Hamelin Bay Jetty

A study of the Hamelin Bay Jetty

Above: Hamelin Bay Jetty 2001. Photo: Colin Cockram
Watermark: Cape Leeuwin (Hope,1898b:47)

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Thesis submitted for the degree of
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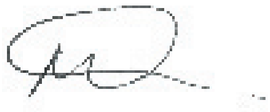

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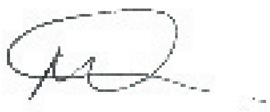

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Abbreviations

AIMA	*Australasian Institute for Maritime Archaeology.*
CSO	*Colonial Secretary's Office.*
CSV	Comma Delimited File Suffix.
ICN	*Inquirer and Commercial News.*
IJNA	*International Journal of Maritime Archaeology.*
MAAWA	Maritime Archaeological Association of Western Australia.
MADWAM	Maritime Archaeology Department, Western Australian Maritime Museum.
RWAHS	*Journal of the Royal Western Australian Historical Society.*
SUHR	Society for Underwater Historical Research.
SWN	*South Western News.*
TWM	*The Western Mail.*
UNESCO	*United Nations Educational, Scientific and Cultural Organisation.*
UTM	Universal Transverse Mercator.
WA	*Western Australian.*
WAGG	*Western Australian Government Gazette.*

Abstract

The Hamelin Bay Jetty was a culmination of one man's driving need to succeed in business. Maurice Coleman Davies originally of English birth moved to Tasmania with his family to start a new life. Davies then embarked on a career that would lead inexorably to the domination of the timber trade from south-western, Western Australia. Furthermore, his civil constructions have survived many years after his demise. These include jetties, mills, a lighthouse and general works (Heritage Council 1993:5).

Jetties in Australia have been studied infrequently and therefore modest archaeological data is available concerning these structures compared to shipwrecks. To advance our knowledge of the jetty resource more investigation should be conducted on these structures. Studies should not just focus on the historical but also incorporate archaeology such as formation processes and systematic surveys of remaining structure and artefact deposits.

This thesis has focussed on researching and analysing information derived from historical data on Hamelin Bay, legislation and control of jetties in Western Australia. From this information an archaeological analysis of the remaining structure of the Hamelin Bay Jetty and an analysis of site formation processes is attempted. These analyses are discussed in relation to Hamelin Bay and jetties Australia wide. Also, a comparison of survey techniques has been used to map the physical remains of the jetty structure providing insight into problems with jetty surveys and possible ways to survey a similar structure. Surveys have incorporated a range of techniques including, photographs of the structure for *PhotoModeler*, tape trilateration surveys and a plane table survey. Timber sampling was an aim but could not be completed due to time constraints. All accumulated survey data has been processed using specific programs, for example, *Site Surveyor*, *PhotoModeler* and *ArcMap*.

This thesis provides information on the jetty structure and its degradation. It also allows ideas or techniques to be further developed into the future. Results from this study have highlighted deficiencies in the survey of jetty structures and possible ways that these might be overcome in the future employing either the same techniques or using more technology. It also concludes that there are a significant number of site formation processes acting on jetty structures that must be understood before disturbance work commences. A lack of legislation in Western Australia is also a problem for jetty sites. The minimal legislative framework for jetties is evident by the number of structures currently protected.

Acknowledgements

This thesis would not have been possible without the help of certain individuals and volunteer groups.

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Chapter 1. Introduction and jetty significance

1.1. Introduction

This study focuses on one particular jetty site of the many that dot the Western Australian coastline. It is a compilation of information gathered from archival sources, registers and archaeological investigation. It investigates one particular site: the Hamelin Bay Jetty, a jetty that was a private reaction to develop the burgeoning trade of the region, and compares it to other jetties in Australia. During this period, the region was being exploited of hardwoods by entrepreneurs, in particular Karri (which was relatively unknown), and Jarrah (well known in overseas markets).

This thesis in addition to compiling a comprehensive study of the historical aspects of the jetty and the region, has also explored the archaeology of the jetty structure and how it has transformed into its current condition, by investigating site formation processes and survey methods. Furthermore, it has examined existing legislation for jetties in Western Australia and its effectiveness.

Various sources have been utilised to prepare a comprehensive account of the Hamelin Bay Jetty. This has included determining the number of vessels visiting the port and their purpose. Investigation into the development of the timber trade; illustrated how Davies influenced that trade by developing his mills and industry. The comprehensive study of the historical records provided significant information to develop a complete account of the Davies family and their industry.

Archaeologically, minimal work has been conducted at Hamelin Bay until recently. The Maritime Archaeological Association of Western Australia (MAAWA) has been involved in the survey of the remains and has accomplished most of this survey using either tape trilateration or plane table. This thesis has built on those surveys compiling a survey of most of the remaining structure. This allowed the writer to attempt to tie all survey results to each other. From the surveys it was not possible to determine the point where the jetty built during stage one ended and stage two (or the material used in its construction) began. Tape trilatertion was used as the survey method for most previous surveys; new surveys were then added to these and data the processed using computer programs. This developed a survey that was overlaid onto charts and an aerial photograph. Timber sampling was planned but this was not undertaken due to time constraints; therefore it has not been possible to determine the construction material of the jetty. The bay itself, weather conditions and cultural factors have been analysed to determine the site formation processes of the jetty, what has occurred and what will possibly be the result if the jetty is left without any protective or restorative measures.

1.2. Jetty Significance

The use of jetties around Australia (not only Western Australia) was important to its colonies thriving. Davies' exploitation of Karri in Western Australia was the first development of the Karri export industry in Western Australia. Until this time Karri had not been exported on a major scale because other timbers, for example, Jarrah, were the staple export. Davies' new enterprise led to a thriving export industry within Western Australia to interstate and overseas markets. The number of vessels visiting the port was significant (surpassing some larger ports in exports), as the value of eucalyptus species was well known. Construction of the jetty would have been based on the number of vessels, its geographical location, lie of the seabed and distance to resources. Transport during this period was largely by sea, and it is this factor also, that makes Hamelin Bay and its jetty significant not only to the people of Hamelin Bay, but also to the wider community. Davies' empire influenced the timber trade during a period when other ports were deemed more important (for example, Rockingham) (Fall 1972:135). The enterprise constitutes a significant period of the regions' history including the development of settlements, population growth and trade as well as influencing other competing businesses in Western Australia. This significance has been attributed to other jetty sites in Australia for example the Holdfast Bay Jetty and the Fremantle Long Jetty. The Holdfast Bay Jetty was ascribed similar attributes including its influence in the growth of South Australia and Glenelg (location of the jetty) as a suburb (Richards & Lewczak 2002: 19).

Archaeological and historical investigation is integral in understanding the role jetties played in influencing the social and economic state of their communities. It is also salient to add that a site like Hamelin Bay has essentially no monetary value for the current government and as a result has fallen into disrepair, becoming more of an eyesore than an attraction (see Figures 1 & 2). It is therefore important to record these structures before they degrade further so that comparative studies can be developed (Ford 2000:166). Jetty sites can also provide information on construction methods, and processes by which jetties develop into their current form.

Figure 1. Remains of Hamelin Bay Jetty 2004. Photo: M. Gainsford.

Comprehensive studies of jetties in a historical and archaeological sense will bolster the information already existing. This study of the construction, site formation processes and methods to record the Hamelin Bay Jetty has been initiated, but should be expanded to illuminate generalities relevant to other sites in Australia and overseas. Although jetties may be slightly different from each other, and each of their environments and uses different, general conclusions can be drawn by the archaeologist. Jetties as a complete unit have not been studied to the same degree as shipwrecks or other maritime sites, but from archaeological studies more inferences and data can be generated to increase awareness of jetty sites and their importance as a cultural resource for understanding past human behaviour. There are a number of processes affecting jetties that can be identified and quantified; the ramifications of these provide a more diverse understanding of jetties in general. The site formation processes from its construction to present day can provide a model for broadening information on jetty construction, degradation and the behaviour of humans in the use of their constructions. Many site formation processes have affected the Hamelin Bay Jetty for example:

> ... heavy seas smashed the remains of the old Hamelin Bay Jetty. At the turn of the century sailing ships tied up at the jetty load timber from the mills. Local people said the storm was the worst in 30 years (*WA*, 9/6/1961:7c).

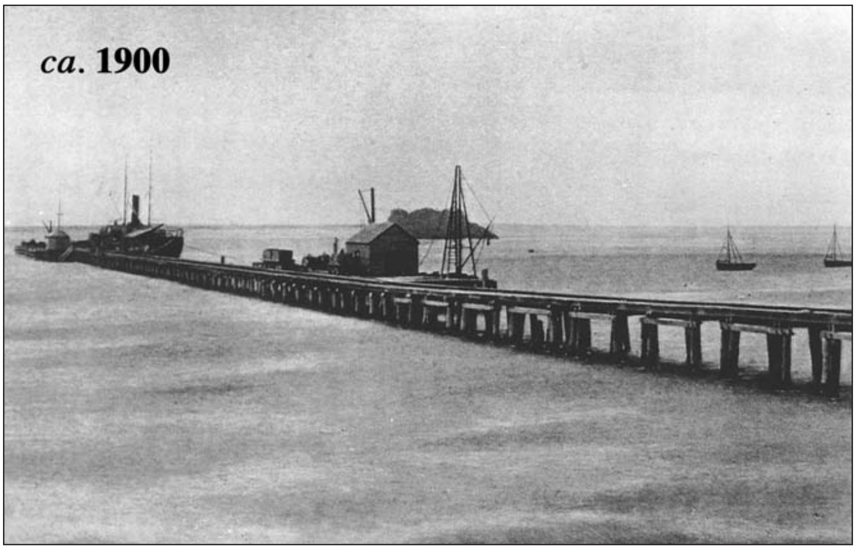

Figure 2. Hamelin Bay Jetty *c.* 1900. Photo: courtesy of MAAWA.

This study will determine if the historical record can provide enough information on the site and its structure and, if archaeology can fill any holes. Researched and developed information can be inferred to jetty sites as a complete unit. The result will be a detailed account and survey of the Hamelin Bay Jetty that can provide more insight into jetty structures and their history in Western Australia and Australia.

Chapter 2. Literature review and research questions

2.1. Literature review

A number of sources were consulted during this study establishing a comprehensive account of information pertaining to the Hamelin Bay Jetty. Sources utilised were the Department of Maritime Archaeology Library, Western Australian Maritime Museum; local information from Hamelin and Flinders Bays; Western Australian State Library; State Records Office; National Archives; *Australasian Institute of Maritime Archaeology* (*AIMA*) journals; *International Journal of Nautical Archaeology* journals (*IJNA*); a thesis by Julie Ford (1993); personal communications with Maritime Museum staff and MAAWA members, and the Fremantle Public Library (local history section). Through this comprehensive search, all relevant information regarding the Hamelin Bay Jetty was located. Once accomplished this information was correlated and developed for presentation in this thesis. The information gathered not only focused on the jetty itself but incorporated a wider scope, including the history of the region, developments derived from the jetty usage, jetty constructions and their use, site formation processes and surveying techniques used for surveying archaeological sites.

Compared with shipwreck sites, there is a paucity of definitive work on jetties in Western Australia. The Department of Maritime Archaeology, Western Australian Maritime Museum has references and site reports for some jetties but the majority still have little or no published material. The most comprehensive archaeological reports come from the Albany Town Jetty and the Long Jetty, Bathers Bay, Western Australia (Garratt 1993; Garratt *et al.* 1994, 1995; McCarthy 2002). Other Western Australian studies are either mainly historical (Cumming *et al.* 1995) or inspection reports (Garratt 1993a, 1993b, 1993c, 1993d). Information from other jetty sites was also included to advance this study. These reports or theses were mainly provenanced from South Australia as jetties there have been subject to more comprehensive studies (Ford 2000; Richards & Lewczak 2002; Rodrigues 2002a, 2002b). Other works that relate to jetties are at a different level, referring to them as either recreational structures or allude to their importance for immigration and trade (Adamson 1977; Bach 1982; Bainbridge 1986; Broeze 1984, 1998; Fall 1972; Stannage 1981).

Development of site formation processes have concentrated on the shipwreck. Most material available on disintegration theories and survey use the shipwreck as a model for study. Formation theory does not seem to be as concerned with jetty sites compared with other archaeological sites (Muckelroy 1978; Schiffer 1983, 1987; Ward *et al.* 1998). The writer sought to identify site formation processes by consulting relevant literature and then to mould theories to Hamelin Bay. Through coastal and biological formation and archaeological theory, better developed processes can be established (Komar 1998; Pearce 1992; Pearson 1987; Yang 2003). Surveys of jetties can be difficult because of their size and accessibility. Relevant information was read to determine the best method and comparison methods for surveying a jetty site which was applied to the Hamelin Bay Jetty (Dean *et al.* 2000; Green & Gainsford 2003; Holt 2003).

Jetty construction information was difficult to source. Most information concentrated on modern techniques and techniques other than wooden pile construction (Du-Plat-Taylor 1928; Quinn 1972). Most information available in the historical record relates to the structure and the amenities that adorned it but make no mention of its construction, or techniques used in its construction (Clark 1986:7; Fall 1974:127–154; Hope 1898:56; Ridgway 1988:32–33). This is perhaps sufficient information to make inferences: but conclusions are substantially more difficult to draw without more research focusing specifically in this area.

Legislation pertaining to jetties in Western Australia and Australia was also examined. Legislation that applies to these structures is minimal and somewhat variable (Department of Culture and the Arts 2003; *Heritage of Western Australia Act 1990*; *Historic Shipwrecks Act 1976*; *Maritime Archaeology Act 1973*). These legislative frameworks provide a concession for maritime archaeological sites to be buried but do not provide significant power to protect jetty structures.

Historical information relating to the Hamelin Bay Jetty was relatively easy to locate, although some resources (including statistical information) proved difficult. Especially difficult was determining numbers of vessels arriving and departing Hamelin Bay and information on construction techniques used to build the jetty.

Information gathered by the author was sufficient to answer most questions and to suggest further studies. Information on the construction of the jetty and jetties of this era was limited and therefore paints an imperfect picture and inferences had to be made. Historical information is more complete concerning the structure although there remains gaps in important areas, which is not surprising. This information was enough to build up a précis of the site, the surrounding infrastructure and a large amount of information about the timber industry and its population, but not a complete image of the structure and its construction.

Site formation studies and surveys are quite involved processes. Literature on these was broad and had a shipwreck-dominated focus. These two sections are relatively complete although further on-site studies must be commenced to further determine the nature of jetty site formation processes and to detail the remains on the seabed.

2.2. Research questions

Jetty sites have been studied in less detail as a complete set of archaeological structures than shipwrecks. Jetties studied, have been mostly examples that are deemed to have high importance to the public or archaeologists; or jetties that have been under threat, for example, the Albany Town Jetty and the Fremantle Long Jetty.

This thesis will develop an interpretation of the Hamelin Bay Jetty as an archaeological structure and how the site has developed into its current state. The structure, the artefacts remaining at a site and the environmental conditions all determine how an archaeological site is perceived, the level of interest generated, the amount of archaeological work performed and the rate of degradation of the remaining structure. It is the writer's perception that inferences drawn from this study of the Hamelin Bay Jetty are both independent of and connected with studies of jetties both in Australia and world-wide. Hamelin Bay can be used as a case study, which has extensive implications about jetty degradation.

The writer will attempt to investigate:

If the historical background of the Hamelin Bay Jetty through available resources can provide enough information on the Hamelin Bay Jetty in terms of its structure and uses, or does it contribute to the historical setting only?

Site formation processes and construction of the jetty: do these processes need to be analysed to determine how jetty structures degrade in the marine environment. Most literature is shipwreck dominated and therefore inferences have to be made linking formation processes to jetty sites. In analysing the formation processes at Hamelin Bay the information can add to the body of literature on similar structures.

Site recording methods for jetty survey: the remains of the jetty have been mapped using different techniques. The methods have been analysed and commented on providing information on jetty survey. Other techniques are also detailed to further enhance how a jetty could be surveyed and plotted. There is also reference to a number of amenities (storehouse, cranes, fresh water pipes, rowing boats etc.) provided on the jetty, surveys could determine their extent and nature (*Countryman* 13/7/1961:11).

Other studies that have been conducted of jetties or port-related structures around Australia for similar reasons. Examples of these are: Western Australia, Albany Town Jetty & the Long Jetty and South Australia, most notably the SUHR excavation of the Holdfast Bay Jetty. Investigations of such structures has yielded a significant amount of information about human culture (Cumming *et al.* 1995; Garratt 1994; McCarthy 2002; Richards & Lewczak 2002; Rodrigues 2002a, 2002b). All of these studies can be interlinked allowing researchers of other jetties to draw on information and to impart their own knowledge and studies on other sites.

Jetty sites are archaeological sites of both State and National importance. Greater information is needed to build a knowledge bank of data on these structures, their environments and the formation processes involved from their construction through to the modern day. Jetty sites were used before major rail networks and the explosion of mass transport (when shipping was the dominant form of long distance trade until around the middle of last century) (McCarthy 2002). In the process of studying Hamelin Bay a series of questions need addressing to further our understanding of jetties, their construction and site formation and to develop a model for these processes. Furthermore, the protection of jetty sites needs addressing and the ramifications of current legislation to this site and by extension all sites, understood in depth to further develop their protection and integrity for the future.

Therefore the question that has been endeavoured to be answered is:

How can jetty structures be studied, surveyed and legislated for within the maritime archaeology framework, using the Hamelin Bay Jetty as a case study: can such a study add to the minor body of literature on jetty sites and their formation?

Secondary Questions

What information is accessible pertaining to Hamelin Bay and jetty structures in the broader sense. Can this information impart knowledge towards the archaeological record or merely set the scene for archaeological investigations?

Is the construction of Hamelin Bay Jetty that of normal timber pile jetties and how did this influence its degradation and the remains of the site today?

There is a poor understanding of jetty formation processes—investigation of the Hamelin Bay site to further develop jetty site formation processes; to identify the processes directly related to Hamelin Bay, and what structure remains as a result of these?

Site recording procedures—what methods can be utilised in jetty survey? These will be detailed and commented on comparing results and effectiveness. The remains of jetty structures if surveyed accurately provide a benchmark for further studies at the site.

If jetties are to be considered a source of archaeological importance, how they are legislated for must be addressed. The writer will identify and describe legislation relating to jetties in Western Australia. Can these structures be easily legislated for?

Chapter 3. Methodology

3.1. Introduction

The jetty at Hamelin Bay has been a focus of the amateur maritime archaeology group MAAWA for the last few years. It was decided by the writer to help MAAWA collate their data into a comprehensive format that included previous data and data acquired through the duration of this thesis. MAAWA has been included in all fieldwork with previous MAAWA survey data submitted to the writer for incorporation in this thesis. The focus was to complete a survey of the site and to gather as much data as possible regarding the jetty and its structure.

3.2. Survey overview

Four distinct zones identify the Hamelin Bay Jetty. The first resides in the terrestrial environment and the other three in the marine environment. MAAWA have concentrated the majority of their surveys on all remains of the jetty that are above the low water mark. Original surveys concentrated on both submerged and non-submerged piles, but the focus of this thesis is piles that are proud of the surface at mean low water (Gilman, J., 2004, pers. comm., February).

All sections that have been previously outlined—i.e. all four sections have been surveyed to date (the first two sections were amalgamated for the survey)—have had their piles breaking the surface surveyed. All piles that could be surveyed from the surface of the three marine sections were plotted using either least squares trilateration or plane table (Dean *et. al.* 2000:162–170; Green & Gainsford 2003:256). This created a two-dimensional layout of the jetty piles above the surface at low water. However, this did not take into account the piles that lie on the seabed and there is future work planned to cope with this issue.

MAAWA has determined with relative accuracy the position of most piles, where they lie in relation to each other and the basic extent of the jetty. This work has provided sufficient information to constitute a survey of these jetty sections. Although it does not include all piles, it does incorporate the majority of visible jetty remains. The writer has been working to determine the extent of MAAWA's survey to date compiling data and incorporating the following methods to present a survey that is both representative and informative.

3.3. Survey Techniques

A variety of techniques were utilised during the study of the remains of the Hamelin Bay Jetty:

- Detailed manual tape surveys of the remaining structure above the waterline with data manipulated and processed using *Site Surveyor*, then linked with GPS readings taken during the survey for processing in *GIS* (*ArcMap*);
- A plane table survey of the piles above the waterline; and
- A series of photographs, both head on and oblique, using digital cameras both on land and in the water used to construct a model of the structure that remains on land, using *PhotoModeler*.

3.3.1. Tape trilateration

Tape trilateration uses measurements referenced to a baseline that runs adjacent to, or through a site being surveyed. Tape measurements are taken from two, three, four, or more points along the baseline to a feature on the site. This allows the surveyor to obtain an accurate position of the feature with some redundancy. In this case, the decision was to conduct a trilateration survey using an inter-point trilateration method instead of a baseline. Inter-point tape trilateration allows each point to be referenced to a series of other points in a survey matrix. Therefore, each point has measurements from it to other points in the network forming a series of triangles. This allows the surveyors to obtain a two-dimensional fix on a point with a great deal of accuracy. A minimum of three or four points should be measured to other points to lock them into the survey grid and provide accurate results (Green and Gainsford 2003:256–257).

3.3.2. Plane Table Survey

Plane table surveys are excellent for large-scale surveys. The equipment consists of a levelled board and an alidade (sighting device) that can pivot on the table. This system is set up by levelling the board over a known position with the use of a plumb-bob. This first point represents one end of a baseline. The table is set up again at another known point exactly as above and this point forms the other end of the baseline. Direction of magnetic north is also recorded and therefore the surveyors can begin. A surveyor moves out from the table to a point to be measured with a ranging pole and a tape measure. The plane table operator marks along the pivoted alidade with a line, and the distance is recorded with the use of a scale ruler. This is repeated for all measurable points and then repeated from the other control point at the end of the baseline. This allows the surveyors to establish a series of intersecting lines of sight for all measured points and develop a plan of the site (Dean *et. al.* 2000:169–170).

3.3.3. *PhotoModeler*

PhotoModeler software allows the user to develop a series of three-dimensional points for a survey using photographs taken with a calibrated camera. The method is to identify what exactly is needed to be included in the photographs. A series of photographs should be acquired with a calibrated camera (camera calibrator in *PhotoModeler*) to provide a series of oblique angle images. This means that at least eight as close to orthogonal (*c*. 45°) photographs must be taken (one of each side and one of each corner). These photographs should also be taken from above the horizontal to capture the top of a structure also. This does not limit the user to eight as more photographs can be acquired. Once the images have been downloaded they are imported into the *PhotoModeler* software. The software allows the user to identify targets on one image and then cross-reference these to all other images. The result is a series of images with points cross-referenced to each other. *PhotoModeler* can then calculate the positions of these points in three-dimensional space (Green & Gainsford 2003:257–258).

3.3.4. Timber Sampling

Timber sampling of a jetty structure involves choosing a selected or random sample set of piles for sampling. Random or non-random samples are obtained using a wood saw and then transported to the laboratory. Samples can establish whether a structure was built of different materials or built during different stages: evidenced from the grain pattern or the amount of relative wood degradation of the sample. Samples must have suitable stable wood remaining to provide an accurate analysis (Carpenter, J., 2004, pers. comm., March).

3.4. Hamelin Bay Jetty Survey Methodology

3.4.1. Plane Table Survey

The shore section is broken into two distinct areas - a submerged section and a shore section. MAAWA have conducted a survey of the submerged section and the land section using a plane table. The method was to set up a baseline on the shoreline with two base stations 150 metres apart (base station N and base station S). Positions of piles were located, shot to and plotted for further analysis. Piles that resided in other sections were plotted on the survey also (Gilman, J., 2004, pers. comm., February).

3.4.2. Shore section

Complementary to the plane table survey, a three dimensional survey of the land section was completed. This involved using a previously calibrated digital camera (Camedia 4050) to take a series of photographs around the structure. Photographs acquired were as close to orthogonal as possible around the remains (about nine–ten photographs were recorded around the site). This incorporated side, corner and head on photographs taken from the cliffs (*c.* 25°–30° above horizontal) that adjoin the beach to the east of the site, and the water. Once photographs were obtained; they were imported into *PhotoModeler* and processed to provide a series of three dimensional points of the site. Dimensions for the site could then be obtained after the data was processed.

GPS positions of the piles were recorded to assist the process of orientating the survey for *GIS*. However, the GPS positions could not be directly input into *GIS* software from the GPS. The positions were converted into decimal degrees in *Geocalc* before addition to the *ArcMap* project.

3.4.3. Middle section

This section of the jetty was surveyed in one weekend of fieldwork. Fieldwork methods were similar to the survey of the end section. The number of piles in this section are fewer than the other two, therefore the survey was not too difficult to complete in the specified time.

Tape trilateration was the method for measuring piles into the network: the type of trilateration used was inter-point trilateration. This is because the low number of piles provided accurate measurements due to relatively low distances involved. Measurements taken from a pile were trilaterated to two–three others providing a series of measurements to a number of other piles. This information was input into surveying software (*Site Surveyor*) and the information further processed to be plotted on an aerial photograph using *GIS* software.

Snorkel and buoyancy compensator were used for the duration of the survey, with a small dinghy as a standby vessel in case of emergency. The time taken to complete the survey of the section was *c.* 2-3 hours and all piles were located and surveyed into the matrix.

3.4.4. End section

The end section of the jetty is perhaps the largest i.e. it has the most number of piles than any of the other three sections. The section begins some 400–500 metres from the shore and extends to the original extent of the remains.

SCUBA was not utilised for this survey, instead team members used mask, snorkel and buoyancy compensator (BCD) to stay afloat for the duration of the survey. Dinghys were utilised for transportation to and from the site because of its distance from the shore. The period taken to complete this section was two to three periods of fieldwork because of the large numbers of piles in this section of the jetty (Gilman, J., 2004, pers. comm., February).

The surveying method employed was inter-point tape trilateration. A baseline was run across the shoreward end of the piles. Once established, each pile was then surveyed (via inter-point trilateration) into the network. The area was split into two halves with a team on either side. Each team worked on their side of the site surveying all plies that were above the surface and submerged piles reachable by hand i.e., all piles measurable from the surface: this included submerged piles and piles that break the low water mark (Gilman, J., 2004, pers. comm., February).

Data for each half was collated and compiled onto an A3 piece of drawing film. Further processing occurred when the points and measurements taken, were imported into *Site Surveyor* to obtain an accurate two-dimensional layout of the site and an error of the total survey. This data when stitched together was unable to be georeferenced and overlaid on to an aerial photograph (see Figure 3) using *ArcMap* because of the poor results.

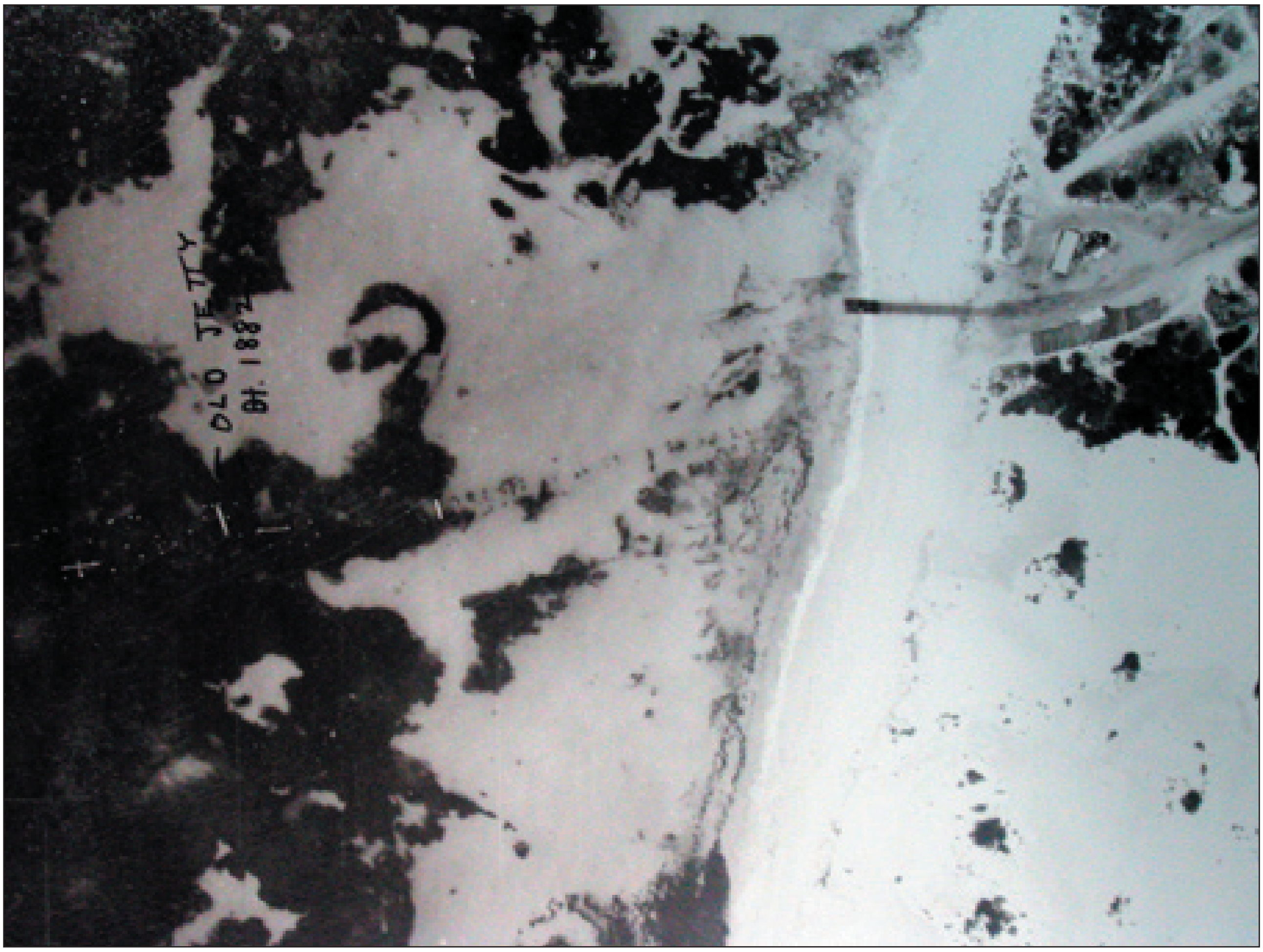

Figure 3. Aerial photograph of the jetty 1955. Photo: courtesy of Western Australian Maritime Museum.

3.4.5. Timber sampling

Argument exists about the material used for the construction of the jetty. It is undecided if the jetty is constructed from Karri or Jarrah. Both are hardwoods, extremely strong and would serve the purpose almost as well as each other. The process of timber sampling involves a selection of zones in which timber samples are taken for analysis. One sample at least has to be taken from each section so that a comparison can be drawn between all sections and to determine if different woods were used during the construction. Since the jetty was constructed in two phases a selection of timbers across all remaining sections incorporates all phases of the process. When sampling the timber it is necessary to acquire a sample that is not too degraded (i.e. with little or no solid timber remaining). Since the problem with timber degrading in the marine environment is unavoidable the use of a timber probe decreases the chance of a poor samples being chosen. Samples are acquired by hand-saw and taken from either the surface or underwater as the situation dictates. Once samples have been acquired they will be presented to the Western Australian Maritime Museums, Materials Conservation Department for analysis and speciation.

Due to time constraints timber sampling was not completed. It is a goal of MAAWA and the writer to complete this in the future.

Nota bene: All fieldwork disincluding fieldwork in 2004 has been under the leadership and guidance of MAAWA whom have been conducting this survey as a private project. The author has used data from all MAAWA surveys as well as data gathered in 2004 for the production of this thesis, with the express permission of MAAWA.

Chapter 4. Historical Background

4.1. Historical Background

Before the time of Eldridge and Davies (William Eldridge and Maurice Coleman Davies at different times promoted the export of hardwood timbers from Hamelin and Flinders Bays), the south-west region was relatively remote. Flinders Bay was first settled in 1830, at the mouth of the Blackwood River (Augusta). This area provided shelter desperately needed from the westerly gales that dominated the winter. During the fifty years up until its use as a major port, there is no mention of the regions' use by vessels to either berth or trade (Ridgway 1988:31). Eucalyptus forests mainly comprised of Karri and Jarrah dominate the region. This was a major motivation for businessmen to settle and exploit the area.

Hamelin Bay is located in the south-western part of Western Australia. It lies south of Margaret River and north of Cape Leeuwin. Its position is latitude 34°13' south and longitude 115°02' east. Flinders Bay was also part of Davies' enterprise and is located slightly south of south-west of Hamelin Bay, forming part of Cape Leeuwin on latitude 34°20' south and longitude 115°10' east (see Figure 4).

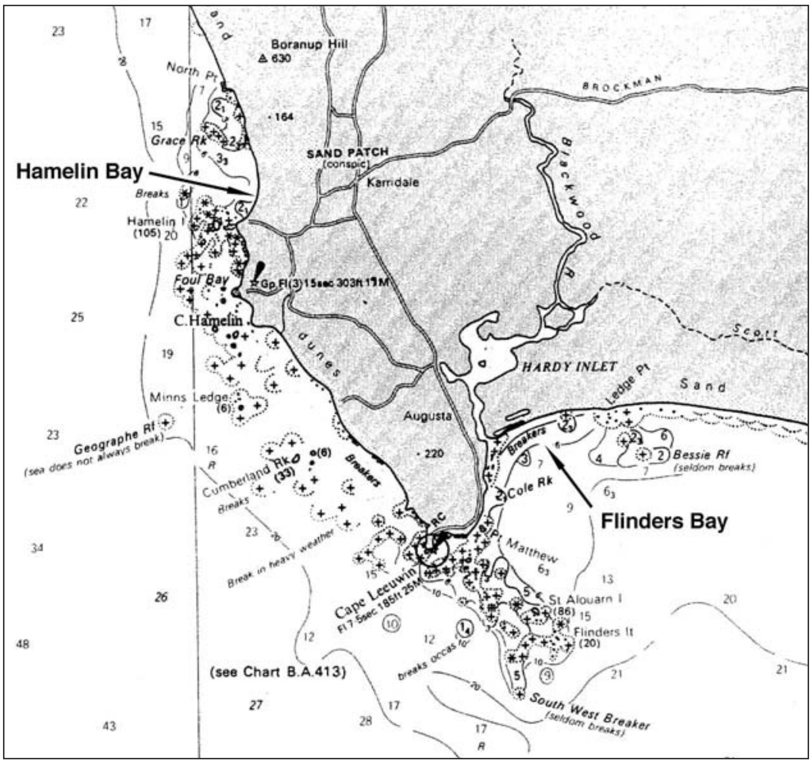

Figure 4. Chart excerpt showing both, Hamelin and Flinders Bays (AUS 335).

The jetty at Hamelin Bay represents a period in Australian history when transport by road was, at best, poor. Long distances, degraded roads and a limited railway system encouraged the extensive use of jetties (Fall 1972:127). Transport by seagoing vessel for trade was simpler and more cost efficient than land transport: evidenced right around the coast of Australia during this period (*c*. 1860–1920) for both trade and travel (Broeze 1984:1–5; 1988:117–118). People, exports and imports mainly travelled via the water. This combination of use and material culture at jetty sites offers us an important insight into the economic, and social structure of early Australian society during this period (McCarthy 2002:

8). Furthermore, jetties were constructed for ease of transport to and from their product markets (Ford 2000:2–3).

The timber trade in Western Australia thrived during the late nineteenth and early twentieth centuries. As a significant amount of timber was exported (to satisfy the high demand for this product) the need for jetties increased. This is an important subject of study because little of these structures remain today (Fall 1972:166). In the case of Hamelin Bay minimal archaeology has been undertaken on the structure of the jetty. Due to its deteriorating condition, there is need for increased archaeology and investigation before it totally degrades. The increased trade of hardwoods helped build a community in an otherwise remote area (Fall 1972:135). The Hamelin Bay jetty is an important study area for a greater understanding of the hardwood trade to the history of the Western Australian colony. Studies include how these structures remain today, how they can be investigated and possibly protected in the future. Davies recognised the export potential of the region. This foresight combined with the outcomes of his success, represent a period in Western Australian history that was dynamic. During the short period that Hamelin and Flinders Bays were in operation there were substantial changes to the landscape and environment. Forest was cleared and there was a significant level of technology employed (for example steam locomotives, mills and cranes); made necessary by the scale of Davies' business.

During the middle to late nineteenth century, growth of timber exports increased (see Table 1). This increased demand for Western Australian hardwood allowed businessmen to further exploit the area of timber. Hardwoods were exported mainly to other colonies, for example, South Australia and Victoria, and overseas to South Africa and England. Most of the timber exported was hardwoods like Karri (*Eucalyptus diversicolor*) and Jarrah (*Eucalyptus marginata*) mainly for railway sleepers or paving blocks (*Journal of the Royal Western Australian Historical Society* 1929).

Toward the end of the nineteenth century hardwoods which thrived along the west coast of Australia were being continuously felled and shipped through Western Australia's major ports (see Table 2) (Clark 1986:4). In the south-west of Western Australia, Karri was one of the dominant species which grew fast and was of high quality (Hope 1898a:10–11). This trade could only be successful via strategically placed ports along the coast (Clark 1986: 4).

Port	***No. of loads***
Karridale (Hamelin Bay)	8,371
Rockingham	7,109
Torbay	5,212
Quindalup	1,438
All other ports	870
Total	**23,000**

Table 1. Timber export figures for 1890 (Fall 1972:109).

Ship numbers 1882–1885

Port	*Number*
Rockingham	65
Lockville	43
Hamelin (Karridale)	32
Quindalup	22
Total	**162**

Table 2. Ship numbers visiting ports in the south-west (Fall 1972:135).

The exploitation of Karri was not fully developed until Davies arrived in 1875 from South Australia (Ridgway 1988:31). Previously there had been an attempt to develop the timber industry by Eldridge in the region but this was unsuccessful (Clark 1986:4). Davies developed Karridale forest and built a series of mills that cut and processed Karri logs for export, both domestically and overseas (*Inquirer and Commercial News* 14/9/1881:2c). This included laying railway lines to establish easier methods for transporting timber to the jetty for export (*Herald* 7/5/1881:6f). Jetties were established in Hamelin Bay (7 May 1881, the approximate start date) and Flinders Bay (*c*. 1881, most probably later), Augusta (Garratt 1993d:6; Hope 1898:56; Research Note 433).

Eldridge had set up facilities to export timber from shore based facilities at Flinders and Hamelin Bays after he secured a timber lease in 1874 (Lands Title RM/BY 332). In 1875, he was listed in the *Western Australian Almanac and Directory* as, Manager, W. A. Timber Company, and in 1876–77 as Eldridge W. Timber Merchant. In 1877, he was granted a fourteen year lease for 75,000 acres to cut timber in the Augusta–Hamelin Bay District (Fall 1974:116). Many factors contributed to his demise especially competition from Davies. Some of these may have been beyond his control. A combination of inadequate resources coupled with misfortune halted his plans to fully develop the area. During this period, no insurance was available for either Flinders or Hamelin Bays. This coupled with the wrecking of vessels carrying his timber did not help matters with his creditors. There is also mention that Eldridge was reneging on his agreement for the annual payment of his license fee (£50) for his timber concession (Fall 1974:116). The combination of the above forced the relinquishment of his Special Timber Lease providing other entrepreneurs with an opportunity. The area that was covered by the lease was from north of Boranup to south of Karridale (Clark 1986:4).

Before Davies began his new venture he had settled in the area. He founded an estate at Karridale that was in close proximity to both Hamelin and Flinders Bays. At this time, Jarrah was a well-known export commodity, but Karri not so. Davies therefore would be the provisor for the Karri export industry (Spackman 196-?:1). He was already a successful businessman and had a considerable amount of experience in the timber industry. It was this reason that he settled in the area and applied for a Special Timber Lease (Clark 1986:4).

Davies' business was based on constructing (earlier, buying into) mills to exploit the region of its Karri timber. After hearing of untouched Karri forests in south-western, Western Australia, he secured a concession and built his first mill at Coodurup. The jetties at both Hamelin Bay and Flinders Bay were established to exploit this new industry. Four years later, a second mill established in Boranup was of the same capacity, however this mill was destroyed by fire in 1891. A final mill constructed in 1892 at Jarrahdene was the largest of the three mills. To cope with the mounting pressure a steel railway line had to be constructed to both harbours (*RWAHS* 1929:34). In 1897 the M. C. Davies Karri and Jarrah Co. was formed in London with a total capital of £250 000. Davies boasted to his competitors: *'it was mainly his timber that paved at least 200 streets in London'* (Spackman 196-?:6). Davies also established a thriving community that he cared for, clothed and fed. They had their own currency and Davies was required for a time to act as landlord (Hope 1898:53). The company thrived until a drop in timber prices forced the Davies into amalgamating with other companies in 1902, forming the Millars Timber & Trading Company (*Countryman* 13/7/1961:11).

Figures 5 & 6 show the two bays that were the ports for the M. C. Davies timber company and the M. C. Davies Karri and Jarrah Co. 1897 (Spackman 196-?:6).

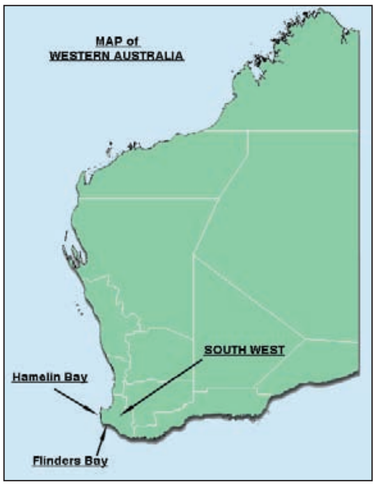

Figure 5. Map of Western Australia.

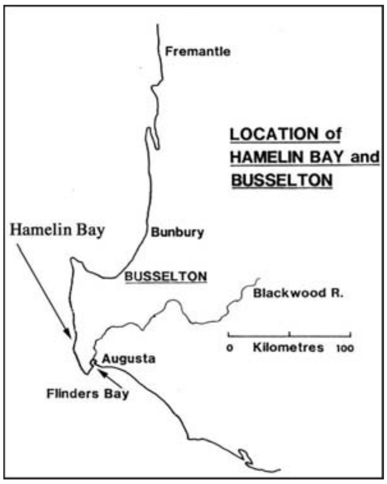

Figure 6. Location of Hamelin Bay (Hope 1898:30).

The rush to the Western Goldfields caused a population influx, with many workers leaving their jobs in search of gold. Labour became a problem: finding people to work the jetty and mills became difficult and labour had to be secured from the Eastern Colonies. Inter-colonial steamers therefore frequented Hamelin Bay regularly providing a constant source of immigrants and supplies (see Table 3). Even though the inner harbour was relatively protected by reef, and vessels had solid jetty and heavy swing moorings, there was still the factor of the detrimental weather from the north-west. In 1900, Herbert Davies was proved wrong when he claimed the inner harbour was safe in all weather. In the following year, six vessels were wrecked during storms (Ridgway 1988:33; Spackman 196-?:10).

Ships Wrecked at Hamelin Bay

Date	Ship	Tons	Flag	Detail
19 April 1882	*Agincourt*	443	Australia (SA)	Dragged anchor on to reef. Total loss.
4 July 1883	*Chaudiere*	470	British	Dragged anchors.
18 October 1884	*Greyhound*	231	Australia (Vic.)	Wrecked in gale.
25 September 1889	*Aristides*	399	French	Parted cables and driven on beach in gale.
28 September 1895	*Omeo*	——	British	Broke from jetty and driven ashore. Later towed to Fremantle.
4 October 1897	*Anna Marie*	——	Danish	Broke cables and grounded on rock. Later toed to Albany and became a coal hulk.
25 April 1900	*Arcadia*	571	Norwegian	Broke moorings to jetty and went ashore. Refloated.
22/23 July 1900	*Arcadia*	571	Norwegian	Broke mooring and went on beach.
22/23 July 1900	*Norwester*	547	Danish	Broke jetty moorings and driven ashore.
22/23 July 1900	*Lovespring*	566	Norwegian	Broke jetty moorings and sank.
22/23 July 1900	*Katinka*	843	German	Broke outer harbour and driven ashore with loss of five lives.
2 September 1900	*Else*	488	German	Wrecked on reef west of Hamelin Island.

Table 3. Ships from Fremantle to other ports wrecked at Hamelin Bay (Ridgway 1988:37).

By 1913, the timber industry had well entered decline. Combined with this most of the timber in the area had been felled. Hamelin Bay ceased to be a major port and the jetty fell into disuse. Since its demise as a regular port, it has been used as a popular fisherman's haunt. The construction was robust enough to last many more years until fire destroyed the majority of the structure. All that remains of the original structure are the piles (Ridgway1988:36). The jetty has been further altered by storms, for example, 1961: the worst storm in 30 years which removed most of the remaining structure (*South Western News* 15/6/1961:2a). Recently two channels have been created through the jetty with explosives, dividing it into three sections to assist navigation through the bay (Gilman, J., 2004, pers. comm., February).

Hamelin Bay Jetty played an integral part in the history of the area for around two decades in the late nineteenth and early twentieth centuries. It still plays a significant role of the areas' history although its uses differ somewhat from the original purpose for which it was intended. It has been modified by natural and cultural elements including ferocious storms and fire that have destroyed the majority of its structure (*SWN* 28/5/1959:12b; 15/6/1961: 2a). The remains of the jetty are also used for a number of recreational purposes including diving, tourism and recreational fishing; which is a main focus of, if not the dominant use for the majority of jetties today (McCarthy 2002:8).

4.2. Maurice Coleman Davies

Maurice Coleman Davies born in London, emigrated with his parents to Tasmania, Australia in 1840 (see Figure 7). After seven years the family moved to New Norfolk. After a successful period working the Victorian Goldfields, Davies moved with his family to Adelaide and started a business as a contractor and supplier of building materials (Heritage Council 1993: 5). In 1875, he moved to Western Australia (due to a lack of indigenous timbers in South Australia) and acquired 4200 acres of land in the Wellington District. In 1876 he expanded his interests acquiring shares in the 'Rockingham Jarrah Timber Company' which he studied noting their successes and failures (this venture was abandoned after two years due to poor access roads). Soon after, he acquired shares in the timber industry near to Karridale (see Figure 8). Eldridge had previously created gluts and shortages in the timber market and Davies realised the need for a regular and constant supply of hardwoods both domestically and overseas (Fall 1974:116; Ridgway 1988:31). However there is no direct evidence of Davies processing timber between October 1878, when he accepted the amended terms of a Special Timber Lease until he erected his first mill in 1881. Davies had proposed a Timber Lease of 70,000 acres for 50 years but was rejected by the Executive Council on 27 September 1879, but was eventually granted a lease of 46,000 acres for 42 years at £150 per year in 1882 (Winfield 1986:11). It is evident that Davies had already been negotiating with Eldridge for the sale of his machinery and unshipped timber. This precluded the need for Davies to construct a mill sooner because there was enough timber awaiting shipment (sold over three years) (Fall 1974:127).

Figure 7. Maurice Coleman Davies, (Winfield 1986:11).

Figure 8. Plaque commemorating M. C. Davies in old Karridale. Photo: M. Gainsford 2004.

Davies was a man renowned for his foresight and business sense:

> I hear also that most energetic gentleman Mr. M. C. Davies has begun to lay down a tramway, which will run from the lakes to the beach at Port Hamelin. A jetty also is about to be built there, which will be of great use to those who visit the port. I believe that Mr. Davies has his intentions of soon extending his tramway some five miles inland, as far as Borunup (*Herald* 7/5/1881:6f).

In 1881–3 Davies constructed the Coodurup mill and started constructing the Hamelin Bay Jetty because of the resultant increase in output. Another larger mill was also built at Karridale in 1884. As a contractor, Davies was also responsible for other projects in Western Australia (*RWAHS* 1929:33). During his time as a contractor he constructed:

> Jetties at Fremantle and Canarvon in 1886, the jetty at Eucla with Baille and Wishart in 1887, and Cape Leeuwin Lighthouse with J. Wishart (q.v.) in 1895. He built a third mill at Boranup in 1888 and a fourth at Jarrahdene in 1892, and Alexander Bridge over the River Blackwood in 1897 [400 feet long for £1100] (Heritage Council 1993:5).

Davies was appointed in 1891 as a Justice of the Peace and elected Chairman of the Augusta Roads Board. He retired in 1902 when his company merged with Millars Timber and Trading Company (Heritage Council 1993:5).

However not everyone was so impressed with Davies' foresight:

> Sir it has been brought to my notice that by one of the clauses … granted by the late Governor to Mr. M. C. Davies, of the Hamelin saw mill, Mr. Davies is empowered to take from the small settlers holding annual pastoral licenses, and also from the lease holders, when their leases fall in, all their pastoral rights, contained in his [M. C. Davies] concession, which comprises I believe some 90,000 acres of land … grievous and cruel injustice of the settlers of Augusta by exercising it … (*The Western Mail* 23/1/1886: 3c).

4.3. The family members

Davies' sons were encouraged to play an integral part of his business (see Figure 9). Each son had to start at the bottom as a labourer working his way up to manager. Essentially this was an apprenticeship, which would have allowed each to understand all aspects of the industry. All of his sons became managers at Karridale and then progressed to better or more diverse occupations throughout the industry. Robert became the London director for both the Davies' company and the amalgamated company in 1902. Walter, known as 'Karri' Davies, represented the company in South Africa. Herbert died in 1915 after working both for his father and as manager for the Wellington mills of the amalgamated company.

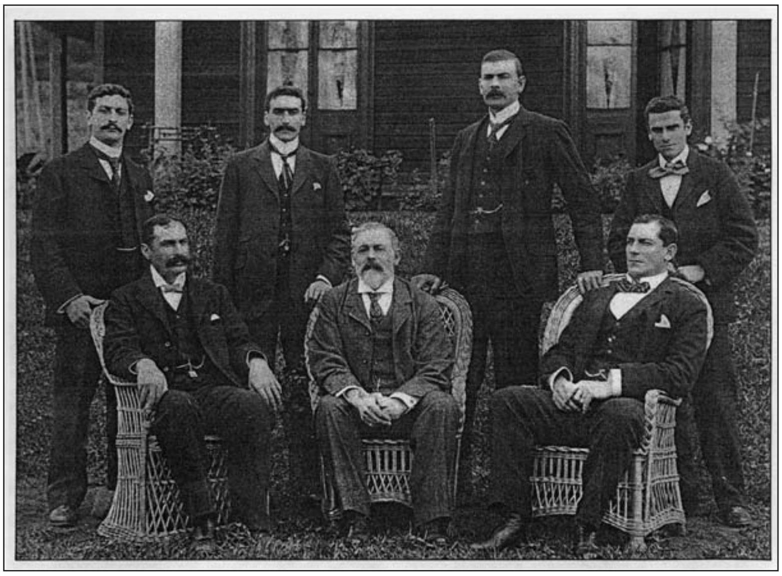

Figure 9. M. C. Davies and sons (Winfield 1986:12).

Phillip, after holding vital roles for the company in Karridale, represented the United Companies in the Far East. Arthur went to India to fulfill a role as manager for the same company. Frank also fulfilled many positions of importance in Karridale, including a managerial role. Frank also worked for the amalgamated company in Marrinup, Denmark, Jarrahdale, Canning and Wellington. He furthered his career by becoming the Managing Director of Trees Ltd. in Mornington, Victoria (*RWAHS* 1929:35).

4.4. Karridale Settlement

Karridale was a busy township with a total population of *c*. 600–800 people, it had to be self-sufficient as Perth was at least a full day's journey away by cart. Davies produced a unique currency (that he paid his workers in), which was readily cashable anywhere in the state (*RWAHS* 1929:34; Spackman 196-?:7).

The government during the primary settlement of the township and its early growth offered no assistance for the fledgling community (see Figure 10). Therefore, all public works were deemed the responsibility of Davies who fulfilled this role until *c*. 1898. The government, after recognising the size and demand of the settlement, provided funds for schools and teachers' residences. With a hospital to be constructed, the community flourished and visitor numbers increased (Hope 1898:53).

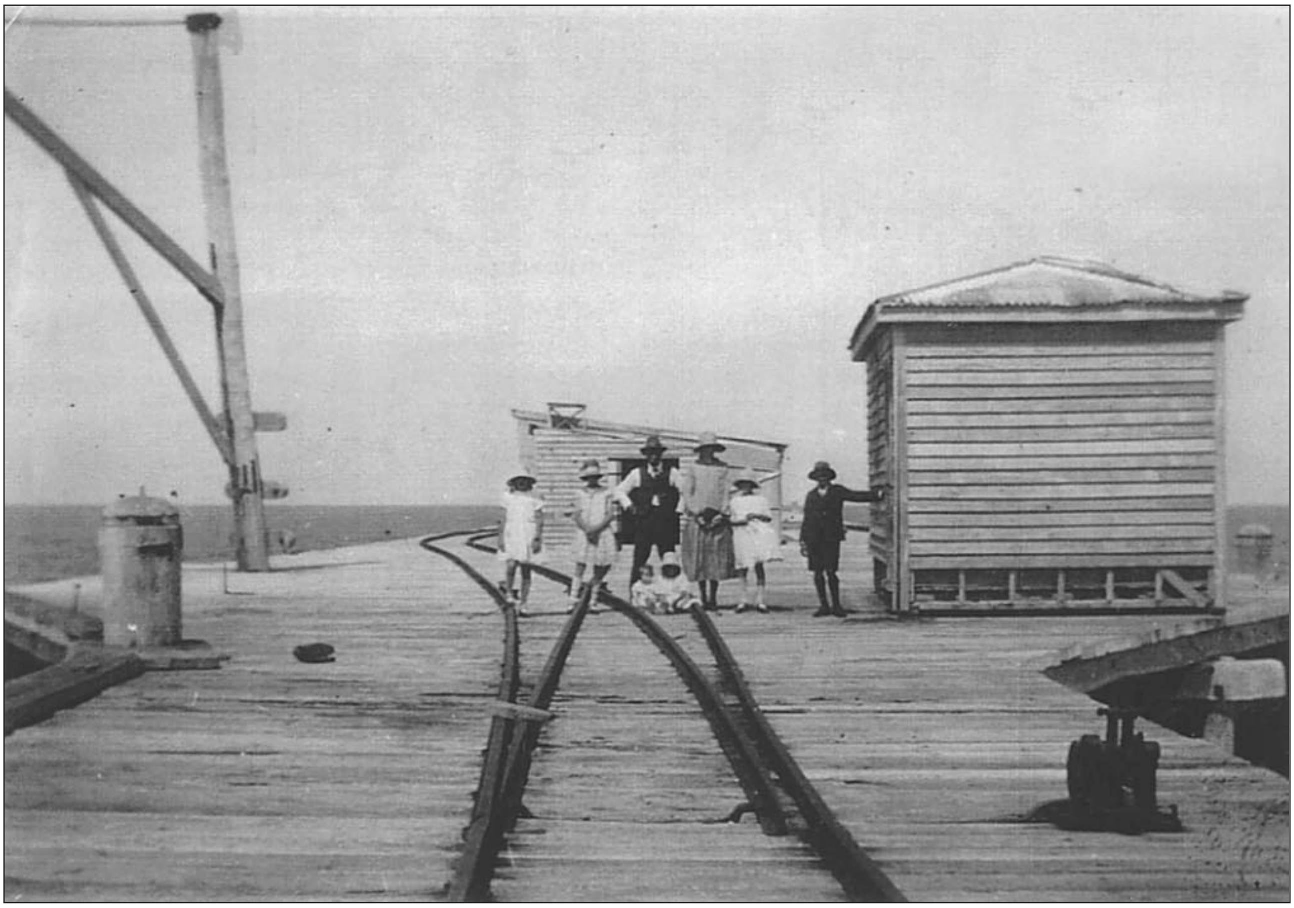

Figure 10. Immigrants or local family on the jetty?, n.d.. Photo: courtesy of MAAWA.

The mills and the resulting townships employed a great many horses, which needed feeding. This new labour provided the surrounding community of farmers with a commercial opportunity - that of supplying fodder for the horses. With the growth of the timber industry farmers could easily export their goods, with a significant number of farmers benefiting from this arrangement (*RWAHS* 1972:41).

4.5. Conclusion

The historical information that relates to Hamelin Bay is based more upon the townships, the mills, the family and Davies himself. There is information that applies to the jetty structure but this is limited and refers mainly to the amenities of the jetty, why it was constructed, dates of construction and what vessels visited. Not how the jetty was constructed, what it was constructed of and what was the expected time frame of the structure to last or be used. Information from other sources, for example, Du-Plat-Taylor (1928) have been investigated to understand the structure of the jetty and why it was built in this fashion. This may not be the case for all jetty sites but because this jetty was built by a private entrepreneur in a remote location the details seem to have been lost. Perhaps more information is available but it could not be located by the writer.

Chapter 5. Jetty Construction

5.1. Introduction

Is the construction of the Hamelin Bay Jetty that of normal timber pile jetties and how did this influence its degradation and the remains of the site today? The main focus is understanding the construction of the Hamelin Bay Jetty and jetties that have been similarly constructed. It was the writer's aim to locate information about jetty construction elsewhere, similar to methods used to build a jetty the contemporary of Hamelin Bay. The writer located two sources that provided the major insights into timber pile constructed jetties, Du-Plat-Taylor (1928) and Quinn (1972). The type of jetty structure investigated is the wooden pile constructed jetty.

Before detailing construction of jetties or the Hamelin Bay Jetty, the term 'jetty' must be defined:

> The term jetty covers, as the word implies, structures 'thrown out' or built into deep water from the shore, and it is generally used as distinct from wharves and quays constructed along the bank (Du-Plat-Taylor 1928:178).

It is also beneficial to define terms used in this section that relate to the Hamelin Bay Jetty. These terms are basic nonclementure for describing and understanding the morphology of jetties around the world. Bent, a section of jetty that runs perpendicular to the direction of the jetty laid in transverse rows i.e. two piles that are connected by halfcaps and walings (Quinn 1972:269-270). Fender, a sacrificial pile on the outside of the main pile preventing impact from vessels. Crosshead, a horizontal length of timber joining piles together by their tops longitudinally. Braces, diagonal beams that strengthen the jetty structure between piles or other similar. Decking, the walking surface usually laid perpendicular to the direction of the structure. Corbels, short lengths of timber secured to piles to support the halfcaps. Halfcaps, horizontal length of timber joins piles together (see Figure 11) (Lewczak, C., 2002, pers. comm., February).

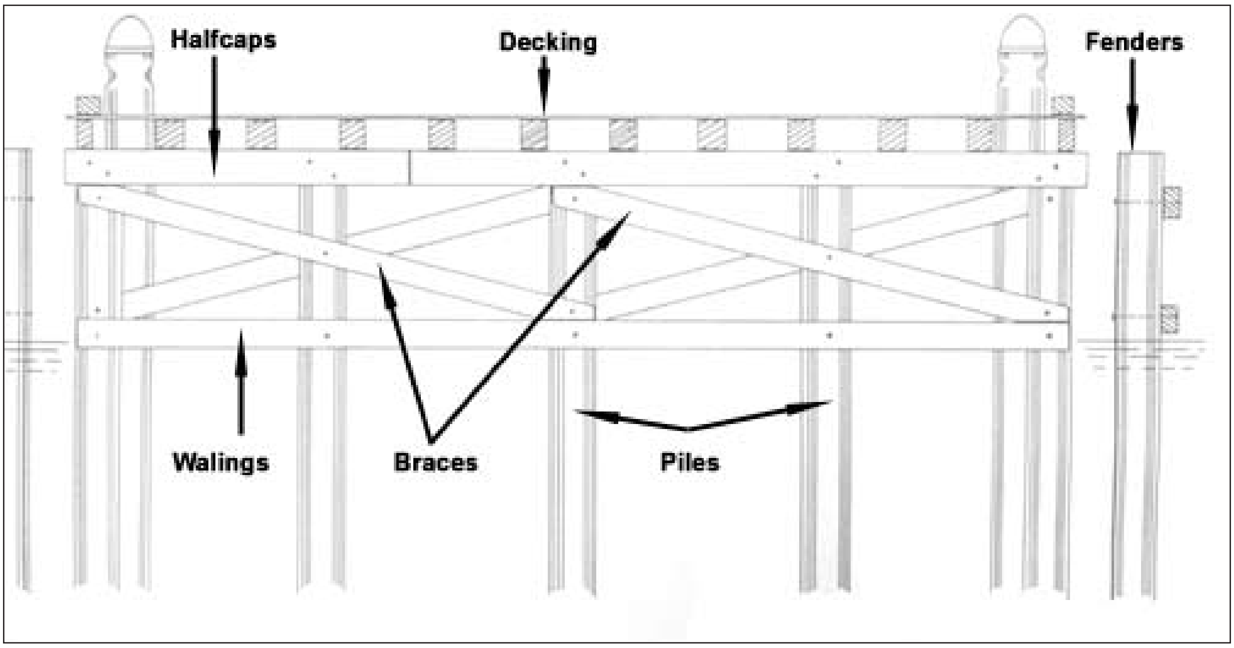

Figure 11. End view of the Albany Town Jetty: various parts of a jetty (Wolfe 1996:9).

5.2. Construction of Jetties

Jetties are structures built to facilitate transport, immigration and trade via the ocean. Certain principles should be adhered to with recognised features facilitating the strengthening of structures. Cultural and environmental factors will determine the type and location of a jetty structure. Is a permanent or temporary structure required, what type and size of vessels will be utilising it; what direction are prevailing conditions, their nature and strength, and what structure is best suited for the job in terms of economy (Quinn 1972:265–269)? What information is accessible pertaining to Hamelin Bay and jetty structures in the broader sense: can this information impart knowledge towards the archaeological record or merely set the scene for archaeological investigations? Is the construction of Hamelin Bay Jetty that of normal timber pile jetties and how did this influence its degradation and the remains of the site today?

Wooden pile jetties form the majority of jetties constructed owing to the ease and relative cheapness of their construction. They are also quite durable and can last as long as jetties of other design (Du-Plat-Taylor 1928:179). Timber jetties are quick to construct and they seem to be more able to sustain stress from docking vessels and environmental conditions because of their ability to flex (Du-Plat-Taylor 1928:179). Wooden pile jetties formed a structure that was usually perpendicular to the shore with a number of features that can be easily distinguished. In general, the jetty structure was foremost constructed of piles driven into the seabed until a suitable depth into solid sediment or similar was attained. Once established other additions could be added to the structure to both make it more stable and secure but also provide a safer working platform. Piles could be overlaid with crossheads running along the piles joining them together further supported by corbels. Halfcaps could then be laid perpendicular to the structure forming bents to provide more support and support for decking. Fenders added as sacrificial piles prevented damage to the structure also. Braces were then added diagonally to provide lateral and longitudinal strength, and finally decking to provide a platform with kerbing running along the deck longitudinally. The above were then fastened with iron fastenings to attach wooden sections together (Du-Plat-Taylor 1928:180–181).

Some jetties in Great Britain and Australia have been more substantially constructed than at Hamelin Bay, for example, the jetty at Dundee, Scotland is 27 ft. wide and has four rows of piles spanning its width. It also has diagonal bracing along its bents that is double in the outer bays and single in the inner bays. The structure seems to be significantly stronger than the structure at Hamelin Bay and perhaps this suggests a different use. The jetty at Hamelin Bay is approximately five metres or 16.4 feet wide but only has a pile at the end of each bent with no other piles or cross bracing evident (Du-Plat-Taylor 1928:179–180). This is in direct comparison to the jetty at Flinders Bay that has the remains of three piles across each bent with diagonal cross-bracing at each bent (see Figure 12). The jetty at Holdfast Bay, Glenelg, South Australia similarly had the diagonal cross-bracing that Hamelin Bay lacks.

5.3. Hamelin Bay Jetty remains

From the historical evidence it appears that Hamelin Bay was the first of the two jetties to be constructed. Two reasons for the construction of a second jetty at Flinders Bay was; to cope with an increased demand for timber (see Figure 13); and that Hamelin Bay was very exposed to north-westerly weather during the period, May to November (Ridgway 1988:33; *SWN* 15/6/1961:2a).

Figure 12. Remains of Flinders Bay Jetty, 2004. Photo: M. Gainsford.

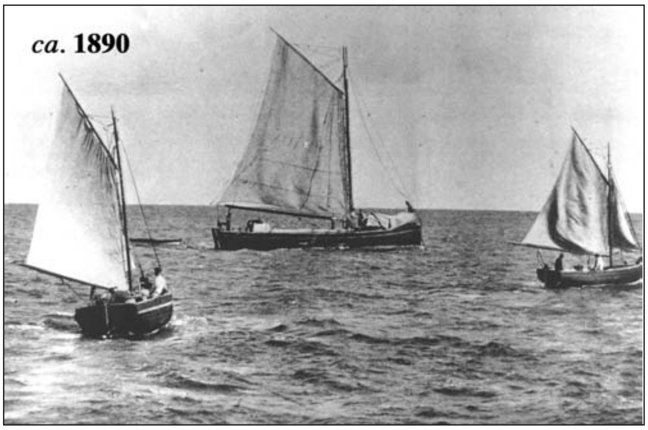

Figure 13. Lighters used in the loading process *c.* 1890. Photo: courtesy of MAAWA.

Hamelin Bay Jetty was constructed in two distinct phases. During phase one, 500 feet of jetty was constructed (1881–1882) and during stage two this was extended to 1800 feet (1882–) (Clark 1986:11; *Countryman* 13/7/1961:11; *Western Australian Government Gazette* 1883: 3, 416). After completion of stage two vessels of deeper draft could sidle up to the jetty and load to the point where the draft reached five metres (Clark 1986:6). Afterward the vessel, if big enough, would anchor again and be loaded via lighter at the company's expense (Clark 1986:6). Despite the effort to construct the jetty, it was only in use for a relatively short period (1882–1913) as the advent of steam allowed greater access to Flinders Bay and therefore fewer vessels serviced Hamelin Bay. Until the completion of the second stage vessels anchored in the harbour and were loaded by lighter.

Substantial modifications and amenities were added to the jetty as well as the bay during its lifetime, none of which remain today, including:

> Fender piles at each berth; rails with numerous sidings have been laid the entire length; midway there are some storehouses, while the telephone has been laid to the office at the end. Pipes for fresh water also extend the entire length. In addition to stationary cranes there are two steam cranes with wood-jacketed vertical boilers, mounted on trucks, and movable to any part of the pier. Some well built rowing boats hang on davits ready for use by the pilot and harbour master when required. There are three berths at the jetty. On the north side the outermost one has 18ft. of water and the inner one 13ft., while that on the south side owns to 15ft. (Hope 1898:56; Colonial Secretary's Office 5205/86 1887; *Countryman* 13/7/1961:11).

Hamelin Bay Jetty is broken up into four sections. Section one resides in the terrestrial and intertidal areas and is comprised of remains of nine piles represented in two sections (one set of four piles and one set of two piles) joined by crossheads (see Figures 14 & 15). Individual piles also constitute part of the shore section. Remains of the four joined piles; form the only two enduring bents of the jetty (there appears to be no other remaining bents at the site with the majority of the jetty sections consisting of piles only). Remains of the set of two piles are joined by what appears to be a crosshead. At the shore site, remains of through-bolts and the holes where these would have joined jetty structure are evident, but significant numbers of these are degraded or missing. There are also numerous recesses for bolts, missing beams or crossbeams on the remaining piles.

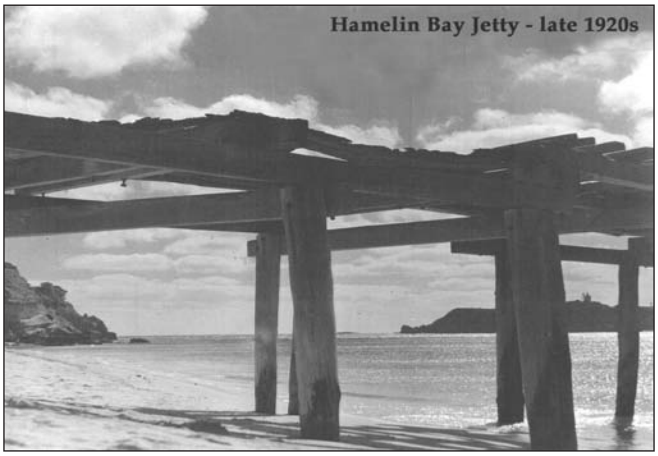

Figure 14. Hamelin Bay Jetty, late 1920s. Photo: courtesy of MAAWA.

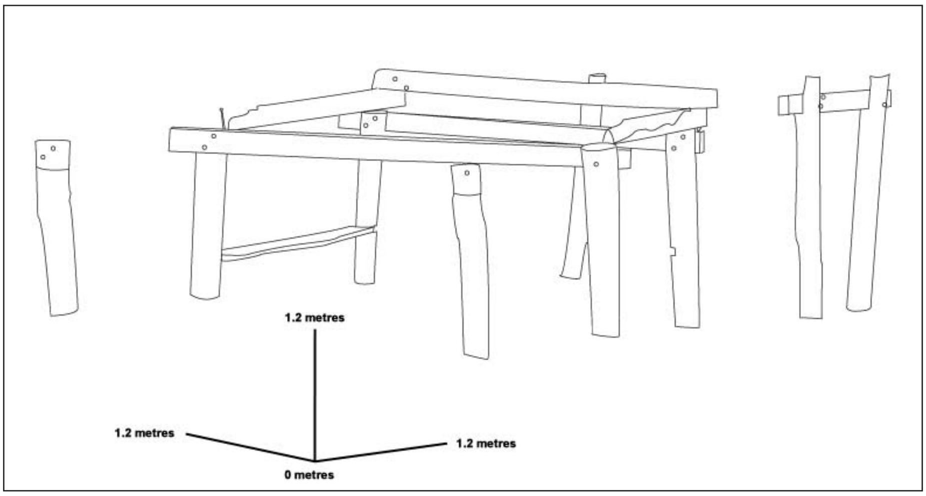

Figure 15. Lines drawing of the land section of Hamelin Bay Jetty, 2004. M. Gainsford.

The remains of the other three sections of jetty reside in the marine environment. The first of these adjoins the section on land (and for the survey is considered part of the shore section), but the environment that they are in slightly differs. All three sections are comprised of piles that are either standing, in the process of falling or have fallen over. There is some evidence of bolts and recesses but the majority of the piles have degraded over time which is most likely a result of the jetty undergoing numerous site modifications, the most recent the use of explosives at the site to create two channels through the remains.

There are no remains of the infrastructure that once adorned the jetty or any decking planks. Most of these materials either having been removed by environmental factors, fire, secondary use or blasting. Once again, it is hard to surmise from observable archaeological material exactly the extent of material at the site.

Aside from the obvious, there appear to be no other distinct jetty remains at the site. Smaller sections of the jetty once removed: could have been carried-away in storms or used by the residents of the area for other purposes.

5.4. Structure

It appears that the shore remains represent the basic structure of the jetty. Analysis of historical photographs has led to the conclusion that the jetty was probably built with a two pile bent system (see Figures 16–19). These bents consist of two piles with a halfcap joining them together horizontally and longitudinal beams (crossheads) between bents. There appears to be no cross bracing evident at the site and perhaps this is one reason for the limited remains of the structure. In addition to the piles, fenders were also incorporated in the structure of the jetty. These were used to stop vessels from damaging the main jetty structure (fenders are placed alongside piles of a jetty as sacrificial piles) however, none of these are visible today (Ford 2000:75; Wolfe 1996:9).

Figure 16. The Jetty slowly degrading, *c*. 1940. Photo: courtesy of MAAWA.

Figure 17. The jetty degrading, date unknown. Photo: courtesy of MAAWA.

Other additions or amenities that formed part of the jetty structure can be elaborated on minimally. Aside from historical documentation (i.e. pictures and contemporary accounts) there appears to be no information concerning a plan of the jetty, its original structure or how it was modified as situation dictated. None of the amenities remain today and therefore the former structure of these cannot be surveyed or elaborated on significantly (Hope 1898:56; Colonial Secretary's Office 5205/86 1887; Countryman 13/7/1961:11).

5.5. Materials

There is arguement concerning the materials used during the jetty's construction. Is it Karri, Jarrah or perhaps even another eucalyptus species, or a combination? This is difficult to elaborate upon unless tests are conducted after gathering samples from the site. This was an initial aim of the writer but after conducting primary fieldwork it was abandoned due to time constraints. During this period it was quite common to build jetties out of Jarrah or other hardwoods but unless samples are taken in the future it will be difficult to establish what species it was constructed of (Stanley 1927:59).

Figure 18. Jetty degrading, date unknown. Photo: courtesy of MAAWA.

Figure 19. Layout of the piles, date unknown. Photo: courtesy of MAAWA.

As well as timber remains there are remains of iron bolts used to fasten the structure. These appear to be in a state of active corrosion (iron oxide on their surface, Fe_2O_3). Their rate of deterioration is dependant on immersion, time immersed and whether they are alternating between wet and dry environments. Bolts or fastenings on the land section should be corroding significantly faster than if they were submerged in the marine environment. This is a result from repetitive wetting and drying of the iron and wood. When iron artefacts are subject to this wetting and drying, salts that have been embedded into the structure of the iron when wet can migrate slightly outward from the iron on drying, increasing reactions that occur in marine archaeological materials. This increases the rate of corrosion and the amount of iron corrosion products present. This is a problem with artefacts where the item is in poor condition or in an intertidal zone (Pearson 1987:68–75). Water movement can cause objects to often, or occasionally, expose themselves to the atmosphere by wave action. This causes periodic wetting and drying of the object, increased oxygen availability, physical destruction of protective concretions and an increase in corrosion products, larger variations of temperature and concentration of aggressive salts (Pearson 1987:68–75). Fastenings that reside wholly in an underwater environment should be corroding at a slower rate. However, this rate of corrosion is dependant on, salinity, temperature, dissolved oxygen, light and depth (Pearson 1987:74).

5.6. Conclusion

Hamelin Bay Jetty seems not to have been built to an atypical standard based on the remaining structure. It appears therefore to be more the exception than the rule with other jetties boasting cross-bracing and other structural strengtheners. There are no plans or details that the writer could locate on the subject to further identify the exact methods of its construction. Therefore, a number of inferences have been made to arrive at a conclusion of how the jetty was constructed and why. Perhaps the development of such a structure was only intended for short term use. Davies seemed to be a visionary, possibly foreseeing the demand hardwoods dwindling, or that the resource would be exhausted relatively quickly. If this was the case, the construction of the jetty seems appropriate. From the remaining structure, there is little evidence to support anything other than a temporary jetty. Since there is no evidence of cross-bracing to strengthen the structure both currently or in the historical photographs available to the writer, the degradation of the jetty may have been accelerated (Du-Plat-Taylor 1928:179–180). If a more solid jetty had been constructed then perhaps there would be more remains presently. At Flinders Bay, the remains of evidently a more substantial jetty reside. Here there is evidence of cross-bracing and three piles per bent, suggesting a more solid structure. This port was used after Hamelin Bay ceased to be used and perhaps it was Davies' intention from the outset to accomplish this. There is currently no evidence available to distinguish the two sections of the Hamelin Bay Jetty and whether they were built to a similar standard or of the same material. More information is required including a selection of timber samples from the jetty.

Chapter 6. Jetty use

6.1. Jetties in Australia

Australia has been dependant on the sea for its early development as a nation. The combination of long distances and poor roads ensured that trade via the sea was viable. A burgeoning Australia was reliant on the sea for communications with the outside world, for example, newspapers, Government dispatches and letters were carried and delivered by sea. The jetty was the primary marine structure for Australia to open its states to the outside world. In South Australia for example, there are *c*. 190 jetties in total, equalling one jetty for every thirteen kilometres of coastline (Ford 2000:22). Not only were communities relying on the incoming information from foreign or interstate ports to survive; private entrepreneurs were also reliant on the sea for their livelihood (Ford 2000:2–3). Colonies in Australia relied directly on jetties for growth in population, and jetty ports allowed migrants from interstate or overseas direct access to new towns and communities (Staniforth 1991:94–95). The jetty provided direct access to areas previously difficult to reach with relatively simple transfers (Ford 2000:5). Population during the late nineteenth century showed a marked increase in Western Australia. Most arrived with the prospect of becoming rich from gold and working the land. They then eventually settled in other areas of the state (Stannage 1981:211). As the colony's size increased, so did imports and exports. Shipping during this period increased significantly: from 1870–1890 a 283% increase in shipping from 3.7–14.2 million tons, and from 1890–1900 an increase of 66%, 14.2–23.6 million tons (Bach 1982:143; Broeze 1998:90). The initial uses for jetties are markedly different than today. Uses have shifted to recreation, enjoyment or study rather than the transfer of passengers and cargo (Broeze 1998:241–249).

6.2. Change in jetty usage

Jetty usage is fluid, and changes in response to demand or economic value. In general, usage has developed from working port structures used for immigration and trade, to recreational structures used for fishing and promenading. Jetty usage developed from a period where the main transfer of passengers and trade goods was by the sea, which is a direct link to the seafaring tradition of Europe and reliance on external contact (McCarthy 2002:8). Sadly over time in many cases jetty structures have fallen into disuse as structures become unstable and too costly to repair (Ford 2000:25–26).

Trade via the sea was considered quick, cheap and the only viable method for moving large amounts of cargo or passengers. Passengers and goods would either be directly transferred from vessel to jetty if deemed safe enough otherwise they could be lightered from a safe distance (McCarthy 2002:8). Some jetties in Western Australia were built by entrepreneurs expressly for their businesses. This was the case with Davies constructing two jetties. Since transport by road was expensive and laborious, it was more efficient to build a jetty and have ships arrive directly at the port. This also allowed vessels to import a cargo for sale as well as loading one (Broeze 1998:79).

Since the 1950s roads have become increasingly better constructed, in more frequency and are better maintained (also seen at Hamelin Bay (Spackman 196-?:11)). During this period transportation has become more efficient, due mainly to a road dominated trading network with the shear volume of traffic making it cheap (McCarthy 2002:8). Jetty-dominated trade networks have largely become extinct and therefore the use of jetties has changed in focus. Jetty usage is now dominated by recreational purposes that reflect the needs of the population (Ford 2000:25–26; McCarthy 2002:8). Government support for these structures has dwindled and jetties that serve no economic purpose have been left to degrade. This is a common theme, Ford (2000) notes that up until 1994 jetties in South Australia were regularly maintained to extend their use life, but after this date repair ceased and jetties were left to the elements. This is perhaps the perception that jetties provide only a drain on resources, or shipping hazards (Ford 2000:26; McCarthy 2002:8). At Hamelin Bay, the time line suggests that once the port ceased to be used for the import and export of goods and immigrants, the jetty was left to degrade without significant maintenance. This seems to be a dominant feature of jetty use in modern culture where economically redundant features of the past are simply left to rot. Although we do have designated ports for transport and trade, there are numerous jetties that are not in use today with their actual use completely different from their intended purpose (Bach 1982:404–440).

This should not imply that they be left in a state of disrepair, quite the opposite. Jetty structures used for purposes other than their intended purpose should have some measure of control and maintenance to extend their use, preserving them for the future, for example, the Hamelin Bay Jetty has been used for promenading and fishing since its disuse as an export port. Significant numbers of jetties are now used for a purpose other than which they were intended. They are historically significant and/or recreational icons. Reasons such as these should help structures to be managed better. Understanding the use of jetties allows the archaeologist to determine what cultural evidence may be represented. The historical and structural evidence can also be used to determine this, for example, the Hamelin Bay Jetty was used as a port for importing goods and immigrants and for exporting timber. Later it was used for fishing and promenading, eventually being destroyed by fire, storms and explosives. Both the historical and structural components of the jetty should evidence these and therefore the changing use of the jetty should be evident in the sediment below the structure. History and archaeology of the jetty not only concentrate on the structure but a series of uses that have developed the archaeological record. Essentially, they are similar in this respect to the shipwreck. The major difference between shipwreck and jetty sites is their usage. The shipwreck wrecks and essentially forms part of the archaeological record with minimal interference from divers and the populace if the site is not well known. A jetty on the other hand develops through multiple uses from a port-related structure to a recreational icon. This is attributable to its structure that remains solid for a number of years but slowly degrades, with its location well known and accessible to human interaction. Therefore, jetties progress through multiple series of transformations both cultural and environmental with the eventual result either a maintained jetty or a jetty that degrades to the point of non-use (Schiffer 1987:23).

6.3. Hamelin Bay

Hamelin Bay has changed from an untouched bay, to a major port, to a seaside escape for tourists and Western Australians. Previous to the construction of the jetty the area was already used as an export point by Eldridge to export timber from shore based facilities (Fall 1974:116). Subsequently the venture was purchased by Davies and a jetty was built in two stages eventually reaching 1800 feet (Clark 1986:11; *Countryman* 13/7/1961:11; *WAGG* 1883:3). During the initial period of construction vessels were loaded by lighter and after construction of phase two, more vessels were able to load from the jetty directly (Clark 1986:6). During the period that Hamelin Bay was in use as a trading port, shipping costs had decreased significantly allowing vessels to make the run to Australia. Also, vessels under flags other than British were allowed to trade with Australia, and British traders could purchase vessels from other countries around the world. The restrictions had been lifted during the 1850s and presented a great economic climate for Davies to exploit (Broeze 1998:86). Coupled with this was a new variety of hardwood that had not been exported extensively and was relatively unknown. Hamelin Bay Jetty, if not for the Karri and other eucalypts that grow in the area, seems unlikely to have been constructed.

During the gold rush workers for the jetty and mills became hard to locate therefore inter-colonial steamers frequented the port supplying cargoes and immigrants (see Figure 20) (Ridgway 1988:33). By 1913, the timber industry was depressed and the dominant jetty use changed. It became a popular fisherman's haunt until fire destroyed most of the structure in *c*. 1921 (Ridgway 1988:36). More recently the jetty was altered by fisherman to increase its usable space by repairing sections. Storms have also modified its use largely rendering many sections unusable (*SWN* 28/5/1959:12b). Currently all that remains are the original piles of the structure and the main purpose it fulfills is as a tourism interest and fish cleaning station. Aside from the shipwrecks in Hamelin Bay, evidence that survives regarding the developments of its early use are historical not archaeological. Further investigation after this thesis must be conducted to ascertain what, if any, material (artefact assemblages) remains at the site and whether clearer links can be generated between the historical and the archaeological records. A concise understanding, incorporating site formation processes and how these influence material remains or the jetty structure in the future needs to be further developed (Schiffer 1983:676–677; 1987:362–364). Hamelin Bay appears to have degraded to a point where minimal demand for the structure exists except for tourism and the cleaning of fish. Its current state and economic value suggests there is no demand for a jetty at the site. A new jetty would be too costly construct and maintain due to population density of the area and the amount of trade that would result in its construction. Perhaps an extension of the beach remains should be investigated to increase public and tourist awareness of the site.

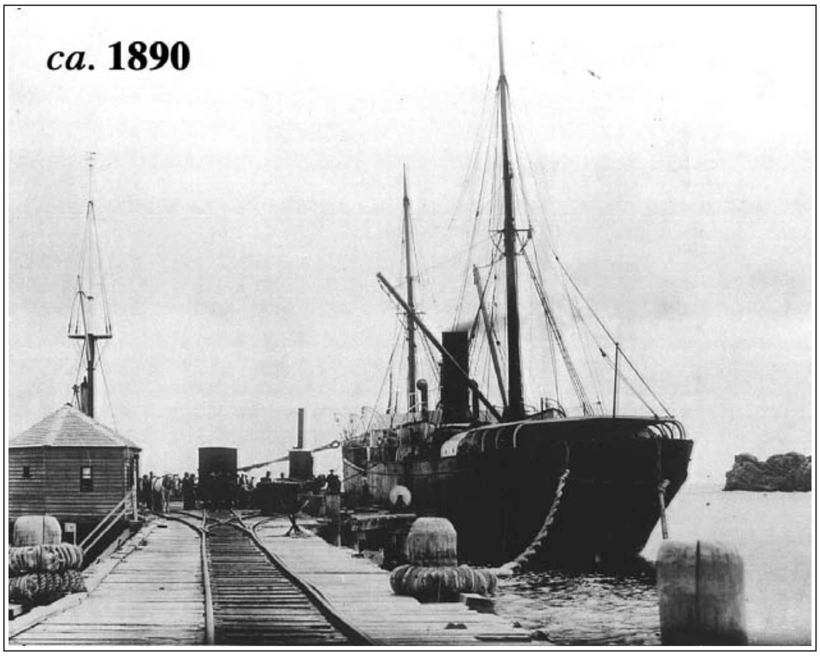

Figure 20. A ship being loaded at the Hamelin Bay Jetty. Photo: Courtesy of MAAWA.

Chapter 7. Site formation processes

7.1. Site Formation Processes

Site formation processes affect all archaeological deposits or structures. In the case of Hamelin Bay, the jetty has undergone a series of cultural and non-cultural processes to arrive at its current state. Although these processes are indicative to Hamelin Bay they can be generalised somewhat with reference to jetty sites both in Australia and overseas. A combination of environmental, commercial and recreational uses have altered the jetty from an operational site to how it is represented today. It is a requirement of the archaeologist to understand such processes and synthesise a schema to determine how these processes both affect a specific site and marine archaeological sites in general (Schiffer 1983:675–697; 1987:339–340). Links made between other sites and Hamelin Bay can further determine formation processes that dominate the site. Therefore, the best way to establish the formation processes at Hamelin Bay is to address Hamelin Bay as a case study, examining it in conjunction with information from other sites and site formation theory to develop the pattern that is occurring (Schiffer 1983:675–967). To fully determine the site formation processes at Hamelin Bay, there must also be an investigation of the material deposits at the site. However, this is beyond the scope of this thesis, which has specifically focused on pre-disturbance methods of investigating an archaeological site. It is also pertinent to add that transformation processes acting on jetty sites be identified to allow for some degree of control when investigating a site such as the Hamelin Bay Jetty (McCarthy 1996:202). Models constructed for maritime sites concentrate on the shipwreck event and following processes (Muckeroy 1978:157–159; Murphy 1990:15). These models provide an overview and not a complete analysis of shipwreck site formation processes in the archaeological record. Many other factors also need addressing to further understand the formation of archaeological sites (Ward *et al.* 1998:109). Not enough site formation analyses relate to jetty sites in Australia. Therefore, site formation theories concerning these sites is inferred and developed from existing data. This thesis incorporates theory developed for coastal and shipwreck site formation, but refines it for the specific investigation of jetty sites.

There are a number of factors influencing site formation processes that should be outlined generally before Hamelin Bay is investigated. These incorporate the geology of the region, environmental and cultural transformations occurring at maritime sites: that is, a series of dynamic forces that modify sites from an organised structure to a seemingly disorganised archaeological site. Although these currently relate primarily to shipwreck sites, links to jetty sites can be made. Muckelory (1978) developed a model by which a series of events alter sites from their construction or deposition creating an archaeological site. Labelled as ‘extracting filters’ and ‘scrambling devices’ these transformations alter a site by different processes but are not mutually exclusive. Extracting filters are transformations that remove material from a site including salvage, flotsam and material disintegrating over time. Scrambling devices are transformations that move material around a site and ‘scramble’ the archaeological record. It is important to note that material floating away some distance from a site is both an example of an extracting filter and a scrambling device (Muckelroy1978:165–182). On the other hand, different theories state that the formation processes are divisible into two distinct classes. Schiffer (1987) describes these as cultural (c-transforms), that is human influence or interaction and environmental (n-transforms), both of which are subject to translation (the movement of artefacts from causal factors) (Schiffer 1987:25–140, 141–261). This is a more succinct argument for site formation and can encompass a more diverse range of influencing factors affecting archaeological sites. Transformations in this thesis are divided into, environmental and cultural (translation is incorporated into both).

As Hamelin Bay Jetty has been subjected to the above transformations, their exact significance and nature will be outlined in the below passages. These conform to two major divisions: environmental (which is outside human interference including biological) and cultural (interference of humans by directly or indirectly influencing the site). These factors are more expansive than just deriving a simple model and incorporate a number of biological, environmental and cultural influences (Ward *et al.* 1998:109–114).

7.1.1. Environmental

Environmental conditions determine the morphology at any point along the coast and any sites that lies within those parameters. Conditions include wind fetch, wind direction, wind speed, sediments and beach slope. Wind produces waves and their size is directly proportional (incorporating fetch, direction and speed) to the wind. Resultant factors are the size and strength of waves and their ability to erode shorelines and move sediments (Komar 1998:45; Murphy 1990:15–16). The coastline of Hamelin Bay is a high-energy site that has a significant fetch in certain wind directions (see Figure 21). Fetch determines the strength of wind, waves or swell size, amplitude, frequency and the amount of suspended sediment and other materials in the water column; which influences erosion, shoreline drift and deposition at the site. This movement will determine the levels of artefact concentration, their condition and their scarcity across the site. Jetty structures are affected by these and the nature of prevalent conditions determine the level of deterioration of the site (Komar 1998:377–382; Murphy 1997:386–388).

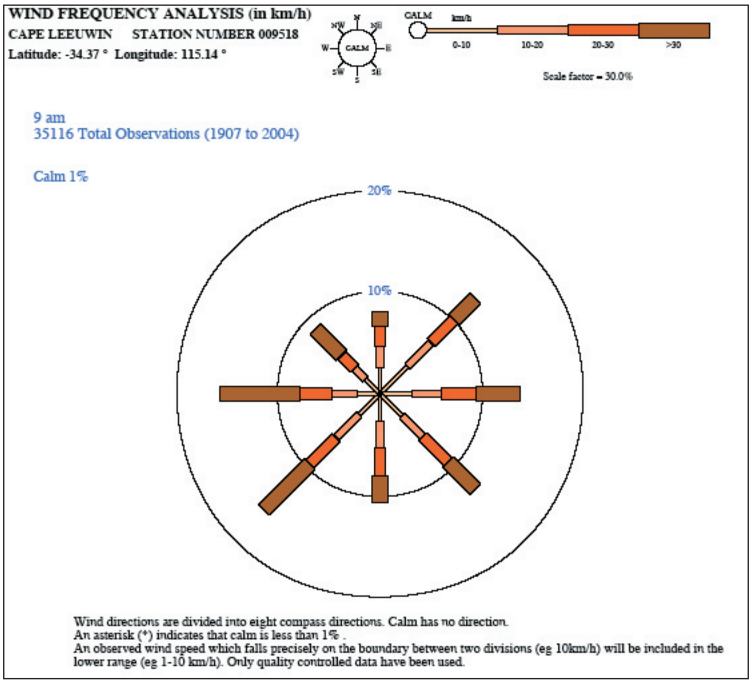

Figure 21. Wind directions at Hamelin Bay. Image: Bureau of Meteorology (BOM) website.

Hamelin Bay is located north-west of Cape Leeuwin. At this geographic location it has a set of seasonal conditions that affect the coastal development and the archaeological remains that lie in its vicinity. The pattern is north-west winds between May and September (winter) and then predominantly south-westerly winds for the remainder of the year. Storms originate from the north-west, and because Hamelin Bay is exposed to this direction these storms have caused significant damage to structures in the bay. The ferocity of storms tending from the north-west is well documented in this region. Wind speeds reach averages of 20 m/s (39 knots or 72 km/h) and in extremes produce winds of 40 m/s (77 knots or 144 km/h) (Pearce 1992:13–15). When the weather tends to the south-west, the bay is reasonably sheltered by the cape, the outlying islands and reef (*SWN*, 15/6/1961:2a). Studies in 1983 analysed by Pearce (1992) developed the idea that there are minimal occasions where winds in the region abate. It was determined that for 1983, wind speeds lower than 2 m/s (4 knots or 7.2 km/h) occurred only three percent of the year (Pearce 1992:13–15).

Sediment in the bay is light coloured medium to fine grained and has the ability to be highly mobile at certain times of the year (see Figure 22). During fieldwork sediment was evident throughout the water column, and visibility was reduced to *c.* one–two metres. At the site it can be highly mobile with little evidence of anoxic (oxygen deficient) sediment. This pattern is evidenced in modern day Cockburn Sound, Western Australia, where one-metre sediment cores failed to demonstrate any anoxic environment (Richards, V., 2004, pers. comm., February). This highly mobile sediment has the ability to both protect (slightly, dependant on depth) and uncover remains depending on season: it also influences artefact preservation. If sediments are mobile and provide a more oxygenated environment, artefact degradation and movement across the site are significantly increased (Pearson 1987:74–75).

Figure 22. Sediment sample, 2004. Photo: M. Gainsford.

Seasonal changes produce variance in wind direction, frequency and strength. Since Hamelin Bay is sheltered from most wind directions except north-west winds (which occur in winter) it follows that most transformation and sediment movement occurs during these periods. The amount of suspended sediment that is able to accrete and erode areas has a direct relationship to wave amplitude and frequency (Komar 1998:134–142, 208–217).

The size of waves and swell determine the nature of the suspended sediment, its amount and particle size suspended (Murphy 1990:14–16). Slope of a shoreline is also determined by wave size and influences sediment movement and build up on shore lines described as cross-shore drift: i.e. the movement of sediment up and down the beach slope (Komar 1998:137–142). Slope is usually steepest at the shoreline progressively decreasing in slope further away from the shore (Komar 1998:285–290). The area of the Hamelin Bay Jetty is subject to low slope variances. This can be evidenced from previous studies of the region where the bathymetry off Bunbury one to two kilometres from the shore was only ten metres deep and at four kilometres only fifteen metres deep (Pearce 1992:15–16). Slope and size of waves also has a direct relationship. Slope of a beach and the foreshore is determined by grain size of sediments. Larger grain sizes allow more water to percolate into sediment. The result is a steeper beach front with less sediment travelling seaward compared to onshore (Komar 1998:285–290). Not only does the amount of water percolation have an influence on slope but the size and amplitude of the waves also have an effect on beach slope. It would seem that an increase in wave steepness has a tendency to produce lower sloped beaches (Komar 1998:270–90). Greater wave steepness would occur during winter, a result of north-westerly dominant winds and the storms they produce. However, in summer the predominant winds are from the south-west and Hamelin Bay is sheltered from this direction. Beach slope at Hamelin Bay should therefore increase during summer and decrease during winter. From winter storm activity, the wave height is increased and there should be an increased sediment deposition at the site further decreasing the slope.

Longshore drift or littoral sediment transport is closely linked with the seasons and wind direction. Littoral drift (the total amount of sediment transfer) manifests itself in a pronounced state when coming into contact with a structure. A build up or accretion will occur when sediment transport comes into contact with jetties, breakwaters, groynes or similar. Littoral drift causes a build up of sediments at these structures, but also has the ability to erode them. Shoreline drift is detailed by Komar (Komar 1998:397–417):

> It can be expected that longshore sediment transport rates will depend on environmental factors such as sediment grain size, the beach slope, and factors such as wave steepness. The most obvious dependence that might be expected would be with the sediment grain size, intuition suggesting that beaches composed of coarser sediment experience decreased rates of longshore transport (Komar 1998:397).

Hamelin Bay adheres to this model with sediment accreting in winter and eroding during summer due to longshore drift (Komar 1998; Winton, T., 2004, pers. comm., September). This highly mobile sedimentation should allow some artefacts of differing sizes to remain, some migrate, others disintegrate and others wash away. The nature of mobile-oxygenated sediments suggests that some artefacts may remain at the site. Artefacts deep enough to avoid this movement may be oddly shaped or too heavy (according to their specific gravity, or size) to migrate easily. Smaller artefacts could more easily migrate along the shore or down the slope if sediments move by large amounts during a season or seasons (Schiffer 1983:679–680; Stewart 1999:578–582). A spatial distribution of these artefacts is alluded to, but unproven at this stage. A lack of disturbance archaeology at the Hamelin Bay Jetty allows the archaeologist to provide suggestions and models for conditions that are possibilities based on data available but not concrete evidence. Therefore, horizontal and vertical distributions, artefact assemblages and their densities cannot be fully understood or analysed until disturbance work is conducted (Schiffer 1983:685). The sedimentation process has possibly increased the degradation of the remaining timbers and piles at the site. The highly mobile sediment both covers and uncovers the structure where sediment-sea interfaces are present. This is more pronounced where the interface is in the inter-tidal region. Noted at the Hamelin Bay Jetty where degradation has been evidenced as darker sections on the structure which are smaller in diameter than the more stable sections of the jetty. This is most likely a result of wood wetting, drying, being covered and uncovered over long periods of time (Pearson 1987:55–61).

Wind direction and strength also play a role in the destruction of jetty structures. When winds come from certain directions they have a calming effect on areas while wind from other directions tend to aggravate conditions (Murphy 1990:14). This case is prevalent at Hamelin Bay, as wind from the south-west tends to produce smaller wave action in the bay and wind from the north-west more aggressive wave action. This is a direct correlation to the surrounding landmass, offshore islands and reef system. From the south-west the jetty is relatively more sheltered than from other directions. When the wind tends to the west and to the north-west the intensity of waves and swell increase: this coupled with an increase in wind sheer, produces the most damage environmentally to the site. With respect to the jetty at Hamelin Bay this can be proved by the historical record. There are references to storms that on more than one occasion destroyed sections of the structure and amenities (Ridgway 1988:33–35; *SWN* 15/6/1961:11). Storms are a major influencing factor in jetty destruction or transformation and this jetty is not an exception to the rule. Other jetty structures that have proceeded through similar events are, for example; a storm that destroyed a significant section of the Holdfast Bay Jetty, South Australia in 1948; and the Brighton Jetty, South Australia in 1994 (Ford 2000:93; Richards & Lewczak 2002:19). These transformations remove sections as flotsam, or deposit material in the sediment. The Hamelin Bay Jetty structure consists primarily of wood. The majority of the structure during stress periods and disintegration would drift off unless already waterlogged. Structure remaining if heavy enough, would sink to the seabed and the composition of these materials would determine depth of penetration into the sediment or distance of migration from the primary site (Schiffer 1983:684–685).

Water temperature also provides a process to increase the rate of site degradation. Water temperature in Western Australia ranges from temperate to tropical in the north. A major feature of Western Australia is the Leeuwin Current, which transports warmer water from the north of Western Australia to the south-west. The Leeuwin current extends down the length of Western Australia reaching the Hamelin Bay region in winter. Increases in temperature from the current may allow marine fauna and flora to dominate previously uninhabitable waters. Temperature increases could influence teredo worm activity, algae and other flora growths on the structure (see Figure 23). However in Hamelin Bay there is little evidence of teredo worm activity. Evidence for this is derived from the jetty site and from shipwrecks located in Hamelin Bay. Wooden cargoes from shipwrecks in the bay are in a good state of preservation. This proves that at least there is minimal interference from worm infestation and other marine fauna (Gilman, J., 2004, pers. comm., February). However, there is the possibility of attack from other sources than marine borers. Bacteria and fungi can also penetrate timber degrading its structural integrity (Ward *et al.* 1998:109–110). At Hamelin Bay there appears to be minimal attack by these, but it cannot be totally discarded from fieldwork conducted. Further analysis must be conducted on timber samples to determine, if any, the amount of infestation in the remaining timbers.

Aside from the obvious degradation of wood from marine fauna there is also a chemical component to the process. When wood is submerged in any aqueous environment it is the nature of the wood to absorb the solution. In the marine environment seawater comprises an electrolyte (water) and a mixture of gas, particles and other chemicals. When wood is immersed in the marine environment it slowly becomes waterlogged. From this point the internal structure of the wood degrades and the cells fill with water leaving only cell walls of the original structure (Pearson 1987:55–59). The structure of the wood is essentially now less stable than previously because water fills the cells. If the timber is in the region of intertidal movement cell degradation could increase the destruction of the remaining structure. This seems to be evident at the Hamelin Bay Jetty where there is more pronounced necking around the base of piles in the intertidal region than of the piles further up the beach. This, however, cannot totally rule out other possibilities and a process of abrasion by cross-shore littoral drift may be producing the necking of timbers.

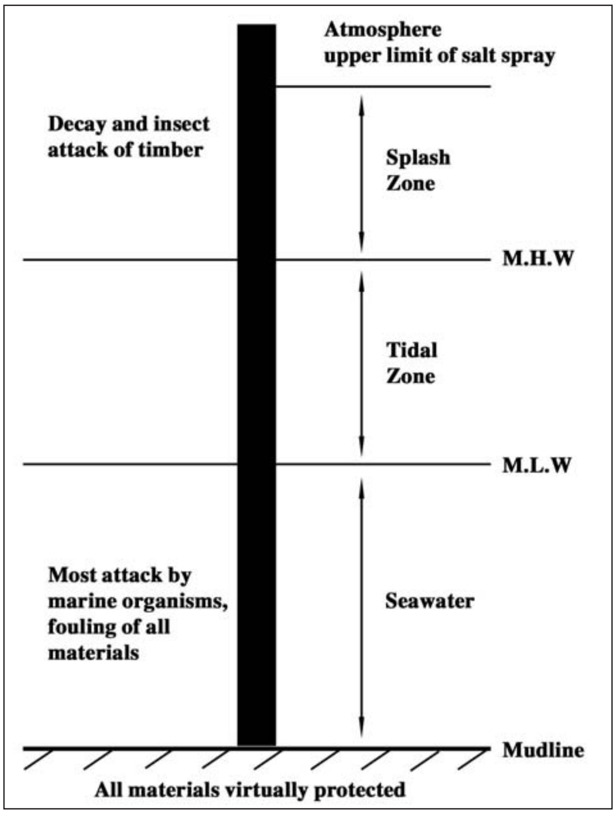

Figure 23. Pile degradation from Gaythwaite (1981:260).

7.1.2. Cultural

Cultural transformations are the result of human interaction with a site whether direct or indirect. Direct interaction is described as the removal of material for salvage, purposeful demolition of the site, discard, loss and even intervention by archaeologists. Indirect interaction is delineated by increased marine contaminants (or similar) and increased human activity around structures that impinge on the seabed or surrounding area (Schiffer 1987: 47–50, 76–79, 339–340). Jetty sites offer increased opportunities for cultural interference because the time-period and uses they undergo allow a substantially greater number of phases by which culture influences their development and degradation.

Loss, discard, archaeological and non-archaeological recovery of artefacts or salvage are all examples of direct human cultural transformations (Rodrigues 2002a:31). Not only did vessels loading timber use the Hamelin Bay Jetty. Employees, fishermen and local residents used it as well. The site has experienced significant amounts and types of usage for the above processes to occur. At jetty sites there is quite often a significant amount of material that lies around the structure. This scatter should be denser around the immediate vicinity of the site, dissipating from the edge of the structure outwards (e.g. Port Victoria Jetty, South Australia and the Busselton Jetty, Western Australia). This loss or discard forms layers in the archaeological record over time and is dependant on the sediment composition and environmental conditions, where artefacts either settle in the immediate vicinity, or distribute themselves further away from the site. Recovery of material also plays a significant role in the formation of the site. Once a site is deemed non-operational or of non-importance site souveniring or scavenging may occur, removing items of value or significance. This removal of material further alters a site and must be taken into account during investigation. Coupled with this ‘removal’ is the notion of restructuring for recreation. If a site falls into a state of disrepair decisions may be made to repair or reorganise the structure to extend its recreational life: occurring in Hamelin Bay when the structure was added to and repaired to increase its recreational life for fishing (*SWN* 28/5/1959:12b). Since the repair it was deemed a hindrance to navigation and two channels were created with explosives to allow safer navigation through the bay.

Other structures or geological formations that have been erected or formed near the site may influence its formation. If present, they may alter what cultural remains dominate the site or possibly only affect the site minimally (Murphy 1997:22–26; Rodrigues 2002a:32). It is possible the boat ramp and its usage have indirectly altered sand accretion and erosion at the site. There is significant boating traffic at certain times of the year and this constant movement could influence the natural environment and accretion of sediments (Komar 1998:377–382).

Hamelin Bay Jetty in its current state is represented by three sections (as previously mentioned the first two sections have been combined) of jetty interposed by two channels. The formation processes that have contributed to the sites formation are necessary for an understanding of why the structure is in its current condition and what, if any types of cultural material remain at the site.

The Bay was an entrepôt for trade - not only was timber being exported from Hamelin Bay but migrants disembarked and goods were traded. Subsequently this port was subjected to a significant number of docking vessels that had a variety of purposes. A number of major influences have transformed the site both culturally and environmentally degrading the site and altering its form and record:

1.) Disuse of the jetty as a prime port of hardwood export, trade or migrant immigration;
2.) Storms that ravaged Hamelin Bay from the north-west. Destructive storms in 1900 and especially in 1961, described as the *‘worst storm in 30 years’* that destroyed most of the remains of the jetty since the fire (Ridgway 1988:33; *SWN* 15/6/1961:2a);
3.) Fire, deliberately lit—During the group settlement era (*SWN* 28/5/1959:12b);
4.) Modification of the jetty by fishermen—Local men modifying the jetty for fishing and promenading (*SWN* 28/5/195912b);
5.) Use of explosives to create shipping channels through the jetty structure (Gilman, J., 2004, pers. comm., February); and
6.) Mobile oxic sediments that can scour out sediment around piles weakening foundations

and moving artefact concentrations.

7.2. Conclusion

The Hamelin Bay Jetty as outlined above is subject to a number of forces both cultural and environmental. At present it appears that environmental factors pose the more serious threat. The jetty is no longer used as a fishing or promenading structure because only piles and some bents remain in three sections of the original structure. The force of environmental factors increases during winter. These factors influence wind direction, wave speed and amplitude, littoral drift, beach slope and biological and chemical degradation. The site is subject to accretion of sediment during the winter and erosion during the summer. Wind speeds and wave size also increase in the winter posing more of a threat. Further studies to measure this movement and wave amplitude would be an invaluable source of information to understand the processes in more detail and how they affect the structure and the deposited remains at the site. Chemical and biological information should also be studied to determine more completely the extent of degradation at the site and predict more accurately what is happening or what could happen. Cultural transformations also have influenced the record at the site, and how the jetty has degraded. Fire and explosives have been the two major cultural transformations changing the structure and adding to the archaeological record. The major features have been outlined as the writer perceives them in reference to the Hamelin Bay Jetty. It incorporates literature from other sources not directly relating to jetties, however information is inferred. Site formation processes for jetties have not been fully investigated and a thorough understanding of a site is needed before disturbance archaeology is begun (Rodrigues 2002a:30–31). It is the hope of the writer to further develop these ideas creating a more sound site formation theory for similar structures.

Chapter 8. Survey Results

8.1. Introduction

A number of methods were utilised throughout the survey with varying results. Data gathered has been developed through various stages to enable it to be presented in different formats and so allow other archaeologists to build on and cross-reference it. There have been inherent problems during this thesis with data gathering and processing, in the future it may be possible to rectify these errors and provide more data, adding to the existing. These techniques also are an indication of how a jetty survey may be conducted, it does not encompass all the survey methods available but incorporates some of the simpler methods of site survey.

8.2. Plane table survey

The plane table survey proved very successful. A baseline was set up with two stations 150 metres apart on a bearing of 40° (220° reciprocal), one station called south (S) and the other called north (N). The plane table was assembled and levelled on station S and points were shot to various piles both in the shore section and to the extremes of the jetty, and the plotted using a scale ruler. The station was then set up on station N and all points were shot again providing a series of intersecting points where features lay. This system has proved successful insofar as it provides a basis for further survey and is a simple system to replicate. The results of the survey were input into an excel spreadsheet, imported into site surveyor in csv format and processed (see Appendices A & B). The process returned an adjusted error of RMS±0.271 metres (green coloured lines are good measurements; blue not as good and red not so good) (see Figures 24 & 25).

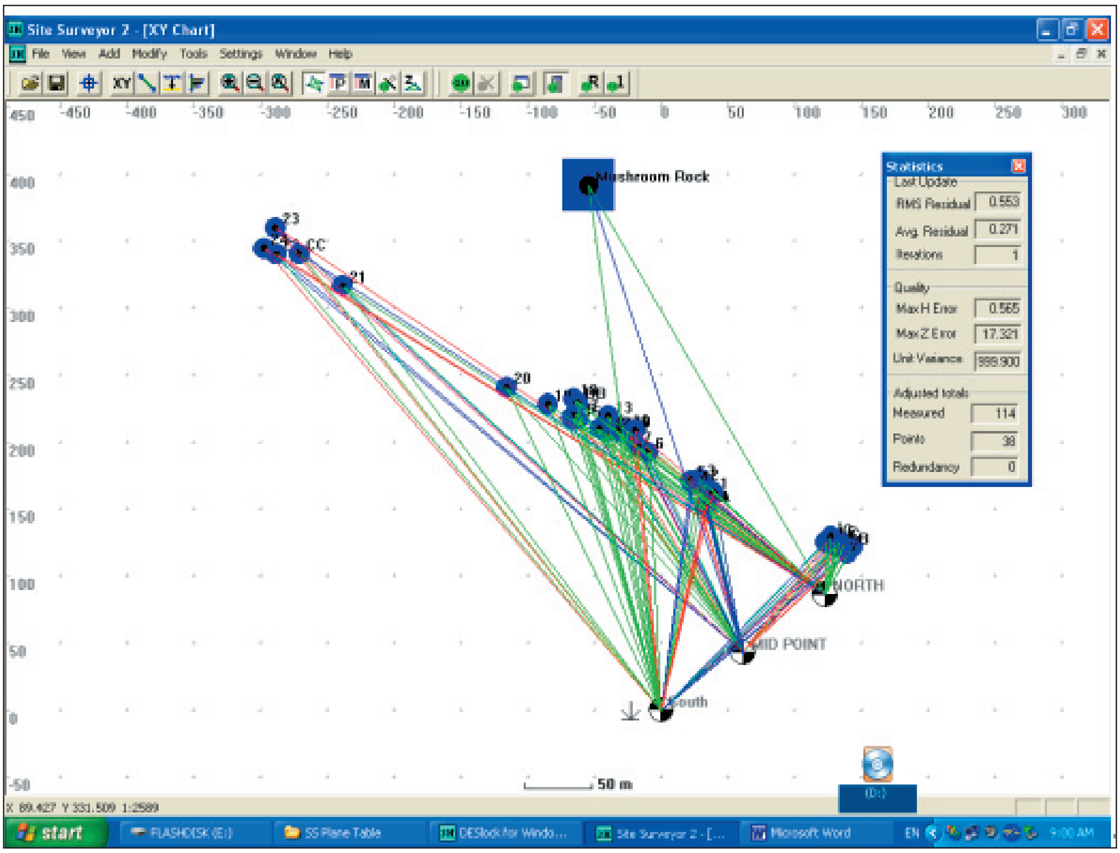

Figure 24. Adjusted *Site Surveyor* plot for the plane table survey.

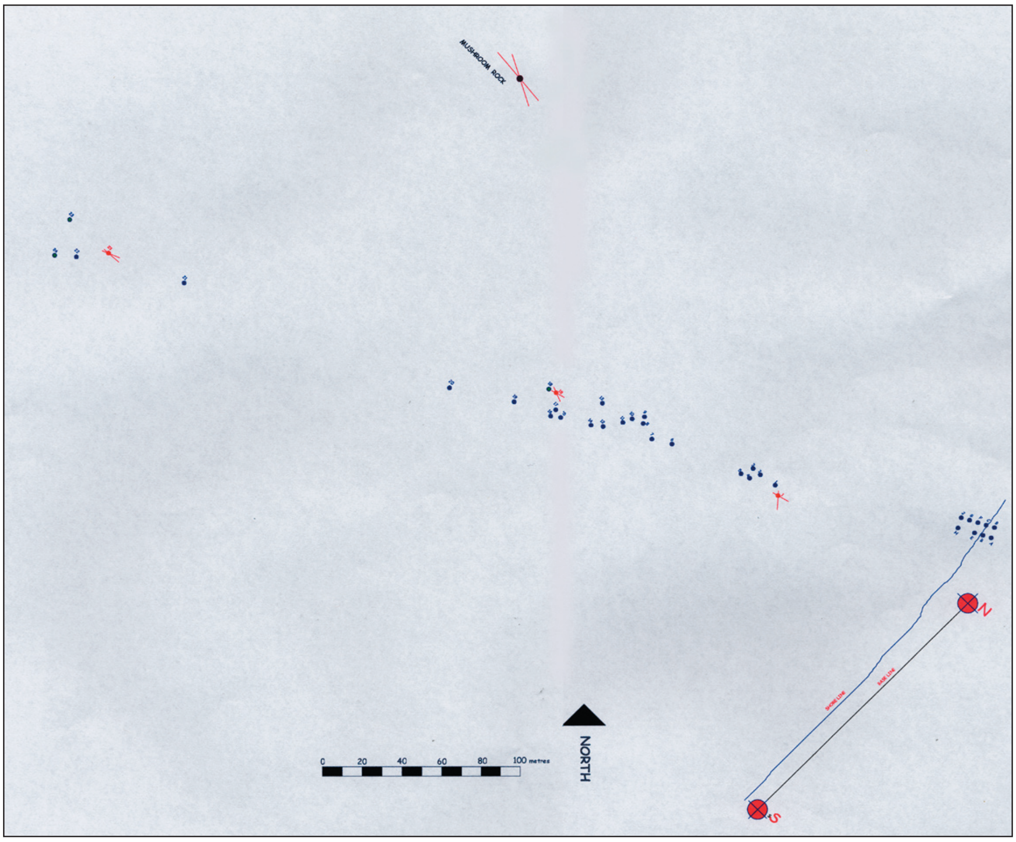

Figure 25. Plane table survey. Courtesy of C. Cockram (MAAWA).

8.2.1. Constraints

Because of the long distances involved, errors in slight adjustment of the alidade can generate large errors in position over the distance. It is a good method for generating an overview of a site like a jetty because many points can be recorded with relative ease. These errors constitute the major error type of the method but there is also the problem of incorrect levelling, transcription and precision errors (writing the wrong distance down or incorrect measurement of the distance) (Green & Gainsford 2003:252–261).

8.3. Shore section

A standard Camedia 4050 digital camera which had been previously calibrated was used to record a series of photographs of beach remains of the Hamelin Bay Jetty. Photographs were side on, end on and oblique angled images from *c.* 25°–30° above the horizontal taken from cliffs along the shoreline. Ten photographs in total were acquired of the remains. Photographs chosen for the project were as far as possible orthogonal. Photographs were downloaded from the camera, exported into a *PhotoModeler* project and then referenced to each other. This was accomplished by selecting points appearing in a photograph and then referencing the point to the same point in other photographs. Once a series of points had been cross-referenced to each other in multiple photographs, it was possible to process the data. The result of this was a series of referenced photographs where measurements from one point to another are obtainable using the program (see Figure 26). Further processing will allow a three dimensional image of the jetty remains to be developed. This is an excellent program that allows a quick survey to be completed, in minimal time and with minimal error (Green & Gainsford 2003:252–261).

GPS positions were acquired for some of the piles (the two bent sections) that remain on the shore section of the jetty. This helped with the processing of the data in the *GIS* software.

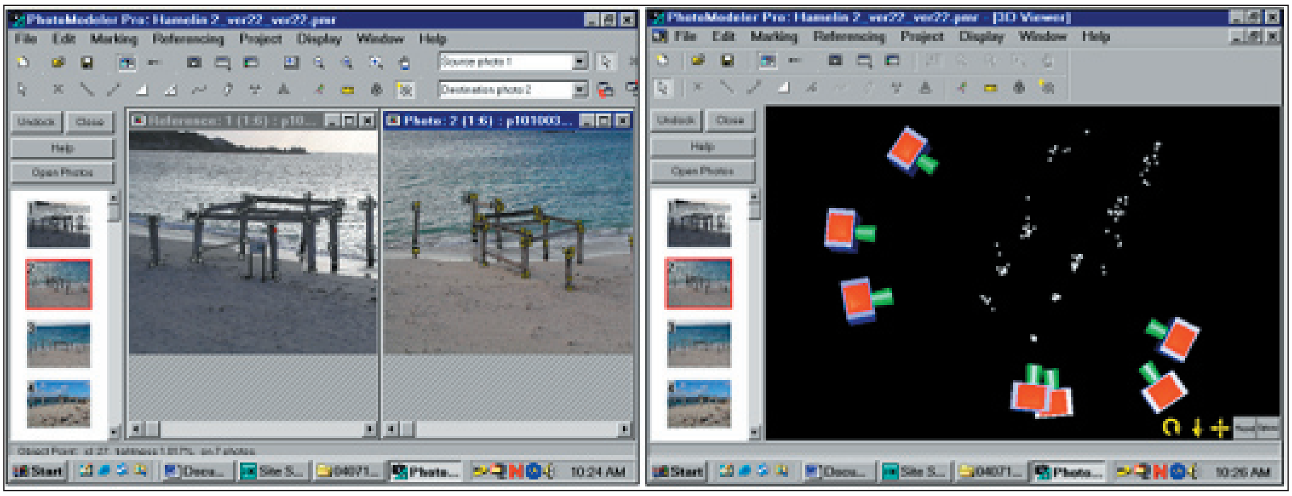

Figure 26. *PhotoModeler* screen captures of the shore section. M. Gainsford.

8.3.1. Constraints

Although this technique in theory is a great tool for the three-dimensional modelling of archaeological sites it requires a certain amount of expertise to use the software and acquire the photographs. In this particular project the photos acquired during fieldwork were good but not excellent, one or two more photographs from the sea side on an oblique angle would have made the survey simpler to complete and even more accurate. However, once the user has grasped how the software works then it becomes quite simple to operate.

8.4. Middle section

Only one survey could be conducted during the April fieldwork at Hamelin Bay by MAAWA volunteers and MADWAM staff. This was due to inclement weather on the first day and only a small window of fine weather on the second. Personnel included Sandy and Helen McCall, Clive Tolley and Matthew Gainsford. Snorkel and BCD were utilised for the survey as per previous surveys. The team swam out to the site, which is located about 250 metres from the shore. The section consists of both submerged piles and piles that break the surface. Piles measured, were all piles that broke the surface at low water (see Figure 27).

The survey used inter-point tape trilateration successfully surveying all of the middle section of the jetty. Two–three points were measured to each pile and measurement origins taken from the same position on each pile (the mid point of the pile). Transcription and measurement errors were minimised by repeating measured distances and rechecking measurements. Once data had been obtained it was collated and a plan drawn up with all measurements and piles labelled (see Appendicies C & D).

The data was then transferred to an *Excel* spreadsheet. This format was modified to comma delimited file format (csv), then was exported into *Site Surveyor* (*Site Surveyor* will only accept csv imports). After the data was imported into *Site Surveyor* it was adjusted with the programs formula which produced a real site plan of the measured points with error (this formula is a set of parameters that the computer uses to calculate a series of iterations on the data). This site plan is representative of the jetty remains at Hamelin Bay for the middle section. Once the project had been adjusted the total error of the survey was RMS±0.005

metres (see Figure 28).

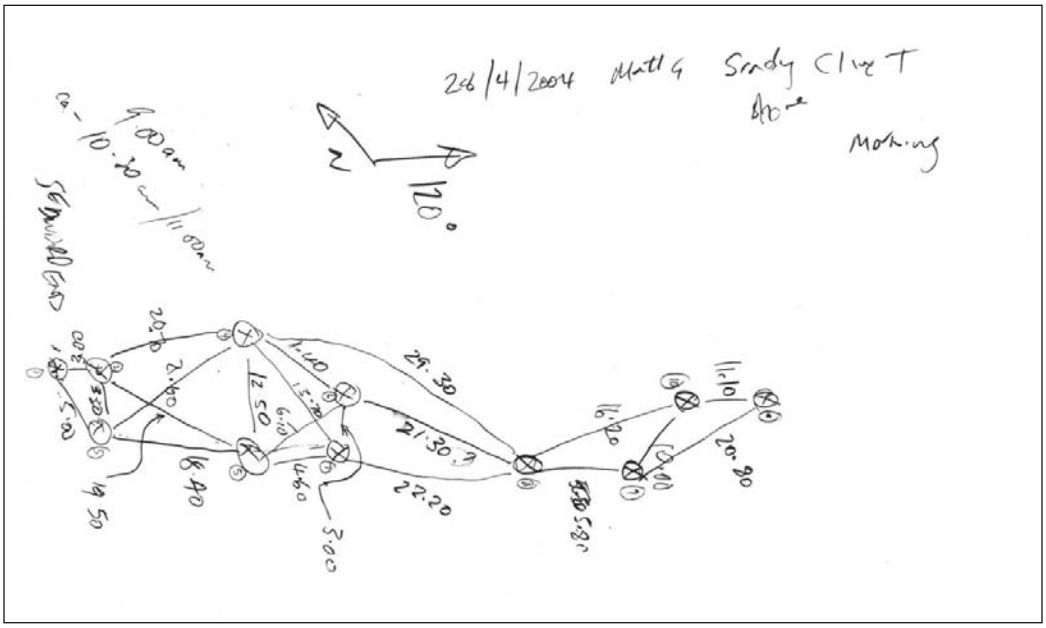

Figure 27. Underwater sheet for the middle section survey.

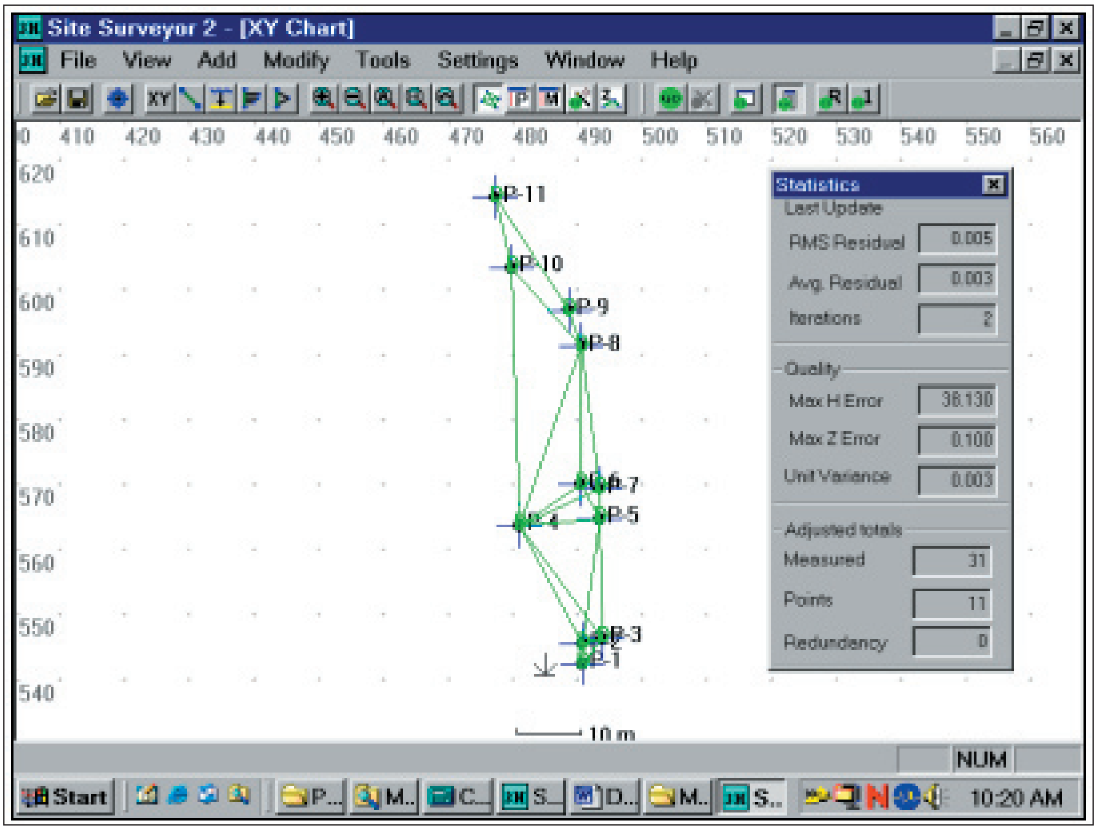

Figure 28. *Site Surveyor* plot for the middle section.

8.4.1. Constraints

The survey of the middle section was undertaken with minimal constraints, more measurements could not be taken because the team had to wait for inclement weather to pass before the survey could begin. The system was relatively simple to employ but carries with it the problem of measurement error over distance and transcription errors that can occur from misreading the tape, or miswriting the measurement. However, data collated and processed returned favourable results.

8.5. End section

The survey required the use of dinghies for transporting personnel to the site, about 400–500 metres from the shore. The site was divided into two halves with a team on either side of a baseline surveying their side. The survey was successful, locating all piles within reach of the surface i.e., both submerged piles and non-submerged piles (see Figure 29). It did not include all piles that could be seen from the surface, or piles that could not be reached from the surface or were not visible. The survey was conducted using inter-point tape trilateration - all points were measured with standard fibreglass tape measures and fixed into the network (and baseline) with measurements to other points. The amount of data gained was satisfactory with sufficient redundancy to each point. However, when the data was imported into *Site Surveyor* (csv import) it did not adjust well (adjust, i.e., apply its formula to the data to provide a plan with error). It appears that there is considerable error in many of the measurements making the survey difficult to process (see Figure 30). Types of error that could account for this could be transcription error, measuring to the wrong point or possibly tape catinering (bowing). The survey whilst it looks good on paper at present cannot be adjusted to provide real error. Furthermore, not all of the points can be included in the *Site Surveyor* adjustment because of the poor measurements and illegible writing. The total error of the adjustable points is RMS±0.233 metres (see Appendix E).

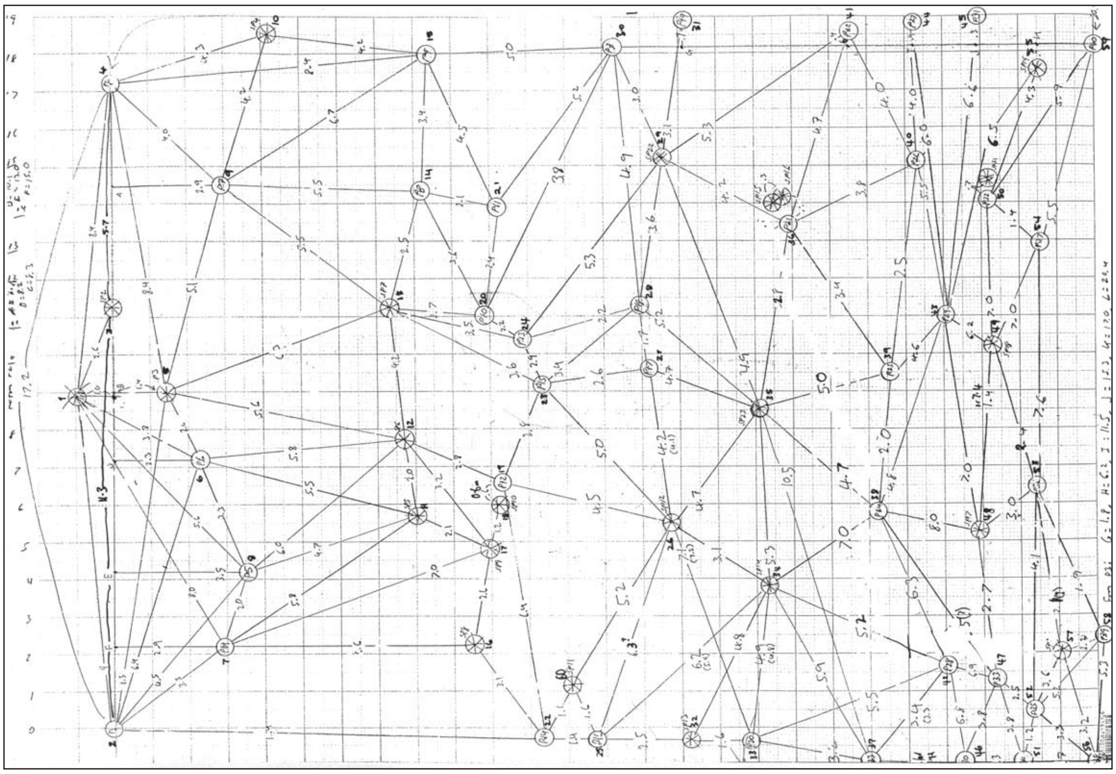

Figure 29. Underwater survey sheet for the end section.

8.5.1. Constraints

The survey of the end section perhaps would have been more easily completed with one team all working under strict guidelines. A more structured plan should have been established because of the large number of piles to be measured. Another problem is that piles may have been measured twice, more than twice, not at all, or the wrong pile was measured. To be entirely positive that piles are only fixed into the network once each pile should in future, be labelled with a plastic tag with a number or letter. The data was entered into *Site Surveyor* for processing, but because the data is in a state of disarray it seems unlikely that an adjusted survey with real error will result for all of the piles, only (as mentioned above) a minority of the piles can be adjusted.

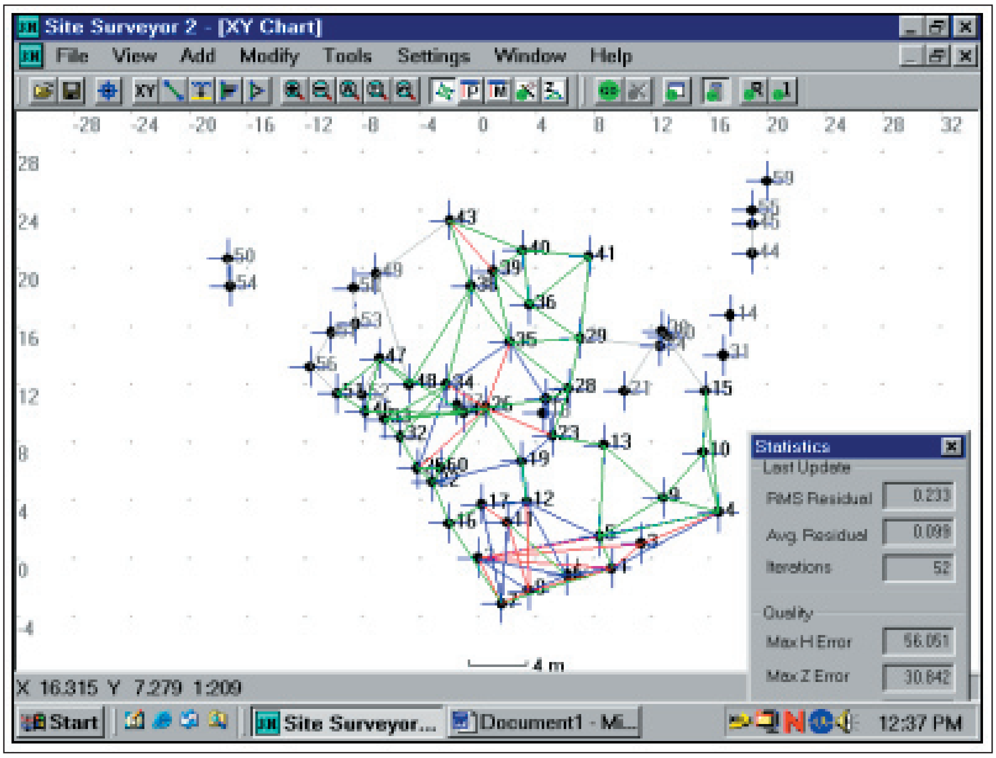

Figure 30. Adjustable points for the end section of the jetty.

8.6. Survey conclusion

Based on survey results, the amount of jetty surveyed and its attributable error was deemed a relatively successful exercise. Most of the structure has been surveyed using techniques that were reasonably simple that produced in most cases results with minimal error for the area covered. Error for the surveys ranged from ±0.005 m to ±0.271 m (not including the end section that had an error of ±0.233 m). Most methods used are simple to replicate and more surveys can be added to the existing data. A major problem is that piles have not been labelled and some confusion may result when adding to the survey.

Gathered data has been manipulated for use in *GIS* (*ArcMap*) software to produce a survey on geo-referenced charts and aerial photographs (see Figures 31 & 32). The surveys though they have been successful in plotting the remains of the jetty, have been unable to illustrate where the two main sections of jetty lie (two phases of construction). This may be a result of the blasting that occurred which has destroyed the link between the two. Survey results for the plane table were also exported into *Rhino*: a three dimensional modelling program. This enables the reader to view the remains in a simple side-on profile.

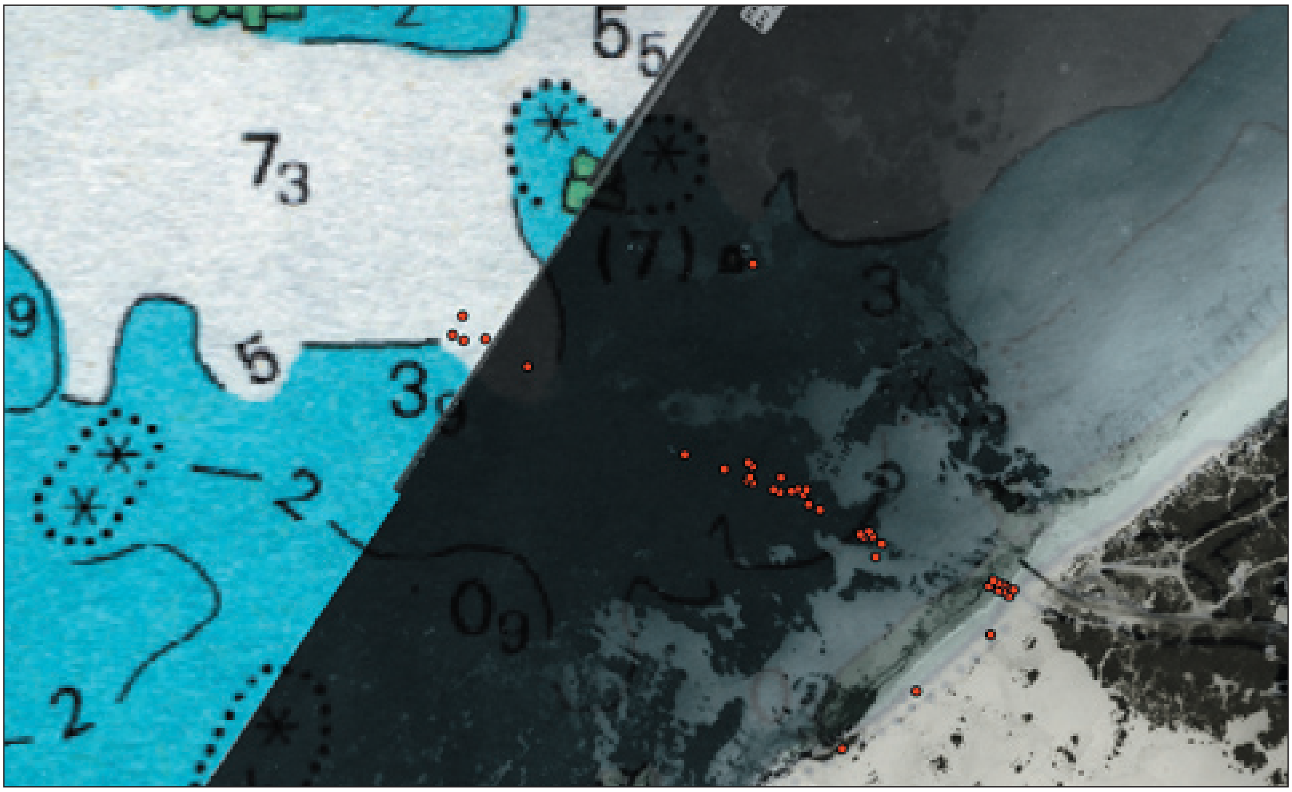

Figure 31. *GIS* image of survey data overlaid on to a geo-referenced chart and aerial. M.Gainsford.

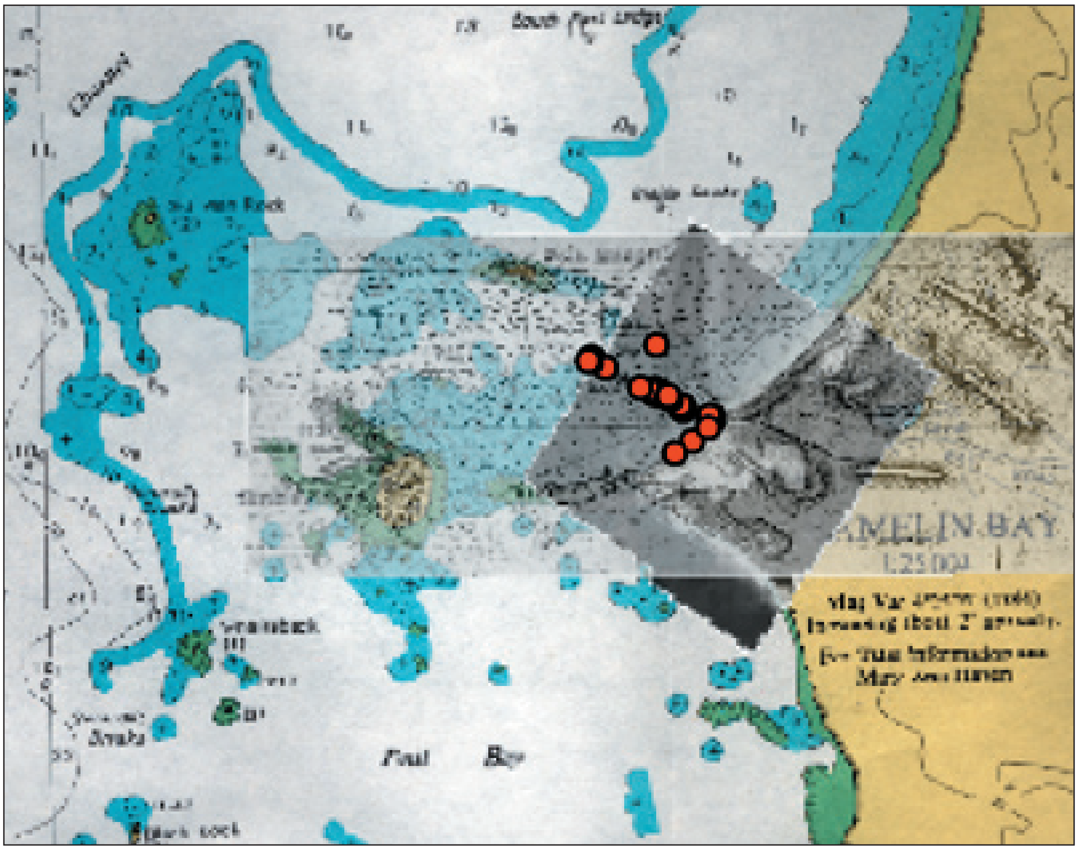

Figure 32. *GIS* image of Hamelin Bay area with survey data. M. Gainsford.

Further fieldwork is intended including the survey and analysis of structure that lies below the reach of snorkelers, pre-disturbance surveys, underwater photography, sediment movement patterning and timber sampling. A total station should be used for future surveys to minimise error and plot positions on to a map grid. Further surveys could be conducted using the same methodology as completed surveys, allowing new results to tie into previous networks, but utilising a total station to tie together existing surveys more effectively. It is not recommended that disturbance work be conducted at the site until all pre-disturbance work has been completed and a suitable hypothesis developed. This allows all the site formation processes to be fully understood and the structure comprehensively surveyed before disturbance work changes the dynamic of the site.

Chapter 9. Legislation and Control

Current legislation pertaining to jetties in Western Australia is not effective for their protection - jetties are not specifically covered under either Commonwealth legislation (*Historic Shipwrecks Act 1976*) or the Western Australian State Act (*Maritime Archaeology Act 1973*). What is debatable about the protection of jetties is that they are not shipwrecks, but may be associated with an historic shipwreck or made of materials from an historic shipwreck. In the case of the Long Jetty, Fremantle it was associated with materials from historic shipwrecks and therefore only the seabed could be covered under this legislation (*Maritime Archaeology Act 1973*):

Section 4(1) that describes maritime archaeological sites states that:

> 4. (1) For the purposes of this Act -
>
> (a) any area in which the remains of a ship, which in the opinion of the Director may have been a historic ship, are known to be located; (b) any area in which any relic is known to be located, or where in the opinion of the Director unrecovered relics associated with a ship which may have been a historic ship are likely to be located; and
> (c) any structure, campsite, fortification or other location of historic interest that, in the opinion of the Director, is associated with, and was occupied or used by, persons presumed to have been in a historic ship, shall be a maritime archaeological site.
>
> (2) A maritime archaeological site may be situated below low water mark, on or between the tide marks, or on land, or partly in one place and partly in another.

One would assume after reading s.4(1)(c) that jetties and other sites should be protected if a structure is of historic interest and is, or has been, used by, or presumed to have been used by, an historic vessel and is considered an archaeological site. However there have been issues raised concerning definitions of terms in the Act:

> The issue of what constitutes a 'structure' for the purposes of the State Act was called into question over the Fremantle Long Jetty in 1984, prior to the Americas Cup Challenge. Crown advice with regard to the jetty piles was quite specific. Delaney (Delaney to director, 14 February 1986, File MA-124/84) stated:
>
> In my opinion s.4(1)(c) is concerned with structures etc. which acquired their association with a historic ship by being occupied or used after that ship was lost, wrecked, abandoned or stranded. The mere fact that a jetty was at some time used by the crew of a ship which was later wrecked etc. does not appear to bring that jetty within the terms of s.4(1)(c) (Delany to Director, 14 February 1986, File MA-124/84) (Department of Culture and the Arts 2003).

The Commonwealth Act is however more specific than its counterpart stating that:

> …an article that appears to have formed part of, to have been installed or carried on, or to have been constructed or used by a person associated with, a ship

(*Historic Shipwrecks Act 1976*, s.3(4)).

Unfortunately, there seems to be a limited explanation of the terms 'constructed or used by a person' (Department of Culture and the Arts 2003). Although there has been a move by the Western Australian Maritime Museum to make the legislation more jetty friendly it seems not to have worked effectively. Although the jetty at Hamelin Bay is not considered a maritime archaeological site under current state legislation, the artefacts present in the seabed, the sediment and the surrounding area become an archaeological site. This has no impact on the jetty structure, and therefore it is not protected from modification or removal. Since the majority of the jetty resides in Commonwealth waters and only some on the shore the best way to protect the site is using a combination of (if possible) Commonwealth and State legislation and the *Heritage of Western Australia Act 1990*.

The Heritage of Western Australia Act 1990 is more specific when dealing with heritage sites for addition into the register and can provide additional protection for jetty sites. Section 47 states:

47. (1) Subject to this Part, where the Minister is of the opinion, having regard to any advice given by the Council in relation to that place and to any report of the Council as to submissions made to the Council under subsection (3) —

(a) that a place —

(i) is of cultural significance; or

(ii) possesses special interest related to or associated with the cultural heritage,

and is of value for the present community and future generations; and

(b) that the protection afforded by this Act is appropriate notwithstanding that the place may be afforded protection by the operation of any other written law or law of the Commonwealth.

The Minister may direct the Council to enter that place in the Register, either as an interim registration or on a permanent basis, and effect shall be given to the direction in accordance with section 50 or 51 as may be specified.

Section 47. (2) states

(a) any distinctive features or scarcity value, the character of the environs of the place, its landscape or township value and, …

(b) any strong association which the place has with any historic personage or significant event or discovery or any development or cultural phase, or whether or not the place provides a notable example of a particular period or type important for general educational, architectural or archaeological reasons that distinguish it from other such examples, or has intrinsic merit and is commonly agreed to be—

(i) a work of art in itself that enriches the environment; or

(ii) held in high public esteem or sentiment.

Section 48 also has relevance to the idea of nominating jetty sites that are part of a wider precinct:

> 48. Where the Minister is of the opinion that a group of places together form a precinct which is of cultural heritage significance notwithstanding that each place within the precinct does not itself have cultural heritage significance, he may, in accordance with section 47, direct the Council to enter that group of places in the Register as an historic precinct.

Other states' legislation defines maritime cultural heritage in a clearer fashion also. The *New South Wales Heritage Act 1977* defines what items are considered to have cultural significance for protection, the issuing of interim heritage orders and nomination of sites for the State Heritage Register. Section 4A defines State and local significance:

> **4A** Heritage significance—interpretation
> (1) In this Act:
> ***State heritage significance***, in relation to a place, building, work, relic, moveable object or precinct, means significance to the State in relation to the historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic value of the item.
> ***local heritage significance***, in relation to a place, building, work, relic, moveable object or precinct, means significance to an area in relation to the historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic value of the item.
> (2) An item can be both of State heritage significance and local heritage significance. An item that is of local heritage significance may or may not be of State heritage significance.
> (3) The Heritage Council is to notify the Minister of the criteria that it uses for the making of decisions as to whether or not an item is of State heritage significance and is to notify the Minister of any change to those criteria that may occur from time to time. The Minister is to cause notice of the criteria and any such change to the criteria to be published in the Gazette.

Also, the Act allows the Minister to make interim heritage orders and direct listings on the State Heritage Register:

> **24** Minister can make interim heritage orders for items of State or local heritage significance
> (1) The Minister may make an interim heritage order for a place, building, work, relic, moveable object or precinct that the Minister considers may, on further inquiry or investigation, be found to be of State or local heritage significance.
> (2) The Heritage Council is to provide advice to the Minister on the making of interim heritage orders, either at the request of the Minister or on its own initiative.
>
> **32** Minister can direct listing on State Heritage Register
> (1) The Minister may direct the listing on the State Heritage Register of a place, building, work, relic, moveable object or precinct that the Minister

considers is of State heritage significance, but only if the Heritage Council recommends the listing.
(2) The Heritage Council may make such a recommendation to the Minister either at the request of the Minister, or on the Heritage Council's own initiative, or at the request of the owner of the item concerned or of the council of the area in which the item is situated.
(3) A listing in respect of an item can be expressed to apply (and if so expressed does apply) to:
(a) if the item is a building—the curtilage of that building or the site of that building, being the curtilage or site specified or described in the listing, or
(b) if the item is a work or a relic that is attached to or forms part of land—the site specified or described in the listing of that work or relic.

40 What heritage agreement can provide for
A heritage agreement in respect of an item can include provisions relating to all or any of the following:
(a) the conservation of the item,
(b) the financial, technical or other professional advice or assistance required for the conservation of the item,
(c) the review of the valuation of the item or the land on which it is situated,
(d) the restriction on the use of the item or the land on which it is situated,
(e) requirements for the carrying out of specified works or works of a specified kind,
(f) the standards in accordance with which the works are to be carried out,
(g) the restriction on the kind of works that may be carried out,
(h) the exemption of specified activities or activities of a specified kind from Part 4 (Effect of interim heritage orders and listing on State Heritage Register),
(i) the repayment of money advanced or loaned by the Minister under section 45 (Financial and other assistance),
(j) the public appreciation of the State heritage significance of the item,
(k) the availability of the item for public inspection,
(l) the charges made for admission,
(m) such other matters as the Minister considers, on the advice of the Heritage Council, will assist in the conservation of the item,
(n) such other matters as may be prescribed by the regulations.

The *UNESCO Convention on the Protection of the Underwater Cultual Heritage 2001* also is directed at underwater heritage and states that, all underwater cultural heritage should be protected if sites are older than 100 years and are associated with water. Article One states:

For the purposes of this Convention:

1. (a) "Underwater cultural heritage" means all traces of human existence having a cultural, historical or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years such as:
(i) sites, structures, buildings, artefacts and human remains, together with their archaeological and natural context;

(ii) vessels, aircraft, other vehicles or any part thereof, their cargo or other contents, together with their archaeological and natural context; and
(iii) objects of prehistoric character.

The Hamelin Bay Jetty could be nominated as an historical site or historical precinct under a combination of State, Commonwealth and *The Heritage of Western Australia Act 1990,* but again it comes down to interpretation of the legislation. If the *UNESCO* convention was adopted the jetty would be covered under its parameters, because it is a structure that has been '*partially or totally underwater, periodically or continuously, for at least a 100 years*' (*UNESCO* 2001). Jetties in New South Wales are also protected beacsue their legislation states that if a '*place, building, work, relic ... has significance to the state in relation to the historical, scientific ... value of the item ... the Minister can make interim heritage orders for items of State or local significance ... may direct the listing on the State Heritage Register*' (*NSW Heritage Act 1977*).

If there is evidence to suggest one of the above criteria or a combination of criteria then a more solid case can be developed. For sites in Western Australia the *UNESCO* convention is the most likely to provide adequate protection of jetty sites. However, at present the process of protecting jetties in Western Australia (compared with New South Wales) is difficult and unlikely. The Long Jetty is more an exception rather that the rule (Garratt *et al.* 1994; Souter & McCarthy 1998).

More jetties should be protected in Western Australian waters around the state. More examples should be preserved across a cross-section of typologies. Perhaps it is best to follow suit of previous protection and have a two-fold protection of jetties, by firstly protecting the seabed around the site using State and Federal Acts and protecting the structure using the *Heritage of Western Australia Act 1990.* There is always the potential to protect something under the legislation but all avenues need addressing in conjunction with current legislation to remedy the problem of proving its association with the maritime culture, its significance and historical value.

Chapter 10. Discussion and conclusion

10.1. Discussion

Hamelin Bay Jetty is a significant site for Western Australian and Australian history. Jetties were used as prime export and import points around Australia at a time when transport by land was laborious and expensive, providing necessary links to other towns, states and countries previously inaccessible to the population. Trade was the prime focus at Hamelin Bay. Two businessmen settled in the region to export hardwoods from Western Australia's south-west. Initially this did not prove successful and a change in lease-holder from W. Eldridge to M. C. Davies enabled the timber industry to flourish in the region. The region developed as a prime export centre for Karri and other hardwoods with a population that reflected this increased trade. Not only was Hamelin Bay an export port, it was also used for the import of immigrants and supplies. This import and export relied on the jetty that Davies constructed to combat the problem that Eldridge had with poor loading techniques.

The jetty was constructed in two phases and eventually attained a length of 1800 feet (*c.* 550 metres). Its new length allowed vessels of larger drafts to visit the bay and sidle up for loading. However, Hamelin Bay is exposed to the north-west, and storms arriving from this bearing were often severe and wreaked havoc with the vessels in the port. This prompted the construction of a second jetty at Flinders Bay. It was envisaged that vessels would load from Flinders Bay in the winter and Hamelin Bay in the summer, avoiding storms that were frequent in Hamelin Bay during winter. However, the interests of Davies appeared to favour Hamelin Bay and it developed into the prime export port. The industry operated at Hamelin Bay from *c.* 1880–*c.* 1913. The historical information did not provide many answers to the research questions but supplemented the archaeology. It provided information about a host of uses for the jetty and the history of the area but only minimal information concerning the structure itself.

Archaeological work has been conducted by MAAWA and the writer over the last few years. To date most of the jetty has been surveyed with all structure that breaks the surface surveyed. Remains of the structure are mostly represented by piles that both break the surface in three sections and a terrestrial section (part of the shore section), comprised of two bents and other supporting structure. The surveys have concentrated on the remains that break the surface at low water. Jetty remains were divided into three sections to survey: shore, middle and end sections. These were surveyed using a variety of techniques, i.e., tape trilateration, plane table and *PhotoModeler*, with data processed in *Site Surveyor*, *Rhino* and *ArcMap*. Further work should be conducted on the jetty to complete a survey of all structural remains. This should include a total station survey to reduce survey error and provide a systematic survey that can be added to existing data. Results from the surveys varied between good and not so good. The shore section and middle section produced good survey results and error whilst the end section was disjointed and returned unfavourable results. The end section does not seem to have been properly surveyed and subsequently the results during processing in site surveyor returned poor results. Also, more pre-disturbance work should be conducted at the site. This includes, determining what remains lie on the seabed (if any) and the amount of sediment movement and biological fauna and flora dominating the site, working in conjunction with current site formation theory. If necessary, disturbance work may be conducted, although this is subject to strict considerations and is not considered at this point. The site to date has no legislation covering the structure but if the site is further threatened by development or modification it would be wise to consider nominating some of the structure and the area around the site as a heritage precinct under the *Heritage of Western Australia Act 1990*. Sites in Western Australia and Australia-wide could be more easily legislated for in the future by adopting the *UNESCO Convention on the Protection of the Underwater Cultural Heritage 2001* as a basis for protecting all underwater cultual heritage.

10.2. Conclusion

Hamelin Bay was a focal point for the timber industry in the south-west of Western Australia. During a period when the region was sparsely populated with pastoralists and settlers, Eldridge moved in to take advantage of the timber resource, but failed from both misfortune and poor business sense. Davies filled the gap in the industry securing timber leases, machinery and building a jetty to provide more secure transfer of timber from the shore to vessels. The jetty was constructed in two phases eventually reaching a length of *c*. 1800 feet (550 metres) and included a number of amenities to assist the process of transfer.

This thesis provides an historical account of the jetty, the timber trade and the region. It has investigated the various types of vessels that frequented the port, their number, their destination and their cargo. It is now apparent that vessels were not only loading timber but also trading in other goods. Mail, imports and immigrants were all imported to Hamelin Bay by the vessels that plied the route. Often vessels would stop *en route* to load a cargo of timber on their way back from Fremantle or other ports. Research utilised a number of sources and developed information on the historical background of the area, but could not locate significant information on the structure of the jetty in the records. Either, these are missing, or were not archived from the construction. The historical information detailed very accurately the life of Davies, his family and the business but did not outline exact dates of construction for the jetty. Also, it did not mention why the jetty was built to this format, how it was built or how long the construction lasted. The jetty is wooden pile construction but the method does not seem to conform with other contemporary jetties, for example, Flinders Bay Jetty, Augusta because of the lack of strengthening braces. Perhaps the jetty was seen as a temporary structure that was intended to be used for a relatively short period. Perhaps this was until the supply of wood diminished or Flinders Bay was established enough to take over? It is difficult to establish whether the method of construction increased the destruction of the jetty. There have been many cultural transformations that have destroyed significant sections of the structure including fire and blasting. More investigation is needed in this area. It therefore follows that archaeological investigation of such structures is necessary when investigating these sites as the historical accounts provide information that is interesting but not always relavent to what is being studied. This may not always be the case but it is with the Hamelin Bay Jetty. Limited information must be coupled with archaeological information to compose a more complete picture of the jetty and its construction. In this case the historical information sets the scene more than it provides information relavent to the construction and use of the jetty.

Site formation processes at the site have been investigated. The site resides within a highly mobile environment. The sediment is light coloured, medium-to coarse grained, and highly mobile.The site is subject to north-westerly winds in winter that transport sediment on to the site by cross-shore and longshore drift. This decreases the slope of the beach and covers the site with sediment possibly protecting the site slightly. However the ferocity of storms is well documented during this period and the strong wind and wave action have destroyed a significant amount of the site. This weather pattern also has the ability to transform the site, altering the layers in the sediment and disorganising material culture that lies below. In summer the site is more protected because winds tend from the south-west, producing lower wind and wave forces. This decrease in wind and wave activity produces a greater sloped beach because cross-shore and longshore drift remove sediment and possibly expose material and the structure. Cultural transformations have also affected the jetty. Fire and blasting have destroyed significant sections of the stucture which has accelerated the degradation of the jetty. Aside from environmental forces the archaeological record has been influenced by people using the jetty. Loss and discard of objects or materials would have occurred frequently, and some record of these should be evident if they have survived the forces acting on the site. The jetty is in a state where the environmental site formation processes are now becoming increasingly dominant, because only piles remain which have little structural support. It is recommended that more pre-disturbance work be conducted to accurately map the remaining structure of the jetty before the amount of sediment migration and the levels of infestation from marine fauna accelerate its degradation. Site formation processes occurring at Hamelin Bay are inferred from a range of sources and have been built into a schema for Hamelin Bay and jetty sites in general. Further study should be conducted to more fully understand formation processes of similar sites, including sediment migration patterns, wind direction and strength and biological processes. Information gathered in this thesis concentrates on jetty site formation processes. Other sites should have similar components to their formation. Therefore, this information can be modelled to other sites or used as a reference to build on.

There are significant jetty remains at the site and surveys of the structure to date are useful for interpreting the size of the jetty and its structure. Until these surveys, the jetty had not undergone any major archaeological work. The focus was shipwrecks as archaeological sites. Surveys of the jetty have been conducted over the last few years by MAAWA and more recently the writer. They have covered most sections of the jetty that are above the low water mark reachable by snorkellers on the surface. The main methods employed were, a plane table survey from the beach and tape trilateration surveys in the water. The plane table survey incorporated piles from all sections of the jetty using two base stations and returned an error of ±0.271 metres. Other sections of the jetty produced good results also: the middle section (inter-point tape trilateration) returned an error of ±0.005 metres and the end section ±0.233 metres. However, the end section would not adjust completely. There remain substantial points that need to be re-measured, though it is hard to determine what points need re-measuring from the previous survey. It is perhaps best to re-survey all of the end section with a total station. Other archaeological techniques that were used during the survey were *PhotoModeler* (survey of the shore section) and the *GIS* application *ArcMap. PhotoModeler* was used to reference a series of photographs of the jetty to each other enabling a lines drawing of the structure to be developed. It also generated three-dimensional points that can be further processed to develop a model of the structure. The survey established by *PhotoModeler* after processing represents the land section of the jetty. The *GIS* processing of data involved geo-referencing *TIFF* images (charts, aerial photographs and survey data) and overlaying them on top of each other. The survey data can then be viewed with different background information. This was very successful as the data is now in a format that can be easily interpreted by a large section of the community. Surveying jetty sites requires a reasonable amount of planning. Often sites are broken up or lie over a large area. Survey methods outlined in this thesis are all suitable for jetty survey, however some are better than others. For jetty sites a system should be considered that provides the lowest amount of error possible and can cover a jetty quickly and completely. From this thesis it is proposed that inter-tape trilateration in combination with a plane table survey are used. These return complete and relatively accurate surveys with reasonable error and provide quite accurate results that do not require a lot of capital or expertise in their execution. Problems that must be planned for are the correct measurement of the jetty structure and the problem of transcription error. If these are accounted for a survey could be accomplished relatively quickly and accurately.

The Hamelin Bay Jetty is not protected by any legislation. This is a problem with jetty structures in Western Australia. Sites can be nominated under Commonwealth and State legislation if a site is associated with or formed part of an historic vessel. However, this does not apply to the structure of a jetty but the sediment surrounding it, because the Acts do not properly define terms or there is arguement to their exact definition. The site therefore could be considered under multiple legislation. Either the State or Commonwealth Acts could protect the seabed and the *The Heritage of Western Australia Act 1990* could cover the structure. This has previously been the case for jetties in Western Australia, for example, the Fremantle Long Jetty. This does not seem to be the most efficient way to protect a site because of the probelms in nominating the site under both legislations. If a more holistic legislation was adopted like the *UNESCO Convention on the Protection of the Underwater Cultural Heritage* (2001) then the site would be protected automatically if it was *'partially or totally underwater, periodically continuously, for at least a hundred years*.*'* Currently jetty sites in Western Australia can be legislated for but the process is two-fold in its approach. It would be simpler to propose legislation for Australia like the *UNESCO* convention as it automatically covers sites irrespective of their nature, if they are associated with water and are older than a hundred years.

Since timber sampling was unable to be accomplished due to time constraints, it is a recommendation of this thesis to acquire timber samples from the site in the future. This should help to determine the construction materials of the jetty, and also if there is a difference between materials used in the two major construction periods.

Jetty sites need to be increasingly investigated into the future because they are currently at risk from a lack of legislation or maintenance. They are structures that are archaeologically important because they played a significant role in colonies flourishing and early trade in Australia. This thesis has identified ways that a jetty can be studied historically, archaeologically (survey and site formation), legislatively and offers information to build on in the future. If more studies are available then more information can be accessed by other archaeologists or the public when investigating jetty structures. Further interpretation can also be preapred as a result of more study. Signage and public information enables a greater section of the community access to information outlined in theses or other historical-archaeological studies.

Glossary

Barque	Three or more masts fore and aft rigged on the aftermost mast and square rigged on all others.
Barquentine	Three or more masts fore and aft rigged on all but the fore-mast which is square rigged.
Bent	A section of jetty that runs perpendicular to the direction of the jetty i.e. two piles that are connected by halfcaps and walings.
Berth	Place a vessel can dock and stay at until completion of loading.
Braces	Diagonal beams that strengthen the jetty structure between piles or similar.
Brig	Two-masted vessel square rigged on both masts.
Burthen	In weight.
Calibrate	Checking an instrument against an accurate standard to find errors to correct for.
Corbels	Short lengths of timber secured to piles to support the halfcaps.
Crosshead	A horizontal length of timber joining piles together by their tops longitudinally.
Davit	Used like a small crane but with pulleys and blocks.
Decking	The walking surface of a jetty, usually laid perpendicular to the direction of the structure.
Draft	Depth of the hull below the waterline.
En route	On the way to.
Fender	A sacrificial pile on the outside of a main pile preventing impact from docking vessels on the main structure of a jetty.
Halfcaps	Horizontal lengths of timber that join piles together by the tops in a bent.
Hawse	The way which a ships' lines are deployed when both anchors are deployed at the same time.
Lighter	Light or small vessels used to load larger vessels at anchor.
Matrix	Reference grid to determine the least number of measurements needed.
Pile	Poles that are rammed into the seabed to create the basis of support for a jetty.
Redundancy	Number of measurements you can remove before your data does not work anymore.
Sidle-up	Dock to a structure.
Super feet	100 super feet = 0.236m^{3}.
Walings	Similar to halfcaps, but join piles below the bracing in a bent.

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Appendix A: Plane table survey results for *Site Surveyor*

Plane Table Survey						
	Survey			Metres		
	N	M/P	S	N	M/P	S
a	2.30	7.10	12.10	34.5345	106.6066066066	181.6816816817
b	2.70	7.50	12.50	40.5405	112.6126126126	187.6876876877
c	2.70	7.40	12.30	40.5405	111.1111111111	184.6846846847
d	2.35	7.05	12.05	35.28525	105.8558558559	180.9309309309
e	2.40	6.95	11.90	36.036	104.3543543544	178.6786786787
f	2.75	7.33	12.25	41.29125	109.984984985	183.9339339339
g	2.80	7.25	12.17	42.042	108.8588588589	182.7327327327
h	2.60	6.83	11.70	39.039	102.5525525526	175.6756756757
I	2.90	7.20	12.10	43.5435	108.1081081081	181.6816816817
1	7.55	8.10	11.10	113.36325	121.6216216216	166.6666666667
2	8.20	8.60	11.45	123.123	129.1291291291	171.9219219219
3	8.50	8.90	11.65	127.6275	133.6336336336	174.9249249249
4	8.45	8.65	11.35	126.87675	129.8798798799	170.4204204204
5	8.80	8.90	11.50	132.132	133.6336336336	172.6726726727
6	11.30	11.00	12.80	169.6695	165.1651651652	192.1921921922
7	11.95	11.55	13.15	179.42925	173.4234234234	197.4474474474
8	12.45	12.15	13.70	186.93675	182.4324324324	205.7057057057
9	12.50	12.30	13.95	187.6875	184.6846846847	209.4594594595
10	12.90	12.50	14.05	193.6935	187.6876876877	210.960960961
11	13.10	12.60	14.00	196.6965	189.1891891892	210.2102102102
12	13.60	12.90	14.10	204.204	193.6936936937	211.7117117117
13	14.00	13.55	14.85	210.21	203.4534534535	222.972972973
14	13.95	13.20	14.30	209.45925	198.1981981982	214.7147147147
15	15.10	14.17	15.00	226.7265	212.7627627628	225.2252252252
16	15.40	14.45	15.20	231.231	216.966966967	228.2282282282
17	15.35	14.50	15.30	230.48025	217.7177177177	229.7297297297
18	15.85	15.17	16.05	237.98775	227.7777777778	240.990990991
19	16.75	15.70	16.20	251.50125	235.7357357357	243.2432432432
20	18.95	17.70	17.80	284.53425	265.7657657658	267.2672672673
21	28.55	27.05	26.40	428.67825	406.1561561562	396.3963963964
22	32.20	30.60	29.70	483.483	459.4594594595	445.9459459459
23	32.90	31.50	30.70	493.9935	472.972972973	460.960960961
24	32.85	31.25	30.30	493.24275	469.2192192192	454.954954955
A	7.30	7.70	10.25	109.6095	115.6156156156	153.9039039039
B	15.60	14.90	15.83	234.234	223.7237237237	237.6876876877
C	31.25	29.70	29.00	469.21875	445.9459459459	435.4354354354
MR	23.50	24.45	26.30	352.8525	367.1171171171	394.8948948949

Appendix B: Photograph outlining points used in the plane table survey

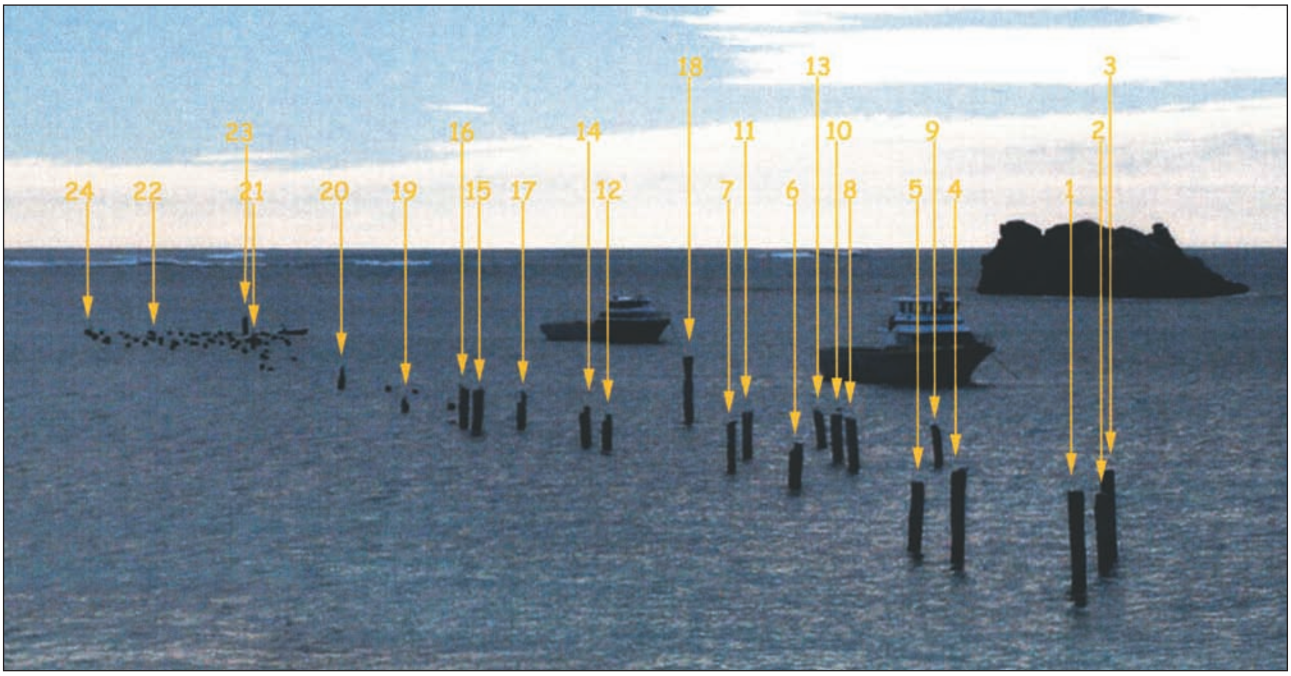

Photo: courtesy of C. Cockram

Appendix C: Middle section survey data for *Site Surveyor*

PRJ							
PNT	P-1	0	0	0	NORMAL	N	N
PNT	P-2	0	3	0	NORMAL	N	N
PNT	P-3	3.3	3	0	NORMAL	N	N
PNT	P-4	0	23	0	NORMAL	N	N
PNT	P-5	12	21	0	NORMAL	N	N
PNT	P-6	0	30	0	NORMAL	N	N
PNT	P-7	3	26	0	NORMAL	N	N
PNT	P-8	2	50	0	NORMAL	N	N
PNT	P-9	2	59	0	NORMAL	N	N
PNT	P-10	0	65	0	NORMAL	N	N
PNT	P-11	0	76	0	NORMAL	N	N
MES	DIST	P-1	P-2	3	0.1	N	
MES	DIST	P-1	P-3	3.3	0.1	N	
MES	DIST	P-2	P-4	20.7	0.1	N	
MES	DIST	P-2	P-5	19.5	0.1	N	
MES	DIST	P-3	P-4	21.6	0.1	N	
MES	DIST	P-3	P-5	18.4	0.1	N	
MES	DIST	P-4	P-5	12.5	0.1	N	
MES	DIST	P-4	P-6	11.4	0.1	N	
MES	DIST	P-4	P-7	13.7	0.1	N	
MES	DIST	P-4	P-8	29.3	0.1	N	
MES	DIST	P-5	P-6	6.1	0.1	N	
MES	DIST	P-5	P-7	4.6	0.1	N	
MES	DIST	P-6	P-7	3	0.1	N	
MES	DIST	P-6	P-8	21.3	0.1	N	
MES	DIST	P-7	P-8	22.2	0.1	N	
MES	DIST	P-8	P-9	5.8	0.1	N	
MES	DIST	P-8	P-10	16.2	0.1	N	
MES	DIST	P-9	P-10	10	0.1	N	
MES	DIST	P-9	P-11	20.8	0.1	N	
MES	DIST	P-10	P-11	11.1	0.1	N	

Appendix D: Inspection data from last fieldwork

Inspection Data

Site Name: Hamelin Bay Jetty   Date Lost/or in Disuse: 1913

Date of Inspection: 26-28 March 2004   OIC: Matthew Gainsford

Personnel: Matthew Gainsford, Clive Tolley & Sandy McCall

Approximate Location (sketch): See thesis
Sailing directions: Nil (Hamelin Bay)

GPS: 34°13.263' south, 115°01.660 east   Datum: WGS 84

Chart used + No.: AUS 335

Compass Bearings: Not needed
Sextant Angles: Not needed
Visual Transits: Not needed

Site Photographs:
Colour (SLR or Digital): Digital see Maritime Volume 2 server: Hamelin Bay

Site Conditions on Inspection:
Sea and Swell: Choppy sea nil swell
Surge: nil
Visibility: 1-2 metres
Current: slight
Sea-bed Coverage: sand

Diving Medium (salt or freshwater): salt

Chemical Measurements:
Temperature: Nil
Salinity: Nil
pH: Nil
Dissolved Oxygen: Nil
Corrosion Potentials (Reading and Location): Nil

Biological Data:
Colonising Fauna: Stingrays and other fish

Colonising Flora: clorophytes

Site Condition and Integrity:
Site is broken into three section, a section close to and adjoining the beach, a middle section and an outer section. These sections have been separated via blasting for shipping channels. A significant number of piles remain in quite good condition, however there is also quite a number that have been blasted away or lie on the bottom.

Appendix E: End section survey data for *Site Surveyor*

PRJ						
PNT	1	5	0	0	NORMAL	L1
PNT	2	0	0	0	NORMAL	L1
PNT	3	7	0	0	NORMAL	L1
PNT	4	10	0	0	NORMAL	L1
PNT	5	5	1	0	NORMAL	L1
PNT	6	4	2	0	NORMAL	L1
PNT	7	2	3	0	NORMAL	L1
PNT	8	3	3.5	0	NORMAL	L1
PNT	9	8	4	0	NORMAL	L1
PNT	10	11	5	0	NORMAL	L1
PNT	11	4	8	0	NORMAL	L1
PNT	12	5	8	0	NORMAL	L1
PNT	13	6	8	0	NORMAL	L1
PNT	14	8	8	0	NORMAL	L1
PNT	15	10	8	0	NORMAL	L1
PNT	16	2	10	0	NORMAL	L1
PNT	17	4	10	0	NORMAL	L1
PNT	18	4.5	10	0	NORMAL	L1
PNT	19	4.75	10	0	NORMAL	L1
PNT	20	6	10	0	NORMAL	L1
PNT	21	8	10	0	NORMAL	L1
PNT	22	0	12	0	NORMAL	L1
PNT	23	5	12	0	NORMAL	L1
PNT	24	5.5	11	0	NORMAL	L1
PNT	25	0	13	0	NORMAL	L1
PNT	26	5	15	0	NORMAL	L1
PNT	27	9	14	0	NORMAL	L1
PNT	28	10	13	0	NORMAL	L1
PNT	29	14	14	0	NORMAL	L1
PNT	30	17	12	0	NORMAL	L1
PNT	31	17	14	0	NORMAL	L1
PNT	32	0	14	0	NORMAL	L1
PNT	33	0	16	0	NORMAL	L1
PNT	34	5	16	0	NORMAL	L1
PNT	35	10	16	0	NORMAL	L1
PNT	36	15	17	0	NORMAL	L1
PNT	37	0	19	0	NORMAL	L1
PNT	38	7	19	0	NORMAL	L1
PNT	39	11	19	0	NORMAL	L1
PNT	40	16	20	0	NORMAL	L1
PNT	41	19	18	0	NORMAL	L1
PNT	42	3	22	0	NORMAL	L1
PNT	43	12	22	0	NORMAL	L1
PNT	44	19	21	0	NORMAL	L1

PNT	45	19	23	0	NORMAL	L1
PNT	46	0	22	0	NORMAL	L1
PNT	47	3	23	0	NORMAL	L1
PNT	48	7	23	0	NORMAL	L1
PNT	49	12	23	0	NORMAL	L1
PNT	50	16	23	0	NORMAL	L1
PNT	51	0	24	0	NORMAL	L1
PNT	52	1.5	24	0	NORMAL	L1
PNT	53	8	24	0	NORMAL	L1
PNT	54	15	24	0	NORMAL	L1
PNT	55	19	24	0	NORMAL	L1
PNT	56	0	26	0	NORMAL	L1
PNT	57	3	25	0	NORMAL	L1
PNT	58	3.5	26	0	NORMAL	L1
PNT	59	20	26	0	NORMAL	L1
PNT	60	2	12	0	NORMAL	L1
MES	DIST	1	2	9	0.1	
MES	DIST	1	3	2.6	0.1	
MES	DIST	1	4	8.4	0.1	
MES	DIST	1	5	2.4	0.1	
MES	DIST	1	6	3.8	0.1	
MES	DIST	1	7	8	0.1	
MES	DIST	1	8	5.6	0.1	
MES	DIST	2	3	11.3	0.1	
MES	DIST	2	4	17	0.1	
MES	DIST	2	5	8.5	0.1	
MES	DIST	2	6	6.4	0.1	
MES	DIST	2	7	3.3	0.1	
MES	DIST	2	8	4.5	0.1	
MES	DIST	3	4	5.7	0.1	
MES	DIST	4	5	8.4	0.1	
MES	DIST	4	9	4	0.1	
MES	DIST	4	10	4.3	0.1	
MES	DIST	4	15	8.4	0.1	
MES	DIST	5	6	2.4	0.1	
MES	DIST	5	9	5.1	0.1	
MES	DIST	5	12	5.6	0.1	
MES	DIST	5	13	6.3	0.1	
MES	DIST	6	8	3.3	0.1	
MES	DIST	6	11	5.5	0.1	
MES	DIST	6	12	5.8	0.1	
MES	DIST	7	8	2	0.1	
MES	DIST	7	11	5.8	0.1	
MES	DIST	7	16	6.6	0.1	
MES	DIST	7	17	7	0.1	
MES	DIST	8	11	4.7	0.1	
MES	DIST	8	12	6	0.1	

MES	DIST	9	10	4.2	0.1	
MES	DIST	9	13	5.5	0.1	
MES	DIST	9	14	5.5	0.1	
MES	DIST	10	15	4.2	0.1	
MES	DIST	11	12	2	0.1	
MES	DIST	11	17	2.1	0.1	
MES	DIST	12	17	3.2	0.1	
MES	DIST	12	19	2.8	0.1	
MES	DIST	13	14	2.5	0.1	
MES	DIST	13	20	2.7	0.1	
MES	DIST	13	23	3.6	0.1	
MES	DIST	13	24	3.5	0.1	
MES	DIST	14	15	3.4	0.1	
MES	DIST	14	20	3.6	0.1	
MES	DIST	14	21	2.1	0.1	
MES	DIST	15	21	4.5	0.1	
MES	DIST	15	30	5	0.1	
MES	DIST	16	17	2.6	0.1	
MES	DIST	16	22	3.1	0.1	
MES	DIST	17	18	1.2	0.1	
MES	DIST	18	19	0.6	0.1	
MES	DIST	19	22	6.4	0.1	
MES	DIST	19	23	2.8	0.1	
MES	DIST	19	26	4.5	0.1	
MES	DIST	20	21	2.4	0.1	
MES	DIST	20	24	2.2	0.1	
MES	DIST	20	30	3.8	0.1	
MES	DIST	21	30	5.2	0.1	
MES	DIST	22	25	1.4	0.1	
MES	DIST	22	60	1.1	0.1	
MES	DIST	60	26	5.2	0.1	
MES	DIST	60	25	1.6	0.1	
MES	DIST	23	26	5	0.1	
MES	DIST	23	27	2.6	0.1	
MES	DIST	23	28	3.4	0.1	
MES	DIST	24	28	2.2	0.1	
MES	DIST	24	29	5.3	0.1	
MES	DIST	25	26	6.3	0.1	
MES	DIST	25	32	2.5	0.1	
MES	DIST	25	34	6.2	0.1	
MES	DIST	26	27	4.2	0.1	
MES	DIST	26	33	7.1	0.1	
MES	DIST	26	34	3.1	0.1	
MES	DIST	26	35	4.7	0.1	
MES	DIST	27	28	1.7	0.1	
MES	DIST	27	35	4.7	0.1	
MES	DIST	28	29	3.6	0.1	

MES	DIST	28	30	4.9	0.1	
MES	DIST	28	35	5.2	0.1	
MES	DIST	29	30	3	0.1	
MES	DIST	29	31	3.8	0.1	
MES	DIST	29	35	4.9	0.1	
MES	DIST	29	36	4.2	0.1	
MES	DIST	29	41	5.7	0.1	
MES	DIST	30	31	2	0.1	
MES	DIST	32	33	1.6	0.1	
MES	DIST	32	34	4.8	0.1	
MES	DIST	33	34	4.9	0.1	
MES	DIST	33	37	3.2	0.1	
MES	DIST	33	42	5.5	0.1	
MES	DIST	34	35	5.3	0.1	
MES	DIST	34	37	5.9	0.1	
MES	DIST	34	38	7	0.1	
MES	DIST	34	42	5.2	0.1	
MES	DIST	35	37	10.5	0.1	
MES	DIST	35	38	4.7	0.1	
MES	DIST	35	39	5	0.1	
MES	DIST	36	39	3.4	0.1	
MES	DIST	36	40	3.8	0.1	
MES	DIST	36	41	5.3	0.1	
MES	DIST	37	42	3.4	0.1	
MES	DIST	37	46	2.1	0.1	
MES	DIST	38	42	6.3	0.1	
MES	DIST	38	43	4.8	0.1	
MES	DIST	38	48	8	0.1	
MES	DIST	39	40	2.5	0.1	
MES	DIST	39	43	4.6	0.1	
MES	DIST	40	41	4.6	0.1	
MES	DIST	40	43	5.5	0.1	
MES	DIST	40	44	4	0.1	
MES	DIST	42	46	6.8	0.1	
MES	DIST	42	47	6.9	0.1	
MES	DIST	43	48	7	0.1	
MES	DIST	43	49	6.2	0.1	
MES	DIST	43	55	6.5	0.1	
MES	DIST	43	45	6.9	0.1	
MES	DIST	44	45	1.8	0.1	
MES	DIST	46	47	3.8	0.1	
MES	DIST	46	51	2.3	0.1	
MES	DIST	47	48	2.7	0.1	
MES	DIST	47	51	3.8	0.1	
MES	DIST	47	52	2.5	0.1	
MES	DIST	48	49	7.4	0.1	
MES	DIST	48	53	3	0.1	

MES	DIST	49	50	7	0.1	
MES	DIST	49	53	2.4	0.1	
MES	DIST	49	54	7	0.1	
MES	DIST	50	54	1.4	0.1	
MES	DIST	50	55	4.3	0.1	
MES	DIST	50	59	5.9	0.1	
MES	DIST	51	52	1.2	0.1	
MES	DIST	51	56	2.7	0.1	
MES	DIST	52	53	4.1	0.1	
MES	DIST	52	56	3.3	0.1	
MES	DIST	52	57	3.6	0.1	
MES	DIST	52	58	5.2	0.1	
MES	DIST	53	54	7.6	0.1	
MES	DIST	53	57	2.1	0.1	
MES	DIST	53	58	1.9	0.1	
MES	DIST	54	59	5.5	0.1	
MES	DIST	56	57	3.2	0.1	
MES	DIST	56	58	5.3	0.1	
MES	DIST	57	58	2.3	0.1	

Appendix F: Dive plan from fieldwork

Dive Plan — Hamelin Bay

OIC:	Matthew Gainsford
Place:	Hamelin Bay Jetty
Dates:	26 – 28 March 2004
Dives:	1 per day Sat and Sun

During the period 26-28 March 2004 fieldwork conducted in Hamelin Bay will consist of one dive possibly on each day.

Each dive will be conducted on SCUBA apparatus and as such all divers will have the necessary qualifications and a current medical before diving. Also all divers are trained to AIMA/NAS Part One or greater and have been involved in such procedures before.

Dives will be conducted in sheltered waters within 200 metres from the shore with the focus of the dives being to survey the piles of the Hamelin Bay Jetty, which will be used as a support mechanism. There is to be no boat diving during the fieldwork.

Matthew Gainsford

Appendix G: Hardwood comparison

Comparison: Jarrah and Karri (Clark, 1927)

Jarrah

	Mean
A. Transverse bending test (beams of 20 sq. in. sectional area and at 12 per cent. moisture)—	
Modulus of rupture, lbs. per sq. in.	15,000
Modulus of elasticity, lbs. per. sq. in.	2,080,000
B. Compression test along the grain (ratio 24/1)	
Crushing strength, lbs. per. sq. in.	7,700
C. Compression test along the grain (ratio 12/1 and under)	
Crushing strength, lbs. per. sq. in.	9,100
Modulus of elasticity, lbs. per. sq. in.	1,490,000
D. Compression test along the grain (half length of specimen loaded)	
Fibre stress at 3 per cent. deformation, lbs. per. sq. in.	2,500
E. Shearing test along the grain	
Shearing strength {method of double shear, lbs. per. sq. in.	1,050
Shearing strength {method of single shear, lbs. per. sq. in.	2,010
F. Density	
Green, lbs. per cubic foot	68
Dry (at 12 per cent. moisture), lbs. per. sq. in.	55

Karri

	Mean
A. Transverse bending test (beams of 20 sq. in. sectional area and at 12 per cent. moisture)—	
Modulus of rupture, lbs. per sq. in.	17,300
Modulus of elasticity, lbs. per. sq. in.	2,680,000
B. Compression test along the grain (ratio 24/1)	
Crushing strength, lbs. per. sq. in.	9,400
C. Compression test along the grain (ratio 12/1 and under)	
Crushing strength, lbs. per. sq. in.	10,200
Modulus of elasticity, lbs. per. sq. in.	2,030,000
D. Compression test along the grain (half length of specimen loaded)	
Fibre stress at 3 per cent. deformation, lbs. per. sq. in.	2,800
E. Shearing test along the grain	
Shearing strength {method of double shear, lbs. per. sq. in.	1,050
Shearing strength {method of single shear, lbs. per. sq. in.	1,800
F. Density	
Green, lbs. per cubic foot	72
Dry (at 12 per cent. moisture), lbs. per. sq. in.	58

Appendix H: Excerpt from Lloyd's Australia

No. 2.—A TABLE exhibiting the different Descriptions of TIMBER, of good Quality, to be used in the Timbering of Ships, as the same will be applicable to the several Terms of Years appointed for Ships to remain on the Character A.

PARTS OF THE FRAME OF A VESSEL.	TWELVE YEARS.	TEN YEARS.	NINE YEARS.	EIGHT YEARS.	SEVEN YEARS.	SIX YEARS.	FIVE YEARS.	FOUR YEARS.	PARTS OF THE FRAME OF A VESSEL.
FLOORS............	Red Gum, Flooded Gum, Blackwood, Box, Iron Bark, Swan River Mahogany.	The same as in the preceding class, and admit Blue Gum, Grey Gum, Messmate, Cedar.	(1) The same as in the preceding class, and admit Stringy Bark.	(1) The same as in the preceding class, and admit White Gum and Mountain Ash.	The same as in the preceding class, and admit other colonial Hardwood.	The same as in the preceding class, and admit Kaurie Pine and Huon Pine.	The same as in the preceding class.	The same as in the preceding class.	FLOORS.
1st FUTTOCKS....	Red Gum, Flooded Gum, Blackwood, Box, Iron Bark, Swan River Mahogany.	The same as in the preceding class, and admit Blue Gum, Grey Gum, Messmate, Cedar.	The same as in the preceding class.	The same as in the preceding class, and admit Stringy Bark, White Gum, and Mountain Ash.	The same as in the preceding class, and admit other colonial Hardwood.	The same as in the preceding class, and admit Kaurie and Huon Pine.	The same as in the preceding class.	The same as in the preceding class.	1st FUTTOCKS.
2nd FUTTOCKS...	Red Gum, Flooded Gum, Blackwood, Box, Iron Bark, Swan River Mahogany.	The same as in the preceding class, and admit Blue Gum, Grey Gum, Messmate, and Cedar of the best quality.	The same as in the preceding class.	The same as in the preceding class.	The same as in the preceding class, and admit Stringy Bark, Mountain Ash, White Gum, & other colonial Hardwood.	The same as in the preceding class, and admit Kaurie and Huon Pine.	The same as in the preceding class.	The same as in the preceding class.	2nd FUTTOCKS.
3rd FUTTOCKS and TOP TIMBERS...	Red Gum, Flooded Gum, Blackwood, Box, Iron Bark, Swan River Mahogany.	The same as in the preceding class, and admit Cedar of the best quality.	The same as in the preceding class, and admit Blue Gum, Grey Gum, and Messmate of the best quality.	The same as in the preceding class.	The same as in the preceding class, and admit Stringy Bark, Mountain Ash, White Gum, & other colonial Hardwood.	The same as in the preceding class, and admit Kaurie and Huon Pine.	The same as in the preceding class.	The same as in the preceding class.	3rd FUTTOCKS and TOP TIMBERS.
MAIN and RIDER KEELSONS.....	Red Gum, Flooded Gum, Blackwood, Box, Iron Bark, Swan River Mahogany.	The same as in the preceding class, and admit Blue Gum, Messmate.	The same as in the preceding class, and admit Grey Gum.	The same as in the preceding class, and admit Cedar.	The same as in the preceding class, and admit Stringy Bark, Mountain Ash, White Gum, & other colonial Hardwood, and Kaurie Pine.	The same as in the preceding class, and admit Oregon Pine (2) & Huon Pine.	The same as in the preceding class.	The same as in the preceding class.	MAIN and RIDER KEELSONS.
STEM and STERN POSTS............	Red Gum, Flooded Gum, Blackwood, Box, Iron Bark, Swan River Mahogany.	The same as in the preceding class.	The same as in the preceding class, and admit Blue Gum of the best quality.	The same as in the preceding class.	The same as in the preceding class, and admit Grey Gum, Messmate, and Cedar of the best quality.	The same as in the preceding class, and admit Stringy Bark, White Gum, Mountain Ash of the best quality.	The same as in the preceding class, and admit other colonial Hardwood, & Kaurie & Huon Pine of the best quality.	The same as in the preceding class.	STEM and STERN POSTS.
TRANSOMS........ KNIGHT-HEADS HAWSE TIMBERS........ APRON and DEADWOOD......	Red Gum, Flooded Gum, Blackwood, Box, Iron Bark, Swan River Mahogany.	The same as in the preceding class.	The same as in the preceding class, and admit Blue Gum of the best quality.	The same as in the preceding class.	The same as in the preceding class, and admit Grey Gum, Messmate, and Cedar of the best quality.	The same as in the preceding class, and admit Stringy Bark, Mountain Ash, and White Gum of the best quality.	The same as in the preceding class, and admit other colonial Hardwood, & Kaurie & Huon Pine of the best quality.	The same as in the preceding class.	TRANSOMS, KNIGHT-HEADS, HAWSE TIMBERS, APRON and DEADWOOD.
BEAMS............... and HOOKS.............	Red Gum, Flooded Gum, Blackwood, Box, Iron Bark, Swan River Mahogany.	The same as in the preceding class, and admit Blue Gum of the best quality.	The same as in the preceding class, and admit Messmate of the best quality.	The same as in the preceding class, and admit Cedar.	The same as in the preceding class, and admit Grey Gum, Stringy Bark, Mountain Ash, White Gum.	The same as in the preceding class, and admit Kaurie Pine, Huon Pine, Oregon Pine.(2)	The same as in the preceding class, and admit other colonial Hardwood.	The same as in the preceding class.	BEAMS and HOOKS.
KNEES................	Red Gum, Flooded Gum, Blackwood, Box, Iron Bark, Swan River Mahogany.	The same as in the preceding class.	The same as in the preceding class, and admit Blue Gum.	The same as in the preceding class.	The same as in the preceding class.	The same as in the preceding class.	The same as in the preceding class, and admit other colonial Hardwoods of the best quality.	The same as in the preceding class.	KNEES.

(1) Stringy Bark, White Gum, Mountain Ash, allowed for Floors in Midships to an extent not exceeding three-fourths the entire length of the Keel in Ships of the nine, eight and seven years' grade.

(2) Oregon Pine will be allowed for Main and Rider Keelsons and for Beams and Hooks in Ships of the six years' grade.

Appendix I: Letter from National Archives

NATIONAL ARCHIVES OF AUSTRALIA

Our reference:

Mr Matthew Gainsford
Fremantle Maritime Museum
Cliff St
FREMANTLE WA 6160

Dear Mr Gainsford

Thank you for your enquiry regarding records held by the National Archives.

I have searched our RecordSearch database for records on Hamlin Bay and the timbe
industry, but I have been unable to identify anything relevant. We do have records o
Hamelin Island and a couple on Cape Hamelin, but these (as far as I can tell) do not r
the timber industry. We also have some records that relate to the timber industry in W
the early part of last century, but I can't say whether or not these files contain inform
about Hamelin Bay.

If you would like to see additional information on any of these files on the timber ind
or those on Hamelin Island etc, go to our RecordSearch database, which is available o
website at http://www.naa.gov.au/the_collection/recordsearch.html.

Please do not hesitate to contact me again if you identify any files that you would like
view, or if I can be of any further assistance.

Yours sincerely

J Butterfield

James Butterfield
Public and Reader Services (Perth)
3 November 2003

Telephone: 1300 886 881 Fax: 1300 886 882 E-mail: *ref@naa.gov.au*
Explore our Internet World Wide Web site at: *http://www.naa.gov.au*