Coastal Erosion: An "Elegantly Simple Solution" at Harrington

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ABSTRACT

An "elegantly simple solution" was how Engineer Bruce Collins described a proposal from Surveyor Grant Calvin to address the problems of siltation within the entrance of the Manning River at Harrington on the Mid North Coast of NSW. He provided full support for this economic and viable answer to these siltation problems. This paper first explores the background to the problem and its solution, providing historical and current maps of the area in explanation of the hydrological forces involved. A photographic record of the coastal erosion that appears to be caused by a shifting river entrance at Harrington is also presented. It then looks at the historic recovery of the beaches when the entrance stabilises in a location by the Harrington sea wall, which is the desired outcome of this solution for the river between Harrington and Manning Point and the beaches south to Old Bar. The ideas presented in this paper have the potential to dramatically reduce coastal erosion in at least one of the coastal erosion hot spots in New South Wales, at a fraction of the cost of other heavily engineered solutions.

KEYWORDS: *Harrington, Manning River, beach erosion.*

1 INTRODUCTION

The northern entrance of the Manning River at Harrington has always had shifting and siltation problems. After extensive investigations in the late 1880s by eminent British harbour designer Sir John Coode (Coode, 1889), a design was prepared, adopted and commenced for rock walls to facilitate safe shipping. The closing comments of Coode's report included a warning that the project should be completed in its entirety as designed: "It would certainly be preferable to defer action rather than embark on a project of insufficient scope or extent."

Unfortunately, over the course of time, the economic importance of a safe entrance to the Manning River has been reduced due to increase of rail and road infrastructure. Consequently, it was never completed. The long-term implications of not completing the project are currently showing with massive environmental degradation impacts of siltation, entrance mobility and devastating beach erosion.

A simple modification to the existing northern wall as proposed by this paper may reduce siltation, enhance natural scouring required to maintain a deep channel along the break wall and in turn dramatically reduce beach erosion evident along the adjoining beaches. These modifications, utilising the natural ebb and flow of the tides, are negligible in comparison to the long-term impacts of not doing anything. There are no perceivable negative effects. With the cost of perpetually studying the situation and never determining an ideal scenario, it is about time to try a tangible, simple proposal at a cost that is lower than some of the individual studies.

A 300 m shift in the beach alignment has occurred on the southern shore of the river entrance at the northern tip of Mitchells Island. This shift can be seen in the aerial photographic record around 1965-69 and 2011-22 and to a lesser extent around 1997. The beach to the south adjusts to keep in contact with this 300 m shift in the beach alignment. During the most recent event, the adjustment of the beach alignment and erosion of the foredunes has been photographed and forms part of this paper. The apparent cause of this change in the beach alignment is anthropogenic with a shoal of rocks in the beach being problematic.

Erosion along this beach has been subject to numerous studies (see section 9). To date none of these has made the connection between these seemingly innocuous rocks and the dramatic and devastating erosion that occurs on the adjoining beaches when the river interacts with these rocks (Figure 1). For comparison, if a similar 300 m shift in the beach alignment occurred at Collaroy, an erosion site of recent interest, the residents on The Avenue, located a couple of blocks west of Pittwater Road, would have ocean frontage (Figure 2).

Figure 1: Shoal of rocks on the beach that play their part in the occurring beach erosion.

Figure 2: Photomontage of the effect a 300 m shift would have at Collaroy Beach.

This paper explores the background to this problem and its solution, providing historical and current maps of the area in explanation of the hydrological forces involved. A photographic record of the coastal erosion that appears to be caused by a shifting river entrance at Harrington is also presented. It then investigates the historic recovery of the beaches when the entrance stabilises in a location by the Harrington sea wall, which is the desired outcome of this solution for the river between Harrington and Manning Point and the beaches south to Old Bar and Wallabi Point.

2 AN ELEGANTLY SIMPLE SOLUTION

“Time is an illusion – lunch time doubly so”, a line from Douglas Adams’ poorly named trilogy *The Hitchhiker’s Guide to the Galaxy,* is an apt place to start. The idea behind this “elegantly simple solution” came along one lunch time, as they do. It was the start of a journey that led to historic engineering reports and government investigations, crossing paths with a wide variety of people, state bureaucracy and exalted engineers’ reports that only a fertile mind like Adams might conjure up. This paper attempts to describe this journey.

At lunch time, survey field parties everywhere seek a comfortable high point from which to observe surroundings as the sandwiches or hot pies are consumed. At Harrington, the place to go for lunch is Pilot Hill overlooking the northern entrance of the Manning River. This location has always been a prominent place for surveyors. From this vantage point, on this particular lunch time in the 1990s, you could observe a jet of water spewing through the rock sea wall at the bottom of an outgoing tide. It looked like this jet of water was literally bending the flow of the ebb tide and pushing it away from the wall. On this day, it looked like this disruption to the river’s tidal flow had caused the river to change direction and flow to the sea well away from the rock wall that had been built to guide its flow.

On this particular lunch time, the surveyor chainman banter included thoughts like “Could the energy down there be redirected to actually stabilise the river entrance up against the rock break wall?”, “Would that maintain a usable entrance into and out of the river?” and “Could the changes observed in the river entrance that day be prevented by simply redirecting the flows we were observing?” It was a thought bubble of this ilk that led to the “elegantly simple solution” presented in this paper.

That thought bubble may have burst right then and there and died as most lunch time discussions do, had it not been shared with local Engineer Bruce Collins back at the office that afternoon. Bruce, the Collins in Collins Walshe & Fitzsimmons (CW&F), was the engineer in the consulting surveying and engineering firm in Taree. He was enamoured with the ideas and encouraged progressing it into a working concept. With the firm’s backing, local photographer Karl Bayer provided a quality electronic image and Peter Calabria, from Sunne Printing, generated a photomontage of the jet of water and the concepts (Figure 5). A colour poster was produced (Figure 3) and sent out with letters of support from Bruce (Figure 4) to council, politicians, the Public Works Department (PWD) and the like. Bruce and his father-in-law Jack Dunn took a stand at the local Envirofair, displayed the poster and handed out flyers to attendees.

To put this into perspective, in the late 1990s electronic manipulation of imagery was not widely available. Sunne Printing’s computing systems, though old hat now, provided computing power beyond anything else available in town. Both Peter and Karl, upon hearing about the concepts we were trying to portray, provided their imagery, time and expertise gratis to the cause.

What caused this jet of water through the rock wall? To answer this question, we need to gather a bit of background information. Note that the jet of water going out also goes inside the wall with the flood tide. A plume of sand locates the ‘gantry’ or hole in the wall. This plume of sand, visible in aerial images, will assist the reader in locating the ‘gantry’ in the images.

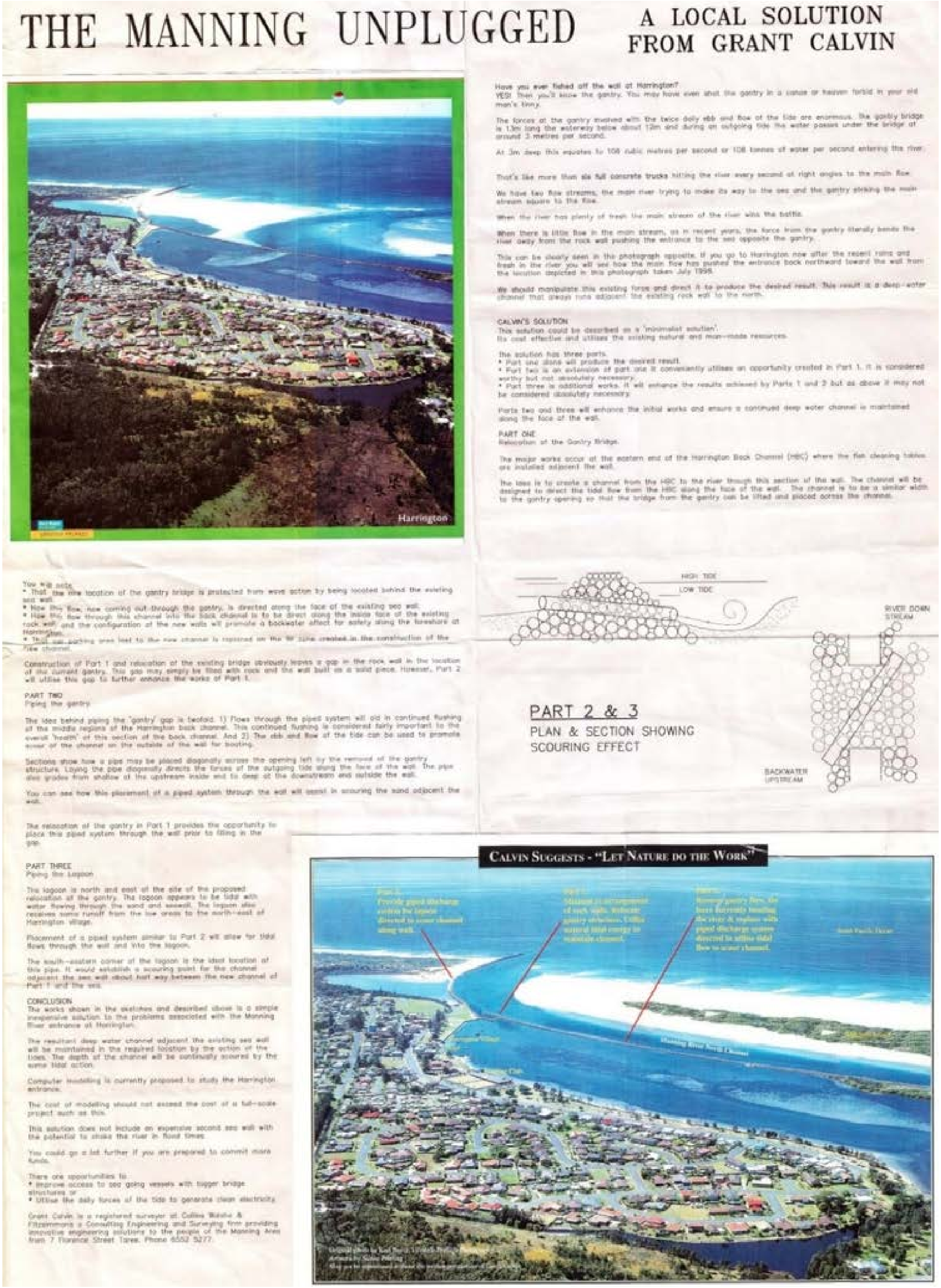

Figure 3: Original promotional poster from Collins Walshe & Fitzsimmons (1999).

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15 June 1999

Stebercraft
Elizabeth Avenue
TAREE NSW 2430

ATTENTION: ALLAN STEBER

Dear Sir

RE: THE MANNING UNPLUGGED

Grant Calvin is a surveyor with Collins Walshe & Fitzsimmons Pty Ltd has developed an explanation for the current problems with the siltation of the Manning River entrance at Harrington and has developed a solution to this problem. His solution is elegantly simple and utilises existing structures without major works. The limited work involved in implementing Grant's solution means that the costs will be limited.

Grant is seeking support for his solution as an economic and viable answer to the siltation problems at the river entrance. I have assessed his proposal and he has my full support.

Please contact myself or Grant if you have any questions in relation to this matter.

Yours faithfully
COLLINS WALSHE & FITZSIMMONS PTY LTD

Bruce Collins

BRUCE COLLINS MIEAust CPEng

Figure 4: Engineer's letter of support for an "elegantly simple" solution.

Figure 5: Harrington circa 1998, courtesy of Karl Bayer and photoshopped by Peter Calabria.

3 HISTORICAL BACKGROUND

In the 1800s, the Manning was a rural settlement that supplied raw materials consumed by the growing colonial cities of Newcastle and Sydney to the south. Trade with these major cities was by coastal ships that plied up and down the coastal rivers. Harrington was where these ships ventured into the sea from the Manning River. Navigation of "the bar" was fraught with danger and ships were often stuck and lost crossing into and out of the river system. The information sign atop Pilot (or Flagstaff) Hill tells us that over 50 ships were known to have foundered on the Manning bar between 1824 and 1941. To aid safe navigation of the bar, a marine pilot station was established in 1856 (Figure 6). The pilot boat was a 16-foot rowing skiff manned by a boat crew of 4 to 6 boatmen. Some 12 pilots served at Harrington continually from 1856 right through to 1961.

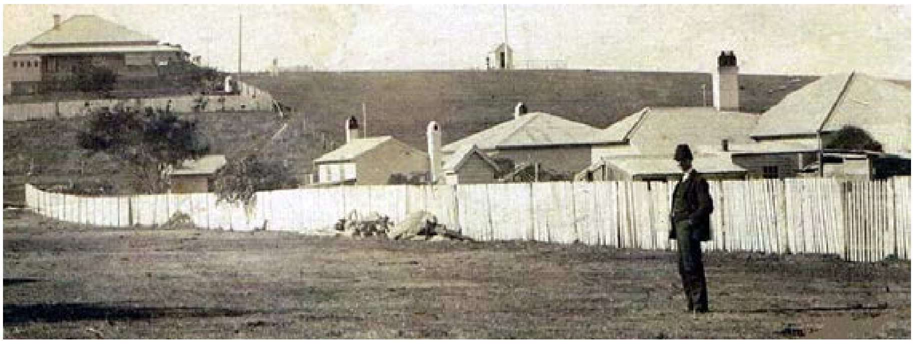

Figure 6: Pilot's house, boatman's cottages and the signal shed and flagstaff atop Pilot Hill, ca. 1900 (https://www.flickr.com/photos/glmrsnsw/24239664794/).

Not surprisingly, the pilot lived on Pilot Hill. The actual pilot's house is long gone but the flagstaff that communicated with ships awaiting entrance to the river still stands on the brow of the hill. In preparation, the pilot and his crew would row around and depth-sound the shoals and channels of the entrance. They would use this information to mark the best passage to take from the ocean into the river.

Approaching ships were observed from this prominent hill, signals sent to and fro using the flagstaff. The pilot would take to the pilot boat, row out to the ship and pilot her through the shoals and channels of the bar they had marked. The changeable entrance configuration meant sounding and marking the channels was a constant and ongoing operation for the pilot and his boatmen. Once over the bar, ships would go upriver to carry out their enterprises at the various river towns and villages.

Figure 7 shows an old parish map with Pilot Hill (indicated by the arrow) together with trigonometric station 464 marked (now TS2417 HARRINGTON) and the latitude and longitude of the Harrington Astronomical Station (31°52’26” S and 152°41’37” E) notated on the sandbanks in the river. The beginnings of the training wall can be seen at the base of Pilot Hill.

Figure 7: Parish map 1897, County of Macquarie, Parish of Harrington, edition 3 (LRS, 2023).

In the 1800s, coastal steamers and river traffic were the life blood of the many small communities that formed along the rivers of the north coast of New South Wales. The bar at the entrance to these rivers was a major impediment to this river trade. The importance of this trade was described in the Parliamentary Standing Committee on Public Works report in relation to the Harrington entrance and the Manning River. In 1909, exports included butter 2,228,571 lb, maize 300,000 bushels, timber 6,750,000 lineal feet with 1,825 passengers departing. Imports consisted of 5,600 tons of general merchandise. “The steamships trading to the port were those of the North Coast Steam Navigation company, Allan Taylor, Langley Brothers, Dick and Company (Newcastle) and Whatmore and Company. These [ships] paid 335 visits during the year ending 31 December 1909” (PWD, 1910).

The report went on to say the bar at Harrington “is considered one of the most, if not the most, dangerous bar on the colony, as shown by the number of wrecks and loss of life upon it.” The maps shown in Figures 8-10 were prepared in order to assess the changing nature of the bar and the potential for installing sea walls to provide a safer entrance into the river.

“Crossing the bar” when shipping perishable goods or livestock was risky. One report given to the Standing Committee (clause 1106) notes a total of 86 days of delay for 6 different steam ships due to the conditions of the bar in 1909. Ships were recorded as “bar-bound” unable to cross into the Manning River, with delayed departure from Sydney owing to bad bar conditions or aground. Delays in shipping could ruin perishable goods, causing financial loss for farmers.

In 1881, the Assistant Engineer for the Harbours and Rivers Department, Cecil West (C.W.) Darley, visited the site: "I proceeded to the Manning Heads and carefully examined the Entrance with the view of suggesting means of improving the navigation." He went on to say: "The Department being in possession of recent and accurate detailed surveys [Figures 8 & 9], little more than mere inspection of the locality was necessary on my part." He suggested some dredging and provided some ideas to building a sea wall, including where the source of rock may come from at Crowdy Head (Darley, 1881).

His commentary was prescient on the outcome currently in place: "To maintain the channel in its present position would be most desirable, but it could only be effected by the construction of a costly breakwater extending out from the 'Painted Rocks' [at the base of Pilot Hill] a distance of about 2,500 feet [760 m], in an east by south direction. In the event of a break wall being run out, it will become necessary to protect the foreshore westward from the 'Painted Rocks' by a training dyke about three quarters of a mile in length [1,210 m], otherwise the wash which will be thrown in along the breakwater will encroach upon the beach and cause the channel to shoal up or take an irregular course."

The 'Painted Rocks' were on the corner of the river at the base of Pilot Hill. Some pundits have said they were so called because the narrow shipping channel passed so close to the shore that vessels were said to scrape the paint off their sides (McNeil, 2011a). It is considered more likely that the prominent rocks adjacent to the deep channel were where birds roost, consistently watching for prey or drying their wings. The 'Painted Rocks' at this corner in the shoreline were probably painted white with guano and were a clear marker as reference to these 'Painted Rocks' is common in the texts.

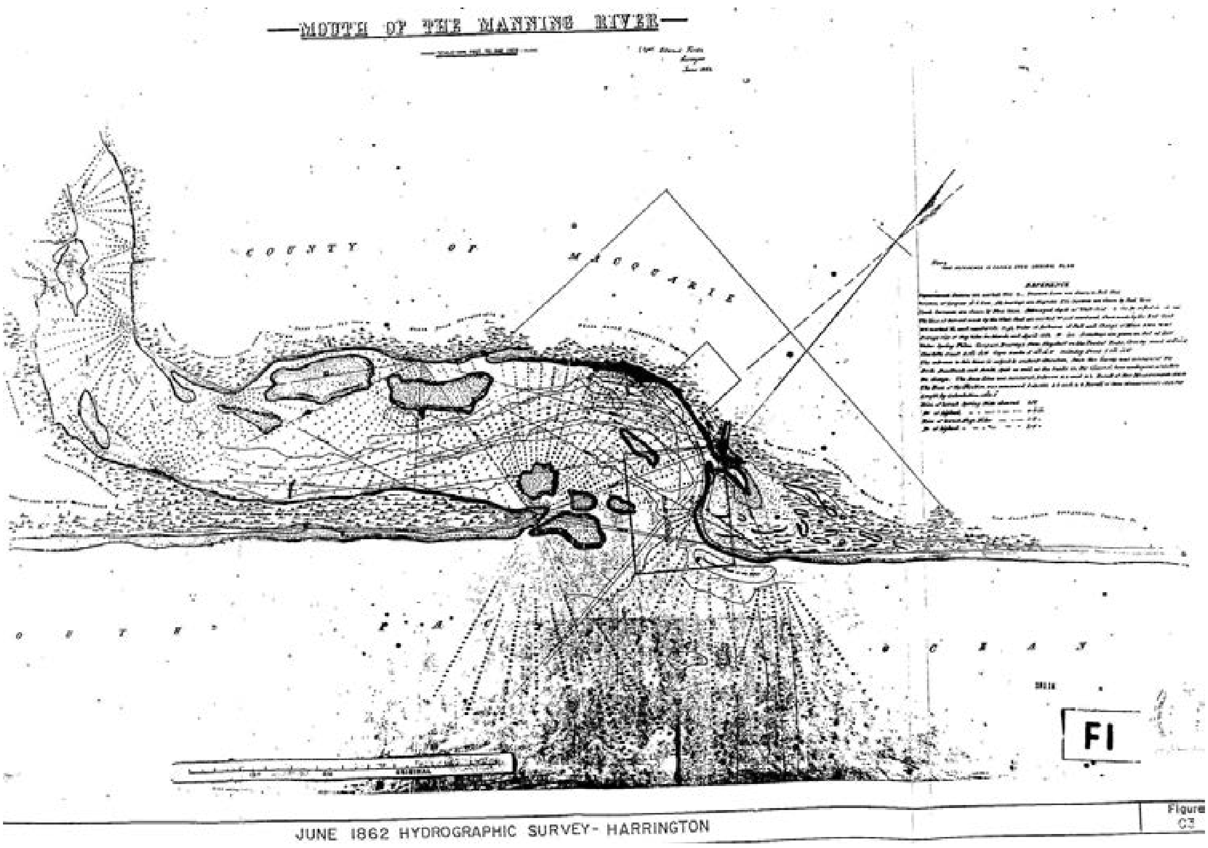

Figure 8: Mr Forde's survey, 1862.

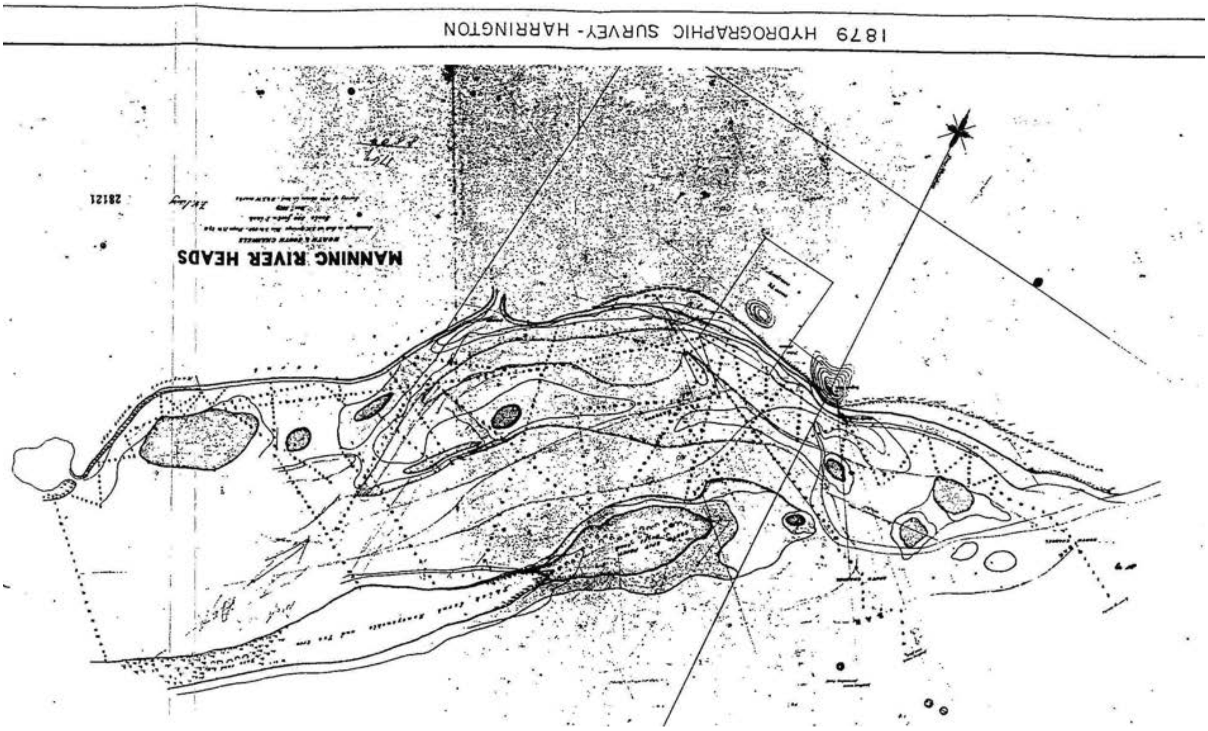

Figure 9: Mr Sydney’s survey, 1879 (deliberately reversed to keep orientation of harbour similar).

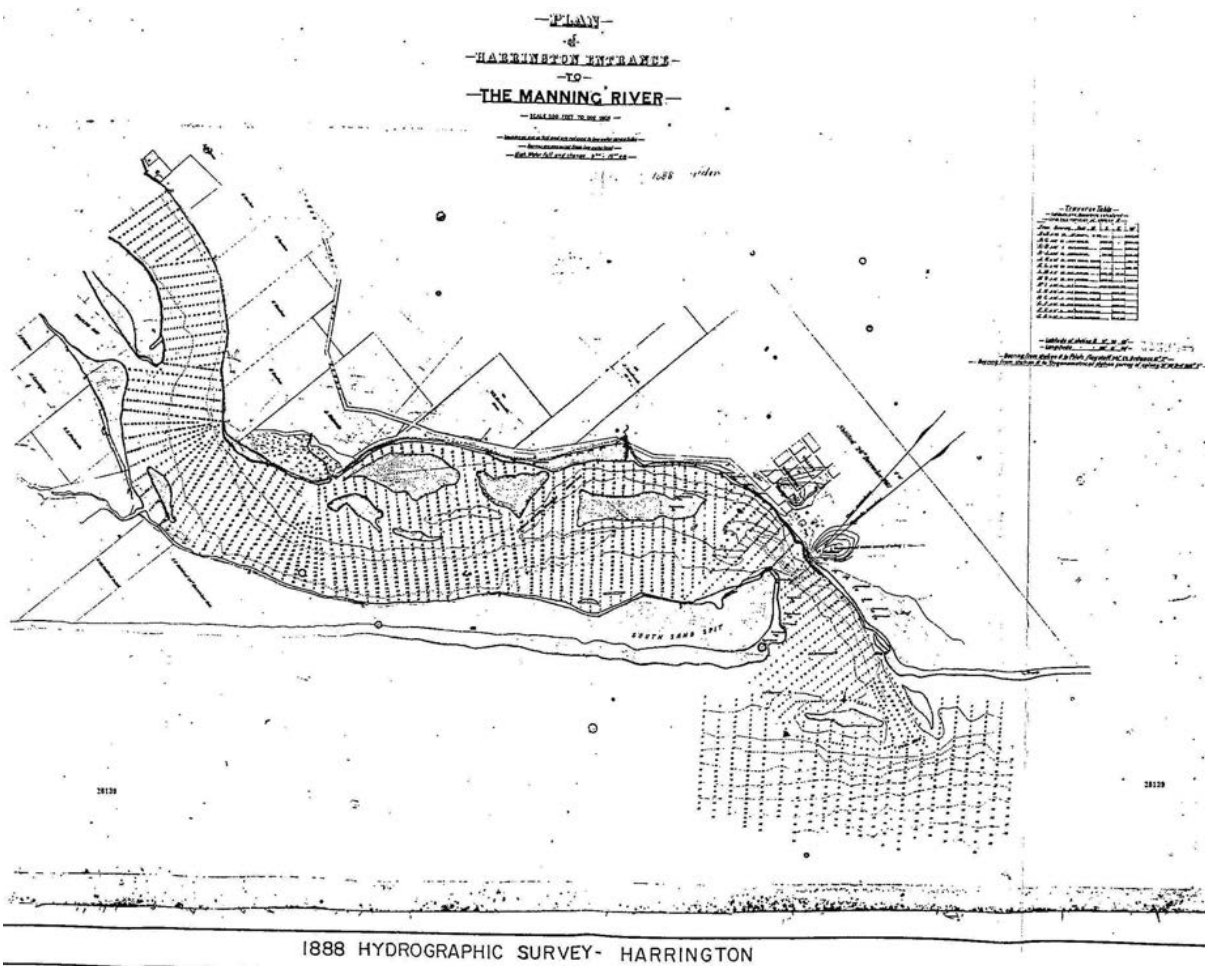

Figure 10: Mr Carleton’s survey, 1888.

In 1885, the prominent harbour engineer John Coode visited Australia and was employed by the government to provide information on a number of harbour works. He met with the master of the steamer Rosedale, Captain Martin Prendergast, who regularly traded on the Manning River, making several trips per month and Mr John Muir, the pilot of 10 years on the Manning. Coode gave detailed instructions for the compilation of information to assess the situation. This information was provided by Henry Richard Carleton, Supervising Engineer with the Harbours and Rivers Navigation Department, and provided as an appendix to Coode's report (Coode, 1889). His report included commentary on the river system and its tributaries and principal towns. There were also cross sections and soundings providing waterway areas, catchment areas, rainfall and flood measurements, wind records and borings taken on the sand spits in the entrance checking for possible reefs.

Upon receipt of Carleton's information, Coode, now back in England, compiled a report and plan (Figure 11). Part of the information compiled by Carleton to Coode included the catchment area of the Manning, no mean feat in 1889, given the ruggedness of the Barrington Tops that form part of the catchment boundary. His calculations showed a catchment area of 3,170 square miles (8,210 km²) and broke that down into the sub-catchments of the tributaries (Barrington & Barnard, Gloucester & Avon, and Dawson & Lansdowne). For comparison, recent flood studies provided 8,160 km² as the Manning River catchment area. This is an indication of the quality of the information provided to Coode for his assessment.

Mr Carleton's 1888 survey (see Figure 10) was used in the production of the plan by harbour engineer and designer Sir John Coode. In summary, Coode's plan was for:

- Southern breakwater: 4,000 feet (1,220 m).
- Barrier bank to south spit: 6,700 feet (2,040 m).
- North training bank: 2,300 feet (700 m).
- Northern breakwater: 2,200 feet (670 m).

He estimated an expenditure of £194,000. Coode's plan (see Figure 11) included a low training bank extending seaward of the 'Painted Rocks' to be only 2 feet above low water. This bank would guide the flow of the tides yet allow wave action to flow over it. Behind this training wall, between the training wall and the proposed northern breakwater, is a wave trap or stilling beach. Waves propagate in the entrance break over the training wall and dissipate their energy on the small beach. This would ameliorate the wave action for which Darley suggested a 1,210 m long training dyke is required as protection.

The barrier bank on the south spit is similar to the dyke suggested by Darley in that it prevents erosion of the sand spit from the actions of the river flows. Coode's design, however, continues the south barrier bank to become the southern breakwater. Thin red lines depict the training wall and barrier bank, while thick red lines show the breakwater or sea walls. Coode proposed that the opening between the south and north walls be 800 feet (250 m) wide. This width "will be sufficient for the discharge of flood waters without creating a gorge." Carleton's cross sections and flood flow measurements were used to calculate flows and provide these critical design criteria.

The closing comment of his report was prescient: "The expenditure I have named may be considered too great to be incurred under present conditions. Should this be the case, it would certainly be preferable to defer action rather than to embark on a project of insufficient scope and extent. Certainly, if any action is to be taken, it should be on the line referred to herein and shown on the accompanying drawings."

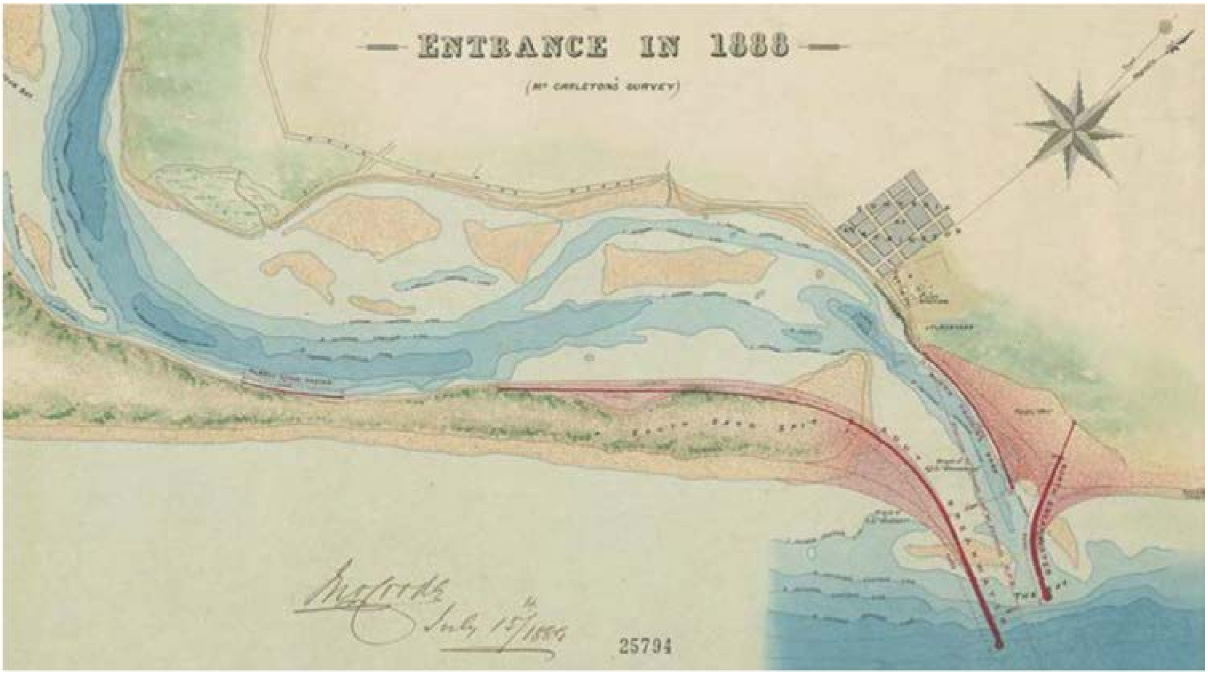

Figure 11: Entrance in 1888 and Coode's proposed rock walls, shown in red (DPI, 2018).

One might detect a certain amount of colonial engineers' one-upmanship here. The local engineer Darley, Engineer in the Chief Harbours and Rivers Navigation Branch of the Public Works Department from 1889, had planned for a single sea wall (760 m long) on the northern side of the river starting from the 'Painted Rocks' (at the base of Pilot Hill) and heading southeast, a river wall (1,210 m long) upstream of the 'Painted Rocks' and also a dyke of stone (2,400 m long) protecting the southern bank of the river upstream of the entrance (Darley, 1881).

The plan of English engineer Coode (see Figure 11 and Coode, 1889) showed rock walls only east of the 'Painted Rocks' (nothing upstream) and a southern wall extending from the sand spit to the south and extending to a point just beyond the extent of the northern wall. Coode's commentary was that the southern wall should be completed first or at least in conjunction with other works to afford protection of shipping from the prevailing southerly winds, wave action and incursion of sand into the entrance of the river.

Figure 12 shows the outcome of the construction as it stands today (the north spur was removed in the 1980s). Despite orders being issued by two separate Parliamentary Standing Committees on Public Works in 1898 and 1910 (PWD, 1910), recommending that Coode's plan be endorsed and constructed without delay, the current status of the entrance at Harrington is testament to whose plan has ultimately been followed by Public Works. There is no stilling beach.

Instead of Darley's suggested 760 m long north breakwater, it is 1,150 m long. The inner north training wall is 1,210 m long in Darley's report but ended up 2,900 m long. The north training wall and spur walls do not exist on Coode's plan. The important barrier bank to the south spit remains incomplete. The southern breakwater, an extension of the barrier bank shown in Figure 11 does not exist (marked as not built in Figure 12). It was Coode's plan that was publicised to the locals as the plan for the works and endorsed by the Parliamentary Standing Committee to be progressed, twice! Coode Street in Harrington has been named in his honour.

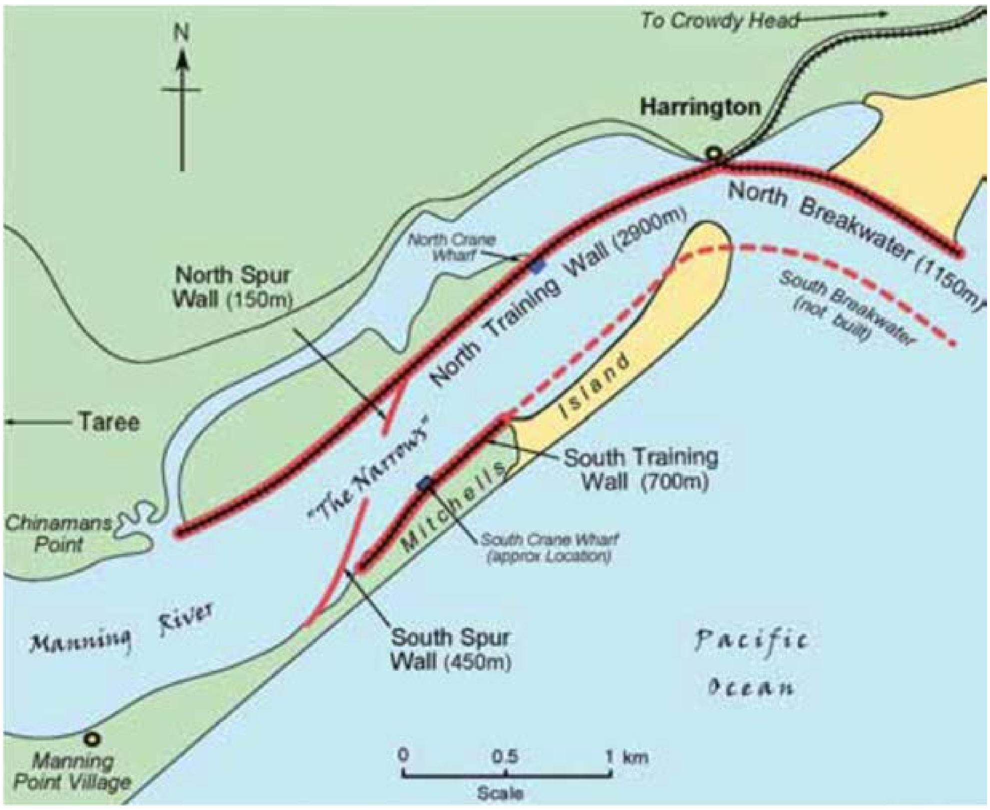

Figure 12: Rock walls today (McNeil, 2011a).

Importantly, the 2,900 m long north training wall was not part of Coode's plan. The south training wall (700 m long) in Figure 12, was in Darley's report meant to be a mile and a half long (2,400 m). In Coode's plan, the barrier bank to the south spit was designed to be 2,040 m long. The conclusion of Coode's 1889 report still rings true today, 134 years later. In today's parlance, if you cannot afford to do all the plan, then do not start. The communities of Harrington and the Manning Valley have been suffering the consequences of not following the closing comments of his report for more than 100 years now. One can only hope that this may be remedied in the near future.

One can imagine how the residents of Harrington felt as they watched the north training wall progress across the front of their town:

- Access to the sea for the local fishing fleet was getting cut off.
- The boarding and drinking establishments that had grown as part of this harbour port were literally getting cut off from their clientele.
- Local tourism was affected as it became more and more difficult to access the town for river traffic, which was still the primary conveyance around the area.
- For the pilot and his boatmen, the row or pull from their boat house out into the entrance, where they worked, increased every day.

A wharf was built on the outer side of the north training wall that was used to tranship passengers and freight onto more shallow draught vessels to continue journeys upriver when the lager ocean-going vessels found they could not enter the river. As early as 1898, the Manning River Times reported passengers for Harrington faced "a long and rough walk along the wall, and when the trucks are working it is not altogether safe." This wharf, known as the crane wharf, can be seen on the outer side of the wall in Figure 13.

Figure 13: Northern training wall extending upriver, ca. 1901 (Manning District Historical Society collection).

We know the boatmen were still rowing about, even though the steam tug John Gollan in Figure 13 was working the river. On 18 December 1901, a serious accident at Crowdy quarry was reported: "Mr George Henley, aged 28 years, was engaged with some other men yesterday (Tuesday) morning pulling stone from the face of the Crowdy Head quarry, when a large stone fell and struck him on the hip. He was brought to Harrington in the train, and was pulled up to Taree in the pilot boat – the John Gollan being engaged that morning – and was admitted to the Hospital about 2pm, where he was attended to by Dr Gormley" (McNeil, 2011a). A row of 27 km with a badly injured man in their 16-foot skiff indicates the strength of the pilot's boatmen, not to mention the return journey probably after some refreshing ales. One can only feel for the suffering of poor Mr Henley with a smashed hip. Row boats do not exactly run smoothly. Every catch of the oars comes with a jerk of the boat. His 27 km pull to the hospital would not have been a comfortable journey.

Imagine you are one of the boatmen who rows the pilot around the entrance to sound and mark the shoals. Your skiff is stored near the bottom right of Figure 13. Your daily row is extended with every rock that progresses the training wall upstream.

4 THE GANTRY

Some pundits say the 'gantry' was installed to provide for tidal flushing of the impoundment behind the wall that was cutting the town off from the river and the sea. However, local legend says it was a delegation of the pilot's boatmen that resulted in the gantry being installed. One might imagine that the engineer in charge of building the rock wall may well have been 'persuaded' that it would be in his interests to help out the boatmen with their daily grind by a forthright delegation of these strong rowers. Whatever the reason, some 430 m from the corner where the pilot's skiff was stored, a small opening was left in the rock wall with originally a timber bridge spanning the gap. The gap was supposed to give boat access to the local seafarers and fishermen from their town out into the river entrance and the sea.

The jet of water spewing through the rock sea wall we observed from Pilot Hill that particular lunch time was coming through this hole in the wall. Nearly a half a kilometre from the corner below us on Pilot Hill, this jet of water looked to be literally bending the river. Locally known as the gantry, the timber bridge has been replaced and updated in the intervening years. It still is not really suitable for boat traffic (Figure 14).

Figure 14: Gantry bridge, spanning a 13.5 m gap in the rock sea wall.

Flow, measured in this waterway, exceeds velocities of 2.2 m/s. On the ebb tide, the river drops below the level of the water behind the wall, and a drop of up to 0.5 m can be seen through this gap (Hawkins, 2007). The volumes of water that may be expected are actually easy to calculate, far easier than performing catchment calculations to work out flows in the traditional manner (e.g. CIA). Put simply, it is the area of the waterway behind the wall multiplied by the tidal height. The waterway area behind the wall, known locally as the back channel, is 58.088 ha. That is, a 1 m tide means that there will be a volume interchange of about 580,880 m^3. During spring tides, the volume of water interchanged may be closer to a million cubic metres (1,000,000 m^3).

It is these flows that the "elegantly simple solution" would utilise to stabilise the river channel up against the rock wall. When fishing in the upstream end of the back channel, the ebb tides seem to continue to flow into the channel from the upstream end for the entire cycle. This indicates that the flow volumes above may be conservative.

5 REDIRECTING THE GANTRY FLOWS

The idea is to close the current gantry, or potentially pipe it effectively, and create a similar opening at the inner corner some 400 m closer to the entrance, redirecting the tidal flows of the back channel along the face of the outer break wall. In this way, the forces that currently disrupt the tidal flow at the bottom of the tide will act as a giant venturi, literally dragging the river's flow at the bottom of the tide toward the entrance. The venturi acting on the river's tidal flow in this manner will have a multiplying effect on the flow volumes coming out of the back channel. It was suggested that the natural tidal flows, in the range of half a million to a million cubic metres of water, at every ebb tide will stabilise the river flows against the rock wall.

The rock walls that would be adjusted to achieve the redirection shown in Figures 15 & 16 can actually be seen in Figure 13. The sections of wall that would be adjusted are located between the camera position and the ship Electra and the tugboat John Gollan visible in the photograph. When drawn on the original 1998 imagery by Karl Bayer, the logic becomes clear (Figure 17).

Figure 15: Concept sketch of the water forces at play.

Figure 16: Concept sketch of how the water may be redirected.

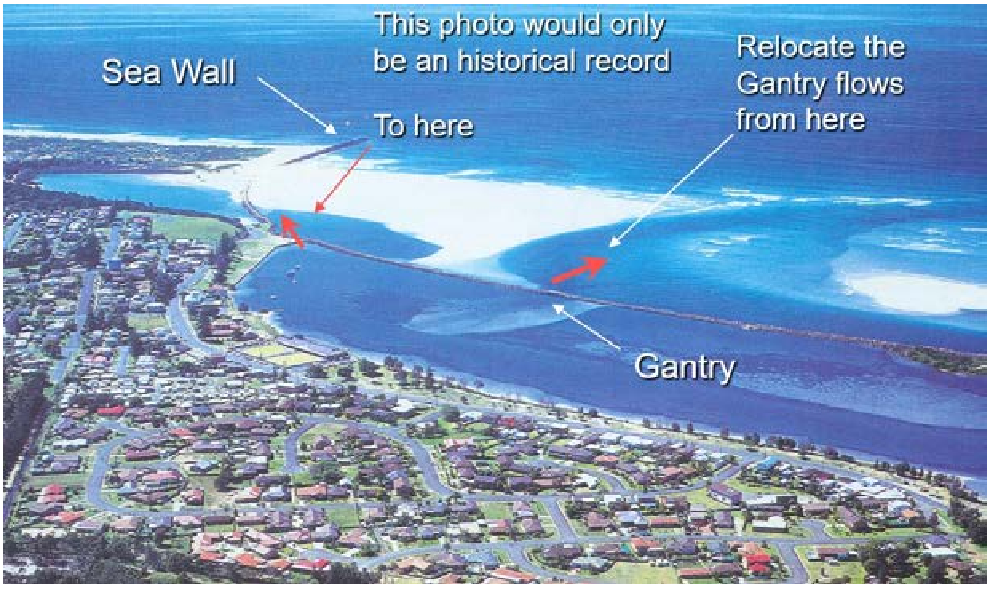

Figure 17: Concept of how the water may be redirected, drawn on the original 1998 imagery by Karl Bayer.

The apparent influence of the gantry on the river channel seems clear. What is there, but is not obvious in Figure 17, is the small channel that continues to flow along the face of the sea wall between the lagoon behind the green brow of Pilot Hill, all the way back to the river opposite the gantry. It seems that the tidal flux from the lagoon maintains this flow, even though the beach infills along and over most of the outer wall. In Figure 17, it can be seen that the water area, and thus tidal flow, of the back channel is vastly greater than this lagoon. It is believed that tidal flows from the back channel, jetting along the outer wall, will similarly maintain an open channel along the outer wall to the sea.

Figure 18 visualises the three components of the original concepts. In addition to relocating the gantry flows into the corner, the original concepts suggested that the existing hole at the gantry location may be piped, with the pipe laid in such a way that flow jetted into the sand on the outer side of the wall creates a scour hole just downstream. It was surmised that the tidal flows from the river would join these scour holes into a deep channel adjacent to the wall. This was described on the original poster developed by CW&F (see Figure 3).

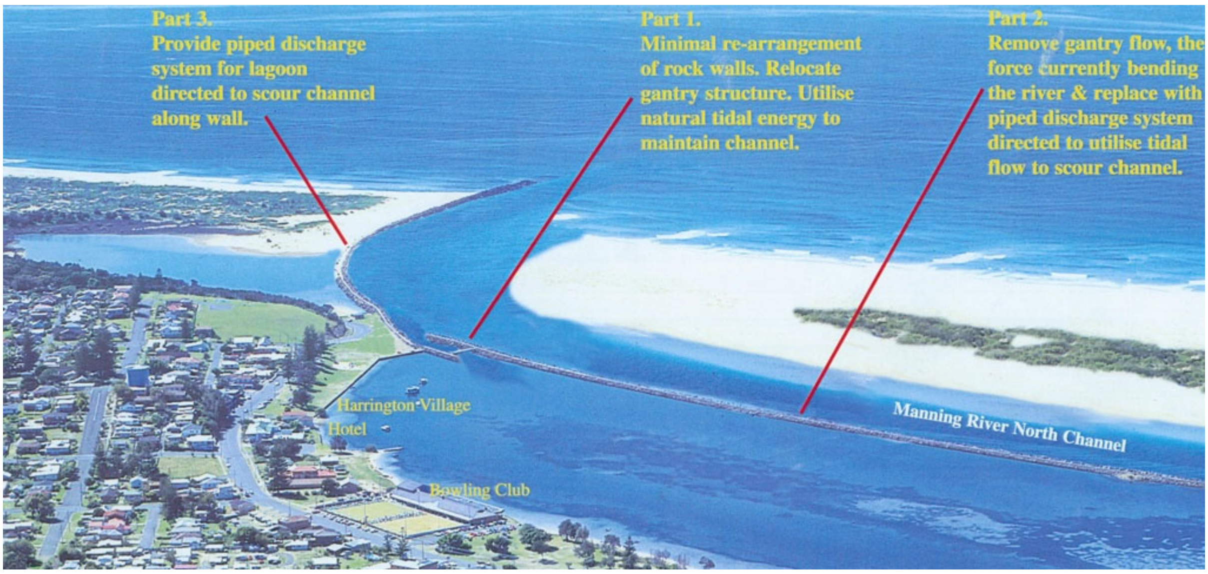

Figure 18: Photoshopped image illustrating the three components of the original concepts.

The proposed pipe system(s), which could be implemented at the gantry, are outlined in Figure 19. In combination, Figures 15-19 show that the scale of these proposed works is minuscule in comparison to the overall scale of the rock walls at Harrington – truly an “elegantly simple solution”.

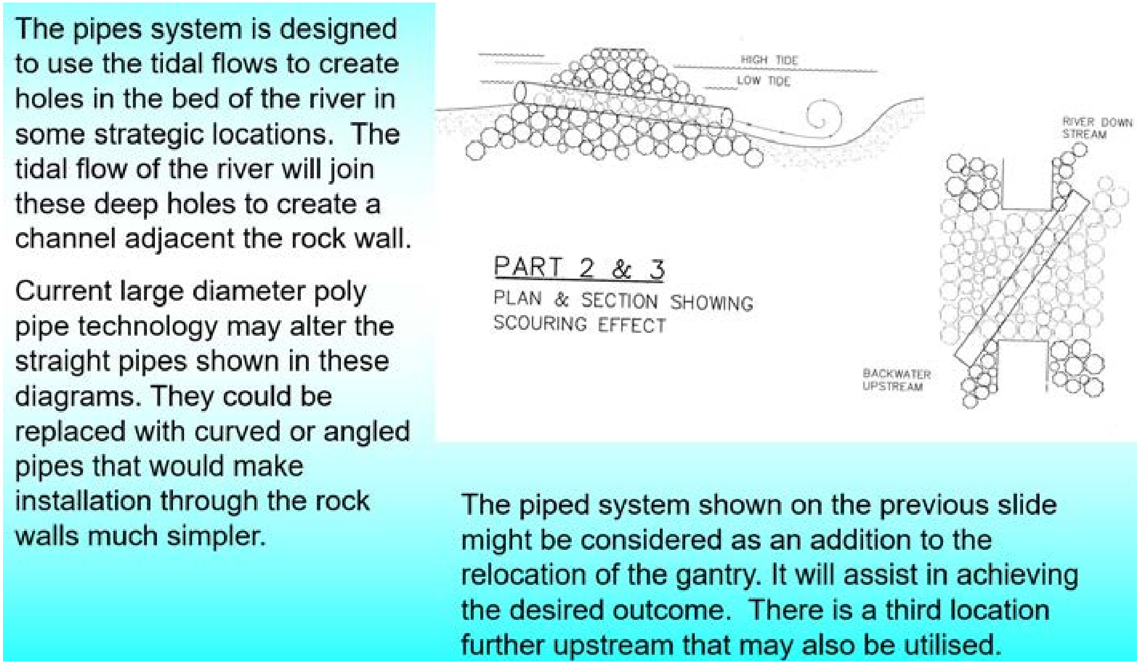

Figure 19: Proposed pipe system(s), which could be implemented at the gantry.

6 A QUESTION OF COST

A consulting surveying and engineering firm in Taree just does not deal with construction of sea walls, so understanding the costs involved in a project as proposed with these concepts was beyond our expertise. Therefore, a local contractor, Ron Mills of Mills Earthmoving who was and still is involved in repair works on the Harrington sea walls, was consulted. When asked about how we might go about costing these works, he suggested that it may be considerably less than $500,000.

The Manager of Minor Ports at the former Department of Lands heard of the concepts through the representations made of our local politicians and asked us to explain why we considered this project worthy of his attention:

- The jet of water coming out of the gantry appears to be disrupting the flow of the river in the entrance particularly at the bottom of the tide, causing the river entrance to shift radically up and down the beach.
- The entrance, once shifted to the south, causes excessive incursion of sand into the entrance.
- Redirection would change the entrance configuration, so the main channel would remain against the existing rock wall.
- The jet of water flowing with the tidal flow, instead of directly across it, would act as a venturi, significantly increasing the effect of the volume of water flowing out of the back channel and along the river near low tide.
- The shift into the corner would enhance these effects, as against simply redirecting the flow in the current location. This could be achieved for an estimated $500,000.

Several hours were spent with the Manager of Minor Ports and another local Lands officer looking over the concepts and ideas that had been developed at CW&F. The Manager considered that the proposal had merit and confirmed that our rough cost estimate would probably be in the ballpark.

Probably most telling from these discussions was a question in relation to what his department might be able to do: “So how many boats actually use this river entrance as a port?”. CW&F’s answer was that Stebercraft takes a few new ones out for delivery every year – not many. The reply was emphatic: “That’s about how many dollars I’ve got to spend on this minor port.” The manager who looks after NSW’s minor ports recognises the frequency of use that Harrington as a port actually attracts and has a budget for Harrington that is commensurate with that low frequency.

Even though he could see the merits in doing this minimalist project, his budgets would not extend to these costs for the very few boats that used the port of Harrington – fair call. This is where this story might have ended but for a beach fishing trip, and several beach walks where we could see first-hand the disturbing amount of coastal erosion on our beaches.

Recognising the links involved between the beach erosion and the river entrance mobility prompted this paper.

7 COASTAL EROSION

7.1 The Coast

Some knowledge of the area is needed to understand the proximity of the locations described in this section. The coast is the section where the Manning River enters the sea. The river system, a delta by definition, has two entrances: one at Harrington and the other at Farquhar near the village of Old Bar. The beach itself is one long sandy strip, although the sections of beach have different names. Crowdy Head is the headland at the northern extremity. Heading south, the next feature is the Harrington river entrance with its historic rock walls as described above. On the southern shore of this entrance is Mitchells Island, and the village of Manning Point is at the north-eastern corner of the island. The village is located about 4 km south of the break walls constructed in the late 1800s.

The next beach feature is the Farquhar entrance, the southern connection to the sea and the south-eastern corner of Mitchells Island. Farquhar is located about 8.5 km south of the village of Manning Point. About 3 km south of Farquhar is the village of Old Bar, so named because the bar had closed in the 1840s. There are a couple of reefs offshore at Old Bar that create a salient, first and second corner surf locations, that can be seen in Figure 20. The southern headland of this length of beach is at Wallabi Point. Saltwater Point, a well-known surfing break, is located 1.5 km further south of Wallabi Point.

Figure 20: Map of the Manning estuary coast (Nearmap image, August 2015).

7.2 Going Fishing at Manning Point

Manning Point provides an access onto the beach. The beach is usually a wide expanse of sand with a longitudinal gutter just offshore and sand banks beyond where the waves break. The beach access is also the primary access to the camping ground at Farquhar Park, the southern entrance of the Manning. Campers drive onto the beach, the length of Mitchells Island and camp just inside the entrance at the State Park Farquhar Inlet camping area.

Around August 2012, the author and fellow surveyor Matt McGuire prepared to go fishing for the Mulloway (jewfish) that frequent the gutter along Manning Point beach. The tides were right and we were looking forward to quite a few hours about the low and incoming tide, tight lines and a good catch. As we drove over the dunes to access the beach, we were confronted with a very narrow beach and waves almost lapping against the dunes. Stopping atop the dune access, we could see travel along the beach was limited. “Isn’t it supposed to be low tide?” Consulting the smartphone, we confirmed that low tide was still an hour or so away. We ventured a short distance toward the entrance and fished for a short time, retreating early when the tide changed and the incoming tide and waves started to make travel along the beach precarious. What was happening here?

7.3 Beach Walks and Photo Monitoring

To try to ascertain what was happening along this section of beach, several beach walks were done, photographing the beach erosion that was taking place between the access ramp at Manning Point and the entrance to the river on the northern tip of Mitchells Island.

Photographic monitoring was performed on four occasions:

- 11 September 2012.
- 6 May 2013.
- 4 July 2013.
- 25 June 2015.

The coast of Mitchells Island, a tad over 10.5 km long, is actually quite remote. There are basically three points of access onto the beach. The village of Manning Point has a dedicated 4WD beach access (Figures 21 & 22) and some of the local caravan parks have pedestrian access. Just over 4 km (4.3 km) south of the 4WD access is the end of Beach Road, where a small carpark and pedestrian walkway provides fishermen and walkers beach access. The access into the State Park Farquhar Inlet camping area is 3.5 km south of Beach Road.

During the period of beach monitoring, the 4WD access to the beach was restricted to low tide. To travel to the Farquhar camping area one had to wait until low tide before venturing onto the beach. Otherwise, waves were lapping against the base of the sand dunes and travel was not recommended (if not impossible). During this time, even walking along the beach at high tide was very restricted. Our photographic expeditions were always tide dependant.

7.4 Photo Beach Monitoring

Over this period, features photographed one time were completely gone the next. This made continuity of images difficult. For example, between 2012 and 2015, the beach at the 4WD access point receded, causing access to be reconstructed, each time a little steeper (Figures 21 & 22). Note that at least three panels of southern fence were gone, and the vegetation was suffering.

Figure 21: Manning Point access ramp, September 2012.

Figure 22: Manning Point access ramp, July 2015.

7.4.1 Photo Monitoring of the Northern Tip of Mitchells Island

Probably most telling of these on-the-ground images were those looking into the entrance (Figures 23 & 24 and through to Figure 33). The river entrance shifted south and ran into the end of the incomplete south barrier bank rocks placed around 1904 to protect the southern sand spit (i.e. the south training wall in Figure 12). The height of the dune is a testament to its usual location well behind the beach alignment. The proximity of the end of the rocks is clear. Harrington water tank can be seen on the hill behind.

Figure 23: Northern tip of Mitchells Island showing high dunes near the end of the rocks, September 2012.

Figure 24: Northern tip of Mitchells Island showing ocean waves breaking on the rocks of the northern end of the south barrier bank, September 2012.

From down near the rocks, looking upriver, trees have been left strewn about from the waves washing across the sand spit at high tide (Figure 25). The edge of a tuckeroo grove planted by the local Dunecare/Landcare group can be seen on the far left of the photograph. Rocks can be seen along the shoreline. Works around 1901-04 had placed the rocks to protect the southern sand spit. This was the start of the important barrier bank on the southern sand spit described by Coode (1889). Darley (1881) also described how the southern sand spit warranted rock protection with a stone dyke.

Figure 25: Looking upriver, September 2012.

By July 2013, all the high dunes had disappeared (Figure 26). Much more of the barrier bank rocks was visible extending out into the river. Waves break along the shore where the beach alignment now meets the river at these rocks. The eastern side of the tuckeroo grove can be seen on the left of the photograph adjacent the drop off to the beach.

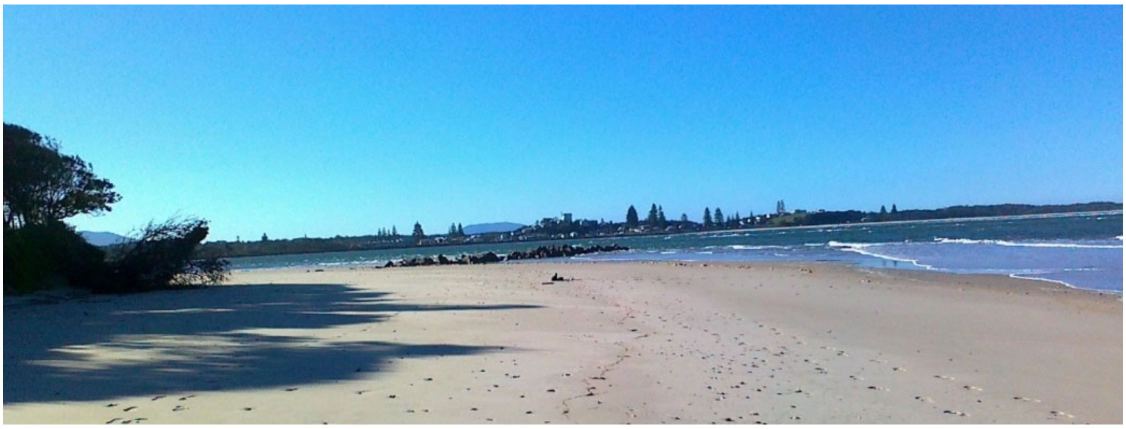

Figure 26: Looking north, July 2013.

Looking back from the remnant rock wall in 2013, the grove of tuckeroo trees is right on the edge of the beach scarp (Figure 27). Waves have been flowing from the sea into the river between the rock wall and the vegetation on the spit.

Figure 27: Looking south, July 2013.

Looking back upriver from the northern end of the spit, the tuckeroo grove is on the left (Figure 28). Vegetation is still being strewn across the sand spit from wave action. The sections of the south barrier bank rocks can be seen along the edge of the river. Manning Point village is visible in the distance.

Figure 28: Looking upriver, July 2013.

By June 2015, the grove of planted tuckeroos was gone (Figure 29), and the remnant northern end of south barrier bank rocks can be seen much further from the vegetation than in 2013. The distance to the water tower at Harrington appears to be much greater than in 2012 (see Figures 23 & 24).

Figure 29: Looking north, June 2015.

Comparison with the 2012 photographs shows a disturbing amount of sand has been removed in the intervening 3 years. Closer to the entrance of the river, the expanse of sand between the vegetation and the rock wall is evident (Figure 30). Waves washing over the sand spit in 2015 have washed away the fallen vegetation from the beach. Again, the water tower at Harrington is visible in the distance.

Figure 30: Looking north, June 2015.

Looking south from the sand spit, it can be seen that the entire tuckeroo grove prominent only 2 years earlier had completely disappeared (Figure 31). Rocks from the barrier bank poked through the sand. The beach alignment to the south had marched even further westward since the 2013 images.

Figure 31: Looking south, June 2015.

Looking upriver south from the sand spit, the rock barrier bank can be seen along the edge of the river, with the village and pine trees of Manning Point in the background (Figure 32).

Figure 32: Looking upriver, June 2015.

Looking north, the expanse of the sand spit between the vegetation and the end of the rock barrier wall is evident. The end of the rock barrier was now well out into the river. Tops of small waves can be seen breaking along the shoreline.

Figure 33: Looking north across the sand spit, June 2015.

Upstream of the entrance, the inner side of the sand spit had also been devastated by the changes that occurred in the location of the entrance to the river (Figures 34 & 35). This is evidenced by the number of trees fallen into the river as we made our way back to Manning Point. Along the river side of the sand spit, significant erosion had occurred. Beyond the upstream limit of the southern barrier bank, large trees fallen into the river made moving along the foreshore difficult even at low tide.

Figure 34: River side of the sand spit, June 2015.

Figure 35: River side of the sand spit, June 2015.

This photographic record over 3 years from 2012 to 2015 shows what happened when the river shifted away from the northern sea wall around 2009/2011 and migrated south. At the southern extent of this shift, it has come up against the northern end of the incomplete south barrier bank rock wall. When the river entrance channel is flowing against the northern sea wall, this remnant section of south barrier bank rocks is about 300 m west of the beach alignment (Figure 36).

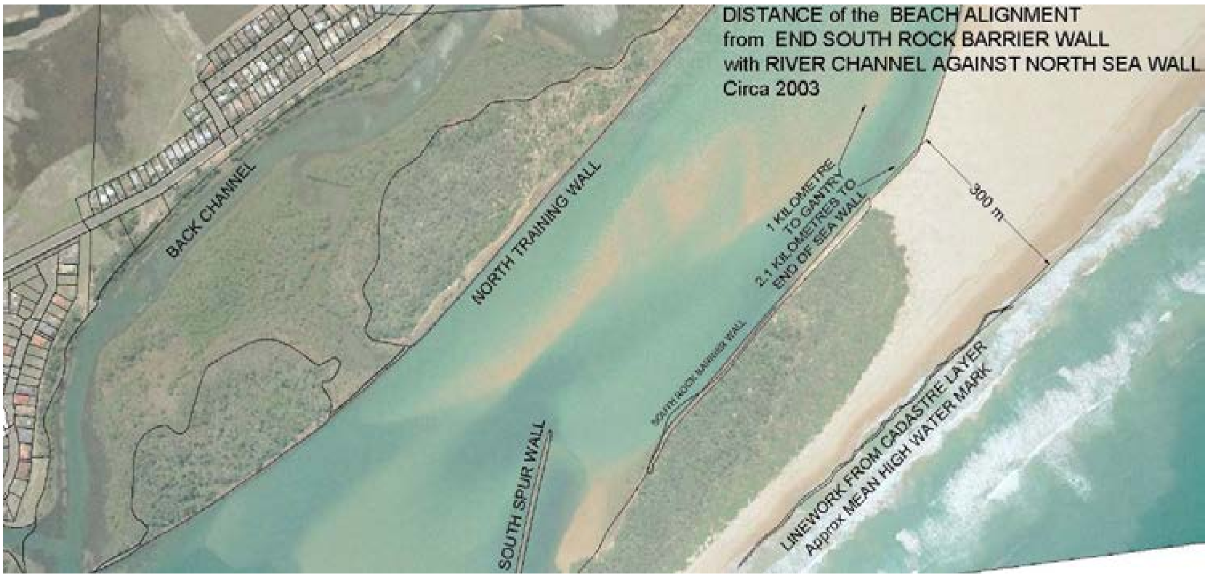

Figure 36: Beach near south barrier bank rocks, ca. 2003.

When the river flows interact with this remnant section of barrier bank rocks, tidal flows and waves cut off the beach in a south-westerly direction. The beach alignment has shifted landward by 300 m. Waves now break directly over these rocks that are usually on the river side of a wide sand spit (Figure 37). The original cadastre linework of the Mean High Water Mark (MHWM) can be seen out in the ocean waves well off the beach.

Figure 37: Aerial Nearmap image, September 2016.

7.4.2 Photo Monitoring of the Adjacent Beach of Mitchells Island

The photographs in the following figures show what was happening along the frontal dune system between the beach access and the river entrance during this time. The erosion along the beach is obvious. The scarp in 2012 was not full height. The peak of the foredune is behind and higher (Figures 38 & 39).

Figure 38: Adjacent beach of Mitchells Island, September 2012.

Figure 39: Adjacent beach of Mitchells Island, July 2013.

The sand scarp is nearing the peak of the foredunes all the way along the beach. On a human scale, the dunes are quite high in places. The wave action at the toe of the dune is evident by the lack of debris. The whole beach front is actively eroding, and the erosion scarp appears to be at full height of the dunes (Figures 40 & 41).

Figure 40: Adjacent beach of Mitchells Island, July 2013.

Figure 41: Adjacent beach of Mitchells Island, June 2015.

Closer to the river entrance, coastal littoral rainforest trees were dropping onto the beach (Figure 42). Large trees still on the dunes were suffering from exposure to the prevailing winds (Figures 43 & 44).

Figure 42: Coastal littoral rainforest trees dropping onto the beach, September 2012.

Figure 43: Trees suffering from exposure to the prevailing winds, May 2013.

Figure 44: Trees suffering from exposure to the prevailing winds, July 2013.

By 2015, large sections of the fontal dunes were gone. In Figure 45, the tall trees and water tank of Harrington village can be seen across the river entrance to the sea.

Figure 45: Tall trees and water tank of Harrington village across the river entrance, June 2015.

From these figures, it is evident that the foredunes along the front of Manning Point beach from the beach access to the river have eroded dramatically in this period as the whole beach front remained connected to the 300 m shift in the beach alignment at the northern tip of Mitchells Island at the south barrier bank rocks. Beach erosion south of the beach access has also occurred in this same time frame.

Could it be that the entire beach, 16 km long, all the way to Wallabi Point might be trying to realign to this changed northern point 300 m west at the tip of the incomplete south barrier bank rocks?

Could the erosion we have experienced on this part of the coast, some of the worst in NSW, be the result of the Manning River interacting with this small section of incomplete rock bank protection abandoned in 1904 by PWD?

7.5 Smiths Beach Coastal Erosion

Smiths Beach, partway along Mitchells Island, is a popular fishing spot. At the end of Beach Road is a small carpark and a sandy pedestrian access track. At Smiths Beach, 3.2 km south of the south barrier bank rocks, the beach scarp progressed about 10 m westward, from 81 m 2011 to 70 m in 2016 (Figures 46 & 47). The lines seen in the images are the cadastral layer in the Nearmap imagery.

Figure 46: Smiths Beach (Nearmap image, September 2011).

Figure 47: Smiths Beach (Nearmap image, August 2016).

7.6 Old Bar Beach Coastal Erosion

Closer to Old Bar, a small reef (Urara Reef) lies just offshore, which creates good surf breaks. The energy lost by the waves breaking around the reef creates a salient. The surf breaks are known as first and second corner, named as such from the apparent bend in the alignment of the beach behind the reef. At second corner, there is a carpark, shower and (there was) a 4WD timber slat access ramp onto the beach, used to beach-launch small fishing boats. A viewing platform was constructed on the edge of the dune to check out the surf and limit damage to the dune (Figure 48).

Figure 48: Second corner beach access and viewing platform (Nearmap image, 2011).

Between 2011 and 2015, the entire timber access ramp and viewing platform disappeared (Figure 49).

Figure 49: Second corner beach access and viewing platform disappeared (Nearmap image, 2015).

In 2018, a near vertical drop was evident. Council's GIS airborne laser scanned contours provide an elevation higher than 14 m (AHD) at the top of the dunes (Figure 50). By 2022, the top of the beach scarp had progressed beyond the top of the foredune and was starting to reduce in height down the rear of the dune (Figure 51).

Figure 50: Second corner (Nearmap image, 2018).

Figure 51: Second corner (Nearmap image, May 2022).

Like the beach at Manning Point, it is difficult to quantify the erosion simply because there is little built infrastructure in the area. What was there is now simply gone! It is sufficient to say that in this 10-year period significant erosion has taken place at the second corner access track. (Measurements from the edge of the nearby road to the toe of the scarp indicate about 133 m in 2011 and about 113 m in 2022, i.e. a change of about 20 m.) The second corner access track is 12.2 km south of the tip of the southern bank barrier rocks at Manning Point and 4 km north of Wallabi Point.

Between the villages of Old Bar and Wallabi Point, there is a disused sand quarry that now contains the Old Bar Waste Water Treatment Plant (WWTP) sand infiltration ponds. Between September 2011 and May 2022, the distance from the pump house to the edge of the dune scarp reduced from about 170 m to about 151 m, i.e. by almost 20 m (Figures 52 & 53).

Figure 52: Old Bar WWTP sand infiltration ponds (Nearmap image, September 2011).

Figure 53: Old Bar WWTP sand infiltration ponds (Nearmap image, May 2022).

For MidCoast Council, this is an important facility because it effectively caters for the waste water from a couple of important seaside villages. This waste water facility is 15.3 km south of the tip of the south barrier bank rocks and 950 m north of Wallabi Point.

7.7 Coastal Erosion Conclusion

The investigation has shown that significant erosion (300 m) occurred where the Manning River has shifted in location south and interacted with a remnant section of what Coode described as “barrier bank to south spit”. This work, abandoned in 1904, is a small section of rock wall that appears to have a dramatic effect on the alignment of the beach. The erosion appears to occur for the full length of the beach, as the beach tries to align with the changed location of the northern end (Wallabi Point is 16 km south of the entrance). In the village of Old Bar, several houses have been lost to this beach erosion.

The key question is: Could the erosion noted all the way along this beach be ameliorated by stabilising the Manning River entrance against the Harrington sea wall? Would limiting the interaction of the entrance with the south barrier bank rocks ameliorate the beach erosion?

Just to put a figure on the value, let us say the toe of the foredune shifts about 20 m if it averages a height of 5 m. This results in a loss off the dunes of 100 m^3 per metre over 16 km, i.e. 1,600,000 m^3 of sand. Local suppliers give sand a value over \$80/m^3 wholesale, putting a dollar value of \$128 million on these losses. However, the coastal foredunes have a much greater intrinsic value to the people and environment adjacent to the coast. Surely, it is worth a small investment to protect them!

7.8 Historic Coastal Erosion

The 1990 Coastline Management Plan for Racecourse Creek / Lewis Street, Old Bar (PWD, 1990) was produced after noticeable erosion had been occurring in the vicinity. PWD had done a photogrammetric analysis of the beach profile in 1989. Obviously, this most recent erosion event recognised by the river flows interacting with the south barrier rock wall, which occurred around 2009, could not have influenced the erosion that caused Council to employ PWD to analyse the aerial photographs, report and provide a Coastline Management Plan.

The Coastline Management Plan did, however, report on the erosion and the analysis of the occurrence. There were variations through changes to Racecourse Creek, but for areas away from the creek, the PWD report provides the following commentary (PWD, 1990): “On the open coast south of the creek entrance, the profile information indicates that the frontal dune was advanced seaward by up to about 10 m during the period 1940-1965. Between 1965 and 1989 the shoreline has progressively receded. Most of the recession has occurred within the 30 m road reserve located east of the allotments fronting Lewis Street.”

The Coastline Management Plan further indicates that the erosion seemed to start in about 1965: “During the period 1965-1989 recession trends indicate a mean of approximately 0.2 metres per annum with a maximum up to 0.3 metres per annum at individual locations.” Prior to 1965, from 1940 onward, the frontal dune was 10 m further out.

The 1965 aerial photograph shown in Figure 54 indicates that a similar southern migration of the river entrance had occurred at some time prior to 1965:

- The northern rock sea wall is covered by beach sand.
- The main channel of the river appears to be directly in front of the gantry opening.
- The river has interacted with the northern tip of the southern barrier bank rocks.
- The tip of the rocks is visible near the southern most channel in this image.
- The face of the beach has been torn off almost exactly as it has been around 2016 (Figure 55).
- Vegetation on the coast between Manning Point village and the river entrance has been stripped back to a slender island of dark-coloured vegetation.
- In comparison, the vegetation strip in 1965 (Figure 54) appears to be even more slender than in 2016 (Figure 55).
- Significant influx of sand into the river channels upstream of the entrance and south spur wall has occurred with the entrance in this southern location.

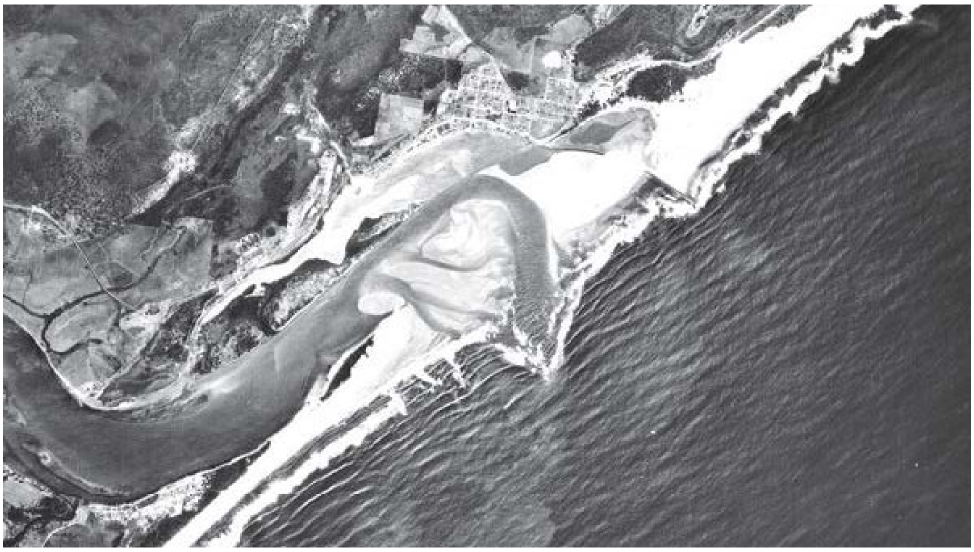

Figure 54: Aerial photograph of Harrington entrance, 1965.

Figure 55: Aerial photograph of Harrington entrance (Nearmap image, 2016).

Similar points can be seen in the aerial photograph of 1969 (Figure 56). Looking at these images from the 1960s, one might expect that coastal erosion similar to that recorded between 2012 and 2015 and presented earlier in this paper would have occurred along the coastline in the late 1960s. PWD (1990) recorded that erosion commencing around 1965 at Old Bar. It is a pity that they did not look up the beach to Manning Point to find a reason for this behaviour.

Figure 56: Aerial photograph of Harrington entrance, 1969.

7.9 Historic Imagery

The aerial photograph of December 1972 (Figure 57) shows that the main river flow had started to migrate back toward the northern sea wall, which is still buried by beach sand for much of its length. The plume of sand in the back channel from the gantry flows is clearly visible. The main river channel is just downstream of the gantry. The width of the southern spit had started to recover. The vegetation on the spit appears to have started to take hold once again. There is a thin line visible that probably indicates the sand scarp location visible in the 1965/69 aerial imagery.

Figure 57: Aerial photograph of Harrington entrance, December 1972.

The series of aerial photographs in Figure 58 shows the recovery of the river channel back to the sea wall and subsequent shifts over time. The cadastral line work visible in these images is the same shown in part in Figures 36 & 37.

Figure 58: Aerial photographs showing the recovery of the river channel over time.

7.10 Commentary on Historic Imagery

The historic aerial images show the amazing recovery of the beach alignment from 1969 to 1972, which indicates the 300 m width of sand east of the remnant barrier bank rocks had been restored. What happens to the alignment of the remainder of the beach when this occurs is hard to determine and beyond the scope of this paper. Suffice to say that the mobilisation of over a million cubic metres of sand from the dunes is not considered a beneficial process. The images clearly show the significant changes that take place in this river entrance.

In 1997, the river had once again shifted south, with the south barrier bank rocks just starting to impact the flow. The alignment of the beach was again under threat. What occurred over the length of the beach to Wallabi Point at this time is unknown. It is interesting to note that the sand built up over the wall in the 1997 image has a beach alignment similar to that of the cadastral linework. This is also similar to the beach alignments that are shown on the historical maps from 1862, 1879 and 1888 (see Figures 8-10). This indicates that the natural stable beach alignment is in approximately this location.

By 2005, the river had migrated north again, the full beach width about 300 m wide appears to be present at the location of south barrier bank rocks. These images only provide a snapshot in time, and the fluctuations between the images are hard to discern. Times of flood or freshet can make dramatic changes that are not specifically related to these images. To see if patterns occur, several images have been overlayed on the cadastre and the sand banks traced to see if a trend might be discerned. The following is one potential scenario.

In Figures 59 & 60, there is a build-up of sand in front of the gantry. At the bottom of the tide, the jet of water coming out of the gantry is potentially blocking the last of the river's outgoing tide. This minor blockage over several tidal cycles has the potential to cause the upstream channel to meander. Between 2003 and 2006, the upstream channel meandered about 100 m.

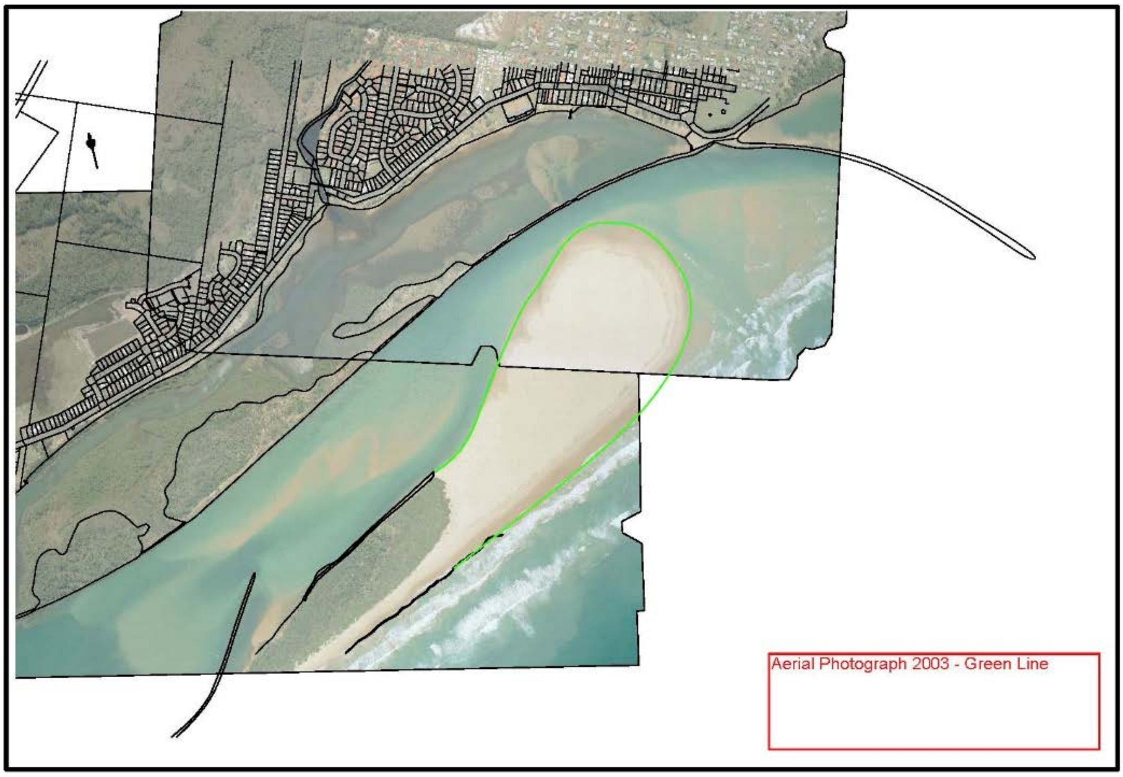

Figure 59: Aerial image (2003) overlayed on the cadastre and the sand bank outlined green.

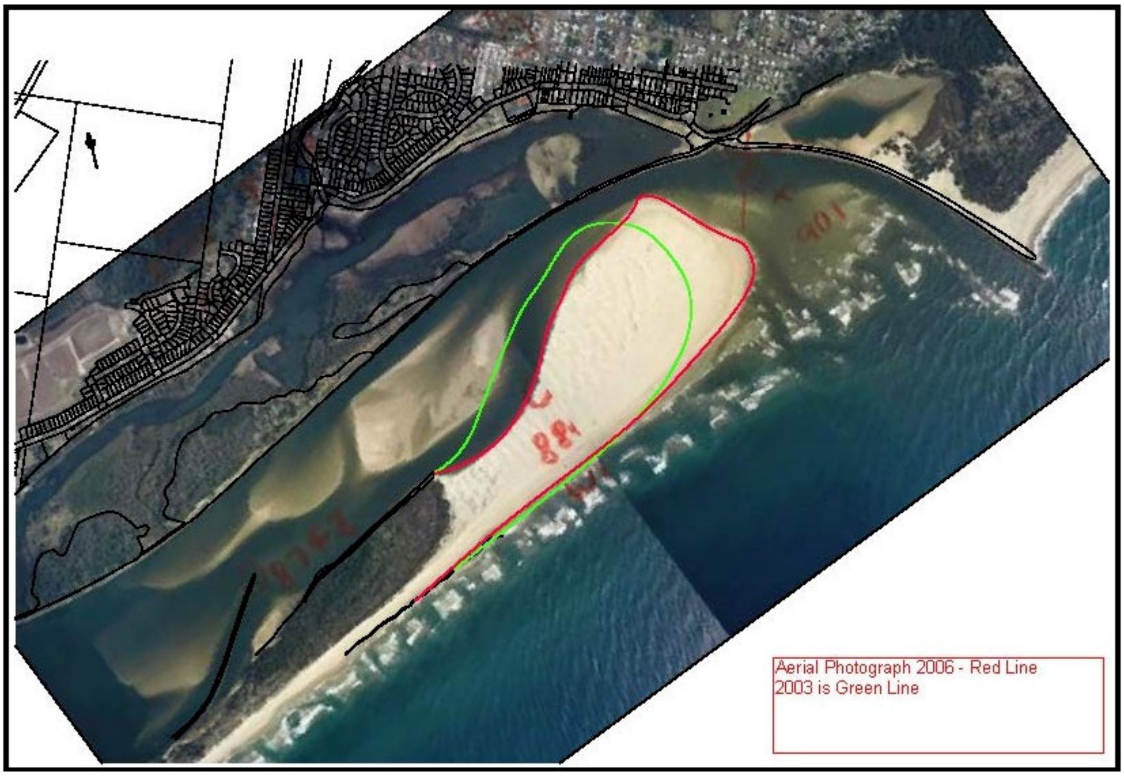

Figure 60: Aerial image (2006) overlayed on the cadastre and the sand bank outlined red.

The July 2009 aerial image (Figure 61) depicts the continued migration of the southern shore of the river eastward. From the 2003 shoreline, it has travelled almost 300 m closer to the ocean. Channels across the beach in this image show signs that the sand spit has been over-topped, probably by flood water. The beach alignment has receded marginally. The channel against the north break wall remains restricted. Council records show significant flows were encountered in the catchment in April and September 2008 and also in February and May 2009, not long before the image in Figure 61 was flown in July. Minor flooding also occurred in October and November 2009 and in December 2010.

Figure 61: Aerial image (July 2009) overlayed on the cadastre and the sand bank outlined blue.

Lines depicting the extent of vegetation traced from the 1965 and 2005 aerial images have also been added to this image. Between 2005 and 2009, the vegetation band along this section of Manning Point beach had actually progressed marginally seaward. At the minimum, the 2005 vegetation line is more than 50 m east of the 1965 vegetation strip. At the northern tip of the 1965 vegetation strip, the vegetation in 2009 is over 200 m seaward, indicating good dune recovery occurred in that time period.

7.11 Imagery 2011 to 2021

A major flood occurred in June 2011, not long before the image in Figure 62 was taken. It is unknown whether the river had broken through the beach before this time. One might postulate that the reduced channel by the north wall and reduced width of the southern sand spit has allowed the river to break through the sand spit and migrate radically south. The river entrance is flowing through the entire area between the northern tip of the south barrier bank rocks and the north break wall, i.e. a distance of 2.1 km.

Figure 62: Aerial image (Nearmap, September 2011) overlayed on the cadastre and the sand bank outlined.

The frequency of available imagery and its resolution has increased dramatically in the past decade. The following images show changes at Harrington between 2011 and 2021 (Figures 63-65). A major flood occurred in the Manning on 20 March 2021, only a couple of weeks before the image of 9 April 2021 (Figure 65) was flown. The reduction in sand noticeable in the inlet can be explained as a result of this flood event.

Figure 63: Aerial image (Nearmap, 2016) overlayed on the cadastre and the sand bank outlined.

Figure 64: Aerial image (Nearmap, 2019) overlayed on the cadastre and the sand bank outlined.

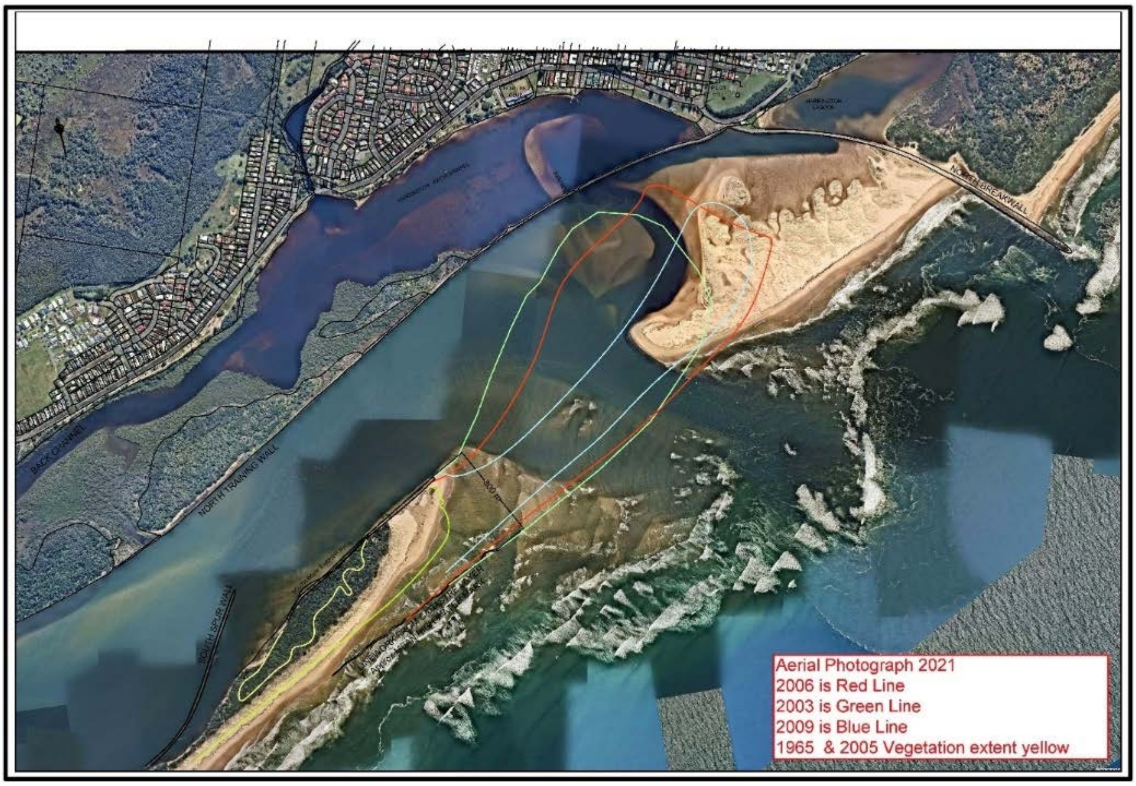

Figure 65: Aerial image (Nearmap, 2021) overlayed on the cadastre and the sand bank outlined.

In summary, the following can be deducted from these images:

- The river continues to flow adjacent to the northern tip of south barrier bank rocks.
- The beach alignment south is still connected to the tip of the south barrier bank rocks (300 m west of its natural location, ca. 1972-84 and 2003-06).
- The adjacent vegetation strip has reduced in size continuously since 2011.
- Significant sand influx into the entrance is notable. The southern location of the entrance has promoted greater deposition of sand upstream of the spur wall.
- The beach alignment of sand covering the north break wall is similar to the beach alignment in 2003 (green) and 2006 (red), indicating that this is the natural location of the beach alignment (as it has been since the earliest surveys of the estuary, see Figures 8-10).
- Deep flow channels, in front of the gantry, are evident, prominent and significant for over 10 years since the 2011 aerial image.

Regarding the “elegantly simple solution”, now imagine the gantry flow, which is generating these deep flow channels, being relocated to near the notch in the corner of the wall, under Pilot Hill, and directed along the face of the northern break wall.

It is the contention of the author that energy coming through the gantry, so obvious in these images, directed in that way would produce a very different and much more desirable outcome for the river and indeed the coastline all the way to Wallabi Point.

8 LOCATION VS. SAND INFLUX AND DEPOSITION IN THE ESTUARY

As noted above, the variation in location of the entrance configuration changes the area in which sand is deposited into the estuary. This is relevant for both the Harrington and Farquhar entrance configurations. In a greater area, there is potential for more sand to be deposited inside the estuaries, which detracts from the available sand on the beaches. To assess this, circles of 1.2 km radius have been drawn centred on the apparent entrance locations. This represents a reasonable travel distance before sand mobilised off the beach would be deposited. An area is then calculated within the estuary and this circle.

For Harrington, the 2009 and 2014 images were used with the entrance located (Figure 66):

- North – Area of deposition: 48 ha.
- South – Area of deposition: 105 ha.

With the entrance located in the south, by the south barrier bank rocks, the area of sand deposition within the estuary is over twice that of when the entrance is in the north near the northern breakwater. The implication of this at Harrington is that the northern entrance location is by far the preferred location in respect to sand that is deposited into the estuary and lost to the surrounding beaches.

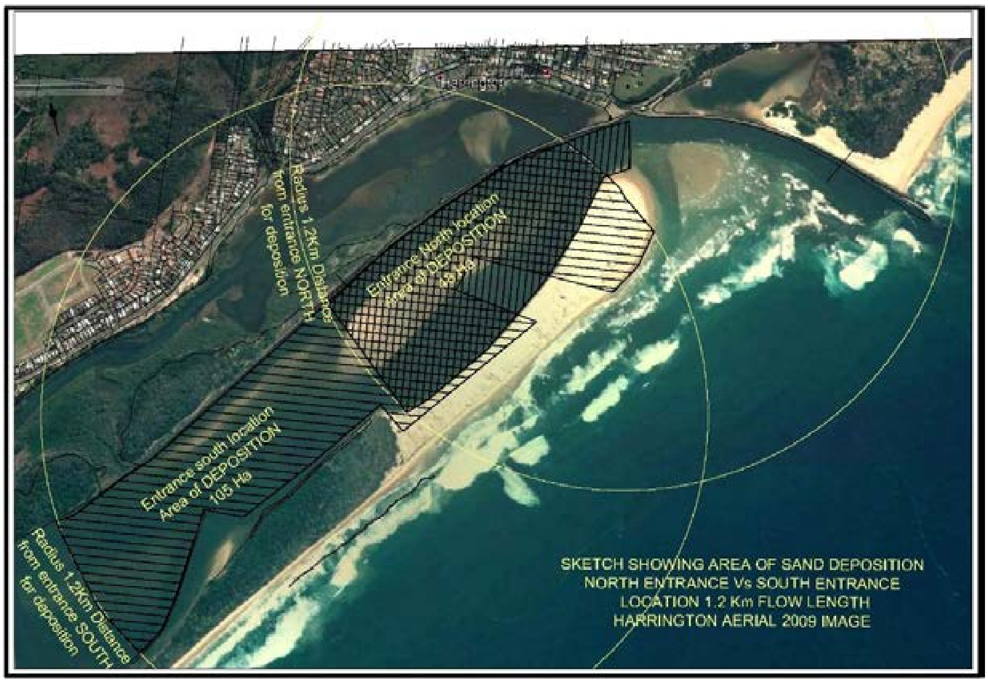

Figure 66: Sand deposition areas at Harrington.

A similar exercise was performed for Farquhar, using the 2011 image with the entrance located (Figure 67):

- North – Area of deposition: 139 ha.
- South – Area of deposition: 78 ha.

With the entrance located in the south by the soft rocks, the area of sand deposition within the estuary is almost half that of when the entrance is located in the north. Therefore, at Old Bar, the southern entrance location is by far the preferred location in respect to sand that is deposited into the estuary and lost to the surrounding beaches.

Figure 67: Sand deposition areas at Farquhar Inlet, Old Bar.

The Farquhar Inlet Old Bar Entrance Opening Management Plan provides a strategy for opening the entrance at Old Bar when it closes. There are environmental and flood triggers that, when activated, allow for mechanical opening of the river to the ocean. These observations in relation to potential sand deposition may assist in determining the location selected to open the entrance. The sand shoals in Farquhar (see Figure 67) are now making it difficult to navigate other than at high tide. Even the smallest tinny can struggle to get around the estuary. Historically, the steam ship Electra (see Figure 13) would take people to Farquhar campground for bridal races, community gatherings and picnics on the beach spit, so this is a significant change.

There may even be a correlation between the two entrances and the relative location of each, but this is beyond the scope of this paper. Once in the estuary, other than floods, only a significant dredging program can re-establish the sand back onto the beach alignment. Replenishment of our beaches in this way may still be an option in the future.

9 COMPILATION OF STUDIES ON THE MANNING RIVER

This section lists a non-exhaustive compilation of studies that have been conducted in and around the Manning and this estuary. In the late 1990s, Council was intent on doing another study. From memory, the stated value of the proposed study was in excess of $450,000. This was about the same amount as that required for the proposals discussed with local earthmoving contractor Mills Earthmoving. CW&F argued that the entire cost of their proposal would likely be less than the cost of the computer modelling. Why don’t we do the modelling in real life? We were assured that such studies need to be done and that the “elegantly simple” proposal would be modelled in order to prove that it works. Unfortunately, this has never occurred and the only references to the “elegantly simple solution” have been unsubstantiated opinions (DPI, 2018).

Some of these studies did do amazing things. The numerical modelling produced incredibly natty simulations of sand influx and salinity increases after flooding. However, they did not do anything for the river! Unlike life, where there are no guarantees, there is an iron-clad guarantee in relation to these studies. We can absolutely, hand on heart, guarantee that if another study is done, absolutely nothing will change in the river or on our beaches.

Since the discussions with Council and the Manager of Minor Ports at the former Department of Lands, who had no budget for Harrington port, numerous studies have been performed. The cost of these studies has probably exceeded the cost of initiating and completing the “elegantly simple solution” several time over.

The following is a non-exhaustive list of studies on the Manning River:
- Forde’s survey (1862).
- Sydney’s survey (1879).
- Engineer’s report by C.W. Darley (1881).
- Carleton’s survey (1888).
- Manning River report by John Coode (1889).
- Hydrographic survey (1906).
- Report minutes of evidence and plan relating to proposed completion of harbour works at the entrance to the Manning River, Parliamentary Standing Committee on Public Works (July 1910).

- Hydrographic survey (1912).
- Old Bar coastal erosion study, Sinclair Knight and Partners (SKP) (draft, August 1982).
- Manning River entrance study: Background & issues of concern, PWD (1987).
- Old Bar photogrammetric analysis, PWD (November 1989).
- Coastline management plan for Racecourse Creek / Lewis Street, Old Bar, PWD (October 1990) – includes provision of a 100-year impact line plan.
- Manning River estuary processes study, Webb, McKeown & Associates (September 1997).
- Quaternary geology of the Forster-Tuncurry coast and shelf, southeast Australia, Geological Survey of NSW (December 1997).
- Manning River hydrographic survey 1999, Department of Lands and Water Conservation Estuary Management Program (August 2000).
- Manning River estuary management study, numerical modelling, discussion paper and final report, WBM Oceanics Australia (December 2000).
- Proposed dredging of the Manning River for Harrington Waters Estate, Harrington, environmental impact statement, WBM Oceanics Australia (February 2002).
- Manning River entrance improvement project: Economic scoping study, Rolyat Services (April 2003).
- Manning River entrance at Harrington: Review of economic scoping study for southern break wall, Department of Infrastructure, Planning and Natural Resources (2003).
- Manning River estuary management study, Worley Parsons (July 2009).
- Farquhar inlet, Old Bar entrance opening management plan, Worley Parsons (May 2010).
- Greater Taree coastline management study: Black Head to Crowdy Head, Worley Parsons (October 2010).
- Manning River maintenance dredging strategy, Greater Taree City Council (August 2010 & May 2015).
- Coastal zone management plan for Greater Taree, Worley Parsons (March 2013).
- Old Bar beach coastal protection structure design investigation, Royal Haskoning (December 2013).
- Cost benefit analysis of options to protect Old Bar from coastal erosion, The Balmoral Group – Australia (August 2014).
- Manly Hydraulics Laboratory slides, G. Calvin (May 2015).
- Manning Point beach photo monitoring (July 2015).
- Harrington Waters dredging project final environmental management report, Umwelt (September 2015).
- Old Bar beach sediment tracing, Royal Haskoning (draft, July 2015).
- Erosion analysis of the Manning Valley coastal sediment compartment, Report MHL2408 (March 2017) – marked “not for release”.
- Manning River entrance investigations: Manning River southern breakwater feasibility study, Manly Hydraulics Laboratory (September 2018).
- The Manning River floodplain risk management study and plan, MidCoast Council (2019).

The remarkable outcome of most of these studies is the recommendation to do yet another study! For example, a common theme is: “Any feasible option worthy of further consideration will require additional investigations” (DPI, 2018). There is a plethora of information buried in these reports and studies. Much is said about coastal processes, fluvial inputs, sediment sinks, longshore littoral transport and much conjecture is made about anthropogenic influences. When making comparisons, these studies always start with a “do nothing” option.

The observations documented in this paper indicate that the current status of Harrington estuary is extremely detrimental to the river, beaches and coastline of the Manning. Unfortunately, none of these studies actually recognise the damaging and detrimental effect and environmental cost of the "do nothing" option.

10 CONCLUDING REMARKS

Faced with this mass of highly educated writings from exalted engineering companies with double-barrel names or 3-letter acronyms, one feels like the little boy in the fairy tale when he says: "Look Ma, the emperor has no clothes on!" This paper has shown that the greatest anthropogenic influence on the river entrance and very likely on the coastline compartment from Crowdy Head to Wallabi Point is the unfinished rock wall, left incomplete north of Manning Point by PWD in 1904 (McNeil, 2011b).

In summary, photographic evidence provided in this paper shows:

- When the river entrance shifts to the south, it interacts with the unfinished south barrier bank rocks (see Figures 23-33).
- This interaction causes the beach alignment to shift westward 300 m to the northern tip of the incomplete south barrier bank rocks (see Figures 36 & 37).
- The remaining beach south erodes dramatically as it tries to maintain a connection to this new location at the rocks, now 300 m inland of its natural status (see Figures 38-41).
- Coastal littoral rainforests are destroyed (see Figures 27-35 and 42-44).
- The coastline south for 16 km to Wallabi Point appears to be similarly affected by this shift in the northern end of the beach alignment (see Figures 46-53).
- Archival aerial photographs show that there has been a cycle of this southerly shift in the river entrance, i.e. 1965-69, 1997-??, and 2011-22 and continuing (see Figures 54-58 and 62-65). This is consistent with the unstable nature of the recent erosion history of this beach.
- This fluctuation in the beach alignment causes erosion of the frontal dunes with mobilisation of over a million cubic metres of sand in this recent event. There is immeasurable damage to our coastline.
- The economic and environmental cost of this damage is not registered as part of any "do nothing" option in any of the studies listed above.
- This cause and effect is not mentioned in any previous studies. How did they miss it?

This paper has investigated the historic engineer's reports from Darley (1881) and Coode (1889) and compared the outcome of the works with the plan and reports (see Figures 11 & 12):

- Both Darley and Coode (more than 130 years ago) recognised the importance of protecting the south sand spit. Darley's "dyke of stone" proposal is 1.5 miles (2,414 m) long, while Coode's "barrier bank to south spit" is 6,700 feet (2,042 m) long. The existing rock rubble facing on the south spit is only 700 m long (see Figure 12).
- It is this short piece of unfinished south barrier bank rock that interacts with the river, causes the beach alignment to shift 300 m landward and results in dramatic and excessive beach erosion.
- Coode's plan did not include a north training wall upstream of the 'Painted Rocks' at the corner under Pilot Hill. Darley's report calls for a "training dyke about ¾ of a mile in length" (1,207 m).

- The north training wall ended up 2,900 m long (see Figure 12). One might ponder, had this rock been used to do the important south sand spit work, this entire conversation may not be necessary.
- Coode's plan, promoted as the design in the early 1890s (see Figure 11) and still being promoted as the design in DPI (2018), bears little resemblance to the break walls and training walls in place today (see Figure 12).

Ah, but there is a possible solution! As stated by Engineer Bruce Collins on 15 June 1999, the "solution is elegantly simple and utilises existing structures without major works. The work involved in implementing this solution means that costs will be limited." In summary, this includes the following:

- The evidence for the hydraulic energy, proposed to be redirected in the "elegantly simple solution", is found in the photographs provided.
- The sand plume in the backwater locates the gantry. The energy in the flow coming out of the gantry interacts with the river and forms flow channels through the sand shoals.
- These flow channels can be seen in Figures 17, 54, 55, 57, 58 (1997), 63, 64 and 65.
- It is not hard to imagine how different those figures might look if these flow channels were relocated near the notch in the corner, rather than at the current gantry location.
- Now, while the proposed location is located in quiet backwater, is the time to get in and do the construction. Waiting until this section is part of the full river flow will make the job so much more difficult.

One might ponder if the "elegantly simple solution" had been taken up back in 1999, could the houses since lost to beach erosion in Old Bar still be there?

One can only hope that the author does not find himself revisiting this same situation again in another 20 years. This paper has clearly shown that "do nothing" is not an environmentally valid option.

It would be a shame to have to continue witnessing the destruction of our beaches and coastline environment into the future.

ACKNOWLEDGEMENTS

Bruce Collins, gentleman, surfer, engineer, mentor and friend, passed away in the ocean at Forster in April 2022. His contribution to this paper was considerable, looking at the photographic evidence together, sharing ideas and encouraging and developing rational engineering concepts out of vague ideas, and promoting and supporting those ideas and concepts for the good of the community and environment. Vale Bruce Collins.

The author also acknowledges and thanks Peter Calabria for his time, capabilities and computing power with photographic manipulation before Photoshop made it de rigueur, Karl Bayer (photographer and fellow beach fisherman) for providing his high-quality aerial images, Lee Kiernan (chainman, friend and a good laugh on many a survey job) and staff at MidCoast Council who have assisted with editing and producing this paper.

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