How and to what extent can Historical Ship Structural Components be Observed in a Shallow Dynamic Environment?

The Case Study of SS *Admella*

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By

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Declaration of Candidate

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

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Abstract

On the morning 6 August 1859, SS *Admella*, a modern 3-masted screw steamship was travelling towards Cape Northumberland with 88 passengers and 23 crew when it struck Carpenters Reef, roughly 3.2 km northwest of Carpenter Rocks town. It was there that the vessel had been lifted on to the reef's plateau and the people onboard experienced the greatest horrors of their lives. Severe storms and swell lashed at the vessel until the bulkheads gave way from the pressure, tearing apart the stern and bow of the vessel, disappearing into the night with only the midships intact and what was left of the passengers and crew. This thesis investigates the shallow dynamic environment with the case study focussing on historical ship loss in a high energy environment. The overarching research design asks the question of 'how and to what extent can historical ship structural components be observed in a shallow dynamic environment?'. The results provide an understanding of the submerged landscape context and how a shallow reef environment with severe hydrodynamic movement has been the cause for seven known shipwrecks and one newly discovered. The remote sensing Coastal Integration Workflow (CIW) method proved to be exceptionally worthwhile in producing an image of the submerged landscape and supported in identifying reef bommies. When combined with ROV, the RPAS CIW method can be utilised more thoroughly to understand the underwater environment and gather information on the hydrodynamic flow in Cape Banks. The applied methods resulted not in the finding of *Admella* but of a smaller iron-built vessel making it potentially the eighth vessel to be wrecked on Carpenters Reef. The historic comparison of three screw steamships is undertaken in this thesis to understand why the experimental bulkheads were not the primary issue for the wrecking of *Admella*.

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List of Abbreviations (alphabetical)

ADM1 – Admella Site 1

ADM2 – Admella Site 2

AE2P – Autel Evo 2 Pro

AUV – Autonomous Underwater Vehicle

AWP – Admella Wreck Project

CIM – Coastal Integration Method

cm – Centimetres

CM2 – Chasing M2

DEM – Digital Elevation Model

DES – Department of Environment and Science

DEW – Department of Environment and Water

DSM – Digital Surface Model

DTM – Digital Terrain Model

E&A - The Eastern and Australian Mail Steam Company

GCPs – Ground Control Points

GNSS – Global Navigational Satellite System

GPS – Global Positioning System

GRT – Gross Register Tonnage

GSD – Ground Sampling Distance

H.M.S – His/ Her Majesty's Ship

H.M.V.S – His/ Her Majesty's Victorian Ship

Hz – Hertz

IJNA - The International Journal of Nautical Archaeology

km – Kilometre

km/h – Kilometre per hour

kn – Knots

m – Metre

mm - Millimetre

m/s – Metre per second

M2P – Mavic 2 Pro

M2Z – Mavic 2 Zoom

nT – Nano Tesla

PS – Paddle Steamer

QGIS – Quantum Geographic Information System

ROV – Remotely Operated Vehicle

RPAS – Remotely Piloted Aerial System

SfM – Surface from Motion

SS – Steam Ship

UAV – Unmanned Aerial Vehicle

UTM – Universal Transverse Mercator

Note on Sources

This thesis follows the Australian Archaeology style guide (version: 7th May 2021) and adheres to the requirements laid out.

The source material for iron vessel terminology comes from '*Paasch's Illustrated Marine Dictionary (1885)*' and Williams and Hutchings (2017) 'Shipowners and Iron Sailing Ships: The First Twenty Years, 1838-1857'.

The picture used for the cover page: James Shaw, 1858, Adelaide Gallery of South Australia.

All images in the text are the work of the author unless otherwise credited.

Definitions for environmental processes were taken from: Short, A.D 2020 *Australian Coastal Systems: Beaches, Barriers, and Sediment Compartments*. Springer International Publishing. Sydney.

Chapter 1 Introduction

1.1 Introduction

On the morning 6 August 1859, SS *Admella* was travelling south along the Canunda coastline towards Cape Northumberland in thick white-out fog, heavy swell, and extreme winds when it ran aground on Carpenters Reef, South Australia. Tragedy had captured the attention of the South Australian and Victorian colonies when the vessel, carrying 113 passengers and crew, smashed into Carpenters Reef, leaving only 24 survivors (Mossman 1859:5; Mudie 1966:25). *Admella* was a 3-masted screw steamship that had travelled the Adelaide-Melbourne-Launceston route for 18 months without fault, attributed to Captain McEwan, an experienced sailor and navigator. The Commission of Inquiry's investigation into the 'Loss of *Admella*' resulted in the experimental water-tight bulkheads being at fault for poor rivet design, thus incompetently built. This thesis will attempt to investigate and answer the reliability of this report and contextualise steamship competency through the case study of *Admella*.

1.1.1 Overarching Research Topic

The thesis explores the relationship between steamship use and submerged landscapes. The research analyses the socio-economic pressure of steamship construction during the industrial revolution in relation to standardised practise. The submerged landscape context is essential for interpreting the hazardous environment that has attributed to seven known vessel tragedies in the Cape Banks and Carpenters Reef inlet study area and continues to be an intriguing shallow dynamic environment.

1.1.2 Defining Shallow Dynamic and High Energy Environments

The common affiliation for a shallow environment is a water covered area shallower than 200 m depth, close to shore and with a high degree of dynamic variations and inclusions (Blondel 2009:185–186). This covers the subtidal to intertidal zone within the shallow waters found at Cape Banks, where the hydrodynamic and geological conditions produce a high energy zone that controls sediment and shipwreck material distribution (Blondel 2009:186). A high energy environment is created when high winds of 13 kn and high tidal ranges average 2.2 m, coincide with 'abnormal' sea conditions (Williams et al. 2015:1–2). The combination of strong hydrodynamic flow and shallow submerged reef landscapes are considered shallow dynamic environments that are generally associated with high energy swell reactivity (Blondel 2009:185–186; Williams et al. 2015:12).

1.2 Historic Context

The vessel ran from **Ad**elaide to **Mel**bourne and then to **La**unceston, thus the initial letters of each city's name gave '**ADMELLA**' (Mossman 1859:1; Mudie 1966:13). *Admella* is a 'Clyde' steamship that was built in Glasgow, Scotland in 1857 (Mossman 1859:2). It was purchased for the intercolonial trade along the South-eastern Sea route by Adelaide and Melbourne Steamship Company (Mossman 1859:2; Mudie 1966:16). The vessel grossed 395 tons and developed 100 horsepower with its engine, making *Admella* the fastest vessel of its time to travel from Adelaide to Melbourne (Mossman 1859:10; Mudie 1966:15). The vessel had an iron hull comprised of wrought iron, reaching to the beams, the decks were made from wood, and had three wooden masts (Mossman 1859:10; Mudie 1966:15–16). This unique vessel could outpace most British intercolonial steamers, a feat that made the Australian colonialists very proud (Anae 2013:3; Mossman 1859:11). *Admella* was deemed a civilian flagship that rivalled HMVS *Victoria* and HMS *Nelson*, two of Australia's main warships, for beauty and speed (Mossman 1859:10–11; Mudie 1966:24).

Before *Lloyd's Rules for Building Iron Ships* (1863) had been disseminated by the Underwrites of Lloyd's Registry, many of the early screw steamships were built using non-standardised practices and potentially unregulated shipbuilding material (Anderson 2009:153–154). The fundamental basis around the change to steam technology was evolved parallel with the first use of iron hulls, which were structurally more durable for ocean voyages (Allen 1997:7; Schwerin 2004:88–89; Sexton 1991:60). Steam engines were a newly produced technology which became publicly available in the late 1700s with the introduction of the steam train and were not incorporated into the maritime merchant trade effectively until the 1820s (Allen 1997:7; Schwerin 2004:89).

The effectiveness of the Clyde screw steamships would not be fully realised until the mid-1830s when the demand for iron-hulled Clyde steamships increased dramatically (Schwerin 2004:89). *Admella* was built during the mid-steam-propulsion maritime revolution, when shipbuilders in Glasgow were transitioning from 'composite' to iron-hulled vessels (Allen 1997:7–8; Williams and Hutchings 2017:115). The replacement of wooden overlay structures and sacrificial planking with iron improved the overall structural sturdiness of the vessel, but ultimately brought significant drawbacks during the industrial revolution (Allen 1997:8). Iron was increasingly hard to acquire due to burgeoning demand and cost. Many shipbuilders were acquiring wrought iron from any available resource, regardless of its refined grade (Allen 1997:8–9; Sexton 1991:59). This is prior to the introduction of iron steel that would not be available until the 1880s and will not be speculated on much further.

1.3 Location

As recorded by Mossman (1859), *Admella* sank on the rocks approximately 1.9 km directly northwest of Cape Banks, South Australia. Loney (1975a) reports a scatter of shipwrecks near Cape Banks, with the closest one being *Admella* at 1.6 km from Cape Banks Lighthouse and 1 km offshore, as is confirmed by DEW report (Drew and Taffs 1981). The approximate location was labelled as: ADM1. The vessel itself lies in 5 to 8 meters of water, subject to rough swell and surge (MacLeod 1998:82).

Figure removed due to copyright restriction.

Figure 1.1. Highlighted red area of ADM1 site, the potential location of SS *Admella*'s wreck site (QGIS, 2021).

Cape Banks is 3.2 km northwest of Carpenter Rocks town and is regarded as one of the few local areas with a sheltered reef-inlet for fishing, as observed throughout numerous field-excursions to the site. The coastline is built-up of limestone material and flint stone nodules. The limestone is eroded into loose sandy sediment that is brought down from the large sand dunes facing west (Short 2020: 860-865). The sand-dunes along the entire beach are affected by high winds and tides, two factors that are eroding the dune system in a complex but systematic process (Short 2020: 860-865) (Fig. 1.2). The sediment layers on the beach are loose and prone to consistent change in height and build-up, thus exposing material and reburying it continuously.

No ship remains are observed in the conditions present on Cape Banks foreshore, especially after 163 years of salvage (legal and illegal), fishing, anchoring, storms, and continuous swell movement.

A modern shipwreck can be found 320 m east-south-east from Cape Banks Lighthouse (1863), a concrete yacht leaning on its starboard side, half submerged in sediment – *Pisces Star* (1997). Built in 1996 of ferro cement by Freddie Wolf, the 24-ton yacht was beached after a winter storm in March 1997 on its maiden voyage (Fig. 1.3).

In addition to the shifting landscape, the submerged environment is home to an abundance of seagrass, seaweed, and kelp (Fig. 1.4). The organic material found on the coastline of Cape Banks comes directly from the submerged environment in large quantities.

Figure 1.2. Cape Banks coastline and dune system (northeast, M2P, 2021-07-07)

Figure 1.3. *Pisces Star* 1997 (left) and 2021 (right) in Lighthouse Bay, Cape Banks (Unknown, 1997. South; M2Z, 2021-03-20)

Figure 1.4. Beach seagrass-wrack accumulation on Cape Banks foreshore (north, 2021-08-02)

1.3.1 High energy environment

The environment *Admella* has been exposed to is considered ‘high energy’, which includes strong currents, large swell, surge, and breaking surf (MacLeod 1998:91). This environment is known to disintegrate vessels in a matter of years (Harvey and Shefi 2014:191; Kingsley 2016:185; MacLeod 1998:81; Moore 2015:191). A subsequent aim of the project would be to understand the submerged hydrodynamic flow to determine the approximate intensity of the high energy environment and to correlate the rate of preservation for shipwrecks in the area.

1.4 Research Question

This thesis’ research question is:

How and to what extent can historical ship structural components be observed in a shallow dynamic environment?

The study of shallow dynamic environments relating to the case study of *Admella* is based on numerous shipwrecking events attributed to this stretch of coastline (Fig. 1.5). The secondary research questions are employed to add furthered context to the main research question:

1) Can structural compromise be determined based on observed *in situ* artefacts?
2) Can structural compromise be determined based on direct historical parallels?

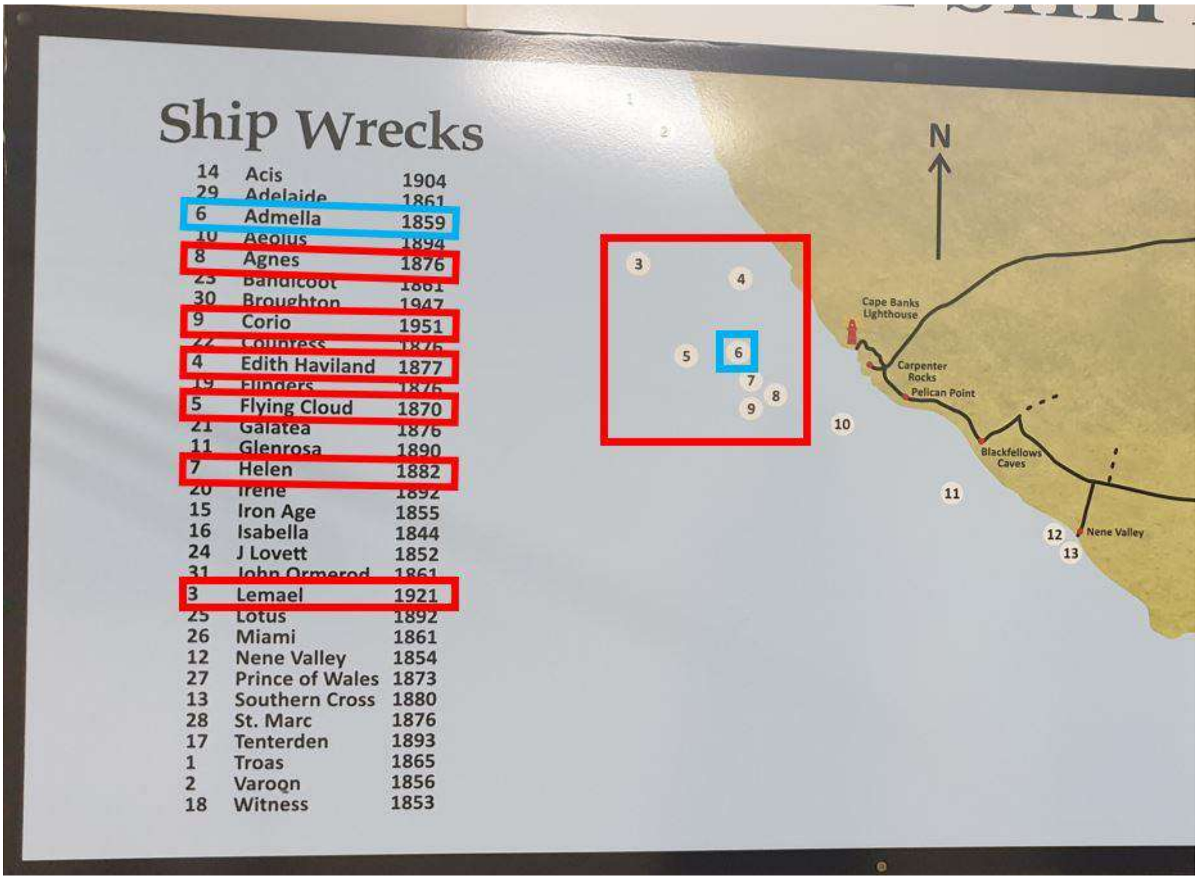


Figure 1.5. Known locations of shipwrecks in south-eastern region, SA (Board 1, Port MacDonnell Maritime Museum, 2021-03-20)

1.5 Subsequent Aims for Context Analysis

This project has five subsequent aims that are addressed throughout this paper. The aims are to provide context to the broader landscape than what the current literature has recorded, and the use of newer technology to refine already existing remote sensing techniques for archaeological purposes. However, this will not discuss the overarching use of certain applied technology in archaeology.

Subsequent aims include,

1) Create high resolution georeferenced orthomosaics of the reef and surrounding environment to visualise the extent of reef outcrops and potential wreck sites,

2) survey the submerged landscape to understand the dynamic environment and to potentially identify ferrous structures,

3) applying new survey methods to relocate *Admella* through remote sensing techniques,

4) use available historical records and published literature to conduct a comparative analysis of steamships built during the experimental transition to screw steamship technology around Australia (i.e., SS *Gothenburg* (1854) and SS *Brisbane* (1874), and SS *Xantho* (1848)).

5) lastly, study the taphonomic processes of shipwreck material in Cape Banks to understand the deterioration processes of ship remains in a shallow dynamic environment.

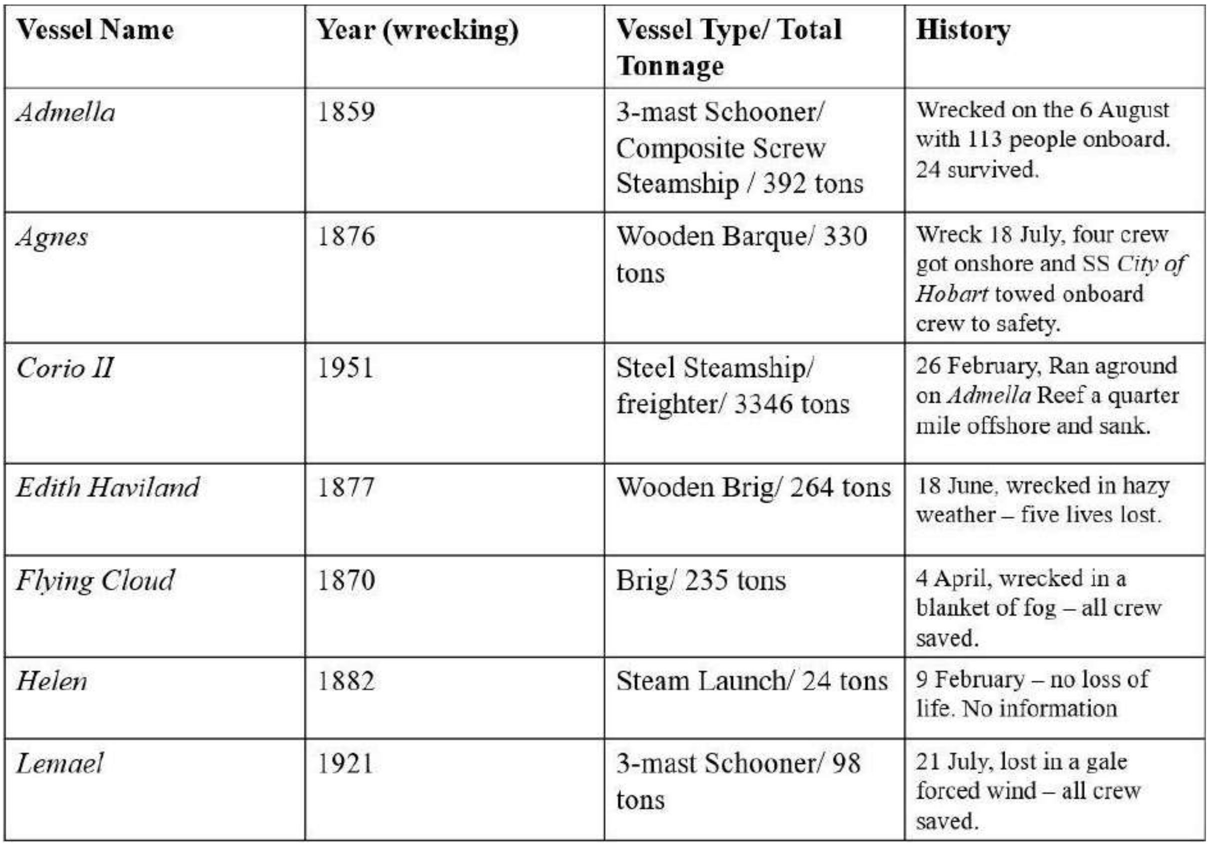
1.6 Research Gap

Since 1859, little archaeological work has been undertaken to identify and survey *Admella*, potentially due to the high energy environment in which the vessel is found, which complicates access (MacLeod 1998:81; Mudie 1966:88). One of the main aims of this project is to investigate the possibility that *Admella* had been structurally compromised either through manufacture or quiet 'refittings'. This speculation has arisen from the Commission of Inquiry Report submitted by the South Australian Governor, Sir Richard Graves MacDonnell (1859:4–5) that states the vessel's 'experimental design of the watertight bulkheads was the cause of the breakup'. This point of contention is part of the secondary question, can structural competency be observed by using historic steamship parallels?

It is agreed by historic authors like Samuel Mossman (1859) and Ian Mudie (1966) that *Admella*'s construction by Lawrence Hill & Co was efficient and structurally sound and confirmed by Lloyd's surveyors' certificate (Appendix 1H). Messrs A & J Inglis (an engineering firm) were only beginning to enter the shipbuilding industry, supplying *Admella* with its twin 100 horsepower engines (Mudie 1966:20–21). No original schematics of the engines or vessel have been obtained by this author, only reproductions made from historical accounts having made their way into Trove archives, libraries, and museums. The South Australian Department of Environment and Water have supplied a Lloyd's Registry entry with the engineer's certificate for 'competency'.

This undocumented shipwreck has also been degraded by previous salvage operations that have taken place as recently as 1957 (Mudie 1996:13). The shallow dynamic environment of Cape Banks has been the cause of numerous shipwrecking incidents as recently as 1997 (*Pisces Star*) and therefore, should be studied to broaden the understanding of *Admella*'s deterioration and material spread (Harvey and Shefi 2014:191–192; Moore 2015:191) (Table 1.1).

Table 1.1. Seven shipwrecks in Cape Banks region, less than 1 km from SS *Admella* prior to 1960 (Port MacDonnell Maritime Museum Archives).



Vessel Name	**Year (wrecking)**	**Vessel Type/ Total Tonnage**	**History**
Admella	1859	3-mast Schooner/ Composite Screw Steamship / 392 tons	Wrecked on the 6 August with 113 people onboard. 24 survived.
Agnes	1876	Wooden Barque/ 330 tons	Wreck 18 July, four crew got onshore and SS *City of Hobart* towed onboard crew to safety.
Corio II	1951	Steel Steamship/ freighter/ 3346 tons	26 February, Ran aground on *Admella* Reef a quarter mile offshore and sank.
Edith Haviland	1877	Wooden Brig/ 264 tons	18 June, wrecked in hazy weather – five lives lost.
Flying Cloud	1870	Brig/ 235 tons	4 April, wrecked in a blanket of fog – all crew saved.
Helen	1882	Steam Launch/ 24 tons	9 February – no loss of life. No information
Lemael	1921	3-mast Schooner/ 98 tons	21 July, lost in a gale forced wind – all crew saved.

The surrounding shallow dynamic environment is a critical case study for providing an analysis of deterioration rates of vessels found in similar coastal landscapes (MacLeod 1998:81; Moore 2015:192). Studying high energy environments may also lead to understanding what types of preserved material remains can be found *in situ* (Jeffrey and Melchers 2007:145; Lucejko et al. 2015:584–585; Moore 2015:192).

1.7 Significance

Despite the records *Admella* set for its time, the vessel has been largely ignored since the start of the 1900s (Mudie 1966:16). Located in a shallow dynamic environment with little to no physical protection, the wreck of *Admella* is in a highly destructive zone (MacLeod 1998:81). With little published material publicly available the remains of *Admella* are deteriorating with no survey records available to consider whether the study of a steamship in a shallow dynamic environment warrants the research of that calibre in another couple decades. Moreover, the location of the vessel's engine, boilers and propeller may give an indication of whether *Admella* was built to its original specifications, or if it had been 'refitted' or altered, potentially revealing weak points in the structure.

Admella should be prioritised as a significant archaeological site for survey into the method and material use for construction, and how the vessels archaeological material correlates to the manufacturers design, or to similar screw steamships built by the same companies.

1.8 Methods

The methods employed within this research include qualitative data in the form of historic archival research collected from online indexes, historic archives in museums, and libraries. Community involvement from Carpenter Rocks, Port MacDonnell, and Mount Gambier have supplied numerous points of interest that have worked in combination to historic data output.

Furthermore, qualitative, and quantitative units of data were able to be collected by applying fieldwork methods for the Cape Banks coastline and Carpenters Reef, including a multidisciplinary approach combining remote sensing instruments and techniques to expand the context of the investigation site.

1.9 Limitations

Cape Banks coastal zone is open to the Southern Ocean's currents, winds, and at times heavy storms (Mudie 1966:65). In an exposed area with minimal shelter in the form of Carpenters Reef and a stretch known as Admella Reef, the possibility for adverse conditions is in the medium to high range.

1.9.1 Availability of Published Resources

Due to the rough terrain and difficult conditions that the site is found in, very few articles have been written including *Admella* as a research topic or adjacent. The few that have, explore the sociological and historical narrative, depicting what happened prior to the ships sinking, who was on board, the cargo it carried, and how it affected those involved with the tragedy (Anae 2013:1–19; Mossman 1859; Mudie 1966). No other published sources can be found regrading what state the wreck of *Admella* is now in, nor do any photos capture the wreck in its current form. The few places to acquire further information will be through Trove archives, Port MacDonnell Maritime Museum, Mount Gambier State Library and Maritime Museum records, Port Adelaide Maritime Museum, and Beachport Museum, in South Australia.

1.9.2 Covid-19 Pandemic

From mid-2020, the covid pandemic had spread across Australia. Apart from the main concern to public health, the availability and access to libraries and museums hindered the project. Documents that had not been initially digitised were harder to acquire and fieldwork access to the main survey area had been restricted by Flinders University due to Covid-19 cases spreading in Mount Gambier, SA.

1.10 Chapter Outlines

Chapter 1 identifies the case study area, historic gap of information involving the vessel and landscape, and gave a detailed historic background. Furthermore, this chapter provided the research question, secondary questions and subsequent aims that are used for the overarching research design.

Chapter 2 reviews the current literature on steamship archaeology philosophies and previously undertaken steamship archaeological research. A comparative analysis on steamship vessel design with applicable case studies are presented, as well as the socio-economic pressure for shipbuilding practises. Previous surveys of Cape Banks are explored with a focus on salvaging, state, and citizen science surveys. The theme of vessel identification and Middle Range theories are explained and how they relate to the overarching thesis research question.

Chapter 3 explains the methods that are used over the course of this thesis. Historic background research needed to narrow down two confident sites. The fieldwork techniques applied and why they were significant in understanding the context of the Cape Banks coastline. Survey methods included walking transect, RPAS, ROV, magnetometer, video transects, measuring, and photography.

Chapter 4 describes the results of the applied methods and direction of research. These sections are organised into coastal beach survey, kelp sampling, taphonomic analysis, and remote sensing. The coastal area of Cape Banks is contextualised first before moving out to the site identified as ADM1. Lastly, the recorded artefacts are presented with locations marked.

Chapter 5 interprets the results and how the material found at ADM1 is in fact a vessel structure of iron material, but that it cannot be associated with *Admella*. The chapter is divided into two parts, the first explores all the results within the survey area and taphonomic study. The second part uses three case studies of steamship vessel loss and landscape formation as the comparison study.

Chapter 6 concludes the discussion threads of the revisited subsequent aims presented in chapter 1, as well as the secondary and main research questions. A positive accumulation of data leads to the certainty of the taphonomic study and the comparative study of the four steamship vessels.

Ch. 2 Literature Review

2.1 Introduction

Michael McCarthy (2006:1) and Keith Muckelroy (1978:4) discern that maritime archaeology is the study of material remains of human activity around coastal and near shore communities. Muckelroy (1978:23) stated that the primary objective of maritime archaeology is knowledge of people and culture, and not ships, diagnostic structuring, instruments, or even the cargo onboard with which researchers are to contextualise. McCarthy (2006:4–5) argues that Muckelroy's own statements were not appreciated for their time until the scientific reform of maritime based archaeology, introducing new philosophical ideas into the archaeology mainstream, stemming from Richard Gould in 1983. However, an integral part of studying a ship in an underwater context requires the researchers to be familiar with the vessel's structure, mass, rigging, fittings, structural designs, and construction (Green 2006:97). Richards (2006:42–43) states that the transition from the 'historical particularism' and 'over-particularisation' was the overt implementation to further ground the discipline to achieve thorough methodological practises, straight forward project orientation for theoretical estimation and research design. The explicit design of archaeology is understandably the combination of historic desktop research partnered with direct archaeological methods when approaching shipwreck research.

The literature review outlines the gap of information missing from Cape Banks region, briefly discussing previous archaeological surveys undertaken on the site, and previous archaeological studies performed on similar shipwrecks and their respective landscapes from the period of experimental iron-hulled steamships. The methodologies used for the identification and analysis of shipwrecks are discussed. Middle-Range Theory is presented as the framework that the thesis has incorporated to provide the method of analysis and answering of the research question.

2.2 Previous Steamship Archaeology

Steamship archaeology, as stated by Muckelroy (1978) is an ‘unnecessary duplication of information already appearing in archives and museums. McCarthy’s (1998:99) support for steamship archaeology unpinned previous objectors by acknowledging Gould’s reinterpretation of the discipline which argued for a cross temporal archaeological and cultural framework which was not specified to a particular point in the past. McCarthy’s own work on SS *Xantho* (1848) was instrumental in confirming that material culture observed and interpreted on a ‘modern’ vessel was significant enough to inform the researchers of design faults, maintenance schedules, engine workflows, and the industry climate. The representation of this discipline, although in its infancy in Australia, was being recognised overseas as ‘industrial archaeology’ (Crisman 2012:610–611). Muckelroy’s (1978:249, 1980:55) interpretation of submerged archaeology was still very applicable to ‘steamship’ and ‘industrial’ archaeology despite his own statements that the 1800s were the point of cut off for maritime archaeology (McCarthy 1998:99). The framework that Muckelroy had designed laid the foundation for ‘problem-orientated’ investigation to be used on steamship archaeology, including ‘the formulation of research strategies to investigate, interpret and resolve a specific question or idea based upon the collection and recording of data as feasible evidence to test hypotheses and ideas (McCarthy 1998:99–100).

McCarthy’s project on *Xantho* proved that this approach was not only feasible and allowed problem orientated research questions to be answered, but it provided a greater context that no longer existed in public record (McCarthy 2002:121–122). Revisiting Muckelroy’s (1978:10) statement ‘iron and steamship wrecks as an unnecessary duplication of information' can be argued against when intentional destruction of material from a 'cause of loss' by the owners (i.e., *Xantho*) or by other means, like war, fires, flooding, etc.

2.3 Comparative Archaeological Approaches in Australia

2.3.1 Screw Steamship Vessels

Clyde vessels as the name suggests were built on the river Clyde, Scotland. Although the first ocean-faring steamships came from the United States, it was Glasgow shipbuilders who helped innovate and revolutionise steam engine complexity and combine it with sea transportation (Allen 1997:7; Lebiedowski 2011:147; Riley 1999:27). Britain was second to the United States in building and facilitating use of steam propulsion at sea, and it quickly came to dominate the market by 1812 (Armstrong and Williams 2017:240; Delgado and Nagiewicz 2020:27; Smith 2014:95). The British registry only accounted for 30 registered tons, and by 1890 it had a registered scale of more than 8,000,000 tons of steamships operating through the region (Allen 1997:7–8; Armstrong and Williams 2017:240–241; Lebiedowski 2011:147). The increasing manufacture of steamships was unequivocally dangerous for the seamen who had to voyage in these vessels, especially in the early stages of the experimental build of composite designs in 1850s (Sexton 1991:59; Williams and Hutchings, 2017:115–116). It has been widely noted that the economic pressure from the mailing system in the wake of steam-propulsion being utilised for seafaring had created a hazardous competition between leading transport companies (Smith 2018:285–286). The pressure manifested through the need for more steamships to be manufactured, but with limited resources of metal and wood (imported from Canada, Iceland, Norway, etc), the shipbuilders had to explore new avenues of material use at the risk of structural competency

(Allen 1997:7–8; Lebiedowski 2011:148; McCarthy 2005:115; Sexton 1991:59; Smith 2018:288).

‘Composite’ refers to vessels that were built with mixed technologies, such as wooden hull with auxiliary engines, or even iron hull with wooden super structure, etc (McCarthy 2005:118–119; Sexton 1991:60; Smith 2018:290; Williams and Hutchings 2017:115–116).

Composite and auxiliary vessels were replaced by complete iron hull and superstructure vessels during the experimental era from 1840s to 1860s that provided greater structural support for coastal navigation, as well as ocean voyages (McCarthy 2002:118; Sexton 1991:60). This new design was primarily about cost and was a solution in overcoming a serious problem of fouling (Sexton 1991:59). Fouling restricted the speed of wooden ships and had the adverse effect of rotting the hull structure if the vessel was not brought into dry-dock for cleaning; in tropical areas fouling was extremely common and dry-docking was very expensive (McCarthy 2002:118–119; Sexton 1991:60). The transitional phase, however, did change the evolution of the Clyde steamship with the iron hull structure having a much smoother surface that increased speed (Sexton 1991:60).

The three selected case studies in the following sub-sections were selected based on their similar environments, vessel structure and maintenance, structural manipulation and refitting designs, overburdening of cargo, weather events, and consequences of investigation. The importance of the case studies is to highlight the similar factors contributing to the disastrous impacts of all four vessels and to interpret the significance behind the Royal Commissioner Report’s conclusions, further discussed in Chapter 5.

2.3.2 SS Xantho (1848–1872)

Xantho is not a composite steamship and was chosen as a comparative case study for the relevancy of ‘quiet refitting’s’ in an era of shipbuilding that evolved quickly away from sail, and how ship-owners like that of the Broadhurst family adapted the vessel to their needs. The wreck lies outside Port Gregory, Western Australia, in a prominent sea-trafficking area (McCarthy 2002:70). The wreck is subject to heavy currents, swells, and further violent impacts from storms (McCarthy 2002:72–73). However, part of the existing reef and eelgrass organisms help protect the wreck from the high energy environment, providing evidence of natural environmental protection over an extended period (Kingsley 2016:186; McCarthy 2002:73–74; Moore 2015:193). The vessel was discovered by fishermen in the 1970s and looters raised artefacts without recording or admission, and fishermen have anchored around the wreck potentially damaging the area (Harvey and Shefi 2014:197; McCarthy 2002:73–4). The refitting’s undertaken for this vessel and the assessment of why this vessel was converted from a paddle steamer to screw will be discussed in Chapter 5.

2.3.3 SS Brisbane (1874–1881)

The addition of *Brisbane* was based on the shipbuilding company A & J Inglis, who had partnered with Lawrence Hill & Co to construct *Admella* (Mudie 1966:16). *Brisbane* was a much larger vessel compared to *Admella* (85.9 m in length, 9.8 m in beam, and a draught of 6.1 m); however, the vessel had been constructed in a similar design, appearing as a two masted vessel (Steinberg 2008:12). *Brisbane* had been an intercolonial passenger and trading vessel travelling from Darwin, Brisbane, Sydney, Melbourne, and Adelaide for E&A (Steinberg 2008:12). The vessel had not been refitted during its active service in Australia and the reason for the vessel’s loss was attributed by inquiry of the relative authorities as being ‘human error’. The vessel was used as a secondary product of salvage for the town of Darwin during long periods of supply shortage, offering the local communities the opportunity to continue construction works from the vessel’s large unaffected portions of wood and iron (Steinberg 2008:22–23).

2.3.4 SS Gothenburg (1854–1875)

Gothenburg is an ‘auxiliary’ steamship built in 1854, Essex, UK. The vessel’s history of operation is much lengthier than *Admella*’s, although its demise is eerily similar. *Gothenburg* was a 60 m long vessel, built with three masts, a single engine and with two boilers positioned at the stern of the vessel (DES 2019:9). It struck a reef in 1875 during strong cyclonic weather, causing the vessel to sit on the reef system known as ‘Detached Reef’ (DES 2019:12–13).

The wreck is quite well preserved despite weather conditions, with engine components and boilers exposed (DES 2019:21; Viduka 2020:2). *Gothenburg* was constructed before Lloyd’s shipbuilding guidelines in 1863 and was classed as an auxiliary vessel (Williams and Hutchings 2017:118-119). The vessel, as photographed at Port Adelaide in 1873 has a close resemblance in structure to that of *Admella*, allowing for an observation of the ships overall outward structure (Fig. 2.1). Therefore, *Gothenburg* is included as a comparative case study for all the reasons above (DES 2010a:131).

Figure removed due to copyright restriction.

Figure 2.1. *Gothenburg* docked at Port Adelaide wharf in 1873 (1873, John Oxley Library, State Library of Queensland).

2.4 Contextualising the Socio-Economic Steamship Building Industry

Lindsay (2020:44) speculates that the mid-nineteenth century shipbuilders were beginning to overhaul small freighting vessels by installing 'auxiliary' engines. These powerful additional drives supported an increased towing capacity, allowing for greater distances to be covered in relatively short amounts of time (Lindsay 2020:43–44). However, these rigorous overhauls came with engineering faults, corner cutting for cost saving, and significant human made errors that followed (McCarthy 2009:8).

Glasgow shipwrights were considered very efficient and cheap in labour for building Clyde steamships and were employed by many wealthy sea-merchants to construct their vessels (Moss 2012:483). The problems arose when the shipbuilding companies were overloaded with work orders (Anderson 2009:153; Lindsay 2020:49; Moss 2012:483–484). Vessels and their auxiliary engines were produced through factories in conditions that reached the bare minimum for compliance within *Lloyd's Rules for Building Iron Ships* (1863) (Anderson 2009:153; Lindsay 2020:49; Moss 2012:483–484). The admissions from William Schaw Lindsay's (1815–1877) diary provided context to the excessive number of projects taken on by Glasgow shipwrights leading to difficulty in consistent standards of workflow, with timelines and quality of the vessels coming under more scrutiny due to employed working methods (Lindsay 2020:50).

Furthermore, the mid-nineteenth century saw a growing need to switch to machine building practises for consistent mass-manufacturing with better cost-effective rates. This caused a response from the 'general assembly' of workers from the mills and weavers being displaced by machines in regional factories at the time, having the natural means of production taken away many workers were required to upskill for jobs. This was thought to be the beginning of a new social and economic backdrop that displaced many workers and their families, having dire consequences in the future establishment for 'Unionised' sectors (Lebiedowski 2011:158–160).

2.5 Previous Surveys in Cape Banks

2.5.1 Department of Environment and Water, South Australian State Government Report

To date, there is little published research documenting this region or any of the submerged material culture of any kind. A small report filed by Drew (1981) documents the site sporadically from 1962 and 1981. The questionnaire styled report documents the location of *Admella* from Carpenter Rocks town (3.2 km northwest) with the nearest 'prominent landmark' being Cape Banks Lighthouse, built in 1863 due to the number of vessels wrecking on that section of reef. Drew and Taffs (1981) list the current condition of the observable area, documenting the location with what can be presumed are sextant angle resections, sighted on fixed markers found along that coastline (DEW 1981:6). The ‘fixed’ markers used by DEW have been sketched onto a gridded map, indicating three points of conjunction; the sand dunes (appropriately named ‘The Admella Dunes’) directly east and approximately 1 km from their position, two large limestone rocks (the outer ocean side of the two sponsoring a colony of <40 brown fur seals) that are 1.6 km southeast, and lastly, the lighthouse (DEW 1981:6). Drew’s assessment of the site indicates that the high energy environment in 1961 had no observable effect on the engines and boilers that could still be seen above low tide peak swells (DEW 1981:1).

In 2014, the DEW led by Amer Khan visited Carpenter Rocks in search of a suspected anchor disclosed to the department by local cray-fishermen (DEWNR Blog 2014a). The anchor was not found but the survey team did investigate the remains of *Pisces Star* and performed walking transects across Lightening Bay’s foreshore (DEWNR Blog 2014b; ABC 2014). Maddy Fowler and Jennifer McKinnon (2012) investigated possible shipwreck material in Port MacDonnell and the surrounding waters, however, the research and outcomes are considered too far away and is not regarded as informative to this research project (Fowler and McKinnon 2012).

2.5.2 Salvaging of SS Admella

‘Admella’ was sold for salvaging rights a couple months after the inquiry had been completed (Mudie 1966:171). The vessel was sold to undisclosed parties of nine people and salvaging operations ran from late 1859 to February 1860 (Mudie 1966:172). The operations included skin diving, rigging and crane support through barges. Mudie states that one boiler eventually rolled further into deeper water and that the iron-hull plates descended into open crevices (Mudie 1966:172–173). The rights were then sold to Robert Anderson and Henry Chant, who continued to perform small scale salvaging operations on the vessel from 1860 until 1865 but

no record is kept of these operations (Mudie 1966:173).

Then in 1873, a group of six men came back to Cape Banks and recovered two tons of copper and lead from the vessel (Port MacDonnell Museum, Admella Board no.3). 1957 saw the opportunity to explore SS *Corio II* (1951) that had wrecked there six years prior. Two ‘frogmen’ had come to recover 250 tons of copper, a bell, and a porthole (Port MacDonnell, Admella Board no. 3).

The approximate amount of copper mentioned from 1957 could be that from *Admella* but would most likely pertain to the salvaging of copper piping found on SS *Corio II* which was a complete steel hulled vessel. My hypothesis for the declaration of such large amounts of copper been recovered, could be related to the small illegal salvaging attempts made in the area, thus discouraging furthered salvaging attempts.

2.5.3 Diving Community Outreach

Avocational surveys in an area 1.2 km northwest of the site mentioned by Drew (1981), have been recorded by Von Stanke and Saville in 2019, at the apparent site of *Edith Haviland* (1877). However, they have produced no written record or published material of the area, site formation, referencing, or material exposed. Saville has stated ‘*Edith Haviland*’s remains are situated near *Admella*’s stern with the debris of both wrecks reaching SS *Corio II* between 80–100 m’ (S. Saville 2021, pers.comm). The validation of this data or approach were not disclosed and the credibility of their ‘citizen science’ approach in defining an affiliation to the shipwreck is questionable.

2.6 Methods of Ship Identification

Harpster's (2013:588) theoretical approach to research methods affiliating ship remains to a vessels name from historic narrative has furthered earlier debates of historical and processual approaches that have significant changes to 'nautical' archaeology. The matching of a site with a certain affiliated vessel contributes to facilitating an interpretive context for the site, with material scatter across the seafloor being able to be studied more confidently (Harpster 2013:589). The issue for ship identification using historic narrative sources before attempting field methods, is that this builds upon the issue of biased interpretation towards what the vessel *will* be and not what the vessel *might* be (Harpster 2013:595).

As a branch of archaeology, maritime archaeology aims for unbiased interpretation, but how is that accomplished? Harpster (2013) conducted a thorough examination of the research publications into shipwreck identification approaches in *The International Journal of Nautical Archaeology* (IJNA). The study was limited to papers in IJNA published from 1972 to 2008 (Harpster 2013:590). The objective was to consider how maritime archaeologists interpret their own methods when affiliating a site to a vessels original name, type, country, or region. Harpster (2013:591–593) broke up these approaches into four categories that spanned over 250 separate articles.

Type A approach has an affiliated name at the beginning of the research, using historic narrative and recorded accounts; then moves onto narrowing down the location of that vessel by the characteristics recorded in the historic narratives through archaeological methods (i.e., RMS *Titanic*). Type B approach is like Type A, in the contextual need to affiliate a name with a site; however, it is the site that is found first which prompts further investigation into what the affiliation could be, adding a source name after the archaeological interpretation. Type C approach is recognition of affiliation not by vessel name from historic narrative but through nation, state, kingdom, empire, or community that has presences in historic narrative (i.e., *Skuldelev* Viking ships, Denmark). Type D approach takes a step back from specific affiliation to any socio-structure, simply affiliating a ship based on typology and linking to no historic narrative, instead noting a region of affiliation (i.e., Southeast Asia).

Schweitzer (2022:304) introduces an informed division of Type A and B approaches by ‘Historical’ and ‘Archaeological’ classification. The defining factor for historical classification includes hull type, rigging, design and specification, size, armament, and known historical types. Archaeological classifications are separated from historical by recording the remaining hull and calculating buoyancy or primary building material (dendrochronology), vessel function, roots (archetypes), and by observed construction methods (Schweitzer 2022:304).

Vessel interpretation can be based upon typology or construction method, denoting that affiliation of Type D approaches are prompts for further investigation that can be relegated to Type C or higher (Schweitzer 2022:204). Schweitzer argues that historical and archaeological (anthropological) approaches for vessel affiliation based on typology is rarely cross-referenced, leading to typological short-comings that can be further investigated by the geographical and chronological confined building traditions (Schweitzer 2022:304–305). Harpster and Schweitzer’s concern for comprehensive understanding and cross referencing of all available material in nautical archaeology has drawn attention to maritime datasets not having comprehensive enough evidence, or knowledge of rudimentary ship types and typologies to garner further evolvement of the discipline (Harpster 2013:617; Schweitzer 2022:307).

2.6.1 Middle Range Theory

Archaeology methods are part of the humanities 'social sciences' branch that is always questioned as whether it is scientific. Trigger (2006:26) explains that the body of knowledge is far less important than the method of knowing, observing, interpreting, classifying, comparing, and experimenting for objective means when applicable. How is this related back to maritime archaeology? By reviewing Harpster (2013), the explicit notion of isolated finds not being the whole context, like 'one Roman coin found in the submerged assemblage does not make the vessel Roman', is representational of a larger foundation of thought (Harpster 2013:603–605). The find itself does not represent the entire context of a site, as an individual artefact has no significance if it is not compared to the entirety of the assemblage, which would include the ship's design and construction (Trigger 2006:27). The represented corpus of archaeology theories stemmed from the 1960s, dissatisfaction within conclusive arguments from numerous publications warranted larger scrutiny and more direct cross-referencing of material was to be used to reinvestigate historical perspectives against processual and post-processual views, coining the term 'New Archaeology' (McCarthy 1998:99–100; Renfrew and Bahn 2012:40; Trigger 1989:27).

The fascination with artefacts and not their use within a cultural sphere predisposed early archaeological theories, indicating a change for the use of object 'x' without deriving an informed interpretation of *why* that artefact was used in this way before, *what* forced change, and *how* did it effect the larger context? (Renfrew and Bahn 2012:40–41).

To understand the archaeological interpretation of an artefact, site, and the complimentary context, a theoretical framework is established to provide a construct method of disseminating the data with comprehensible understanding (Trigger 2006:27–28). Relating to the framework proposed, Middle Range Theory has three levels of interpretation; low, middle, and high generalisation categories (Trigger 2006:30). Low level generalisations do not offer the ability to be called theories or hypotheses, due to the nature of examining physical particulars of a site and assemblages within an artefactual context, as they attempt to analyse patterns in the archaeological data (McCarthy 1998:100; Trigger 1989:31). Low level generalisation relies less on human behaviour and focuses instead on artefacts through observation. Middle level theories are generalisations used to define multiple correlating patterns and interpreting them through multiple instances (Trigger 1989:32). Middle level theories use multiple reoccurring low level generalisations to form a broader contextual design and find the regularities within that framework (McCarthy 1998:100; Trigger 2006:32). Middle range is different to middle level. Middle level can exclusively focus on human behaviour within the model of regularities, whereas middle range must account for object distribution and patterning as well as human behaviour as complementary to each other (Trigger 1989:33).

High level or ‘research strategies’ are ‘abstract rules that explain the relationships among the theoretical propositions that are relevant for understanding major categories of phenomena’ (Trigger 1989:32–34). Categories include cultural materialism, historical materialism and they rely on the refining of middle level and middle range theories, thus, encouraging the development of change and correlating or identifying genuine behavioural attributes via modelling, which could be used for maritime archaeology (McCarthy 1998:100; Trigger 2006:33–34).

Middle Range Theory, as stated by McCarthy (1998), must be reframed into what the question is asking at its basic level, as denoted by Muckelroy (1978), is to understand whether the research project is conducted to the appropriate maritime archaeological standards; do the question(s) broaden the scope of maritime archaeology by data-gathering and subsequently adding to the overall larger body of knowledge (technologically and historically), and whether it continues to facilitate the knowledge of behaviour of the people constructing, owning, sailing, operating, and servicing these vessels (McCarthy 1998:100–101).

Middle Range Theory was adapted into this research design to support the interpretation of low-level generalisations, gathered by using on site observations and remote sensing tools to establish reef bommie locations to larger submerged limestone structures in the area, and to establish the pockets of potential artefact placement within the reef itself. Middle-level generalisations were used to establish the artefact distribution within ADM1 in correlation to reef structure and hydrodynamic flow volumes, yet the correlations subsequently fitted the Middle Range framework more adequately and thus changed to it. High-level generalisations will be discussed in Chapter 5.

2.7 Conclusion

Due to the changing economic and social climate that came with the industrial revolution (1760–1840), resource management, social economic impact, and steam-powered engines quickly opened the market for greater expansion into trade with unrivalled speed in the form of steamships. The increase in pressure from clients that required vessels with more power and greater hauling capacity resulted in of Glasgow shipbuilding companies, who consistently took on work for favour with future contracts and tenders, becoming overwhelmed. Although it is still far-fetched to say that most steamships were poorly mismanaged and not properly regulated before being given over to clients, it should be noted that there is a far more concerning trend of vessels that conceal documentation of mismanagement after being acquired from previous owners who did not maintain regulatory standards.

The overarching research question for this thesis is based upon the theoretical framework discussed (Middle Range Theory) which is applied to the investigation, as provided in the next chapter. Certain historical narratives may have misinterpreted the collected information which will be assessed in Chapter 5. The reassessment of *Admella* is the investigation of human behavioural perception of evolving steamships and the failures to recognise appropriately larger bodies at fault other than watertight bulkheads.

The identification of shipwrecks as discussed earlier can attribute to four main category types that define the theoretical approach. For this thesis project, only three are applicable; affiliating vessels through the historic narrative (Type A), versus observable *in situ* artefacts that would require further investigation after-the-fact and matched with a potential named affiliation (Type B). Lastly, the investigation result of this thesis comes to a Type B and C Null, evidently providing the project with a new shipwreck but with no historical context or affiliation.

Chapter 3 Methodology

3.1 Introduction

The project aims to examine the structural design of *Admella* through historic parallels and physical remains, to determine whether the Clyde steamer was structurally competent or had been augmented after its departure from Port Glasgow, Scotland. The first step was to conduct an in-water survey to determine the percentage of ship remains still discernible, and whether the material can be used to assess the structure of the vessel. The second step is to use parallel historic information from steamships built mid-1800s and to assess the shallow dynamic landscape they had wrecked on.

Much of the research undertaken for this project has been qualitative evidence, as significant work was explored by the author to provide greater detail. The quantitative data focusses on the layout and structure of the vessel *in situ*, the location of the engine, boilers, propeller, hull structure, its greater context on the landscape, measurement of taphonomic processes, assessment of structural components, and lastly the comparative data-set analysis of mid-nineteenth century steamships found in Australian coastal waters. Steamships were evidently a popular choice for sea-faring and intercolonial trade in Australia prior to Federation in 1901 (Smith 2018:287–288). Many vessels have sunk due to faulty management or to poor construction, and to a greater extent, it is more evident in this case study that some vessels underwent unsustainable restructuring for a particular purpose other than that of the original design (Lindsay 2020:47).

3.2 Historical Data Research

The initial data-collection was conducted through Trove archives with the assistance of Rick Bullers, (former) Senior Heritage Officer for Department of Environment and Water. A 'finder's report' was located with affirmation of the wrecks *in situ* location by Terry Drew (Senior Heritage Officer) and R. Taffs from 19 October 1981.

Figure removed due to copyright restriction.

Figure 3.1. Approximate location of *Admella* (Drew and Taffs 1981:6).

The ‘finder’s report’ questionnaire filled out by the two divers helped outline the basis for this project. It was confirmed by Drew, that the vessel’s boilers, engine, hull planting, and copper was still *in situ* in an exposed area (fig. 3.1). Drew has stated the approximate location of *Admella* was 1.6 km northwest of Cape Banks lighthouse (fig. 3.2). The location of *Corio II* (1951) is also mentioned, having run aground over the top of *Admella* and sank 50-100 m from the site facing northeast.

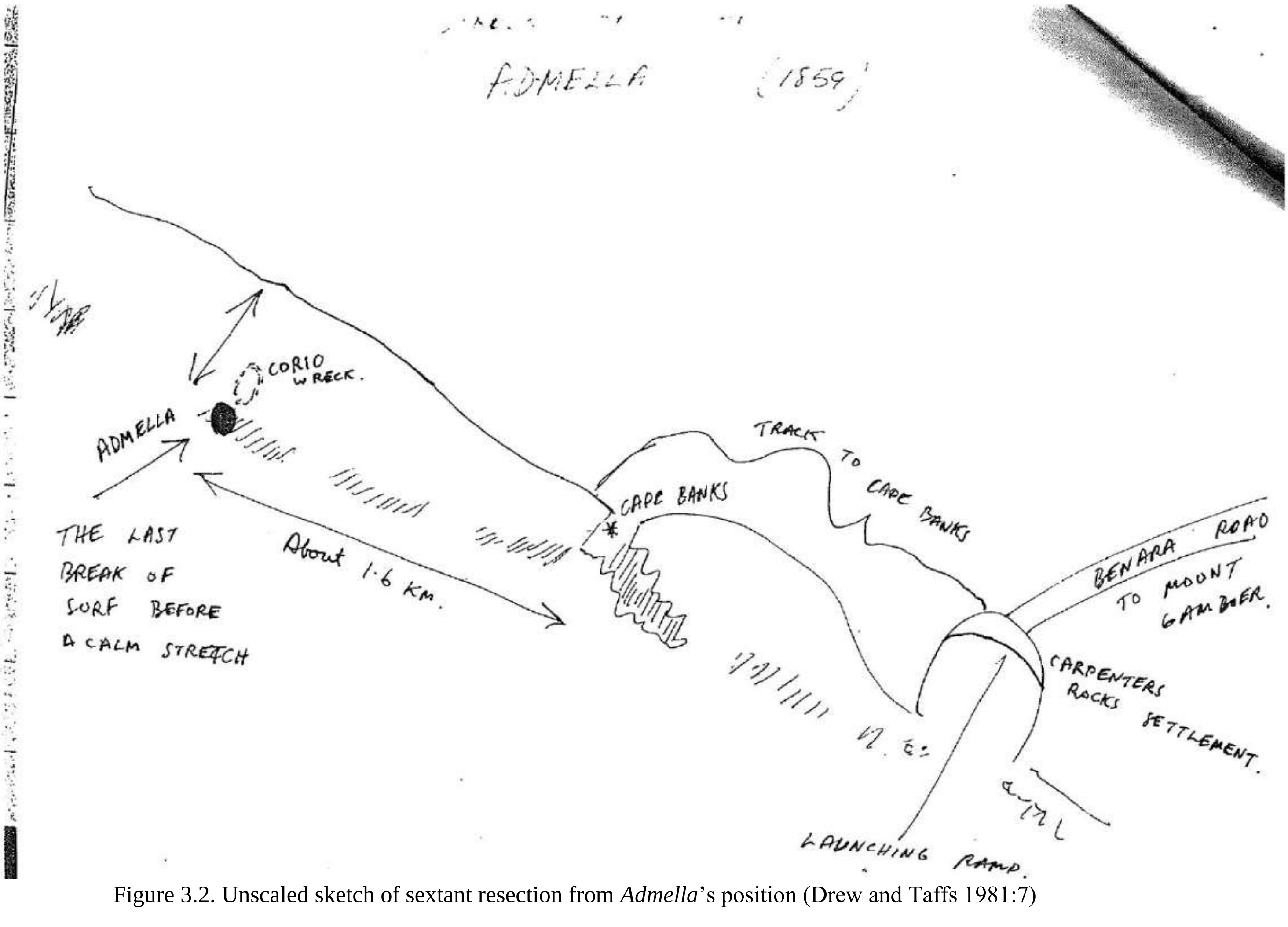


Figure 3.2. Unscaled sketch of sextant resection from *Admella*’s position (Drew and Taffs 1981:7)

Port MacDonnell Maritime Museum’s archives and artefacts are rich in material culture and information, particularly two significant objects (Fig 3.3 & Fig. 3.4). The double-sided AutoCAD remake of the vessel with its volume, draft, spacing, curvature, etc; of *Admella* recreated by Adrian Brewer. The work was commissioned by the Port MacDonnell Maritime Museum to create the models as part of the 160th anniversary of the wrecking. The collected data for reconstruction reads as follows:

> “RECREATED DIMENSIONS AND DATA RECORDED IN LLOYDS REGISTERS; THE REGISTER OF BRITISH SHIPS; SPECIAL SURVEY NO.3821 DATED 24 SEPTEMBER 1857 DETAILING FULL CONSTRUCTION OF SHIP; CONTEMPORARY PAINTING BY JAMES SHAW 1858 SHOWING DECK LAYOUT; NEWSPAPER REPORTS BY SHIPPING REPORTER, RICHARD JAGOE, PROVIDING BOTH TECHNICAL AND COSMETIC DESCRIPTIONS, AS WELL AS BELOW DECK ARRANGEMENTS.”
>
> – **Adrian Brewer, 2007**

Figure removed due to copyright restriction.

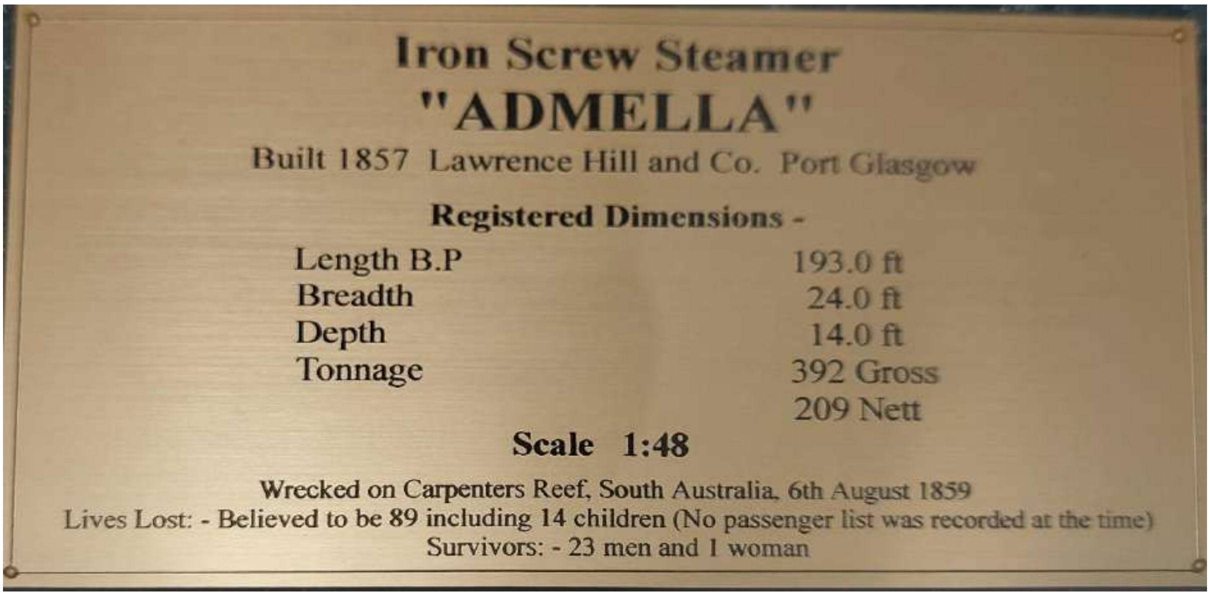
Figure 3.3. Auto-CAD model of *Admella* (Side A: Brewer, 2007)

Figure removed due to copyright restriction.

Figure 3.4. Auto-CAD model of *Admella* (Side B: Brewer, 2007)

The engineering inspection survey prepared 24 September 1857 and approved 2 October 1857 was used by Brewer through AutoCAD, as stated by an information card next to the model (highlighted red in figure 3.4). The second object of interest is a 1:48 scale waterline model of the vessel with a total length of a little over a metre. The model was constructed in 2009 at the same scale as the AutoCAD model by Brewer and presented to Port MacDonnell Maritime Museum (fig 3.5 & fig 3.6).

Figure 3.5. *Admella* waterline model produced by A. Brewer (2009) (2021-08-02)



Iron Screw Steamer

"ADMELLA"

Built 1857 Lawrence Hill and Co. Port Glasgow

Registered Dimensions -

Length B.P	193.0 ft
Breadth	24.0 ft
Depth	14.0 ft
Tonnage	392 Gross 209 Nett

Scale 1:48

Wrecked on Carpenters Reef, South Australia, 6th August 1859
Lives Lost: - Believed to be 89 including 14 children (No passenger list was recorded at the time)
Survivors: - 23 men and 1 woman

Figure 3.6. Small plaque on base of *Admella* waterline model (2021-08-02)

3.2.1 Estimated location: ADM1 and ADM2

The precise location of *Admella* has been widely speculated by communities in Mount Gambier, with numerous volumes having been written about the survivors, little has been recorded of the final resting place. By analysing Mossman (1859) and Mudie's (1966) narratives, the two authors mention that the vessel can be found 18.2 nautical miles northwest from Cape Northumberland. The plaque erected at Cape Banks Lighthouse states that *Admella* can be found 4 km northwest of that position. Drew and Taffs (1981) provided three maps with estimated locations from their sextant angle resections indicating the precise location as 3.2 km northwest of Carpenter Rocks town, 1.6 km northwest from Cape Banks lighthouse, and 1 km west offshore. Port MacDonnell's large board of approximate shipwreck locations has *Admella* 1.4 km north-northwest of Cape Banks Lighthouse, as well as *Corio II* – 2.8 km north-northwest (Port MacDonnell entry board no.1). Loney (1975a, 1975b) produced a miniature version of Mudie's original publication with source material from undisclosed newspapers, with two maps confirming Drew and Taffs estimated position of 1.6 km northwest (Deeprose, 2005:1). The estimated locations from all sources were plotted on a map for reference (Fig. 3.7).

The overlap of targets positioned near 1.6 km northwest and 3.0 km north-northwest of Cape Banks Lighthouse were allocated as ADM1 and ADM2 target sites (Fig. 3.8).

Figure 3.7. Potential locations of SS *Admella* from historic sources (P. Kermeen, Google Earth Pro, 2021-05-10)

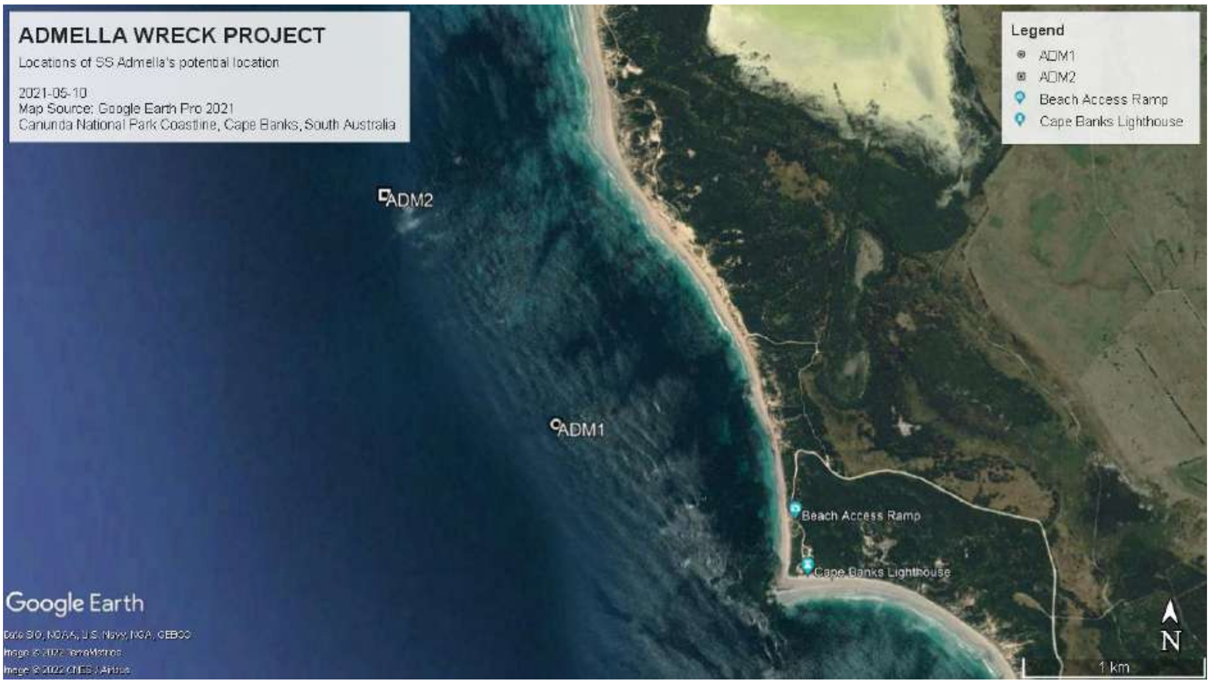


Figure 3.8. Chosen site locations of ADM1 and ADM2 (Google Earth Pro, 2021-05-10)

The Admella Plaque’s estimate of 4 km northwest is observed to be an outlier in the recorded measurements and therefore was dismissed from appointing ADM3 target. With the source material corroborating the observational data for ADM1 with more confidence, it was chosen as the primary site for investigation.

3.3 Field Work Methods

The objective of the fieldwork methods is to establish a foundation for research in this area and to enable interpretation of the coastline, intertidal, and subtidal landscape dynamics to better understand the entirety of the landscape. The methods presented in this section create a context for the entire landscape structure of Cape Banks, as well as understanding of site formation processes.

3.3.1 Observational Survey at Cape Banks Beach

A systematic walking transect survey technique was implemented on the beach to further assess sediment transgression (Renfrew and Bahn 2012:75). Drew and Taffs’ (1981) sextant transect results were from the visual reference marker of a ‘drainage basin’ within the sand-dunes. The observational transect would be used to delineate a 1.5 km boundary, encompassing the eastern side of ADM1 target site’s coastline and to record historic cultural material. A transect survey with two metre spacing was employed for the two-person survey, allowing for a one metre overlap. Four transect lines were achieved over a 1.5 km area. The transect survey included detailed recording of relative features by photography, coordinate marking, and sampling.

3.3.2 Organic Material Sampling

The walking survey would produce an understanding that Cape Banks coastline is a dynamic environment that is in constant motion. Large wrack bundles were recorded spanning from the two survey marker rocks near Cape Banks lighthouse up to 1.56 km northwest, up the beach (Fig. 3.9). Beach-cast wracks of organic material would be able to provide context of submerged conditions without the need for entering the water (Baring et al. 2014:397). The sampling of seagrass and kelp can inform researchers of the oxygen content of the water, including nitrogen percentage, and types of sediment that can be observed in the roots system (Baring et al. 2014:397–398). The incidence of sediment being imbedded within the roots of seagrass and kelp will help explain the effect large swell and storm events have on the submerged landscape of Carpenter Rocks reef system, thus, providing valuable information on the taphonomic processes. Although this is a maritime archaeology project, the collaboration with institutional partners has the benefit of combining techniques that can gather supplementary low-level generalisations, providing discernible patterns of organic sea growth and their effect on the submerged landscape and cultural material (Bowens 2008:60; Trigger 1998:30–31).

The method of sampling was unsystematically chosen from the four largest wrack piles found along the coastline; the method of selecting was based on spread of pile to collect larger variation of seagrasses (Baring et al. 2014:398)


Figure 3.9. Seagrass and kelp cast wrack on Cape Banks foreshore (north, 2021-08-02)

3.4 Determining Shallow Dynamic Environment Context

3.4.1 Remote Sensing Survey

Remotely Piloted Aerial Systems (RPAS)

An RPAS survey was planned in the initial project stage to accomplish five objectives. The objectives were to (1) obtain information from the submerged landscape from an aerial perspective, (2) observe seasonal weather patterns concerning the submerged environment, (3) observe location of the wreck(s), (4) determine depth range of ADM1 site, and (5) observe the structure of the reef system (Mancini and Dubbini 2020:87). The use of light-weight quadcopter drones has gained major popularity in recent years and has become an important utility for pre- and post- disturbance survey work within archaeology; and is being implemented for long term conservation monitoring of historic landmarks and landscapes (Fernandez-Hernandez et al. 2015:128–129; O’Driscoll 2018:33). RPASs have been used quite significantly in the past two years with the adoption of consumer-rate drones becoming part of the archaeologist’s toolkit (Campana 2020:233). The reliable flexibility, cost-effectiveness, high geometric resolution, and enhanced accuracy over potentially thousands of kilometres has made consumer drones one of the fastest and easily obtainable resources for data collection not seen from any other device today (Benjamin et al. 2019:212; Casado et al. 2020:56–57; Calantropio et al. 2021:643–644; Carrivick and Smith 2018:3–4; Doukari and Topouzelis 2022:2–4; Trendafilova and Dechev 2021:323–324).

The adoption of RPASs have greatly enhanced the ability to provide more visual context, however, the application of these drones with an archaeology perspective is still quite unrefined, even less so when considering maritime archaeology (Campana 2020:227; Pecci 2020:2). Mancini and Dubbini’s (2020) workflow for coastal environment applications is considered the closest form of geospatially referenced mapping over the sea surface that has been published. However, their workflow focusses on environmental mapping and less so for submerged archaeology purposes. Therefore, this thesis proposes a new ‘Coastal Integration Method’ workflow for maritime archaeology specifically, produced from the significant developments made by Campana (2020), Casado et al. (2020), and Mancini and Dubbini (2020) (Appendix 1I).

During an initial flight, 20 March 2021, a Mavic 2 Zoom was used to measure the sextant angles used by Drew in reference to the 1981 finders report (Drew and Taffs 1981:3). The areas of interest were photographed, and coordinates recorded by onboard GNSS. This initial preliminary survey was fundamental in establishing continuous remote sensing in the area over the duration of the project. From early August 2021, RPAS survey missions were conducted from select locations along Cape Banks coastline. The primary drone used for this survey was a DJI Mavic 2 Pro (M2P), although a DJI Mavic 2 Zoom (M2Z) and an Autel Evo II Pro (AE2P) were used for different segments; the main utility was the first remote-sensing-unit (fig. 3.10). The flight paths were created through a third-party program DroneDeploy 2021 (https://www.dronedeploy.com/about/), allowing for the customisation of flight area, range, direction, altitude, overlap, flight speed, and type of drone that can be used with the application (Table 3.1) (Fig. 3.11, 3.12, 3.13, 3.14, 3.15). The captured images are then processed by DroneDeploy or WebODM (Open Drone Mapping 2021), which utilises a photogrammetry system and combines overlapping images by stitching them together for the final products. The results are an ‘orthomosaic’, digital terrain model (DTM), digital elevation model (DEM), and a 3D model (if certain parameters have been met in the initial capture of the area).

Table 3.1: Method of parameters applied to flight surveys indicating the altitude, overlap of images, mapping speed, area coverage, flight time, and number of georeferenced images.

Map Name	Altitude (m)	Overlap % (f/s)	Mapping Speed (m/s)	Area Coverage (m^2)	Flight Time (minutes)	Images Taken
Admella Survey (Fig. 3.11)	50	F: 80 S: 70	3	260,000	88:40	1703
North-west Beach, Cape Banks (Fig. 3.12)	80	f/s: 85	4	140,000	49:46	963
Carpenter Rocks 1 (Fig. 3.13)	85	f/s: 85	4	700,000	208:38	4162
Carpenter Rocks 2 (Fig. 3.14)	80	f/s: 80	5	630,000	117:49	2426
Carpenter Rocks 3.1 (Fig. 3.15)	80	f/s: 82	5	530,000	111:58	2520
Carpenter Rocks 3.2	80	f/s: 80	5	800,000	145:48	3062
			Total	3,060,000 (3.06 km^2)	720:79 (12.01 hrs)	14,836

Figure 3.10. M2P (left), M2Z (right), and AE2P (bottom) (2021)

All pre-flight survey data was programmed by DroneDeploy Cloud Mapping System's automated flight paths.

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Figure 3.11. Admella Reef Survey area (ADM1)

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Figure 3.12. Cape Banks Coastal Survey area

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Figure 3.13. Carpenter Rocks 1 Survey area

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Figure 3.14. Carpenter Rocks 2 Survey area

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Figure 3.15. Carpenters Rocks 3.1 Survey area

Remotely Operated Vehicle (ROV)

The availability of ROVs in the current state of research within maritime archaeology is very limited due to biased perception from ‘scientific diving’ organisations, even more so in Australia (Gately 2013:26). The introduction of lightweight tethered submersibles has become more accessible over the past two years, allowing for hand carried ROVs to be transported to site without much effort (Gately 2013:27). These small submersibles can record hydrodynamic data, imagery, and information about the seabed composition (Bowens 2008:112; Green and Gregory 2020:274).

The ROV ‘Chasing M2’ was used to inspect anomalies and surveyed ADM1 to further understand the extent of the site (Fig. 3.16). The ROV recorded the hydrodynamic speed and direction of flow during the positive surge exhibited during dive missions. The data has the potential to inform us of the site’s submerged characteristics that lend better understanding of material spread and deterioration effects. Through the hydrodynamic recording system, the ROV was then used to sweep the area in an unsystematic survey.

The ROV system does not come with a portable GPS unit, thus the boat tracking system onboard RV *Bungaree* was used as a georeferenced marker. A compass bearing can be taken with the ROV and measuring the amount of tether released, an area of coverage can be estimated.

Figure 3.16. Chasing M2 compact ROV used for AWP at ADM1 (2020)

3.4.2 Geophysical Survey

Marine Magnetometer

Magnetic surveys have long been used in maritime archaeological practices, as the applied search patterns used for diver investigations of the sea floor can be appropriately employed for geophysical surveys (Bowens 2008:103). Magnetometers can detect the earth's magnetic field with variations caused by ferrous elements in any environment and relay a response measured by the frequency of the object (Bowens 2008:111; Jones et al. 2005:186). As the spatial distribution of the site is unknown, the magnetometer was employed to survey the boundary area of ADM1.

The Cape Banks coastline is predominately limestone material, and the submerged environment is observed to have a high dissolved oxygen content percentage based on the widespread growth of seagrass throughout the entire reef system (Baring et al. 2014:401-403). The seagrass overgrowth impeded visual observation with the ROV and made affiliating objects with ship material or natural reef structure difficult.

Surveys of a submerged environment for shipwrecks with limited information benefit from using a marine magnetometer for sensing ferrous material in areas where RPAS or ROV have trouble distinguishing natural geomorphology from ferrous concretions (Firth 2010:132; Missiaen et al. 2017:27). The 'Marine Magnetometer Explorer' was used for this survey, owned by Flinders University. The software used by the surface unit is called 'BOB' and is processed using 'MagPick'. The proposed area of survey is 1.28 km^2, however, this was unachievable due to reef bommie obstructions. Instead, the survey area was broken up into three surveys. An important step in understanding the magnetic reading of potential anomalies, is to first understand the background 'magnetic declination' of the survey region. This is measured in nano-teslas and is important in determining ferrous material signatures against unrelated information being recorded by the instrument. The magnetic declination in Carpenter Rocks is recorded at 60601.8 nT and this reading is used as the baseline for the survey parameters.

Due to the weather conditions and elevation of reef, the survey was positioned around the ADM1 site to establish a large survey area for material distribution across Admella Reef. The survey was divided into four parts, with an average spacing of 20-30 m depending on the swell and wind experienced. Surveys heading north-northwest and south-southeast have the advantage of covering greater distances to record distributional spread of potential material and can be kept at 20 m line separation.

Surveys heading east and west are more likely to be hazardous due to observed swell and potential for grounding, therefore only the north section of ADM1 was surveyed with 30 m line spacing (Fig. 3.17).

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Figure 3.17. Magnetometer Survey area at ADM1 (QGIS, 2021-11-29)

3.5 Mapping ADM1 site

3.5.1 Snorkel Survey

After the initial magnetometer survey had been completed, a non-disturbance snorkel transect-survey was used to narrow down the site extent (Bowens 2009:96). The survey started in the south-southeast ADM1 area, where the swell would slowly drift the divers in a north-northwest direction. The swimline search was administrated for the snorkel survey due to moderate surface current and strong submerged uplift (Bowens 2009:97).

Four members snorkelled at 2 m spacing from each other with a shared rope held out in front of themselves. At each end was a surface marker buoy (SMB) with a Garmin GPS device attached, tracking the direction and area covered. Knots were tied every 2 m as handholds for the snorkelling team to keep position without drifting into each other (fig. 3.18). Each snorkeller had a GoPro Hero 5, 6 or 9 in a waterproof case. The compact cameras were best suited to keep the snorkeller light and not task loaded in the swell. The time from each video or photograph would be matched up to the Garmin GPS time, then a marker was placed in post-processing to show the location of an object of interest. A ‘dry-run’ of this plan was performed on the beach (Fig. 3.19).

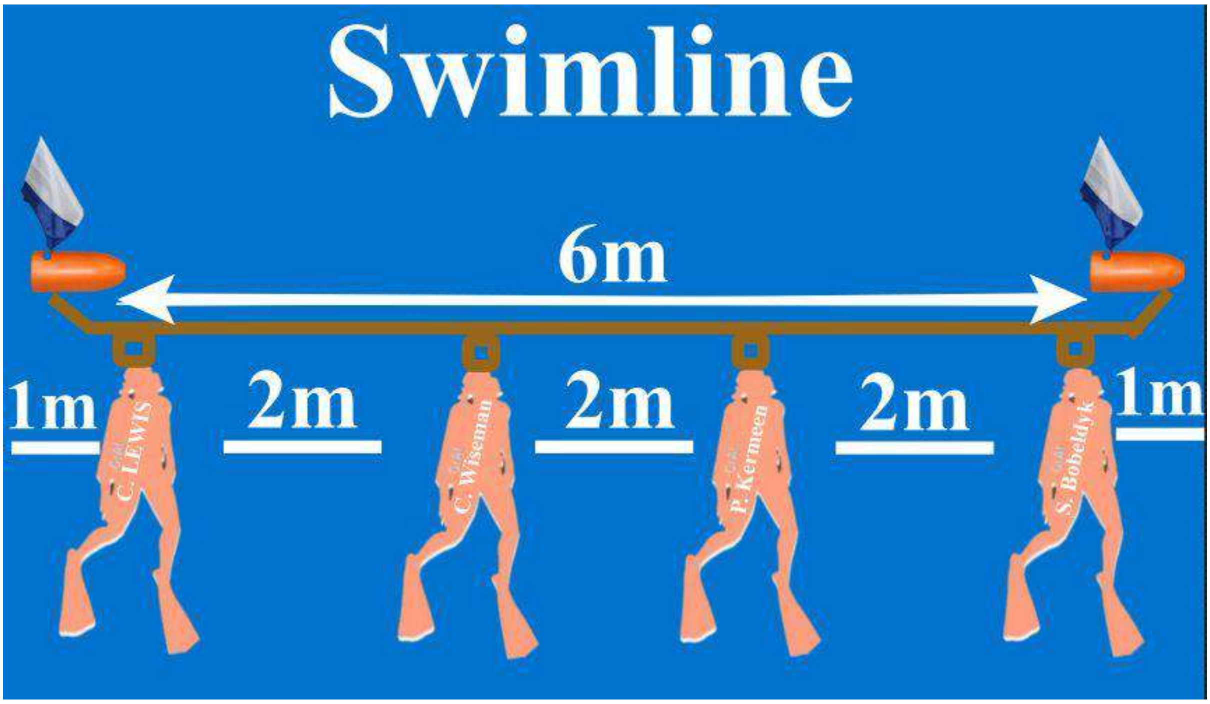

Figure 3.18. The swimline method for snorkel observation transect survey. (2022)

Figure 3.19. Team performing a swimline dry run. C. Lewis (left), C. Wiseman, P. Kermeen, S. Bobeldyk (right). (H. Yoshida, 2022-01-12)

The freeline search was employed to survey the northern portion of the reef and slowly go around in an anti-clockwise rotation following the reef to the western section (Bowens 2009:98-9). The snorkel surveys were accomplished through three drifting linear pathways (Fig. 3.20). The third snorkel transect was based on a freeline search pattern which manoeuvred around the outer edge of the reef and to a point where the swell break had the survey turn around and head back, re-examining the site area, as recorded on the GPS (Fig. 3.21).

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Figure 3.20. Garmin GPS tracks of snorkel team transect pathways (QGIS, 2022-04-13)

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Figure 3.21. Snorkel survey corridors and distance simplified (QGIS, 2022-04-15)

3.5.2 Non-Disturbance Observational Diver Survey

The transition to scuba is the last yet best remote sensing application that maritime archaeologists have at their disposal. Archaeologists can do most of the remote sensing methods with smaller, more precise equipment when diving on a site, as the precision that a maritime archaeologist has versus near any other remote sensing tool cannot compare. However, diving cannot cover hundreds of metres within a day or be submerged for 24 hours, therefore diving is used explicitly for short interval operations where precise recording is needed in areas where ROVs and AUVs cannot access.

The team swapped to scuba or to a closed-circuit single tank system (Bowens 2009:114). The objective was to record multiple objects and formations that had been observed to greater detail, while reducing the surface swell impacts on the divers. No sketches or scaled drawings could be attempted due to the strong swell.

The diving commenced with a snorkel survey along the western reef edge. A notable feature, a sharp-edged limestone wall was spotted and allowed dive team to orientate themselves and descend to 4 m, heading south along the western wall of the reef. The group went past the feature (completely covered by seagrass) and continued south; an area that had not been explored in the snorkel surveys due to wave-breakers in that area. During this observational search, more objects came into view that were recorded as potential ship-structures. The dive group came back to original area of interest and began recording (Fig. 3.22).

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Figure 3.22. Initial dive survey on Western reef outcrop (QGIS, 2022-05-01)

A second and third dive was performed. These two surveys were intended to record all points of interest recorded from the snorkel survey. Marker buoys were installed at the site of the last dive survey area. Average depth was 4.3 m and visibility continued to be >8 metres. The surge made it difficult to perform tasks, making the dives longer to record in ideal conditions. Overgrowth of seagrass became an obstacle due to the length covering the entire scale bar, causing it to completely disappear until the next surge interval brought it back into view to be recorded. The third dive headed southwest towards breakers to complete the survey for that area (Fig. 3.23).

After recording, the team left the site heading southeast away from the reef and to an open area where RV *Tom Thumb* could extract the team (Fig. 3.24).

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Figure 3.23. Day 2 diving transect coverage of ADM1 site (QGIS, 2022-05-01)

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Figure 3.24. Reef outcrop at ADM1 site and area of safe pick up of divers (QGIS, 2022-05-01)

Chapter 4 Results

4.1 Introduction

This chapter presents the data collected, including observations of Cape Banks shoreline and physical material related to the vessel, while the historical information pertaining to *Admella* is discussed in Chapter 5. This chapter provides data gathered relating to the submerged landscape topography, taphonomy of vessels located on the foreshore, and ship-related material. The archaeological fieldwork is separated into two sections. Section 4.2 will focus on the ‘observational’ survey performed across the Cape Banks coastline. Section 4.3 will provide information on the Admella Reef survey; the remains observed and how they are potentially related to the stern of an iron-built vessel.

4.2 Observational Coastal Survey

4.2.1 Surface Transect Survey

The transect survey offered a view of a moving landscape built-up by sand-dunes on the foreshore. These dunes are eroding with regular high tides, strong winds, storm events, and swell movement (see Appendix 1A). The shoreline of Cape Banks and ‘Admella Dunes’ are a repository for organic material and modern debris, constantly being deposited ashore and buried by sediment eroding from the dunes above (Fig. 4.1). As discussed in Chapter 3, a two person transect was performed starting at the limestone signal marker rocks, heading north along the beach. Four transect lines at 6 metres spacing for 1.56 km were accomplished, (Fig. 4.2). At 1.34 km heading north, a solid ferrous object was found within the intertidal zone (Fig. 4.3), the object is directly 1.1 km east of ADM1. It may be related to any of the numerous shipwrecks in the region. The rising tide interrupted any further investigation, but the object was very solid. However, other ferrous material has been found along the shoreline of Cape Banks, as the beach is in constant use by 4WD vehicles. A ferrous object found closer to Cape Banks lighthouse was identified as an axel for a car (Fig. 4.4). Therefore, it cannot be assumed that all ferrous material is strictly ship related until proven through excavation and interpretation.

Figure 4.1. Modern discard from crayfishing activities on Cape Banks foreshore, SA (2021-08-09)

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Figure 4.2. Beach survey coverage along Cape Banks coastline (QGIS, 2021-10-10)

Figure 4.3. Ferrous object located 1.34 km northwest of Cape Banks Lighthouse (2021-09-26)

Figure 4.4. Excavated ferrous object identified as rear axle of car. Right Side: location of axle to ‘Signal Marker’ rocks, Cape Banks. (2021-08-29)

4.2.2 Seagrass and Kelp Results

Beach-cast wrack can be spotted on Cape Banks foreshore frequently in bundles (Baring et al. 2014:397–398). The bundles were monitored during the transect with the inclusion of concretion and limestone material observed to be imbedded within the root system. By assessing the amount of material found imbedded in the root systems and estimating the volume of seagrass wrack found on the foreshore, we can potentially average the overall rate of deterioration to ship-material for the year (Fig. 4.5).

Samples were collected and transported to Flinders University Marine Biology Department to be inspected by Dr. Ryan Baring, who has experience with seagrass species in

Carpenter Rocks region. Two variations of kelp were identified by Baring through observation and comparison to samples retained at the facility, they were *Macrocystis* C. Agardh – ‘giant kelp’, and *Durvillaea potatorum* Bory – ‘bull kelp’ (Fig. 4.6). More importantly, the storm events are not the sole contributory factor to the deterioration of the reef through the uprooting of seagrass and kelp. The kelp can be up-rooted by the changing of swell from 2.6 m (average) to 3.6 – 4.8 m, depending on wind intensity.

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Figure 4.5. Beach cast wrack accumulation (red) and sampling sites (blue) (QGIS, 2021-10-10)

Figure 4.6. Kelp (left) and seagrass (right) samples from Cape Banks, SA (2021-09-26)

4.2.3 Pisces Star

The transects contributed to understanding the movement of sediment in relation to weather events and how it affected the overall process of material build-up. However, the sediment movement and material observed in kelp roots could only provide a shallow interpretation of the site. The last part of the terrestrial investigation included surveying the intact remains of *Pisces Star* (Fig. 4.7). The vessel wrecked in 1997 after its maiden voyage was affected by major storms. The vessel is used as a small case study to provide a real-time taphonomic process in the shallow high energy dynamic environment from March 2021 to July 2022 (Fig. 4.8).

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Figure 4.7. Location of *Pisces Star* in Cape Banks, Lighthouse Bay, SA (QGIS, 2021-10-10)

Figure 4.8. *Pisces Star* 2021 (left) and 2022 (right) deterioration process (2022-06-22)

Pisces Star, from 1997 to present has been constantly deteriorating in the intertidal zone at a faster speed than expected. The vessel is impacted by constant swell, sediment movement (listing to starboard), southerly and south-westerly winds, corrosion, and marine growth. Interpreting *Pisces Star*'s deterioration rate and applying that framework onto *Admella*, provides an understanding of taphonomic processes on ship material in high energy environments and preservation results over 25 years. The M2P was used in spiral rotation to complete a video transect of the vessel in 2021 and a second video transect in 2022, and both videos were used to create 3D models through Agisoft Metashape (2021) to show the variational change in deterioration rate (Fig. 4.9).

Figure 4.9. 3D photogrammetry comparison of missing main cabin roof and overgrowth of algae (Agisoft Metashape, 2022-07-30)

4.3 ADM1 Site Survey

4.3.1 Remote Sensing

RPAS Transect Survey

Based on aerial surveys conducted between August 2021 to July 2022, large sections of the reef were recorded in high resolution provided by a DJI Mavic 2 Pro and DroneDeploy Cloud Mapping Systems (2021). The use of +70% overlap for each transect resulted in high resolution orthomosaics that were needed to observe the submerged landscape, as the resolution from Google Earth and similar data has yet to reach that region (Table 4.1). The orthomosaics that were generated through DroneDeploy were able to detail the inner outline of the reef structure, starting from the signal marker rocks and venturing northwest towards ADM1. As a biproduct, the team was able to examine the inlet to the reef and to understand where reef bommies are present, and how to avoid them during ROV and magnetometer surveys.

Table 4.1: Results of drone survey including rendering processes that failed (pink), low level success (orange), and complete projects.

Map Name	**Area Coverage (m^2)**	**GPS Accuracy (m)**	**Image Quality**	**GSD (cm/px)**	**Images Aligned (%)**	**GPS Aligned Images (%)**
North-West Beach, Cape Banks	138,564.03	10	High	1.77	83	17
Admella Survey	2,089,412.75	NA	Inconclusive	Inconclusive	0	0
Carpenter Rocks 1 (CR1)	1,218,177.55	10	High	1.82	43	52
Carpenter Rocks 2 (CR2)	1,248,308.50	10	High	1.70	44	52
Carpenter Rocks 3 (CR3)	1,475,241.69	10	Low	1.86	9	18
Carpenter Rocks 3.2(1) (CR3.2-1)	1,825,924.54	10	Low	1.75	9	78
Carpenter Rocks 3.2(2) (CR3.2-2)	1,886,763.81	10	Low	1.77	9	71
TOTAL	**7,792,980.12**					

North-West Beach Survey:

This survey produced the highest percentage of images aligned and the highest degree of accuracy, which can be attributed to the altitude and overlap factor covered in Chapter 3. The high degree of resolution can be attributed to the number of static pixels that are required for all photogrammetric rendering processes (Carrivick and Smith 2018:2). Large portions of the ocean context are in constant motion, affecting image quality and accuracy through sun-glare and refraction, which is constantly changing throughout the flight (Benjamin et al. 2019:217)

(Fig. 4.10). The orthomosaic was able to penetrate 3 m below the water's surface, characterising the seafloor near the signal marker rocks. The orthomosaic offers an approach to identify limestone seafloor (smoothed limestone pebbles), kelp growth areas, and possible vessel material (Fig. 4.11).

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Figure 4.10. North-west beach survey over Cape Banks coastal shoreline, intertidal and subtidal (QGIS, 2022-08-04)

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Figure 4.11. Observable limestone seafloor with surrounding seagrass reef-outcrop (QGIS, 2022-08-04)

Admella Survey:

This survey was an experiment to understand the seafloor through aerial imagery without using CIM workflow. The post-processing product was inconclusive due to image alignment failure (Fig. 4.12). The photos individually could be used to see through the cloudy haze for specific objects if they were observed or indicated prior, however, when used with programs utilising SfM it fails to render (Carrivick and Smith 2018:8). The issue of not using the coastline integration workflow for RPAS survey mapping is that the coastline's static capture is used as an anchor point for the SfM process to begin, then working slowly outwards to fewer connectivity points (Fernandez-Hernandez et al. 2015:133).

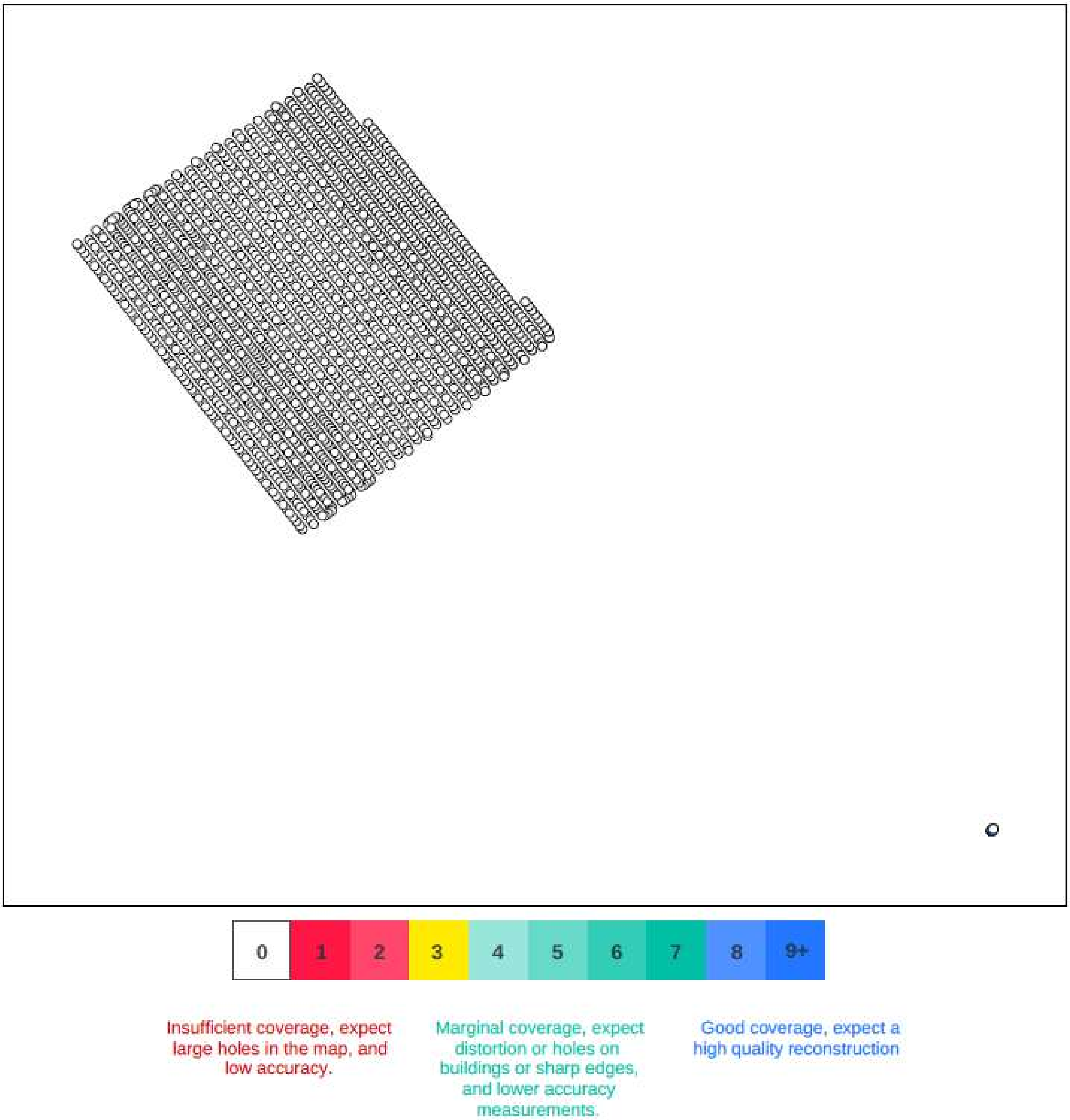

Figure 4.12. DroneDeploy assessment failure for appropriate coverage (DroneDeploy, 2021-07-09)

Carpenter Rocks 1 (CR1) & Carpenter Rocks 2 (CR2):

CR1 was the first large successful survey over the coastal area and accomplished 43% image alignment, the majority of the orthomosaic used GPS positioning to reconstruct the region and use dense-point cloud meshing to give an accurate render (Fig. 4.13).

The orthomosaic was able to produce an accurate depiction of the submerged landscape with reef bommie locations evident (Fig. 4.14). As part of the aims, the orthomosaic was used to identify ship-material and shipwreck locations.

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Figure 4.13. Orthomosaic of southern Cape Banks region and reef outcrop (QGIS, 2022-08-04)

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Figure 4.14. Reef bommie locations indicated in red from survey data (QGIS, 2022-08-04)

CR2 used the same overlap method, using 15% of CR1 photos and integrating them into the process allowed for smooth fitting and gap filling of the orthomosaic. Gaps in the orthomosaic were created by white-wash, refraction, and glare. The overlap of CR1 and CR2 orthomosaics (Fig. 4.15) fitted nicely in place with one another despite the problem of getting images from two different days. The image alignment total of 44% is again reconstructed mostly from GPS aligned images (52%) during process rendering (Fig. 4.16).

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Figure 4.15. CR1 and CR2 orthomosaic alignment for furthered context (QGIS,2022-08-04)

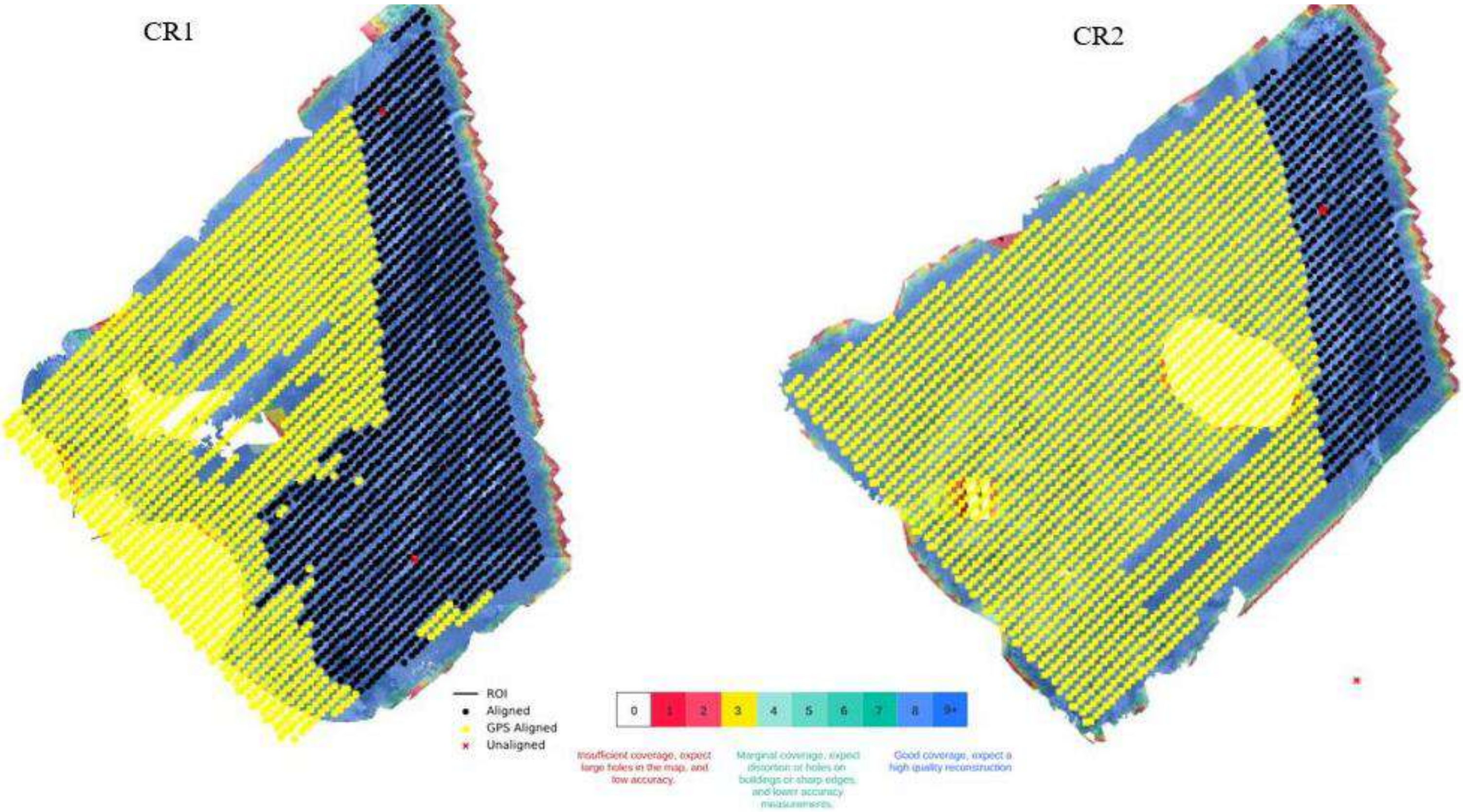

Figure 4.16. Display of images aligned by SfM and GPS comparison of CR1 and CR2 (DroneDeploy, 2022-08-04)

Carpenters Rock 3 (CR3):

Prior to this survey, refraction and depth was minimal for the area covered (not including the wave breakers located southwest), allowing for high resolution orthomosaics to be produced with 1.778 cm/px average. CR3 orthomosaic failed to render due to deep water colouration producing fewer colourising pixels to target. The amount of refraction became overwhelming due to intense sun-glare in November 2021, which contributed to fewer connective-points for SfM rendering (Fig. 4.17).

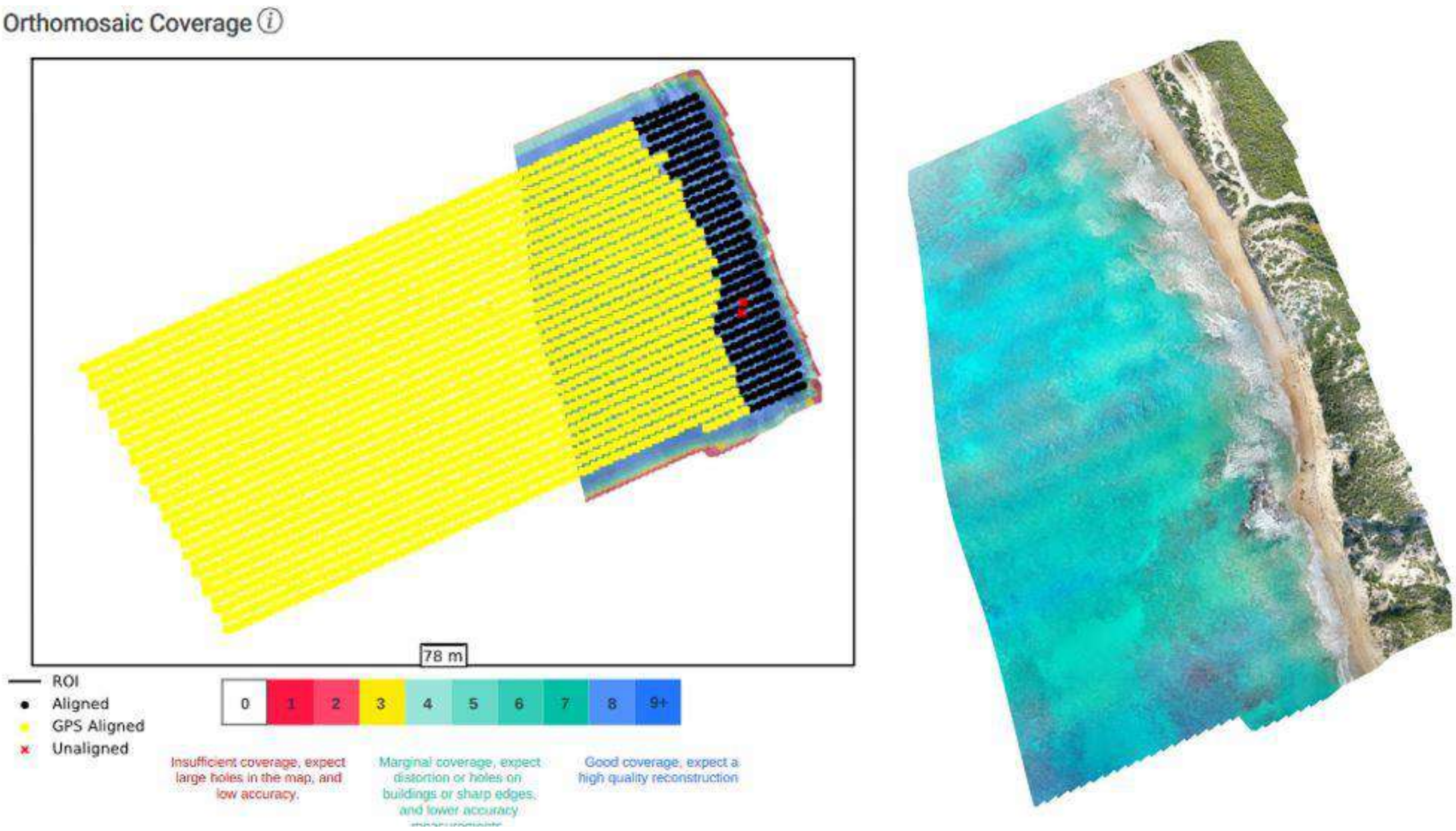

Figure 4.17. GPS alignment error due to refraction and sun-glare with low image alignment (DroneDeploy, 2022-08-10)

Carpenter Rocks 3.2(1) (CR3.2-1) & Carpenter Rocks 3.2(2) (CR3.2-2):

A CPL (circular polarizing lens) filter was used to reduce refraction rate and increase depth perception for sea coverage during this survey.

The two orthomosaics produced, CR3.2-1 and CR3.2-2, were recorded from the same flight transect survey as CR3 but with original parameters extended. DroneDeploy servers can upload 3,000 photos per batch, therefore, the data was separated into two equal parts of 3,000 – applying at minimum 500 photos (16.66%) from CR3.2-1 to create anchor points with overlapping parameters. The integration of the photos created an accurate overlap to mediate the loss of accuracy and function during SfM processing (Fig. 4.18).

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Figure 4.18. CR3.2-1 and CR3.2-2 orthomosaic coverage of ADM1 area (QGIS, 2022-08-04)

Furthermore, most images are aligned by placing the target photos corresponding to the UTM coordinate and deriving a continuous sequence of connecting tie-points (Fig. 4.19). Essentially, the coordinates within the image data are placed into position on a grid and then connecting tie-points render an orthomosaic from isolated pockets that would slowly bridge isolated segments into the final product.

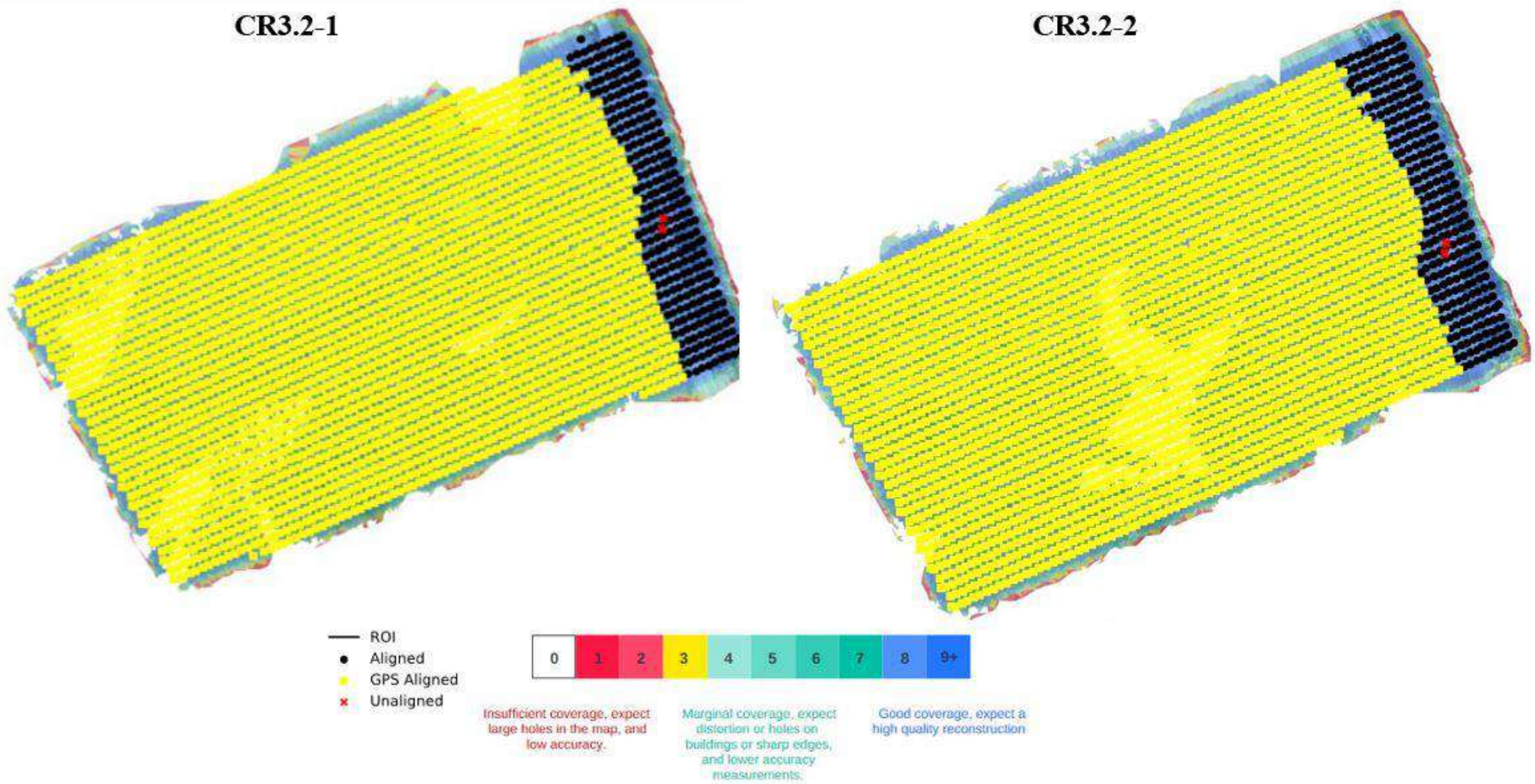

Figure 4.19. Comparison of image and GPS alignment for before overlay process (DroneDeploy, 2021-12-23)

RPAS Survey Conclusion

The orthomosaics generated from DroneDeploy were able to give the team an up-to-date high-resolution map of the area, observing locations of reef bommies with accurate coordinates (Fig. 4.20). The team was able to plot magnetometer transect lines and get an overall understanding of the reef structure by importing CR1, CR2, CR3.2-1, and CR3.2-2 into QGIS and overlapping them to produce one high resolution image for the entire survey area. Obvious shipwreck material was not distinguishable from the orthomosaics; however, anomalies were spotted along the reef edge but were not able to be investigated due to rough weather (Fig. 4.21).

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Figure 4.20. Complete orthomosaic overlay with coverage from signal marker rocks to ADM1 (QGIS, 2022-08-04)

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Figure 4.21. ADM1 highlighted (green) with possible ship material (red) (QGIS, 2022-08-04)

Remotely Operated Vehicle Survey

Chapter 3 discussed the varying historical literature that alluded to *Admella*'s location. From the orthomosaics, DEW report (Drew and Taffs 1981), and the accounts from Loney's book (1975a), the chosen site location ADM1 was investigated as the primary survey area. The area is commonly known as 'Admella Reef' by cray-fishermen from Carpenter Rocks (T. Sheard 2021, pers. comm). When deployed from RV *Bungaree,* the ROV's top speed of 3 knots (1.5 m/s) gave the team an understanding of the swell conditions that the research vessel could not clearly identify with surface current. We were able to visualise the submerged landscape from a three-dimensional perspective (Fig. 4.22). The ROV does not come with a portable GPS unit, therefore, the boat tracking system onboard RV *Bungaree* was used as a georeferenced marker. To accurately record the ROV's distance and location when pinpointing objects, a forbearing from the submersible was recorded that could be backlogged from the vessel and marked tape points (10 m per section) were used to record distance (Fig. 4.23).

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Figure 4.22. Location of ROV during sweeping search and visual footage of reef recess facing west (QGIS, 2022-08-04)

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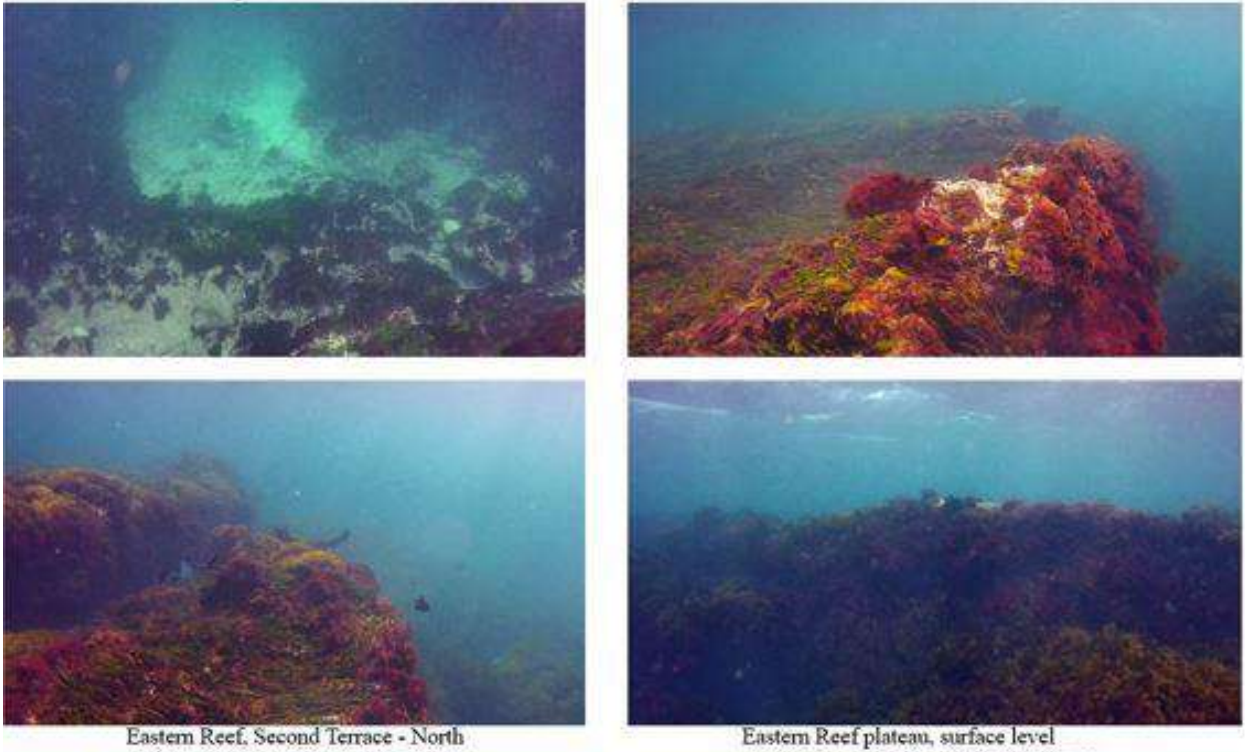
Figure 4.23. Area covered by ROV from *Bungaree* over ADM1 (QGIS, 2022-08-04)

Surf was minimal, yet the submerged conditions recorded by the ROV indicated that the force of the surge was above 3 knots at the height of each interval. The various odd-shaped anomalies were recorded thoroughly to document and assess for the potential of ship-related material. Having launched two missions in ideal conditions, site extent was able to be narrowed to less than two hundred metres that would need to be investigated further by diver survey. The landscape provided evidence of a rocky eastern reef system covered by seagrass and kelp. Between the rocky alcoves within the reef, clearings were observed as having bare white limestone pebbles in areas with little vegetation present. The clearings had peculiar-shaped objects nestled in the centre with seagrass overgrowth (Fig. 4.24). Without a magnetometer or underwater metal detector, the objects with overgrowth could not be positively associated as being ship related. The Western section of reef was not observed due to sea surface level from reef seafloor recorded at 600 mm, creating a hydrodynamic fluvial bottleneck exceeding ROV's speed of 3 knots.



Limestone clearing – Sandy bottom with less vegetation – South-East

Eastern Reef plateau, Limestone - North

Eastern Reef, Second Terrace - North

Eastern Reef plateau, surface level comparison to sea level (high tide) - West

Potential anchor fluke – North-North-West

Potential anchor fluke – North - East

Ferrous debris/ bulging limestone outcrop - West

Exterior hawsepipe/ cat's hole – South - West

Figure 4.24. ROV recorded data of natural limestone reef structure (top) in comparison to irregular structure littered throughout ADM1 (Chasing M2, 2022-08-05)

Sidescan Sonar

As part of an initial survey 19 October 2021 over Admella Reef, the EdgeTech-Marine 4125(P) Sidescan Sonar unit was to be deployed. However, after examining the elevation of reef bommies to surface with the ROV and observing the submerged landscape morphology, it was determined that the instrument could not be deployed in the manner intended.

Although the unit had been used in similar reef environments before, the 1.9–2.3 m swell, with the addition of loose kelp, would ‘struggle with the swell and surge during recording, creating stripes of no data, the destripe filter through SonarWiz would reduce the overall image aspect, resulting in a loss of a clear indication of wreck and reef’; affecting the acoustic waves during their propagation within the water column, resulting in quenching and short-wave readings causing blanking of data sets with inconclusive results (Blondel 2009:10-12; Wiseman 2021, pers.comm).

Marine Magnetometer

The magnetometer was used on the project to identify potential ferrous material on site that had either been missed by the ROV or too overgrown and concreted to discern. To maximise the use of the magnetometer, the survey parameters were extended to encompass the area around the survey site.

The proposed survey area was 1.28 km^2; however, the survey tracks were reconsidered after the initial expedition, and ROV data had confirmed that the reef bommies were the main concern for the use of the magnetometer, as the instrument could be snagged or damaged during survey. Therefore, the area was broken up into three sections that could achieve the desired outcome and avoid any reef-outcrop that was too close to the sea surface. As specified in Chapter 3, the background magnetic declination in Carpenter Rocks (60,601.8 nT) was used to scale the range of magnetic frequency detected by the transducers on the magnetometer.

Magnetometer Survey 1:

Pool noodles were attached to the towfish due to reef bommie elevation from seabed to surface recorded between 0.5–1.6 m. The added security of attaching pool noodles was to stabilise the towfish in 1.8–1.9 m swell that was experienced as recorded by Bureau of Meteorology 2022 (Appendix 1A). With a layback of approximately 24 m from GPS antenna and survey speed averaged 4–6 kn (8–12 km/h), two transect lengths of 250 m were completed heading west-northwest and east-southeast with line spacing at 30 m. The sampling ‘Command 1’ function used at highest sample rate of 4 hz for all surveys, which allowed the magnetometer to sense for the smallest ferrous material signatures present.

The increased swell contributed to caution over magnetometer safety and the survey was brought back to the south-eastern quadrant with another portion being surveyed heading north-northwest and south-southeast. Spacing (30 m), survey speed (4 knots), and layback (24 m) kept the same. The survey length was changed to 300 m and four transect lines were completed before winds of 23 kn (46.7 km/h) began affecting vessel positioning. An estimated coverage of 0.3 km^2 had been completed in the survey area.

Due to swell, kelp entanglement, and vessel speed, the floatation noodles applied to the magnetometer had displaced the instrument’s horizontal positioning during survey.

The distortion recorded was interference of large swell forcing the towfish out of water. These readings were initially interpreted as propellers being recorded by the instrument; however, the anomalies were reinterpreted as swell distorting the imagery, giving an inconclusive reading for that survey section.

Magnetometer Survey 2:

Floatation noodles had been reinstated to counter the speed, swell, and kelp entanglement before survey was launched (Fig. 4.25). The towfish’s layback was approximately 27 m from GPS antenna and survey speed averaged 4–6 kn (8–12 km/h). Eight lines were completed over a 1 km length with a directional heading of north-northwest and south-southeast and line spacing of 30 m. The weather was ideal for surface towing with swell less than 1.3 m and wind speed 5.7 kn (11.2 km/h), covering an estimated 0.27 km^2. Craypots were being placed in front of the vessel during recording, forcing the vessel to divert and overlap transect lines causing target spikes. Location of craypots and time of passing were recorded to compare to mag-data in post-processing (Fig. 4.26).

Figure 4.25. J. Buchler inspecting magnetometer after first day of survey (top). Pool noodle attachment (bottom) for increased stability (2022-01-11)

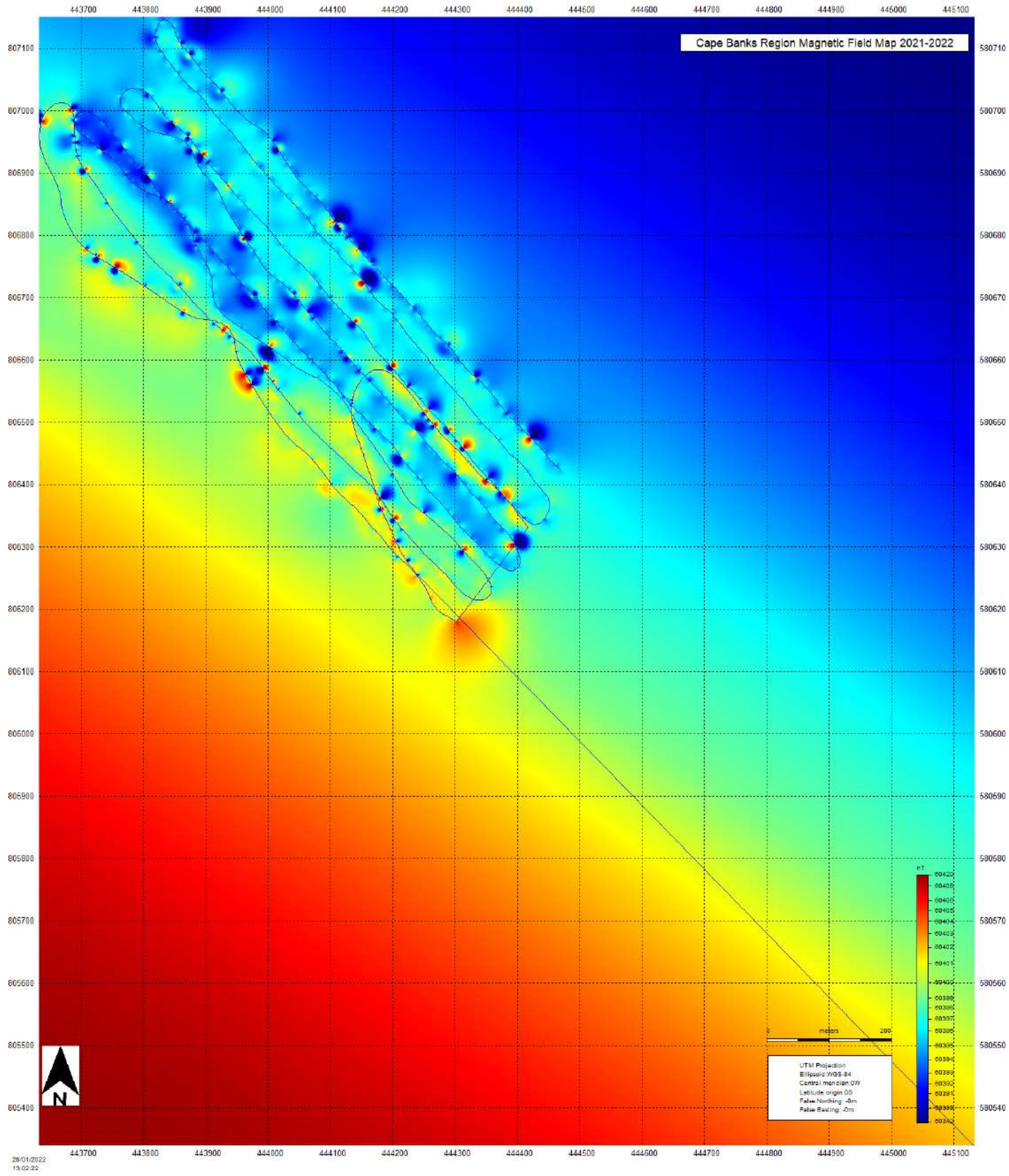


Figure 4.26. Eastern survey of ADM1 with no ferrous anomalies observed (J. Buchler, MagPick, 2022-01-28)

With the range of -119.00 nT to 141.00 nT after smoothing, the indication is that no ferrous material was detected in this area apart from the observed craypots. Regarding anomaly size, ferrous material relating to iron and steel vessels would be identified with a reading equal to or greater than -500 nT and/or 1000 nT (Ponce et al. 2016:8). The dipoles recorded in the survey reflect the signatures of ferrous material at junctions of observable craypot drops. Other negative unipoles can be attributed to overlapping of transect lines.

Magnetometer Survey 3:

All parameters set from 'Magnetometer Survey 2' were duplicated for this transect, with coverage of area +/- 20 m from original survey. The objective was to resurvey the area to avoid overlapping lines which caused dipoles of inconclusive data. Moreover, it was to correct any information that may have been lost during the original transect and to determine if any ferrous material was still present.

Swell recorded at 2.6 m and southerly winds of 15 kn (32 km/h) affected survey throughout recording. The range of -255.00 nT to 82.00 nT after smoothing showed no significant dipoles detected, suggesting that magnetometer survey 2 was confident.

Magnetometer Survey 4:

The western reef transect was abandoned due to 2.6 m swell and appropriate caution for the boat, towline, and towfish had to be considered due to the risk of entanglement or damage. The new survey area in the north-western section in the open channel inlet entry (approximate depth of 5–8 m) was chosen to confirm no material spread of ferrous material was found north of the site, which would indicate larger context area (Fig. 4.27). Towfish layback measured 26 m from GPS antenna with survey speed averaging 5 kn (10–11 km/h) and length of the lines measured 900 m heading northeast and southwest, with six lines completed at 50 m spacing and covered an estimated 0.62 km^2.

The lack of magnetic signatures recorded in this northwest area were due to three factors. 1) The swell was diminished closer to the shoreline; however, the uplift of the swell caused the towfish to change horizontal orientation at near two-second intervals. 2) Two cray-fishing vessels came close to the towfish when entering the inlet, creating large dipole anomalies. 3) The craypots were placed at odd intervals throughout the survey during recording.

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Figure 4.27. Repositioned magnetometer survey in northwest vicinity of ADM1 (QGIS, 2022-08-05)

Non-Disturbance In-Water Survey

The initial remote sensing surveys provided a clearer image of the site and the surrounding landscape. The ROV data contextualised the submerged landscape morphology and an estimate of the high energy potential on site before entry. The magnetometer survey ruled out numerous areas for inspection, including the north, northeast, and east of the site. Areas with reef elevation <2.6 m or kelp groupings were not included and would need further investigation. The main survey area recorded by the ROV was not accessible by boat nor able to be surveyed by magnetometer, necessitating the need to perform an in-water survey.

As outlined in Chapter 3, the swimline method was applied for snorkel survey. Swell conditions were consistently observed to be from south-south westerly direction, coming along the Southern Ocean route and driving north before refracting northeast towards South Australia's south-eastern coastline (Fig. 4.28).

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Figure 4.28. Area covered by snorkel and diver surveys (QGIS, 2022-08-06)

The survey was started in the south-southeast of ADM1, where the surface current slowly drifted divers towards north-northwest direction with little effort. The swimline method was used for the snorkel survey due to moderate surface current and strong submerged uplift. The initial swimline survey covered an 8 m wide lane and drifted approximately 368 m over the site in a linear direction before being extracted by boat in the north-western sector. The second survey achieved a 231 m swimline in a north-westerly direction, covering the same lane width, with swell lessening during this interval allowing for slower inspection across site.

The team completed a third survey, heading north-northwest in a linear direction with 8 m lane width, covering 170 m. The third survey had very little current, allowing for a slower pace to inspect potential objects observed in crevices, rocky outcrops, and kelp grouping roots. After reaching the 170th metre at the northern edge of the reef, the team begin tracing the reef outcrop edge, beginning with the closer eastern portion. The team headed east-northeast before reaching the end of uplifted reef with no observable ship material. Swimline survey was turned around and traced reef back to western section. At this time, the lane width was shortened to 6 m coverage and headed west-northwest for 185 m before following reef outline southwest for 100 m (Fig. 4.29). Nearing the end of the third survey, a large wave break at south-western portion of the reef was observed. However, 20 m before the wave break, a diagnostic frame structure was observed through the overgrowth (Fig. 4.30).

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Figure 4.29. Third survey transect with reef's northern and western edge outlined (QGIS, 2022-08-06)

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Figure 4.30. All surveyed areas and diagnostic structure (QGIS, 2022-08-06)

ADM1-019 and ADM1-020

From plan-view the object resembles an 'A' frame with a triangular hole in the middle. The structure creates an overhang on the outer-western reef, rising forward out of the reef by 3.5 m and standing 2.8 m above the seafloor (Fig. 4.31). A round concreted shape can be observed at the intersection of the frame making the structure standout from the limestone reef (Fig 4.32). Furthermore, at approximately 1.7 m below the 'A' frame structure, a long rectangular shape is found jutting-out of the reef on the western side, directly underneath the western side of the 'A' (Fig. 4.33). This structure is severely deteriorated; however, the thickness (0.6 m x 0.5 m) matches the 'A' frame and is observed to be jutting out in the same direction. At the time of wrecking this structure would have been positioned at the stern, making up part of the rudder trunk frame (Fig. 4.34) (Paasch 1885:53–58). The structure underneath the 'A' frame came into perspective during the dive and could be observed at length from the seafloor. The tilted upward-angle of the bottom beam suggests that it would connect to a fixed spot near or on the circular point depicted in figure 4.32 (Fig. 4.35). The standing 'A' frame had likely held in place the rudder trunk underneath the rudder-tiller (Paasch 1885:57). The 'A' frame was recorded by photographs and videos; no photogrammetry could be processed due to the movement of seagrass.

Figure 4.31. The ‘A’ frame structure facing (northwest, 2022-01-12)

Figure 4.32. Circular point on end tip of structure (2022-01-12)

Figure 4.33. Angle structure below western side of ‘A’ frame (2022-01-12)

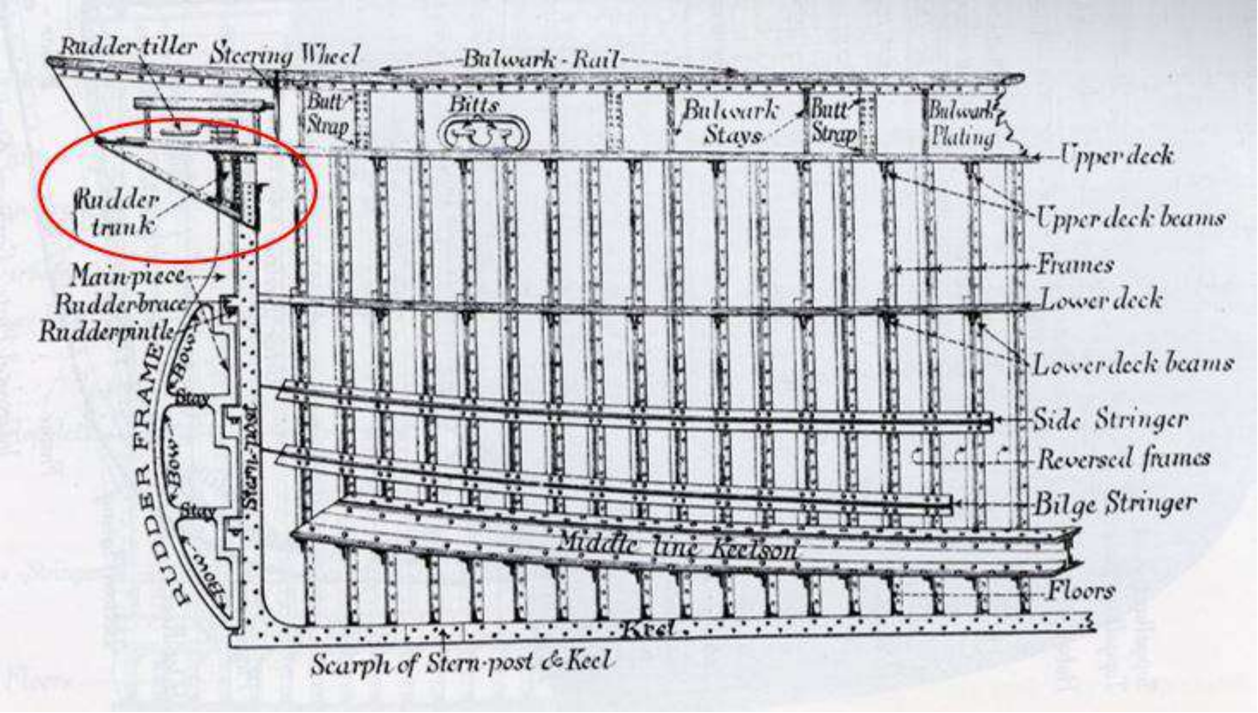

Figure 4.34. Rudder trunk support frame on stern of vessel (Paasch 1885:53–58)

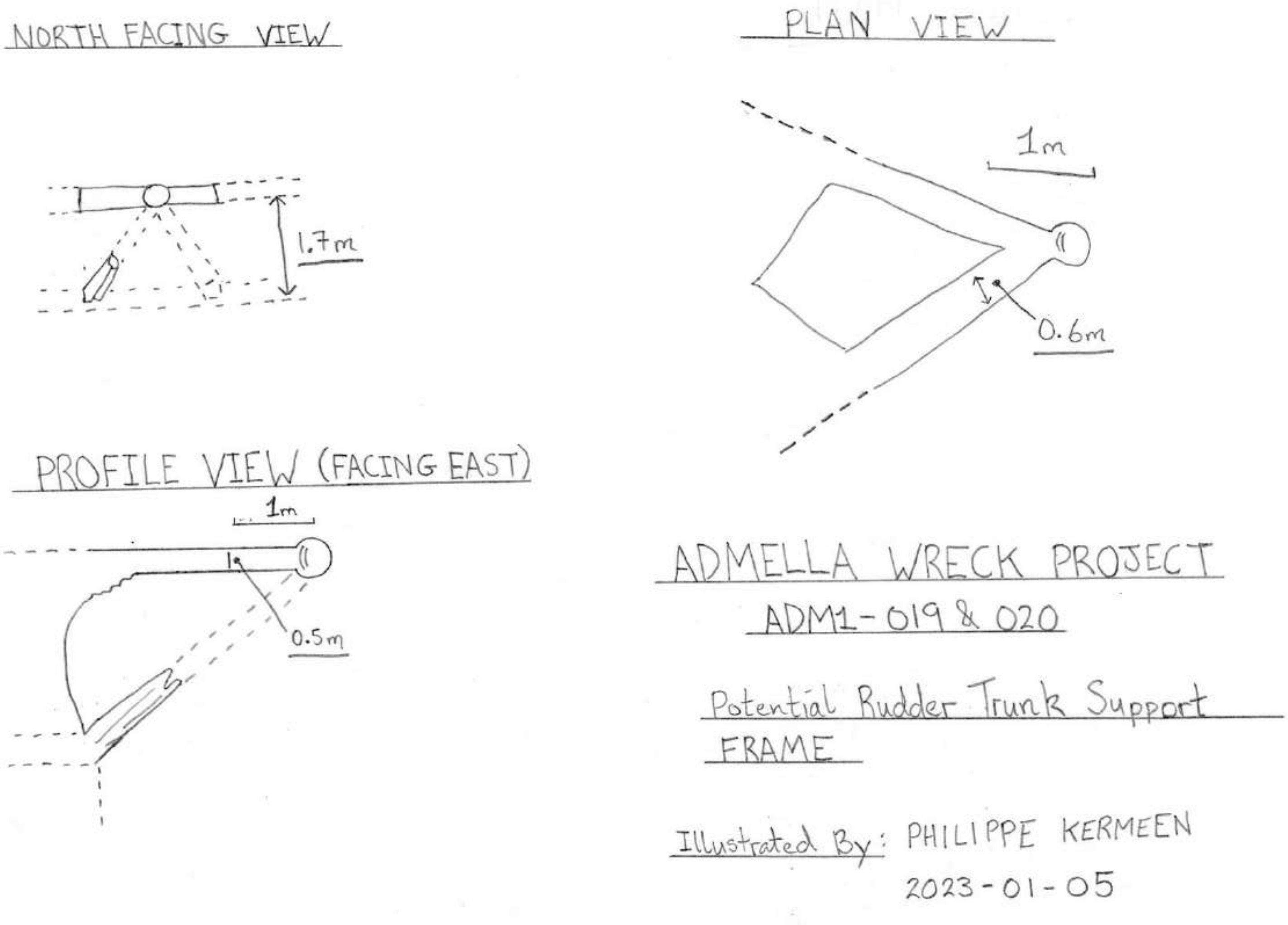

Figure. 4.35. Sketch of potential rudder trunk support frame from ADM1 (2023-01-05)

Other material observed through the in-water surveys were vague in appearance and attempts to distinguish their use or position on a vessel were inconclusive. However, throughout the survey the team did record areas of significance (Fig. 4.36). A list of the materials observed, and their location, are recorded below in Table 4.2. Refer to Appendix 1G for recorded vessel material.

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Figure 4.36. Location of all potential ship related material at ADM1 (QGIS, 2022-08-09)

Table 4.2: List of recorded material with potential significance at ADM1 site (Fig. 4.36). Appendix 1G.

Item no.	**Location**	**Measurements L x W (x T) – (cm)**	**Description**	**Potential Use**
ADM1-001.	South-eastern section	98 x 30	Concreted ferrous material with square 'U' shape culvert – heavily overgrown with seagrass	Upper or lower deck beam – semi box beam
ADM1-002.	South section	unknown	Flat concreted spade shaped object – heavily overgrown w/ seagrass. – found by ROV previously in Fig. 4.24	Potential fluke of an anchor
ADM1-003.	Eastern section	620 x 60 x 36	Concreted/ overgrown circular base – defined curved shape	Base for iron funnel/ stacks
ADM1-004.	South-eastern section	650 x 60 x 29	Concreted/ overgrown circular base – defined curved shape	Base for iron funnel/ stacks
ADM1-005.	Eastern section	180 x 45	Flat concreted object with a narrow jutting base	Unknown – has little growth on flat area and is potentially exposed to swell in low tide.
ADM1-006.	Western section – closest to wave breakers	310 x 40 x 30	Long U-shaped object with 20 cm standing ridges (runs the entire length), and corroded holes roughly every 10 cm	Fragment of the 'main-line keelson'
ADM1-007.	Inner western section	120 x 50 x 25 (both objects) 60 x 50 x 25 (individual)	Two concreted/ overgrown objects with similar size flat tops, narrow stems and rectangular base	Bitts (posts used to secure moorings to)
ADM1-008.	Inner eastern section	290 x 35	Long concreted/ overgrown U-shaped structure	Semi-box beam
ADM1-009. ADM1-0010. ADM1-0011.	Inner eastern section	400 x 25	Three elongated ridges that stick above the limestone reef with sharp defining walls not found in the area	Bulb-iron or single angle iron beams
ADM1-0012.	Inner eastern section	180 x 23(15)	Concreted object with wide flat no growth area, with a section of the object narrowing to a thinner piece that stems away from itself.	Anchor fluke and arm

ADM1-0013.	North-eastern section	Debris area – no definitive start to object	Concreted bundle of misshapen objects – triangular structure that rises above seafloor with cut round hole.	Unknown – potential cats-eye for anchor and chain
ADM1-0014.	North-eastern section	Debris area – no definitive start to object	Large concreted/ overgrown object elongated top and solid base	Unknown – potential anchor stock and head.
ADM1-0015.	North-eastern section	Debris area – no definitive start to object	Large overgrown bulk area with twisting concreted structure	Unknown – potential anchor chain
ADM1-0016.	North-eastern section	340 x 40	Long concreted/ overgrown U-shaped structure	Semi-box beam
ADM1-0017.	Northern section	40 x 25	Upright concreted structure with two small cylindrical shapes jutting out either side	Unknown
ADM1-0018.	North-western section	260 x 180	Large overgrown object in middle of limestone pebble clearing – isolated from rest of reef in large portion	Unknown
ADM1-0019.	Western Section	350 x 30 x 15	Large concreted/ overgrown 'A' frame structure. Circular endpoint 12-14 cm diameter.	Rudder trunk holding frame
ADM1-0020.	Western Section	98 x 30 x 15	Concreted rectangular structure that juts out from reef wall underneath item no. 19	Rudder trunk holding frame
ADM1-0021.	North - western Section	Unknown	Structure with heavy concretion – two arm like structures jut out of centre to either side.	Potential arms of anchor and chain
ADM1-0022.	Western section	80 x 75	Ring object with smooth edge and grown over	Potential cats-eye

Note* The source material for iron vessel diagnostics comes from *Paasch's Illustrated Marine Dictionary (1885)*

Conclusion

The methods used in this project to survey the coastal, intertidal, and subtidal landscape have proven beneficial in contextualising the sediment movement, hydrodynamic effects, and deterioration processes (both intertidal and subtidal) for additional low-level generalisations that can be observed and interpreted. The applied methods worked better in combination and offered different contextual sources of information on how the site is formed. The Coastal Integration workflow has proven extremely valuable in determining reef extent, alcoves, reef crevices, reef bommie locations, and estimated depths.

The area in which *Admella* may have run aground fits the description from Mossman’s and Mudie’s detailed accounts. The western side of the reef is a large flat plateau, with sections of submerged alcoves acting like repositories for ship material. The reef outcrop spans roughly 250 metres in diameter and varies in depth. The plateau, with its varying recesses, is estimated to be less than 30 metres long (northwest/ southeast) and 18 metres wide (southwest/northeast).

The case study of *Pisces Star* and the taphonomic process which impacts the vessel to a greater extent is a primary factor in understanding the overall deterioration effect of all vessels in Cape Banks and Carpenter Rocks area and will be discussed in the next chapter.

Chapter 5 Discussion

5.1 Introduction

The thesis question posed in Chapter 1, 'how and to what extent can historical ship structural components be observed in a shallow dynamic environment?' a case study of SS *Admella*, is divided into two secondary questions that were developed to address the overarching research question. 1) 'can we determine structural compromise based on observed *in situ* artefacts?', was attempted to be answered by archaeological field methods and through Type A vessel identification. 2) 'can structural compromise be determined based on direct historic parallels?', is investigated as a historical desk-top study by using the results to corroborate the historical narrative and understand the gaps of information. Middle Range and high-level generalisations will be discussed in this chapter in sub-sections 5.3.

The five subsequent aims outlined in Chapter 1, including the taphonomic case study of *Pisces Star*, will help frame a coastal and submerged environmental context that will be used to support the two secondary research questions.

5. 2 Data Interpretation

The subsequent aims outlined from Chapter 1,

1) Create high resolution georeferenced orthomosaics of the reef and surrounding environment to visualise the extent of reef outcrop and potential wreck sites,

2) survey the submerged site area to understand the environment and to identify ferrous structures,

3) Applying new survey methods to re-find *Admella* through remote sensing techniques,

4) using available historical and archaeological records to conduct a comparative analysis of steamships built during the experimental transition to screw steamship technology around Australian waters (i.e., SS *Gothenburg* (1854), SS *Brisbane* (1874), and SS *Xantho* (1848)).

5) Lastly, a case study of the taphonomic processes for shipwreck material in Cape Banks/ Canunda will be explored and discussed in relation to understanding the deterioration process of ship remains in a shallow dynamic environment.

5.2.1 RPAS and ROV Carpenter Rocks Survey Data

Using the ‘Coastal Integration Method’ workflow, the results of the RPAS data produced significant information about the landscape, having provided a high-resolution image of the current reef outcrop, inner reef bommie dimensions, intertidal shoreline, submerged fissure locations that were free of standing reef, and the potential for analysing the area for shipwreck material. The accuracy of the four orthomosaics (without the use of conventional GCPs due to limited access over water) were critical for visually referencing within 2 cm of accuracy, especially considering the total area covered was 7.79 km^2 (Campana 2020:223; Casado et al. 2020:62). The procedures of the workflow adopted elements from Campana (2020), Green and Gregory (2020), Mancini and Dubbini (2020), and Casado et al. (2020), and were augmented for a maritime archaeology survey approach contributing to a new workflow that has yielded successful results via sea surface mapping, with visible submerged landscape aiding in large data acquisition for the project (Benjamin et al. 2019:212–213). DEMs and DSMs were able to be generated as biproducts from the dataset but are not integral to the research question, and therefore will not be included (Casado et al. 2020:60).

Furthermore, the data processed was essential for interpreting the site geomorphology, partnered with the remote sensing techniques of ROV, magnetometer, and diver-based operations (Casado et al. 2020:56). The remote sensing in collaboration with geophysical techniques were able to cover an enormous area that had previously only been recorded in DEW short report with unscaled drawings (Drew and Taffs 1981). The lack of any GNSS covering Australia between 1975 to 1988 made it difficult to acquire accurate horizontal position data. Drew applied visual line of sight using sextant resection angles to estimate reference targets from a fixed position. The RPAS data has significantly improved the visual understanding of the landscape (terrestrial and submerged) with accurate position fixing on targeted sites and artefact locations.

The submerged landscape when viewed from the ROV's visual data clarified the fissures mentioned by Drew and Taffs (1981) are natural recess pits for debris that may come from vessels. The odd shaped objects that were identified would also appear in the sheltered areas of the reef plateau, adding more credibility to the narrative that had *Admella* been swept up by large swell, the vessel could most certainly have been laid flat on its beams and deposited material. The use of the ROV improved understanding of the reef structure, seagrass distribution, how they react in adverse conditions, and enabled investigation of the hydrodynamic flow intensity. The hydrodynamics at ADM1 are more complex than previously speculated and could be monitored by the ROV, recording interval changes in its own localised environment. Four knot surge was experienced in four second intervals by the ROV, coupled with the visual rolling plain of the reef, suggests that the limestone reef outcrop should typically be deteriorating quickly. However, the thick, strong seagrass observed in the area evidently protects the reef from the strong consistent surge, only being severely impacted during heavy storm events. During heavy storms the roots of the seagrass and kelp are violently torn from the limestone reef, deteriorating the structures beneath significantly over time, as observed at Cape Banks foreshore. Therefore, for most of the nonstorm related activities, structures are impacted minimally across the reef, suggesting that preservation is attributed to seagrass presence on ferrous material found at Cape Banks (Baring et al. 2014:404) (Fig. 5.1).

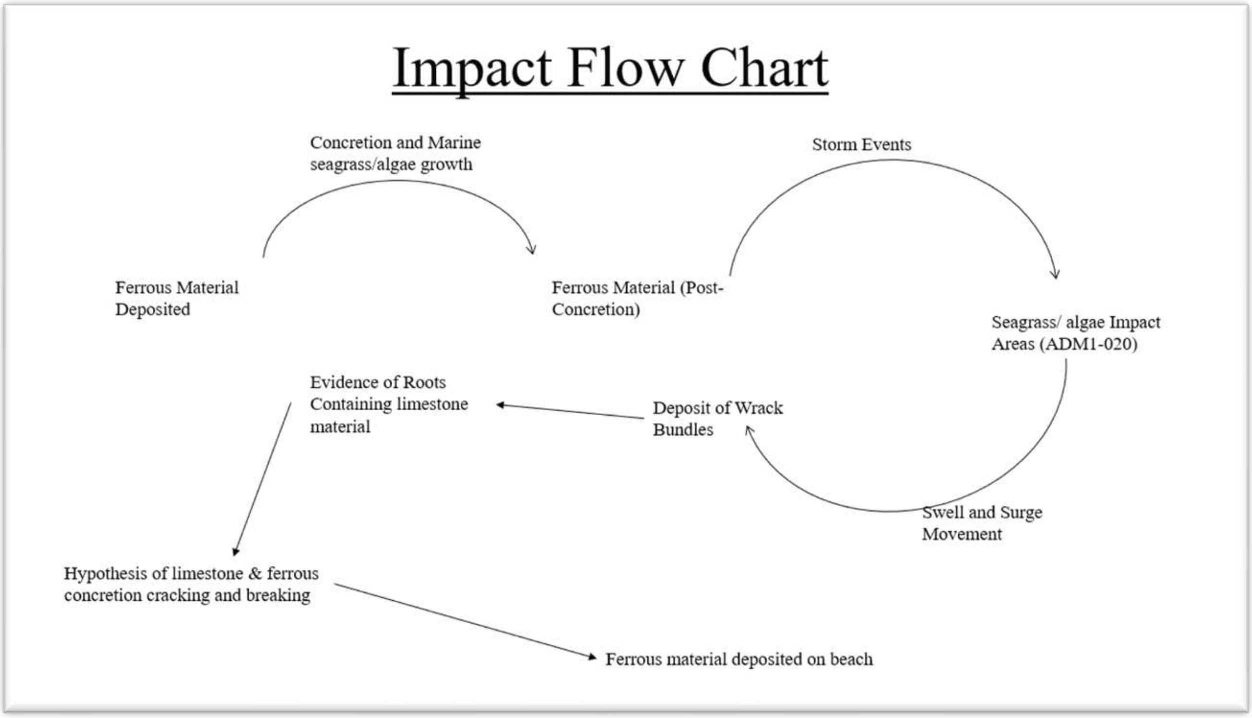

Figure. 5.1. Hydrodynamic impact flow chart depicting movement of material from ADM1 site (2022-11-02)

The heavy storm events occurred more frequently over the South-eastern portion of South Australia, between the periods of March 2021 and July 2022, resulting in significant seagrass wrack accumulations on the beach in bundles measuring approximately >1.0 m height and >6.0 m in length. Most of the roots inspected had limestone material imbedded in them measuring between 8–10 cm. The visual analysis of ADM1-020 supports the hypothesis that seagrass growth and storm events had impacted the structure and that deterioration occurred over a long period (Fig. 4.33).

Considering the use of only two small compact remote sensing tools (M2P and CM2), the interpretation of the data proved viable for this shallow dynamic environment. With regular wind gusts up to peaks of 45 km/h, consistent average swells between 2.2 and 2.4 m (with peaks reaching 4.8 m), relatively strong 2.5–4 knot currents, and heavy storm activity becoming more consistent, the coastal reef acts as a deadly collision feature for any vessel, no matter the size, shown with *Pisces Star* and SS *Corio* II (Mudie 1966:174–175).

5.3 Site Interpretation

The shallow and dynamic limestone reef runs parallel to Cape Banks foreshore, providing a natural barrier to the inner limestone outcrop, where reef bommies can grow in more abundance (Fig. 5.2). The natural reef plateau continues to add intrigue in exhibiting the dynamic movement of water in relation to spatial material spread. This section will focus primarily on the site and interpreting the recorded data.

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Figure 5.2. Visual of reef bommie areas behind limestone reef (middle) (QGIS, 2022-08-04)

5.3.1 Formation of the site: understanding the relative positions of ship material.

ADM1, identified as the primary area for investigation was further investigated with magnetometer and diving surveys. From the results of the magnetometer and the discussed limitations of covering the boundary of the site, the survey was able to substantially cover the northwest, north, and northeast sections of the site boundary. As recorded by the ROV, the swell movement angles south-south-westerly (Fig. 5.3) and any ship material that washed over the reef would end up in this area due to the directional flow. The collected data in this area was complicated by the continuous placement of metal craypots from commercial cray-fishing vessels navigating through the reef inlet during the surveys. The dipoles are recorded from the craypots and as a precaution, the time of passing the material was recorded to isolate them from the rest of the dataset. The magnetometer results indicate that the magnetic anomalies attributed in these sectors are only to do with the craypots and response from large swell uplifts effecting the horizontal positioning of the instrument. No large anomalies of ferrous material were recorded during the surveys and therefore the RPAS and ROV surveys did not need to extend any further north.

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Figure. 5.3. Swell movement as recorded by ROV and in-water team for spatial distribution of material at ADM1 (2022-11-02)

When considering the results from the magnetometer surveys, it suggests targets are too small to register when environmental factors of swell (average 1.8 m) affect the recording processes, or that large ferrous material has deteriorated beyond sensing capabilities, or potentially never there to begin with. The in-water surveys at ADM1 recorded twenty-two anomalies that are potentially ship-related material; the most convincing is ADM1-019: ‘A’ frame structure that resembles a rudder trunk support frame. The features have a relative spatial distribution if we are to consider the rudder trunk frame as the stern of the vessel, with the surf and swell over the reef structure heading in an east-north-east direction, the distribution of recorded points would fit the hydrodynamic flow towards the eastern section of the reef. The three most southern points (Fig. 5.4) were found in deep fissures of the reef structure and therefore were not able to be shifted during heavy storm events or tidal currents.

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Figure 5.4. Three isolated ship-related materials found within fissures (QGIS, 2022-08-09)

5.3.2 Vessel identification: ADM1 target site

This thesis had implemented Harpster's (2013) vessel identification method, thus, approaching a shipwreck without a biased predetermined affiliation was necessary (Harpster 2013:592). A list of known features relating to *Admella* were collected through historic archive data and museum desktop research. Diagnostic elements mentioned in historic narratives and reports included engine, boilers, iron hull plating, copper cakes and ingots stamped with 'Kapunda', a drive shaft, and twisted debris as the main artefacts that could still be observed *in situ* (Drew and Taffs 1981:3–4; Mudie 1966:172–173).

The Type A theoretical approach was chosen for this thesis, mainly using known historical accounts and references to reconstruct a picture of what the vessel would look like and how it could confirm the affiliation (Harpster 2013:592–593), including using unique objects or material that can only be affiliated with that vessel alone (Harpster 2013:592).

AWP followed this same paradigm in search of the vessel in question. However, the relative features recorded on this site are irregular in size, artefact distribution, and overall diagnostic detailing (Harpster 2013:596). Focusing on ADM1-019 and 020, it can be clearly stated that the structural orientation is in an upright position, having sunk straight down into its vertical place. This is supported by the secondary support frame angling upwards to meet the horizontal frame (Paasch 1885:57). The concretions and marine growth on the structure made it difficult to assess the precise thickness of the rudder trunk support frame; however, figure 5.5 gives an example of the overall size, with an estimated thickness measurement of 150 mm.

Figure 5.5. Rudder trunk support frame displaying the size of the structure (2022-01-12)

Considering *Admella* was a 60 m long vessel with a beam of 8 m and a draught of 4 m, the rudder trunk and rudder would need to match the vessel’s length by angle of attack and hydrodynamic pressure durability ‘output’ on such components (Liu and Hekkenberg 2016:496). The frame support structure of modern vessels that would adhere to that level of pressure (simply by association) would need a minimum of 750 mm thickness and 500 mm width for the equivalent support of turning the vessel in combination with propellor generated drag force (Liu and Hekkenberg 2016:497–498). The rudder trunk support frame observed at ADM1 does not match the width (300 mm) and the thickness (150 mm) of a rudder trunk support frame that would be engineered for a 55–60 m long vessel (Liu and Hekkenberg 2016:498). Furthermore, the position of the rudder trunk support frame is a potential indicator that it is not *Admella,* on account of the facing direction by compass bearing from stern towards bow: 45 degrees north-east. However, due to the high energy environment discussed in previous chapters, the structure could have potentially moved. Another major component that does provide more confidence that ADM1 is not the site of *Admella,* would be the lack of magnetic signatures from *Corio* II, a large steel wreck from 1951 on the eastern inner reef.

The most discernible diagnostic structure along the reef site of ADM1 is potentially not part of *Admella*. The magnetometer data shows no ferrous anomalies recorded immediately north or east of the site, indicating that this site is not the targeted vessel. This is supported by the lack of distinguishable artefacts observed during survey, which is in contradiction to what was described by Drew in his 1981 report.

> Section 6a. 'It is very well smashed [up], with parts of the boiler [and] engines standing tallest. Pieces are spread over the reef from the surf break – inwards [of the reef] maybe 50 meters. Wreckage seems to join up with [SS] *Corio* [II].'
>
> Section 6b. 'There is supposed to be more copper under the iron plates – [what is left] boiler, parts of the engine – when we dived, we saw copper ingots marked 'KAPUNDA' (1968)'. - Drew and Taffs, 1981.

ADM1 site complicates what has been previously recorded by Drew and Taffs (1981), as the recording of the site came from line-of-sight positioning from the area which 'was' the wreck site. The recording of a particular coastal dune with an adjacent drainage basin as a sighted reference added to the inaccuracy (Drew and Taffs 1981:7). Furthermore, the consistent wind speeds of >25 km/h persists in sediment movement over the dune system all year round, effectively providing the landscape with moderate dune transgression - regression and consistent movement of 1.2 m per year (not indicative of horizontal or vertical movement) (Short 2020:861–863). Moreover, measuring-in Cape Banks Lighthouse and the signal marker rocks by resection method continues to add further inaccuracy over such large distances.

The AWP survey data has disproven the location of *Admella* at the site specified by Drew and Taffs, and Lonely (1975a), providing higher resolution imaging with <5 m accuracy for GPS discrepancy with comparable measurements. However, Drew and Taffs were limited by the technology available and could not access aerial imagery as easily as we can today, nor were they able to implement proper survey techniques within the high energy environment they were surveying.

5.3.3 Vessel Identification: Type B – Type C Null

The vessel discovered at ADM1 now opens a new avenue for investigation, as the distribution of ship material follows the same patterns as most reef impact wrecks. However, the main concern comes from the lack of distinguishable material of any kind, besides ADM1-007, 019, and 020. The white limestone fissures had no evidence of non-ferrous material fragments (i.e., porcelain, bone, copper alloy, etc), suggesting that the vessel did not use copper fasteners, nails, sheathing, or bolts. The size of the rudder trunk support frame is indicative of a smaller vessel, with a counter stern over the rudder and the potential of the rudder trunk support frame being a part of a larger structure imbedded in the overgrowth.

The support for ADM1-019 and 020 being of ferrous material is due to the statements made in Chapter 4; the horizontal length jutting out from the reef and the impact of the surf break located <5 m would suggest that its durability is not that of wooden material (on account of it still being present). This could be indicative of an iron hull-structure with a sturdy counterbalance to support the weight of the horizontal position projecting 3.5 m away from the rest of the reef. However, ADM1-020 shows signs of significant deterioration over many years by storm events, adding more speculation as to how the weight and length are supported without falling over, even with the four second interval of 4 knot current.

What can be currently stated is this: the rudder trunk support frame suggests that it would support a vessel size of 20–25 m in length and 2.5–4 m in beam, however the draught is unknown (Liu and Hekkenberg 2016:500). The vessel's hull structure was made from iron, indicating the earliest estimate of 1830s but no later than 1910s, as the common adaption of steel hull plating occurred 1890 – 1900 and the deterioration of the vessel suggests a prolonged period of being submerged (Williams and Hutchings 2017:115).

Based on this evidence we can confirm *Admella*'s location is not at ADM1, however, the study continues to analyse *Admella*'s probable condition through the taphonomic study and historic comparative analysis. Further investigations identified a second site, ADM2, 4.3 km north-west of Cape Banks Lighthouse, but due to limited resources, funding and caution over safety, the northern site was not inspected.

5.4 Taphonomic Process: Cape Banks

Although *Admella* had not been located at ADM1, the project can determine whether structural compromise can be observed using *in situ* artefacts through the analysis of taphonomy. The vessel located at ADM1 cannot be used for the case study as the estimated year of wrecking is undetermined, therefore the case study will focus on an intertidal wreck within a sheltered area found on the northern beach of Lighthouse Bay, Cape Banks.

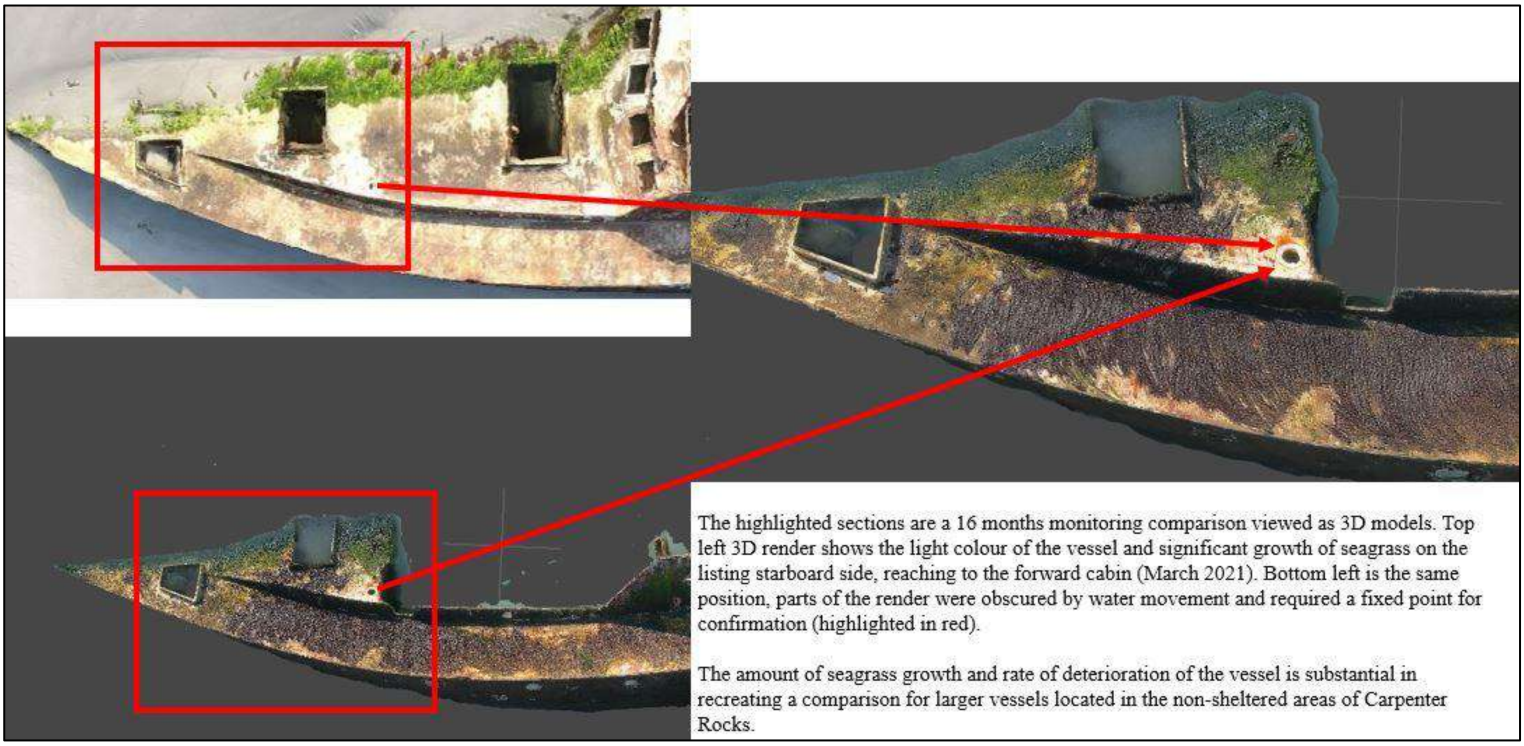
5.4.1 Pisces Star taphonomic case study

Taphonomy is used in maritime archaeology by understanding landscape impacts on vessel structure through material analysis, how it is affected over the course of time, and interpreting the rate at which the material culture deteriorates. *Pisces Star* (1997) was used in this project as a case study due to its comparably recent abandonment. The vessel is beached on the south-eastern side of Cape Banks Lighthouse, approximately 310 m away and 1.8 km southeast from ADM1 site.

The vessel was first recorded in March 2021, using a drone to capture 95% of the vessel's structure and rendering it through Agisoft Metashape. A storm had passed through the area in late July 2021, travelling from the north-west down to Portland, Victoria. By August 2021, the vessel was observed as having lost the entire stern, evidently breaking off and sinking below the surface into the sediment except for a few visible steel-cord fixtures. By late-July 2022, the vessel is completely missing the roof of the main cabin area, and the starboard side is evidently being buried beneath the sediment (Fig. 5.6).

Figure 5.6. Deterioration process from A) August 1997, B) March 2021, C) August 2021, D) September 2021, E) December 2021, F) January 2022, and G) July 2022.

Considering *Pisces Star* is in more stable conditions than most vessels in the area, it still needs to be stressed that the vessel from 1997 to July 2022 has effectively deteriorated down to the structural components, which are now deteriorating with heavy storms and high 25 knot winds becoming commonplace. Furthermore, the area that *Pisces Star* is located, it was evident that the vessel was only affected by winds coming from the southerly and south-easterly directions. The south-westerly swell is reduced in force by the southern reef structure that can be observed adjacent to the signal marker rocks. The reduction of swell helps to reduce the overall impact force that *Pisces Star* experiences, aiding in the shipwreck’s overall preservation. The vessel is observed to have significant marine growth in July 2022 and implies that the structure is now more frequently submerged then in previous years, which is attributed to the listing to starboard and envelopment by sediment (Fig. 5.7).



The highlighted sections are a 16 months monitoring comparison viewed as 3D models. Top left 3D render shows the light colour of the vessel and significant growth of seagrass on the listing starboard side, reaching to the forward cabin (March 2021). Bottom left is the same position, parts of the render were obscured by water movement and required a fixed point for confirmation (highlighted in red).

The amount of seagrass growth and rate of deterioration of the vessel is substantial in recreating a comparison for larger vessels located in the non-sheltered areas of Carpenter Rocks.

Figure 5.7. 3D model rendering *Pisces Star* for visual taphonomic dissemination (Agisoft Metashape, 2022-07-30)

What is speculated from the observable remains of the concrete yacht *Pisces Star,* it is protected from the severe Southern Ocean swell impacts, current, and omni-directional winds. Nevertheless, the vessel structure from 1997 to 2022 shows a considerable amount of deterioration occurring over a short period of time, and the addition of severe storms becoming far more consistent, the vessel has been heavily impacted in its fragile state. Relating this case study back to ADM1 and ADM2 sites, the shipwreck material on the western reef outcrop would be expected to be extremely deteriorated, if not, completely unrecognisable when attempting to pursue studies detailing their diagnostic structure, as the natural landscape protection observed at *Pisces Star*, is evidently not homogenous for the shallow high energy environment of Carpenters Reef (Macleod 1998:81).

The vessel at ADM1 has significant signs of long exposure to current, swell impact, marine growth, and subsequent storm impacts which have crumbled the remaining structure. Drew and Taffs (1981:1) state that they had visited *Admella* in 1961, when the engine and boilers were exposed above low tide on the western side of the reef. Drew goes on to explain that in 1975, the area was blasted to try and get more copper from underneath the iron hull plating, and by 1981, the engine and boilers could no longer be seen during peak low tides (1981:1–2). Considering the large-scale salvage works, blasting, high energy swell, and severe storm impacts ripping dense seagrass and kelp roots from the structures, it can be inferred that the observable *in situ* remains would be undiagnosable. Even the vessel found at ADM1 has evidence of damage on the remaining structure from storm activity tearing seagrass violently from it.

5.5 Historic parallels of structural competency: comparison of sites and screw steamships.

This section provides an analysis of three vessels that correlate to *Admella* through structural design, submerged landscape impacts, and conclusions from report inquiries of the relative government authorities at the time. The analysis focusses on when the vessels were built, any alterations that were made prior to wrecking, what weather conditions contributed to the events, and what structural damage was associated with the wreckage. The vessels are compared through analytical interpretations sourced from historic narratives, state heritage records, and published material.

5.5.1 SS Brisbane and A & J Inglis

SS *Brisbane* was built by A & J Inglis as their 110th ship on the river Clyde in 1874, Glasgow (Steinberg 2008:12). However, Steinberg (2005:29; 2008:12) points-out that Lloyd’s lists 110 is the shipyard number, not the vessel. A & J Inglis had originally started out as an engineering firm at Whitehall Foundry in 1847 (Index of Firms 1888:1). By 1862, they had shifted into larger facilities to begin shipbuilding internally, avoiding collaboration with other shipbuilding companies (e.g., Lawrence Hill & Co). *Brisbane* was built from stem to stern solely by A & J Inglis, as their reputation in Glasgow had marked them as one of the few top contending engineering companies in the port (Index of Firms 1888:1).

Brisbane was built after the experimental steamship era and conformed to Lloyd's rules for shipbuilding practises (1863). This vessel was built to larger dimensions than *Admella*, being 905.26 grt, 85.9 m in length, 9.8 m in beam, and 6.1 m draught (Steinberg 2008:16–17). *Brisbane* had been installed with four decks to accommodate a 250-horsepower 2-cylinder engine and four boilers, necessary to move the sheer size and still have enough speed for travel (Steinberg 2008:16–17). The vessel had struck Fish Reef, 47 km west of Darwin, in 1881 due to supposed navigational error, hazy conditions, lack of navigational markers, and inaccurate plotting of tide mark charts (Steinberg 2005:38; Steinberg 2008:16).

The vessel had struck a reef the day prior to this and was able to lift itself off without breaking apart due to low winds and calm seas, occurring with the effect of tidal shift. The vessel was found to be competently built and no issue was warned of the vessel's 'water-tight bulkheads' which had not split apart on the reef. The bow came to rest on Fish Reef and the stern left afloat until low tide caused it to dangerously list to one side and the vessel was abandoned (Steinberg 2005:38). The Captain and crew had originally been found innocent of wrongdoing before having their innocence revoked and found to be at fault (Steinberg 2005:39; Steinberg 2008:16). In this instance, A & J Inglis were rightly not blamed for any wrongdoing and sole blame was put on the Captain and crew. *Brisbane* was built 17 years after *Admella* and it can be speculated that the engineering turned shipbuilding company had envisaged a different outcome for their vessel, as well as the sister vessel *Singapore* (1877), wrecked on Keswick Island, Queensland (Steinberg 2008:12).

The reef structure that the vessel was stranded on, has similar features to Carpenters Reef at Cape Banks, with a large plateau area to support the bow of the vessel to near midships (Steinberg 2005:83). The vessel dwarfs *Admella* in all aspects including hull and super-structure, with four levels of decking and much larger engines and coal bunkers, indicative of a reinforced robust iron framework structure that allowed for the entire vessel to be left intact before salvage operations began. Furthermore, the vessel was part of the 'Eastern and Australian Mailing Steam Company' (E&A) and was used foremost as a passenger vessel (Steinberg 2008:12–13), thus the larger design alleviated the stress of not fitting the entire cargo onboard, leading to no overloading or cargo-hold breaches (Mudie 1966:25).

5.5.2 SS Gothenburg and Lungley Charles & Co

SS *Gothenburg*'s inclusion was imperative to establish a baseline within the interpretive analysis of understanding structural competency through historic parallels in shallow dynamic environments. The vessel built by Lungley Charles & Co in 1854 coincidentally parallels not only *Admella*'s structural framework and parameters but shares a harrowingly tragic story of its own. However, there are several differences. For instance, the vessel that Lungley Charles & Co originally built was registered as *Celt* and was a 459 grt vessel, 59.9 m in length, 8.5 m beam, and had a 5 m draught (DES 2010a:34–35; DES 2010b:5–6). This vessel had three masts with a steam propulsion engine of 120-horsepower, allowing for sail with wind or power through heavy current and swell by screw propellor (DES 2010b:5–6). In 1862, Blackwood & Co purchased the vessel for the Australian intercolonial trade and renamed it '*Gothenburg*', and in 1863, the vessel was lengthened in Adelaide (no measurement of the new length is recorded) and weighed in at 737 grt (DES 2010b:6). No mention of this is recorded in Lloyd’s register, except for a small ‘refitting’ occurring in that same year (1863) (DES 2010a:131).

The signature trait of the vessel was its sleek design and light-weight capacity to travel from South Australia to Victoria, then to Queensland and Darwin respectively. *Gothenburg*’s efficiency had made it one of the most consistent and long serving intercolonial passenger vessels in Australia (DES 2010b:6). In 1875, *Gothenburg* was carrying 88 passengers and 25 crew when it ran into Detached Reef during heavy storms, and like *Brisbane*, the vessel was run aground adjacent to the main plateau, the bow resting on the reef and midships sitting on jagged rocks (DES 2010b:12–13). The vessel attempted to be reversed with no success, and the decision to wait for high tide in the morning was issued. By 0300 the next morning, low tide shift had created swells that were not present the previous afternoon. The south-easterly swell and surf forcibly tipped the vessel on its portside and pushed it onto the main reef plateau, holding there for a day (DES 2010b:13). The next morning, the winds had grown to high peaks, creating a storm-like high energy environment with large swells that dwarfed *Gothenburg*. The effect of the severe change in weather and the position of the vessel resting on its port beam, had the effect of tearing and breaking apart the vessel within minutes of the first strong impact (DES 2010b:13–14).

Undeniably, when the vessel had been propped up onto the reef plateau on 24 February 1875, the swell and current had not destroyed or torn apart the bulkhead installations, retaining a list to port for over a day. The circumstances for such an event mirror that of *Admella*, and the reef structure plays a pivotal role in understanding the delay of complete bulkhead structural failure as not being a cause of manufacture design as speculated by the Royal Commission of South Australia. The Marine Board of Queensland (MBQ) engaged in an investigation to assess the damage and fault of those involved, calling into question the Captain’s decision to travel through this area when far safer passages were available (MBQR 1875:1). Due to the Captain and crew's competent experience navigating the route for prolonged periods of time, the fault was solely placed on the Captain for failing to navigate and spot Cape Bowling Green lighthouse or even Cape Upstart. Part of the failure was blamed on the storm that had intercepted *Gothenburg*'s usual route, but no blame was issued on the hull structure of the vessel for breaking apart on its beams, and no recommendation for better riveting positions had been issued, nor was there mention of the vessel's competency after its 'quiet refitting', and no inquiry into the steamer vessel's non-standardised design.

5.5.3 SS Xantho: a case study of extreme refittings

As discussed earlier in Chapter 2, SS *Xantho* was a former paddle steamer built in 1848, having been converted to screw propulsion in 1871 by Robert Stewart in Glasgow (McCarthy 2002:52–53). The vessel was fitted with a large steam engine whilst the coal bunkers were left in the original design for lightweight efficiency (McCarthy 2002:53). *Xantho*'s dimensions were 36.8 m in length, 5.3 m beam, and 2.5 m in draught, considerably smaller than the other two vessels discussed above (McCarthy 2002:50). McCarthy (2002) details several transformations that *Xantho* had undergone after being bought by Charles Broadhurst. Most of the augmentations and refittings in Glasgow were documented in Lloyd's Register, with engineering surveyors recorded as stating that the vessel is of 'competent' design (McCarthy 2002:54–55).

McCarthy continues to state that *Xantho*'s second transformation (after having the RA-57 engine placed within the undersized engine room) was the actual defining factor that had caused major problems leading up to its loss. The 'second transformation' of the ship was how the crew would operate in the confines of the vessel with its constrained dimensions. The engine block footrest was too close to the vessel's rotating shaft, only mere centimetres away from causing serious injury to a member of the crew, who would be checking the pressurisation of the valves (McCarthy and Garcia 2004:333; McCarthy 2002:156–157). The matter of continuous maintenance was another large issue with the RA-57 engine. It was one of the first engine types to be mass produced during the Crimean War, making parts readily available and easy to replace. The drawback was the rate at which parts had to be repaired, as regular repairs were evidently more difficult to effect in the remote coastal waters of Western Australia (McCarthy 2002:119).

Xantho's eventual sinking was caused due to lead ore overloading, bilge pump disrepair, rusting of inner hull structure due to the engine and boiler size restricting maintenance access, and the low freeboard causing any large swell to flood the main deck area and start a series of unfortunate events (McCarthy 2002:45–47).

5.5.4 Steamship Structural Failure

In the case studies explored, it can be stated that weather conditions, human errors, and the submerged reef landscape played major roles in the events that culminated in the disastrous situations which were labelled as 'accidental'. However, *Xantho* was the only case study that had produced a degree of certainty that the vessel's augmentation and quiet refitting in Glasgow had played a major part in the overall design flaw (McCarthy 2002:53), as well as poor maintenance conditions within the overall working life of the vessel. *Gothenburg* is therefore the best-case example for comparison with *Admella*. Its structural capacity and competency are observed to be comparable to *Admella*'s (DES 2010a:58).

When examining *Gothenburg*'s historic narrative, the vessel was said to have been run aground bow first, and after tidal shift, the wind and swell had moved the vessel to run parallel with Detached Reef, before listing onto its port side and resting on its beam (DES 2010b:13–14). *Admella* and its crew had experienced near similar conditions; the list to port eventually placed it on its beam and having been overloaded at the rear and forward cargo-holds, coupled with the crashing waves, the strain put on the vessel was enough to split the bulkheads from position.

Gothenburg had tried to fill the cargo holds with ballast two days prior to its wrecking, but severe storms had stopped the crew from loading it to the appropriate weight (DES 2010b:7). This could explain why *Gothenburg* had not immediately broken apart with the strain of the waves and wind, whereas *Admella* had sought to carry as much weight as possible to deliver the influential passengers and cargo to Melbourne quickly, aiding in the decline of structural competency.

5.6 Conclusion

The interpretation discussed in this chapter provided necessary context to a developing technology that had only entered Australian waters not long after its initial establishment in Britain and Ireland. The submerged landscape topography and climatic events are partially responsible for the human error in the case studies presented in this chapter. Moreover, it is evident that the marine vessel auditors had inadequate knowledge of the dominating fleets of screw propulsion steamships navigating Australia's intercolonial coastlines.

Using Harpster's (2013) Type A vessel theoretical approach and Middle Range theoretical framework, the set of outlined methods resulted in a coverage of context greater than that originally projected. The yield of results from the newly applied methods and the refinement of others, allowed for large sections of the submerged landscape to be used as contextual evidence when attempting to tie together historic events to current context. The applied ‘Coastal Integration Method’ for mapping of coastal shorelines with reef structuring as a direct point of investigation, provided detailed information about the sea floor composition, location of fissures, and direct parallels when used in combination with ROV, snorkelling, and diving.

The magnetometer had provided less information than expected, but the data recorded during the investigative period observed the lack of ferrous material in the northern and eastern sections of ADM1. Further investigation would be necessary to excavate the unknown ferrous object imbedded 1.34 km northwest of Cape Banks lighthouse, and to assess the possibility of salvage discard left on the beach (Mudie 1966:172–173). Using the Type A approach did result in the affirmation that *Admella* did not wreck in this research area (Harpster 2013:597), evidently ADM1 would now be appropriately labelled as Type B – Type C Null (Harpster 2013:595).

Further investigation lies in understanding the full extent of shipbuilding practises prior to Lloyd’s Register for standardised shipbuilding methods and that will be discussed in the next chapter.

Chapter 6 Conclusion

6.1 Introduction

The primary objective of this thesis was to understand how and to what extent can historical ship structural components be observed in shallow dynamic environment, with the case study focusing on *Admella*, and why its structural competency was dismissed by the Commission of Inquiry's report stating, 'the rows of rivet-holes necessary for securing these bulkheads tend greatly to weaken the hull of a vessel so fitted' (RCSA 1859:4–5). The thesis then focused on a range of issues that came with that statement and the assessment of shallow dynamic environments encouraged a more diverse approach to assessing and interpreting the vessel in question and comparing it to three similar case studies in Australia. Adding to the overall summary of shallow dynamic environments and the understanding of coastal climate in Cape Banks, a taphonomic study on an intertidal wreck had been accomplished to corroborate the entire process from submergence to current time. This thesis provides the first overall study of multiple wrecks within the Cape Banks, southern Canunda National Park coastline, and Carpenters Reef.

6.2 SS *Admella* and the Shallow Dynamic Environment

The beginning of the investigation warranted an in-depth assessment of the physical remains left on Admella Reef. However, the reef in question was never properly recorded, as with other records that were not kept of what was salvaged, apart from copper ingots and cakes (Mudie 1966:175). Following the DEW report submitted by Drew and Taffs in 1981, the investigation was confident in the two areas that were explored in Chapter 3. ADM1 was chosen due to its closer proximity to Cape Banks Lighthouse and was considered a more feasible target.

The remote sensing survey methods were based upon the Type A vessel identification method outlined by Harpster (2013). Attributes listed by Drew and Taffs included the engines, boilers, iron hull-plating, and copper cakes and ingots marked with ‘KAPUNDA’. Based upon the results and interpretation of ADM1, it can be stated that the check list of known features to affiliate *Admella* to the area investigated came with a negative result. However, the site can be identified as another, smaller, iron frame vessel that has yet to be affiliated with any name, type, or country of origin (Harpster 2013:594).

It is also necessary to address the inaccuracy of the 1981 report submitted by Drew and Taffs. The non-scaled sketched location of *Admella* (Drew and Taffs 1981:5) was subsequently investigated and through interpretive analysis was found to be inaccurate. Their horizontal sextant angle resection for references were of the coastal dunes directly east of their position (1981:6–7), the two limestone signal marker rocks (south-southeast), and lastly Cape Banks Lighthouse (southeast) (1981:6). With coastal sand dune movement being mild to moderately transgressive with consistent high winds, it is probable that the dune system as a reference point would become increasingly inaccurate each year. Furthermore, the extended resection distance to the latter markers would add to the growing inaccuracy of the site.

What can be corroborated with Drew and Taffs’ assessment, is that Carpenters Reef structure is a high energy environment that creates dynamic variations in swell and surge-uplift, one that can be comparable to all wreck sites found along the Carpenters Reef landscape.

6.2.1 A Shallow Dynamic Landscape

Mossman (1859) and Mudie (1966) describe Carpenters Reef as an inflexible array of sharp pointy ‘teeth’ that have the adverse effect of stopping vessels on their respective routes between Adelaide and Melbourne. The descriptions from passengers were that the reef structure protruded out from the surf, like ‘teeth on a saw’ (Mudie 1966:33). The data captured through the RPAS surveys observed that the reef outcrop from Cape Banks to ADM2 site would not be suited for such a name, unless that be ‘reef of molars’, as the topside of the reef outcrop has an observable plateau, as expected for an intertidal limestone reef. What can be confirmed through the results is that Carpenters Reef does not have the capacity to support an entire 60 m long vessel on its beams from stern to bow, and with the discussed variation in weather and issue of overloaded cargo holds, the vessel wouldn’t be able to support itself either (Mudie 1966:25).

The landscape and climate provided an opportunity to understand how this shallow dynamic environment would affect a shipwreck site over time. The case study of *Pisces Star* as a controlled intertidal wreck-site with a more stable environment, had the benefit of separating observed environmental impact from that of deterioration by intensive salvaging operations including the use of explosives (as salvaging works took place on *Admella*, *Corio II* (1951), *Edith Haviland* (1877), and *Flying Cloud* (1870)). The taphonomic study produced pertinent results on the effect of climate change, severe weather patterning, and storm impacts. As recorded from 2021 to mid-2022, *Pisces Star* showed a high rate of deterioration, with the stern and the main-cabin roof being torn from the wreck. A consistent list to starboard suggests that the water movement is scouring fine grain sediment from the bow, assisting in the vessel’s eventual covering by sea and sediment. With structural fatigue evident from one year of prolonged exposure, it can be estimated that a shipwreck from 1859, 1870, or 1877 is likely deteriorated to a level of very few recognizable parts and features, as evident from ADM1.

6.3 Assessing Structural Competency from Direct Historic Parallels

6.3.1 An overall interpretation into screw steamship assessment

In Chapter 5, the historic parallels of three screw steamships were discussed to understand the context of their structural design, the weather experienced by crew, and to what extent human error or structural incompetency played a role in the vessel's abandonment. *Brisbane* (1881) and *Gothenburg* (1875) were discussed at length for their similarities in structural design and reef landscapes that attributed to their structural damage. Fish Reef (47 km West of Darwin, NT) and Detached Reef (131 km Southeast of Townsville, QLD) are comparably similar in climate, however the weather in the Timor Sea changes drastically during the monsoon season. As described by Steinberg (2005:83), the reef structure is not made up of coral but is 'predominately a rock formation' acting as a plateau during low tide peaks. ADM1 and ADM2 as observed from the RPAS data parallels Steinberg's analysis that the limestone does act as a natural plateau with imbedded fissures running parallel with the coastline.

Historic evidence of *Gothenburg*'s grounding and eventual break up reveals that the vessel had stayed intact for almost a day and a half, before being pushed over onto the reef and consequently collapsing (DES 2010b:9). *Gothenburg* had paralleled *Brisbane*'s grounding and had sustained no damage to the structural framework, indicating that the vessel would be damaged but not extensively or critically. It would be sufficient to say that the vessels when in their upright position are capable of surviving and even being lifted off by high tides to seek port for repairs. However, *Gothenburg* and *Admella* were roughly lifted onto a reef plateau and subsequently came to rest on their port beams. In contrast, *Brisbane* had sprung numerous leaks and then was unable to gain the high tide elevation needed to seek repairs. Lloyd's Register for Iron shipbuilding practices (1863) only states that a vessel should be pressure tested at the bulkheads for bow to stern uniformity and material out of alignment must be booked for reinspection (Robertson 1974:224). The uniformity statement from 1863 comes six years after *Admella* was built and nine years after *Gothenburg* (*Celt* at that time), suggesting that shipwrights learnt to pressure test vessels within their own individual apprenticeships from local marine engineering companies (Robertson 1974:223). However, it is never mentioned that vessels must complete bulkhead stress inspections for horizontal dead-weight support, this is comparable to modern day shipbuilding that continues to not require such extreme testing, as any vessel listing beyond 35 degrees would be considered 'a loss' (Robertson 1974:223-225).

6.3.2 Socio-Economic Pressures vs. Vessel Construction

Lawrence Hill & Co, and A & J Inglis from the 1850s to 1860s were part of the revolutionary change from ships with oversized steam engines, which needed frameworks to match in size, to moderately large vessels with far more compact steam engines that were produced for light-weight transportation. The socio-economic pressure detailed in Chapter 2 had painted a stark image of client pressure that pervaded the shipbuilding industry; nevertheless, when relating the work of Lawrence Hill & Co, the historic narrative presented by Mudie (1966) suggests that the company was very well suited to building iron ships. Steinberg (2008) states that A & J Inglis were quite renowned for their shipbuilding practices and had a good reputation for providing vessels with adequate spacing for price and time.

Although *Admella* was constructed by both companies, it can be stated that the experimental screw steamship had been unduly documented as a vessel of incompetent design, with focus placed on the watertight bulkheads. Richard Jagoe's review of *Admella*

(1858) in *The South Australian Register* and *The Adelaide Observer* had been a far more credible assessment of the vessel's structural competence (Mudie 1966:16–24). This thesis suggests that the new technology being transported to the Australian mainland lacked informative documentation to the colonial states maritime boards and inclusive inductions on steamship structural methodologies.

6.4 Further Research and Investigation

The Admella Wreck Project was able to produce significant results in relation to submerged landscape morphology, rate of taphonomic processes at Cape Banks, spatial spread of vessel structures, weather patterning, and vessel positioning within a high energy shallow dynamic environment. Moreover, AWP has exposed new avenues for research, as stated within this thesis. ADM1 resulted in the finding of a shipwreck not previously discussed by local communities and could benefit from a Type B approach for investigation. The subsequent aims rendered a thorough contextualization for the Cape Banks landscape at ADM1. Yet, there is more to be gained from continuing research into other areas along the Cape Banks and Canunda National Park coastline.

6.4.1 The Northern Site of ADM2

As presented in Chapter 4 and 5, RPAS results were able to be combined with a multitude of remote sensing data to give a clearer understanding of Cape Banks and Carpenters Reef. The survey parameters following the coastal integration workflow served to fill the high-resolution spatial gap that could not be attained through any publicly available resource (e.g., Google Earth 2022). The high-resolution RPAS results can be mimicked to extend further north to provide spatial referencing to limestone reef outcrops, reef bommies, and to limestone fissures found throughout this diverse submerged landscape.

The RPAS data could then again be paired with the magnetometer survey data, which would yield results as seen in Chapter 5, as a negative result is still viable data to observe spatial distribution and preservation of material. ADM1 could benefit from having the western section explored further, as part of the original scope of works. ADM2 would benefit regardless, as the recorded magnetic anomalies from previous surveys are either not published or have not been completed, as witnessed throughout the AWP research component. This again, could be paired with the RPAS data for an enhanced overview of significant features to be surveyed by ROV or divers.

6.4.2 ADM1 - Vessel Identification Type B

Further research with the above specified remote sensing methods has already been accomplished (although it could be more refined) and can be used to form a new investigative direction. Following Harpster's (2013) Type B approach to vessel identification methods, ADM1 is a remarkable case study to follow up on in future research of unreported or undocumented shipwrecks in the area.

6.5 Conclusion

The case study of SS *Admella* in understanding how historical ship structural components can be observed in shallow dynamic environments was attempted to be answered throughout this thesis with significant results. The formation of this case study did follow the appropriate methods to attain the results; however, more necessary context in the form of landscape morphology and submerged reef structuring had to be further investigated to provide the relative context to the Cape Banks area. Attempts have been made to give an overall context of approximate locations of vessels in the region, as seen in Chapter 3. It was beneficial to understand how seven known vessels had come to wreck in less than a 1 km radius of the site, with the inclusion of ADM1 vessel as no.8, was accomplished through the understanding of weather patterns, submerged geomorphology, and hydrodynamics of Cape Banks.

How could historical ship structural competency be observed from *in situ* material? The material investigated at ADM1 and the taphonomic study on *Pisces Star* conclude that the variation in climate, current consistency, high energy swell, and wind, have enormous effects on the preservation of shipwrecks. However, the *Admella* shipwreck site is probably no longer diagnosable with non-invasive remote-sensing methods after 163 years of being exposed to the high energy environment, especially on the western section of the reef outcrop. Furthermore, Drew and Taffs (1981) concluded that the engine components were possibly damaged with demolition works on the reef outcrop between 1961 and 1981. It is evident that most structures would be overgrown or concreted or damaged to the point of complete unreliability when it comes to observable assessment. Thus, invasive measures such as extracting ferrous material for metallurgical studies could be performed to analyse the potential origin of material and carbonization percentage.

The historic parallel included in this thesis was to compare four unique vessels from an experimental stage in shipbuilding practices which included the use of steam engines, new watertight bulkhead designs, and the implementation of high-capacity cylinders. What was discovered by the author is this: due to the rapid revolution from sail to steam, partnered with a lack of information crossing from the British shipbuilders to maritime inspectors in Australia, and the lack of navigational route data updates for every new Captain beginning to work across multiple intercolonial states, had lacked the in-depth knowledge of these new vessel designs creating a mixed degree of negligible recommendations, investigations, and routine maritime inspections.

Historical ship structural components present in shallow dynamic environments should be observed through many avenues of research to reach conclusions which are appropriately informed. The historic narrative, contextualized by the socio-economic background of the mid-nineteenth century shipbuilding practices outlined above, confirm that a mixed degree of technological advancements could have created gaps of information that were not readily available to the public. This conclusion is supported by the remote sensing data detailed in this thesis. The observable *in-situ* material can be used to inform the preservation status of certain vessels, but it cannot be solely relied on to make confident statements about overall structural competency. Nor can structural competency be determined merely from historic parallels with vessels linked exclusively by typology and environment. All available resources on historical ship structural components should be used to inform the extent of shallow dynamic environmental influence on vessels and the potential failures thereof. Summating, that it is not only *Admella* that had suffered under unpredictable environmental conditions, but that of the newly relocated ship remains of ADM1, adding to the conclusive evidence of a shallow dynamic environment and the impacts on seafaring vessels.

In conclusion, *Admella* broke at the watertight bulkheads due to overloading issues within the cargo holds. Impacted by heavy swell, jagged reef and no support from the reef plateau at either end of the vessel, the hull structure became compromised, and the vessel came apart at the weakest points. Thus, *Admella* was a structurally competent vessel built confidently for intercolonial passenger faring in south-eastern Australia, but the capacity had been deliberately over-estimated in structural function in emergency situations, prioritizing instead, the value of profit and haste.

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Appendix

Appendix 1A – Weather data

Table 1A.1. Recorded Wind data (kilometre per hour and direction)

Date	0630 (km/h & D)	0930 (km/h & D)	1230 (km/h & D)	1530 (km/h & D)
1/08/2021	15 - W	25 - SW	28 - SW	37 - S
2/08/2021	18 - NE	28 - NE	34 - NE	40 - N
3/08/2021	28 - N	33 - N	38 - N	40 - NE
7/08/2021	8 - S	10 - S	16 - S	20 - SE
8/08/2021	8 - S	10 - S	16 - S	21 - SE
29/08/2021	13 - W	26 - WNW	31 - WNW	33 - WNW
25/09/2021	25 - SW	29.5 - SSW	17.6 - SSW	18 - S
26/09/2021	8 - NNE	10.4 -NNE	5.4 - ESE	14.8 - SSE
27/09/2021	17.7 - NE	20.9 - NE	18 - NNE	12.6 - ENE
5/10/2021	43.6 - WSW	37.8 - WSW	27.7 - W	21.6 - WNW
6/10/2021	22.7 - NNE	23.0 - NNE	24.5 - N	24.8 - NNW
7/10/2021	42.5 - WSW	37.3 - WSW	34.9 - W	37.8 - W
19/10/2021	20.5 - SSE	19.4 - ESE	21.2 - SE	25.9 - SE
20/10/2021	20.5 - ENE	20.9 - NE	19.4 - NE	19.4 - NE
21/10/2021	18.7 - N	18.7 - NNW	21.6 - NW	24.5 - WNW
30/11/2021	13 - NE	17.3 - NNE	18.7 - W	23.4 - W
1/12/2021	12.6 - W	16.2 - SSW	18.4 - SSW	22 - SSW
2/12/2021	15.5 - S	20.5 - SW	23.4 - SW	25.6 - SW
10/01/2022	23 - ESE	24.5 - SE	30.2 - SE	29.9 - SSE
11/01/2022	30.2 - ESE	31 - SE	36.7 - SE	39.6 - SE
12/01/2022	30.2 ESE	28.4 - ESE	29.2 - SE	29.2 - SE
13/01/2022	23 - SE	26.3 - ESE	27 - ESE	23 - ESE
14/01/2022	16.6 - ESE	17.6 - SE	19.8 - S	19.4 - SSE

Date	Rainfall %	Rain Fall (mm)	High Tide (t/m)	Low Tide (t/m)	Swell (m)
1/08/2021	30	10-25mm	0100 - (5.8m)	1300 - (3.6m)	SSW 2.8
2/08/2021	25	5-10mm	0708 - (0.8m)	1235 - (0.4m)	SSW 2.2
				2100 - (0.4m)	
3/08/2021	50-75	1-5mm	1000 - (0.9m)	2015 - (0.5m)	SSW 2.4
7/08/2021	25	1-2mm	1310 - (0.8)	0430 - (0.4m)	SSW 2.2

				2110 - (0.6m)	
8/08/2021	15	<1mm	1320 - (1.3m)	2000 - (0.5m)	SSW 2.2
29/08/2021	75	1-5mm	0321 - (1.1m)	0910 - (0.5m)	SSW 2.3
			1330 - (0.9m)	2120 - (0.5m)	
25/09/2021	50	<1mm	0134 - (1.0m)	0747 - (0.4m)	SSW 4.5
			1308 - (0.8m)	1917 - (0.2m)	
26/09/2021	10	<1mm	0201 - (1.0m)	0815 - (0.5m)	SSW 2.9
			1308 - (0.8m)	1932 - (0.2m)	
27/09/2021	5	<1mm	0232 - (1.0m)	0837 - (0.5m)	SSW 1.8
			1303 - (0.7m)	1949 - (0.2m)	
5/10/2021	40	<1mm	0039 - (0.7m)	0618 - (0.4m)	SW 4.9
			1254 - (1.0m)	1921 - (0.4m)	
6/10/2021	95	5-10mm	0049 - (0.8m)	0649 - (0.3m)	SW 2.3
			1307 - (1.0m)	1912 - (0.4m)	
7/10/2021	55	<1mm	0109 - (0.9m)	0721 - (0.3m)	SW 3.5
			1320 - (0.4m)	1917 - (0.3m)	
19/10/2021	10	<1mm	1230 - (0.9m)	0630 - (0.4m)	SSW 2.1
				1830 - (0.4m)	
20/10/2021	25	<1mm	1230 - (0.9m)	0700 - (0.4m)	SSW 1.3
				1830 - (0.3m)	
21/10/2021	70	<2mm	1240 - (0.8m)	0730 - (0.4m)	SSW 1.1
				1840 - (0.3m)	
30/11/2021	5	<1mm	0906 - (0.9m)	1656 - (0.5m)	SSW 2.2
1/12/2021	15	<1mm	0007 - (0.8m)	0537 - (0.2m)	SSW 2.1
			1017 - (0.7m)	1657 - (0.4m)	
2/12/2021	10	<1mm	0008 - (0.9m)	0654 - (0.3m)	SSW 2.1
			1056 - (0.9m)	1710 - (0.4m)	
10/01/2022	20	<1mm	0501 - (1.0m)	1150 - (0.4m)	SSW 1.8
			1752 - (0.8m)	2308 - (0.6m)	
11/01/2022	20	<1mm	0517 - (0.9m)	1223 - (0.4m)	SSW 1.7
			1939 - (0.7m)	2323 - (0.7m)	
12/01/2022	30	<1-5mm	0520 - (0.9m)	1258 - (0.4m)	SSW 1.5
13/01/2022	45	<1-5mm	0254 - (0.8m)	1333 - (0.4m)	SSW 1.3
14/01/2022	10	<1mm	0146 - (0.9m)	1424 - (0.4m)	SSW 1.4
			1505 - (0.4m)	2352 - (0.8m)	

Table 1A.2. Recorded Weather data (rainfall, tides, swell)

Appendix 1B Equipment

Table 1B.1 Equipment used throughout the project.

Type	**Product**	**Model**	**Sensing Range**	**Megapixel**

Cameras				
Drone	Mavic	2 Pro	Aerial	20MP
Drone	Mavic	2 Zoom	Aerial	48MP
Drone	Autel	Evo 2 Pro	Aerial	20MP
Drone	Chasing	M2	ROV	12MP
DSLR	Nikon	D3400	Terrestrial	24.2MP
Phone	Samsung	A52	Terrestrial	64MP
Action Camera	GoPro	Hero 9	Submerged	20MP
Action Camera	GoPro	Hero 9	Submerged	20MP
Action Camera	GoPro	Hero 6	Submerged	12MP
Action Camera	GoPro	Hero 5	Submerged	12MP
Compact	Sony	RX100	Submerged	20.2MP
Geophysical Unit				**Range**
Magnetometer	Marine	Sea Spy Explorer	4 Hz - 0.1 Hz	18,000 nT - 120,000 nT
Vehicles				
RV *Bungaree*	Sailfish Catamaran	Canyon Master XL		
RV *Tom Thumb*	RHIB	Centre Console		
Archaeology LC	Toyota	Landcruiser 70		
GNSS Units			**GNSS**	**Accuracy**
Handheld	Garmin	eTrex 10	GPS	3 m +/- 1 m
			GLONASS	

Appendix 1C Kelp and Seagrass Samples

1C.1 Kelp and Seagrass samples

1C.1.1 Sample one of kelp specimen (2021-09-25, P. Kermeen)

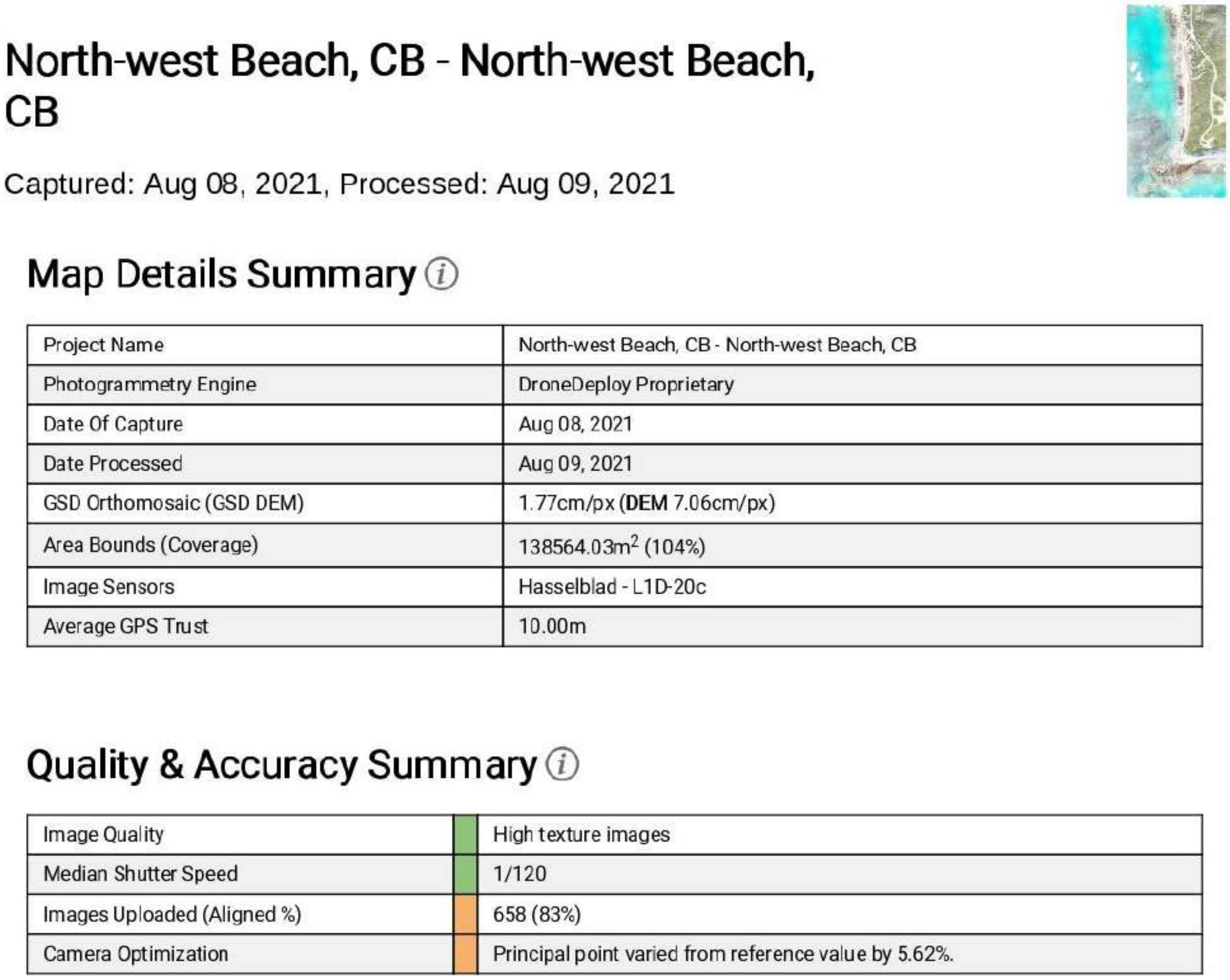
1C.1.2. Sample two of seagrass specimen (2021-09-26, P. Kermeen)

1C.1.3. Sample 3, 4, and 5 of kelp specimens (2021-10-01, P. Kermeen)

1C.1.4. Sample 6 of seagrass specimen (2021-10-01, P. Kermeen)

Appendix 1D DroneDeploy Rendering Reports

1D.1. North-west Beach DroneDeploy Report



North-west Beach, CB - North-west Beach, CB

Captured: Aug 08, 2021, Processed: Aug 09, 2021

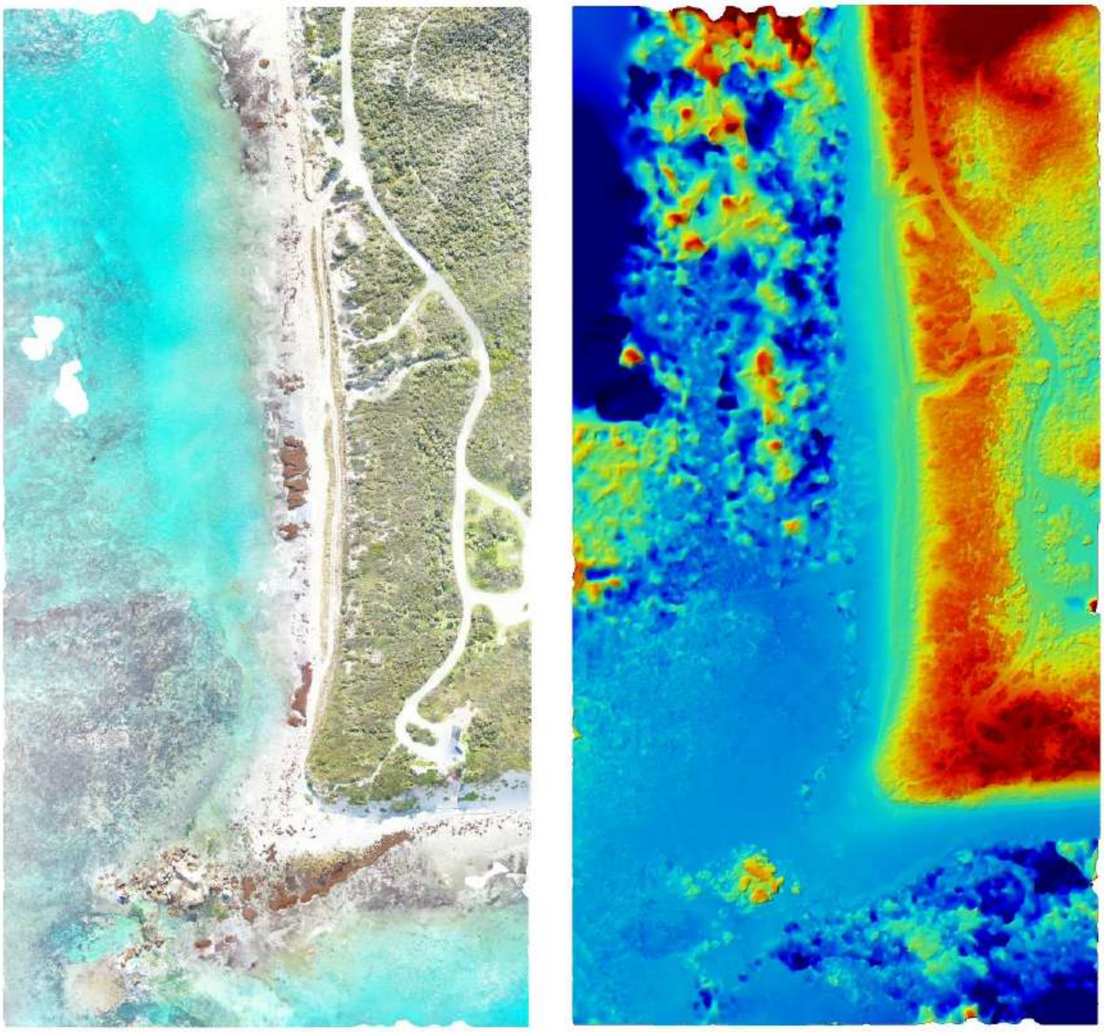
Map Details Summary ⓘ

Project Name	North-west Beach, CB - North-west Beach, CB
Photogrammetry Engine	DroneDeploy Proprietary
Date Of Capture	Aug 08, 2021
Date Processed	Aug 09, 2021
GSD Orthomosaic (GSD DEM)	1.77cm/px (**DEM** 7.06cm/px)
Area Bounds (Coverage)	138564.03m^2 (104%)
Image Sensors	Hasselblad - L1D-20c
Average GPS Trust	10.00m

Quality & Accuracy Summary ⓘ

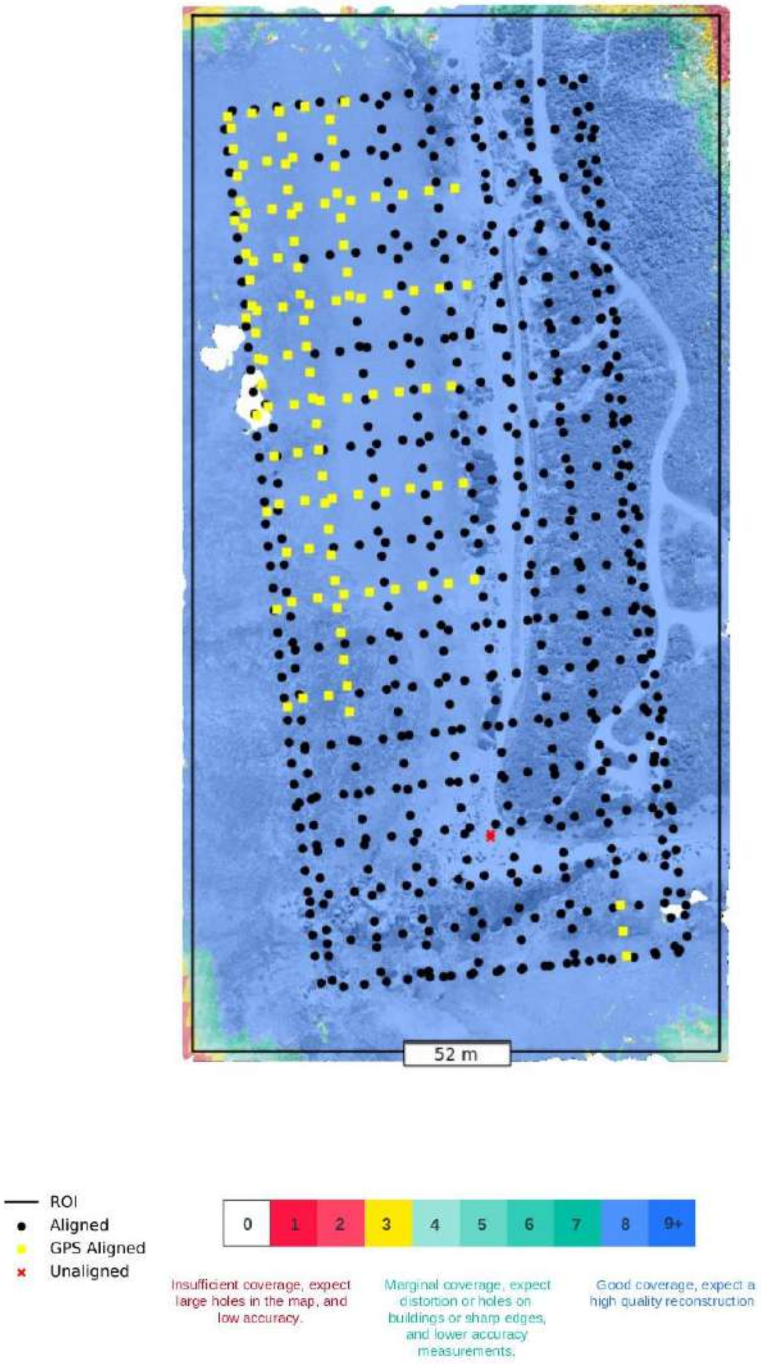
Image Quality	🟩	High texture images
Median Shutter Speed	🟩	1/120
Images Uploaded (Aligned %)	🟧	658 (83%)
Camera Optimization	🟧	Principal point varied from reference value by 5.62%.

Preview ⓘ



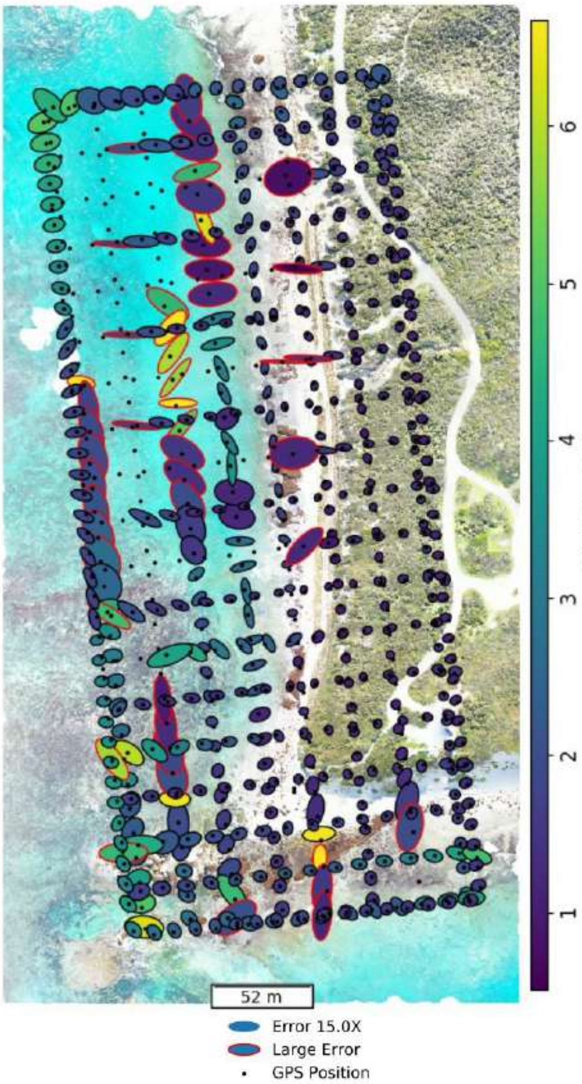
Dataset Quality Review

Orthomosaic Coverage ⓘ



Sensor(s) Used	Hasselblad - L1D-20c
Image Count (by sensor)	658
Image Resolution	5472x3648 (~20MP)
Orthomosaic coverage (% of area of interest)	104.49
Average Orthomosaic Image Density within Structured Area	46 images/pixel
Median Shutter Speed	1/120

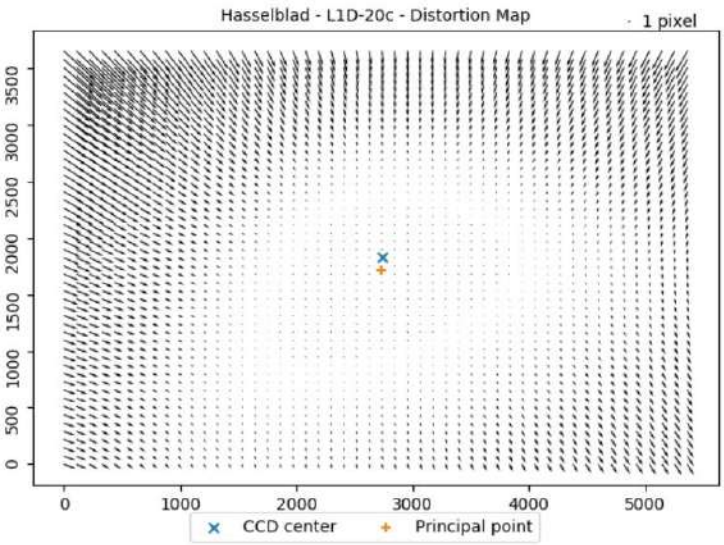
Structure from Motion ⓘ



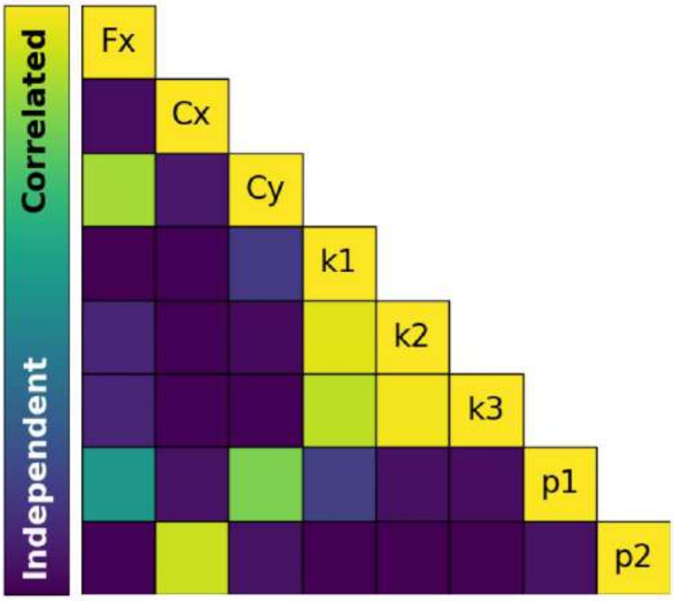
Aligned Cameras	🟧	83% 544/658
RMSE of Camera GPS Location	🟩	X 1.00m Y 1.34m Z 1.71m **RMSE** 1.38m

Camera Calibration ⓘ

Camera Optimization	🟧	Principal point varied from reference value by 5.62%.



	Fx	Cx	Cy	k1	k2	k3	p1	p2
Value	4333.1	2733.3	1713.38	-0.0109764	0.0246799	-0.0276999	-0.003064	0.00117292
Error	0.147885	0.0744983	0.139642	0.405463	1.58651	1.90578	0.0393954	0.0304187

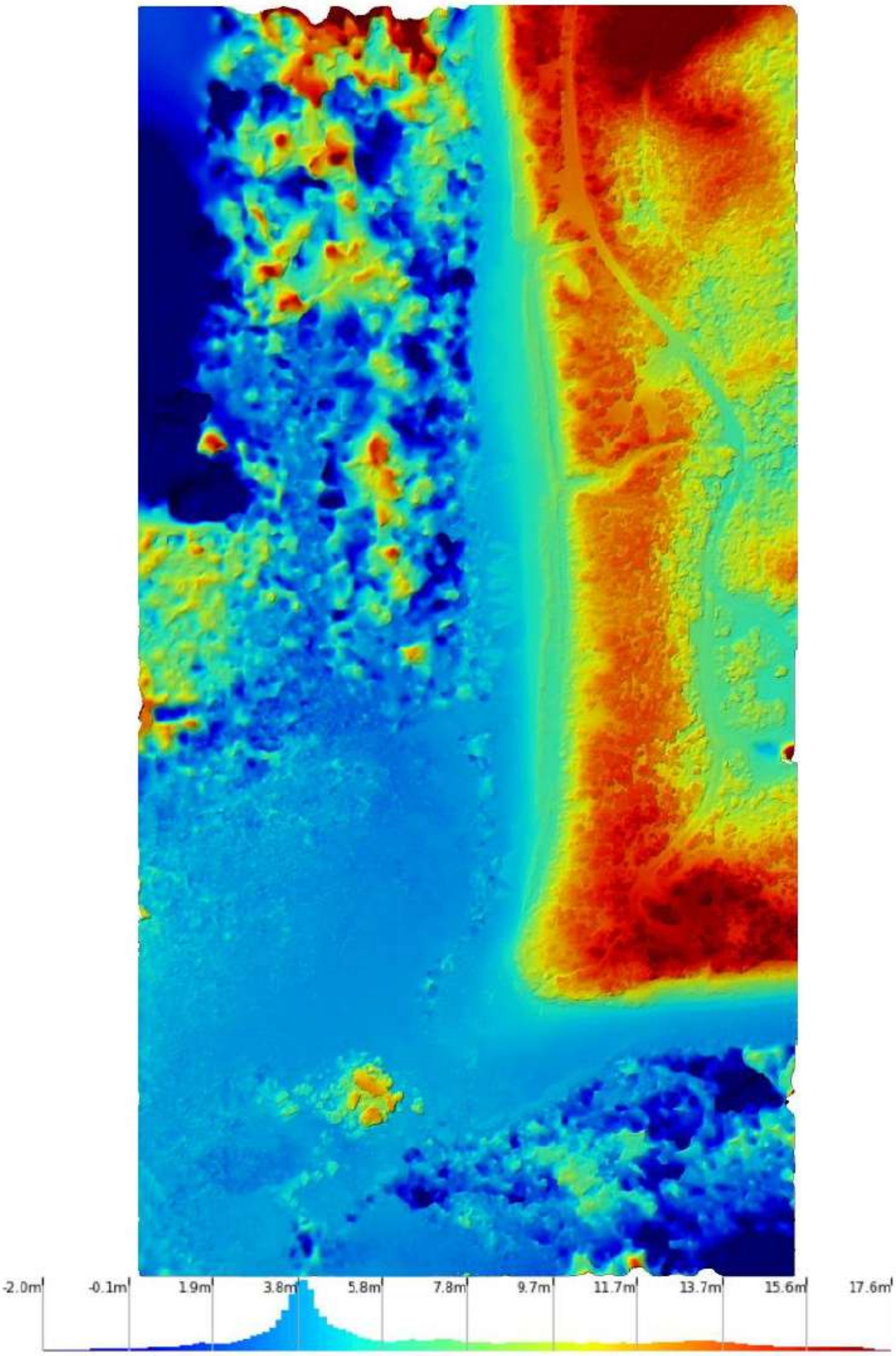


Densification and Meshing ⓘ

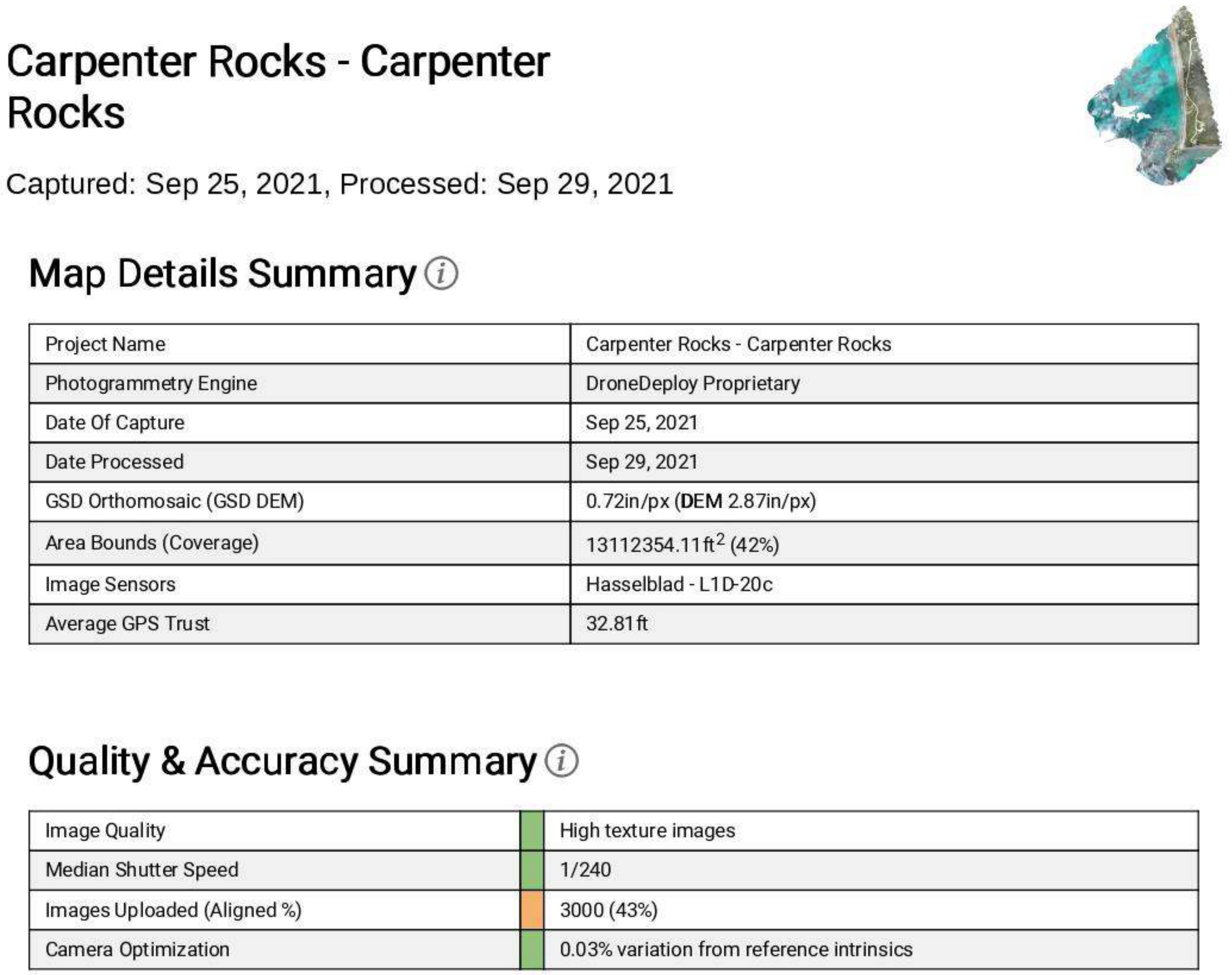
Processing Mode Quality	🟩	High
Nadir Images	🟧	0% Include predominantly nadir images to optimize processing for natural terrain.
Oblique images	🟩	97%
Horizontal images	🟩	3%
Total Points		26.9 million
Point Cloud Density		185.99 points/m^2
Mesh Triangles		1.9 million

Digital Elevation Model ⓘ

Mode	Generated from Mesh
DEM GSD	**DEM** 7.06cm/px
Relative/Absolute	Absolute Altitude



1D.2. Carpenter Rocks 1 DroneDeploy Report



Carpenter Rocks - Carpenter Rocks

Captured: Sep 25, 2021, Processed: Sep 29, 2021

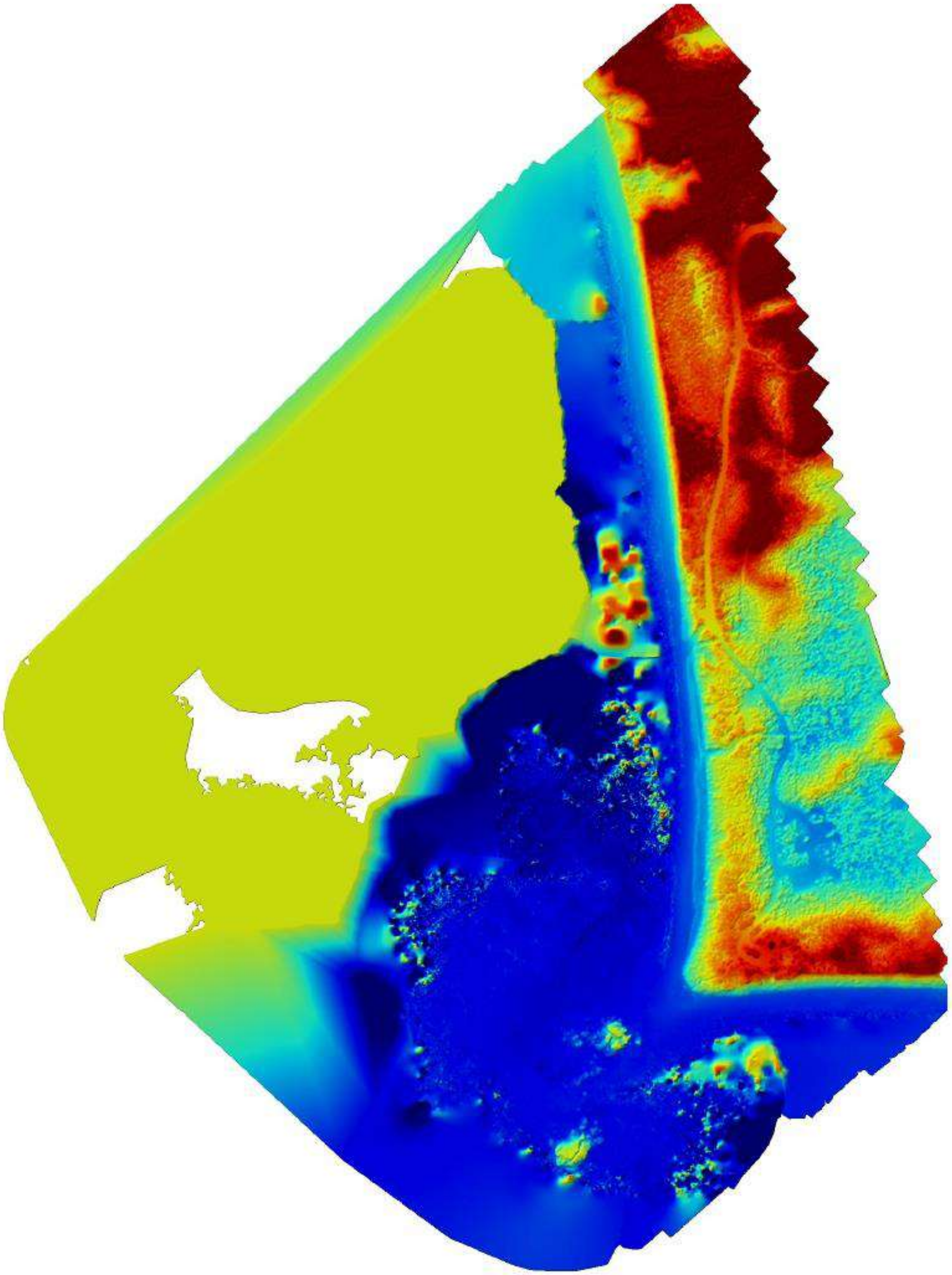
Map Details Summary

Project Name	Carpenter Rocks - Carpenter Rocks
Photogrammetry Engine	DroneDeploy Proprietary
Date Of Capture	Sep 25, 2021
Date Processed	Sep 29, 2021
GSD Orthomosaic (GSD DEM)	0.72in/px (**DEM** 2.87in/px)
Area Bounds (Coverage)	13112354.11ft^2 (42%)
Image Sensors	Hasselblad - L1D-20c
Average GPS Trust	32.81ft

Quality & Accuracy Summary

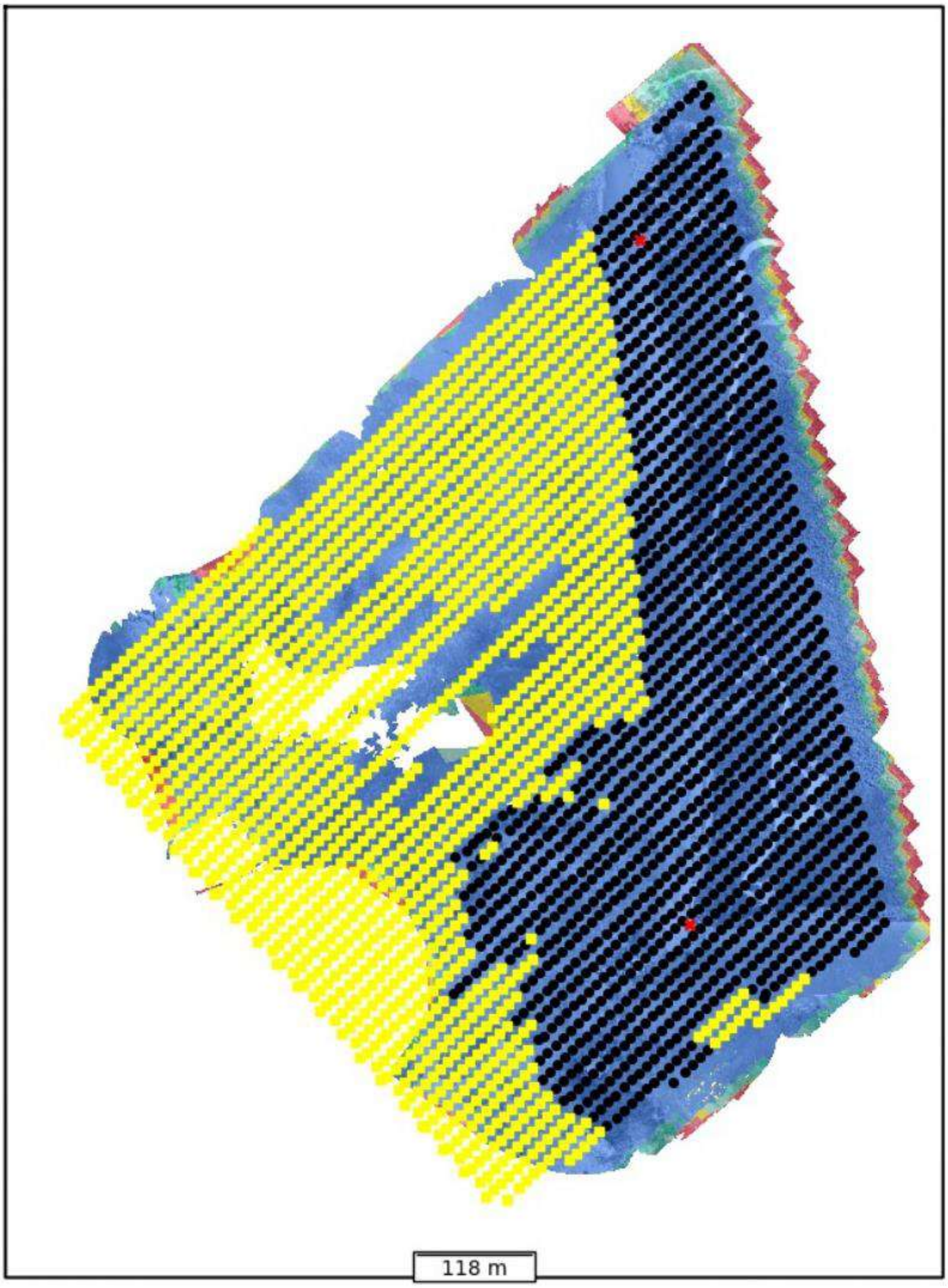
Image Quality	🟩	High texture images
Median Shutter Speed	🟩	1/240
Images Uploaded (Aligned %)	🟧	3000 (43%)
Camera Optimization	🟩	0.03% variation from reference intrinsics

Preview ⓘ

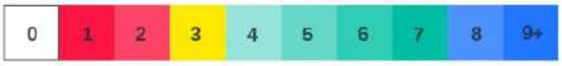


Dataset Quality Review

Orthomosaic Coverage ⓘ



— ROI
● Aligned
🟨 GPS Aligned
× Unaligned



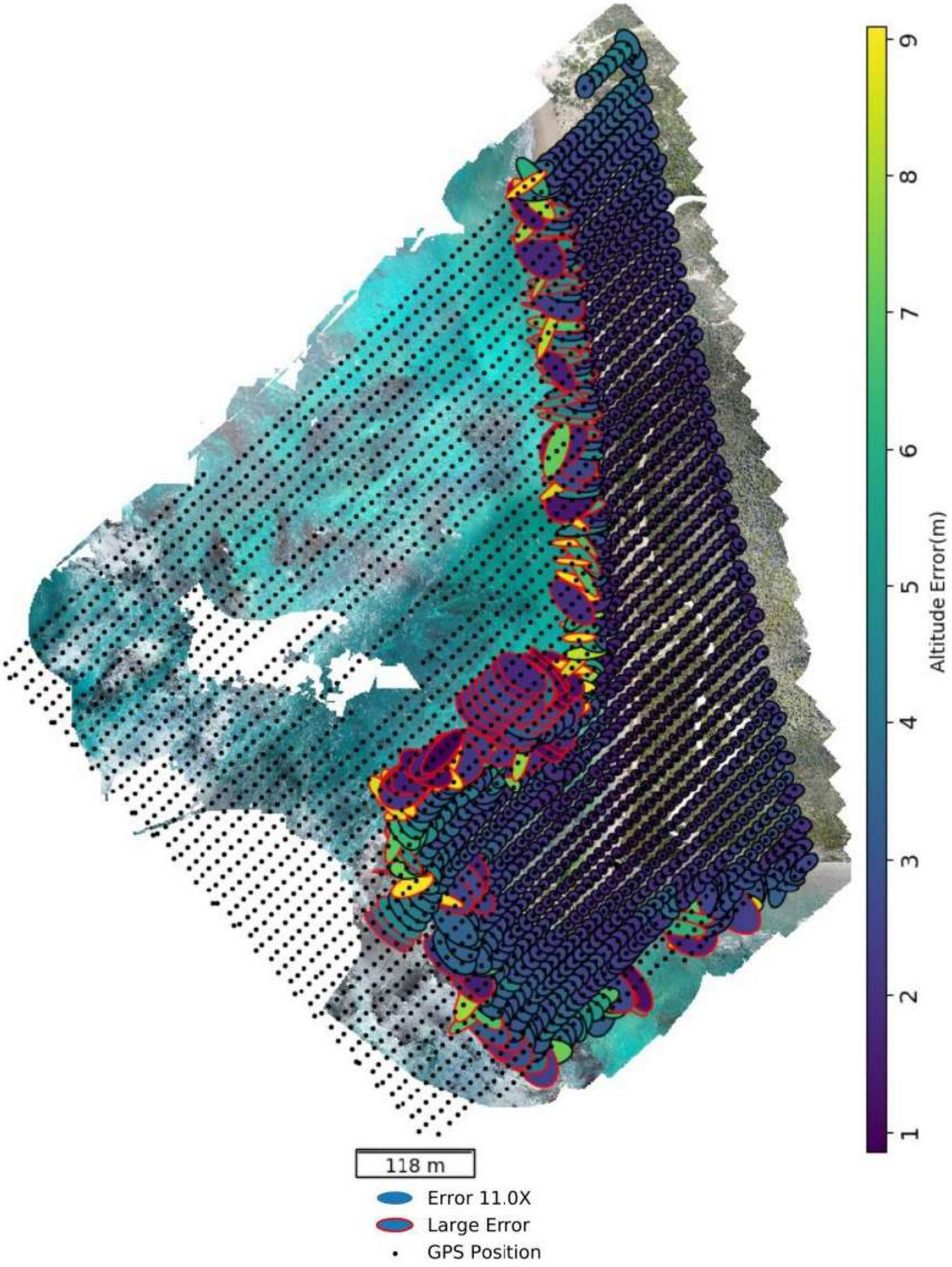
Insufficient coverage, expect large holes in the map, and low accuracy.

Marginal coverage, expect distortion or holes on buildings or sharp edges, and lower accuracy measurements.

Good coverage, expect a high quality reconstruction

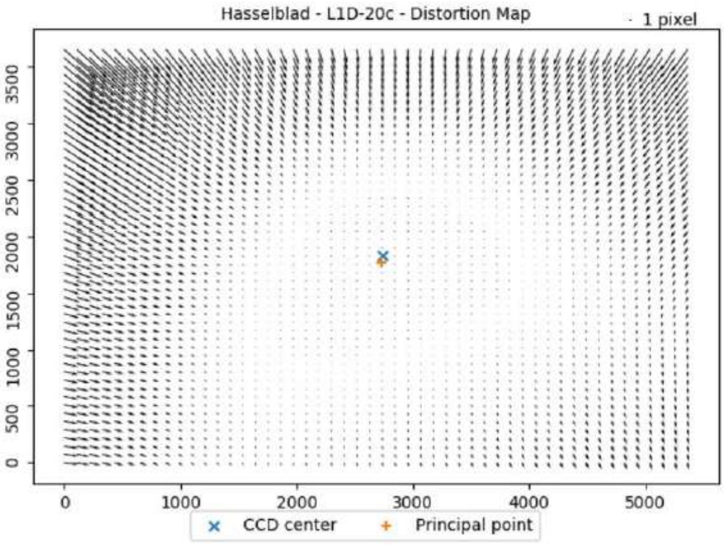
Sensor(s) Used	🟩	Hasselblad - L1D-20c
Image Count (by sensor)	🟩	3000
Image Resolution	🟩	5472x3648 (~20MP)
Orthomosaic coverage (% of area of interest)	🟧	42.07
Average Orthomosaic Image Density within Structured Area	🟩	29 images/pixel
Median Shutter Speed	🟩	1/240

Structure from Motion ⓘ

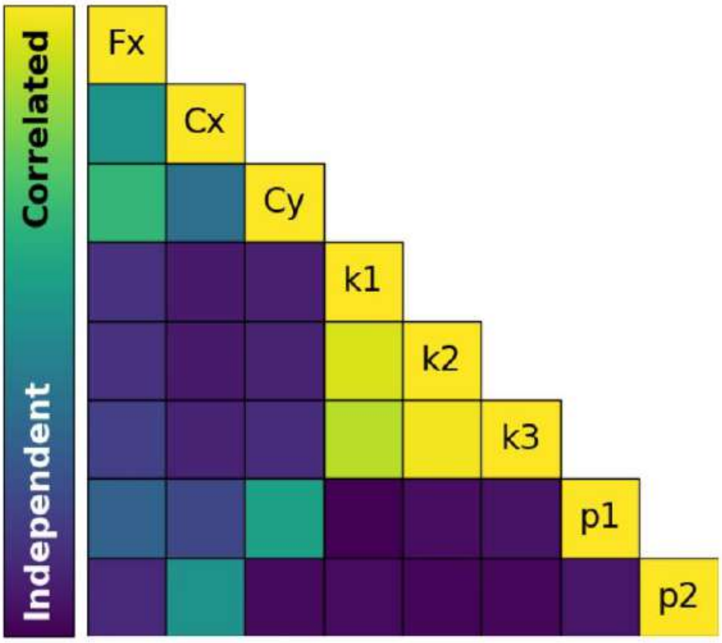


Aligned Cameras	🟧	43% 1291/3000
RMSE of Camera GPS Location	🟩	**X** 3.23ft **Y** 4.23ft **Z** 4.42ft **RMSE** 3.99ft

Camera Optimization	🟩	0.03% variation from reference intrinsics



	Fx	Cx	Cy	k1	k2	k3	p1	p2
Value	4346.03	2731.51	1763.93	-0.0163069	0.0328066	-0.0362053	-0.00343793	0.00115616
Error	1.08812	0.0625939	0.0612046	0.303348	1.23693	1.54564	0.0135351	0.0171231

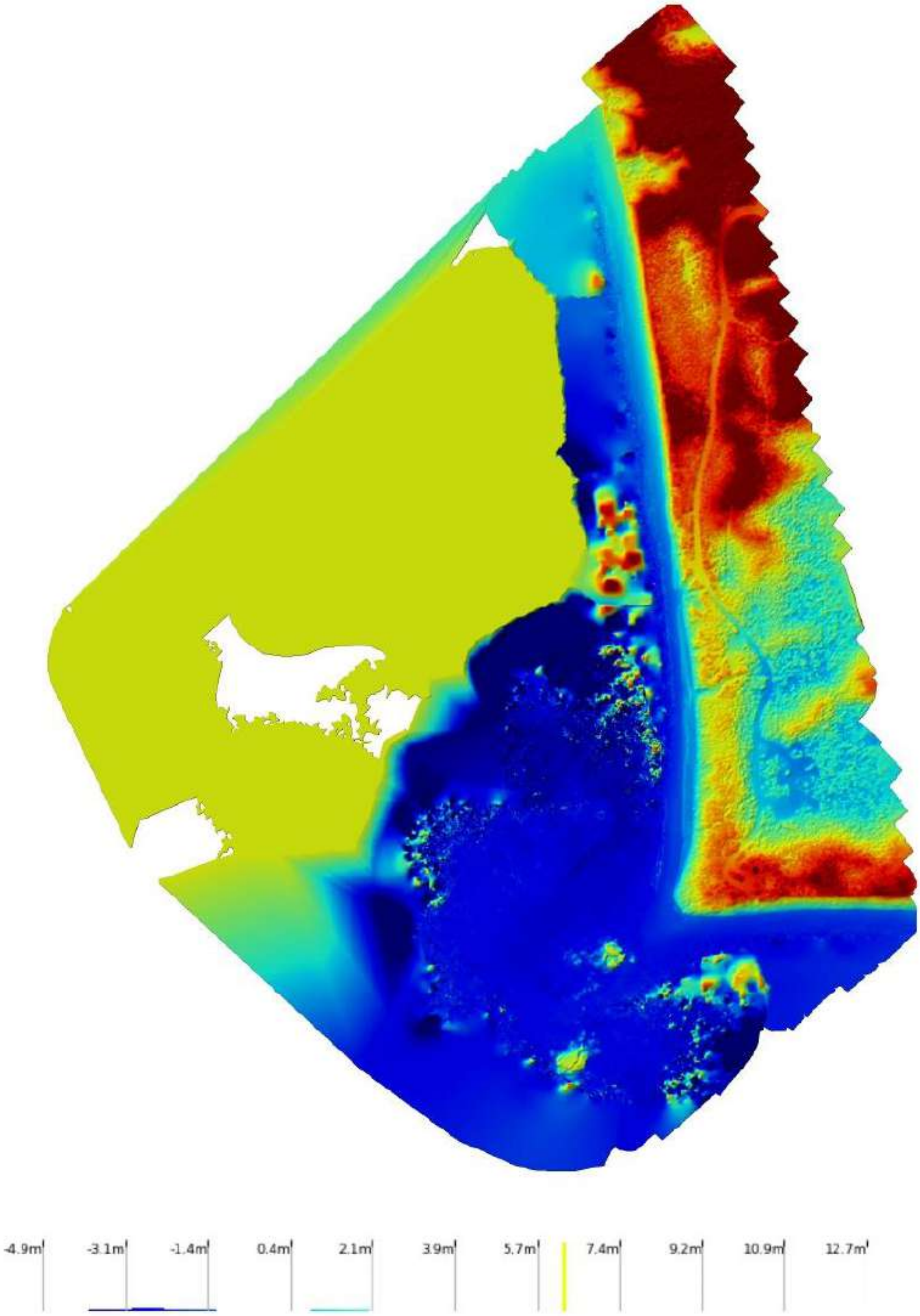


Densification and Meshing ⓘ

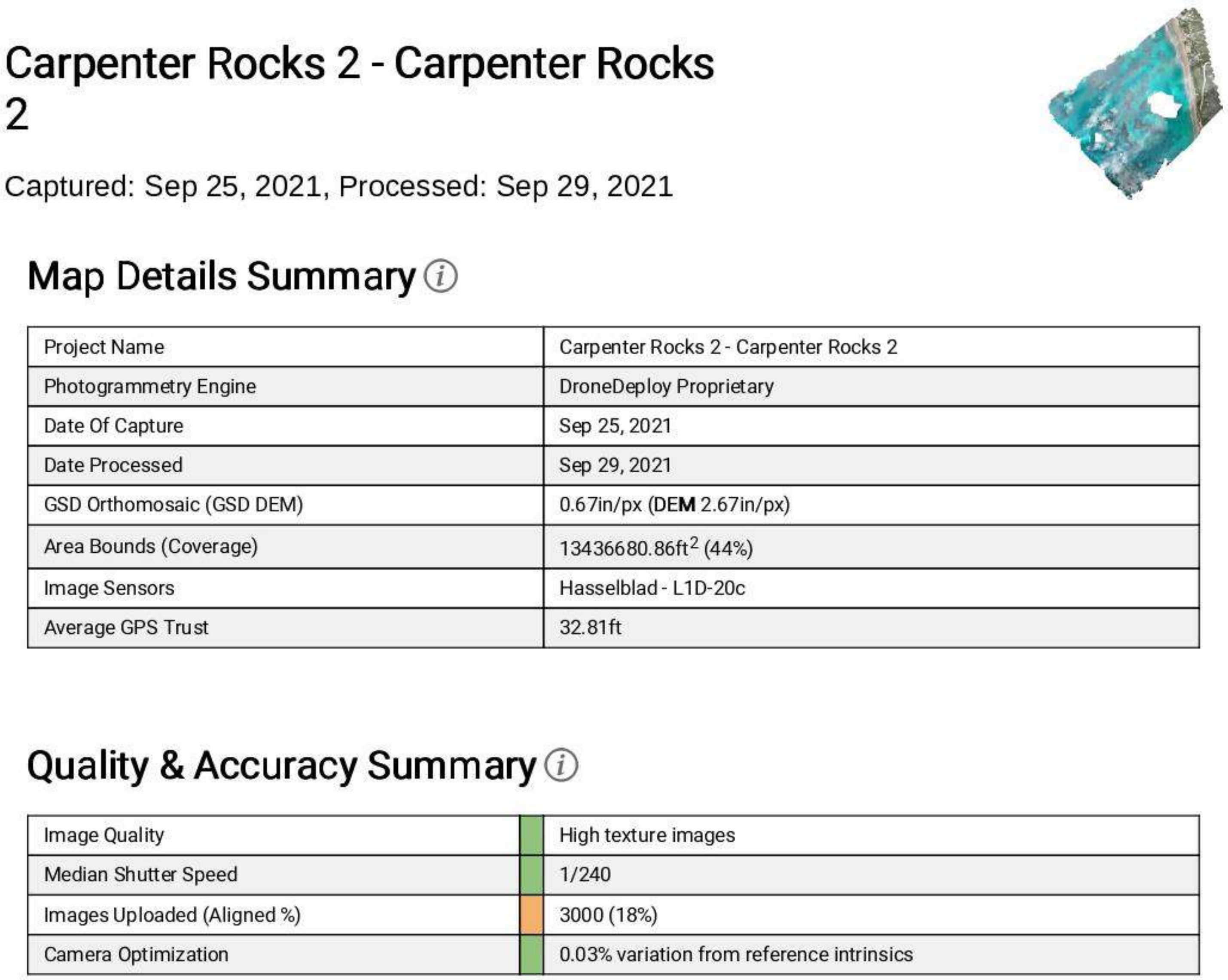
Processing Mode Quality	🟩	High
Nadir Images	🟧	100% Include oblique or horizontal images to improve reconstructions of man-made structures.
Oblique images	🟩	0%
Horizontal images	🟩	0%
Total Points		3.5 million
Point Cloud Density		0.64 points/ft^2
Mesh Triangles		4.0 million

Digital Elevation Model ⓘ

Mode	Generated from Mesh
DEM GSD	**DEM** 2.87in/px
Relative/Absolute	Relative Altitude vs Drone takeoff



1D.3. Carpenter Rocks 2 DroneDeploy Report



Carpenter Rocks 2 - Carpenter Rocks 2

Captured: Sep 25, 2021, Processed: Sep 29, 2021

Map Details Summary ⓘ

Project Name	Carpenter Rocks 2 - Carpenter Rocks 2
Photogrammetry Engine	DroneDeploy Proprietary
Date Of Capture	Sep 25, 2021
Date Processed	Sep 29, 2021
GSD Orthomosaic (GSD DEM)	0.67in/px (**DEM** 2.67in/px)
Area Bounds (Coverage)	13436680.86ft^2 (44%)
Image Sensors	Hasselblad - L1D-20c
Average GPS Trust	32.81ft

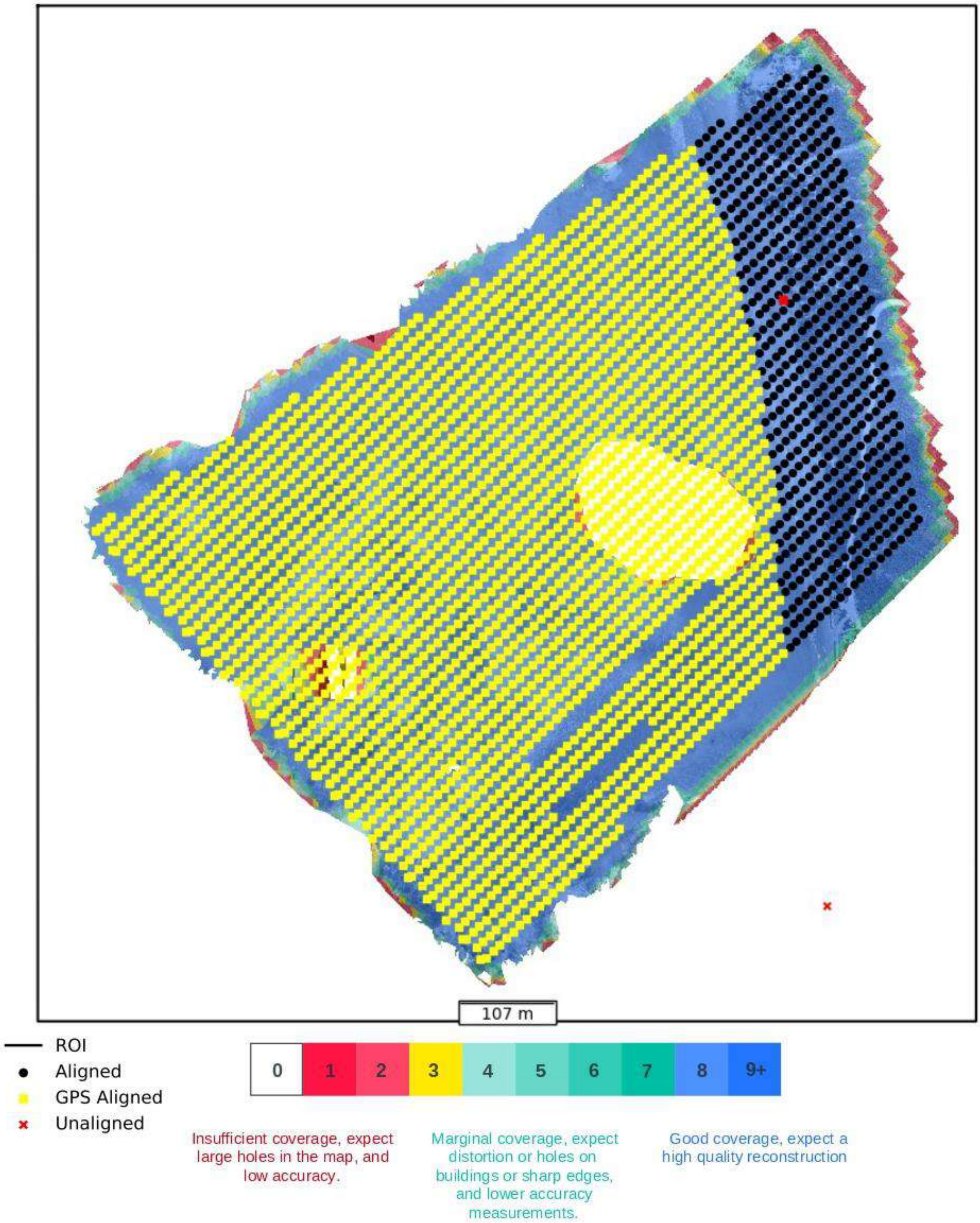
Quality & Accuracy Summary ⓘ

Image Quality	🟩	High texture images
Median Shutter Speed	🟩	1/240
Images Uploaded (Aligned %)	🟧	3000 (18%)
Camera Optimization	🟩	0.03% variation from reference intrinsics

Preview ⓘ

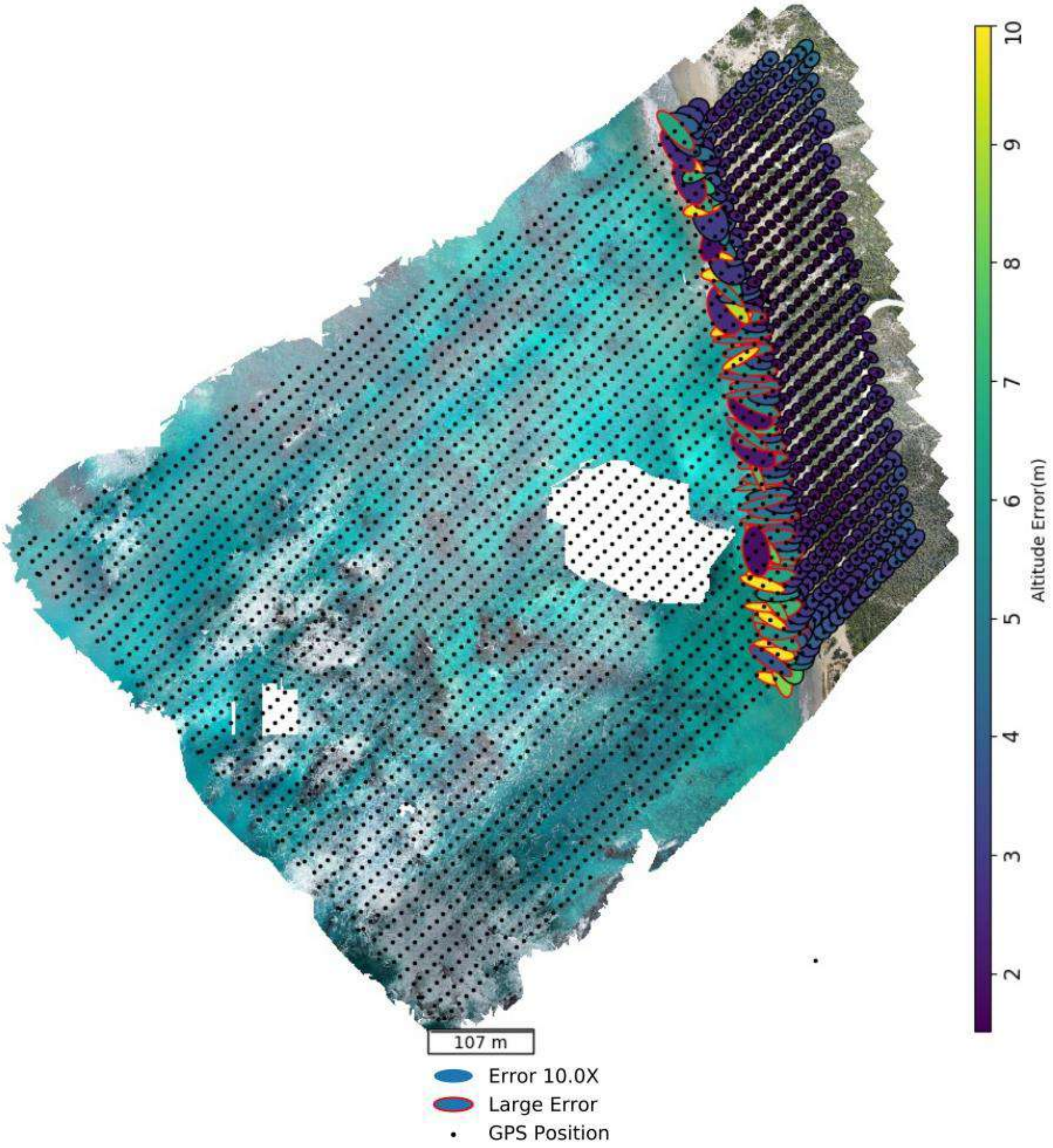
Dataset Quality Review

Orthomosaic Coverage ⓘ



Sensor(s) Used	🟩	Hasselblad - L1D-20c
Image Count (by sensor)	🟩	3000
Image Resolution	🟩	5472x3648 (~20MP)
Orthomosaic coverage (% of area of interest)	🟧	44.44
Average Orthomosaic Image Density within Structured Area	🟩	26 images/pixel
Median Shutter Speed	🟩	1/240

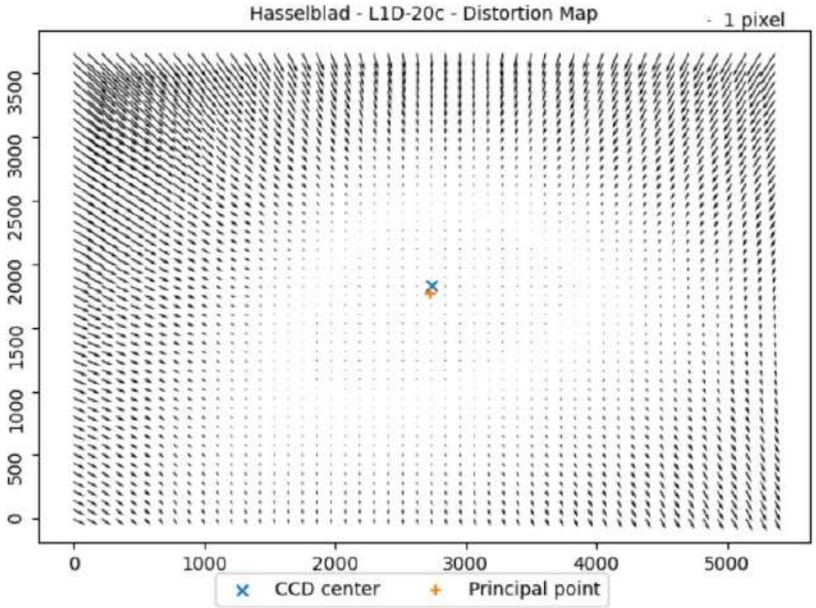
Structure from Motion ⓘ



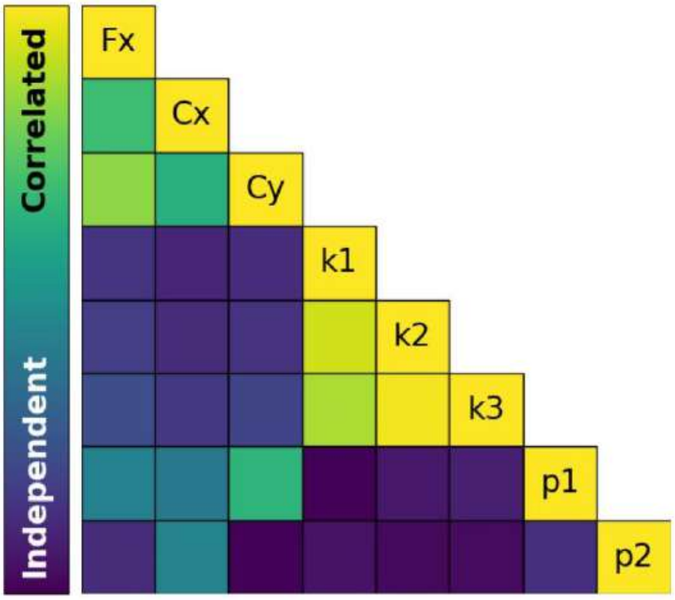
Aligned Cameras	🟧	18% 544/3000
RMSE of Camera GPS Location	🟩	**X** 2.45ft **Y** 3.35ft **Z** 4.37ft **RMSE** 3.48ft

Camera Calibration ⓘ

Camera Optimization	🟩	0.03% variation from reference intrinsics



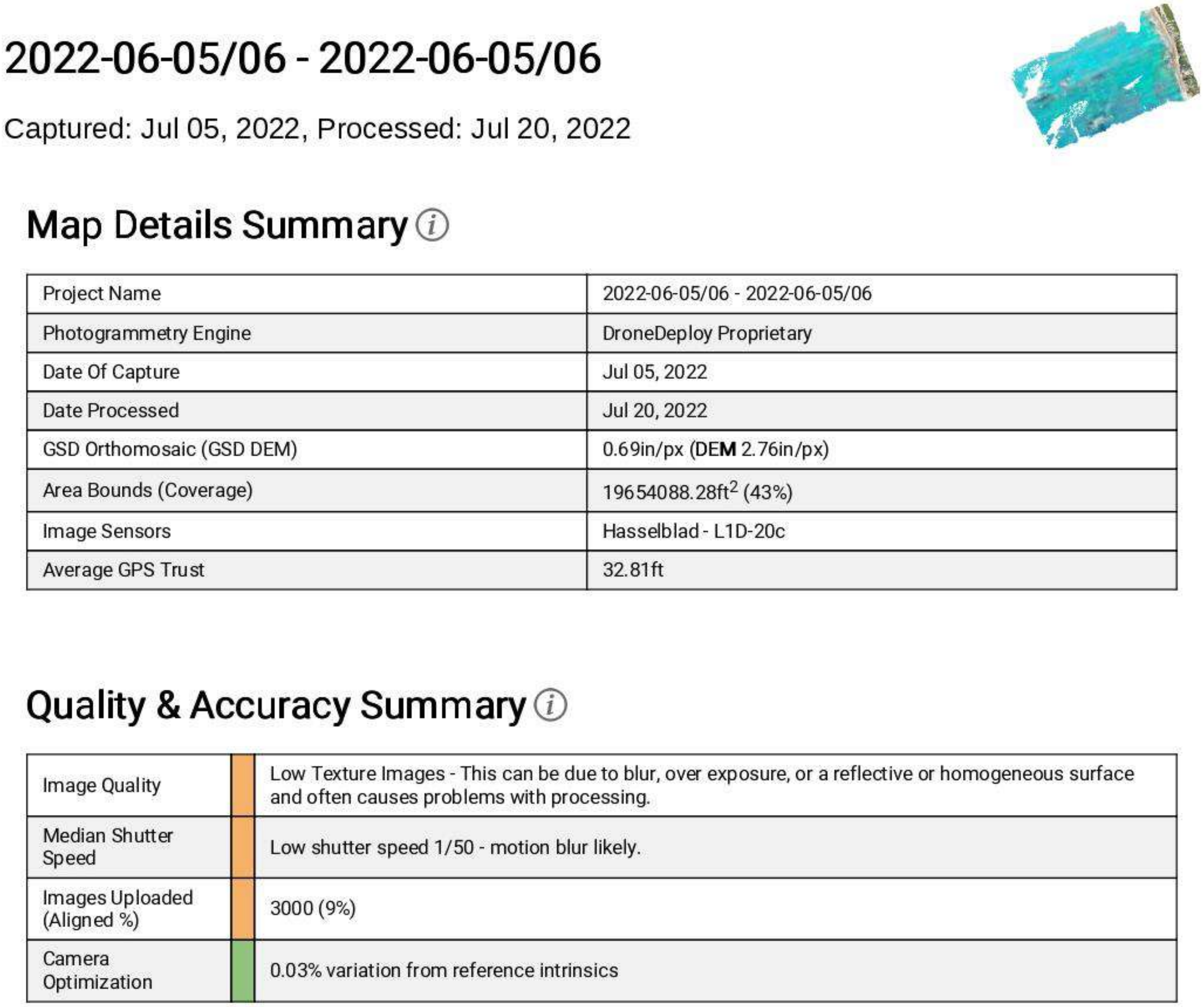
	Fx	Cx	Cy	k1	k2	k3	p1	p2
Value	4309.23	2732.38	1764.76	-0.0129492	0.0291842	-0.0317863	-0.00350232	0.00109411
Error	2.13073	0.100995	0.107889	0.443058	1.75613	2.17876	0.0208806	0.0261534



Densification and Meshing ⓘ

Processing Mode Quality	🟩	High
Nadir Images	🟧	100% Include oblique or horizontal images to improve reconstructions of man-made structures.
Oblique images	🟩	0%
Horizontal images	🟩	0%
Total Points		1.8 million
Point Cloud Density		0.31 points/ft^2
Mesh Triangles		2.6 million

1D.4. Carpenter Rocks 3.2(1) DroneDeploy Report



2022-06-05/06 - 2022-06-05/06

Captured: Jul 05, 2022, Processed: Jul 20, 2022

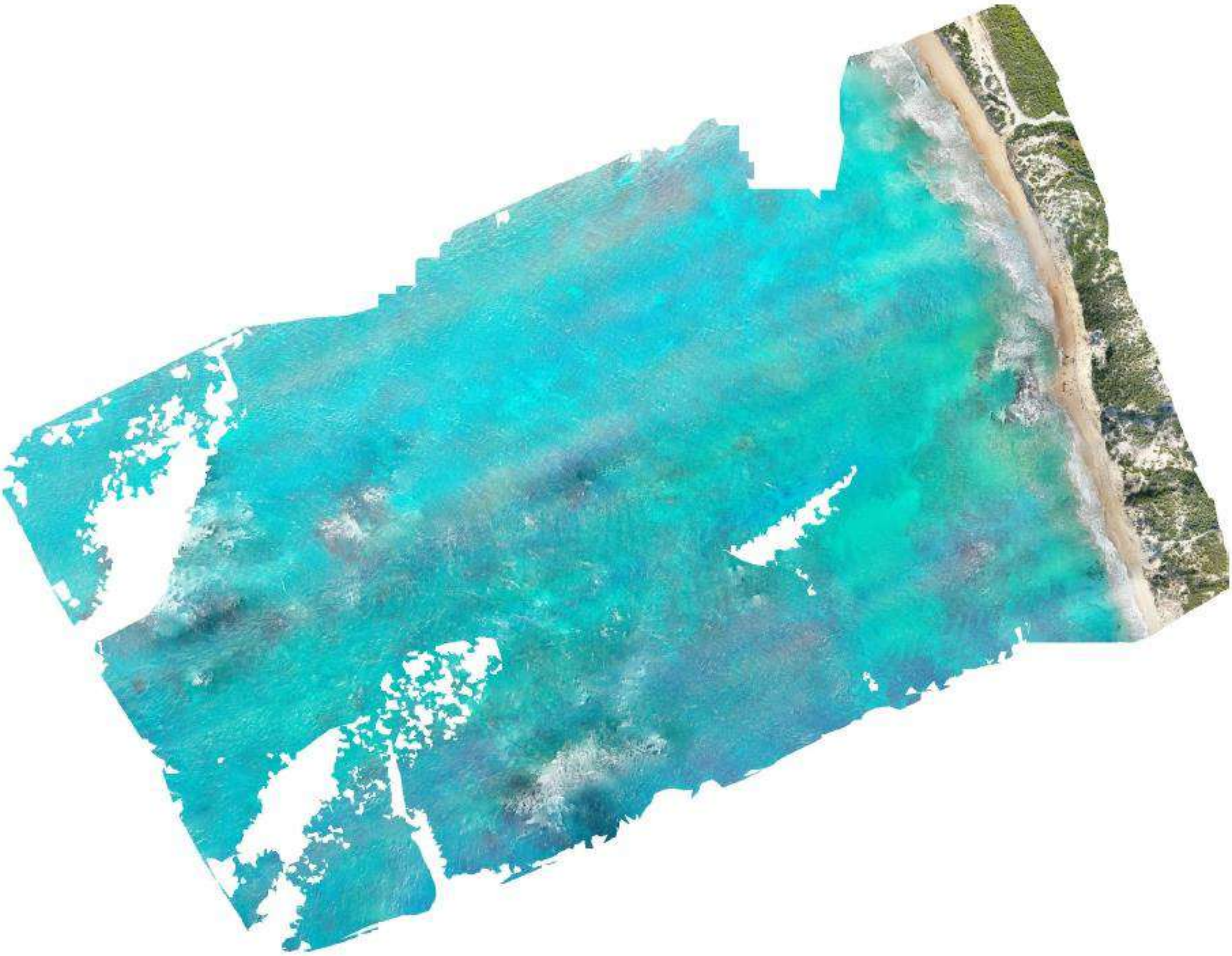
Map Details Summary ⓘ

Project Name	2022-06-05/06 - 2022-06-05/06
Photogrammetry Engine	DroneDeploy Proprietary
Date Of Capture	Jul 05, 2022
Date Processed	Jul 20, 2022
GSD Orthomosaic (GSD DEM)	0.69in/px (**DEM** 2.76in/px)
Area Bounds (Coverage)	19654088.28ft^2 (43%)
Image Sensors	Hasselblad - L1D-20c
Average GPS Trust	32.81ft

Quality & Accuracy Summary ⓘ

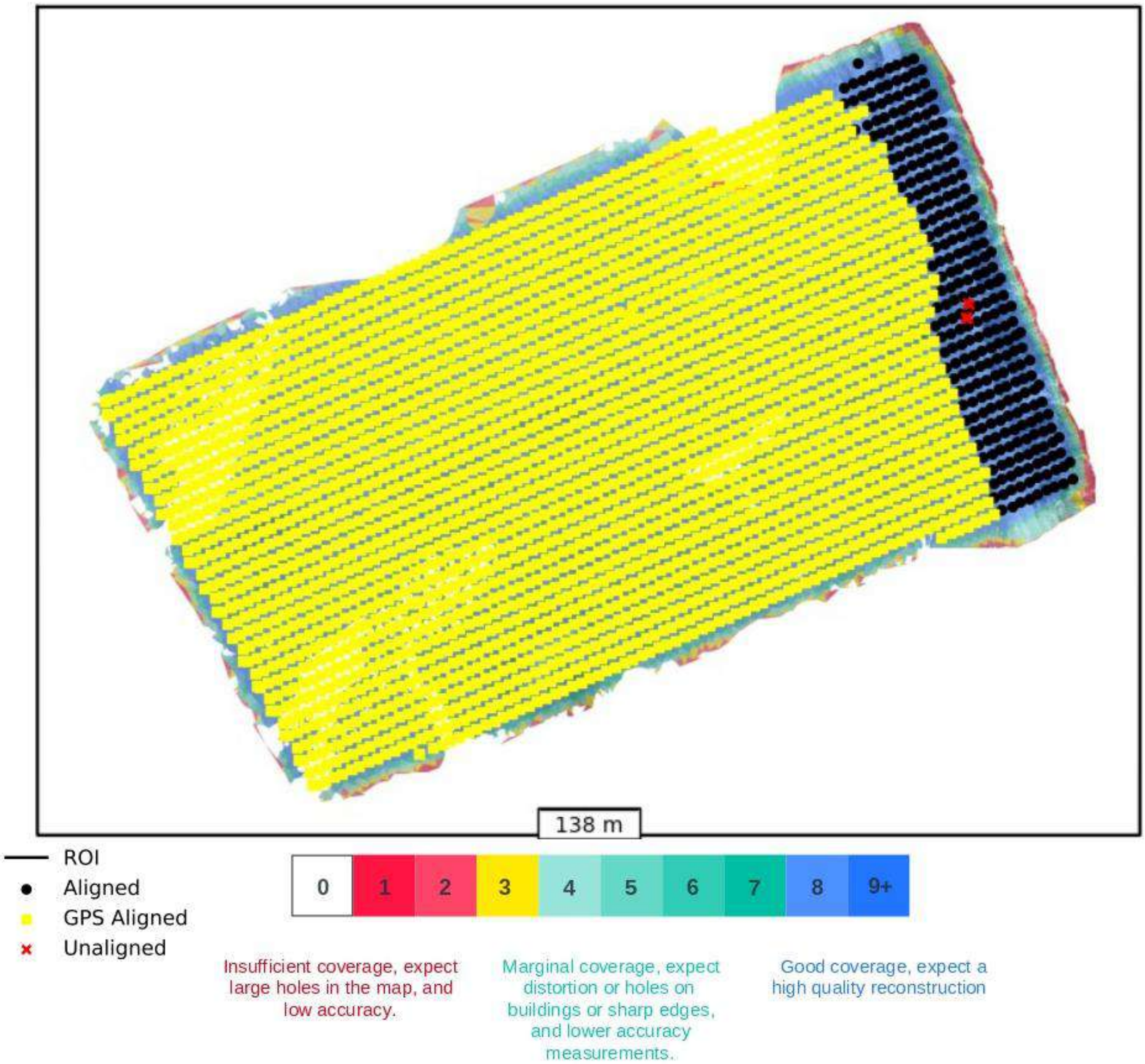
Image Quality	🟧	Low Texture Images - This can be due to blur, over exposure, or a reflective or homogeneous surface and often causes problems with processing.
Median Shutter Speed	🟧	Low shutter speed 1/50 - motion blur likely.
Images Uploaded (Aligned %)	🟧	3000 (9%)
Camera Optimization	🟩	0.03% variation from reference intrinsics

Preview ⓘ



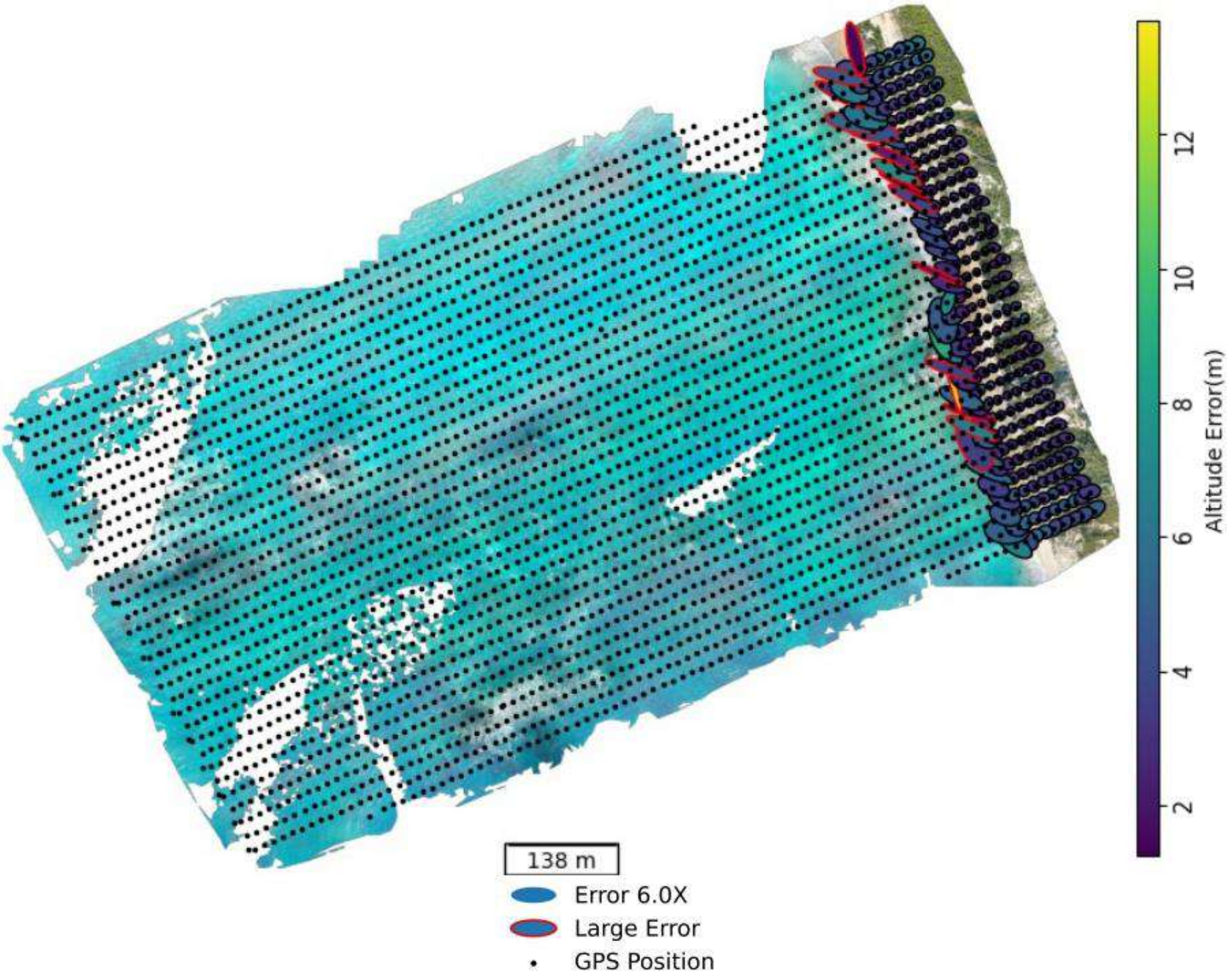
Dataset Quality Review

Orthomosaic Coverage ⓘ



Sensor(s) Used	🟩	Hasselblad - L1D-20c
Image Count (by sensor)	🟩	2999
Image Resolution	🟩	5472x3648 (~20MP)
Orthomosaic coverage (% of area of interest)	🟧	43.52
Average Orthomosaic Image Density within Structured Area	🟩	18 images/pixel
Median Shutter Speed	🟧	Low shutter speed 1/50 - motion blur likely.

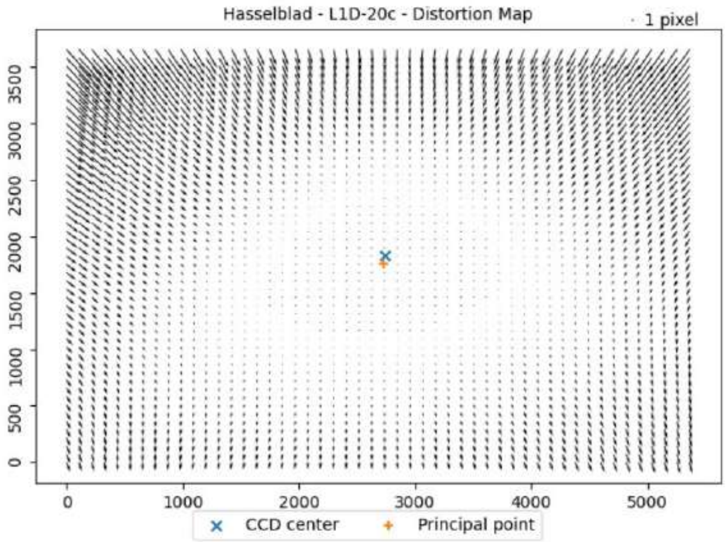
Structure from Motion



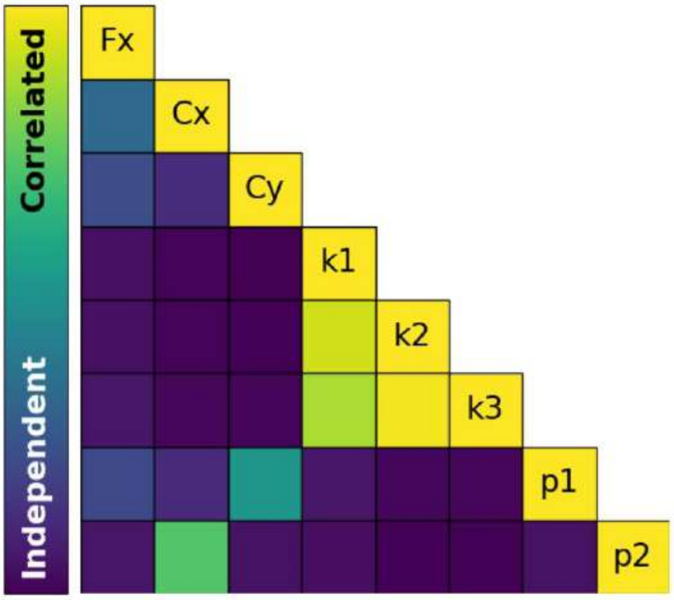
Aligned Cameras	🟧	9% 279/3000
RMSE of Camera GPS Location	🟩	**X** 7.97ft **Y** 8.76ft Z 6.74ft **RMSE** 7.87ft

Camera Calibration

Camera Optimization	🟩	0.03% variation from reference intrinsics



	Fx	Cx	Cy	k1	k2	k3	p1	p2
Value	4346.68	2725.51	1757	-0.0118285	0.0214237	-0.0249734	-0.00483277	0.000510003
Error	0.961353	0.113974	0.0827164	0.618708	2.43167	3.0239	0.0248052	0.0411218

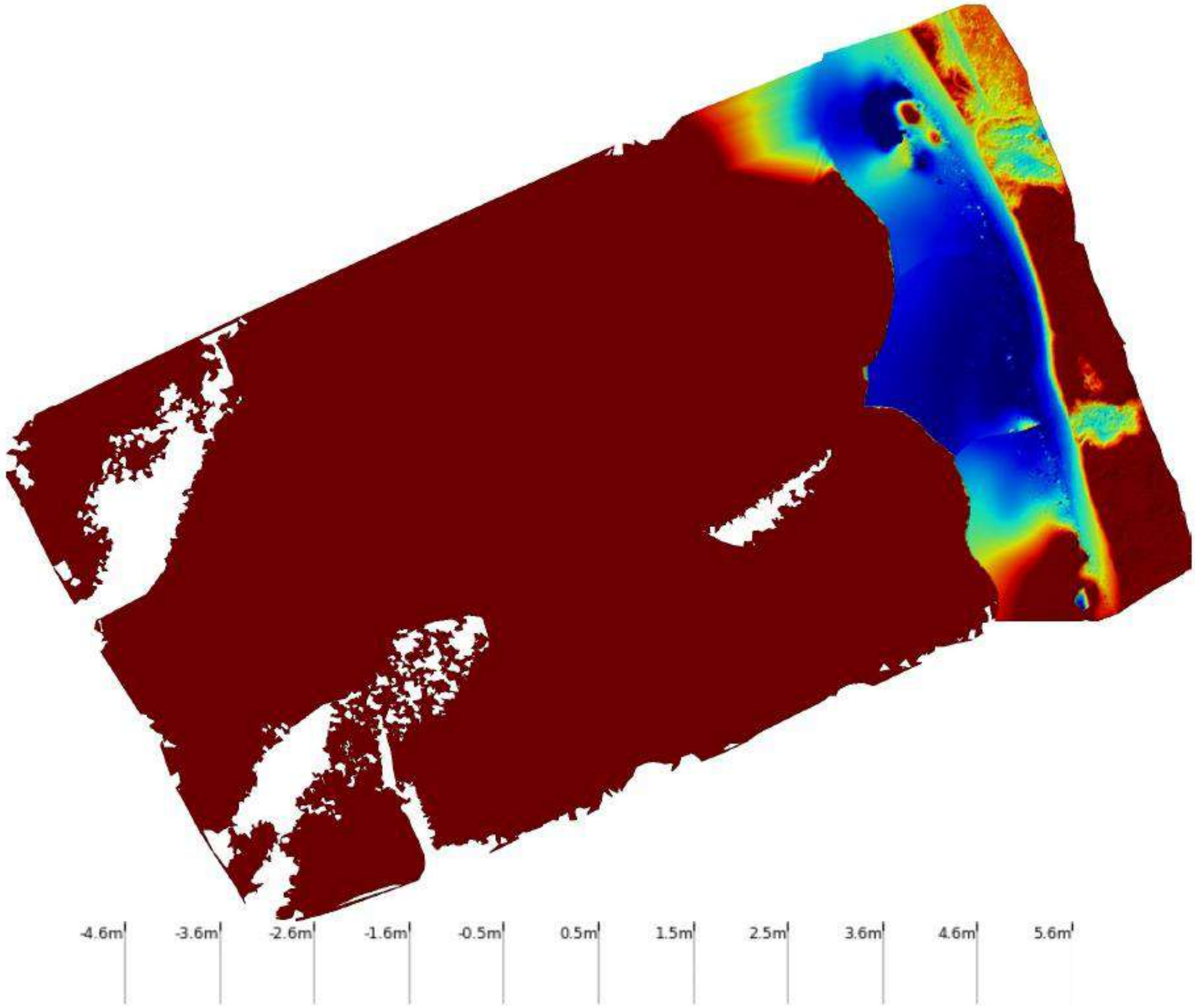


Densification and Meshing ⓘ

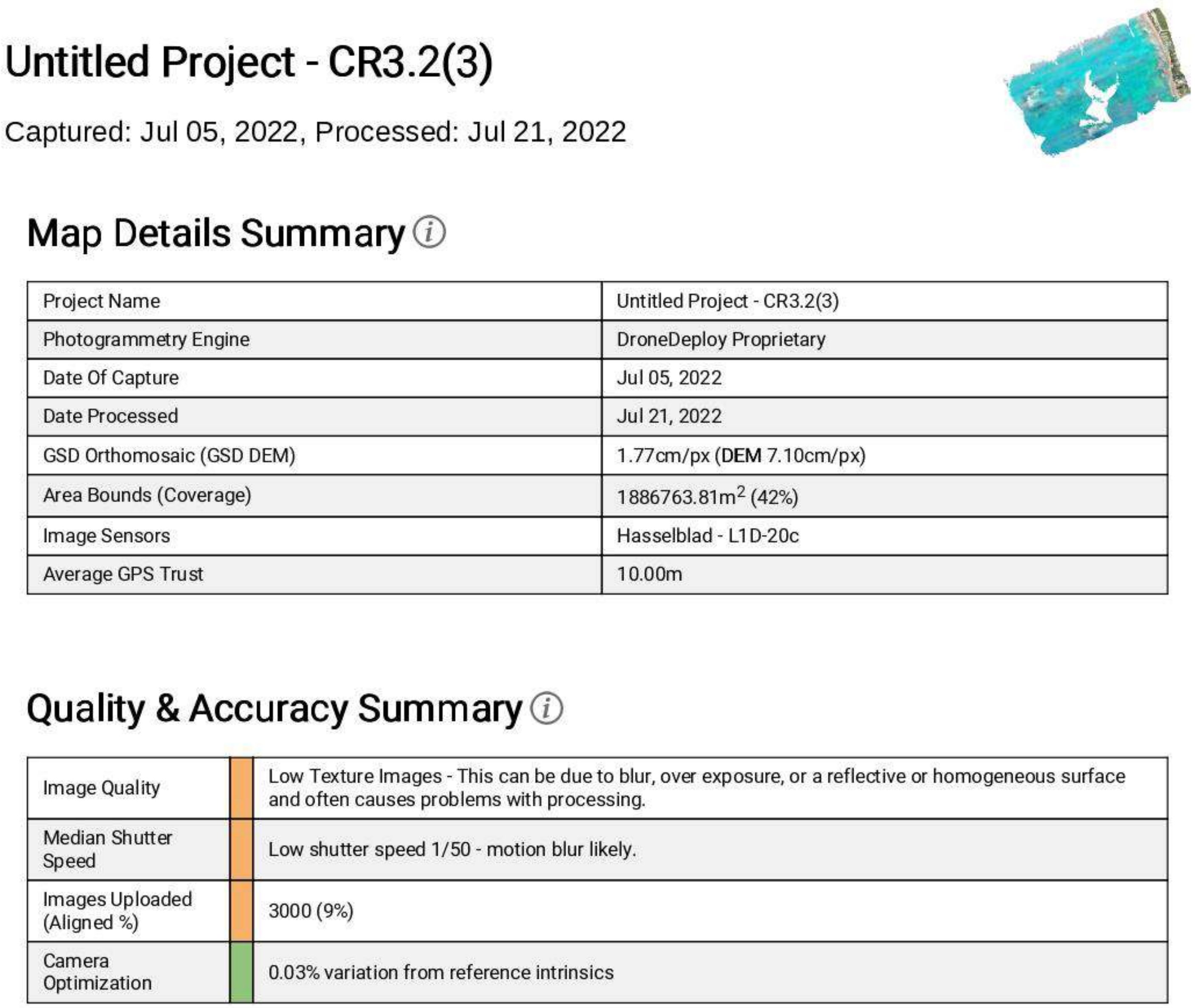
Processing Mode Quality	🟩	High
Nadir Images	🟧	100% Include oblique or horizontal images to improve reconstructions of man-made structures.
Oblique images	🟩	0%
Horizontal images	🟩	0%
Total Points		3.2 million
Point Cloud Density		0.38 points/ft^2
Mesh Triangles		2.6 million

Digital Elevation Model ⓘ

Mode	Generated from Mesh
DEM GSD	**DEM** 2.76in/px
Relative/Absolute	Relative Altitude vs Drone takeoff



1D.5. Carpenter Rocks 3.2(2) DroneDeploy Report



Untitled Project - CR3.2(3)

Captured: Jul 05, 2022, Processed: Jul 21, 2022

Map Details Summary ⓘ

Project Name	Untitled Project - CR3.2(3)
Photogrammetry Engine	DroneDeploy Proprietary
Date Of Capture	Jul 05, 2022
Date Processed	Jul 21, 2022
GSD Orthomosaic (GSD DEM)	1.77cm/px (**DEM** 7.10cm/px)
Area Bounds (Coverage)	1886763.81m^2 (42%)
Image Sensors	Hasselblad - L1D-20c
Average GPS Trust	10.00m

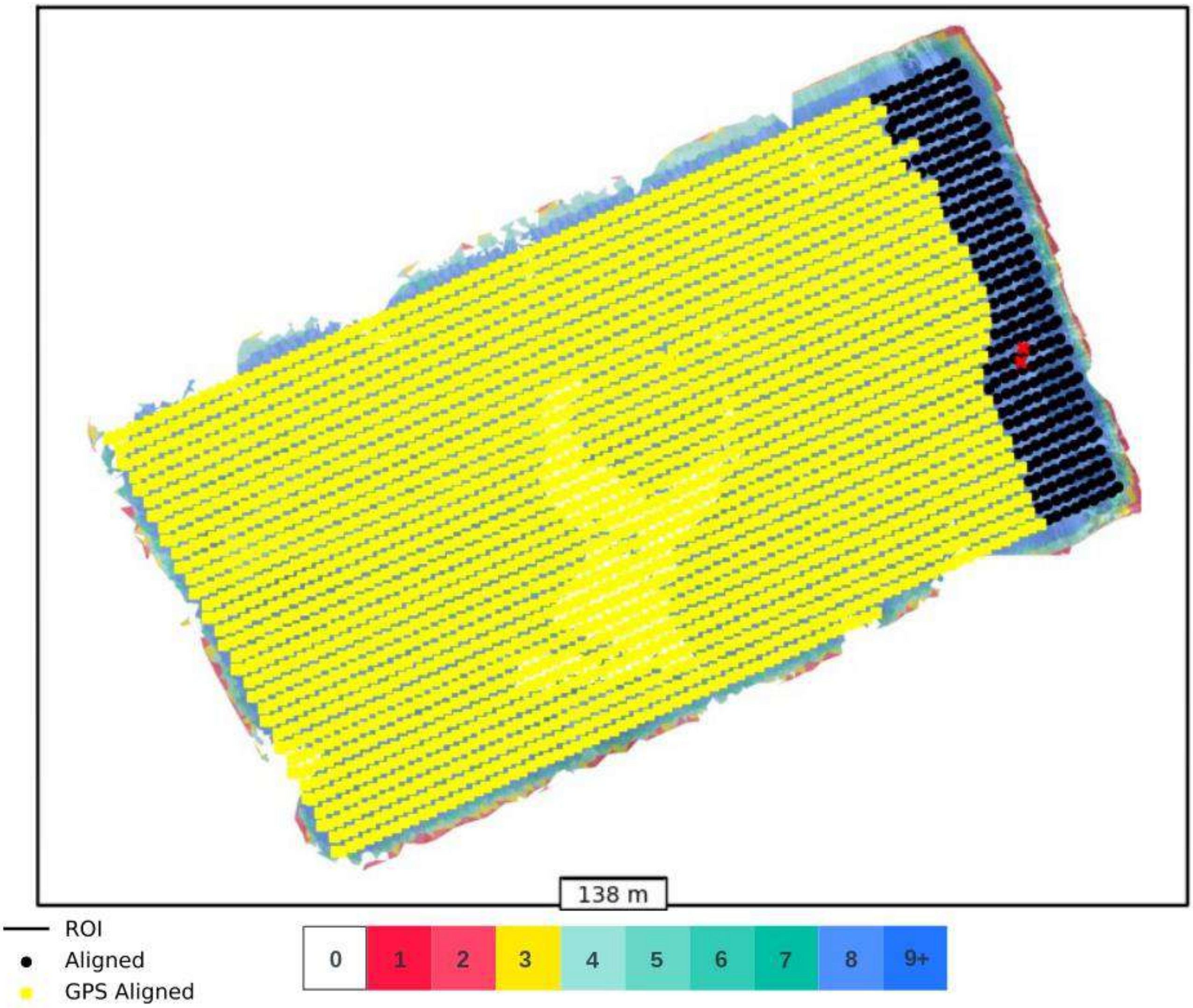
Quality & Accuracy Summary ⓘ

Image Quality	🟧	Low Texture Images - This can be due to blur, over exposure, or a reflective or homogeneous surface and often causes problems with processing.
Median Shutter Speed	🟧	Low shutter speed 1/50 - motion blur likely.
Images Uploaded (Aligned %)	🟧	3000 (9%)
Camera Optimization	🟩	0.03% variation from reference intrinsics

Preview ⓘ

Dataset Quality Review

Orthomosaic Coverage ⓘ



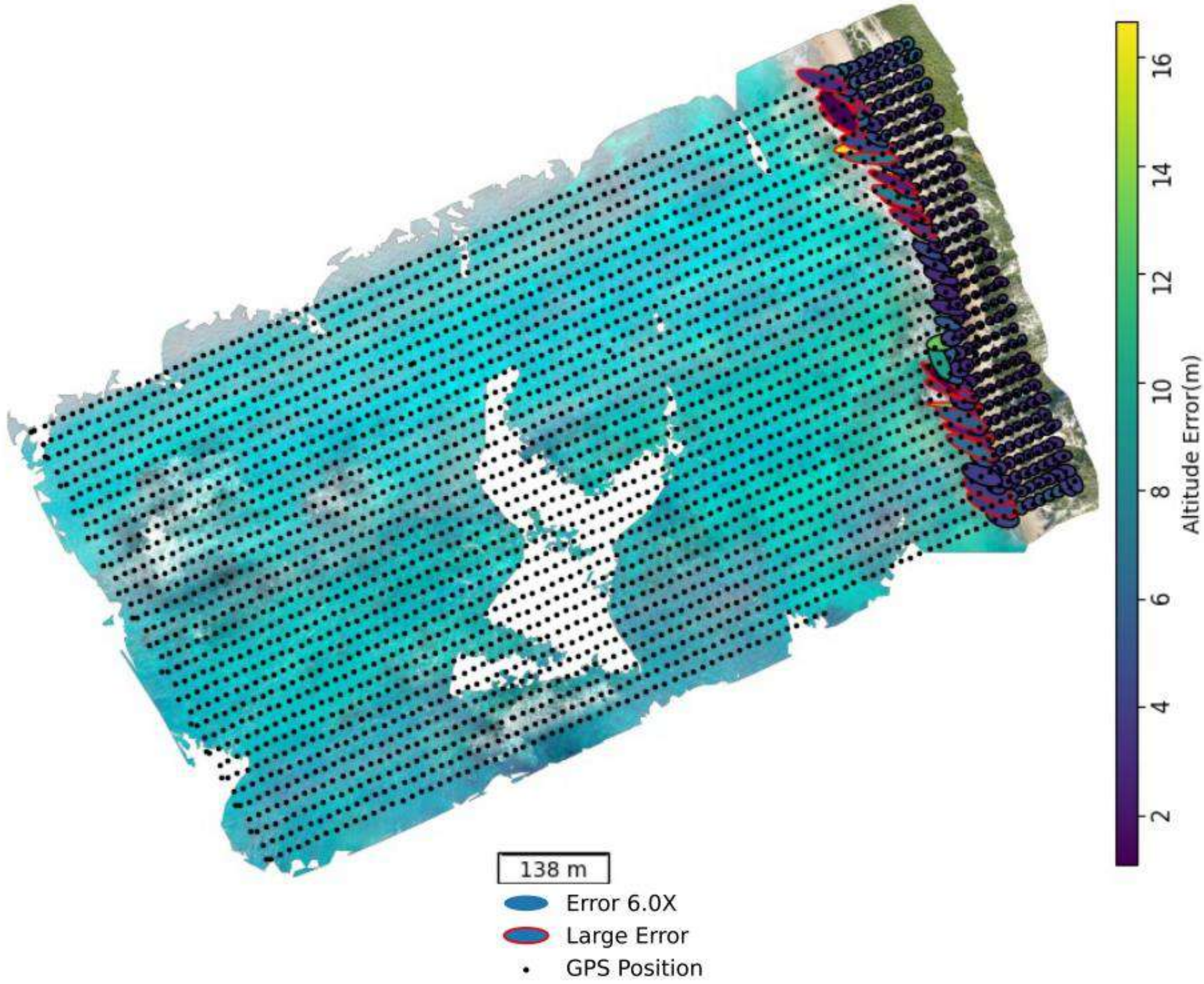
Insufficient coverage, expect large holes in the map, and low accuracy.

Marginal coverage, expect distortion or holes on buildings or sharp edges, and lower accuracy measurements.

Good coverage, expect a high quality reconstruction

Sensor(s) Used	🟩	Hasselblad - L1D-20c
Image Count (by sensor)	🟩	2999
Image Resolution	🟩	5472x3648 (~20MP)
Orthomosaic coverage (% of area of interest)	🟧	42.43
Average Orthomosaic Image Density within Structured Area	🟩	18 images/pixel
Median Shutter Speed	🟧	Low shutter speed 1/50 - motion blur likely.

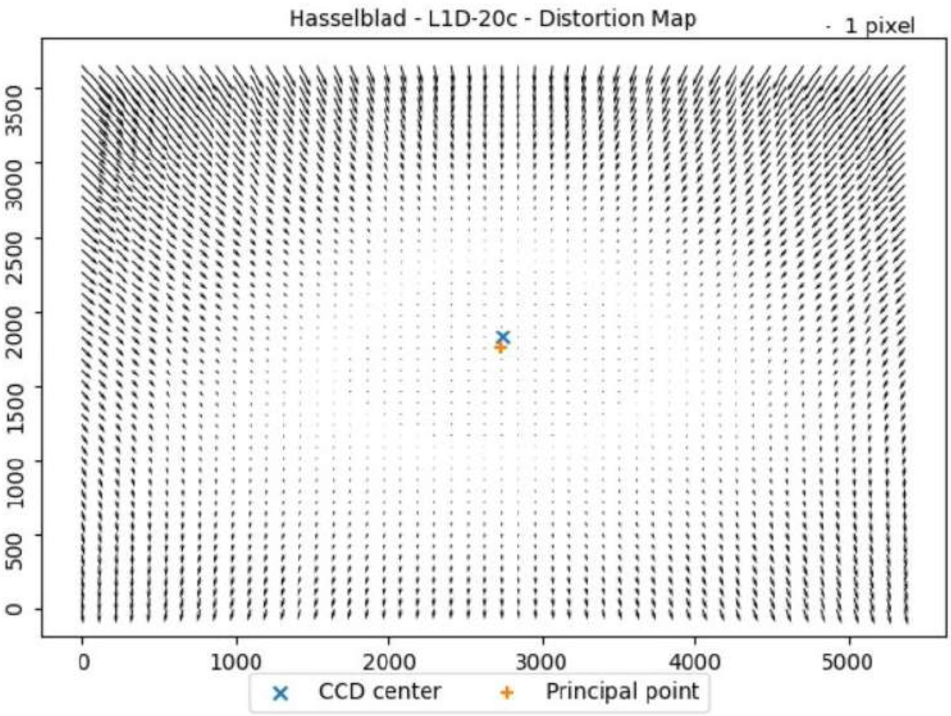
Structure from Motion ⓘ



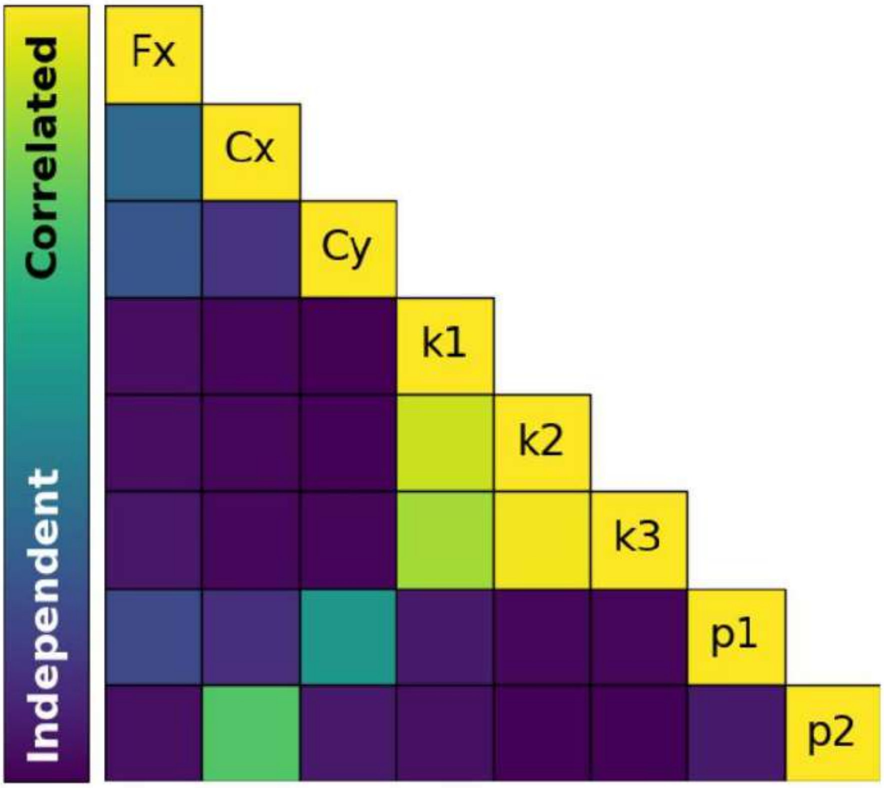
Aligned Cameras	🟧	9% 266/3000
RMSE of Camera GPS Location	🟩	**X** 1.60m **Y** 0.92m **Z** 1.90m **RMSE** 1.53m

Camera Calibration ⓘ

Camera Optimization	🟩	0.03% variation from reference intrinsics



	Fx	Cx	Cy	k1	k2	k3	p1	p2
Value	4349.68	2723.93	1756.47	-0.0111387	0.0214358	-0.0246931	-0.00485269	0.000238625
Error	0.987218	0.116619	0.086977	0.631427	2.47891	3.09564	0.0253022	0.0417732

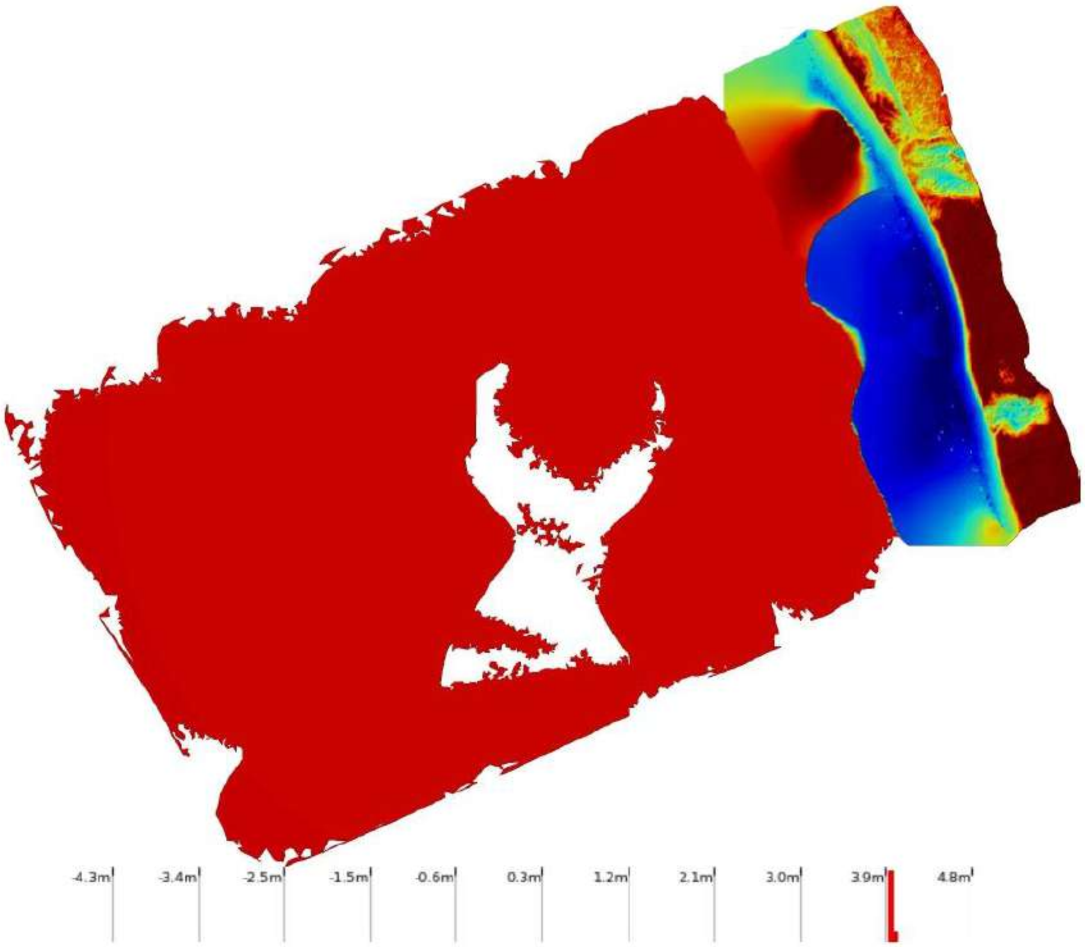


Densification and Meshing

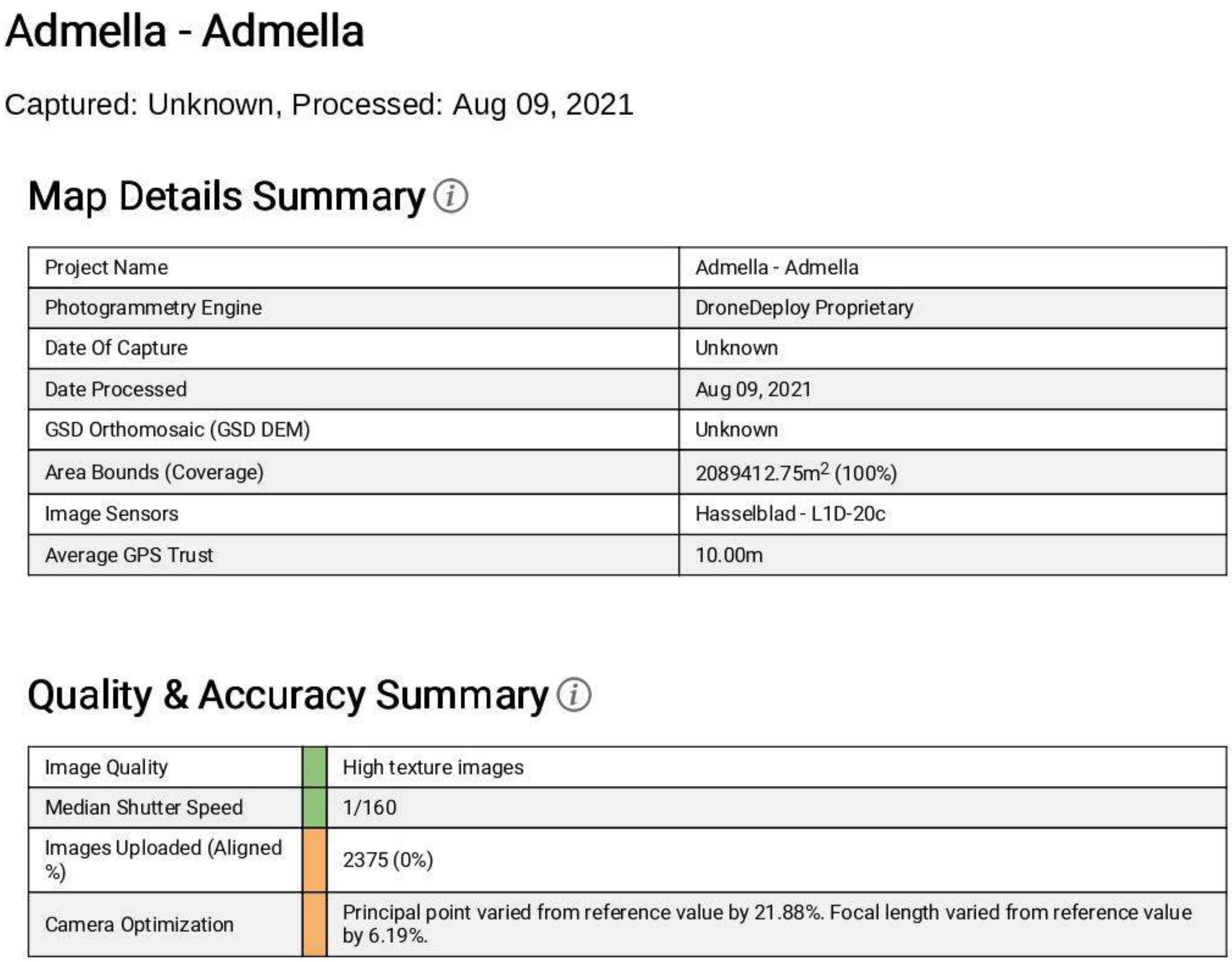
Processing Mode Quality	🟩	High
Nadir Images	🟧	100% Include oblique or horizontal images to improve reconstructions of man-made structures.
Oblique images	🟩	0%
Horizontal images	🟩	0%
Total Points		3.0 million
Point Cloud Density		3.76 points/m^2
Mesh Triangles		2.4 million

Digital Elevation Model

Mode	Generated from Mesh
DEM GSD	**DEM** 7.10cm/px
Relative/Absolute	Relative Altitude vs Drone takeoff



1D.6. Admella DroneDeploy Report



Admella - Admella

Captured: Unknown, Processed: Aug 09, 2021

Map Details Summary ⓘ

Project Name	Admella - Admella
Photogrammetry Engine	DroneDeploy Proprietary
Date Of Capture	Unknown
Date Processed	Aug 09, 2021
GSD Orthomosaic (GSD DEM)	Unknown
Area Bounds (Coverage)	2089412.75m^2 (100%)
Image Sensors	Hasselblad - L1D-20c
Average GPS Trust	10.00m

Quality & Accuracy Summary ⓘ

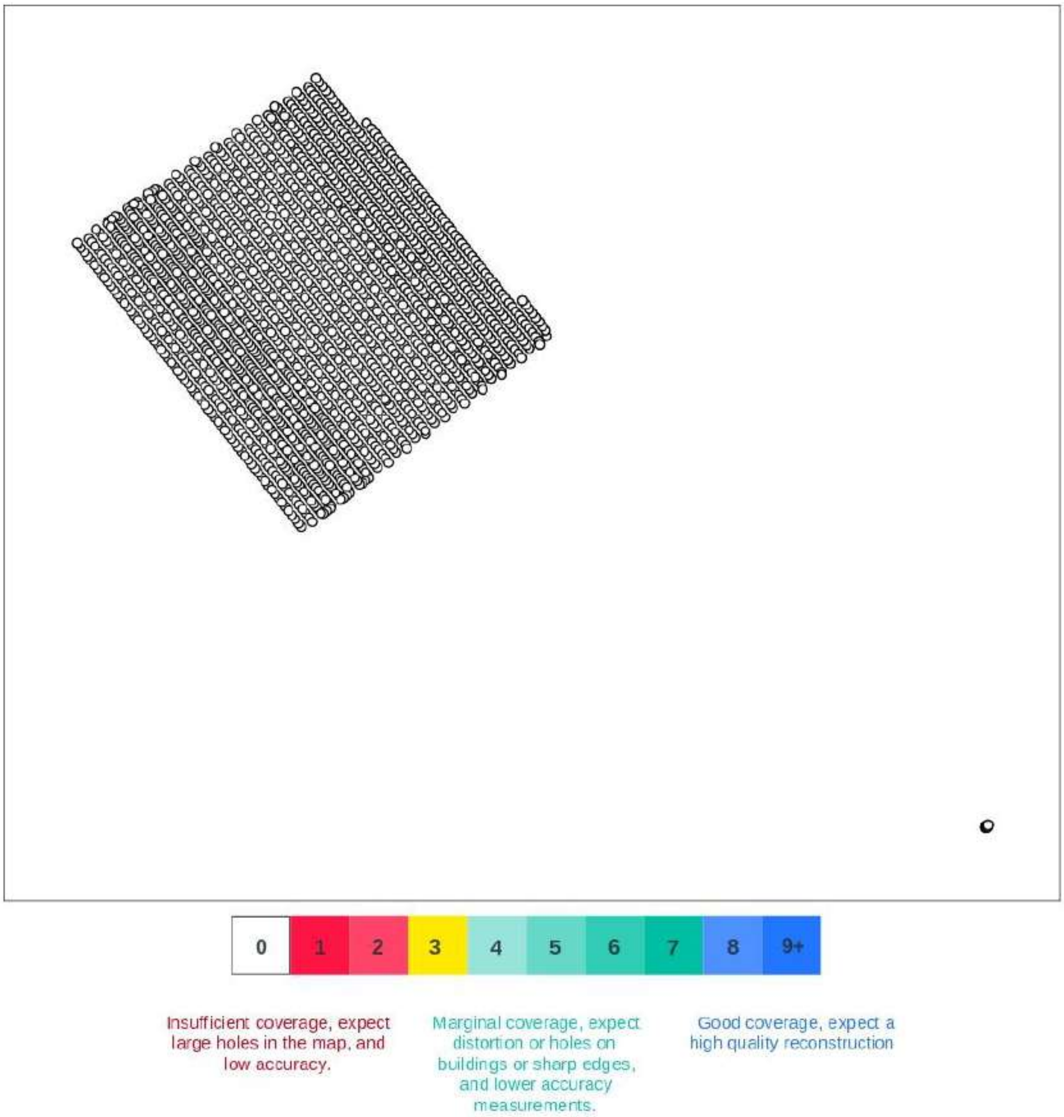
Image Quality	🟩	High texture images
Median Shutter Speed	🟩	1/160
Images Uploaded (Aligned %)	🟧	2375 (0%)
Camera Optimization	🟧	Principal point varied from reference value by 21.88%. Focal length varied from reference value by 6.19%.

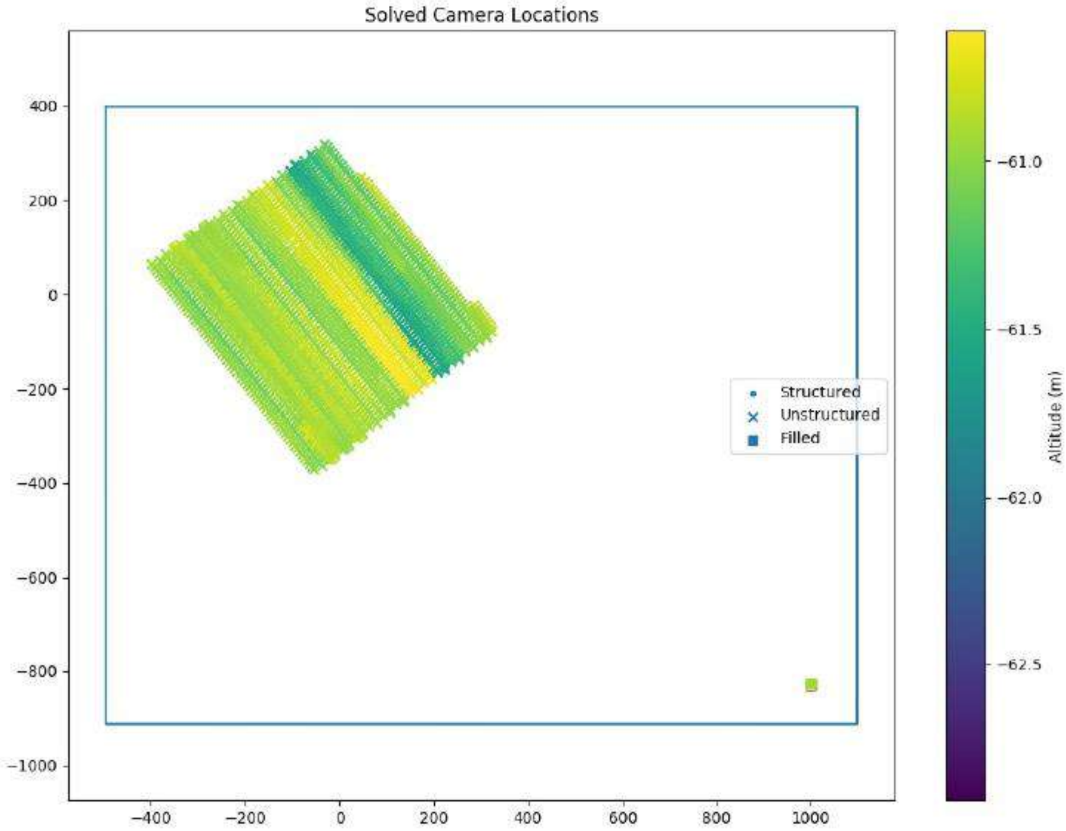
Dataset Quality Review

Orthomosaic Coverage ⓘ

Sensor(s) Used	🟩	Hasselblad - L1D-20c
Image Count (by sensor)	🟩	2370
Image Resolution	🟩	5472x3648 (~20MP)
Orthomosaic coverage (% of area of interest)	🟩	100.00
Average Orthomosaic Image Density within Structured Area	🟥	0 images/pixel
Median Shutter Speed	🟩	1/160

Pairs Connectivity ⓘ



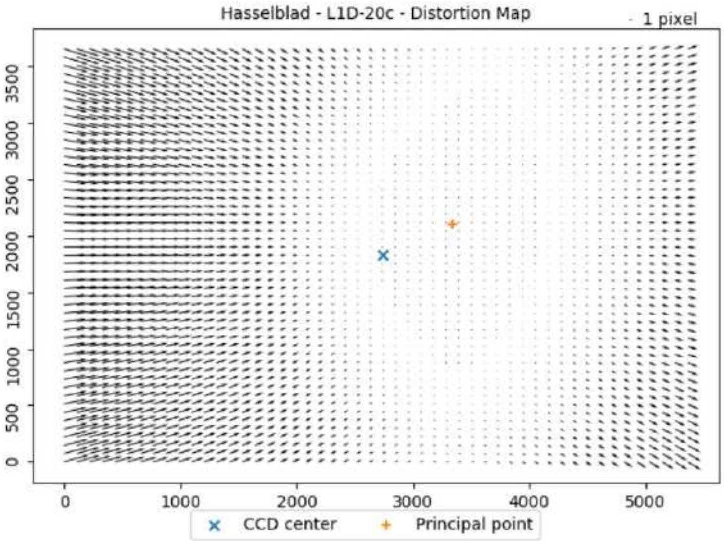


Structure from Motion

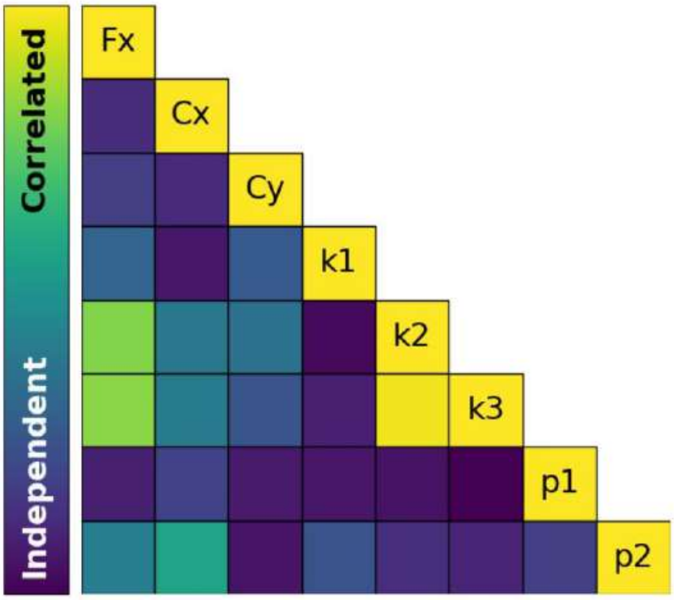
Aligned Cameras	🟧	0% 10/2375
RMSE of Camera GPS Location	🟩	**X** 0.25m **Y** 0.48m **Z** 0.55m **RM**SE 0.44m

Camera Calibration

Camera Optimization	🟧	Principal point varied from reference value by 21.88%. Focal length varied from reference value by 6.19%.



	Fx	Cx	Cy	k1	k2	k3	p1	p2
Value	4106.62	3339.87	2098.32	-0.0908053	0.296437	-0.204618	-0.00443773	0.0421564
Error	290.981	51.3615	37.4166	130.958	616.685	622.977	11.4978	31.9374



Densification and Meshing ⓘ

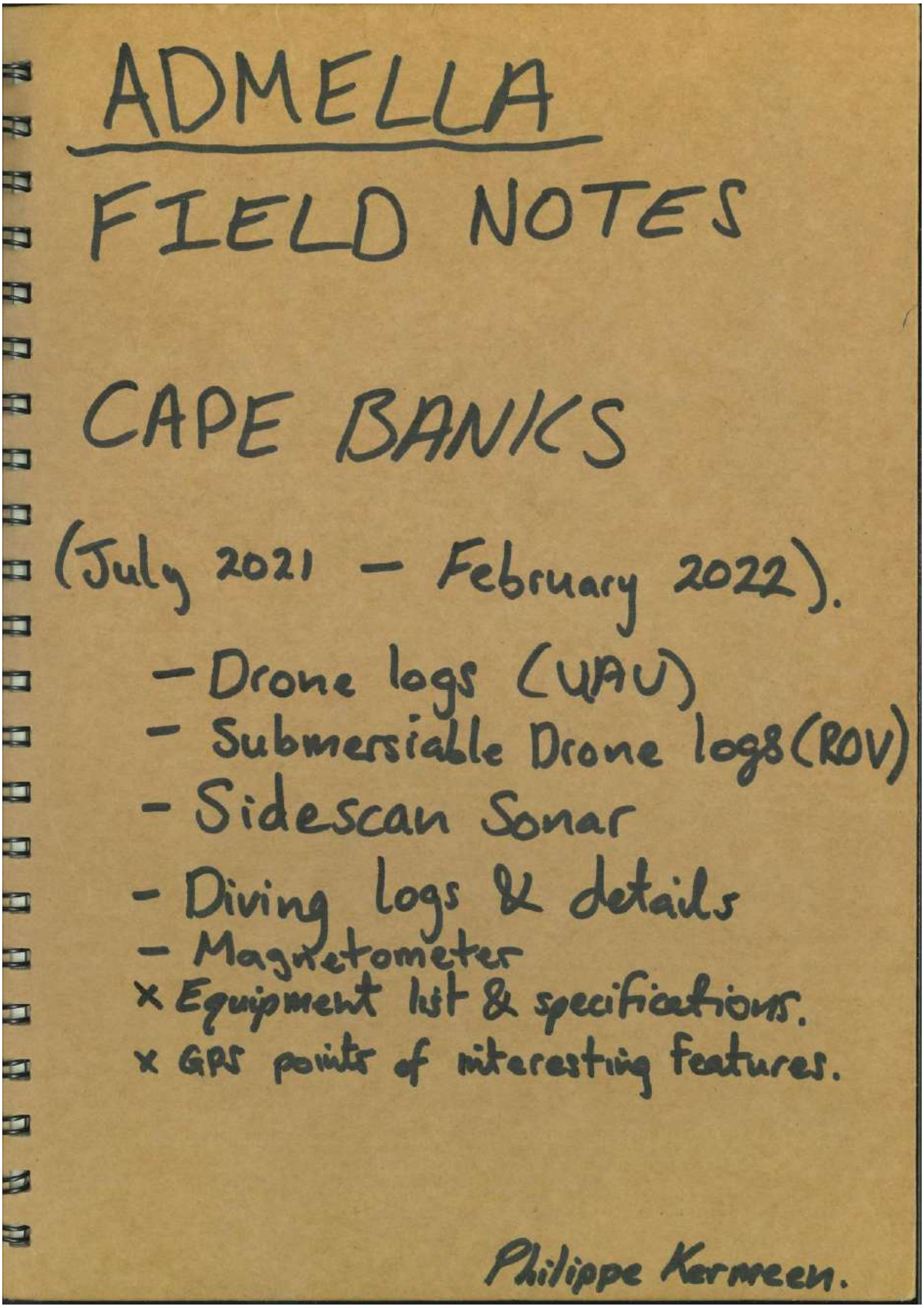
Processing Mode Quality	🟩	High
Nadir Images	🟧	99% Include oblique or horizontal images to improve reconstructions of man-made structures.
Oblique images	🟩	0%
Horizontal images	🟩	1%

Digital Elevation Model ⓘ

Mode	Generated from Mesh
DEM GSD	Unknown
Relative/Absolute	Absolute Altitude

Appendix 1E – Fieldnote Book

1E.1. Admella Wreck Project Field notes



ADMELLA

FIELD NOTES

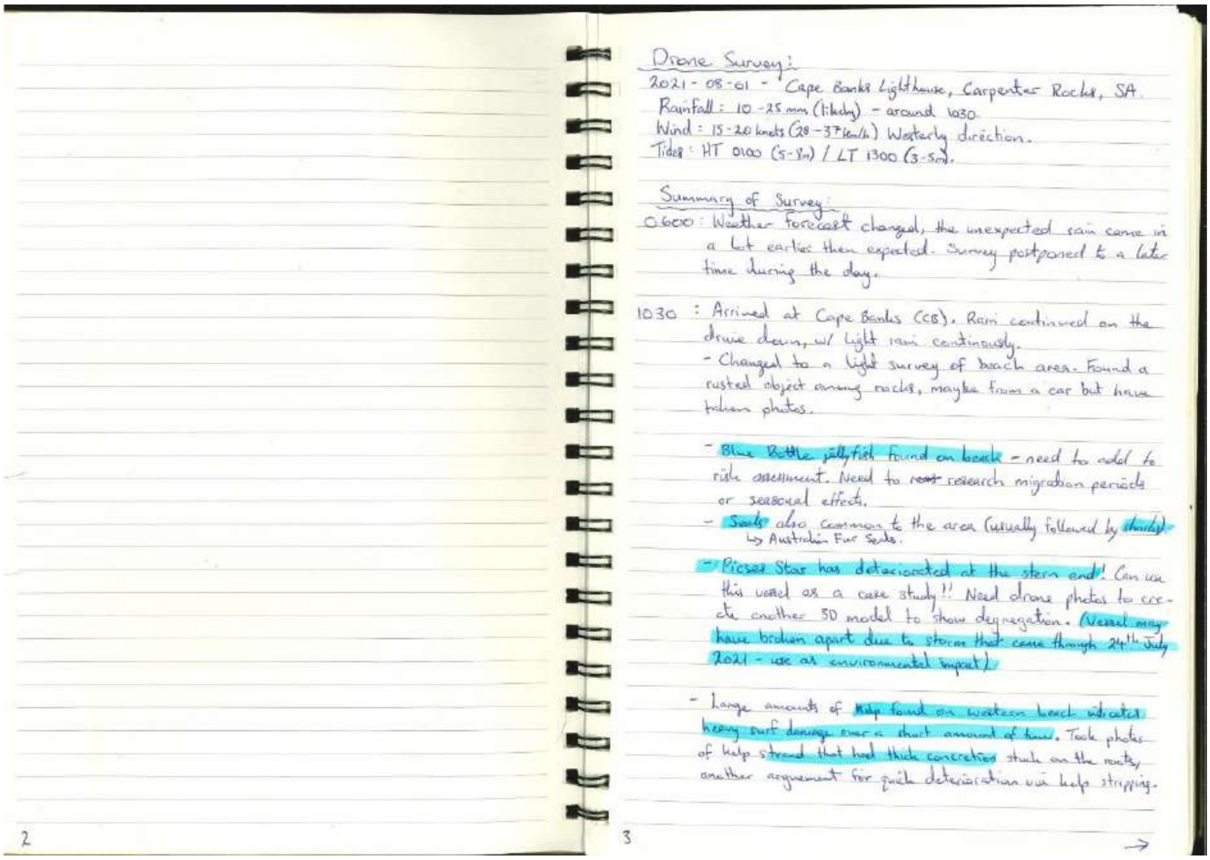
CAPE BANKS

(July 2021 – February 2022).

- Drone logs (UAV)
- Submersiable Drone logs (ROV)
- Sidescan Sonar
- Diving logs & details
- Magnetometer

× Equipment list & specifications.
× GPS points of interesting features.

Philippe Kermeen.



2

Drone Survey:
2021-08-01 - Cape Banks Lighthouse, Carpenter Rocks, SA.
Rainfall: 10-25 mm (likely) - around 1030.
Wind: 15-20 knots (28-37 km/h) Westerly direction.
Tides: HT 0100 (5-8m) / LT 1300 (3-5m).

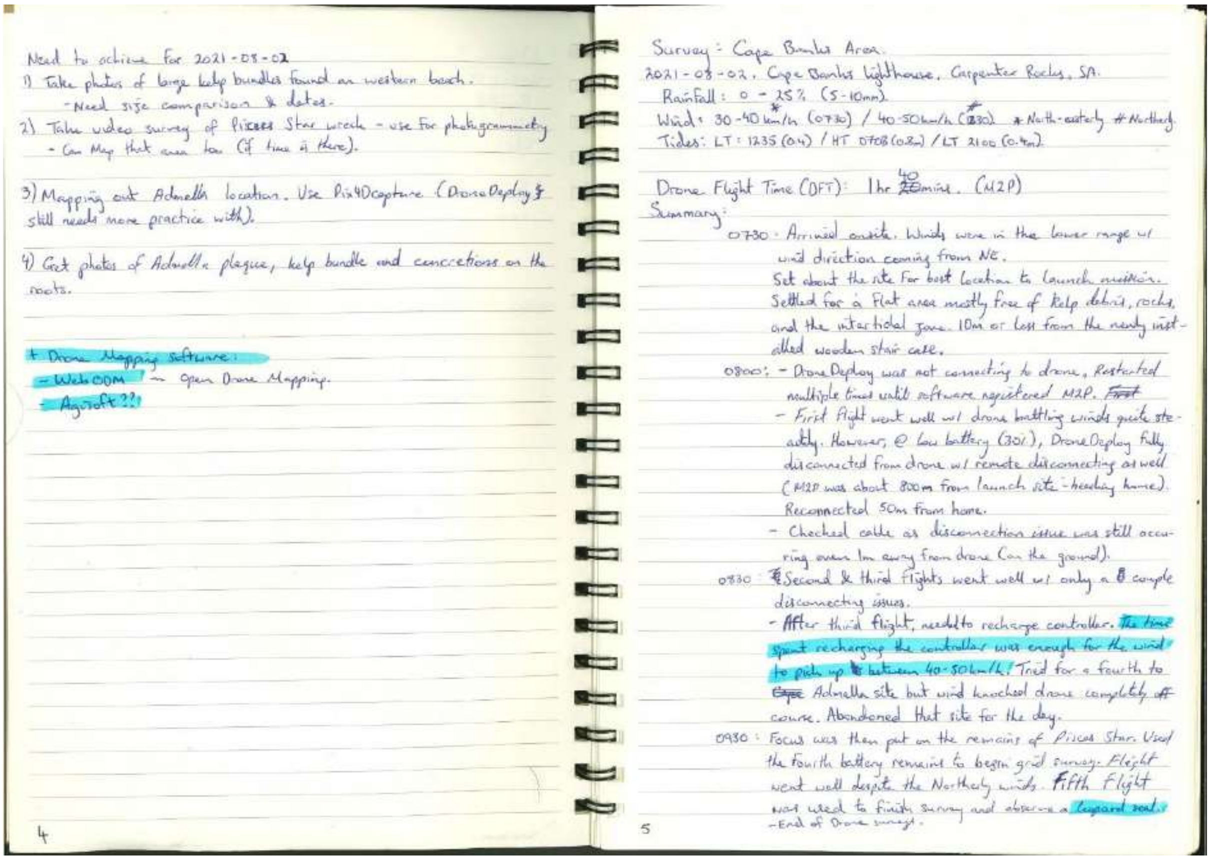
Summary of Survey:
0600: Weather forecast changed, the unexpected rain came in a lot earlier than expected. Survey postponed to a later time during the day.

1030: Arrived at Cape Banks (CB). Rain continued on the drive down, w/ light rain continuously.
- Changed to a light survey of beach area. Found a rusted object among rocks, maybe from a car but have taken photos.

- Blue Bottle jellyfish found on beach - need to add to risk assessment. Need to ~~rest~~ research migration periods or seasonal effects.
- Seals also common to the area (usually followed by sharks).
  ↳ Australian Fur Seals.
- Picses Star has deteriorated at the stern end! Can use this vessel as a case study!! Need drone photos to create another 3D model to show degregation. (Vessel may have broken apart due to storm that came through 24th July 2021 - use as environmental impact).

- Large amounts of kelp found on western beach indicates heavy surf damage over a short amount of time. Took photos of kelp strand that had thick concretion stuck on the rocks, another arguement for quick deterioration via kelp stripping.

3 →



Need to achieve for 2021-08-02
1) Take photos of large kelp bundles found on western beach.
   - Need size comparison & dates.
2) Take video survey of Piscès Star wreck - use for photogrammetry
   - Can Map that area too (if time is there).

3) Mapping out Admella location. Use Pix4Dcapture (DroneDeploy & still needs more practice with).

4) Get photos of Admella plaque, kelp bundle and concretions on the roots.

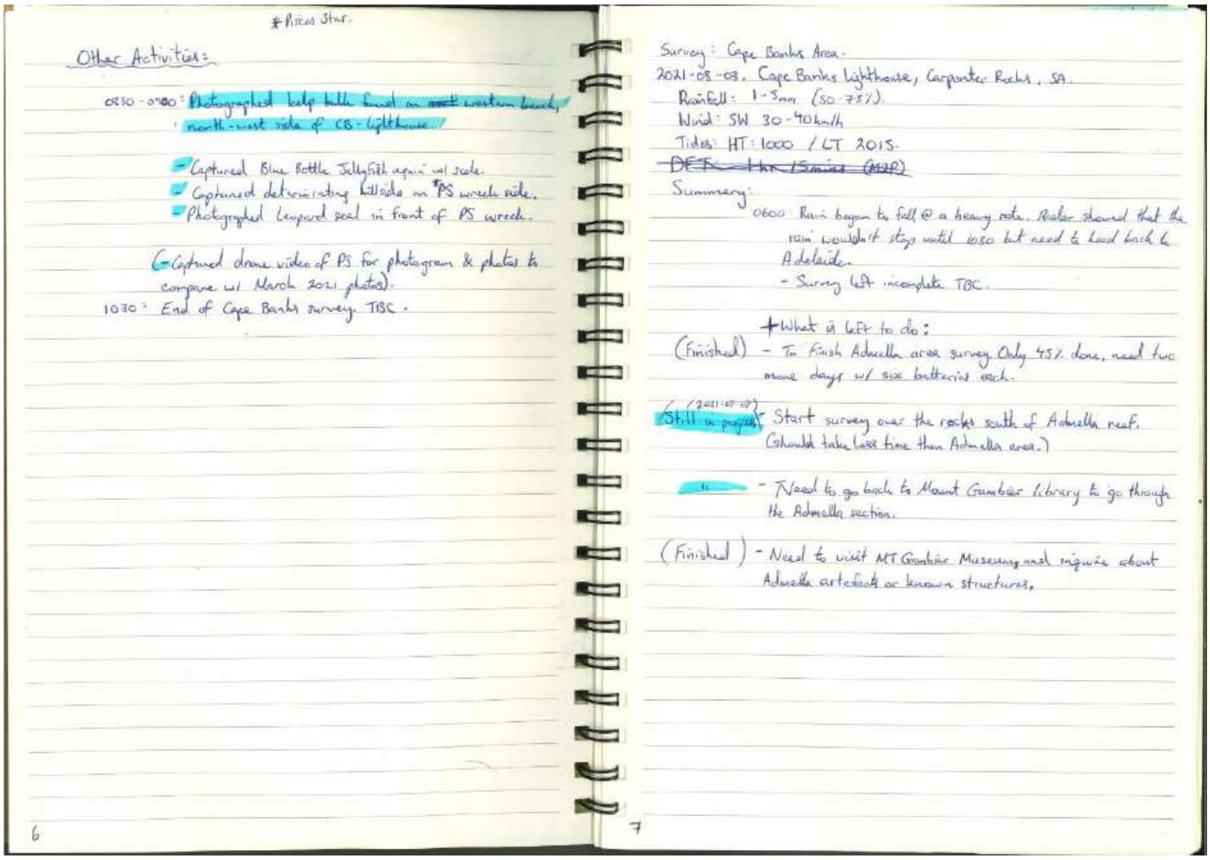
+ Drone Mapping Software:
- WebODM ? ~ Open Drone Mapping.
- Agisoft ??

4

Survey: Cape Banks Area.
2021-08-02. Cape Banks lighthouse, Carpenter Rocks, SA.
Rainfall: 0 - 25% (5-10mm).
Wind: 30-40 km/h* (0730) / 40-50 km/h# (0830) *North-easterly #Northerly.
Tides: LT: 1235 (0.4) / HT 0708 (0.8m) / LT 2100 (0.4m).

Drone Flight Time (DFT): 1hr 40mins. (M2P)
Summary:
0730: Arrived onsite. Winds were in the lower range w/ wind direction coming from NE.
Set about the site for best location to launch mission. Settled for a flat area mostly free of kelp debris, rocks, and the intertidal zone. 10m or less from the newly installed wooden stair case.
0800: - DroneDeploy was not connecting to drone. Restarted multiple times until software registered M2P. ~~First~~
- First flight went well w/ drone battling winds quite steadily. However, @ low battery (30%), DroneDeploy fully disconnected from drone w/ remote disconnecting as well (M2P was about 800m from launch site - heading home). Reconnected 50m from home.
- Checked cable as disconnection issue was still occuring even 1m away from drone (on the ground).
0830: Second & third flights went well w/ only a couple disconnecting issues.
- After third flight, needed to recharge controller. The time spent recharging the controller was enough for the wind to pick up between 40-50km/h! Tried for a fourth to ~~Cape~~ Admella site but wind knocked drone completely off course. Abandoned that site for the day.
0930: Focus was then put on the remains of Piscas Star. Used the fourth battery remaining to begin grid survey. Flight went well despite the Northerly winds. Fifth Flight was used to finish survey and observe a leopard seal.
- End of Drone survey.

5



*Pisces Star.

Other Activities:

0830 - 0900: Photographed kelp bulb found on western beach, north-west side of CB-lighthouse.

- Captured Blue Bottle Jellyfish again w/ scale.
- Captured deteriorating hillside on *PS wreck side.
- Photographed Leopard seal in front of PS wreck.

(Captured drone video of PS for photogram & photos to compare w/ March 2021 photos).

1030: End of Cape Banks survey. TBC.

6

Survey: Cape Banks Area.
2021-08-03. Cape Banks Lighthouse, Carpenter Rocks, SA.
Rainfall: 1-5mm (50-75%).
Wind: SW 30-40km/h
Tides: HT: 1000 / LT 2015.
~~DFT 1hr 15mins (M2P)~~
Summary:

0600: Rain began to fall @ a heavy rate. Radar showed that the rain wouldn't stop until 1050 but need to head back to Adelaide.
- Survey left incomplete TBC.

+What is left to do:

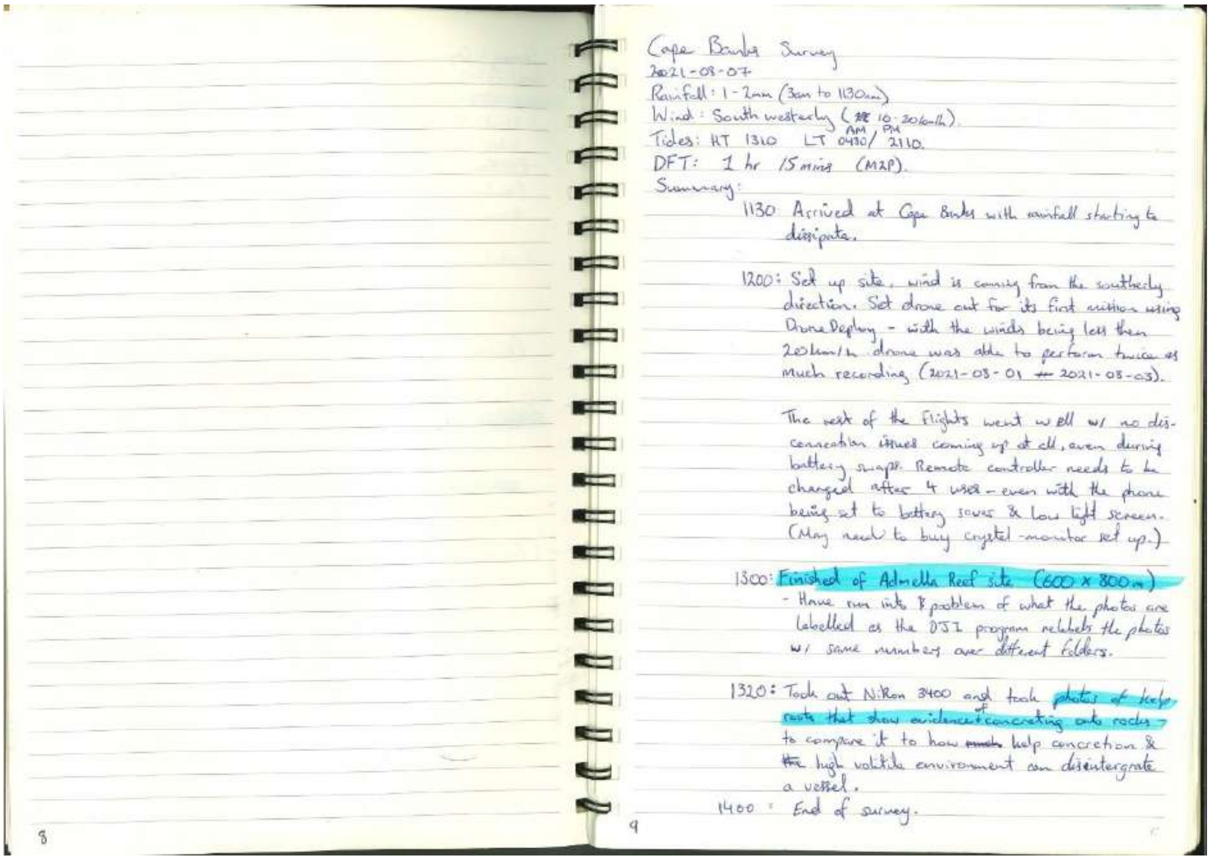
(Finished) - To finish Admella area survey. Only 45% done, need two more days w/ six batteries each.

(2021-07-07) Still in progress - Start survey over the rocks south of Admella reef. (Should take less time than Admella area.)

" - Need to go back to Mount Gambier library to go through the Admella section.

(Finished) - Need to visit MT Gambier Museum and inquire about Admella artefacts or known structures.

7



8

Cape Banks Survey
2021-08-07
Rainfall: 1-2mm (3am to 1130am)
Wind: South westerly (10-20km/h).
Tides: HT 1310 LT 0430 AM / 2110 PM.
DFT: 1 hr 15 mins (M2P).
Summary:

1130: Arrived at Cape Banks with rainfall starting to dissipate.

1200: Set up site, wind is coming from the southerly direction. Set drone out for its first mission using DroneDeploy - with the winds being less than 20km/h drone was able to perform twice as much recording (2021-08-01 + 2021-08-03).

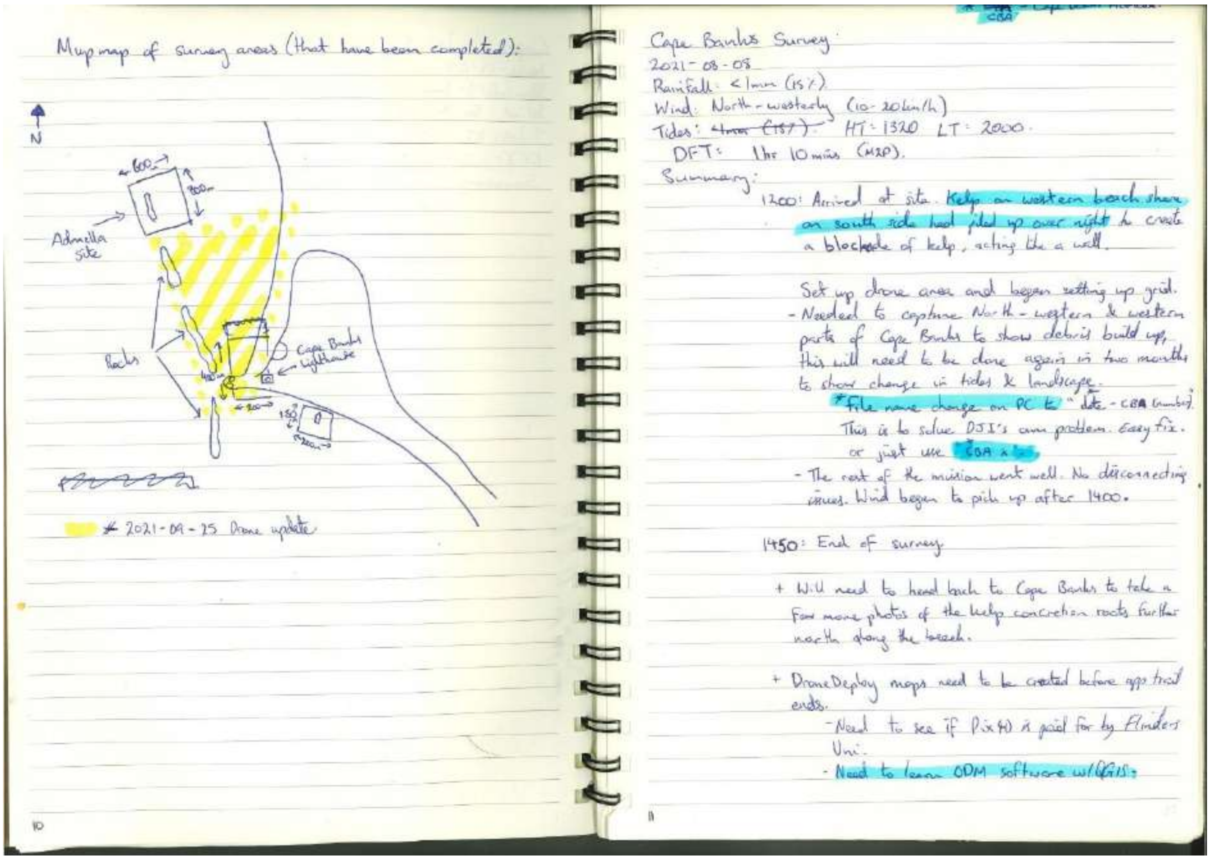
The rest of the flights went well w/ no disconnection issues coming up at all, even during battery swaps. Remote controller needs to be changed after 4 uses - even with the phone being set to battery saver & low light screen. (May need to buy crystal-monitor set up.)

1300: Finished of Admella Reef site (600 x 800m)
- Have run into problem of what the photos are labelled as the DJI program relabels the photos w/ same numbers over different folders.

1320: Took out Nikon 3400 and took photos of kelp roots that show evidence of concreting onto rocks - to compare it to how ~~much~~ kelp concretion & ~~the~~ high volatile environment can disintergrate a vessel.

1400: End of survey.

9



Mup map of survey areas (that have been completed):

★ 2021-09-25 Drone update

10

Cape Banks Survey
2021-08-08
Rainfall: <1mm (15%).
Wind: North-westerly (10-20km/h)
Tides: ~~4mm (15%)~~. HT: 1320 LT: 2000.
DFT: 1hr 10mins (M2P).
Summary:

1200: Arrived at site. Kelp on western beach shore on south side had piled up over night to create a blockade of kelp, acting like a wall.

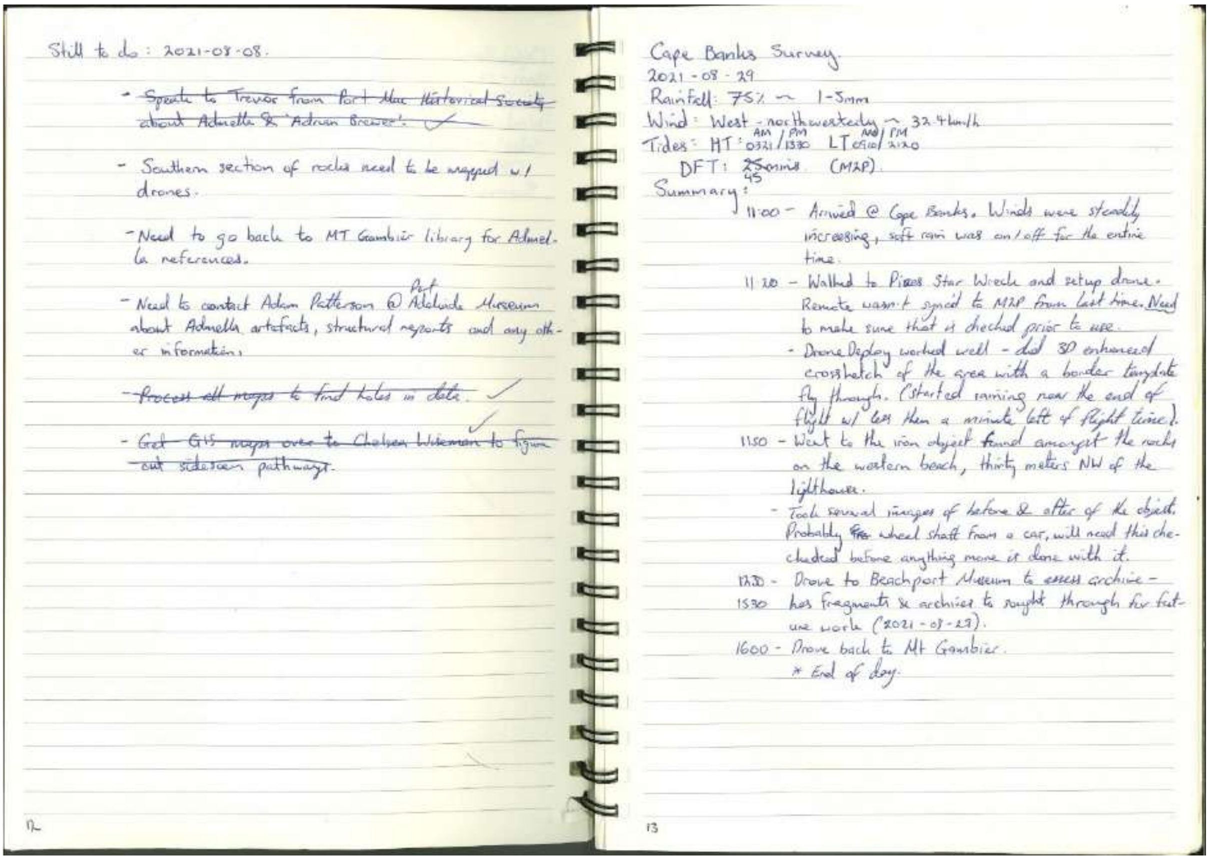
Set up drone area and began setting up grid.
- Needed to capture North-western & western parts of Cape Banks to show debris build up, this will need to be done again in two months to show change in tides & landscape.
  - *File name change on PC to "date - CBA (number)". This is to solve DJI's own problem. Easy fix. or just use "CBA x".
- The rest of the mission went well. No disconnecting issues. Wind began to pick up after 1400.

1450: End of survey.

+ Will need to head back to Cape Banks to take a few more photos of the kelp concretion roots further north along the beach.

+ DroneDeploy maps need to be created before app trial ends.
  - Need to see if Pix4D is paid for by Flinders Uni.
  - Need to learn ODM software w/QGIS.

11



Still to do: 2021-08-08.

- ~~Speak to Trevor from Port Mac Historical Society about Admella & 'Adrian Brewer'.~~ ✓
- Southern section of rocks need to be mapped w/ drones.
- Need to go back to MT Gambier library for Admella references.
- Need to contact Adam Patterson @ Port Adelaide Museum about Admella artefacts, structural reports and any other information.
- ~~Process all maps to find holes in data.~~ ✓
- ~~Get GIS maps over to Chelsea Wiseman to figure out sidescan pathways.~~ ✓

12

Cape Banks Survey.
2021-08-29
Rainfall: 75% ~ 1-5mm
Wind: West - northwesterly ~ 32.4km/h
Tides: HT: AM/PM 0321/1330 LT AM/PM 0910/2120
DFT: ~~25~~ 45 mins (M2P).
Summary:

11:00 - Arrived @ Cape Banks. Winds were steadily increasing, soft rain was on/off for the entire time.

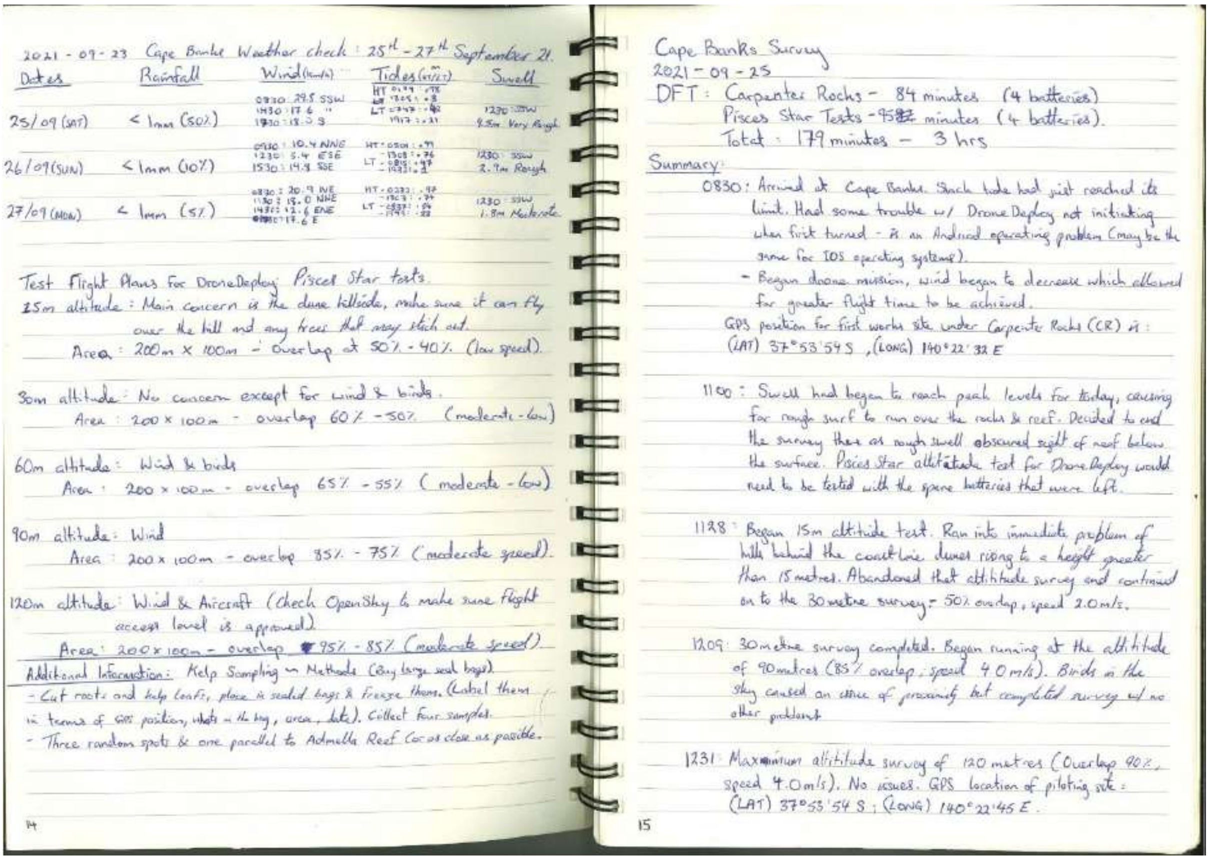
11 20 - Walked to Pisces Star Wreck and setup drone. Remote wasn't synced to M2P from last time. Need to make sure that is checked prior to use.
- DroneDeploy worked well - did 3D enhanced crosshatch of the area with a border template fly through. (Started raining near the end of flight w/ less than a minute left of flight time).

1150 - Went to the iron object found amongst the rocks on the western beach, thirty meters NW of the lighthouse.
- Took several images of before & after of the object. Probably ~~the~~ wheel shaft from a car, will need this checked before anything more is done with it.

1230 - 1530 - Drove to Beachport Museum to assess archive - has fragments & archives to sought through for future work (2021-08-29).

1600 - Drove back to Mt Gambier.
* End of day.

13



2021 - 09 - 23 Cape Banks Weather check : 25th - 27th September 21.

Dates	Rainfall	Wind (km/h)	Tides (HT/LT)	Swell
25/09 (SAT)	< 1mm (50%)	0830 : 29.5 SSW 1430 : 17.6 " 1930 : 18.0 S	HT 0134 : .78 1305 : .8 LT 0747 : .42 1917 : .31	1230 : SSW 4.5m Very Rough
26/09 (SUN)	< 1mm (10%)	0830 : 10.4 NNE 1230 : 5.4 ESE 1530 : 14.8 SSE	HT - 0504 : .79 - 1308 : .76 LT - 0815 : .47 - 1933 : [illegible]	1230 : SSW 2.9m Rough
27/09 (MON)	< 1mm (5%)	0830 : 20.9 NE 1130 : 15.0 NNE 1430 : 12.6 ENE 1830 : 17.6 E	HT - 0232 : .97 - 1307 : .74 LT - 0837 : .54 - 1945 : .22	1230 : SSW 1.8m Moderate

Test Flight Plans For DroneDeploy: Pisces Star tests.

15m altitude : Main concern is the dune hillside, make sure it can fly over the hill and any trees that may stick out.
Area : 200m x 100m - Overlap at 50% - 40%. (low speed).

30m altitude : No concern except for wind & birds.
Area : 200 x 100m - overlap 60% - 50% (moderate - low)

60m altitude : Wind & birds
Area : 200 x 100m - overlap 65% - 55% (moderate - low)

90m altitude : Wind
Area : 200 x 100m - overlap 85% - 75% (moderate speed).

120m altitude : Wind & Aircraft (check OpenSky to make sure flight access level is approved).
Area : 200 x 100m - overlap 95% - 85% (moderate speed).

Additional Information : Kelp Sampling ~ Methods (Buy large seal bags).
- Cut roots and kelp leafs, place in sealed bags & freeze them. (Label them in terms of GPS position, what's in the bag, area, date). Collect four samples.
- Three random spots & one parallel to Admella Reef (or as close as possible.

14

Cape Banks Survey
2021 - 09 - 25
DFT : Carpenter Rocks - 84 minutes (4 batteries)
Pisces Star Tests - 95 minutes (4 batteries).
Total : 179 minutes - 3 hrs

Summary :

0830 : Arrived at Cape Banks. Slack tide had just reached its limit. Had some trouble w/ DroneDeploy not initiating when first turned - is an Android operating problem (may be the same for IOS operating system).
- Began drone mission, wind began to decrease which allowed for greater flight time to be achieved.
GPS position for first works site under Carpenter Rocks (CR) is :
(LAT) 37°53'54 S , (LONG) 140°22'32 E

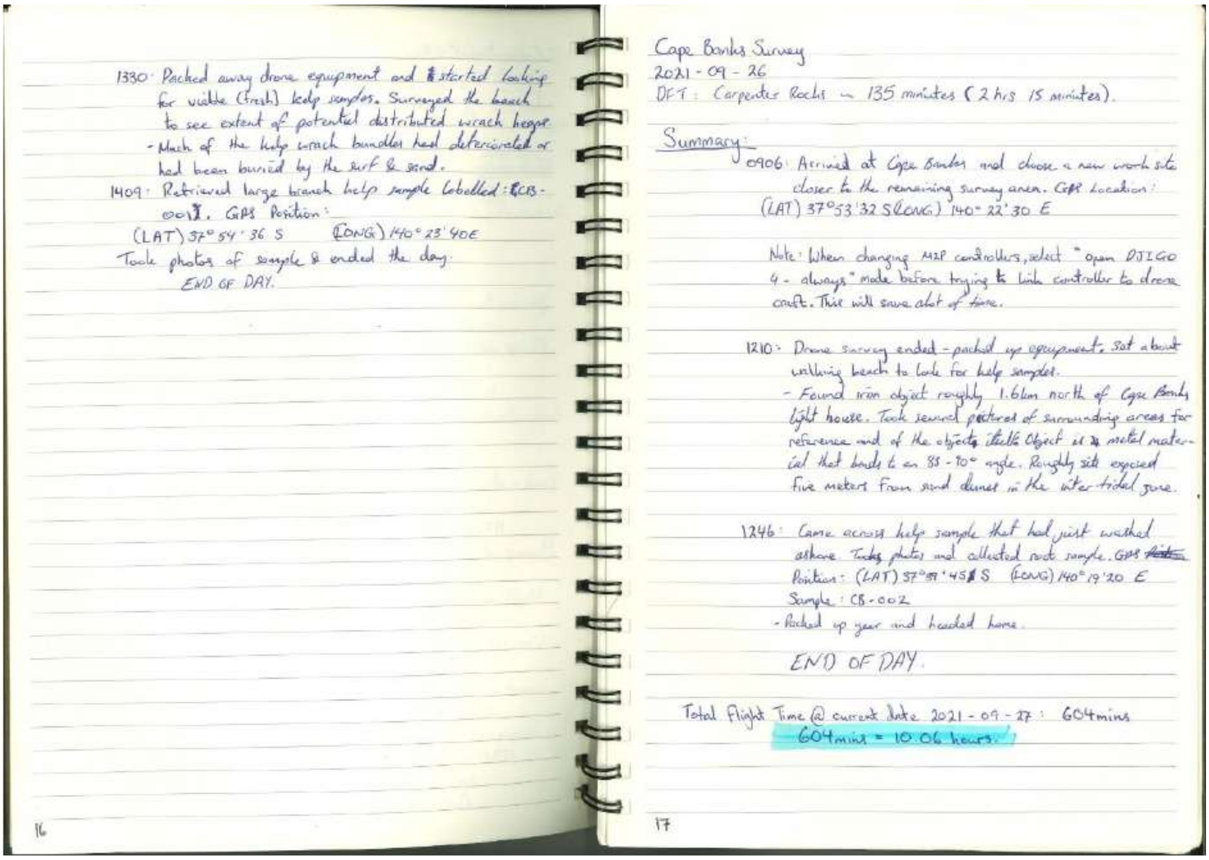
1100 : Swell had began to reach peak levels for today, causing for rough surf to run over the rocks & reef. Decided to end the survey there as rough swell obscured sight of reef below the surface. Pisces Star altitude test for DroneDeploy would need to be tested with the spare batteries that were left.

1128 : Began 15m altitude test. Ran into immediate problem of hills behind the coastline dunes rising to a height greater than 15 metres. Abandoned that altitude survey and continued on to the 30 metre survey - 50% overlap, speed 2.0 m/s.

1209 : 30 metre survey completed. Began running at the altitude of 90 metres (85% overlap, speed 4.0 m/s). Birds in the sky caused an issue of proximity but completed survey w/ no other problems.

1231 : Maximum altitude survey of 120 metres (Overlap 90%, speed 4.0 m/s). No issues. GPS location of piloting site :
(LAT) 37°53'54 S ; (LONG) 140°22'45 E.

15



1330 : Packed away drone equipment and started looking for viable (fresh) kelp samples. Surveyed the beach to see extent of potential distributed wrack heaps.
- Much of the kelp wrack bundles had deteriorated or had been buried by the surf & sand.

1409 : Retrieved large branch kelp sample labelled : CB-001. GPS Position :
(LAT) 37°54'36 S (LONG) 140°23'40 E
Took photos of sample & ended the day.
END OF DAY.

16

Cape Banks Survey
2021 - 09 - 26
DFT : Carpenter Rocks ~ 135 minutes (2 hrs 15 minutes).

Summary :

0906 : Arrived at Cape Banks and chose a new work site closer to the remaining survey area. GPS Location :
(LAT) 37°53'32 S (LONG) 140°22'30 E

Note : When changing M2P controllers, select "open DJI GO 4 - always" mode before trying to link controller to drone craft. This will save alot of time.

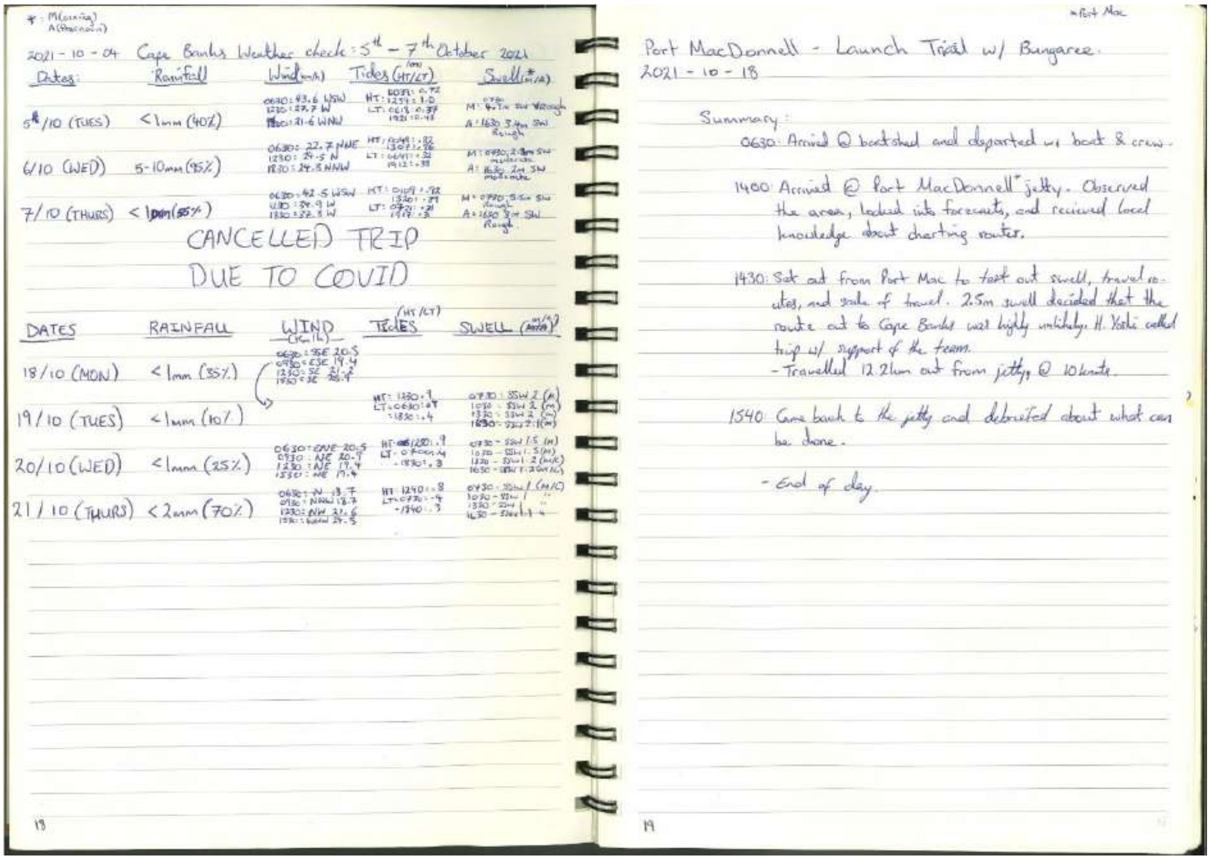
1210 : Drone survey ended - packed up equipment. Set about walking beach to look for kelp samples.
- Found iron object roughly 1.6km north of Cape Banks light house. Took several pictures of surrounding areas for reference and of the objects itself. Object is a metal material that bends to an 85 - 90° angle. Roughly site exposed five meters from sand dunes in the inter-tidal zone.

1246 : Came across kelp sample that had just washed ashore. Took photos and collected root sample. GPS Position : (LAT) 37°57'45 S (LONG) 140°19'20 E
Sample : CB-002
- Packed up gear and headed home.

END OF DAY.

Total Flight Time @ current date 2021 - 09 - 27 : 604mins
604mins = 10.06 hours.

17



*: M(orning)
A(fternoon)

2021 - 10 - 04 Cape Banks Weather check: 5th - 7th October 2021

Dates:	Rainfall	Wind(km/h)	Tides (HT/LT) (m)	Swell* (M/A)
5th/10 (TUES)	<1mm (40%)	0630: 43.6 WSW 1230: 27.7 W 1830: 21.6 WNW	HT: 0031: 0.72 1254: 1.0 LT: 0613: 0.37 1921: 0.43	M: 0730 4.7m SW Rough A: 1630 3.4m SW Rough
6/10 (WED)	5-10mm (95%)	0630: 22.7 NNE 1230: 24.5 N 1830: 24.5 NNW	HT: 0049: .82 1307: .96 LT: 0641: .32 1912: .38	M: 0930 2.8m SW moderate A: 1630 2m SW moderate
7/10 (THURS)	< 1mm (55%)	0630: 42.5 WSW 1230: 34.9 W 1830: 32.3 W	HT: 0109: .92 1320: .89 LT: 0721: .21 1917: .3	M: 0930 5.5m SW Rough A: 1650 3m SW Rough

CANCELLED TRIP

DUE TO COVID

DATES	RAINFALL	WIND (Km/h)	TIDES (HT/LT)	SWELL ([illegible])
18/10 (MON)	< 1mm (35%)	0630: SSE 20.5 0930: ESE 19.4 1230: SE 21.2 1530: SE 26.4		
19/10 (TUES)	< 1mm (10%)		HT: 1330: .9 LT: 0630: .4 : 1830: .4	0730: SSW 2 (M) 1030: SSW 2 (M) 1330: SSW 2 (M) 1630: SSW 2.1 (M)
20/10 (WED)	< 1mm (25%)	0630: ENE 20.5 0930: NE 20.9 1230: NE 19.4 1530: NE 19.4	HT: 1250: .9 LT: 0700: .4 - 1830: .3	0730 - SSW 1.5 (M) 1030 - SSW 1.5 (M) 1330 - SSW 1.2 (M/C) 1630 - SSW 1.2 (M/C)
21/10 (THURS)	< 2mm (70%)	0630: N 13.7 0930: NNW 18.7 1230: NW 21.6 1530: WNW 24.5	HT 1240: .8 LT: 0730: .4 - 1940: .3	0730 - SSW 1 (M/C) 1030 - SSW 1 " 1330 - SSW 1 " 1630 - SSW 1.4

19

*Port Mac

Port MacDonnell - Launch Trial w/ Bungaree.
2021 - 10 - 18

Summary:

0630: Arrived @ boatshed and departed w/ boat & crew.

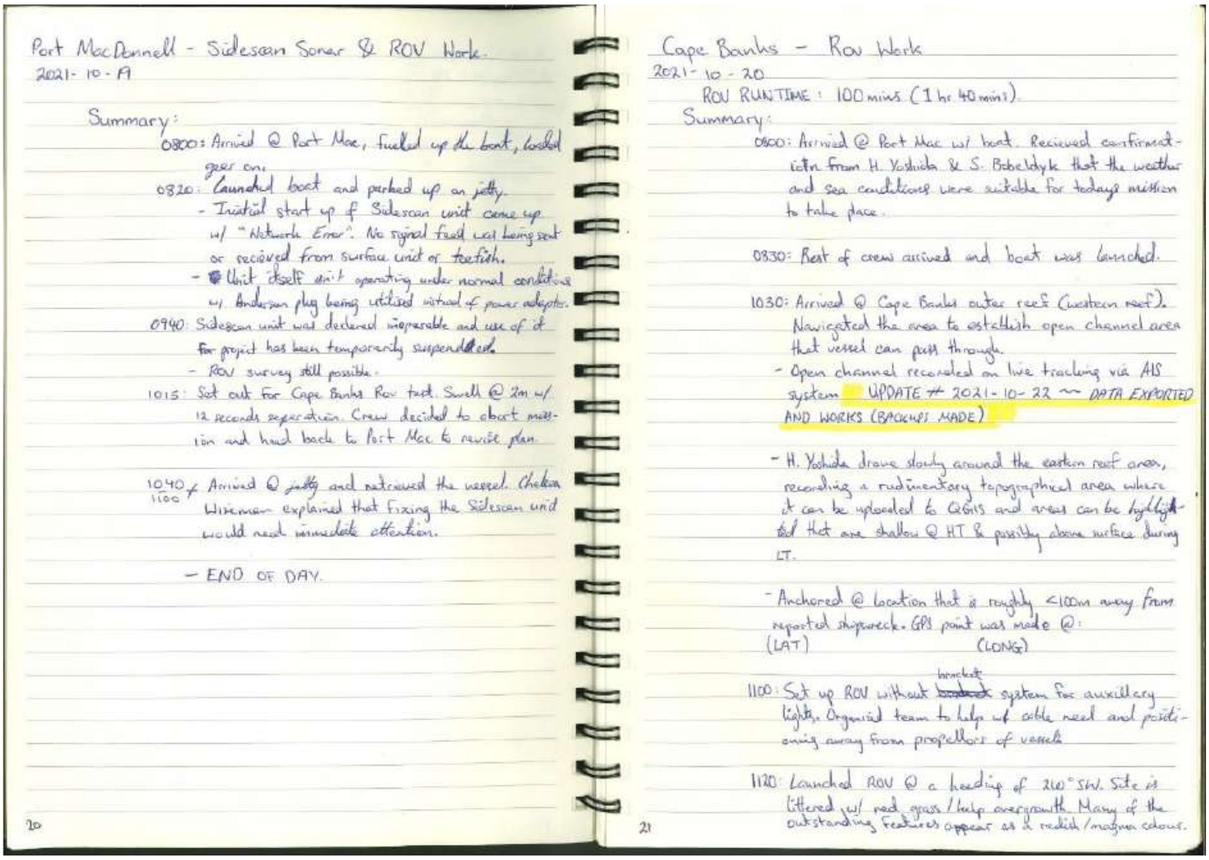
1400: Arrived @ Port MacDonnell* jetty. Observed the area, looked into forecasts, and recieved local knowledge about charting routes.

1430: Set out from Port Mac to test out swell, travel routes, and scale of travel. 2.5m swell decided that the route out to Cape Banks was highly unlikely. H. Yoshi called trip w/ support of the team.
- Travelled 12.2km out from jetty @ 10 knots.

1540: Came back to the jetty and debriefed about what can be done.

- End of day.

19



Port MacDonnell - Sidescan Sonar & ROV Work.
2021 - 10 - 19

Summary:

0800: Arrived @ Port Mac, fueled up the boat, loaded gear on.

0820: Launched boat and parked up on jetty.
- Initial start up of Sidescan unit came up w/ "Network Error". No signal feed was being sent or recieved from surface unit or towfish.
- Unit itself ain't operating under normal conditions w/ Anderson plug being utilised instead of power adaptor.

0940: Sidescan unit was declared inoperable and use of it for project has been temporarily suspended.
- ROV survey still possible.

1015: Set out for Cape Banks Rov test. Swell @ 2m w/ 12 seconds seperation. Crew decided to abort mission and head back to Port Mac to revise plan.

1040 / 1100: Arrived @ jetty and retrieved the vessel. Chelsea Wiseman explained that fixing the Sidescan unit would need immediate attention.

- END OF DAY.

20

Cape Banks - Rov Work
2021 - 10 - 20

ROV RUNTIME: 100 mins (1 hr 40 mins).

Summary:

0800: Arrived @ Port Mac w/ boat. Recieved confirmation from H. Yoshida & S. Bobeldyk that the weather and sea conditions were suitable for todays mission to take place.

0830: Rest of crew arrived and boat was launched.

1030: Arrived @ Cape Banks outer reef (western reef). Navigated the area to establish open channel area that vessel can pass through.
- Open channel recorded on live tracking via AIS system. UPDATE # 2021-10-22 ~ DATA EXPORTED AND WORKS (BACKUPS MADE)

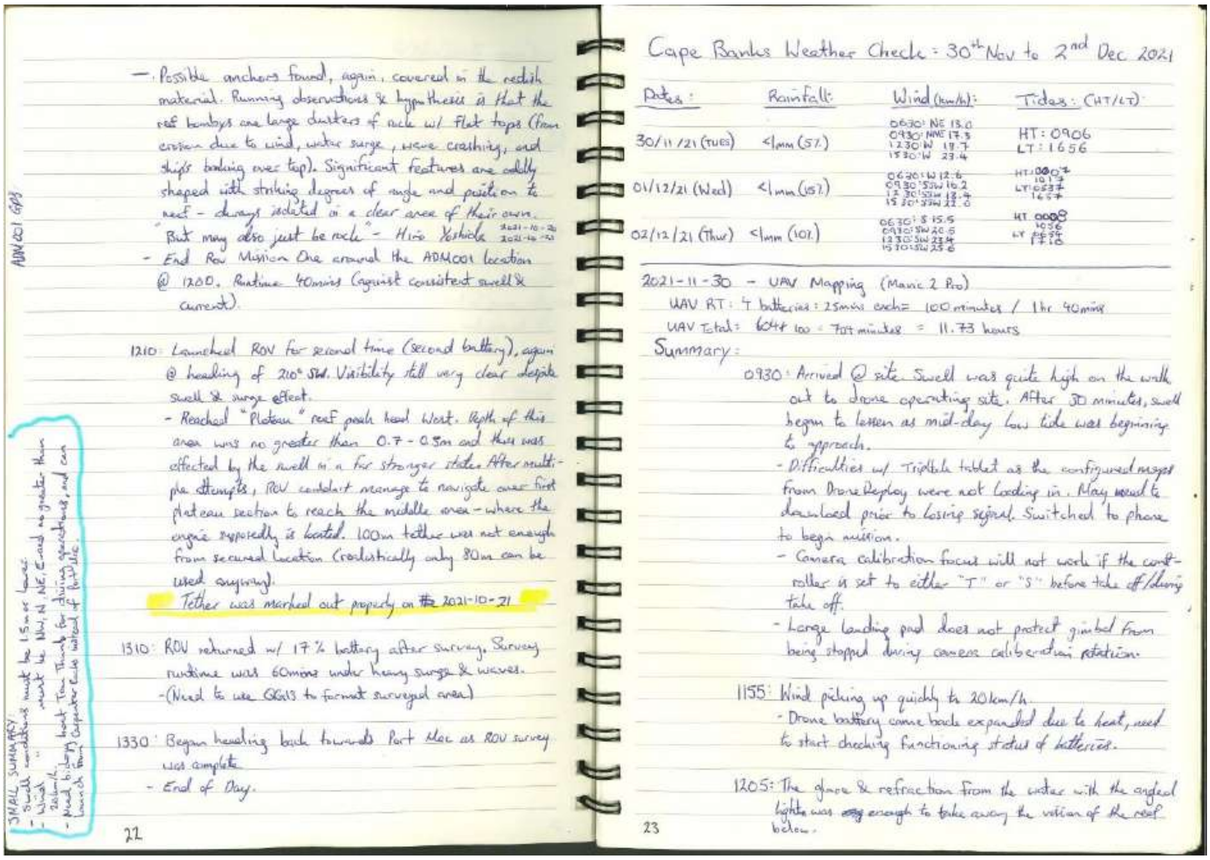
- H. Yoshida drove slowly around the eastern reef area, recording a rudimentary topographical area where it can be uploaded to QGIS and areas can be highlighted that are shallow @ HT & possibly above surface during LT.

- Anchored @ location that is roughly <100m away from reported shipwreck. GPS point was made @:
(LAT) (LONG)

1100: Set up ROV without ~~[illegible]~~ bracket system for auxillary lights. Organised team to help w/ cable reel and positioning away from propellors of vessels.

1120: Launched ROV @ a heading of 260° SW. Site is littered w/ red grass / kelp overgrowth. Many of the outstanding features appear as a redish / magma colour.

21



ADM001 GPS

- Possible anchors found, again, covered in the reddish material. Running observations & hypothesis is that the reef bombys are large clusters of rock w/ flat tops (from erosion due to wind, water surge, wave crashing, and ships braking over top). Significant features are oddly shaped with striking degrees of angle and position to reef - always isolated in a clear area of their own. "But may also just be rock" - Hiro Yoshida 2021-10-21 2021-10-21
- End Rov Mission One around the ADM001 location @ 1200. Runtime 40mins (against consistent swell & current).

1210: Launched ROV for second time (second battery), again @ heading of 210° SW. Visibility still very clear despite swell & surge effect.
- Reached "Plateau" reef peak head West. Depth of this area was no greater than 0.7 - 0.5m and thus was affected by the swell in a far stronger state. After multiple attempts, ROV couldn't manage to navigate over first plateau section to reach the middle area - where the engine supposedly is located. 100m tether was not enough from secured location (realistically only 80m can be used anyway).

Tether was marked out properly on ~~the~~ 2021-10-21

1310: ROV returned w/ 17% battery after survey. Survey runtime was 60mins under heavy surge & waves.
-(Need to use QGIS to format surveyed area)

1330: Began heading back towards Port Mac as ROV survey was complete
- End of Day.

SMALL SUMMARY:
- Swell conditions must be 1.5m or lower;
- Wind " must be NW, N, NE, E and no greater than 20km/h.
- Need bilingy boat Tom Thumb for diving operations, and can launch from Carpenter Rocks instead of Port Mac.

22

Cape Banks Weather Check: 30th Nov to 2nd Dec 2021

Dates:	Rainfall:	Wind (km/h):	Tides: (HT/LT)
30/11/21 (Tues)	<1mm (57.)	0630: NE 13.0 0930: NNE 17.5 1230: W 18.7 1530: W 23.4	HT: 0906 LT: 1656
01/12/21 (Wed)	<1mm (15%)	0630: W 12.6 0930: SSW 16.2 1230: SSW 18.4 1530: SSW 22.0	HT: 0007 1017 LT: 0537 1657
02/12/21 (Thur)	<1mm (10%)	0630: S 15.5 0930: SW 20.5 1230: SW 23.4 1530: SW 25.6	HT 0008 1056 LT 0654 1710

2021-11-30 - UAV Mapping (Mavic 2 Pro)
UAV RT: 4 batteries: 25mins each = 100 minutes / 1hr 40mins
UAV Total: 604 + 100 = 704 minutes = 11.73 hours

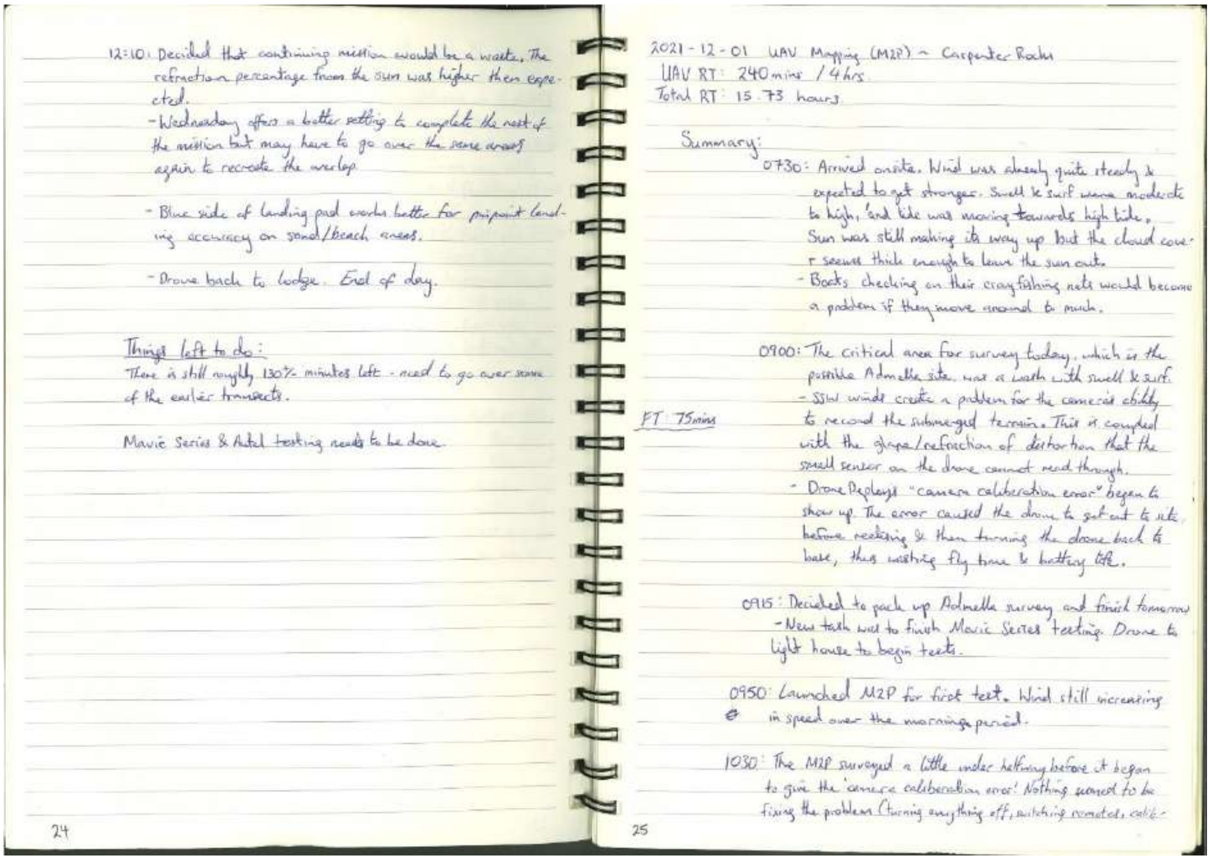
Summary:

0930: Arrived @ site. Swell was quite high on the walk out to drone operating site. After 30 minutes, swell began to lessen as mid-day low tide was beginning to approach.
- Difficulties w/ Triplet tablet as the configured maps from DroneDeploy were not loading in. May need to download prior to losing signal. Switched to phone to begin mission.
- Camera calibration focus will not work if the controller is set to either "T" or "S" before take off/during take off.
- Large landing pad does not protect gimbal from being stopped during camera caliberation rotation.

1155: Wind picking up quickly to 20km/h.
- Drone battery came back expanded due to heat, need to start checking functioning status of batteries.

1205: The glare & refraction from the water with the angled lights was enough to take away the vision of the reef below.

23



12:10: Decided that continuing mission would be a waste. The refraction percentage from the sun was higher than expected.
- Wednesday offers a better setting to complete the rest of the mission but may have to go over the same areas again to recreate the overlap.

- Blue side of landing pad works better for pinpoint landing accuracy on sand/beach areas.

- Drove back to lodge. End of day.

Things left to do:
There is still roughly 130% minutes left - need to go over some of the earlier transects.

Mavic Series & Autel testing needs to be done.

24

2021-12-01 UAV Mapping (M2P) - Carpenter Rocks
UAV RT: 240mins / 4hrs
Total RT: 15.73 hours

Summary:

0730: Arrived onsite. Wind was already quite steady & expected to get stronger. Swell & surf were moderate to high, and tide was moving towards high tide. Sun was still making its way up but the cloud cover seems thick enough to leave the sun out.
- Boats checking on their crayfishing nets would become a problem if they move around to much.

0900: The critical area for survey today, which is the possible Admella site, was a wash with swell & surf.
- SSW winds create a problem for the camera's ability to record the submerged terrain. This is coupled with the glare/refraction of distortion that the small sensor on the drone cannot read through.
- DroneDeploys "camera caliberation error" began to show up. The error caused the drone to get out to site before restarting & then turning the drone back to base, thus wasting fly time & battery life.

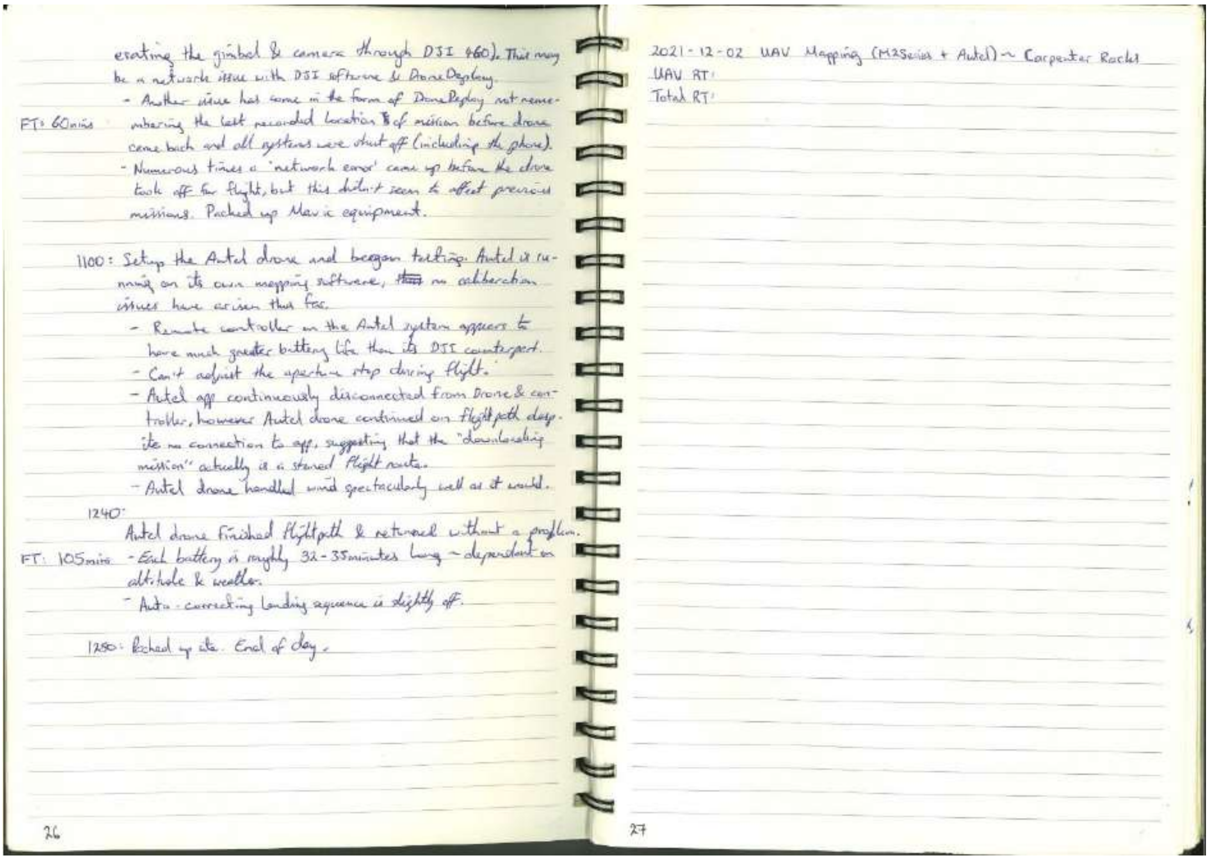
FT: 75mins

0915: Decided to pack up Admella survey and finish tomorrow
- New task was to finish Mavic Series testing. Drove to light house to begin tests.

0950: Launched M2P for first test. Wind still increasing in speed over the morning period.

1030: The M2P surveyed a little under halfway before it began to give the 'camera caliberation error'. Nothing seemed to be fixing the problem (turning everything off, switching remotes, calib-

25



erating the gimbal & camera through DJI 460). This may be a network issue with DJI software & DroneDeploy.

- Another issue has come in the form of DroneDeploy not remembering the last recorded location of mission before drone came back and all systems were shut off (including the phone).

FT: 60mins

- Numerous times a 'network error' came up before the drone took off for flight, but this didn't seem to affect previous missions. Packed up Mavic equipment.

1100: Setup the Autel drone and began testing. Autel is running on its own mapping software, no calibration issues have arisen thus far.

- Remote controller on the Autel system appears to have much greater battery life than its DJI counterpart.
- Can't adjust the aperture stop during flight.
- Autel app continuously disconnected from Drone & controller, however Autel drone continued on flightpath despite no connection to app, suggesting that the "downloading mission" actually is a stored flight route.
- Autel drone handled wind spectacularly well as it would.

1240:
Autel drone finished flightpath & returned without a problem.

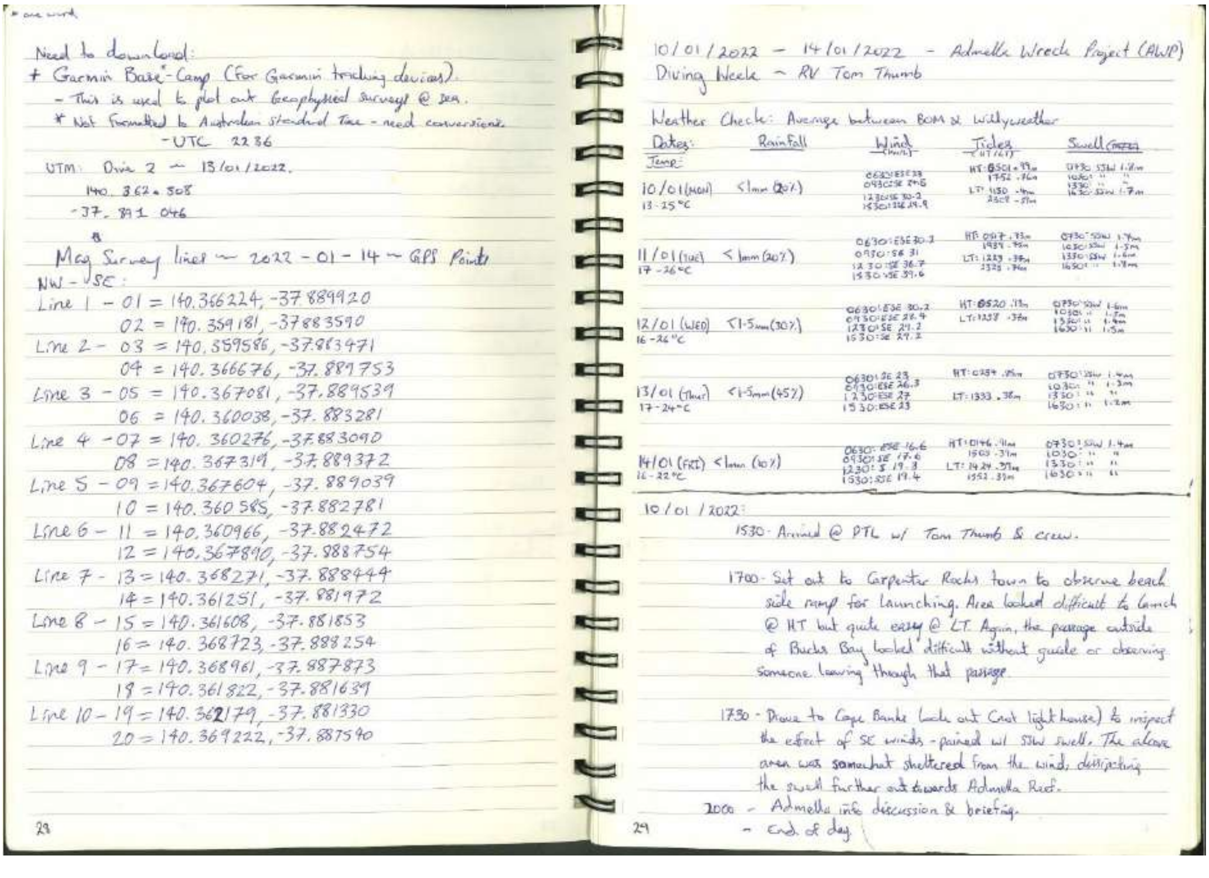
FT: 105mins
- Each battery is roughly 32-35minutes long ~ dependent on altitude & weather.
- Auto-correcting landing sequence is slightly off.

1250: Packed up site. End of day.

26

2021-12-02 UAV Mapping (M2Series + Autel) ~ Carpenter Rocks
UAV RT:
Total RT:

27



* one word

Need to download:
+ Garmin Base*-Camp (For Garmin tracking devices).
- This is used to plot out Geophysical surveys @ sea.
* Not Formatted to Australian Standard Time - need conversions.
-UTC 2236

UTM: Dive 2 ~ 13/01/2022.
140. 362. 508
-37. 891 046

Mag Survey lines ~ 2022-01-14 ~ GPS Points
NW - SE:
Line 1 - 01 = 140.366224, -37.889920
02 = 140.359181, -37.883590
Line 2 - 03 = 140.359586, -37.883471
04 = 140.366676, -37.889753
Line 3 - 05 = 140.367081, -37.889539
06 = 140.360038, -37.883281
Line 4 - 07 = 140.360276, -37.883090
08 = 140.367319, -37.889372
Line 5 - 09 = 140.367604, -37.889039
10 = 140.360585, -37.882781
Line 6 - 11 = 140.360966, -37.882472
12 = 140.367890, -37.888754
Line 7 - 13 = 140.368271, -37.888444
14 = 140.361251, -37.881972
Line 8 - 15 = 140.361608, -37.881853
16 = 140.368723, -37.888254
Line 9 - 17 = 140.368961, -37.887873
18 = 140.361822, -37.881639
Line 10 - 19 = 140.362179, -37.881330
20 = 140.369222, -37.887540

28

10/01/2022 - 14/01/2022 - Admella Wreck Project (AWP)
Diving Week ~ RV Tom Thumb

Weather Check: Average between BOM & Willyweather

Dates: Temp:	Rainfall	Wind (km/h)	Tides (HT/LT)	Swell ([illegible])
10/01 (MON) 13-25°C	<1mm (20%)	0630:ESE 23 0930:SE 24.5 1230:SE 30.2 1530:SSE 29.9	HT: 0501 .79m 1752 .76m LT: 1150 .4m 2309 .51m	0730 SSW 1.8m 1030 " " 1330 " " 1630 SSW 1.7m
11/01 (TUE) 17-26°C	< 1mm (20%)	0630:ESE 30.2 0930:SE 31 1230:SE 36.7 1530:SE 39.6	HT: 0017 .73m 1939 .75m LT: 1223 .37m 2325 .76m	0730 SSW 1.7m 1030 SSW 1.5m 1330 SSW 1.6m 1630 " 1.8m
12/01 (WED) 16-26°C	<1.5mm (30%)	0630:ESE 30.2 0930:ESE 28.4 1230:SE 29.2 1530:SE 29.2	HT: 0520 .13m LT: 1258 .36m	0730 SSW 1.6m 1030 " 1.7m 1330 " 1.4m 1630 " 1.5m
13/01 (Thur) 17-24°C	<1.5mm (45%)	0630:SE 23 0930:ESE 26.3 1230:ESE 27 1530:ESE 23	HT: 0254 .95m LT: 1333 .36m	0730 SSW 1.4m 1030 " 1.3m 1330 " " 1630 " 1.2m
14/01 (FRI) 16-22°C	<1mm (10%)	0630:ESE 16.6 0930:SE 17.6 1230:S 19.3 1530:SSE 19.4	HT: 0146 .91m 1503 .37m LT: 1424 .37m 1552 .39m	0730 SSW 1.4m 1030 " " 1330 " " 1630 " "

10/01/2022:

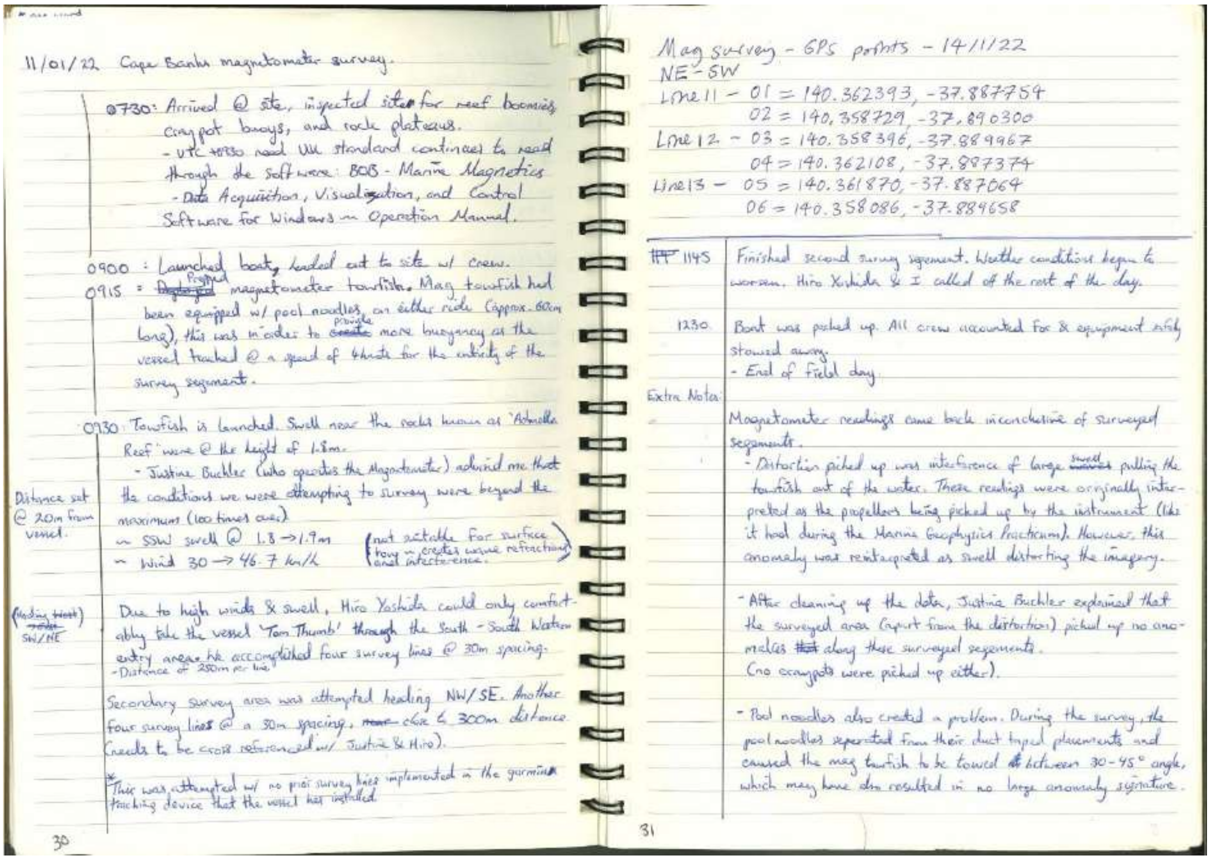
1530 - Arrived @ PTL w/ Tom Thumb & crew.

1700 - Set out to Carpenter Rocks town to observe beach side ramp for launching. Area looked difficult to launch @ HT but quite easy @ LT. Again, the passage outside of Bucks Bay looked difficult without guide or observing someone leaving through that passage.

1730 - Drove to Cape Banks (look out Cast light house) to inspect the effect of SE winds - paired w/ SSW swell. The above area was somewhat sheltered from the wind, dissipating the swell further out towards Admella Reef.

2000 - Admella info discussion & briefing.
- End of day

29



11/01/22 Cape Banks magnetometer survey.

0730: Arrived @ site, inspected sites for reef boomies, craypot buoys, and rock plateaus.
- UTC ~~+0930~~ need UM standard continues to read through the software: BOB - Marine Magnetics - Data Acquisition, Visualization, and Control Software for Windows ~ Operation Manual.

0900 : Launched boat, headed out to site w/ crew.

0915 = ~~Deployed~~ Prepped magnetometer towfish. Mag towfish had been equipped w/ pool noodles on either side (approx. 60cm long), this was in order to ~~create~~ provide more buoyancy as the vessel tracked @ a speed of 4knts for the entirety of the survey segment.

0930: Towfish is launched. Swell near the rocks known as 'Admella Reef' were @ the height of 1.8m.
- Justine Buckler (who operates the Magnetometer) advised me that the conditions we were attempting to survey were beyond the maximum (100 times over)

Distance set @ 20m from vessel.

~ SSW swell @ 1.8 → 1.9m
~ Wind 30 → 46.7 km/h
(not suitable for surface tow ~ creates wave refraction and interference.)

(Heading ~~West~~ ~~?~~ SW/NE)

Due to high winds & swell, Hiro Yoshida could only comfortably take the vessel 'Tom Thumb' through the South - South Western entry area. We accomplished four survey lines @ 30m spacing.
- Distance of 250m per line.

Secondary survey area was attempted heading NW/SE. Another four survey lines @ a 30m spacing, ~~near~~ close to 300m distance (needs to be cross referenced w/ Justine & Hiro).

*This was attempted w/ no prior survey lines implemented in the garmin tracking device that the vessel has installed.

30

Mag survey - GPS points - 14/1/22
NE - SW
Line 11 - 01 = 140.362393, -37.887754
02 = 140.358729, -37.890300
Line 12 - 03 = 140.358396, -37.889967
04 = 140.362108, -37.887374
Line 13 - 05 = 140.361870, -37.887064
06 = 140.358086, -37.884658

~~?~~ 1145 Finished second survey segment. Weather conditions began to worsen. Hiro Yoshida & I called off the rest of the day.

1230 Boat was picked up. All crew accounted for & equipment safely stowed away.
- End of field day.

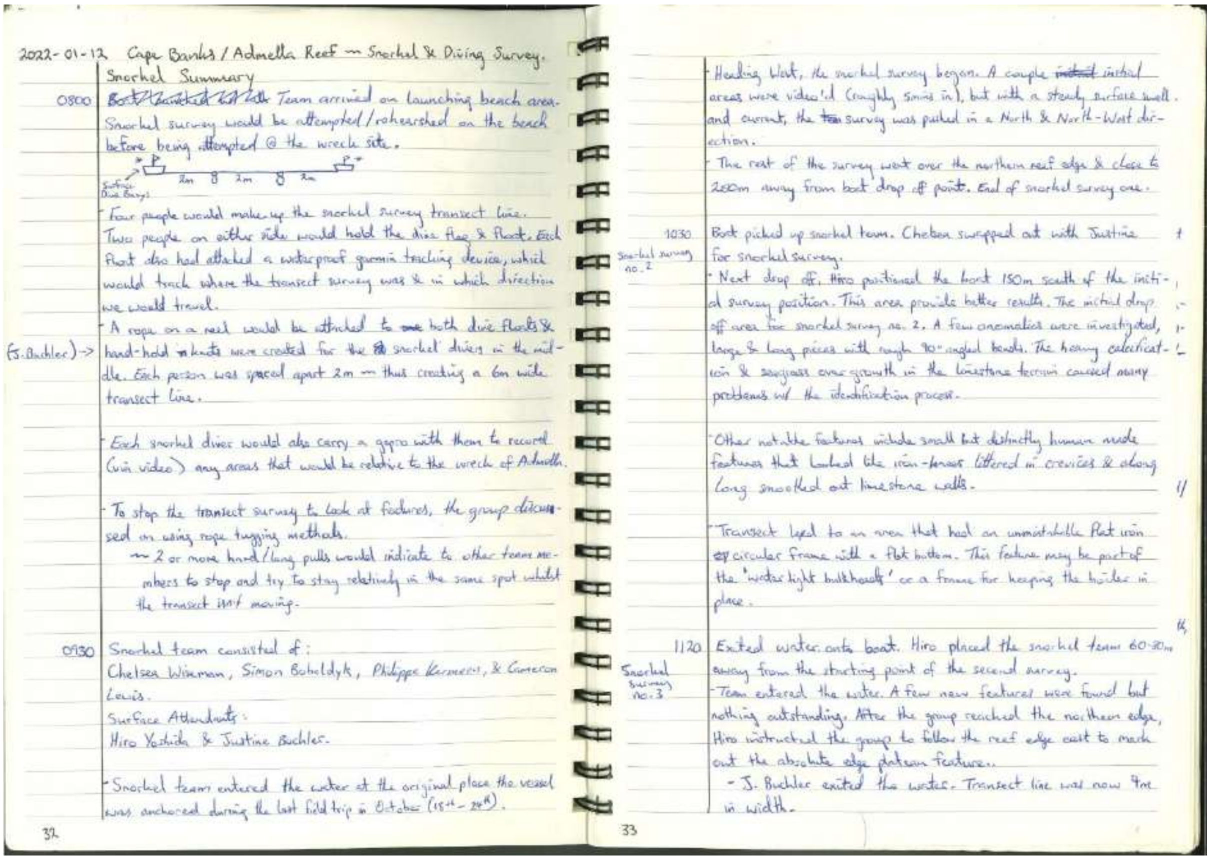
Extra Notes:

Magnetometer readings came back inconclusive of surveyed segments.
- Distortion picked up was interference of large ~~waves~~ swell pulling the towfish out of the water. These readings were originally interpreted as the propellers being picked up by the instrument (like it had during the Marine Geophysics Practicum). However, this anomaly was reinterpreted as swell distorting the imagery.

- After cleaning up the data, Justine Buckler explained that the surveyed area (apart from the distortion) picked up no anomalies ~~that~~ along these surveyed segments. (no craypots were picked up either).

- Pool noodles also created a problem. During the survey, the pool noodles seperated from their duct taped placements and caused the mag towfish to be towed ~~at~~ between 30-45° angle, which may have also resulted in no large anomaly signature.

31



2022-01-12 Cape Banks / Admella Reef ~ Snorkel & Diving Survey.

Snorkel Summary

0800 ~~Boat launched at 0800~~ Team arrived on launching beach area. Snorkel survey would be attempted/rehearsed on the beach before being attempted @ the wreck site.

- Four people would make up the snorkel survey transect line. Two people on either side would hold the dive flag & float. Each float also had attached a waterproof garmin tracking device, which would track where the transect survey was & in which direction we would travel.
- A rope on a reel would be attached to ~~one~~ both dive floats & hand-hold knots were created for the snorkel divers in the middle. Each person was spaced apart 2m ~ thus creating a 6m wide transect line.

(J. Buckler) →

- Each snorkel diver would also carry a gopro with them to record (via video) any areas that would be relative to the wreck of Admella.

- To stop the transect survey to look at features, the group discussed on using rope tugging methods.
  ~ 2 or more hard/long pulls would indicate to other team members to stop and try to stay relatively in the same spot whilst the transect isn't moving.

0930 Snorkel team consisted of:
Chelsea Wiseman, Simon Boholdyk, Philippe Kermeen, & Cameron Lewis.
Surface Attendants:
Hiro Yoshida & Justine Buckler.

- Snorkel team entered the water at the original place the vessel was anchored during the last field trip in October (18th - 24th).

32

- Heading West, the snorkel survey began. A couple ~~initial~~ initial areas were video'd (roughly 5mins in), but with a steady surface swell and current, the ~~team~~ survey was pushed in a North & North-West direction.
- The rest of the survey went over the northern reef edge & close to 200m away from boat drop off point. End of snorkel survey one.

1030 Boat picked up snorkel team. Chelsea swapped out with Justine for snorkel survey.

Snorkel survey no. 2

- Next drop off, Hiro positioned the boat 150m south of the initial survey position. This area provide better results. The initial drop off area for snorkel survey no. 2. A few anomalies were investigated, large & long pieces with rough 90° angled bends. The heavy calcification & seagrass over growth in the limestone terrain caused many problems w/ the identification process.

- Other notable features include small but distinctly human made features that looked like iron-bars littered in crevices & along long smoothed out limestone walls.

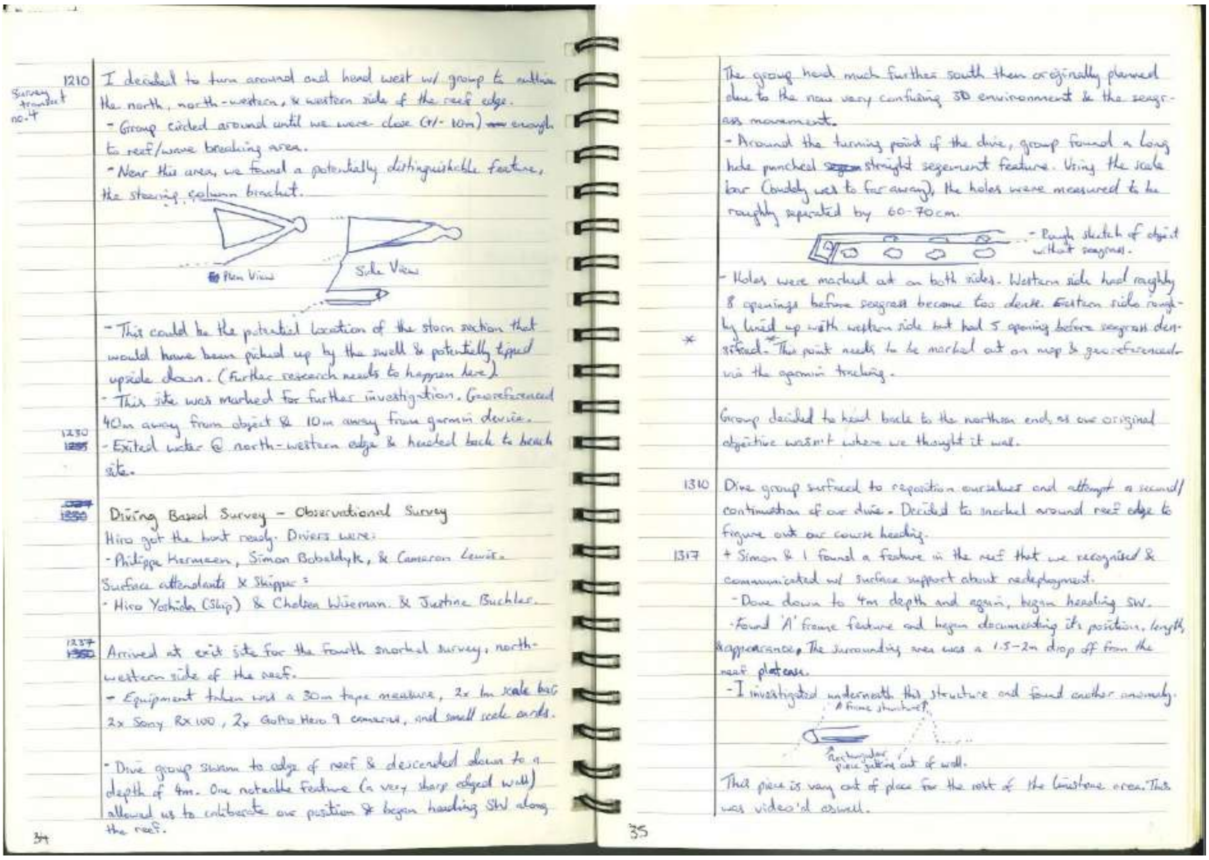
- Transect lead to an area that had an unmistakable flat iron ~~?~~ circular frame with a flat bottom. This feature may be part of the 'water tight bulkheads' or a frame for keeping the boiler in place.

1120 Exited water onto boat. Hiro placed the snorkel team 60-90m away from the starting point of the second survey.

Snorkel survey no. 3

- Team entered the water. A few new features were found but nothing outstanding. After the group reached the northern edge, Hiro instructed the group to follow the reef edge east to mark out the absolute edge platform feature.
  - J. Buckler exited the water. Transect line was now 4m in width.

33



Survey transect no.4

1210 I decided to turn around and head west w/ group to outline the north, north-western, & western side of the reef edge.

- Group circled around until we were close (+/- 10m) ~~on~~ enough to reef/wave breaking area.
- Near this area, we found a potentially distinguishable feature, the steering column bracket.

Plan View

Side View

- This could be the potential location of the stern section that would have been picked up by the swell & potentially tipped upside down. (Further research needs to happen here)
- This site was marked for further investigation. Georeferenced 40m away from object & 10m away from garmin device.

1230 ~~1225~~ - Exited water @ north-western edge & headed back to beach site.

~~1237~~ ~~1250~~ Diving Based Survey - Observational Survey

Hiro got the boat ready. Divers were:

- Philippe Kermeen, Simon Bobeldyk, & Cameron Lewis.

Surface attendants & Skipper:

- Hiro Yoshida (Skip) & Chelsea Wiseman. & Justine Buchler.

1237 ~~1350~~ Arrived at exit site for the fourth snorkel survey, north-western side of the reef.

- Equipment taken was a 30m tape measure, 2x 1m scale bar, 2x Sony RX100, 2x GoPro Hero 9 cameras, and small scale cards.

- Dive group swam to edge of reef & descended down to a depth of 4m. One notable feature (a very sharp edged wall) allowed us to calibrate our position & began heading SW along the reef.

34

The group head much further south than originally planned due to the now very confusing 3D environment & the seagrass movement.

- Around the turning point of the dive, group found a long hole punched ~~segm~~ straight segement feature. Using the scale bar (Conveniently was to far away), the holes were measured to be roughly separated by 60-70cm.

\- Rough sketch of object without seagrass.

- Holes were marked out on both sides. Western side had roughly 8 openings before seagrass become too dense. Eastern side roughly lined up with western side but had 5 opening before seagrass densified.* This point needs to be marked out on map & geo-referenced via the garmin tracking.

*

Group decided to head back to the northern end as our original objective wasn't where we thought it was.

1310 Dive group surfaced to reposition ourselves and attempt a second/continuation of our dive. Decided to snorkel around reef edge to figure out our course heading.

1317 + Simon & I found a feature in the reef that we recognised & communicated w/ surface support about redeployment.

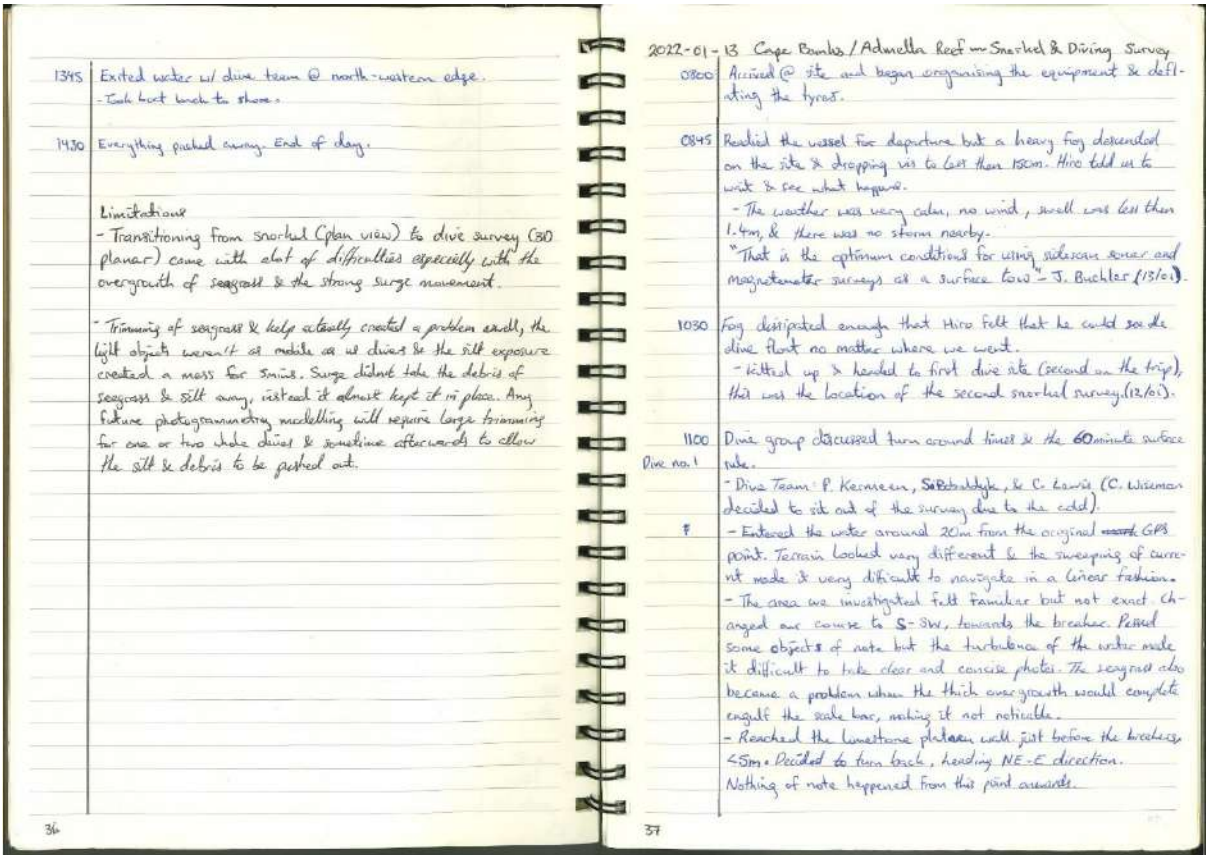
- Dove down to 4m depth and again, began heading SW.
- Found 'A' frame feature and began documenting its position, length & appearance. The surrounding area was a 1.5-2m drop off from the reef plateau.
- I investigated underneath this structure and found another anomaly.

A frame structure?

Rectangular piece jutting out of wall.

This piece is very out of place for the rest of the limestone area. This was video'd aswell.

35



1345 Exited water w/ dive team @ north-western edge.

- Took boat back to shore.

1430 Everything packed away. End of day.

Limitations

- Transitioning from snorkel (plan view) to dive survey (3D planar) came with alot of difficulties especially with the overgrowth of seagrass & the strong surge movement.

- Trimming of seagrass & kelp actually created a problem aswell, the light objects weren't as mobile as we divers & the silt exposure created a mess for snaps. Surge didn't take the debris of seagrass & silt away, instead it almost kept it in place. Any future photogrammetry modelling will require large trimming for one or two whole dives & sometime afterwards to allow the silt & debris to be pushed out.

36

2022-01-13 Cape Banks / Admella Reef ~ Snorkel & Diving Survey

0800 Arrived @ site and began organising the equipment & deflating the tyres.

0845 Reached the vessel for departure but a heavy fog descended on the site & dropping vis to less than 150m. Hiro told us to wait & see what happens.

- The weather was very calm, no wind, swell was less than 1.4m, & there was no storm nearby.

"That is the optimum conditions for using sidescan sonar and magnetometer surveys as a surface tow" - J. Buchler (13/01).

1030 Fog dissipated enough that Hiro felt that he could see the dive float no matter where we went.

- Kitted up & headed to first dive site (second on the trip), this was the location of the second snorkel survey (12/01).

1100 Dive group discussed turn around times & the 60minute surface rule.

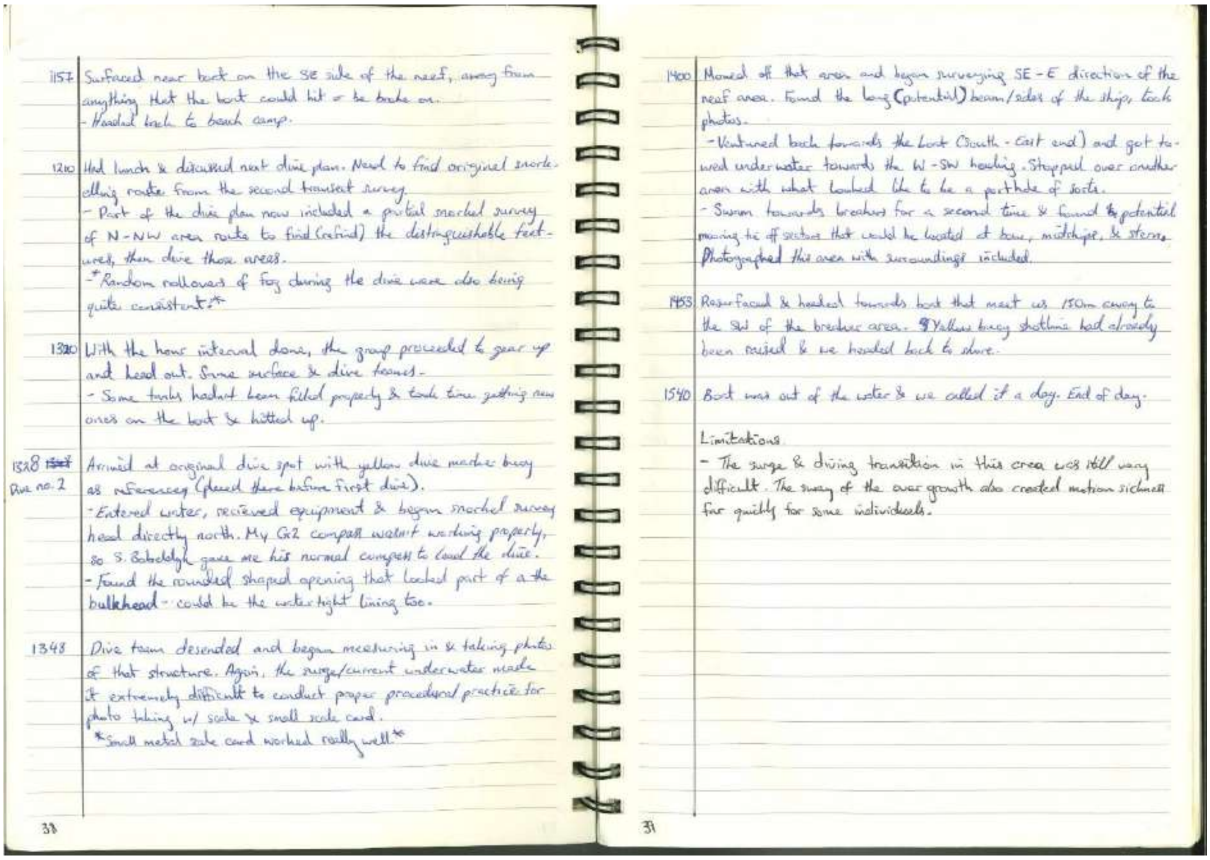
Dive no.1

- Dive Team: P. Kermeen, ~~Si~~ Bobeldyk, & C. Lewis (C. Wiseman decided to sit out of the survey due to the cold).

*

- Entered the water around 20m from the original ~~mark~~ GPS point. Terrain looked very different & the sweeping of current made it very difficult to navigate in a linear fashion.
- The area we investigated felt familiar but not exact. Changed our course to S-SW, towards the breaker. Passed some objects of note but the turbulence of the water made it difficult to take clear and concise photos. The seagrass also became a problem when the thick overgrowth would completely engulf the scale bar, making it not noticeable.
- Reached the limestone plateau wall just before the breakers, <5m. Decided to turn back, heading NE-E direction. Nothing of note happened from this point onwards.

37



1157 Surfaced near boat on the SE side of the reef, away from anything that the boat could hit or be broke on.
- Headed back to beach camp.

1200 Had lunch & discussed next dive plan. Need to find original snorkelling route from the second transect survey.
- Part of the dive plan now included a partial snorkel survey of N-NW area route to find (refind) the distinguishable features, then dive those areas.
-*Random rollovers of fog during the dive were also being quite consistent.*

1320 With the hour interval done, the group proceeded to gear up and head out. Same surface & dive teams.
- Some tanks hadn't been filled properly & took time getting new ones on the boat & kitted up.

1328 ~~1327~~ Dive no. 2 Arrived at original dive spot with yellow dive marker buoy as referencey (placed there before first dive).
- Entered water, recieved equipment & began snorkel survey head directly north. My G2 compass wasn't working properly, so S. Babdolph gave me his normal compass to lead the dive.
- Found the rounded shaped opening that looked part of a the bulkhead - could be the water tight lining too.

1348 Dive team desended and began measuring in & taking photos of that structure. Again, the surge/current underwater made it extremely difficult to conduct proper procedural practice for photo taking w/ scale & small scale card.
Small metal scale card worked really well

30

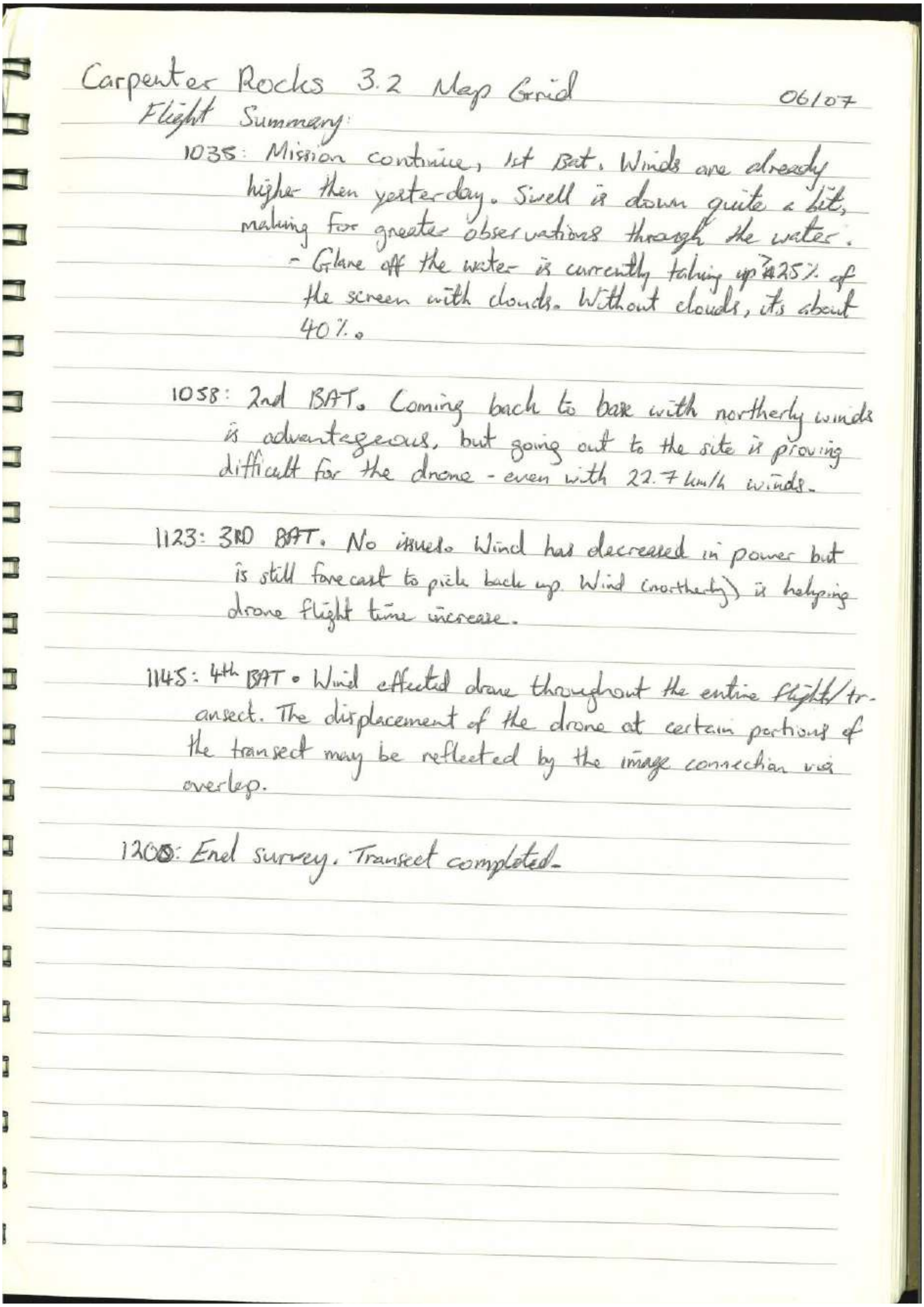
1400 Moved off that area and began surveying SE-E direction of the reef area. Found the long (potential) beam/sides of the ship, took photos.
- Ventured back towards the boat (South-East end) and got towed underwater towards the W-SW heading. Stopped over another area with what looked like to be a porthole of sorts.
- Swam towards breakers for a second time & found the potential mooring tie off sections that would be located at bow, midships, & stern. Photographed this area with surroundings included.

1453 Resurfaced & headed towards boat that meet us 150m away to the SW of the breaker area. Yellow buoy shotline had already been raised & we headed back to shore.

1540 Boat was out of the water & we called it a day. End of day.

Limitations
- The surge & diving transition in this area was still very difficult. The sway of the over growth also created motion sickness far quickly for some individuals.

31



Carpenter Rocks 3.2 Map Grid 06/07

Flight Summary:

1035: Mission continue, 1st Bat. Winds are already higher then yesterday. Swell is down quite a bit, making for greater observations through the water.

- Glare off the water is currently taking up ≈25% of the screen with clouds. Without clouds, it's about 40%.

1058: 2nd BAT. Coming back to base with northerly winds is advantageous, but going out to the site is proving difficult for the drone - even with 22.7 km/h winds.

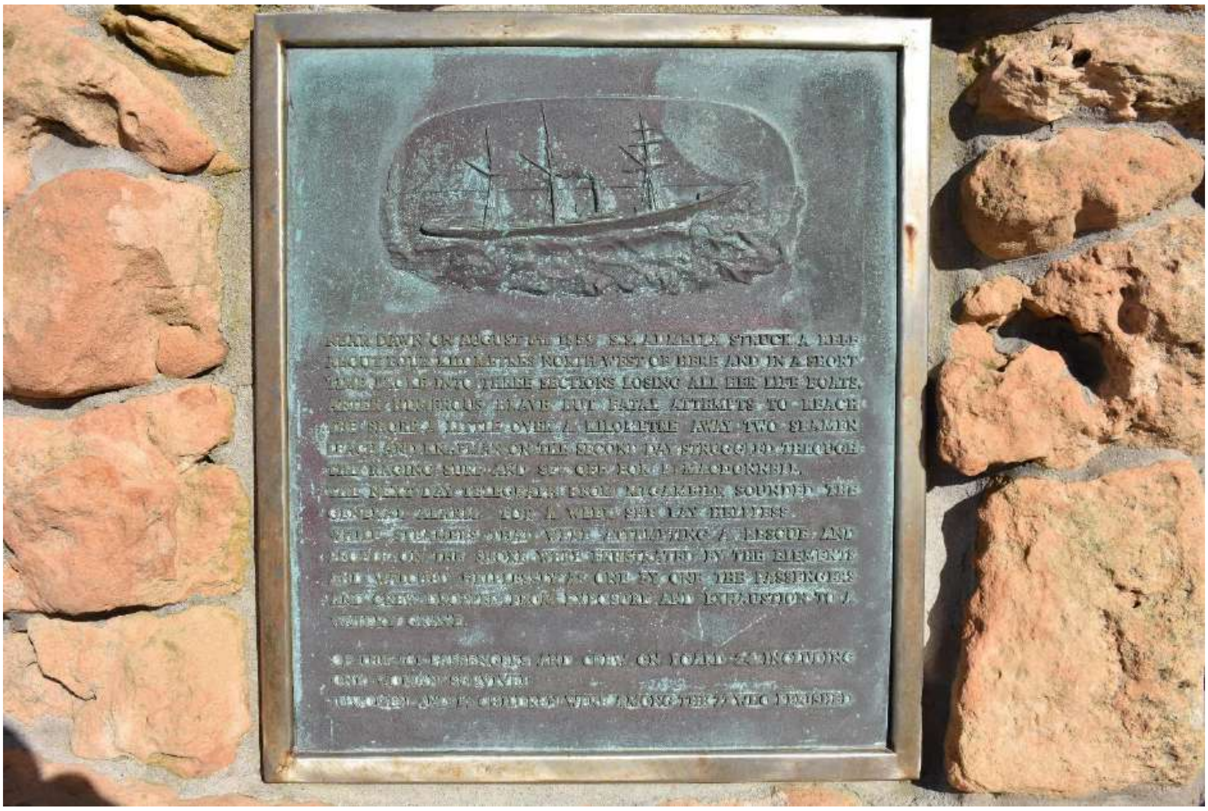
1123: 3RD BAT. No issues. Wind has decreased in power but is still forecast to pick back up. Wind (northerly) is helping drone flight time increase.

1145: 4th BAT. Wind effected drone throughout the entire flight/transect. The displacement of the drone at certain portions of the transect may be reflected by the image connection via overlap.

1200: End survey. Transect completed.

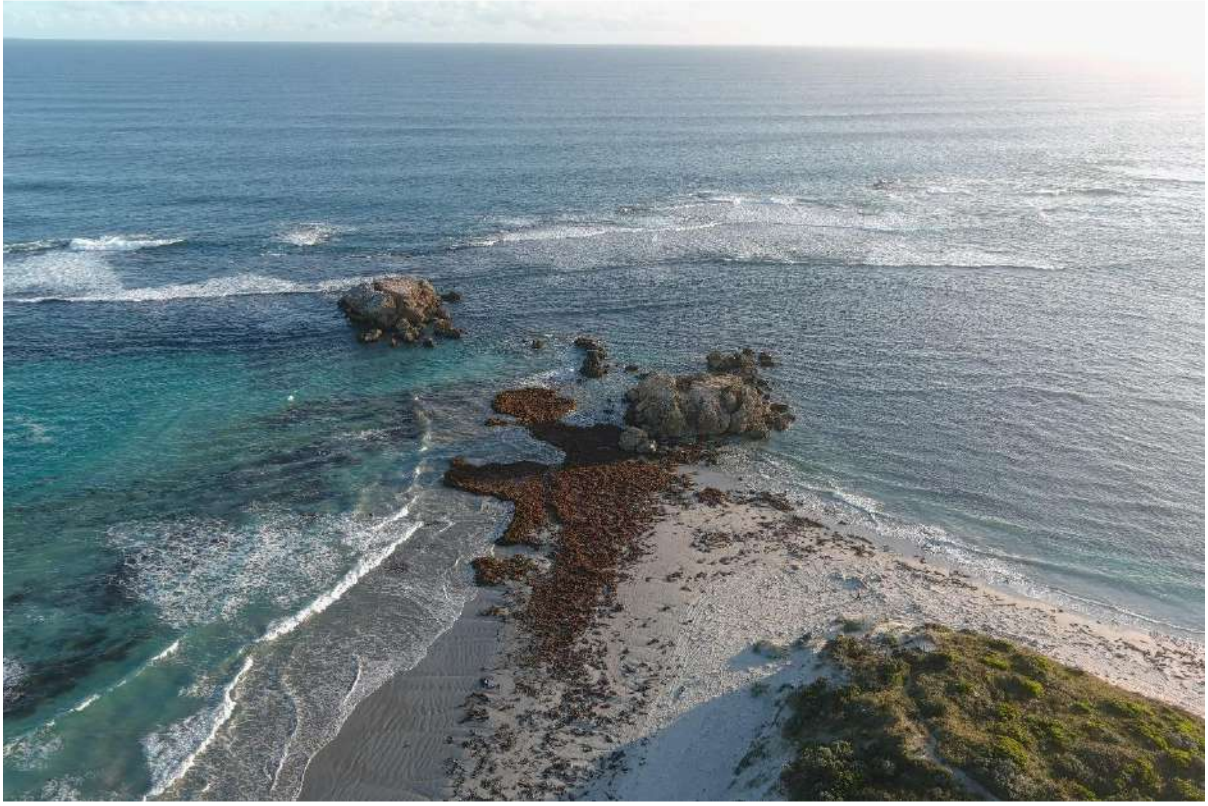
Appendix 1F Relevant photos for AWP


1F.1. SS *Admella* plaque erected in 1860, Cape Banks, SA (2021-03-20, P. Kermeen)


1F.2. Close up of *Admella* plaque, Cape Banks, SA (2021-03-20, P. Kermeen)

1F.3. Part of the SS *Admella* plaque memorialising the people stranded onboard the midships, Cape Banks (2021-03-20, P. Kermeen)

1F.4. 1.5 km northwest of Cape Banks Lighthouse with sand dunes (2021-09-26, P. Kermeen)



1F.5. Oblique view of the Signal Marker rocks facing west, Cape Banks (2022-07-05, P. Kermeen)

Ship Wrecks

14	Acis	1904
29	Adelaide	1861
6	Admella	1859
10	Aeolus	1894
8	Agnes	1876
23	Bandicoot	1861
30	Broughton	1947
9	Corio	1951
22	Countess	1876
4	Edith Haviland	1877
19	Flinders	1876
5	Flying Cloud	1870
21	Galatea	1876
11	Glenrosa	1890
7	Helen	1882
20	Irene	1892
15	Iron Age	1855
16	Isabella	1844
24	J Lovett	1852
31	John Ormerod	1861
3	Lemael	1921
25	Lotus	1892
26	Miami	1861
12	Nene Valley	1854
27	Prince of Wales	1873
13	Southern Cross	1880
28	St. Marc	1876
17	Tenterden	1893
1	Troas	1865
2	Varoqn	1856
18	Witness	1853

1F.6. List of all known shipwrecks in southeast South Australia, Port MacDonnell Maritime Museum, Port MacDonnell, SA (2021-03-20, Side 1, Board 1)

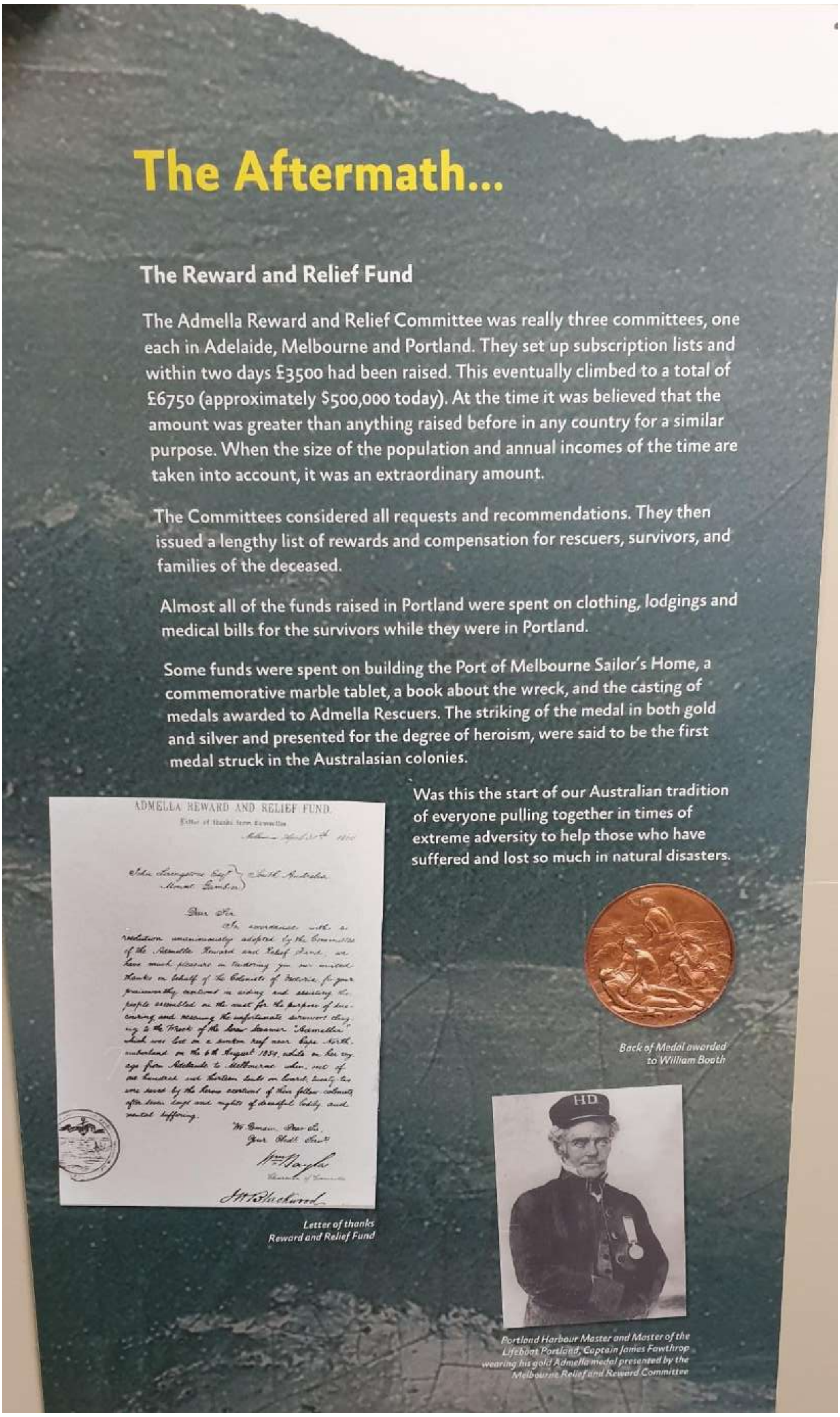
Ships Lost

Emu	1861
Walrus	1862
Triumph	1874
Prima Donna	1880
Lialeeta	1925

Ships Refloated

Young Australian	1854
Jet	1861 & 1862
Flying Squirrel	1862
Sea Bird	1873
Orwell	1873
Rachel Cohen	1877

1F.7. List of lost and refloated vessels in south-east South Australia, Port MacDonnell Maritime Museum, SA (2021-03-20, Side 2, Board 1)



The Aftermath...

The Reward and Relief Fund

The Admella Reward and Relief Committee was really three committees, one each in Adelaide, Melbourne and Portland. They set up subscription lists and within two days £3500 had been raised. This eventually climbed to a total of £6750 (approximately $500,000 today). At the time it was believed that the amount was greater than anything raised before in any country for a similar purpose. When the size of the population and annual incomes of the time are taken into account, it was an extraordinary amount.

The Committees considered all requests and recommendations. They then issued a lengthy list of rewards and compensation for rescuers, survivors, and families of the deceased.

Almost all of the funds raised in Portland were spent on clothing, lodgings and medical bills for the survivors while they were in Portland.

Some funds were spent on building the Port of Melbourne Sailor's Home, a commemorative marble tablet, a book about the wreck, and the casting of medals awarded to Admella Rescuers. The striking of the medal in both gold and silver and presented for the degree of heroism, were said to be the first medal struck in the Australasian colonies.

Was this the start of our Australian tradition of everyone pulling together in times of extreme adversity to help those who have suffered and lost so much in natural disasters.

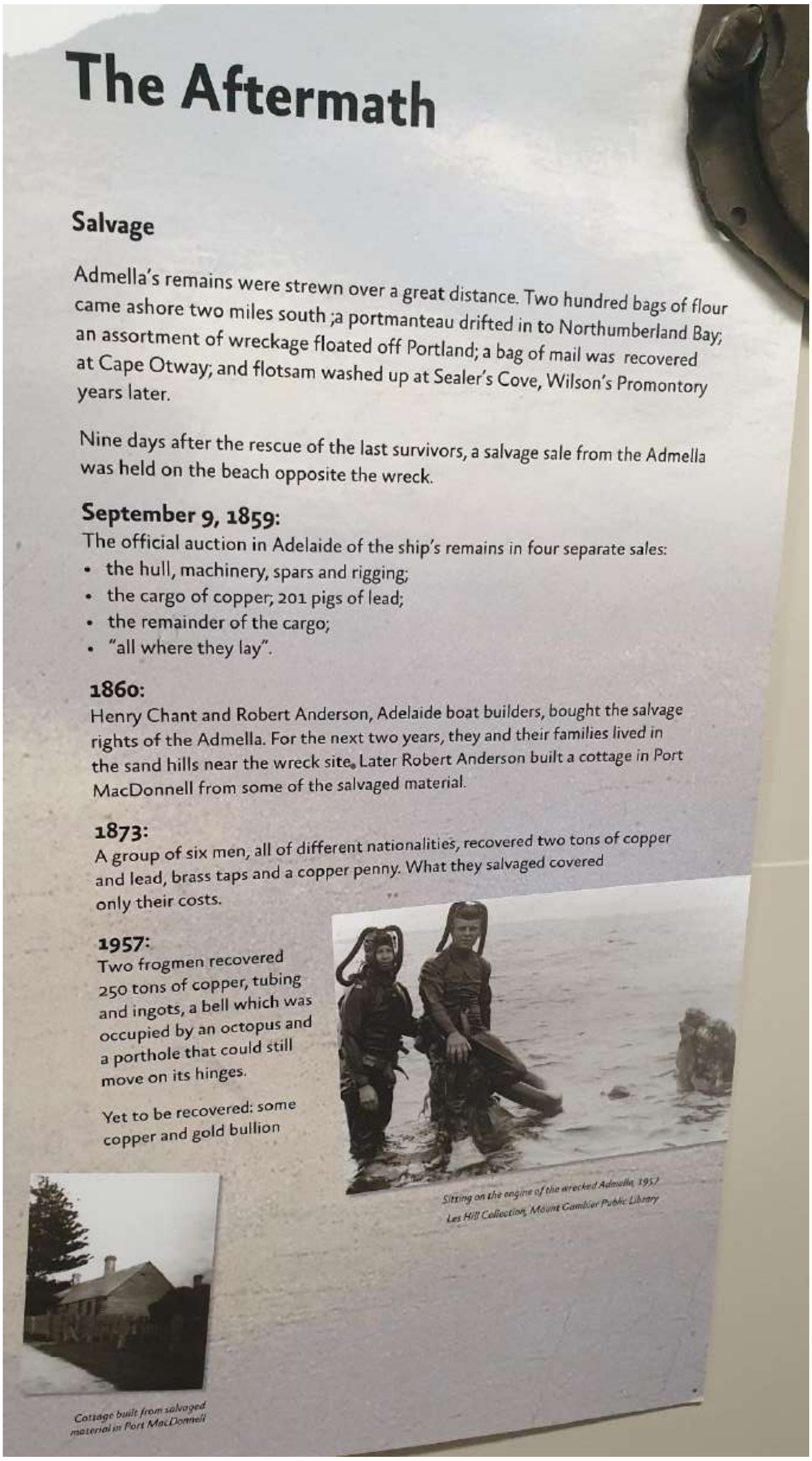
ADMELLA REWARD AND RELIEF FUND.

Letter of thanks
Reward and Relief Fund

Back of Medal awarded to William Booth

Portland Harbour Master and Master of the Lifeboat Portland, Captain James Fawthrop wearing his gold Admella medal presented by the Melbourne Relief and Reward Committee

1F.8. Information board inside *Admella* exhibit 'Aftermath', Port MacDonnell Maritime Museum, SA (2021-03-20, Admella board 4)



The Aftermath

Salvage

Admella's remains were strewn over a great distance. Two hundred bags of flour came ashore two miles south ;a portmanteau drifted in to Northumberland Bay; an assortment of wreckage floated off Portland; a bag of mail was recovered at Cape Otway; and flotsam washed up at Sealer's Cove, Wilson's Promontory years later.

Nine days after the rescue of the last survivors, a salvage sale from the Admella was held on the beach opposite the wreck.

September 9, 1859:
The official auction in Adelaide of the ship's remains in four separate sales:

- the hull, machinery, spars and rigging;
- the cargo of copper; 201 pigs of lead;
- the remainder of the cargo;
- "all where they lay".

1860:
Henry Chant and Robert Anderson, Adelaide boat builders, bought the salvage rights of the Admella. For the next two years, they and their families lived in the sand hills near the wreck site. Later Robert Anderson built a cottage in Port MacDonnell from some of the salvaged material.

1873:
A group of six men, all of different nationalities, recovered two tons of copper and lead, brass taps and a copper penny. What they salvaged covered only their costs.

1957:
Two frogmen recovered 250 tons of copper, tubing and ingots, a bell which was occupied by an octopus and a porthole that could still move on its hinges.

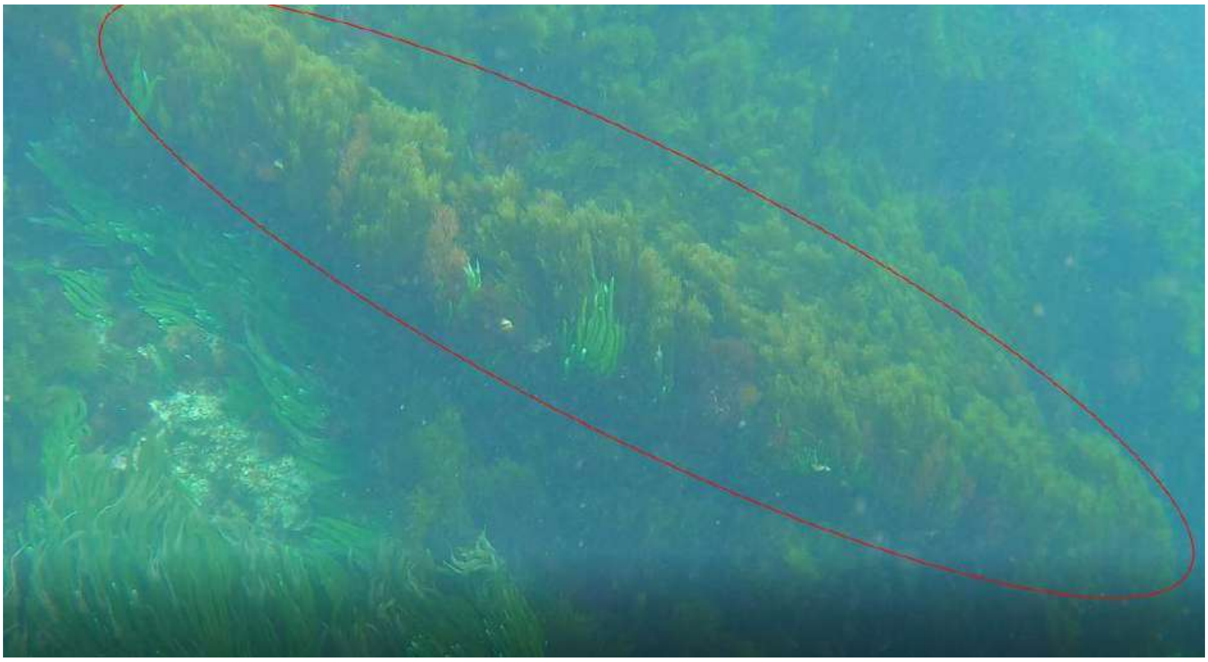
Yet to be recovered: some copper and gold bullion

Sitting on the engine of the wrecked Admella, 1957
Les Hill Collection, Mount Gambier Public Library

Cottage built from salvaged material in Port MacDonnell

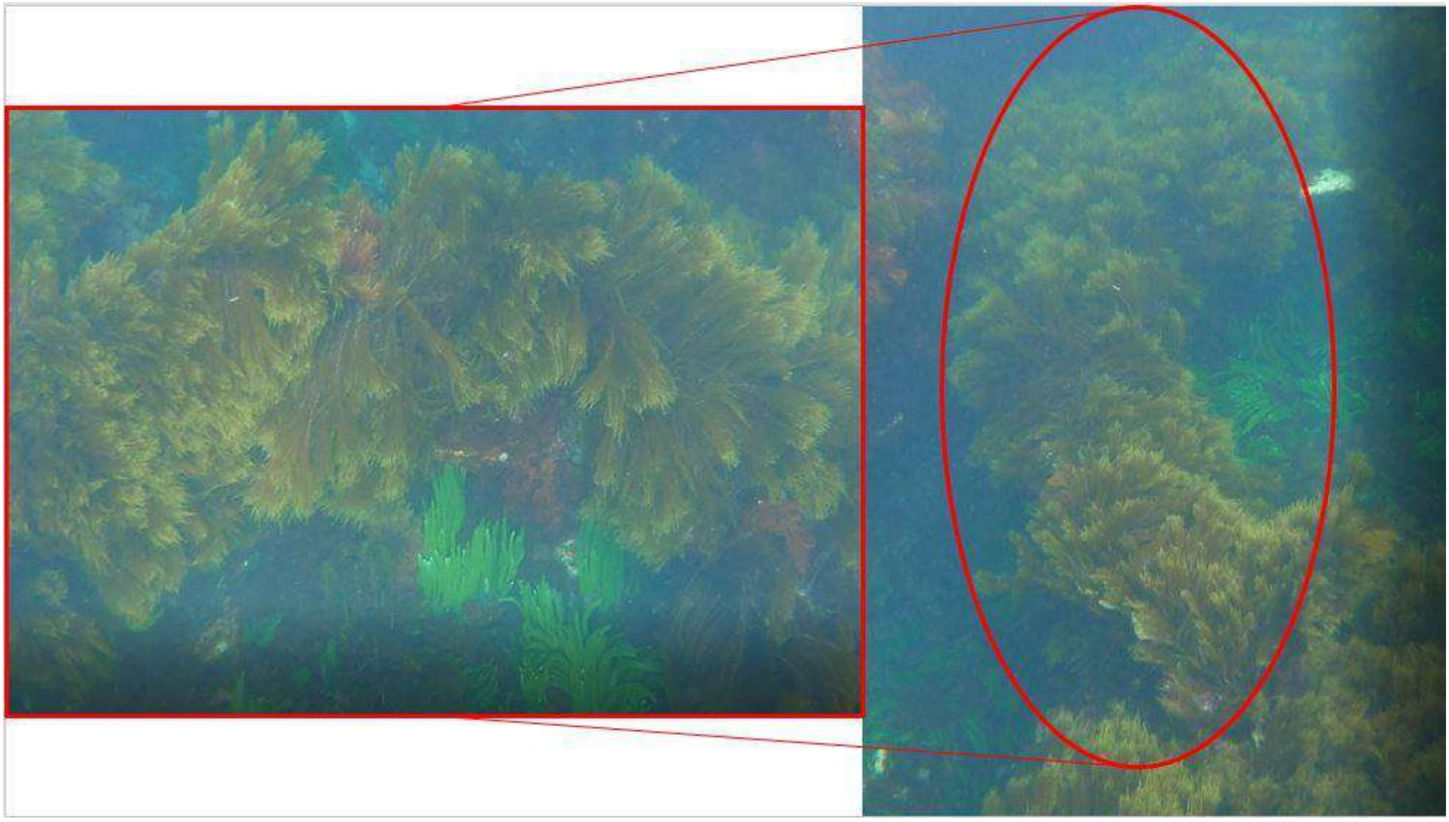
1F.9. Information board inside *Admella* exhibit on salvage operations, Port MacDonnell Maritime Museum, SA (2021-03-20, Admella board 5)

Appendix 1G Ship related material recorded at ADM1



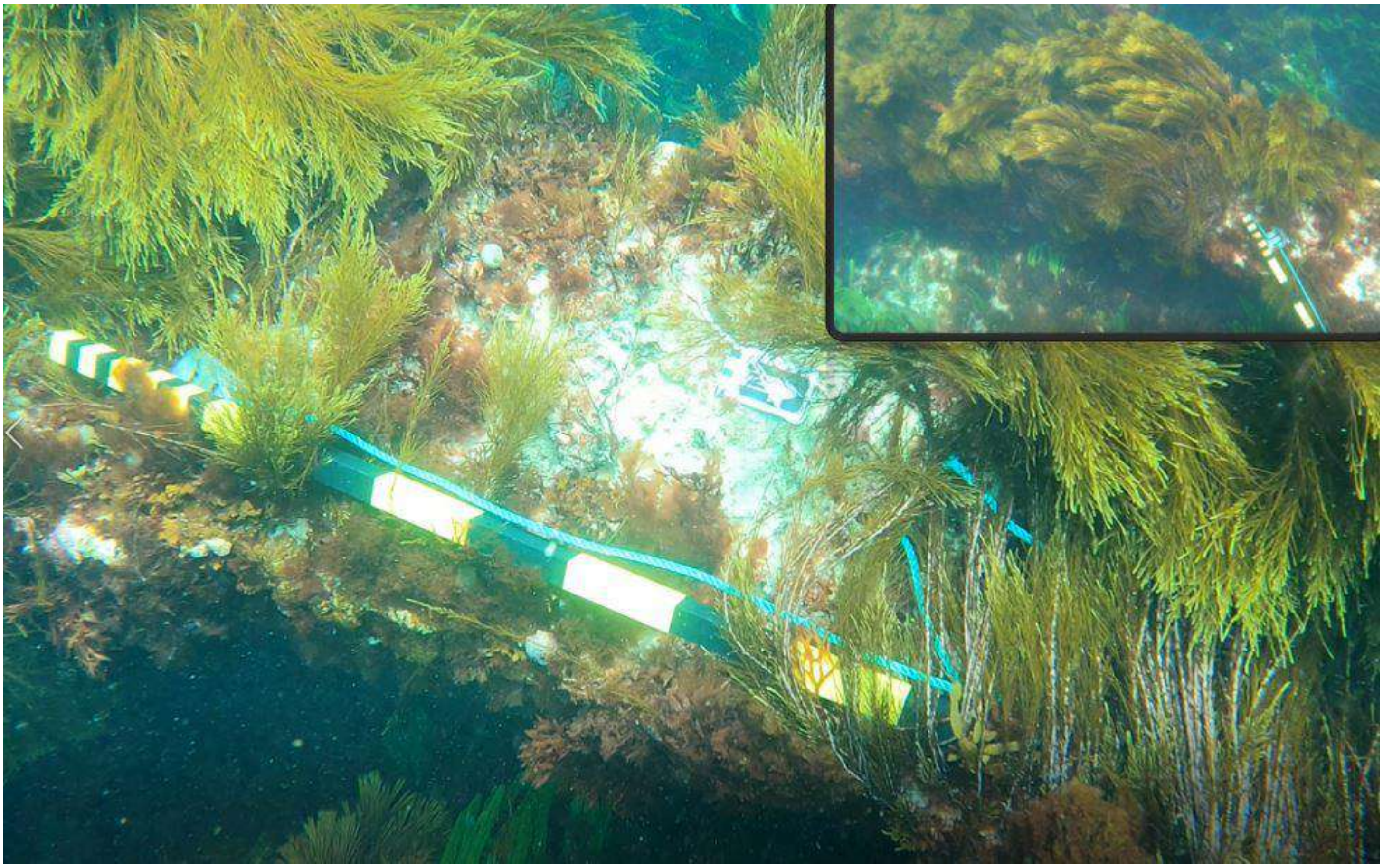
1G.1. ADM1-001 ferrous material with 'U' shaped culvert (2022-01-12, P. Kermeen)

1G.2. ADM1-002 Potential anchor with fluke protruding out from limestone seafloor, C. Lewis in background (2022-01-13, P. Kermeen)



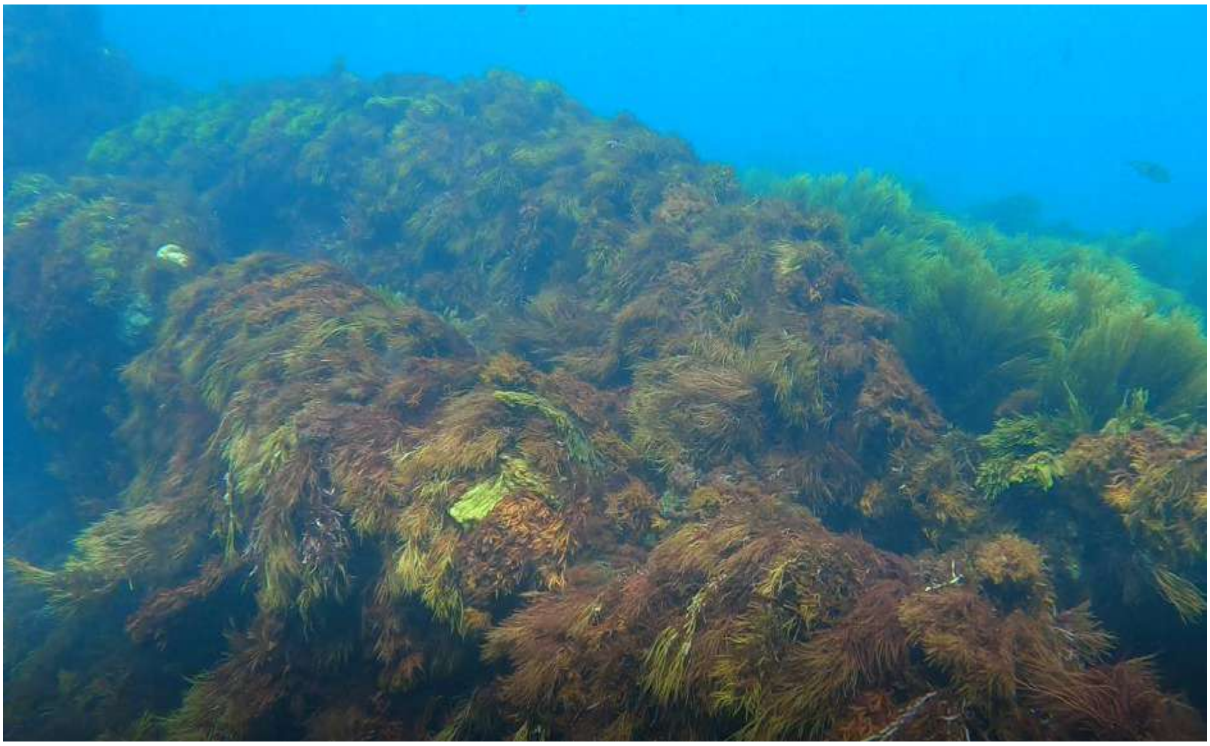
1G.3. ADM1-003 potential base for iron funnel (2022-01-12, P. Kermeen)

1G.4. ADM1-004 second recorded potential funnel base (2022-01-12, P. Kermeen)



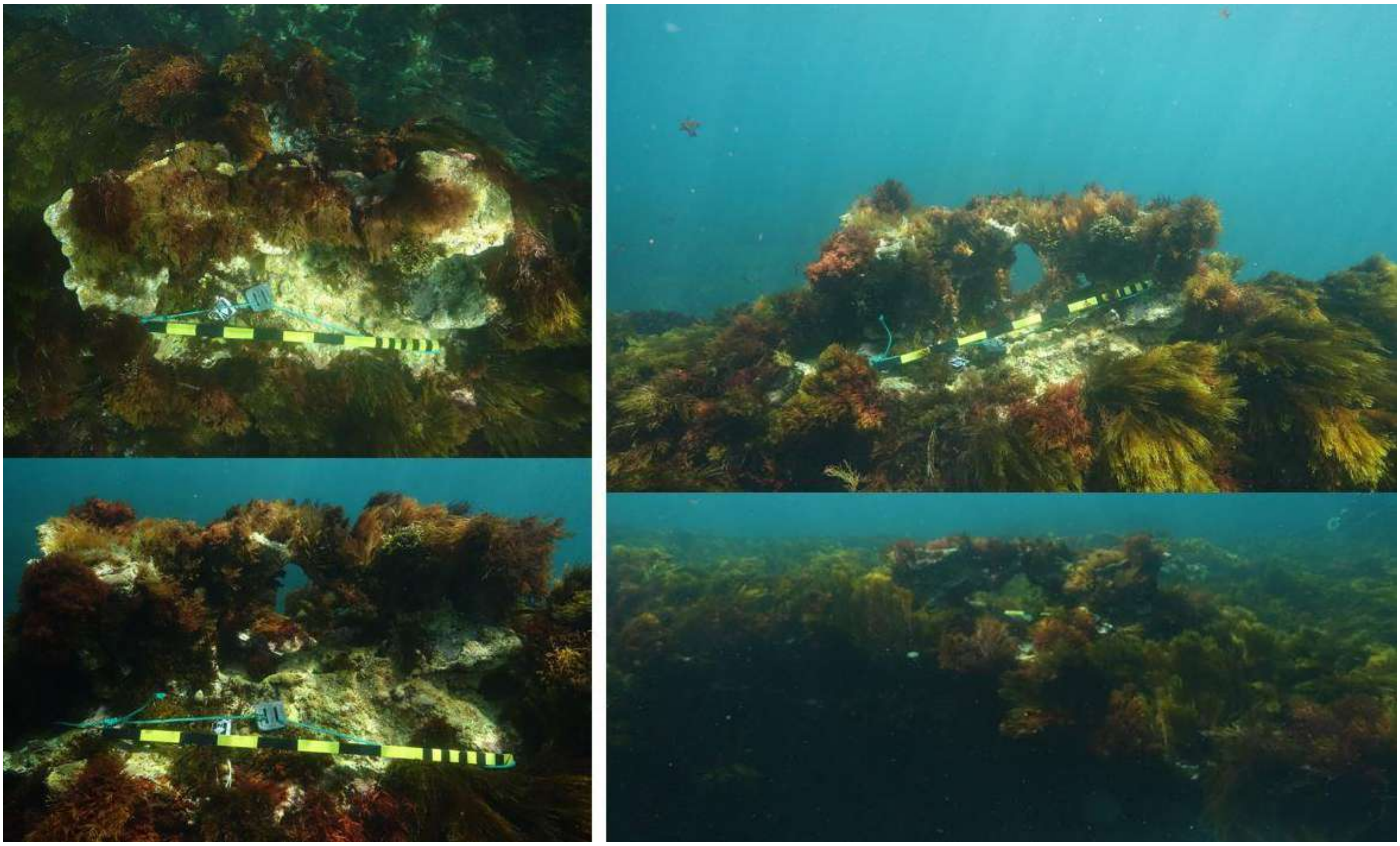
1G.5. ADM1-004 oblique view of ring that sits 10 m from ADM1-003 (2022-01-12, P. Kermeen)

1G.6. ADM1-005 Flat object with narrow jutting base, potentially limestone (2022-01-12, P. Kermeen)



1G.7. ADM1-006 Fragment from main-line keelson (2022-01-12, P. Kermeen)

1G.8. ADM1-006 oblique perspective to observe depth of ‘U’ shape making part of the mainline keelson (2022-01-12, P. Kermeen)

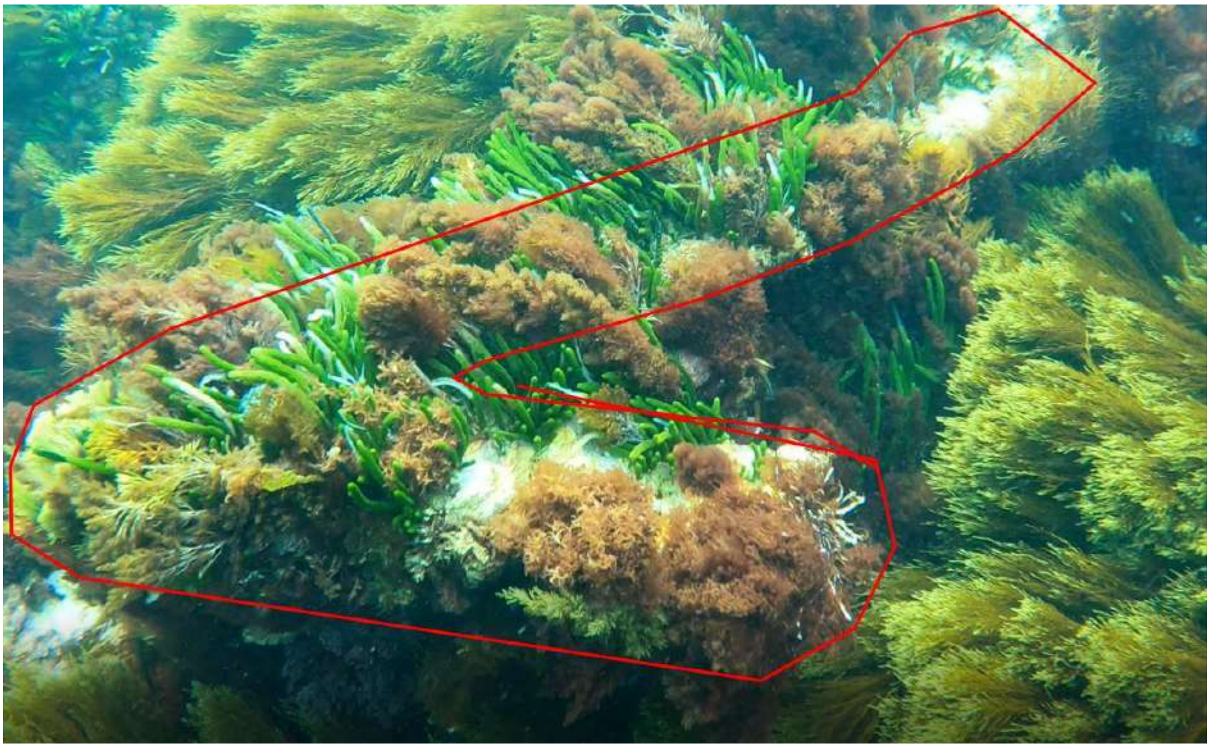


1G.9. ADM1-007 two concreted ‘Bitts’ from vessel (2022-01-13, P. Kermeen)

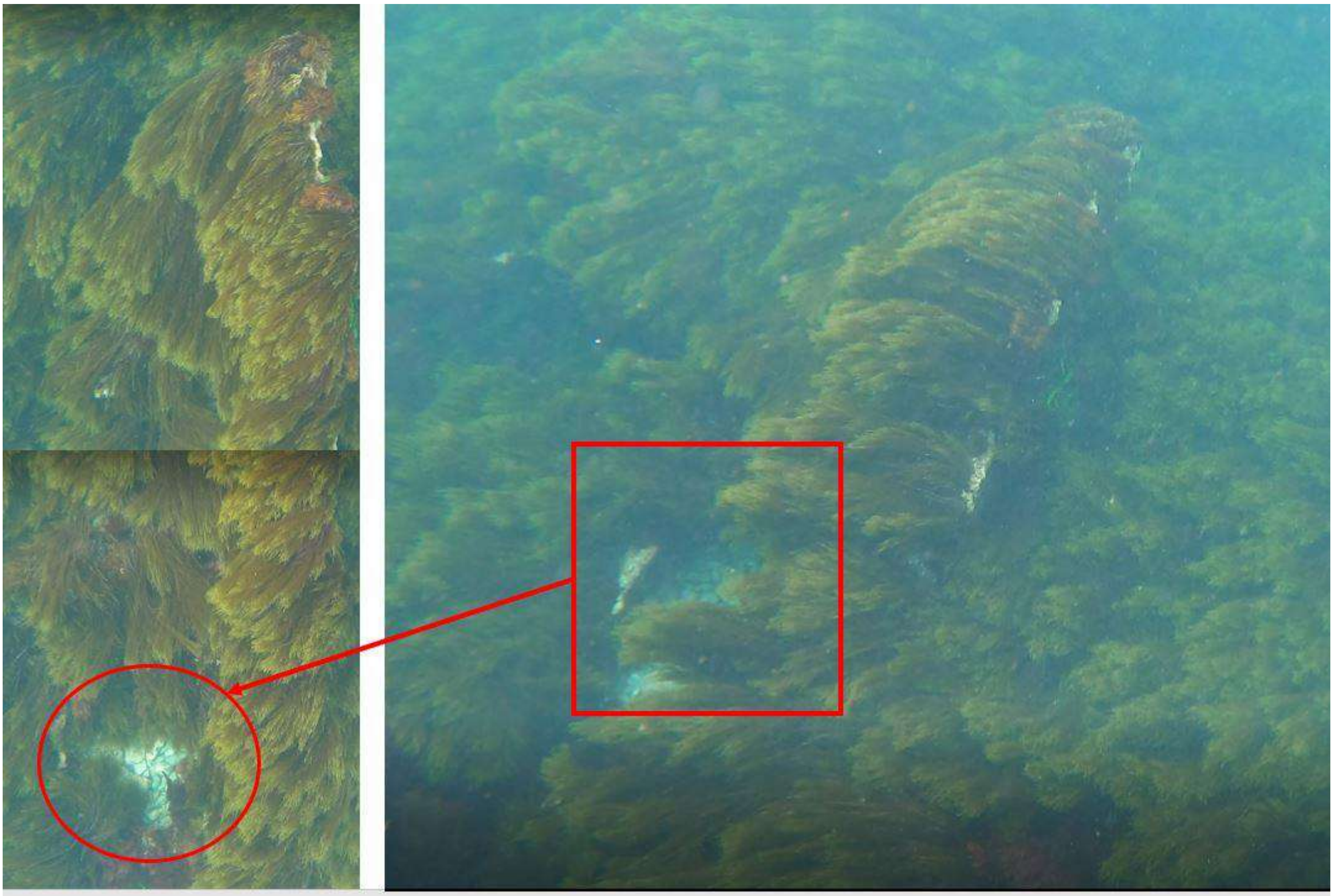
1G.10. ADM1-008 U-shaped structure resembling a semi-box beam (2022-01-12, P. Kermeen)

1G.11. ADM1-009, 010, 011 Three elongated ridges potentially bulb iron or single angle iron beams (2022-01-13, P. Kermeen)

1G.12. ADM010 middle single angle beam’s end point and oblique view height reference (2022-01-13, P. Kermeen)



1G.13. ADM12 potential anchor fluke and arm (2022-01-13, P. Kermeen)



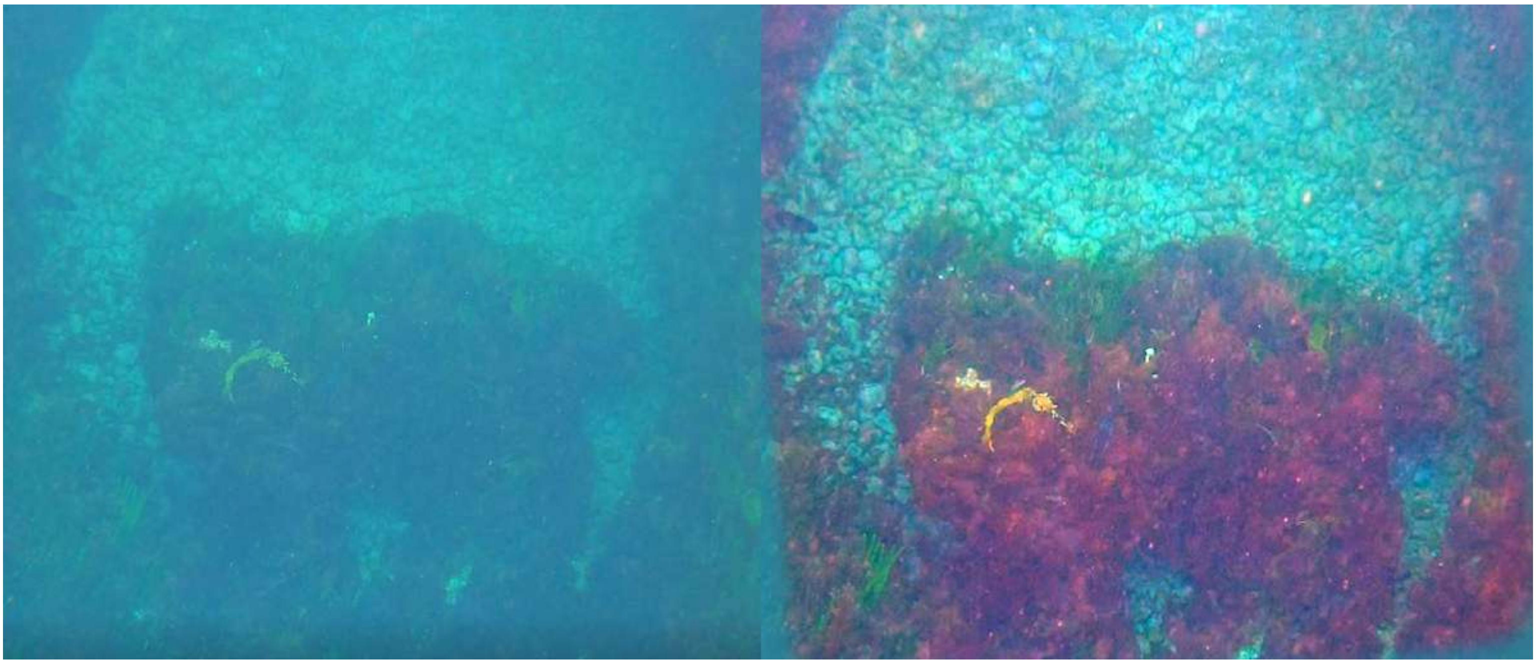
1G.14. ADM1-013 potential remaining hull structure with cats-eye (2022-01-13, P. Kermeen)

1G.15. ADM1-014 potential anchor stock and head (2022-01-13, P. Kermeen)


1G.16. ADM1-015 potentially concreted anchor chain (2022-01-13, P. Kermeen)

1G.17. ADM1-016 potential semi-box beam (2022-01-13, P. Kermeen)

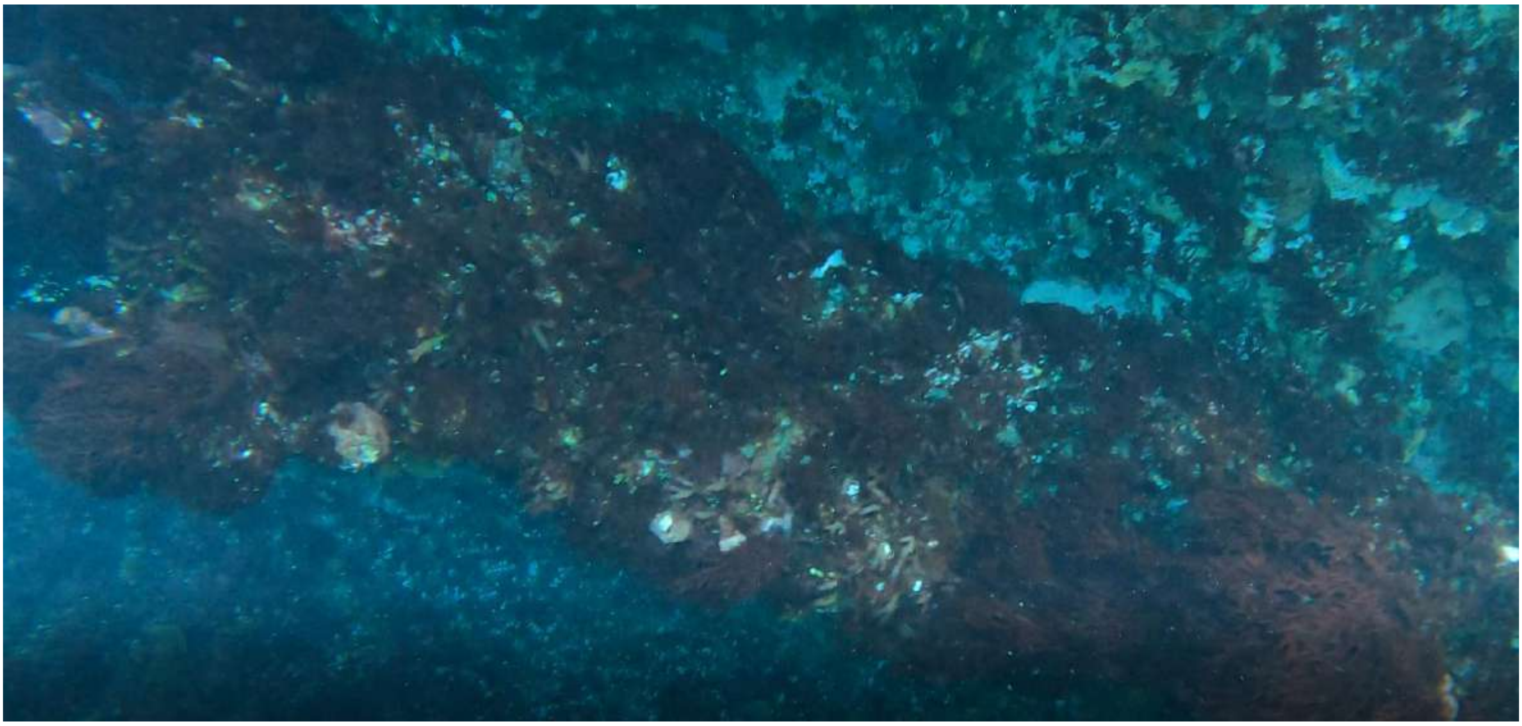
1G.18. ADM1-017 Upright structure with two small cylindrical shapes jutting out either side (2022-01-12, P. Kermeen)



1G.19. ADM1-018 large, concreted structure (2.6 m Length) in fissure at 4.8 m depth (2022-01-12, P. Kermeen)

1G.20. ADM1-019 Rudder truck support frame plan view (2022-01-12, P. Kermeen)

1G.21. ADM1-019 Oblique view of rudder trunk support frame to show extent (2022-01-12)

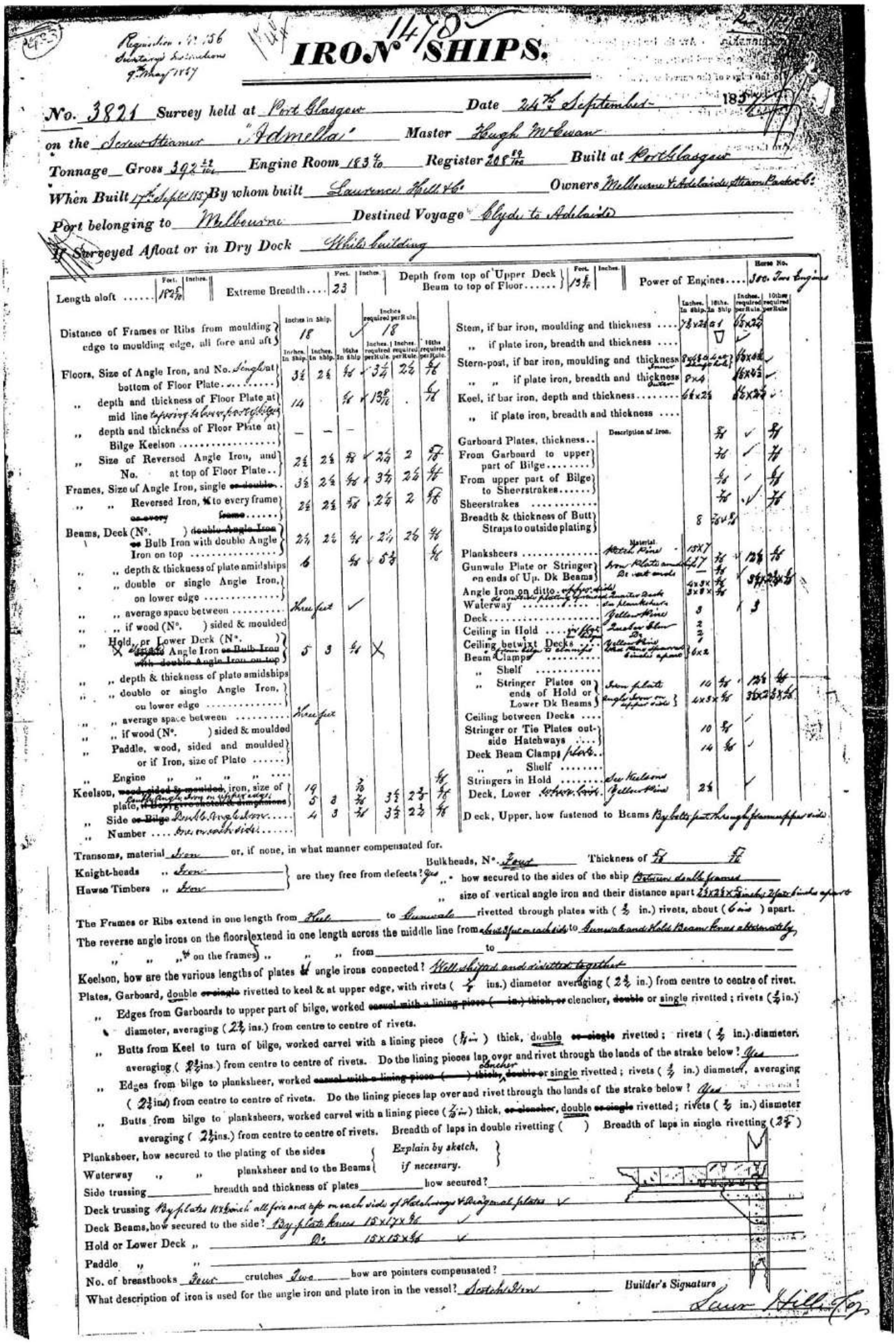


1G.22. ADM1-020 rudder trunk angled support frame heavily deteriorated underneath main ‘A’ frame (2022-01-12, P. Kermeen)

1G.23. ADM1-021 potential arms from anchor with concreted chain (2022-01-13, P. Kermeen)

1G.24. ADM1-22 potential cats-eye with concreted hull remains (2022-01-13, P. Kermeen)

Appendix 1H: Lloyd's Register: Engineering Report



Requisition 42.156
Secretary's Instructions
9th May 1857

1478

IRON SHIPS.

No. 3821 **Survey held at** Port Glasgow **Date** 24th September 1857
on the Screw Steamer "Admella" **Master** Hugh McEwan
Tonnage — **Gross** 392 42/100 **Engine Room** 183 5/10 **Register** 208 69/100 **Built at** Port Glasgow
When Built 17th Septr 1857 **By whom built** Laurence Hill & Co **Owners** Melbourne & Adelaide Steam Packet Co
Port belonging to Melbourne **Destined Voyage** Clyde to Adelaide
If Surveyed Afloat or in Dry Dock While building

Length aloft ...... Feet 182 5/10 | Extreme Breadth .... Feet 23 | Depth from top of Upper Deck Beam to top of Floor ...... Feet 13 5/10 | Power of Engines .... Horse No. 300. Two Engines

	Inches in Ship	Inches in ship	16ths in Ship	Inches required per Rule	Inches required per Rule	16ths required per Rule
Distance of Frames or Ribs from moulding edge to moulding edge, all fore and aft	18		✓	18		
Floors, Size of Angle Iron, and No. single at bottom of Floor Plate	3½	2½	6/16	3¼	2½	6/16
„ depth and thickness of Floor Plate at mid line tapering to lower part of bilge	14		6/16	13 8/16		6/16
„ depth and thickness of Floor Plate at Bilge Keelson	—	—	—			
„ Size of Reversed Angle Iron, and No. at top of Floor Plate ..	2½	2½	5/16	2¼	2	5/16
Frames, Size of Angle Iron, single ~~or double~~ ..	3½	2½	6/16	3½	2½	6/16
„ „ Reversed Iron, to every frame ~~on every frame~~	2½	2½	5/16	2¼	2	5/16
Beams, Deck (Nº.) ~~double Angle Iron or~~ Bulb Iron with double Angle Iron on top	2¾	2½	6/16	2¼	2½	6/16
„ „ depth & thickness of plate amidships	6		6/16	5½		6/16
„ „ double or single Angle Iron, on lower edge						
„ „ average space between	Three feet		✓			
„ „ if wood (Nº.) sided & moulded						
„ Hold, or Lower Deck (Nº.) [illegible] Angle Iron ~~or Bulb Iron with double Angle Iron on top~~	5	3	6/16	✗		
„ „ depth & thickness of plate amidships						
„ „ double or single Angle Iron, on lower edge						
„ „ average space between	Three feet					
„ „ if wood (Nº.) sided & moulded						
„ Paddle, wood, sided and moulded or if Iron, size of Plate						
„ Engine „ „ „ „						6/16
Keelson, ~~wood sided & moulded~~, iron, size of plate, ~~if Bog, give sketch & dimensions~~ double angle iron on upper edges	19 5	 3	7/16 7/16	 3½	 2⅔	7/16 7/16
„ Side ~~or Bilge~~ Double angle iron	4	3	7/16	3½	2½	6/16
„ Number .... one on each side						

	Description of Iron / Material	Inches in ship	16ths in Ship	Inches required per Rule	16ths required per Rule
Stem, if bar iron, moulding and thickness		7½x2¼	6 1	6½x2¼	
„ if plate iron, breadth and thickness				✓	
Stern-post, if bar iron, moulding and thickness Inner		8x4½ [illegible]		6½x4½	✓
„ „ if plate iron, breadth and thickness Outer		8x4		6½x4½	✓
Keel, if bar iron, depth and thickness		6½x2½		6½x2½	✓
„ if plate iron, breadth and thickness					
Garboard Plates, thickness ..			8/16	✓	8/16
From Garboard to upper part of Bilge			7/16	✓	7/16
From upper part of Bilge to Sheerstrakes			6/16	✓	6/16
Sheerstrakes			7/16	✓	7/16
Breadth & thickness of Butt Straps to outside plating		8	7/16 & 8/16		
Planksheers	Pitch Pine	15x7		12½	
Gunwale Plate or Stringer on ends of Up. Dk Beams	Iron Plate and [illegible] Do at ends	17 —	7/16 6/16	✓	5½x2¾x6/16
Angle Iron on ditto. upper side Do outside plating of raised Quarter Deck		4x3x 3x3x	6/16 7/16		
Waterway	on planksheers	3		3	
Deck	Yellow Pine	3			
Ceiling in Hold .... in flat / in bilge	Quebec Elm Do	2 2			
Ceiling betwixt Decks .... from bilge to clamps	Yellow Pine [illegible] spaced 2 inches apart	1 6x2			
Beam Clamps					
„ Shelf					
„ Stringer Plates on ends of Hold or Lower Dk Beams	Iron plate angle iron on upper side	14 4x3x	6/16 6/16	12½ 3½x2½x6/16	6/16
Ceiling between Decks				✓	
Stringer or Tie Plates outside Hatchways		10	8/16		
Deck Beam Clamps plate ..		14	6/16	✓	
„ „ Shelf					
Stringers in Hold	See Keelsons			✓	
Deck, Lower where laid .	Yellow Pine	2½			

Deck, Upper, how fastened to Beams By bolts put through flange upper side

Transoms, material Iron or, if none, in what manner compensated for.
Knight-heads „ Iron } are they free from defects? Yes
Hawse Timbers „ Iron }
Bulkheads, Nº. Four Thickness of 5/16 5/16
„ how secured to the sides of the ship Between double frames
„ size of vertical angle iron and their distance apart 2½x2½x5/16 inches 2 feet 6 inches apart

The Frames or Ribs extend in one length from Keel to Gunwale rivetted through plates with (¾ in.) rivets, about (6 ins) apart.
The reverse angle irons on the floors extend in one length across the middle line from about 3 feet on each side to Gunwale and Hold Beam Knees alternately
„ „ „ on the frames „ „ „ from to
Keelson, how are the various lengths of plates & angle irons connected? Well shifted and rivetted together
Plates, Garboard, double ~~or single~~ rivetted to keel & at upper edge, with rivets (⅞ ins.) diameter averaging (2½ in.) from centre to centre of rivet.
„ Edges from Garboards to upper part of bilge, worked ~~carvel with a lining piece (in.) thick, or~~ clencher, ~~double~~ or single rivetted; rivets (¾ in.) diameter, averaging (2¾ ins.) from centre to centre of rivets.
„ Butts from Keel to turn of bilge, worked carvel with a lining piece (8/16 in) thick, double ~~or single~~ rivetted; rivets (¾ in.) diameter, averaging (2¾ ins.) from centre to centre of rivets. Do the lining pieces lap over and rivet through the lands of the strake below? Yes
„ Edges from bilge to planksheer, worked ~~carvel with a lining piece ( ) thick,~~ clencher ~~double or~~ single rivetted; rivets (¾ in.) diameter, averaging (2¾ ins) from centre to centre of rivets. Do the lining pieces lap over and rivet through the lands of the strake below? Yes
„ Butts from bilge to planksheers, worked carvel with a lining piece (7/16 in) thick, ~~or clencher~~, double ~~or single~~ rivetted; rivets (¾ in.) diameter averaging (2¾ ins.) from centre to centre of rivets. Breadth of laps in double rivetting ( ) Breadth of laps in single rivetting (2¾)
Planksheer, how secured to the plating of the sides { *Explain by sketch,*
Waterway „ „ planksheer and to the Beams { *if necessary.* }
Side trussing breadth and thickness of plates how secured?
Deck trussing By plates 10x⅝ inch all fore and aft on each side of Hatchways & Diagonal plates ✓
Deck Beams, how secured to the side? By plate knees 15x17x6/16 ✓
Hold or Lower Deck „ Do 15x15x6/16 ✓
Paddle „ „
No. of breasthooks Four crutches Two how are pointers compensated?
What description of iron is used for the angle iron and plate iron in the vessel? Scotch Iron

Builder's Signature
Laur Hill & Co

1478 Iron

Workmanship. Are the lands or laps of the clenchwork in all cases in breadth at least five times the diameter of the rivets in double rivetted edges and butts, and at least three times the diameter of the rivets where single rivetting is admitted? *Yes*

Do the edges of the carvel work and of the butts fay close together throughout their length without requiring any making good of deficiencies? *Yes*

Do the fillings between the ribs and plates fill in solid with single pieces, or are they in short lengths of various thicknesses? *Solid*

Do the holes for rivetting plate to frames, lining pieces, or plate to plate, &c., conform well to each other? *Yes* and are the rivet holes well and sufficiently countersunk in the outer plate? *Yes*

Are there any rivets which either break into or have been put through the seams or butts of the plating? *None*

Her Masts, Yards, &c., are in *Good* condition, and sufficient in size and length.

N°.	She has SAILS.	CABLES, &c.	Fathoms.	Inches.	ANCHORS, and their weights.	N°.	Weight.
Four	Fore Sails,	Chain	200	1⅛	Bowers ... *Patent*	3	12. 2. 20 12. 1. – 11. 3. –
		" *Stream Chain*	60	½			
Two	Fore Top Sails,	Hempen Stream Cable	90	7½			
Two	Fore Topmast Stay Sails,	Hawser	90	5	Stream, ... *Patent*	1	4. 1. 15
One	Main Sails,	Towlines	90	4			
One	Main Top Sails,	Warp			Kedge, ... *Patent*	1	2. – –
and *well found in other sails*		All of *Good* quality.					

Her Standing *rigging is Wire* and Running Rigging *Hemp* sufficient in size and *Good* in quality.

She has *One* Long Boat and *Life Boat, Cutter & Gig*

The present state of the Windlass *with patent purchase* is *Good* Capstan *Two double winches Good* and Rudder *Good* Pumps *Three lead Good*

General Remarks, Statement and Date of Repairs, extent of corrosion (if any) both internally and externally, and condition of rivets.

DATES of Surveys held while building, as per Section 17.
- 1st. On the several parts of the frame, when in place, and before the plating was wrought
- 2nd. On the plating during the progress of rivetting
- 3rd. When the beams were in and fastened, and before the decks were laid
- 4th. When the ship was complete, and before the plating was finally coated
- 5th. After the ship was launched

Specially Surveyed

Laid on April, and launched 17th Sept. 1857. Specially surveyed in accordance with Secretary's instructions dated 9th May 1857. She has four watertight bulkheads 5/16 inch, extending to upper Deck Beams, and one ditto aft extending to Cabin sole Beams, forming watertight tank over shaft, rivetted with 5/8 inch rivets, 3 inches apart, and trussed with Angle Iron 2½×2½×5/16 inch, about 2 feet 6 inches apart, rivetted with 5/8 inch rivets, 9 inches apart. Deck Beam Stringer plate cuts off at raised Quarter Deck, and continued aft on raised Quarter Deck Beams. At break of Quarter Deck in 'tween Decks are Iron plates 15×5/8 inch, of 7 feet 6 inches in length, fore side and aft side of bulkhead there, with single Angle Iron on upper and lower edge 3×3×½ inch, well rivetted to frames. Hold Beam Stringer plate extends from forward, aft to Engine Room bulkhead, cut off there, and continued with single Angle Iron 4×3×½ inch between fore and after bulkheads of Engine and Boiler space vertically against frames; stringer plate continued aft side on Hold Beams; Bilge Kelson from forward aft to deep plates forming Engine seat, and connected thereto by plate knees; and extend from aft side of Engine seat to bulkhead forming tank over shaft. Breasthooks formed by plates across upper and lower Deck stringer plates, Bilge Kelson, and independent Hooks. Crutches formed by connection of Hold Beam Stringer plate and Iron flat of tank over shaft. Stringers and clamp plate pass through bulkheads; double Angle Iron 4×3×½ inch from after bulkhead of Engine Room aft in lieu of clamp plate; double Angle Iron Stringer 4×3×½ inch, about 2 feet 6 inches below Hold Beams from after bulkhead of Engine Room right aft. Upper Deck fastened by bolts with nut and screw put through from upper side. Frames are heavy, and plating equal to the Rules for the 9 Years grade. Workmanship and materials good. Ground tackle complete and of the best description. Testing Certificate of chain Cables produced. Engineers Certificate herewith

The frames being heavy, and plating equal to that prescribed by the Rules; we are of opinion she may be classed 9 A1.

In what manner are the surfaces preserved from oxidation? *By three coats of Red lead inside and outside, and one coat of Hancock's composition on bottom*

~~I am~~ *We are* of opinion this Vessel should be classed *9 A1.*

The amount of the Fee ....£ *4 : " : "* is received by me,

Special ......£ *19 : 12 : "*

Certificate (if required) ....£ *" : " : "*

John B. Cummins

Thomas Congdon

Committee's Minute *2nd October* 18*57*

Character assigned *A 1 for 9 Years*

Built of Iron

I see no objection above eleven

1 Oct. 1857

Appendix 1I: Coastal Integration Workflow

The Coastal Integration Workflow is a method designed for maritime archaeologists (research and commercial) to achieve centimetre accurate high resolution orthomosaics for the purpose of analysing cultural material (Aboriginal and colonial), submerged landscapes (including reef outcrops, reef bommies, etc), and submerged geomorphological structures (crevices, fissures, sinkholes, etc). The purpose of this workflow is to gather contextual information on a broader scale to incorporate a larger research design of 'how the landscape impacts cultural material' with the presence of existing natural structures. AWP proved throughout this thesis that the combination of RPAS and ROV can potentially illuminate weather patterns and hydrodynamic flow (direction and speed) to facilitate a better understanding of how cultural material is distributed and in preservation state researchers will likely find on sites like those of Cape Banks. Figure 1.1I details the technique and how to use RPAS autonomous survey for coastal mapping over water surfaces.

Figure. 1.1I Coastal Integration Workflow (CIW) example for Cape Banks near ADM1 site.

The CIW workflow utilises the beach and bushland area to create fixed anchor points for rendering. SfM works better with non-moving pixels from frame to frame and would be undesirable for working over the sea surface. To counter this, 30% of the model must be on land, thus, creating secure tie-points that can be maximised on land leading to better ‘bridging’ when attempting to render over large bodies of water. As seen in the above figure, 30% of 1 km in total then needs at minimum 300 m of land coverage to create strong anchor points for the photogrammetry software to render and build a solid foundation when rendering process starts to establish tie-points over water bodies.