Beaches of Caithness
A survey of the beach, dune and
dune pasture areas of Caithness

Commissioned by the Countryside Commission
for Scotland, 1970.
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Fronticespiece  Duncansby Stacks
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1. The General Setting

Background to the Survey

The beaches of Caithness are becoming increasingly popular as tourism and recreational areas. Large numbers of tourists visit the county, and the main tourist route, leading northwards from Wick to John o’ Groats and hence westwards to Thurso and beyond, skirts the coastline along most of its way. In addition there exists a demand for recreational facilities in the county itself, and some of the beach areas are beginning to be developed for both the local and the national markets. The most popular beach area, that of Dunnet Sands, has a tradition of instability, and it was an awareness of the potential dangers of making ill-advised decisions concerning the use of this and other beach areas which prompted the commissioning of this survey. While most of the proposed developments have been promoted by the local county council, the Countryside Commission for Scotland are interested in ensuring that any developments are along conservational lines. Thus the Commission, in exercise of their powers under Section 4(c) of the Countryside (Scotland) Act, 1967, commissioned Aberdeen University Geography Department to undertake an inventory of certain resources of selected beaches in the County of Caithness with a view to providing the Commission with basic data for conservation and recreation development planning. The following beaches were to be included for consideration: Sandside Bay, Thurso Bay, Murkle Bay, Dunnet Bay, Scotland’s Haven, John o’ Groats, Bay of Sannick, Freswick Bay and Sinclair’s Bay. The focus of attention in carrying out the survey was to be the physical characteristics of the beaches and beach materials, while other factors such as recreational use, land tenure and accessibility were also to be examined.
Figure 1 Location of Beaches
2. Purpose and Methods of Study

Against the background of an increasing use of the beaches and low, unconsolidated coastlines of Caithness, this report forms an inventory of the nature and state of stability of these coastal areas. The current land use is also described and the authors assess the possible effects of this and probable future land uses on the physical environments of the areas in question.

The presentation is largely in the form of large scale morphological maps which are supplemented by descriptive text arranged in regional units. Quantitative information on the nature of the beach and dune sands, is given in appendices.

The principal technique used in the field was large scale (1:5,280 and 1:3,520) landform mapping supplemented by observations of slopes, materials, vegetation and land use practices. Assessments were also made of current processes. Additional information was obtained from documentary and other sources and, if possible, interviews were sought with local land owners and interested parties. Extensive use was also made of photo-interpretation techniques using recent Ordnance Survey aerial photographs.
3. General Physical Factors

The remote, northeast-pointing promontory of Caithness with its level skyline of planes and plateaux stands as an outlier of lowland east coast landscapes separated from the analogous shoulder of Aberdeenshire and Banff by the great indentation of the Moray Firth. Although its individuality has been created by a multiplicity of historical and geographical factors, the sense of landscape unity which pervades Caithness is based firstly in the unity of the Old Red Sandstone bedrock which separates Caithness unambiguously from the igneous and metamorphic rocks of contiguous Sutherland.

3.1 Geology (Figure 2)

As shown on Figure 2 the solid geology of Caithness appears deceptively simple. Within the estimated 5,000–6,000m of ancient sediments lie considerable differences in lithology as, for example, between the fine grained flagstones, the friable red sandstones, the joint-weakened conglomerates of the southeast and the softer calcareous sandstone strata of parts of the north coast.

The fundamental divisions are as shown in the following column:

<table>
<thead>
<tr>
<th>Series</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>UPPER OLD RED SANDSTONE (Mainly Dunnet Headland)</td>
<td>False-bedded yellow and red sandstones. Various hardesses.</td>
</tr>
<tr>
<td>UPPER MIDDLE OLD RED SANDSTONE (Mainly John o’ Groats Series Sandstones)</td>
<td>Softer red and yellow sandstones.</td>
</tr>
<tr>
<td>MIDDLE OLD RED SANDSTONE (Generally known as Caithness Flagstone Group)</td>
<td>Fine grained mudstones, flagstones generally very hard and often impervious.</td>
</tr>
</tbody>
</table>

All three groups outcrop along the hundred-mile coastline of Caithness and apart from very localised volcanic and igneous intrusions form the framework of one of the most interesting coastlines in Great Britain.

The variations in the coastal plan and profile are frequently the result of local variations in lithology and the effects of faulting, jointing and local crushing and folding. More specifically, the key factor is the angle and attitude of these layers of different hardesses as they meet the sea. The tough, laminated flagstone rocks with their fine grain and complete filling of the minute pore spaces are practically watertight and extremely resistant to forces acting on their surface, but they are often easily undermined if even a single band of weaker strata can be reached by sea, spray or land drainage. The most spectacular scenery is found in the geos and stacks where resistant, gently dipping beds of a fundamentally high surface are attacked along vertical joint planes. Low cliffs with foreshore reefs are characteristic of large parts of the north coast especially between Duncansby and Mey, and between Holborn Head and Reay. Thus, although it can be demonstrated that the sandstones of the Upper Old Red Sandstone and the John o’ Groats Series are generally weaker than the Flagstone Series, the particular structural situation must be examined in detail before individual description can be made for each coastal section.
In relation to this report three important structural elements must be mentioned:

1. The group of faults which account for the downthrow and therefore preservation of the John o’ Groats Sandstone Group in the northeast of the county. Two of these faults run through beach areas which have been studied – at Sannick and Freswick Bays.

2. A group of faults which have given a rim of John o’ Groats sandstone to Gills Bay. The west fault of this system has created the depression of Scotland’s Haven.

3. The great fault which runs south from Brough to the southern boundary of the county. This fault appears to run beneath the dunes at the north end of Dunnet Bay and diverges southwards to pass under the links of the southern end.

Igneous intrusions are almost completely absent along the coastline except for a small volcanic neck at Ness of Duncansby and a relatively large area of diorite at Reay.

As a source of materials for coastline evolution the lithology is suitable for the production of sand (especially fine and medium sand) both by direct erosion and indirectly as a result of ice action.

### 3.2 Glaciation (Figure 2)

The passage of ice over Caithness at the maximum stage of glaciation consisting of a great sweeping arc from the southeast which passed over the low ground of the county and terminated in the Pentland Firth to the west of the Orkneys. Except for the southwest corner of the county, the characteristic deposit which masked the preglacial valleys and hollows is shelly boulder clay representing local rock sources and the rock and shell covered sea bed of the Moray Firth. There is a distinct absence of meltwater deposits of sands and gravels except in the northwest near the county border with Sutherland where great thicknesses of outwash sediments fill Strath Halladale and cover the adjacent cliff shorelines.

The till has been described (Crampton and Carruthers, 1914) as a reddish-brown gritty clay with shell fragments. It is rich in stones of various sizes most of which are of a local origin. It is remarkably tenacious and lacks stratification. The till is thin on the higher plateaux and interfluves but deep in pre-existing topographical hollows. Along the coastline it caps most rock cliffs and platforms and forms cliffs in its own right in a few places, notably at Scrabster.

At a later date, the Aberdeen-Lammermuir advance (Sissons, J. B., 1967, p.132) probably saw lobes of ice moving down the Thurso and Wick river valleys. Ground moraine often of a sandy nature and associated meltwater ridges and terraces of sands and gravels fill the lower courses of both rivers and isolated mounds are found in the interior of the county. Current research, however, appears to indicate that Caithness has been generally ice-free for a longer period than was implied by earlier workers. Considerable research, however, is still required to elucidate the detailed movements and chronology of glaciation in Caithness.

West of Reay the north-facing valleys carried considerable meltwater and vast quantities of unconsolidated materials must have been carried into the adjacent shallow offshore ground.
Figure 2  Geology and Glaciation
With the almost complete absence of relief barriers to force convergence of ice movement the general impression of the glacial period is one of slow-moving divergent ice flow, with little erosive power. The evidence consists mainly of depositional features and a general distinction appears to be possible between the till of most of the county which has a high clay content and is often tough and impermeable and sandier tills of a more local and possibly more recent origin in the area north and west of the lower Thurso River Valley. The latter material with its higher sand and shingle content and lower clay fraction (less than 10%) is of greater significance as a source of coastal sediments.

3.3 Climate (Figure 3)

Lying to the east of the mountains and high surfaces of Sutherland the rainfall of Caithness is predictably low, eg

<table>
<thead>
<tr>
<th>1968</th>
<th>J</th>
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<tbody>
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<td>Dounreay</td>
<td>2.20</td>
<td>2.04</td>
<td>2.72</td>
<td>2.12</td>
<td>0.78</td>
<td>1.65</td>
<td>2.86</td>
<td>2.71</td>
<td>2.84</td>
<td>4.72</td>
<td>2.87</td>
<td>3.51</td>
</tr>
<tr>
<td>Wick</td>
<td>2.43</td>
<td>2.21</td>
<td>2.02</td>
<td>2.17</td>
<td>1.28</td>
<td>1.31</td>
<td>2.46</td>
<td>2.91</td>
<td>2.56</td>
<td>2.71</td>
<td>1.92</td>
<td>2.89</td>
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<td>Totals:</td>
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<td>31.02 in.</td>
<td>26.87 in.</td>
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but the high latitude and cool summers, eg

<table>
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<th>1968</th>
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<tr>
<td>Dounreay</td>
<td>3.7</td>
<td>1.9</td>
<td>5.1</td>
<td>6.8</td>
<td>7.4</td>
<td>12.1</td>
<td>12.1</td>
<td>12.7</td>
<td>11.5</td>
<td>10.1</td>
<td>5.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Wick</td>
<td>2.9</td>
<td>1.9</td>
<td>4.8</td>
<td>5.9</td>
<td>6.5</td>
<td>10.9</td>
<td>11.5</td>
<td>12.1</td>
<td>11.3</td>
<td>9.9</td>
<td>6.0</td>
<td>4.5</td>
</tr>
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</table>

lead to low evapo-transpiration rates. If one considers the high degree of impermeability which is a characteristic of the Caithness Flagstone it is not surprising that the lower lying parts of the county are subject to at least seasonal waterlogging and the higher low gradient slopes and platforms are covered in peat. (In the latter context, however, it is probable that many of the peat beds are inherited, in part, from previous, more pluvious climatic phases.)

In some areas, there is the problem of impermeable rock lying beneath permeable till and/or blown sand and this has important consequences on the development of the supra-rock cliff profile where slumping and landslips are common. In the dune and links environment where sub-surface gradients are generally low, seasonal waterlogging may be of considerable geomorphological significance.
Wind directions at Wick for the east coast, and Kirkwall for the north coast have been plotted on Figure 3b. The derivations of the direction resultant of wind work is given in Appendix 4. In general the net direction of wind action is from the southwest in both areas. For marine action one may eliminate the sectors southwest to northeast for the east coast and south from the north coast, since there is negligible fetch for the wind to have any affect on wave action in these directions and thereby produce the resultants of Figure 3. This exercise gives a south-southeast direction for the east coast and a northwest direction for the north coast. Thus the general directions of wave action which will be modified by the local coastal configuration tend to converge on the direction of Duncansby Head.

Examination of wind statistics show that very strong winds can come from most compass directions but are especially significant from the northwest.

Offshore and tidal data are shown on Figure 4. Of greatest significance is the evidence from the Admiralty Charts that most of the Pentland Firth is floored by rock. Unconsolidated sediments which are mainly in the sand range occur near the coast west of Dunnet Head and great patches of shells are shown west of Holborn Head. Apart from shell sand deposits around Strama the remainder of the sea bed is rocky. The association of strong tidal races between the Orkneys generally and the northeast coast of Caithness might account for the absence of sediment in the eastern part of the Firth, although, the alternative suggestion that the sources of sediment, ie cliff erosion, rivers and glacial deposits, might be lacking is more plausible. Certainly the curve of the movement of ice towards the west (Figure 2) and the known distribution of extensive, thick fluvioglacial deposits along the coastline near the Sutherland border at Strath Halladale taken in conjunction with the general east-going movement of wave or current action would suggest that Dunnet Headland may well be acting as a large coastal groyne channelling materials into Dunnet Bay and hence explaining the almost complete absence of beaches between Dunnet Headland and Duncansby apart from the shell beaches near John o’ Groats and Sannick Bay.

Offshore information is lacking for the areas off the east coast of Caithness but large sand and shell areas are shown in association with the only beach areas along the coastline at Freswick and Sinclair’s Bay.

Figure 4 reveals that the greater part of the Caithness coastline plunges steeply to depths of over 20 fathoms and is therefore subjected to the unmitigated action of swell and storm waves. For the restricted areas of bays and beaches with gentle offshore gradients conditions are less severe. In the bays seabed sediments are within the reach of wave action and the effects of the powerful tidal races, overfalls and eddies are minimal. It is important to point out, however, that the prevalence of deep water and cliff sections makes the beaches of Caithness separate entities, isolated from each other and from the great nourishment zones which now appear beyond the reach of present wave action. The bays studied in this report appear with the exception of Dunnet Bay to be largely dependent on local sediment sources and the apparent abundance of unconsolidated sediments within 20km from the Caithness coast should be treated with great reserve and caution since these reserves lie beyond the 20 fathom line.
Figure 3a  Climatic Data – Temperature, Rainfall and Wind Frequency
Figure 3b  Climatic Data – Direction Resultant for Wind Action (Strengths greater than force 4)
Figure 4a  Offshore Data

TIDAL INFORMATION

<table>
<thead>
<tr>
<th></th>
<th>HIGH WATER</th>
<th>LOW WATER</th>
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<tr>
<td></td>
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<td>Mean</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>Neap</td>
</tr>
<tr>
<td>Thurso</td>
<td>14.1</td>
<td>10.5</td>
</tr>
<tr>
<td>Duncansby</td>
<td>10.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Wick</td>
<td>10.2</td>
<td>7.7</td>
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</tbody>
</table>

(Height in feet above datum of soundings)
Figure 4b  Tidal Currents
4. Background Human Factors

The coast of Caithness is one which varies from spectacular sandstone cliff scenery through low rocky shores to long stretches of dune-backed strands, and the degree of attraction to human settlement has varied accordingly. The cliff sections of the coastline are frequently backed by inhospitable moorland, underlain by peat of variable depths, which has never proved suitable for cultivation. On the other hand, the long beaches of Dunnet and Sinclair’s Bay have proved almost equally unattractive, the lightness, erodibility and dryness of the blown sand precluding cultivation as strictly as the waterlogged peat. The most favoured coastal stretches have been those with low cliffs or rocky shores, occasionally containing small beaches composed very largely of shell fragments. Thus the pattern of use and the relative attractiveness of the beach and related areas has tended to be rather different from that of the neighbouring county of Sutherland where the small beach areas have formed islands of agricultural desirability compared with the barren moorland environs. In Caithness arable land is more plentiful than in Sutherland or indeed in any of the other Crofting Counties, and its distribution is much less coastal (Figure 5). Although some beaches have been regarded as valuable assets in providing a source of high lime content shell sand which can be used to counteract the acidity of the soil, some of the beaches have been regarded as hazards in that sand blow could be a nuisance which “frequently hurts the neighbouring lands” (O.S.A., vol. 11, no. 18, p.245) by “drifting into the interior, covering up considerable tracts of arable lands” (N.S.A., vol. 15, pp.36–37).

During the late seventeenth and eighteenth centuries, the landscape of Caithness was radically altered. The driving force to these revolutionary, rather than evolutionary, changes was the famous Sir John Sinclair (Agricultural Sir John) although other improvers such as Traill of Rattar and Dunbar of Hempriggs also achieved remarkable results within their estates. As occurred elsewhere in Scotland at this time, the traditional settlement pattern focusing on the ferm toun and its Highland equivalents was replaced by a more dispersed pattern of individual farmsteads standing in their own fields. Clearly this new system of land holding could not accommodate all those formerly occupying the joint farms, and the surplus agricultural population were forced to look to new areas or new sources of income. Many new holdings were carved out of barren moorland by the displaced tenants, thus spreading the settlement away from the long cultivated, more fertile areas, while crofting came also to be followed as a subsidiary occupation by men turning their hand to fishing or work in the flagstone quarries. Thus at the same time as large, modern farms were being improved, many very small, often part-time, holdings were being created, frequently on the poor quality land. In some parts of the county the situation was aggravated by the reception of displaced tenants from Sutherland and the interior of Caithness. This juxtaposition of large and small units continued down through the nineteenth century and still remains to some extent today, although alleviated in part by the purchase of large farms and their subsequent subdivision into small family units by the Department of Agriculture and Fisheries for Scotland in the second and third decades of this century. Near the end of last century, in particular, considerable land hunger was felt, as is reflected by evidence presented by witnesses to the Napier and Deer Forest Commissions.

During the Improvements changes evolved in the use to which some of the beach areas were put. Prior to then, most of the links were held as common grazings. Dunnet Links, for example, was lot to flanking farms in the early part of the nineteenth century, except for a small area at the north end. Already by 1840, the parish minister of Dunnet had noticed that the stability of the dunes had increased with the process of division and protection. When held as common, the links were overstocked and subject to trampling, leading to the frequent blowing of sand inland (N.S.A., vol. 15, pp. 36–37). After division, however, “bent”
grass was able to become firmly established, and by 1840 the rapidly growing ridge of dunes had reached a height of 20–30ft. It may well be the case that a similar situation obtained on Keiss and Ackergill Links, where today only a very small portion remains as common. According to local inhabitants, the height of the dunes has increased considerably in living memory. At Sandside, although common grazing was permitted on the links, the crofters had to pay rental for this grazing in addition to their normal croft rent (Crofters Commission Minutes of Evidence, vol. 3, p.2399), which would suggest that there also the common grazing rights were no longer fully observed but had been whittled down during the Improvements. Thus the Caithness beach areas are not associated with common grazings in the same way as similar areas in other parts of the Crofting Counties.

Even during the most serious periods of land hunger, the physical limitations of the dune and blown sand areas for agriculture were realised and apparently no attempt was made to cultivate them, except perhaps for the occasional potato patch. However, the grazing value was held in higher esteem than the arable value, and in the 1890’s Dunnet Links were regarded as “fine pasture” (Royal Commission [Highlands and Islands, 1892] Minutes of Evidence, p. 550, para. 23475). Likewise, the minister of Reay parish writes in 1840 of the links at Sandside providing “excellent pasture” (N.S.A., vol. 15, no. 2, p.14). It may well have been the case here that the apparent lushness of the pasture led to its over-exploitation by over-grazing, since witnesses to the Napier Commission speak of the links being partially covered with bare sand and the digestive systems of the stock being upset by ingesting sand.

At the same time as lotting took place, the first efforts are likely to have been made at the draining of some of the wetter areas on the links (N.S.A., vol. 15, p.44), both at Dunnet and Sinclair’s Bay. While the repercussions of this draining are not recorded, they are likely to include changes in the vegetational composition. The possibility exists that the resultant lowering of the water table may have permitted a new phase of wind blow terminating in deflation to a new base level.

In addition to use as grazing areas, whether communally by crofters’ stock or by individual farmers’ stock, the dunes areas and beaches provided a source of shell sand which could be used to lower the soil acidity. During the Improvements, shell sand was applied in large quantities to land being brought into cultivation. In the parish of Olrig, for example, shell sand was applied at a rate of 20–25 loads per acre (N.S.A., vol. 15, p.62). Extraction at this rate must undoubtedly have affected the dune systems, especially since it would have presumably been concentrated into a fairly short period. Sand extraction still occurs at the present day, for liming arable land or pasture, and its influence on the physical characteristics of the beach areas can still be considerable, as at Freswick.

Attempts have been made to solve the problem of dune instability at Dunnet Bay for once and for all by the afforestation of dunes and blown sand areas such as has been successfully done at Culben. Although the erection of wicker fences and other measures have undoubtedly improved the dune stability, especially in the central part of the dunes, the strong exposure combined with the problem of water supply, has meant that tree growth has been extremely slow, or that the trees have failed completely. Thus the Forestry Commission has reluctantly been forced to abandon their plans, although the trees which became established remain.

Subsequent to the withdrawal of the Forestry Commission, recent trends beginning to emerge in the use of beach areas have been given expression by the purchase of the major part of the Dunnet dune system by
Figure 5  North East Caithness – Crofting and Moorland Areas
Caithness County Council. This purchase is motivated by a wish to promote recreational development of Dunnet Sands on a conservational basis. Although the larger links areas of Sandside, Dunnet and Sinclair’s Bay have been used as golf courses either in the past or at present, recreational use of the beach areas is a comparatively new phenomenon.

While intensity of use of the Caithness beach areas is still very small, their recreational potential is gradually coming to be realised, and in the future at least some of them are likely to find their main use in the field of recreation rather than in the more traditional uses. Unlike the situation in Sutherland, accessibility to the beaches of Caithness is not always easy as many of them are not close by main roads. It is significant that the intensity of recreational use is greatest at Dunnet, where the main A836 John o’ Groats to Thurso road skirts the dune ridge and passes within a very short distance of the beach. The high degree of accessibility, combined with scenic and recreational attractions, is reflected in the provision of caravanning and car-parking facilities which do not exist at the other beach areas. The only other beach easily accessible from an important tourist route is the Bay of Sannick, where many tourists stop for a short time en route for Duncansby Head. The rest of the beaches, ignoring the small units at Thurso and John o’ Groats, are by no means remotely situated from roads, but at the same time the road does not closely skirt the dunes or beach and the casual by passer may only be vaguely aware of the existence of the beach. Thus many thousands of tourists use the A9 road from Wick to John o’ Groats and pass the sands of Sinclair’s Bay and Freswick Bay without being attracted to stop. The same holds true for Sandside Bay, while local knowledge is necessary for visiting beaches such as Murkle Bay and Scotland’s Haven. In some ways scope thus exists for the imaginative and efficient use of the beach resources of the county, with levels of accessibility influencing the pattern of development to be permitted or encouraged. However, factors of accessibility and of scenic attraction must be considered in the light of the physical characteristics and capacities of the beaches which this report attempts to describe.
5. Regional Description of the Principal Beach, Dune and Dune Pasture Areas

The subsequent chapters describe and assess the beach, dune and dune pasture areas of Caithness. Each sub-chapter should be read in conjunction with the relevant geomorphological map. There is also additional information in the form of maps, diagrams and tables about vegetation, shelter, beach stability parameters and textural analyses.

Shelter index diagrams were compiled from field measurements using a variation on a standard forestry technique, viz. to measure the slope to the highest skyline in the eight compass directions. These shelter diagrams are given in Figure 6, and, in general, the larger the sector the greater the protection from that direction, and the larger the diagram the greater the all round protection of the beach.

Beach stability parameters consist of chord directions, ie the line joining the points where the low water marks of the beach meet the rock of the supporting headland and converge with high water mark. The orientation of this chord gives the alignment of the beach which, if the beach is in equilibrium, is at right angles to the most important direction of wave action. From the mid point of the chord (c) a perpendicular (p) is dropped to low water mark. The chord (c) divided by the perpendicular (p) gives the Index of Curvature (c/p). Experience elsewhere in the world has shown that the closer the Index of Curvature approaches unity the more stable the beach. A comparison of beach areas on either side of the perpendicular also reveals the direction in which the beach is tending to accrete or rotait.

\[ \frac{c}{p} \]

eg

\[ \text{anti-clockwise rotation} \]

\[ \text{clockwise rotation} \]

Sand samples were also collected from beach, dune and dune pasture areas. The samples were dried and sieved and the quantities passing through each British Standard sieve was weighed, the cumulative percentage calculated and the results plotted on semi-logarithm graph paper. From this graph the median diameter of sand and the quartile values can be abstracted. The median diameter or average grain diameter is related to the strength of the current that moved the sediment to the site of deposition. The difference between the 25% and 75% quartile values gives a measure of the spread of the distribution on either side of the median and as an index of the range of conditions and degree of turbulence in the transporting agent: the wider the spread the greater the range of conditions. The carbonate content, equivalent to the shell sand content of each sand sample was also defined by the carbon dioxide method.

All these results are tabulated in each regional description and consolidated tables are given in the Appendices.
Figure 6  Shelter Index
5.1 Sandside-Reay

Morphology (Figure 7.1); Plates 1 and 2.

Sandside Bay is situated in the northwest of Caithness, 8km east of the Sutherland boundary. The bay faces northwards and is contained by two Flagstone headlands. These headlands are reinforced by wide rock platforms where calcareous sandstone, mudstones and flagstones dip at 10–12° in a northwesterly direction. The eastern headland is lower and rises gently as a till-covered slope to just over 20m O.D. There is active cliff erosion in the southeast corner of the bay and a composite cliff of sandstone and relatively sandy till backs the abrasion platform. The western cliff which is again fronted by a boulder and shingle-covered rock platform is composed of a low (2–3m high) rock cliff which is surmounted by a low till-platform. Inland and northwards of the old stone-built harbour of Fresgoe the slope steepens appreciably and Sandside Head is over 50m O.D. The cliffs, here, are vertical or undercut and deep geos with associated reefs and stacks provide a dramatic contrast to the beach and dunes of Reay. Geological control is also important on the southern limit of the dunes and dune-pasture where the crescentic arc of Reay Diorite forms high, sloping ground just south of the main Thurso-Tongue road. Granitic rock also outcrops within the dune pasture area between the central streams, Reay Burn and the swiftly-flowing Burn of Isauld to the east.

Glacial till of a local origin which is perhaps related to a later series of ice-movements in the northwest corner of the county smooths-over the flanking slopes and has been exposed in good sections along all three streams draining into the bay. Outcrops of indurated till are also exposed beneath the sand where severe deflation has occurred.

The influence of glacial deposition is most clearly seen west of Sandside Burn where a ridge can be traced from its summit next to the stream — a prominent hill surmounted by blown sand and an archaeological site — to Fresgoe. This ridge is covered in blown sand but is easily identified to the east where it slopes gently to the junction with the main 5–10° slope descending from Sandside House and policies. The road to the harbour follows this natural depression. On the seawards side a distinctive break-in-slope can still be distinguished beneath the covering sand and has the appearance of a raised shoreline cliff. This slope can be traced discontinuously westwards between Sandside and Reay Burns where it fades-out against the side of the granitic bedrock mass which dominates the eastern half of the dune-links complex. Thus the pre-sand structure consists of an asymmetric rock depression which has been infilled by glacial deposits. This structure has imposed characteristic seawards-sloping sides to the beach-dune-links area.

Three large streams flow into the bay. In spite of their meandering appearance they are not completely graded to the present base-level. The Burn of Isauld in particular passes through a miniature rock-gorge section just before it passes into the beach. There are also short sections of rapids and all three streams display evidence of vigorous terrace formation and side-erosion undercutting. Since most of their courses are excavated in till, even to quite near the shore, they are still bringing down sand and shingle to the beach.

As a result of an abundant supply of sediment from the streams and the past and present erosion of the surrounding till-capped cliffs, the bay is sand-filled and the beach characteristically wide and thick. The vacillations of the stream outlets and of wave and tide action frequently reveals patches of glacially-derived shingle in the stream beds and under the beach. Many of these stones have not acquired the rounded shapes of marine shingle and are lag deposits from the erosion of earlier till-surfaces or derived from local stream transport.
In spite of its thickness, the great protection offered by the 1,000m long headlands on either side of the bay and the C/p index of 4.7, the upper beach is highly mobile. Field evidence in 1970, aerial photographs of 1946 and 1964 as well as a series of Ordnance Survey maps all show variations in beach outline. In particular the central stream, Reay Burn, often shows a tendency to be deflected up to 300m westwards by a spit-like prolongation of the berm which is almost invariably found on the upper beach. The general direction of beach drift is east to west which tends to imply a strong reflection of the prevailing northwest or north-northwest wave action. In spite of the evidence of short-term shifts in the shape of the beach there is no sign of beach erosion but there is evidence of dune undercutting and blow out development east of Reay Burn which might be correlated with this tendency for a westwards drift of beach materials.

Although the area occupied by the dune pasture, the golf-course and the links is relatively small, the area has undoubtedly sustained a long history of sand-blowing over a very wide area in the past. The spread of sand has been particularly marked over the gentle hillslopes north and east of the Burn of Isauld. There is an active area of dune accretion on top of the platform today but in the past the sand spread far inland where it is incorporated into the regular arable fields of the land surrounding Isauld House. A small spread occurred to the east of the bay and to the south across the line of the present main road. In the extreme southeast corner of the area mapped on Figure 7.1, there is an area of active erosion on this thin machair-like sward caused by severe rabbit and sheep grazing.

As a result of the constriction of the area, the steep slopes, the efficient drainage and the channelling of winds from the south and southeast into the general depression of Sandside-Reay the dune forms are remarkably high and hilly. There is, however, a contrast between the stable, continuous, accreting dune ridges of the western part of the bay and the high, eroding sandhills of the central and eastern sector.

The narrow triangle of dunes northwest of Sandside Burn is stable. Foredunes are encroaching on the upper beach. The stability is basically a product of the underlying till-framework and the absence of biotic interference. There is no sign of grazing and no evidence to suggest that grazing was ever important in this area. Unfortunately a deep sand quarry has opened-up recently in the area between the central ridge and the foredune. The Sandside Burn is also undercutting the west bank and the study of the 1964 aerial photography shows an appreciable retreat of the Cairn-topped central hill. Similar meanders of the stream have occurred in the recent past and fine, level terraces are found between the bridge and the sea.

The area between the Sandside Burn and the Reay Burn is mostly occupied by the golf course although the southwest corner is fenced-off for agricultural use. The evolution of the area is thus a combination of natural and man-induced processes. In nature the area would consist of strong, high, marram-clad foredunes sloping steeply seawards and landwards to meet the dune pasture which slopes at 3–5° westwards to the Sandside Burn on most of the area but at a slightly higher slope to the beach and the Reay Burn in the centre of the area. These slopes are essentially controlled by underlying rock and till formations and related more to the valleys of the streams than any product of dune evolution. Four areas of deflation have introduced flat-floored depressions into the surface. One area is active in its western corner today, the others have stabilised although they were also active in 1946. The stoney till basement has almost been reached in each of these areas and there is accordingly a tendency to water retention and marshiness. The vegetation (see Appendix 3) is also distinctive. Sand extraction perhaps associated with the military use of the area in World War II or with post-war construction in the surrounding area has also promoted V-shaped, deep blow out complexes in the main dune ridge. Two of these blow outs now extend through the ridge and blown sand is encroaching on
a small section of the golf fairways. As a result of this history of land use the area is crossed by several tracks and access to the dunes, but not directly to the beach, is easy across the golf-course.

The most severe erosion occurs immediately east of the Reay Burn. A high (20m O.D.) complex of conical sandhills and ridges, sloping steeply on all sides are interspersed by elongated and circular blow outs. Active sand erosion is prevalent and the impression of destruction is aggravated by a very large sand quarry which is eating back into the main dune complex and barely a few metres short of linking with a large blow out progressing landwards from the beach. This quarry must not be allowed to break through the remaining sand barrier or a large through-corridor will completely breach the dune ridge and could, in turn, lead to extensive destruction of a large area of the dune rampart.

East of the Reay Burn and the sand quarry the coastal dune is more stable. The dune barrier is wider and composed of successive whale-backed ridges which are aligned at right angles to the beach. The 1946 aerial photograph shows this to be an area of limited frontal erosion and sand drifting, and close inspection shows these fossil erosion features still extant but stabilised by marram grass.

The sand cover thins relatively rapidly inland as the surface slopes upwards to the granitic rock exposures which surmount this high (18–25m O.D.) frequently till-covered rock shoulder south and west of the Burn of Isauld. The area is again crossed by roads one of which leads to the large, occupied house near the footbridge over the burn. Leading north off this track is another shallow sand quarry which is now excavated down to the till basement. Between this track and the main Thurso road is a long east-west active deflation area. Blow outs, undercut edges and remnant, mushroom-shaped sand hills create a chaotic topography which is carpeted in summer with an atypical vegetation of agricultural weeds, bird's-foot trefoil and horsetails. The net effect is a curiously attractive landscape which continues to expand northwards as a result of local sand-digging and linear blow out extensions which are generated by southeast winds.

Sandside-Reay for its relatively small size is probably the most complex area in Caithness. Sand quarrying on large and small scales for the shell-rich (over 40%), coarse (400–500 microns, mean diameter) sand conveniently located near what was possibly one of the most intensive and largest construction phases in the Highlands, that is for Dounreay in the 1950's and, earlier, for military and agricultural purposes, has been a major force in shaping the evolution of the area. The proximity of the main road and the village of Reay, (for this area is the only beach/dune area in Caithness which has a settlement of any size sited near it) has led to a long history of use. There are no records of grazing by stock having been important in the immediate past although formerly the lands were common grazings. In the early 1950's an epidemic of rabbits was recorded. The archaeological site near the Sandside Burn as well as other old buildings on the east side of the bay testify to a long history of occupancy and use. The land use today consists of farmland or recreation in the form of a golf course. When one underpins the natural elements of concentrated drainage, ridges of glacial till and variable bedrock it is hardly surprising that the area is complex. Moreover the area has the appearance of instability and erosion as a result of biotic pressures but is naturally stable and resilient.

Paradoxically tourist or recreational pressure on the beach and dunes is relatively slight in spite of the proximity of Thurso and Reay and the apparent ease of access. Closer analysis, however, reveals that the side road to Fresgoe harbour is poorly indicated and, to the stranger, does not appear to lead to the beach. Apart from a limited number of points where a car may be taken off the road there are no parking facilities.
The other tracks all cross the golf course; they appear to be, and may actually be, private access roads to the sand quarries or property. Several footpaths exist but all require a relatively long walk to a beach and dune area which is not easily seen from the access points. The area is generally surrounded by well-fenced and dyked high quality agricultural land or houses and gardens so there is a sense of enclosure which might induce the passing tourist to travel on to the beaches of Sutherland at Melvich or Strathy or seek the more accessible and popular beach of Dunnet Bay.

Against this background it is impossible to make positive recommendations for Sandside Bay. Apart from the control of blow outs by fences and tipping (currently being practiced by the Golf Club), and the suggestion that limits should be set to quarrying, no sweeping changes can be envisaged, and it is questionable if any change in the pattern of use is required.
Plate 1  Sandside Bay – Dune accretion near mouth of Sandside Burn.

Plate 2  Sandside Bay – Sand extraction pit.
5.2 Thurso Bay

Morphology (Figure 7.2).

Although sand dunes are not found in Thurso-Scrabster Bay there are two relatively extensive sand beaches and, at Scrabster, slumping cliffs of glacial till. The erosion of the latter is of some concern as it has already led to the closure of the road along Bishop’s Walk at the Braes of Scrabster and the changes which appear to be occurring in both beach areas are also of some importance to the communities of Scrabster and Thurso. There is also a proposal to extend the existing harbour jetty at Scrabster by approximately 220m eastwards, obliquely into the bay and a preliminary appraisal of current shoreline trends in the bay as a whole is a necessary adjunct to this development.

Strongly supported by flagstone headlands and associated shore reefs, especially on the east side of the bay, the 2.5km wide bay faces north-eastwards to Dunnet Head. Although protected to some extent by the shoal area of The Grounds, the bay is also open to the north and, in particular Thurso harbour is exposed to the north-northwest the direction of the wind resultant as described in Chapter 3.

The offshore gradient is 1:55 which is relatively steep and allows large waves to approach close to the shoreline before breaking. Chart information shows the bay to be largely floored with unconsolidated sediments which are derived from the Thurso River which enters at the extreme east corner of the bay and the erosion of the 25–30m till-cliffs at Scrabster. It is probable, however, that this cover of superficial deposits is thin and overlies a rocky extension of the dipping shore reefs which are characteristic of the central and eastern littorals of the bay.

The essential physiographic elements are as shown, there are thus three main coastal divisions:
1. Braes of Scrabster and its beach;  
2. the central convex portion of Victoria Walk, and  
3. Thurso beach.

Although not a problem of coastal evolution which can be related to marine action the severe slumping of the till-cliffs of the Braes of Scrabster indicate the importance of land processes in the coastal zone. Already the old metalled road along the coast has been closed and some restorative dumping of rubble and earth is being conducted on the west side of the erosion scar. The cliff is composed of a more than 30m thick deposit of typical Caithness gritty-clay till which is liberally charged with sub-rounded and sub-angular boulders some of which are up to 1m in diameter but the main size range is 10–25cm. Both these materials are well-represented on the sand beach below the cliff as lag deposits.

The general process of erosion has undoubtedly been a continuing event for many years and in the early stages was probably accelerated by wave undercutting and spray action; the latter inhibiting the maintenance of a suitable protection of vegetation. The dramatic increase in erosion appears to date from only the last twenty years and, in particular, the period of house-building at Braes of Scrabster associated with the general urban expansion of Thurso which was related to the U.K.A.E.A. expansion at Dounreay. Alterations in subsurface drainage and the unfortunate combination of severe freeze and thaw cycles followed by heavy rain and gales caused severe landslipping. With its known clay and ground water content the cliffs at Braes of Scrabster can never be regarded as stable landform elements until the slope retreats back to an equilibrium position and has a slope angle conforming to the angle of the rest of the constituent materials.

A pertinent observation of the beach, however, is the fact that the sandy nature of the foreshore is thinning and revealing the shore-reef basement and increasingly large shingle and gravel patches. This change may be related to the building of the necessary protective stone sea wall in the west-angle of the bay or to other alterations in the circulation of marine processes in the bay. At high tides wave action now washes the base of the materials slumped from the cliff erosion. It is conceivable that this washing could under severe storm conditions become an undercutting process and the partly-vegetated lower slope could be reactivated. ie

Separating the Braes of Scrabster from Thurso beach is the cliff and geo section of gently dipping flagstone strata. This highly indented rock coastline juts out in a gentle arc into the bay and with its considerable foreshore width of transverse rock reefs, dipping gently north-westwards, effectively hinders any direct sediment exchange between the two beach elements of the bay. Although capped by up to 3m of stoney
clay till and also containing evidence of cliff retreat as a result of the undercutting of softer beds in the flagstone series the general evolution of this attractive and accessible low-cliff zone is extremely slow.

It might be suggested that the scenic attraction as well as the physiographic and geological interests of this cliff section could be promoted and the existing footpath along Victoria Walk improved.

Thurso beach faces north-northwest and is contained between vertical flagstone cliffs on the west and the breakwater on the east. Originally the eastern limit was the great expanse of rock reefs – the Long Skerries and the Slates and the outlet of the Thurso River. The beach is backed by a high-angle sea wall which adjoins the breakwater in the east and protects the old fishing and trading-port nucleus of the town. Towards the west the sea wall gives way about a third of the way along the length of the beach to a low parapet set back from high water mark. This latter area is generally termed the esplanade and the beach here appears to be thick, wide and stable although occasional patches of shingle are revealed where local wave action or ebb-tide drainage has temporarily removed the superficial cover. Near the sea wall-breakwater section of the beach the sandy area is narrower, flatter and large continuous strips of shingle and cobbles are exposed on the upper beach. A storm ridge of 5–20cm sized shingle frequently builds up against part of the sea wall emphasising the exposure and lack of protection in the east corner of the bay. Significantly this cover faces north-northwest into the open fetch just to the east of Holborn Head which shelters the remainder of the bay. The depression of the Crook, channelled by Kirk Ebb undoubtedly causes the wave front to become sinuous with a destructive convergence on the breakwater when the wave front is from a north or northwesterly direction. This convergence multiplies the energy of the wave front and it is not surprising that the breakwater has given way at the section near the outer angle. The other convergence zone occurs approximately 100m west of the innermost angle of the beach which was the first point, significantly, to have a protective wall. Reflection of this energy off the breakwater and sea wall has flattened the beach and allowed bigger waves to come closer in thus worsening the problem. It is again an example of the near-impossible problem of compromising between beach conservation, harbour construction and the protection of shoreside property. It is suggested, however, that should the breakwater be rebuilt some consideration might be given to deflecting or breaking the force of the waves in The Crook as the first line of defence for the eastern angle of Thurso Beach.
5.3 Murkle Bay

Morphology (Figure 7.3); Plates 3 and 4.

Murkle Bay is a small embayment within the larger unit of Dunnet Bay three miles east of Thurso. The bay, which faces the northeast, contains a small shell sand beach about 300m long with a gently shelving intertidal zone almost 200m wide. Inland a shallow, open valley focussing on the bay head is drained by a small stream, and most of the land backing the beach is gently sloping and does not exceed 30m in height. Although the axis of the valley and bay is not fault-guided, a number of minor faults criss-cross, the main directions being north-south and east-west. These faults occur in the Caithness Flags, and since they do not separate rocks of different types and different resistances to erosion their morphological significance is very limited. The north headland of the bay takes the form of a wide abrasion platform backed by an inactive, grassed cliff of no great height. On the south side, the cliff is less subdued, although only about 4m in height, and shows some signs of active erosion in places. A generally fairly thin veneer of till blankets the bedrock over most of the area.

The bay is very sheltered from wave action, being fully open only to the northeast quarter. The fetch in this direction is, however, very short, being only two or three miles across Dunnet Bay. Furthermore, storm winds from this quarter are infrequent so that large waves are most unlikely to be generated. In addition to the unfavourable conditions for wave generation, the beach is fronted by a wide abrasion platform on which the wave energy can be dissipated, so that little energy is available for erosional work. On the north headland, the grassed-over cliff is clearly not being eroded by wave action, while on the south side erosion is only proceeding very slowly and in some places is not occurring at all, although some rockfalls may be affecting the cliff. The amount of sediment supply derived from the marine erosion of the sandstone cliffs is thus very small, although small quantities may come from the slumping of the thin till cover. A second possible source of sediment for beach construction is the Murkle Burn. This stream, which flows along a slightly asymmetrical valley within the broad open valley of which the bay forms the seawards extension, is able to achieve only a very limited amount of erosional work and thus can be expected to supply only very small quantities of sediment. It may, however, function as a recycling agent for sand blown inland, and the accumulations of sand near the burn mouth suggest that this function is of some significance. The third possible source of beach sediment is from the offshore zone. Much of Dunnet Bay is sand floored, although the ground immediately offshore from the bay is largely of weedcovered reefs. More important than the supply of mineral sand from offshore will, however, be the supply of shell debris. On the north side of the bay, the beach thins out to a fringe of broken shell fragments (CaCO₃ content falls from 63.8% at the north end of the bay to 30.0% in the middle), which become more finely comminuted towards the bay head, and it would seem that the bay is the accumulation area for shell debris washed off the abrasion platform and reefs around the bay as well as from dwellers on the offshore reefs or sand banks. Since shell production would be expected to have reached an equilibrium, the supply of sediment is likely to be constant rather than fluctuating, although the supply rate will be fairly slow.

The dune front shows little sign of undercutting by wave attack, and the marine processes are constructional rather than destructive. The waves are impotent to move coarse shingle or cobbles, both of which occur on the coast outside the bay and on the headlands, but fine shingle and gravel occurs in small quantities on the beach and may well underly the shell sand, being exposed only after a period of stormy weather when the beach has been combed down. Near the stream mouth sand seems to be accumulating and tending to deflect the mouth slightly to the south, suggesting that the net direction of drift may be in that direction.
A number of berm-like forms, bearing witness to the constructional processes in operation, ridge the nourishment zone between the high water mark and dune front. This nourishment zone is about 8m wide and is thick and fairly steeply sloping. Thus conditions are favourable for the ready supply of sand for dune construction. Only winds from the northeast quarter, however, can work on the nourishment zone in such a way as to build dune features, and these winds are infrequent. More frequent are southwesterlies which may well tend to operate in the opposite direction, blowing sand back below high water mark so that complex systems of recirculation may occur. In this “low energy” environment, dune development has not proceeded to an advanced stage, and the dune relief tends to be low and subdued. Active accretion is still occurring with lyme grass (*Elymus arenarius*) acting as the primary colonist, but the foredunes do not develop into high ridges. Although the main blown sand area with low ridge accumulations is largely confined by the old cliff line, the movement of blown sand has been able to surmount this obstacle and to form a thin spread in some of the cliff-top area, although the total area affected is small.

Despite the continued accretion at the dune front, the dune and blown sand system is not very active and there are few signs of dune or sand erosion brought about by natural physical conditions. The situation has been greatly complicated by human, and to a much lesser extent, biotic factors. The high lime content makes the bay an attractive source of shell sand for agricultural purposes, and extraction has taken place over a long period of time. Sand has been taken from the dune accumulations against the fossil cliff-foot at the south end of the beach, and also takes place from the beach itself. Here the thickness of the nourishment zone makes possible the easy removal of sand, while sand is also taken from near the stream mouth which might otherwise have a tendency to become choked. The fact that dune accretion still manages to occur despite this extraction is eloquent testimony to the fact that sand supply is not so much the limiting factor to dune building as lack of winds from suitable directions. In addition to the direct effects of extraction, certain indirect effects may be betrayed by the presence of small blow out scars orientated in a northwest to southeast direction leading inland from where the cliff-foot dune ridges have been removed at the south end of the beach. Some scarring is also evident at the complementary position at the north end of the beach, below Mains of Murkle. Here the accumulation is in the form of a spread of sand rather than dunes, and rabbit burrowing has pitted the surface in places, although no large blow outs have occurred. Other direct or indirect human and biotic processes are not of significance and there is no sign of detrimental overgrazing on the limited areas of blown sand pasture.

Murkle Bay appears to be fairly popular as a recreational area for the inhabitants of Thurso and its environs, and on a fine weekend a considerable number of cars may be parked at the end of the access road. The beach is not easily accessible however, being situated off the main road from which a narrow metalled but rough track leads to it. The track is unsignposted, and the casual tourist is unlikely to stumble upon the bay by chance. The main function of the track, which separates the land of East Murkle farm on the east side from that of the Department of Agriculture and Fisheries for Scotland on the west side, seems to be to permit access for agricultural machinery to the flanking fields, and to allow sand extraction. The surface is not really suited for motor cars, and the car parking facilities at the end of the road are not good. In addition to the problems of accessibility to the beach are those concerned with the visual amenity. While sand extraction in itself has effects on the evolution of the beach area, more important,
on the short-term at least, are the associated visual impressions. It is understood that the Department of Agriculture and Fisheries for Scotland has already stopped extraction except for small quantities of sand at the stream mouth, at the suggestion of the county council. On the southeast of the beach the extraction rights are leased by East Murkle farm to a Thurso sand merchant. On the long-term, sand extraction undoubtedly will prevent or slow down the natural evolution of the dune and blown sand area, although it could be argued that little direct harm is being caused at present. On the short-term, however, it must be recommended, if Murkle Bay is to be considered an amenity area, that steps be taken to remove the extraction plant.

In terms of the recreational development of the bay, it is most unlikely that a major scheme such as the provision of a caravan site would be contemplated, and the pattern of use is likely to continue as one of visits by local people rather than tourists. The physical capacity of the beach is limited by accessibility and car parking problems, and the restricted size of the beach rather than by factors pertaining to its physical conservation. If extraction were to be stopped, however, over a long-term period the dune system would develop in such a way as to increase the capacity of the beach area for picnic-makers as well as probably improving the overall visual amenity.

An alternative recommendation might be that, since the area is small, relatively inaccessible and untidy, it might be left as a beach where sand extraction be permitted. This might allow the concentration of conservational efforts elsewhere where the “intrinsic” resource is better.
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Plate 3  Murkle Bay – Derelict sand extraction plant.

Plate 4  Murkle Bay – Sand extraction from stream mouth.
5.4 Dunnet Bay

Morphology (Figure 7.4); Plates 5, 6 and 7

The 4km wide entrance to the 6km deep embayment of Dunnet Bay faces northwest and acts as a great coastal funnel channelling sediments of shell and silicious sand to the great sweep of Dunnet Sands and its backing dunes and links. Inland, this depression, which conforms in part to the boundary between Upper Old Red Sandstone and Caithness Flagstone, extends south-eastwards across the county to the east coast where Sinclair’s Bay forms its natural counterbalance.

The high sandstone cliffs of Dunnet Headland and the low flagstone platform of the south shore maintain the beach as a completely stable unit which can only shift landwards. The only escape for excess sand accumulating on the beach is inland to the dunes and links, and it is not surprising that the height and extent of the dune system and the landwards expansion of over 3km of blown sand towards Loch Heilen is so great.

The c/p index of 6.0 indicates that the beach is stable and the shape of the curve of low water mark shows near perfect symmetry. Offshore the gradient of the sand-covered sea floor is 1:124 which implies a continuing reserve of sediments in the Bay. To the landwards the links spread south-eastwards over a till surface which slopes relatively steeply at 1:12–120 towards the main drainage axis of the area, the Burn of Midsand, in the centre-south of the region. Elsewhere the interior plain tends to be flat and marshy. Towards the interior the blown sand covers peat beds which overlie, in turn, the clay-till basement. The drainage condition of this generally flat or gently sloping links surface east of the Castletown-Dunnet road is of considerable significance since, in some areas, the links are wet, flat and stable as a result of seepage: other areas are subjected seasonally to stream erosion and the exposed sand banks may blow in summer: other areas, especially the inter-stream ridges, are drier and carry irregular recently mobile sand hillocks.

As the terminus of a major depression in the Caithness plateau, nine relatively large streams flow into the bay and tend to subdivide the dunes into separate units of variable size and stability. The amount of fresh water reaching the beach makes the lower beach wet and may be a factor in explaining the flatness (0–2° gradient) and compactness of the sand surface. The upper beach, however, is generally wide and the relatively fine-grained sand (205 microns) moves easily from beach to dune.

Apart from the main dividing line of the Castletown to Dunnet road which generally separates the dune environment from the more stable links area, subsidiary divisions have been created by the stream courses and the great erosion corridors which run back transversely from the beach through the main dune ridge. These blow outs and their associated redepositional sandhills occasionally reach the main road and in winter sand is often carried across this road towards the links area. Because of the height of the main dune barrier which is a single ridge-unit the blow outs have a most spectacular appearance. Frequently they are 10–12m deep, asymmetric in cross-section and almost devoid of vegetation. In most examples the initially linear sand corridor has broadened out by lateral erosion so that great troughs 30–40m wide are found in at least five areas. As shown on Figure 7.4, most of the blow outs have become compound with residual pinnacles of the original surface left in the centre of the bare sand surface. South of the central dividing stream the two main blow outs are active, and steep 20–25° backslopes are found immediately to the rear of the blow out corridor. It is at these points that bare sand continues to spill over as fans and lobes of unconsolidated material. The terminal parts of these blow outs are invariably the most active zones especially where the sand corridor narrows, and turns obliquely to its main axis.
Between the large blow outs (the largest of which in the south is being partially controlled by fences to trap the flow of sand), smaller V-shaped and trench-like blow outs break-up the dune front which is itself high, steep and undercut by wind action. The dune barrier is thus of great diversity and relief with this juxtaposition of vigorous erosion and redeposition through the impressive but recent high foredune ridge.

A distinctive concave break of slope marks the transition from the active marram-clad dune backslope and the beginning of the low angle links surfaces. Apart from a disorderly hillock and ridge complex in the extreme southern angle of the bay in an area which has also been modified by tipping sometime in the relatively recent past, and a semi-circular plateau of sand near the main road about 500m east of the junction of this road with the Sea road to the old airfield, there is a general uniformity in the beach/dune/links profile. The steepness of the backslope of the dunes is probably due to the frequency of strong winds from the southeast which are channelled across the county by the major corridor already described. This to and fro passage of the wind is a striking feature of the dune development at Dunnet Bay since it probably accounts for the vigour and rate of development of the erosion corridors. The blow outs also have a degree of uniformity as shown in the insets to Figure 7.4 where the reversal in gradient between the blow out floor and the backslope of the main dune create an added dimension to the already highly multiform relief.

Although the processes of development were identical and undoubtedly recent the stage of development of the dune system in general is later and more stable north of the central stream. Although, in part, this may be due to natural processes the critical factor in the stabilisation of the worst blow out complexes is due to man. Consequent upon the land tenure passing to the Forestry Commission the blow outs and the dune front over the greater part of the north-central part of the bay has been stabilised by brushwood and the planting of coniferous trees. The tree planting was an extension of the larger programme of converting a large part of the Links of Dunnet to coniferous plantations. Commercially the venture was unsuccessful since the growth rates are too slow and the maintenance costs too high. The establishment costs were also of a high order. Nevertheless the stabilisation of the two great blow out and erosion areas, the one immediately north of the central stream and the other some 1,000m northwards, has been a major positive force in controlling what would have been a threat to the total stability of, at least, the northern part of the dune barrier. In spite of successfully “freezing” the landforms at stages of instability there is little sign of a resurgence of erosion although with the continuing presence of over-steep slopes and topographical depressions which still channel onshore winds to dangerous velocities it would be most unwise to relax surveillance of these areas.

Between the stabilised areas the dune belt is over 350m wide, the dune barrier high (12–20m), and the seawards face more stable. There are even prograding coastal dunes in the centre of this northern part. Only two active, large-scale blow outs break the dune barrier: the southern one is exceptionally wide but not deep, the northern one deep and in its southern bifurcation very active at present. Both blow outs, however, are imperfectly controlled by low fences across these seawards openings. In the northern blow out shingle is found at the erosion base. This shingle is of the same calibre and type as is found in other blow outs to the south. Apart from tapering spreads of shingle associated with the rock platforms which form the pre-cliff boundaries of the beach, this shingle beneath the blow out floors appears to suggest that the dune basement might be partially composed of shingle ridges and bars. As no height readings were available it is not known if these shingle forms are related to the present or to a former higher sea level.

The dune system narrows northwards towards the most used portion of the beach. This area is north of the forestry plantings and crossed by five moderately sized streams. The sand yachting club house, a car park,
a caravan site and easy beach access lead to disproportional pressure on this northern corner. This pressure of people is much greater than at the two other access points, ie the central stream area where the beach comes relatively close to the main road and car parking is available and the south corner where several tracks and parking sites are also available.

With the aid of fences the stream courses have effectively confined this area of relatively heavy use to a beach length of approximately 400m. The foredunes here are variable in height ranging from as low as 2.5–7m. Apart from a few specific localities these dunes are stable and the gently undulating and frequently hilly dune pasture behind the dune is equally stable. It is almost 500m south of this zone before one reaches a dune area which could be described as being at a stage of erosion. The beach is also stable, wide and fringed by a protective storm ridge of shingle. Thus the low relief and generally gently sloping or undulating landforms of this northern area seems the ideal choice for the development of further recreational and tourist facilities. The only area of erosion is immediately beside the car park and is caused by pedestrians crossing the dunes at various ill-defined points to reach the beach. Small-scale circular blow outs and duneface slumping has occurred and from the nature of the adjacent landforms and the presence of pioneer plant species on the upper beach, there can be no doubt that this is man-induced erosion.

Between the sand yachting club house, the rock platform and the village of Dunnet the sand thins out irregularly in the form of marshy depressions and intervening low hills and ridges. There is no unity or organisation about the landforms on either side of the main road. The area is best described as transitional to the glacial till surface, where it is gently sloping the sand is smooth; where the sub-sand relief is higher there is a complex of mature sand ridges.

The vegetation conforms closely to the pattern of landforms. Except where tree planting has occurred marram tussocks and the normal array of early dune species dominate most of the area west of the main road. Near the old and new blow outs marram is almost exclusively dominant and grows in large, tough tussocks up to 1m in diameter. The regularity of the distribution of these tussocks with the intervening paths of bare sand have a most regular, almost artificial appearance and they are undoubtedly stabilising these surfaces most efficiently, and in the absence of grazing even by rabbits (for scarcely any were seen during the course of the survey work), burning or cutting the vegetation seems quite capable of maintaining and improving the total stability of the area.

The anomalous features are the large active blow out complexes. There is abundant sand on the foreshore for nourishment and build-up as is proved by the height and vigour of the inter-blow out dune ridges. There is no pressure of livestock or pedestrians and no evidence of malpractices such as grass burning. The area is fenced and protected. But these blow outs exist and are extending. Moreover, the greater part of the dune front is oversteepened, slumping and in places undercut. There is no relationship between the location of the blow outs and their position in the sweep of the bay. Drainage conditions, offshore sediment supply and local wind patterns all give negative correlations. In the absence of the knowledge of any known trigger factor it must be assumed that the blow outs have a random, stochastic distribution and that the dune barrier as a whole is moving generally landwards. Perhaps a greater amount of wind and wave energy from the northwesterly quarter is attacking the beach/dune fabric, or there is a diminution in the offshore sediment supply but the general impression is that duneface undercutting plus blow out advance is moving the total volume of the dunes landwards and will continue until a new equilibrium position is reached.
As outlined in Chapter 4 the links of Dunnet were lotted to adjacent farms in the early nineteenth century, except for a small area at the north end. As a result of this division and defined individual tenure, compared with the previous common ownership, stability increased and the dune ridge appears to have reached dimensions similar to today. In the twentieth century the Forestry Commission obtained tenure of large areas of dunes and links and the consolidation-by-planting programme as described above has left a permanent mark on the landscape. Today much of the area is owned by Caithness County Council and is destined for development as a recreational and amenity area. Although details of this development have not been finalised the main recreational and tourist facilities will be in the north where car parking and caravan sites already exist. The area will be landscaped and dune-stability measures taken. This amenity complex should draw incipient pressure from the other two areas presently used by tourists and day-visitors.

Apart from the natural erosion features there is one sand quarry area in the south where considerable extraction has taken place in the immediate past. Consolidation of the base level of this extraction has taken place and the area could provide the site for a surfaced car park. The face of the sand quarry now approaches the main crest of the frontal dune ridge and should not be allowed to proceed further seawards. In the southwest corner of the quarry breakthrough has almost been reached and with the evidence that the seaward-facing dune face is also undercutting and slumping a dangerous situation could arise and a blow out might develop from beach to main road.

Apart from the tank-blocks which form a continuous line in the northern part of the bay and shorter lines in the extreme south there is little evidence of direct human influence. Drainage ditches and sand-barrier fences should be maintained as both are valuable to the general improvement of the environment.

It is recommended that the present system of fencing with stiles should be maintained. The general arrangement of three car parks with access paths to the beach should be retained and developed. Good all-weather, surfaced paths should replace the indiscriminate system of footpaths many of which could develop into erosion features. The polluted and dirty outlet of the main central stream, Burn of Midsand, should be cleaned and maintained as this central indentation in the dune arc could well become a most attractive site for management and development. Access to the active and tree-planted blow outs should be discouraged and no practice should be allowed which would interfere with the vigorous development of the natural dune vegetation. Future development after the establishment of the recreational and tourist centre at the north end of the bay should take place at the south corner where the old estate grounds of Castlehill, the harbour, the rock platform and a varied dune, links and beach zone are juxtaposed with short open access to the main road. Against the general background of an increasing awareness of pollution dangers on the balance of the environment the main stream courses entering the bay should be periodically surveyed. Finally, in view of the evidence of the dune area being at a stage of general erosion by blow out and deflation processes no further sand quarrying should be allowed.

In view of its size, degree of accessibility, intrinsic and extrinsic scenic attractiveness and the already established tradition of this area as being a tourist, recreational and sporting (sand yachting) area, it is logical that Dunnet Bay should be chosen as the main area for investment in conservation and controlled development.
Plate 5  Dunnet Bay – Sand extraction at south end.

Plate 6  Dunnet Bay – Caravan site.
Plate 7  Dunnet Bay – Remains of “wicker” fence erected to stabilise dunes.
5.5 Scotland’s Haven

Morphology (Figure 7.5); Plate 8.

Scotland’s Haven is a very small bay on the north coast of Caithness 1km east of St. John’s Point. The bay is only about 200m wide and about 300m deep, and is surrounded by high and steep till-cliffs. Vehicular access is not possible to the bay, although an unclassified road, serving East Mey, approaches to within 1km of it. The amount of sand in the inlet is very limited, being almost completely restricted to the inter-tidal zone. The shelter afforded in the bay by the steep cliffs means that practically no sand blow has occurred.

The inlet follows a fault line which separates the John o’ Groats Sandstones to the east, which have been downfaulted, from the Thurso Flags to the west. This zone of weakness has been exploited by marine and probably also subaerial erosion, over a very long period of time. Certainly the inlet must have been in existence prior to the main period of glaciation in Caithness, since plugging of the inlet has occurred, together with the blanketing of surrounding slopes with a till cover which is as much as 30m thick in places. In the post-glacial period this till plug has been partially excavated by marine erosion, but today wave erosion has practically ceased. On the west side of the inlet, a low rock cliff appears below the till, and this in turn is fronted by an abrasion platform. A number of caves occur in the cliff, but they are no longer active, and the cliff and abrasion platform must have been cut during a period of higher sea level. Similarly on the lower east side, an abrasion platform fringes the cliff-foot, although no rock cliff is visible.

Thus in terms of present-day marine erosion processes the whole unit is one which is fossil. Although the till slopes surrounding the inlet are not subjected to marine erosion, they are still undergoing modification by subaerial processes, and various types of slumping and other mass movements have occurred in the recent past and are likely to occur again in the future. The till contains a high proportion of clay in its matrix, and following a period of heavy rainfall the clay is likely to “fail” and a slump and flow of material down the steep slopes will occur. Several bowl-shaped scars of such slumps scallop the cliff-top, the largest being at the southwest corner of the bay. In some instances the tracks down the steep slope made by the moving mass of material are still only partially healed and are clearly visible. Much of the slumping and earth-flowing activity is associated with seepage zones where soil saturation and slope failure is most likely.

Although there has been much slumping around the cliff-top rim, very little of the slumped debris remains at the cliff-foot. Thus it would seem that although the waves are impotent to erode the till or rock cliff actively, they are able to remove most of the debris supplied to the cliff-foot. An exception to this is the large calibre material, the cobbles and boulders, which have not been moved or have only been moved short distances. The area of sand beach, which exists only at the head of the U-shaped inlet, is very limited, and does not extend above the inter-tidal zone. The rate of sand supply seems to be low, and the beach sand is coarse (435 microns). It seems likely that the main source of this material for the very small beach is till slumping around the cliff-tops. The limited extent of the beach, with a very narrow fringe of shingle above high water mark, combined with the very sheltered situation, open only to a very narrow sector due north, has meant that no deposition of wind-blown sand over the till-cliffs has occurred, and the vegetation is unaffected by blown sand. The environs of the inlet are clothed in wet moorland, and a similar type of vegetation, although enriched by flushing, continues down almost to high water mark.
Physical access is not easy, and unless prior knowledge of Scotland’s Haven exists, only the most serendipitous traveller is likely to enjoy its shelter and tranquillity. Although only 1km from the A836, John o’ Groats to Thurso road, no suggestion of the existence of the bay is visible from the road, and the normal method of access is from the unclassified road serving East Mey. From that road an unmarked and poorly defined path leads to the inlet over wet peaty ground, and the descent down the steep till slope from the cliff-top to beach is not easy. Thus because of the physical difficulties of access, it is most improbable that large numbers of recreation seekers will ever use the beach. Instead, use is likely to be restricted for the most part to local inhabitants in Caithness who know of its existence. Certainly the shelter from wind and waves makes it an attractive although small beach unit, and it is suggested that the present pattern of use, which has not led to any physical deterioration, be allowed to continue, with the unit remaining a rather inaccessible, completely unspoilt little bay.

Plate 8  Scotland’s Haven – Note low rock cliff overlain with thick till cover, and narrow beach zone.
5.6 John o’ Groats and Ness of Duncansby

Morphology (Figure 7.6); Plate 9.

The most frequented part of the Caithness coast is not the most attractive section of the littoral zone. There is an absence of steep slopes and abrupt changes in topography. Landwards the terrain consists of a gently sloping till platform: seawards rock platforms backed by a fringe of beach stretch to the Ness of Duncansby in the east and Ness of Huna on the west. It is the association of the Last House, the small harbour and the proximity of Stroma and the Orkneys as well as the mystique of being at one of the northern edges of Britain that draws thousands of day-visitors to this small area. Apart from residents in the relatively large hotel and in the nearby caravan park few visitors stay for more than an hour. These visitors do not stray beyond the pier and the small apron of sand in front of the hotel.

A comprehensive development proposal has been put forward for this area involving the construction of a sea wall, the general landscaping of the site and the provision of residential accommodation in the form of a well-designed caravan park. A specific commentary upon this proposal is given in Appendix 3.

At an earlier stage there was also a proposal to improve the harbour in order to make this a ferry-point for relatively large vessels to ply to and from the Orkneys. This proposal was the subject of a special Highlands and Islands Development Board Report, “A ferry for Orkney”, in 1969, which reached the general conclusion that the present Scrabster terminus was probably the best one available and that John o’ Groats would be too exposed from both the east and the west and that the offshore ground is too shallow. To overcome this an elaborate and relatively long jetty would have to be constructed. Apart from the problem of economic viability this construction might also bring the entrance to the harbour to a point which was within the reach of the fast tidal currents which run between Stroma and the mainland.

As a physiographic unit, however, the coastline between John o’ Groats and the Ness of Duncansby merits attention in its own right. Although there are only very restricted areas of dunes, the sand having blown on top of the red-clay till platform as a comparatively smooth surface deposit, the sand-affected area is relatively large.

The thickness of wind-deposited, coarse grained, shell fragments is greatest on the flat-topped promontory of Ness of Duncansby which is partly constructed on a geologically interesting series of rocks which include John o’ Groats Sandstones, Flagstone and Tertiary volcanic rocks. The dune pasture extends for up to 400m inland where it gives way to a heath community and to the east rises to over 20m O.D. where it merges into the sand deposits of the Bay of Sannick. The machair-like surface is undercut on the west-facing side and a large shell-midden of unknown antiquity has been exposed. Between the sandstone ridges of the shore reef patches of shell-sand are found and there are also several small beaches some of which are remarkable for the quality and appearance of the shell-sand. One beach, for example, is composed of near-intact shells some of which are almost 6cm long.

Although not so well-developed, the interplay of shore-reef and shell-sand beach continues from Ness of Duncansby past John o’ Groats to Ness of Huna and beyond.
Near John o’ Groats the beach is only a remnant of its former extent since evidence exists that vast quantities of sand were removed during the Second World War for constructional and agricultural purposes. Most of the remaining sand is now concentrated at the base of the undercut and slumping till-cliff (which is rarely more than 3m high), where it is colonised by a rich variety of beach pioneer plants. Shingle patches also occur as discrete entities or as layers beneath the sand, and these add variety to the habitat. The number of shell-midden and other ancient structures buried beneath the sand witnesses to the concentration of peoples here over a long period of time. The prolific shell-life found offshore and within the dipping shore reefs must have been the major factor creating the attraction of this littoral zone.

Thus, unlike other areas in Caithness the attraction of this region lies in the beach and foreshore and the main problem is one of access, for fields reach almost to the cliff edge. A path does exist but in places it is overgrown and broken by landslips in the till-sand cliff edge. It would be feasible to consider this area as being suitable for the provision of a well-signposted coastal path or nature-trail which could complement the existing facilities of John o’ Groats. The under-utilised (in both agricultural and recreational senses) Ness of Duncanaby might also be made more accessible and linked directly to the Bay of Sannick to the east. Hence with the proximity of the magnificent cliff and geo scenery of Duncansby Head a unique assemblage of coastal landforms and vegetation would be encompassed in a total length of coastline of little more than 3km (Figure 7.6).
5.7 Bay of Sannick

Morphology (Figure 7.7); Plate 10.

The Bay of Sannick occupies the northwestern end of the depression extending across the base of the Duncansby Head promontory. The beach is a small one, composed almost entirely of shell fragments, which have accumulated against the cliff-foot and have blown a short distance inland, especially along the valley of the Burn of Sannick. The eastern edge of the Sannick depression is defined by a fault which separates the flagstones of the Thurso Flags of Duncansby Head from the red and yellow sandstones of the John o’ Groats group. East of the burn the beach is composed of coarse material, mainly cobbles and slabs of sandstone moved only a short distance from the cliff at the east end of the bay. West of the burn, the material is mainly shell debris, underlain above high water mark by material similar to that east of the burn, sand below high water mark by the sandstone abrasion platform. Thus the beach forms only a narrow fringe at the top of the abrasion platform.

The beach material is almost entirely organic in origin. The shells contributing to the deposits are mainly the deeper water rock and Laminaria-dwelling species, including species such as Modiola modiola, Buccinum undatum and Pectunculus glycimeris, together with abundant Patella vulgata from the shore reefs and abrasion platform. Apparently erosion of nearby sandstone cliffs contributes little to beach nourishment, while the Burn of Sannick, flowing mainly on peat-covered slopes, is unable to supply more than very limited amounts of recirculated shell fragments. The offshore ground appears to be swept clear of unconsolidated materials, as might be expected in such a situation of strong reversing currents, and little inorganic material is supplied from this source.

Marine processes, other than those involving the supply of shells and shell debris to the beach, do not appear to be very significant in fashioning the beach area at the present day. Little marine erosion is occurring on the sand-covered cliffs behind the bay, while to the west the cliffs again are not very active. Part of the abrasion platform to the west of the beach is likely to have been cut at a period of slightly higher sea level so that today little erosional work is in operation, while any sand supplied by the erosion of the cliffs to the east is unlikely to be carried westwards.

The beach itself is strongly sloping (up to 10°) in response to the strong exposure to the north quarter, although above low water mark the shell sand, which is of a greyish colour, gives way to the abrasion platform. Above high water mark, the shell sand has accumulated over a shingle beach, which is partly fossil in origin and is partly the present storm beach. The sand here is thin, only forming a veneer over the shingle, although further landwards blown sand has accumulated against the cliff-foot. Much of this accumulation, in the form of a sloping wall, is unvegetated although towards the west the sand slope is partially vegetated and at the west end of the beach a small free-standing dune is forming at the cliff-foot and undergoing colonisation by Elymus arenarius (lyme grass). The zone of sand-veneered shingle between high water mark and the fossil cliff-foot is not completely bare but is being colonised by Potentilla anserina (silverweed). This would suggest that removal of sand from this zone is proceeding only slowly, as might be expected since only winds from the northeast quarter, the most infrequent experienced, will be able to act on the sand. In any event the sand only forms a veneer and is supplied to the beach in very limited, although in presumably regular quantities. East of the stream, the sand cover on the fossil cliff-line is thin, there being very little sand on the portion of the beach below this section of the cliff-line. The slope, which is on till, is
covered by a mature grass association. Sand has not been confined to the cliff-foot area despite the obstacle presented to its inland movement by the steep although not actively eroding cliff. The valley of the Burn of Sannick, which is almost graded to sea level, has formed an easy route for the blowing of sand inland, while the cliff-top immediately to the west of it has also been surmounted and a layer of sand 5–8cm thick has accumulated. This layer of cliff-top sand becomes thinner inland and disappears just beyond the road to Duncansby Head. Blown sand thus occurs only in a narrow wedge-shaped area.

The vegetation pattern on the highly calcareous sand differs from the normal sequence. Elymus arenarius (lyme grass) occurs on the small cliff-foot dunes at the west end of the beach, but marram appears to be absent. On the sand-veneered cobbles and shingle the pioneering species is Potentilla anserina (silverweed), not a species commonly associated with pioneering in dry sand areas, although Honkenya peploides (sea sandwort) is also present. On the cliff-top machair there is profuse growth of nettles and other weeds associated with overgrazing and with the colonisation of tipped material.

This small area of cliff-top machair has unfortunately undergone considerable erosion. About half the area of blown sand has been badly affected, and further deterioration is still occurring. The front edge of the machair is still retreating landwards in the form of a small cliff about 5cm high, although a considerable amount of recolonisation by grassy vegetation has occurred on the deflated surface. Sand extraction has been at least partially responsible for the retreat of the low sand cliff, although undoubtedly wind action has aggravated the situation. Efforts have been made to heal some of the wind-controlled finger-like blow outs on the retreating edge by tipping of material, presumably excavated during the cutting of lay-bys on the Duncansby Head road. Unfortunately this tipping, while curing the problem of blow out enlargement, is rather unsightly and further impairs the visual amenity of the bay. Also there is evidence that overgrazing has occurred. The blown sand area forms an island of much greener, more productive vegetation within the acid moorland vegetation around it, and consequently forms an area of great attraction for sheep. It is quite possible that overgrazing in the past led to the initiation of blow out activity, and populations of rabbits may also have at times aggravated the situation.

The Bay of Sannick lies close to the road leading from John o’ Groats to Duncansby Head, and as a result is subjected to a considerable amount of tourist use. Vehicular access is very easy; cars can be driven straight from the road onto the machair surface as far as the retreating machair edge. No evidence of blow out activity connected with car wheel tracks exists, and the vegetation cover has not yet been broken although the surface is rutted. However, between the car parking area and the beach, tracking has developed on the sides of the Burn of Sannick valley, and at the cliff-top where tourists climb down to the beach. Finger blow outs are forming along these tracks and further impairing the amenity.

Indeed the natural beauty of the bay has been seriously reduced by the scarring, which has occurred by natural and direct and indirect human processes, together with the tipping of material and the growth of thistles and other weeds promoted by overgrazing and the dumping of earth. Litter disposal facilities are poor and haphazard, and it is unfortunate that a general air of untidiness pervades an area which is potentially highly attractive.

It is suggested that all sand extraction should be strictly prohibited and that no further tipping should be allowed to take place. While it is unrealistic to suggest that the driving of cars onto the machair area be prevented, the provision of a properly surfaced car park might greatly reduce the danger of further
deterioration. Also, ideally, pedestrian access from the cliff-top machair to the beach should be restricted by a fence to one or two paths which could be maintained, but on the other hand the existence of a fence along the cliff-top would not improve the visual amenity. A solution to the problem might be the provision of one clearly defined and well surfaced and maintained path from the car parking area to the beach, which would carry the bulk of the traffic. The pattern of use is one of short visits rather than of long stays and the amount of pedestrian traffic to the beach is considerable.

It is thus concluded that the situation at the Bay of Sannick is not satisfactory, and to prevent or minimise further deterioration action along the lines suggested will have to be taken within the near future.
5.8 Freswick Bay

Morphology (Figure 7.8); Plate 11.

Freswick Bay occupies a small asymmetrical embayment on the east coast of Caithness between Sinclair’s Bay and Duncansby Head. The coast to the south is one of low cliffs and rocky shores, while northwards the cliff height rises to the spectacular cliff scenery culminating in the Stacks of Duncansby.

The bay has been cut along the line of a fault separating the John o’ Groats Sandstone to the north from the Caithness Flags to the south. Into this bay drains the Freswick Burn, which is formed half a mile inland by the confluence of the Gill Burn and the Burn of Bog, in turn draining an extensive area of peat-covered plateau. Although rock outcrops near the stream mouth at Freswick House, where the course bends sharply northwards and then eastwards, most of the area behind the bay is blanketed in a flat spread of till of considerable thickness. Both limbs of the bay are delimited by rock cliffs.

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The beach materials consist of both shingle and shell sand. The shingle, of which the flanks of the beach and a storm beach fringe is composed, is derived locally from wave erosion of the nearby sandstone cliffs. Only in the head of the bay where the calibre is much finer does the shingle appear to be undergoing much movement at present; elsewhere the slabs of sandstone have only been moved short distances from the source cliffs and the waves are able to move them only very infrequently. Sand on the other hand will be derived from a number of sources. Firstly some will be derived from the disintegration of sandstone on the cliffs. Some material will also be supplied by the Freswick Burn, where undercut banks in till suggest that the stream is able to erode and transport fine-grained material. A third source of beach material will be from the offshore zone. Although much of the ground immediately offshore is weed-covered rock, some patches of sand bottom are also visible. Furthermore, a considerable proportion of the sand is comprised of shell fragments, mainly of rock and weed-dwelling species washing into the bayhead.

The beach is fully exposed to the east and southeast. Some shelter is afforded to the northeast quarter by Skirza Head, but the asymmetry of the bay means that no such shelter is afforded by Ness Head on the south. The shape and orientation of the bay means that wave energy is concentrated on the northwest part of it. Exposure to wind is very similar to that to waves, and the frequently occurring south-easterlies have tended to create maximum sand deposition in a north-westerly direction, creating a triangular-shaped links area.

The strong exposure means that wave erosion is active on the cliffs on both sides of the bay. An abrasion platform of considerable width has been cut, while reefs occur below low water mark in the central part of the bay. Above normal high water mark human modification of the bay-head area has tended to obscure the natural processes in operation, but the attitude of the tank obstacles would suggest that only a small amount of undercutting of the sand front has occurred over the last thirty years. However, high water mark is very close to the sand front and a storm from the east or southeast quarters combined with a high spring tide could mean occasional attack by the waves, although the offshore reefs will go some way towards lessening this hazard.

The shell sand beach is steeply sloping, a reflection of its strong exposure and constructional features such as berms are lacking. The occurrence of seaweed under the sand, betrayed by air bubbles and the smell of decaying organic material, would suggest that the beach is combed down during winter and the sand returned during the less stormy season of summer.
The nourishment zone above high water mark, on which winds can operate, is very narrow, so that the supply of sand for dune building is very limited. However, the dune front has been seriously affected by human interference in the form of sand extraction, and it is not possible to say whether active dune accretion would be taking place under natural conditions. The narrowness of the nourishment zone would nevertheless suggest that such accretion would be extremely slow. Free-standing dunes have not evolved, but rather the sand has been distributed over the till platform backing the beach. At the seaward edge, the sand thickness is about 10m, but inland it rapidly thins out. Only in the northern part of the links do hummocks and ridges occur; elsewhere the sand is in the form of a flat spread. The hummocks and ridges in the north are mostly orientated in a southeast to northwest direction. Clearly in the recent past (within 10–20 years) they have been very much more active than is the case today when they are largely healed, and it is interesting to speculate that their healing may date from the first outbreak of myxomatosis in the area. If this is the case, they are very likely to be re-activated within the near future since the rabbit population, and density of burrows, is extremely high. Elsewhere in the links area the relief is very subdued, except for the long erosion scar which delimits the inland extent of deflation. From the seaward edge, deflation down to the till base level has almost completely removed the blown sand cover, and left a surface sloping gently inland on which vegetation colonisation is well developed. The inner margin of this deflation surface is delimited by a low erosion face which today is mainly inactive except where rabbit burrows have been excavated. The plan shape of this erosion face is that of an asymmetrical V pointing towards the northwest in response to the dominant southeasterly wind direction. A number of small blow outs occur normal to the scar, but despite apparent evidence of overgrazing on the links the rates of erosion and retreat are much slower today than formerly.

Human processes, combined with the activities of rabbits and grazing animals, have been of extreme significance. The most striking of these processes has been sand extraction, mainly from the seaward edge of the blown sand. Large extraction pits fret the line of the natural dune front, and clearly sand extraction has been and is greatly in excess of the rate of sand supply. The removal of sand from the front edge has opened up the zone to the destructive action of wind, and the dune zone, which presumably must at one time have existed, has been completely consumed. The removal of this “buffer”, energy absorbing zone has allowed the wind erosion to work on the links with severely destructive effects. In terms of the physical conservation of the beach area, sand extraction cannot be condoned, and if any recuperation is to be achieved it must be stopped. Equally important to the physical effects of extraction have been the visual effect. The extraction pits themselves are not attractive, nor is the “scalped” appearance of the deflation area behind the sand front. However, not all the visually offensive features of the beach area are attributable to sand extraction; the tank obstacles which litter the shores are equally detrimental to the visual amenity of the beach, and the rank, ungrazed vegetation between the beach and the road from Bridge of Freswick to Skirza has a curiously unkempt appearance not enhanced by the obvious signs of rabbit infestation. Sand extraction has, however, undoubtedly led to the exposure and collapse of an ancient settlement site now exposed on the face of one of the extraction pits. Other evidences of ancient settlement occur near the edge of the zone of low sand ridges and hummocks, and it is most unfortunate that effective steps to protect these relics have not been taken.

In terms of its recreational potential, Freswick Bay is not well endowed. While it is visible from the A9, it is not directly accessible from it but only from a narrow, rough track leading from the unclassified Bridge of Freswick to Skirza road. Nor is it very suitable for recreational visits – the sands are not particularly attractive and indeed on occasions may yield an offensive smell. A zone of dunes where picnics may be enjoyed with a degree of privacy and shelter is lacking, and there tends to be an atmosphere of dereliction about the
place which is not easy to define precisely, but which is certainly connected with the physical deterioration which has taken place. Thus at the present moment the tourist and recreational potential must be regarded as being very low, and it is not suggested that any recreational developments be encouraged in the unlikely event of their being put forward. The first priority must be the strict prohibition, and enforcement of the prohibition, of sand extraction. This in itself will not immediately cure all the problems associated with the bay, but it is certainly an essential step if rehabilitation is to occur.
5.9 Sinclair’s Bay

Morphology (Figure 7.9); Plate 12.

Sinclair’s Bay forms a wide embayment in the north-northeast trending sandstone cliff coastline a few kilometres to the north of Wick. The dune-backed beach extends for 5km, forming one of the longest separate stretches of beach in the mainland of the north of Scotland. Wind-blow of sand has occurred to a distance of at least 1km although the dune zone itself tends to be narrow rarely exceeding 200m and for the most part being under 100m in width. The inter-tidal zone is fairly narrow, although it widens from an average of under 150m to almost 300m at the mouth of the Wester River. Despite the considerable width of the embayment in the sandstone deposits which it occupies, the beach itself has a very large radius of curvature with a high C/p index of 12.0. Despite this index, a state of equilibrium appears to have been reached.

The bay occupies a syncline or downwarping in the underlying sandstone beds (the Ackergill syncline). The southern limit to the bay is a cliff which decreases in height westwards from over 30m at a point 800m west of Castle Girnigoe and finally terminates near Ackergill Tower. The sand beach, however, does not abut against this cliff; instead a stretch of shingle, sand or weed-covered abrasion platform intervenes between the beach and cliffs.

Towards the north end of the beach, sand gives way to shingle, while north of the Rough of Stain a rock abrasion platform appears. Further north, around Keiss, this platform appears to be backed by another raised rock platform, which is overlain with raised beach gravels. The whole embayment has a markedly asymmetrical plan, approximating to an L-shape. This asymmetry is also reflected in the submarine contours, deep water approaching much closer to the south limb, especially east of Castle Girnigoe, than to the north limb. The south limb may in fact function as a giant groyne with respect to drift in a southerly direction.

Inland from the sands, till-covered slopes slope gently (1–3°) seawards from a low peat-clad plateau. This low plateau is broken in its central portion by a broad open valley occupied by the Burn of Lyth, the Loch of Wester and the Water of Wester. This depression continues to the northwest as far as Dunnet Bay; in fact, Dunnet Sands and the sands of Sinclair’s Bay occupy analogous positions at the northwest and southeast ends respectively of this depression. The depression itself is paralleled both to the south, where a similar depression is followed by the Wick River and Wick Bay, and to the north where two depressions occur, one occupied by Freswick and Gills Bays and the other cutting through the Duncansby peninsula and occupied on its north side by the Bay of Sannick. These parallel depressions, which appear to be related to an ancient drainage pattern rather than to structure, have played an extremely important role in the coastal evolution, presenting as they do suitable zones for the accumulation of marine sediments. In the Sinclair’s Bay area, the Loch of Wester has been impounded by the accumulation of material of mainly marine origin, possibly at more than one sea level, while the outlet from the Loch, on the other hand, has influenced the morphology and evolution of the central part of the bay.

Marine erosion is active both on the low cliffs occurring north of the bay, and to a greater extent, on the cliffs forming the south limb. The role of this marine erosion in the supply of material for beach and dune construction appears to be limited. The erosion is not taking place rapidly; in some instances, at least, the cliffs are partially fossil. North of Keiss the cliffs are very low, with the seaward dipping beds tending to dissipate the wave force and so reduce the rate of wave erosion. However, most of the cliffs, both to the
south of the bay and to the north are till-capped, and the slumping of till into the sea does provide material ranging in size from clay to cobbles. Where the beach is of shingle or has a storm beach containing shingle, it is significant that almost invariably this shingle contains pebbles of metamorphic rock and conglomerate as well as of sandstone. This pattern prevails both at the north and south ends of the bay, and strongly suggests that glacial deposits, whether occurring on cliff-tops or offshore, have played important roles in the supply of materials to the beach. Furthermore, during a period of a slightly higher sea level, it is likely that till-cliffs were cut, especially towards the south end of the beach. The till-cliffs are now buried under blown sand accumulations, as for example near the golf clubhouse, but formerly would undoubtedly have provided considerable quantities of easily movable material. The other main source of material is the Water of Wester. The seaward convexities of the plans of low water mark and the submarine contours might suggest that large quantities of material are being supplied by this source. This, however, is difficult to reconcile with the fact that just one mile inland from the mouth of the river occurs the Loch of Wester which might be expected to act as a sediment trap, and furthermore, the river system drains a low, gently sloping, peat-clad catchment which would not yield large quantities of sediment. At present the Water of Wester can only be recirculating sand which has blown inland, although in the past it may well have supplied larger quantities of material in the form of a delta, now below low water mark, which the submarine contours appear to betray.

In addition to the mineral, terrestrial fraction of the beach and dune material there is also the fraction composed of shells and shell debris (the CaCO₃ content is 63%). Most of the shells have been finely comminuted, but appear to be mainly fragments of shallow water rock dwellers, from the reefs of the abrasion platforms, such as *Littorina* and *Patella* and of sand dwellers such as *Tellina* and *Mactra* from the sandy offshore ground.

In terms of marine processes, the bay seems to have reached a state of relative stability. While there is evidence that the dune ridge has been undercut by the waves in the past, little undercutting is now taking place. Military defences, presumably built at the dune front, have been unaffected by wave attack over the last thirty years except in one or two instances where very slight undercutting has occurred. Accretion, on the other hand, is occurring at places in the central part of the beach, especially to the north of the river mouth. The width and degree of development of the dune system here might suggest that this process has been in existence for some considerable time. A tendency for a beach to straighten, as opposed to become more arcuate, in plan is unusual, as it is generally the case that stability varies inversely with radius of curvature, and it can only be concluded that the phenomenon of central accretion in Sinclair’s Bay is due to the relative abundance of offshore sediment in the central part of the bay as compared with the flanks. The beach narrows northwards and southwards to a shingle beach and a sand and shingle veneered abrasion platform respectively. The nourishment zone between high water mark and dune front is extremely narrow except where berms have been constructed in the vicinity of the river mouth.

Although most of the present day beach, except in the extreme north, is mainly of sand, it is clear from exposed “windows” in deflation hollows in the dune system that the sand rests on shingle beach or spit. This spit appears to have been responsible for the initial partial closing of the wide embayment which would have once existed, and for the impounding of the Loch of Wester. It appears then that the evolution of the beach system began when materials different from those of the present day were available, probably during a period when the post-glacial sea level stood slightly higher than that of today, and could rapidly erode till-cliffs and till clad slopes to yield large quantities of coarse shingle material.
This underlying shingle spit acts as a base on which the present-day dune system has evolved, and indeed also the links area stretching behind the dunes. The dune system consists basically of a single, very steep-sided dune ridge in the northern and southern parts of the bay with a much wider, more complex and more active central part, the variable factors being availability of sand from the beach (in turn related to the width of the nourishment zone) and wind direction frequency.

Although some low dunes, bearing healed blow out scars, do occur to the south of the golf clubhouse, for the most part these dunes have simply accumulated against a pre-existing till slope and are not free-standing. The true dune ridge begins to the north of the clubhouse, and takes the form of a knife-edge ridge increasing in height northwards. The landwards slope angle is practically equal to that of the formerly undercut but now mainly healed seawards slope. The steep landwards slope is related to the strong exposure to the west and northwest which will tend to counteract wind-blow of sand inland. Although the strongest winds come from the southeast and the northwest, the direction resultant of wind work is from the southwest, and this section of dunes is orientated at right angles to it. Indeed, instead of a simple seawards-landwards sand transfer there is likely to be a much more complex movement in a zig-zag fashion almost parallel to the coast. Some semi-circular blow outs scallop the edge of the dune front, and the importance of southeast winds is reflected in the development of a low, subdued now inactive spur of sand let off from the main ridge in a northwesterly direction. Most of the blow outs have at least one limb orientated in a southeasterly direction. However, the general picture of this section of the dune system is one of simplicity and stability, with the blow outs being largely healed and inactive. About 900m north of the clubhouse, however, the ridge begins to widen and become more active. Large blow outs, with flanks orientated in all directions from northeast to southeast, have been cut to a depth of 10m or more, frequently down to a base level which is usually the shingle ridge in the seaward part and the sand water table behind the shingle ridge further back from the sea. Redeposition of excavated material is partially responsible for the widening of the dune system, but much of the sand must also have been deposited in the form of a featureless spread well inland from the dunes. Some of the blow outs are very wide, well over 100m in some instances, and seem to have resulted from the coalescence of two or more smaller blow outs. Across the mouth of the large blow outs, however, dune ridge formation has already recommenced and the “cauldrons” are infilling. It is significant that in the area of active dune blow outs adequate sand is available in the nourishment zone between the line of the dune front and high water mark for dune formation to recur, so that although blowing has occurred vigorously in the immediate past, and is in fact still occurring, natural processes are in operation to heal the blow out by forming these incipient dune ridges across their mouths. The southeast component figures strongly in the orientation of the largest blow outs; in fact dune activity begins approximately at a point where the shelter from the southeast afforded by Noss Head ceases. In other words, the portion of the dune system beyond a point about 900–1,000m north of the clubhouse is altogether a much more active, high energy environment than the portion to the south of that point. This does not mean, however, that the former is more unstable than the latter or that it should be protected from all use or interference. The difference lies simply between a dynamic and a stable equilibrium.

At the river mouth young foredunes are in the process of evolution on both the north and south sides. These have had the effect of moving high water mark outwards on the south side, while on the north side the effect has been to extend the spit-like form southwards, continuing the process of southwards deflection of the river which has gone on for some time. However, the southwards deflection has been held up by the dune formation on the south side of the mouth, the net result being that the channel has become much more sinuous in plan than is shown in the Provisional Edition 6° map (revised before 1930). However, although
changes have occurred right at the mouth of the river they have not extended upstream at all, since tank obstacles a short distance from the mouth have not been affected since their construction. Although the beach above high water mark consists of a mixture of sand and shingle, clearly wind action is able to operate on the sand fraction and low ridges of foredunes, being colonised by lyme grass and marram, are forming. This phase of dune accretion at the river mouth has commenced fairly recently, but already pill boxes presumably built at the former dune edge are now separated from the beach by some distance. Behind the young foredunes, however, is a zone of intensely eroded, though now almost completely healed, residual dune relief. Thus there is evidence that a change has occurred in the relative intensity of the processes of erosion and accumulation.

Although the gradient of the Water of Wester is not strong, the rate of discharge, especially as the tide ebbs, is considerable, and it is able to scour its outlet clear with little difficulty. The load consists of small pebbles, presumably from a marine built plain under the links, as well as recirculated sand, and the maintenance of this load can only be explained by the gradual migration of the river and its upstream meanders. Certainly in the vicinity of the river mouth material is much more abundant than elsewhere in the bay and berms and dune construction are in evidence only in this zone.

North of the river mouth the dune zone increased to its maximum width and complexity. Here large blow outs have been deflated to shingle or water table base level, while the excavated sand has accumulated in formless hummocks and ridges, or been dispersed inland and deposited in flat spreads. Most of the blow outs have on their inner edges a series of finger-shaped linear type blow outs some of which are orientated southeast to northwest although this is by no means the only orientation. These finger blow outs, together with the flanks of the larger parent blow out, are still active, but at the mouth of the blow outs, at the line of the dune front, young dune accumulations are in process of formation. These recent dune accumulations have reached a much more advanced degree of development than is the case south of the river mouth, and indeed in some instances the blow outs are becoming rapidly filled by formless, very active dunes with a low degree of marram cover. It is clear that large quantities of sand are available on which the southeast wind in particular can operate. In this area varied and spectacular dune scenery is found, and although the dunes are extremely active, a dynamic equilibrium has been reached and there is no reason why the dunes should not be used for recreational purposes. Only at one point has the dune system been almost breached by a particularly large blow out with a northwest pointing finger-like extension, but even here sand accumulation has commenced at the seaward edge and gradually healing should occur. Deflation of the main dune ridge has exhumed the remains of brochs and other historical or prehistoric structures, but the actual damage caused to these does not appear to have been great and again healing seems to be taking place. In fact aprons of angular stone fragments around the structures may well have protected them from serious undercutting.

Northwards from this zone of great complexity, the simpler, more stable knife-edged form of the dune system is resumed, with the dune height gradually declining northwards until the dune ridge gives way to a marram-clad sand capping on the underlying parent material. In this northern section of the bay the amount of sand available for dune construction declines rapidly and the sand beach narrows and gives way to a steeply sloping shingle beach. Again, however, the coastline is fairly stable, with little undercutting or accretion taking place.
Inland from the main dune zone extends an area of blown sand, triangular in shape and tapering towards the south end where it becomes very narrow. The shape of this blown sand area again reflects the importance of the winds from the southeast quarter. Some hummocks and ridges of blown sand occur, mostly with very low relief and not exceeding 3m, but most of the sand has been redeposited in flat spreads rather than in mounds. The existence of lagoon-like pools and marshy depressions immediately to the landwards of the main dune zone has had the effect of minimising dune migration inland. Today most of the pools have been drained, but their sites are still waterlogged and marshy, and sand does not blow readily over them. South of the river mouth a subdued break of slope may represent the former shoreline of an extensive lagoon, while further north, on Keiss Links, the ground surface is close to the water table except in the small area of slightly higher, drier ground near the Bridge of Wester. Since the water table is practically at the ground surface, no deflation is occurring on the links, except around Bridge of Wester where some blowing and scarring is associated with rabbit activity.

The vegetation sequence is the “normal” one, with species diversity and closeness of carpet increasing with distance inland from the dune front. Marram is dominant on the seaward edge of the dunes, with lyme grass playing an important role in the evolution of the low ridges of foredunes near the river mouth. The landward slopes of the dunes are largely clothed in turf of fescue and other grasses, with species such as lady’s bedstraw (Galium verum) and common bird’s foot trefoil (Lotus corniculatus) occurring in places. On the links the water table is not far below the surface, and the wettest areas are carpeted with mosses and sedges, while elsewhere patches of marsh horsetail (Equisetum palustre) and silverweed (Potentilla anserina) occur. The greater part of the links, however, consist of meadows of Agrostis and Festuca grasses, dotted with flowers such as Grass of Parnassus (Parnassia palustus) and common bird’s foot trefoil (Lotus corniculatus).

A track leads from near Bridge of Wester across the links towards the river mouth. Slight rutting has occurred along parts of this track and multiple tracking has developed, but it is only in the dry machair area immediately east of the main A9 road that much damage has been caused. Here the tracks have been incised to a depth of several feet, and the visual amenity is further impaired by the existence of thistles and other weedy vegetation which may well be associated with overgrazing by rabbits or domestic stock. The track ultimately leads to the most active area in the dune system, and sand extraction has taken place in the past and is still occurring to some extent at present. Most of the extraction appears to be from the inner, landwards edge of one of the large blow outs, although a smaller pit has been opened on the landward slope of the dune system. In comparison with the magnitude of the dunes and the rate of activity, extraction is now on a very small scale, and it is unlikely that any damage will be done, since much of the sand, if not extracted, would probably be blown inland. A branch of the track leads to the river mouth, where shingle, despite its admixture with sand, apparently is being extracted. Again the scale of operations in comparison with that of the beach is small and no detrimental repercussions are in evidence. Probably of much greater significance have been the attempts at draining the areas of high water table. On Ackergill Links (on the golf course), a network of well maintained ditches has been established, while on Keiss Links another network of shallower drains has been laid out. The effect of these drains is to lower the water table and so possibly allow further deflation of the sand surface to occur to the new base level. However, since the vegetation cover is well established, blowing has not occurred, and in any event the lowering of the water table, especially on Keiss Links, would only be slight so that the potential thickness of sand which could be deflated is not large. Perhaps more important than the overall lowering of the water table has been the draining of some of the marshy pools indicated in the Provisional Edition of the 6” map. Some shallow pools exist behind the dune zone on Keiss Links, especially after a prolonged period of heavy rainfall, but south
of the river mouth and immediately to the north of it the pools have been drained. This might be expected to have the effect of removing a barrier to the inland extension or migration of the dunes should vigorous dune activity take place. There is some evidence that this has begun to happen a short distance to the north of the river mouth. Here an inlet from the river has drained out and the area formerly occupied by it [perhaps the attenuated remnant of a lagoon] is now covered by a low sand hill, while the same is happening a short distance further to the north. It is not possible to separate out the effects brought about by natural processes and those set off by indirect human interference through drainage, but in the long-term the removal or attenuation of the water-covered or high water table areas is likely to have the effect of facilitating the inland migration of sand dunes (and altering the ecology or vegetation of the area).

Ackergill Links, to the south of the river, are used as a golf course, with a stretch of rough grazing extending southwards from the golf course to the vicinity of Ackergill Tower. The nature of use combined with intensity of management and a generally fairly high water table means that little erosion of the sand cover is likely to occur. Moreover, the sand is fairly thin and is underlain by peat-covered till. North of the river, the southern half of Keiss Links is held as grazing by Aukhorne Farm, with considerable numbers of both cattle and sheep being carried. Here, especially on the landward slopes of the dunes, rabbits are much more numerous than to the south of the river. The northern part of the links, north of the fence extending from the A9 towards the beach, is common grazing held by Keiss township.

At present the intensity of use of the beach and dunes for recreational purposes is low (apart from golf). This is at least partly due to the difficulty of physical access to the beach. Although the dunes can be seen from the A9, the beach itself is not visible, and is about half a mile from the road from which it is separated by fields and fences. Only at one point, near the golf clubhouse, vehicular access is possible to within a short distance of the beach. A signposted and well-surfaced road, terminating in a car park, leads from the A9 to the south end of the dune system. However, here the dune system is rather narrow and not particularly interesting, although stable, and there are few blow outs or other sheltered spots where picnics could be enjoyed. Also the wording “Reiss Sands Golf Course”, in two lines, at first sight suggests, at least to some road users, that the road leads only to a golf course, and a reversal of the wording, to read “Golf Course Reiss Sands” might have been preferable. Such a point is rather trifling, but certainly the intensity of use at the present is slight. A second road, or rather a track, leads from Bridge of Wester to the more active section of the dunes near the river mouth. This road is unsurfaced and rutted, and being a private road is not signposted. The necessity of having to open two gates further detracts from its use. This track is the only means of vehicular access to Keiss Links; access further north requires a walk of several hundred metres across ground which is rather wet in places, or else a walk southwards from Stain along a rather uninteresting shore.

Purely from the physical characteristics, and leaving aside problems of road improvements and access, the optimal area for recreational use lies in the zone extending 800m northwards from the river mouth. Here the dune scenery is spectacular and the relief is intensely accidented. Indeed such is the intricacy of the pattern of relief that several scores, if not several hundreds, of people could be accommodated without seriously encroaching on each other’s privacy. Also, although erosional activity is clearly evidenced in the large blow outs, equally in evidence is the vigorous dune building which is occurring across the mouths of the blow outs, so that there is no physical reason why the dunes should not be used. Also, the area of flat links and low sandhills immediately to the landward of the dune system would seem to provide an admirable caravan site, again simply in terms of the physical characteristics of the area and leaving aside such problems as
land tenure, access and water supply. Adequate shelter would be provided by the dune system to the
seawards, and some shelter and screening by the low sandhills to the landwards. Provided that normal
precautions were taken and the site restricted to 30–50 caravans, no seriously detrimental repercussions
should result. While it is also attractive to think in terms of a caravan site and possibly other recreational
developments around the nucleus provided by the golf clubhouse and the existing road, it is felt that the
recreational capacity and overall attractiveness of the dunes and beach at the south end of the bay are
limited. Also access to the golf course from a caravan site situated north of the river could be relatively easily
provided by means of a footbridge (it is unlikely that a high proportion of the caravanners would insist on
commencing play at the first hole).

In conclusion Sinclair’s Bay is a unit of considerable magnitude, with a long sand beach and spectacular
dune scenery in places. Although its natural resilience is variable, and is perhaps least in the places
which are today stable, there are no physical reasons which preclude a greatly increased intensity of
recreational use.
6. Conclusion

The foregoing chapters have illustrated the diversity of the dune and beach areas of Caithness. The beach units are diverse in size, ranging in length from several kilometres to little more than 100m. There is also a diversity in the level of accessibility. No beach is situated more than a few minutes’ walk from a motorable road, but some are much more readily accessible than others. The scenic value of the beaches is also variable, and while most of the beach units have a fairly high degree of natural stability, others show signs of physical deterioration which may be associated with human use.

The main contribution of this report in any planning context is its capacity to look at the beach and dune resources of Caithness as a whole and to assess their possible values on a county and local scale. Today all the beaches are relatively under-utilised and several land uses co-exist and will continue to co-exist as long as the intensity of use remains low. Several types of recreational use, grazing, sand extraction and shooting are found represented in most of the beach areas and all the beaches have the basic function of coastal protection elements. If any single use becomes dominant, however, then there will be visible reactions on the other land uses, and without management the substance of the resource could break down. It is therefore suggested that in anticipation of increased tourist and recreational pressures that each beach be assigned a primary use to which it is best suited and the other uses be relegated to decidedly secondary roles. The large accessible beach units might be developed for large-scale recreational and caravanning use, while others should be laid aside as remote “unspoilt” beaches where vehicular access is not permitted. This management policy which is aimed at maintaining diversity and therefore resilience on a regional scale must also recognise the two main types of demand, from local inhabitants and visitors. Developmental (and conservational) effort should not be spread thinly over all the beaches but should be specifically concentrated on the most suitable beach and dune units.

It is suggested that development and necessary conservational and physical safeguards be concentrated on the most used and largest beaches. The major unit is clearly Dunnet Bay, which already has a nucleus of recreational and conservational infrastructure. Not only is Dunnet Bay suitably located for the local population centred on the Thurso area, but also it is readily accessible from the important tourist route from John o’ Groats westwards, with the road actually passing through the links. The size of unit means that it is able to accommodate fairly large numbers of recreation-seekers, while its natural stability is reasonably high. Sinclair’s Bay is well suited for fulfilling a similar function. It is similar to Dunnet Bay in its natural stability, in its proximity to a centre of population (Wick) and in its accessibility from a major tourist routeway. Analogous patterns of development should thus be possible. The recreational nucleus of the golf course at Sinclair’s Bay compares with the sand yachting centre at Dunnet, so that in detail the pattern of development may be different although in general terms it will be similar.

Should it be wished to develop another beach area along similar lines to those of Dunnet and Sinclair’s Bays, the unit suggested is Sandside Bay. Here the scenic value is somewhat higher than that of the two larger bays, although the beach is smaller and slightly more inaccessible. The availability of the golf course and the possibility of the development of marine activities from the small harbour offsets the slight locational disadvantages, and the physical characteristics are suitable for increased recreational use. Furthermore, the proximity of fine cliff scenery and the presence of rock pools enhances the bay, and a basic infrastructure of services already exists at Reay village.
It is thus suggested that these three beach units be retained for "active" or participant recreation, not excluding caravanning, and that the remainder be reserved for more informal use. Small beaches such as John o’ Groats and Bay of Sannick which are subjected to much visual "use" require certain conservational measures to improve their visual amenity and to prevent further deterioration, and are not recommended for "active" recreation or caravanning. It is appreciated that there is strong pressure for a caravan site at John o’ Groats at present. Provided that adequate safeguards are provided, there is no reason why the caravan site should not be permitted, although examination of the intrinsic beach resources on a county basis indicates that it is not the optimal location for the site. A third group including Thurso Bay and Scotland’s Haven may be recognised which fulfill individual, "unique" functions. Scotland’s Haven should be retained as a small, relatively inaccessible beach used by small numbers of mainly local residents; in any case it is difficult to visualise any large scale development. Thurso Bay, on the other hand, is used by large numbers but since it contains only a small beach backed by a sea wall and lacking a zone of wind-blown sand, no management problems arise.

The remaining beaches, Murkle Bay and Freswick Bay, receive a fairly low intensity of recreational use and are not particularly easy of access. Furthermore, they form important sources of shell sand sought after by agriculture. While strictly speaking sand extraction should not be permitted since both areas are under Coast Protection Orders, nevertheless quantities of sand are still being removed and it does not seem that the orders are being enforced. It is thus suggested that this state of affairs should be recognised and that the beach areas be left to serve their present function. It is with reluctance that this suggestion is made, since both beaches could have a considerable recreational and scenic value, although to be realistic, at the present time their visual amenity has greatly deteriorated.

The beaches of Caithness form an important recreational resource in the county, not only for the local population, but also for a wider, tourist market. The diversity of the beaches allows an imaginative deployment of developmental and conservational effort, and it is to be hoped that these resources are efficiently used and that the valuable asset which the beaches constitute is not allowed to deteriorate.
Geomorphological Symbols

**ASSOCIATED WITH ROCK SURFACES**

- ▲ Major steep slope
- ▲ Steep slope or cliff with lower part in bare rock
- — Ridge crest
- ● Rock exposure
- ⚪ Caithness flagstone or Old Red Sandstone series

**ASSOCIATED WITH SAND SURFACES**

- ➯ Smooth vegetated sand surface (alignment indicates main slope of ground)
- ▼ Undulating vegetated sand surface (includes marram, dunes and sandhills)
- ◆ Transition zone
- △ Dune edge (prograding with vegetation)
- △ Dune edge (prograding with bare sand)
- △ Dune edge (eroding edge)
- △ Sand hill
- △ Bare sand
- △ Blow out or other erosion scar
- △ Ridge crest (in sand)
- △ Area of broken sand hills, ridges and hollows
- △ Major slope (in sand)
- △ Major slope (in till)
- △ Rock slope partly covered by blown sand
- △ Solifluction terraces
- △ Slump
- △ Embryo dunes
- △ Terrace edge (mainly in rock)
- △ Terrace edge (mainly in till or sand)
- △ Flat surface
- △ Sand and scree fan
- △ Selected contour lines in feet
- △ Generalised break of slope or crest lines
- △ Indefinite
- ● B Beach rock

**ASSOCIATED WITH SURFACES SUBJECT TO GLACIAL AND FLUVIO-GLACIAL ACTION**

- ▲ Erratic
- ▲ Till

**ASSOCIATED WITH SURFACES SUBJECT TO MARINE ACTION**

- ▽▽ Live cliff
- ▽▽ Solid black - rock
- ▽▽ Dead cliff
- ▽▽ Open - till or sand
- △ Stack
- △ Abrasion platform
- △ Beach sand
- △ Sand under young marram communities
- △ Shingle
- △ Cobbles
- △ Shingle/cobble ridge
- □ Low and High Water spring tide marks
- □ HWM
- □ LWM
- □ Cave

**GENERAL**

- ▼ Peat
- ▼ Marsh
- ▼ Saltmarsh
- ▼ Sandy saltmarsh
- ▼ Bridge
- ▼ Pier
- ▼ ▼ Track/Road
- ▼ 23' Spot height (in feet above O.D.)
- ▼ 9' Slope gradient
- ▼ Buildings
- ▼ Stream or drainage ditch
- ▼ Waterfall
- ▼ Rapids in stream
- ▼ A Archaeological sites
- ▼ Tank obstacle
Figure 7.1 Sandside Bay
Figure 7.2  Thurso Bay
Figure 7.3  Murkle Bay
Figure 7.4 Dunnet Bay
Figure 7.5 Scotland’s Haven
Figure 7.6 John o’ Groats
Figure 7.7 Bay of Sannick
Figure 7.8  Freswick Bay
Figure 7.9 Sinclair’s Bay
### Appendix 1  Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABRASION PLATFORM</td>
<td>Rock surface of low relief cut by marine erosion. An abrasion platform</td>
</tr>
<tr>
<td></td>
<td>normally fringes a sea cliff, and is cut near high tide level.</td>
</tr>
<tr>
<td>BERM</td>
<td>A temporary ridge of beach sand, usually in the inter-tidal zone.</td>
</tr>
<tr>
<td>BLOW OUT</td>
<td>Erosion corridors or depressions in a dune or machair surface caused by</td>
</tr>
<tr>
<td></td>
<td>wind scour.</td>
</tr>
<tr>
<td>CONGLOMERATE</td>
<td>A sedimentary rock consisting of larger rounded stones cemented by a</td>
</tr>
<tr>
<td></td>
<td>finer matrix.</td>
</tr>
<tr>
<td>DEFLECTION</td>
<td>A general term describing the removal of sand by wind action.</td>
</tr>
<tr>
<td>DIORITE</td>
<td>A basic igneous rock.</td>
</tr>
<tr>
<td>DIP AND STRIKE</td>
<td>The attitude of geological beds eg</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Diagram" /></td>
</tr>
<tr>
<td>DRIFT</td>
<td>i. General term for unconsolidated material such as till, sand, etc.</td>
</tr>
<tr>
<td></td>
<td>ii. Movement of material by marine action.</td>
</tr>
<tr>
<td>DUNE PASTURE</td>
<td>A vegetated sand area inland from the active dune accumulation zone</td>
</tr>
<tr>
<td></td>
<td>(akin to links and machair).</td>
</tr>
<tr>
<td>ERRATICS</td>
<td>Boulders carried by ice from their source region and deposited on top of</td>
</tr>
<tr>
<td></td>
<td>a different bedrock.</td>
</tr>
<tr>
<td>FETCH</td>
<td>The amount and direction of open water in front of any specified point on</td>
</tr>
<tr>
<td></td>
<td>the coastline.</td>
</tr>
<tr>
<td>GEO</td>
<td>A narrow, steep-sided sea inlet usually cut along a joint or other line of</td>
</tr>
<tr>
<td></td>
<td>weakness.</td>
</tr>
<tr>
<td>LAG DEPOSIT</td>
<td>Residual cobbles and boulders from which the finer material or matrix has</td>
</tr>
<tr>
<td></td>
<td>been removed.</td>
</tr>
<tr>
<td>LINKS</td>
<td>Flat or gently undulating vegetated, sand-covered surface.</td>
</tr>
<tr>
<td>MACHAIR</td>
<td>Relatively smooth sand surface stabilised by vegetation forming a</td>
</tr>
<tr>
<td></td>
<td>continuous short grass and herb-rich sward.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Refraction</td>
<td>The bending and modification of a wave front as it approaches and reaches the coast.</td>
</tr>
<tr>
<td>Regolith</td>
<td>Layer of weathered material overlying unweathered rock.</td>
</tr>
<tr>
<td>Schist and Gneiss</td>
<td>Types of metamorphic rock.</td>
</tr>
<tr>
<td>Skerry</td>
<td>Small offshore rocky island.</td>
</tr>
<tr>
<td>Slump</td>
<td>A type of mass movement of soil or unconsolidated material resulting from slope failure.</td>
</tr>
<tr>
<td>Soil Creep</td>
<td>The gradual movement of soil and regolith downslope, mainly under the action of gravity.</td>
</tr>
<tr>
<td>Terracettes</td>
<td>Small “break of slope” features criss-crossing a slope actively subjected to certain rates of soil creep.</td>
</tr>
<tr>
<td>Till</td>
<td>As moraine but characteristically unsorted.</td>
</tr>
<tr>
<td>Area</td>
<td>N.G. Co-ords. (all N.D.)</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Sandside/Reay</td>
<td>296,965</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Thurso Bay</td>
<td>311,969</td>
</tr>
<tr>
<td>Muckle</td>
<td>317,969</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Dunnet Bay</td>
<td>321,970</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Scotland’s Haven</td>
<td>332,974</td>
</tr>
<tr>
<td>John o’ Groats</td>
<td>338,973</td>
</tr>
<tr>
<td>Sannick</td>
<td>340,973</td>
</tr>
<tr>
<td>Freswick</td>
<td>388,967</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Sinclair’s Bay</td>
<td>335,957</td>
</tr>
</tbody>
</table>

**Notes:**

Stability scale 0–5; 0 = completely unstable; 5 = very stable and accreting.

Calcium carbonate percentage was calculated using a Collins’ Calcimeter. The lower the C/p index the greater the general stability of the beach in terms of lateral shifts. Natural stability is the author’s estimate of the condition of the area if quarrying, agricultural or recreational practices were relaxed.

In general, fine sand has a median diameter less than 200 microns; medium sand, less than 600 microns.
Appendix 3  *Vegetation Analysis – Sandside Bay*

The area of Sandside Bay is used as an example of the types of vegetation found in the Caithness dune and dune pasture areas. The vegetation at Sandside is not entirely representative of all the beach and dune areas in Caithness since Sandside has endured a greater degree of biotic modification than several of the other areas which are described in the report. The general characteristics and degree of richness of the flora of these high latitude dune areas, however, is clearly demonstrated.

The scale used in the following tables is the DOMIN SCALE for cover estimates.

**DOMIN SCALE for cover estimates.**

<table>
<thead>
<tr>
<th>Number</th>
<th>Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>90–100% cover</td>
</tr>
<tr>
<td>9</td>
<td>75–90%</td>
</tr>
<tr>
<td>8</td>
<td>50–75%</td>
</tr>
<tr>
<td>7</td>
<td>1/3–50%</td>
</tr>
<tr>
<td>6</td>
<td>1/4–1/3</td>
</tr>
<tr>
<td>5</td>
<td>1/5–1/4</td>
</tr>
<tr>
<td>4</td>
<td>1/20–1/5</td>
</tr>
<tr>
<td>3</td>
<td>Small individuals frequent. Low cover &lt; 1/20.</td>
</tr>
<tr>
<td>2</td>
<td>Small individuals rare (sparsely distributed).</td>
</tr>
<tr>
<td>1</td>
<td>Individuals very rare, or 1 or 2 only.</td>
</tr>
</tbody>
</table>

Plot area in each case was 4sq m.

*This appendix was kindly provided by Miss A. Slater of the Department of Botany, University of Aberdeen.*
Appendix 3  Sandside Bay
### DUNE

<table>
<thead>
<tr>
<th>Species</th>
<th>Species</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achillea millefolium</td>
<td>Agrimony repens</td>
<td>Aquilegia sylvestris</td>
</tr>
<tr>
<td>Angelica sylvestris</td>
<td>Aira caryophyllum</td>
<td>Arabis alpina</td>
</tr>
<tr>
<td>Atriplex spp.</td>
<td>Ammophila arenaria</td>
<td>Arabis flexuosa</td>
</tr>
<tr>
<td>Bellis perennis</td>
<td>Carex arenaria</td>
<td>Artemisia vulgaris</td>
</tr>
<tr>
<td>Centaurea nigra</td>
<td>Carex flacca</td>
<td>Artemisia vulgaris</td>
</tr>
<tr>
<td>Cirsi um arvense</td>
<td>Dactylis glomerata</td>
<td>Artemisia vulgaris</td>
</tr>
<tr>
<td>Cerastium semidecandrum</td>
<td>Festuca rubra</td>
<td>Artemisia vulgaris</td>
</tr>
<tr>
<td>Campanula rotundifolia</td>
<td>Holcus lanatus</td>
<td>Artemisia vulgaris</td>
</tr>
<tr>
<td>Equisetum arvense</td>
<td>Damptothecium lutescens</td>
<td>Artemisia vulgaris</td>
</tr>
<tr>
<td>Galium verum</td>
<td>Claceu trium scoparium</td>
<td>Artemisia vulgaris</td>
</tr>
<tr>
<td>Hieracium pilosella</td>
<td>Ditrichium flexicaule</td>
<td>Artemisia vulgaris</td>
</tr>
<tr>
<td>Honkenya peploides</td>
<td>Hylcomium splendens</td>
<td>Artemisia vulgaris</td>
</tr>
<tr>
<td>Lathyrus montanus</td>
<td>Hypnum cupressiforme</td>
<td>Artemisia vulgaris</td>
</tr>
<tr>
<td>Leontodon taraxacoides</td>
<td>Pseudoscleropodium purum</td>
<td>Asplenium scolopendrium</td>
</tr>
<tr>
<td>Linum catharticum</td>
<td>Rhytidiadelphus squarrosus</td>
<td>Asplenium scolopendrium</td>
</tr>
<tr>
<td>Lotus corniculatus</td>
<td>3 Rhytidiadelphus triquetus</td>
<td>Asplenium scolopendrium</td>
</tr>
<tr>
<td>Plantago lanceolata</td>
<td>3 Tortula ruraliformis</td>
<td>Asplenium scolopendrium</td>
</tr>
<tr>
<td>Primula veris</td>
<td>2 Peltigera canina</td>
<td>Asplenium scolopendrium</td>
</tr>
<tr>
<td>Rumex acetosella</td>
<td>2 Senecio jacobaea</td>
<td>Asplenium scolopendrium</td>
</tr>
<tr>
<td>Senecio jacobaea</td>
<td>2 Senecio vulgaris</td>
<td>Asplenium scolopendrium</td>
</tr>
<tr>
<td>Taraxacum officinale</td>
<td>3 Thalictrum minus</td>
<td>Asplenium scolopendrium</td>
</tr>
<tr>
<td>Thalictrum minus</td>
<td>3 Thymus drucei</td>
<td>Asplenium scolopendrium</td>
</tr>
<tr>
<td>Trifolium repens</td>
<td>3 Veronica officinalis</td>
<td>Asplenium scolopendrium</td>
</tr>
<tr>
<td>Veronica officinalis</td>
<td>2 Viola tricolor</td>
<td>Asplenium scolopendrium</td>
</tr>
<tr>
<td>Viola tricolor</td>
<td>2</td>
<td>Asplenium scolopendrium</td>
</tr>
</tbody>
</table>
## DUNE PASTURE

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achillea millefolium</td>
<td>—</td>
<td>4</td>
</tr>
<tr>
<td>Angelica sylvestris</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Arabis hirsuta</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Atriplex spp.</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Bellis perennis</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cerastium semidecandrum</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cirsium arvense</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Euphrasia officinalis</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Galium verum</td>
<td>2</td>
<td>—</td>
</tr>
<tr>
<td>Hieracium pilosella</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Lathyrus montanus</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Lotus corniculatus</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Parnassia palustris</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Plantago maritima</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Plantago coronopus</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Plantago lanceolata</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Pteridium aquilinum</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Ranunculus acris</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Rumex acetosella</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Succisa pratensis</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Thalictrum minus</td>
<td>2</td>
<td>—</td>
</tr>
<tr>
<td>Trifolium pratense</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Trifolium repens</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Thymus drucei</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Urtica dioica</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
## PLANTAGO MARITIMA SWARD

<table>
<thead>
<tr>
<th>Plant</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achillea millefolium</td>
<td>—</td>
</tr>
<tr>
<td>Anthyliis vulneraria</td>
<td>—</td>
</tr>
<tr>
<td>Armeria maritima</td>
<td>3</td>
</tr>
<tr>
<td>Bellis perennis</td>
<td>—</td>
</tr>
<tr>
<td>Cerastium semidecandrum</td>
<td>2</td>
</tr>
<tr>
<td>Cirsium arvense</td>
<td>—</td>
</tr>
<tr>
<td>Euphrasia officinalis</td>
<td>2</td>
</tr>
<tr>
<td>Galium verum</td>
<td>2</td>
</tr>
<tr>
<td>Gentianella amarella</td>
<td>—</td>
</tr>
<tr>
<td>Leontodon taraxacoides</td>
<td>—</td>
</tr>
<tr>
<td>Lotus corniculatus</td>
<td>3</td>
</tr>
<tr>
<td>Plantago maritima</td>
<td>4</td>
</tr>
<tr>
<td>Plantago lanceolata</td>
<td>—</td>
</tr>
<tr>
<td>Plantago coronopus</td>
<td>—</td>
</tr>
<tr>
<td>Prunella vulgaris</td>
<td>—</td>
</tr>
<tr>
<td>Ranunculus acris</td>
<td>—</td>
</tr>
<tr>
<td>Senecio jacobaea</td>
<td>—</td>
</tr>
<tr>
<td>Thalictrum minus</td>
<td>—</td>
</tr>
<tr>
<td>Thymus drucei</td>
<td>2</td>
</tr>
<tr>
<td>Trifolium repens</td>
<td>3</td>
</tr>
<tr>
<td>Urtica dioica</td>
<td>—</td>
</tr>
<tr>
<td>Viola tricolor</td>
<td>—</td>
</tr>
</tbody>
</table>
WET FLUSH

Agrostis stolonifera  —
Angelica sylvestris  —
Bellis perennis  —
Centaurea nigra  —
Cardamine pratensis  —
Dactylis glomerata  —
Deschampsia caespitosa  —
Filipendula ulmaria  —
Galium palustre  —
Iris pseudacorus  —
Juncus articulatus  —
Juncus effusus  —
Luzula multiflora  —
Lathyrus montanus  —
Mentha aquatica  —
Potentilla anserina  —
Prunella vulgaris  —
Rosa canina  —
Rubus fruticosus  —
Rumex acetosella  —
Salix atrocinerea  —
Salix repens  —
Senecio vulgaris  —
Ulex europaeus  —
Urtica dioica  —
Veronica officinalis  —
Appendix 4 Derivation of the Direction – Resultant of Wind Work

The direction resultant of the wind work (DRW) is a vector quantity used in coastal geomorphology to assist in the analysis of the trend of coastal simplification. Since the movement of waves is normally the prime force modifying coastal outline and these movements, in turn, are controlled by wind strengths and directions, the raw data for the calculation of the DRW are statistics of wind strengths, frequencies and directions.

The calculation of DRW is as follows. The frequency percentage and the Beaufort value are multiplied, and values for the same wind direction added. The sum totals are illustrated graphically as lengths of line with real compass orientation in a vector diagram, and the resultant is constructed as a connecting line between the initial point and the end point. Only Beaufort values greater than 4 are used.

With this vector and a knowledge of fetch sectors and distances an analysis of coastline simplification can be readily made. Under normal conditions, the trend of the coastline will lie in accordance with the relationship between the DRW and the direction of maximum fetch. For example, where these directions coincide there will be a very strong tendency for the coastline to be aligned squarely to this direction.
Appendix 5  John o’ Groats Interim Report on Development Proposal

The Proposal

With its focus on the harbour and hotel there are proposals to landscape and develop the area of coastline at John o’ Groats. Apart from levelling the surface and designing amenity areas and services such as a caravan park, the plan envisages the building of a sea wall which will extend for up to 200m on either side of the harbour.

This report seeks to assess the possible effects of the building of this wall on the physical condition of the littoral zone.

General

The area may be divided east and west of the pier. To the west the coastline consists of 1–2m high sand cliff of stratified shell-rich sand. There are no dunes but normal high water spring tide does not reach the base of the cliff. In general the edge is subject to slumping with the greatest intensity being close to the hotel. This is undoubtedly caused by walking along the edge of the sand cliff since significant patches of colonising vegetation are now establishing embryo dunes on the sand apron between the base of the cliff and high water mark. Sea lyme grass is a conspicuous pioneer. There are patches of shingle and larger stones on the upper beach but it is generally quite restricted and ribbed bedrock reefs are not far from the surface and the whole coastline must be regarded as a rock platform zone with the beach being almost incidental although there is map and other evidence to show it was more extensive in the past but was apparently removed in wartime. There are also crude attempts to dump topsoil and rubble especially near the hotel. There is no evidence to suggest the direction of beach drifting. With the open exposure to west, north and east it is probably true to say that wave action can come from any direction. The jetty is curved against northeast gales so it is presumed that storm action is most probable from that sector.

The only break in the rock platform occurs at the harbour where a slight depression occurs in the rock structure. In line with this is the largest exposure of beach which encroaches in a triangular-shaped slope onto the glacial till platform which is found at +5 to +10m O.D. (The hotel, Last House and other buildings are on this platform of red, clay-rich glacial deposits.)

East of the pier there is little or no sand beach and the physiography is generally similar although the cliff and platform surface is slightly higher. Again it is undercut by path-generated slumping and again sea lyme grass and other foreshore species are present in a form that would suggest that natural stability and even prograding conditions could be easily maintained. On this evidence it is suggested that the rock platform with its oblique ridges and depressions may act as an effective wave-screen for the upper beach. Two additional features must be mentioned on this stretch east of the pier;

1. the undoubted effect of the pier acting as a groyne and deflecting wave action into the angle formed between it and the promontory on which is sited the Last House, and

2. erosional gullies which are used by pedestrians from the caravan site. One of these gullies is emphasising the “headland” appearance of the sand and till-cliff c.100m east of the Last House. This slight alteration in coastal outline could make it more vulnerable to wave attack during exceptionally high tides.
Specific Problems

In the light of the foregoing the questions to be raised are whether or not the proposals increase or decrease the stability of the area or introduce new elements into the processes of coastline evolution. There can be no doubt that the proposals greatly improve the appearance of the area which must be a great disappointment to most visitors.

The key issue is the placing and shape of the sea wall. An effort must be made to resist the temptation to push the wall seawards of the present coastline. It would be better to move it slightly inland and create a low angled coastal protection. The wall should be gently curved and should not contain irregularities or sinuosities in outline. Right-angled corners especially at the junction with the existing harbour must be avoided since this will cause undue pressure on the apex. The beach east of the pier will probably disappear but this is probably unimportant since the actual coastal protection is the rock platform and not the sand beach. If this removal does occur then the tendency for the sea to attack the east side of the harbour wall will be reinforced and reinforcing of this part of the jetty/sea wall might be necessary.

By removing the absorbent nature of the present till and sand cliff and replacing it with an impermeable barrier the general “circulation” of longshore currents and sediment movement will be accelerated and even exaggerated. One result of this would be that the harbour might be subject to sand accumulation during periods of westerly and northwesterly winds. Although the evidence is scanty it is possible that the beach immediately in front of the hotel may thicken and become more extensive. This would be valuable as this is the only beach area that is used to any extent today and would be a useful addition to the attractiveness of the general area. A gabion-type section, although initially unattractive, might provide a suitable nucleus for the retention of sand and the development of vegetation as for example sea lyme grass at this point. Similar gabion sections would provide the best transitions at either end of the stone or concrete wall.

Since the area is in process of re-adjusting to the unnatural removal of its protective beaches the general rule should be to observe the current trends of erosion and accretion and design the location and type of sea wall accordingly, in order that it conforms closely to natural conditions.
Appendix 6 Coastal Protection Orders, Caravan Sites and Sites of Special Scientific Interest

(a) Coastal Protection Orders

John o’ Groats 1954
Dunnet Bay 1957
Braes of Scrabster 1960
Dunnet Bay 1961
John o’ Groats and Sannick Bay 1962
John o’ Groats and Ness of Duncansby 1964

(b) Licensed Caravan Sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Type</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dunvegan, Reay</td>
<td>Residential/Holiday</td>
<td>14</td>
</tr>
<tr>
<td>Blackhills, Reay</td>
<td>Residential</td>
<td>17</td>
</tr>
<tr>
<td>Halkirk</td>
<td>Holiday</td>
<td>6</td>
</tr>
<tr>
<td>Castletown</td>
<td>Residential</td>
<td>15</td>
</tr>
<tr>
<td>Dunnet Links (East)</td>
<td>Holiday/Tourist</td>
<td>15</td>
</tr>
<tr>
<td>Dunnet Links (West)</td>
<td>Holiday/Tourist</td>
<td>15</td>
</tr>
<tr>
<td>Huna (Canisbay)</td>
<td>Holiday/Tourist</td>
<td>15</td>
</tr>
<tr>
<td>John o’ Groats</td>
<td>Holiday/Tourist</td>
<td>15</td>
</tr>
<tr>
<td>Wick (Thrumster)</td>
<td>Holiday/Tourist</td>
<td>35</td>
</tr>
<tr>
<td>Wick (Lochshell Farm)</td>
<td>Residential</td>
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</tr>
</tbody>
</table>

(c) Sites of Special Scientific Interest

Dunnet Links – Botanical and Physiographical
Stacks of Duncansby – Geological
Leavad, Latheron – Geological
Achanarras Quarry, Halkirk – Geological
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