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PRODUCTION 55

STATUS, EXTENTS, DEVELOPMENT IMPACTS AND MITIGATION FOR KEY VEGETATION TYPES AND RARE SPECIES AT MENIE

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1.0 INTRODUCTION

This document updates information on the habitat and rare species baseline for the Menie survey area. It discusses the accuracy of site information and hence the quality of baseline information, including reference to earlier survey information for the site. It updates the baseline and a 2008 version of a site habitat map is included. It is focussed on the seaward side of the development area, where two links golf courses are proposed for development.

The revised baseline is used in a comparison with earlier NVC surveys to consider the condition of site habitats, with emphasis on Foveran Links SSSI. The baseline is then used to review the importance of site biodiversity and nature conservation interest.

Updated comment is made upon the direct and indirect effects of the proposed development. An outline of mitigation proposals for the first golf course is included here. This subsumes material to be presented in Production 56 which is not being submitted to the Inquiry.

The findings reported here will support the Precognition Statement of the author, as a witness for the Applicant.

2.0 THE HABITAT SURVEY DOMAIN AND ITS COMPONENTS

The development area is shown in Figure 1. All of this area was surveyed in 2006 using a combination of the Joint Nature Conservation Committee (JNCC) Phase 1 Habitat Survey system and the National Vegetation Classification (NVC) (Rodwell 2006, Document 42).

Since golf development is proposed as links courses which are located entirely on blown sand, data here are summarised for the wind blown sand area alone. There is little reference here to land on higher ground inland at Menie. This allows a clearer analysis of golf development impacts on the dune system when compared to results in earlier submissions (2007 ES and Response to Aberdeenshire Council & Statutory Consultations). It also allows easier comparison with earlier surveys which concentrated on the dune environment.

The seaward survey limit is Mean High Water Springs (MHWS). The inner limit of blown sand has not been surveyed in detail but was estimated in a 1999 NVC dune survey of the East Coast of Scotland (Dargie 2001, Document 36). That 1999 boundary is used here to delimit the wind blown sand area, also called the links zone. It is shown in Figure 1 and has an area of 263.1 ha.

The links zone can be divided into three sub-sectors:

- Menie Estate ground within Foveran Links Site of Special Scientific Interest (SSSI). The SSSI has a total area of 202.8 ha. SSSI habitats above MHWS totalled 154.7 ha in a 1990 NVC survey (digitised data of the author from a paper map in Doarks, Holder & Radley 1992, Document 23). Habitats on Menie Estate ground, surveyed mainly in 2006, total 67.3 ha (Document 4). Menie Estate habitats therefore make up 43.5% of the SSSI supratidal habitat resource. The SSSI boundary and overlap with Menie Estate are shown in Figure 1.
- Menie Estate ground within Foveran Botanical Site of Interest to Natural Science (SINS). The SINS has a total area of 315.2 ha. Menie Estate habitats (2006 survey) make up 85.4 ha (27.1%) of SINS extent (Document 4). The SINS extent overlaps much of Foveran Links SSSI but extends further south and west on Menie Estate, except for one small sector of the SSSI. The larger SINS area for Menie has a net difference of 18.1 ha of habitat compared to the SSSI sector. The SINS boundary is shown in Figure 1.
- Remaining Menie Estate ground on wind-blown sand, i.e. outside land protected by either or both of SSSI and SINS. This totals 176.5 ha and is approximately double the habitat area which is SSSI-SINS in the north (86.6 ha).

Separation of the Menie links zone into the above components is important. It allows the habitat character of the SSSI and SINS areas to be examined separately, as two types of ground designated for nature conservation interest, as well as the larger extent of unprotected land further south.

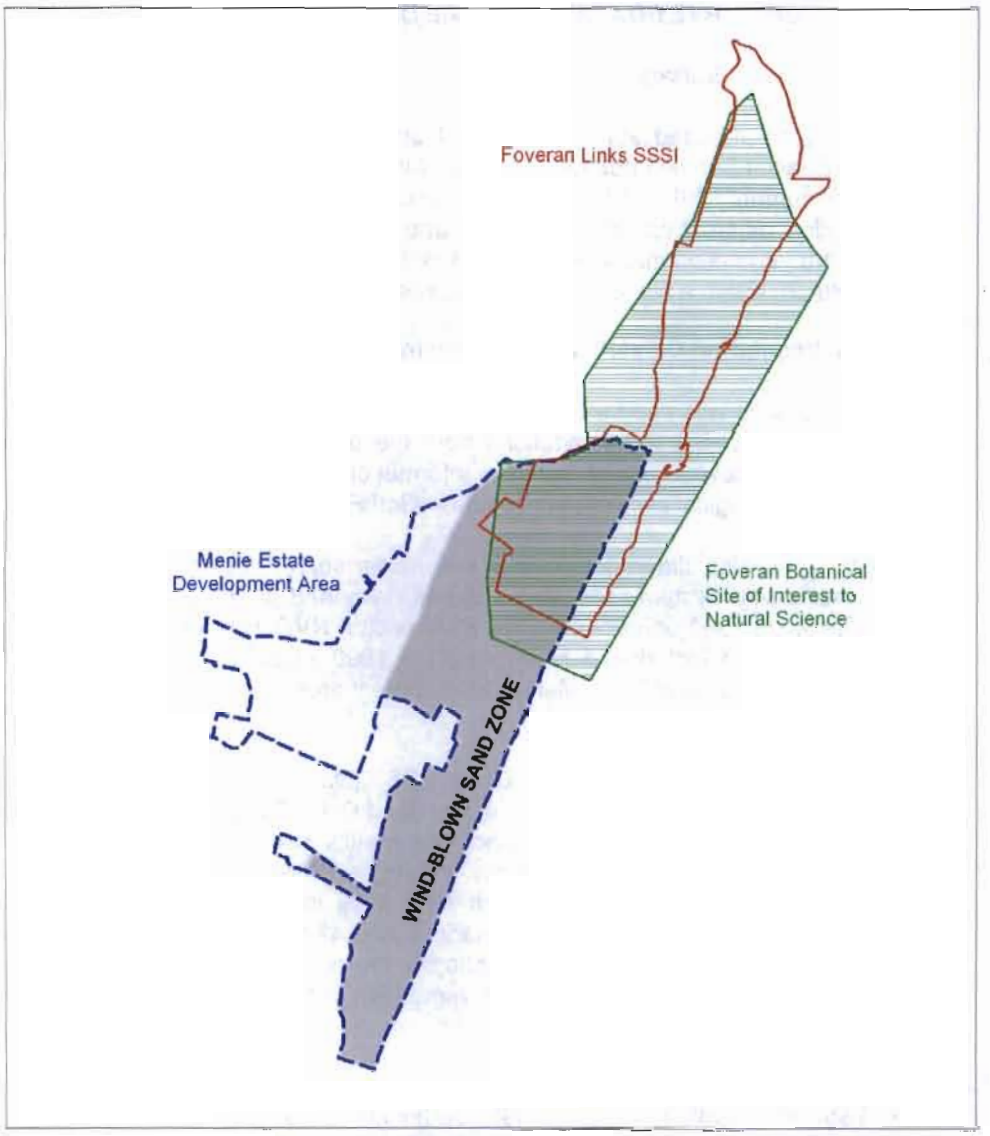

Figure 1 Key site components for reporting on habitats for the Menie Development

3.0 VEGETATION SURVEY DATA FOR MENIE DUNES

3.1 Scottish Coastal Survey

The first quadrat-based survey of ground at Menie was undertaken as part of a Scottish Coastal Survey undertaken for the Nature Conservancy Council, published in 1983 (Document 29). The method of quadrat sampling, vegetation and site classification differs from NVC methods and results are probably only of general interest. No vegetation map was produced in this survey. The site description (Site 84 Don to Ythan) within a site classification fits results from later surveys well.

3.2 National Vegetation Classification survey in 1990 and 1999

The NVC system was used as the method for most habitat data collection in summer 2006. This followed recommendations from the project scoping phase and agrees with best practice for use of detailed information in assisting course design and undertaking ecological assessment (Scottish Golf Environment Group, Document 49).

Using the NVC also allows comparison with earlier surveys using the same approach and classification system. The Menie dunes have had partial coverage from other work. Survey in 1990 only covered the SSSI sector. NVC work in 1999 mapped non-SSSI ground and included a brief check of 1990 mapping. The survey in 2006 covered all dune ground in the Menie Development area.

3.2.1 1990 NVC survey

A 1990 NVC survey of Foveran Links SSSI (Doarks, Holder & Radley 1992, Document 23) was completed as part of the Sand Dune Survey of Great Britain. Non-SSSI ground at Menie was not included. The results of that work are included in an all-Scotland report which is based on a sample of Scottish sites (Dargie 1993, Document 33). Field time was 9 staff field days in May, recording 205 habitat polygons covering 154.7 ha, plus 23 quadrats and 42 target notes. Field mapping of boundaries used 1976 aerial photographs but the NVC report does not discuss the difficulties encountered with 14 years of vegetation change in SSSI sectors which are very dynamic.

3.2.2 1999 NVC survey

Non-SSSI ground was covered in 1999 (Dargie 2001, Document 36). This was part of a survey of all dunes and machair in Scotland, with results also included in a national report (Dargie 2000, Document 31). The dunes at Menie were part of a large coastal site extending from Newburgh to Bridge of Don.

The 1999 work cannot be considered precise for several reasons and it is best termed reconnaissance or 'broad-brush' NVC. The Menie Estate sector was covered in two days, going inland as far as the estimated inland limit of blown sand. The mapping base was poor. No recent aerial photography was available from SNH, an important element for accurate mapping. A complete collection of SNH maps at one large scale was not available for the coast from Newburgh to Aberdeen and the Menie site had to use 1:25000 maps enlarged to 1:10000. Field boundaries on these had changed markedly, with some fences disappearing under moving sand and new fences erected.

A handheld GPS was used to assist in locating boundaries but GPS in 1999 was still subject to selective availability and signal degradation, with possible errors in position of up to 100 metres. The resulting map was therefore a major approximation in terms of boundary positioning between different mapping units. The Menie site probably

has one of the most intricate habitat mosaics on East Coast dunes. A total of 360 habitat polygons was mapped for an area of 410 ha, including checks on 114 polygons mapped in 1990 NVC survey of Foveran Links SSSI (Doarks, Holder & Radley 1992, Document 23). About 50 target notes and 7 quadrats were also recorded in 1999.

3.3 The accuracy of the 2006 Menie NVC baseline survey

3.3.1 Field methods and accuracy

All mapping was undertaken by the author who was already familiar with the site, having made three earlier visits, including NVC survey for Scottish Natural Heritage in 1999 (Dargie 2001, Document 36).

The developers supplied copies of very recent winter (2005/6) aerial photography but this did not cover a southern sector, the sand dome at Balmedie. Other recent aerial orthophotography (summer 2003) was purchased for all of the survey area and this proved more useful than the winter cover due to less shadow and lack of a leaf cover on trees. Large-scale prints overprinted with 1 km grid squares were laminated and used in the field with a drafting film overlay for recording habitat types and clear boundaries.

Field navigation used a differential GPS system (accurate to 1 metre) linked to GIS on a small portable computer. This was used to record some subtle boundaries and areas of recent change around moving sand, plus precise locations for important plant species. A total of 6 field days (early July and August) was involved. Some quadrat samples were collected in these visits but work concentrated on visual identification of NVC types and recording their boundaries.

Identification of NVC type was based on the author's experience (18 years of dune survey, mostly in Scotland), including potential new NVC types. The Sand Dune Vegetation Survey of Scotland lists 37 such types with floristic tables (Appendix 6 in Dargie 2000, Document 31). Some of these have been included in potential additions to the UK NVC system (Document 41). Several of these new types were mapped at Menie, mainly forms of acidic dune grassland, wet dune heath and young dune slacks.

Only limited quadrat data collection was done initially, concentrating on slack vegetation due to the discovery of several important populations of Curved Sedge *Carex maritima* and later Small Adder's-tongue *Ophioglossum azoricum*. Additional fieldwork using four experienced field assistants supplemented the sample set, obtaining 167 samples which later were allocated to 24 vegetation types.

To summarise the field stage, the 2006 NVC survey was well-resourced, with 16 staff days used for mapping (Dr Dargie), quadrat recording (Dr Dargie plus 4 additional surveyors) and Phase 1 habitat survey (1 additional experienced surveyor). The timing of work extended between early July and early September, with most mapping done at the optimal time of year in July.

It is probably the most thorough NVC survey which has been applied to the Menie dune sector, with NVC boundaries captured with good accuracy. A total of 391 polygons was mapped for a development survey area on wind-blown sand of 263 ha.

3.3.2 Map production

The 2006 habitat map was assembled in GIS over several days using a mix of data sources:

- Roads and field boundaries supplied by chartered surveyors working for the applicant;
- Boundaries captured in the field;
- Boundaries captured from 'heads-up' digitising from orthophotographs, based on information recorded using air photos in the field, as well as identifying obvious features visible on images (tracks, bird pens);
- Boundaries from Integrated Habitat Data system in Aberdeenshire, used to cover the interior of Menie Estate. This was later verified using Phase 1 Habitat Survey in September 2006.

3.3.3 The accuracy of 2006 NVC identification

Published NVC coverage of dune vegetation in Scotland
Accurate up-to-date boundaries on a map of NVC habitats are not sufficient to make an accurate survey. The habitat types must be identified correctly too. The NVC classification system is complex, with several hundred communities and over a thousand sub-communities, some of which have variants too.

Most NVC types are made up multiple species and many key species are not confined to one particular NVC type. A decision on identification requires experience and is subjective, with validation requiring the assembly of quadrat samples in floristic tables to determine the most frequent species (constants) and those showing degrees of confinement to a potential sub-community (preferential and differential species). These results then have to be compared with the published types which are only table summaries which record the frequency (constancy classes) and range in cover – abundance (Domin score range) (Rodwell 2006, Document 42). There are computer techniques to assist the identification process (MATCH, TABLEFIT) but these should not be taken as final judgement, nor are they recommended (Rodwell 2006, Document 42).

Menie is dominated by sand dune (SD) types which reduces the scale of complexity but there are other difficulties. The published NVC account of sand dune types is in two volumes covering dune heath and other sand dune vegetation (Rodwell 1992 and 2000, Document 39). The published dune types (SD1 to SD19, plus H11 dune heath) are based on samples which in several cases do not include quadrats from Scotland, or are based on data from just a handful of sites in Scotland.

The following NVC dune community types are clearly under-sampled in Scotland: SD7, SD11, SD12 and SD19. The SD7 and SD12 types are now known to be particularly extensive in Scotland which holds the bulk of the British resource (Dargie 2000, Document 31). The British distribution of samples used to produce several NVC types is not known: SD9 and the dune slack types SD13, SD14 and SD15. The slack types are clearly based on samples and sites which are from South Wales. No Scottish samples have been included in the tables for SD10, SD16, SD17 and SD18.

The Sand Dune Vegetation of Great Britain (SDVSGB) was undertaken in the late 1980s and early 1990s, but only a few of these studies provided quadrats which were used to prepare the published SD NVC tables. The SD8 calcareous dune grassland type, dominant in western Scotland, seems to be the only case. It is unfortunate that

the large quadrat sets accumulated by the SDVSGB were so underused in the NVC system, given that the published NVC SD account was produced in 2000.

The net result of this under-sampling is that important dune variation in Scotland is missing from the published NVC. More than 30 provisional new sub-communities and perhaps a new community type are described in the regional volumes of the Sand Dune Vegetation of Scotland (SDVSS), undertaken between 1994 and 2000. These are summarised in Document 31 and they are included in an atlas of all vegetation types mapped on dunes in Scotland (Volume 2 of Document 31) which has not been placed before the Inquiry. Any dune survey in Scotland should therefore make detailed reference to Document 31, plus the atlas component, as part of the NVC identification process, and as part of any validation that might be needed. Some reference to a JNCC report on national NVC coverage is also needed (Document 41). The use of the published SD NVC chapter alone is not sufficient for work on dunes in Scotland.

This advice on additional key sources is also reflected in official guidance for JNCC Common Standards Monitoring for sand dunes and machair (Documents 26 and 27). However, the SNH web link to Document 31 has been broken for several years and it is likely that many NVC surveyors are not aware of the full Scotland dune and machair NVC survey.

An experienced dune surveyor who is fully familiar with documented British dune types does not need to collect any quadrat samples to validate survey work (Rodwell 2006, Document 42). However, for important sites involving potential development, it is essential that NVC mapping is subject to scrutiny, including the accuracy of NVC identification. This explains the large quadrat total collected at Menie in 2006.

Several vegetation types with floristic tables in Appendix 7-1 of the applicant's environmental statement represent potential new NVC variation which is described in Document 31: SD6x, SD12xy, SD12yy and SD12z. An SD16x type was recorded as M16x in Document 31 and as M15x in Document 36. This is now considered by the author to be a very acidic type of SD16 dune slack, which can even have bog moss *Sphagnum* spp. present. A damp ground variant of H11b dune heath (Table A7-1t) is also described in the environmental statement and this might warrant NVC sub-community status. It is locally extensive at Menie in the older floors of slacks and is best regarded as a form of wet dune heath. It is likely to be present in some quantity at Sand of Forvie. The NVC description of H11 probably includes samples from Sands of Forvie, close to Menie, and about 20% of H11b quadrats are damp (based on the presence of Four-leaved Heath *Erica tetralix*, constancy class I). This suggests under-sampling of a vegetation type in the published NVC which is probably a significant component of the regional variation for acidic dunes around Menie.

To summarise the position on NVC accuracy so far, scrutiny must be made using not only to the published NVC but also results recorded as part of the SDVSGB (summarised in Dargie 1993, Document 33) and the SDVSS (Documents 36 and 31). Given that significant new variation is described in these sources, computer methods for assisting identification (MATCH, TABLEFIT) must not be used because they do not cover the additional Scottish variation.

Standard and non-standard practice in deciding NVC type

Standard practice (Rodwell 2006, Document 42) involves careful reference to the published NVC tables. NVC determination starts with assembly of quadrats. These record each species in terms of cover – abundance (using non-linear categories termed the Domin scale). Quadrats are assembled into putative NVC groupings (as floristic tables) to calculate the frequencies of individual species. These are recorded

on a standard five class Roman numeral constancy scale: I = present in 1-20 % of quadrats (termed scarce), II = present in 21-40 % (termed occasional), III = present in 41-60 % (termed frequent), IV = present in 61-80 % (termed constant), V = present in 81 % or more quadrats (termed constant). Floristic tables are drawn up, allocating constancy values and usually listing the range of Domin scores shown by each species. It is at this stage that comparison with published NVC types (or rather their floristic tables) can begin.

The floristic tables included in published volumes are based on multiple analyses using results which appeared to show stable vegetation types, with species grouped according their frequency and degree of association with the community type and sub-communities. The species listing order is therefore, first, community constants, then a set of preferential/differential species for each sub-community, then a set of general associates (sometimes called companions) which were present in >5 % of quadrats. If field quadrat sets show a good fit to one NVC type in terms of constants, preferential/differentials and general associates, then that is considered suitable validation. It is a subjective determination.
Standard NVC practice for identifying dune vegetation types (e.g. as published in Rodwell 2006, Document 42) is therefore difficult in Scotland, since that relies on the published NVC types and their floristic tables. There must be additional reference to potential new NVC types, published as part of the Sand Dune Vegetation Survey of Scotland.

There are alternative published non-standard methods of determining NVC type. One such method, published by RSPB (Lindsay 2005, Document 57), has been used to attack the work of this author for peatland NVC survey in the Western Isles. It is applied to a range of deep peatland types covering very wet to very dry conditions, re-examining quadrat data submitted in a baseline survey for a wind farm planning application for a designated area (Lewis Peatlands SPA, Lewis Peatlands Ramsar Site).

The method of NVC determination put forward by the RSPB consultant (Mr. Richard Lindsay) seeks "indicator species" which are both typical of an NVC type and which are largely restricted to that type. These of course should be similar to "preferential" or "differential" species which are identified in published NVC tables on the basis of their frequency in a set of quadrats. However, that is not the case. The Lindsay method is simply based on presence/absence, with no reference to frequency scores in the published tables. Indeed, many species listed as preferential or differential in the NVC system are ignored by Lindsay and species selection uses relatively infrequent species.

This is a major departure from standard practice. It is quite wrong, when making a NVC comparison with a new floristic table, to select just a handful of species, ignoring the full NVC set, because that destroys, distorts or oversimplifies the structural integrity of the dataset used to form the original NVC table. It is therefore a dangerous technique which, if used more widely, could discredit the entire NVC system.

This author will strongly contest any attempt by RSPB to employ this published Lindsay method. It seems to have been devised to cast doubt on the validity of an NVC baseline of designated ground. Scrutiny must be fair and either based on standard practice or alternative methods which use all floristic data. The faults in the Lindsay approach are identified in a rebuttal of the RSPB document. The rebuttal is based on a very thorough re-analysis of peatland quadrat data (Appendix 2 in Dargie 2007, Document 21). Appendix 2 in that rebuttal vindicates the original NVC determinations.

Scrutiny by SNH

The 2006 Menie NVC survey has been scrutinised by SNH. The 2006 map has had its boundaries checked and some additional quadrats have been produced (Smedley 2007, Document 43). The SNH report includes maps, parts of which are illegible. There are no conclusions. Liaison with SNH Coastal Adviser, Mr Stewart Angus, in late 2007 and April 2008, suggested that SNH considered that the 2006 NVC survey had underestimated the extent of H11 dune heath at Menie. The SNH report (Document 43) also has reservations on some 2006 NVC vegetation types, particularly several SD12 acidic dune grassland types and the absence of any SD11 lichen-rich acidic dune grassland which is considered to be present by SNH. It is recorded, for example, on dunes nearby at Sands of Forvie (Dargie 1992, Document 32).

Revision of the Menie 2006 NVC survey

The author has considered SNH opinion and re-examined the 2006 NVC survey results in the field and via further analysis of quadrats. The field checking was done 5-6 May 2008, with GIS NVC data revised on 7 May 2008. A brief discussion was held with SNH at Menie (6 May). A copy of the revised GIS NVC data was supplied to SNH by e-mail on 7 May 2008.

The following results were produced from this revision process:

- There are important changes in mapped extents for several habitat types, between the 2006 NVC survey and corrections applied in early May 2008. These are summarised in Table 1.
- Dry dune heath (H11b) present in mosaics with SD12 acidic dry dune grassland had not been recorded in nine large mapped polygons mapped as SD12 types. These have been corrected and recorded as H11b - SD12 mosaics. These changes are largely responsible for H11b increasing from 3.8 ha in 2006 to 10.6 ha in 2008. A small proportion of the increase is also made up of dry H11b rises in slacks which were not mapped in 2006. The increase in all mapped H11b, adding the wet variant to the typical dry type (3.8 to 14.6 ha), is substantial and should now agree with SNH views on H11 extent on the site.
- There is a concomitant fall in SD12 grassland extent between 2006 (75.9 ha) and 2008 (67.3 ha) as a result of treating 9 polygons as H11b and SD12 mosaics.
- The damp ground variant of H11b dune heath (Table A7-1.4t in ES Appendix 7-1) was recorded in the 2006 NVC map as SD16 (referring to the SD16x type to which it is closely related – SD16x at Menie is the successional precursor of the H11b damp ground variant). The continuous nature of variation between SD16c, SD16x and damp H11b made it impossible to fit exact boundaries and no attempt was made in 2006 or 2008 to separate the SD16c and SD16x types. The 2008 correction largely explains the decrease in SD16 extent and the inclusion of the H11b wet variant in the 2008 map.
- There is a slight increase in SD13 young dune slack area, due to its separation from 2006 SD16 in a slack close to Hole 3. The SNH survey (Document 43) correctly picked up this difference (0.06 ha).
- There is a marked increase in SD12z acidic semi-fixed dune (a form with much Marram *Ammophila arenaria*) in 2008 results, a result of incorrect 2006 mapping as SD12xy (a form with much *Deschampsia flexuosa*). This was noted in 2008 checking and is not the result of SNH scrutiny.

Table 1 Changes in vegetation extent arising from 2008 corrections to 2006 NVC mapping at Menie

Habitat mapped as	ES Floristic tables (ES Appendix A7-1)	2006	2008
H11b dry dune heath	A7-1.4s	3.76	10.62
H11b wet variant	A7-1.4t		4.94
SD12a/b acidic fixed dune grassland	A7-1.4i	22.49	21.90
SD12b acidic fixed dune grassland	A7-1.4k	8.99	7.98
SD12xy acidic fixed dune grassland	A7-1.4l	33.78	15.43
SD12yy acidic fixed dune grassland	A7-1.4m	6.22	5.08
SD12z acidic semi-fixed dune	A7-1.4n	4.39	16.92
SD13 young dune slack	A7-1.4s	3.73	3.79
SD16 dune slack	SD16c A7-1.4q, SD16x A7-1.4r	11.83	7.51
SD16/M15/M16 dune slack - wet heath	See Q66 in SD16c A7-1.4q	0.10	0.10

3.3.4 Review of 2006 vegetation identification via quadrat data

The "proof" of NVC status can only come through use of quadrat data. Given SNH concerns on aspects of the 2006 survey, and the chance that RSPB might challenge NVC work along the lines of Lindsay work in Document 58, a further check on Menie vegetation types has been undertaken. This uses a similar approach to work upon acidic dune grasslands by the Countryside Council for Wales (Rhind, Stevens & Sanderson 2006, Document 40).

The UK status of grey dune vegetation

There have been doubts raised elsewhere in the UK on the status of vegetation mapped as SD11 in various site vegetation surveys (Rhind, Stevens & Sanderson 2006, Document 40). This NVC type is described as lichen-rich grey dune. In British vegetation literature this describes dune ground with a grey colouration arising from the high cover of lichens, particularly belonging to the genus *Cladonia*. The European literature, particularly that used in the EC Habitats Directive, uses the term grey dune in a wider context and it refers to all dry fixed dune vegetation and probably much of semi-fixed dune too (the SD7 type in the UK NVC system).

The CCW work in Document 40 applies a method which relates quadrats from recent dune survey to the NVC in an objective manner which uses all species information. It is important here to explain the basics of the work in Document 40.

This uses modelled data to simulate NVC quadrats (so-called pseudo-random quadrats, or pseudoquadrats). This is necessary because the original quadrats used to produce the UK NVC system are not available – we cannot return to the original data for use in comparing more recent data.

The analysis in Document 40 generated sets of pseudoquadrats for 14 NVC sub-communities based on data in the published floristic tables. Each NVC type was simulated by 50 pseudoquadrats. All 14 NVC types had a large number of lichen species or a high overall lichen cover (CG7b, H1a, H1b, H10b, H11a, H11b, SD11a, SD11b, SD12a, SD12b, U1a, U1b, U1c, U1d). Many of these types occur on dunes.

These samples were compared using a multivariate graphing technique termed ordination. The graphical solution placed samples on three axes. Ordination methods place samples which are similar in species composition close together, distant from samples which are very different in species content. Quadrats from UK dune NVC surveys identified as SD11 or as SD11/SD12 acidic dune grassland intermediates were then introduced into the graphs as passive samples. Their location in the graphs (axes 1/2, 1/3, 2/3) was related to the 14 sets of simulated NVC types. If a dune survey quadrat fell within the scatter of samples for one particular sub-community, it most likely is an example of that sub-community type.

The results show that, UK-wide, a rather small number of quadrats identified as SD11 actually fall close to pseudoquadrats of the SD11a or SD11b types. For example, of five quadrats from Sands of Forvie (taken from Document 32), only one falls close to SD11a. The other four are placed in "no-mans-land" between SD11a, H11b, SD12a and SD12b (Fig. 4 in Document 40). Most UK mapped SD11 seems to be intermediate between SD11 and SD12, SD11 and H1/H11, or SD11 and CG7 (a type of calcicolous grassland) – U1 (a type of calcifugous grassland).

Document 40 gives little interpretation to the underlying environmental factors shaping the spread of pseudoquadrats. As part of work assessing Menie quadrat data, this was examined as follows. The Document 40 pseudoquadrat data was supplied to this author by Dr Roy Sanderson (University of Newcastle) with the permission of Dr Peter Rhind (Countryside Council for Wales).

The data was used to calculate environmental scores (Ellenberg Values) for each quadrat on the basis of its species composition and species quantities. These environmental values are based on UK scores for plant species derived from the results of Professor Heinz Ellenberg for central Europe. These apply to five environmental gradients: L light, F moisture (F = *feuchtigkeit*), R reaction (low scores = acid, high scores = alkaline, a gradient of increasing pH), N nitrogen (a fertility gradient) and S salt (a salinity gradient).

The UK scores for higher plants are published in Document 37. Ellenberg values for bryophytes were supplied as a spreadsheet by Dr Mark Hill (Centre for Ecology and Hydrology). Scores for dune lichens are not available but were estimated by applying scores equivalent to important bryophytes found with such lichens (e.g. the moss *Polytrichum piliferum*). An average value per pseudoquadrat for each gradient was calculated using the species present, their quantities measured as percent cover, and their Ellenberg scores for the gradient.

The graphing method used in Document 40, an ordination based on detrended correspondence analysis (DCA), was repeated using supplied pseudoquadrat data. The number of pseudoquadrats per sub-community was reduced from 50 to 25 by random selection. This gave an analysis set of 14 sub-communities x 25 samples = 350 pseudoquadrats. The same result was obtained as in Document 40 except that points were reflected. A different ordination method (called non-metric multidimensional scaling, NMS) was also applied. This gave a more even spread of pseudoquadrats, compared to clustering present in the DCA result. Trends in Ellenberg scores for three-dimensional graphs were calculated using regression of Ellenberg values upon graph axis co-ordinates:

$$\text{Ellenberg Score} = a + b_1\text{Axis 1} + b_2\text{ Axis 2} + b_3\text{Axis 3}$$

The strength of trends was recorded (percent variance explained) and results are given in Table 2. Percent variance explained values >50% generally indicate a strong underlying habitat trend in vegetation.

Table 2 Strength of regressions for trends in Ellenberg scores in two three-axis ordinations

Ellenberg Gradient	DCA ordination Percent variation explained	NMS ordination Percent variation explained
F Moisture	20.9	51.4
R Reaction	85.3	76.5
N Nitrogen	70.3	70.3
S Salinity	58.8	59.4

Results for both ordinations show the following underlying habitat trends:

- A very strong gradient in R Reaction is present and this coincides with interpretation in Document 40 of a sequence from heathland to grassland along DCA Axis 1. This can be interpreted as a gradient from acidic to less acidic soils (Fig. 2 in Document 40, DCA Axis 1: H10b to H1 to H11 to SD11/U1a to SD12 /U1bcd/CG7b). The trend in N Nitrogen is almost collinear with R Reaction. The acidity gradient (acidic to less acidic) should therefore also be read as lower to higher available soil nutrients. A very similar sequence is present in NMS results.
- A moisture gradient is present which is rather weak for the DCA result (but still significant statistically) and much better for NMS analysis. This represents a sequence in NMS from very dry vegetation to wetter samples (SD11/ U1 to SD12 to CG7b to H11a to H11b/H1 to H10b).
- Weak trends in a third direction are present which are difficult to interpret. Both ordinations show a significant relationship with S Salinity but all 14 sub-communities are not knowingly affected by such a gradient. In both ordinations the H10b sub-community is clearly separated. This is a submontane dwarf-shrub habitat which only descends to low altitude on dry blanket bog in the Western Isles and Shetland (see Appendix 2 in Dargie 2007, Document 21). This trend is best ignored here.

The key outcome of this further work on Document 40 data is that two separate environmental gradients (reaction/nitrogen, moisture) are strongly related to the differences in the species composition of the 14 sub-community types. This outcome is used in assessing the NVC status of Menie vegetation.

3.3.5 The NVC status of Menie dune vegetation types

Method for assessing NVC status

The approach in Document 40 is simplified here to provide a method to assess the interpretation of the NVC units mapped on dunes at Menie. The approach uses all species information. It is a means of objective graphing of quadrat data for comparison purposes.

The strong relationship between vegetation and the two environmental gradients suggests that there is no need to process Menie quadrat data via complex methods such as DCA and NMS ordination. Instead, the Ellenberg scores calculated from quadrat species data are used as graph axes. Axis 1 represents R Reaction scores, Axis 2 represents F Moisture scores. This approach is termed direct gradient analysis in plant ecology.

The graph is presented in Figure 2. It has been constructed and should be interpreted as follows:

- Additional pseudoquadrat data probably relevant to Menie were supplied by Dr. Roy Sanderson (University of Newcastle): H11c, SD7a, SD13a, SD13b, SD16a-d inclusive. The mean and standard deviation of each pseudoquadrat NVC subset were calculated from their Ellenberg R Reaction and F Moisture scores.
- The "space" occupied by each of the 22 NVC subsets is represented by a probability ellipse. This is based on distances of two standard deviations either side of the means for reaction and moisture scores. The NVC sub-community label is placed on the edge of the ellipse. Approximately 95% of pseudoquadrat samples should fall within the ellipse boundary. The 350 pseudoquadrats are not plotted, to maintain clarity for interpreting results.
- Ellenberg R Reaction and F Moisture scores have been calculated using the quadrat data for the following Menie vegetation types: H11b, H11b wet variant, SD12ab intermediate, SD12b, SD12xy Wavy Hair-grass *Deschampsia flexuosa* type, SD12yy lichen-rich type, SD12z Marram *Ammophila arenaria* type, SD13 young dune slack, SD16c Dune Willow *Salix repens* – Fog Grass *Holcus lanatus*, SD16x Four-leaved Heath *Erica tetralix* type and SD7 semi-fixed dune. The results for each quadrat allow that quadrat to be plotted upon the direct gradient graph.
- Ellenberg values are not labelled on graph axes. Mean and standard deviation values for probability ellipses, plus the R and F scores for Menie quadrats will be supplied to any interested party requesting them. The Ellenberg scale for R Reaction (soil or water pH) ranges between 1 (indicator of extreme acidity) and 9 (indicator of basic reaction, always found on calcareous or other high-pH soils. The scale for F Moisture ranges between 1 (indicator of extreme dryness, restricted to soils that often dry out for some time) and 12 (submerged plant, permanently or almost constantly under water). The ellipses illustrated show the following ranges: 2.1 - 6.5 for R Reaction and 2.8 – 7.0 for F Moisture.

The status of Menie vegetation types is assessed by considering the positions of constituent quadrat samples in relation to the boundaries of NVC types. If these fit within their named NVC type, they are considered correctly allocated. Quadrats possibly representing vegetation which is not covered by the NVC system is assessed in two respects. First, if it is new variation, it should not fall within an NVC ellipse. Second, its position in relation to the graph axes should fit with the ecology of the vegetation type.

As an example, the H11b wet ground variant should have a similar reaction position to typical H11b, but should be placed in a wetter position on the moisture axis.

Results of NVC status assessment

1. There is considerable variability in the area of graph space occupied by pseudoquadrat ellipses. Most dry dune types vary more in relation to the R reaction gradient. Slack types vary more in relation to F moisture. Heath types and dune slacks vary the most in size.
2. Most H11b Menie samples (10 out of 13) are correctly placed, with a further two on the boundary and possibly representing H11c vegetation. The remaining sample is placed in the SD12b ellipse.
3. The H11b wet variant has a wide scatter, roughly equivalent to the R reaction range in dry (typical) H11b. One sample might be a misclassification as typical H11b and another as SD12b. Two further samples are on the edge of the H1a ellipse. Five samples occupy notably wetter positions than typical H11b. On balance this suggests that this variant occupies markedly wetter ground than the typical form. It does seem to be a possible new NVC type. If wet heath NVC ellipses (M15 or M16) were added,

they might occupy the graph space with most of these samples. There is a strong case for considering this vegetation as a slack type, as mapped in 2006. The re-allocation to H11b in 2008 is partly a matter of semantics, depending on where a line is drawn between acidic mature slack, wet dune heath and dry dune heath. The position remains unresolved. The 2006 mapping as SD16 was not an error.

4. All but one of the SD12ab samples fall within the space occupied by the SD12a and SD12b ellipses, with one sample suggesting a grassy form of typical H11b. This type is probably correctly identified, with variation spanning the SD12a and SD12b ranges.
5. SD12b samples show quite high variability and many occur just outside the SD12 ellipses, with two in wetter positions. Samples are generally wetter than Menie SD12ab and this might be typical of SD12b in Northern Scotland for climatic reasons. Further sampling, including data from other sites, is probably needed. Menie samples are quite close to the correct probability ellipse and the 'misses' are not serious.
6. SD12xy quadrats mostly occupy more acidic positions than all other SD12 types at Menie, to be expected from vegetation with a high cover for Wavy Hair-grass *Deschampsia flexuosa*. This type mainly occupies the transition between acidic grassland and dry heath. This suggests correct identification as probable new NVC variation.
7. The SD12yy samples are all displaced towards drier conditions, with a single sample placed in SD11b. This result confirms that most lichen-rich acidic dune grassland at Menie cannot be considered as SD11, an inference in SNH work. However, there is evidence for a small proportion of SD12yy representing the SD11 type. The location of most samples suggests that soil moisture is too high for most conditions at Menie to allow SD11 development.
8. The SD12z Marram *Ammophila arenaria* quadrats are scattered within and around the edge of the SD12 ellipses, with one wet outlier sample. This is weak evidence for a new NVC type and these samples could simply be regarded as SD12ab or SD12b. However, it is proposed to maintain the distinction because the best examples of this type are present on acidic dunes closest to the sea, and further inland on steeper dunes which were probably mobile in recent times. This type therefore probably marks former large mobile dunes. The graph variables R reaction and F moisture probably do not relate strongly to the successional evidence represented by this type. Indeed, successional trends in acidic grassland might represent a third gradient.
9. The SD13 young dune slack samples show a wide scatter along the F moisture axis. The range present much exceeds the large SD13a ellipse, showing that slack succession occurs on surfaces ranging from dry to very wet. The wettest samples are also less acid and this might be the effect of a high dune watertable for much of the year, protecting surface soils from leaching. More than half of samples lie outside the SD13a ellipse, in more acidic conditions. This might represent the effect of acidic glacial till under a thin sand cover in some young slacks. Alternatively, the displacement could represent a difference between such slacks in Scotland and South Wales.
10. The SD16c samples are displaced towards more acidic conditions than the small SD16c ellipse. Four fall within the SD13a ellipse and might be better placed there. Again, like SD13, displacement towards higher soil acidity could represent underlying soil material, or more acidic sand than in dunes elsewhere.
11. SD16x samples are mostly in more acidic locations than SD16c quadrats and this distribution is good evidence for probable new variation.
12. SD7 quadrats are largely contained, correctly, by the SD7a ellipse. These samples probably represent near-neutral soil acidity, the least acidic of dry dune conditions sampled.
13. Overall, most identification of quadrat samples has been validated, either as a published NVC type or as likely new vegetation. There is an excellent successional

sequence in dry dune samples (from SD7 to H11b) which is oblique to axes. This probably reflects increasing organic matter accumulation in soils over time, allowing higher moisture retention and availability. Slack vegetation has an equivalent parallel trend (SD16x to H11b wet variant) but other wet dune vegetation more strongly reflects wetness alone.

3.4 Conclusions on baseline habitat data

This assessment of baseline data has shown the following key points which are important for the Inquiry:

1. Survey effort and habitat boundary quality are probably as better than preceding work.
2. NVC determination of quadrat data sets by the direct gradient RF graph suggests that NVC field mapping units are well-defined and include potential new NVC types, most of which have been described by the Sand Dune Vegetation Survey of Scotland.
3. A brief SNH NVC survey of the site found missed H11b dune heath, mostly in mosaics with acidic dune grassland. This has been corrected by checking in early May 2008, together with other more minor errors. These changes to the 2006 baseline require a new NVC habitat map to be produced for the Inquiry.
4. Corrected digital GIS data has been given to SNH and their opinion on agreement with the baseline is awaited.
5. Checks on NVC status show that successional trends in soil acidity (time since a surface was stabilised) and variation in soil wetness are key factors in understanding Menie vegetation. These factors require consideration in assessing development effects, particularly changes to soil drainage and the location of ground for use in mitigation work.

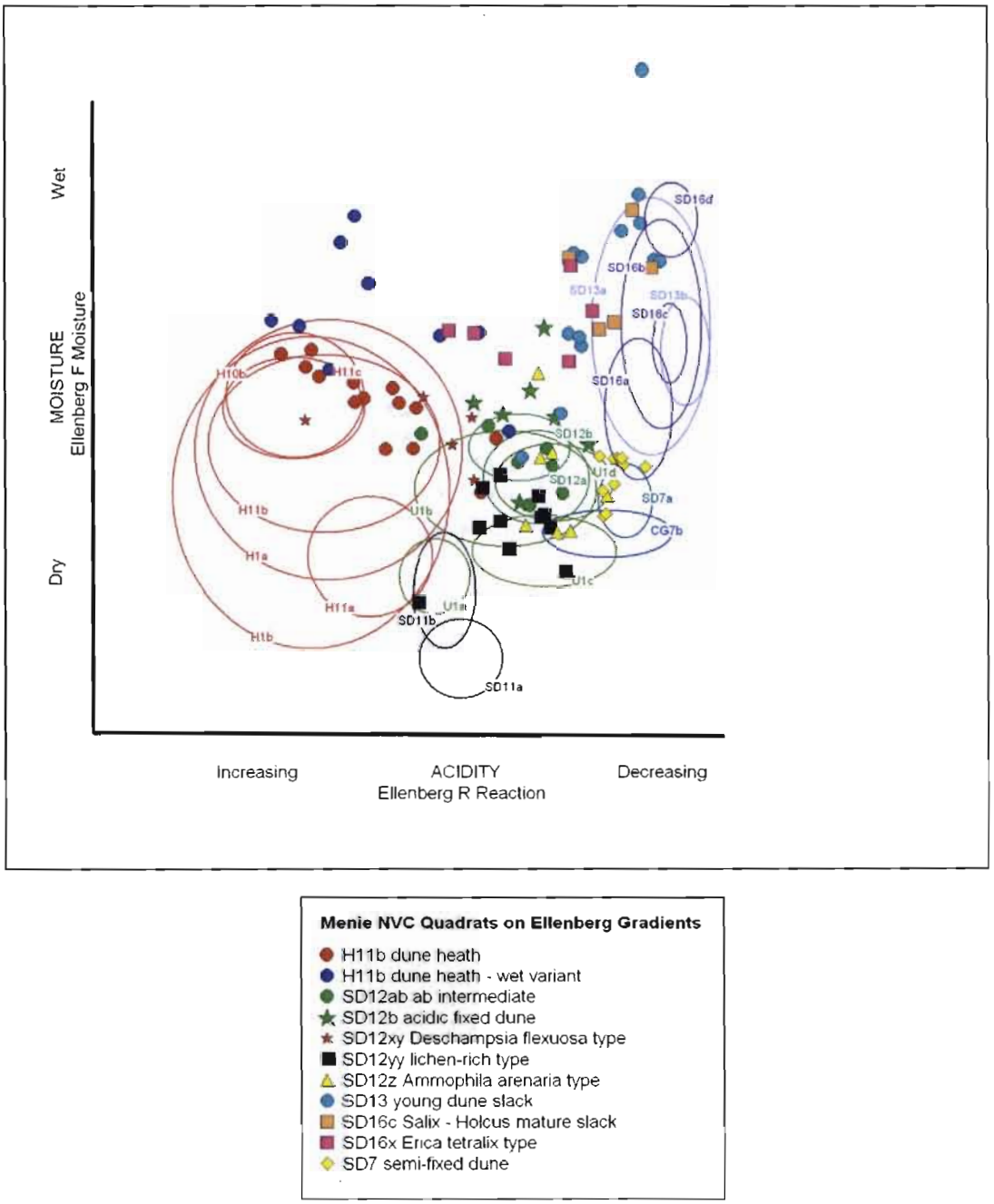

Figure 2 The position of Menie quadrat types on gradients of soil acidity and soil moisture

Ellipses represent probability bands (95% confidence limit) for pseudo-random quadrat sets generated from published NVC tables (see Rhind, Stevens & Sanderson, Publication 40)

4.0 REVISED NVC HABITAT MAP

The changes made in May 2008 to dune heath and SD12 acidic dune grassland extents are significant. A revised NVC habitat map has therefore been produced. The whole of the Menie coast is shown in Figure 3. An enlarged map covering Foveran Links SSSI and the Foveran Botanical SINS is shown in Figure 4.

The categories in the map legend are organised in a sequence show first dry dune successional types (bare sand to W23 gorse scrub), then a wet dune succession (SD13 young dune slack to SS willow scrub). A set of other non-dune NVC habitats of some nature conservation interest are then listed (MG10-M23-*Juncus* swamp to SM13/SM16 saltmarsh). A large number of minor categories are then aggregated into two final legend units: Other habitat (moderate interest) and Other habitat (low interest).

Tables with the extents of vegetation types are in Production 4: Revised Hole-by-Hole Analysis of February 2008 Golf Course Masterplan. Habitat totals there use a similar three sequences of groupings: key habitats of major dune nature conservation interest; other habitats of moderate interest; and other habitats of low interest.

The vegetation map baseline was used in GIS to produce the following tables in Production 4:

Table 1 Direct habitat loss due to development, Holes 1 to 9 (the last two columns give the revised habitat totals on blown sand in the links zone and the totals remaining after construction of the first golf course).

Table 2 Direct habitat loss due to development, Holes 10 to 18 (the last two columns give the revised habitat totals on blown sand in the links zone and the totals remaining after construction of the first golf course).

Table 3 Direct habitat loss due to development: transition rough, all holes, other infrastructure and dome stabilisation (the last two columns give the revised habitat totals on blown sand in the links zone and the totals remaining after construction of the first golf course).

Table 4 Direct habitat loss due to development within Foveran Links SSSI (the second column gives 1990 NVC survey data for habitats in all of the SSSI, the third data column gives corrected 2008 extents for habitats in the SSSI sector within Menie Estate.

Table 5 Direct habitat loss due to development within Foveran Botanical Site of Interest to Natural Science (SINS). The second column gives SINS habitat extents for ground within Menie Estate.

Table 6 Direct habitat loss due to development outwith Foveran Links SSSI and Foveran Botanical SINS. The current habitat extents in this area are given in the second column.

Table 7 is a comparison of habitats affected by the 2007 Fazio golf course and the 2008 Hawtree course submitted to the Inquiry. The comparison is based only on fairways and greens for 18 holes plus a proposed driving range.

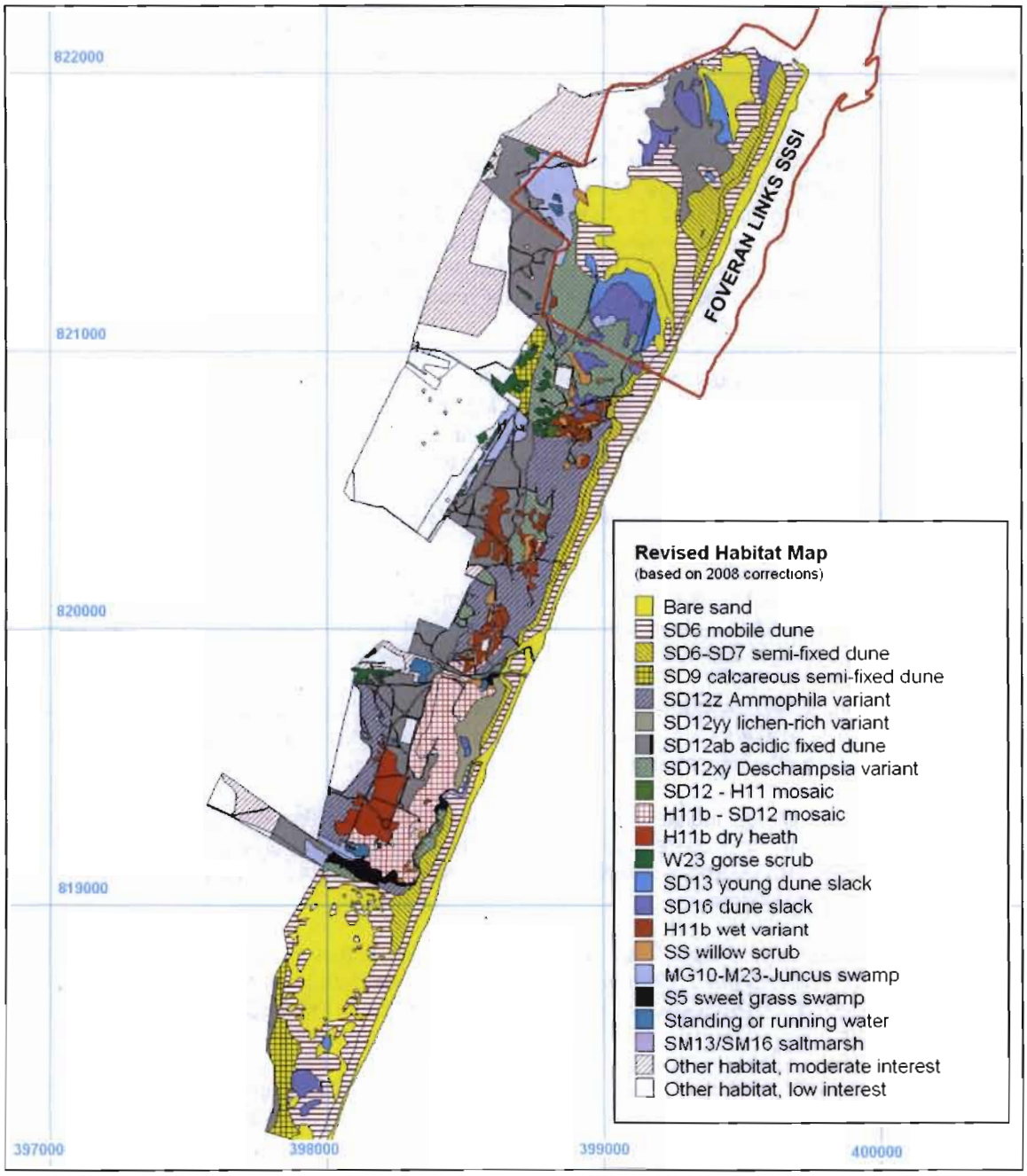

Figure 3 Revised NVC habitat map for blown sand in the development area

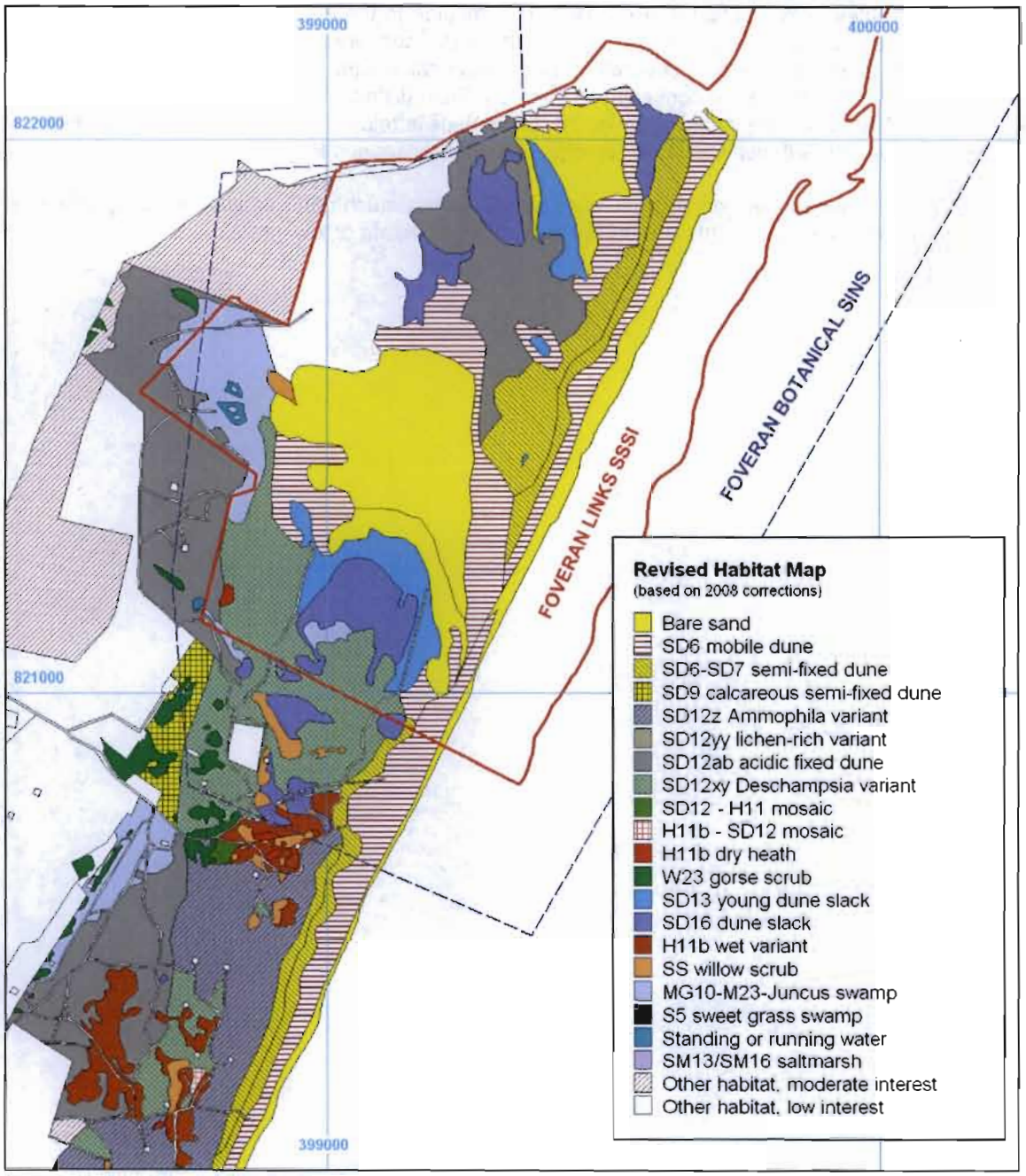

Figure 4 Revised NVC habitat map for Foveran Links SSSI and Foveran Botanical SINS sectors of development area

5.0 NATURE CONSERVATION INTEREST

Tables in Production 4 are organised in relation to three sets of habitats mapped in the revised baseline: key habitats (high nature conservation interest), other habitats of moderate interest (moderate nature conservation interest) and other habitats of low interest (low nature conservation interest). Their distribution is mapped in Figure 5. A striking feature of this site is the continuous stretch of ground regarded as high interest, with vehicle tracks representing the only serious fragmentation.

The dune inner sector on thinning sand has lost much dune habitat and is replaced by quite large extents of modified habitat, of moderate or low interest.

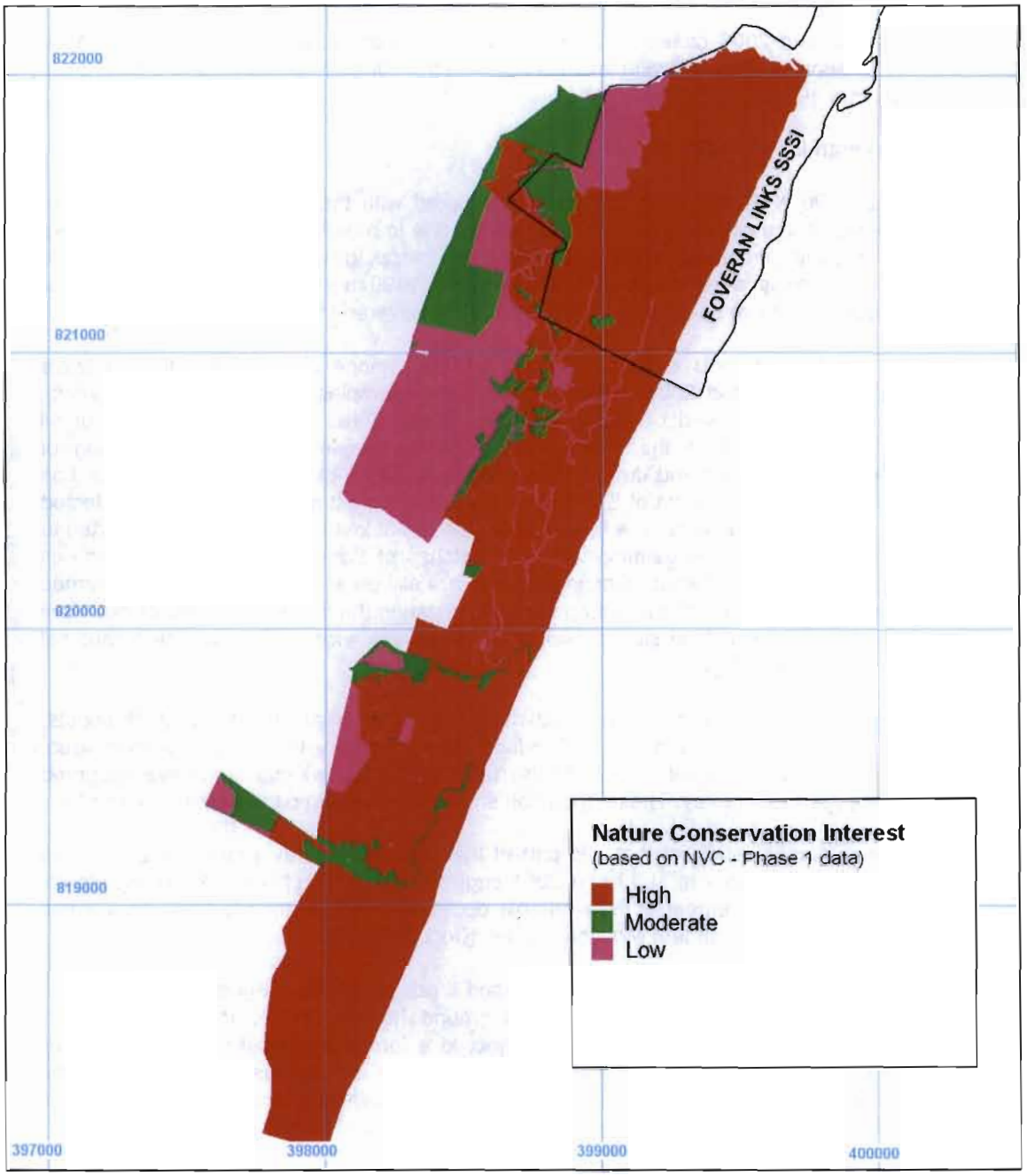

Figure 5 The distribution of ground of high, moderate and low nature conservation interest

6.0 SITE CONDITION

The revised 2006 baseline has been used in a comparison of results from earlier NVC surveys. The following findings relate to the condition of habitats in different site sectors.

6.1 Foveran Links SSSI

The 1990 NVC survey is not easily compared with the 2008 baseline. There are doubts on the accuracy of 1990 boundaries due to movement of the dome, because 1976 aerial photographs were used for 1990 mapping. However, away from mobile sand there is a reasonable match between 1990 and 2003 habitat boundaries, allowing a simple analysis of change within the Foveran Links SSSI.

A striking feature is quite widespread loss or change of important dune habitats between 1990 and 2006. Table 3 gives eight examples of interest features which have been destroyed or highly modified. These areas total 7.3 ha (10.8% of all supratidal habitat in the Menie sector). Winter feeding of stock, spreading of contaminated straw and dunging have removed >4 ha of H11 dune heath. This has been replaced by 1.7 ha of SD16 dune slack and almost half of that is badly affected by stock-related effects. The largest area (2.4 ha) of lost H11b has been converted to nitrophilous weedy vegetation with only patches of Sand Sedge *Carex arenaria* as evidence of past interest. Grazing impacts are still present and SNH have confirmed that there are no management agreements covering the SSSI. Large terracettes have formed on steep dune slopes and stock tracks are widespread, so effects are not confined to flatter ground.

Other smaller impacts involve excavating ground to create ponds for duck shoots, plus tree planting south of the Sandend Burn boundary to the development area. These features are not marked on the 1990 habitat survey map and have appeared since the 1990 survey. These operation should have required the permission of SNH.

These findings suggest that this part of the SSSI is in unfavourable condition. Site visits by the author in 1999 and 2001 suggest that stock effects are getting worse, with a likely judgement of unfavourable declining condition for the SSSI as a whole using Common Standard Monitoring rules (Document 27).

This decline in condition will be addressed if golf development goes ahead. Hole 11 has been routed over weedy ruderal ground (former H11b). Management of all ground beyond the course will be subject to a formal management plan which will include remediation and enhancement measures to restore destroyed and damaged dune habitats to favourable condition. Methods for treating stock damaged ground on dunes are discussed in Dargie 1998 (Document 34) and Dargie 2004 (Document 20).

Table 3 Foveran Links SSSI (Menie Estate sector): Habitat changes to selected areas of 1990 NVC mapping which indicate unfavourable condition and/or habitat destroyed

Grid reference	Extent (ha)	Comment	Condition status
399195 821745	0.80	H11b dune heath in 1990 recorded as SD16 slack in 2006. Excessive stock grazing probably responsible. Much of 2006 area covered in thick layer of animal bedding. Nutriphile species (indicators of dunging and nutrient enrichment) extensive. Seepage of polluted water from adjacent ruderal ground to north-west noted in May 2008.	Site interest (dune heath) partially destroyed. Replacement habitat (SD16 dune slack) can be considered unfavourable declining or partially destroyed.
399172 821956	0.25	SD12 acidic dune grassland in 1990 planted with fenced strip of young mixed plantation.	Site interest (SD12 grey dune) partially destroyed.
399307 821891	0.91	H11b dune heath in 1990 recorded as SD16 slack in 2006. Stock grazing probably responsible.	Site interest (dune heath) partially destroyed.
398968 821735	2.36	H11b dune heath in 1990 recorded only as extensive weedy (ruderal) vegetation in 2006.	Site interest (dune heath) partially destroyed.
398963 821612	0.59	SD12 acidic dune grassland recorded only as extensive weedy (ruderal) vegetation in 2006.	Site interest (SD12 grey dune) partially destroyed.
399057 821807	1.89	SD10 dune (considered to be SD12y type) in 1990 recorded only as extensive weedy (ruderal) vegetation in 2006.	Site interest (SD12 grey dune) partially destroyed.
399002 821099	0.27	Bare sand in 1990 recorded as Soft Rush *Juncus effusus* swamp in 2006, as very flat ground with over-deepened sectors, wet all year. Excavated since 1990 and used until recently for duck shooting. Without scraping and excavation, succession to H11b wet variant would have occurred (present on adjacent ground which was bare sand in 1990).	Site interest (dune heath) partially destroyed.
398830 821530	0.19	SD17 dune slack in 1990 now contains two excavated ponds with Soft Rush *Juncus effusus* swamp. Enclosed by banks, weed-infested. No record of ponds in 1990 target notes. Presumed excavated since 1990 and used until recently for duck shooting.	Site interest (SD17 humid dune slack) partially destroyed.

6.2 Foveran Botanical Site of Interest to Natural Science

The poor and declining habitats noted for the SSSI are also present within the SINS boundary. The SINS sector south of the SSSI boundary contains a young forestry plantation which is not appropriate use of high-quality dunes. If Common Standards Monitoring rules were applied to SINS it would be considered in unfavourable declining condition.

As with the SSSI sector, golf development would address the problem of declining condition. The forestry plantation would be removed and the ground restored to an appropriate habitat (probably the H10b wet variant).

6.3 Other ground

Land south of the SSSI is not grazed and has no major stock feeding impacts. There are localised nutrifying effects around bird cages formerly used to raise partridges for shooting. Vehicle tracks are extensive and have greatly fragmented some areas in slacks and dune heath. SDVSS results from 1999 suggest that little or no poor habitat management or change has occurred. There is scope for remediation in areas of young forestry plantation and around lines of straw bales positioned to provide shelter for birds.

Overall, this sector can be placed in favourable condition and this is a paradox when compared to the declining condition in the SSSI to the north. Ground of moderate and low interest will be targeted for use in mitigation of development impacts.

7.0 DIRECT AND INDIRECT IMPACTS OF THE DEVELOPMENT

7.1 Direct impacts on habitats and mitigation

7.1.1 Likely total direct habitat loss due to first course construction

Calculations of direct habitat loss for individual habitats are provided in Document 4 as part of the Hole-by-Hole analysis. Table 4 here updates the 2007 Environmental Statement totals for all habitats combined. It is based on totals in Table 3 and Table 4 of Document 4. As elsewhere, habitat totals in this section are split into three classes: key dune habitats of international, national and regional importance; other habitats of moderate interest and other habitats of low interest.

Table 4 Extents (ha) of likely direct habitat loss and habitat totals due to first golf course development

[1] 12.65 ha if mitigated by establishing grey dune and other habitat on stabilised sectors of the SSSI dome; 8.62 ha if, in addition, high quality grey dune and other habitat developed in transition rough is also counted as mitigation

Habitats	Menie Blown Sand Development Area		Foveran Links SSSI Menie Sector	
	Direct Habitat Loss	Habitat Total	Direct Habitat Loss	Habitat Total
Key dune habitats	35.08	182.78	19.35[1]	55.62
Other habitats, moderate interest	1.49	29.58	0.02	3.85
Other habitats, low interest	5.13	50.71	2.36	7.84
Total	41.70	263.08	21.72	67.32

There is little change in the nature conservation evaluation of site habitat and flora receptors, except for an increase in importance for some higher plant species. The key dune habitats present, within and outwith Foveran Links SSSI are considered to represent SSSI quality ground. This is the same level of valuation reached in the 2007 Environmental Statement.

Without considering mitigation, the quantities of key dune habitat loss indicated in Table 4 are considerable. They should be considered severe adverse.

7.1.2 Outline mitigation proposals

The applicant proposes to mitigate for all key habitat losses, in the SSSI sector and outwith on land further south. Most mitigation is proposed via the golf course design. Key dune habitats, dominated by grey dune, but also with dune heath, will be established on the SSSI dome. The wet southern foot of the dome within the SSSI will be used to establish new SD13 young dune slack, plus SD13 and SD16 habitat translocated from ground affected by the golf course within the SSSI.

These mitigation proposals, as outline totals, probably balance or exceed the direct losses of key dune habitat.

Detailed mitigation proposals will be drawn up by MEMAG. This will include appropriate construction method statements and planned phased turf stripping from donor sites on the golf course. Stripped turf will be placed in prepared appropriate receptor areas which will have conditions which will replicate the habitat transitions and mosaics already present.

A basic distinction is likely to involve different methods for wet and dry habitats. There is sufficient space to do this on site, within and outwith Foveran Links SSSI. The main mitigation method will involve habitat translocation. Some translocation will involve important species of flora. Wet and dry areas of habitats of moderate and low interest will be targeted as receptor areas. A map of potential wet and dry ground is given in Figure 6, derived from baseline data and using only habitats of moderate and low interest. These will receive turf and dune topsoils stripped from areas excavated for golf course construction.

Translocation on this scale (19.4 ha within the SSSI, 35.1 ha for the development area as a whole) is a very large project which has to be done in an environmentally sensitive way. Large-scale dune restoration by translocation has not been attempted before in Scotland. Staff training and development of specialist equipment will be needed before

An initial short demonstration of habitat translocation has been applied to slack, grey dune and semi-fixed dune in the south of the site. A contractor experienced in translocating semi-fixed dune was used. Each trial involved excavating a 2 m by 1m 30 cm deep turf and placing it upon a trailer, then transferring it from trailer back to excavation. This was very successful for the grey dune slab (a piece of SD12yy ground). There was moderate success for semi-fixed dune habitat, with some break-up of the slab. The slack trial resulted in very uneven ground restoration because the soil contained a high volume of shingle and cobbles, leading to breakage and stone loss.

All vegetation types in the trials are likely to recover within 1-2 years of the initial disturbance by translocation. This method is likely to be largely successful because dune vegetation can usually cope with some turf damage (e.g. rabbit burrowing and scraping) and will recover. Damaged ground offers bare soil for germination of annual species and perennial herbs which might be suppressed by competition on lightly grazed ground. In the short term it can increase species biodiversity. Further demonstrations are likely to improve procedures and increased success.

It is not certain that such translocation can be done entirely successfully. The author does, however, consider that it will be successful for large areas of translocated ground, if planned and controlled well via MEMAG. At least two-thirds of translocation is considered likely to be successful in the short term. This is probably a conservative estimate.

Given this level of confidence, residual impacts are likely to be low (of the order of 7 ha in the SSSI and 12 ha overall for the development). Such ground would be subject to remedial measures and it is likely that in the medium term this too would develop into good quality key dune habitat.

Given these short to medium term results, residual impacts will be low. This can probably be considerate as adverse moderate for the SSSI and adverse low for ground outside the SSSI. The 7 ha area for the SSSI is probably less than the area affected at present by ground in unfavourable condition.

As additional mitigation, all large extents of ground in unfavourable condition will be identified by MEMAG and restoration measures applied.

7.1.3 Strategic biodiversity objectives of mitigation and management

The strategic objective of mitigation and site environmental management will be no net loss of key dune habitats in the medium to long term. Habitat zonations and successional sequences will be retained on ground unaffected by course

construction. Elsewhere, in mitigation areas, they will be simulated. Overall habitat quality and biodiversity in the long term, particularly in the SSSI sector, will be better than at present.

7.2 Indirect habitat loss

There has been no further work to quantify likely habitat or species losses via indirect impacts. The sources of indirect impact are discussed in the 2007 Environmental Statement.

Potential indirect impacts will be established via literature review and visits to other golf course located in dunes important for nature conservation. Some sites are regarded to have high conservation interest due to the light touch of their site management (e.g. Royal St George's, Sandwich Bay – Doody 2001, Document 22). However, recent repeat NVC survey at Sandwich Bay revealed considerable habitat change which might involve indirect factors such as a rising dune watertable, the cause of which is uncertain (Dargie 2001, Document 22). Conflicting opinion will be scrutinised as part of the review process, to feed into a Menie EIA process operating via MEMAG.

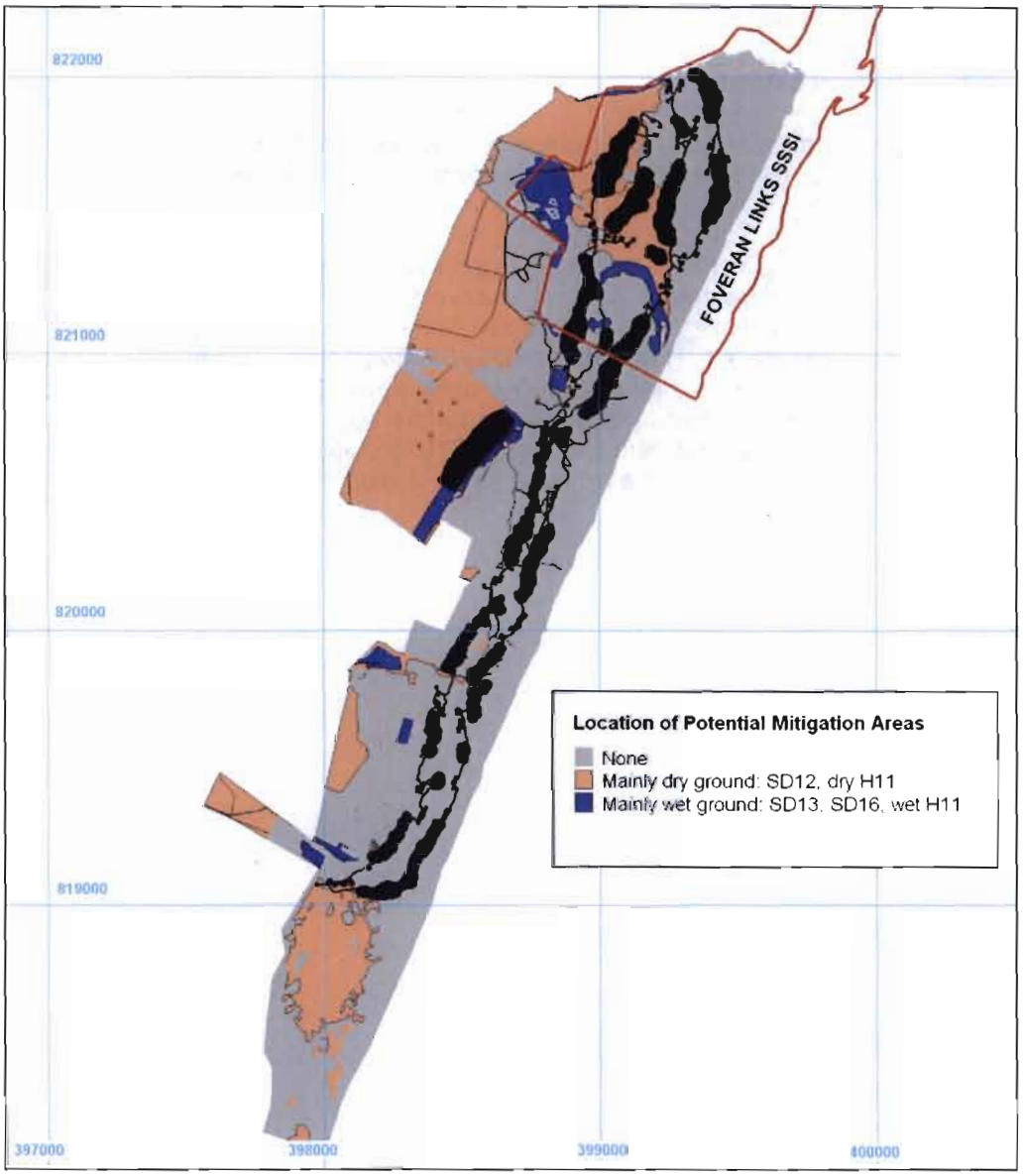

Figure 6 Wet and dry potential receptor areas of moderate and low nature conservation interest, for use in mitigation

7.3 Impacts on flora

7.3.1 Higher Plants

New locations for a population of Small Adder's-tongue *Ophioglossum azoricum* and two small *Pyrola media* populations were reported in the July 2007 Response to Aberdeenshire Council & Statutory Consultations. A reference in an October 2007 SNH report (Document 43) to a new *O. azoricum* population is actually the same as the July 2007 record.

All records have been added to a site rare plants GIS database. The status of some species has also been clarified and these produce changes in species rankings compared to the original ES. These changes are listed in Table 4. Status information is based on the JNCC Taxon Designations database (20080415).

7.3.2 Bryophytes

Dr Martha Newton has been contracted to undertake a bryophyte survey and this will probably take place in late May, too late to place results before the Inquiry. If a report is submitted during the Inquiry it might be referred to verbally if the surveys have found any species of national significance.

7.3.3 Lichens

No further survey has been undertaken. The main species of interest, *Leptogium palmatum*, is listed as Nationally Scarce and as Red List GB post 2001 in the JNCC Taxon Designations database.

7.3.4 Fungi

Annual surveys are likely. The main interests are in slacks and dune grassland and are probably of regional or national importance.

7.3.5 Impacts on species and important lichen and fungi areas

Potential impacts from golf development are high, with direct loss likely or possible in most locations. Important plant distributions are shown in Figures 6 and 7. All locations with likely problems have been discussed with the course designer.

Within Foveran Links SSSI potential damage or loss at a Hole 17 tee (*Leptogium palmatum*) will be avoided by moving the tee east of an existing track. Species on wet ground (young dune slack) around paths between Hole 14 and 15 can probably be avoided by routing the path along the edge of drier ground. The paths will be designed to maintain surface water flow and seepage. There is major interest on the fairway of Hole 18 and avoidance is impossible. Species material here will have to be translocated to suitable habitat elsewhere.

Outwith the SSSI there will be impacts on *Pyrola* at Hole 1, part of the large *Ophioglossum* population close to Hole 3, and widespread potential loss of lichen-rich grassland in an area marked as important by national experts.

Impacts on fungi are likely to be adverse severe in slacks and dune grasslands. Mitigation via translocation might be possible and will be monitored.

Table 5 Important and possibly important higher plants in the Menie development area

Species	UK and Scotland Status	Importance ranking	Notes
Curved sedge *Carex maritima*	UK BAP list, Priority Species (BAP 2007) IUCN Threatened (Red List GB) UK List of priority habitats and Species Nationally Scarce	National	No fruiting specimens seen in 2007, in contrast to several thousand in 2006
Rush-leaved Fescue *Festuca arenaria*	Nationally Scarce species	Regional	Not seen since 1999
Intermediate Wintergreen *Pyrola media*	Nationally scarce species Species for Conservation Action in Scotland (2008)	National	Dune slack is an unusual habitat for this species.
Small Adder's-tongue *Ophioglossum azoricum*	Nationally Scarce species	National	
Early Marsh-orchid *Dactylorhiza incarnata*	EC CITES: B UK BAP Priority Species BAP2007 2 Red List GB subspecies	Possibly national if either subspecies *cruenta* or *ochroleuca* are confirmed	Recorded in three 2006 quadrats, from largely spent flowers. Identification needs confirmation.

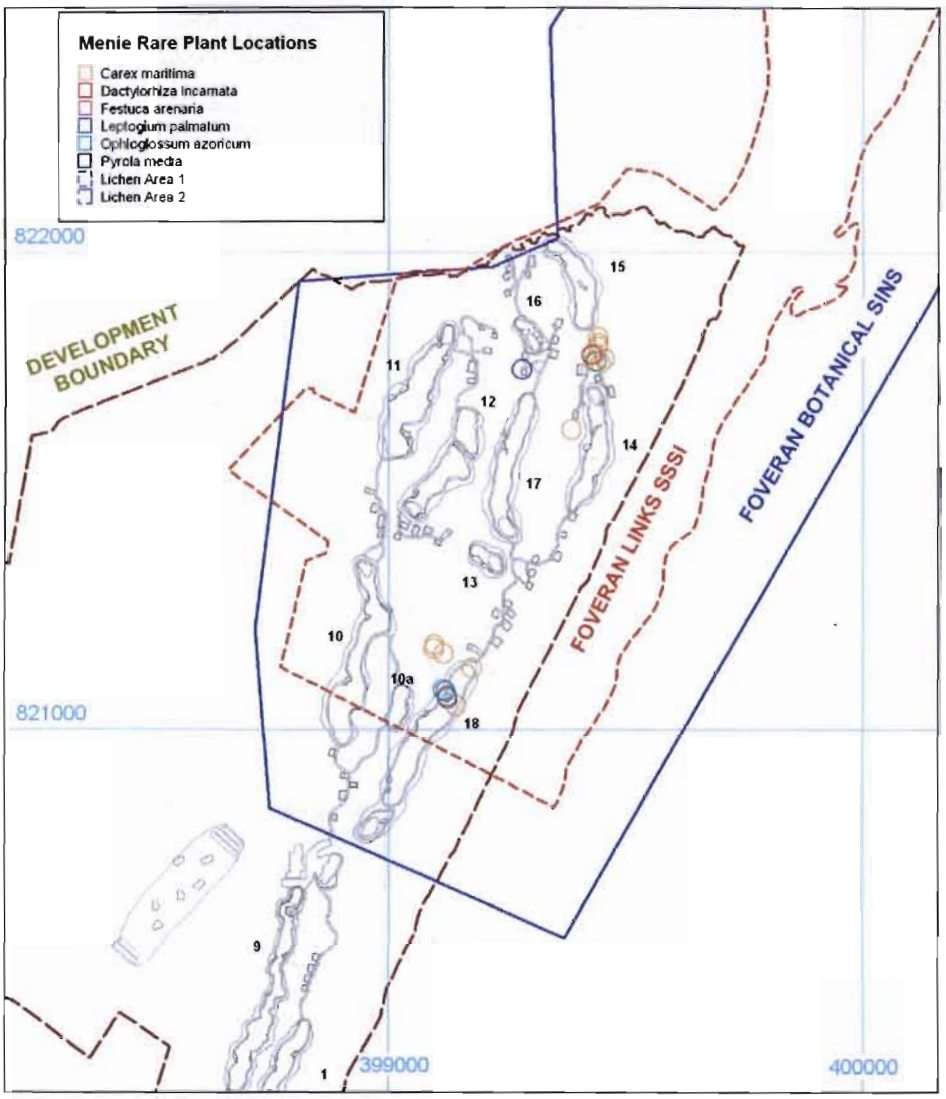

Figure 7 Important plant and lichen distribution in relation to revised golf course: Foveran Links SSSI and Foveran Botanical SINS

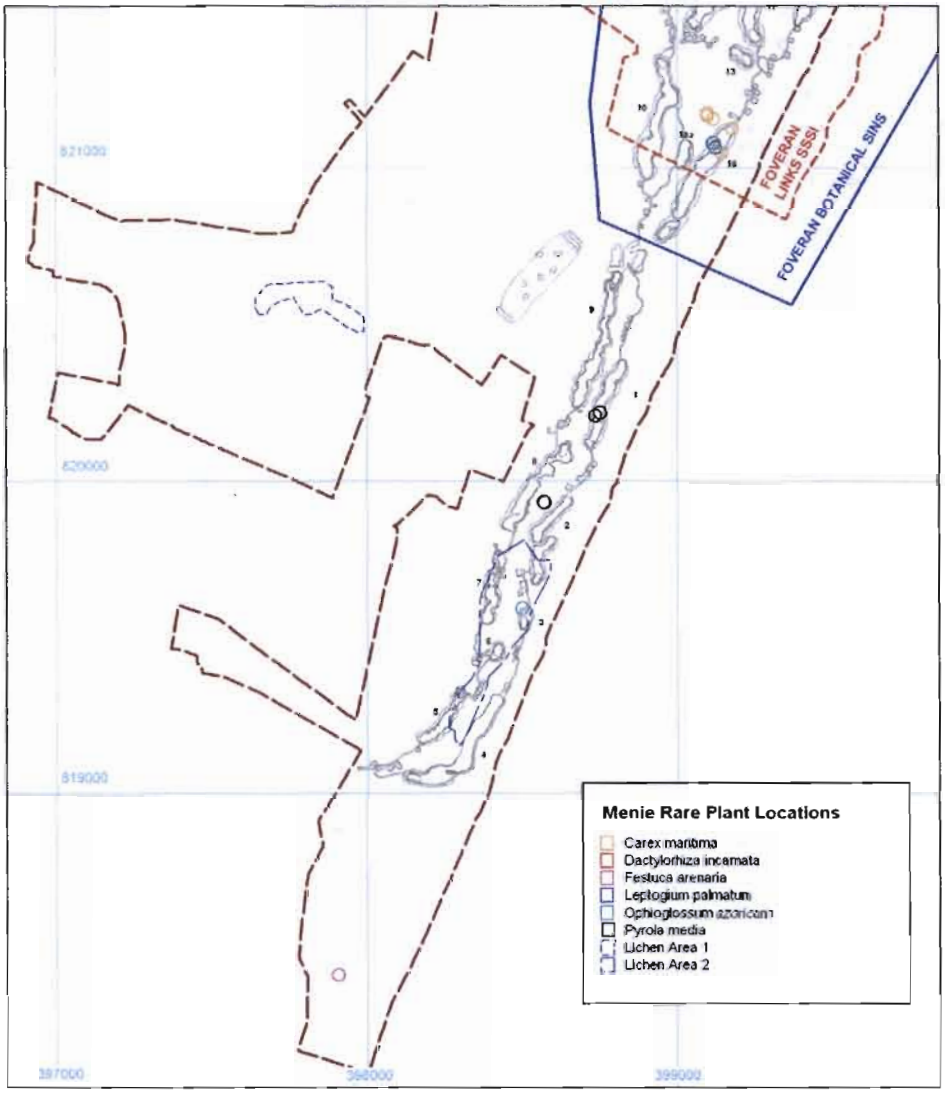

Figure 8 Important plant and lichen distribution in relation to revised golf course: ground outwith Foveran Links SSSI and Foveran Botanical SINS