Description	*Gazetteer Example*
Coast Unit Number/Name	1 Strone Point
National Grid Reference	NS 1911 8043
Coast length of unit	0.81 km
Long term erosion class	LT: Erosional - Low
Long term erosion class	ST: Stable - Low
Description of coastal unit	The littoral coverage was of <10%……

5.3 *Hinterland Geology and Coastal Geomorphology*

The gazetteer entries accompanying the Hinterland Geology and Coastal Geomorphology maps are set out as follows:

Description	*Gazetteer Example*
Coast Unit Number/Name	1 Strone Point
National Grid Reference	NS 1911 8043
Coast length of unit	0.81 km
Foreshore type	Mainly rock platform
Coast edge type	Sea Wall
Hinterland type	Raised Beach
Description of coastal unit	The rock headland at Strone……

6.0 Background to the Archaeology of the Survey Area

The three areas within the survey zone have had varying degrees of archaeological investigation carried out within them prior to the survey. A brief overview of this is given below.

6.1 *Cowal Peninsula*

The first major archaeological survey was included in the production of the first edition OS maps in the late 1860's. This noted sites of archaeological and historical interest and there have been follow up visits from Ordnance Survey throughout the twentieth century. The Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) produced an inventory of sites ranging from the prehistoric to Medieval and later sites, which was published in two volumes in 1988 and 1992. Follow up visits by the RCAHMS have also been undertaken. While the Cowal Archaeological and Historical Society have been active in this area (Rennie, 1993 & 1997), recorded excavations in the survey zone on the Cowal Peninsula are few. In May 1994 rescue excavations were undertaken by J Atkinson (GUARD) on five graves at Chapelhall, Innellan. Previous reports from the area in the mid nineteenth century noted remains of a chapel and burial ground in the area.

6.2 *Great Cumbrae*

Little recorded work appears to have taken place on the Island of Great Cumbrae. Most of the records relate to work carried out in the late nineteenth century (Chardenal 1883), and the production of the first edition OS maps in the late 1860's included notes on archaeological and historical sites. The former tumulus GC20 at the northern end of the island was investigated in 1879 and 1881. The vast majority was removed later during the construction of the road. Just to the south of this another cairn (GC21) was partially excavated in 1878. There are also records of a tumulus at the northern end of the island (GC32) that was destroyed in 1873 during the construction of the road (MacGowan 1883).

6.3 *Ayrshire*

The Ayrshire coastline has been subject to a variety of archaeological and historical surveys. These include the production of the first edition OS maps in the late 1850's, which included notes on archaeological and historical sites, and a publication on sites relating to prehistory (Smith 1895). More recent surveys include an inventory of sites in the southern area of the survey zone by the RCAHMS in 1983 and a coastal survey from Culzean to Dunure (Addyman 1998) in advance of a woodland regeneration scheme. E M Patterson produced an article on a survey of possible ancient fish traps in 1989 which covered the area from Ardrossan to Hunterston. Due to the heavily built up nature of the coastline north of Doonfoot, it would be expected that much of the pre twentieth century archaeological remains are destroyed, resulting in a lack of documented excavations in this area.

7.0 Physical Background to the Coastal Zone of the Firth of Clyde

7.1 *Coastal Cells*

The concept of coastal cells was adopted in England and Wales in 1993 as a framework for strategic management of the coastline (MAFF 1993). The Scottish coastline was categorised in 1996 by Wallingford into 11 sediment cells. These cells defined lengths of coastline where the movement of sand and gravel was relatively self-contained and so any interruption to movement within one cell may affect other locations within the same cell but should not have a significant impact on adjacent cells. The boundaries of such cells were identified as two basic types:

1) Littoral drift divides which normally occur at a point where the coastal orientation changes direction abruptly, for example at a headland, or where a parting of sediment drift occurs, for example at an eroding beach where sediment on either side moves in both directions away from the eroding section. In some cases a less fixed drift divide may occur where there is no such dramatic change in coastal orientation, and whose position can vary with relatively small change in wave conditions; and
2) Sediment sinks, which are points where sand or gravel transport paths meet, such as in deeply indented bays, tidal inlets and estuaries. Sediment then tends to accumulate in such locations and may be complicated by tidal flows and currents in estuaries.

The large-scale coastal cells defined by Wallingford (Ramsay & Brampton 2000) are appropriate for discussions at a large spatial scale. The Firth of Clyde, stretching form the Mull of Kintyre to the Mull of Galloway, was divided by Ramsay & Brampton (2000) into 4 cells (6a – 6d, Figure 2).

This Coastal Zone Assessment focuses on a smaller scale; hence the coastline was further divided into sub-cells, between which little or no sediment exchange occurs. The sub-cells for this Coastal Zone Assessment are defined in Figure 3. The Cowal Peninsula is divided into 3 sub-cells, namely The Holy Loch, Dunoon and Innellan and finally Toward to Ardyne Point. Great Cumbrae is within its own sub-cell. The Largs section of the Ayr coast is delimited by Cloch Point (Gourock) to the Southannan Sands Pier. A small cell will exist between the Southannan Sands Pier and Farland Head. A possible sub-cell boundary exists at Ardrossan, and extends to possible boundary at Troon. Significant amounts of sediment exchange are occurring in the Ayr Bay, but little sediment will pass the cliffs at Dunure. The final cell within the site boundaries extends from Dunure to Turnberry point.

7.2 *The Quaternary Inheritance*

The fjord landscape of Western Scotland, including the Firth of Clyde, reflects the environmental changes that occurred during the repeated glaciations of the Quaternary. In contrast, the intertidal and subtidal Firth of Clyde still continues to adjust to more recent (and current) changes to the environment.

During the last glacial period (30-10,000 yrs) ice moved along the Clyde from both the north and the south. Ice from the Highlands and the Southern Uplands converged north of the Southern Upland Fault (Sutherland 1984). Numerical models (Bolton *et al* 1991) suggest that by the glacial maximum (*c* 18-20,000 yrs BP) the ice was up to a 1 km thick over the Clyde area. Subsequently, the Clyde region underwent rapid deglaciation associated with iceberg calving as the ice limit receded up the fjords. This resulted in much of the region being free of ice by 13,000 years before present (Sutherland 1981). The climate ameliorated for 2000 years prior to a cooling associated with the Loch Lomond Stadial when glaciers re-advanced along Loch Lomond, Loch Fyne and Loch Long to their maximum extent around 10,500 yrs BP (Rose et al 1988). During these times periglacial conditions occurred at the coastal and erosion was extensive, forming or re-trimming a rock platform and shoreline known as Main Late-Glacial Shoreline (Sissons 1974). This brief period of arctic conditions came to an abrupt end around 10,000 yrs BP, marking the start of the Holocene warming

Glacial recession revealed a coastal landscape veneered by glacial sediments, such as tills moraines, glacial-fluvial sands and gravels. Along much of the Inner Clyde the lower lying coastal fringe would have been till covered and this sediment has been accessed by the sea from beaches.

Figure 2, Cell 6 Mull of Kintyre to Mull of Galloway.
Ramsay & Brampton (2000)

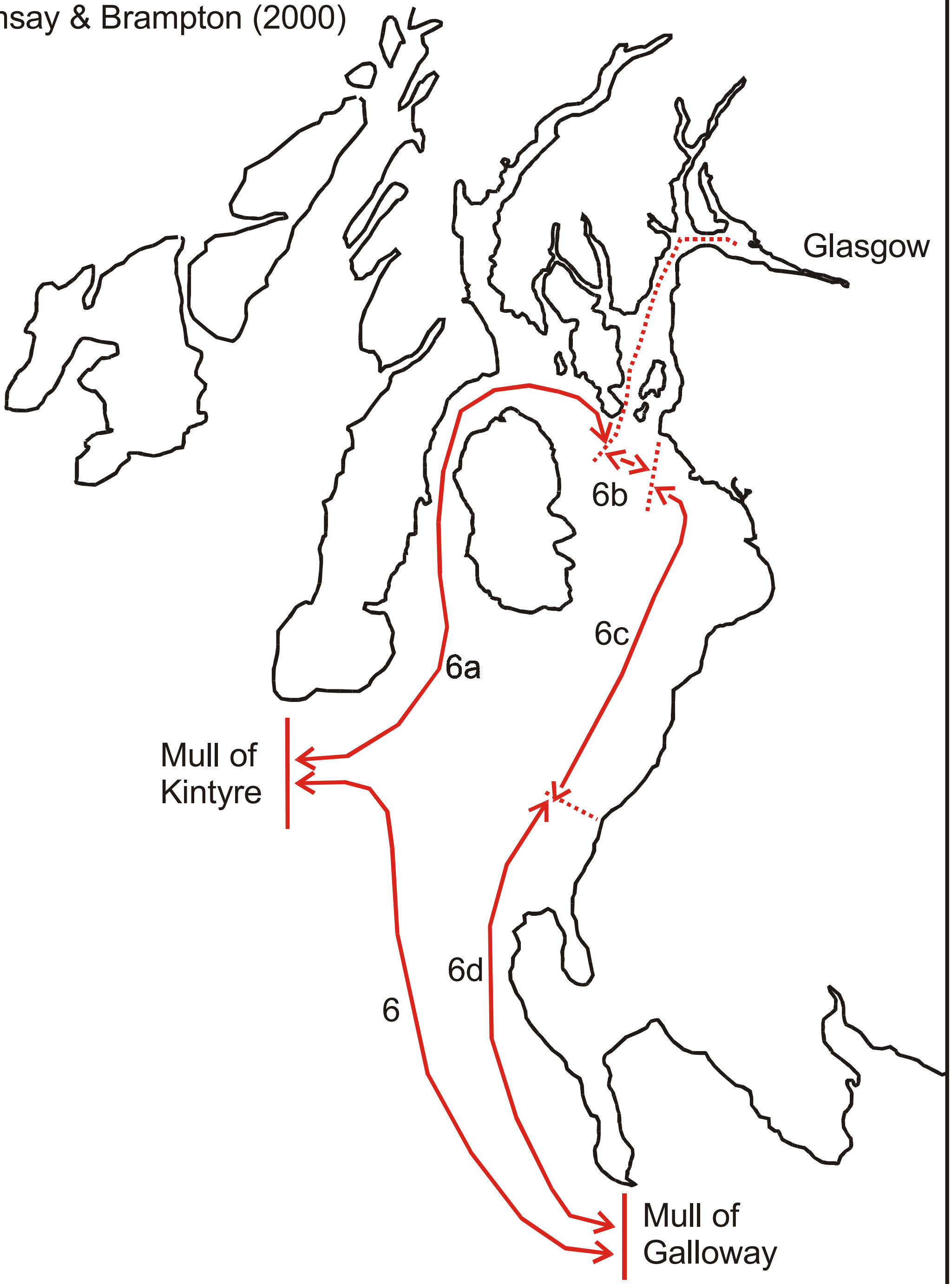
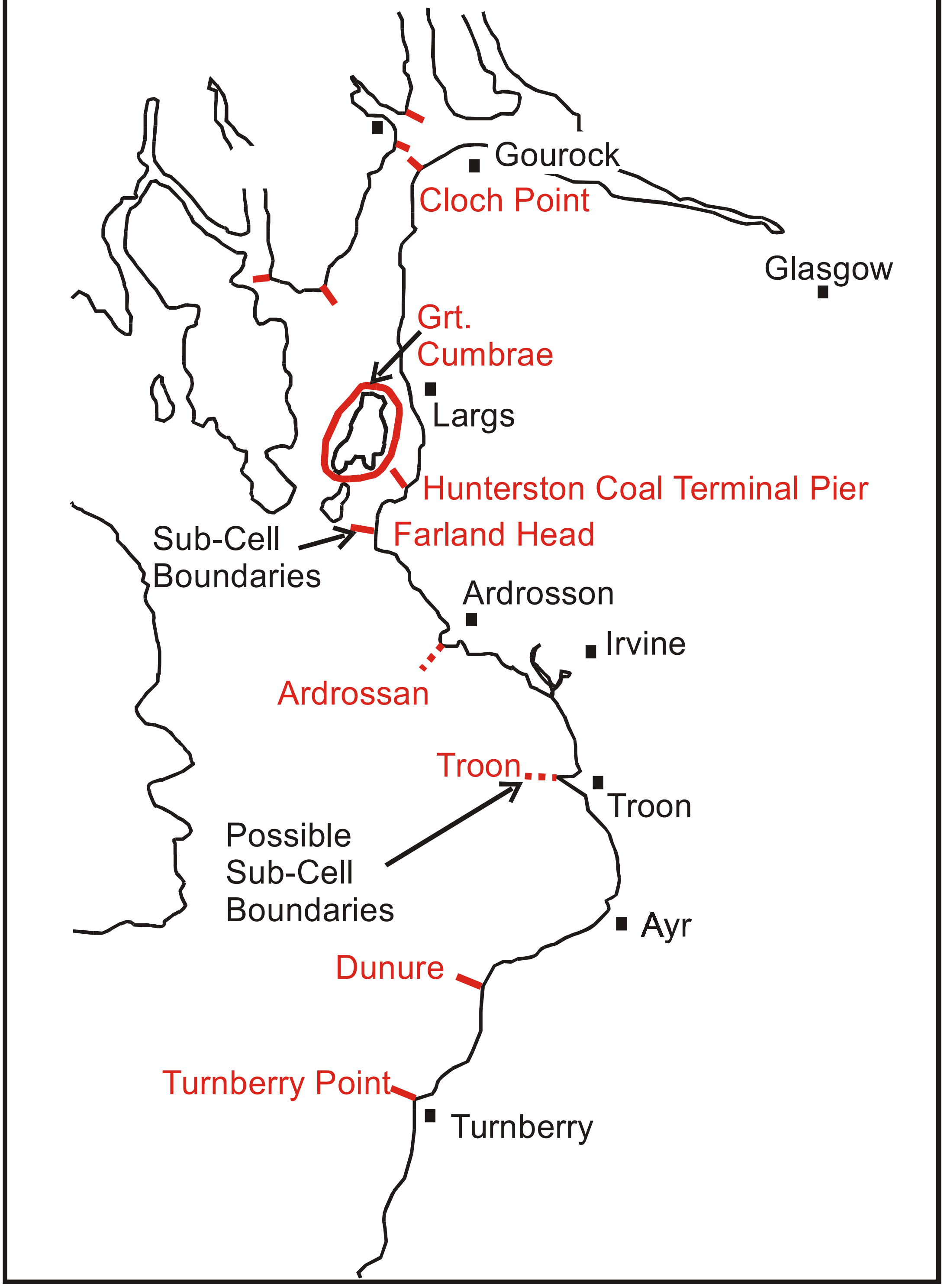


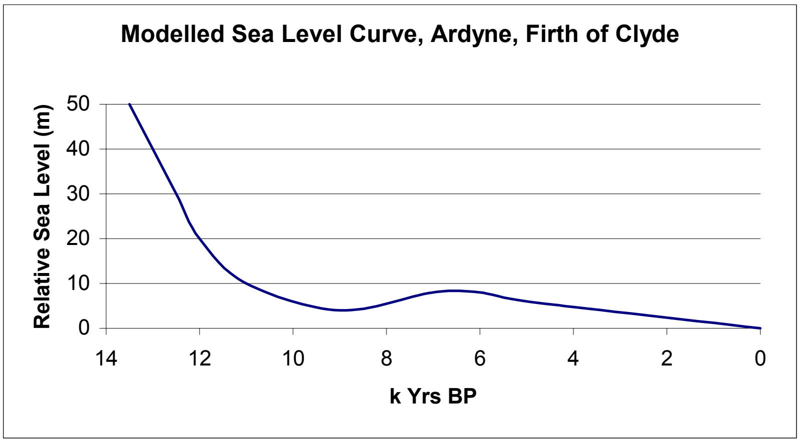
Figure 3, Sub-Cell Boundaries



7.3 *Sea Level Changes*

Relative sea level rose initially reflecting eustatic inputs (the ice melt contribution form retreating ice masses), however as the ice melted isostatic rebound was initiated (the crustal uplift responding to the removal of the ice mass) which overtook eustatic contributions around 6000 Yrs BP Sea level has fallen since to its current location.

The previous section briefly summarised the main environmental changes during the Quaternary. The retreat and subsequent demise of the glaciers within the Clyde had a significant effect on the volume and distribution of sediments made available to terrestrial and marine processes. The spatial focus of these marine processes is driven by the relative sea level; which is dependant on global sea levels (fuelled by glacial melt) and isostatic recovery (land recovering from the removal of the weight of the ice mass) during the Holocene. These relationships have been modelled for the Firth of Clyde and are presented in Figure 4.



After Lambeck (1991)

Figure 4:

Modelled Sea Level Curve.

7.4 *Sediment Provenance*

The interaction of the spatial variations of drift geology and relative sea level has had a significant impact on the Firth of Clyde. The classification and documentation of the Firth of Clyde's glacial landforms is beyond the remits of this investigation; however, the broad description of glacial drift in association with sea level changes will inform the reader of the principles of sedimentary inheritance in contrasting areas and its consequences for continued coastal evolution.

The contrasting morphologies of the cliffed coastline (northern and southern sections of Ayrshire site) with that of the low lying coastline (central sections of the Ayrshire site) reflect the effect of geological inheritance, sediment supply and sea level changes – which are driving mechanisms of coastal geomorphology.

The cliffed sections of the coastline, associated with more resistant rock types (Old Red Sandstone) have steeper off- and on-shore profiles. During the Holocene the changing sea level results in a small lateral shift of the coastline, providing little change in the sediment availability. This is contrasted in the low lying sections of the coastline, with associated shallow off- and on-shore profiles, where the same sea level changes resulted in much larger lateral shifts in the shoreline. This resulted in larger volumes of sediments being introduced to the wave base, creating large depositional features, the remnants of which are still present today (ie the narrow dune ridge fringing the central Ayrshire coastline).

The rapid sea level rise up to 6,500 yrs BP led to a minor landward relocation of the coastline, associated with flooding of low lying areas. The sea level rise slowed and changed to sea level fall at 6,500yrs BP. This emergence resulted in large amounts of sediment movement on-shore and the creation of beaches. As the emergence continued, sediments were made increasingly available to beaches and wind processes resulted in the development of dunes. As time continued and sea level fall slowed, the sediment sources have become increasingly exhausted. This reduction in sediment supply has resulted in coastal erosion. This erosional trend continues to the present and rivers and offshore sources now contribute only limited volumes of sediment. Although erosion is present over the whole coast, the erosional landforms are greatest in soft coastal areas and least in rocky areas.

The net result of the availability of sediment in conjunction with isostatic uplift has been the development of suites of raised (emerged) beaches along the Clyde Coast, usually lying to the rear of modern beaches. The main Late Glacial Shorelines in the Firth of Clyde have been investigated by Dawson et al (2001) and are presented in Figure 5.

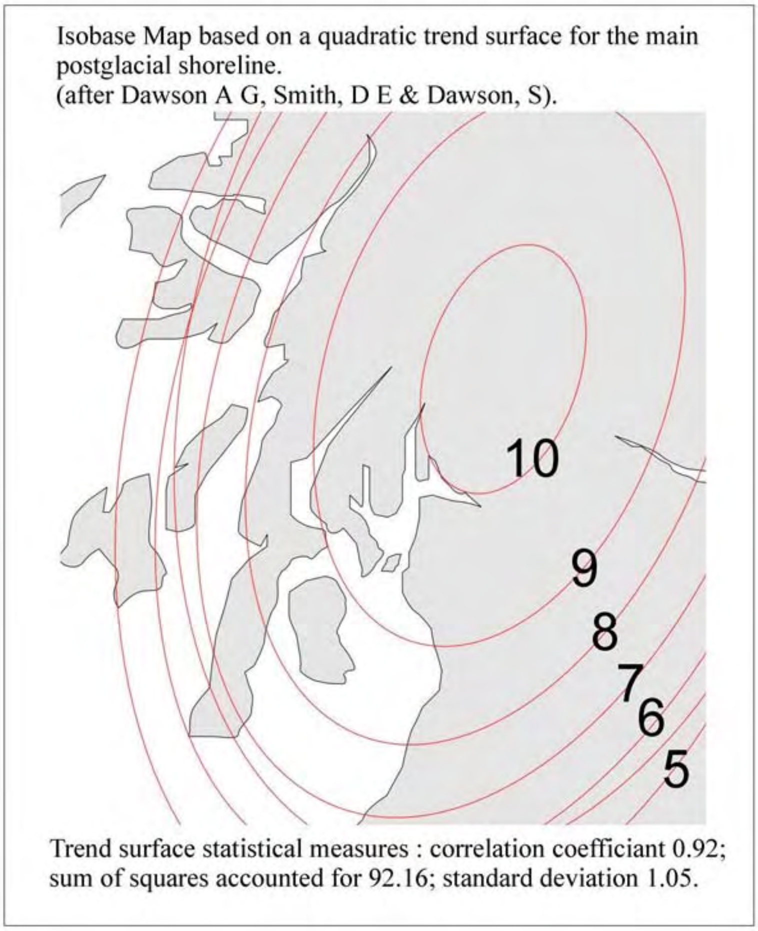


Figure 5:

Late Glacial Shorelines in the Firth of Clyde.

7.5 *Wave Climate – Firth of Clyde*

The Firth of Clyde, and particularly the Inner Firth, is enclosed and narrow. This has clear implications for the amount of waves propagating into the Firth and the fetch available for wave generation within the Firth itself. For limited areas of the wider Firth (south facing section of the Kintyre Peninsula) the fetch is significant, greater than 300 km. However for much of the Firth the fetch rarely exceeds 100 km and is frequently less than 10 km (Firth and Collins 2002).

Wave measurement and modelling, conducted by Wallingford (1996) for the Ayrshire coast, showed a dominance of south-westerly waves, which rarely exceed 1.6 m in the offshore and 1.2 m for inshore waters. This results in a dominance of northerly sediment movement with local deficits at the southern ends of beaches.

7.6 *Human Development and Interference*

Large sections of the Ayrshire coast are eroding slowly or moderately. Much of this can be attributed to the geological and quaternary inheritance of these sections of shoreline. However, anthropomorphic factors are increasingly likely to have had a negative effect on the health of the shoreline. It is widely accepted that the key to managing coastal erosion is the management and control of sediment. If sediment is protected, it does not contribute to the internal sediment balances within the cell. The cell then erodes adjacent unprotected stores to account for the shortfall, producing an erosional bite.

This principle is aggravated when large sections of the shoreline are protected, as in the case of Ayrshire, resulting in the focussing on fewer stores to supply the wider need of the cell/sub cell. This problematic situation is hindered further by the extraction of sediment from river mouths. Given the size and location of the rivers in question these are unlikely to contribute significant volumes of beach material to the cell; however, the dredged material is likely to beach material moving alongshore. The removal of this 'beach sediment' from the foreshore to an offshore dump below the wave base can be a significant loss to the cell.

60,000 tonnes of sediment are extracted annually from Ayr Harbour. A significant proportion of this sediment is likely to be beach grade material. If this could be fed to the near shore, the erosional problems would decrease.

8.0 Summary of Results

A summary of results dealing with Archaeology and Built Heritage and Erosion Class is given below.

8.1 *Archaeology and Built Heritage*

8.1.1 *Number of Sites*

The desk based assessment and the field survey produced a total of 299 sites. Of these, 195 were previously recorded in the WoSAS Sites and Monuments Record and in the National Monuments Record held by the RCAHMS. The field survey produced another 104 sites that were previously unrecorded. Of these 299 sites, a total of 21were Listed Buildings, the majority of which lay inland from the coast edge but all within the survey zone of 50 – 100 m from the coast edge. A total of 11 Scheduled Ancient Monuments were located in the survey area. Four of these sites were both Listed and Scheduled. For the purpose of this project they were counted as Scheduled. A breakdown of the sites can be seen in Table 2. The number of these sites present in the different coastal sections can be seen in Table 3, the Scheduled Ancient Monuments in Table 4 and the Listed Buildings in Table 5.

Table 2: Number of Sites

Sites	*No of Sites Located During Survey*	*% of Total No of Sites*
Listed Building	21	7
Scheduled Ancient Monument	11	3.5
Designed Landscape	2	0.5
Designated Wreck	0	0
Undesignated Wreck	13	4.5
Other Known Site	243	81.5
Insufficient information	9	3
TOTAL	299	

Table 3: Sites per Coastal Section

Sites	*Ayrshire Coast*	*Cowal Peninsula*	*Great Cumbrae Island*	*Total*
Listed Building	13	7	1	21
Scheduled Monument	8	3	0	11
Designed Landscape	0	2	0	2
Designated Wreck	0	0	0	0
Undesignated Wreck	6	5	2	13
Other Archaeological Site	146	57	40	243
Insufficient Information	9	0	0	9
TOTAL	182	74	43	299