

Sand Management Study.

Summary Report and Recommendations

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Attachments. The following Reports form part of this Study.

- I. Study Brief.
- II. Lakes Entrance Bar and Channel Dynamics, Coastal Engineering Solutions, December 2003.
- III. Lakes Entrance Sand Management Study, Computer Predictions and Bar Volume Calculations. Lawson & Treloar, December 2003
- IV. Sand Management Study, Bar Removal/ Reduction of the Bar, Budget Prices, Evers Consult, December 2003.
- V. Gippsland Port. Lakes Entrance Sand Management Study, Jesz Fleming and Associates, December 3003
- VI. Definitive Design and Cost for Lakes Entrance Sand Transfer System Upgrade to Sand By-pass Operation, Slurry Systems P/L, 29/8/03.
- VII. Sand Bypass and Channel Maintenance Dredging, SSM Proposed Methodology. Slurry Systems Marine P/L, December 2003.
- VIII. Business Case for Sand Management at Lakes Entrance. Dr. R.R.Noakes, Consulting Economist, January 2004.

Introduction

This Study was requested by the East Gippsland Shire and funded by the Federal Government. The Study objective was to consider the potential for increased social and economic benefit to the region, which might arise from an improvement in the ocean access to the port at Lakes Entrance. This improvement being largely achieved through improved management of the sand accumulated on the Bar and in the main navigation channels. As the Managers of the Port, Gippsland Ports were asked to undertake the Study.

A Number of specialist consultants were appointed to undertake sections of the Study, in particular.

- Bar and Channel Dynamics.
- Computer Modelling of Options.
- Dredging Options and Budget Costs.
- Design and Cost of Installing a By-pass System.
- Social and Economic Outcomes of Proposals.

These reports are presented as Attachments to this Summary Report.

A. Recommendations.

- The dual direction by-pass as specified and costed in Attachment VI should be installed at the Entrance.
- The channel from the ocean through the Bar and Entrance walls should be improved, initially to a minimum of 3m deep by 80m wide.
- The channel should be maintained by means of a dredge permanently based at the Entrance.
- Once the 3m channel has been established and the contractor has demonstrated it's ability to maintain minimum channel dimensions at the agreed service level, the depth should be progressively increased up to a maximum of 5m.
- A contract should be negotiated with Slurry Systems Marine P/L for the maintenance and progressive reduction of the Bar and the maintenance of the other main channels at Lakes Entrance, based on Proposal 5E.
- As part of the Bar channel maintenance, cut a concave profile at the seaward end of the channel to investigate the benefit of profile dredging as described in Appendix II.
- April Hamer should be de-commissioned and sold.
- The Sandpiper should be sold or scrapped.
- Waterfront land on Bullock Island should be reserved for berthing and support services for deeper draught vessels attracted to the port as a result of the improved access and safety.
- No matter which of the Options/Proposals is adopted, it is essential that Gippsland Ports set up and maintain a significantly better system of monitoring, recording, reporting and managing the Bar and main channels around the Entrance. Making recommendations on this important function of the Port Manager is beyond the scope of this Study, but should be addressed as a matter of urgency.

B. Overall Summary.

B.1. Current Situation.

Consideration and understanding of the current situation with respect to the Bar and the outcomes of previous action or failure to act is an important part of assessing what should be done in the future.

The total accretion of sand around the Entrance is calculated at 14.75 million m³ (Attachment III). This is largely a result of inadequate and inappropriate dredging and a lack of full understanding of the natural processes that create and sustain the Bar. Most of this sand is in the form of growth seaward of the beaches on either side of the Entrance walls. This has caused at least two major problems.

- The beach has grown to the end of the Entrance walls, thus negating their ability to act as sand traps. As a result any littoral drift along the beach tends to spill around the end of the wall into the channel.

Note. At the time of writing this report, sand had spilled around the Western entrance wall, reducing the channel width by 50%.

- The beaches have all but attached to the offshore Bar. This has in effect created a 'soft groin', which tends to increase the entrapment of sand in the Entrance sand system.

A major contributor to problems at the Entrance in the past 27 years was the selection and purchase of a side-casting dredger (April Hamer) to maintain the channel through the Bar. This type of dredge may well be suitable for periodic maintenance of very slow moving shoals. It is not suitable for highly dynamic environments as here where the dredged spoil is readily and quickly returned to the channel by wave, tide and current energy.

As described by Riedel in Attachment II, this sand mass has changed the beach profile from concave with a 50km radius to a convex profile in the area surrounding the Entrance. This he states refracts the direction of the wave energy, focusing it and the resulting sand, inward towards the channel entrance, thus adding to the problems.

Past reports have stated that the Bar size had stabilised. It is now accepted that this is not so and that the volume in the Bar system is growing at between 100,000m³ and 150,000m³ per annum.

In summary.

1. A huge volume of sand has been allowed to accumulate around the Entrance to the extent that it is financially impractical to consider removing all but a small portion of it in the short term. Because the majority of sand remains adjacent to the Entrance channel at the end of each campaign, there is considerable risk of channel closure between campaigns. As a result, maintenance of a safe and adequate passage into the Port by means of periodic bulk dredging campaigns, as happened occasionally prior to the purchase of the April Hamer, is no longer an option.
2. The current inadequate sand management system is allowing the Bar to continue growing. As a result, if no changes are made, the access to the Port will deteriorate with time whilst the costs escalate.

What is needed is a management system which, whilst maintaining the channel at the specified dimensions and service level,

- a) removes sand from the Bar system at a greater average rate than the present accretion rate, thereby gradually reducing the Bar volume and therefore the cost of maintenance, and
- b) uses the forces of nature to assist in the channel maintenance and Bar reduction process thereby reducing the cost for a given outcome..

B.2. Bar and Channel Dynamics With Respect to Recommendations.

B.2.1 Littoral Drift, Quantity and Direction.

The gross littoral drift is estimated to be in the order of 1 million m³/annum in either direction, with the net amount being in the order of 100,000m³. The direction of the net drift is uncertain with early estimates being W to E but more recently the evidence is E to W (Appendix II & III). The direction of the drift is not important, as the bi-directional by-pass recommended here will cope with either.

Of more importance is the volume. If the Entrance were to be protected primarily with a by-passing system as with say the Nerang River, then a very large, physically intrusive and costly system would need to be built in order to cope with the gross drifts. As these gross drifts move across the Entrance in both directions (unlike Nerang where it is predominantly uni-directional), much of the by-pass structures, jet pumps etc would need to be duplicated, with a minimum of 50% of it idle at any one time.

It should be noted that large by-pass systems such as Nerang and Tweed Heads, which were built to protect the main channel and nourish the Northern beaches, still require a greater amount of support from other dredging devices than originally thought (see 3.4).

What is being proposed here, is a very low cost, flexible and small dual by-pass system, which is but an integral **part** of the overall Bar maintenance/reduction system.

During the trial of the SSSS by-pass, the system removed 2,400m³ in one 8hr shift. Over the last year of the trial the system removed on average 840m³ per 8hr shift. This was achieved with a smaller unit than is proposed here.

The design of the by-pass system proposed (Attachment VI) is based on the maximum pumping capacity of the Sand Transfer System, which is 400m³/hr. For budget purposes, it has been assumed that a modest 200,000m³/annum would be removed from the Bar area using the by-pass time allocation of the Sand Management System. This compares with zero at present and is by itself well in excess of the overall annual accretion rate.

B.2.2 Bar Channel Infill Rate.

Even though the April Hamer has been maintaining the channel through the Bar for 26 years, the volume of sand that needs to be dredged in order to maintain a given channel dimension is still not known.

Until 1999 when a mass flow meter was fitted to the April Hamer, the volume of sand dredged was little better than a guess. Even now inadequate recording and calibration of the instruments mean the accuracy of records are questionable.

However, even if accurate quantities of dredged volumes were known, due to the dredging process it is virtually impossible to know how much of the dredged sand returns quickly to the channel. That which does not do so is deposited only 30m from the dredge on the shoulder of the channel where it is readily moved back into the channel.

Computer modelling (Attachment III) indicates that maintaining a 3m channel would require the removal of 1,200m³/day from the channel based on a continuous moderate wave climate for a period of 75 days. The recommended Proposal 5E is capable of dredging almost twice that amount in a 12hr shift (Attachment VII). The computer model further shows that deposition of sand in the channel is reduced when the by-pass is operational. Riedel also states that a bi-directional by-pass system would assist with channel maintenance.

Riedel describes how the convex shape of the outer edges of the Bar, refract the wave energy and as a result focuses the suspended sand towards the entrance channel. He suggests that Profile Dredging at the outer end of the Bar channel could be of benefit. There would be no problem in dredging a concave hole at the seaward end of the Bar channel with any of the Proposals. If it did not work, nothing is lost as volume is still being removed from the Bar. If it does work, then we will be harnessing a natural occurrence to the benefit of reduced channel maintenance.

Under the present system of Bar management, the volume of sand around the Entrance is increasing at a rate estimated at 100,000m³ pa or above. Therefore any new management system should remove from the 'Bar system' in excess of this amount if the Bar volume is to be reduced over time. All of the Proposals in Options 4 and 5 discussed in this study will reduce the Bar volume over time, the rate of reduction is simply a matter of cost. Slurry Systems state in their Proposal that it is possible to reduce the overall bar to a 5m datum within 12 to 18 months.

B.2.3 Optimum Channel Dimensions.

Riedel states that the theoretical stable maximum channel depth for the channel through the Entrance walls is 3m. This is based primarily on channel water velocity and the sand drop out velocity. The theory assumes no channel maintenance and a symmetrical channel cross section. Neither of these will be so.

In addition there will be a deep sand trap on either side of the Entrance walls (up to 8m), a Bar maintenance programme which will over time reduce the Bar height and size and an ongoing internal channel maintenance/sand removal programme. All of these will reduce the availability of sand for pickup by the tidal flows. **No sand in the tidal flow, no shallowing to the natural depth whatever that may be.**

Furthermore it is not necessary to have the channel at a constant depth across the width. Indeed it would be difficult to achieve and is not desirable, as it could undermine the Entrance walls.

Therefore it is considered entirely feasible to maintain a channel deeper than the suggested theoretical minimum. Even so the recommendation is to first establish a

reliable, safe and sustainable minimum channel of 3m. *A current target depth rarely achieved.* Once this has been achieved and the need demonstrated, it would be a simple matter to progressively increase the dredged volumes to achieve the desired channel depth. This would not require any additional capital, as all the main elements of the recommended system will, on average, be operating well within their maximum capacity for the 3m channel.

B.2.4 Discharge / Disposal.

When the Sand Transfer System was designed, it was only considered necessary to pump the sand sufficiently far along the beach to be outside of the Bar system. To pump it further (there is no theoretical limit) would only incur additional capital and operating cost. This has been born out by 4 years of operational experience and is supported by Riedel (Attachment II).

The method and point of discharge with respect to the beach was also considered for the STS. Aerial discharge into the tidal regime was by far the lowest cost and easily met Dredging Protocol requirements. Again 4 years of operational experience has not produced any reason to do it differently in the future. Note. *When the STS was installed it was recommended that some sort of security system be installed at the discharge point or at least remote video monitoring as part of the automation of the STS. This has not been done to date.*

All of the proposals other than 5E require the dredged sand to be discharged in water sufficiently deep to allow safe manoeuvring of the fully loaded hopper dredge. Discharge as close to the beach as possible may avoid the need for a Dredging Permit. Deep sea dumping would require a permit from the Federal EPA and is undesirable for other reasons.

B.3 Economic/Social Benefits.

These are described in detail in Attachment VIII. That report clearly supports investment in improving the access and safety of the channels leading into the Gippsland Lakes at Lakes Entrance.

The price of the recommended Proposal 5E was revised downward after the Economic report had been completed (see Section D below). This was due to an initial misinterpretation of the specification by Slurry Systems. As a result the favourable outcome shown in Attachment VIII are understated. Furthermore the other Proposals considered in detail by the economist, use the price estimates submitted by the dredging consultants and not those lower prices arrived at as a result of the equalisation described in the financial section D. Again therefore the Benefits, Return on Investment, etc are therefore favourably understated in the Economic Report.

Even so many of the Proposals presented in this Study, exceed the Government's requirement for investments of this kind and a few by a considerable amount.

Social impacts resulting from an improved Port would come mainly from improved economic activity and safer waterways.

Improved safety in the use of the channels would, with marketing and time, reduce the markets view that ocean access to the Port and to the Lakes themselves is dangerous and

should be avoided. This will improve the use of the Port by recreational and commercial users. In addition improved safety should lead to reduced accidents and the resulting trauma within the community.

B.4 Risk.

Risk in its various forms is covered in a number of Sections in this Study. The risks associated with the Study Recommendations are minor. **Indeed the biggest risks arise if dredging is discontinued, Option 1, or continued as now, Option 2.**

If the recommended Proposal 5E is adopted, there is in effect no risk at all from a financial point of view. Not only do we get an improved and safer channel and a gradual reduction in the Bar volume, but this is achieved at a lower cost to Gippsland Ports, and hence the Government, than is currently being spent on maintaining a deteriorating channel with a deteriorating vessel.

There is minimum risk from using the proven technology, after all it is in the main 'just plumbing'. The systems and equipments are flexible, as would be any contract entered into with the operator, so that volumes and methods can be changed as the programme outcomes are realised and needs dictate.

VIMA have been contacted with regard to the possibility of a reduction in the cost to Government in the event that the recommendations of this Study are implemented and lead to a safer Port. This is also considered in the Economic report, Attachment VIII.

B.5 Proposal Outcomes.

These are discussed in detail elsewhere in this report, but it should be noted that whilst Proposal 5E is by far the most attractive, all of the Proposals will remove sand at a greater rate than the estimated current Bar growth rate. Over time they will reduce the Bar volume and therefore the effort and cost of maintaining a channel into the Port. The main downside of these Proposals compared with 5E (other than their higher cost) is the risk of channel inundation between campaigns.

B.6 Statutory and Planning.

Meeting requirement in these areas are not expected to a problem.

- Approval under the Coastal Management Act will be required.
- EPA approval should be routine. See Attachment V.
- There is no need to further disturb the Heritage site around the STS pump-house.
- The possible need for a planning permit from EGSC will need to be checked.

C. Discussion on Options.

The following discussion reviews each of the 5 Options agreed to as the basis for this Study. Where not covered elsewhere, comment is made on the Options from a number of aspects,

- Technical
- Social and Economic
- Environment
- Risk
- Financial.

Assumed Quantities Used to Aid Comparisons.

• <i>Net littoral drift</i>	<i>150,000m³/annum</i>
• <i>Maintenance dredging from internal channels</i>	<i>100,000m³/annum</i>
• <i>Volume by-passed</i>	<i>200,000m³/annum</i>
• <i>Average volume removed in Bar maintenance</i>	<i>200,000m³/annum</i>
• <i>Offshore Bar volume above 5m datum</i>	<i>750,000m³</i>
• <i>Offshore Bar volume to adjacent beach profiles</i>	<i>3,000,000m³</i>

OPTION 1. DO NOTHING.

This option means in effect the phased cessation of all maintenance dredging on the ocean side of the Entrance. It is assumed that,

- maintenance of the internal boating channels will continue at the current level using the Sandpiper and the Sand Transfer System (STS), and
- the by-pass is not installed.

1.1 Technical.

- In the past the channel through the Bar has deteriorated significantly in a matter of weeks at times of prolonged rough weather (the design of the April Hamer (AH) is such that it can not operate in significant swells/waves or high winds) or periods of absence from the Port of the April Hamer for maintenance or other duties. This resulted in major restrictions on when and what vessels could enter or leave the Port. There was a corresponding increase in risk to those who did.
- There will be a need to continue maintenance dredging of the internal channels using the Sandpiper or similar dredge in conjunction with the STS booster station. (Note, that as the Sandpiper is not self propelled and has difficulty in holding station in strong tidal flows, the STS will not operate as effectively without the AH to move sand shoals quickly from the navigation channels to the sand holding dumps).
- Contrary to earlier reports and thinking, there is significant evidence to show that the Bar has continued to grow (Attachment II), certainly since the arrival of the April Hamer. As a result, whilst the Bar channel did not completely close between the completion of the Entrance and the commencement of dredging by the April Hamer, with the increased **and increasing** volume of the total sand surrounding the Entrance, there is a

corresponding increased risk of Entrance closure if dredging was discontinued.

1.2 Social/Economic.

- All else being equal, the reduced certainty of channel reliability and depth will lead to negative influences on the existing fishing fleet and the future ocean access at Lakes Entrance **for all users.**
- With reduced ocean access to the Port there will be a reduction in the economic activity in and around Lakes Entrance.
- With the increased threat of flooding in areas surrounding the Lakes, insurance prices could increase or not be available. Infrastructure and property construction will decline in low-lying areas, particularly those with water frontage where most of the development is taking place.

1.3 Environmental.

- With increased shoaling at the Entrance, and possible channel closure, flooding of low-lying land and townships such as Paynesville and Lakes Entrance is likely to be more frequent and to a greater depth than previously experienced. (There is major new construction underway in this threatened area).

1.4 Risk.

- Vessels will continue to traverse the Bar, but with no maintenance it will be at additional risk.
- In the past 11 years there have been two major floods in the area surrounding the Gippsland Lakes. The floodwater in the townships of Lakes Entrance and Paynesville caused damage to many properties. In the flood of 1998, the water level was recorded at 1.8m above chart datum before the recording equipment failed. Whatever the final water level, it was sufficiently high to breach the sea wall along the Esplanade at Lakes Entrance and at Slip Road at Paynesville and to flood adjacent low-lying property. Should such events occur following full or partial closing of the Entrance the flood levels would be significantly higher.

1.5 Financial.

It is assumed for the purposes of this Study that maintenance of the channels inside the Entrance will continue at the present service level.

- There would be a possible capital return from the sale of the April Hamer. The vessel's potential sale value is difficult to assess, as it is a unique type of dredge with limited potential buyers. For the purposes of this Study, it is assumed that there would be a neutral outcome in capital terms, with the sale of the vessel covering the current GP WDV of \$1 million.
- An expense of \$70,000 to cover marketing and shut down expenses has been used in the calculations.

- There would be a one off termination costs of about \$350,000 for the 8 April Hamer crew.
- The saving to GP over the 20 year period is estimated

Recurrent expense saved	\$34,159,000
Non recurring expense	\$ (350,000)
Marketing and shutdown expense	<u>\$ (70,000)</u>
Total Saving to GP over 20 years	<u>\$33,739,000</u>

In summary adoption of this Option would, lead to a reduction in the long term cost to GP but with a corresponding shrinking of the local economy, combined with an increased risk to those who currently use the Entrance, the surrounding land and built infrastructure, Gippsland Ports and ultimately the State Government.

OPTION 2. CONTINUE AS NOW.

2.1 Technical

- With the current Bar maintenance equipment and procedures the Bar will continue to grow at a rate estimated to be about 100,000 to 150,000 m³ per year (Attachment II) This will mean that the effectiveness of the side-casting dredge April Hamer (AH) will continue to reduce and therefore the time and cost spent on dredging to maintain the current level of channel service will increase.
 Whilst the continued growth of the Bar has only been confirmed in recent years, the US Corps of Engineers (designers of the April Hamer) in their 1972 report to the Victorian Government stated “**It is emphasised that the effectiveness of the side-casting technique diminishes as the project dimensions increase because of a reduction in current velocities through the prism. Ultimately a point is reached where it is no longer economic to utilise the side-casting technique alone.**” There is evidence to show that this point was reached some years ago.
- In the event that it was decided to continue with the AH for the 20year time frame, prudential management requirements would dictate changes.
 - The AH is over crewed by industry standards in the order of a factor of two. Crew reduction could be achieved by all or a number of the following.
 - Changing operating hours from the current 12 hr to an 8hr day.
 - Using prepared lunches.
 - Automating the helm/main engine controls.
 - Automating the drag arm and dredge pump controls.
 - Programmed dredging regimes based on improved surveying, vessel positioning and dredge management techniques.
 - Possible addition of bow thrusters to improve manoeuvring.

Most of the above would require significant upfront capital expenditure on the vessel plus some one off non-recurrent expenditure related to the crew reductions.

- Whilst the above improvements may help in the short term, none of them will overcome the fundamental problem, which is that the side-casting method of dredging the channel through the Bar at Lakes Entrance is inadequate.
- It is inevitable that unless the April Hamer is replaced or is supported by additional dredging capability, the quality of the channel across the Bar will continue to decline.
- It is also inevitable that the annual cost of major maintenance, averaging \$202,000 pa over the past few years, will increase each year in line with the vessels age as will the chance of catastrophic failure of some major equipment.
- Internal channel dredging will need to be continued as now and although this Study is about managing the sand outside the Entrance, the two are directly linked and need to be considered together.

2.2 Social/Economic.

- For reasons outlined above, the progressive decline in channel quality and depth will lead to negative influences on the existing fishing fleet and the future ocean access at Lakes Entrance for all users.
- With reduced ocean access to the Port there will be a reduction in the economic activity in and around Lakes Entrance.

2.3 Environmental.

With the Bar continuing to grow there will be a progressive increase in risk of flood damage to surrounding land and infrastructure.

2.4 Risk.

- The risks associated with the adoption of this Option would increase in line with the gradual increase in Bar volume and the corresponding reduction in the capability of the April Hamer to maintain an acceptable channel through the Bar.
- This reducing channel reliability would lead to a reduction in the number and size of vessels using the Port.
- There will be an increasing risk of a catastrophic failure of April Hamer's equipment in line with the vessel's increasing age. This could lead to a significant period of time when there was no Bar channel dredging.

2.5 Financial

This option is dependant on the April Hamer being retained in an operational condition for the 20 year time period under consideration.

The main factors to be considered are the condition of the hull and that of the main engines and those driving the dredge pumps.

- The cost of maintaining the vessel will increase in line with its age and cost of the required periodic refits will be higher than for the past 20 years. This increasing cost of maintenance is difficult to forecast, however a modest real 5% pa increase on the average recent refit cost has been built into this Option.
- The cost of a possible catastrophic equipment failure has not been estimated. **Needless to say this possibility should be recognised as a significant cost downside when considering this Option.**
- It is generally accepted that the vessel is over manned. Therefore if the vessel is to be retained, some capital would need to be invested to reduce the inefficient manual input required in the areas of vessel engine and steering control and dredge arm and dredge pump control.
In addition to the capital, there would be a non-recurring expense related to the crew reductions.
- This Option would not produce any increased benefit to the local economy and may inhibit any potential increased benefit from other factors such as increasing local offshore oil and gas activity, increased leisure boating trends, etc. (Attachment VIII).
- As explained above, the cost of continuing with the current dredging of the internal channels using the Sandpiper, April Hamer and STS booster station has been added to this Option cost
- The cost to GP over the 20 year period for Option 2 is estimated at,

April Hamer Expense	\$34,159,000
Sandpiper Expense	\$ 6,640,000
STS Booster Station Expense	<u>\$ 1,780,000</u>
Total Cost to GP over 20 years	<u>\$42,579,000</u>

This figure is used as a basis by which other Option/Proposal costs are compared.

OPTION 3. INSTALL A BY-PASS SYSTEM AT THE ENTRANCE.

It was agreed as a basis for this Study that any new sand management systems introduced at the Entrance would include a sand by-pass system. Therefore this is not strictly an Option in itself but a common part of all of the Proposals presented in Options 4 and 5

It was further agreed that the system was to be based on the successful and extensive trials undertaken by GP of the Slurry Systems Sand Shifter (SSSS) system.

The system design and cost breakdown is shown in Attachment VI to this report.

3.1 Technical.

- The by-pass system should be integrated with the existing GP owned Sand Transfer System. There is no technical justification for building a stand-alone system.

Furthermore to do so would,

- add significant cost to the overall system (Attachment VI),
 - increase the building mass on the foreshore,
 - leave the existing STS under-utilised.
- The proposed system is capable of handling well in excess of the net littoral drift of between 100,000 and 150,000 m³ pa. The computer modelling indicates that the by-pass reduces the amount of sand re entering the dredged channel.
 - It is estimated (Attachment II) and confirmed by computer modelling (Attachment III) that the installation of the proposed Slurry Systems Sand Shifter dual direction by-pass would significantly reduce the amount of sand brought in through the Entrance and deposited in the inside channels.
 - The by-pass trial demonstrated that in addition to removing littoral drift sand trapped by the Entrance rock walls, sand was removed from the inside of the bar itself. This is also confirmed by the computer modelling.
 - **As a result of the above, the installation of this by-pass system will improve the outcome of all of the Proposals in Options 4 & 5 below.** This improvement will be achieved in three ways.
 - It will reduce the amount of sand brought in by the incoming tidal current and as a result reduce the cost of maintaining the internal navigation channels.
 - As the system pumping capacity is greater than the net littoral drift and the collection sumps extends beyond the Entrance walls, sand will also be removed from the inside faces of the Bar. This will be particularly so in the early years of operation, thus speeding up the reduction in the size of the Bar and the eventual cost of whichever of the Proposals in Options 4 or 5 are perused.
 - These reductions in the volumes to be dredged from the Bar and from the internal channels, will be achieved at a reduced cost per m³. This is due to the fact that the by-pass system requires no direct operating labour and only a modest capital investment.

Overall cost savings therefore are achieved on all Options in two ways. In reduced time to achieve a given reduction in Bar and internal channel shoal volumes and in the reduced unit cost of removal. **These savings are real but difficult to quantify and have not been taken into account in the cost calculations thereby providing a favourable upside to overall Proposal costs.**

3.2 Social/Economic.

By improving the effectiveness of all the relevant Proposals, installing this system will have a positive impact on the outcomes.

3.3 Environmental.

- The by-pass system simply transfers sand, which migrates naturally along the beach and collects against the Entrance rock walls, to the beach on the other side of the Entrance. In effect it is designed to replicate the natural beach processes, which would occur if the impediment of the Entrance were not there. In doing so it prevents the excess build-up of sand at the Entrance rock walls, which currently spills around the wall and is a major source of the sand brought in through the Entrance by the tide. Some of this sand remains as shoals in the navigation channels inside the Entrance.
- As it is replicating a natural process, there is no environmental impact on the beach system, in fact it is an improvement on the current situation where sand is building up on the weather side of the Bar and being removed from the lee side. This reduction of the western beach width can easily be seen from aerial photographs, a reflection of the current net E to W littoral drift.
- The design of the system has taken into account that the Western side of the Entrance is a Coastal Park. There is no power required on that side. All valves and moving parts are located on the Eastern side. Most of the minimal installed hardware is buried in the sand and requires a minimum of maintenance.
- The existing Gippsland Ports Sand Transfer System was designed and built with the capacity to control and handle the slurry processing of a by-pass system. The only additions will be to equipment inside the STS existing pump-house, additional pipelines buried in the beach, some valves and an additional small pump-house on the Eastern rock wall of the Entrance. Slurry and water pipelines will be laid under the Entrance channel to link the Western and Eastern parts of the by-pass system.
- Unlike most other by-pass systems in Australia, there is a negligible amount of built infrastructure on the beach and as a result there will be minimal visual environmental impact.
- The only noise addition to the STS will be from the electrically driven pump at the seaward end of the Eastern rock wall. This will be inside a sound insulated building and will only be operating when conditions are right for efficient by-passing, ie in heavy sea-states, when the natural background noise will far exceed the low level sound emissions from the pump-house.

3.4 Risk.

There is little risk in proceeding with this part of any Proposal.

- The previous project (STS) undertaken by GP with Slurry Systems was completed to specification and under budget. It has operated to specification with little or no maintenance since it was commissioned in 2001
- The proposal is based on two years of successful practical trials and is very simple in construction.
- Most other by-pass systems in Australia (and elsewhere) require expensive, massive and permanent piers to be built to hold the jet pumps. If these piers are wrongly placed at the construction phase or if there are significant changes in the coastal processes after construction, the cost of correction will be high.

The SSSS units are not permanent. They can be raised/lowered in the sand bed or moved in the horizontal plane to optimise performance over the life of the system. The units can be replaced with larger or smaller units or additional units can be added at relatively low cost.

3.5 Financial.

The System has been costed two ways.

Proposal 3A.

GP pay for and own all the capital additions to the STS except the additional pumps and the Sand Shifter units. These will be owned and maintained by Slurry Systems. GP will operate the System as part of the STS operations. Slurry Systems will charge a royalty based on the mass of sand by-passed. Slurry Systems prices are based on a minimum initial contract of 5 years.

- The cost to GP over the 20 year period is estimated as,

GP Capital cost	\$ 1,775,000
GP STS operating expense.*	\$ 3,100,000
SS charges	<u>\$18,500,000</u>
TOTAL.	\$23,375,000

* Excludes any cost relating to Sandpiper or April Hamer. Assumes 100,000m³ of sand pumped through the STS from internal channel maintenance, this being the incremental cost of operating and maintaining the STS as a result of pumping an additional 200,000m³ of sand from the by-pass units.

Proposal 3B.

GP pay for and own all the capital additions to the STS except the additional pumps and the Sand Shifter units. These will be owned and maintained by Slurry Systems. Slurry Systems will operate and maintain the complete STS/By-pass system. Slurry Systems will charge a unit rate

based on the mass of sand by-passed. Slurry Systems prices are based on a minimum initial contract of 5 years.

- The cost to GP over the 20 year period is estimated as,

GP Capital cost	\$ 1,775,000
SS charges. *	<u>\$21,280,000</u>
TOTAL	\$23,055,000

* Excludes any cost relating to Sandpiper or April Hamer and assumes 100,000m³ of sand pumped through the STS from internal channel maintenance and 200,000m³ of pumped through the STS from the by-pass units.

OPTION 4. REMOVE ALL /PART OF THE BAR.

This Option was specified to investigate the possible benefit of a major capital dredging campaign compared to frequent smaller campaigns or continuous dredging.

Unlike now where all sand dredged from the channel is dumped back on the Bar adjacent to the channel, the specification for this Option was that all dredged sand was to be removed outside of the Bar area, at least 1km from the Entrance.

At the start of this Study, calculations were made of the total volume of sand that had accumulated in the area surrounding the Entrance since the Entrance was built. This was based on the difference between the historical records of the coastline before the Entrance was built and a Gippsland Ports survey undertaken in 2000. The volume increase was calculated at 14.75 million m³ (Attachment I). Most of this sand is in the form of growth to seaward of the beaches surrounding the Entrance.

Early in the Study it was agreed that it was impractical to consider returning the beach profiles to their pre Entrance alignments. (The up front capital cost would probably be in excess of \$70 million). Therefore, for the purpose of this Study, it was agreed that the following volumes should be used. They were calculated by Fleming and Ass. and based on Gippsland Ports survey data.

- a) Total volume of the offshore Bar compared to the existing immediate beach profiles, 3 million m³.
- b) Volume of the offshore Bar compared to the existing immediate beach profiles above a 5m datum, 750,000 m³.

The Consultants presented price estimates for one off major capital dredging programmes ranging from 850,000m³ to 3.2 million m³.

The consultants agreed that, as the majority of the 14.75 million m³ would remain in the immediate vicinity of the Entrance after the one off major capital dredging campaigns, these campaigns could only be considered as a precursor to additional maintenance dredging over the 20year period. As a result Option 4 Proposals are only discussed briefly.

Proposals 4A and 4B were prepared by Evers Consult, and are described in detail in Attachment IV. These were in fact Proposals for Option 5, however the Capital dredging costs and method as required for Option 4 can and have been extracted and are discussed briefly here.

Proposal 4C, 4D, 4E & 4F were prepared by Fleming & Ass. and are discussed in detail in Attachment V.

4.1 Technical.

- The Capital dredging cost estimates were for the removal of between 850,000m³ and 3.2 million m³. The former would provide a datum depth across the Bar of approximately 5m and the latter would remove the offshore Bar to the immediate adjacent beach profiles.
- For Proposals 4 & 5, Evers proposes dumping the sand either to the East or West of the Entrance and as close to the beach as practical. Fleming suggests dumping the sand in deep water to the South. Beach dumping is preferred as it does not require a deep water permit and does not remove sand from the beach system .
- Dredging would be carried out using an external contractor with a small hopper dredge for the lower quantity proposals plus a supporting medium hopper dredge for the 3million m³ plus proposals.
- Evers states that further capital or maintenance dredging would be required 3 years after completion of the 850,000 proposal and 5 years after the 3.2 million proposal. Fleming is not clear on this point but implies some additional dredging would be required within a year.
- As much of the Bar total sand volume remains in place, there will be a risk of local shoaling on the Bar, reducing the Port access depth below the target level during the 3 or 5year period.
- As agreed at the start of this Study, any recommendation for proposals arising from Options 4 or 5 would only be made in conjunction with the installation of a by-pass (Option 3). Whilst the by-pass will reduce the amount of sand deposited in the inside channels, sand would still be lifted into suspension by wave action on the remaining Bar and carried in through the Entrance channel on the incoming tidal flow. Dredging of the internal channels will therefore need to be continued. The cost of the Sandpiper in conjunction with the STS would need to be added to all of the Option 4 proposals.
- Fleming recommends the dredging of a turning circle for the dredges immediately inside the Entrance walls. Depending on the draught of the dredges used, this may need to be done for all of the Proposals except 5E.
- Fleming also proposes the use of the April Hamer for part of the Capital dredging campaign. This would not be operationally attractive as close co-ordination between Gippsland Ports and the Contractor would be essential if costly over runs were to be avoided.

4.5 Financial.

Stand-alone Capital Dredging.

	<u>Cost</u>	<u>Cost/m3</u>
Proposal 4A, dredge 850,000m ³	\$4,503,000	\$5.30
Proposal 4B, dredge 3,200,000m ³	\$13,211,000	\$4.13
Proposals 4C & D, dredge 3,000,000m ³	\$16,350,000	\$5.45
Proposals 4E & F, dredge 1,000,000m ³	\$13,211,000	\$9.30

OPTION 5, MAINTAIN AN IMPROVED CHANNEL THROUGH THE BAR.

This Option was specified to consider the outcomes from maintaining access to the port over the Bar by means of regular channel maintenance.

Two channel specifications were defined for consideration. The first for a channel similar to the current GP target of 3m (rarely achieved) and 80m wide but with an improved service level. The second specification was for a similar width but increased depth to 5m.

Unlike now where all sand dredged from the channel is dumped back on the Bar adjacent to the channel, the specification for this Option was that all dredged sand was to be removed outside of the Bar area, at least 1km from the Entrance.

Proposals 4A, 4B, 5A and 5B were prepared by Evers Consult, and are described in detail in Attachment IV.

Proposal 5C, 5D, 5H, 5I, 5J & 5K were prepared by Fleming & Ass. and are discussed in detail in Attachment V.

Proposal 5E was prepared by Slurry Systems Marine Pty. Ltd and is discussed in detail in Attachment VII.

5.1 Technical

- All of the Option 5 Proposals considered in detail, with the exception of Proposal 5J, 5K & 5F, are based on carrying out an initial capital dredging campaign followed by annual or bi-annual campaigns over the 20 year time frame,
- As agreed at the start of this Study, any recommendation for proposals arising from Options 4 or 5 would only be made in conjunction with the installation of a by-pass (Option 3). Whilst the by-pass will reduce the amount of sand deposited in the inside channels, sand would still be lifted into suspension by wave action on the remaining Bar and carried in through the Entrance channel on the incoming tidal flow. Dredging of the internal channels will therefore need to be continued. The cost of the Sandpiper in conjunction with the STS has been added to all of the proposals where relevant in order to simplify price comparisons.
- **Proposal 4A** is based on initial Capital dredging of 850,000m³ from the top of the Bar, producing minimum water depth of 5m at datum and followed after 3 years by 17 annual campaigns each removing 200,000m³.

- The dredged sand would be deposited either to the East or West of the Entrance and as close to the beach as practical.
- Dredging would be carried out by an external contractor using a small hopper dredge.
- Over the 20year time frame, the net volume of sand removed with this proposal will be,

Total dredged by contractor	+4,250,000
Total accretion	- 2,000,000
<u>Total by-passed</u>	<u>+4,000,000</u>
<u>Net volume dredged from Bar system.</u>	<u>+6,250,000m3</u>

- **Proposal 4B** is based on initial Capital dredging of 3.2 million m³ reducing the Bar to the immediate adjacent beach profiles. This would be followed after 5 years by 15 annual campaigns each removing 200,000m³
 - The dredged sand would be deposited either to the East or West of the Entrance and as close to the beach as practical.
 - Dredging would be carried out by an external contractor using a small and a medium hopper dredge for the capital dredging and a small dredge for the annual campaigns.
 - Over the 20year time frame, the net volume of sand removed with this proposal will be,

Total dredged by contractor	+6,200,000
Total accretion	- 2,000,000
<u>Total by-passed</u>	<u>+4,000,000</u>
<u>Net volume dredged from Bar system.</u>	<u>+8,200,000m3</u>

Proposal 5A provides a cost and method to meet the required channel specification of 3m deep by 80m wide. The costing has been done based on an external contractor using a small hopper dredge permanently based at the Port. The proposal clearly shows that this does not make economic sense. The reason for this is due to a number of factors.

- The size of the hopper dredge proposed is dictated by the sea conditions that the vessel will need to contend with on the Bar.
- A vessel of this size is much larger than is required for the volumes involved in maintaining the proposed channel.
- To meet the specification the owner could not deploy the dredge elsewhere. As a result the dredge will spend much of its time idle and at a high cost.

This Proposal is not considered further

Proposal 5B provides a cost and method description to meet the required channel specification of 5m deep by 80m wide. The Proposal is similar to Proposal 5A in that it uses an external contractor using a small hopper dredge but based at the Port only for the initial phase of the project. This enables the contractor to utilise the dredge on other work at a significantly lower cost to Proposal 5A.

- The same size hopper dredge is used as for Proposal 4A above and for the same reasons.

- The dredge is used to its optimum for the initial Capital dredging task, operating 24hrs per day over a period of 4.2 weeks and removing 125,000 m³.
- The next phase will have the dredge remain on station for a further 62 weeks but operating a 50hr, 5day week. During this time the dredge is expected to remove 625,000m³ from the Bar. This is much more than needed to maintain the specified channel but Evers claims that in doing so a buffer is created enabling the dredge to be deployed elsewhere until needed for periodic maintenance in phase 2.
- Phase 2 commences at year 4 and comprises 16 annual campaigns of 5 weeks, removing 200,000m³ at each campaign.
- Whilst the method is slightly different, the outcome is very similar to Proposal 4A.
- Over the 20year time frame, the net volume of sand removed with this proposal will be,

Total dredged by contractor	+4,100,000
Total accretion	- 2,000,000
<u>Total by-passed</u>	<u>+4,000,000</u>
<u>Net volume dredged from Bar system.</u>	<u>+6,100,000m³</u>
- **Proposal 5C** is based on initial Capital dredging of 3 million m³ reducing the Bar to the immediate adjacent beach profiles. This would be followed by bi-annual dredging campaigns each campaign removing 130,000m³ to maintain a channel through the Bar of 5x80m. Fleming does not state when the bi-annual dredging should commence, so year 6 has been used in order to make comparisons with other proposals possible.
 - Fleming suggests dumping the sand to the South. Beach dumping is preferred as it does not require a deep water permit and does not remove sand from the beach system.
 - Dredging would be carried out by an external contractor using a small and a medium hopper dredge assisted by the April Hamer for the capital dredging and a small hopper dredge for the bi-annual campaigns. Using the April Hamer would not be operationally attractive as close co-ordination between Gippsland Ports and the Contractor would be essential if costly over runs were to be avoided.
 - Over the 20year time frame, the net volume of sand removed with this proposal will be,

Total dredged by contractor	+6,900,000
Total accretion	- 2,000,000
<u>Total by-passed</u>	<u>+4,000,000</u>
<u>Net volume dredged from Bar system.</u>	<u>+8,900,000m³</u>
- **Proposal 5D** is similar to Proposal 5C but in this case a channel of 3x80m is maintained requiring only annual 130,000m³ maintenance campaigns. As with 5C these would also commence in year 6 in order to make comparisons with other proposals possible.
 - Fleming suggests dumping the sand to the South. Beach dumping is preferred as it does not require a deep water permit and does not remove sand from the beach system.

- Dredging would be carried out by an external contractor using a small and a medium sized hopper dredge assisted by the April Hamer for the capital dredging and a small hopper dredge for the bi-annual campaigns. Using the April Hamer would not be operationally attractive as close co-ordination between Gippsland Ports and the Contractor would be essential if costly over runs were to be avoided.
- Over the 20year time frame, the net volume of sand removed with this proposal will be,

Total dredged by contractor	+4,950,000
Total accretion	- 2,000,000
<u>Total by-passed</u>	<u>+4,000,000</u>
<u>Net volume dredged from Bar system.</u>	<u>+6,950,000m³</u>

Proposal 5E by Slurry Systems is different to all other proposals in that it is based on continuous maintenance of a channel through the Bar using equipment permanently based at the Port rather than periodic bulk dredging using remotely based dredges. The proposal provides cost and method description to meet the required channel maintenance specification of 3m deep by 80m wide but with the ability to increase channel depth if required. The costing has been done based on a barge capable of operating on the Bar and fitted with a Slurry Systems Sand Shifter unit identical in method of operation to that used for the By-pass. When not operating on the Bar the barge would be used on internal channel maintenance, thus replacing the Sandpiper. The Proposal costs are inclusive of the cost of operating the By-pass and the dredging of the internal channels. This Proposal offers much more than the specification requirements.

- In this situation, the dredge barge suggested in the Proposal has a number of advantages over more conventional dredging devices.
 1. The drag arms of the April Hamer and the trailing arm suction hopper dredges suggested by the consultants are prone to damage in rough weather due to the semi rigid nature of their construction. Whereas with the Slurry Systems barge, the dredge head is connected to the barge only by flexible hoses and cables.
 2. The width and fluidising design of the dredge head of the SSSS is more efficient and has a wider sweep area than that of the trailer suction dredges of similar capacity.
 3. The capital investment in the barge is significantly less than a hopper dredge.
 4. It can operate in much shallower water than the hopper dredges proposed by the consultants.
- The barge will discharge the dredged sand via floating/submerged hoses to the STS for disposal to the Eastern or Western beaches.
- When weather conditions are unsuitable for dredging on the Bar or the channel is to specification, the barge can be used on internal channel maintenance, connecting directly to the existing STS pipe network.
- The barge is capable of dredging to a depth of 12m if required.

- The barge is capable of operating on the Bar in wave conditions up to 1.5m.
- The barge can dredge up to 300m³/hr and remove 2,200m³ of sand in an average 12hr shift. This compares with the required rate calculated by computer modelling of 1,200m³/24 hrs.
- Over the 20year time frame, the minimum net volume of sand removed with this proposal will be,

Total dredged by contractor	+4,000,000
Total accretion	- 2,000,000
<u>Total by-passed</u>	<u>+4,000,000</u>
<u>Net volume dredged from Bar system.</u>	<u>+6,000,000m³</u>

Note. **The Slurry Systems price also includes the cost of removing 100,000m³ from the internal channels.**

- **Proposal 5H** is similar to Proposal 5C but in this case the initial capital dredging is reduced to 1 million m³ and the bi-annual dredging is increased to 200,000m³ per campaign. These would commence in year 4 in order to make comparisons with other proposals possible.
 - Fleming suggests dumping the sand to the South. Beach dumping is preferred as it does not require a deep water permit and does not remove sand from the beach system.
 - Dredging would be carried out by an external contractor using a small hopper dredge
 - Over the 20year time frame, the net volume of sand removed with this proposal will be,

Total dredged by contractor	+7,400,000
Total accretion	- 2,000,000
<u>Total by-passed</u>	<u>+4,000,000</u>
<u>Net volume dredged from bar system.</u>	<u>+9,400,000m³</u>
- **Proposal 5I** is similar to Proposal 5D but in this case the initial capital dredging is reduced to 1 million m³ and the annual dredging campaigns are increased to 200,000m³ per campaign. These would commence in year 4 in order to make comparisons with other proposals possible.
 - Fleming suggests dumping the sand to the South. Beach dumping is preferred as it does not require a deep water permit and does not remove sand from the beach system.
 - Dredging would be carried out by an external contractor using a small hopper dredge.
 - Over the 20year time frame, the net volume of sand removed with this proposal will be,

Total dredged by contractor	+4,200,000
Total accretion	- 2,000,000
<u>Total by-passed</u>	<u>+4,000,000</u>
<u>Net volume dredged from Bar system.</u>	<u>+6,200,000m³</u>

- **Proposal 5J** is based on an initial dredging of 153,000m³ followed immediately by the first of 20 annual dredging campaigns of 500,000m³. This proposal aims at maintaining a channel 5m deep x 80m wide
 - Fleming suggests dumping the sand to the South. Beach dumping is preferred as it does not require a deep water permit and does not remove sand from the beach system.
 - Dredging would be carried out by an external contractor using a small hopper dredge.
 - Over the 20year time frame, the net volume of sand removed with this proposal will be,

Total dredged by contractor	+10,153,000
Total accretion	- 2,000,000
<u>Total by-passed</u>	<u>+4,000,000</u>
<u>Net volume dredged from Bar system.</u>	<u>+12,153,000m³</u>

- **Proposal 5K** is similar to Proposal 5J but in this case a channel of 3x80m is maintained requiring only initial dredging of 45,000m³ followed by 20 annual 300,000m³ maintenance campaigns.
 - Fleming suggests dumping the sand to the South. Beach dumping is preferred as it does not require a deep water permit and does not remove sand from the beach system.
 - Dredging would be carried out by an external contractor using a small hopper dredge
 - Over the 20year time frame, the net volume of sand removed with this proposal will be,

Total dredged by contractor	+6,045,000
Total accretion	- 2,000,000
<u>Total by-passed</u>	<u>+4,000,000</u>
<u>Net volume dredged from Bar system.</u>	<u>+8,045,000m³</u>

5.2 Social/Economic.

See Section C above and Attachment VIII

5.3 Environmental.

All of the proposals presented in this Study are in effect different ways of moving the sand, which has accumulated in the shipping channels, back to the beach system from which it came.

During the preparations for installing the STS, Gippsland Ports discussed the issue of dumping the dredged sand from around the Entrance with both the Federal and State EPA.

- The Federal EPA advised that dredging the sand in question on to or close to the beach as proposed for the STS did not require a permit and was a matter for the State EPA.
- The State EPA advised that dredging the sand in question on to or close to the beach as proposed for the STS did not require a permit and complied with the State Dredging Protocol.

For more details on dredging permit regulations see Appendix B of Attachment V.

5.4 Risk.

- Proposals 4A, 4B, 5A, 5B, 5C, 5D, 5H & 5I.
As most of the 14.75 million m³ will remain after the capital dredging, there will be a risk of significant shoaling on the bar during the period between the capital dredging and the commencement of the periodic maintenance campaigns and between the periodic maintenance campaigns themselves.
- All Proposals other than Proposal 5E.
As there will be no locally based dredging equipment capable of operating on the Bar, there will be a risk of Port closure or restricted access due to shoaling on the Bar between the periodic maintenance campaigns. It is unlikely that the contractor will have suitable equipment available on call to deal with such an event.
- Unless locally based on-call dredging equipment is retained to cope with shoaling of internal channels between campaigns, any improved access across the Bar could be negated.
- All Proposals other than Proposal 5E.
Due to the low numbers of hopper dredges in Australia, there will be a risk that the vessel may be unable to meet its scheduled periodic maintenance dates. Having Failure to Show financial penalty clauses in the Contract will not keep the Port open.

- Option 5E.
Slurry Systems propose having two barges capable of carrying out the proposed dredging, both permanently based at Lakes Entrance.

5.5 Financial.

See Section D below.

5.6 Other Proposals Considered

- **Proposal F.** Use of dumb hopper barges in conjunction with a modified April Hamer.

With this system, the April Hamer would discharge its dredged spoil into a hopper barge moored alongside. When full, a tug would take the barge to a site away from the Bar and dump the sand. The tug would return the empty barge to the April Hamer to repeat the exercise.

Whilst this proposal overcomes the problems that the April Hamer does not remove any sand from the Bar and is inefficient in removing sand from the channel, there are many disadvantages.

- None of the other operational disadvantages of the April Hamer are removed.
- The April Hamer would have to stop dredging when the barge is full and whilst the tug takes the barge to the dump-site and returns. Or in the case where two barges are used, whilst the tug brings the empty barge alongside and picks up the full barge from the other side of the dredge.
- The April Hamer dredge discharge system would require redesign and modification.
- A tug-boat large enough to manoeuvre the fully laden barge in operational sea conditions on the Bar would need to be acquired.
- One and possibly two hopper barges will need to be acquired.
- There would be the additional operating and maintenance cost of a tug and one or two hopper barges plus at least two additional crew to operate the tug and barge(s).

For these reasons, no further consideration of this proposal has been undertaken.

- **Proposal G.** Re-install the April Hamer Pump Ashore Capability.

The April Hamer was designed and built with a pump ashore capability. However the equipment was removed and disposed of shortly after the vessel was purchased. This capability could be reinstalled. This would theoretically enable the vessel to pump its spoil through a long discharge line outside of the Bar area or to the eastern or western beaches via the STS, as in proposal G.

Whilst this proposal overcomes the problems that the April Hamer does not remove any sand from the Bar and is inefficient in removing sand from the channel, there are many disadvantages.

- There would be a significant cost to redesign and install the modifications to the April Hamer.
- The production rate through the pumps compared to now would be reduced due to the higher discharge impedance.
- The set-up and shutdown time each day would be significant and not economically viable. New rostering and manning arrangements would need to be introduced to optimise good weather periods to enable 24hr a day working. Then there is the problem of what to do with these increased crew numbers when weather prevents dredging operations.
- None of the other operational disadvantages of the April Hamer are removed.

For these reasons, no further consideration of this proposal has been undertaken.

D. Financial.

Table D1 shows a summary of the total cost over 20 years for the Current Gippsland Ports Entrance dredging activities plus those for Options 1, 2 and 3. The costs are all at present day values and exclude GST. No escalation has been included in the costs with one exception, that being a 5% annual real increase in the cost to maintain the April Hamer in Option 2.

The total forecast cost for Gippsland Ports to maintain the Bar and internal channels using their current equipment for the next 20 years is \$42.6 million. This amount is used as a base by which all Options/Proposals are compared.

An estimate of the cost to dispose of the April Hamer and Sandpiper have been made and used in preparing net costs where Proposals offer alternatives.

Table D2 shows the summary costs of all the Proposals considered in detail for Option 5. The costs are all at present day values and exclude GST. The bottom line shows the Cost Variance for each Proposal, ie the additional or reduced cost resulting from the adoption of the Proposal

The budget costs put forward by the two dredge consultants vary considerably, ranging from \$33 million to \$77 million. Most of the variation arises from a difference between the consultant's estimates of the dredging quantities required for the periodic maintenance campaigns. As both the quantities dredged and the period between the campaigns can be varied without significantly effecting the \$ rate per m³, the consultants estimated prices have been amended to bring all Proposals into line with respect to the 20 year dredged volume, that being 4 million m³ as estimated for Proposal 5E. The effect of this 'equalisation' is shown in the Corrected Total collum. Equalisation has two effects. It reduces all of the Proposal total costs and it significantly reduces the variation between them. The remaining variance equate almost entirely to the different effective dredging rates per m³ offered.

Proposal 5E is by far the lowest cost and is the only one that produces an outcome at less than the current cost. The saving of \$5.2 million over 20 years is \$18.4 million better than the lowest corrected Proposal, 4B and the average dredging rate is \$4.38/m³ compared to the lowest alternative Proposal, 4b at \$6.25/m³ and the average for all other Proposals of \$7.64/m³.

There are a number of reasons why this Proposal is so much lower than any other.

- The capital cost of the dredge barge is very much lower than the hopper dredges used in all the other Proposals. This impacts significantly on the depreciation cost which obviously form part of the prices quoted.
- The dredge barge is much simpler than the hopper dredges and therefore has much lower operating and maintenance costs.
- All of the other Proposals involve significant costs for mobilisation and demobilisation for each separate campaign.
- The dredging process is more efficient than the hopper dredges. The sand is pumped via the STS directly to the disposal site as it is dredged. The hopper

dredges have to cease dredging when the hopper is full, steam to the disposal site then back to the dredge site.

- Proposal 5E includes the operation of the by-pass and the dredging of the internal channels, neither of which are included in any of the other Proposals. Significant economies of scale, effective utilisation of plant and people are achieved by the contractor.

Table D1 **SUMMARY OF OPTION 1, 2, & 3 COSTS**

		\$x1,000		
		Expense	Capital	Total
D1a	April Hamer. Cost to continue as now			
	a AH Recurrent Expense (average over past 3 years)	27,480	0	27,480
	b Refit costs (average over past 7 years + inc. @ 5% pa)	<u>6,679</u>	<u>0</u>	<u>6,679</u>
	c Total AH operating cost	<u>\$34,159</u>	<u>\$0</u>	<u>\$34,159</u>
D1b	Internal channel maintenance. Cost to continue as now			
	a Sandpiper operating cost	6,640	0	6,640
	b STS, 100,000m3 pa	<u>1,780</u>	<u>0</u>	<u>1,780</u>
	c Total Internal channel Maintenance cost	<u>\$8,420</u>	<u>\$0</u>	<u>\$8,420</u>
D1c	a T.cost to G.Ports to Maintain Bar and Internal Channels As Now	<u>\$42,579</u>	<u>\$0</u>	<u>\$42,579</u>
D1d	Cost to Close Down April Hamer			
	a Crew retrenchment	350	0	350
	b Vessel selling expense	<u>70</u>	<u>0</u>	<u>70</u>
	c Total	<u>\$420</u>	<u>\$0</u>	<u>\$420</u>
D1e	Cost to close down Sandpiper			
	a Crew retrenchment	<u>\$80</u>	<u>\$0</u>	<u>\$80</u>
OPTION				
1	Do Nothing			
	a Save A.Hamer Operating Cost. Line A.c above.	-34,159	0	-34,159
	b Add Cost to Close Down A:Hamer. Line D.c above	420	0	420
	c Continue with Internal Channel Maintenance. Line B.c above	<u>8,420</u>	<u>0</u>	<u>8,420</u>
	d Net Total for Option 1	<u>-\$25,319</u>	<u>\$0</u>	<u>-\$25,319</u>
2	Continue as Now			
	a Total Cost to G.Ports. Line C.a above	<u>\$42,579</u>	<u>\$0</u>	<u>\$42,579</u>
3	Cost to Add Dual By-pass			
3A	G.Ports to Operate, S.Systems to Own & Maintain By-pass			
	a Capital additions to STS	0	1,775	1,775
	b GP operate, direct costs	3,100	0	3,100
	c Costs from SS, based on 200,000m3/annum	<u>18,500</u>	<u>0</u>	<u>18,500</u>
	d Total Cost for G.Ports to Operate	<u>\$21,600</u>	<u>\$1,775</u>	<u>\$23,375</u>
3B	Slurry Systems to Operate & Maintain By-pass & STS			
	a Additions to STS	0	1,775	1,775
	b GP operate, direct costs	0	0	0
	c Costs from SS, based on 200,000m3/annum	<u>21,280</u>	<u>0</u>	<u>21,280</u>
	d T.Cost for S.Systems to Operate & Maintain By-pass & STS	<u>\$21,280</u>	<u>\$1,775</u>	<u>\$23,055</u>

Table D2**SUMMARY OF PROPOSAL COSTS****\$x1,000**

Proposal Number	4A				4B			
	Expense	Capital	Total	Cor.Total	Expense	Capital	Total	Cor.Total
Cost as Quoted	29,091	4,353	33,444	\$31,477	25,786	12,961	38,747	\$24,998
Plus A.Hamer Disposal	420	0	420	420	420	0	420	420
<u>Plus Internal Channel Maintenance Cost</u>	8,420	0	8,420	8,420	8,420	0	8,420	8,420
Total Cost of Proposal	37,931	4,353	42,284	\$40,317	34,626	12,961	47,587	\$33,838
<u>GP Cost Now</u>	42,579	0	42,579	42,579	42,579	0	42,579	42,579
Variance, (+ve unfavourable, -ve favourable)	-4,649	4,353	-296	-\$2,263	-7,953	12,961	5,007	-\$8,741
Add Cost of By-pass	21,280	1,775	23,055	23,055	21,280	1,775	23,055	23,055
<u>Less one person from STS/Sandpiper</u>	-1,100	0	-1,100	-1,100	-1,100	0	-1,100	-1,100
T. Cost Variance of Proposal + By-pass	\$ 15,531	\$ 6,128	\$21,659	\$19,692	\$12,227	\$14,736	\$26,962	\$13,214

Proposal Number	5A			5B			
	Expense	Capital	Total	Expense	Capital	Total	Cor.Total
Cost as Quoted	103,750	676	104,426	27,388	8,004	35,392	\$34,529
Plus A.Hamer Disposal			"	420	0	420	420
<u>Plus Internal Channel Maintenance Cost</u>			"	8,420	0	8,420	8,420
Total Cost of Proposal				36,228	8,004	44,232	\$43,369
<u>GP Cost Now</u>				42,579	0	42,579	42,579
Variance, (+ve unfavourable, -ve favourable)				-6,351	8,004	1,653	\$789
Add Cost of By-pass				21,280	1,775	23,055	23,055
<u>Less one person from STS/Sandpiper</u>				-1,100	0	-1,100	-1,100
T. Cost Variance of Proposal + By-pass	\$ -	\$ -	\$ -	\$13,829	\$9,779	\$23,608	\$22,744

Table D2 (cont)

Proposal Number

Cost as Quoted

Plus A.Hamer Disposal

Plus Internal Channel Maintenance Cost

Total Cost of Proposal

GP Cost Now

Variance, (+ve unfavourable; -ve favourable)

Add Cost of By-pass

Less one person from STS/Sandpiper**T. Cost Variance of Proposal + By-pass**

	5C				5D			
	Expense	Capital	Total	Cor.Total	Expense	Capital	Total	Cor.Total
Cost as Quoted	34,900	14,450	49,350	\$28,608	18,400	14,450	32,850	\$26,545
Plus A.Hamer Disposal	420	0	420	420	420	0	420	420
<u>Plus Internal Channel Maintenance Cost</u>	8,420	0	8,420	8,420	8,420	0	8,420	8,420
Total Cost of Proposal	43,740	14,450	58,190	\$37,448	27,240	14,450	41,690	\$35,385
<u>GP Cost Now</u>	42,579	0	42,579	42,579	42,579	0	42,579	42,579
Variance, (+ve unfavourable; -ve favourable)	1,161	14,450	15,610	-\$5,131	-15,339	14,450	-890	-\$7,194
Add Cost of By-pass	21,280	1,775	23,055	23,055	21,280	1,775	23,055	23,055
<u>Less one person from STS/Sandpiper</u>	-1,100	0	-1,100	-1,100	-1,100	0	-1,100	-1,100
T. Cost Variance of Proposal + By-pass	\$21,341	\$16,225	\$37,565	\$16,824	\$4,841	\$16,225	\$21,065	\$14,761

Proposal Number

Cost as Quoted

Plus A.Hamer Disposal

Plus Internal Channel Maintenance Cost

Total Cost of Proposal

GP Cost Now

Variance, (+ve unfavourable; -ve favourable)

Add Cost of By-pass

Less one person from STS/Sandpiper**T. Cost Variance of Proposal + By-pass**

	5H				5I			
	Expense	Capital	Total	Cor.Total	Expense	Capital	Total	Cor.Total
Cost as Quoted	50,560	9,100	59,660	\$32,249	25,280	9,100	34,380	\$32,743
Plus A.Hamer Disposal	420	0	420	420	420	0	420	420
<u>Plus Internal Channel Maintenance Cost</u>	8,420	0	8,420	8,420	8,420	0	8,420	8,420
Total Cost of Proposal	59,400	9,100	68,500	\$41,089	34,120	9,100	43,220	\$41,583
<u>GP Cost Now</u>	42,579	0	42,579	42,579	42,579	0	42,579	42,579
Variance, (+ve unfavourable; -ve favourable)	16,821	9,100	25,921	-\$1,491	-8,459	9,100	641	-\$996
Add Cost of By-pass	21,280	1,775	23,055	23,055	21,280	1,775	23,055	23,055
<u>Less one person from STS/Sandpiper</u>	-1,100	0	-1,100	-1,100	-1,100	0	-1,100	-1,100
T. Cost Variance of Proposal + By-pass	\$37,001	\$10,875	\$47,876	\$20,464	\$11,721	\$10,875	\$22,596	\$20,959

Table D2 (cont.)

Proposal Number	5J				5K			
	Expense	Capital	Total	Cor.Total	Expense	Capital	Total	Cor.Total
Cost as Quoted	76,000	1,300	77,300	\$30,454	50,000	550	50,550	\$33,449
Plus A.Hamer Disposal	420	0	420	420	420	0	420	420
<u>Plus Internal Channel Maintenance Cost</u>	8,420	0	8,420	8,420	8,420	0	8,420	8,420
Total Cost of Proposal	84,840	1,300	86,140	\$39,294	58,840	550	59,390	\$42,289
<u>GP Cost Now</u>	42,579	0	42,579	42,579	42,579	0	42,579	42,579
Variance, (+ve unfavourable, -ve favourable)	42,261	1,300	43,561	-\$3,285	16,261	550	16,811	-\$290
Add Cost of By-pass	21,280	1,775	23,055	23,055	21,280	1,775	23,055	23,055
<u>Less one person from STS/Sandpiper</u>	-1,100	0	-1,100	-1,100	-1,100	0	-1,100	-1,100
T. Cost Variance of Proposal + By-pass	\$62,441	\$3,075	\$65,516	\$18,670	\$36,441	\$2,325	\$38,766	\$21,665

Proposal Number	5E		
	Expense	Capital	Total
Cost as Quoted by Slurry Systems	33,300	1,775	35,075
Plus A.Hamer Disposal	420	0	420
<u>Plus Sandpiper Disposal</u>	80	0	80
Total Cost of Proposal	33,800	1,775	35,575
<u>GP Cost Now</u>	42,579	0	42,579
Variance, (+ve unfavourable, -ve favourable)	-8,779	1,775	-7,004
Add Cost of By-pass	0	1,775	1,775
	0	0	0
T. Cost Variance of Proposal + By-pass	-\$8,779	\$3,550	-\$5,229