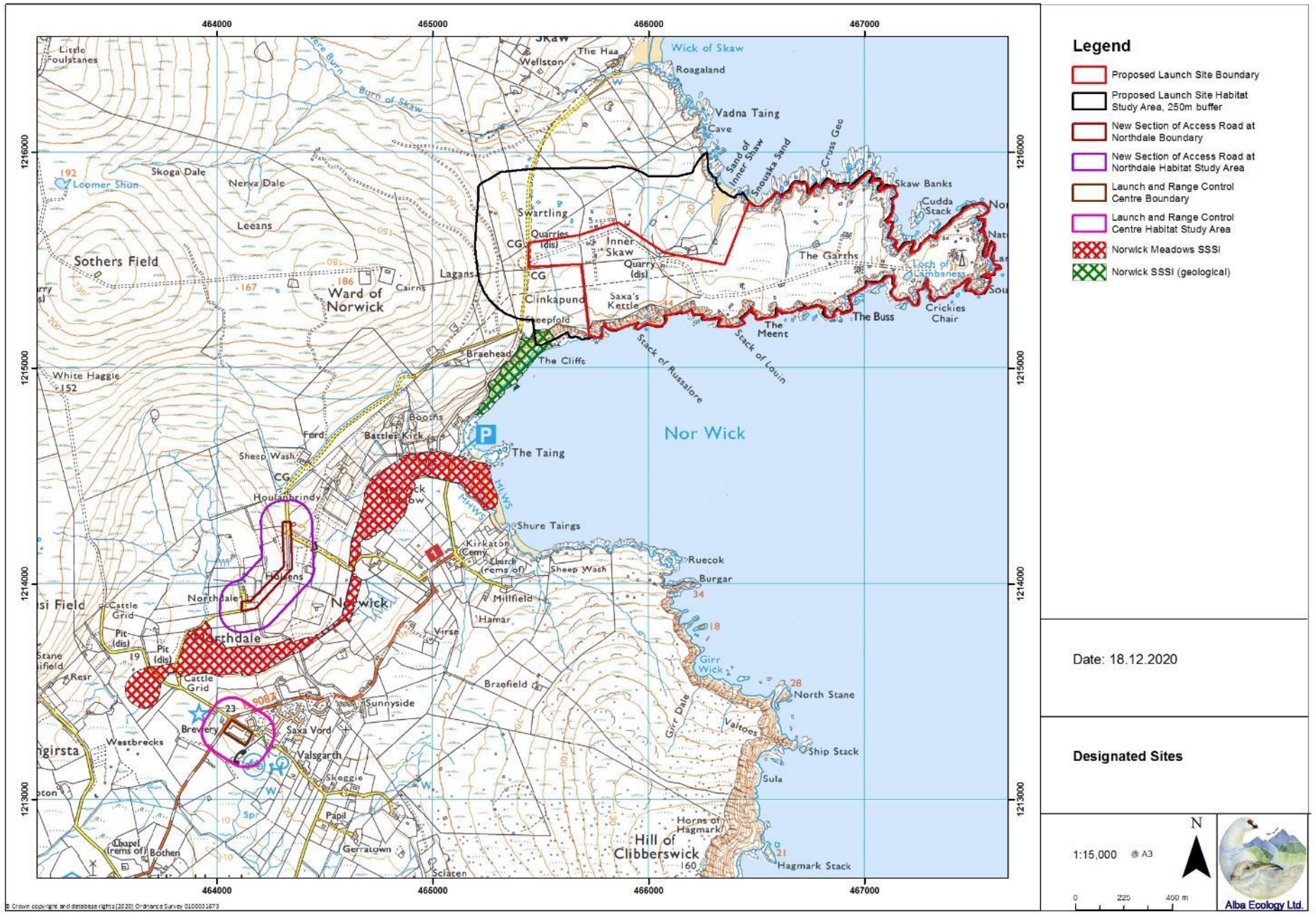
Appendix 7.2 Drawing 9: NVC communities at the LRCC Habitat Study Area and New Section of Access Road at Northdale Habitat Study Area



Appendix 7.2 Drawing 10: Potential GWDTEs at the LRCC Habitat Study Area and New Section of Access Road at Northdale Habitat Study Area



Appendix 7.2 Drawing 11: Target Note Locations at the LRCC Habitat Study Area and New Section of Access Road at Northdale Habitat Study Area



Appendix 7.2 Drawing 12: The location of the designated site, Norwick SSSI (geological) and Norwick Meadows SSSI in relation to the Study Areas

Appendix 6.3a Otter Species Protection Plan

SaxaVord Spaceport Otter Protection Plan

Alba Ecology Ltd.

February 2022, Updated March 2022

This report should be quoted as '*Alba Ecology Ltd. (2022). Unst Space Port Otter Protection Plan*'.

Registered Office: Coilintra House, High Street, Grantown on Spey, Moray PH26 3EN Tel: 01479 870238. *enquires@albaecology.co.uk*

INTRODUCTION

A proposal for a satellite launch facility has been made by the Applicant in north Unst, Shetland - known as the '*SaxaVord Spaceport'*. As part of the proposal, Alba Ecology Ltd. was commissioned to produce this Otter Protection Plan as part of pre-commencement planning.

Otters are known to be present within the Planning Application Boundary area, which was surveyed in detail for otters in both 2018 and 2020. The survey methods involved a systematic survey of terrestrial, aquatic and riparian habitats within the Study Areas looking for places otters use for shelter, resting and protection (such as couches, lying-up sites and holts), or for signs of activity (such as spraints, feeding remains, runs or footprints).

Legal protection

Otters are classed as European Protected Species (EPS) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).

According to NatureScot's standing guidance on otters (accessed 24/11/20), it is an offence to deliberately or recklessly:

- capture, injure or kill an otter;
- harass an otter or group of otters;
- disturb an otter in a holt or any other structure or place it uses for shelter or protection;
- disturb an otter while it is rearing or otherwise caring for its young;
- obstruct access to a holt or other structure or place otters use for shelter or protection, or otherwise deny the animal use of that place;
- disturb an otter in a manner or in circumstances likely to significantly affect the local distribution or abundance of the species; and
- disturb an otter in a manner or in circumstances likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young.

It is also an offence to:

- damage or destroy a breeding site or resting place of such an animal (whether or not deliberately or recklessly); and
- keep, transport, sell or exchange, or offer for sale or exchange any wild otter (or any part or derivative of one) obtained after 10 June 1994.

Otter shelters are legally protected whether or not an otter is present.

This means that if otters could be affected in these ways by a development, and no action is taken to prevent it, an offence may be committed. According to NatureScot "*Licensing allows named individuals to carry out actions that could otherwise constitute an offence. If you're planning any activities that could affect otters or the places they use, you must make sure you stay within the law*".

PREVIOUS SURVEY RESULTS

2018 data

Numerous otter field signs were recorded in the Proposed Launch Site Otter Study Area during targeted surveys in June 2018 (Table 1) and October 2018 (Table 2). Based on June 2018 survey data, there was a total of ten otter holts within the Proposed Launch Site Otter Study Area, six of which were in the Proposed Launch Site Boundary (EIAR Drawing 7.10). Based on October 2018 survey data, there was a total of eight otter holts within the Proposed Launch Site Otter Study Area with all but one of these in the Proposed Launch Site Boundary (EIAR Drawing 7.10). Based on the 2018 survey data, there were no otter holts within the Launch and Range Control Centre and New Section of Access Road at Northdale Otter Study Area (EIAR Drawing 7.11). Only spraints and footprints were recorded within the Launch and Range Control Centre and New Section of Access Road at Northdale Otter Study Area and these were adjacent to the Burn of Norwick.

Table 1. Otter signs June 2018

O/S grid reference	Type of otter sign	Note
HP6580215203	Holt	Obvious holt site with spraint at foot of cliff amongst boulder scree
HP6604915254	Holt	Obvious holt amongst boulder scree at foot of high cliff - located from top
HP6649615366	Spraint/print	Small amount spraint but many fresh paw prints inside old concrete bunker
HP6667215410	Spraint	Spraint site with drying green by concrete found of old bunker and run leading to flash pool
HP6694415371	Holt	Active holts in boulder scree at foot of cliffs
HP6705015430	Holt	Recently active holt at top of cliff in boulder scree
HP6709915521	Spraint	Spraint site at old bunker
HP6718515489	Spraint	Active spraint site at bottom of cliff on boulder scree
HP6720315508	Spraint/run	Run leading from spraint point at foot of cliff across headland through underpass to the other side.
HP6762115529	Holt	Active boulder scree holt at foot day of cliff
HP6720815622	Spraint	Freshwater bathing pool active spraint site run from one side of headland to other
HP6707815936	Spraint	Active spraint site
HP6704215811	Spraint	Stream side spraint site, inactive
HP6702915769	Spraint	Stream side spraint site
HP6701415731	Spraint	Stream side spraint point active
HP6682215819	Holt	Active holt at foot of cliff boulder scree
HP6666915820	Run	Run up and down cliff from small geo leading up to small ditch
HP6630416163	Holt	Active boulder scree holt at foot of cliff
HP6634616188	Holt	Run across small headland provable holt below cliff top
HP6628316222	Holt, inactive	Clifftop holt, not recently active
HP6626616261	Holt, inactive	Clifftop holt, not recently active
HP6624416270	Spraint	Stream side spraint site
HP6475316325	Spraint	Stream side spraint point, just outside buffer zone
HP6451216235	Spraint	Stream side spraint site
HP6471814142	Spraint	Spraint point, bridge

HP6477814289	Spraint	Stream side spraint site
HP6483414368	Spraint	Stream side spraint site
HP6495114419	Spraint	Stream-side spraint point
HP6538914686	Spraint	Inactive spraint site
HP6524614816	Spraint	Inactive spraint site

Table 2. Otter signs, October 2018.

O/S grid reference	Type of otter sign	Note
HP6604915254	Holt	Obvious holt amongst boulder scree at foot of high cliff- located from top
HP6647715340	Spraint/print	Currently inactive- spraint/paw prints in old bunker
HP6668815436	Spraint	Active spraint site
HP6696015377	Holt	Active holt in boulder scree bottom of cliffs
HP6705115430	Holt	Relatively active holt at top of cliff
HP6762115529	Holt	Active boulder scree holt at foot day of cliff
HP6754015606	Holt	Bunker used as holt v active
HP6754715719	Spraint	Active bunker spraint site
HP6724715610	Holt/lay-up	Boulder scree holt/lay-up
HP6720615630	Spraint	Active spraint site by stream and run across headland
HP6713915851	Spraint	Spraint at clifftop
HP6708915930	Spraint/lay-up	Active spraint site, lay-up
HP6701615730	Spraint	Active stream Spraint site
HP6681515845	Holt	Active hots in boulder scree foot of cliffs
HP6628416216	Print	Paw prints aside fresh dug holts but no spraint point (previously active) along clifftop
HP6623916259	Holt/spraint	Active spraint site by stream, relatively active holt on clifftop
HP6534214469	Tracks/spraint	Tracks and spraint on sand and at stream
HP6526314527	Spraint/print	Spraint site and paw prints along stream and beach
HP6521114661	Spraint	Very active spraint site by underpass - cub spraint noted confirming mother with family
HP6502514580	Spraint/print	Spraint and paw prints in mud by stream
HP6497714508	Spraint/print	Paw prints and spraint along stream- mum and cub sets together
HP6495214421	Spraint/print	Spraint and paw prints along stream- again cub prints with adult
HP6472914171	Spraint	Spraint site at underpass
HP6352014285	Spraint	Fresh spraint at roadside underpass
HP6385913627	Spraint	Fresh spraint site at underpass
HP6391513674	Spraint	Spraint site at underpass

2020 data

In July 2020, additional otter surveys were undertaken at the Proposed Launch Site Boundary. Numerous otter signs were recorded (EIAR Drawing 7.12, Table 3). This included eight holts located within boulder scree, below the cliff tops but above the high tide mark within the Proposed Launch Site Boundary. The holts were in inaccessible locations, between boulders or going into rock caves/crevices and were viewed from the cliff tops with binoculars (Photo 1). Scats and regularly used runs were recorded near and at the holt sites, and otters were occasionally seen/heard. One particular holt on Lamba Ness, which had a large build-up of scats, was clearly being used by a female and her young cubs in July 2020 (Photo 2).

Scats and footprints, including those of adults and young, were also recorded in the abandoned buildings across Lamba Ness (Photo 3). It was considered likely that some of the buildings were used as lay-ups during poor weather conditions, when holts at the base of cliffs would potentially be inundated with sea water.

Otter use of the existing track underpass at HP 671 154 was particularly noticeable. It was considered likely that otters use this underpass as a regular route to cross from the north to south side of Lamba Ness. The route was well delimitated on the grassland and rocks showing a well-established run (Photo 4). These data indicated that there was one female, with dependent young, using Lamba Ness as their core home territory. Regular sightings of a male indicated that Lamba Ness also formed part of at least one dog otter territory.

Table 3. Otter signs July 2020

O/S grid reference	Type of sign	Note
HP 66032 15254	Holt	Inaccessible holt within boulders of cliff face.
HP 66033 15255	Holt	Inaccessible holt within boulders of cliff face.
HP 66367 15253	Prints	Fresh footprints located within the small, abandoned building at this location.
HP 66764 15296	Holt	This holt was inactive in July 2020.
HP 66832 15296	Holt	This holt may have been active in July 2020. There were old & more recent spraints visible.
HP 66854 15291	Lay-up	The lay-up was in the boulder scree at this location.
HP 67046 15425	Holt	There was a holt at this location, within the boulder scree.
HP 67091 15465	Run	The underpass showed signs of frequent use by otters. There was a clear run from the rocks to the underpass.
HP 67510 15446	Lay-up & run	A commonly used lay-up & run within the rocks of the edge of the cliff.
HP 67530 15451	Holt	Potential holt site. Appears inactive this season.
HP 67431 15532	Spraint/print	This abandoned building had many signs of otter use including spraints & footprints. It is likely used as a couch.
HP 67439 15637	Prints	There were otter footprints in this abandoned building. The prints were of two different sizes, indicating a female & young.
HP 67136 15532	Holt	This was the most active holt in 2020. There was a large pile of spraints which included crab remains. Crabs are easy kills for young otters. This holt was likely to have a female with young.
HP 66740 15785	Holt	Potential holt. Spraints recorded here.

Example photos (from 2020 and 2022)

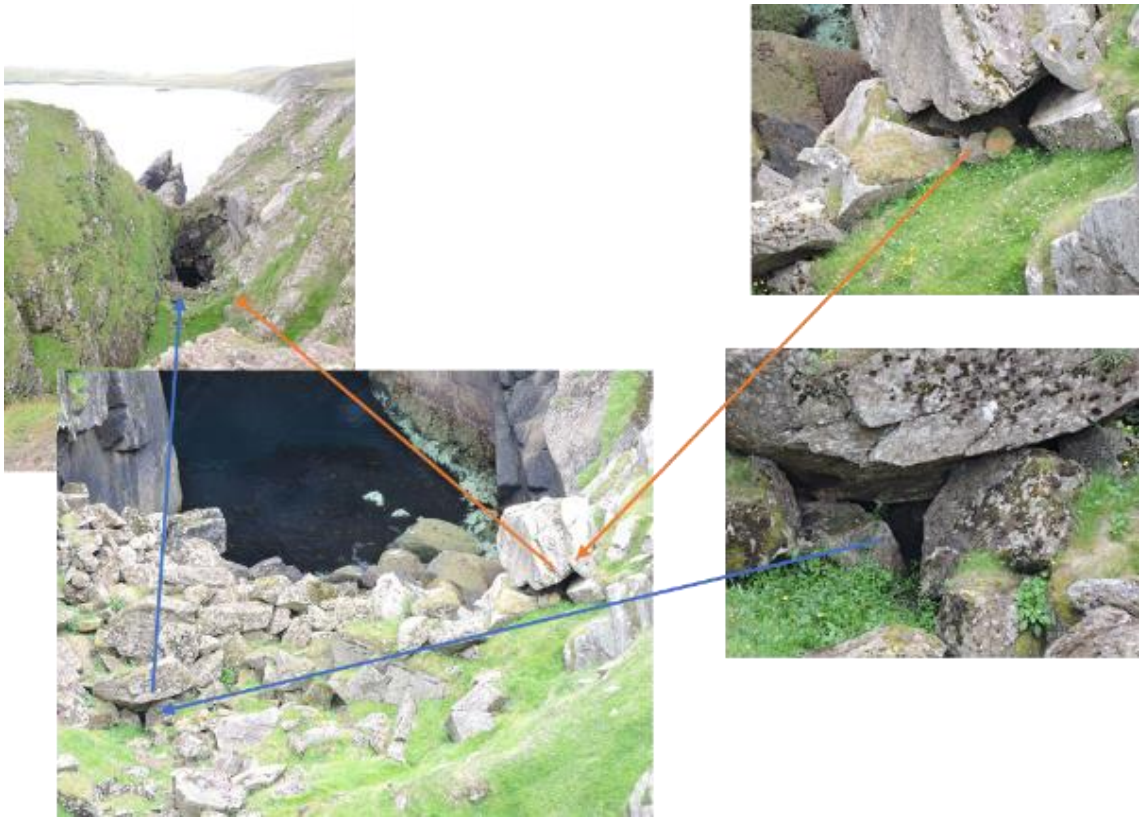


Photo 1: Two inaccessible otter holts were viewed from the cliff top. They were located within boulder scree. Spraint marks around the entrances were evident (OS grid reference HP 66032 15254), as was flattened vegetation.

Photo 2: The most active holt location was likely used by a female with young. The spraint pile nearby was very fresh and included crab remains (OS grid reference HP 67136 15532).

Photo 3: Fresh otter prints, of two different sizes, were clear within this abandoned military building (OS grid reference HP 67439 15637).

Photo 4: A clearly defined otter run (slightly dark coloured curved area of grass in the foreground) going towards and through the track underpass (OS grid reference HP 67091 15465).

Photo 5. Clearly defined otter run on the north side of track underpass (OS grid reference HP 67091 15465) to a small freshwater pool. Based on field signs, this pool is regularly used by otters to clean themselves after leaving saltwater.

There is evidence that the Proposed Launch Site Boundary is regularly and indeed heavily used by otters (e.g. EIAR Drawing 7.10 and 7.12). The presence of multiple holts and lay-up sites within the Application Boundary and other signs means that otters could potentially be directly affected by the proposed development.

Based on the indicative planned site layout and the most up to date (July 2020) otter survey data, the main sensitivities are considered to be:

- The access road bend by the Satellite Tracking Station is relatively close to an otter holt (ca. 240m separation).
- Launch Pad 1 is close to an otter holt (ca. 30m separation).

- The access road between Launch Pad 2 and Launch Pad 3 is close to two otter holts (ca. 55m south and 80m north separation) and crosses the otter run.
- Launch Pad 3 is situated on buildings used by otters and is close to an otter holt at the end of Lamba Ness (ca. 100m separation).

There is no evidence that the proposed development at the proposed Launch and Range Control Centre and proposed New Section of Access Road would impact on any otter breeding site or resting place (e.g. EIAR Drawing 7.11). Otter use of this area appears occasional and is focussed along the Burn of Norwick. Consequently, it is unlikely that proposed development in the Launch and Range Control Centre and New Section of Access Road Otter Study Area would kill, injure, capture or disturb an otter whilst it is occupying a holt or other places of rest/shelter. This assumes that best practice construction methods are employed under the supervision of an Ecological Clerk of Works.

The EIAR recognises that otters could be directly affected by the Proposed Launch Site (i.e. the planned work could potentially kill, injure, capture or disturb an otter whilst it is occupying a holt or other places of rest/shelter) and so an Otter Species Protection Plan is necessary. Figure 1 illustrates the known legally protected otter features across the Site based on 2018-2020 data.

Figure 1. Known Otter Constraints 2018-2020.

MINIMISING IMPACTS

There is a good understanding of how otters at Lamba Ness use the habitats present with many holts at the base of sea cliffs and used during suitable weather (e.g. Photos 1-2). During inclement weather (e.g. winter storms), some of these holts would potentially be inundated with sea water. At such times, the otters probably make regular use of the old abandoned open military buildings which become *de faco* holts/resting places (e.g. Photo 3). Any development related work on these buildings must therefore be considered as potentially affecting resting/holt sites. It should be noted that fresh otter footprints inside buildings were recorded in July 2020 during a period of good weather, suggesting the building may also offer shelter outwith adverse weather conditions. It may be that natural resting/holt sites in the Proposed Launch Site Boundary (away from the base of cliffs) are limited and are therefore perhaps used year-round.

The track underpass (Photo 4) is also an important feature for otters, allowing them to cross from one side of Lamba Ness to the other, (bathing/cleaning in the freshwater pool - Photo 5) without having to swim around the point or cross a large area of open ground and an access track. This feature might be extremely important functionally, particularly during inclement weather and it should be treated as such in construction plans (e.g. CEMP).

The measures within this Otter Protection Plan follow the well-established hierarchy of avoidance, mitigation and compensation as outlined in the actions in Table 4. It is important to recognise that otter use of the Site may vary over time and planned actions will need to account for this. Consequently, the Otter Protection Plan Actions (Table 4) should be regularly reviewed to ensure they are fit for purpose and this document should remain 'live' and be updated by the ECoW when necessary.

Table 4. Otter Protection Plan Actions

Action	Location	Comments
Tool-box talk & construction site materials.	Site Office	Construction workers & site staff must be given a tool-box talk (provided by the ECoW) which covers otter species protection issues. Sensitive & legally protected otter features must be marked-up on relevant construction plans & updated in light of new information.
Create otter sensitive zones.	Holts, couches & underpass/ pool area	Physically mark sensitive areas on the ground using coloured pegs & possibly rope/line marker chalk paint. It should be recognised that standard canes & marker tape typically used to mark-up sensitive areas might get damaged & blown away by strong winds. Therefore, strong, low markers, fixed securely into the ground or marked directly onto the ground with line marker chalk paint will likely be most resilient to adverse weather conditions.
Pre-construction survey	Site wide	Pre-construction surveys for signs of otters was undertaken in march 2022 prior to any works commencing on the Proposed Development.
All construction work must avoid damage &/or destruction of otter holts/couches unless under licence from NatureScot.	Site wide	Construction plans avoid damage &/or destruction of natural otter holts/couches, most of which lie at the base of sea cliffs & so will be unaffected (Figure 1). In the 2020 otter surveys one existing building, in the east of the Site at proposed Launch Pad 3, had evidence of use

		by otters and was identified as being directly lost by the construction of the Proposed Development. At the single, known otter resting place, where avoidance is not possible, a pre-construction survey was carried out. In the pre-construction otter survey all the existing buildings on Lamba Ness were surveyed. One existing building, in the east of the Site at proposed Launch Pad 3, had evidence of use by otters in March 2022 and will be directly lost by the construction of the Proposed Development.  *Footprints of an individual otter were recorded in a building within the development footprint at HP6743915639.* This area was identified as a couch. Couches are daytime resting places for otters. Therefore, the destruction/modification of this building will require a licence from NatureScot. While no other resting places will be destroyed given current information, the ECoW will provide regular inspections/surveys of the buildings and note any change in use of the buildings by otters. Artificial holts/shelter will be used to replace the lost spaces in the building at a very similar nearby location providing alternative resting sites.
Retain the established and well used run, underpass & freshwater pool (Photos 4 & 5).	HP 671 154	The vehicle track running on top of the underpass will need strengthening & widening. As a consequence, the existing underpass will be extended & an additional tunnel added to facilitate crossings if the existing tunnel is inundated during wet weather. The well-used run & freshwater pool will be retained to maintain important connectivity between the north & south sides of Lamba Ness. Every effort will be made to ensure the underpass and runs to and from the underpass are not destroyed or obstructed though the construction period. This will be achieved by:

		• The underpass will remain open during the construction phase, as far as possible. • The route of the run will be avoided, with exclusion zones marked and not entered unnecessarily. • Either side of the underpasses will have an artificial holt/shelter designed into it, so otters can use them for refuge.
Avoid working in vicinity of otter holts/couches in the hours darkness.	Site wide	Unlike on the mainland, otters using coastal habitats on Unst are diurnal & so not limited to nocturnal or crepuscular hunting/feeding.
Avoid disturbance to otter holts/couches.	Site wide	Mark work exclusion zones around any holts & shelters. If otters are breeding, the disturbance-free zone should be at least 200m. However, it could be reduced to 100m depending on the nature of the works, topography & natural screening. This will require judgement from an experienced ecologist. For holts & shelters where otters are not breeding, the exclusion zone should be 30m. Where exclusion zones of the required size are not possible, works will require a licence from NatureScot before they can proceed. 30m exclusion zones will be maintained around the three active holt locations identified in March 2022. These are shown in Figure 3. The proposed works are all outwith 30m. The holts were located within inaccessible boulder scree at the base of sea cliff. They were viewed with binoculars from safe locations from the top of the cliffs. Therefore, some of the grid references are indicative, and are likely further away than shown. As the Lamba Ness peninsula is actively used by otters, the construction team and the Ecological Clerk of Works should be aware of, and keep a watching brief for their presence, especially when working in and around the old military buildings and at/around the underpass.
Cap exposed pipes when not in use.	Site wide	All exposed pipes must be capped to prevent otters from entering them & potentially getting injured/killed. See example photo below.

		
Enforce safe-working vehicle speed limit.	Site wide	Vehicle speed limit of 10 mph across the Site to reduce possibility of otter traffic mortality/injury.
Awareness raising for drivers.	Entrance & main track	Otter crossing road signs will be located at the Site entrance & at other strategic locations along the main track, including either side of bridge with the otter underpass.
Construct ten artificial holts to replace any natural holts/couches that have to be destroyed or damaged.	Site wide	None of the natural holt sites will be directly lost due to construction as they were all recorded in inaccessible locations in the boulder scree and caves at the foot of cliffs which are deliberately avoided by the design layout. The construction of the Proposed Development will result in the direct loss of ten abandoned military buildings/ruined infrastructure, including one that is known to be used by otters (and considered above) and an additional nine abandoned military buildings/ruined infrastructure. There is no evidence that these nine locations have been used as resting places by otters from previous surveys. However, otters are mobile and so occasional use cannot be ruled out. Therefore, pre-construction otter surveys will be required. To mitigate for the loss of potentially occasionally used shelter a series of artificial otter holts will be built as identified in Figure 2 to provide additional resting places away from the coast.

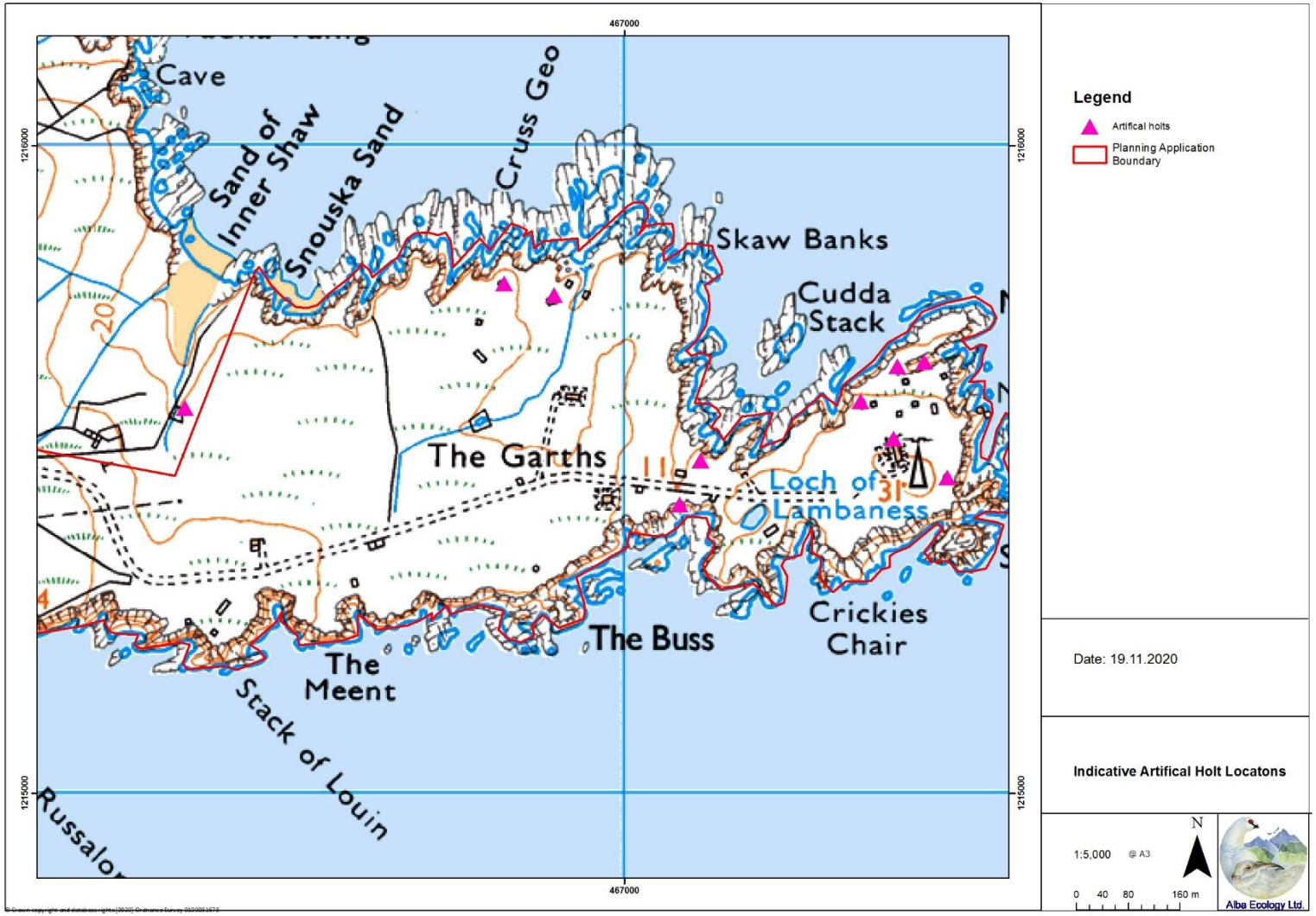


Figure 2. Artificial Otter Holt Locations.

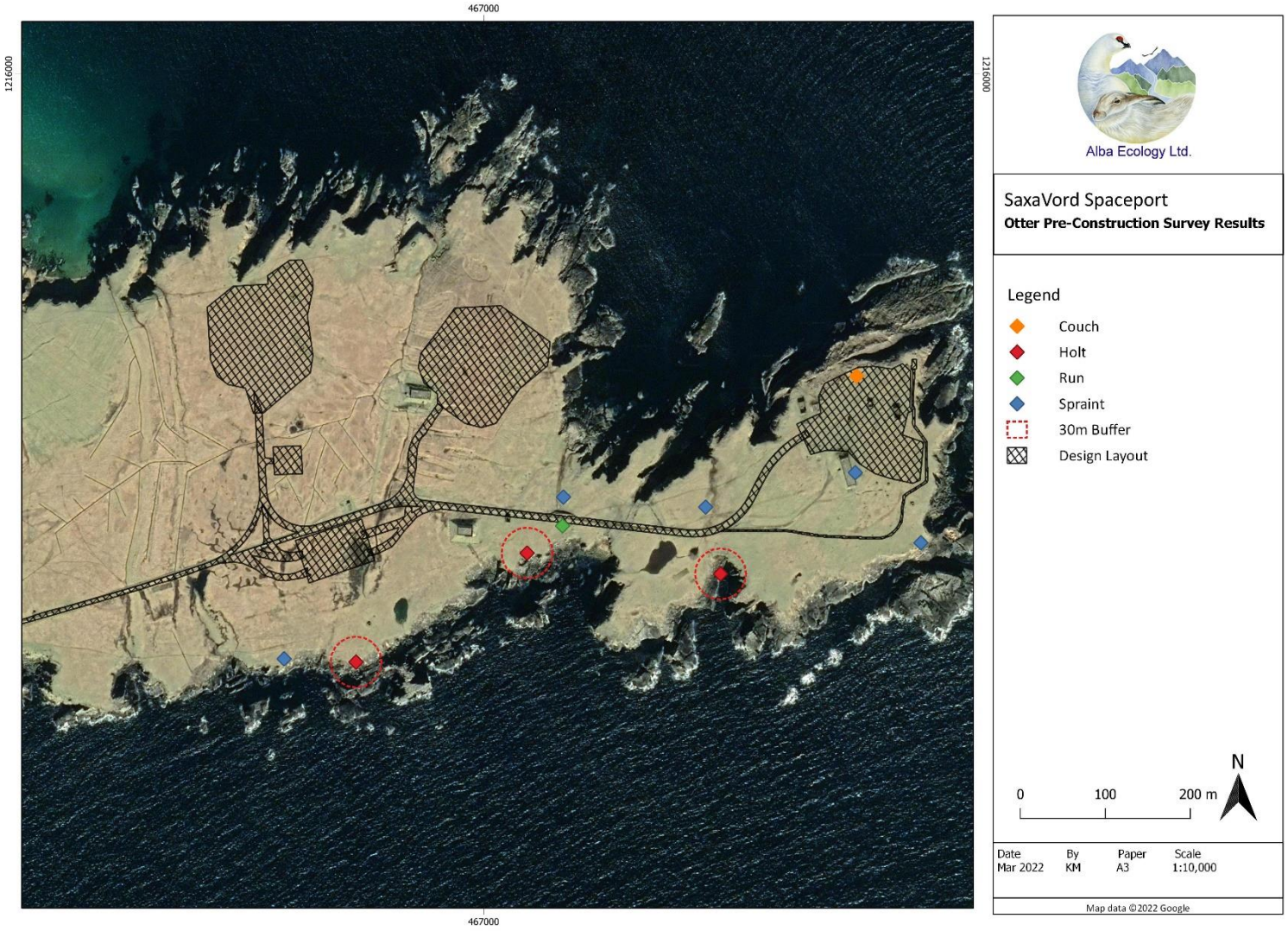


Figure 3. 30m buffer around holt locations.

Licensing development works affecting otters

Licences for development works that would otherwise result in an offence with respect to EPS such as otters, can only be issued if it can be demonstrated that the following three tests are all met:

- Test 1 - that the purpose of the licence is to preserve public health or public safety or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment.
- Test 2 - that there is no satisfactory alternative.
- Test 3 – that the proposed action will not be detrimental to the maintenance of the population of the species at a favourable conservation status in their natural range.

There is a presumption against licensing disturbance to breeding otters and damage or destruction of an otter holt while being used for breeding. Nevertheless, according to the NatureScot standing advice "*developers can apply for a licence to allow proposed development works that might affect otters to proceed legally*". An example of the type of information likely to be require for licencing is provided in Annex 1.

For all development proposals where otters are a consideration, pre-construction surveys should be timetabled into project plans. This is to enable checks for any new holts or resting places that may have become occupied after the original surveys, and to ensure the measures proposed to minimise impacts on otters remain appropriate. Consequently, a pre-construction otter survey will need to take place within 4-6 weeks of constructions works commencing.

REFERENCES

Chanin P. (2003) Monitoring the otter *Lutra lutra*. Conserving Natura 2000 Rivers Monitoring Series No.10. English Nature, Peterborough.

NatureScot (no date) Standing Advice for Planning Consultants. Protected Species: Otter. Otters: licences for development | NatureScot [accessed February 2022].

ANNEX 1. Example of Likely Otter Licensing Requirements

Introduction

A proposal for a satellite launch facility has been made by the Applicant in north Unst, Shetland - known as the 'Unst Space Port'. Targeted otter surveys (2018-2020) demonstrated that the Proposed Launch Site Boundary is regularly used by otters. Chapter 7 of the Environmental Impact Assessment Report (EIAR), identified that the proposals would potentially result in the destruction of a single occasionally used otter resting place within an abandoned military building on Lamba Ness. The destruction of the resting place of an EPS, such as an otter, is an offence unless licensed. Construction work on this military building will therefore require a licence from NatureScot to destroy this shelter if it is still used being otters.

This Annex provides an outline of the likely licensing requirements and obligations and the information required for the licence application.

Legal protection

The Eurasian otter (*Lutra lutra*) is an EPS under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). According to NatureScot's standing guidance on otters, it is an offence to deliberately or recklessly:

- capture, injure or kill an otter;
- harass an otter or group of otters;
- disturb an otter in a holt or any other structure or place it uses for shelter or protection;
- disturb an otter while it is rearing or otherwise caring for its young;
- obstruct access to a holt or other structure or place otters use for shelter or protection, or otherwise deny the animal use of that place;
- disturb an otter in a manner or in circumstances likely to significantly affect the local distribution or abundance of the species; and
- disturb an otter in a manner or in circumstances likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young.

It is also an offence to:

- damage or destroy a breeding site or resting place of such an animal (whether or not deliberately or recklessly); and
- keep, transport, sell or exchange, or offer for sale or exchange any wild otter (or any part or derivative of one) obtained after 10 June 1994.

Otter shelters are legally protected whether or not an otter is present.

Licencing

NatureScot is responsible for considering and issuing licences to permit actions related to developments that might affect EPS, such as otters. A licence allows activities to be carried out which would otherwise be unlawful. Licences are granted subject to conditions and licence holders are responsible for ensuring compliance with conditions. Failure to comply with conditions is an offence.

Applications for a licence should be made to NatureScot for work that could otherwise result in an offence in relation to otters. The Application form and accompanying guidance is on the NatureScot webpage at: Otters: licences for development | NatureScot [accessed February 2022].

Avoiding the Need for a Licence

When considering activities that could affect otters the primary aim is to avoid impacts in the first place. Given that otter use of an area changes over time, it is important that up to date information (in the form of a pre-construction otter survey and report) is available and used to inform whether a licence is needed or not.

Offences and impacts can be avoided in a number of ways, such as;

- modifying the location of a proposed action/piece of work;
- timing operations to avoid times when the species is likely to be present;
- protecting important features from disturbance by creating 'no disturbance zones';
- retaining certain areas/structures used by the species;
- modifying working practices; and
- look at alternative solutions to problems.

If there are no satisfactory alternatives to avoiding an impact/offence, a licence may be necessary. If this is the case the applicant will need to clearly demonstrate the alternatives that have been considered and why they are not satisfactory.

Tests for Granting a Licence

A licence can only be granted if the three strict EPS licensing tests are met.

- Test 1 - that the purpose of the licence is to preserve public health or public safety or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment.
- Test 2 - that there is no satisfactory alternative.
- Test 3 – that the proposed action will not be detrimental to the maintenance of the population of the species at a favourable conservation status in their natural range.

Supporting Information

In order to apply for a licence, supporting information must be provided by the Applicant to the licensing authority (NatureScot in this instance). NatureScot provides guidance on the supporting information needed (*Guidance notes on providing supporting information for a licence for European protected species*).

The supporting information includes:

- Survey and site assessment (in the form of an up-to-date pre-construction survey report);
- Impact assessment, mitigation and compensation;
- Method statement; and
- Appropriate maps.

It is the responsibility of the Applicant to demonstrate (and provide supporting evidence where necessary) why the proposal (in its submitted form) is necessary. The Applicant should explain any alternatives that were considered and justify why these were discounted. The application should provide objective evidence of a lack of satisfactory alternatives. Applicants will need to provide detailed proposals of all the mitigation and compensation measures that they will undertake to ensure that impacts on the species concerned are minimised.

The Species Protection Plan should outline the measurers that planned to mitigate/compensate for the otter feature(s) that may be lost through construction and be provided to NatureScot. The Species Protection Plan should allow NatureScot to consider the merits and potential efficacy of the measures proposed to reduce impacts on otters.

Outline rationale for the Licence Application

Based on existing information, the construction of the Unst Space Port has the potential to adversely impact otters in one way; through the destruction of a single known resting place (an old abandoned military building). This activity is likely to require an agreement with, and a licence from, NatureScot.

Avoidance

Avoidance of impacts on otters was achieved through in-built design in several ways. For example:

- The cliffs and their bases (where most otter holts were identified) have been avoided by the design layout, therefore the majority of the otter holt locations will not be directly impacted by any land-take.
- Two out of three of the old military buildings known to be used by otters have been avoided by the design layout.

- An important under-road culvert, which is regularly used by otters crossing overland from one side of Lamba Ness to the other will be retained (and extended).

Additional Mitigation in Relation to Otters

To further avoid and minimise impacts on otters additional mitigation will be undertaken in relation to the Proposed Development:

- An Ecological Clark of Works (ECoW) will ensure that pipes etc. are stored correctly reducing likelihood of otters using them and being present in potentially 'high risk' areas during construction.
- Enforced low vehicle speed limits (10mph) would greatly reduce the likelihood of injury or death from vehicle collisions happening during construction. Similarly, low enforced vehicle speed limits (10mph) during operation would greatly reduce the likelihood of any operational mortality.
- Otter crossing road signs will be located at the Site entrance and at the frequently used otter run to further help prevent mortality caused by vehicle traffic during construction and operation.
- The frequently used otter run, crossing from the north to south of Lamba Ness and using the underpass at HP 671 154 has the potential to be damaged or destroyed during construction. The road will be reinforced and widened at this location for access. However, the design will deliberately be otter friendly. The current underpass will remain and will be extended on either side. As the road will be reinforced and widened at this location an additional underpass will also be created, slightly above and along from the current location. This will provide an alternative, easy route for otter if, for example there is any period of heavy rain causing flooding/puddling of the current underpass or if it gets blocked for any reason. Either side of the underpasses will have an artificial holt/shelter built (Figure 2), so otters can use them for refuge.
- Fencing around the Proposed Development has the potential to impede otter movements to and from the buildings. It is also possible that otters may want to occasionally cross the site during construction and operation at other locations. To avoid blocking potential routes, and as part of embedded mitigation, permeable (otter friendly) boundary fences will be used during construction and operation. They will be otter friendly in-so-far as they will have regular small gaps for otter to move through. The spacing of gaps along the fence will be agreed with NatureScot and will form part of the otter licencing/planning conditions.

Predicted Impacts of the Proposed Development and Mitigation

Despite the avoidance and mitigation outlined above, the construction of the Unst Space Port would likely result in the unavoidable destruction/modification of a resting place/holt within a single abandoned military building around the area of Launch Pad 3 (EIAR Chapter 7). Targeted otter surveys showed that this building has been occasionally used in the past as a resting place by otters. Assuming pre-construction surveys demonstrate that the building is still used, the destruction/modification of this building will require a licence from NatureScot.

While no other resting places will be destroyed given current information, pre-construction surveys will assess whether any of the other areas or buildings which will be lost during construction are used by otters.

Nine artificial holts/shelters (Figure 2) will be created across the top of the Lamba Ness area (in which the current use by otters appears limited). These include two at either side of the regularly used underpass. These should provide appropriate multiple alternative resting sites in lieu of the old military building. This mitigation will be embedded within the planning conditions and will be constructed prior to the works on the military buildings commencing.

Application and Supporting Information for Licence Application

To apply for a NatureScot otter licence the Applicant will provide an application form detailing:

- That the purpose of the licence is of a social/economic nature;
- That there were no satisfactory alternatives; and
- That the proposed action will not be detrimental to the maintenance of the population of the species at a favourable conservation status in their natural range.

To support the licence application the Applicant will provide:

- Appendix 7.3: Otter Survey Report;
- EIAR Chapter 7: Ecology;
- Appendix 6.4 OHMP;
- An up to date pre-construction otter survey of the abandoned military buildings; and
- A method statement outlining details of the works and associated mitigation.

The methods statement and pre-construction otter survey will be written post-consent and submitted as part of the licence application.

Appendix 6.3b Pre-Construction Otter Survey Report

SaxaVord Spaceport Pre-construction Otter Survey Report

Alba Ecology Ltd.

March 2022

This report should be quoted as '*Alba Ecology (2022). SaxaVord Spaceport Pre-construction Otter Survey Report 2022*'.

Registered Office: Coilintra House, High Street, Grantown on Spey, Moray PH26 3EN Tel: 01479 870238. *enquires@albaecology.co.uk*

Introduction

An application for a satellite launch facility has been made by SaxaVord Spaceport in north Unst, Shetland (formerly known as the Shetland Space Centre). Planning permission was granted in March 2022.

Previous surveys of the area in support of the initial application (Alba Ecology, 2020a) found numerous otter signs, and use of some of the buildings present on the Lamba Ness peninsula. As part of the planning conditions, Alba Ecology Ltd. was commissioned to conduct a pre-construction otter survey targeted around the site works of the launch facilities at Lamba Ness. This was to provide up-to-date information of the current use of the area by otters.

Aim

The aim of the SaxaVord Spaceport pre-construction otter survey was:

- To provide up-to-date information and inform the SaxaVord Spaceport development on the current use of the area by otters; and
- To provide advice in regard to the requirement of a licence from NatureScot to undertake construction work.

Legal protection

Otters are classed as European Protected Species (EPS) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). It is therefore an offence to deliberately or recklessly:

- Kill, injure, capture or harass an otter;
- Disturb an otter whilst it is occupying a holt (underground den) or other place it uses for shelter or protection, or while it is rearing or otherwise caring for its young, or in any way that impairs its ability to survive or breed, or significantly affects the local distribution or abundance of otters; and
- Obstruct access to an otter breeding site or resting place, or otherwise prevent their use.

And whether or not deliberate or reckless:

- To damage or destroy an otter breeding site or resting place.

This means that if otters could be affected in these ways by a development, and no action is taken to prevent it, an offence may be committed.

Methods

Surveyor

According to the NatureScot otter standing guidance "*surveys should be done by persons with the appropriate knowledge of otter ecology and practical experience of otter survey work*"(NatureScot, 2020). The Study Area was surveyed for otters in March 2022 by Mr Donald Shields MCIEEM, a highly experienced mammal surveyor and ecologist. Mr Donald Shields has the knowledge, skills and experience required to survey, disturb and/or to carry out research works on otter in accordance with the CIEEM (2013) '*Competencies for Species Survey: Eurasian Otter*'.

Study Area

The Study Area was based on two factors: The first was the design layout of the development at Lamba Ness (Figure 1), and the second, where otter signs were recorded in previous surveys.

NatureScot's standing guidance (2020) states that "*Surveys should be done by persons with the appropriate knowledge of otter ecology and practical experience of otter survey work. All suitable otter habitat within 200m of the proposed works should be surveyed, including a systematic search for spraints, paw prints, otter paths, slides, food remains, holts and places used for shelter*". This is in accordance with general best practice guidance e.g. Chanin (2003). As a consequence of this guidance, outwith the footprint of the design layout, a 200m buffer was also surveyed for signs of otter, and termed the Study Area.

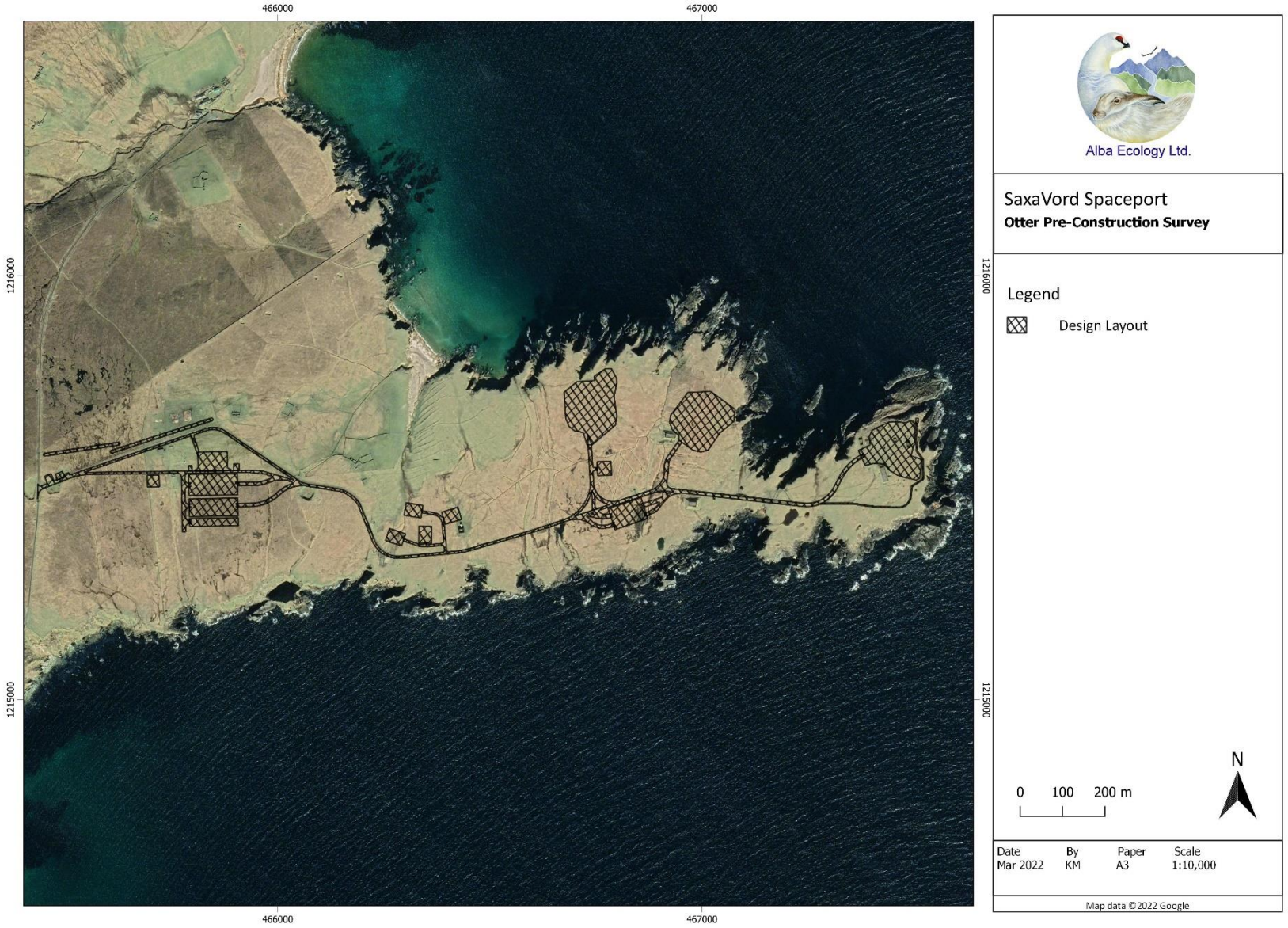


Figure 1: *Lamba Ness with SaxaVord Spaceport (Shetland Space Centre) design layout*

Survey methodology

As a pre-construction survey, this was conducted just prior to the planned commencement of construction works on the project.

The survey methods involved a systematic survey of terrestrial, aquatic and riparian habitats within the Study Area looking for places otters use for shelter, resting and protection (such as couches, lying-up sites and holts), or for signs of activity (such as spraints, feeding remains, runs or footprints) (Chanin, 2003).

Where signs were located, a grid reference was recorded along with notes on the types of signs present and a photograph taken. Many of the otter signs were located within inaccessible boulder scree at the base of cliff faces at Lamba Ness. They were viewed with binoculars from safe locations from the top of the cliffs. Therefore, some of the grid references are indicative. Additionally, some of the clifftop edges were deemed to be too dangerous to survey during high winds that were ongoing during the survey period.

The otter surveys took place during suitably dry weather conditions, so that otter field signs (spraints, slides, sheltering or resting places etc.) would have had time to build up, be relatively visible and would not have been degraded/washed away e.g. after heavy rain.

Results

Numerous otter field signs were recorded during targeted surveys in March 2022 (Table 1). Three otter holts were recorded during surveys, though none were recorded within the design layout itself.

One building within the design layout was recorded as being used as a couch. Couches are daytime resting places for otters.

Several sprainting sites were recorded around the design layout during the survey, with the most active one recorded near an underpass below the main track across Lamba Ness which also had an otter runway through it.

O/S grid reference	Type of otter sign	Note
HP6743915639	Couch	Small building occasionally used by otters during survey. Footprints and spraint recorded.
HP6744115528	Spraint	Old spraint, area not recently used.
HP6751315453	Spraint	Fresh spraint.
HP6726915424	Holt	Holt site at foot of cliffs. Not visited directly due to access issues and high winds.
HP6725815487	Spraint	Fresh spraint.
HP6709015483	Runway	Clear runway through underpass.
HP6708915502	Spraint	Regularly and heavily used sprainting site.
HP6704815435	Holt	Holt site in boulder field at foot of cliffs.
HP6684315302	Holt	Holt site at base of cliff in scree slope.
HP6675915307	Spraint	Old spraint, not recently used.

Table 1: *Study Area otter signs March 2022*

Photo 1: *Footprints of an individual otter were recorded in a building within the development footprint at HP6743915639.*

Photo 2: *Fresh spraint was also recorded in the doorway of this building at HP6743915639.*

Photo 3: *Several of the old military buildings were partially if not fully submerged in water during the survey.*

Photo 4: *Underpass still showing signs of use, with trails leading through and sprainting site used recently (HP6709015483).*

Photo 5: *Spraining site by lochan near underpass showing signs of recent use (HP6708915502).*

Photo 6: *Spraining site near entrance to main bunker at HP6744115528. This was not a recent spraint and no further evidence of use of the bunker was recorded.*

Photo 7: *Spraints and holts were recorded as in previous surveys outwith the design layout (often along the cliff edge and down scree areas).*

Photo 8: *Additional areas within the design layout which could potentially be used as resting sites or couches were surveyed. None showed any evidence of regular use by otters.*

Discussion

The survey recorded evidence of use of parts of the design layout by otters. Following on from previous surveys, Lamba Ness remains important for otters. While some of the buildings were noted as being used by otters during the previous survey, only one had any evidence of recent activity during this pre-construction survey. This building was within the design layout (Figure 2) and in use as an otter couch/resting place.

The track underpass remains an important feature for otters, with a large and active sprainting site recorded near it. This appears to allow them to cross from one side of Lamba Ness to the other without having to swim around the headland. Also, the freshwater lochan on the north side of the underpass is considered likely to be an important place for otters to wash.

As a result, any changes to or demolition of the building being used as a couch at HP6743915639 will require a licence from NatureScot (as outlined in Alba Ecology, 2020b) before any works can commence on this building. Works across the remainder of the Study Area will be unaffected and do not require licensing. Finally, as the Lamba Ness peninsula is actively used by otters, the construction team and the Ecological Clerk of Works should be aware of, and keep a watching brief for their presence, especially when working in and around the old military buildings and at/around the underpass.

References

Alba Ecology (2020a) Shetland Space Centre Otter Survey Report 2018 and 2020.

Alba Ecology (2020b) Shetland Space Centre Otter Licensing Requirements.

Chanin P. (2003) Monitoring the otter *Lutra lutra*. Conserving Natura 2000 Rivers Monitoring Series No.10. English Nature, Peterborough.

CIEEM (2013). Competencies for Species Survey: Eurasian Otter.

NatureScot (2020) Standing Advice for Planning Consultants. Protected Species: Otter. Standing advice for planning consultations - Otters | NatureScot [accessed March 2022].

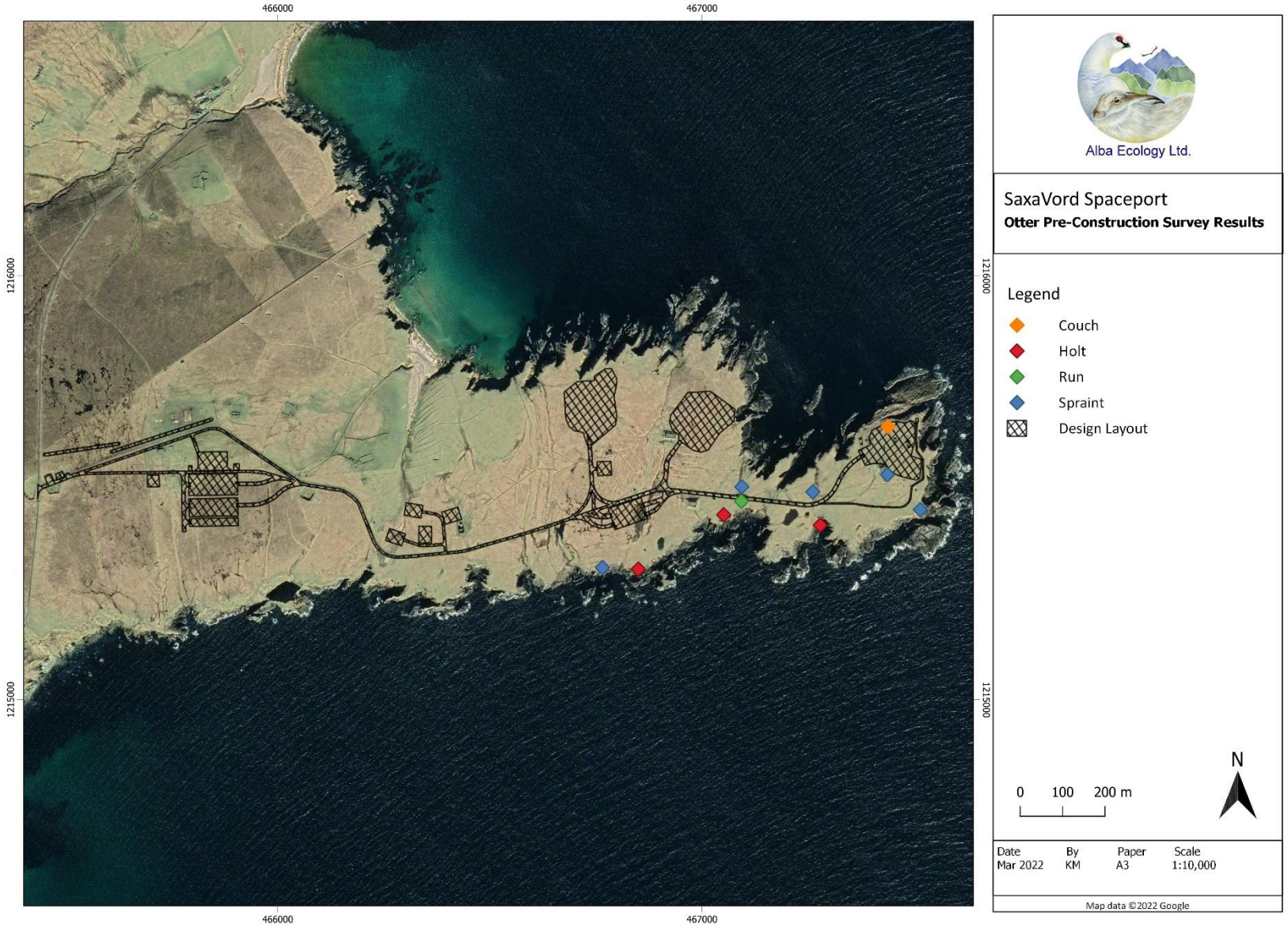


Figure 2: *Results of SaxaVord Spaceport Pre-construction Otter Survey*

Appendix 6.4 Freshwater Pearl Mussel Survey Report

Shetland Space Centre Freshwater Pearl Mussel Survey

Alba Ecology Ltd.

April 2020

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Summary

Background

Scotland is a global stronghold for the freshwater pearl mussel (*Margaritifera margaritifera*), a species now fully protected under the Wildlife and Countryside Act (1981) (as amended) of Great Britain. It is also listed on Annexes II and V of the EC Habitats Directive (Council Directive 92/43/EEC) and Appendix III of the Bern Convention. Estimates suggest that Scotland holds a large proportion of the world's remaining viable populations, with several sites of national and international importance in the north of Scotland, including Shetland.

A proposal for a space centre has been made by the Applicant in north Unst, Shetland. As part of this proposal, Alba Ecology Ltd. was commissioned to conduct a freshwater pearl mussel survey in a watercourse immediately adjacent and downslope to the proposed planning application boundary on Unst. The proposal comprises of work in three discrete areas: (i) a proposed New Section of Access Road at Northdale, (ii) a proposed Launch and Range Control Centre Site, and (iii) a proposed Launch Site. The first of these areas had running water (the Burn of Norwick) downslope and so was considered further in relation to potential freshwater pearl mussel sensitivities.

Main Findings

- The Burn of Norwick was surveyed by Dr Peter Cosgrove, an experienced and licensed freshwater pearl mussel surveyor in September 2018.
- No evidence of freshwater pearl mussels was found in the Burn of Norwick survey reach.
- No patches of suitable or potentially suitable substrate habitat were recorded in the Burn of Norwick survey reach.
- This report provides survey evidence that no freshwater pearl mussels were present within the Burn of Norwick survey reach. Consequently, the survey evidence suggests that there are no special freshwater pearl mussel sensitivities that need to be considered. Nevertheless, freshwater pearl mussels are highly sensitive to changes in water quality, and if present and undetected (and there is no evidence for this) it will be important to avoid any sources of pollution or runoff from the site during proposed works by following best practice measures when working around watercourses.

Introduction

Aim

To provide information to inform the proposed Shetland Space Centre (SSC) development in Unst, Shetland a freshwater pearl mussel (*Margaritifera margaritifera*) survey with three main stages was considered necessary.

- Watercourse survey site selection;
- Freshwater pearl mussel survey of all potentially affected watercourses; and
- Report and recommendations.

Species background

During the past 100 years, the freshwater pearl mussel has declined throughout its Holarctic range to such an extent that it is now listed as an endangered species (IUCN, 1991). Scotland is a global stronghold for the freshwater pearl mussel, a species which is now fully protected under the Wildlife and Countryside Act (1981) (as amended) of Great Britain. It is also listed on the Annexes II and V of the EC Habitats Directive (Council Directive 92/43/EEC) and Appendix III of the Bern Convention.

Recent estimates suggest that Scotland holds an important proportion of the world's known remaining viable populations (e.g. Cosgrove *et al.* 2000a; Cosgrove *et al.* 2016). However, the species has declined in Scotland, with gross industrial and agricultural pollution, over-exploitation by pearl fishers, decline in salmonid host stocks (the short parasitic larval stage of freshwater pearl mussels is entirely dependent upon salmon and trout fry) and physical river bed habitat degradation due to hydro-electric operations and small-scale river engineering works (Cosgrove *et al.* 2000a; Cosgrove *et al.* 2016).

Every year, new undiscovered pearl mussel populations are found in Scotland during targeted surveys. Freshwater pearl mussels were rediscovered in Shetland in 2002 (Cosgrove and Harvey, 2003; Cosgrove and Harvey, 2005) and so surveys of watercourses holding potentially suitable freshwater pearl mussel habitats in Shetland are required to account for this legally protected species within the SSC Study Area.

Habitat requirements

Freshwater pearl mussels are found in fast flowing rivers and streams, with detailed studies on Scottish freshwater pearl mussel populations suggesting that optimum water depths of 0.3 - 0.4m and optimum current velocities of 0.25 - 0.75ms-1 at intermediate water levels are most suitable (Hastie *et al.* 2000). River bed substratum characteristics appear to be the best physical parameters for describing freshwater pearl mussel habitat. Freshwater pearl mussels prefer stable cobble/boulder dominated substrate with some fine substrate that allows the mussels to burrow (Cosgrove *et al.* 2000b). Adult and juvenile mussels tend to have similar habitat 'preferences', although adults are found over a wider range of physical conditions and juveniles appear to be more exacting in their requirements and sensitivity to environmental disturbance (Hastie *et al.* 2000). Juvenile mussels prefer finer stable sediments than adults, particularly clean sand and gravel.

Freshwater pearl mussels live buried or partly buried in the beds of clean, fast-flowing unpolluted streams and rivers and subsist by inhaling and filtering for the minute organic particles on which they feed (Cosgrove *et al*. 2000b). Of specific importance to freshwater pearl mussel survival are detrimental levels of silt, algae, suspended solids, calcium and chemical compounds generally associated with enrichment (eutrophication) i.e. nitrate, phosphate and biological oxygen demand (Bauer 1983). Various types of river engineering work can detrimentally impact the habitat of freshwater pearl mussels (Cosgrove and Hastie, 2001).

Freshwater pearl mussels have a short parasitic larval phase on the gills of suitable host fish. The larvae (glochidia) are very host-specific and can only complete their development on Atlantic salmon *Salmo salar* or brown trout *Salmo trutta*. Usually juvenile fish (fry and parr) are utilised (Young and Williams 1984). The presence of freshwater pearl mussels in any river therefore depends on salmonid host fish availability. It is usually considered necessary for migratory salmonids to be present within a catchment for freshwater pearl mussels to be present.

Methods

Survey site selection

A proposal for a space centre has been made by the Applicant in north Unst, Shetland. As part of this proposal, Alba Ecology Ltd. was commissioned to conduct a freshwater pearl mussel survey in watercourse immediately adjacent to the proposed planning application boundary on Unst. The proposal comprises of work in three discrete areas: (i) a proposed New Section of Access Road at Northdale, (ii) a proposed Launch and Range Control Centre Site, and (iii) a proposed Launch Site. The first of these areas had running water (the Burn of Norwick) downslope and so was considered further in relation to potential freshwater pearl mussel sensitivities.

On the basis that there are no known historical records of freshwater pearl mussels within the Planning Application boundary, survey site selection was directed towards establishing the status (presence or absence) of freshwater pearl mussels and habitat suitability within potentially suitable watercourses in (or immediately adjacent to) the proposed planning application boundary.

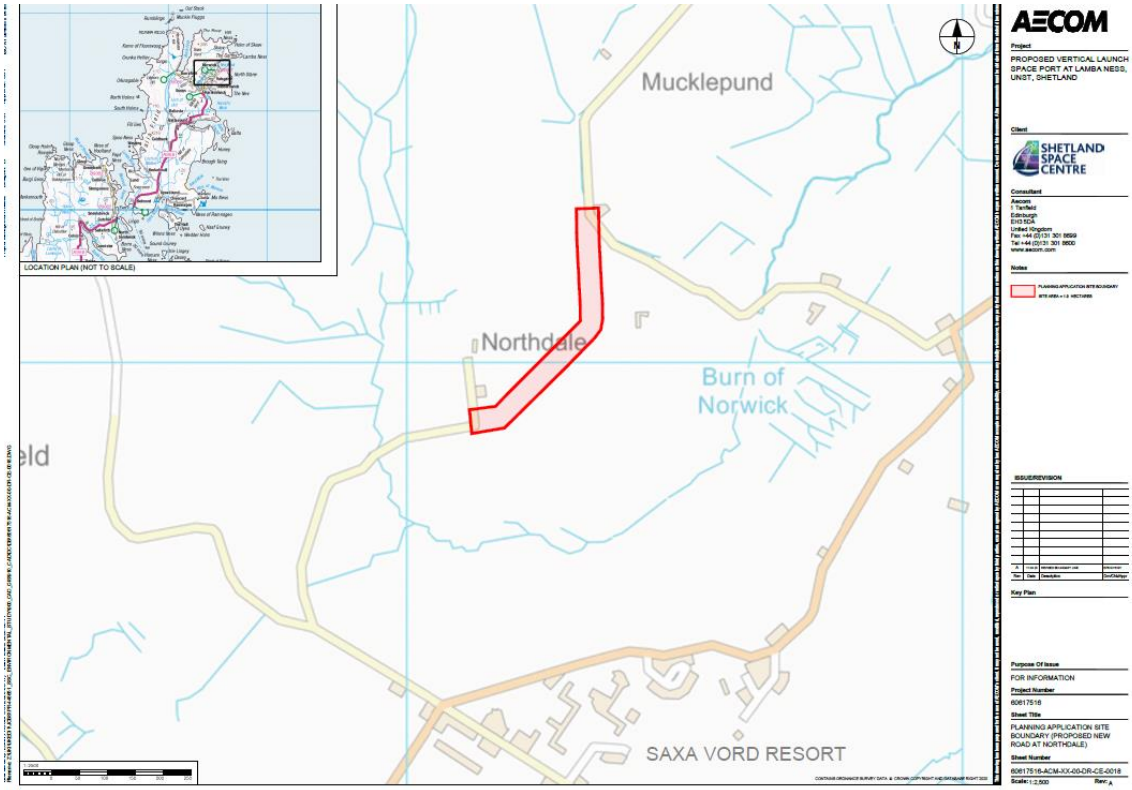


Figure 1. Proposed New Section of Access Road Boundary (red line) and the Burn of Norwick.

Survey site selection was based around knowledge of the species' habitat, host fish requirements, the Study Area and standard SNH guidance for shallow-water freshwater pearl mussel surveys (SNH, 2008). Whilst the proposed New Section of Access Road does not cross the Burn of Norwick, access from the west to and from this new road does and so it was considered important to establish presence or absence of freshwater pearl mussels (as well as habitat suitability) around this existing bridge crossing.

Survey methodology

The watercourse was entered and searched for freshwater pearl mussels, where Health and Safety conditions allowed, using an adapted version of the standardised shallow-water survey methodology (SNH, 2008).

A general survey was made of the Burn of Norwick and its substrate types within the survey reaches; defined as 100m upstream and 500m downstream of the existing bridge crossing at Northdale. This was carried out by walking along the bank and/or by wading in the water using thigh waders. The aim was to identify specific areas that were most likely to harbour mussels using information on their habitat preferences from previous studies and experience. Once an apparently suitable area was found, the watercourse was entered at the nearest point and search conducted, concentrated in the most favourable substrate types so as to optimise search efficiency. The searches were conducted in the following manner to ensure compatibility with other surveys and the standard SNH recommended methodology (SNH, 2008):

- Searches were made using a glass-bottomed viewing bucket;

- Viewing was conducted under favourable conditions i.e. bright light, clear water, low flow regime;
- Searches were made in water sufficiently shallow for safe wading;
- Searches were made in an upstream direction, checking favourable sites e.g. in the shelter of cobbles, boulders or overhanging banks;
- Loose debris and trailing weed were moved gently aside but no disturbance of the river bed was required; and
- The substrate in each transect was recorded and classified using the standard Wentworth Scale (1922).

Mussel abundance categories

For conservation reporting purposes, standard criteria were used for describing the abundance and status of the pearl mussels in 50m x 1m transects, based on counts of visible mussels (Cosgrove *et al.* 2000a). Any description of the conservation status of a mussel population must refer to the current ability of that population to recruit juveniles. The relative abundance and status terms used in this report (Table 2) match those used in previous survey work are therefore based on the recommended SNH terminology and, importantly, are directly comparable to those used on all other Scottish pearl mussel Site Condition Monitoring assessments.

Table 2. Standard relative abundance terms and codes for 50m x 1m transect counts.

Visible mussels per 50m x 1m transect	Terminology	Abundance code
0	Absent	E
1-49	Rare	D
50-499	Scarce	C
500-999	Common	B
1000+	Abundant	A

Results

The Burn of Norwick was surveyed under SNH licence (No 33634) for freshwater pearl mussels in September 2018 by Dr Peter Cosgrove, a highly experienced freshwater pearl mussel surveyor. The water levels were low and clear and the weather was bright and clear providing ideal conditions throughout surveying. No live mussels or empty/dead freshwater pearl mussel shells were found within the 600m survey reach.

The Burn of Norwick is small, recently dredged permanent watercourse. It has a gentle gradient within the 600m survey reach. Sometime after 2010, the survey reach on the Burn of Norwick at Northdale was dredged. The resultant instream substrate habitat is dominated with fine sized silt/peat sediment (Table 3). The catchment lies within an area dominated by sheep grazing and degraded blanket bog on upslope hillsides. No host fish were recorded present during surveys.

Table 3. Typical Burn of Norwick typical habitat summary

Location surveyed			**Substrate stability**			**Width**	**Depth**	**Land use/riparian vegetation**
600m around bridge @ Northdale			Unstable			2m	0.25m	Grazing pasture
	Bedrock	**Boulder**	**Cobble**	**Pebble**	**Granule**	**C sand**	**F sand**	**Silt/ Peat**
Substrate					5%	5%	+	90%
Comments: Muddy, silty and dredged channel. Wholly unsuitable for freshwater pearl mussels.								

+ = present, but less than 5%.

Photo 1. Burn of Norwick, Northdale @ HP639138, September 2018.

DISCUSSION

Summary of results

The Burn of Norwick was surveyed using SNH recommended standard shallow-water methodologies under ideal survey conditions. The relative abundance and status of the watercourse was classified as E 'Absent'. The sample based survey methodology used does not search every square metre of stream bed, so it is conceivable that a small number of freshwater pearl mussels may have remained undetected somewhere within the survey reaches. However, the use of an experienced surveyor meant that all potentially suitable habitats were thoroughly searched. It is highly unlikely (although hypothetically possible) that freshwater pearl mussels occur in the surveyed reaches where no mussels were found.

These limitations would apply to any freshwater pearl mussel survey carried out using the standard methodologies because it is a sample-based survey and not a complete census. Such a census would require the destructive searching of all loose substrate, including all

potentially suitable habitats to search for hidden mussels. Census work of this nature is not carried out in Scotland due to the endangered status of the species and its legal protection, as well as Health and Safety considerations.

Implications of results

There is no evidence that freshwater pearl mussels are present within the section of the Burn of Norwick surveyed. Consequently, there are no particular freshwater pearl mussel sensitivities that need to be considered further. Nevertheless, freshwater pearl mussels are highly sensitive to changes in water quality, and if present and undetected (and there is no evidence for this) it will be important to avoid any sources of pollution or runoff from the site during proposed works by following best practice pollution prevention measures when working around watercourses.

REFERENCES

Bauer, G. 1983. Age structure, age specific mortality rates and population trend of the freshwater pearl mussel (*M. margaritifera*) in North Bavaria. Archiv für Hydrobiologie 98: 523-532.

Cosgrove, P. J. and Hastie, L. C. 2001. Conservation of threatened freshwater pearl mussels populations: river management, mussel translocation and conflict resolution. *Biological Conservation* 99: 183-190.

Cosgrove, P. J. Young, M. R. Hastie, L. C. Gaywood, M. and Boon, P. J. 2000a. The status of the freshwater pearl mussels *M. margaritifera* Linn. in Scotland. *Aquatic Conservation: Marine and Freshwater Ecosystems* 10: 197-208.

Cosgrove, P. J. Hastie, L. C. and Young, M. R. 2000b. Freshwater pearl mussels in peril. *British Wildlife* 11: 340-347.

Cosgrove, P. and Harvey, P. 2003. An unusual freshwater pearl mussel *Margaritifera margaritifera* (L.) population in Scotland*. Journal of Conchology* 38: 139-146.

Cosgrove, P.J. and Harvey, P.V. 2005. The rediscovery of freshwater pearl mussels *Margaritifera margaritifera* (L.) in Shetland. *Shetland Naturalist* 2:2 pp 57-64.

Cosgrove, P., Watt, J., Hastie, L., Sime, I., Shields, D., Cosgrove, C., Brown, L. Isherwood, I. and Bao, M. 2016. The status of the freshwater pearl mussel *Margaritifera margaritifera* (L.) in Scotland: extent of change since 1990s, threats and management implications. *Biodiversity and Conservation* 25: 2093-2112.

Hastie, L. C. Boon, P. J. and Young, M. R. 2000. Physical microhabitat requirements of freshwater pearl mussels *M. margaritifera* (L). *Hydrobiologia* 429: 59-71.

IUCN. 1991. Invertebrate Red List. *International Union for the Conservation of Nature*.

SNH (2008). Freshwater pearl mussel survey protocol. https://www.nature.scot/freshwater-pearl-mussel-survey-protocol-use-site-specific-projects.

Wentworth, C. K. 1922. A scale of grade and class terms for clastic sediments. *Journal of Geology* 30: 377-392.

Young, M. R. and Williams, J. C. 1984. The reproductive biology of the freshwater pearl mussel *Margaritifera margaritifera* (Linn.) in Scotland I. Field Studies. *Archive für Hydrobiologie* 99: 405-422.

Appendix 7.1 Traffic Assessment

Operational Phase Traffic Data

The operational phase traffic generation data were supplied by AECOM for each week of a typical five-week launch cycle as shown in Table 1. The maximum number of development-generated movement is in week one which corresponds to a launch event and is due to the extra launch support vehicles and site visitors.

The data have been processed to calculate the maximum daily and maximum hourly light goods vehicles (LGVs) and heavy goods vehicles (HGVs) in order to predict the magnitude of change at sensitive receptors adjacent to any of the road links.

Using the same procedure as described for the construction phase vehicle emissions in Appendix 11.2, the modelled concentrations of NO_x, PM_{10} and $PM_{2.5}$ attributable to the development-generated operational phase traffic was added to the 2020 background concentration of each pollutant.

The results of the assessment are summarised in Tables 3 - 7.

Table 1 Operational Phase Traffic Movements

Operational Phase Traffic Data													
Event	**Assumptions**	**Wk 4**		**Wk 3**		**Wk 2**		**Wk 1**		**Wk +1**		**Maximum Daily for Wk 1**	
		HGV	**Car**	**HGV**	**Car**	**HGV**	**Car**	**HGV**	**Car**	**HGV**	**Car**	**HGV**	**Car**
PL arrival (1)	One truck	2											
PL prop/pyros (2)	Separate to PL arrival? One truck	2											
LV arrival (3)	Three trucks. One truck PL+LV recovery wk+1			6						2			
LV commodities arrival (5)	Two LO2 tankers. One gases (He, N2) truck					6							
LV RP-1 arrival (7)	One tanker					2							
LV commodities return (5)	One LO2 tanker									2			
LV RP-1 return (7)	One tanker									2			
PL support staff	10 in 2 vehicles 7 days a week one shift		28		28		28		28				4
LV support staff	40 in 8 vehicles 7 days a week one shift				112		112		112		112		16
Site general deliveries	One per week	2		2		2		2		2		2	
Site diesel / water deliveries	One truck each per launch							4				4	
Site staff	Eleven staff M-F travelling independently (Jobs for Launch 002)		110		110		110		110		110		22
Security staff	Two staff. One vehicle 7 days a week 2 shifts		28		28		28		28		28		4
Range staff	Three staff 7 days a week one shift travelling together (Jobs for Launch 002)				14		14		14		14		2
Emergency vehicles	One fire, one ambulance for 3 days (LV fuelling, static and launch) one day (PL fuelling)			4				12				3	
Mobile launch support vehicle	One vehicle for 5 days (eg RF/ tracking off site)							10				2	
Site visitors - launch	20 in 10 vehicles for 2 days								40				20
Site Visitors - commercial	One per week		2		2		2		2		2		2
Weekly movements total		6	168	12	294	10	294	28	334	8	266	11	70
	Notes (11):											Max Daily	Max Daily
1	Based on 4 week launch cycle + 1 week recovery												
2	Working week 7 days											0.5	2.9
3	Number of vehicle movements per week											Max Hourly	Max Hourly
4	**Vehicle to/from site = 2 movements (vehicle numbers = half total)**												
5	Event number as per SSC typical 30 day launch schedule												
6	All deliveries = HGV												
7	Excludes tourist visitors												
8	Excludes IT/Electrician/Maintenance/Fuelling crew/Met/Environmental as per Jobs for Launch 002												
9	Use SSC electric shuttle vehicles to move customers on/off site?												
10	Site deliveries may not follow launch cycle if concurrent launch cycles ie per calendar week for site												
11	LV RP-1 and He N2 deliveries may not follow launch cycle for commercial reasons												

Table 2 – Modelled Operational Phase Traffic Data

SUMMARY OF OPERATIONAL PHASE TRAFFIC DATA

Scenario: **WITH DEVELOPMENT**

Link	Street Name	Development	AADT	AADT LDV Flow	Hourly LDV Flow	LDV Speed (Kmh)	AADT HGV Flow	Hourly HGV Flow	HGV Speed (Kmh)	Canyon	Road / Canyon Width (m)	Canyon height (m)
B9087 Through Saxa Vord and Norwick												
1	B9087 from south of Saxa Vord to Village of Norwick	81	70	3	32.0	11	1.0	32.0	NO	5	N/A	
Holsens Road												
2	Single Lane Road from Norwick to Skaw through SSSI	81	70	3	24.0	11	1.0	24.0	NO	5	N/A	

Table 3 Summary of Predicted NO_2 Annual Mean Concentrations at Roadside Receptors with Proposed Development Operational Traffic

NO_2 CONCENTRATIONS

Receptor ID	Receptor Name	Without Scheme Concentration ($\mu g/m^3$)	With Scheme Concentration ($\mu g/m^3$)	Numerical Magnitude of change ($\mu g/m^3$)	% of change relative to AQS	Concentration as % of AQS	Impact Descriptor	
							Negligible/ Slight/ Moderate/ Substantial	Adverse/ Beneficial
1	SAXA VORD Resi	1.3	1.4	0.1	0.2%	3.5%	Negligible	-
2	NORWISK RESI	1.3	1.4	0.1	0.2%	3.5%	Negligible	-
3	NORWICK MEADOWS SSSI	1.3	1.3	0.1	0.2%	3.3%	Negligible	-

Table 4 NO_x to NO_2 Annual Mean Concentrations at Roadside Receptors with Proposed Development Operational Traffic

Local Authority:	Shetland Islands					Year:	2021	
						Traffic Mix:	All non-urban UK traffic	
Receptor ID	Easting,m	Northing, m	Road increment NO_x µg m^{-3}	Background µg m^{-3}		Fraction emitted as NO_2 (fNO2)	Total NO_2 µg m^{-3}	Road NO_2 µg m^{-3}
				NO_x	NO_2			
SAXA VORD	464493	1213474	0.102096	1.81	1.31		1.37	0.06
NORWISK RI	464988	1213954	0.114699	1.81	1.31		1.37	0.06
NORWICK MI	464634	1214095	0.125701	1.73	1.25		1.32	0.07

Table 5 Summary of Predicted PM_{10} Annual Mean Concentrations at Roadside Receptors with Proposed Development Operational Traffic

ITPENERGISED

PM_{10} CONCENTRATIONS

Receptor ID	Receptor Name	Without Scheme Concentration (µg/m^3)	With Scheme Concentration (µg/m^3)	Numerical Magnitude of change (µg/m^3)	% of change relative to AQS	Concentration as % of AQS	Impact Descriptor	
							Negligible/ Slight/ Moderate/ Substantial	Adverse/ Beneficial
1	SAXA VORD Resi	5.9	5.9	0.0	0.0%	33.0%	Negligible	-
2	NORWISK RESI	5.9	5.9	0.0	0.1%	33.1%	Negligible	-
3	NORWICK MEADOWS SSSI	5.6	5.6	0.0	0.0%	31.2%	Negligible	-

Table 6 Summary of Predicted $PM_{2.5}$ Annual Mean Concentrations at Roadside Receptors with Proposed Development Operational Traffic

ITPENERGISED

$PM_{2.5}$ CONCENTRATIONS

Receptor ID	Receptor Name	Without Scheme Concentration (µg/m^3)	With Scheme Concentration (µg/m^3)	Numerical Magnitude of change (µg/m^3)	% of change relative to AQS	Concentration as % of AQS	Impact Descriptor	
							Negligible/ Slight/ Moderate/ Substantial	Adverse/ Beneficial
1	SAXA VORD Resi	3.3	3.3	0.0	0.0%	33.1%	Negligible	-
2	NORWISK RESI	3.3	3.3	0.0	0.1%	33.2%	Negligible	-
3	NORWICK MEADOWS SSSI	3.2	3.2	0.0	0.1%	32.3%	Negligible	-

Table 7 Summary of Predicted NO_x Annual Mean Concentrations at Norwick Meadows SSSI with Proposed Development Operational Traffic

NOx CONCENTRATIONS

Receptor ID	Receptor Name	Without Scheme Concentration ($\mu g/m^3$)	With Scheme Concentration ($\mu g/m^3$)	Numerical Magnitude of change ($\mu g/m^3$)	% of change relative to AQS	Concentration as % of AQS	Impact Descriptor	
							Negligible/ Slight/ Moderate/ Substantial	Adverse/ Beneficial
3	NORWICK MEADOWS SSSI	1.81	1.94	0.07	0.2%	6.5%	Negligible	-

Impact at Receptors

The assessment of operational phase traffic emissions concludes that:

- The magnitude of change in concentration of each pollutant is significantly below 0.5 % of the relevant annual mean AQS at all receptors.
- The maximum predicted total concentration of NO_2 at a sensitive receptor is less than 4 % of the annual mean AQS.
- The maximum predicted concentration of PM_{10} at a sensitive receptor is less than 33 % of the annual mean AQS.
- The maximum predicted concentration of $PM_{2.5}$ at a sensitive receptor is less than 34 % of the annual mean AQS.
- There is no predicted risk of exceedance of the annual mean or short-term AQSs at any residential receptor due to the emissions from the forecast peak number of operational vehicles during a launch event.
- The magnitude of change in concentration of each NO_x is significantly below 0.2 % of the relevant annual mean AQS for the protection of vegetation and ecosystems.
- The maximum predicted annual mean NO_x concentration at the Norwick Meadows SSSI is less than 7 % of the annual mean AQS or critical level.
- There is no predicted risk of exceedance of the critical level threshold at a roadside ecological receptor.

Significance of Effect of Operational Phase Vehicle Emissions

The effect of operational phase vehicle emissions at all identified receptors is therefore predicted to be of **negligible** significance**.**

Appendix 7.2 Generators Assessment

Generator Data

Until a permanent three phase power supply is secured for the Proposed Project launch site, primary energy demands will be met through the use of diesel generators. The anticipated generator requirement comprises:

- Launch Site Processing Facility (LSPF) - two 275 kVA diesel generators (prime) to provide power requirements for the Administration/Gatehouse/Integration Building/Stores and external lighting.
- Integration Hangar – two 230 kVA diesel generators (prime) to supply the building/services requirements and lighting and small power to the Launch Pads.
- Water Deluge at Launch Pads – two 500 kVA diesel generators (standby) will supply the deluge pumps. These generators will run for a maximum of 30 minutes per launch event and short periods for regular maintenance/testing. The sets will be moved between launch pads as required.

A screening assessment of the potential impact from generator emissions was calculated using a "unit conversion and screening tool" (AEA, 2008) based on fuel use data provided in the manufacturer brochures for each proposed type (FG Wilson, 2020) and emissions factors for diesel-fuelled mobile combustion plant from the National Atmospheric Emissions Inventory (NAEI, 2020).

The estimated emissions for those running continuously in prime mode were calculated. The "planning tool" part of the assessment spreadsheet was used to determine a minimum stack height for each generator assuming it was positioned in close proximity to the building it served, such that, for the calculated emissions rates of NO_x and PM_{10} did not result in an exceedance of the relevant annual mean AQSs at any location. The P500-3 generators will only operate for 30 minutes per launch and therefore their contribution to annual mean concentration is considered to be negligible.

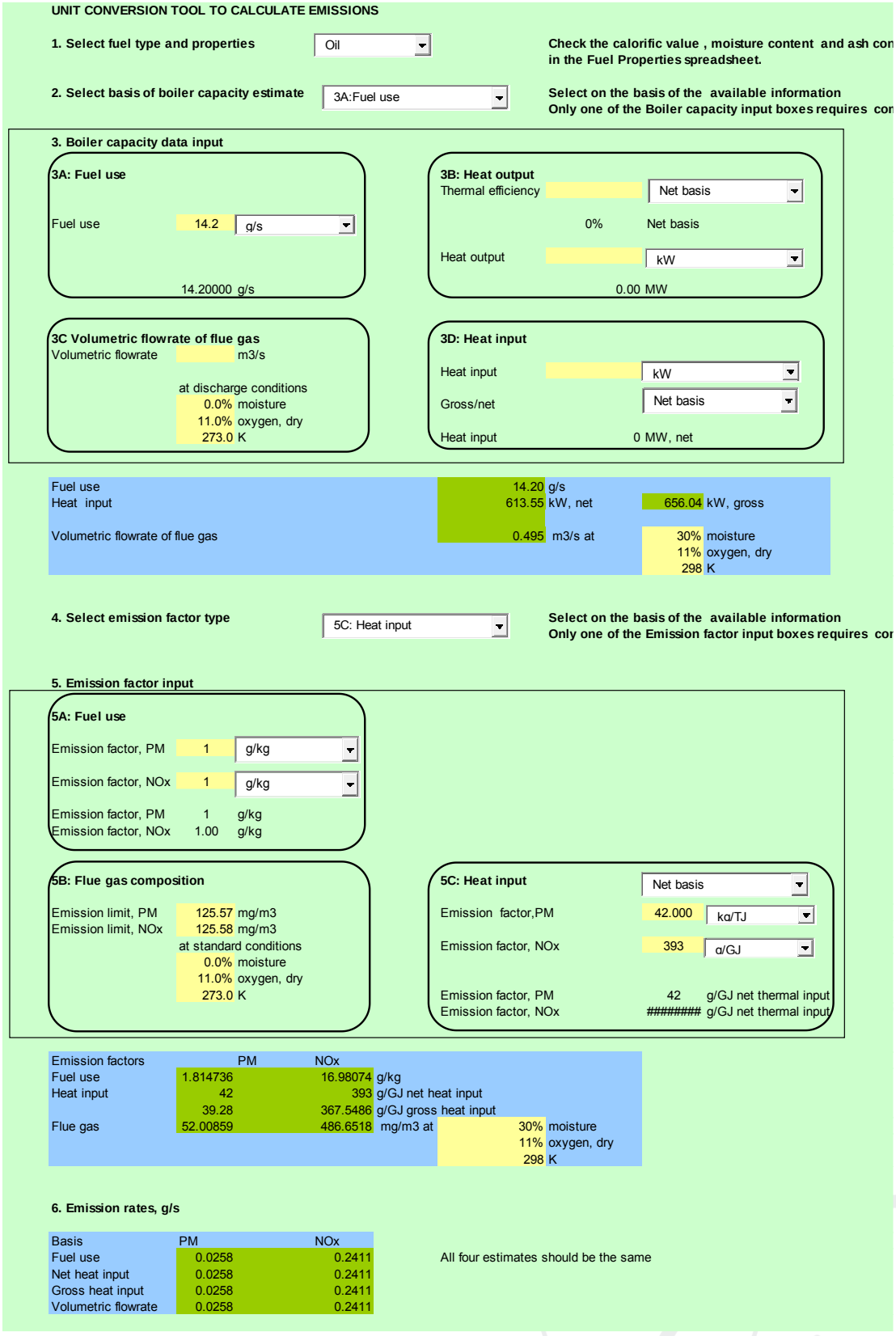
The proposed generators and emissions are summarised in Table 1.

Table 1 Generator Types, Power Ratings and Emissions

Site Location	Generator Type	Power Rating (Prime) (kVA)	Power Rating (Standby) (kVA)	Fuel Use (g/s)	Emission Factor for Diesel Combustion from NAEI (kg/TJ)		Estimated Emission Rate (g/s)	
					PM_{10}	NO_x	PM_{10}	NO_x
LSPF	2 No. FG Wilson P400-3	350	400	16.2	42.1	393	0.029	0.27
Integration Hangar	2 No. FG Wilson P300-4	275	300	14.2			0.026	0.24
Deluge	2 No. FG Wilson P500-3	-	500	21.6			0.04	0.36

The results are shown in Figures 1 and 2 for the P300 generator, and in Figures 3 and 4 for the P400 generator.

Figure 1 – Calculation of Emissions for the P300 Generator



UNIT CONVERSION TOOL TO CALCULATE EMISSIONS

1. Select fuel type and properties — Oil

Check the calorific value , moisture content and ash con
in the Fuel Properties spreadsheet.

2. Select basis of boiler capacity estimate — 3A:Fuel use

Select on the basis of the available information
Only one of the Boiler capacity input boxes requires cor

3. Boiler capacity data input

3A: Fuel use

Fuel use 14.2 g/s

14.20000 g/s

3B: Heat output

Thermal efficiency — Net basis

0% Net basis

Heat output — kW

0.00 MW

3C Volumetric flowrate of flue gas

Volumetric flowrate m3/s

at discharge conditions
0.0% moisture
11.0% oxygen, dry
273.0 K

3D: Heat input

Heat input — kW

Gross/net — Net basis

Heat input 0 MW, net

Fuel use	14.20	g/s	
Heat input	613.55	kW, net	656.04 kW, gross
Volumetric flowrate of flue gas	0.495	m3/s at	30% moisture 11% oxygen, dry 298 K

4. Select emission factor type — 5C: Heat input

Select on the basis of the available information
Only one of the Emission factor input boxes requires cor

5. Emission factor input

5A: Fuel use

Emission factor, PM 1 g/kg

Emission factor, NOx 1 g/kg

Emission factor, PM 1 g/kg
Emission factor, NOx 1.00 g/kg

5B: Flue gas composition

Emission limit, PM 125.57 mg/m3
Emission limit, NOx 125.58 mg/m3
at standard conditions
0.0% moisture
11.0% oxygen, dry
273.0 K

5C: Heat input — Net basis

Emission factor,PM 42.000 kg/TJ

Emission factor, NOx 393 g/GJ

Emission factor, PM 42 g/GJ net thermal input
Emission factor, NOx ######## g/GJ net thermal input

Emission factors	PM	NOx		
Fuel use	1.814736	16.98074	g/kg	
Heat input	42	393	g/GJ net heat input	
	39.28	367.5486	g/GJ gross heat input	
Flue gas	52.00859	486.6518	mg/m3 at	30% moisture 11% oxygen, dry 298 K

6. Emission rates, g/s

Basis	PM	NOx
Fuel use	0.0258	0.2411
Net heat input	0.0258	0.2411
Gross heat input	0.0258	0.2411
Volumetric flowrate	0.0258	0.2411

All four estimates should be the same

Figure 2 – Calculation of Minimum Stack Height for P300 to comply with Annual Mean AQS for NO_2

This spreadsheet provides a screening tool to calculate the contribution from stack emissions to maximum annual mean ground level concentrations

Enter required information in Cream Cells
Resulting ground level concentration in Red Bold

Proposed stack height: 8.5 m

List the buildings within a distance of 42.5 m of the chimney
Include any building to which the chimney is attached

Building	Height, m	Width, m	K	T
A	5	10	5	12.5
B				
C				
D				
E				
F				
G				

Calculated Effective stack height: 5.8 m

Proposed stack diameter: 0.3 m

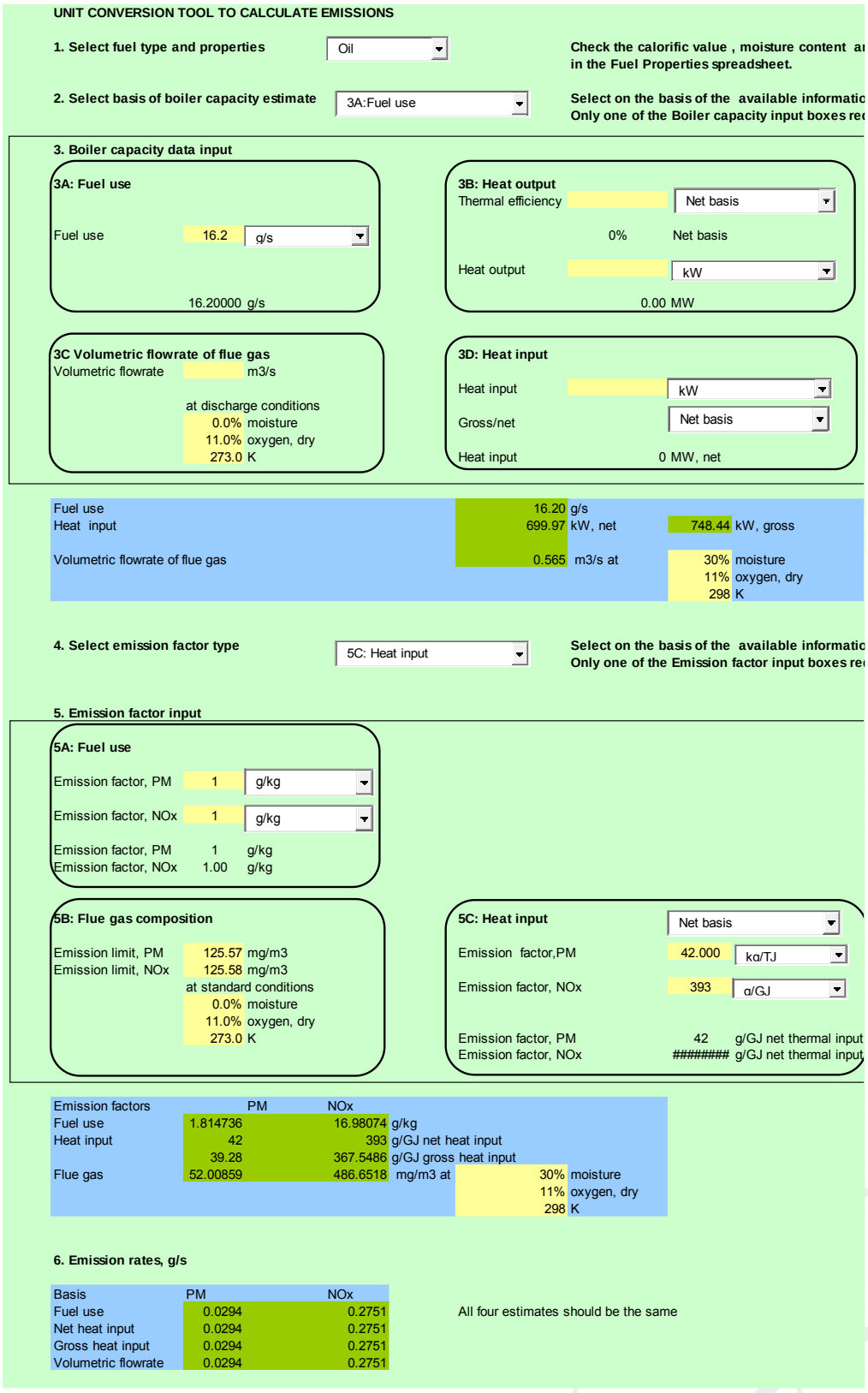
Location {Scotland, Rest of UK}: Scotland

Maximum emission rate: 0.24 g/s

Maximum contribution to annual mean

35.0151	µg m^{-3}	Biomass nomographs
#N/A	µg m^{-3}	Industrial nomographs

Figure 3 – Calculation of Emissions for the P400 Generator



UNIT CONVERSION TOOL TO CALCULATE EMISSIONS

1. Select fuel type and properties — Oil

Check the calorific value , moisture content ar
in the Fuel Properties spreadsheet.

2. Select basis of boiler capacity estimate — 3A:Fuel use

Select on the basis of the available informatic
Only one of the Boiler capacity input boxes re

3. Boiler capacity data input

3A: Fuel use

Fuel use 16.2 g/s

16.20000 g/s

3B: Heat output

Thermal efficiency — Net basis

0% Net basis

Heat output — kW

0.00 MW

3C Volumetric flowrate of flue gas

Volumetric flowrate m3/s

at discharge conditions
0.0% moisture
11.0% oxygen, dry
273.0 K

3D: Heat input

Heat input — kW

Gross/net — Net basis

Heat input 0 MW, net

Fuel use	16.20	g/s		
Heat input	699.97	kW, net	748.44	kW, gross
Volumetric flowrate of flue gas	0.565	m3/s at	30%	moisture
			11%	oxygen, dry
			298	K

4. Select emission factor type — 5C: Heat input

Select on the basis of the available informatic
Only one of the Emission factor input boxes re

5. Emission factor input

5A: Fuel use

Emission factor, PM 1 g/kg

Emission factor, NOx 1 g/kg

Emission factor, PM 1 g/kg
Emission factor, NOx 1.00 g/kg

5B: Flue gas composition

Emission limit, PM 125.57 mg/m3
Emission limit, NOx 125.58 mg/m3
at standard conditions
0.0% moisture
11.0% oxygen, dry
273.0 K

5C: Heat input

Net basis

Emission factor,PM 42.000 kg/TJ

Emission factor, NOx 393 g/GJ

Emission factor, PM 42 g/GJ net thermal input
Emission factor, NOx ######## g/GJ net thermal input

Emission factors	PM	NOx			
Fuel use	1.814736	16.98074	g/kg		
Heat input	42	393	g/GJ net heat input		
	39.28	367.5486	g/GJ gross heat input		
Flue gas	52.00859	486.6518	mg/m3 at	30%	moisture
				11%	oxygen, dry
				298	K

6. Emission rates, g/s

Basis	PM	NOx
Fuel use	0.0294	0.2751
Net heat input	0.0294	0.2751
Gross heat input	0.0294	0.2751
Volumetric flowrate	0.0294	0.2751

All four estimates should be the same

Figure 4 – Calculation of Minimum Stack Height for P400 to comply with Annual Mean AQS for NO_2

This spreadsheet provides a screening tool to calculate the contribution from stack emissions to maximum annual mean ground level concentrations

Enter required information in Cream Cells
Resulting ground level concentration in Red Bold

Proposed stack height: 9 m

List the buildings within a distance of 45.0 m of the chimney
Include any building to which the chimney is attached

Building	Height, m	Width, m	K	T
A	5	10	5	12.5
B				
C				
D				
E				
F				
G				

Calculated Effective stack height: 6.7 m

Proposed stack diameter: 0.3 m

Location {Scotland, Rest of UK}: Scotland

Maximum emission rate: 0.27 g/s

Maximum contribution to annual mean

34.542	µg m^{-3}	Biomass nomographs
#N/A	µg m^{-3}	Industrial nomographs

The estimated stack heights for the generators are estimated to be 8.5 m and 9 m respectively.

While the precise stack dimensions and exhaust gas conditions are not confirmed for the generators at this stage, it is likely that for stacks in this height range, the maximum ground level impact from generator emissions will occur within 100 m to 200 m from the sources.

All impacts will be within the boundary of the Launch Site and therefore, it is considered that the emissions at the closest sensitive receptor >900 m from the launch site buildings will be negligible.

The stack and generator position will be optimised at detailed design stage in order that the effective plume dispersion is achieved and building downwash effects are minimised.

Appendix 7.3 Launch Emissions Assessment

Scope of assessment

The scope of the assessment has included the following:

- Consultation with Shetland Islands Council to agree an appropriate method of assessment;
- Identification of study area and air quality sensitive receptors;
- Collection of baseline CO concentrations at the proposed development;
- Collection of emissions data from two candidate rockets from the manufacturers Large Mass Emission LV (up to 850 kg payload) and Small Mass Emission LV (up to 350 kg payload);
- Development of representative scenarios: Large Mass Emission LV from Launch Pad 3 and Large and Small Mass Emission LV from Launch Pad 1 (closest to receptors);
- Development of a time-dependant puff model (duration up to 30s) of a jet release using ADMS 5 in a range of meteorological conditions and wind directions in typical UK and Shetland-specific wind speeds;
- Development of a time-integrated dose model to predict total concentration at receptors during the lifetime of the puff release (calculated at 1-minute intervals) using ADMS 5 in a range of meteorological conditions and wind directions;
- Conversion of dose concentrations to 8-hour running mean concentrations and comparison with the AQS for CO;
- Contour maps and results tables demonstrating the puff concentration at 5-minute intervals after release for the worst case meteorological condition; and
- Report on findings.

Study Area and Air Quality Sensitive Receptors

The closest air quality sensitive receptors in each direction from Launch Pads 1 (in the west) and 3 (in the east) were identified, and a study area up to 4 km from each launch position identified to track the puff release until concentrations returned to ambient background levels under a range of meteorological conditions. The closest occupied sensitive receptor is Banks Cottage at Norwick which is 1840 m from Launch Pad 1 and 2470 m from Launch Pad 3. This is shown as R1 on Drawing 7.2.

Method of Assessment

Consultation with Shetland Islands Council

A Shetlands Islands Council Environmental Health officer was consulted on the proposed scope and approach of the air quality assessment. Confirmation that the approach for the modelling of launch events was appropriate was received from a Senior Environmental Health Officer on 26th June 2020.

Baseline CO Concentrations

There are no local monitoring stations measuring background concentrations of CO in the Shetland Islands. The background concentration of CO for the study area was therefore downloaded from the Defra background concentration maps (Defra, 2020) for Shetland based on 1km x 1km grid square values. The maximum background concentration of 0.05 mg/m^3 from the grid squares covering a 25 km^2 study area around the proposed development (NGR 462500,1211500-NGR 467500, 1216500) was used as a representative value for all receptors in the assessment.

Launch Event Scenarios

The Proposed Project includes three launch pads, available for use by multiple launch service providers (LSPs) using a range of different launch vehicle (LV) types. The proposed Launch Pads are designed to accommodate LVs between 13 m and 30 m in height. There is also potential for sub-orbital or sounding rocket launches. These LVs are much smaller, ranging from about 1.5 m to 8 m in height.

Launches will take place in a northerly direction over the sea. Launch events will not occur simultaneously from more than one Launch Pad.

The Applicant is looking to achieve a maximum of 30 launches per year; however, in the first year it is anticipated that there will be up to 10 launches, made up of both orbital and sub-orbital LVs.

Only the largest mass emission LV (approximately 30 m in height and up to 850 kg payload) will launch from Launch Pad 3. All candidate LVs will potentially be launched from Launch Pad 1 (closest to receptor) or Launch Pad 2.

Rockets generally use a mixture of RP-1 (a highly refined form of kerosene similar to jet fuel) and liquid oxygen (LOX) to fuel the first stage. The majority of emissions from burning RP-1 and LOX are nitrogen gas and oxygen gas, alongside much smaller quantities of carbon dioxide (CO_2) and CO. Trace amounts of other NAQS pollutants, such as Volatile organic compounds (VOCs), oxides of nitrogen (NO_x), oxides of sulphur (SO_x) and particulate matter (PM_{10}) could be released, but the total amount of any given release would be negligible per event and recorded as zero.

Launch event greenhouse gas emissions (including CO_2) are quantified in Chapter 11.

The only pollutant that requires assessment with respect to air quality for potential effects on human health is CO.

There are no airborne pollutants considered likely to have any significant adverse effects on important local ecology.

In order to determine worst case launch event effects at sensitive receptors, as agreed with Shetland Island Council, this assessment considers the following two scenarios:

- Large Mass Emission LV (approximately 30 m in height and up to 850 kg payload) launching from Launch Pad 3; and
- Large (as above) and Small Mass Emission LV (approximately 13 m height and up to 350 kg payload) launching from Launch Pad 1.

Effects from launch events taking place at Launch Pad 2 are considered to be represented effectively through the Launch Pad 1 scenario. In reality, effects from launch events at Launch Pad 2 will be lower as the launch event will occur at greater distance from any given receptor.

The Civil Aviation Authority (CAA) guidance document CAP1616 “Airspace Change – Guidance on the regulatory process for changing the notified airspace design and planned and permanent redistribution of air traffic, and on providing airspace information”, states that assessment of emissions on local air quality is required for any airspace change less than 1000 feet in altitude. It is therefore only necessary for the AQIA to consider emissions from LVs during Stage 1 as subsequent stages occur at significantly higher altitudes. This has been estimated to take a maximum of 30 seconds dependent on LV type.

Depending on LV type, the period taken to reach an altitude of 1000 ft is between 21 to 30 seconds, according to LV manufacturer data. As a conservative assessment and to consider potential maximum exposure for receptors, it has been assumed that the total emissions are all released at ground level via the flame deflector chute and the puff “tracked” as it moves downwind after the maximum emission period of 30 seconds.

Emissions Data

The emissions data for each launch were confirmed by the rocket manufacturer engineering teams and are summarised in Table 1. Any assumptions are highlighted where specific data were not available due to confidentiality agreements.

Table 1 Rocket Emissions per launch (Stage 1 only)

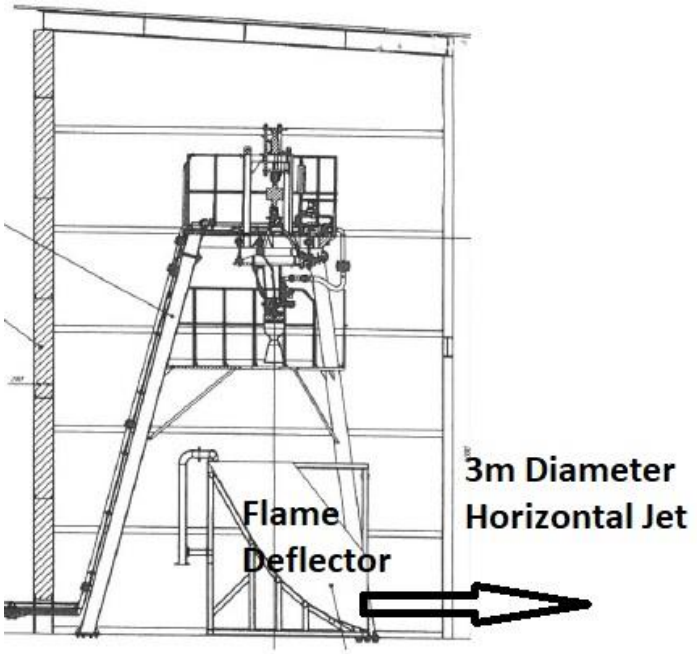
Parameter	Large Mass Emission LV (up to 850 kg Payload)	Small Mass Emission LV (up to 350kg Payload)
Temperature (◦K)	1858	1450
Exit Diameter of Nozzles (m)	1.12	0.276
Exit diameter of flame deflector (m)	3	3
Exhaust gas density (kg/m^3)	0.696	0.9
Mass of gas emitted per Stage 1 launch (kg)	4912	400
Mass of CO emitted per Stage 1 launch (kg)	90	15.5
Ignition to 1000 ft altitude (seconds)	21.5 (rounded to 22)	30
Volume of gas emitted in Stage 1 launch (m^3)	70575	444.44
Volume Flow Rate (m^3/s)	320.8	14.81
Emissions Area (m^2)	7.065	7.065
Jet Velocity at flame deflector (m/s)	454	2.1

Modelling Assumptions

The launch rig has a flame deflector underneath the LV exhaust jet which will direct the jet from the vertical to the horizontal plane. The width of the flame detector chute is 3m. ADMS 5 has been used to model a horizontal jet release based at ground level with a diameter equivalent to the width of the flame deflector. The height of the centre of the jet release is the therefore 1.5m above ground level. The duration of the release is 22 or 30 seconds, depending on the rocket, with the exhaust gas volume flow rate, temperature and mass emissions of CO as specified in Table 1.

A diagram of the test rig demonstrating the assumed model setup is shown in Figure 1. The direction of the jet from the facility is northerly for Launch Pad 1 and north-easterly for Launch Pad 3.

Figure 1 Schematic of Launch Rig



Meteorological Conditions used in the Assessment

It is not possible to predict exact meteorological conditions of future launch events. As such, the ADMS 5 puff model has been run for a set of seven different meteorological conditions that roughly correspond to seven atmospheric stability classes known as Pasquill-Gifford Stability Classes A-G.

Stability is the tendency of the atmosphere to resist or enhance vertical motion and thus turbulence and potential dispersion of pollutants released within it. Stability is related to both the change of temperature with height (influenced by cloud cover and solar radiation) and mechanical friction influenced by the wind speed together with surface characteristics (roughness). The stability class conditions range from very convective (turbulent) conditions with a high surface solar heat flux, low winds and cloudless skies, (A), through to neutral conditions which are prevailing for approximately 40-50% of the time in the UK with moderate wind speeds and partially cloudy skies, (D), to very stable (calm) conditions with low temperatures and low wind speeds typically associated with nightime or winter conditions (G).

It is recognised that the wind speeds on Unst can be considerably higher than the average UK conditions, therefore a detailed analysis of meteorological data from Baltisound Airport in Unst from 2015-2019 has been undertaken in order to determine the average wind speed in each of eight compass directions and the prevailing wind speed across all directions locally. This is summarised in Table 2. The wind roses for each year are shown in Drawing 7.3.

Table 2 Analysis of Baltisound Wind Speed and Direction 2015-2019

Wind Direction (sector °)	Humber of Hours per annum	Percentage of hours per annum	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)	Minimum Wind Speed (m/s)
2015					
North (337.5-22.5°)	675	7.7 %	6.8	16.5	0.0
North-East (22.5-67.5°)	313	3.6 %	5.6	14.4	0.5

Wind Direction (sector °)	Humber of Hours per annum	Percentage of hours per annum	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)	Minimum Wind Speed (m/s)
East (67.5-112.5°)	441	5.0 %	5.7	14.4	0.5
South-East (112.5-157.5°)	961	11.0 %	7.9	21.6	0.5
South (157.5-202.5°)	1765	20.1 %	7.7	20.6	0.5
South-West (202.5-247.5°)	1578	18.0 %	7.3	23.7	0.5
West (247.5-292.5°)	2022	23.1 %	8.5	26.8	0.5
North-West (292.5-337.5°)	969	11.1 %	6.8	24.7	0.5
Missing	36	0.4 %			
Total	675	7.7 %			
2016					
North (337.5-22.5°)	946	10.8 %	6.1	16.5	0.0
North-East (22.5-67.5°)	780	8.9 %	6.7	17.5	0.5
East (67.5-112.5°)	719	8.2 %	5.7	17.0	0.5
South-East (112.5-157.5°)	841	9.6 %	7.2	19.1	0.5
South (157.5-202.5°)	1682	19.1 %	7.4	19.1	0.5
South-West (202.5-247.5°)	1216	13.8 %	6.5	29.4	0.5
West (247.5-292.5°)	1612	18.4 %	7.1	29.4	0.5
North-West (292.5-337.5°)	926	10.5 %	6.5	22.7	0.5
Missing	62	0.7 %			
Total					
2017					
North (337.5-22.5°)	835	9.5 %	6.8	21.1	0.0
North-East (22.5-67.5°)	514	5.9 %	6.3	17.0	0.5
East (67.5-112.5°)	597	6.8 %	5.5	18.6	0.5

Wind Direction (sector °)	Humber of Hours per annum	Percentage of hours per annum	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)	Minimum Wind Speed (m/s)
South-East (112.5-157.5°)	1332	15.2 %	7.6	17.5	0.5
South (157.5-202.5°)	1029	11.7 %	6.8	15.5	0.5
South-West (202.5-247.5°)	1711	19.5 %	8.5	21.1	0.5
West (247.5-292.5°)	1174	13.4 %	8.0	26.3	0.5
North-West (292.5-337.5°)	424	4.8 %	6.8	21.1	0.0
Missing	835	9.5 %			
Total	514	5.9 %			
2018					
North (337.5-22.5°)	561	6.4 %	4.7	14.9	0.0
North-East (22.5-67.5°)	545	6.2 %	5.7	12.4	0.5
East (67.5-112.5°)	626	7.1 %	5.3	14.9	0.5
South-East (112.5-157.5°)	1136	13.0 %	8.7	23.2	0.5
South (157.5-202.5°)	1989	22.7 %	7.7	21.1	0.5
South-West (202.5-247.5°)	1188	13.6 %	6.5	20.1	0.5
West (247.5-292.5°)	1476	16.8 %	7.4	22.7	0.5
North-West (292.5-337.5°)	697	8.0 %	6.4	20.6	0.5
Missing	542	6.2 %			
Total	561	6.4 %			
2019					
North (337.5-22.5°)	955	10.9 %	6.6	16.0	0.0
North-East (22.5-67.5°)	761	8.7 %	6.9	16.5	0.5
East (67.5-112.5°)	761	8.7 %	5.7	15.5	0.5
South-East (112.5-157.5°)	1244	14.2 %	7.0	16.0	0.5

Wind Direction (sector °)	Humber of Hours per annum	Percentage of hours per annum	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)	Minimum Wind Speed (m/s)
South (157.5-202.5°)	1553	17.7 %	6.9	18.6	0.5
South-West (202.5-247.5°)	1127	12.9 %	6.6	19.1	0.5
West (247.5-292.5°)	1350	15.4 %	6.9	20.6	0.5
North-West (292.5-337.5°)	1005	11.5 %	6.0	21.1	0.5
Missing	4	0.0 %			
Total	955	10.9 %			
	Average Wind Speed 2015-2019 (m/s)				
North (337.5-22.5°)	6.2				
North-East (22.5-67.5°)	6.3				
East (67.5-112.5°)	5.6				
South-East (112.5-157.5°)	7.8				
South (157.5-202.5°)	7.5				
South-West (202.5-247.5°)	6.8				
West (247.5-292.5°)	7.7				
North-West (292.5-337.5°)	6.7				

The number of hours that the wind speed was greater than 5 m/s was between 54 % and 73 % of each year.

The prevailing wind direction is from the south to the west, and Unst wind speeds are higher than UK averages, therefore the emissions from any launch event will most likely be directed out towards the sea, rapidly dispersed and pose no risk to any onshore sensitive receptors, however the potential effects at the closest onshore receptor have been assessed in all meteorological conditions.

The jet has a specific direction (north for Launch Pad 1 and north-west for Launch Pad 3), therefore the wind direction will have an impact on the predicted downwind concentrations. The stability A-G meteorological file has therefore been used for each of the eight main 45° compass sectors in order to model the dispersion of the jet puff release in a range of meteorological conditions and determine the worst case impact at the nearest sensitive receptor R1.

The meteorological conditions used in the modelling assessment for each wind direction in Table 2 are summarised for the UK and Unst Average wind speeds in Table 3.

Table 3 Modelled Meteorological Conditions for Eight Compass Wind Directions

Stability Class	UK Average Wind Speed (m/s)	Unst Average Wind Speed (m/s)	Surface Solar Heat Flux (W/m^2)	Atmospheric Boundary Layer Height (m)
A	1	0° = 6.2 45° = 6.3 90° = 5.6 135° = 7.8 180° = 7.5 225° = 6.8 270° = 7.7 315° = 6.7	113	1300
B	2		84	900
C	5		74	850
D	5		0	800
E	3		-10	400
F	2		-6	100
G	1		-6	100

Because the jet has a specific direction (north for Launch Pad 1 and north-west for Launch Pad 3), the wind direction has an impact on the predicted downwind concentration. The r91A-G.met file has therefore been used for each of the eight main 45° compass sectors in order to model the dispersion of the jet puff release in a range of meteorological conditions and determine the worst-case impact at the nearest sensitive receptor.

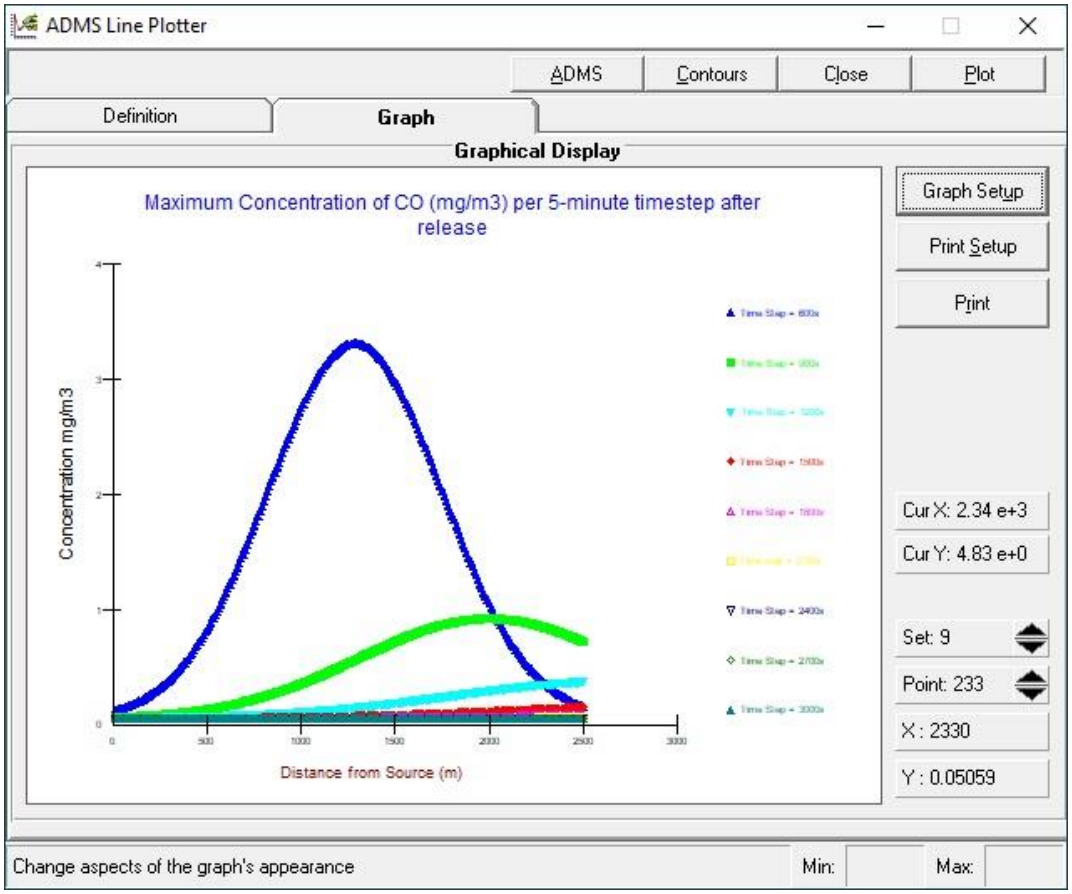
Results

Dose and 8-hour Average Results

The closest identified receptor to either launch pad is Banks Cottage at Norwick which is 1840 m from Launch Pad 1 and 2330 m from Launch Pad 3. This is shown as R1 in Drawing 7.2. The total dose due to emissions from either launch event was calculated at R1 for the seven stability classes (A-G) and eight wind directions in both UK and Unst average wind speeds.

For the Launch Pad 3 event, the maximum period when the CO concentration was detectible above background levels at receptor R1 is 40 minutes in Stability Class B conditions. This is shown in Figure 2 where the concentration at 2330 m downwind of the launch site is first above the background concentration of 0.05 mg/m^3 at 600 s (ten-minutes) after the release and returned to the background concentration value at 3000 s (50 minutes).

Figure 2 Timestep Concentrations after Release of the Large Mass Emission Rocket from Launch Pad 3



Over one hour, the total concentration was the dose concentration plus existing background for 40 minutes (two-thirds of the hour) and then concentrations reverted to the background concentration 0.05 mg/m^3 for 20 minutes (one-third of the hour). The hourly mean was therefore calculated from the following equation:

Hourly average = ((total dose concentration + 0.05)x 0.66) + (0.05 x 0.33))

For the small mass emission Launch Pad 1 event, the maximum period when the CO concentration is detectible above background levels at receptor R1 is 30 minutes in Stability Class B conditions. This is shown in Figure 3 where the concentration at 1840 m downwind of the launch site is first above the background concentration of 0.05 mg/m^3 at 600 s (ten-minutes) after the release and returned to the background concentration value at 2400 s (40 minutes).

In one hour, the concentration was the dose concentration plus existing background for 30 minutes (half of the hour) and reverted to the background concentration 0.05 mg/m^3 for 30 minutes (half of the hour). The hourly mean was therefore calculated from the following equation:

Hourly average = ((total dose concentration + 0.05) x 0.5) + (0.05 x 0.5))

For the large mass emission Launch Pad 1 event, the maximum period when the CO concentration is detectible above background levels at receptor R1 is 47 minutes in Stability Class B conditions. This is shown in Figure 4 where the concentration at 1840 m downwind of the launch site is first above the background concentration of 0.05 mg/m^3 at 420 s (seven-minutes) after the release and returned to the background concentration value at 3240 s (54 minutes).

In one hour, the concentration was the dose concentration plus existing background for 47 minutes (78% of the hour) and the background concentration of 0.05 mg/m^3 for 13 minutes (22% of the hour). The hourly mean was therefore calculated from the following equation:

Hourly average = ((total dose concentration + 0.05) x 0.78) + (0.05 x 0.22))

Figure 3 Timestep Concentrations after Release of the Small Mass Emission Rocket from Launch Pad 1

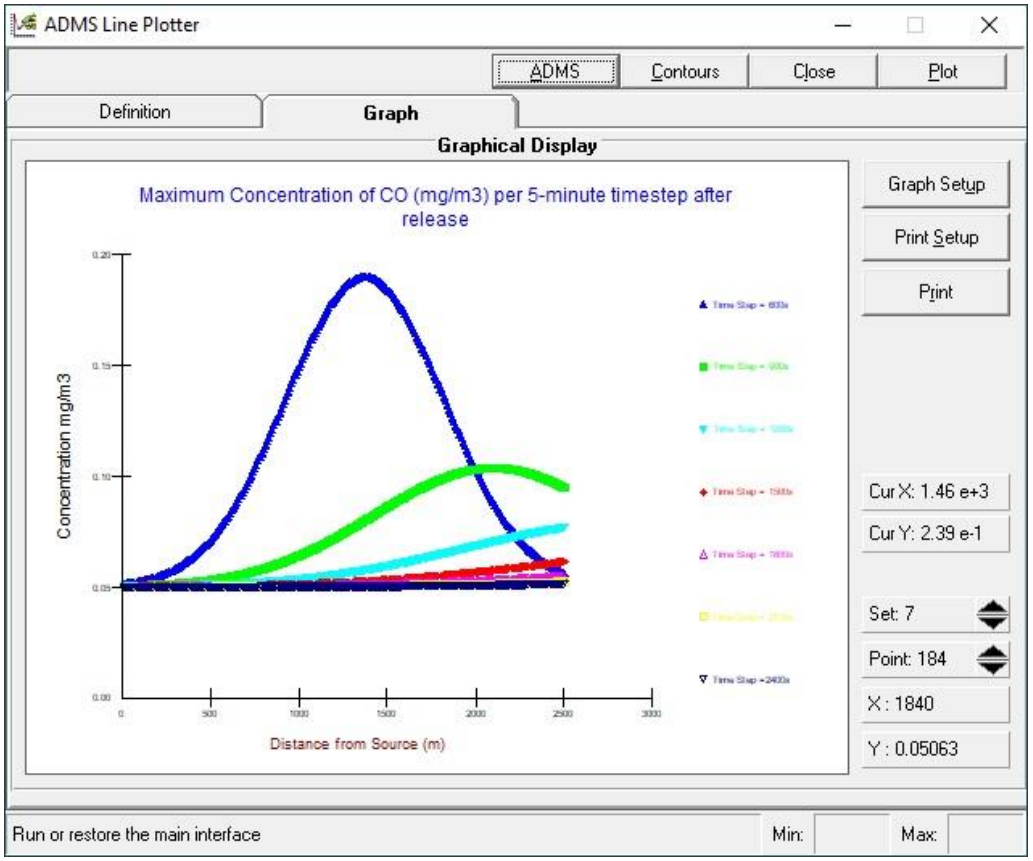
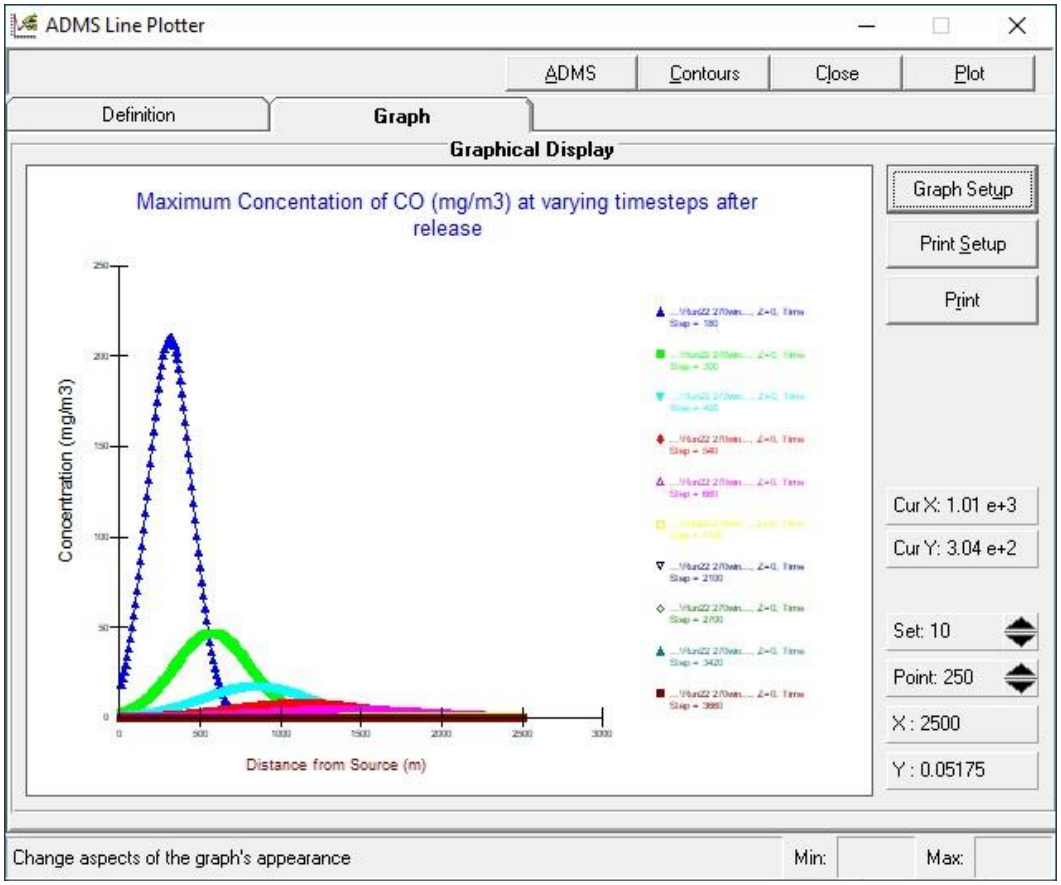


Figure 4 Timestep Concentrations after Release of the Large Mass Emission Rocket from Launch Pad 1



To calculate the running 8-hour average, the concentration will be as background for the seven hours before release. Therefore, the maximum 8 hour average can be calculated from the following equation:

8-Hour average = (hourly average + (7 x 0.05)/8)

There will be no more than one test in any 24-hour period so the maximum 8-hour running mean can only be as above.

The results for the large mass emission LV from Launch Pad 3 are summarised in Table 4. The results for the large mass emission LV and small mass emission LV from Launch Pad 1 are summarised in Tables 5 and 6 respectively.

Table 4 Calculated Dose and 8-Hour Average CO Concentrations at Receptor R1 – Large Mass Emission LV from Launch Pad 3

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Maximum Dose at R1 (mg.s/m^3) Unst average	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
Wind = 0 NORTH						
A	0.0003	0	0.05	0.05	0.05	0.50%

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Maximum Dose at R1 (mg.s/m^3) Unst average	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 45 NORTH EAST						
A	11.0	0.048	0.05	7.31	0.96	9.58%
B	2.4	0.002	0.05	1.62	0.25	2.46%
C	0.009	0.001	0.05	0.06	0.05	0.51%
D	0.0001	0	0.05	0.05	0.05	0.50%
E	0.0011	0	0.05	0.05	0.05	0.50%
F	0.009	0	0.05	0.06	0.05	0.51%
G	0.58	0	0.05	0.43	0.10	0.98%
Wind = 90 EAST						
A	9.4	0.084	0.05	6.25	0.83	8.25%
B	1.2	0.004	0.05	0.85	0.15	1.50%
C	0.008	0.002	0.05	0.06	0.05	0.51%
D	0.0001	0.0001	0.05	0.05	0.05	0.50%
E	0.001	0	0.05	0.05	0.05	0.50%
F	0.003	0	0.05	0.05	0.05	0.50%
G	0.2	0	0.05	0.19	0.07	0.67%
Wind = 135 SOUTH EAST						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 180 SOUTH						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Maximum Dose at R1 (mg.s/m^3) Unst average	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 225 SOUTH WEST						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 270 WEST						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 315 NORTH WEST						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%

Table 5 Calculated Dose and 8-Hour Average CO Concentrations at Receptor R1 – Large Mass Emission LV from Launch Pad 1

Stability Class	Maximum Dose at R1 ($mg.s/m^3$) UK average	Maximum Dose at R1 ($mg.s/m^3$) Unst average	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
Wind = 0 NORTH						
A	0.52	0	0.05	0.45	0.10	1.01%
B	0.0004	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 45 NORTH EAST						
A	13.73	2.89	0.05	10.76	1.39	13.89%
B	3.79	0.62	0.05	3.01	0.42	4.20%
C	0.10	0.38	0.05	0.13	0.06	0.60%
D	0.09	0.25	0.05	0.12	0.06	0.59%
E	0.35	0.14	0.05	0.32	0.08	0.84%
F	2.73	0.00	0.05	2.18	0.32	3.16%
G	4.01	0.00	0.05	3.18	0.44	4.41%
Wind = 90 EAST						
A	9.40	0.0020	0.05	7.38	0.97	9.66%
B	1.21	0.0004	0.05	0.99	0.17	1.68%
C	0.01	0.0001	0.05	0.06	0.05	0.51%
D	0.00	0.0000	0.05	0.05	0.05	0.50%
E	0.00	0.0000	0.05	0.05	0.05	0.50%
F	0.00	0.0000	0.05	0.05	0.05	0.50%
G	0.21	0.0004	0.05	0.22	0.07	0.71%
Wind = 135 SOUTH EAST						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Maximum Dose at R1 (mg.s/m^3) Unst average	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
G	0	0	0.05	0.05	0.05	0.50%
Wind = 180 SOUTH						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 225 SOUTH WEST						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 270 WEST						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 315 NORTH WEST						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%

Table 6 Calculated Dose and 8-Hour Average CO Concentrations at Receptor R1 – Small Mass Emission LV from Launch Pad 1

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Maximum Dose at R1 (mg.s/m^3) Unst average	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
Wind = 0 NORTH						
A	1.91	0	0.05	1.01	0.17	1.69%
B	0.0001	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 45 NORTH EAST						
A	32.1	29.3	0.05	16.09	2.06	20.56%
B	44.3	28.9	0.05	22.18	2.82	28.17%
C	31.7	28.7	0.05	15.88	2.03	20.28%
D	19.5	18.5	0.05	9.81	1.27	12.70%
E	31.5	11.8	0.05	15.79	2.02	20.17%
F	11.5	2.4	0.05	5.81	0.77	7.70%
G	1.9	2.7	0.05	1.01	0.17	1.70%
Wind = 90 EAST						
A	20.4	0.2	0.05	10.26	1.33	13.27%
B	5.5	0.04	0.05	2.81	0.40	3.95%
C	0.05	0.025	0.05	0.08	0.05	0.53%
D	0.0001	0.0001	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0.0002	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 135 SOUTH EAST						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Maximum Dose at R1 (mg.s/m^3) Unst average	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
G	0	0	0.05	0.05	0.05	0.50%
Wind = 180 SOUTH						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 225 SOUTH WEST						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 270 WEST						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%
Wind = 315 NORTH WEST						
A	0	0	0.05	0.05	0.05	0.50%
B	0	0	0.05	0.05	0.05	0.50%
C	0	0	0.05	0.05	0.05	0.50%
D	0	0	0.05	0.05	0.05	0.50%
E	0	0	0.05	0.05	0.05	0.50%
F	0	0	0.05	0.05	0.05	0.50%
G	0	0	0.05	0.05	0.05	0.50%

For each Scenario, the maximum predicted dose is due to the UK average meteorological data for stability classes A-G. The higher modelled average wind speeds on Unst dilute and disperse the release more rapidly and it is possible for launch events to occur in higher wind speeds than have been modelled. The calculated 8-hour average concentrations for comparison with the AQS are therefore conservative worse-case results.

The maximum predicted concentrations at R1 occurred during the Small Mass Emission LV from Launch Pad 1 scenario due to a lower exhaust gas exit velocity than the Large Mass Emission LV which resulted in reduced momentum and rate of dispersion of the modelled release.

The maximum predicted dose at R1 is 44.2 mg/m^3 CO over 30 minutes. This is equivalent to a concentration dose of 38.5 parts per million (ppm). There are no health effects of this level of exposure to CO over periods of 30 minutes. A person would have to be exposed to this dose for six to eight hours of constant exposure to experience headache or dizziness (Goldstein, 2008). For a health effect to arise from 30 – 40 minutes of exposure, the dose would need to be of the order of 800 ppm to 1600 ppm.

The maximum predicted 8-hour concentration at R1 is 2.82 mg/m^3, 28 % of the AQS, when modelled using UK average convective (Stability B) meteorological conditions with wind from the north east (45°). This reduced to <19% of the AQS when average Unst wind speed conditions were modelled for this direction.

On analysis of the meteorological data, a north east (45°) wind only occurs for approximately 9 % of the year on Unst. Drawings 11.5 to 11.9 show the concentration contour plots of the puff as it moves downwind in ten minute timesteps from after the start of the release for the worst case launch event. The concentration scale demonstrates how quickly the puff dilutes and disperses after release, with no concentrations above background levels from 40 minutes after release. The predicted peak concentration after release is only 0.25 mg/m^3 above ordinary background levels and so significantly below the AQS.

Summary

The assessment has considered ambient CO concentrations at the closest residential receptor to the proposed Launch Site, R1, at 5 minute intervals after release.

The modelling identified that the downwind concentration was slightly detectible above background levels following launch for a period of up to 40 minutes from Launch Pad 3, and 47 minutes from Launch Pad 1. After this time, concentrations reverted to background levels.

The maximum predicted concentrations at R1 occurred during the Small Mass Emission LV from Launch Pad 1 scenario. The maximum predicted dose at R1 is 44.2 mg/m^3 CO over 30 minutes. This is equivalent to a concentration dose of 38.5 parts per million (ppm). There are no health effects of this level of exposure to CO over periods of 30 minutes. A person would have to be exposed to this dose for six to eight hours of constant exposure to experience headache or dizziness (Goldstein, 2008). For a health effect to arise from 30 – 40 minutes of exposure, the dose would need to be of the order of 800 ppm to 1600 ppm.

Dispersion of the jet-puff was assessed across a range of representative atmospheric conditions, to ensure all potential meteorological conditions were considered. The maximum concentrations at the closest sensitive receptor were determined and a time-averaged concentration determined over the 8-hour period equivalent to the relevant AQS for CO.

The maximum predicted 8-hour concentration at R1 is 2.82 mg/m^3, 28 % of the AQS, when modelled using UK average convective meteorological conditions with wind from the north east (45°), reducing to 19% of the AQS when modelled with Unst average wind speeds.

On analysis of the meteorological data, a north east (45°) wind only occurs for approximately 9 % of the year on Unst. There is therefore a high probability that launch events will take place under

the local prevailing wind condition which, over the period 2015-2019, was southerly to westerly. Under prevailing conditions, there is no detectible impact at the closest receptor R1.

The assessment has demonstrated that there is no risk of exceedance of the 8-hour AQO for CO at any sensitive receptor in the vicinity of the proposed development irrespective of the prevailing weather conditions during a launch event and there are no health effects associated with the maximum predicted exposure over 30 – 40 minutes.