BRISBANE SOUTH MARINE STUDIES PROJECT

MARINE STUDIES SERIES

UNIT 8

COASTAL PHYSICS

written by

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"TO GREAT DAYS AT THE ALEX"

Australia's coastline forms a special place in our environment because over 90% of us live there. Due to different Ecological, Economic, Social and Recreational interests many conflicts arise over the use of our Estuaries, Beaches and Barrier Reefs. Sand Mining, High Rise development, Longline Fishing, Low water Land sales, Resort Development and Oil Pollution are but a few of the real issues that face us now. There is an urgent need for all Australians to develop an attitude towards sensible resolution of these conflicts. This set of notes is one in a series that hopefully will give students the skills necessary to become involved in these issues and make sensible contributions to coastal environmental decision making. In doing so I hope that the coastline may be managed in such a way that future Australians will derive as much pleasure out of it as I have.

My thanks must go to STAQ for providing the financial backing and support to start this project. Thanks also to my Mother and Father who deciphered and typed my bad writing; and to Len Zell of the Great Barrier Reef Marine Park Authority who read and critised the draft and for making many useful contributions. As this is a first draft any comments would be gratefully acknowledged.

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COASTAL PHYSICS

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COASTAL PHYSICS

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This module has 3 sections:

special thanks to

Dianne Hempenstall
Benowa State High School

This module is compatable with the Syllabus Topics:
* Man, Resources and Environment *
* Energy *

Students, Teachers and Parents are referred to the Multistrand Science Syllabus (Qld) Board of Secondary School Studies, Spring Hill, Brisbane.

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Also Beach Protection Authority, Harbours and Marine and Gold Coast Authority

Unit 8: Coastal Studies (29 hrs)

Many Queenslanders live within one hours drive of the sea. Many will spend their holidays at some kind of coastal development. For schools that are on the coast, there is a special type of coastal enviroment which pervades the lifestyles of students. It is important for students growing up in this holiday atmosphereto realize the problems associated with it. Equally important is the problem of visitors to the coastal areas adopting codes of behaviour that are different to their normal lifestyle.

Content Objectives

The student should have knowledge of:
(a) General coastal features such as headlands, bays, beaches, landforms, wave motion and coastal development.
(b) How waves are formed and affect the coast
(c) Coastal developments and engineering works eg. groynes
(d) Political implications of beach resource development.
(e) Enviromental implications of developing beaches, dunes or inland waterways.
(f) The history of a local beach area. eg. The Spit.
(g) Recreational activities that can be carried out on the coast.
(h) Coastal disasters such as cyclones and floods and what to do when these occur.
(i) Dangers associated with beaches and coastal bars.
(j) Tides and their effects.

Process Objectives

The student should be able to:
(a) Discuss different types of beach accommodation.
(b Compare different tariffs from different areas in Queensland (Lizard Island, Gold Coast)
(c) Collect information on different peoples attitudes to a local development.
(d) Debate the information collected rationally.
(e) Understand the rules and regulations associated with beach homes, units, time sharing etc.
(f) Understand local council building regulations regarding cyclones and floods.

Skill Objectives

The student should be able to:
(a) Construct a model wave tank to illustrate principles of beach erosion
(b) Illustrate with the model, the effects of groynes.
(c) Use a phone book,newspaper or travel brochure to obtain tariffs for an area.
(d) Plot a graph of tides over a month.

Affective Objectives

The student should:

(a) Become receptive to different arguments for coastal development
(b) Become aware of the fragile nature of the coast and the effects of cyclones.
(c) Appreciate the need to be careful while camping.
(d) Develop a respect for the surf or sea.
(e) Tolerate different developers opinions and criticise only when well substantiated facts are available.

Electives

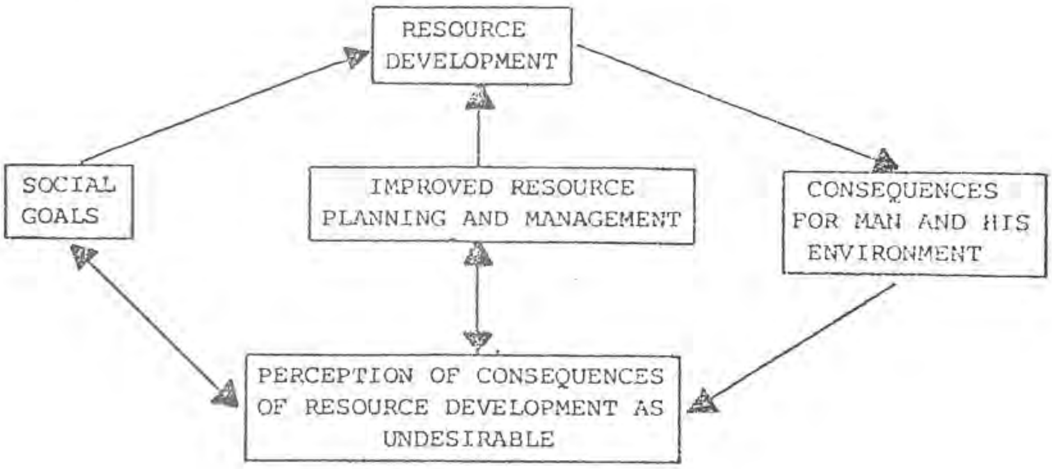
Wave models and harbour design, Coastal jobs, Foreshore ecology, Animals and plants that inhabit the coast, Observe cyclone proofing on a construction site, study changes that have occurred in a local area because of management.

WHY STUDY THIS UNIT

"The extent and type of resource development in any society depends on the goals and values of that society. These goals and values are not determined in isolation but are historically and culturally conditioned.

Equally, any resource development has consequences for society. These consequences include both intended and unintended outcomes. Pollution, for example, is not an intended outcome of the development of secondary industry. It is the consequence of industry in some environmental contexts. Perception of the consequences of resource development may lead to the recognition that an environmental problem worthy of attention exists.

Two kinds of processes may follow from this realisation. These are summarised in the flow chart.



Firstly, better management and planning can be called for, aimed to minimise the less than desirable consequences of resource development; for example, State Governments in Australia legislate to control exhaust emissions from cars to minimise the effect of these emissions on the environment.

In addition, a re-evaluation and possibly modification of social goals may occur simultaneously. For example re-evaluation of the consequences of unrestrained personal urban mobility has lead to improved public transport systems.

The flow chart suggests that such processes in society are continually ongoing and interactive. One purpose of the topic 'Man, Resources and Environment' is to increase awareness of such processes, and thus encourage responsible participation in them. Thus students are helped to consider the question: 'What kind of world do we want?' and to consider the role of science, technology and resource development in this question."

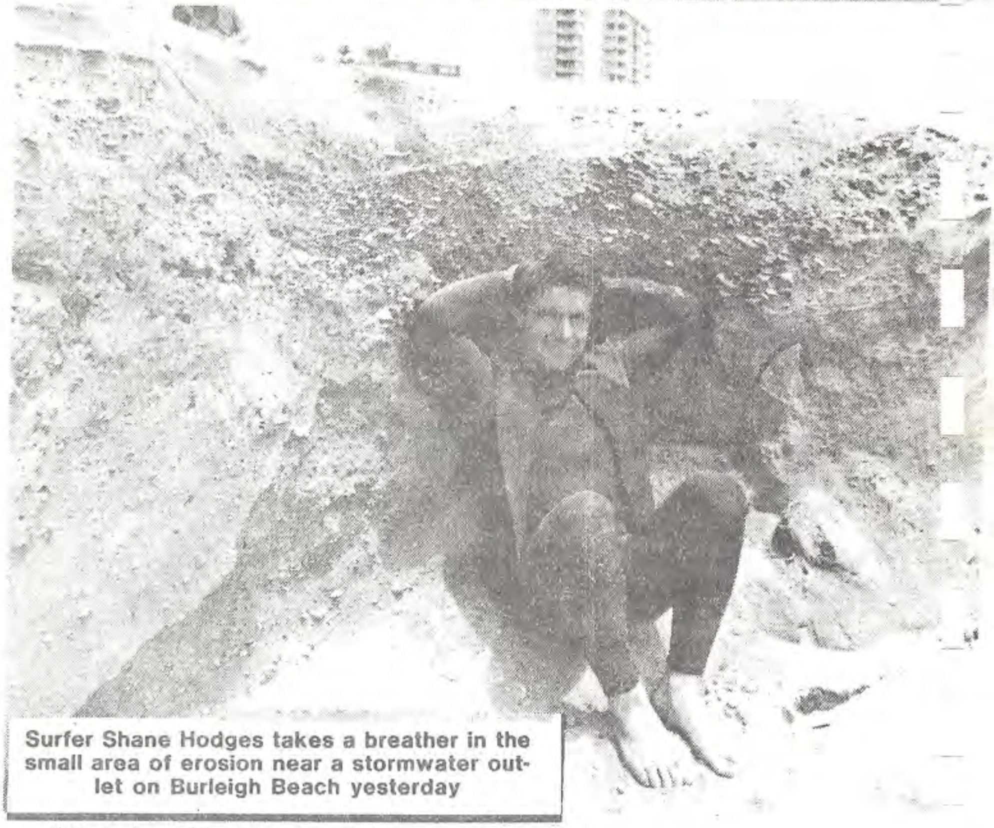
From: Multistrand Science Syllabus 1982
BOSSS

A study of our coastline provides an excellent opportunity to explain how this flow chart can be explained.

Massive restoration programme put to the test by natu[re]

BEACHES WEATHER STORMS

by GREG STOLZ



Surfer Shane Hodges takes a breather in the small area of erosion near a stormwater outlet on Burleigh Beach yesterday

GOLD Coast beaches have weathered their first battering since hundreds of thousands of cubic metres of sand were dumped on them in a $3.5 million pumping operation.

Heavy seas and driving rain, whipped up by gale-force winds, pounded the beaches at the weekend.

It was their first big test at withstanding Mother Nature's onslaughts since the six-week sand dredging operation finished last week.

A Bulletin check yesterday revealed that only Burleigh beach, which received 385,000 cubic metres of sand in the pumping programme, experienced any erosion — and that, at a stormwater outlet, was only minor.

But the rest of the beaches involved in the dredging scheme — North Kirra, Palm Beach and Surfers Paradise — appeared to have stood up well to the pounding, according to Gold Coast City Council works committee chairman Trevor Coomber.

"Our coastal engineers have been up and down the coast all weekend and are happy with the state of the beaches," he said.

"We had considerable rain and the seas were fairly rough, but the beaches have coped fairly well."

Ald Coomber said the key to protecting the beaches from further erosion was the natural build-up of an offshore sand bar.

"The sooner that builds up, the better. We'll just have to keep our fingers crossed," he said.

Ald Coomber said installation of the special filter fabric 'sausage groin' at North Kirra to try to protect the 315,000 cubic metres of sand dumped there, should be completed today.

In this unit you will learn about the following coastal landforms:

Bay
Point
Tombolo
Sea Stack
Wave cut bench
Wave cut cliff
Wave built terrace
Groyne
Bar
Spit
Sand dunes
River mouth
Cove

PRACTICAL INVESTIGATIONS

1. Waves and Reflection
2. Reflection
3. Longshore Currents and Groynes
4. Aerial Photograph Study of Beaches

STUDY ASSIGNMENTS

1. Selected Questions
2. Class Debates
3. Collection of Posters and Pamphlets
4. Interviews with Resource Developers

MAN, RESOURCES AND ENVIRONMENT

1. OBJECTIVES
2. WAVE FORMATION
3. BREAKING WAVES
4. BEACH CURRENTS
5. POINT DIFFRACTION
6. REFRACTION
7. WAVE SET UP AND SET DOWN
8. LONGSHORE CURRENTS
9. DEPOSITIONAL LANDFORMS FROM LONGSHORE CURRENTS
10. HOW MAN INTERFERS WITH LONGSHORE CURRENTS
11. MAN, RESOURCES AND ENVIRONMENT

DIRECTED TOPICS

1. Class Lessons on Waves, Currents and Beaches
2. Visit to Local Headland and Beach
3. Class Talks by conflicting parties

AUDIO VISUAL

1. Display of Posters
2. Films on Behaviour of Light
3. Study of Aerial Photography

OBJECTIVE STATEMENT (SYLLABUS)

CONTENT AREA: The student should have knowledge of:

a) A selective history of mankind in terms of his capacity to develop resources.

b) How social needs determine resource development.

c) Physical and social aspects of resource development.

d) Some unexpected and/or undesirable consequences of resource development.

e) Possible conflict between different interest groups regarding resource development.

f) How changes in social goals and improved resource management are brought about through a perception of undesirable consequences of resource development.

PROCESS AREA: The student should be able to:

a) Identify resource development which serves only a narrow interest group.

b) Predict possible environmental consequences of proposed resource development.

c) Identify the necessity for compromise between environmental and resource development objectives through case studies.

d) Discuss resource development protects objectively and assess desirable as well as undesirable features of specific projects and

e) Present a case in debate to ensure effective communication between different interest groups involved in resource development and environmental assessment.

SKILLS AREA: The student should be able to:

a) Carry out field studies so as to assess man's impact in resource development.

b) Use appropriate equipment to assess impact (transect, metrorological, survey).

AFFECTIVE AREA: The student should have the opportunity to:

a) Develop a personal position in relation to resource development and environmental questions.

b) Value the existence of legitimate differences in opinion between interest groups involved in resource development and environmental assessment.

OBJECTIVE STATEMENT (TEACHER)

CONTENT AREA: You should be able to:

a) Recall the development of a local beach area from its wilderness state to the present.

b) Recall the stages of development of a local beach area, and list the recreational developments that have occurred to meet the social needs.

c) 1. State how waves form and deposit their energy and how currents form
   2. List social implications and beach development

d) 1. Diagram erosion problems caused by groynes, breakwaters and harbours
   2. List undesirable consequences of high rise development

e) List groups in conflict with beach development and state conflicts.

f) 1. List successes in Beach Protection Authority due to management programs
   2. List undesirable consequences of high rise development/ sand mining/dogs on beaches/four-wheel drive clubs.

PROCESS AREA: You should be able to:

a) Discuss the interests of Real Estate Developers/or Sand Miners in beaches.

b) Predict the environmental consequences of Real Estate Development/Sand Mining.

c) Describe how the Beach Protection Authority/Great Barrier Reef Marine Park Authority/Queensland Fisheries Service/ Harbours and Marine have compromised in a local beach/ coastal development (eg. marina, high rise, trawling ground).

d) Discuss a proposed resource development project (eg. proposed marina, canal estate, high rise building, Barrier Reef resort, mining proposal) and list desirable and undesirable features of its development.

e) Prepare a class debate on the proposed resource development or a written submission to a court taking either/both sides in the debate.

SKILLS AREA: You should be able to:

a) Interview resource developers to identify needs.

b) Use appropriate equipment to undertake a small environmental impact study.

AFFECTIVE AREA: You should develop:

a) A personal opinion about a local environmental development on attitude towards resource developers.

STUDENT MATERIALS:

Specific learning tasks are found in the Student Notes however posters, pamphlets, broadsheets will need to be available from Coastal Management Authorities. It will be necessary to develop a method of recording your information which does not rely on a record book - this means keeping all laboratory and study assignments.

PRE EXPOSURE

No specific knowledge required for entry into this unit. Student activities assume a satisfactory level of achievement in Junior School Science.

COASTAL MANAGEMENT AUTHORITIES

1. Queensland Fisheries Service: PO Box 36, North Quay, 4000, Brisbane
2. Department of Harbours and Marine: Edward Street, Brisbane
3. The Beach Protection Authority: PO Box 2195 GPO, Brisbane
4. Great Barrier Reef Marine Park Authority: PO Box 1379, Townsville, 4810
5. National Parks and Wildlife Service: PO Box 190, North Quay, 4000

RESOURCES/REFERENCES

1. Reflections available from (1) above
2. Posters available from (2), (3), (4) and (5)
3. Pamphlets available from (1), (2), (3), (4), (5)
4. Publications, Annual Reports available from (3), (4)
5. Societies: Queensland Litoral Society
   The Australian Conservation Foundation
6. History of the Gold Coast

TIME REQUIRED

Minimum of 10 hours, otherwise depending on debates and student/teacher motivation.

EXCURSIONS

1. Visit to area of resource development essential.
2. Visit to Mining Wardens Court.

SECTION 1

WAVES, CURRENTS AND BEACHES

PRACTICAL INVESTIGATIONS

1. Waves and Reflection
2. Refraction
3. Longshore Currents and Groynes

STUDY ASSIGNMENTS

1. Selected Questions
2. Debate on Local Authority Beach Management
3. Collection of Beach Protection Authority Pamphlets, Posters

Introductory Geomorphology Questions

1. What is a sea-stack ?
2. What is a tombolo ?
3. Describe the term swash zone.
4. Describe the difference between a wave cut bench, a wave built terrace and a wave cut cliff.
5. What is the name of a ridge of sand or gravel that completely blocks the mouth of a bay?
6. What is a spit?

DIRECTED TOPICS

1. Visit to Local Headland and Beach.
2. Lessons on the Behaviour of Waves near Beaches and Headlands.

AUDIO VISUAL

1. Display of Beach Protection Authority Posters, Films.
2. P.S.S.C. Films on Light Behaviour

SECTION 1: WAVES, CURRENTS AND BEACHES

CONTENT OBJECTIVES: You should be able to:

1) State how waves form and how they break.

2) Recall the meaning of the terms Fetch, Swell, Crest, Wave Length, Trough, Height of Wave, Crest Angle, Reflection, Refraction.

3) State a relationship between Angle of Incidence and Reflection.

4) Diagram reflected waves off beaches.

5) Define Rip Current, Point Diffraction, Wave Set Down, Orthogonal, Wave Set Up, Longshore Current, Groyne, Accretion, Breakwater, Beach Erosion, Rock Revetment.

6) List 5 steps to conserve beaches.

PROCESS OBJECTIVES: You should be able to:

1) Describe how wind forms.

2) Distinguish between Wind Waves and Swell.

3) Given the height and length of a wave, predict if it will break.

4) Distinguish between Spilling, Plunging and Surging Waves.

5) Model Wave Diffraction.

6) Explain how Rips form off beaches.

7) Compare different Near Shore Bathymetry with Direction Waves approach the shore.

8) Explain how Force Vectors change direction as wave crests approach a shore

9) Explain the significance of Wave Set Up, Longshore Current.

10) Explain how man has interfered with Longshore Currents.

11) Debate the use of Groynes and Breakwaters.

SKILL OBJECTIVES: You should be able to:

1) Use a Ripple Tank to explain Refraction, Reflection and Diffraction

2) Make a model beach and construct models to explain how Longshore Current can be affected.

ATTITUDE OBJECTIVES: You should

1) Appreciate the need to conserve beaches

2) Appreciate the need to manage beaches wisely

SECTION 1: WAVES, CURRENTS AND BEACHES

.1 *Wave Formation*

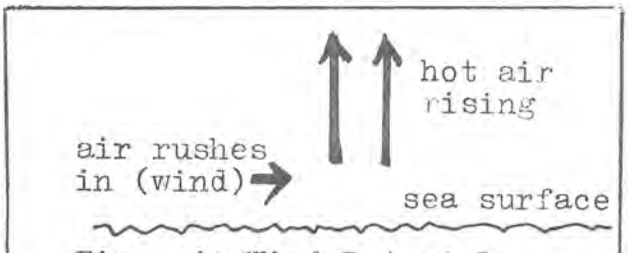


Fig -1: Wind Principle

As hot air rises over the sea it creates an area of low pressure below it.

Air from a higher pressure closer by moves into the low pressure area.

The moving air is called *WIND* and starts ripples on the sea surface. As the wind continues to blow, *WAVES* form and begin to move.

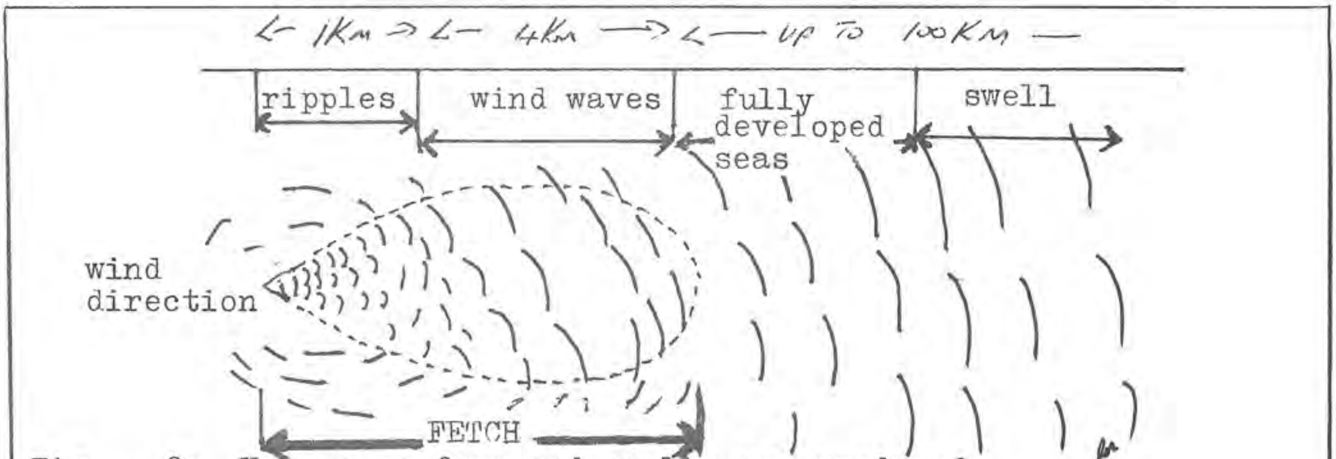


Fig. -2: How waves form and swells are produced.

The length of water over which the wind blows is called the *FETCH* and wave size increases proportionally with the length of the fetch, as well as with the strength of the wind. When waves leave the fetch zone they form a *SWELL*, and travel under their own *MOMENTUM*. Estuaries can be affected by wind, waves, or swells. As the waves move towards the estuary, the water depth decreases and the waves break.

.2 *Breaking Waves*

The length of a wave is the distance between troughs. The height is the distance from the trough to the crest.

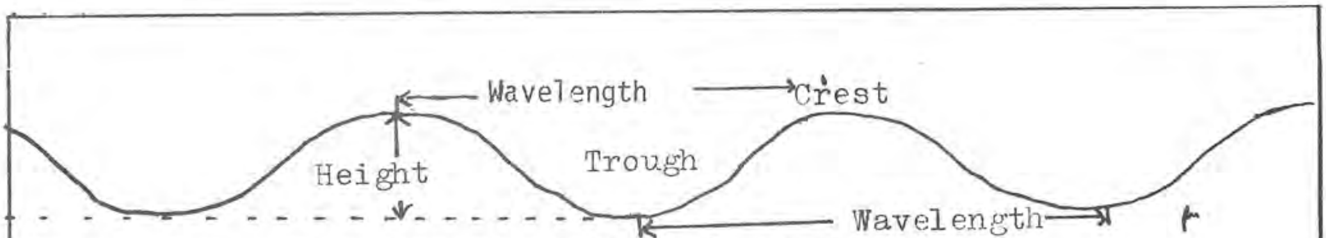


Fig. -3: Some characteristics of waves.

In the ocean, the maximum height a wave can attain is limited by the angle of steepness.

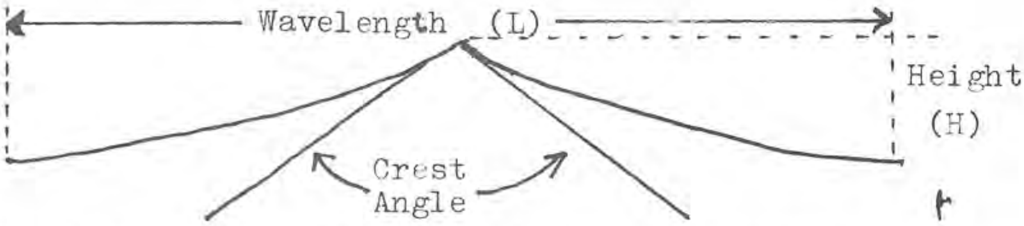


Fig. 4: Wave characteristics relevant to Breaking

Limiting Steepness $\frac{H}{L}$ = 0.142 or about 1/7th.

If the value of $\frac{H}{L}$ does not exceed 1/7th, then the wave will not break. If the value of $\frac{H}{L}$ is greater than 1/7th, then the wave will break.

Look at the two waves below. Measure their heights and lengths. *WAVE A* (1/7th) will not break, but *WAVE B* (2/7th) will.

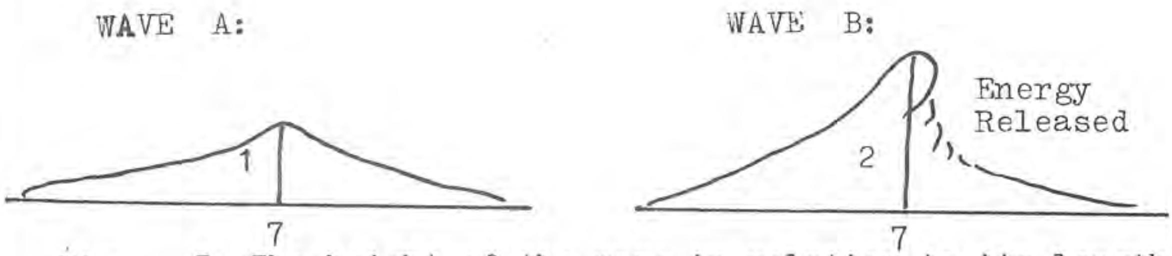


Fig. 5: The height of the wave in relation to its length.

As the wave breaks, its energy will commence to dissipate.

As the waves approach the shore, the limiting factor will be depth.

Three types of waves are seen in estuaries, each determined by the slope of the ocean floor.

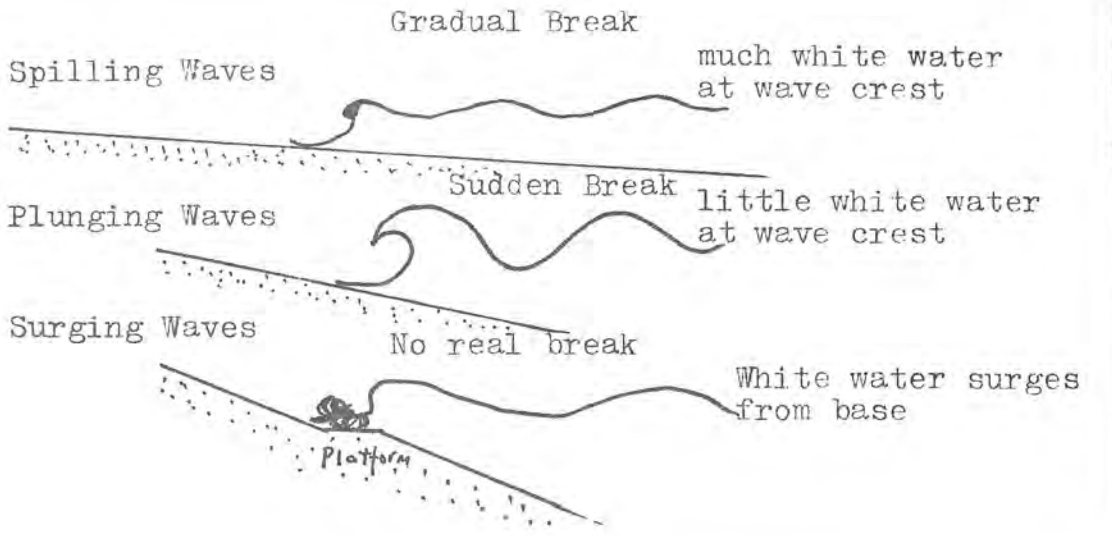


Fig. 6 A: Spilling Waves

Fig. 6 B: Plunging Waves

Fig. 6 C: Surging Waves

A. *Spilling Waves:* These are waves which break gradually and have much white water at the crest.

B. *Plunging Waves:* These waves curl over at the crest and this upper mass of water forms a pipe line break.

C. *Surging Waves:* These waves are seen at rocky outcrops or at breakwaters where the wave seems to surge from the base.

.3 *Wave Refraction and Reflection* (SEE PAGES 14 – 25 for a complete description)

Wave refraction is the bending effect on the wave crest as the wave tends to align itself with the shallowing sea bed.

Investigation 1: Waves and Reflection

You will need

* One ripple tank (complete with dampers)
* One overhead light
* One sheet of white paper
* A Wave generator (or piece of Dowel)
* Wax blocks or barriers
* Glass sheet

NOTE! BRIGHT LINES OCCUR WHERE LIGHT RAYS MEET

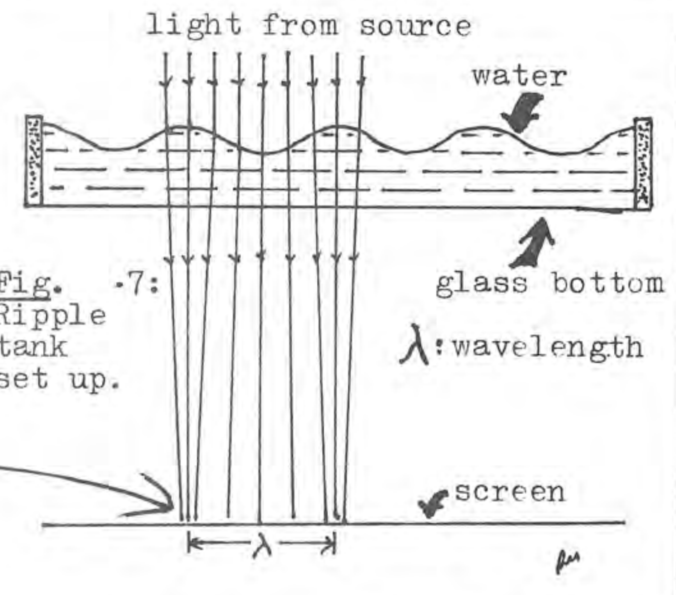


Fig. ·7: Ripple tank set up.

PART A. Waves and Wave Length

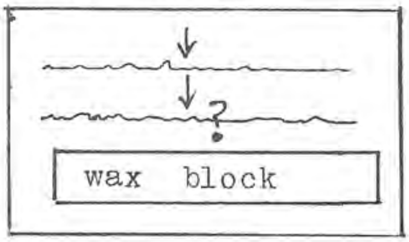
UNIVERSAL WAVE EQUATION - SEE PAGE 20

Sometimes it is easier to fill the tank up and then siphon off to the required level. Note: Adding a drop of liquid detergent to the water breaks down the surface tension in the water, making the shadows more distinct.

What to do If you have a strobe light you can stop the waves:

1. Generate some waves with the Dowel or Wave Generator.
2. Measure the wave length in cm. for various speeds of wave generation.

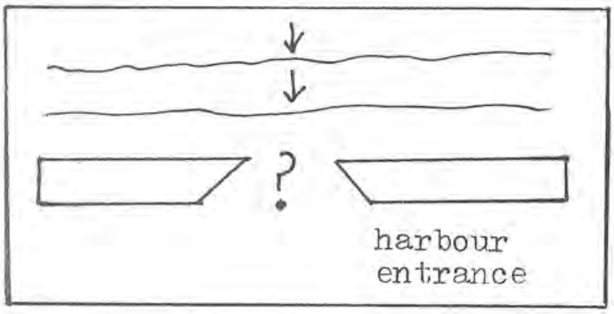
☐ Record in data table for *FAST*, *MEDIUM*, and *SLOW* wave generations.



PART B. Reflection

1. Use a wax block to study the effect of waves striking in at *straight* and at *angles*.

☐ Record the Angles of Reflection in each case.

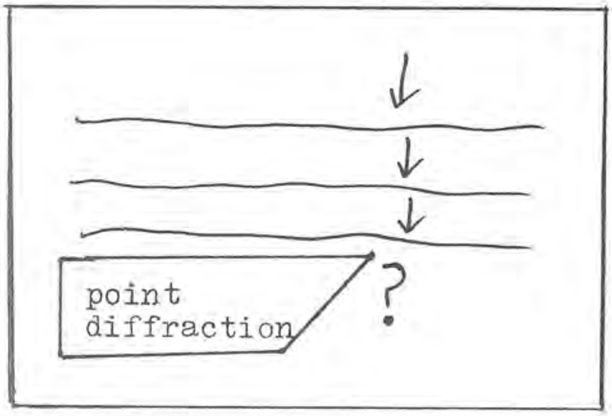


PART C. Waves and Diffraction

1. Use two sets of shaped paraffin blocks to model the harbour.
2. Generate short waves at the harbour entrance and observe what happens.
3. Slowly increase the speed of the waves.

☐ Record what happens.

4. Now use one of the shaped blocks and generate waves at the block.
5. Study the wave pattern around the sharp end of the block.
6. Now increase the speed of the waves and study the effect of shorter wave lengths.



☐ Record and draw what happens.

Questions:

PARTS A and B

1. When a straight wave strikes a barrier so that its wave front is parallel to the barrier, in what direction is the wave reflected?
2. When a straight wave strikes a barrier at an angle, how do the angles of incidence compare with the angles of reflection?
3. How are straight waves affected by a parabolic reflector?
4. Make accurate drawings to illustrate your results.

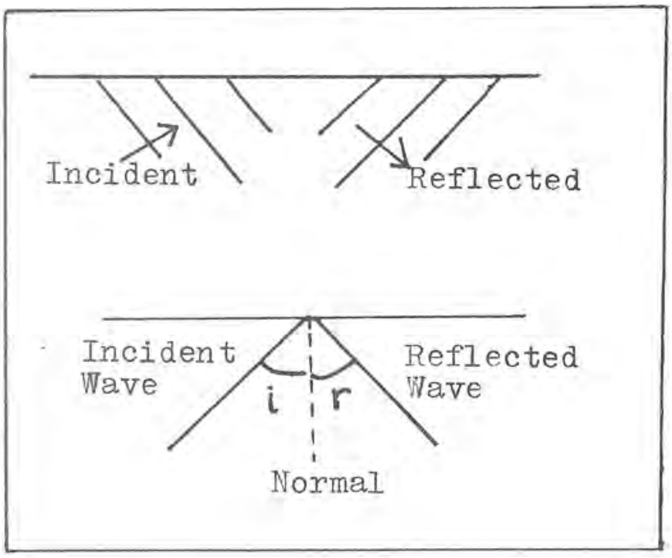
PART C

1. What kind of wave lengths are diffracted more? Long ones or short ones?
2. What is the relationship between the size of the opening and the amount of diffraction?
3. What happens around the ends of the shaped block?
4. Make accurate drawings of your results to illustrate your answers.

When waves strike a beach they are said to be reflected. Waves striking a beach straight on, are reflected straight back. The wave coming in is called the *incident* wave, and the wave going out to sea is called the *reflected* wave.

However, when waves strike a beach at an angle, the angle of strike becomes important.

If we draw a perpendicular to the beach (called the normal) there is a special relationship that exists between the angle the wave hits the beach and the angle reflected back.



THE ANGLE OF INCIDENCE = THE ANGLE OF REFLECTION

Pages 14 - 23 Were pages from a Physics book describing classic wave experiments and have been removed as we could not trace the copyright source (sorry)

9.12 Summary

1. A wave is a transfer of energy through a medium in the form of a disturbance. All waves originate from a vibrating source.
2. Frequency is the number of cycles per second. One cycle in one second is defined as one hertz (Hz).
3. The period is the time required for one cycle, and the unit in which the period is expressed is usually the second.
4. The frequency (f) and the period (T) are related by these equations:

$$f = \frac{1}{T} \text{ or } T = \frac{1}{f}$$

6. In a transverse wave, the particles of the medium move at right angles to the direction of the wave motion.
7. The speed of a wave is unaffected by changes in the frequency or amplitude of the vibrating source.
8. One wavelength is the distance between the mid points of successive crests or troughs.
9. If the frequency of a wave increases, the wavelength decreases, provided that the medium does not change.
10. One vibration of the source produces one complete wavelength.
11. The frequency and the period of a wave are the same as those of the source, and they are not affected by changes in the speed of the wave.
12. An equation governing all waves is: $v = f\lambda$. It is called the Universal Wave Equation.
13. Pulses reflected from a rigid obstacle (or a fixed end) are inverted. Pulses reflected from a free end are not changed.
14. A wave ray is a straight line drawn at right angles to the wavefront, indicating the direction of the wave motion.
15. When waves are reflected from a solid obstacle, the angle of incidence is always equal to the angle of reflection. This is one of the laws of reflection and it holds for both curved and flat reflecting surfaces.
16. Waves bend, in a phenomenon called diffraction, when they pass edges and go through small openings. Waves with longer wavelengths are diffracted more than waves with shorter wavelengths.
17. When waves enter a medium in which their speed is reduced, their wavelengths decrease. If their speed is increased, their wavelengths increase. An equation relating velocity to wavelength is:

$$\frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$$

18. Refraction is the change that occurs in the direction of motion of a wave when it passes obliquely into a medium that causes it to change speed.

Universal Wave Equations Revision Questions

1. The speed and wavelength of waves in deep water are 15cm/sec and 2.2cm respectively. If the speed in shallow water is 10cm/sec, what is their wavelength.

2. Waves travel 0.75 as fast in shallow water as they do in deep water. What will their wavelength be in deep water if in shallow water the wavelength is 2.0cm ?

3. Water waves with a wavelength of 6.0m approach a lighthouse at 5.6m/s.
a) what is their frequency? (0.93 Hz)
b) what is their period? (1.1s)

4. 5.0 Hz waves move along a rope with a wavelength of 40cm. What is their speed? (2.0 10 squared cm)

5. The wavelength of a water wave is 3.7m and its period is 1.5s.
Calculate a) the speed of the wave (2.5m/s)
b) the distance travelled by the wave in 1 min.(1.5 x 10squared m)
c) the time required for the wave to travel 100m (41s)

6. The period of a sound wave emitted by a vibrating string is 3.0 x 10 to the third power / s . If the speed of the sound wave is 360 m/s, what is its wavelength? (1.1 m)

.4 *Beach Currents*

Reflected waves are usually the start of rip currents along the beaches. We can make a generalized drawing of these currents.

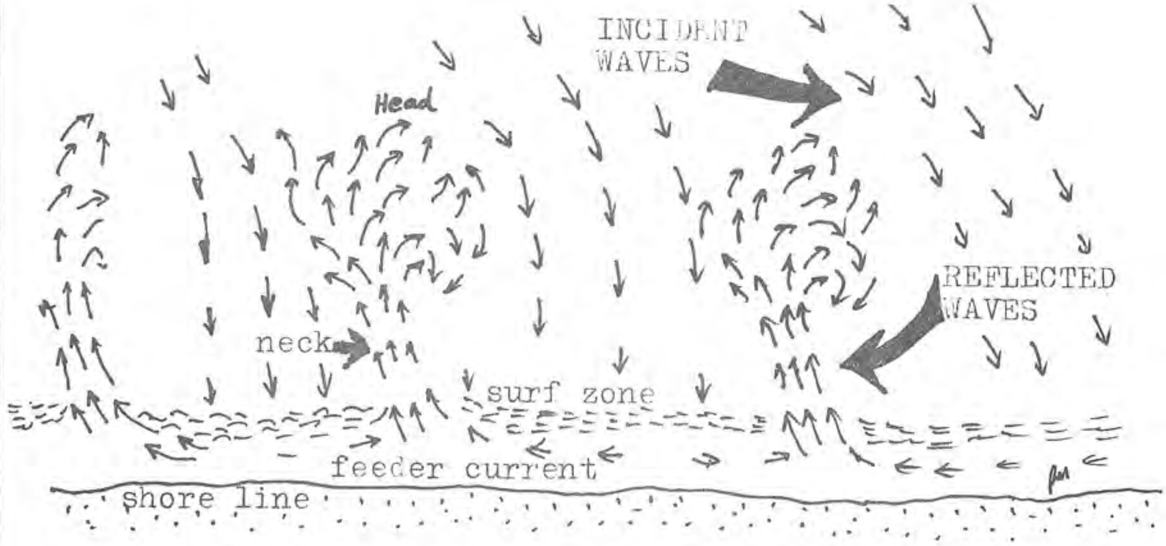


Fig. -8: Reflected waves off beaches cause rips.

FOR A BEACH LIKE SURFERS PARADISE

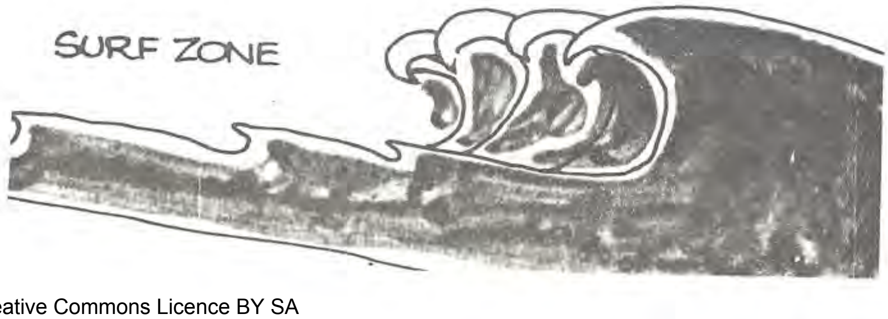
SEE PAGE 27,31 FOR OTHER RIPS THAT SURFERS USE TO GET OUT INTO THE SURF.

A rip current could be described as a concentrated stream of water moving through the breaker zone. It represents the return movement of water piled up on the beach by incoming waves and wind. An idealised rip current has a feeder system made up of *REFLECTED* waves, a *NECK* (where the feeder current converges to flow through the breakers), and a *HEAD* (where the rip widens and disperses).

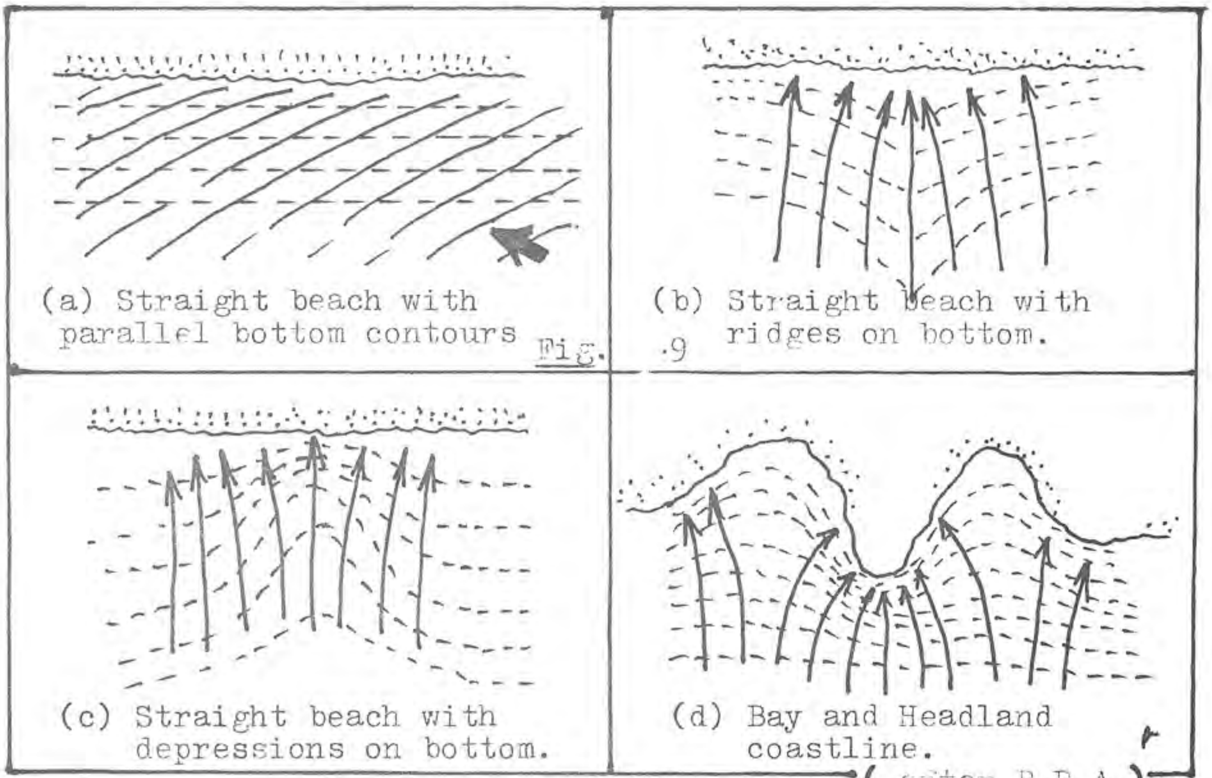
NB: ON GROYNES AND POINTS

SWEEPS

The number of, and speed of, rip currents, seems to be closely related to wave size and speed. Faster and bigger waves tend to generate bigger rips. However, much seems to depend on the bathymetry of the beach.



Consider a Bathymetric Survey



(a) Straight beach with parallel bottom contours

Fig. 9

(b) Straight beach with ridges on bottom.

(c) Straight beach with depressions on bottom.

(d) Bay and Headland coastline.

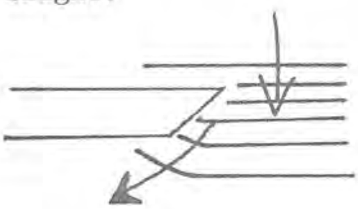
(after B.P.A.)

So, to predict the direction and speed of rips is very difficult. On the Gold and Sunshine coasts of Queensland, life savers have the constant week-end problem of collapsing sand-banks and changing rips. However, surfers have a more enjoyable time at points because of wave *DIFFRACTION*.

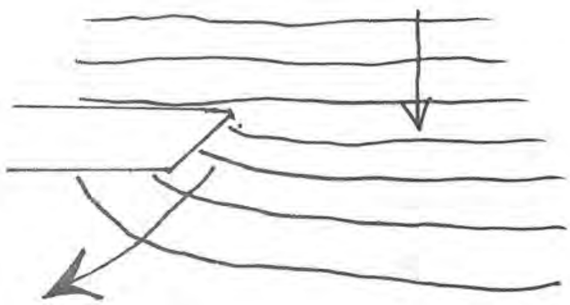
.5 *Point Diffraction*

Consider Investigation 1, PART C

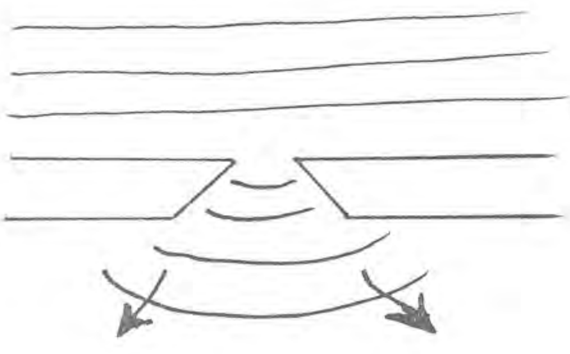
For *Short* Waves, diffraction was slight.



For *Long* Waves, the effect was more dramatic.



This can be seen to a larger extent when we consider two wax blocks together.



The effect can be seen around a headland when a swell coming in gets defracted as it passes the point.

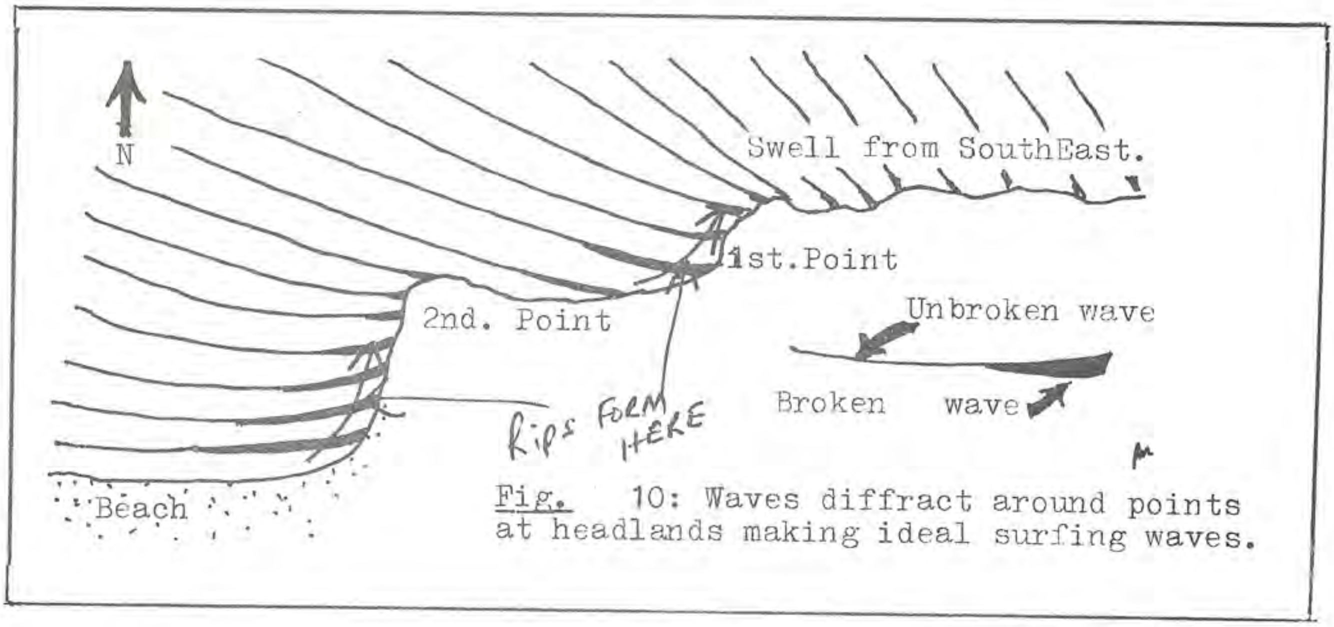


Fig. 10: Waves diffract around points at headlands making ideal surfing waves.

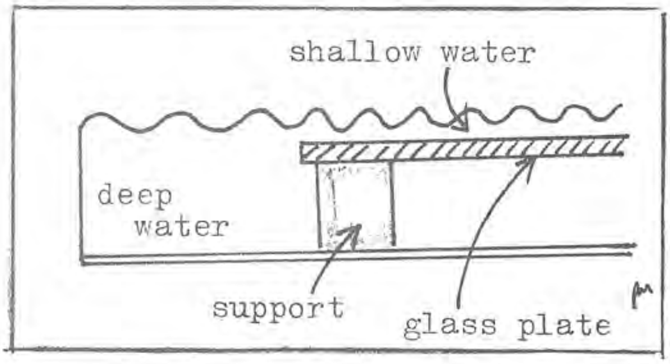
6. *Refraction*

Investigation 2: Refraction

You will need

* A ripple tank assembly * Sheet of glass * Block

Set up your ripple tank as follows:



What to do

PART A

1. Support a glass plate on the spacers so that it is approximately 1.5 cm above the bottom of the tank, and about 15 cm from the wave generator. Its longest edge should be parallel to the generator.

   Note: Sometimes it is easier to fill the tank until the glass plate is covered and then siphon off the water until only a thin film (1mm) remains over the glass.

2. Put enough water in the tank to cover the glass plate to a depth of about 1mm. Adjust the height of the wave generator so that the bottom of the vibrator is just below the surface of the water.

3. Adjust the generator so that it produces waves with a long wavelength.

☐ As the waves pass from the deeper water to the shallow water, note what changes occur in their speed and their wavelength.

☐ Draw a diagram to show clearly what changes occur in their wavelength.

PART B

Now set the glass plate at an angle of approximately 45° to the incoming waves. Note any changes that occur in the direction of the motion of the waves.

☐ Draw clearly what you see.

Questions:

1. Does the wavelengths change from deep to shallow?
2. If so, by how much?
3. What changes in directions occurred when waves entered shallow water straight on or obliquely?

As you see there are many different ways that forces could be exerted. How many of you have been dumped by big waves at the beach and felt yourself hurled in all directions. However, in general -

(i) the bigger the waves, the bigger and more complicated will be the movements of their water particles

(ii) the bigger the force.

The force exerted by some waves can be as much as 27,000 kilograms per square metre, or 30 tons per square metre.

No wonder our beaches wash away.

Investigation 2 showed that waves approaching an estuary or beach at an angle were bent. Such "bending" is called *REFRACTION*. We can summarize these ideas in the figure below:

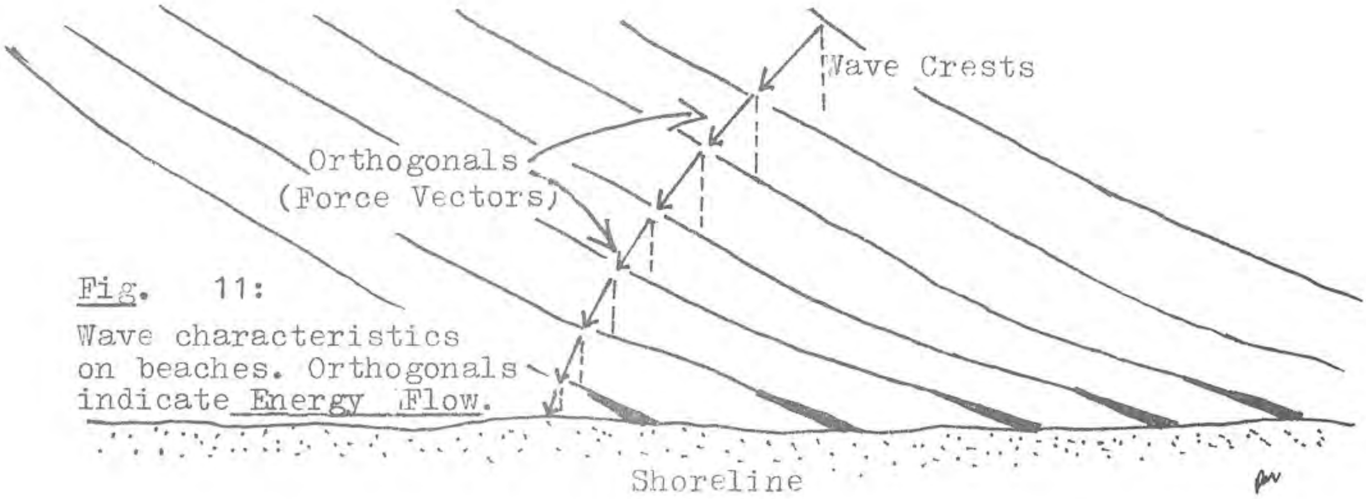
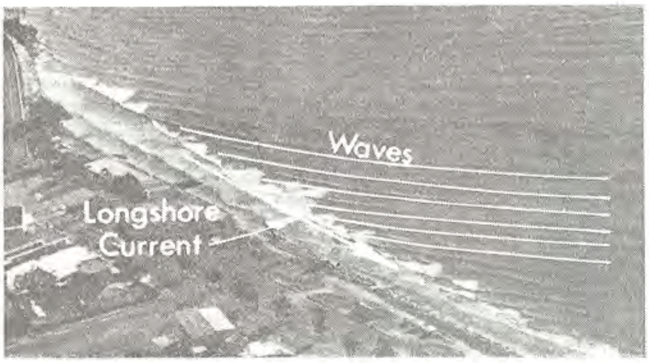
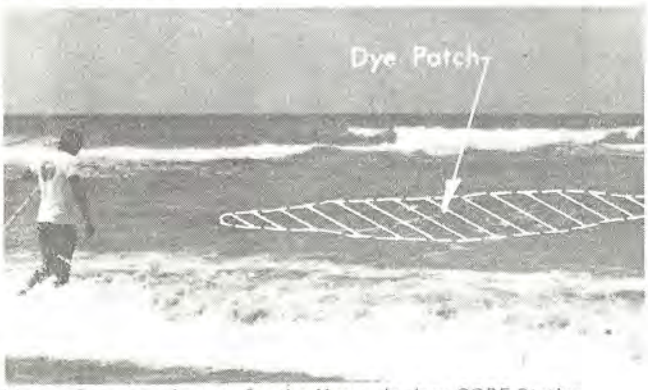


Fig. 11: Wave characteristics on beaches. Orthogonals indicate Energy Flow.

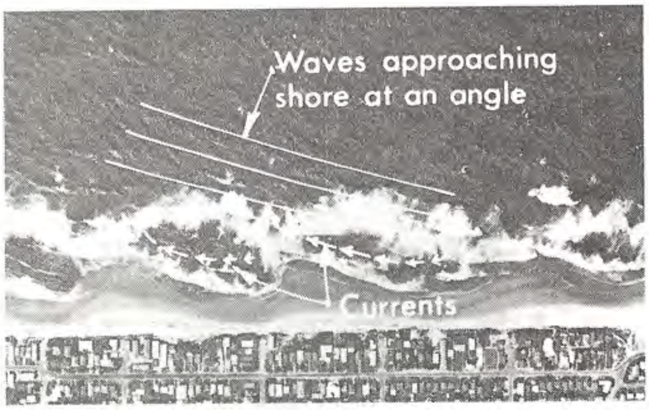
Lines drawn perpendicular to the wave crest are called *ORTHOGONALS* and can indicate how much refraction is taking place. Wavelength also decreases. Orthogonals represent the direction in which wave energy is transmitted.



An aerial photograph showing an asymmetrical current pattern generated by the combination of an oblique wave approach and a cell circulation system.



Warren Bennett, observer for the Maroochydore COPE Station, following the dye thrown into the surf zone to measure the longshore current.



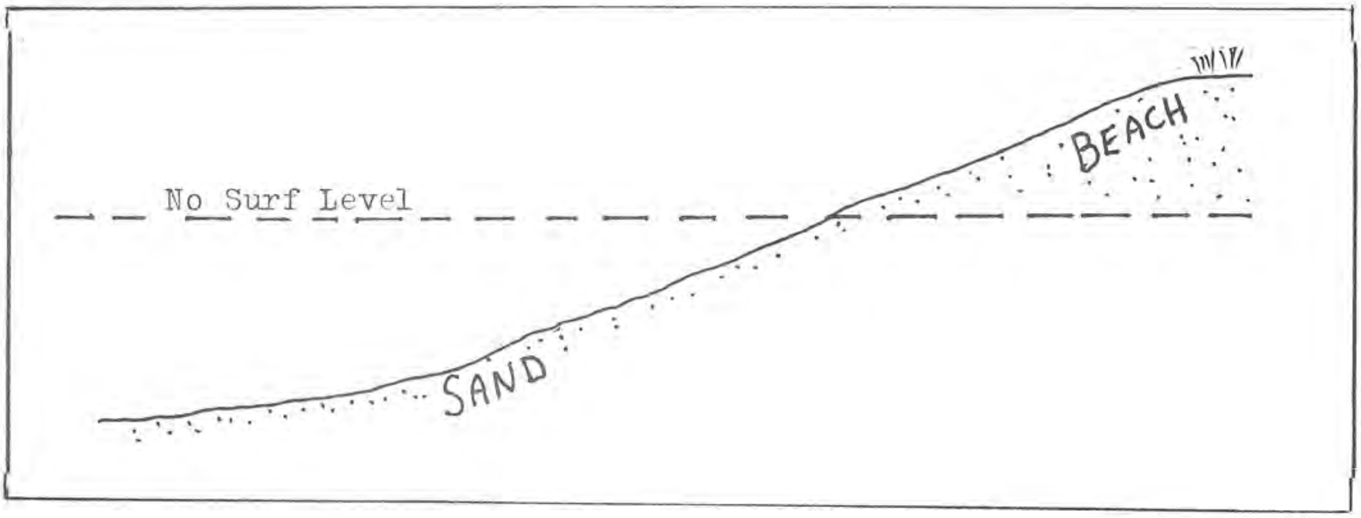
Waves approaching the shore at an angle generate a longshore current.

DIAGRAMS AND PHOTOGRAPHS COURTECY BEACH PROTECTION AUTHORITY, GPO BOX 2195 BRISBANE, 4001.

.7 *Wave Set Up and Set Down*

Once the waves have been refracted, they break on the shoreline. This is known as *WAVE RUN UP*.

Consider a beach with no surf. We can represent this with a line which we call a still water level.



Now consider the same beach a few days later *WITH SURF*

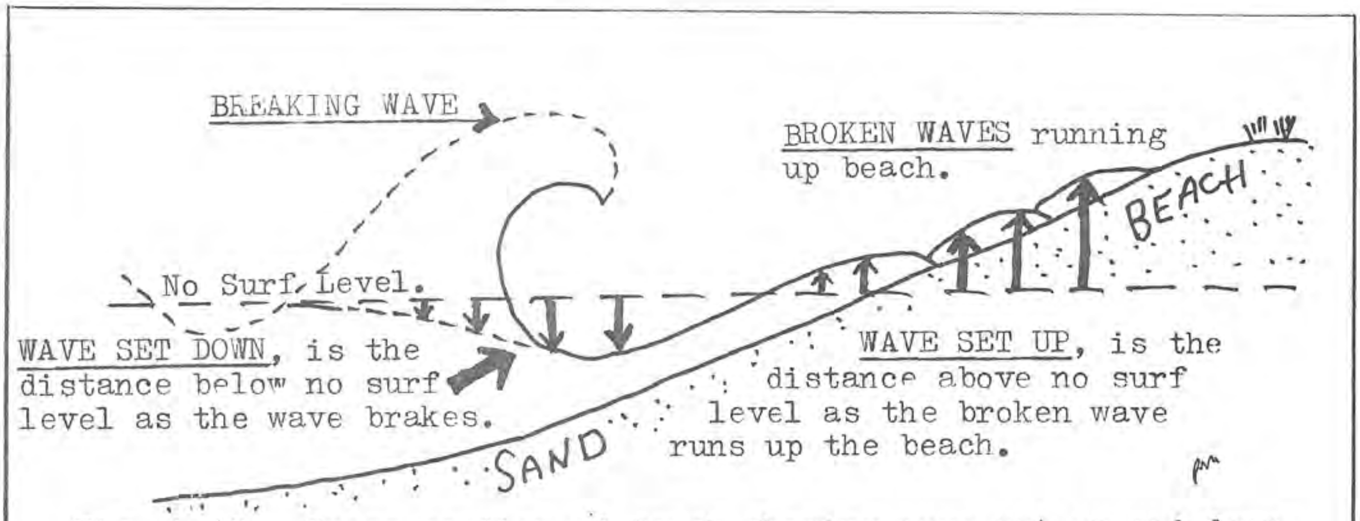


Fig. -12: Cross section of beach showing wave set up and down.

After the wave has broken, the height decreases rapidly and moves towards the shore. It may break again and run up the beach. The *maximum wave set up* is the average maximum level that water reaches on the beach.

.8 *Longshore Currents*

Currents move along the shore from areas of large wave set up, to areas of small wave set up. NB.

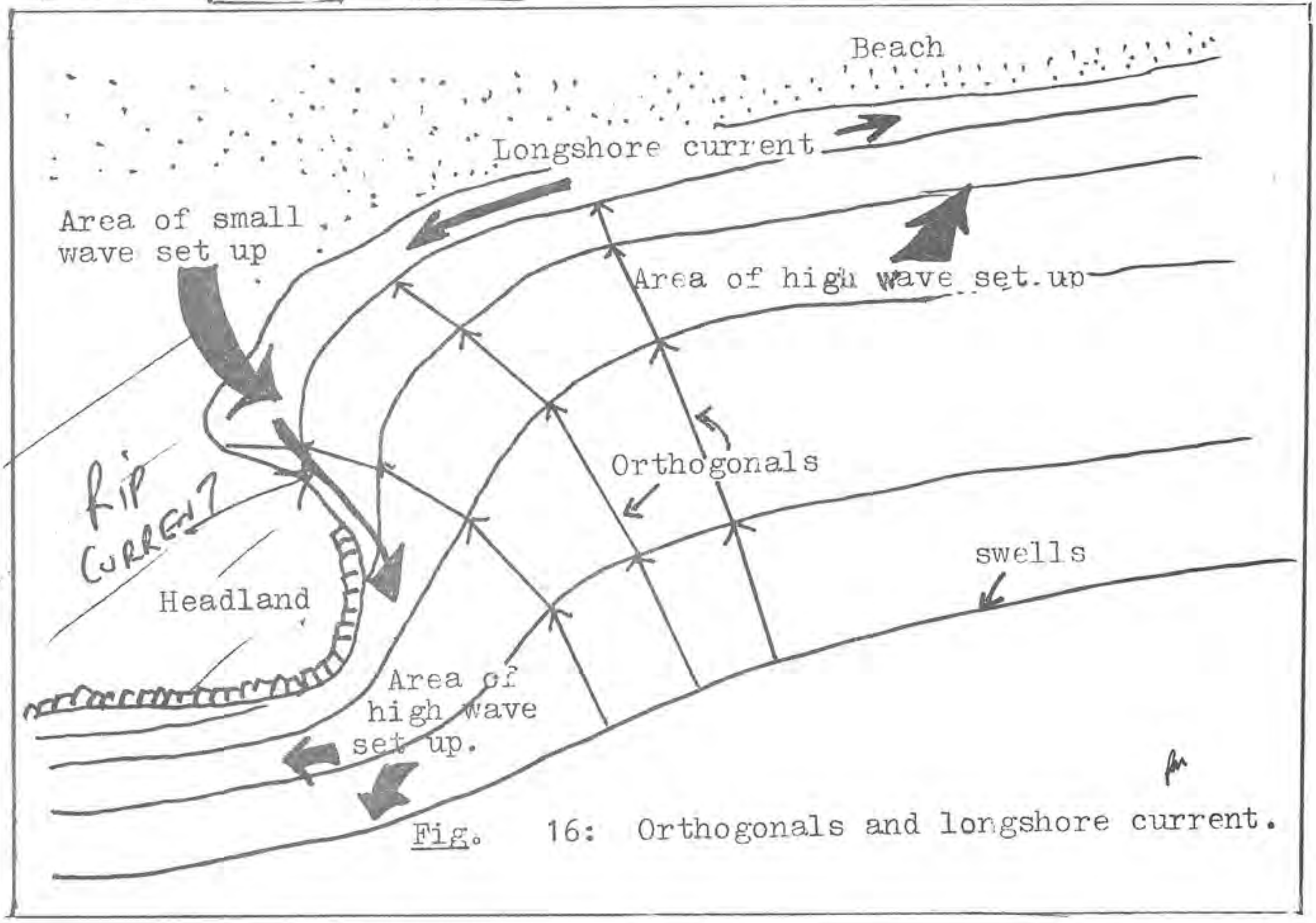


Fig. 16: Orthogonals and longshore current.

FIGURE 1

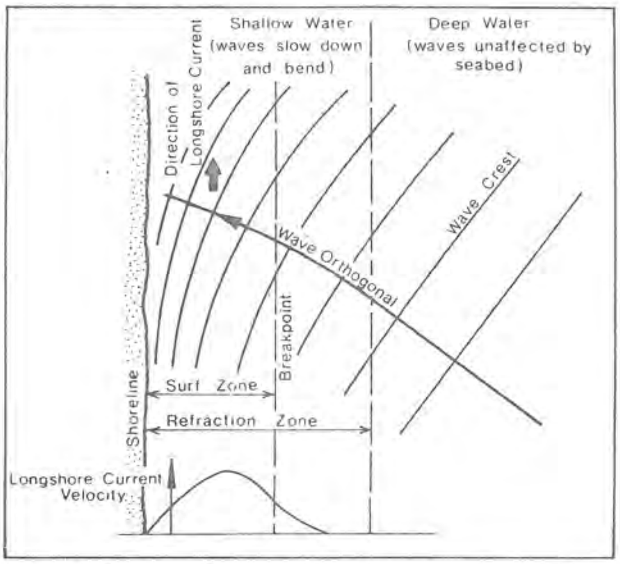


Figure 1. Nearshore Zone showing an oblique wave approach and a typical longshore current velocity distribution.

FIGURE 2

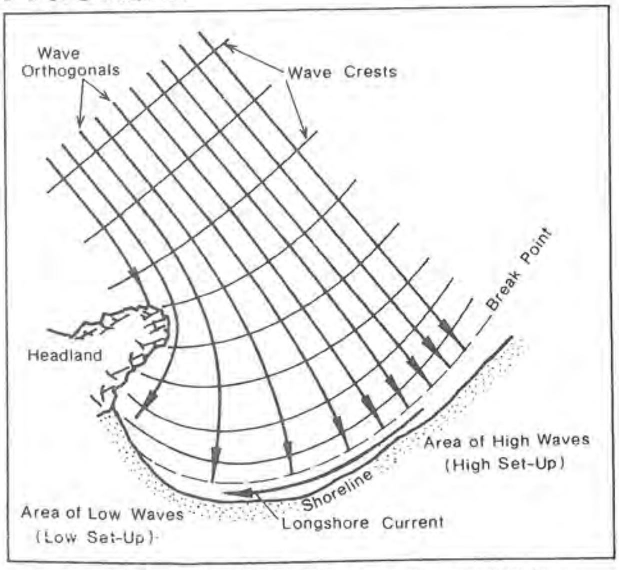


Figure 2. An example of a longshore current generated by a variation in wave height along the coast.

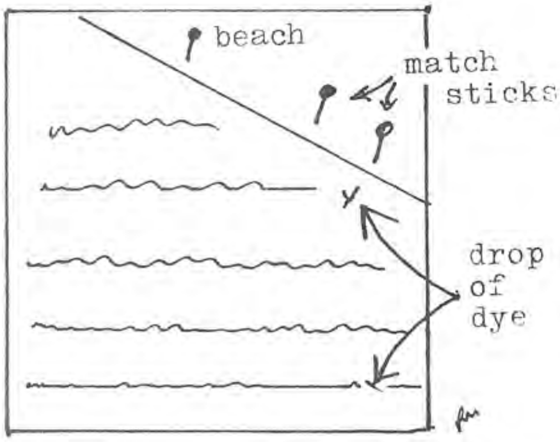
DIAGRAMS COURTESY BEACH PROTECTION AUTHORITY

Investigation 3: Longshore Currents and Groynes

You will need

* A ripple tank or stream tray
* Some sand
* Wave generator
* Some Dye - Condys crystals
* 4 match sticks
* Some wood to make a Groyne

Longshore current ripple tank simulation set up.



What to do

PART A: Longshore Current:

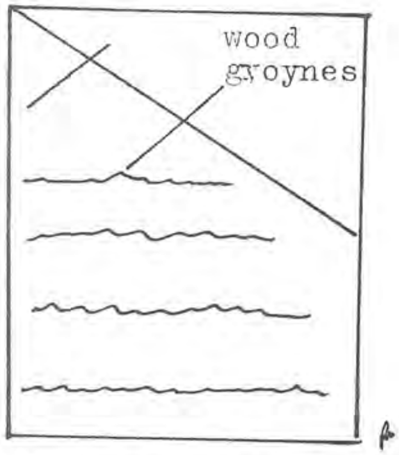
1. Build a beach as shown in figure ➡ and insert four match sticks as shown.
2. Generate waves at the rate of about 100 per minute, as shown.
3. Drop a grain of Condys crystals at the point shown and study the movement of the Dye.

Questions:

1. What was the effect of the waves on the simulated beach?
2. Where did the Dye go, and in which direction.
   Draw a diagram to illustrate your answer.

PART B: Groynes

1. Rebuild your beach as shown in Fig. ☞ and add 2 Groynes.
2. Generate the waves as before with the wave generator.
3. Drop in a drop of Dye and observe what happens.
4. Observe carefully what happens around the model groynes.



Groyne effects in simulated ripple tank

(ORIGINAL BY A.S.E.P. SEASHORES.)

Questions:

1. Where did sand build up *MOST?*
   WASH AWAY MOST/
2. Where have groynes been built on Queensland beaches?

The logo of the Beach Protection Authority depicts waves, beaches and dune vegetation which are the principal natural features determining beach characteristics and therefore of concern to the Authority. Protection of beaches requires an understanding of the behaviour of each of these elements and also the way they interact. Investigation of these processes is the main role of the Beach Protection Authority.

.9 *Depositional Landforms From Longshore Currents*

A common depositional landform is a *SPIT*. A spit is usually composed of sand that runs along the beaches.

The Southport Spit is an excellent example of sand build up due to a longshore current that runs along the beaches at the Gold Coast in Queensland.

At other places along Queensland's Gold Coast sand movements also occur. So important are these sand movements to the tourist industry, that millions of dollars have been spent to keep the sand moving in the right directions.

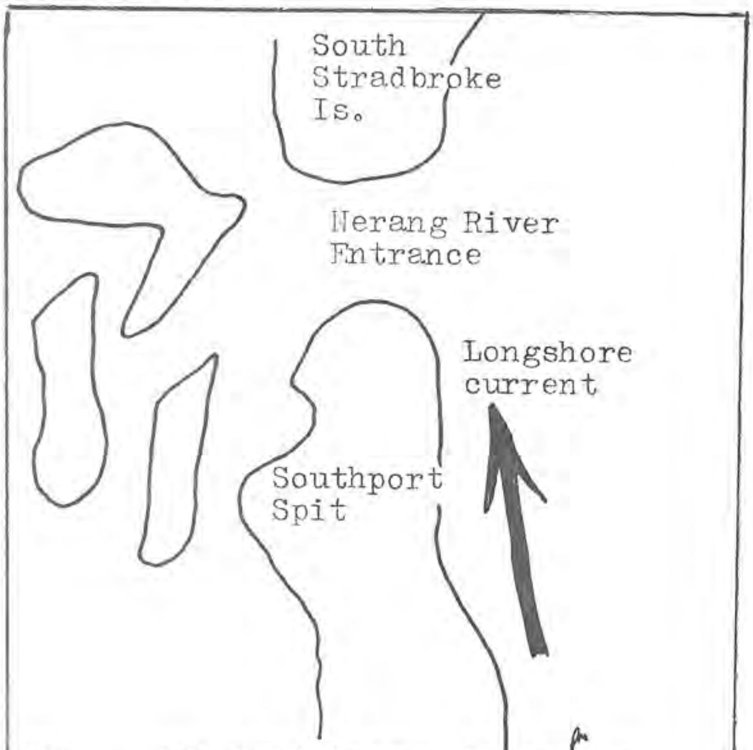


Fig. 17: Gold Coast: Longshore current direction.

On the Sunshine Coast at the mouth of the Maroochy River, a small island called Pincushion Island became joined to the mainland by a *SPIT* in 1962.

During a period of heavy weather, the longshore build up of sand closed off the old river mouth and caused the Maroochy River to make a new river mouth just to the *NORTH* of Pincushion Island.

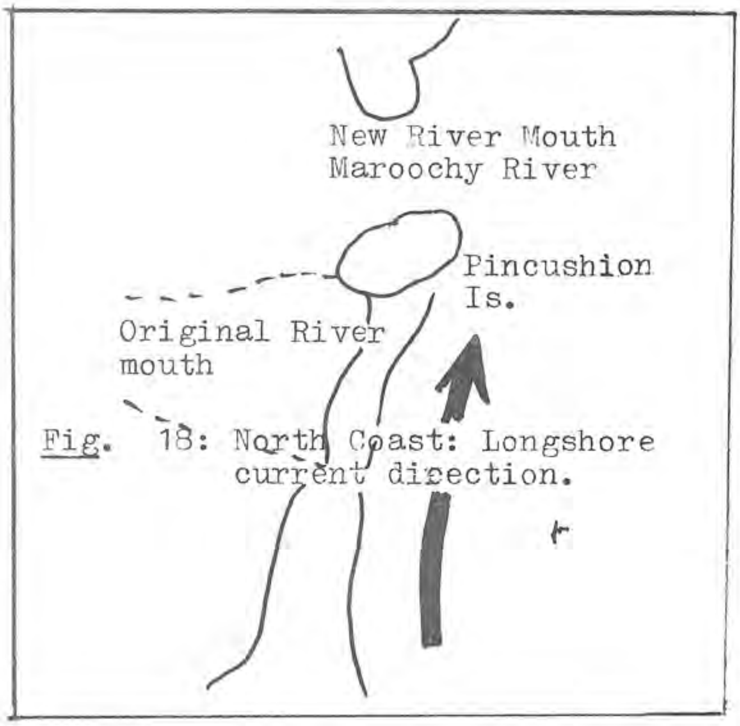
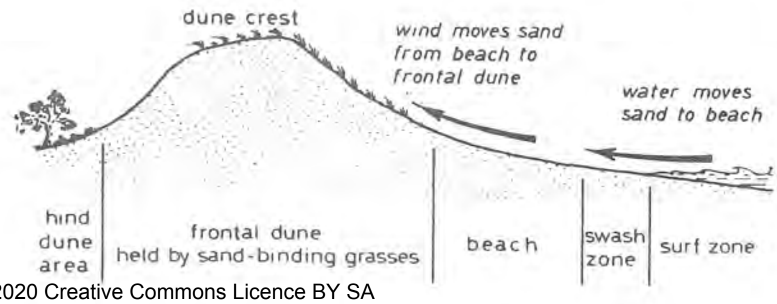


Fig. 18: North Coast: Longshore current direction.

TYPICAL STABLE DUNE SYSTEM DURING DUNE BUILDING CONDITIONS



Courtesy Beach Protection Authority

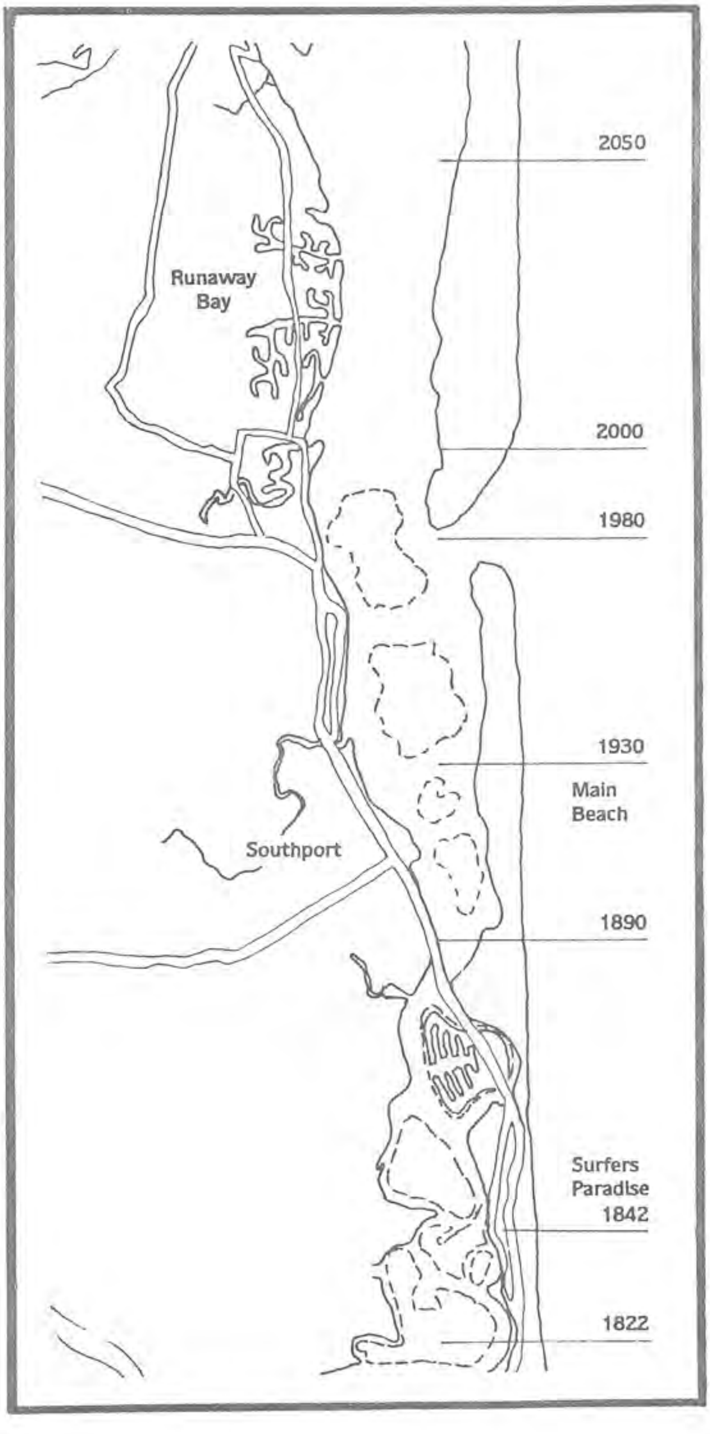
GOLD COAST — A MARINE WONDERLAND

BACKGROUND TO THE NERANG RIVER PROJECT

Queensland's Nerang River, with the Broadwater, and the adjoining waters of Moreton Bay and the South Pacific, together form one of the World's most attractive boating and fishing environments.

Ever since the white man came to what we now call the Gold Coast, people in boats have sought the haven of the Nerang River. But the Bar has always proved an obstacle, and a dangerous and fickle one at that . . . to their safe passage.

For decades, people interested in the marine environment of the Gold Coast Region, have sought ways of controlling the moods of the Southport Bar.



THE RIVER MOUTH WAS MOVING

But more than that, as the years have progressed, it became evident that the location of the River mouth was continually moving North. As recently as 1927 the river entered the ocean where the Seaworld Car Park is now located. Back in 1840 it was much further south at Broadbeach. History tells us that the Cedar cutters, who pioneered the white settlement of the area now known as the Gold Coast, built their wharf near what is now the Cascade Gardens opposite the new Jupiters Casino. (Pioneer cedar-cutter Ned Harper is buried nearby.)

From this rudimentary wharf they shipped their timber north to the settlement of Brisbane, and south to Sydney. The continued movement of the mouth of the Nerang River was accompanied by the erosion of the southern extremities of Stradbroke Island, threatening the delightful and still unspoiled environment of that area, and by massive siltation of fish habitats in the vicinity.

LEFT: Over the years the mouth of the Nerang River has moved steadily northwards. Without the Nerang Training Scheme, it is estimated that by the year 2050 it would be north of Runaway Bay.

THE NEED FOR A WATERWAYS AUTHORITY

URBAN DEVELOPMENT DEMANDS

The inescapable requirements for the urban development of Australia's fastest growing community also gave Local Authorities (in the form of the Gold Coast City Council and the Albert Shire Council) a vital interest in the stabilisation of the River Mouth.

For instance, Local Authority engineers grappling with the dramatic population growth of the Region, planned an ocean outfall for the Region's treated sewerage effluent. This was proposed to be placed off South Stradbroke Island, and was estimated in 1976 to cost some $7 million.

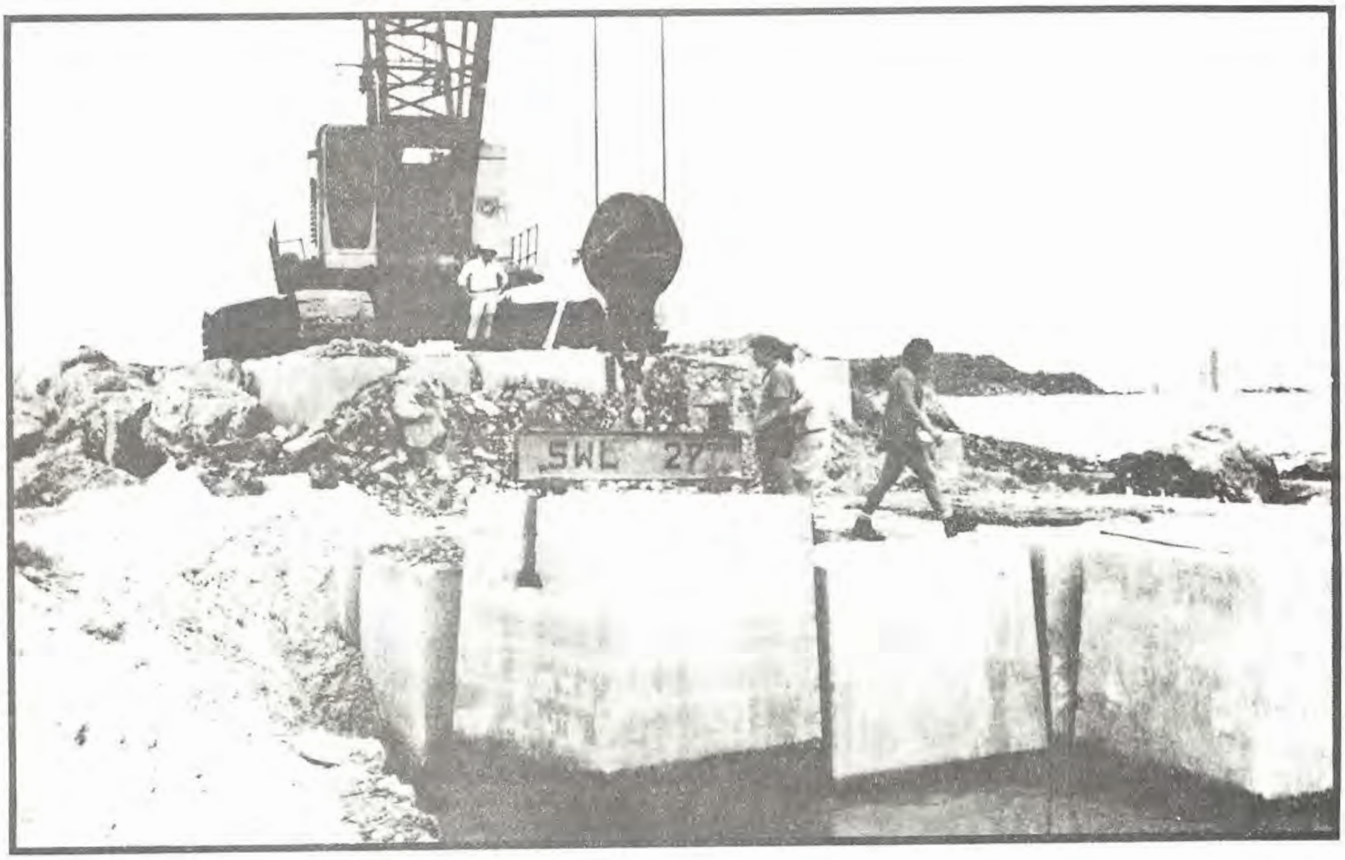
At the same time burgeoning boat ownership figures indicated an urgent need to upgrade facilities to cater for that growth.

THE BIRTH OF THE AUTHORITY

The Broadwater/Nerang River system, with the other waterways of the Region, represent without doubt one of the Nation's most popular recreational boating areas, with exciting potential for the enhancement of the tourism industry. This, with the unique engineering challenges involved, led the Queensland Government to establish a special Authority with the charter to plan and implement the various controls and physical developments to ensure the parallel aims of stabilisation and orderly development of the Gold Coast's unique waterways — hence in June 1979 the GOLD COAST WATERWAYS AUTHORITY came into being under a special Act of Parliament.

The Authority's physical area of responsibility stretches from near the mouth of the Logan River, south to the Queensland/New South Wales border, and includes all navigable waters in the Logan, Albert, Nerang, Pimpana and Coomera Rivers, the Broadwater, Coombabah, Biggera, Loder's, Tallebudgera and Currumbin Creeks, and all canals connected to those streams.

BELOW: One of the thousands of massive concrete cubes which, with massive armour rocks, make up the two training walls.



THE AIMS OF THE AUTHORITY

THE AUTHORITY TAKES UP THE CHALLENGE

The first pioneering meeting of the new Gold Coast Waterways Authority was held on 11th July, 1979, and since that date the Authority's Members and Staff have been dedicated to achieving the aims set out in the Authority's charter

The prime objective is to achieve a harmony between man, his legitimate recreational pursuits, and the Region's unique marine environment.

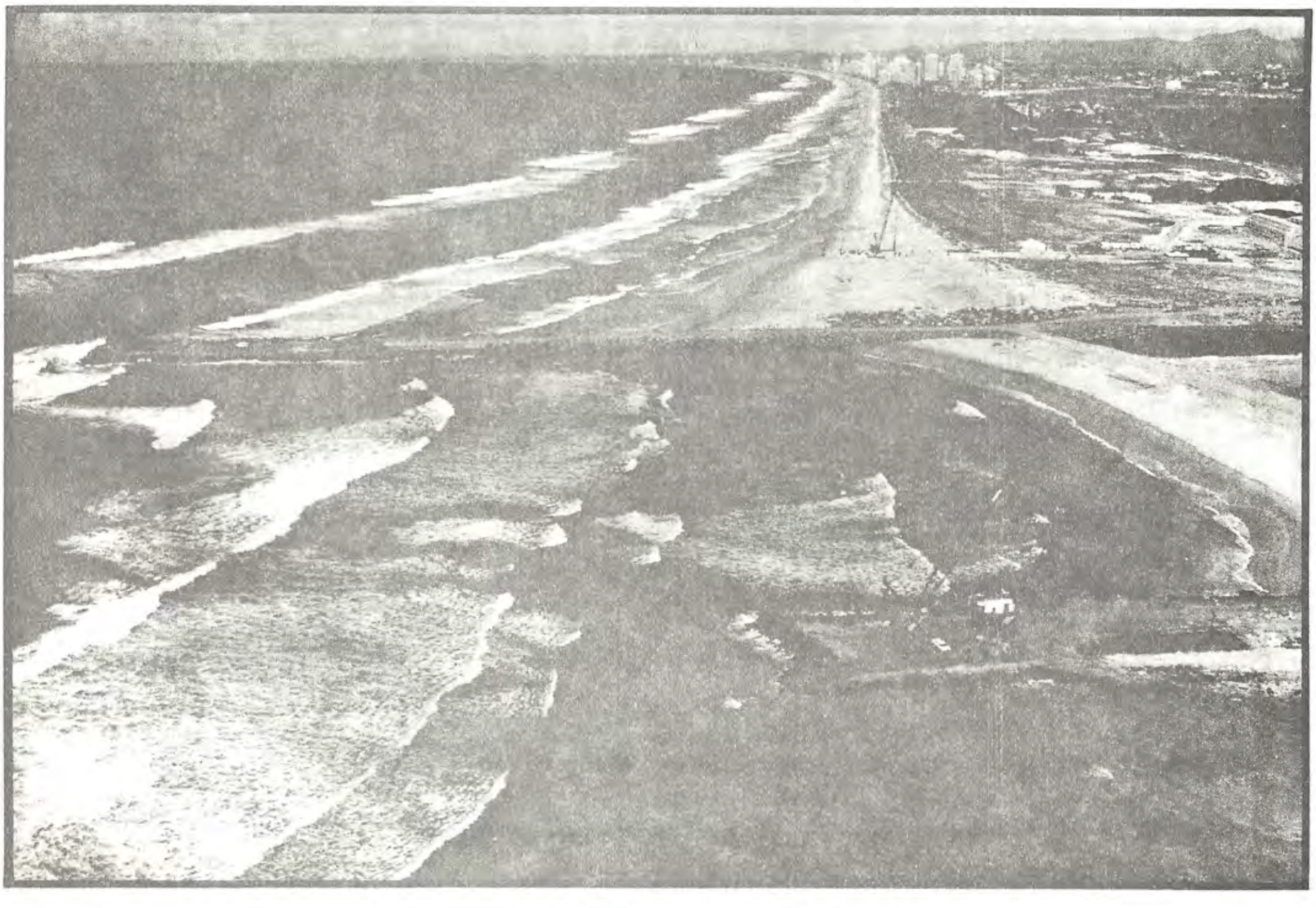
Early in the life of the Authority, regional boat ownership climbed to more than 18% of that of the whole State of Queensland. In 1984 there were some 9,297 boats registered on the Gold Coast.

Accordingly, the Authority has devised a most comprehensive overall Strategy Plan, which will assist in the continued enhancement of the Gold Coast as one of the World's premier tourism and recreational destinations.

THE NERANG BAR GIVEN TOP PRIORITY

Top priority has been given to the training of the mouth of the Nerang River. The completion of this complex undertaking will very significantly increase the potential for marinas, for land for maritime service industries, for space for aquatic sports, yacht club developments, tourist boat terminals and for the quiet enjoyment of this unique group of natural assets by all who care to participate.

BELOW: Work continues on the two Training Walls. In the mid-distance can be seen cranes working on the Jetty which forms an integral part of the sophisticated Sand Bypass System.



NERANG RIVER TRAINING PROJECT

THE NERANG TRAINING PROJECT

In essence, the Nerang scheme calls for the construction of two massive training walls shielding a new passage located some 700 metres south of the existing channel. The walls are aligned to extend approximately 15 degrees North of East.

SAND BYPASS UNIQUE FEATURE

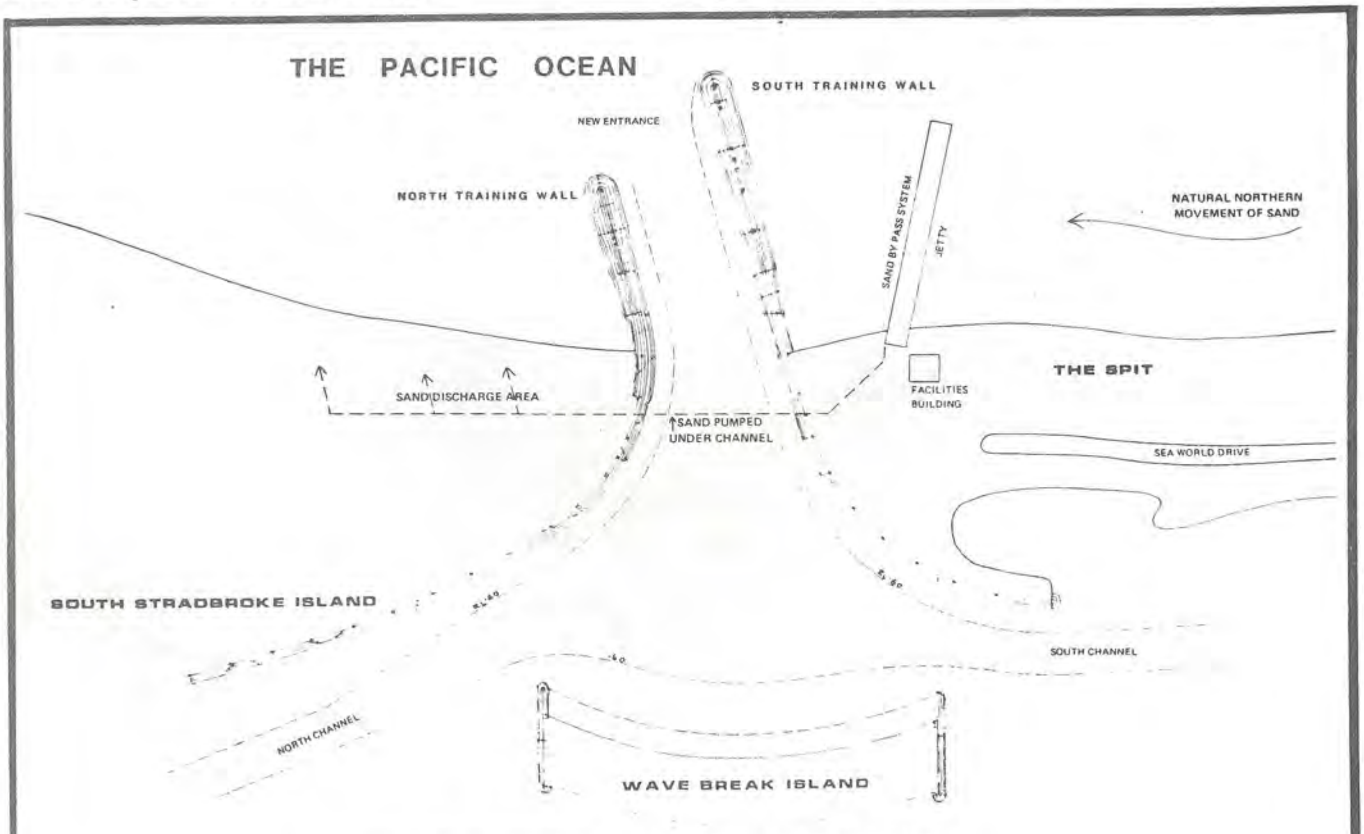
The eastern Australian coast features a natural northern movement of sand. The function of the Sand Bypassing System is to collect the northward-moving sand as it reaches the Southern Training Wall, and then to pump it via a conduit located under the passage, to be deposited on the beach on South Stradbroke Island. This effectively prevents sand entering the Broadwater where it would form a bar. Instead, the maximum amount of sand will reach the Island to prevent further erosion.

The stabilisation of the River Mouth also presented an economical opportunity for a sophisticated effluent diffusion system. This supplants earlier proposals for an ocean outfall off South Stradbroke Island, saving the Ratepayers of the Gold Coast Region a substantial capital investment. The system will automatically discharge on each outgoing tide.

Recreational and fishing craft will for the first time enjoy a stable, deep and safe passage between the Pacific Ocean and the Broadwater. The navigation channel will be 170 metres wide with a low-water depth of 4.5 metres.

THE BROADWATER PROTECTED

Wave Break Island has been reclaimed immediately inside the new mouth. Comprising over a million cubic metres of sand, this island will protect the beaches of Labrador from the effects of waves penetrating the new Entrance.



NERANG RIVER ENTRANCE TRAINING WORKS

THE LOGISTICS OF THE NERANG PROJECT

LOGISTICS

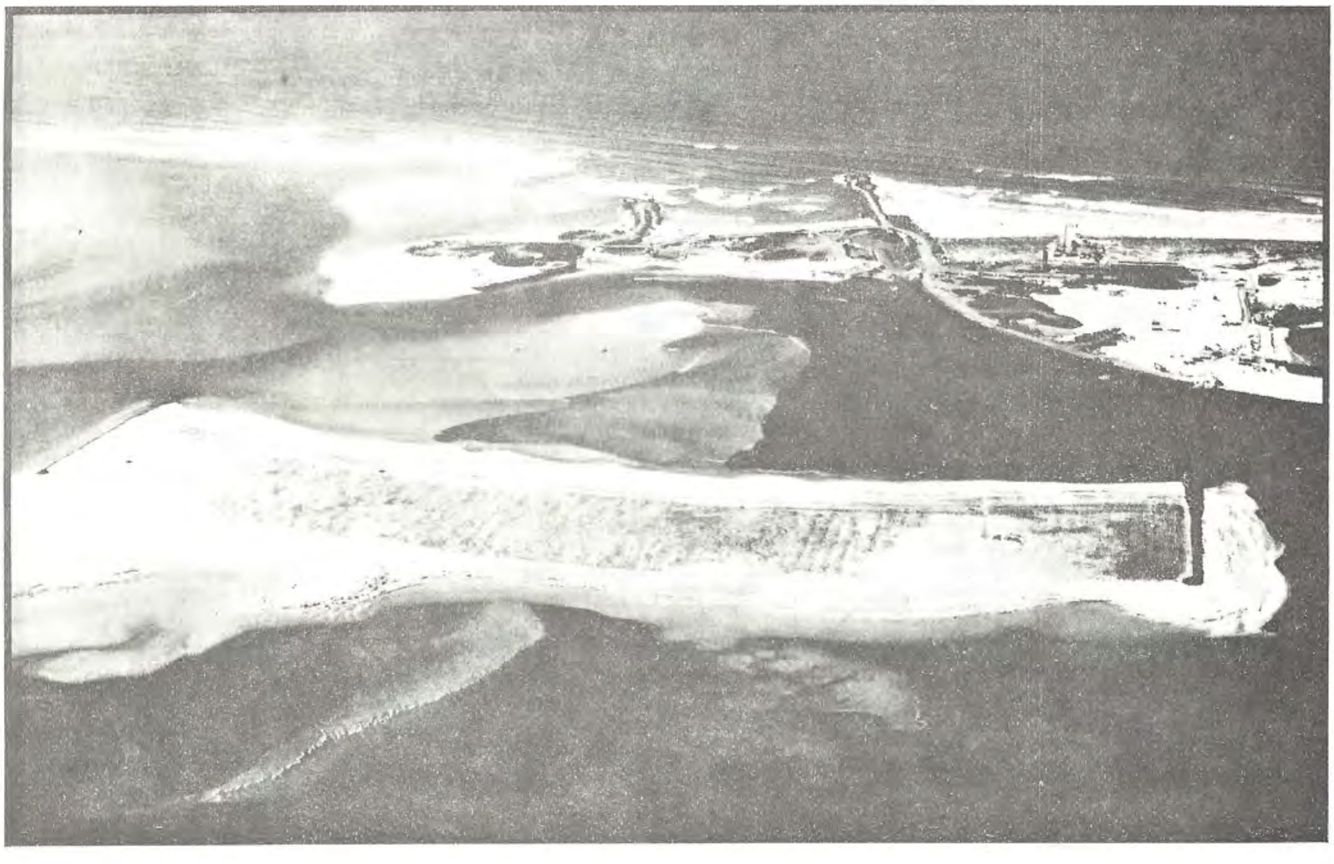
The Nerang River Training Scheme is a significant engineering undertaking, with a total cost estimated to be $36,800,000. These costs include the following:

	$ Million
* Wall Construction & Dredging	26.6
* Sand Bypass System	7.2
* New MacArthur Parade	1.1
* Design & Documentation	.8
* Navigational Aids	.5
* Dune Stabilisation	.4
* Road Maintenance	.2
	$36.8

The wall construction and dredging works included the quarrying, hauling and placing of 1,000,000 tonnes of rock, plus the dredging and placing of 4,500,000 cubic metres of sand. Additionally, some 3069 twenty tonne concrete cubes, and 1400 twenty-five tonne cubes were cast on the site.

The supply of rock has involved quarries from all over the Gold Coast Region.

BELOW: Wave Break Island — comprising over a million tonnes of sand — will protect the Labrador beach front from waves penetrating the new Entrance.



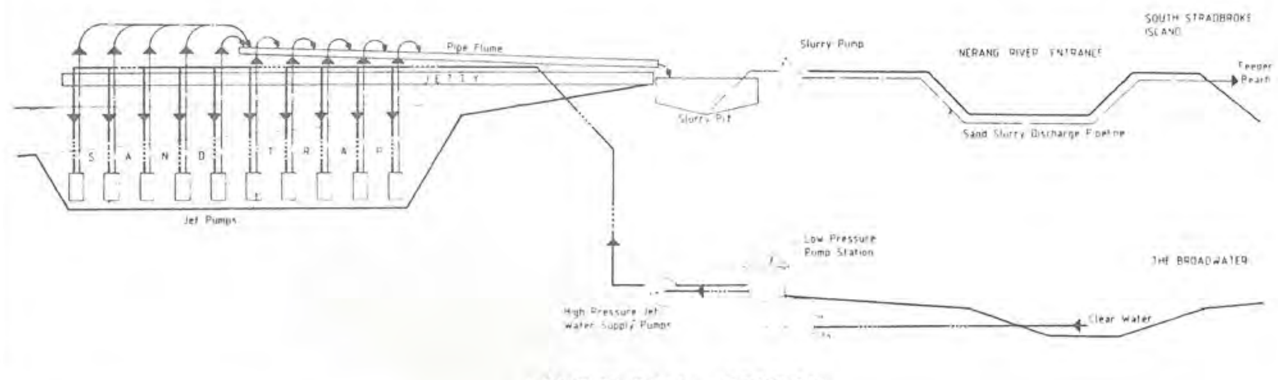
AND THE BENEFITS

THE BENEFITS

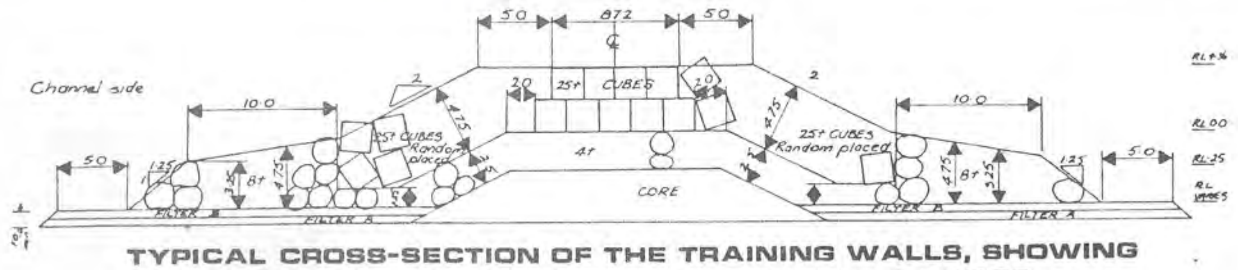
This development will be of long-standing benefit to the whole community. The unique environment of South Stradbroke Island will be protected — pleasure boat traffic and the fishing industry will enjoy virtually unrestricted access to the Pacific Ocean, the silting of invaluable fishing habitats will be very substantially reduced, water sports enthusiasts will have a vastly extended playground, the Region's attraction to both Australian and International tourists will be enhanced, and new public recreational land will be created at the end of the Southport Spit.

The Gold Coast Waterways Authority is proud of its role in bringing this exciting development to fruition.

BELOW: Sand moving northwards will be pumped under the new passage and distributed on the southern tip of South Stradbroke Island, effectively stopping the on-going erosion of that area.



LONGITUDINAL SECTION



TYPICAL CROSS-SECTION OF THE TRAINING WALLS, SHOWING FILTER LAYERS, ARMOUR ROCK & CONCRETE CUBES.

MEMBERS OF THE BOARD OF THE AUTHORITY ARE:

Mr. W. M. Laver (Chairman)
Mr. P. V. Gay (Deputy Chairman)
Mr. G. H. Burchill
Mr. J. D. D'Arcy
Mr. J. A. Neumann
Mr. R. J. Penhaligon.
Mr. D. D. Pie

The Authority's Manager is
Mr. John Hamilton.

JULY 1984

Nerang River Development

1. Give three reasons why the Nerang River Training Scheme was considered necessary.

a)..

b)..

c)..

2. Describe the role played by the Gold Coast Waterways Authority and the priorities set by them

....

3. Complete the map provided to show :

a) Where the mouth of the Nerang River was located.
b) Where the mouth would go if left unchecked.
c) Name the Spit and South Stradbroke Island.

MAP 1

4. State the depth of the channel at low water and its width

a) Depth .... b) Width.....................

5. Dramatic population growth in the region has created a problem which is often sent out to sea. What is this problem and its suggested solution.

....

....

6. Complete the diagram to show:
a) Natural movement of sand
b) Wave Break Island
c) Sand pumping and discharg region

MAP 2

7. Why does the southern wall extend further into the ocean than the northern wall?

....

8. What is the purpose of the sand pumping onto the northern region ?

....

9. What is the function of the jetty and why has it been placed south of the south training wall?

....

....

10. List 5 benefits which you believe this development may create.

a)..

b)..

c)..

d)..

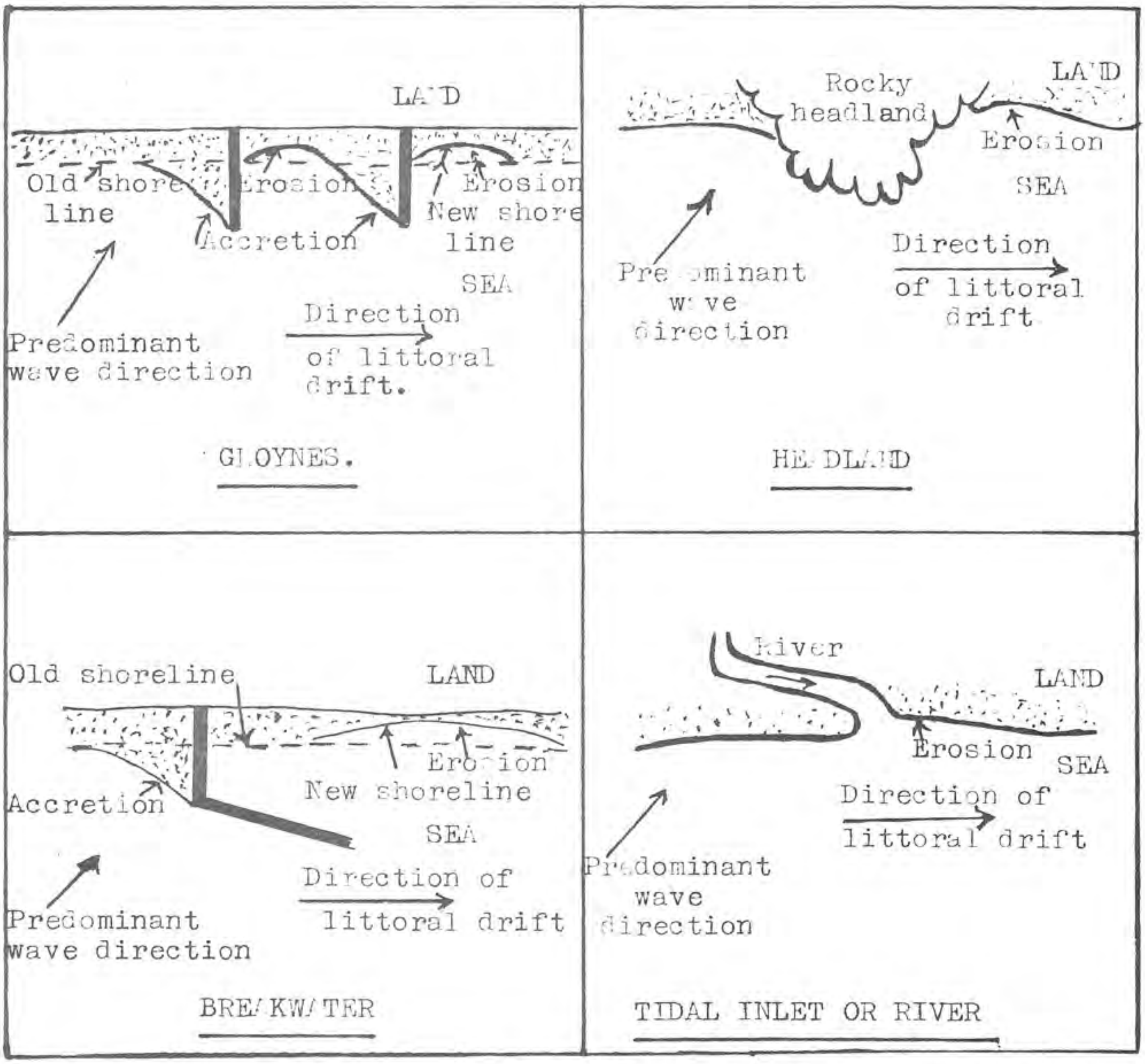
e)..

.10 *How Man Interferes With Longshore Currents*

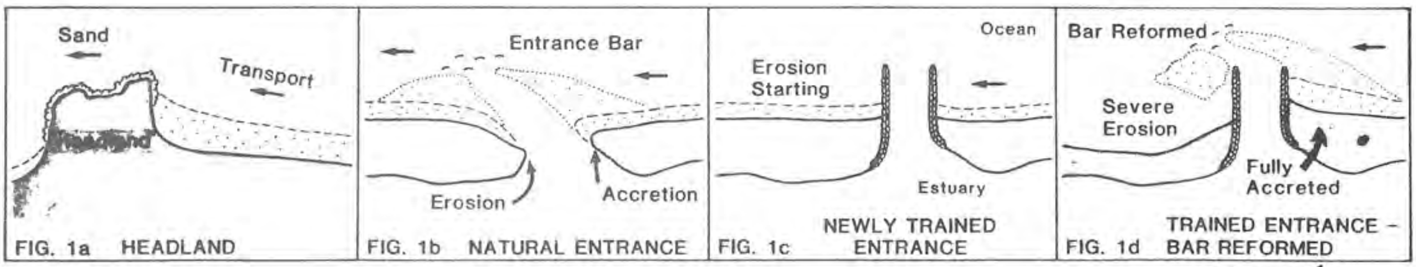
You have seen how longshore currents can move sediment such as sand. These currents can cause the building up of deposits of sediment in some places and their removal from others.

Groynes and breakwaters are two examples of how man does this. In Investigation 3 we saw that when a groyne was built, the sediment built up (called *ACCRETION)* on one side, and eroded on the other.

Four effects are shown below:



(after Ford, 1980.)



COURTESY BEACH PROTECTION AUTHORITY

.11 Beach Erosion

The Problem. Beach erosion is a natural part of beach behaviour and becomes a problem only when it threatens property and improvements. The essence of the problem is not that beaches erode, but that development has occurred within the zone of these natural beach movements.

Combatting any particular beach erosion problem is usually a very expensive business which, in the case of future development, can be completely avoided simply by the provision of an adequate buffer zone between the development and the beach.

However, where existing development is experiencing erosion problems, remedial action can be taken by implementing one or more of the measures outlined below.

Alternative Erosion Control Measures

The selection of the most appropriate method of combatting an erosion problem is by no means simple and will be influenced by the type of beach, the erosion mechanisms at work and the availability of funds for the project.

There are 6 basic ways of dealing with beach erosion problems which can be implemented individually or in various combinations. These are:

1.	*No Action*	- allowing nature to take its course and accepting the resulting property losses
2.	*Relocate Development*	- removing the problem by relocating development outside the threatened zone.
3.	*Rock Revetment*	- providing a physical barrier to further erosion.
4.	*Groynes*	- to trap sand in the eroding areas.
5.	*Offshore Breakwaters*	- to reduce wave energy behind the breakwater and to trap sand in the eroding areas.
6.	*Beach Nourishment*	- rebuilding eroding beaches by direct placement of sand onto the beach.

Fig. -19:

No Action.

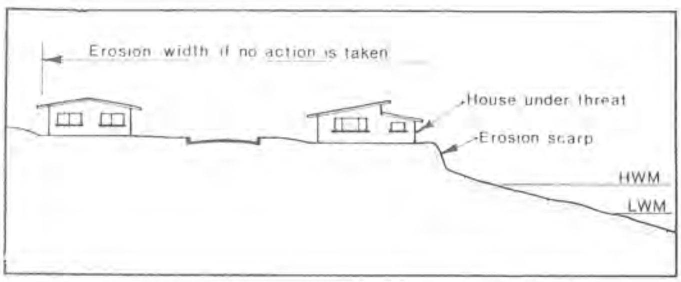


DIAGRAM COURTESY BEACH PROTECTION AUTHORITY.

1. *NO ACTION* (see Fig. 19)

A decision to take no action and allow erosion to continue is the best course of action when the threatened development has little value. Such a course of action requires no expenditure on protective measures and involves minimal interference with existing beach behaviour.

However, residents will naturally take action to protect their homes and Government agencies will also wish to protect their assets and amenities, making this method often impractical.

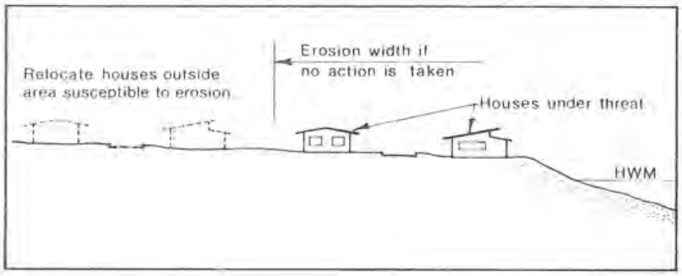
Before this course of action is rejected as unacceptable, it is desirable that the costs of the protective measures and the value of the assets to be protected be compared objectively. This has not always been done in the past.

2. *RELOCATE DEVELOPMENT* (see Fig. 20)

In cases where the development can be re-established elsewhere at reasonable cost, buffer zones can be provided where they previously did not exist. Such provision may necessitate moving amenities, roads and even domestic houses with payment of compensation to the people involved.

The financial and social costs involved in resumption and compensation payments are usually high especially in densely populated areas and public reaction against this general approach is understandably strong. In spite of its apparent drawbacks, in some areas relocation may well be cheaper in the long run than expensive protection works.

Fig. -20: Relocate Development.



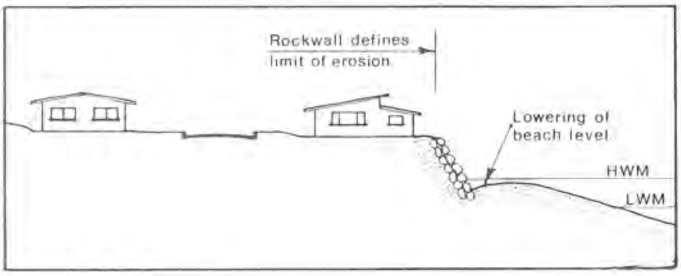


Fig. 21: Rock Revetment

(diagrams courtesy beach protection authority)

3. *ROCK REVETMENT* (see Fig. 21)

Rock revetment is probably the most commonly adopted method of combatting erosion problems in Queensland. Rock walls are surprisingly expensive, but can be provided at short notice and, for this reason, are commonly used for erosion control during cyclones and severe storms. They also give property owners a feeling of security by their solid appearance but this will be an illusion unless the wall has been properly designed and constructed to resist severe wave attack.

Once provided, rock walls constitute a lasting artificial impediment to natural beach behaviour and generally result in an appreciable drop in the level of the beach. Erosion can still continue at each end of the rock wall and may even be accentuated at these locations.

Rock revetment offers protection against further erosion but only at the expense of the beach which may need beach nourishment to restore its value as a recreational asset.

4. *GROYNES* (see Fig. 22)

Groynes are a common but sometimes misunderstood method of combatting erosion. Groynes function by trapping sand moving along the coast on the updrift side of the groyne, but starve the beach of sand supply on the downdrift side.

The main problem with groynes is they do not solve an erosion problem but merely transfer it along the beach. Often this leads to the construction of a series of groynes (a groyne field) with the result that the erosion problem becomes concentrated on the downdrift side of the last groyne.

During severe wave attack, groynes do not prevent erosion because they have no effect in reducing the movement of sand in the offshore direction (i.e. at right angles to the beach). However, by trapping sand on the updrift side they do help to provide a wider beach to accommodate erosion. At the same time, the depleted beach on the downdrift side of the groyne will be more susceptible to erosion than before.

The erosion problems associated with groynes can be compensated for to a large extent by beach nourishment. As a general rule a combined approach is preferable to using groyne construction by itself unless the concentration of erosion on the downdrift side is acceptable.

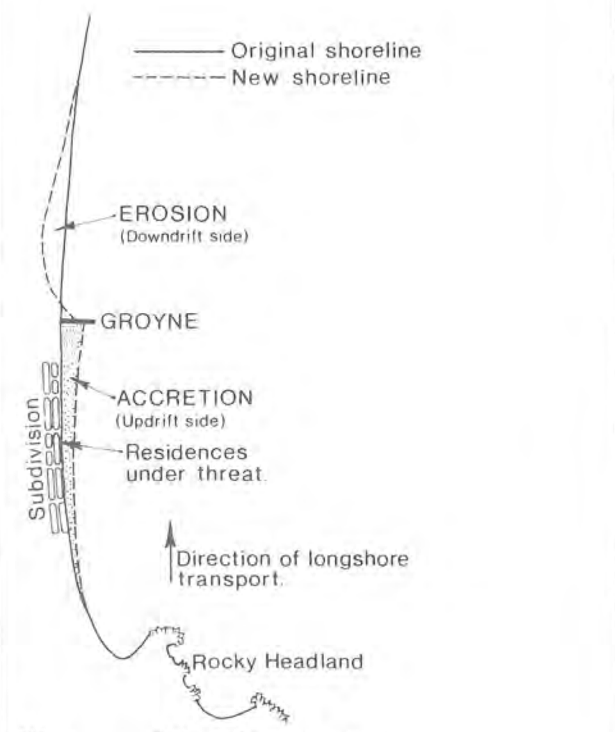


Fig. 22: Groynes
(after Ford, 1980)

5. *OFFSHORE BREAKWATERS* (see Fig. ·23)

Offshore breakwaters constructed parallel to the beach alter the height and direction of waves reaching the beach. They create a sheltered zone behind them into which sand may be moved by longshore transport processes but out of which longshore transport will be greatly reduced because of the altered wave climate. In addition, short term storm erosion will be reduced as much smaller waves will reach the beach.

6. *BEACH NOURISHMENT* (see Fig. 24)

Beach nourishment refers to the deposition of sand onto beaches by pumping or other means with a view to restoring an adequate buffer zone in front of the threatened property.

Beach nourishment has been carried out successfully in Queensland on the Gold Coast and the approach is undoubtedly suitable for many of the erosion problems throughout the State.

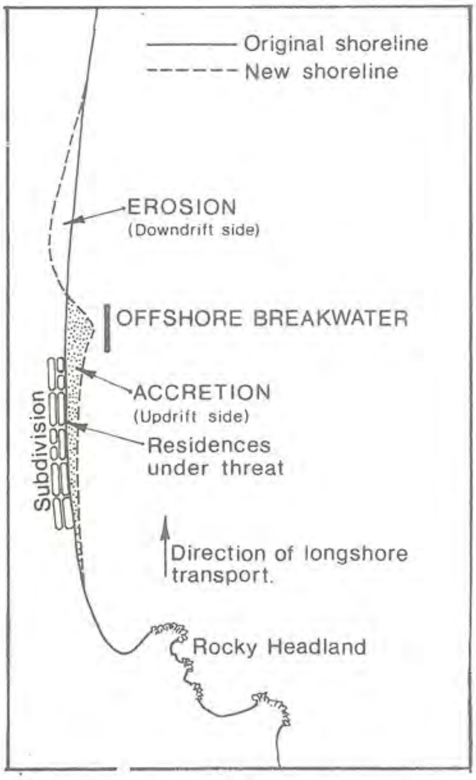


Fig. ·23: Offshore Breakwater

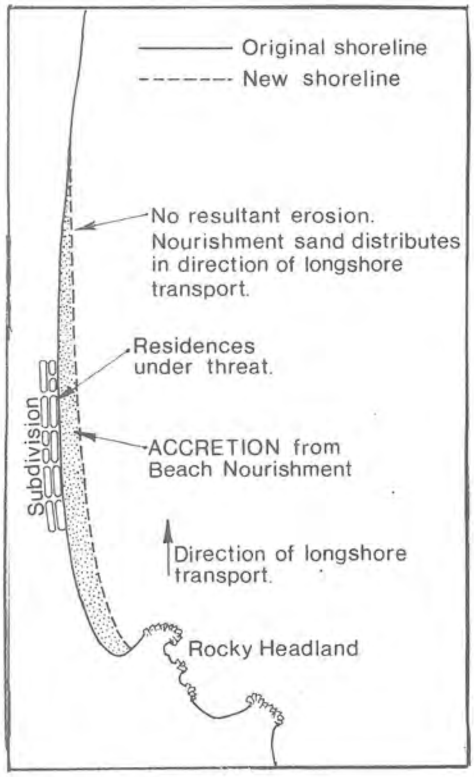


Fig. 24: Beach Nourishment

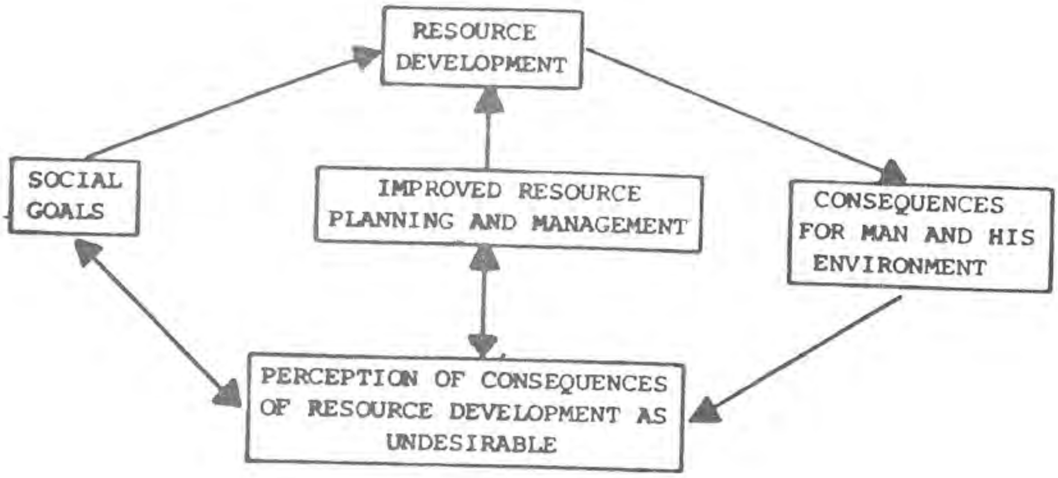
(diagrams courtesy Beach Protection Authority)

12. MAN, RESOURCES AND ENVIRONMENT

"The extent and type of resource development in any society depends on the goals and values of that society. These goals and values are not determined in isolation but are historically and culturally conditioned.

Equally, any resource development has consequences for society. These consequences include both intended and unintended outcomes. Pollution, for example, is not an intended outcome of the development of secondary industry. It is the consequence of industry in some environmental contexts. Perception of the consequences of resource development may lead to the recognition that an environmental problem worthy of attention exists.

Two kinds of processes may follow from this realisation. These are summarised in the flow chart.



Firstly, better management and planning can be called for aimed to minimise the less than desirable consequences of resource development. for example, State Governments in Australia legislate to control exhaust emissions from cars to minimise the effect of these emissions on the environment.

In addition, a re-evaluation and possibly modification of social goals may occur simultaneously. For example re-evaluation of the consequences of unrestrained personal urban mobility has lead to improved public transport systems.

The flow chart suggests that such processes in society are continually ongoing and interactive. One purpose of the topic Man, Resources and Environment is to increase awareness of such processes, and thus encourage responsible participation in them. Thus students are helped to consider the question 'What kind of world do we want?' and to consider the role of science, technology and resource development in this question."

From: Multistrand Science Syllabus 1982
BOSSE

MAIN IDEAS

1. Nearly *all waves are formed* by wind in an area called a fetch. Wave height is proportional to fetch length.

2. *Waves break* when their height exceeds their length by one-seventh.

3. Three types of breaking wave are spilling, plunging and surging.

4. Wave motion can be simulated in a ripple tank.

5. Beach currents transport sand along the shoreline.

6. Longshore currents can be affected by beach housing development and groynes.

7. The Beach Protection Authority has been established to conserve and research our beaches.

REVIEW QUESTIONS

1. Draw a fully labelled diagram of a *WAVE*.

2. What is a *FETCH?* How is it important in establishing a swell?

3. Diagram the apparatus used in a Ripple Tank.

4. Distinguish between *INCIDENT*, *REFLECTED*, *REFRACTED* and *DEFFRACTED WAVES*.

5. How does the Ocean Bathymetry affect wave set up?

6. How does a Groyne affect the Longshore Current?

7. List any 5 steps used to conserve our beaches.

8. What is *ACCRETION?*

STUDY ASSIGNMENTS

1. Write to the Gold Coast Waterways Authority and ask them for their proposal to redevelop the Southport Spit. Summarise their proposals in 500 words and debate the value of this project.

2. Design a Wave Tank or try to build one to show wave notions.

3. Build a Beach and Headland Model and outline what beach protection measures you would take.

4. Compare and contrast the Surfers Paradise Beach Highrise with Sunshine Coast Frontal Dune Systems.

1. Outline a selective history of man's use of our beaches in terms of his capacity to develop resources.

2. How do man's social needs determine beach resource development?

3. What are the physical and social aspects of beach resource development. Make a table or chart.

4. What are some unexpected and/or undesirable consequences of beach resource development?

5. What possible conflict could develop between different interest groups regarding beach resource development.

6. How are changes in social goals and improved resource management brought about through perceptions of undesirable consequences of resource development (eg. beach erosion ⟶ Beach Protection Authority.

7. Identify a beach development project which would only serve a narrow interest group.

8. Predict possible environmental consequences of a proposed resource development.

9. Identify the necessity for compromise between environmental and resource development objectives by citing a core study in beach protection.

10. Present a case in debate to ensure effective communication between different interest groups involved in resource development and environmental assessment.

Coastal Physics Review Ch 1:

1. Explain what causes wind formation

2. Wind creates ripples on the sea surface. Draw and label a diagram to show how waves form and swells are created.

3. Define the term FETCH.

4. Draw and label a diagram of a wave with the following characteristics:
    * height
    * wavelength
    * wave shape
    * crest
    * trough
    * relationships between height and length

5. List three types of waves and describe each.

6. What factor affects the formation of each of the waves in Q.5?

7. Define the term "wave refraction."

8. Define wave "reflection."

9. Draw a diagram to illustrate wave diffraction.

10. Draw a simple diagram to illustrate how RIPS form.

11. Complete this statement - "The angle of incidence =

12. Draw a diagram to illustrate what an orthagonal is.

13. How does a groyne affect sand distribution when a northward longshore current exists.

14. Explain how man can combat erosion on beaches.

15. Describe the process which has taken place at the spit.

PRACTICAL INVESTIGATIONS

1. Marine Electricity: The wiring of a Power Boat
2. Marine Batteries
3. Model Tide/Current/Wave Power Stations

STUDY ASSIGNMENTS

1. Selective History of Man's Development of Energy
2. Environmental Implications of Tidal/Current/Wave Power Station
3. The Need to Suppliment Current Energy needs with Extractive Industries

ENERGY

1. OBJECTIVES

2. TIDES:
- *a) Importance*
- *b) Sun, Earth, Moon systems*
- *c) Phases of Moon*
- *d) Daily, Fortnightly, Quarterly Tides*
- *e) Tidal Variation and Prediction*

3. SELECTED READING:
- *a) History of man's use of Energy*
- *b) Energy Transformations*
- *c) Renewable/Non Renewable Energy*

4. TIDAL/WAVE/POWER STATIONS
- *a) Comparison with Conventional*
- *b) Efficiency*

5. OUTBOARD MOTORS

DIRECTED TOPICS

1. Costing Energy Needs and Uses
2. Lessons on Reasons for Tides

AUDIO VISUAL

1. Films on Conventional Power Stations
2. Johnson and Johnson Technical Training Films on outboard motors

OBJECTIVE STATEMENT (SYLLABUS)

CONTENT AREA: The student should have knowledge of:

a) A selective history of the development of energy use by man.
b) Some forms of energy and energy transformations and transfer.
c) The types and origins of non-renewable and renewable energy resources of the world.
d) Some methods of extracting and harnessing energy resources.
e) Some energy converters used by man and their efficiency.
f) Some ways energy can be stored.
g) The environmental implications of some energy resource developments and some energy converters.
h) The need for extractive industries to supply man's current energy needs.
i) How the sun, wind and water can offer renewable energy supplies.
j) Costing of energy need and uses.

PROCESS AREA: The student should be able to:

a) Discuss and compare energy use by modern man with that of past man.
b) Interpret graphs and tables showing world production and use of energy resources.
c) Draw energy flow diagrams to show energy conversions and tables for a range of converters.
d) Discuss inefficiencies of a range of energy converters and suggest ways in which energy loss may be reduced.
e) Calculate energy lost.
f) Discuss proposed energy development projects objectively.

SKILL AREA: The student should be able to:

a) Experiment to compare the energy available from different sources.
b) Demonstrate a range of energy transformations and transfer.
c) Perform experiments to show energy consumption and efficiencies of simple converters

AFFECTIVE AREA: The student should have this opportunity to:

a) Value the significance of our energy resources.
b) Curious and interested in different forms of energy.
c) Become critically aware of energy problems.

OBJECTIVE STATEMENT (TEACHER)

CONTENT AREA: *You should be able to:*

a) Copy a table of man's developing use of energy.
b) List the forms of energy that could be associated with the sea and possible transformations.
c) List non-renewable and renewable energy resources.
d) Recall how tidal and wave power stations operate.
e) Recall functions of power boat electrical system (ignition, magneto, power tilt and trim, bilge pump).
f) Recall operation of marine battery.
g) Recall the benefits of solar, tidal and wave power stations.
h) Recall the needs of extractive industries to supplement power supplies.
i) Recall how solar, wind and wave generator power stations can supply electricity.
j) Recall the current cost of electricity.

PROCESS AREA: *The student should be able to:*

a) Compare and contrast the energy requirements of say a coastal high rise consumer with a South Sea Islander/or early aboriginal coastal user.
b) Interpret a table showing maximum world tidal capacity.
c) Draw energy flow diagrams to show energy conversions and losses in a generator bilge pump, trim and tilt pump, echo sounder, port and starboard lights.
d) Discuss inefficiencies in a generator bilge pump, echo sounder, navigational lights and suggest ways in which energy loss could be reduced.
e) Calculate energy costs for navigational aides.
f) Debate usefulness of tidal/wave power stations

SKILL AREA: *The student should be able to:*

Dismantle an outboard motor so as to identify the energy converting components.

AFFECTIVE AREA:

The student should be given an opportunity to marvel at the complexities of the outboard motor.

STUDENT MATERIALS:

Specific learning tasks are found in the Student Notes however considerable reading needs to be done in conjunction with the Energy Transformations Section.

Exploring Science Book 3 and Towards Tommorrow Book 2 have excellent chapter references.

PRE EXPOSURE

It would be helpful to revise Electrical Energy after the section on Tides.

REFERENCES

1. Oceanography, Fuse. Section 11, The Sea in Motion.

2. Stannard and Williamson, Exploring Science Book 3, Chapters 12 and 13.

3. Criddle, Izett and Ryan, Towards Tomorrow Book 2, Chapters 7, 8 and 9.

RESOURCE MATERIAL

An old outboard motor will provide all the components for energy transformations. However simple model generators, lights, batteries could be used to demonstrate the principles of Marine Electronics.

TIME REQUIRED

Minimum of 15 hours, but may be extended if students have success with model power stations/boat wiring/electrical assistance of outboard motor.

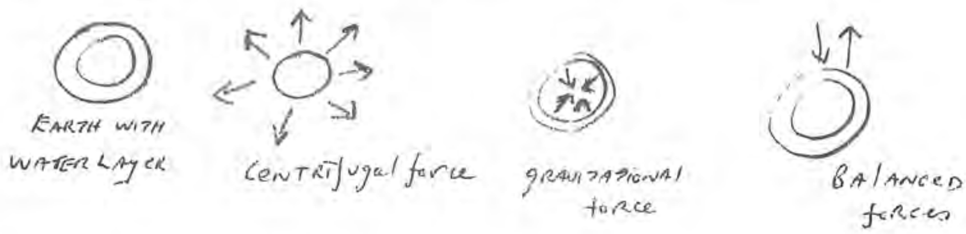
Hydrology - Tides, Waves, Currents

All bodies of water are subject to various forces which cause them to move.

1. Gravity --> sun, moon & earth --> tides
2. Density --> convection currents due to insolation.
3. Wind --> surface waves
4. Earth rotation --> gyres, seiches (standing waves)

Gravity

Centrifugal force at the surface of a rotating earth equals gravitational force holding water to the earth's surface. The moon exerts a gravitational force - that is - the force on the side facing the moon is GREATER.



With gravitational force from the moon the resultant water shape will be:

∘ The Bulge represents high Tides
∘ The Top + bottom -> Low Tides

*The bulges represent high tides
*The water has moved from the top and bottom --> low tides

As the earth rotates each 24 hours, we move into and out of the tide bulges - that is - we usually experience 2 high tides and 2 low tides per day. (24 hours and 50 minutes) (50 minutes later each day)

The sun also exerts a gravitational pull but less so due to the distance involved. When sun, moon and earth are on one plane --> Spring tides (Twice each lunar month). When sun, moon and earth are at right angles, we get Neap tides.

Absolute height depends on LOCAL TOPOGRAPHY and oscillation eg. Mediterranean Sea (6 inches), Bay of Findy, St. Malo, Bristol Channel, Darwin, Broadsound (Qld.)

SECTION 2

TIDES

INVESTIGATIONS

1. Plotting the Tide
2. Tide Models

STUDY ASSIGNMENTS

1. Selected Questions

CORE

1. The Importance of Tides
2. The Sun, Earth, Moon Systems
3. The Moon's Orbit
4. Period of Moon's Revolution
5. Phases of the Moon
6. Rotation of the Moon
7. Gravitation and Tides
8. Daily Tides
9. Spring and Neep Tides
10. River Tides

DIRECTED TOPICS

1. Lessons on Tides
2. Observations of Moon for one month

AUDIO VISUAL

1. Earth, Sun, Moon Models

SECTION 2

TIDES

OBJECTIVE STATEMENT (STUDENT)

CONTENT OBJECTIVES: *You should be able to:*

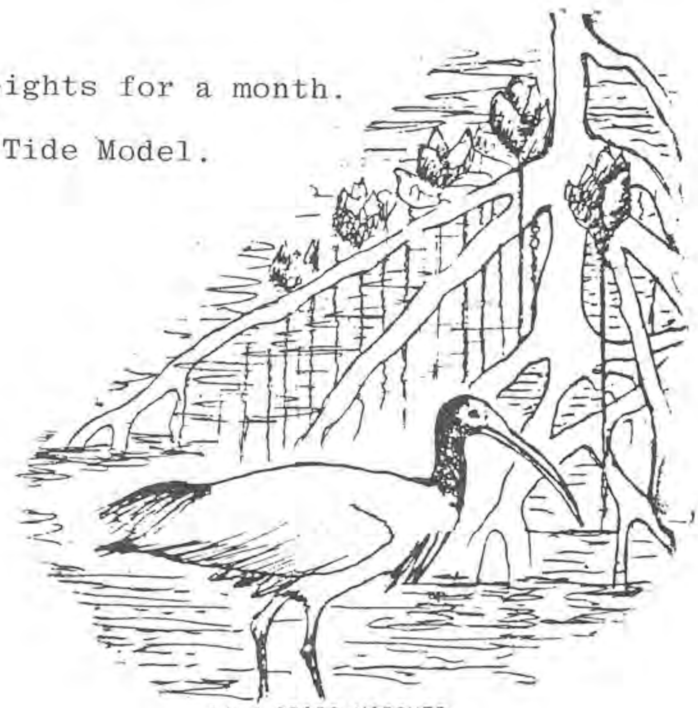
1) Define Tides.
2) Diagram the Sun,Earth System.
3) Define Quadrature, Conjunction and Opposition.
4) State Newtons Law of Gravity.
5) Define Centrifugal Force.
6) Define Flood Tide, Ebb Tide, Sidereal Month.
7) State a formula for the Rate of Travel of a Wave in a Tidal Bore.

PROCESS OBJECTIVES: *You should be able to*

1) Distinguish between Apogee and Perigee.
2) Explain how a Gibbons Moon forms with the aid of a diagram.
3) Explain how High Tide and Low Tide occur daily.
4) Distinguish between and explain why different tide heights occur during the day and night.
5) Make a model Tide chart.
6) Explain why tides at Mackay are higher than at Brisbane.
7) Distinguish between Spring and Neep Tides.

SKILL OBJECTIVES:

1) Plot a graph of Tide Heights for a month.
2) Cut out and paste up a Tide Model.



SALT GRASS MARSHES

TIDES

.1 *The Importance of Tides*

An understanding of tides and tidal currents is important to all who live near an estuary. For the fisherman, they provide the times to fish - most fish, they say, are caught at the top or bottom of the tide when the water currents are low, which allows the fish to feed; therefore a baited hook is more likely to be taken then.

Also, Department of Harbours and Marine engineers need to know how far water levels will fall in order to construct jetties; ships' masters need to know how much water is in a shipping channel before attempting to navigate through that channel; even social clubs have planned afternoon get-togethers on the foreshore around the tides, so that mud banks are covered and the area is therefore aesthetically pleasing. Over history, tides have played an extremely important part in naval battles (some say the battle of Alexandria was lost due to an unfavourable tide). So what are the causes of tides?

HYDROLOGY

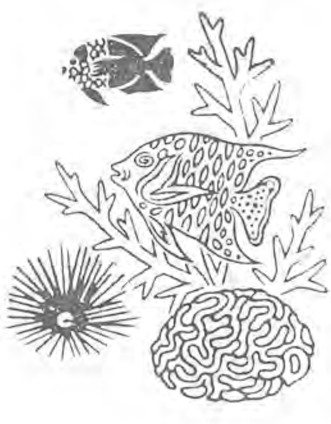
.2 *The Sun, Earth, Moon Systems*

A knowledge of the Sun, Moon and Earth's Orbital Systems is essential, because both the sun and the moon exert tide producing forces on the earth's waters. However, it is the moon that controls the timing of the tidal rise and fall of the ocean head.

Investigation 1: Plotting the Tide

You will need

* 2 sheets of Graph paper
* Tide book (or tidal predictions for Brisbane and Mackay)
  Use data on Page 58.
* A "Phases of the Moon" chart (see desk diary for this or tide book).



What to do

PART A: The Tide over 24 hours

1. Select a day which has *four* tides in it.
2. Plot the tide height versus time for that day at the Mackay and Brisbane Bars.

PART B: The Tide over a month

1. Select any month of the year and plot the tide heights for that month versus days in the month for Brisbane and Mackay (on the same graph, but using different colours).
2. Mark on your graph the phases of the moon with the symbols:

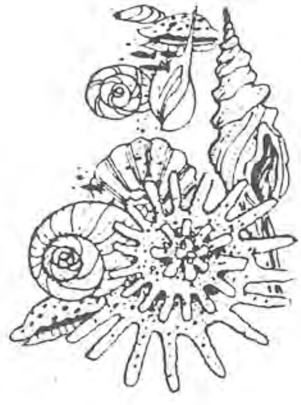
New  First Quarter  Last Quarter  Full 

Analysing the Results

In PART A:
1. What are their heights for high and low tides?
2. Are the high tides the same height?
3. Are the low tides the same height?
4. Why is there a difference in heights?

In PART B:
1. Are there any differences in tidal height over the month?
2. Is there any correlation between the moon phases and this?

To understand fully Investigation 1: we need to look at the moon's orbit.



.3 *The Moon's Orbit*

The moon, a satellite of the earth, is about 3,500 km in diameter, and has a mass of about 1/81th of the earth. The moon revolves in a elliptical orbit in which the mean distance between the earth and the moon is about 386,400 km. The direction of revolution is similar to the earth's direction of revolution about the sun. If we imagine ourselves to be looking *down* on the earth, moon and sun so that the earth's north pole is between us, the moon's motion is clockwise.

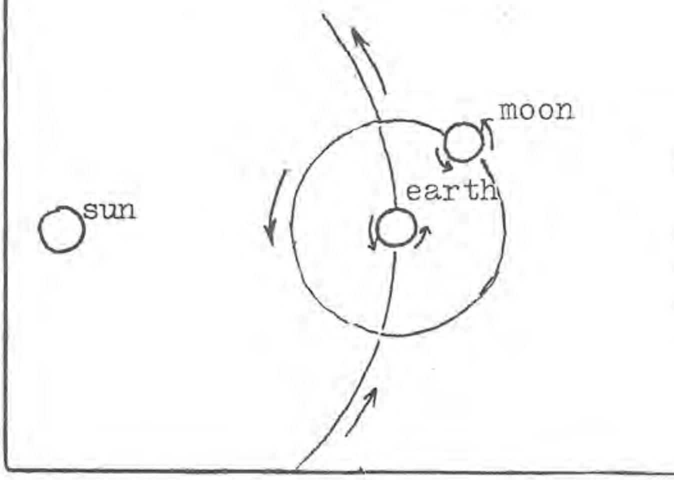


Fig. 1:

Moon and Earth revolve and rotate in the same direction.

The Moon Orbit is an ellipse, considerably more flattened than the ellipse of the earth's *ORBIT* with the earth located at one *FOCUS*.

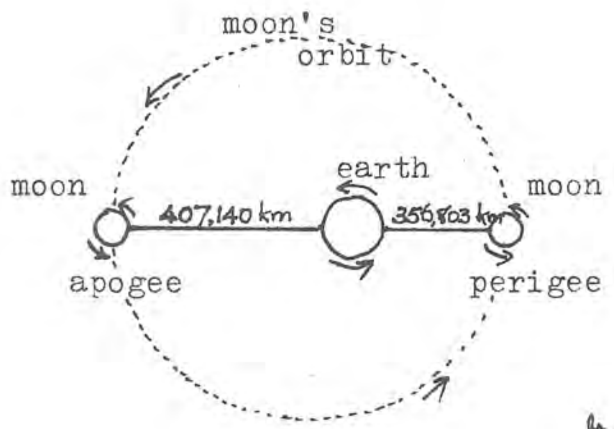


Fig. 2: Apogee and Perigee

When the moon is at its nearest point, the moon is said to be at *PERIGEE*, and when farthest, in *APOGEE*. Distances are 407,104 km. *APOGEE*, and 356,803 in *PERIGEE*.

.4 *Period of Moon's Revolution*

If we observe the position of the moon in the sky, we notice that it changes every 24 hours. In fact, each night it is about 13^{o} eastwood. It takes about 29½ days for the moon to make one complete revolution of the earth. This time is called a *SYNODIC MONTH*.

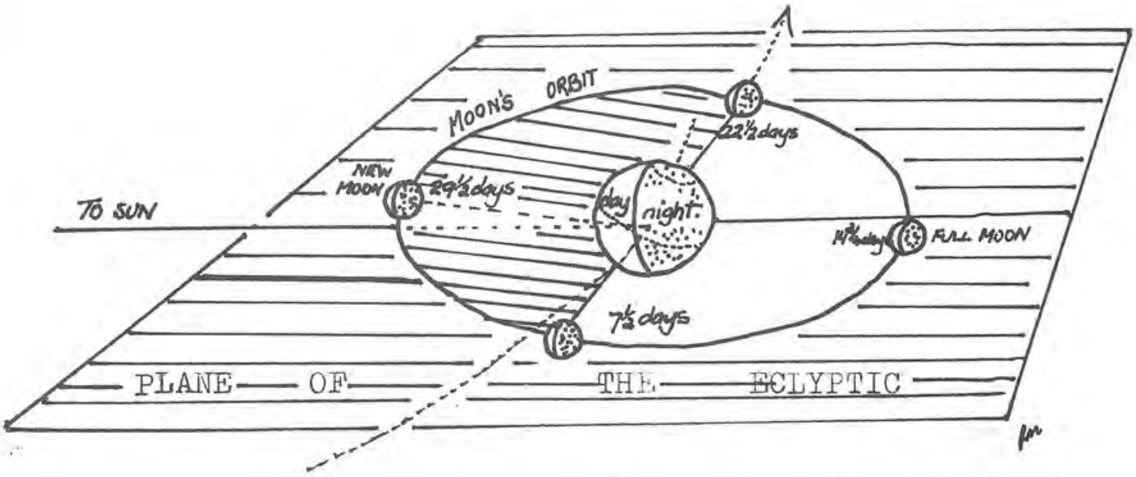


Fig. 3: The eclyptic of the Moon's Orbit

NOTE: THE PLANE OF THE MOONS ABOUT THE EARTH IS NOT THE SAME AS THE PLANE OF THE EARTHS ORBIT ABOUT THE SUN.

.5 *Phases of the Moon*

As seen in your last Investigation, the moon is said to have various phases. The *SYNODIC* month begins with a new moon (see Fig. 4-1). Because the illuminated half of the moon faces entirely away from the earth, the moon would appear entirely dark to the observer on the earth except for a faint glow of light reflected to it by the earth. A new moon is seen about 3-3/4 days of the *SYNODIC* month because the sun's rays can then reflect off the moon's surface.

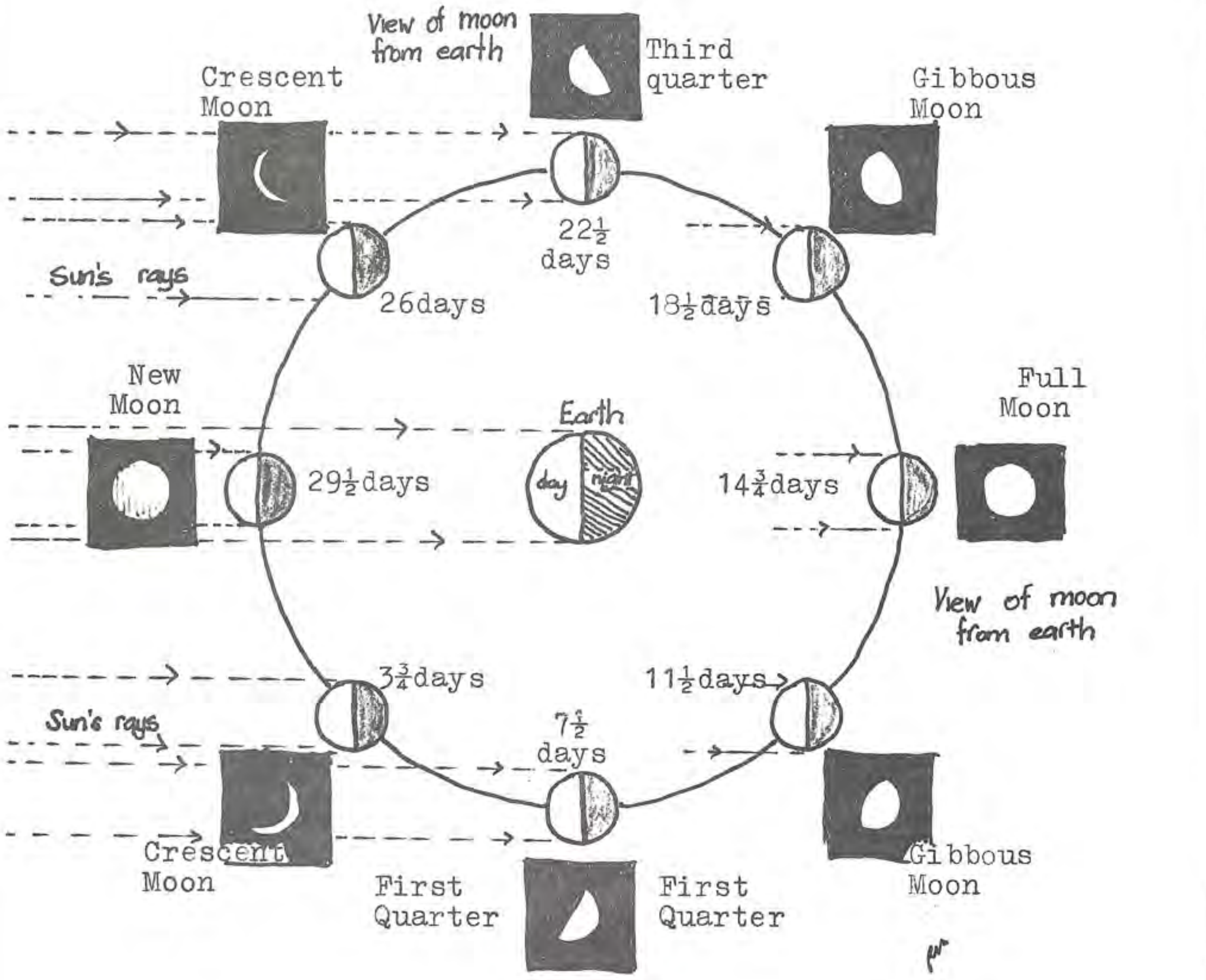


Fig. ·4:
Moon Phases

This is called a CRESCENT new moon. During the preceding 3 3/4 days the moon has dropped behind the sun in the sky about 45°, hence the crescent new moon rises in the eastern horizon when the sun has already reached a point in the sky about midway between the horizon and its new position.

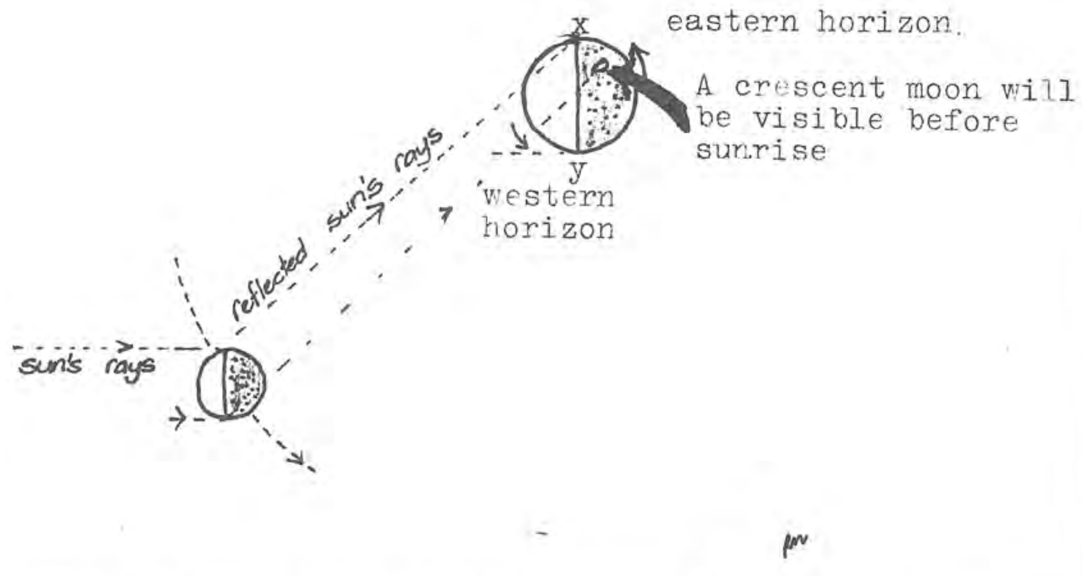


Fig. 5 The Earth-Sun-Moon System as seen from the North Pole. Sunrise is at (x) and Sunset is at (y)

The crescent moon follows the same general path as the sun, but is still shining low in the Western sky long after the sun has set.

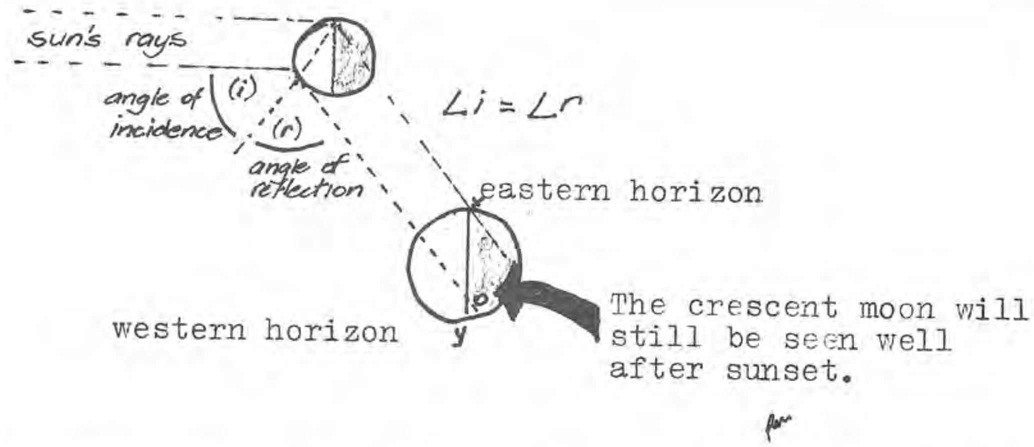


Fig. 6: After $7\frac{1}{2}$ days have elapsed, Quadrature is reached.

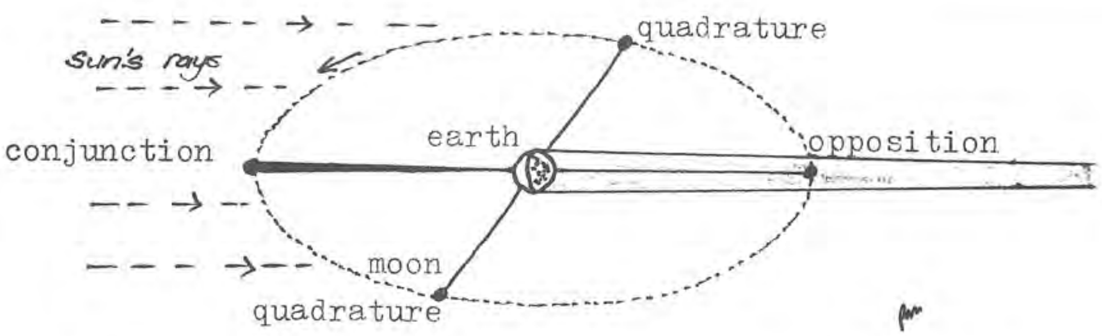


Fig. 7: These relationships among the Sun-Moon-Earth influence the height of the tide.

QUADRATURE means that the sun and the moon are so situated that there is an angle of 90° between the sun and the moon, ie. when the moon is at its first and last quarters.

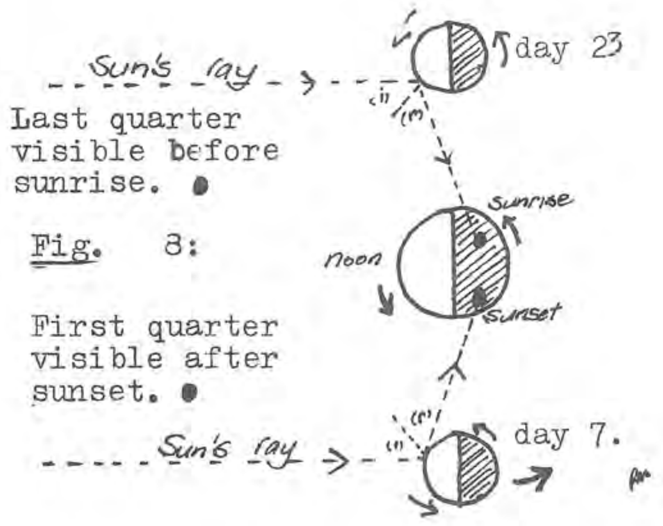


Fig. 8:

Roughly speaking, the moon in this phase rises about the time the sun is in the noon position, and reaches its highest point in the sky when the sun is setting. (AT RIGHT Angles)

We assume that the sun rises at 6 am and sets at 6 pm as it would at the equinoxes, or at the Equator.

By the time the moon has travelled 3/8 of its orbit and after about 11¼ days, the moon is 3/4 illuminated. It is called a *GIBBOUS* moon.

When the moon is 14-3/4 days old in the *SYNODIC* north, it is on the opposition position (see Fig. 2), and is in full moon phase.

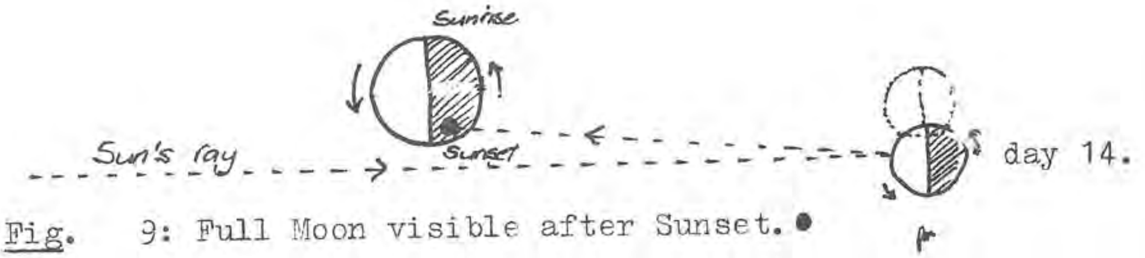
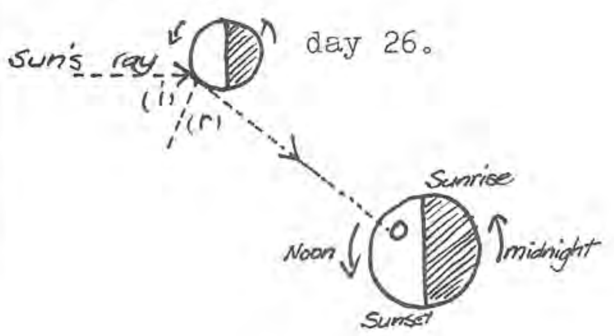


Fig. 9: Full Moon visible after Sunset. ●

The moon appears red at moon-rise due to the fact that the sun's rays are reflected through the earth's atmosphere. Because the moon and sun are on opposite sides of the earth, the full moon will be highest in the sky about midnight. If day and night are about equal length, the moon will rise as the sun sets, and will set when the sun rises.

The remaining phases of the moon are similar to those already described, except that they occur in the reverse order. One important difference is that the moon appears as if it were a mirror image of its corresponding phases of the first half of the *SYNODIC* month. By the time the phase of the old crescent moon is reached, 26 days have elapsed in the *SYNODIC* month and the moon will have lagged so far behind the sun in the sky that it seems, instead, to be travelling about 45° ahead of the sun.



By the 29th day the moon has fallen back to a place in line with the sun and the *SYNODIC* month draws to a close.

Fig. 10: Crescent Moon visible during the day.

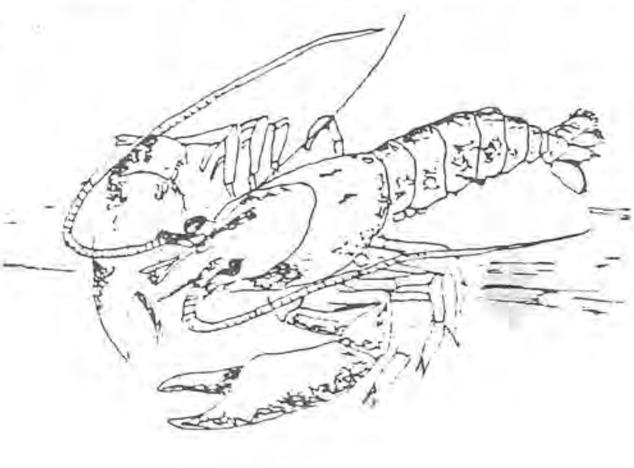
6 Rotation of the Moon

If we photographed the moon continually over a year and compared the photographs, we would find that only 59% of the moon's surface is seen. This means that the moon rotates on its axis exactly once each *SIDEREAL* month of 27-1/3 days.

DEMONSTRATION

USE MODEL

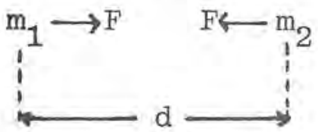
Phys Ed
Yellow CAP
marker



.7 *Gravitation and Tides*

In 1686 a famous scientist, Sir Isaac Newton, published the Law of Universal Gravitation. Newton decided that every apple, every rock, every planet, every particle in the Universe, attracts and is attracted to every other particle in the Universe. The strength of the attraction depends on the masses of the objects and on the distance between them. The equation Newton gave for this force is:

$$F = \frac{G\, m_1\, m_2}{d_2}$$



when F is the force of attraction between the objects

m_1 is the mass of one object

m_2 is the mass of the other

d is the distance between them

and G is a Constant = $6.67 \times 10^{-11} N.m^2/Kg^2$

Now, water being made of particles, will be attracted to the moon.

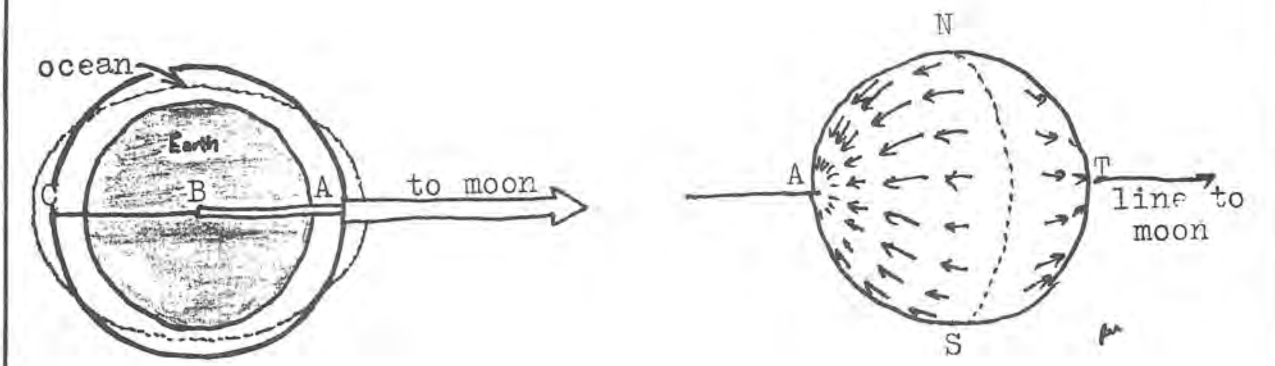


Fig. 11: Gravation and the Moon.

.8 *Daily Tides*

Consider Fig. 8-1 and let us make the assumption that the ocean has uniform depth. On side A. the moon attracts the water toward it. As the earth spins, water on the other side is spun out by *centrifugal force* (much the same way as the clothes are spun out in a clothes dryer).

Let us go back to Investigation -1. Suppose that your graph looked like this. Sunrise was at 6 am and sunset at 6pm and that the moon did not move around the earth.

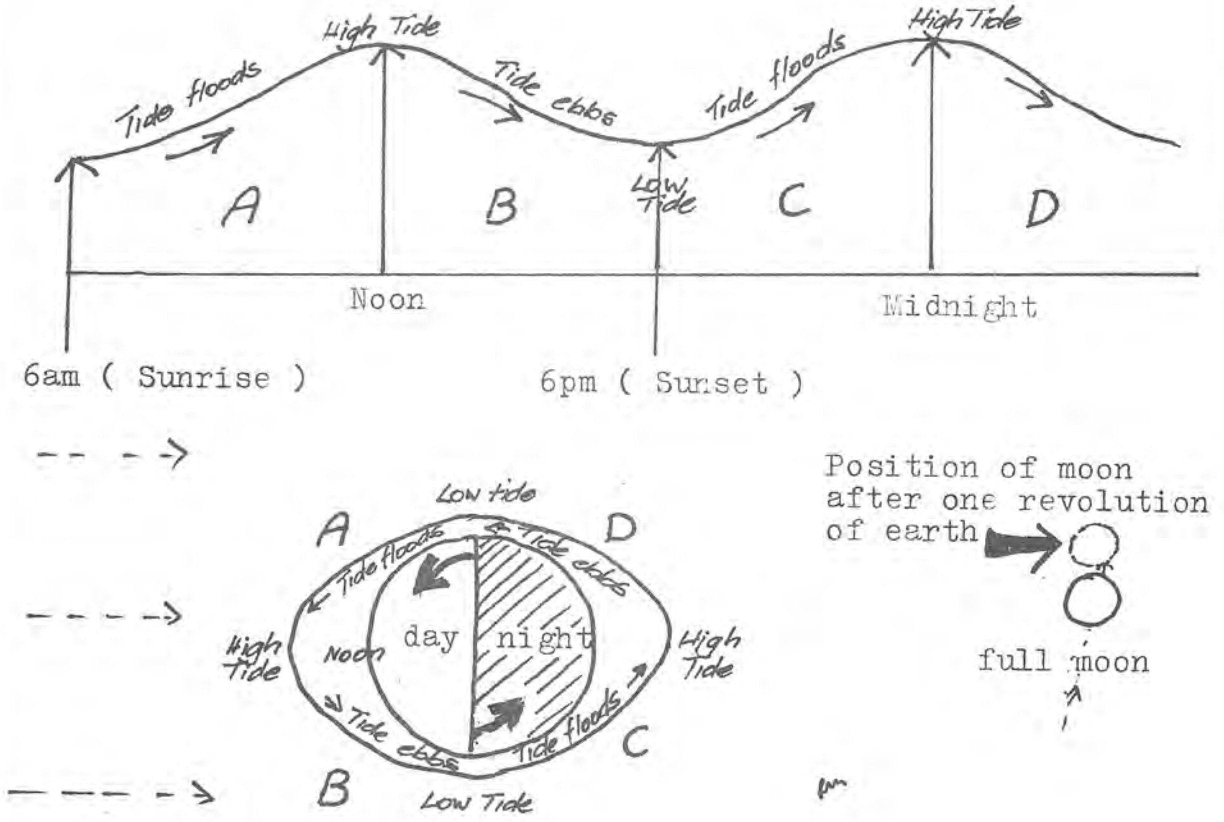
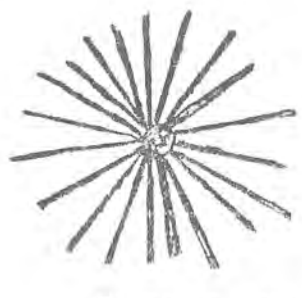


Fig. 12: Explanation of high and low tides.

As the earth rotates, the coast line "runs into" the humps of ocean pulled up by the moon. The effect is like that of water slashing up against one end of a bath. As the moon "sets" its pull lessens, and the seas - like the water in the bath - run back to their normal level. Some ocean basins are "in tune" with the moon, and so experience large tidal ranges (the difference between high and low tide), whereas others are completely out of tune, such as the Mediterranean Sea, which has a range of 24".



Radiolarian x100

In the last Investigation we saw that the land really moves into a body of water that is called the tide. Because the moon moves around the earth by the time the earth has made one revolution, the moon is now a little bit further around. (see Fig. 1). This accounts for the fact that the tides occur about every 6¼ hrs, *OR* there would be about 12-1/8 hrs. between two high tides.

But, why are the two high tides of different heights? (eg. look at the tide book for the year). You may notice that in Summer the highest high tide is during the day, whereas in Winter, the highest high tide is during the night.

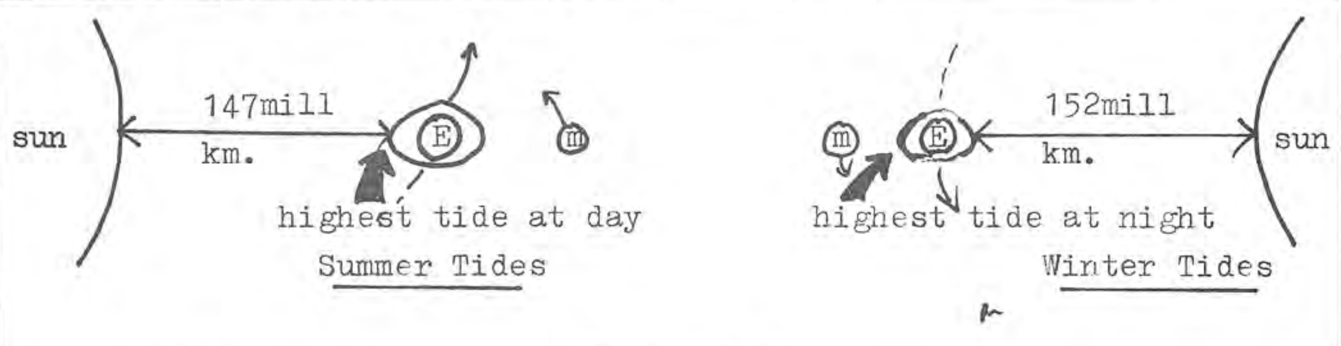


Fig. : Summer and Winter Tides.

This raises the question of the effect of the Sun.

.9 *Spring and Neap Tides*

In Investigation you discivered that the tide heights changed over the month. A typical Group would look like this:

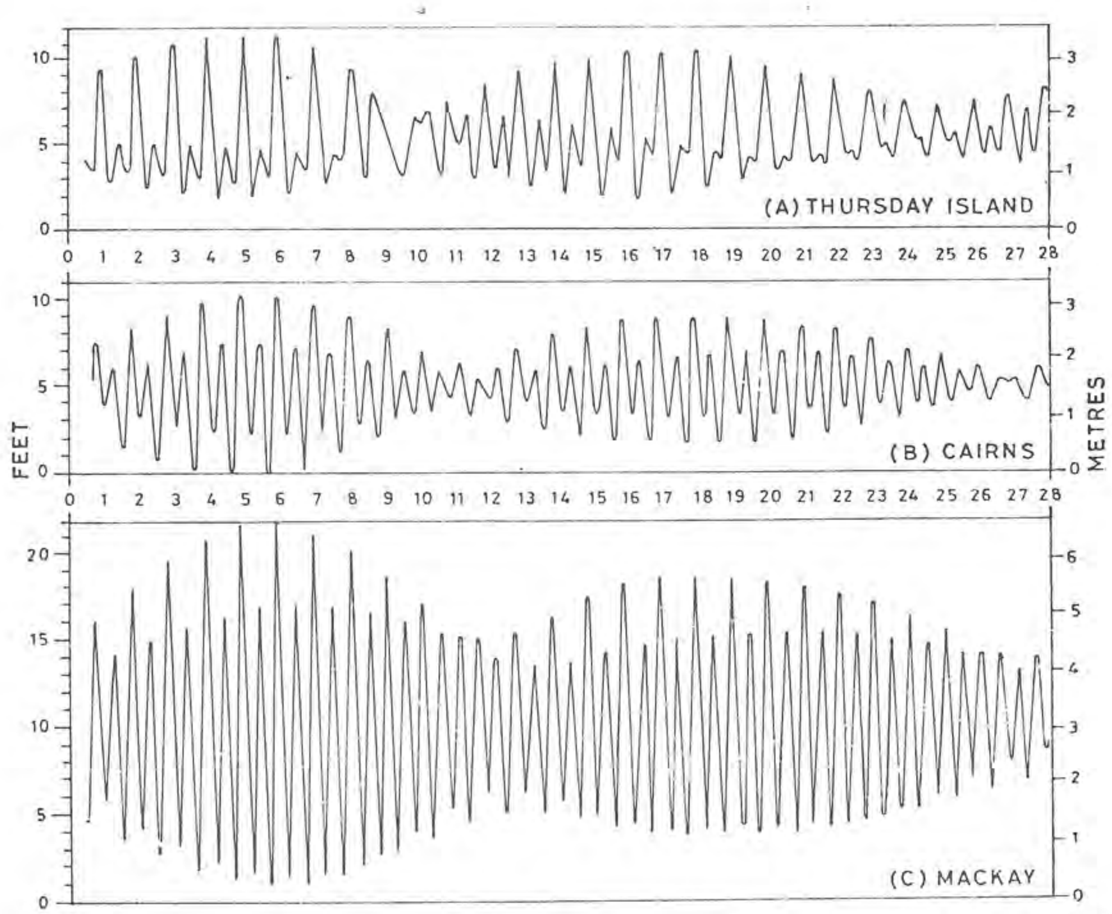


Fig. 13: Typical Tide variations over Qld. Coast. (after Maxwell)

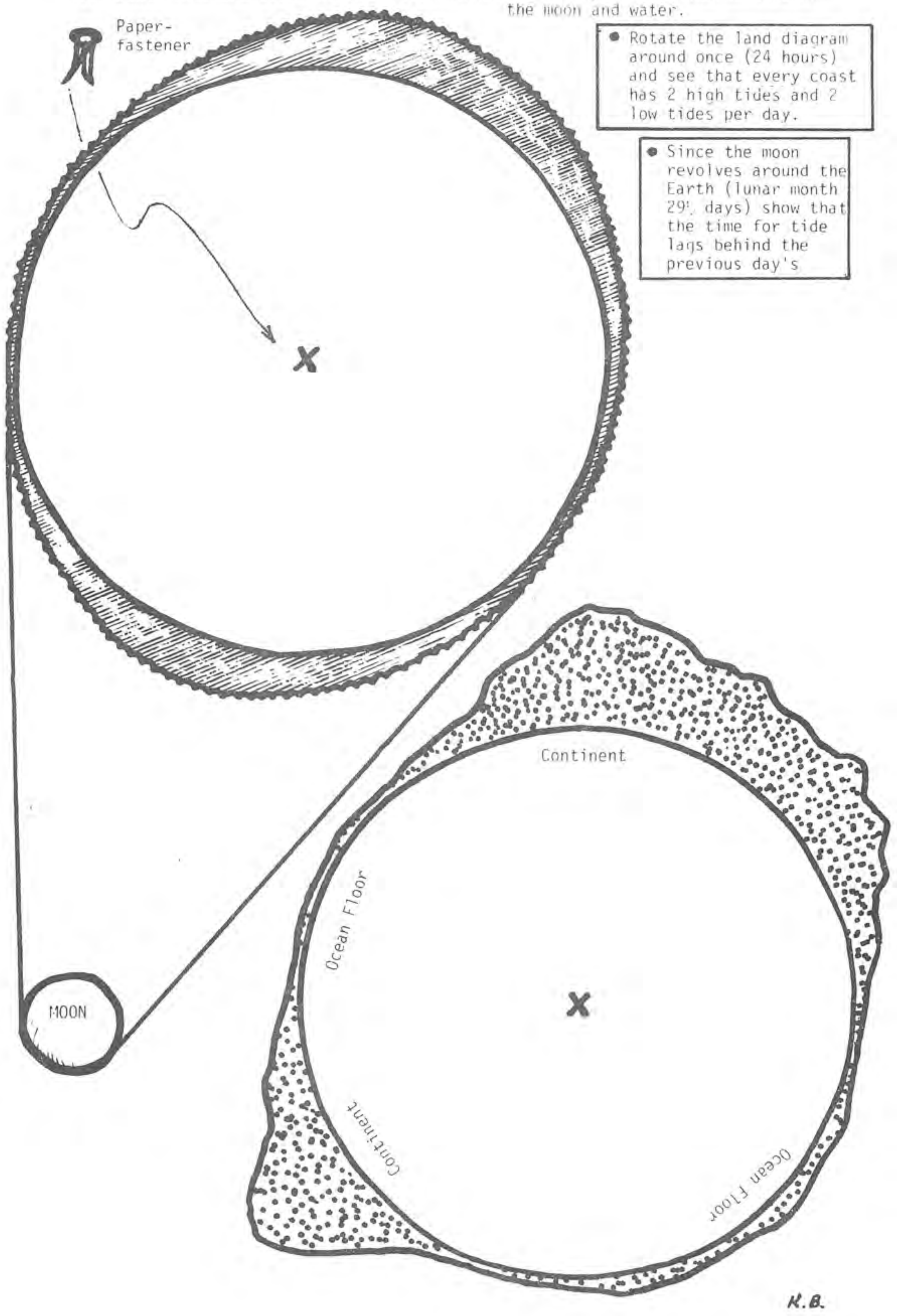
Investigation 2: Tide Models From, " Oceanography ", by R. Jenkin, F.U.S.E. Australia, Comm. Gov.

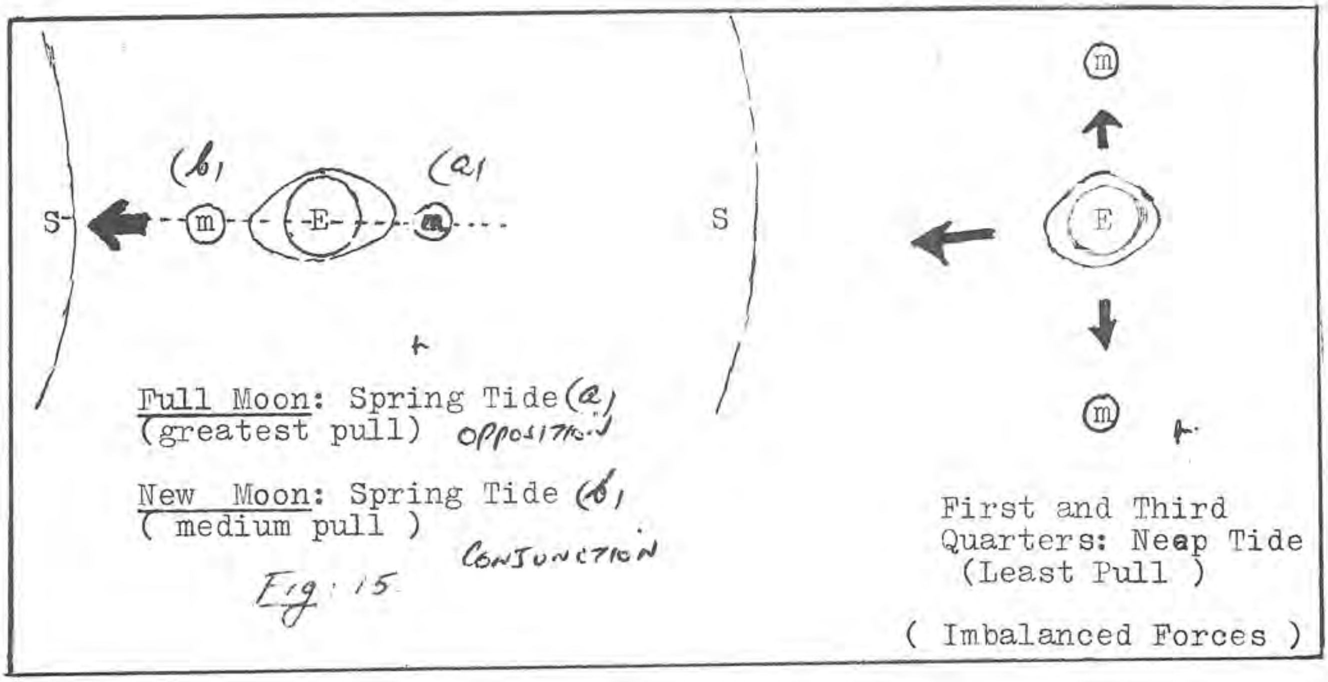
THE TIDES

PASTE whole sheet on to stiff cardboard.
CUT out both shapes below around the outside heavy line. PUNCH a hole in the centre of each diagram, and JOIN with a paper fastener, so that the diagram showing the continents and ocean floor is free to rotate on top of the diagram showing the moon and water.

- Rotate the land diagram around once (24 hours) and see that every coast has 2 high tides and 2 low tides per day.

- Since the moon revolves around the Earth (lunar month 29½ days) show that the time for tide lags behind the previous day's





We can explain the difference in tide height by the diagram

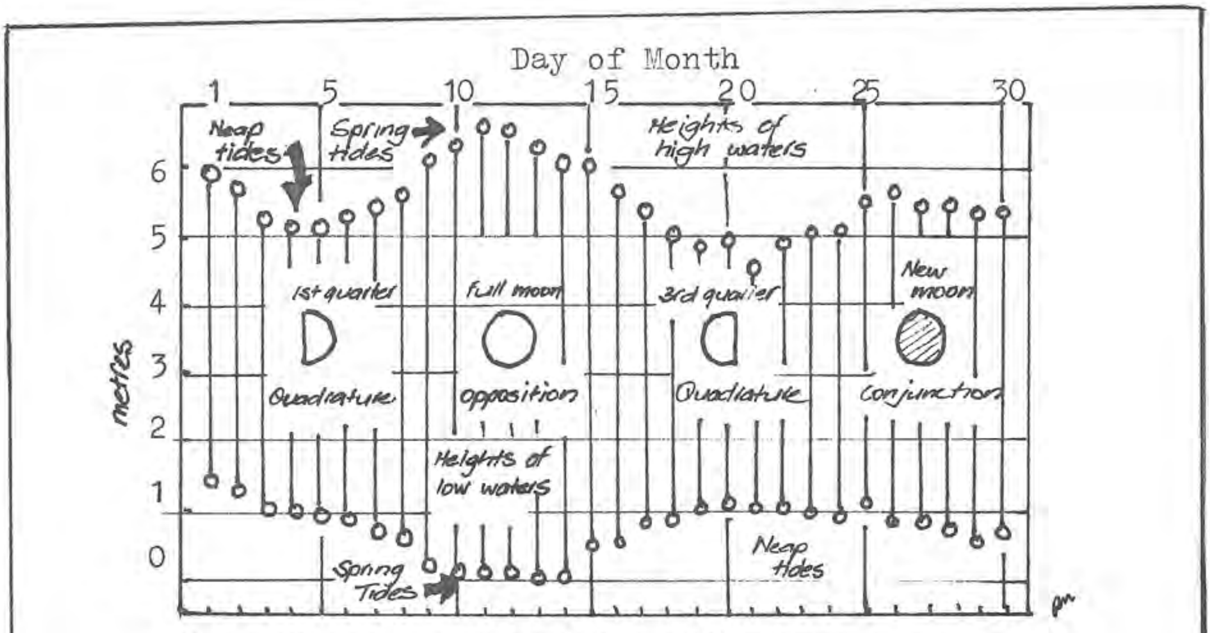


Fig. 16: Spring and Neep Tides over one month.

.10 River Tides

Many rivers experience tides in their lower parts. This condition often results when the coast has subsided, or the ocean level risen. As the tide rises (or more correctly we move into the tidal bulge), a wave is generated which runs into the inner end. Rate of travel of this tidal wave depends upon the depth of water. It is expressed mathematically by the formula

$$v = 3.6 \sqrt{d}$$

When v = speed of the wave in knots, and d = depth in metres. River tides can sometimes be faster, so much so that in some parts of the world a wave can be seen. This is called a Tidal Bore. Some surfers can surf a Tidal Bore.

These tides are used in France to run Tidal Power Stations. The electricity generated is from a renewable source and could prove useful to solving some energy crisis problems. Find out more about this.

MAIN IDEAS

1. *TIDES* are the periodic up and down movement of the sea.

2. *TIDES* are caused by the dynamic interaction of sun, moon and earth.

3. *THESE FORCES* pull the water outwards in certain places and the earth spins into this water causeing a *"TIDE"*.

4. There are four tides each day. Each tide has a different height caused by different positions of earth and moon.

5. There are four tides over a month. These are *MEAN HIGH WATER SPRING (M.H.W.S.); M.H.W.N. (MEAN HIGH WATCH NEEP); M.L.W.N; M.L.W.S.*

6. *SPRING TIDES* are caused by the sun, moon and earth in line.

7. *NEEP TIDES* are caused by the sun and moon at right angles.

8. The tides vary over the year due to the changing positions of the earth around the sun.

REVIEW QUESTIONS

1. Draw diagrams which show - *THE MOON'S ORBIT AROUND THE EARTH, THE EARTH'S ORBIT AROUND THE SUN.*

2. Where is the moon at *APOGEE, PERIGEE?*

3. How long is a *SYNODIC* month? A *GIBBOUS* moon is how many days old? Draw a diagram to show the 2 positions of a *GIBBOUS* moon.

4. State Newton's Law of Gravitation and write a formula for it.

5. Why would the high tides at midnight and midday be different heights?

6. Why does Mackay have 6 metre tides whereas Brisbane only 2 metre?

7. What are *RIVER TIDES?* What is the speed of a wave in a 9m river?

STUDY ASSIGNMENTS

1. Obtain a Tide Book and find out how to calculate the tide height and time for in between predicted times.

2. What is the uniform System of Bouyage? In 1000 words explain why it is useful to mariners.

3. Make a poster on the International Code Signals

4. What is the Beaufort Winds Scale.

5. Why does the Mediterranean Sea have no tide?

6. Find out about *TIDAL POWER*. How is the energy converted to electricity? Where does the energy come from originally? Is it a non renewable source of energy?

DIRECTED TOPICS:

1. Discuss energy converters and how they could apply to a power boat motor.

2. Obtain a power boat motor or visit a boat workshop and find out how many energy converters are in it.

3. ALTERNATIVELY, have a friend, maybe a parent bring in his/her boat and have the outboard motor explained.

4. Look up how generators, alternators, ignition timing, magneto work.

5. Interpret the table Maximum World Tidal Power Capacity from the table below.

Maximum World Tidal Power Capacity

Location	Average Power Potential (Mw)(a)	Potential Annual Energy (B kw-hr)(b)
Bay of Fundy	29,000	255
Argentina	5,870	52
England	1,700	15
France	11,100	98
U.S.S.R.	16,000	140
Total	63,800	560

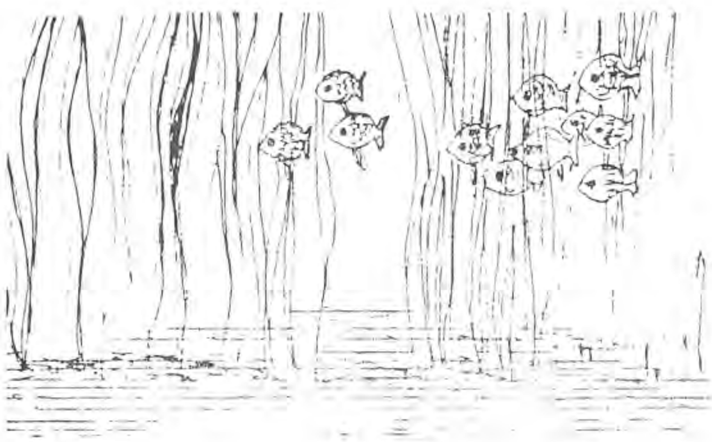
PRACTICAL ACTIVITIES:

1. Design a tidal power station.

2. Build a model of a tidal power station.

3. Design models for current or wave power stations. How useful would they be in Japan, Queensland?

4. Set up simple circuits to show how a boat would be wired for port and starboard lights.



HARNESSING THE TIDES

from FUSE "Oceanography"

MACKAY OUTER HARBOUR

Long 149 14' E

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

YEAR 1982

FEBRUARY

Day	Time	m	Day	Time	m
1 M	0414	4·15	16 Tu	0536	4·14
	1024	1·97		1157	2·29
	1633	4·27		1749	3·75
	2311	1·51			
2 Tu	0544	4·42	17 W	0000	1·86
	1158	1·90		0653	4·33
	1803	4·24		1319	2·15
				1907	3·81
3 W	0027	1·32	18 Th	0104	1·75
	0659	4·91		0747	4·62
	1320	1·60		1415	1·91
	1919	4·43		2001	3·99
4 Th	0131	1·02	19 F	0155	1·56
	0759	5·45		0827	4·91
	1423	1·22		1456	1·68
	2019	4·69		2042	4·20
5 F	0227	0·73	20 Sa	0236	1·36
	0850	5·92		0901	5·18
	1517	0·88		1531	1·46
	2111	4·92		2117	4·40
6 Sa	0317	0·50	21 Su	0314	1·16
	0935	6·26		0932	5·42
	1604	0·63		1602	1·26
	2157	5·09		2150	4·59
7 Su	0402	0·35	22 M	0349	0·98
	1019	6·44		1004	5·62
	1648	0·49		1633	1·10
	2241	5·19		2223	4·76
8 M	0445	0·30	23 Tu	0424	0·84
	1101	6·46		1037	5·75
	1729	0·44		1705	0·97
	2322	5·21		2257	4·88
9 Tu	0527	0·35	24 W	0459	0·76
	1140	6·34		1112	5·80
	1808	0·49		1737	0·90
				2332	4·96
10 W	0003	5·16	25 Th	0536	0·76
	0607	0·50		1146	5·74
	1219	6·09		1810	0·90
	1846	0·62			
11 Th	0042	5·04	26 F	0007	4·97
	0648	0·75		0614	0·87
	1259	5·72		1222	5·57
	1924	0·83		1846	0·99
12 F	0124	4·83	27 Sa	0046	4·90
	0728	1·10		0653	1·09
	1338	5·26		1302	5·26
	2004	1·10		1926	1·16
13 Sa	0208	4·58	28 Su	0130	4·75
	0815	1·51		0740	1·42
	1422	4·76		1347	4·85
	2047	1·40		2012	1·40
14 Su	0301	4·32			
	0911	1·91			
	1512	4·28			
	2141	1·67			
15 M	0410	4·14			
	1026	2·21			
	1621	3·91			
	2247	1·84			

MARCH

Day	Time	m	Day	Time	m
1 M	0226	4·56	16 Tu	0256	4·27
	0842	1·79		0925	2·34
	1446	4·40		1511	3·71
	2117	1·64		2125	2·10
2 Tu	0345	4·45	17 W	0413	4·09
	1010	2·05		1101	2·50
	1613	4·05		1645	3·48
	2241	1·74		2245	2·23
3 W	0522	4·59	18 Th	0550	4·14
	1154	1·97		1245	2·35
	1757	4·04		1832	3·57
4 Th	0008	1·60	19 F	0012	2·14
	0646	5·02		0703	4·41
	1320	1·60		1345	2·05
	1917	4·33		1934	3·86
5 F	0121	1·28	20 Sa	0119	1·88
	0748	5·53		0748	4·76
	1419	1·16		1425	1·72
	2015	4·71		2015	4·21
6 Sa	0218	0·92	21 Su	0205	1·56
	0837	5·96		0826	5·12
	1507	0·80		1457	1·40
	2103	5·06		2050	4·56
7 Su	0305	0·63	22 M	0246	1·24
	0921	6·26		0900	5·44
	1549	0·55		1529	1·12
	2145	5·31		2124	4·88
8 M	0349	0·45	23 Tu	0325	0·97
	1002	6·38		0936	5·69
	1627	0·44		1602	0·89
	2224	5·46		2159	5·15
9 Tu	0430	0·39	24 W	0403	0·77
	1041	6·34		1012	5·85
	1704	0·43		1635	0·73
	2302	5·52		2234	5·36
10 W	0509	0·44	25 Th	0441	0·66
	1118	6·16		1048	5·88
	1739	0·51		1709	0·66
	2339	5·48		2311	5·48
11 Th	0547	0·60	26 F	0520	0·66
	1153	5·87		1126	5·77
	1812	0·67		1746	0·69
				2349	5·50
12 F	0014	5·36	27 Sa	0600	0·79
	0622	0·86		1204	5·53
	1228	5·50		1822	0·82
	1843	0·90			
13 Sa	0048	5·15	28 Su	0028	5·41
	0659	1·19		0643	1·04
	1300	5·06		1245	5·16
	1916	1·18		1902	1·05
14 Su	0124	4·88	29 M	0114	5·22
	0737	1·58		0733	1·39
	1335	4·59		1333	4·69
	1948	1·49		1949	1·36
15 M	0204	4·57	30 Tu	0211	4·97
	0822	1·99		0837	1·75
	1415	4·12		1436	4·21
	2027	1·82		2053	1·69
			31 W	0327	4·77
				1009	1·96
				1609	3·90
				2220	1·86

APRIL

Day	Time	m	Day	Time	m
1 Th	0502	4·82	16 F	0423	4·15
	1153	1·81		1144	2·35
	1756	3·99		1736	3·41
	2353	1·74		2306	2·30
2 F	0627	5·14	17 Sa	0551	4·31
	1310	1·41		1255	2·04
	1912	4·39		1852	3·75
3 Sa	0107	1·40	18 Su	0028	2·05
	0730	5·56		0655	4·63
	1404	0·99		1338	1·66
	2004	4·84		1938	4·19
4 Su	0204	1·03	19 M	0127	1·68
	0818	5·89		0742	5·01
	1447	0·67		1415	1·29
	2047	5·22		2016	4·65
5 M	0250	0·75	20 Tu	0215	1·31
	0901	6·07		0825	5·35
	1527	0·49		1451	0·95
	2127	5·50		2054	5·08
6 Tu	0332	0·59	21 W	0258	0·99
	0941	6·10		0904	5·60
	1602	0·44		1528	0·70
	2204	5·65		2132	5·43
7 W	0412	0·57	22 Th	0341	0·76
	1017	5·98		0945	5·72
	1635	0·49		1604	0·53
	2240	5·69		2210	5·70
8 Th	0449	0·65	23 F	0423	0·64
	1052	5·75		1026	5·71
	1708	0·61		1642	0·47
	2313	5·64		2249	5·85
9 F	0525	0·82	24 Sa	0505	0·64
	1126	5·45		1106	5·57
	1737	0·78		1722	0·52
	2346	5·51		2332	5·88
10 Sa	0600	1·06	25 Su	0549	0·76
	1157	5·10		1149	5·29
	1805	1·00		1801	0·68
11 Su	0017	5·32	26 M	0014	5·78
	0632	1·35		0636	0·99
	1227	4·72		1234	4·91
	1832	1·24		1845	0·94
12 M	0046	5·07	27 Tu	0103	5·58
	0706	1·68		0731	1·28
	1256	4·33		1326	4·48
	1859	1·51		1934	1·26
13 Tu	0119	4·78	28 W	0201	5·32
	0744	2·01		0839	1·55
	1328	3·94		1433	4·08
	1930	1·81		2039	1·59
14 W	0158	4·49	29 Th	0312	5·09
	0836	2·30		1004	1·65
	1415	3·59		1604	3·88
	2016	2·10		2202	1·78
15 Th	0258	4·24	30 F	0438	5·03
	1000	2·46		1133	1·49
	1541	3·35		1740	4·04
	2132	2·31		2330	1·71

Courtesy Dept. of Harbours & Marine

Coastal Physics Review

1. List 5 reasons why knowledge of tides is important.

2. Name 3 objects (Planetry (?) bodies which influence tides

3. USUALLY how many high tides are there each day?

4. Usually how many tides are there each day?

5. Define APOGEE and PERIGEE.

6. What is the difference betweena SYNODIC MONTH and a SIDEREAL MONTH ?

7. Describe the phases of the moon (use diagrams)

8. When the moon appears as a cresent to an observer on earth, would it be on the side of the earth closest to the sun or furtherest away ?

9. Draw a diagram to show the positions of the moon, sun and earth for
   a) full moon
   b) new moon

10. Draw a diagram to show the moon's orbit around the earth and it's position for a
    a) CONJUNCTION
    b) OPPOSITION
    c) QUADRATURE

11. What force holds the water on the earth ?

12. What force pulls the water away from the earth ?

13. When these two forces are equal, what sahpe does the water make?

14. When the gravitational force of the moon affects the water about the earth, what shape does it make ? (Use a diagram)

15. Name a place which has very small tides.

16. Nane three places which have very high tides (including Australia)

17. In summer, the highest high tide is during the ....

    In winter, the highest high tide is during the ....

18. Define Spring and Neap tides

19. Draw a diagram to show the position of the earth and moon when there is LEAST effect on the tides.

20. What causes river tides?

21. State Newton's Law of gravitation with its formula.

22. Why does Mackay have higher tides than the Gold Coast ?

BENOWA HIGH SCHOOL PARENTS & CITIZENS ASSOCIATION

STRIVING BENOWA HIGH SCHOOL CARING

PRESIDENT: Roger Brewster
Ph. 381 755 Bus.
501 660 A.H.

SECRETARY: Leslie Ponti
Ph. 323 782

17th July, 1986

Mr. R. Moffatt,
Benowa State High School,
Mediterranean Drive,
BENOWA. QLD. 4217

Dear Bob,

On behalf of the P & C Association and the students of the school, I would like to express our deep appreciation for your personal commitment and untiring efforts in relation to the Marine Studies program.

The P & C Association has benefitted financially from your generous loan of the copyright over the Marine Studies classroom notes. The sale of notes to other schools has defrayed the costs of establishing the Marine Studies program here at Benowa as well as assisting many other schools in Queensland to begin their school programs.

This letter acknowledges the return of the copyright over the following classroom notes to yourself as owner:

Navigation, snorkelling, coastal physics, fisheries biology, estuarine chemistry, oceanography, science of diving, field methods, boating and marine radio.

The P & C Association will continue to be able to sell copies of the sea notes which will continue to operate under the Marine Studies Sub Committee. The Association acknowledges that these notes were produced in school time and therefore remain the property of the Education Department.

Finally, we are very pleased that the inaugural Castrol Sea Safety Award was made to you. It is a fitting tribute and worthy honour to your entrepeneurial achievement.

Yours faithfully,

Roger J Brewster

ROGER J. BREWSTER
PRESIDENT

MARINE STUDIES SERIES

OTHER UNITS :

There are two types of Classroom Note : Practical & Applied

(a) Practical Notes

Unit 1	: Navigation	: Features of the Coastline, Navigation Methods, Practical, Weather, Pilotage, Tides, Exam.
Unit 2	: Snorkelling	: Physiology, Techniques, First Aid, Dangerous Marine Animals, Safety, Certificate.
Unit 3	: Radio	: Components, Features, Discipline, Types, Practice Excercises, Certificate.
Unit 4	: Boating	: Buying a Boat, Safety, Seamanship skills, Handling, Maintenance, Licence.
Unit 5	: Camping	: Types of, Equipment for Camping with a boat, Campsites, Practical Conservation, Safety, Leadership Skills.

(b) Applied Notes

Unit 6	: Fisheries Biology	: Plankton, Nekton, Benthos, Fishing Methods, Protected Species, Fisheries Management
Unit 7	: Estuarine Chemistry	: Laboratory Methods, Pollution, Salinity, Temperature, Ph, and other parameters.
Unit 8	: Coastal Physics	: Waves, Tides, Beach Erosion, Beach Protection, Coastal Management, Local Coast Management
Unit 9	: Diving Science	: Boyles Law, Charles Law, Effects of Pressure on Diver, Marine Medicine.
Unit 10	: Sampling Methods	: Marine Technology in Scientific sampling apparatus, student project, collection methods.

SAFE BOATING = KNOWLEDGE + COMMON SENSE + COURTESY