

Report on the development of Badgee Lagoon, Sussex Inlet, NSW. January 1967.

Author:

Hattersley, R. T.

Publication details:

Report No. UNSW Water Research Laboratory Report No. 92

Publication Date:

1967

DOI:

<https://doi.org/10.4225/53/57999bdd008d8>

License:

<https://creativecommons.org/licenses/by-nc-nd/3.0/au/>

Link to license to see what you are allowed to do with this resource.

Downloaded from <http://hdl.handle.net/1959.4/56251> in <https://unsworks.unsw.edu.au> on 2024-03-29

The quality of this digital copy is an accurate reproduction of the original print copy

SIT

set 2

REPORT ON THE DEVELOPMENT OF BADGEE LAGOON
SUSSEX INLET, N. S. W., FOR RESIDENTIAL WATERFRONT
DEVELOPMENT.

by

. R. T. Hattersley

Report No. 92

January, 1967.

Preface.

The material for this report was compiled during research and investigation by the author of coastal lagoon and inlets in New South Wales.

This report in this instance contains specific reference to the question of residential development of Badgee Lagoon compiled by the author from comprehensive field and laboratory studies of the Sussex Inlet, St. Georges Basin area carried out for Unisearch Ltd. on behalf of Paradise Lagoon Pty. Ltd.

The main report is in course of preparation at the date of issue of this report.

R. T. Hattersley,
Senior Lecturer in Civil Engineering,
Officer-in-Charge.

Contents.

Page No.

Preface

1. Introduction	1.
2. Existing Canal	2.
3. Conditions in Existing Canal	2.
4. Salinity	3.
5. Proposal to develop Badgee Lagoon	4.
6. Model Test	5.
7. Observations of the Model	5.
8. Modification of Canal System	6.
9. Further Investigations	7.
10. Channel Velocities	8.
11. Modifications to Existing Canal	8.
12. Conclusion and Recommendation	9.

1. Introduction

The Director of Paradise Lagoon Project in a letter dated 1st April, 1966, referred to a question of developing the island fronting Badgee Lagoon known as area "C" on Provisional Layout Drawing No. B. 1-677A. The drawing is by Cardno and Davies, Consulting Engineers to the Company of Brisbane and Sydney.

The drawing represents a plan of a region bounded generally by Sussex Inlet Road and Chris Creek on the South, Sussex Inlet Village on the North and East and Badgee Lagoon on the North West.

Area "C" being part of the whole development bounded by an existing subdivision fronting Jacobs Drive on the South and Badgee Lagoon on the North West. The existing subdivision adjoins an artificial dredged canal which terminates parallel to Jacobs Drive in a dead end, approximately 2,800' west of Wunda Avenue.

Area "C" is additional to the land proposed for canal type residential development on which the author was requested to report on behalf of Unisearch Ltd. in arrangements with Paradise Lagoon Pty. Ltd. earlier.

The technical investigation on the whole scheme is still proceeding and covers many aspects of the developmental works on the Sussex Inlet area including such matters as circulation of tidal flows, flooding, pollution and ecological aspects. It is intended that these aspects will be dealt with in due course in a comprehensive report by the author for Unisearch Ltd.

In a letter dated 11th January 1966, Messrs. Cardno and Davies referred the following decision of the Shoalhaven Shire Council affecting Area "C", to the writer for consideration of the aspects of tidal circulation: -

"Prior to any report being made to Council, it is requested that you furnish proof that the proposed canals north of Jacobs Drive will circulate water under tidal influence alone. It is appreciated that the water will rise and fall under the influence of tidal action from both inlets to Badgee Creek but it is not clear if

any circulation will be set up due to the presence of the "equaliser culvert".

To meet the request of Paradise Lagoon Pty. Ltd. it is proposed to report separately on the limited aspects of circulation in the Badgee Lagoon area and refer only to the main development scheme where such comment is relevant to the development of Area "C".

2. Existing Artificial Canal

It is proposed that the canal be extended and additional dredging be completed in Badgee Lagoon using the material obtained from the deepening of the Lagoon to raise the level of the area lying between the North side of the canal and the Lagoon and so render the reclaimed land suitable for residential occupation.

3. Conditions in the Existing Canal

It has been in existence in its present form for approximately 11 years although it is only in recent years there has been extensive occupation of the allotments facing Jacobs Drive.

The author observed superficially conditions in the canal since December 1960 again in February 1964 and more recently in November 1965 and August 1966.

Prior to general occupation of the southern side of the canal growth of rushes were observed, but little bottom sediment had accumulated, marine growth was generally absent. This condition existed in February, 1964.

In August, 1966, an inspection of the canal showed certain significant changes. Measurements were made of salinity samples of marine growth and algae were collected. Growth of rushes previously in evidence was generally absent except at the head of the canal.

In the early years, the original subdivision remained largely unoccupied but in more recent years more houses have been erected and the southern shore of the canal is now occupied mainly by holiday cottages.

Deposition of fine sediment of organic origin is evident on the bottom and sides of the canal. At the entrance near the Bridge over Badgee Lagoon weed growth of the variety of *Zostera* which is common in other parts of Sussex Inlet was observed. Halfway towards the head of the Canal this plant was observed in patches.

Samples of plant growth taken from the head of the canal included a variety of *Halophila* but no *Zostera*. *Halophila* has been noted to favour deep and muddy conditions. Considerable growth of various types of algae were noted. The growth of floating algae appeared, at the head of the canal, to be reaching a noxious extent. Under stagnant conditions, the relatively small turbidity of the water admits light freely, so contributes towards accelerated photo synthesis of algae. Algae growth, if unchecked, could intensify the stagnant conditions and could encourage dissolved oxygen depletion in the water. If nothing is done to improve circulation at the head of the canal objectionable conditions arising in future summer periods appear imminent.

4. Salinity

No heavy rainfall was experienced immediately prior to the visit in August, 1966, and salinity measurements taken by means of hydrometer showed a difference of 1 to 2 parts per 1000 between the bottom and the surface water indicating a slight amount of stratification. The readings indicated that mixing processes between top and bottom layers is only slight and that wind-wave action is negligible. Similar readings taken in the Sussex Inlet channels and in St. Georges Basin beyond the "drop over" from the inlet showed the salinity to be the same at the surface and the bottom.

Salinity of the surface water at the head of the canal was read subsequently to approximately 60 points of overnight rain and at the next high tide.

The salinity difference between surface and bottom then reached 3 parts per 1000. Similar measurements at the same time in the inlet channels showed again no observable difference as also did readings taken in Badgee Lagoon itself.

The evidence of the sediment, algae growth and salinity

measurements show that tidal influence on the mixing of water at the head of the existing canal works is weak and there are indications that the build-up of organic bottom sediments and algae growth is likely to continue.

5. Description of Proposal to Develop Badgee Lagoon

The proposal by Paradise Lagoon Pty. Ltd. to develop the area fronting Badgee Lagoon entails connection of the head of the existing canal with the southern most portion of Badgee Lagoon by means of a curved canal with a narrow length to provide for a bridge crossing from the eastern bank of the existing canal to the island formed in Badgee Lagoon by the Canal system. The provision on the connecting canal and the narrowed section do not in themselves provide a means of inducing a satisfactory circulation in the canal system, essential adequate mixing of the water layers and cleansing of the canal system.

The surface area of Badgee Lagoon is relatively large by comparison with the canal surface area. Records of tidal water surface changes taken by the Water Research Laboratory show that for a tidal range for a 5 foot tide range at sea near the entrance of Sussex Inlet is about eight inches in Badgee Lagoon for spring tides.

The tidal prism, that is the volume of water flowing in and out of Badgee Lagoon for each high tide has been calculated from the gaugings and information on existing maps to be about 732,000 cubic feet.

By placing a controlling levee at the entrance of Badgee Lagoon, part of the tidal storage of Badgee Lagoon may be filled via the existing canal and its extension.

It is proposed that the levee constructed of sand dredged from the lagoon be extended to a height approximately 2 feet above mean high water on ordinary spring tides. The entrance will require stabilisation with concrete sheeting, rubble or similar construction. It is proposed that the entrance be approximately 15 feet wide at the surface, a width which is sufficient to allow boats of the kind normally used in Sussex Inlet to pass through.

6. Model for Test of Circulating Flow

To examine qualitatively the distribution of flow in the proposed canal, a tidal model was constructed in simplified form having a horizontal scale of 1 to 2,400 and a vertical scale of approximately 1 to 50 based on a tide rise of $\frac{1}{2}$ foot.

Because of lack of detailed data on the channel cross sections, the model was initially constructed with rectangular cross sections but this discrepancy will not affect the results significantly. The combination of horizontal scale 1 to 2,400 and vertical scale 1 to 50 yields a tidal period for the model equivalent to the natural semi diurnal tide of slightly more than 1 minute. Since the time of rise and of spring tides in Sussex Inlet is slightly less than 6 hours, as observed, a period of 1 minute was adopted for the model and a mechanism designed and built accordingly.

The model is illustrated in Figure 1. The movement of the water in the model was observed by sprinkling isolated particles of potassium permanganate on the bottom of the model which dissolved slowly in the flowing water producing dye trails and by sprinkling aluminium powder on the surface. The movement of the powder indicated the surface flows.

7. Observations of the Model

Existing Conditions

The model was operated in the first stages of the test programme with no control levee across the entrance of Badgee Lagoon but the existing canal was extended and connected to the south western extremity of the Badgee Lagoon.

The tidal inflow via the Badgee Bridge opening was observed as it occurs at present both along the Badgee Canal and into the Lagoon. The velocity of inflow to the canal was at a maximum at the entrance. It was zero at the head of the existing canal. The inflow to the lagoon occurred in a spreading fashion and little current movement occurred at the head of the lagoon. The connecting canal section between the canal and Badgee Lagoon was then made in the model but this in itself did nothing to improve the water movement at the head of the lagoon or the canal.

Another test was conducted with a salt solution of strength approximating that of sea water coloured with dye. The solution was fed from the tide generator starting from a low water condition in the model of the lagoon. The salt solution was seen to penetrate beneath the fresh water in the canal section lifting it without disturbing it until the high water condition was reached. Several tidal cycles were required to achieve transference and mixing of the salt water with the fresh by diffusion processes. In the small scale model the diffusion and entrainment processes were not truly represented to scale.

In the full scale channel the effects of stratification would persist over a greater number of tidal cycles.

Therefore it would be expected that less saline water collecting from ground water or storm run-off would tend to stagnate at the end of the existing canal. This is partly confirmed by salinity readings referred to in Part 4 of this report.

In the open lagoon surface because of the shallow water and the broad expanse of surface, stratification would be less persistent. Wind and wave action at the surface would be more intense than in the sheltered canal region. This would contribute to the mixing and maintenance of the dissolved oxygen balance in the water in the lagoon.

8. Modification of Canal System

As described under Section 5 a levee construction is proposed to control the direct influx of water from Sussex Inlet to the Badgee Lagoon.

The existence of the storage volume for tidal water in Badgee Lagoon may be utilised to obtain a flushing action on the existing canal system. This would be achieved if a levee was formed to block the existing entrance of the lagoon and the head of the existing canal opened into the south western end of the lagoon.

Complete blockage of the lagoon entrance is undesirable for the following reasons:-

1. Access of boats directly from Sussex Inlet to occupations facing the dredged Badgee Lagoon is desirable.

2. A controlled opening through the levee assists in mixing the flows passing from Badgee Lagoon via the canal and via the gap in the levee as the ebb flow occurs towards the Badgee Bridge.
3. The opening in the levee may be varied easily if experience in future years shows this is desirable to optimise circulatory patterns.

The model was modified by inserting a barrier with an adjustable opening on the south eastern side of the lagoon. The opening was adjustable in size to obtain the best pattern of circulation and flow in the lagoon to induce a flow via the canal and to mix the flows arriving in the lagoon each tide.

The best pattern is shown in Fig. 2. It consists of two general circulations set up on the rising tide with a common line between them. Ebb flow changes the pattern and mixing of the water arriving in the lagoon is achieved.

The volume of the tidal prism of the water arriving via the canal is about 412,000 cubic feet. The tidal prism of the existing canal is about 320,000 cubic feet. The two add to 732,000 cubic feet.

All the dimensions of the existing Badgee Canal are not known but the total volume of water in the canal is estimated to be approximately 3.5 million cubic feet. Thus a single tidal flush produces an interchange of water throughout the length of the canal of approximately $1/5$ of its total volume which is a considerable improvement on the conditions which exist at the present time when the head waters of the existing canal are not subject to any flushing action.

9. Further Investigations

Investigations are still proceeding on the general question of flood discharge and tidal flows in the Chris Creek area, but it is clear at this stage that to obtain adequate control and flushing of the Chris Creek development a tidal discharge is required via Badgee Lagoon. The tidal discharge can be readily obtained by utilising part of the tidal prism of St. Georges Basin which has about fifteen square miles of surface area.

The scheme now proposed for Badgee Lagoon is suitable for further development by providing an opening under Jacobs Drive. The work constructed under the present proposal would not be fundamentally altered to provide for these more extensive proposals. The existing Badgee canal and the lagoon channels will then carry in parallel with the main Sussex Inlet channel a proportion of the tidal prism of St. Georges Basin, which, after passing the Badgee section will flush the Chris Creek Section to rejoin the main ebb flow in the Sussex Inlet channel at its junction with Chris Creek.

10. Estimated Channel Velocities in the Proposed Badgee Scheme

The channel velocities necessary to effect the transfer of the proportion of the tidal prism of Badgee canal calculated on the existing channel cross section are too small to transport silt being about 1/10 f. p. s. maximum. The canal will therefore remain as a silt collecting basin. This in itself is considered an acceptable condition if the canal bottom is regular and smooth since the deposition rate of organic silt is small. Development of the Chris Creek Badgee connection at a later date will provide for, as discussed in the foregoing section, higher velocities sufficient to move flocculated organic silts but not high enough to cause erosion. Flood flows will also provide additional flushing of the system.

11. Modification of Existing Canal as part of Improvement and Development of Badgee Lagoon Section

Examination of the cross section and depth of the existing Badgee Canal discloses a depth at mid canal sections of about 7 feet increasing to pot-hole conditions at the head of the canal where the depth reaches 11 feet. Such an irregular bottom profile is considered undesirable and tends to trap the organic silts which are subject to anaerobic decomposition processes if flushing is incomplete.

Without significant decrease of the tidal prism circulating through the canal the cross section of the existing Badgee canal could with advantage be reduced in width at the water line to approximately 100 feet with a centre line depth of about 6 feet. A suitable cross section is shown in Figure 3 attached.

Because of the low velocities in the proposed scheme, the cross section will ^{be} stable for all tidal flows. This cross section should be maintained at a uniform width of 100 feet for the whole

of the length of the canal except that it may be contracted as shown in C and D, Drawing No. B1-677A, where it is required to allow construction of a bridge. The position of the bridge is not, however, critical, and can be constructed where conditions might indicate a preferential site.

Restoration of the width of Badgee Canal to 100 feet will require filling of certain sections of the western banks as shown on Plan No. 1-677A. It is also desirable that the potholed length at the head of the existing canal be filled with sand to produce a uniform depth along the length of the canal.

If no other work other than that proposed for Section C is carried out at Sussex Inlet, then conditions in regard to flood waters will remain much the same as at the present time. At the present time excess flood flows pass over Jacobs Drive and spill through the Chris Creek region. There is in effect a natural floodway at the present time which is intercepted by the pavement of Jacobs Drive. As part of the proposal for the control of floods in Sussex Inlet, it is intended that the main report to Unisearch Ltd. (see Part 1 above) will consist of a recommendation to the effect that a connection be made between Badgee Lagoon and Chris Creek area which is under development. This recommendation will provide for an opening principally for tidal flushing purposes but flood control measures are quite likely to be taken into account in fixing the upper limit of waterway area and the design of the upper parts of any construction in the floodway. The work covered by the recommendation in this report to develop the Badgee Lagoon area (area C) will form essentially the component of any overall scheme and therefore is consistent with any further recommendation which would be made in connection with the development of the Badgee Lagoon - Chris Creek area as a whole.

12. Conclusion and Recommendation

The circulation of tidal water in Badgee Lagoon and the canal adjacent to Jacobs Drive will be considerably improved by adoption of the scheme outlined in Section 5 of this report and illustrated in Figure 2.

It is recommended that this scheme be proceeded with in order to improve existing conditions in the canal adjacent to Jacob's Drive.

It is further recommended that the Badgee system proposed under this report be ultimately connected to the Chris Creek section which is at present under construction and on which it is proposed to report in due course.

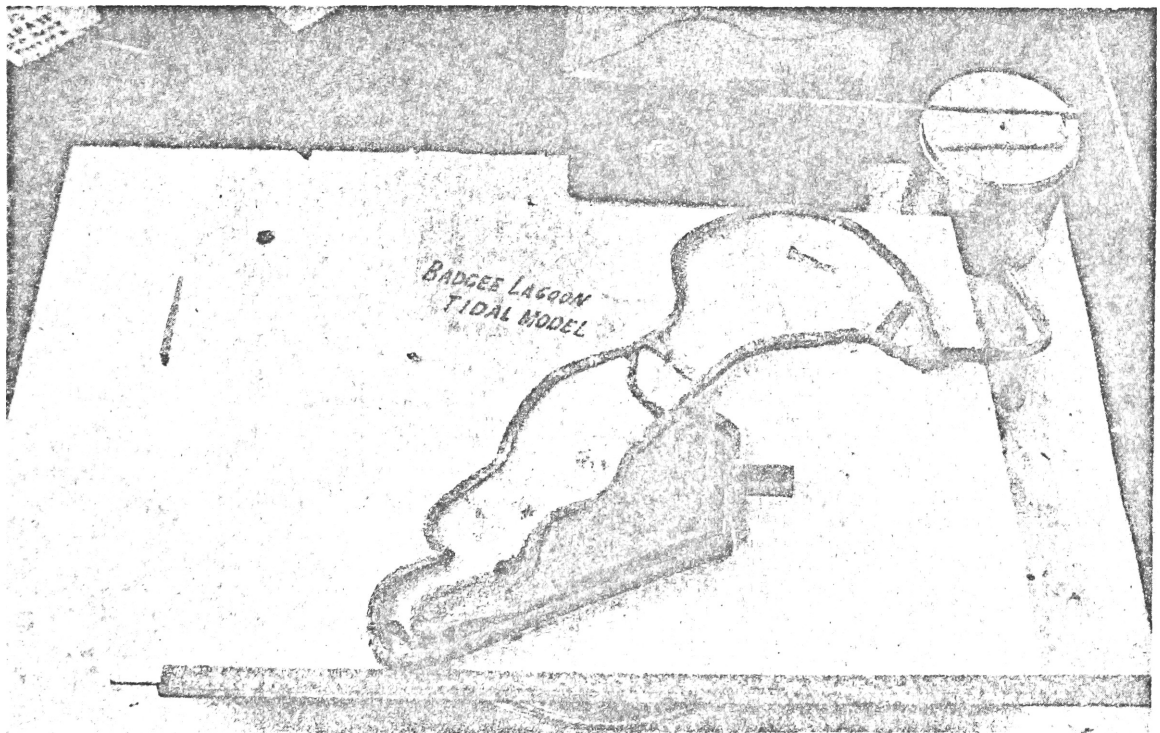
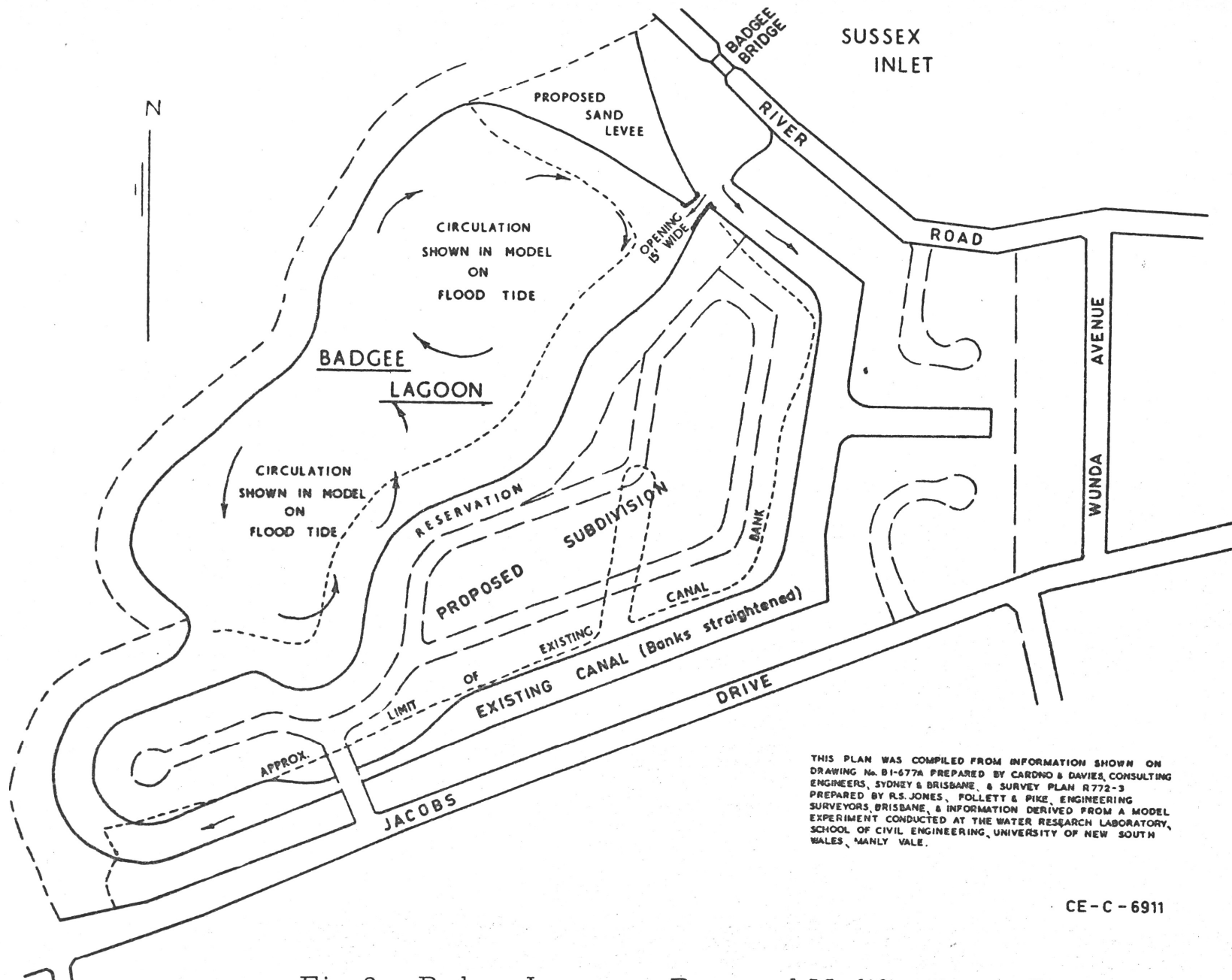
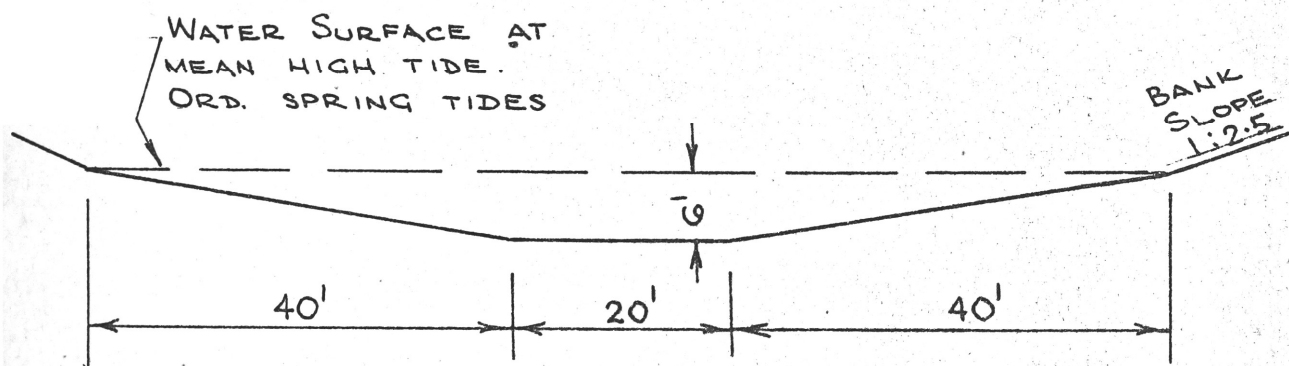


Figure 1: Tidal Model - Badgee Lagoon,
Sussex Inlet, N. S. W.



CE-C-6911

Fig. 2: Badgee Lagoon - Proposed Modification to Canal System.



Recommended Cross Section
Badgee Canal.

Figure 3.