"BEING MORE AWARE OF THE DYNAMIC OF SAND MOVING PAST THIS COASTLINE, EVEN IN TIMES OF NO STORMS OR SWELL, HAS PROVED TO ME THAT SAND HAS ITS OWN LIFE FORCE, AND IT'S INCREDIBLE"

Wayne 'Rabbit' Bartholomew AM,
TSB Advisory Committee member.

04
Tweed Sand Bypassing

PART A: THE NATURAL ENVIRONMENT

KEY INQUIRY QUESTIONS

HOW DOES TWEED SAND BYPASSING (TSB) ATTEMPT TO MIMIC THE NATURAL PROCESSES THAT FORM AND TRANSFORM TWEED AND GOLD COAST BEACHES OVER TIME? AN

WHAT WOULD BE THE ENVIRONMENTAL, SOCIAL AND ECONOMIC IMPACTS OF ENDING TSB? EV

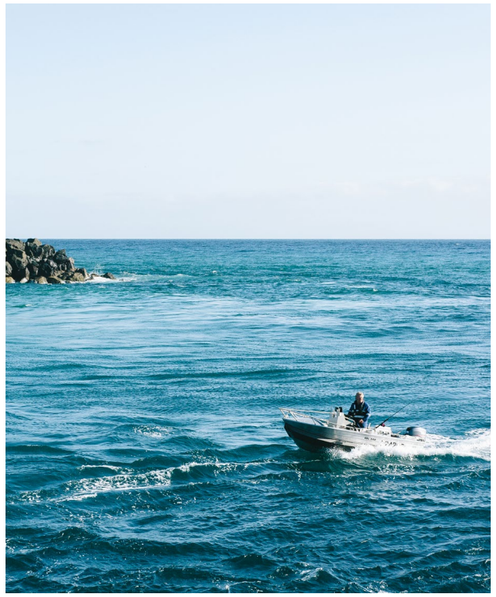
PART 4A CONTENTS

INTRODUCTION

Tweed Sand Bypassing (TSB) is a joint coastal management initiative of the New South Wales and Queensland State Governments, with financial support from the City of Gold Coast. The objectives of the project are to:

1. establish and maintain a safe, navigable entrance to the Tweed River
2. restore and maintain the coastal sand drift to the southern Gold Coast beaches.

The project area is located on the border of NSW and Queensland, approximately 100 km south of Brisbane and 900 km north of Sydney. The project area falls into the jurisdiction of both the City of Gold Coast and Tweed Shire Council. Figure 1.



One objective of the project is to establish and maintain a safe, navigable entrance to the Tweed River.

The second objective of the project is to restore and maintain the coastal sand drift to the southern Gold Coast beaches.

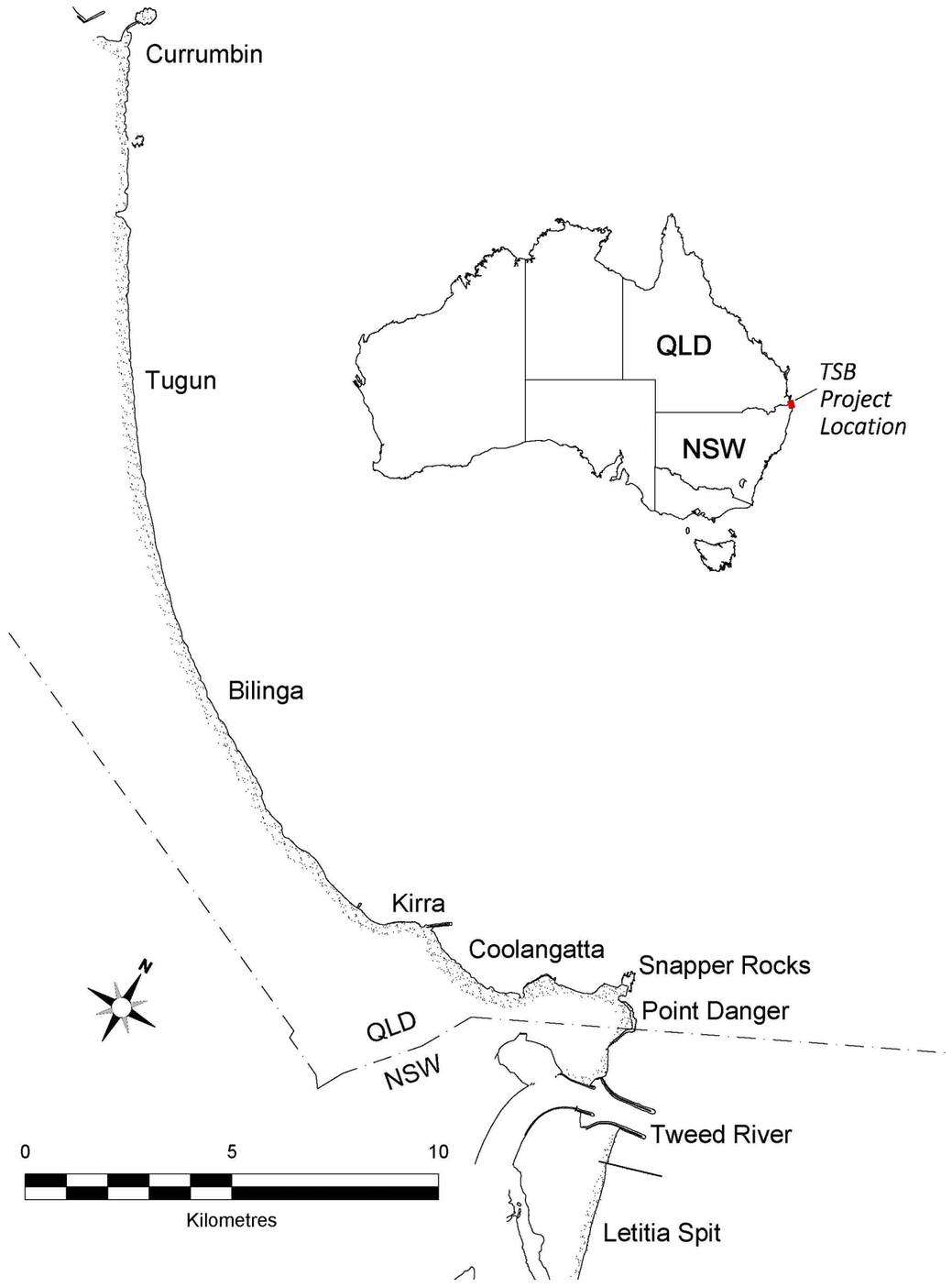


Figure 1: Tweed Sand Bypassing project area location map. Source: Tweed Sand Bypassing

Tweed Sand Bypassing is made up of both a permanent sand transport system located at Letitia Spit, NSW, and periodic river entrance dredging.

The sand-pumping jetty (Figure 2) collects naturally moving sand from the southern side of the Tweed River entrance at Letitia Spit, and pumps it under the Tweed River to outlets on the northern side. From there the sand is transported by waves and currents to nourish the southern Gold Coast beaches. The sand pumping jetty is unable to collect all of the longshore drift that moves past it. For this reason it is also necessary to periodically dredge the sand bar that forms over time at the entrance of the Tweed River (Figure 3). The dredged sand is delivered to several locations both in Queensland and NSW.

Figure 2: Tweed Sand Bypassing sand-pumping jetty. Source: Tweed Sand Bypassing

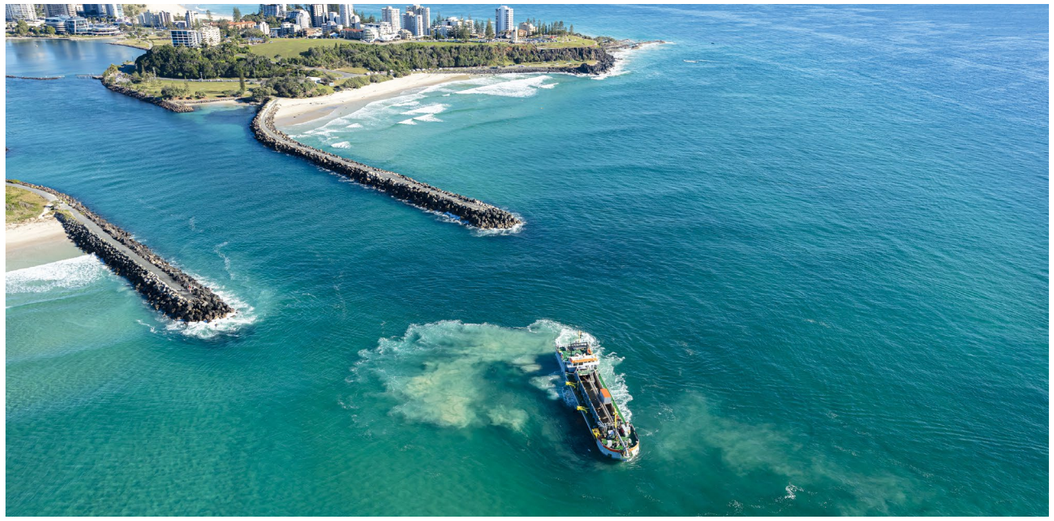


Figure 3: Dredge boat removing sand from the Tweed River entrance 2019. Source: Tweed Sand Bypassing

STUDENT ACTIVITIES

KN KNOW
UN UNDERSTAND
AP APPLY
AN ANALYSE
EV EVALUATE
CR CREATE

1. Suggest ways that beaches in northern NSW and Southern Queensland are connected to each other? UN

2. Why is Tweed Sand Bypassing made up of both a permanent sand bypassing jetty and floating dredge? UN

3. Refer to the Stimulus Booklet with this resource. Answer the questions that refer to the topographic map of the project area. KN UN AP AN

THE NATURAL ENVIRONMENT

The Tweed/Gold Coast region is an area of natural beauty (amenity) with world-class beaches and surfing breaks, headlands and river environments (Figure 4). These are highly valued by local residents and businesses as well as domestic and international tourists. The beaches are important for recreational activities, connection to nature, tourism and the local economy, making the maintenance of the beaches a high priority in coastal management.

The Tweed/southern Gold Coast is a dynamic coastline that is continuously fluctuating. Sand is constantly moving due to changes in environmental conditions that include wind, waves, currents, tides and storm events. Change occurs over different temporal (time) and spatial scales.

The effective and sustainable management of this coast depends on an understanding of the interconnected natural processes that cause change.

Four key influences determine the environmental processes operating in the Tweed/Gold Coast project area. These are:

- topography and geology
- coastal sediment supply
- wind, waves and sediment transportation
- extreme weather events.

Figure 4: Natural and cultural features of the Tweed/southern Gold Coast. Source: Tweed Sand Bypassing

Topography and geology

The Tweed River catchment is approximately 1,000 km^2 in size and contains the caldera of a large inactive volcano. After 20 million years of erosion, Mt Warning remains as a volcanic plug, while Point Danger and Snapper Rocks are remnants of resistant rock from past lava flows that now influence sand movement along the coast. The rest of the catchment is fairly flat and comprises rich volcanic and alluvial soil.

The Tweed River delivers eroded sediment from higher land to the floodplain, the estuary and through the river mouth to the sea where it feeds into longshore sand transportation or moves back into the river through wave action. The Queensland section of coast is generally low-lying with long beaches and dunes that make it very vulnerable to wave erosion during king tides and storms. Figure 5.

Another remnant volcanic feature is Cook Island, located just offshore from Fingal Headland. For local Aboriginal people this Island is known as Jungarra Ngarian (the pelican's playground or ceremony place). Figures 6 and 7 on the next page.

The island is named after Captain Cook, who arrived in the region in 1770, with the ocean between Cook Island and Fingal Headland sometimes called the Giant's Causeway. This is likely in reference to the Giant's Causeway in Northern Ireland, a region that also has basalt column formations and is steeped in Celtic myth. The Fingal Head basalt column outcrop at Fingal Head is known to Aboriginal people as Mynjung Booning (the place of the echidna).

Coastal sediment

An abundance of sediment is delivered to the northern NSW coast through the process of longshore drift. This 'river of sand' originates from large sand deposits just offshore of the Clarence River near Yamba. The sand slowly moves northwards until it reaches the northern tip of Fraser Island, and slips over the continental shelf. The size of this sand reserve and how long it will continue to flow is largely unknown. This is an example of long-term change at an interstate scale. It can take years for a grain of sand to move a few kilometres along the coast. Figure 8 on the next page.

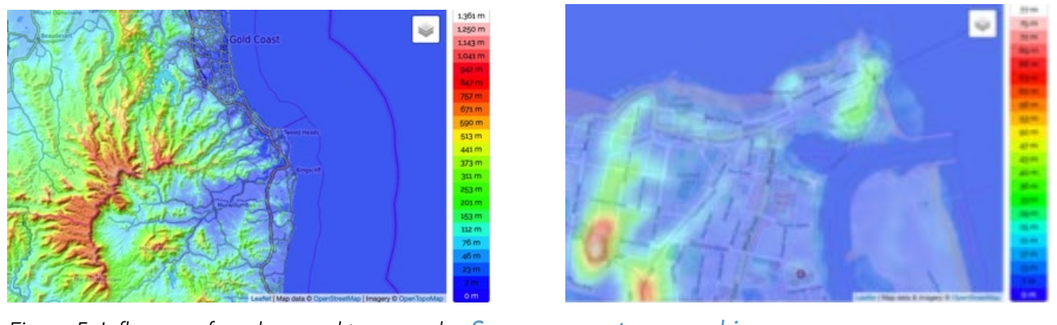


Figure 5: Influence of geology and topography. Source en-au.topographic-map.com

Figure 6: Jungarra Ngarian (Cook Island) located offshore of Fingal head. Source: Tweed Sand Bypassing

Figure 7: Oblique aerial photograph of Jungarra Ngarian (Cook Island). Source: Tweed Sand Bypassing

River of sand

WHERE DOES THE SAND IN NORTHERN NSW AND SOUTH EAST QUEENSLAND COME FROM?

The sand that forms the wave at Snapper is on an ancient journey that started high in the mountains of northern NSW over 16,000 years ago. During this time the world was in the middle of the most recent ice age and the sea level was 120 m lower than it is today. The mountains of The Great Dividing Range were higher, when compared to sea level, and eroded easily sending large quantities of quartz and other rock down the rivers to the Pacific Ocean.

One of the largest sand reserves in NSW is just offshore of the Clarence River near Yamba. As the ice age ended and the earth's climate began to warm, the sea level rose, bringing the shoreline 20 km landward. The rising sea level, waves, tides and currents, pushed the sand that had been deposited offshore towards the land, creating the current coastal landscape.

Through the process of longshore drift, this reserve continues to feed sand along the giant natural conveyor belt from northern NSW towards southern Queensland. The predominant south easterly waves push and drag the sand on and off the beach, in and out of the swash zone, moving sand north and creating the region's famous sandy bottom point breaks.

The sand spills around large headlands such as Cape Byron, flows in and out of estuaries, and tracks along the southern Queensland barrier islands until it reaches Fraser Island. Here, the sand finds its final resting place as it slips off the northern end of the Island and is lost to the deep waters of the continental shelf.

It's entirely possible that if you're surfing The Pass at Byron, you may end up surfing over the same grain of sand years later at Snapper.

No one knows exactly how large the Clarence sand reserve is, or how long the sand will continue to flow. What we do know is that the sand volumes moving along the coast of the NSW - Queensland border are some of the largest in Australia. With an average of 200 full sized swimming pools of sand moving on this journey beneath the ocean's surface each year.

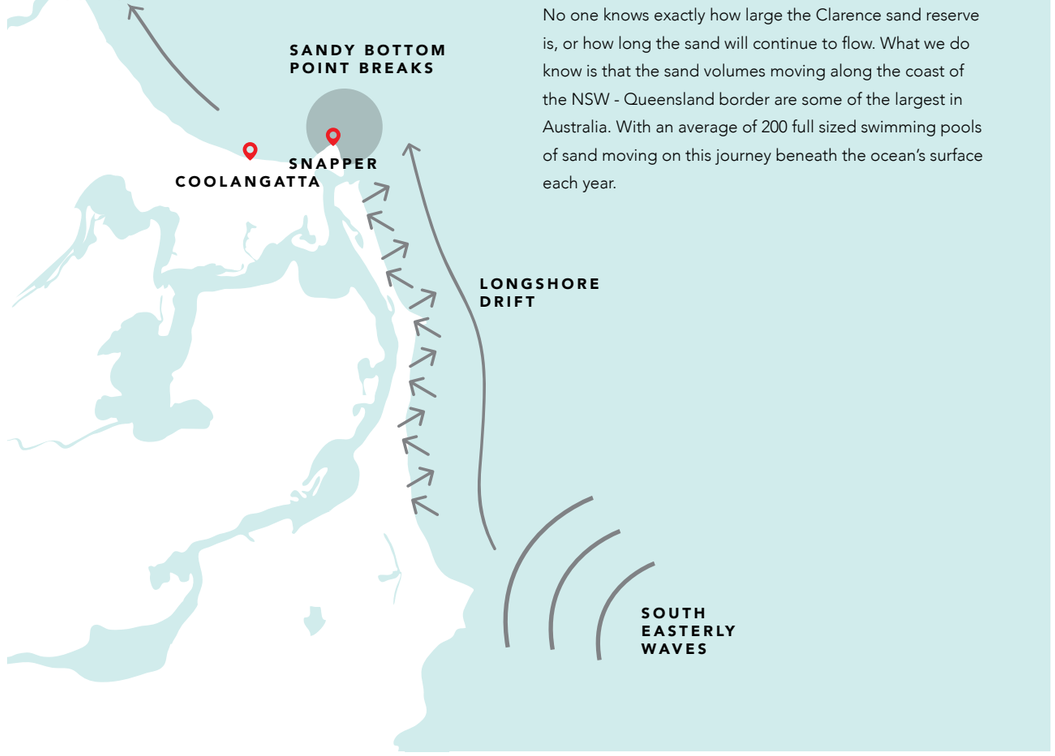


Figure 8: Excerpt from Sand *magazine. Source: Tweed Sand Bypassing*

WIND, WAVES AND SEDIMENT MOVEMENTS

Wind-generated waves change the shape of beaches by moving sediment onto, from and along beaches.

Longshore drift

Along the Tweed and Gold Coast beaches, the predominant wave direction is from the south-east. These waves push sand in a northerly direction. When the wave direction is from the north-east, sand is moved in the opposite direction, from north to south, but this does not happen often. Each year approximately 500,000 m^3 of sand moves northwards along Letitia Spit. However this can vary between 250,000–1,000,000 cubic metres. This is equivalent to filling 200 Olympic-sized swimming pools with sand.

Cross-shore transport

On smaller, pocket beaches, such as Duranbah, where a headland and training wall restrict longshore drift, sand moves perpendicular to the coast. This cross-shore *sand transport* causes deposition during periods of constructive waves and beach erosion during destructive waves and storm events. This happens on a time scale from days to weeks and at a local spatial scale.

Figure 9: Longshore sand transport on Letitia Spit.

Figure 10a: This image shows Duranbah in October 2010. The beach has lots of sand and is wide after a period of constructive waves. Source: Ashley Rogers, NSW Government

Figure 10b: This image shows Duranbah in February 2020, just after landfall of Cyclone Uesi. Lots of the sand from the beach has been removed and there is lots of debris. Source: Ashley Rogers, NSW Government

Figure 11: Aerial photograph showing southeasterly waves refracting around Snapper Rocks. Source: Tweed Sand Bypassing

Figure 12a: Oblique aerial photograph showing wave refraction at Snapper Rocks. Source: Tweed Sand Bypassing

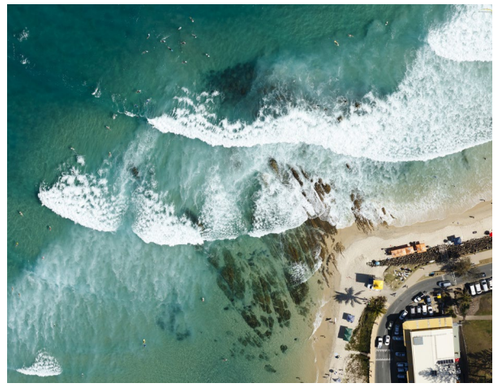


Figure 12b: Aerial photograph showing wave refraction at Snapper Rocks. Source: Tweed Sand Bypassing

Figure 12c: Oblique aerial photograph showing wave refraction at Snapper Rocks. Source: City of Gold Coast

Wave refraction

At Point Danger, the coastline changes direction by almost 90 degrees. This causes southeasterly waves to bend and refract around the headland. The sand transport rate slows down significantly once it reaches Snapper Rocks. This is because the southern Gold Coast beaches face north-west, as opposed to north-east like Letitia. It is wave refraction that causes such high-quality surf at Snapper Rocks. (Figure 11, Figure 12a, 12b, 12c and Figure 13.)

Sand moves through Coolangatta Bay through both longshore and cross-shore drift, with the rate of sand movement being dependent on the height and direction of the waves.

Seasonal change

As Tweed Sand Bypassing only delivers the natural flow of sand that is moving along Letitia Spit through the process of longshore drift, natural variation in beach width is experienced on the southern Gold Coast beaches. A good example of seasonal change is Rainbow Bay in Queensland. Figure 13, an excerpt from *Sand* magazine explains this process in more detail.

Extreme weather events

The Tweed/Gold Coast region averages 1.3 cyclones per year. In some years it is possible for several cyclones to occur one after the other, or for a larger and more intense cyclone to impact the area. Both situations can leave beaches scoured of sand. Intense east coast lows are common in autumn and winter, and can generate strong winds and large seas that cause coastal erosion. If there is a lack of sand to replenish beaches or insufficient time between storm events, it is difficult for the beaches to recover from natural processes.

Rainbow Bay

QUEENSLAND'S SOUTHERNMOST BEACH, RAINBOW BAY, IS KNOWN FOR ITS ICONIC BEAUTY AND WORLD-CLASS SURFING CONDITIONS. IT IS ALSO ONE OF THE FEW BEACHES ON THE EAST COAST OF AUSTRALIA THAT FACES NORTH.

The shoreline at Rainbow Bay is constantly moving but the overall beach width and shape generally fall into two distinct patterns.

In the first half of the year, the wave direction is more southerly. After being captured by the jetty and discharged on the northern side of the river entrance, or travelling offshore of Letitia in deeper water, large quantities of sand makes their way northward around the headland at Snapper Rocks.

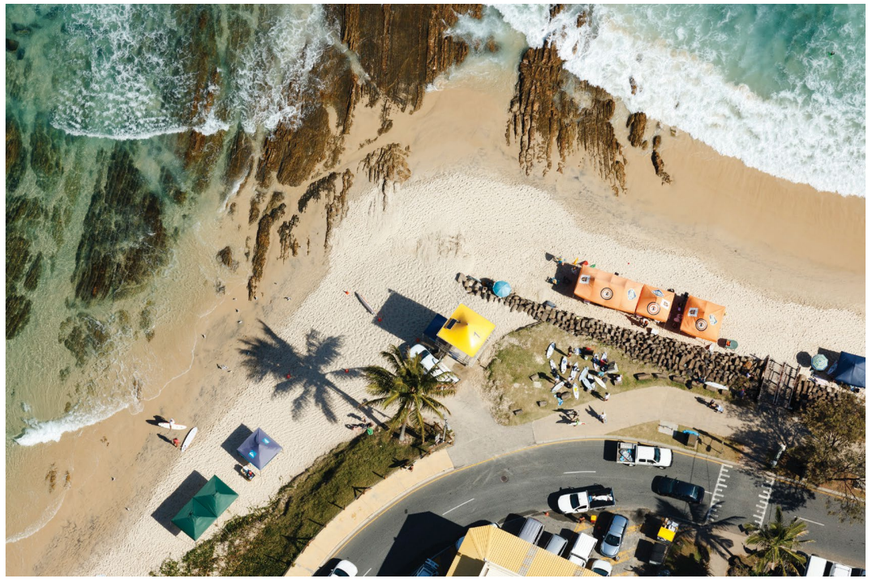
Once sand has moved around Snapper, it slows down and temporarily builds up at Rainbow Bay. The beach continues to increase in width until sand at the northern end of Rainbow starts to flow around Greenmount headland.

In the second half of the year the average wave direction typically shifts more to the north, accompanied by strong northerly winds. This means that less sand moves around Snapper Rocks and into Rainbow Bay, and the beach begins to wash away. This creates a deeper Bay with a large separation between the swimming and surfing areas. As slugs of sand begin to move back around Snapper Rocks, a lagoon is sometimes seen as the sand migrates from the seabed to the beach.

Rainbow Bay, although always beautiful, naturally fluctuates with the changing seasons. Tweed Sand Bypassing has captured beach conditions on the southern Gold Coast beaches since the late 1990s. This information is used to track changes to the beaches caused by the impact of the seasons, storms, and sand delivery.

Image: Rainbow Bay's seasonal pattern of retreat was clearly evident in January 2017. The almost constant stream of northerly winds and lack of swell throughout late 2016 and early 2017 reduced the natural northward flow of sand around Snapper Rocks. As a result, Rainbow Bay continued to change shape with the ocean moving closer to the dunes. Rainbow Bay should begin to increase in size once wave conditions become more southeasterly, and sand is pushed along the coast and around Snapper Rocks.

Figure 13: Excerpt from Sand *magazine. Source: Tweed Sand Bypassing*



STUDENT ACTIVITIES

- KN KNOW
- UN UNDERSTAND
- AP APPLY
- AN ANALYSE
- EV EVALUATE
- CR CREATE

1. List 3 ways sand is transported to and from Tweed/Gold Coast beaches. KN

2. State the 'prevailing' wind direction on this coastline. What does 'prevailing' mean and why is it important? KN UN

3. Refer to the Stimulus Booklet with this resource. Answer the questions that refer to the Tweed Heads (Sources J and K) Wave Rose. AN

4. Explain the link between wave refraction and past volcanic activity. UN

5. Study Figure 5 and the topographic map in the Stimulus Booklet.
   i. Identify the location of Point Danger and Snapper Rocks. KN
   ii. Describe the altitude of coastal land on the Queensland side of Snapper Rocks. KN

6. Why do beaches face different directions on this coast? Why is this important? KN UN

7. What do you understand by 'river of sand' and its importance for east-coast beaches? UN

KEY LEARNING

- The environmental processes of weathering, erosion, transportation and deposition continuously change Tweed/Gold Coast beaches.
- Each beach is unique due to differences in how coastal processes operate.
- Longshore drift, cross-shore sand transport and wave refraction play a role in changing beach conditions.
- East coast lows and cyclones have always eroded Tweed/Gold Coast beaches.