UNIVERSITY COLLEGE CORK
Coláiste na hOllscoile Corcaigh

Coastal & Marine Resources Centre
Ionad Acmhainní Cósta is Mara

Review of the Coastal Protection at Tramore Strand

FINAL REPORT

MAY 2006

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EXECUTIVE SUMMARY

This report was commissioned by the Heritage Office of Waterford County Council to review coastal protection at Tramore Strand in the South East of Ireland and the research was conducted by members of the Coastal and Marine Resources Centre (CMRC) and the Department of Geography of University College, Cork. The objective of this study was to make recommendations to assist with contemporary coastal management issues at Tramore and provide suggestions for the future research programmes that would be required to develop an overall management strategy for the site.

To achieve this, the views of local users and Council officials were obtained by conducting a questionnaire survey and through a number of informal interviews. These responses were then combined with the reports generated from site visits to establish the current usage patterns and concerns of users, the local management issues and to produce a visual assessment of the contemporary coastline at Tramore.

A review of the available documentation concerned with the management of Tramore was conducted and from this a series of tables was produced describing the historical attempts that have been made to manage the area. Where possible, the costs of any coastal protection schemes were highlighted and for comparison converted to their modern day equivalent.

Relevant data for the area were collected and collated and used to create a dedicated Geographical Information System (GIS) for Tramore. This was subsequently utilised to assess changes in historical coastline position and illustrate channel migration change and demonstrate the usefulness of GIS as a coastal management tool.

Finally, the research output was utilised to produce a series of management recommendations and to suggest the type of monitoring programme that would be required prior to the production of an overall management strategy for Tramore.

CONTENTS

FIGURES

TABLES

1.0 INTRODUCTION

This report was commissioned by the Heritage Office of Waterford County Council to review coastal protection at Tramore. The research was subsequently conducted between July 2005 and February 2006 by members of the Coastal and Marine Resources Centre (CMRC) and the Department of Geography of University College Cork.

The objective of this study was to make recommendations to assist with contemporary coastal management issues at Tramore and to provide suggestions for future research programmes required to develop an overall management strategy for the site.

1.1 SITE LOCATION AND ISSUE IDENTIFICATION

Tramore Strand is situated on the south-east coast of Ireland south of the city of Waterford (Figure 1.1). The maximum tidal range in the area is *c.*3.3m and the beach is characterised by high energy waves making it popular with surfers. The Strand forms part of a rectangular basin with *c.*1000 hectares of water surface between the two headlands of Great Newton Head and Brownstown Head (McGrath, 2001). Tramore Strand faces south-west and sequentially, from west to east, is backed by

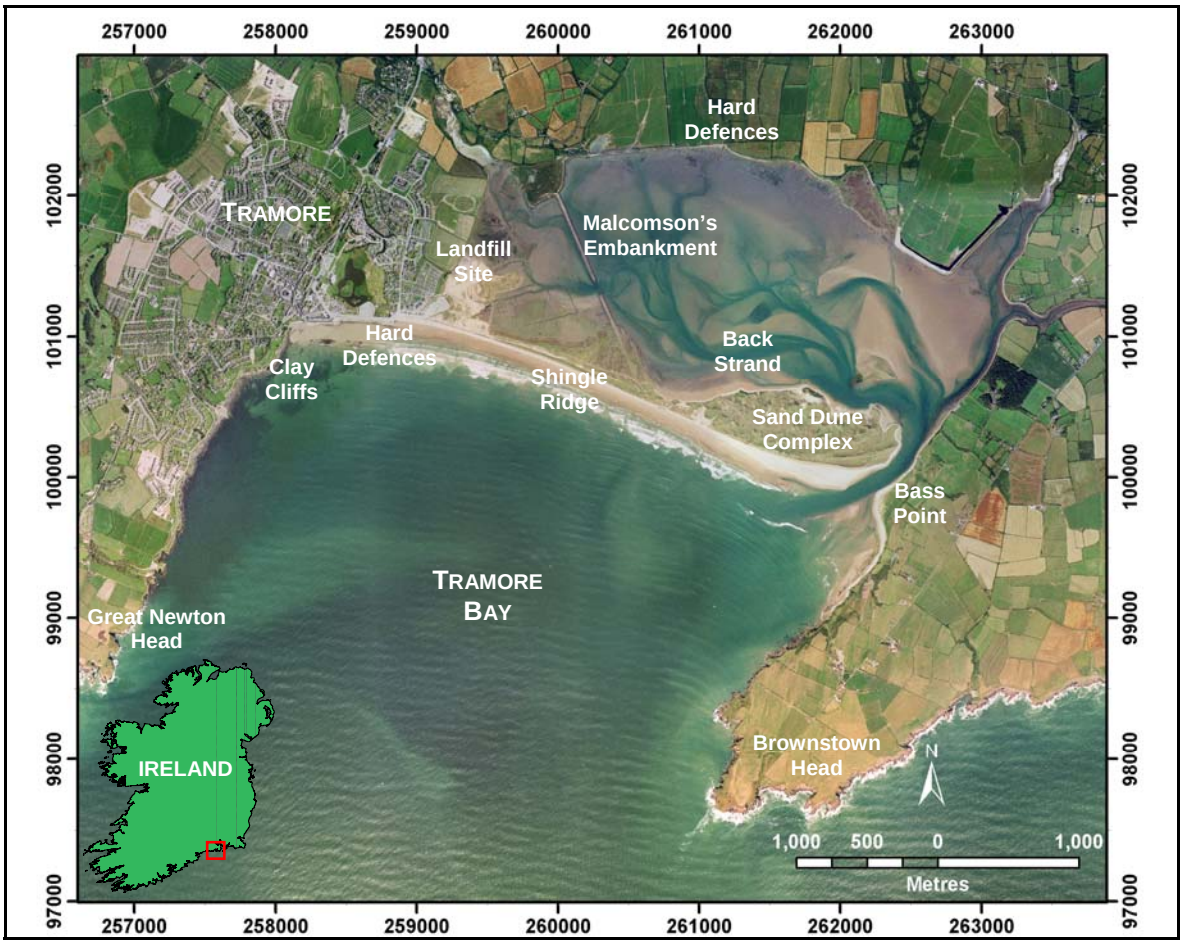


Figure 1.1: Annotated aerial photograph of Tramore (for enlarged version see Appendix 2)

clay cliffs composed of organic sediments, hard shoreline defences; a shingle ridge; and finally a dune-beach barrier system dominated by a mature dune complex. The beach extends to over 5km in length and varies in width from 100m to 300m. In the inter-tidal Back Strand, behind the spit, there is

an extensive area of shallow water characterised by inter-tidal sediments and extensive channel development. To the North of these meandering channels there is protected farm land. To the West there is a breached historical embankment known as Malcomson's embankment.

This beach and spit system is a local amenity and is heavily utilised by both local residents and a large number of tourists during key holiday periods. In recent years, Tramore has become a commuter town and the associated increase in population has further elevated the pressure on the natural resources on this section of coastline. The main concerns in the region include erosion, resulting from both natural processes and levels of usage, and waste management, especially issues surrounding the recently decommissioned landfill site. Previous water quality concerns appear to have been offset by the recently completed water treatment and drainage scheme (Figure 3.17/18).

1.2 BACKGROUND

Coastal erosion and associated processes are a natural and ongoing part of coastal changes. The rise of sea level at the end of the last glaciation from positions below *c.* –120m OD *c.*18,000 years ago has subsequently forced coastal systems across the continental shelves and progressively on land (Carter et al., 1989; Swift et al., 2006). In south-east Ireland, and in neighbouring regions, peats and organic muds exposed now in the intertidal zone have resulted from the formation of swamps and lagoons behind coastal barrier systems and show a late stage in this pattern of changing coastal positions. At Tacumshin and Lady's Island barriers, and at many other similar sites along Ireland's southern coasts, these swamps and lagoons are shown to have formed behind dune – gravel barriers some 4,000 – 5,000 years ago. Onshore movement and shape changes of such barriers under rising sea level and other coastal processes continues to take place (Devoy et al., 2006).

Beaches can form a vital part of the coast's defence against erosion or flooding by offering a natural buffer between the sea and the land. At Tramore, the beach and spit system forms a physical barrier that protects the interior coastline and the adjacent infrastructure of the embayment immediately behind the spit (Figure 1.1). Tramore Strand has been subjected to wave and tidal erosion as part of coastal morphological changes at short to long term timescales. In addition, the dune system has suffered internal impact from human activities and this impact has contributed to the formation of blowouts as a result of wind erosion.

A combination of the sea walls, shingle ridge and the natural spit protects the coastline and adjacent infrastructure. All of these areas have suffered erosion either as a result of catastrophic events such as storms or routine wave and tide action and continue to be vulnerable today. The sea walls and the shingle ridge are routinely maintained and any storm damage is repaired as a matter of course. In contrast the majority of the spit still has a natural coastline and has not tended to be protected with the exception of localised attempts to shore up the more vulnerable sections.

There is considerable local pressure on the local authority to continue to maintain the coastline and control any potential for change in order to protect the economic, cultural and environmental assets

from the threat of erosion. As the western section of Tramore is protected by permanent sea walls, this study focussed on the remaining largely unprotected areas. There have been several attempts undertaken to afford protection to these natural areas but unfortunately to date these schemes have only temporarily arrested the erosion process.

Continued shoreline erosion is threatening the dunes and, therefore, the viability of the spit and there is concern that any potential breach of this spit could cut off the dune system as a public amenity and expose the coast behind to the full force of the wave action.

Local authorities can, however, implement coastal management policies, especially when the seashore is being placed at risk by certain land-use activities. Recent amendments to the Planning & Development Acts, 2000-2004 and the Foreshore Acts, 1933-2005, through the Maritime Safety Act, 2005 have extended the functional area of a local authority to include “inland waters, the foreshore and coastal waters adjoining its functional area” (Part 2, Maritime Safety Act, 2005). It is important to note however that this excludes waters under the control or management of a harbour authority or Waterways Ireland. While “coastal waters” are not defined in the new Maritime Safety Act, the Foreshore Acts, the Planning and Development Acts or the Local Government Act, essentially the effect of this is to extend “coastal waters” to the territorial limit, i.e. 12 nautical miles. At the landward side the definition of the “foreshore” was amended by Section 224 of the Planning & Development Act, 2000 for planning purposes so that it now includes land between the line of high water of ordinary or medium tides and land within the functional area of the local authority.

With respect to third party coastal protection works, if a county council believes that such works when constructed by a private third party may affect the integrity of the coastal area or were undertaken without the prior permission (licence or lease) from the Department of Communications, Marine & Natural Resources (DCMNR), the Council may ask the DCMNR to begin enforcement proceedings under the Foreshore Acts, 1933-2005 for the removal of such structures.

Similarly a council may apply for permission from the Department to carry out coastal protection works on privately owned land. If such works exceed a one kilometre stretch an EIA is required. If the works are less than one kilometre they may still require an EIA depending on the proposed location and sensitivity of the area to such works. Also in this regard, under Section 227 of the Planning & Development Act, 2000 a local authority can compulsorily acquire areas of foreshore from the State. This is however an exception to the general rule regarding State lands.

Local authorities can make bye-laws to control or restrict certain activities in certain areas at certain times. This is generally available under Section 199 of the Local Government Act, 2001 (previously contained in the 1994 Act). The power to make bye-laws is usually exercised where it is in the interests of the common good to regulate activities or to control a nuisance. Sub-section 6 of this

section applies specifically to the foreshore and coastal waters adjoining the local authority's functional area.

Bye-laws can also be made under the following legislation:

- Control of Dogs Act, 1986 (Section 27)
- Control of Horses, Act 1996 (section 17)
- Litter Pollution Acts, 1997 (amended in 2003)
- Maritime Safety Act, 2005 (Section 6) – relates specifically to bye-laws for recreational/personal watercraft)

There are also additional enforcement powers under:

- The Local Government (Planning and Development) Acts where the activity is a change in use;
- The Wildlife Acts, (1976-2000) for infringement of designated areas;
- The National Monuments Acts, 1930-1994 for interference with a recorded site.

Tramore Town Council have already put in place a bye-law (in 2003) to regulate the use of jet-skis and fast power boats under the Local Government Act (2001) and if there were sufficient demand could potentially create other by-laws to control other detrimental activities in and around the dune complex. [*It should be noted that that any bye-laws relating to the use or misuse of recreational and personal watercraft should now be made under the Maritime Safety (2005) and not the Local Government Act (2001*])

1.3 National and International Designations at Tramore

Tramore, as well as affording protection and providing an amenity for tourism, is an important area for conservation and this is substantiated by the numerous national and international ecological and cultural designations attributed to the area. Any proposals for development in the area would have to be aware of the extent (Figure 1.2) and implications of these designations:

- *Special Protection Area (SPA)*

  The Back Strand at Tramore is an area of ecological importance, and has been designated as a SPA {*Site Code: 4027*} (Figure 1.2). It is designated under the EU Birds Directive which seeks to protect, manage and regulate all bird species naturally living in the wild within the EU Member States, including the eggs of these birds, their nests and their habitats. Under this Directive Member States must conserve, maintain or restore the biotopes[1] and habitats of these birds by creating protection zones; maintaining the habitats; restoring destroyed biotopes; and creating biotopes.

[1] **An area that is uniform in environmental conditions and in its distribution of animal and plant life**

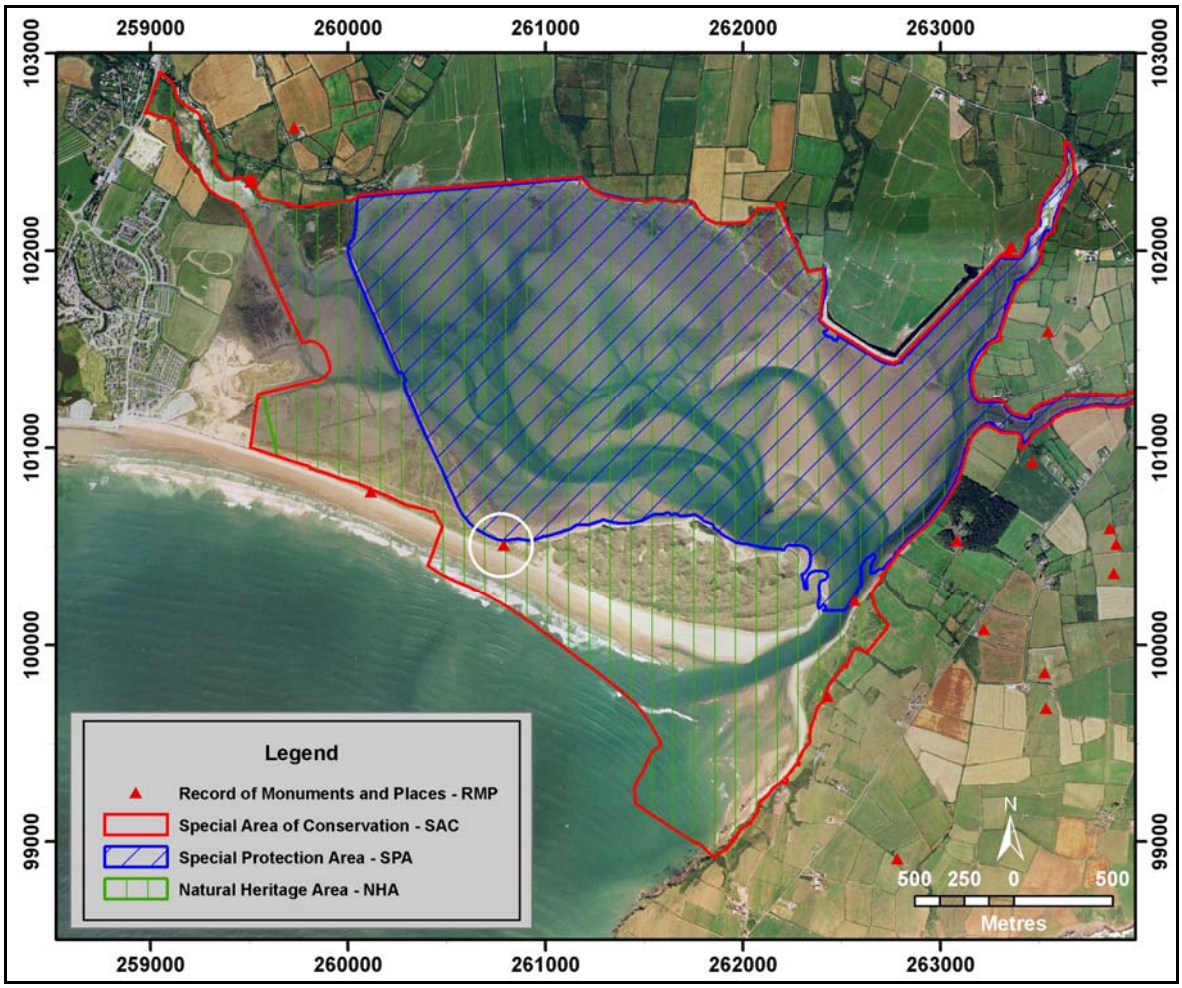


Figure 1.2: Annotated Aerial Photograph showing Designated Areas and Heritage Sites at Tramore (Neolithic Midden in the Burrows is circled in white)

The Back Strand is home to several important species including the Brent Goose (*Branta bernicla*), the Red-throated Loon (*Gavia stellata*) and the Bar-tailed Godwit (*Limosa lapponica*). The Birds Directive is implemented in Ireland by European Communities (Natural Habitats) Regulations 1997. (S.I. No. 94 of 1997). Any new project or major activity likely to be damaging or cause disturbance, situated in or near the SPA is only permitted after permission has been granted by the Minister for the Department of Environment, Heritage and Local Government.

- *Natural Heritage Area (NHA)*

  The Back Strand at Tramore is a Natural Heritage Area (NHA) {*Site Code: 0671*}, and the SPA (above) is contained within this area (Figure 1.2). NHA designation restricts development in an area as defined by the Wildlife (Amendment) Act, 2000.

- *Special Area of Conservation (SAC)*

  Tramore is a candidate Special Area of Conservation (SAC) {*Site Code: 0671*} and is designated under Article 3 of Directive 92/43/EEC on the conservation of natural habitats and wild fauna and flora (the Habitats Directive), as part of the Natura 2000 network (Figure 1.2). Several rare species have been recorded at Tramore including Lesser Centaury (*Centaurium pulchellum*) and Cottonweed (*Otanthus maritimus*) (www.npws.ie) - both now locally extinct. It is also the only

recorded site of nationally extinct Sea Knotgrass (*Polygonum maritimum*) in the country. The Habitats Directive is also implemented through the Wildlife (Amendment) Act, 2000. The European Communities (Natural Habitats) Regulations 1997 (S.I. No. 94 of 1997), which effectively implement SAC designation and management, prohibits any activity or development that would endanger or alter a SAC. Developments outside a SAC, which would have an impact on the designated land, are subject to Environmental Impact Assessment.

- *International Conservation Agreements*

  Ireland has signed the Convention on Wetlands of International Importance (The Ramsar Convention), and, as a party to the Convention, has agreed to protect wetlands of international importance. Tramore Back Strand was proposed for designation as a Ramsar site in the early 1990s and was designated in 1996 {*Site No: 835*}. Tramore Back Strand is a named site under the Important Bird Area Programme {*Site Code: IE095*} which aims to identify, monitor and protect key sites for birds all over the World.

- *Sites of Cultural Heritage*

  In addition to the ecological interest at the site there are several Records of Monuments and Places (RMP) sites in the area (Figure 1.2). Of these, the most important would appear to be the Burrows at Tramore (circled in Figure 1.2 / Figure 3.21). This is detailed as a 'midden', and is stated as a kitchen midden of Neolithic age. According to McGrath (2001) two spreads of fire cracked stones in a black soil matrix and in an eroded state were also located on the Tramore Burrows. Such finds are considered to be important archaeologically because of the information about diet and animal husbandry that they can yield (McGrath, 2001).

Any management strategy would have to take into account the potential effects on over-wintering birds, rare plant species and the sites of historical significance. Subsequent implementation of any schemes under the strategy would be subject to the specific prescriptions of these different designations.

2.0 METHODOLOGY

In order to achieve the main objective, to make management recommendations and suggestions for the direction of any future investigations, it was necessary to:

1) Assess the current usage patterns, the views of relevant stakeholders and review the current condition of the Tramore coastline.
2) Complete a desktop review of the available documentation to assess the effectiveness of previous shoreline protection measures.
3) Compile all the relevant datasets for Tramore into a readily accessible central resource and then utilise these to assess recent coastline change.

2.1 DETERMINATION OF LOCAL USER OPINION AND USAGE PATTERNS

This was achieved through analysis of the output from the combination of meetings, a questionnaire survey and site assessment visits.

- *Meetings:*

  A series of formal and informal meetings was held both on and off-site with Council officials and their opinions were sought with respect to management of Tramore. This input was then used to build up a picture of the issues and management constraints at the site.

- *Questionnaire Survey:*

  It was decided to utilise the responses from a questionnaire (Appendix 1) conducted during the summer of 2005 as part of a Masters thesis in University College Cork. The reasoning behind this decision was that this questionnaire was adequate to fulfil the requirements of the proposed survey and most importantly it avoided the very real chance of "questionnaire fatigue" from prospective respondents asked to complete an additional survey.

  The questionnaire survey was designed to provide an insight into the current public perception of various issues at Tramore. These included opinions on coastal erosion, the type of usage and their knowledge of Integrated Coastal Zone Management (ICZM).

  A total of 125 questionnaires were distributed at Tramore. The survey was conducted virtually exclusively with residents as they were much more willing to participate in the survey than holiday makers (time constraints). Seventy-seven questionnaires were returned which gave a return rate of 62%. The returns from the respondents were collated and the results were used to produce a series of tables and graphs to illustrate the perception users have of Tramore with respect to management approaches (current and historical), resource use and conflicts/issues.

- *Site Assessment Visits:*

  A series of site visits were made between June and November 2005 and observations of beach use were noted and recorded photographically. These were used to catalogue any detrimental usage and the effectiveness of management attempts made to reduce potential impact. In addition,

a Global Positioning System (GPS) was used to survey and fix the shoreline position for subsequent comparison with historical data. The GPS employed was a Trimble GeoExplorer CE (Figure 2.1) used in real-time and to give a positional accuracy (horizontal only) of ±2m.

Figure 2.1: Trimble GeoExplorer CE differential Global Positioning System

2.2 ASSESSMENT OF THE EFFECTIVENESS AND RELATIVE COST OF PREVIOUS PROTECTION MEASURES

This was essentially a desktop review of the material housed across several departments of Waterford County Council and other institutions. The meetings organised as part of the effort to ascertain the opinions of Council officials also afforded the opportunity to source relevant material. The material derived was collated and any reference to previous attempts to manage this stretch of coastline were extracted and tabulated in chronological order (Table 3.3). Where available, the costs of any protection schemes were isolated and converted to their modern day equivalent using a combination of the Consumer Price Index and the Value of the Euro as posted on the Central Statistics Office (4/1/2006). http://www.cso.ie/statistics/valueoftheeuro.htm. Any pre-1920 values were calculated using an online resource on the Economic History web page: http://www.eh.net/hmit/ukcompare/.

2.3 COMPILATION AND UTILISATION OF RELEVANT DATASETS

The most appropriate method to provide a data repository readily accessible to relevant Council officials was to create a stand-alone Geographical Information System (GIS) for Tramore. This involved retrieval of data, the creation of a dedicated Tramore GIS and to facilitate use a CD was produced with both the GIS and the requisite software to read the datasets.

- *Data Retrieval*

  All data holdings received from Waterford County Council and data received from other national repositories and datasets held internally by the CMRC were given an initial assessment and either retained or discarded depending on applicability and quality. Additional layers such as a contemporary coastline were created, as necessary, by conducting on-site field investigations (see 2.2).

- *Creation of a dedicated Tramore GIS*

  A standalone GIS was created on ESRI's ArcGIS 9.1 platform. Datasets that existed in incompatible formats (e.g. ER Mapper) were converted and included. Field data from the GPS survey were processed and included as an additional layer. This GIS and the required software reader were copied to a CD (included with this report) to enable it to be easily transferred to the requisite offices at the discretion of the Council.

- *Assessment of historical coastal change*

  The GIS was utilised to make historical comparisons between the 1920 Ordnance Survey (OS) series, photographs from 2000 and the generated 2005 coastline. The historical 1844 coastline was originally earmarked for inclusion but subsequent investigation revealed that the particular copy to hand was of poor quality and therefore it was discarded. Qualitative assessments were then made regarding the scale of coastal change and the extent of channel migration was examined.

3.0 RESULTS

This section presents the results from (1) the assessment of local user opinion, current usage patterns and condition of the Tramore coastline (2) the desktop review of available documentation and assessment of previous shoreline protection measures and (3) the creation and application of a dedicated GIS.

3.1 LOCAL USER OPINION AND USAGE PATTERNS

The results from the questionnaire, when combined with the outcomes of the meetings held with relevant stakeholders, gave an indication of the level of user pressure on the dune systems at Tramore. The questionnaire provided an insight into the public perception of the level of usage and when considered in parallel with observations from the site assessments provided a comparison between the actual and perceived situation at Tramore. The feedback also allowed the project team to establish how management approaches (current and historical) were perceived and confirmed the existence of certain concerns in the region.

- *Questionnaire Survey*

  The majority (57%) of those surveys thought that recent development at Tramore had been progressive (Figure 3.1). It is probable, but not definite, that this result has been influenced by the recent completion of the water treatment plant and planned closure of the adjacent landfill site. Most respondents also claimed to be familiar with the concept of sustainable development (Figure 3.2) although it should be noted that no interpretation of this term was requested from respondents.

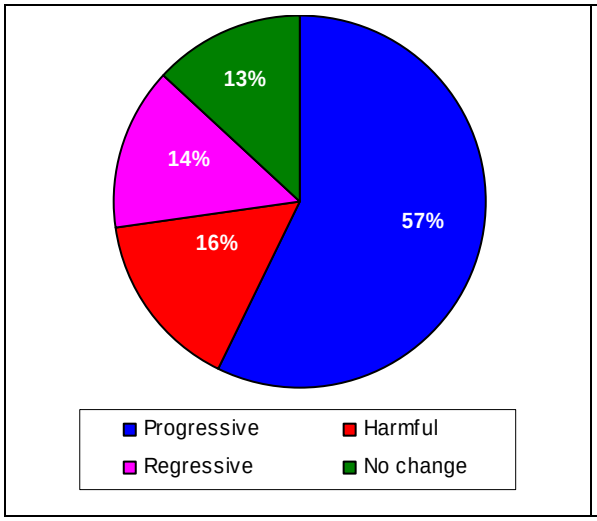


Figure 3.1: Pie chart showing the rating of recent developments at Tramore

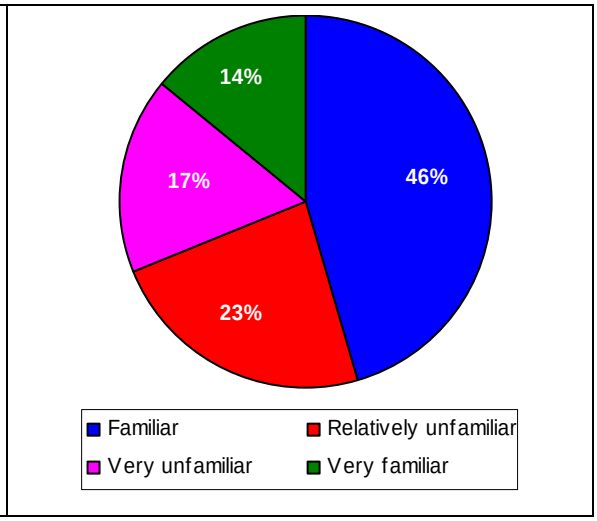


Figure 3.2: Pie chart showing the levels of familiarity with the concept of sustainable development

Recreational use was dominated by walking and watersports with higher impact activities in the minority (Figure 3.3). The actual patterns of usage showed that the Promenade / Pier was the most highly utilised area and this is unsurprisingly given its proximity to car parking and ease of access. The high level of use of the Back Strand and dunes results from the popularity of walking as an activity and the popularity of the dunes with quad bikers and the horse riders. As the promenade area is fully protected the impact from usage is limited with the main problems on this section of the

beach restricted to littering (aesthetically in terms of tourism and physically the disturbance due to the mechanical effort of subsequent cleaning). However, just less than half the respondents concentrated their activities on the dunes and Back Strand (Figure 3.4). Even though the majority are walkers, their high level of activity combined with the higher impact of the minority activities such as quad biking and horse riding is having an obvious and detrimental effect on these largely unprotected areas and this was confirmed by the site visits.

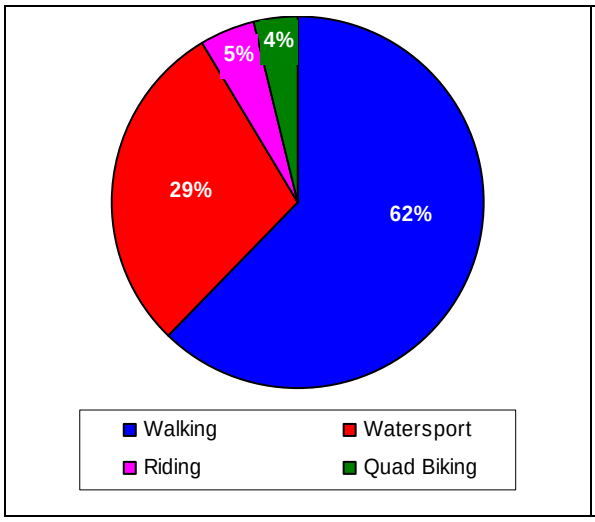


Figure 3.3: Pie chart indicating the proportion of different types of usage at Tramore

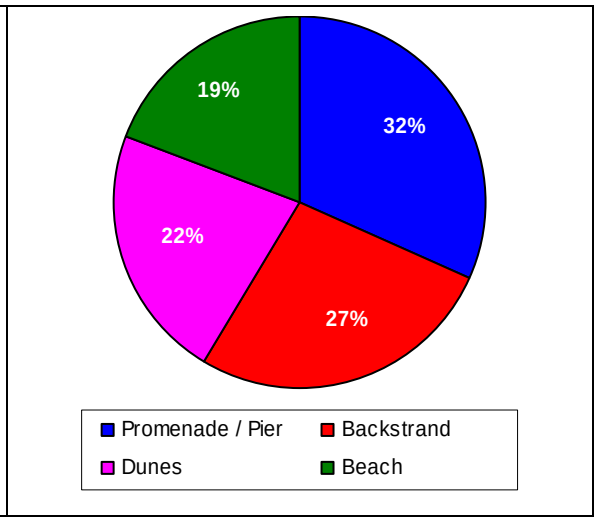


Figure 3.4 Pie chart indicating the proportion of usage by location at Tramore

The majority of the respondents (75%) were aware of the erosion and shoreline change (Figure 3.5) and considered erosion to be an on-going process on the beach, dune and Back Strand, although it wasn't obvious from the survey whether erosion was perceived as a problem. There appeared to be a general lack of awareness of Integrated Coastal Zone Management (ICZM) (Figure 3.6) and, when queried, even those who claimed to be aware appeared to have a

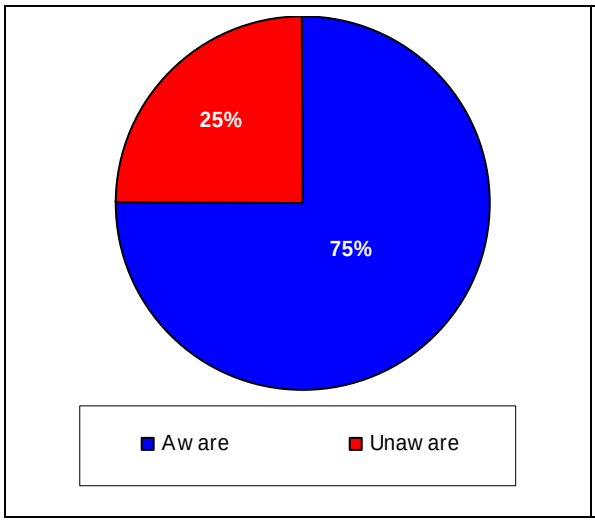


Figure 3.5: Pie chart showing the levels of awareness of coastal erosion at Tramore

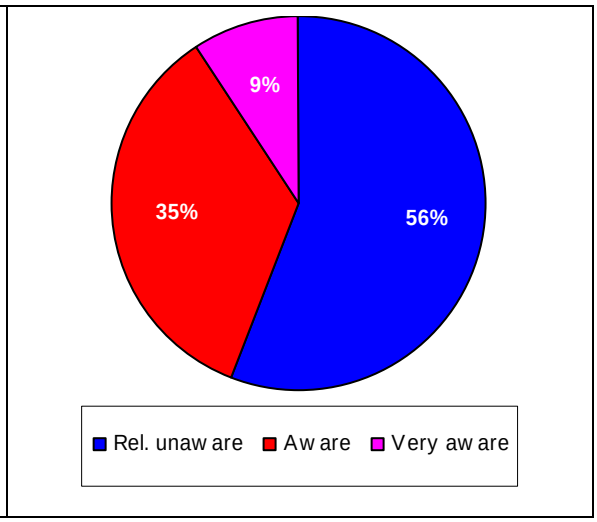


Figure 3.6: Pie chart showing the levels of awareness of the ICZM process

limited grasp of the process (detailed overleaf). As the majority of users are unaware of the ICZM process, by implication, they will have no knowledge of the benefits that ICZM may offer for Tramore.

Effective ICZM, management should:

- Think ahead **- take a long-term view** beyond immediate short-term needs and address longer-term issues, including those associated with climate change
- Try to see the bigger picture **–** view inter-related coastal problems in the **widest possible context**, including consideration of all coastal activities and uses both on land and within coastal waters
- **Be flexible and adaptable** – try to anticipate problems and err on the side of caution where there is potential for unknown damaging effects to result from an action
- **Work with nature** rather than against it – recognize the limitations of the natural environment to assimilate pollution and the negative impacts of development
- **Use a combination of tools** – use legal, economic and educational approaches to tackle coastal problems rather than relying on one instrument in isolation
- Get everyone involved – **include relevant administrative bodies** and local communities. The **involvement of local businesses and people** can help identify the real issues and **harness local solutions,** rather than applying a 'one size fits all' management approach.

Source: http://www.ehsni.gov.uk/natural/coast/icm.shtml

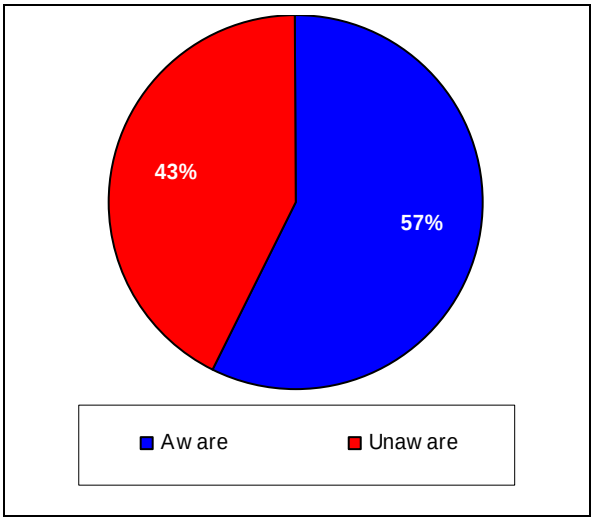


Figure 3.7: Pie chart showing the level of awareness of coastal management at Tramore

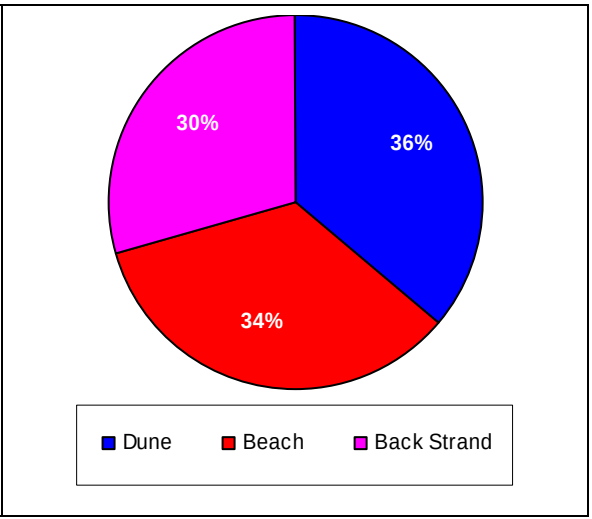


Figure 3.8: Pie chart showing the proportion, by location, perceived to be subject to coastal management at Tramore

Taking the ICZM principle of participatory planning (local stakeholders involvement) as an example – the majority of respondents were aware that Tramore was subject to some form of management (Figure 3.7) and that this management appeared to extend across the entire area (Figure 3.8). But the perceived general level of public participation was only rated at 5/10, with this falling to 3/10 when respondents were asked to rate their own participation (Figure 3.9).

Respondents were very aware of the environmental, social and economic significance of Tramore beach to the local area (Figure 3.10) which would suggest that they felt that there was a need to protect the resource and therefore it would be expected that levels of participation in development would be higher than recorded (Figure 3.9).

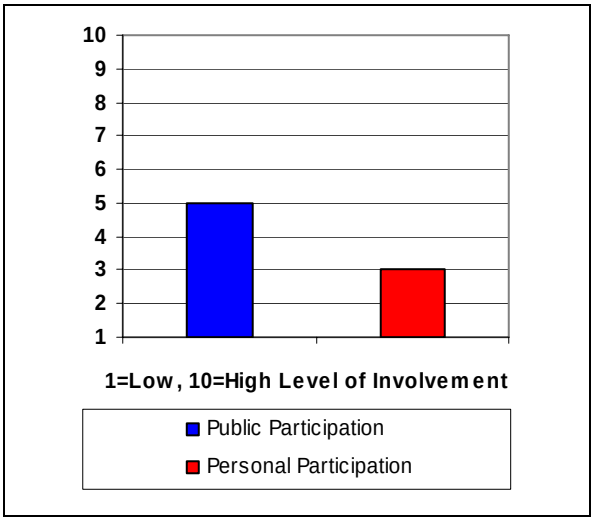


Figure 3.9: Graph showing the perceived level of participation in development at Tramore

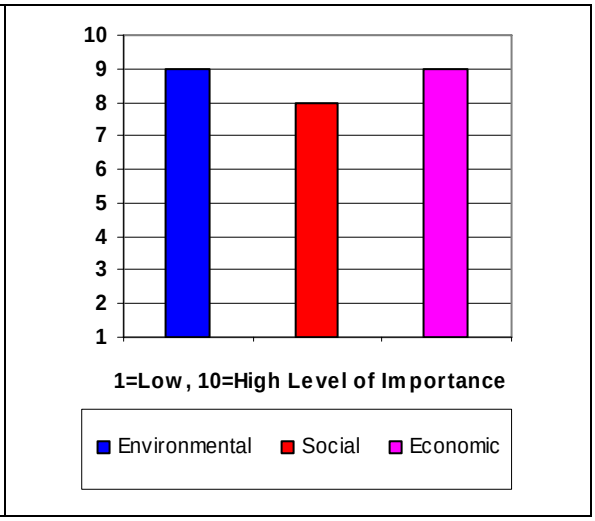


Figure 3.10: Graph showing the perceived level of importance, by sector, of the beach to Tramore.

- *Site Visits*

The majority of site visits took place during the peak, summer season. The photographs taken during the site visits provided further evidence of the current use and condition of the coastline (an index of the photographs from site visits is provided in Figure 3.13). As suggested by the questionnaire survey, the largest proportion of users tended to confine their activities to the promenade and the adjacent beach (Figures 3.11/12). The majority of people in this area were availing of the local shops and amenities on the promenade or swimming, surfing and playing sports on the adjacent beach. As the coastline in this area is effectively fixed by the modern sea walls any user impact is limited to littering. Mechanical beach cleaning is conducted to alleviate this problem (Figure 3.14) and this obviously causes some disturbance to the natural sediment. However, as this is restricted to the summer season the overall impact would be expected to be minimal.

Figure 3.11: View Tramore promenade towards Great Newton Head (west)

Figure 3.12: View of Tramore promenade towards Brownstown Head (east)

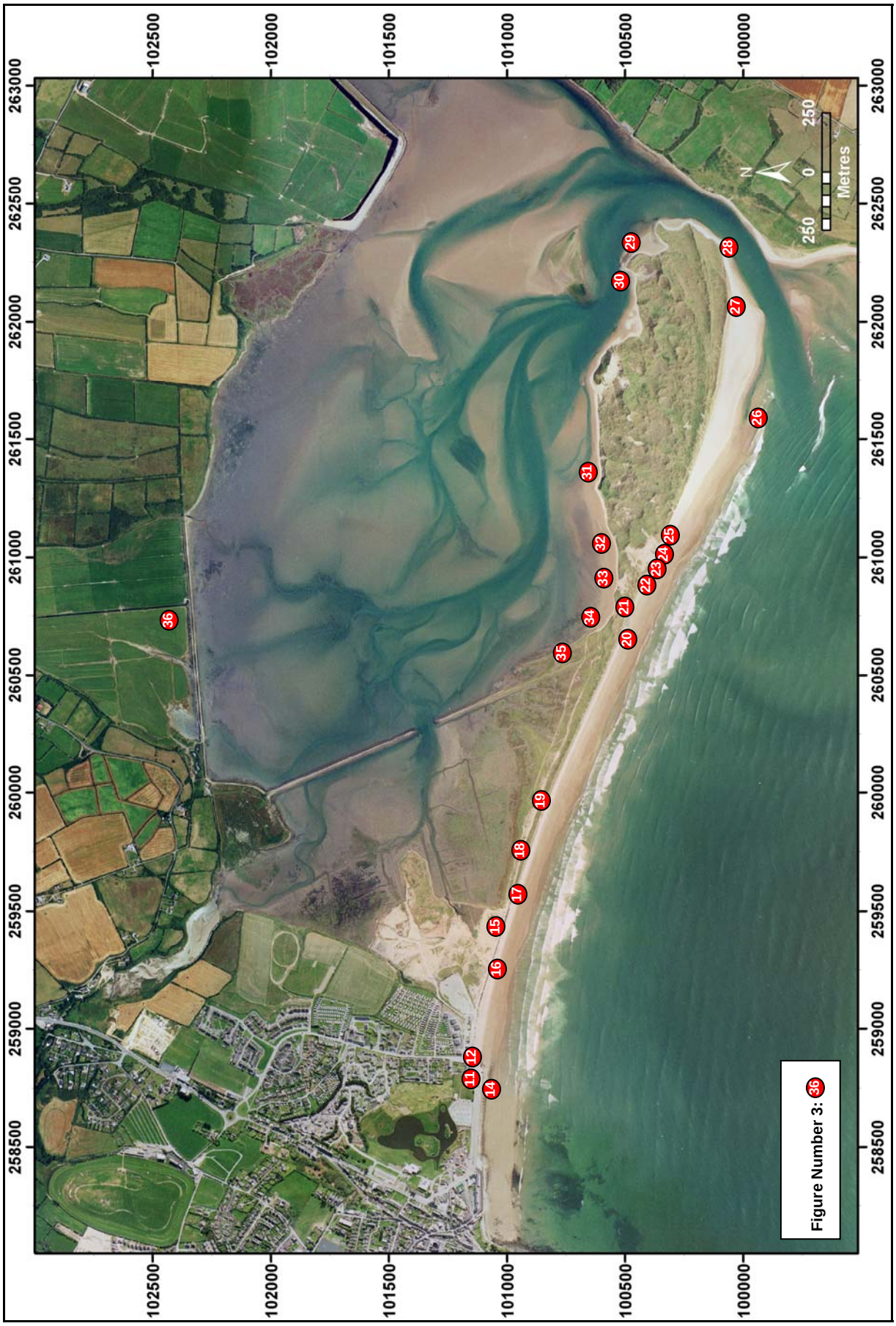


Figure 3.13: Aerial view of Tramore showing the subject of site visit photographs

Figure 3.14: Mechanical beach cleaning on Tramore Strand

Figure 3.15: Impact on shingle bank during the water treatment plant construction at Tramore

Moving east along the shingle ridge the number of people steadily declines on the ridge itself although numbers on the beach itself were consistent with those in front of the sea walls. The questionnaire survey suggested that the most popular leisure activity was walking and therefore people tend to pass through rather than congregate on this stretch of Tramore Strand. The lower numbers observed may have been a temporary effect of the drainage works being undertaken as this resulted in a break in the ridge and had left some areas uneven underfoot (Figure 3.15). However in general these major works didn't appear to deter visitors. The attitude adopted suggests that they accepted that this was a necessary, temporary intrusion with tangible long term benefits in terms of water quality and simply continued their normal behaviour (Figures 3.16/17). This concurs with the findings of the questionnaire where the majority of respondents thought that the planning for the area was progressive.

Figure 3.16: Surfers at Tramore with outflow pipeline construction in the background

Figure 3.17: Walkers amidst construction materials at the site of the outflow pipeline Tramore

There is evidence of wear and tear from walkers along the top of the bank with tracks to the north clearly visible on the aerial photographs (Figure 3.13), which was re-confirmed on the ground, but the bank itself appeared to suffer little detrimental effects as a result of human activity. Of significantly greater impact in this area was the obvious impact of natural processes, wave and

tides, (Figure 3.18) but it would appear that any major resultant damage is repaired by the County Council mechanically re-shaping the shingle bank (Figure 3.19).

Figure 3.18: Erosion on the face of the shingle bank at Tramore

Figure 3.19: Tracks indicating mechanical reworking of shingle bank at Tramore

The neck of the spit is at its thinnest, *c.*55m, and has been obviously subjected to previous erosion. A typical sequence of events leading to erosion of the front face of dunes by marine processes is given as follows by Scottish Natural Heritage (2000):

- Beach profiles in front of the dunes become flatter as a result of destructive wave action.
- The upper beach levels fall, allowing the high tide mark to reach the toe of dunes.
- Waves impact directly onto the dune toe, causing sand to be removed and under-cutting the dune face.
- The front face of the dune collapses or slumps onto the beach, and the sand is carried and redistributed down the beach.

Figure 3.20: Armour at the neck of the spit at Tramore Strand

Figure 3.21: Site of the Midden in the dunes at Tramore

In an attempt to protect against erosion, armouring has been positioned on the southern, beach side (Figure 3.20) and wooden fencing has been erected to the north, on the Back Strand (Figure 3.21/34). This location is probably the area of most concern as it is obviously been subjected to erosion on both aspects, north and south, and if there was a breach at this point it could lead to the spit feature becoming an island. In addition, this is the designated site of the medieval midden as

noted earlier (Figure 3.21) and from a heritage aspect there could be pressure to preserve this site from being lost to the sea.

Further evidence of erosion was found to the east of the armoured section but this large blowout was primarily a result of scouring by the wind rather than the action of waves or tides (Figure 3.22). Blowouts are instigated by a breakdown of the fabric of the vegetation and exposure of the unconsolidated material underneath which is then simply blown away by the wind or washed away by overtopping tides and waves. The cause of this breakdown can be natural but other factors that contribute include impact by animals, large volumes of walkers, detrimental effects of quad or motorbike usage and open fires being lit in the dune system. All of these activities and other detrimental activities such as dune surfing were either recorded at Tramore during the site visits or highlighted by the questionnaire survey (Figure 3.4). Once exposed the dune system will struggle to recover if the uncontrolled use of the dunes continues and at this stage it may be necessary to provide some form of physical barrier to prevent further damage and promote recovery.

Figure 3.22: Dune blowout on Tramore Strand

Figure 3.23: Damage to fencing around a blowout on Tramore Strand

There is evidence of a previous attempt to protect this area from the public by fencing off the blowout areas. Unfortunately, over time, the harsh environment appears to have severely damaged these protection measures to the extent that they now do not serve as any form of deterrent (Figure 3.23). The signage erected at the time had also been completely defaced (Figure 3.24) and therefore there no is way for users to determine the actual nature of the problem or the methodology that had been employed in an attempt to arrest it. Other methods can also be employed to assist natural consolidation of loose material and reverse the process. The experimental brushwood fencing (Figure 3.25) established by Waterford Institute of Technology appeared to be yielding positive results with new growth of Marram Grass, a primary coloniser, clearly evident.

Figure 3.24: Weathering of signage at a restoration scheme at Tramore

Figure 3.25: Remedial fencing in a blowout in the dunes at Tramore

In contrast to the erosion at the neck and in the dune blowouts, there is currently very obvious accretion at the eastern extreme of the Strand at the tip of the spit (Figure 3.26). Loose re-worked sand and the forcing of the drainage channel towards Bass Point are testament to this process and the extent of this accretion and channel migration was clearly illustrated by the results of the GPS survey (Figure 3.39).

Figure 3.26: Accretion at the eastern extend of Tramore Strand

Figure 3.27: Evidence of previous slumping and recent re-growth at the eastern end of Tramore spit

Historical evidence of erosion in the form of slumping (Figure 3.27) was noted at the eastern end of the Strand parallel to the drainage channel but the more obvious trend here was also one of recent accretion. This accretion is supplemented by the presence of fresh plant growth suggesting that the dune system is being augmented at the point of the spit (Figure 3.28).

The highest dune in the complex is located approximately at the mid point of the Back Strand and from the marked tracks visible from a considerable distance, (Figure 3.29), it is clear that this has suffered damage. This was even more marked on the western flank of this dune where a massive blowout was encountered with the chances of recovery reduced by ongoing dune surfing (Figure 3.30).

Figure 3.28: Accretion at the eastern end of Tramore Spit

Figure 3.29: Usage impact on dune system on the Back Strand at Tramore

Figure 3.30: Dune surfing activity on the dunes at Tramore

Figure 3.31: Exposed gabion on the dune complex on the Back Strand at Tramore

Figure 3.32: Protective fencing on the Back Strand at Tramore

Figure 3.33: Exposed gabions and weathered signage on the Back Strand at Tramore

Erosion, both wind and sea driven, and the attempts to curb its effects were noted along the Back Strand (Figures 3.31/32/33). Whilst these attempts appeared to have some short-term success at stabilising the system they appeared to have suffered from a lack of maintenance and this had obviously impacted on their level of long term success (Figure 3.31). Signage in this area has also

suffered as a result of the harsh conditions and therefore there was now no indication of either the problem or the solution attempted (Figure 3.33).

Figure 3.34: Protective fencing at the neck of the spit on the Back Strand at Tramore

Figure 3.35: Evidence of a recent open fire at the western end of the Back Strand

At the inner edge at the neck of the spit there was further evidence of protection from natural processes (Figure 3.34) but given that this is a natural shortcut back to the beach there was no protection from the potential threat posed by walkers tramping across this area. A further indication of detrimental use of the dune system was revealed by the damage caused by open fires in the area immediately adjacent and to the west of the neck (Figure 3.35).

At the western extreme of the Back Strand the intertidal area is extended by the historical breach of Malcomson's Bank which allows the tide to enter at high water (Figure 3.36).

Figure 3.36: View of the defences on the northern edge of the inner bay and the breach in Malcomson's Embankment at highwater at Tramore

3.2 DESKTOP REVIEW OF PREVIOUS PROTECTION MEASURES

This section provides an overview of archive material concerned with the coastal environment at Tramore. Details of the historical context of the coastal protection are provided in section one and a breakdown of the relative costs of the coastal protection schemes put in place is given in section two.

3.2.1 Review of Coastal Management Documentation for Tramore

These documents deal with the physical environment of the area and range from papers, reports and photographic surveys through to personal communications. A synopsis of the material reviewed, as received over the course of this research project, is provided in the tables below:

Author (date)	Title
L'Estrange Duffin, I.C.E.I. (1884).	**The Encroachment of the Sea – Beaches and Groynes.**
Details of L'Estrange Duffin's attempts to address the encroachment of the sea during his time as county surveyor in Waterford. It details an attempt to track annual coastline change relative to the 1840's 6 inch ordnance maps. He authorised the construction of groynes to control longshore movement. The paper also documents the difficulty experienced at Tramore in terms of coastal protection. The author reports on the brittleness of the sea wall, which had been constructed of lime mortar façade over 4-5 feet of loose dry stone rubble some 15 years earlier. Mr. Duffin explains that the shingle accumulating in front of the wall was abrading the wall, and on several occasions it needed repairing.	
Charles N. MacLeod I. (1932).	**Inspection of Tramore Reclamation Areas**
Results of an inspection of the reclamation area, and of the drainage channels, sluices, and embankments. Sketches to supply data for drawing up a report for an Improvement Scheme are also included.	
J.P. Quigley, (1946-1).	**Sea Encroachment at Tramore**
Published in the Bulletin of the Institution of Civil Engineers of Ireland this paper reads more like a modern consultancy document than the previous paper by Duffin (1884). It documents the physical setting at the coast, both in terms of natural and man-made structures, as well as erosion and retreat. The author gives a brief account of the history of sea defences at Tramore and documents the then coastal management plan for Tramore. This dealt primarily with stabilisation and reclamation of the Back Strand using various plant species.	
J.P. Quigley, (1946-2).	**Tramore: Some Growth Options**
Extends the material previously presented by the author in 1946. The report is extended in terms of options for growth and has put on record some of the information gathered in Tramore during 1943-1945, as well as ideas for development:- "*In 1848 Mr. Malcomson and Mr. Power commissioned a Dutch engineering firm to plan the reclamation of the full salt marsh area. In the following year the celebrated legal action was commenced by the representatives of the Earl Fortescue to prevent the spoiling of the view from his marine villa on the east bank of the Back Strand, which he held would be done if this area were to be reclaimed. Final judgement was given in the House of Lords in 1853. Work on the reclamation of the areas allowed by the judgement was commenced immediately and was completed in 1857. The time taken to meadow the new ground was surprisingly small and in 1860 the races were transferred from a strand to the new ground on the eastern intake. The change proved wonderfully popular and it almost immediately became one of the major meetings in the country and it was the foundation of the fame of Tramore as a resort. The final break inundating the golf links and race course took place during the winter of 1912*." It is also stated that "*A great part of the work is yet recoverable. The job of rectifying the great scored gaps in the banks, where the sluices originally were, does not present any great engineering difficulty. The size of the embankment depends primarily on the height. This depends on the height*	

Author (date)	Title
of the wave to be expected. Here, across the protected mud flats, the wave crest might be taken as two feet above water level. Five feet might be allowed for an extraordinarily high tide, giving a total of seven feet above high water mark, or eleven and a half above mud level." And "A guess estimate at the total cost of the full renovation would be at present prices £35,000. This would work out at a cost of £70 per acre, which, for the quality of the land obtained, would be cheap. The project, therefore, is worthy of investigation."	
Ann C. M. Quinn, I. (1975). Conservation and Amenity Advisory Service with An Foras Forbartha	**Proposals for the Burrows Nature Trail in Tramore, Co. Waterford.**
Part one dealt with nature trails in general: their values and objectives, together with practical details, re-construction and maintenance. Part two provided a sample text for the Tramore Burrows[2], which is a sample template for guided tours of the sand dunes into which more detailed local knowledge may be incorporated. This was supplemented by a map showing a suggested route and potential point of interest. This was the first incidence where ownership of the sand dunes is documented. Tramore Failte are stated as owning the Tramore Burrows, while Waterford County Council are stated as being anxious to assist in the conservation of the area. It outlined the value of nature trails, in terms of conserving the environment by reducing such common problems as indiscriminate trampling, and also in terms of educating both young and old. The report continued by defining nature trails as "*planned and fixed pathways through areas of natural beauty and interest, along which are stopping places where particular features can be seen*". A nature trail is also described as a planned way of arousing and sustaining a visitor's interest and of presenting organised information. The report also outlined the objectives of nature trails, stating that the objective of a trail is to show in an organised manner everything that a tract of land offers – from man's influence on the area to how plants and animals are related to each other and to the particular habitats in which they live. The proposal considered best practices in designing, planning and implementing nature trails. The proposal covered such topics as: inventory, design, construction, maintenance, signs and guides, trail types, and management.	
David Cabot, (1977). Conservation and Amenity Advisory Service, Planning Division with An Foras Forbartha in February 1977.	**Proposals for Controlling Erosion on the Northern Part of Tramore Sand Dunes, Co. Waterford.**
Produced in response to a request by Waterford County Council for advice on the implications of erosion occurring on part of the sand dunes at Tramore. It contained advice on implications of erosion occurring on part of the sand dunes at Tramore, as well as suggested remedial measures. It stated that the area most vulnerable to severe erosion is a short section of the northern side of Tramore Burrow to the south east of the embankment. The author believed that the erosion has been caused by wave action from the water in the Back Strand assisted by strong north and north-easterly winds at high tide. The author compiled evidence from the 1905 Ordnance Survey (published in 1922), and the BKS Consultative Technical Services Ltd 1965 survey (an aerial survey was carried out in June 1965). With this evidence the author suggested that erosion rates of 0.21m and 0.43 m per annum for 60-year period occurred at two points in this section of coastline. The author also suggested that continued erosion at the rates documented could eventually lead to the Tramore Burrow becoming an island separated by a tidal channel from the mainland. A remedial action plan is included and consisted of erecting a protective barrier across this	

[2] **Derived from the middle ages when the dunes were used as rabbit warrens (*pers comm*. Berridge 2005)**

Author (date)	Title
vulnerable stretch of coast. The author recommended the use of gabions, and further suggests that material for the gabions be brought into the area so as not to deplete the already fragile sediment budget. The author's remedial plan also consisted of creating a "no-go" area around this delicate part of the coastline. This "no-go" area would be fenced off for a period of two years to allow the regeneration of marram grass and natural vegetation of the dunes. The fencing would prevent excessive human trampling of the vegetation on the dunes, which has damaged the marram grass cover and allowed wind erosion to weaken the dune structure. The author suggested that by making the path to the south more attractive this would encourage visitors to use it and hence divert traffic away from the vulnerable sand dunes.	
Eanna Ni Lamhna (1981), Conservation and Amenity Advisory Service with An Foras Forbartha.	**A Report on the Salt-marsh Area to the West of Tramore Back Strand.**
Produced in response to a call from Waterford County Council for an assessment of the ecological importance of the old race course area on the western extremity of the Tramore Back Strand, as well as the likely effects of reclamation of the race course area for tourist development. It included a description of the area in question and states that it is of very little scientific or ecological importance due to the fact that the area is dominated by pure strands of cord grass (*Spartina*). The author stated that reclamation could have a number of indirect impacts on the ecology of the surrounding area. Of particular importance to the current study at Tramore was the author's impression that reclamation of the racecourse area could conceivably cause a change in the tidal currents in the Back Strand area and cause increased rates of erosion. Despite this, the author believed that these potential impacts may not have serious implications if various conservation measures are implemented. The measures included: implementing a no-shooting order under the Wildlife Act, 1976, on all land that is reclaimed, and encouraging pedestrian traffic along a path to the south and away from the sensitive dune areas (echoing the previous report by Cabot)	
Michael O'Meara (1983), Irish Wildbird Conservancy in February	**Tramore Back Strand & Sand Dunes; Its Present and Future.**
Discusses the state of the Tramore Back Strand and sand dunes with respect to worst-case scenarios for the location. The author suggested that the sand being lost from the dunes is being deposited further inland at Cloughernagh and Lissalan, and has also created an island just north of the dune system that is visible at most tidal levels. This sanding up of the Back Strand has physical consequences in terms of changing the tidal channels and increasing tidal scour, and natural consequences in terms of reducing habitats for Eel Grass and Zostera (food for Brent Geese), and the size of cockle beds. Facts on the ecological importance of Tramore were included: ▪ Priority 'A' Area of National Importance as Ecological, Botanical & Ornithological place of scientific interest (An Foras Forbartha, 1972). ▪ 12th most important area in Ireland for Waders (Prater, 1973). ▪ Largest Gathering of Wildfowl in Waterford (Irish Wildbird Conservancy, 1979). ▪ Spring Peak of Grey Plover is largest in Ireland: making Tramore of International Importance for the Species (International Waterfowl Research Bureau, 1980). The paper proposed a field centre at Tramore as the author believed that Tramore's tourist industry had a lot to gain from its best natural asset. It assessed the potential under such headings as: activities, education/training, natural history, sportsmen, photographers, likely income, costs, and funding.	
Roger Goodwillie (1983) Conservation and Amenity Advisory Service with An Foras Forbartha.	**Comments on Wildlife Development at Tramore.**

Author (date)	Title
Written in response to a request from Waterford County Council for an assessment of the proposals contained in the report written by O'Meara (1983). Goodwillie believed that erosion on the northern edge of the dune system is related to a shift in the pattern of drainage channels over the last 60 years, and especially since 1949. It contained maps highlighting the migration of the channels between 1920 and 1972 and the perceived build-up of successive dune ridges. It pinpointed two of the natural resources of Tramore, the Burrows and the Backstrand, and Goodwillie concurred with O'Meara that it would be both feasible and advantageous to develop these areas. Goodwillie agreed that a field centre would bring benefit, and suggested that it should be a joint venture by the Town Commissioners and the Waterford VEC. With respect to coastal protection, Goodwillie disagreed with O' Meara's proposed strategy of blanketing almost the entire northern shoreline. Goodwillie believed that since scour (currents along the shore) seemed to be more of a problem than direct wave, the use of groynes at right angles to the shore should be combined with a short line of gabions on the shore. Goodwillie stated that the rest of the Burrows will achieve stability naturally.	
Roger Goodwillie, (1987) Conservation and Amenity Advisory Service with An Foras Forbartha	**The Removal of Beach Material from Tramore Strand with Comments on Erosion.**
Written in response to a request from Waterford County Council for analysis on the annual removal of stony material from the beach at Tramore. The author stated the beach has changed from having a consistent width of 53m along its length (between the shoreline and High Water Mark -HWM) to a narrower asymmetric beach measuring 22m at the western end (at 22m) and broading to 35m at the eastern end. Goodwillie believed this can only have been caused by lowering the beach level. While the effect of gravel removal is limited to this short length of beach, the author believed that the artificial pushing of beach material onto the neck to create a bank was a much more important issue. Goodwillie continued by stating that this artificial scraping steepened the beach profile allowing storm waves to break closer to the shore. Therefore, their energy must be dissipated over a shorter length, and may cause instability and shingle movement and possibly endangering the neck.	
Tom Lineen, (1990) Waterford County Council.	**Photographic Report on the Storm Damage during the Winter of 89/90.**
Included a collection of photographs taken from around the county in the aftermath of the large storm during the winter of 1989/1990. The report contained many photographs from Tramore, which as well as showing extensive damage caused by the storm, gave a valuable glimpse into the past composition of the shoreline prior to its transformation during the 90's.	
Michael Punch & Partners, (1990) Consulting Engineers, in association with John O'Flynn, County Engineer with Waterford County Council.	**Report on Coastal Defences 1990.**
Outlined the storm damage at Tramore, Benvoy and Woodstown, Co. Waterford during the winter of 1989/1990. It examined the causes and remedial works required and the logic of the design philosophy and also outlines the estimated costs. The report stated that many of the structures had been weakened over the years and so were unable to withstand the forces exerted by the worse than 1 in 50 year storm of that night. Provided a detailed documentation of the coastal geomorphological change and structural damage as a result of the storm on the night of December 16th/17th 1989. Of particular interest were the geomorphological changes exerted on the sand dune system and the shingle ridge. It stated that serious overtopping occurred along a 280m length of the shingle ridge closest to the town, the result of which was an amount of beach material deposited behind the front of this bank and back into the car park and Back Strand area. Photographic evidence of the deposition substantiated this claim. If stated the neck of the dune system was breached for a distance of about 15m and badly	

Author (date)	Title
damaged for a further 30m, with a result that water passed directly through to the Back Strand. Further information is included on a bank across the breach, built by Waterford County Council, comprised entirely of beach material with a crest level of 5.25m O.D. Several remedial works were suggested to be carried out without delay including: ▪ Reconstruction of the sea wall and slipways. ▪ Pressure grouting of the existing rubble masonry sea wall. ▪ Provide rubble mound embankments at the base of the existing gravity concrete sea wall and the base of the boulder cliff at the western end of Tramore Strand. ▪ Provide a rubble mound embankment along the entire length of Tramore Burrows. It included technical specification, drawings, and a costing of the remediation strategies. The figures provided for the Tramore Sea Wall and the Tramore Burrows are £146,475.42 (*subsequently completed*) and £1,950,000.00 (*not completed*).	
Michael Fehilly (1990) Timoney & Associates (consulting engineers)	**Preliminary Report on Coastal Protection Work at Four Locations in County Waterford.**
Doesn't deal with Tramore specifically, but provided an accurate meteorological and climatic conditions for the night of the December 16th 1989.	
John O'Flynn (1991), County Engineer, Waterford County Council	**Coastal Erosion in County Waterford – Engineering for Coastal Protection Seminar**
Included details of the types of coastline at Tramore and gives details of change for Tramore (quantified as erosion of 0.14m per annum for the west strand and attributed as "accretion" on the East Strand). It included a detailed history of the coastal protection at Tramore, and the problems encountered, from the efforts of the Doneraile Estate in 1820 up until the modern remedial work carried out in response to the storm of 1989 (and completed in September 1990). The report is augmented by diagrams comparing coastline position between 1841 and 1990 and the designs for both the sea wall repairs and the armouring put in place at the western end and the neck of the spit in response to the storm.	
M.C. O'Sullivan & Co. Ltd. (1992) Consulting Engineers	**Environmental Impact Statement on Tramore Sewage Treatment**
Outlines the potential Environmental Impact of this construction	
E. Mansfield, (1995) Senior Engineer, Waterford County Council.	**Proposals for Coastal Erosion Remediation**
Hand written memo by Mr. E. Mansfield on the coastal erosion problem at Tramore. Mansfield believed that the whole dune system required full protection; he does, however, concede that this may prove expensive, and suggests a repeat of a technique used previously. This technique involved recreating the dune by bulldozing material. The author also suggested an extension of the rock armour revetment, a re-establishment of marram grass on the dunes, stone mattress protection for some of the dunes, walkway and crossing points, as well as protective fencing around sensitive areas. Suggested costs are £500 per metre for a length of 400m.	
Waterford County Council (1996)	**Coastal Erosion Study 1996: Waterford County**
A photographic report on Tramore. The photographs were taken prior to major construction in 1997. Some of the photographs pay particular attention to the blowouts just west of the neck of the dune system.	
Waterford County Council (1997)	**Photographic Report at Tramore (1997).**
Photographic report documenting the construction of the buried stone mattress in the shingle ridge.	

Author (date)	Title
Malachy Walsh & Partners (1997)	Coastal Study: Tramore
In August 1996, Waterford County Council commissioned Malachy Walsh & Partners in association with Posford Duvivier of the UK to carry out a coastal study at Tramore. The overall aim of the study was to develop a strategy to protect, in the most cost effective manner, the people, property and environment of Tramore from damage by the sea. The report produced consists of summaries of the findings of the work carried out; detailed evaluation of options or strategies; and lists of conclusions and recommendations. The work leading to the above findings, background data for the evaluation of options leading to the conclusions and recommendations are assessed under the following headings: assessment of existing defences, coastal processes, environmental review, benefit assessment, beach profiles, and the examination of maps and aerial photographs. The report divided the coast at Tramore into three distinct lengths: an area of hard defences (rock armour, masonry and reinforced concrete seawalls); an area of beach backed by a shingle ridge; and an area of sand dunes. It demonstrated that within each of these areas there were assets at risk, including the shingle ridge and the sand dune system. It stated that the westernmost 600m of shingle ridge adjacent to the hard defences are vulnerable to breaching in a relatively mild storm (less than 1 in 10 year return period). If a breach occurred in the area, the assets at risk would have included the car park, access roads, the landfill site and associated plant and buildings. It highlighted that this area most in need of protection works in view of the vulnerability of the defence and the value of the assets at risk. It stated that, in general, the sand dunes can be considered stable. However, the report warned that some blowout areas appear to have been growing since 1974, and suggested that remediation measures be put in place to protect them. The report stated that the blowouts would not re-vegetate without protection from people pressure, wind and wave erosion.	
Waterford County Council 1996-7	**Documents with respect to tendering aspects of Coastal**
Tramore Coastal Defence Emergency Work: Instruction to Tenderers Tramore Coastal Defence Emergency Work: Tender Assessment Tramore Coastal Defence Promenade Site Investigation: Tender Documents Tramore Coastal Defence Cliff Protection Works: Instruction to Tenderers Tramore Coastal Defence Cliff Protection Works: Tender Assessment Tramore Coastal Defence Sand Dune Management: Tender Documents Tramore Coastal Defence Sand Dune Management: Tender Assessment	
Waterford County Council (1997)	**Tramore Coastal Defences: Promenade Investigation.**
Photographic Report on the Coastal Protection Works at Tramore in 1996/1997	
Malachy Walsh & Partners (1998)	**Tramore Coastal Defences: Promenade Investigation.**
Subsequent to the presentation of the initial coastal study (above), Waterford County Council again commissioned Malachy Walsh & Partners in association with Posford Duvivier to further investigate and consider possible options for engineering improvement works specifically to the 400m frontage between the boat slip and the life guard hut, referred to as the promenade. The report documented the findings of those investigations. The report also provided various options for strengthening the promenade structure.	

Table 3.1: Historical documentation of material relating to coastal protection at Tramore

In addition to the above documents several personal communications on the subject of coastal management at Tramore were also catalogued (Table 3.2):

Date	Details
13/1/1987	**County Engineer to Executive Engineer**
Expressed concern in regards to the possibility of erosional damage resulting in the cutting off of the sand dune complex from the main beach.	
15/1/1987	**Senior Executive Engineer to County Engineer**
Memo on Tramore Burrows The Senior Executive Engineer referred the County Engineer to a paper produced by Mr. Micheal O'Meara of the Irish Wild Bird Conservancy, and in particular to its exposition of the mechanics of the erosion process at Tramore. The Executive Engineer reminded the County Engineer of previous steps taken to protect the neck of the dunes, with such defences as sleeper walls and subsequent extensions. The Executive Engineer referred the County Engineer to Caliso Bay as an example of where large-scale abstraction of beach material resulted in erosion occurring. The Executive Engineer recommended commissioning a study by An Foras Forbatha to establish the rate of accretion on Tramore Strand, with a view to seeing how much can be extracted without causing harm, but stressed that this practice may not even be worth the cost of consultation	
5/5/1987	**County Engineer to Mr. David Cabot (An Foras Forbatha)**
Subsequent to a discussion with Mr Billy Moore (Tramore Area Engineer), the County Engineer estimated that each year approx. 2,000m^3 of material is removed at the start of the summer. The material is removed from the upper part of the beach (outlined on an attached map), to an average depth of approximately 150mm. The purpose of this exercise according to the County Engineer was to: • Remove stony material from the beach • Reshape the beach for leisure purposes • Make the removed material available for use as cover material in the nearby landfill. The County Engineer was concerned that this practice may have negative long-term effect on erosion at Tramore Burrows and accordingly asked the Conservation and Amenity Authority Service to examine the matter and provide a report.	
11/10/1994	**County Secretary to County Engineer**
Discussion on the merits of the ECOPRO project. Discussed coastal protection techniques and Data Return Sheets. County Secretary requested the County Engineer complete and returns these Data Return Sheets.	
4/11/1996	**County Secretary to Foreshore Section of DCMNR**
Application for a Foreshore Licence under Section 10 of the Foreshore Act 1933 for coastal protection works at Tramore.	
23/7/1997	**Mr Pat Parle (Malachy Walsh & Partners-MWP) to Mr Jim Casey (DCMNR)**
Letter containing a draft of the Appendix D from the final report on Tramore. This appendix is a benefit assessment for the study at Tramore.	
24/7/1997	**County Secretary to Mr Brian O'Neill (DCMNR)**
Includes a breakdown of the estimated expenditure on priority coastal protection works. The County Secretary requested that finance be made available out the proposals outline by the MWP report.	
29/10/1997	**Mr Pat Parle (MWP) to Mr Tom Ryan (District Wildlife Officer)**
Outlines the sand dune management measures proposed by MWP, and asked the Wildlife Officer for feedback on these proposals.	
18/10/1997	**Mr Pat Parle (MWP) to County Engineer**
Communication recommending the tender submitted by Tony Kirwan Plant Hire by accepted for the	

Date	Details
Sand Dune Management contract.	
15/12/1997	**Mr Pat Parle (MWP) to Mr Tony Kirwan (Tony Kirwan Plant Hire)**
Contained specific details on the requirements for control access on the shingle ridge, and requests a quote for such work.	
23/2/1998	**Mr Pat Parle (MWP) to Mr Tony Kirwan (Tony Kirwan Plant Hire)**
Outlined the causes for concern relating to the work being carried out on the Cliff Protection and Sand Dune Management projects.	
25/2/1998	**Mr Pat Parle (MWP) to Teddy Guilfoyle & Sons Ltd**
Contained a draft of the sign to be erected as part of the sand dune management project and requests feedback.	
4/3/1998	**Mr Pat Parle (MWP) to County Engineer**
Re: Tramore Coastal Defences: Shingle Access Control Following quotes and consultations with Tony Kirwan Plat Hire, Mr. Parle recommended the use of tanalised timber, with top rail, and no sheep wire all at a cost of £13,000. This would allow for the hydro-seeding of the protected area within the £15,000 budget.	
7/5/1998	**Mr Pat Parle (MWP) to County Engineer**
Re: Tramore Coastal Defence – Cliff Protection Works Letter confirming the completion of the cliff protection works at Tramore on May 27th 1998, at a cost of £80,456.71 (+£10,057.09 VAT). Stated that The 12 month period of maintenance will commence from this date.	
23/11/1998	**Ms Linda Barry** (resident/owner of Oceanic Manoeuvres Surf Shop) to County Secretary
Re: Tramore Burrows, Nature Trail Proposal Ms. Barry pointed to the lack of constructive usage on the Burrow and suggests its benefits to the community in terms of tourism and heritage. Ms. Barry attached a sample nature trail for the Burrows with appropriate stops and viewing points. The document was similar in concept and detail to the proposal in 1983 by Micheal O'Meara of the Irish Wildbird Conservancy. Ms. Barry sought the cooperation and assistance of Waterford County Council in bringing this project to fruition.	
27/11/1998	**County Secretary to Ms. Linda Barry**
Letter informing Ms. Barry that her proposal has been forwarded to the Council's Planning, Environmental, and Sanitary Departments for consideration and a report would be produced on the matter.	
3/12/1998	**Area Engineer to County Engineer**
Re: Nature Trail Proposal Letter expressing agreement with the proposal provided that access is controlled and damage is limited.	
3/12/1998	**Sanitary Department to County Engineer**
Re: Nature Trail Proposal Letter backing proposal, but suggested planning permission may be needed for signs and pathways	
10/12/1998	**Planning Department to County Engineer**
Re: Nature Trail Proposal Letter expressing agreement with the proposal provided access is controlled and damage limited. Suggested this is the type of thing that is being pushed by the Blue Flag authorities and An Taisce.	
14/12/1998	**Environment Department to County Engineer**
Re: Nature Trail Proposal	

Date	Details
This department had no objection to the proposal, but suggested it might put the Council under increased pressure to pick up litter windblown from the landfill. Believed Duchas should be consulted.	
9/12/1998	**Mr Pat Parle (MWP) to County Engineer**
Re: Tramore Coastal Defence – Sand Dune Management Letter detailing payment instalments to the contractor.	
10/12/1998	**Mr Pat Parle (MWP) to County Engineer**
Letter containing details of further payments.	
18/12/1998	**Mr Pat Parle (MWP) to County Engineer**
Re: Shingle Ridge Access Control Letter confirming the Shingle Ridge Access Control contract had been substantially completed on December 18th 1998 at a cost of £14,195.76 (+£1,774.47 VAT). The 12 month period of maintenance was to begin from this date.	
4/1/1999	**Mr Pat Parle (MWP) to County Engineer**
Letter containing details of further payments.	

Table 3.2: Personal communication on coastal management schemes for Tramore

3.2.2 Review of Coastal Protection Schemes implemented at Tramore

An indication of the type of coastal protection and their relative costs, where available, is provided in the table below (Table 3.3):

Date	Comment
1820	The first sea wall was constructed at the western end of the strand
1857	Embankments were constructed, which enclosed 500 acres of land at the western end of the Back Strand costing £500,000. (~ €44.5 million euro in 2004) This is known as Malcomson polder. Race Course and Golf links were subsequently constructed on this reclaimed land.
1867	A portion of the beach east of the first seawall was piled with round timber posts in rows parallel to the line of the beach at a cost of £300 (€25,075).
1871	Further extension of the piling was undertaken at a cost of £400 (€35,700).
1877	Further piling repairs £120 (€10,800).
1879	Piling was abandoned due to excessive costs.
1881	Experimental groynes were erected at the west and front of the beach for a distance of 40 yards.
1896	A seawall was constructed which extended across the sea-frontage of the bog marsh (an area which is now fronted by the modern promenade) at a cost of £5000 (€555,360).
1897	Heavy gales and abnormal high tides resulted in damage to the structure. The structure was repaired at a cost of £300 (€32,668).
1910	*Hippophae rhamnoides* (Sea Buckthorn) sowed into the top of the shingle bank.

Date	Comment
1912	A severe winter storm in 1912 caused erosion at the beach to outflank the main seawall at its eastern end. The storm also led to the breaching of the Malcomson embankment allowing the racecourse and golf links to be inundated.
1913-15	A new promenade was constructed.
1930	A new seawall was constructed east and inland of the promenade.
1940's	Waterford County Council installed sand fences on the shingle bank, which were subsequently subject to vandalism.
1940's	Cement filled tar barrels were later positioned on shingle embankment backed by railway sleepers. These reportedly worked very well and allowed stabilisation and marram grass colonisation.
1960's	A sleeper wall was erected to protect the sensitive cliffs at the western end of the Strand. A sleeper wall also protected a section of the landward facing Sand Dune System.
1970's	Extensive sand extraction was prevalent from the foreshore.

Figure 3.37: Examples of storm damage at Tramore in 1989 (Punch 1990)

1990	Following the severe storm on the night of December 16th 1989, the coast of Tramore was badly damaged (Figure 3.37) Remedial works included: Reconstruction of sea wall £73,831.23 Repairs to rubble masonry wall £18,201.83 Repairs to slipway £30,163.58 Rock armouring at neck £24,278.78

Date	Comment
	The barrier of rock armoury was placed along the neck of the dunes. The dimensions of which are 77m long, 18m deep, and with a crest of 5.25m above O.D. The total costs of these remedial works were £146,475.42, (€277,178.03 at 2004-euro values).
1997	1997 The 600m section at the western end of the shingle ridge was strengthened by burying rock gabion baskets and gabion mattressing within the shingle structure and nourishing the ridge with additional shingle. Tony Kirwan constructed this at a cost of £69,001.88 including VAT, (€111,784.54 at 2004-euro values).
1997	Cliff protection was undertaken at the unstable boulder clay cliffs at the western end of the Strand. This involved constructing a 100m length of revetment fronting the base of the cliff, and the erection of a palisade fence on the crest of the revetment. Tony Kirwan constructed this at a cost of £88,007.52 including VAT, (€142,574.09 at 2004-euro values).
1997	A sand dune management scheme was implemented in 1997. This involved erection of signage, access control fencing, wind erosion control fencing, the planting of marram grass, and the construction of gabion mattresses at two locations within the sand dunes. Tony Kirwan, initially tendered this at £51,432.58, however works were restricted to £40,000 due to council budget restrictions, (€64,800.87 at 2004-euro values).
2001	Irish Geotechnical Services Limited carried out the initial site and structural investigations at the promenade at a reduced volume of work cost of £7,630, (€10,722.21). In the years 2000 to 2003, the Department of the Communication, Marine and Natural Resources has contributed 75% of the total costs of refurbishing the promenade. This amounts to €1,165,257.81, with Waterford County Council having to contribute the remaining 25% (€388,419.27) to reach the total refurbishment costs of €1,553,677.08, (€1,719,298.55 at 2004-euro values).
2003	Forestry students from the Waterford Institute of Technology conducted a practical demonstration on the uses of birch brushwood fencing for coastal erosion control. No attributable cost

Table 3.3: Historical breakdown of Tramore's coastal protection schemes with relative costs

€ Value calculated from the Consumer Price Index and the Value of the Euro as posted on the Central Statistics Office (4/1/2006). http://www.cso.ie/statistics/valueoftheeuro.htm. Pre-1920 values were calculated using an online resource on the Economic History web page: http://www.eh.net/hmit/exchange/

3.3 Creation and Application of a Dedicated GIS for Tramore

Thirty eight layers, under nine headings, (Table 3.4) were successfully obtained and imported to ESRI ArcGIS 9.1 environment for inclusion in the standalone GIS for Tramore (see accompanying CD / Appendix 1). The numerous layers ranged from coastline evolution through to essential base mapping (Figure 3.38).

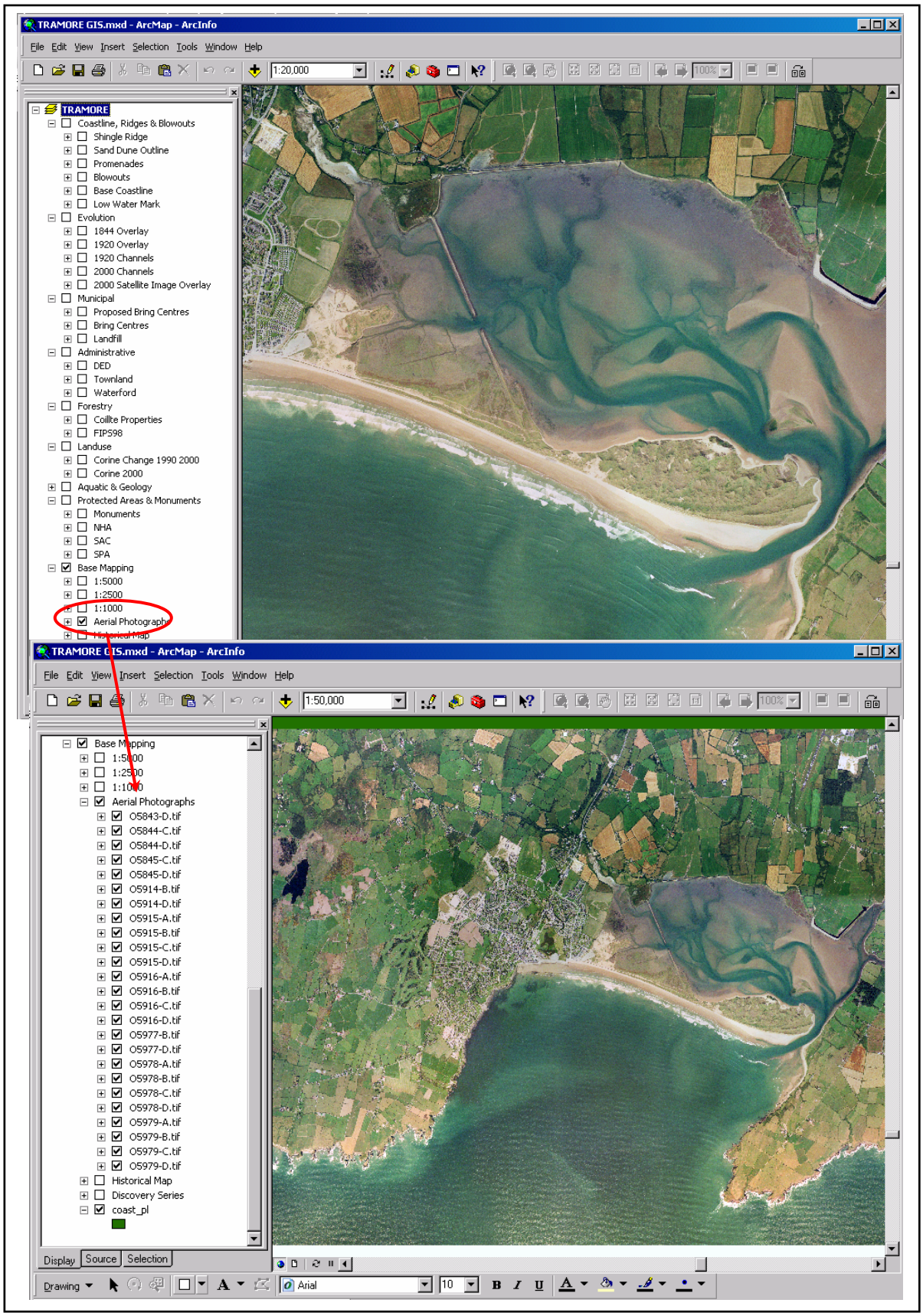


Figure 3.38 Screenshot of Tramore GIS with expansion aerial photograph layer (ArcGIS 9.1)

Description	Layers
Coastline, Ridges & Blowouts	
	Shingle Ridge
	Sand Dune Outline
	Promenades
	Blowouts
	Base Coastline
	Low Water Mark
Evolution	
	1844 Coastline (included but inaccurate)
	1920 Coastline
	1920 Channel Positions
	2000 Channel Positions
	2000 Satellite Image Overlay
Municipal Sites	
	Proposed Bring Centres
	Bring Centres
	Landfill
Administrative Boundaries	
	DED Boundaries
	Townland Boundaries
	Waterford Boundary
Forestry	
	Coillte Properties
	FIPS98
Landuse	
	Corine Change 1990 2000
	Corine 2000
Aquatic & Geology	
	Catchment
	Lakes
	Rivers
	Aquifer Type
	Geology
	Vulnerability
Protected Areas & Monuments	
	Monuments
	Special Area of Conservation - SAC
	Special Protection Area - SPA
	Natural Heritage Area - NHA
Base Mapping	
	OS 1:5000 scale maps
	OS 1:2500 scale maps
	OS 1:1000 scale maps
	2000 Aerial Photographs
	Historical Maps
	OS Discovery Series
	Coastline of Ireland

Table 3.4: List and description of Tramore GIS layers

A GIS is an excellent tool for both illustrating and quantifying coastal change over time or with respect to other considerations at Tramore – i.e. proximity of the coastline to archaeologically significant sites. It can produce concise output for immediate incorporation in dissemination material – all the map

images in this report were exported directly from the GIS. The extent and location of the blowouts, the other major threat in terms of erosion, are also clearly visible in the GIS and an outline of these is included as a layer. These data could provide the sound baseline required for any monitoring scheme put in place to assess the success of a management scheme designed to promote the recovery of the dune system.

Other practical examples of the application of the Tramore GIS to assess the changes in coastline position and patterns of channel migration are provided below.

- *Coastline Position*

  Historical comparisons were made between the 1920 OS series maps, photographs from 2000 and the 2005 coastline generated from the GPS survey. These revealed that there has been an accretion at the eastern (distal) end of the spit with differences of up to 130m being recorded between 1920 and the present day. There appears to have been a period of accelerated growth between 2000 and 2005: an increase of up to 90m was recorded during this time. Over the same period there has been a gradual erosion of the coastline at Bass Point and this has led to a retreat of up to 150m at this location between 1920 and 2000 with a further 60m between 2000 and 2005 (Figure 3.39).

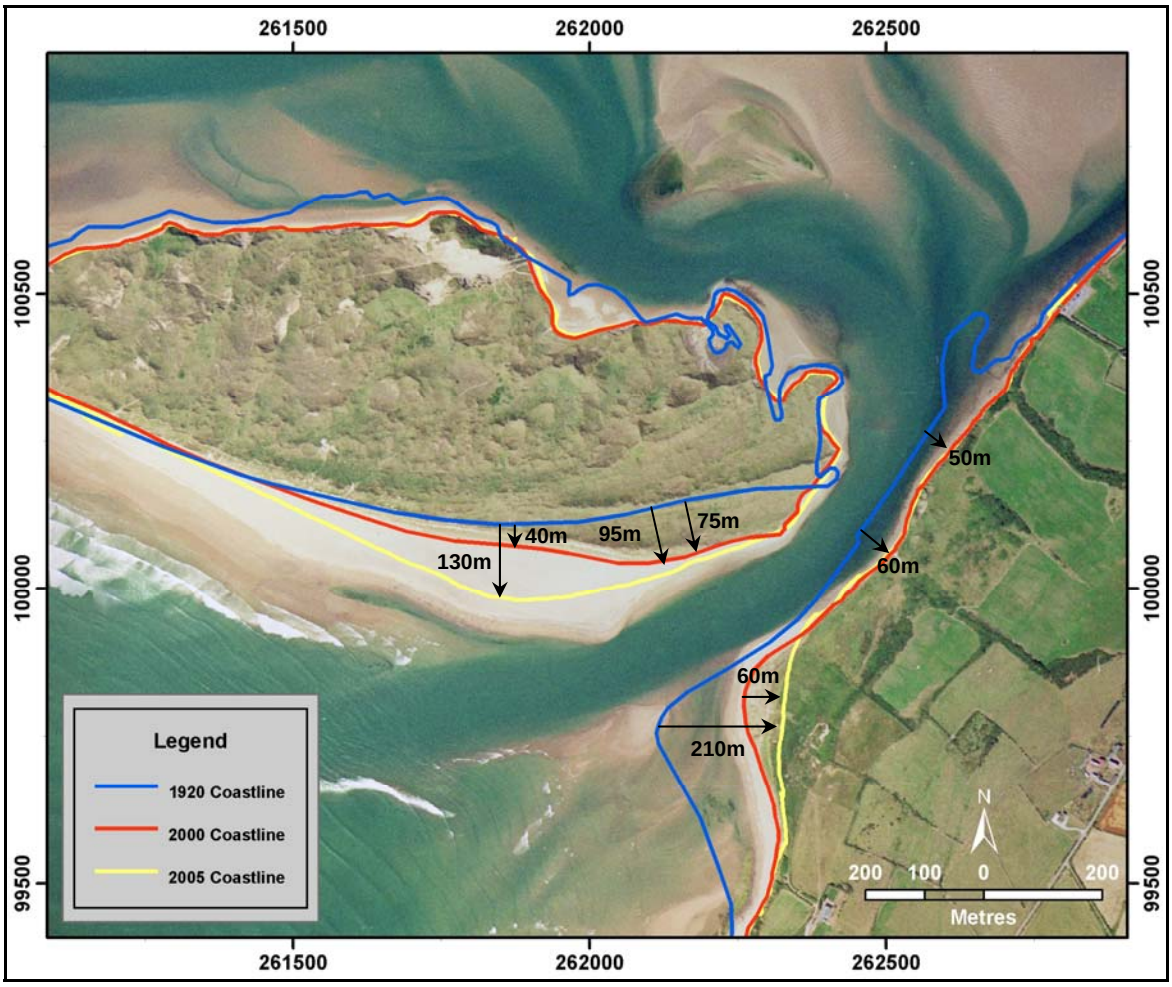


Figure 3.39: Annotated GIS output highlighting levels of coastal change at Tramore (ArcGIS 9.1)

It was initially intended to include the 1844 series as well but there were problems with the quality of the actual source received. After several attempts to utilise this map it was abandoned as it was clearly inaccurate probably due to a combination of survey procedures during that period and storage of the map since its production. The layer with the 1844 data was incorporated into the GIS but any attempt to use this should consider the inherent inaccuracies of the copy that was sourced.

- Channel Migration

Qualitative assessments were made of the extent of channel migration. The migration of drainage/tidal channels in the Back Strand that was referred to in a report by Goodwillie (1983) is clearly illustrated in Figure 3.40. It can be seen that there is both channel migration between 1920 and 2000 in the Back Strand area and in the channel adjacent to Bass Point. This supports the theory put forward by Goodwillie that coastal erosion on the northern (inner) side of the sand dune complex has been caused by shifting of the positions of the channels closer to the dunes. Furthermore, the accretion of the spit appears to be pushing the main channel eastwards towards Bass Point and it is this that is most likely causing the accelerated erosion currently recorded at this point.

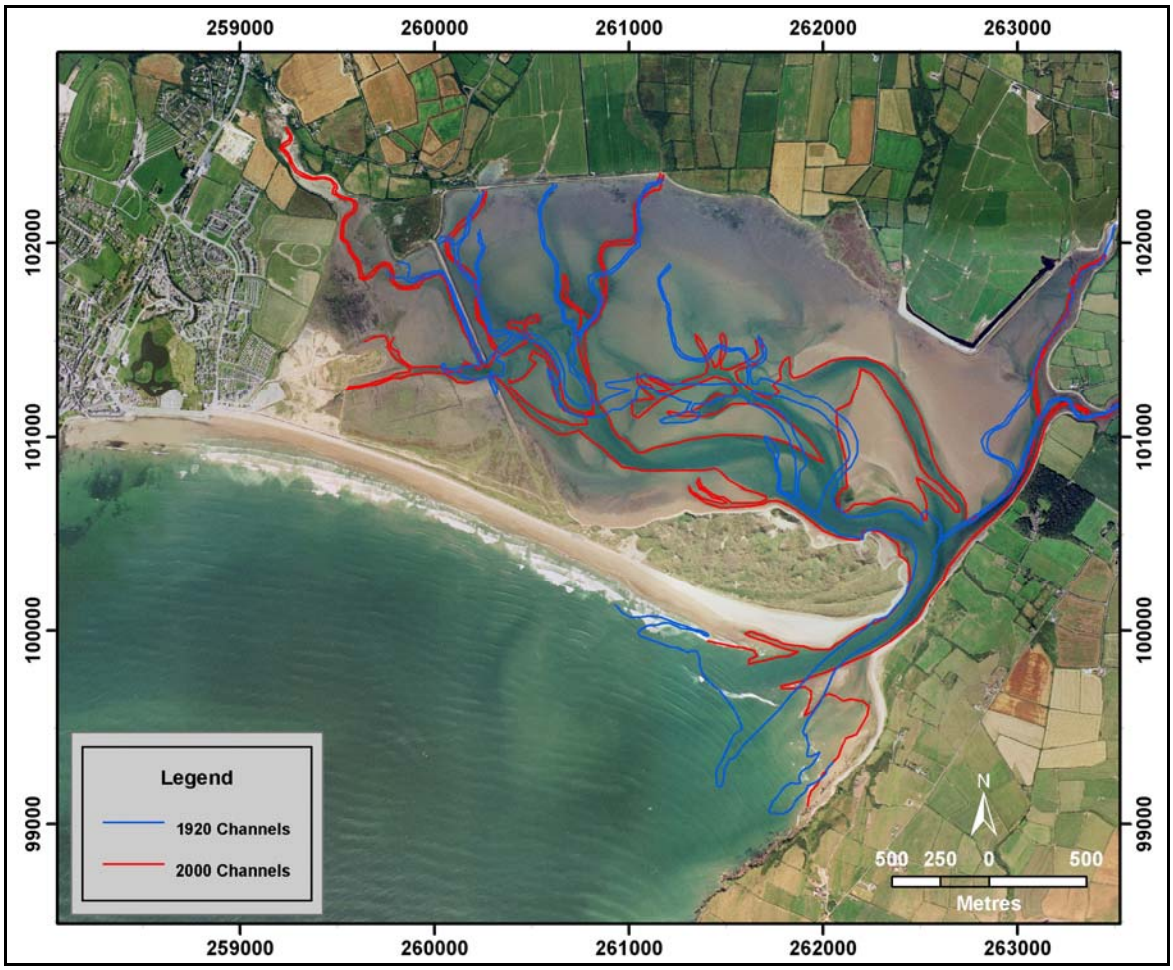


Figure 3.40: GIS Output illustrating channel migration in the Back Strand of Tramore.

4.0 DISCUSSION

In the Republic of Ireland it is the responsibility of the individual property owner to protect that property from erosion or inundation by the sea (ECOPRO, 1996). Where the owner is a public body or the State it is reasonable to use public funds to protect the property subject to prudent investment criteria. According to O'Hagan and Cooper (2002), the general development powers of local authorities are enshrined in the Local Government Acts and those of Government Ministers in the State Authorities (Development and Management) Act, 1993. The Coast Protection Act, 1963, empowered the Office of Public Works (OPW) to carry out coast protection works from exchequer funds with a contribution by the local authority. The OPW no longer carries out these works and maintenance of the schemes under the Act is done by the Department of the Marine (now the Department of Communications Marine and Natural Resources) (ECOPRO, 1996). In addition, this Department carries out major coastal protection schemes on an agency basis for local authorities.

As was revealed by the questionnaire survey local users are aware of the changing coastline at Tramore and that there are ongoing attempts to manage the coastline. They placed a high environmental, economic and social premium on the value of the beach to Tramore but indicated that they felt that their personal level and other users' levels of participation in development at Tramore were low. The majority seemed unaware of ICZM but effective application of this process would increase levels of participation and could provide other tangible benefits, such as an integrated management strategy for Tramore.

The output from the site visits illustrates the different types and current condition of the coastline at Tramore. Coastal change was not limited to erosion: large scale accretion was also recorded at the eastern end of the Strand. There was evidence of the attempts that have been made to control erosion resulting from coastal processes and wind scour. It was hard to determine the time scale of these schemes as the associated signage was in a poor condition and this may indicate that these attempts have been abandoned. For other schemes there appeared to be no public information available on site and this may make it difficult for users to appreciate what is being attempted.

Erosion was also recorded as a result of the detrimental effects of the types and levels of usage at Tramore. This was apparent across the area but was most obvious on the dune complex where for example, user activity had contributed, and was continuing to contribute, to the problems currently being encountered with the blowouts. The more sensitive areas on the sand dune complex may need to be protected to avoid further damage and to encourage recovery the provision of trails and the fencing of the more sensitive areas should definitely be considered. In general there was little public information about the schemes that had been attempted or even general information about Tramore and its cultural and environmental importance. Generally, users are more likely to comply with measures put in place to control their activities if they have been informed of the reasoning behind these schemes. Given that large volumes of data have been gathered for the dedicated GIS the output

from this could be used as the basis for information boards, for example, for the sites of interest such as the SPA and SAC.

The GIS created could be an invaluable tool for coastal management at Tramore. It contains all the relevant base mapping for the area and as demonstrated can be employed to quantify levels of erosion and produce clear illustrations of coastal change. It can be used to produce comparisons between different data sets, for example coastline position with respect to areas of archaeologically importance. The high quality images produced can be easily exported from the GIS for subsequent incorporation in material for dissemination. Finally the dedicated GIS created does not require any additional software (apart from the free reader included) and therefore is readily transferable to relevant Council officials.

It is evident from the protection work undertaken at Tramore (Table 3.3) that numerous attempts have been made to modify or control elements of the coastal system. Whilst the capital costs of these schemes have been established the cost of maintenance is unclear. It is clear that despite the large amount of capital provided to hold the coastline position at Tramore that historically these attempts at hard engineering have all succumbed, to varying degrees, to the forces of nature. The large scale engineering schemes have recently been focussed on the western end of the strand and whilst the most recent developments here are imposing they will only be able to resist these forces with a continued programme of maintenance and upgrading.

It is debatable whether the system has ever had time to respond naturally as there has always been some form of intervention in the region – whether it is the construction of sea walls, removal of sand, re-working of the shingle bank or the recent laying of an outflow pipe. In order to assess what is happening at the site some baseline monitoring needs to be put in place well in advance of any further management schemes.

The effect on the unprotected areas in and around the dune complex is complicated by the fact that it is subject to impact from both natural processes and pressure from users. Many of the schemes applied in this location appear to be one off measures rather than forming part of a structured programme designed to deal with ongoing and longer term changes.

Erosion is universally perceived as a problem rather than a natural phenomenon and it is probably fair to say that it is man, and his desire to build close to the ocean, rather than erosion that is the real problem. Carter (1986) suggests that the first rule of coastal management is to work with natural processes but acknowledged that this rule is hard to adhere to given economic and political pressure. The vast majority of respondents in Tramore were aware of the coastline change but it was not clear as to whether they only thought of this change as being a result of erosion.

From the site investigation it is clear that there was accretion at the tip of the spit as well as an erosion problem at the neck and in the dunes themselves. The erosion recorded at Tramore results from a combination of user pressure breaking up the dune fabric and wind scouring subsequently removing unconsolidated material, and natural coastal processes such as wave and tidal action, lowering the beach and opening up the soft coastline.

Even if the possible negative impacts on the natural processes and the environment were ignored, it would cost several million euros to armour the entire Tramore coastline and this is probably not likely to happen on economic grounds alone. Therefore, the coastline comprised by the shingle bank and the dune complex will continue to be influenced by natural processes. The shingle ridge will continue to afford some protection but it is likely that the occasional mechanical re-shaping will be required as will remedial repair in the wake of severe storms. There are definite problems with erosion at the neck of the spit and this erosion is compounded by the adjacent blowout – one of several found at the site. Armouring is already in position at this location and therefore some form of management scheme to reduce the impact from human activity is probably the best course of action.

Creation of bye-laws and designation can afford some protection and raise awareness of the environmental and cultural significance of sites such as those at Tramore. However, without some form of enforcement, these measures alone do not guarantee protection. It is unrealistic to expect that routine policing could be implemented at Tramore and therefore perhaps the provision and maintenance of on-site information and relevant signage could be a stronger tool for raising awareness. If users are made aware of the potential detrimental effects of usage then they may tend to become self-enforcing and choose to utilise the amenity in a more responsible manner and thus provide the protection required. Evidence from other sites suggests that a combination of management techniques is required.

The provision of nature trails and interpretive centres would provide two main benefits – it would raise awareness of the significance of the area and by guiding users along prescribed routes it would make site management substantially easier (as employed in Barleycove, Co.Cork). Trails could be designed to avoid the most sensitive areas and this in conjunction with the adequate fencing and monitoring of sensitive areas, such as the blowouts, would assist with the natural recovery of the most highly impacted locations. Information is a key element - signs will inform users but an on-site warden can both information and answer any addition concerns of users. Given the budgetary constraints envisaged, innovative funding mechanisms may have to be investigated to cover signage and the provision of a warden. In other locations parking fees and fines have been re-invested to meet these costs and this could be a consideration for Tramore.

Like many locations, in Tramore coastal protection schemes have traditionally resulted from public pressure or as a reaction to storm damage. In recent years there has a been trend to move away from management based on single specific issues towards a pro-active more interdisciplinary, holistic

management process - Integrated Coastal Zone Management (ICZM). This dynamic process encourages development of a co-ordinated strategy for the allocation of resources to achieve the conservation and sustainable use of the coastal zone (Masselink and Hughes, 2003).

The issues encountered at Tramore are not unique and some of the approaches adopted in other areas could be applied. The principles of ICZM are increasingly being applied in both developed and developing countries (Masselink and Hughes, 2003). For example, it would be reasonable to put in fencing to attempt to help consolidate the material in the blowouts at Tramore but it would be preferable if this was formed part of a more wide ranging management scheme. There is little point in implementing a remediation scheme if the detrimental activity that caused the damage continues and the problem is simply transferred to an adjacent location. Therefore any schemes implemented should be form as part of the development of an overall beach management plan as described in McKenna *et al*, 2000. This process should inform all stakeholders of why there is a need for management and highlight the benefits of adopting such an approach in order to convince all relevant parties to actively participate.

5.0 RECOMMENDATIONS

It is obvious that there is concern about Tramore and the threat to the amenity from coastal erosion but users of the beach do not always realise the important role that they can play in helping to reduce the impacts from their usage.

Appropriate structures to consider include:

- Information for users, awareness raising (signage) of the sensitivity of the dune/spit area. Highlight the extent of Tramore's designations, using imagery generated from the GIS output, and including both the extent and the reasons why the areas were designated. Targeted educational measures especially during peak periods could help. A suite of education tools, which could be tailored for use at Tramore, are available to illustrate best practice approaches to beach usage (ECOPRO, Rural Beach Management Guide, CoPraNet).
- Provision of fencing to protect the most sensitive areas from detrimental usage and promote recovery in the short term. This should form part of a longer term scheme to promote responsible usage of Tramore's natural resources and therefore information on the reasons behind implementing such a scheme should be readily available.
- Consultation with groups such as riding clubs, sports clubs, motorcyclists and walkers that utilise the site to ascertain if they would modify their routines in order to reduce impact. This could involve reducing or eliminating the amount of time that they currently spend on sensitive areas such as the dunes.
- Provision of a beach warden - this has been suggested previously by various authors (e.g. Goodwillie, 1983). Whilst there may not be funding for a permanent person for Tramore alone, there may be a case for employing a person at County level to look after a number of beaches or it could be a seasonal position for the peak summer months. Their remit could include education, enforcement, monitoring as well as raising awareness. This should be proactive in nature with the person employed giving presentations to schools, residents associations and local councillors on the concerns at Tramore.
- Investigation of innovative funding mechanisms to provide signage and employ a warden. For example, could the revenue generated from parking and parking fines at Tramore be used to cover the cost of information boards and the warden's salary.
- Building of trails to encourage visitors to adhere to prescribed routes to limit effect of tramping and other usage using the GIS as planning tool.
- Provision of information on the evolution of the coastline possibly as part of an Interpretive Centre to highlight the natural processes occurring at Tramore and their influence on the coastline.
- Explanation of the meaning of Integrated Coastal Zone Management and subsequent promotion of both the process and the benefits of employing the principles of ICZM to all stakeholders.

There is now global recognition that expensive hard engineering solutions may not be sustainable and that in the future the population may have to accommodate nature. This is still too radical for many to consider and it is unlikely that this suggestion would be palatable to the residents and users of Tramore at this time. However, this report has highlighted the cost of coastal defence measures at Tramore, that they are becoming increasingly expensive and that historically they have been proven to be inadequate when it comes to maintaining the position of the coastline.

In the short term there may be considerable pressure to put in place some form of coastline protection (shoreline defences) at the locations under greatest risk (i.e. the neck of the spit) and to curb the detrimental effects of usage. Minor shoreline works (sand trapping brushwood fencing / access control fencing / information boards) could be undertaken immediately to help with remediation but should preferably form part of an overall management strategy.

Any major initiative should be resisted until the output from a thorough baseline study has been analysed. This could help to ensure that the solution employed does not exacerbate the underlying problem in the longer term.

To date only short-term (reactive) schemes have been put in place and it is debatable whether the effects of these structures on the system have been truly assessed. The objective of monitoring would be to expand the desk based knowledge of the coastal processes active on the site (as provisionally discussed by Malachy Walsh & Partners 1997) and to develop a first hand understanding of the extent and mechanisms of the coastline change at Tramore. A baseline survey as part of a monitoring programme would establish the existing physical characteristics of the beach and sand dune complex. It should be as comprehensive as practicable and to limit seasonal effects it should be conducted over at least a 12 month period as detailed below:

- Ongoing monitoring (grain size analysis, sediment tracing) to include a subset of the baseline measurements to assess sediment transfers that occur longshore (in both the shore face and back shore environments) as well as across the dune system. This is necessary to establish the sediment budgets that affect the system's functioning and that have an impact on the spit in terms of shoreline position and shape over time.
- Ideally the above measurements should be linked to separate hydrodynamic modelling of the nearshore environment including the back barrier environment in order to provide a dynamic working model of Tramore. This model could be employed to assess the impacts of a variety of coastal protection options prior to their construction thus ensuring that the most appropriate design is selected.
- A number of datasets should be considered including tide and wave records, meteorological data for full storm analysis and wind and precipitation levels, aerial photography, topographic profiling, bathymetry surveys and regular field observations including monitoring of the blowouts.
- The data collected must be stored effectively if it is to serve any long-term purpose. The GIS (Geographical Information System), as generated for this project offers a convenient data storage,

analysis and display system. To keep this relevant it is essential that some provision is made to maintain and update the GIS.

There are obvious cost implications in instigating such a large scale monitoring scheme (probably running to tens of thousands) but this is insignificant compared with the millions spent to date on coastal protection in spite of the fact that there is a limited understanding of the physical processes in action at Tramore. Data from the monitoring programme should form an essential part of the decision making of any future coastal protection schemes proposed for Tramore.

The data derived from this comprehensive monitoring programme should lead to a pro-active rather than a reactive approach to the provision of coastal protection at Tramore as part of an overall management strategy.

6.0 REFERENCES

Cabot, D. (1977): Proposals for controlling erosion on the northern part of Tramore sand dunes, Co. Waterford". An Foras Forbatha.

Carter, R.W.G. (1988): Coastal Environments: An Introduction to the Physical, Ecological and Cultural Systems of Coastlines, Academic Press, London.

Carter, R.W.G., Devoy, R.J.N., and Shaw, J. (1989): Late Holocane sea-levels in Ireland *Journal of Quaternary Science, 4, 7-24.*

CoPraNet (2006) – Coastal Practice Network: http://www.coastalpractice.net/

Construction Industry Research and Information Association (CIRIA) (1996): Report 153: Beach management manual.

Devoy R.J.N., Nicol, S.L., Sinnott, A.M., (2006): Holocene sea-level and sedimentary changes on the south coast of Ireland *International Coastal Symposium, Brazil 2004* Journal of Coastal Research, SI 39, Proceedings of ICS 2004.

Duffin, L. (1884): The Encroachment of the Sea – Beaches and Groynes. Institute Civil Engineers Ireland.

ECOPRO (1996): Environmental Friendly Coastal Protection (ECOPRO); Code of Practice. Department of the Marine and Natural Resources (Dublin), Forbairt, and the Department of the Environment (Northern Ireland). Government Publications. Dublin.

EUCC (2006): Integrated Coastal Management – do we really have a choice. Coastline Special Volume 15, No2006-1/2 ISSN-0928-2734.

EURIS (2005): Europeans Using Roundwood Innovatively and Sustainably. http://www.eurisproject.com/pages/page16sylvucs.html

Fehilly, Timoney & Associates (1990): Preliminary Report on Coastal Protection Work at Four Locations in County Waterford.

Goodwillie, R. (1983): Comments on Wildlife development at Tramore. An Foras Forbatha. Dublin.

Goodwillie, R. (1987): The removal of beach material from Tramore Strand with comments on erosion. An Foras Forbatha. Dublin.

Intergovernmental Panel on Climate Change (IPCC) (1990): Climate Change, the IPPC Scientific Assessment. Cambridge University Press. London.

Kelleher, Liz Thesis (2005): The Need for Integrated Coastal Zone Management in Tramore, MA Thesis, University College Cork

Lineen, Tom (1989): Photographic report on the storm damage during the winter of 89/90, Waterford County Council.

Masselink, G. and Hughes, M.G. (2003): Introduction to coastal processes and geomorphology. Arnold, London.

Ni Lamhna, E. (1981): A report on the salt marsh area to the west of Tramore Back Strand. An Foras Forbatha. Dublin.

MacLeod, C.N. (1932): Inspection of Tramore Reclamation Areas.

Mansfield, E. (1995): Proposals for Coastal Erosion Remediation, Waterford County Council.

Malachy Walsh and Partners (1997): Prepared by Parle, P.: Coastal Study; Tramore".

Malachy Walsh and Partners (1998): Tramore Coastal Defences: Promenade Investigations.

McKenna, J, MacLeod, M, Power, J and Cooper, A (2000): Rural Beach Management: A Good Practice Guide. The Universities Press (Belfast)

McGrath, D. (2001): A Guide to Tramore; Beach, Dunes and Back Strand. The Heritage Council. Waterford.

M.C. O'Sullivan & Co. Ltd. (1992): Environmental Impact Statement on Tramore Sewage Treatment.

McSweeney, Shane (2005) The implications of Coastal Change for the Management of Tramore Strand, MSc Thesis, Queen's University Belfast

Ni Lamhna, E. (1981): A report on the salt marsh area to the west of Tramore Back Strand. An Foras Forbatha. Dublin.

National Parks and Wildlife Service Website: http://www.npws.ie/Conservationsites/

Office of Public Works (OPW) (1995): Recorded Monuments and Places: Co. Waterford. The Commissioners of Public Works in Ireland. National Monuments and Historic Properties Service.

O'Hagan, A.M., and Cooper, J.A.G. (2002): Spatial variability in approaches to coastal protection in Ireland. *Journal of Coastal Research, 36, 544-551.*

O'Meara, M. (1983): Tramore Back Strand and Sand Dunes; Its present and future. Irish Wildbird Conservancy. Dublin.

Orford, J.D. (1992): Environmental Understanding necessary for coastal planning in Ireland: sea-level change and coastal response. School of Geosciences, Queen's University Belfast. Occasional Papers.

Pilkey, O. (1981): Geologists, engineers and a rising sea-level *Northeastern Geol., 3, 150-158.*

Punch Michael & Partners, (1990) in association with John O'Flynn, Report on Coastal Defences 1990, Waterford County Council.

Quigley, J.P. (1946): Sea Encroachment at Tramore. Institute of Civil Engineers Bulletin, Dublin.

Quinn, A.C.M. (1975): Proposals for the Burrow Nature Trail In Tramore, Co. Waterford. An Foras Forbartha.

Swift, L. J., Devoy, R. J. N., Wheeler, A,. J., Sutton G. D., and Gault J. (2006) Sedimentary Dynamics and Coastal Changes on the South Coast of Ireland, Journal of Coastal Research, SI 39, Proceedings of ICS 2004.

Tissot, C., Le Tixerant, M., Gourmelon, F. and Le Berre, I. (2004): Modeling interactions between human activities and coastal zone environment. Proceedings Volume 1. *Delivering Sustainable Coasts: Connecting Science and Policy. Littoral 2004.* Cambridge Publications.

Waterford County Council: Instruction to Tenderers (November 1996) Tramore Coastal Defence Emergency Work.

Waterford County Council: Tender Assessment (November 1996) Tramore Coastal Defence Emergency Work.

Waterford County Council: Tender Documents (November 1997) Tramore Coastal Defence Promenade Site Investigation (Job No. 3036).

Waterford County Council: Instruction to Tenderers (September 1997) Tramore Coastal Defence Cliff Protection Works.

Waterford County Council: Tender Assessment (October 1997) Tramore Coastal Defence Cliff Protection Works.

Waterford County Council: Tender Documents (November 1997) Tramore Coastal Defence Sand Dune Management.

Waterford County Council: Tender Assessment (November 1997) Tramore Coastal Defence Sand Dune Management.

Waterford County Council (1997): Photographic Report on the Coastal Protection Works at Tramore in 1996/1997.

APPENDIX 1: Questionnaire Survey

Location: Date: Time:

(1)(a) Are you? **(b)** For how long?

Visitor ☐ _____ yrs.

Resident ☐ _____ yrs.

(2) In terms of the recent development(s) in Tramore do you consider them to have been:

Beneficial ☐ Harmful ☐

Regressive ☐ Progressive ☐ (caused no noticeable change) ☐

(3)(a) How do you use the Tramore beach area?

Water sports/ activities ☐ Quad biking ☐

Horse riding ☐ Walking ☐ Other ☐

(3)(b) If so, where?

The Dunes ☐ Newtown ☐ Western end of the beach ☐

The Backstrand ☐ The Pier ☐ Other ☐

(4) Are you familiar with the concepts of sustainable development?

Very familiar ☐ Very unfamiliar ☐

Familiar ☐ Relatively Unfamiliar ☐

(5) On a scale of 1 – 10 how important is the beach to Tramore?

Environmentally ☐ Economically ☐ Socially ☐

(1 being least important and 10 being the most)

(6)(a) Are you aware of coastal erosion and shoreline change in the area?

Yes ☐ No ☐

(6)(b) If yes, which areas in particular have changed and over which time scale?

	0 – 10	10 – 20	20 – 30	>30 Years
Beach	☐	☐	☐	☐
Dunes	☐	☐	☐	☐
Backstrand	☐	☐	☐	☐
Other, please specify:	☐	☐	☐	☐

_____

(7)(a) Are you aware of the concepts of Integrated Coastal Zone Management?

Very aware ☐ Aware ☐

Relatively unaware ☐ Unaware ☐

(b) What is your knowledge of this subject?

_____

(8)(a) Are you aware the coastal area is managed at Tramore?

Yes ☐ No ☐

(8)(b) If yes, where have you noticed management and over which time scale?

	0 – 10	10 – 20	20 – 30	>30 Years
Beach	☐	☐	☐	☐
Dunes	☐	☐	☐	☐
Backstrand	☐	☐	☐	☐
Other, please specify:	☐	☐	☐	☐

_____

(9) On a scale of 1 – 10 how do you rate the level of public involvement in local development?

☐ (1 being least important and 10 being the most)

(10) On a scale of 1 – 10 do you feel that you, personally, have a say in how your area is developed and managed?

☐ (1 being least important and 10 being the most)

APPENDIX 2: ENLARGED ANNOTATED AERIAL PHOTOGRAPH OF TRAMORE

APPENDIX 3: TRAMORE GIS USER INSTRUCTIONS – ARC READER

System Requirements

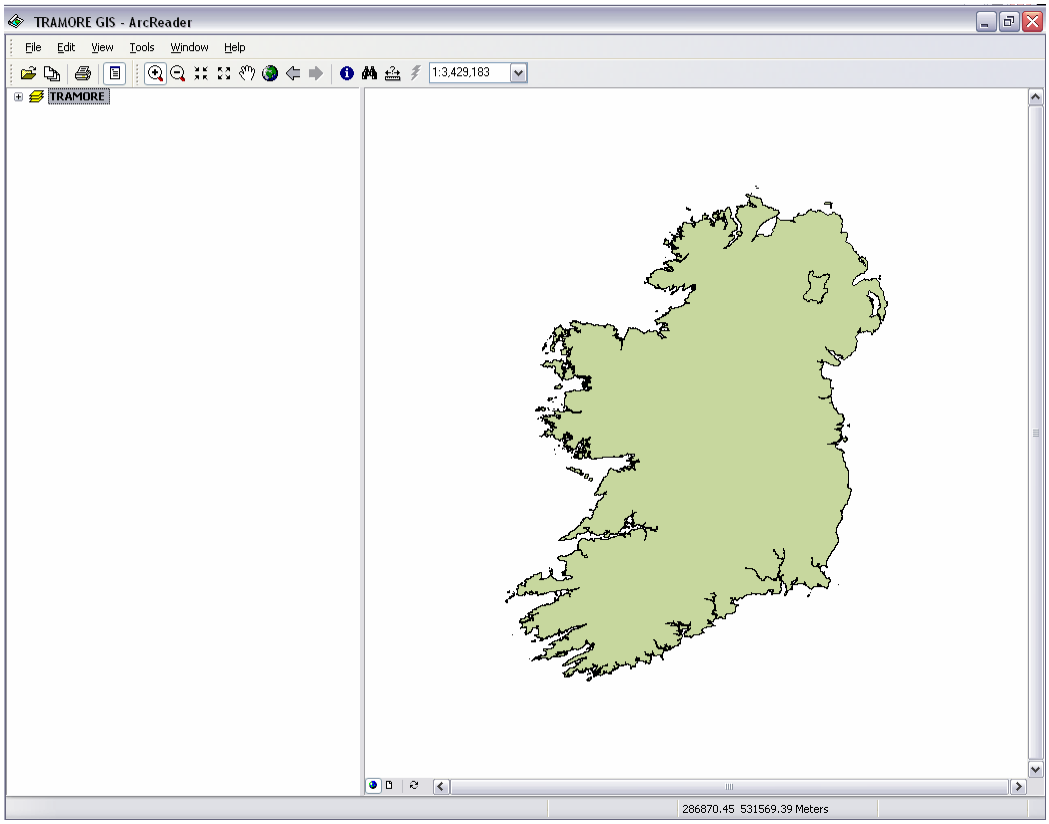
Drive	**CD or DVD**
Platform	**PC**
Operating System	**Windows Pro or XP**
Memory	**256 MB minimum, 512 MB recommended**
Processor	**450 MHz**
Disk Space	**200 MB - In addition, up to 50 MB of disk space maybe needed in the Windows System directory (typically C:\Windows\System32).**

GIS Visualisation

- The required software ESRI's ArcReader is contained on the CD accompanying this report.
- Double click on the setup icon within the ArcReader folder to initialise installation – note if you already have ArcMap installed you may not need to install this software.
- If you having problems installing the software then please consult the following website: http://www.esri.com/software/arcgis/arcreader/index.html
- Once ArcReader is installed, double click on **Tramore GIS.pmf** or open ArcReader and navigate to the **Tramore GIS.pmf** file on the CD.

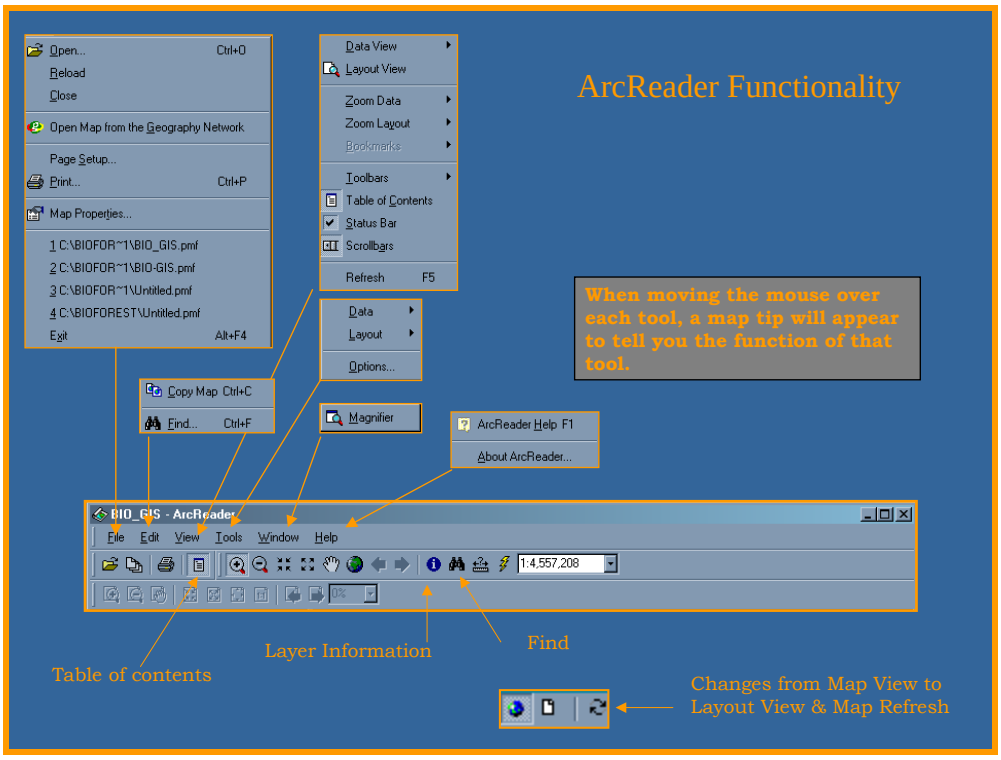
ArcReader Instructions

- Once opened the **Tramore GIS.pmf** ArcReader should appear as shown below:.

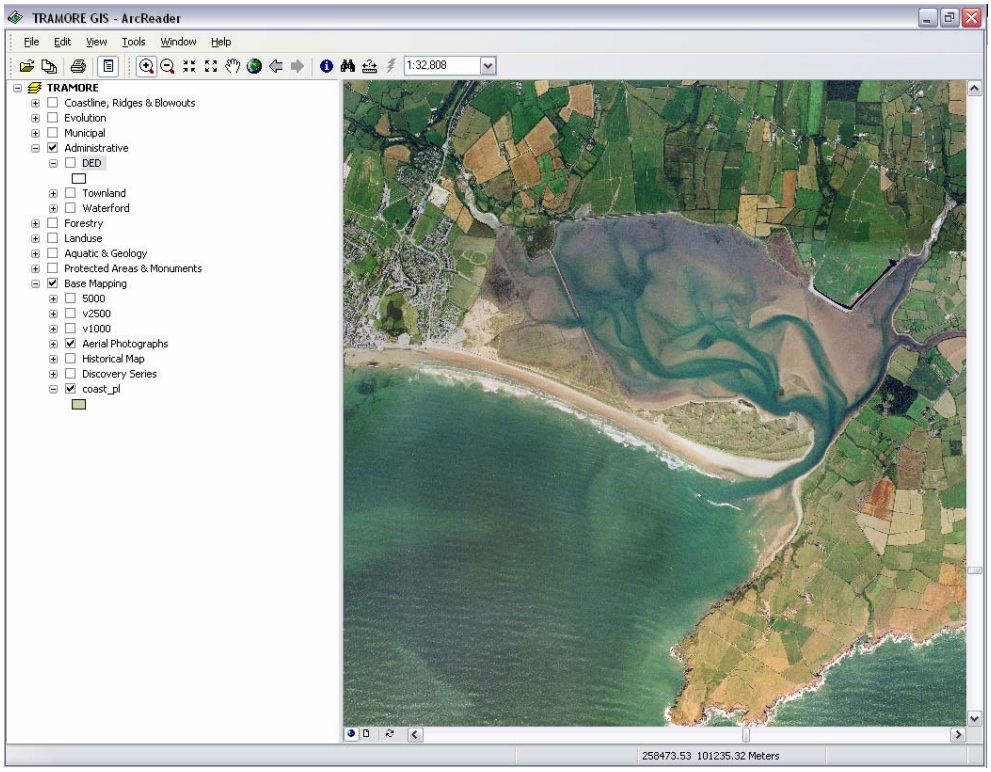


- On the left hand side a Table of Contents allows the user to choose which layers to access.

- Descriptions of the toolbars and functionalities are given below.



- To turn on a layer tick the appropriate box within the table of contents, (on left hand side), as shown below:



- Further information may be obtained using the ArcReader HELP menu.