GOSFORD CITY COUNCIL

43.

Kahibah Creek Floodplain Management Plan

Final Report

APRIL 1996

WILLING & PARTNERS
CONSULTING ENGINEERS

GOSFORD CITY COUNCIL

Kahibah Creek Floodplain Management Plan

Final Report

PROJECT No. 3174

APRIL 1996

AMENDED
gf. 23/9/96 DATE.

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DISCLAIMER

The sole purpose of the services performed by Willing & Partners and of this report is to propose and evaluate at a conceptual level a Floodplain Management Plan for Kahibah Creek on behalf of Gosford City Council in accordance with the scope of services set out in the contract between Willing & Partners Engineers Pty Ltd and Gosford City Council ("the Client"). That scope of services was defined by the requests of the Client, the time and budgetary constraints imposed by the Client, and the availability of access to the site.

Willing & Partners derived the data in this report primarily from a previous Flood Study, field survey undertaken subsequent to the Flood Study and visual inspections of the floodplain management study area. The passage of time, manifestation of latent conditions or occurrence of future events may require further examination of the study area, analysis of the data and re-evaluation of the findings, observations and conclusions expressed in the floodplain management plan report.

In preparing this report, Willing & Partners has relied upon and presumed accurate certain information (or absence thereof) about existing site survey, proposed building and facility layouts, the Client and others identified herein. Except as otherwise stated in the plan report Willing & Partners has not attempted to verify the accuracy or completeness of any such information.

No warranty or guarantee, whether express or implied, is made with respect to the data reported or findings, observations and conclusions expressed in this plan report. Further, such data, findings, observations and conclusions are based solely upon existing site survey, existing building and facility layouts at the time of the investigation.

This plan report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between Willing & Partners and the Client. Willing & Partners accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party.

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PREFACE

The State Government's Flood Policy is directed at providing solutions to existing flooding problems in developed areas and to ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas.

Under the Policy, the management of flood liable land remains the responsibility of local government. The State subsidises flood mitigation works to alleviate existing problems and provides specialist technical advice to assist councils in the discharge of their floodplain management responsibilities.

The Policy provides for technical and financial support by the Government through the following four sequential stages:

1.	Flood Study	-	determines the nature and extent of the flood problem.
2.	Floodplain Management Study	-	evaluates management options for the floodplain in respect of both existing and proposed development.
3.	Floodplain Management Plan	-	involves formal adoption by Council of a plan of management for the floodplain.
4.	Implementation of the Plan	-	construction of flood mitigation works to protect existing development.
		-	use of Local Environmental Plans to ensure new development is compatible with the flood hazard.

The Kahibah Creek Floodplain Management Plan constitutes the third stage of the management process for the Kahibah Creek catchment and has been prepared for Gosford City Council to provide the basis for the future management of flood liable lands along Kahibah Creek.

SYNOPSIS

The Kahibah Creek system, comprising five distinct tributary arms, has a catchment area of 640 ha, and is situated to the south and south-west of Umina. Most of the floodplain is developed, and several areas are subject to damage during major floods. Severe flooding was experienced in 1988, 1989 and 1990.

Gosford City Council sought to examine the range of flood mitigation options which could be employed; firstly, to ensure that any new development would be flood free, based on the 1% AEP flood standard, and secondly, to protect the existing development, as far as possible. In accordance with the 1986 Floodplain Development Manual (Ref 1), Council approached the Department of Land and Water Conservation (formerly the Public Works Department) with regard to preparation of a Flood Study, Floodplain Management Study and Plan. Council established a Floodplain Management Committee consisting of Councillors, Council officers and representatives from the Department of Land and Water Conservation (DLWAC), Department of Urban Affairs and Planning (DUAP) and the community to review the Study. Council had previously adopted the 1% AEP event as the designated flood.

In 1990, Willing & Partners, Consulting Engineers, having already completed the Ettalong Creek Flood Study and Environmental Effects Assessment, were retained to undertake the Kahibah Creek Flood Study and Floodplain Management Study. Computer based hydrologic and hydraulic models were established to simulate flooding within the catchment. The models were calibrated and tested on the historical flood data before being used for estimation of the 1% AEP , 2% AEP , 5% AEP and extreme floods. The results are provided in the Kahibah Creek Flood Study. These models were then used to assess the hydraulic impacts of various flood mitigation and development options.

Under the conditions which applied at the time the study was carried out, 18 dwellings were estimated to be inundated in the 1% AEP flood. The average annual damage cost was estimated to be $16,000.

The Committee recommended that a series of flood mitigation and development scenarios should be examined in the Kahibah Creek Floodplain Management Study in order to provide a basis for formulation of the Kahibah Creek Floodplain Management Plan. The scenarios were:

- preliminary assessment of general flood mitigation strategies,
- construction of the Mt Ettalong Road bridge and associated channel works,
- channel and culvert works throughout the system,
- future catchment development,
- assessment of the possible consequences of severe flooding.

Several floodplain management options, and many variations on options, were considered. Most were dismissed as unfeasible. Ultimately, one option for existing catchment conditions, with further staged works for future development, was considered in greater detail. The matters considered were:

- alternative designs,
- environmental impacts,
- social impacts,
- hydraulic impacts (or benefits) for the range of design floods,
- engineering issues and impacts,
- approximate excavation quantities,
- indicative costings,
- indicative benefit/cost analyses.

It was concluded that the recommended approach for management of the Kahibah Creek floodplain should be a combination of controls on future development and filling and implementation of a range of bridge and channel works. It is also desirable that the channel cross-sections be maintained by routine vegetation maintenance in accordance with a management plan to be developed for the maintenance operations.

This conclusion was arrived at after detailed consideration of the social, environmental, economic and hydraulic factors. The Kahibah Creek Floodplain Management Plan was subsequently prepared by Council. The floodplain was subdivided into eleven areas which are described in this document and shown in figures at the end of each Floodplain Management Area (FPMA) section. The floodplain management areas are:

KC1 Floodways

KC2 Kahibah Creek Main North Arm

KC3 Greenhaven Drive Arm

KC4 Australia Avenue Arm

KC5 Elanora Road Flood Storage Area

KC6 Mt Ettalong Road Floodway

KC7 McLaurin Road to Outlet

KC8 Iluka Creek and Lagoon

KC9 Cowper Road to McLaurin Road

KC10 Neera Road Branch

KC11 Lakeview Parade and Kahibah Road Arm

This Plan has been prepared to establish the development controls which are needed to complement the structural works to ensure that the flood hazard within the Kahibah Creek catchment is managed appropriately. Council has identified areas within the 1% AEP flood limit as being generally unsuitable for development for reasons of flood hazard and the need to maintain flow and storage capacity within the creek system. It is Council's policy not to permit development in flood liable areas.

The key features of the Plan are:

- No buildings will be flooded above habitable floor levels in the 1% AEP flood. This has been achieved by floor level control for new development and channel and bridge works to reduce flood levels below the floors of existing buildings except for one building which is still flood affected due to the ocean conditions. This is discussed in Section KC7;
- provision for limited development on flood fringe land subject to strict controls;
- land within the floodway will be maintained in perpetuity for the passage of flood flows;
- priority of works;
- controls for future catchment development.

The plan is shown on Figures 1 to 10.

The indicative cost for Council to implement the key structural measures of the Plan which are designed to address existing flooding problems is as follows:

• Construct bridge and channel works at and downstream of Mt Ettalong Road	$1,002,000
• Widen Greenhaven Drive Channel	$62,000
• Enlarge Neera Road Channel	$360,000
• Enlarge Ettalong Creek Channel between Cowper Road and McLaurin Road	$106,000
	$1,530,000

The above works are afforded the highest priority and include only those which would result in no flooding of dwellings in the 1% AEP flood for existing catchment conditions. These works have already been completed by Council. Other works identified in the Floodplain Management Study are designed to either increase the available freeboard for existing development and/or allow further urbanisation of the catchment.

The net present worth of the reduced flood damages under these circumstances was estimated to be $198,000 assuming a discount rate of 7% and a design life of fifty years. This gave a benefit cost ratio of 0.15. Intangible flood damages are also reduced. Further works would be required, at extra cost, to enable filling of more flood fringe land at some future time and to enable connection of street drainage from the undrained sandplain area north of Brisbane Avenue and east to Ocean Beach Road into the system. The cost for dredging of sediment from Iluka Lagoon was not included in the total shown above because these works have no tangible benefit in terms of reduced flood levels. Gosford Council is preparing a Rehabilitation and Management Plan for Kahibah, Iluka and Ettalong Creeks and selected reserves at Umina Beach. This plan will address the erosion and siltation control and desilting of the whole floodplain.

The recommended high priority works indicated above have already been implemented by Council.

Further works of a medium priority and designed to increase the available freeboard include:

- construction of a 50 Ml capacity retarding basin at the Council depot site west of the Ettymalong Swamp arm of Kahibah Creek. This project is also required to allow further development in the catchment.

- excavation of an extra channel and bridge at Mt Ettalong Road to convey flows from Kahibah Creek to the northern loop of Ettylong Creek.

However, although the provision of the extra channel will lower flood levels in Ettymalong Creek, Iluka Creek and the Neera Road Channel it is predicted to increase flood levels along the Greenhaven Drive arm and the main channel. Therefore its implementation should not occur without compensating measures in these latter areas.

In addition to the above structural works the following controls will also be required:

- floor level controls to ensure that at least 500 mm freeboard is provided for new development, and

- zoning restrictions defining floodway and flood storage areas, and ensuring that such areas are used only for flood compatible purposes.

The effects of further catchment urbanisation and urbanisation with backyard filling, if left unchecked, will have a pronounced effect on flood levels. Increases in the 1% AEP flood levels with complete urbanisation in accordance with current zonings and in areas where it seems likely that medium density development will occur are estimated to vary between 0.04 m and 0.3 m depending on the location. The impacts of urbanisation may be minimised

by both local and trunk drainage flood control structures. A flood retarding basin constructed upstream of Ettymalong Swamp will reduce flood levels in the northern branches to amounts generally less than 0.1 m. However it will also be highly desirable to introduce an "on-site detention" (OSD) policy for future new development and redevelopment. The basis of the policy would be to restrict discharges for all floods up to and including the 1% AEP flood to the existing (rural agricultural or natural bushland values) as appropriate. The inclusion of floods with frequencies greater than 1% AEP in the OSD policy would ensure that the potential adverse impacts from the more frequent floods is also minimised.

If filling in backyards of flood liable allotments is allowed to occur the 1% AEP flood levels for most areas will increase by between 0.2m and 0.8m. The worst affected areas being near Greenhaven Drive and Australia Avenue. Therefore it is imperative that filling of backyards is prohibited except as explicitly defined in the floodplain management conditions.

These potential rises in flood levels also highlight the necessity for maintaining a minimum standard of channel and culvert capacity for existing catchment conditions and for appropriate further future works to deal with ultimate catchment conditions.

Works of a low priority and designed to allow further urbanisation include:

- Doubling the capacity of the Brisbane Avenue and Calypta Road culverts,
- Lower the bed of the Australia Avenue channel between Australia Avenue and Osborne Avenue together with a new lower and enlarged culvert at McEvoy Avenue, and
- Tripling the capacity of the Etta Road culvert.

THE FLOODPLAIN MANAGEMENT PLAN

KC1 Floodways

KC1.1 Description of the Problem

The Floodplain Development Manual contains the following description of a floodway:

> *FLOODWAYS are those areas where a significant volume of water flows during floods. They are often aligned with obvious naturally defined channels. Floodways are areas which, even if only partially blocked, would cause a significant redistribution of flood flow, which may in turn affect other areas. They are often, but not necessarily, the areas with deeper flow or areas where higher velocities occur.*

Problems with mainstream flooding in the Kahibah Creek catchment have been caused in large part by development in areas which should have been reserved as floodways. Many of the dwellings worst affected by flooding are located in areas which should have been set aside as floodways.

KC1.2 Discussion

It is preferable to implement a system of floodways in the early stages of the planning process, before development takes place, because of the economic and practicability advantages. The benefits of the presence of floodways include preservation of the waterway area; protection of the riverine environment; community awareness of the flood danger; where floor level controls are employed, capacity for floods larger than the 1% AEP flood; and scope for later channel enlargement works to deal with future urban development. After the system of floodways is implemented, its integrity must be safeguarded. No change, however small, in land use in the floodway area which reduces its flood capacity should be permitted.

KC1.3 Description of the Proposal

Restrictions should be placed on land use in the floodways such that no reduction in floodway capacity will occur. No development likely to cause significant increase in flood levels in the system should be permitted. Notwithstanding this, provision for services such as transport routes, gas, electricity, telecommunications, sewerage and water mains will have to be made within the floodway system, subject to careful investigation and design to minimise the impact on flood levels and to ensure that significant damage to the service installations will not occur during floods.

Filling may be allowed outside the floodway alignment in certain localities specified in this Plan if no significant flood level increase will occur. In areas designated "flood storage", filling will not be permitted. If filling up to the floodway limit is approved, the land remaining within the floodway alignment will be set aside as floodway. Fencing would not be permitted to extend into a floodway where it is likely to impede the free passage of

floodwaters. Fencing would therefore be restricted to post and wire strand types where the wire strands are spaced a minimum 300mm apart and preferably more. Chainmesh fencing, swimming pool safety fencing and other forms of solid or "semi-open" fencing should not be permitted.

KC1.4 Economic Analysis

No economic analysis has been performed because no capital expenditure would be required.

KC1.5 Conditions

Future development on the floodplain will be allowed only within areas shown on the plan. Within floodways and flood storage areas, only flood compatible uses will be allowed.

KC1.6 Concise Description of the Plan (Floodways)

- Floodways will be reserved permanently for the conveyance of floodwater.
- No development will be allowed in a floodway that would impede flood flows, or significantly affect flood levels.
- Building in floodways will not be permitted.
- Filling in floodways will not be permitted.
- Fencing, including pool safety fencing, which would collect debris or otherwise hinder flood flows or reduce flood storage are prohibited.
- Land uses in floodways must be flood compatible.
- Crossing of a floodway by services of major regional significance, such as major water, sewer or telecommunications mains and cables, highways, major roads and railways, will be permitted provided they are carefully investigated and designed so as not to affect flood behaviour significantly.

KC1.7 Priority of Work

This work is considered to be of high priority, since no capital cost to Council would be incurred, and the work could be easily implemented.

KC2 Kahibah Creek - Main North Arm

KC2.1 Description of the Problem

This reach of the creek system runs from downstream of Brisbane Avenue to the confluence with Ettalong Creek, upstream of Dora Road. All dwellings are expected to be flood-free in the 1% AEP flood under existing catchment conditions. However, with increasing urbanisation , 1% AEP flood levels are expected to increase. The floor levels of three dwellings along the main north arm of Kahibah Creek are estimated to have less than 500mm freeboard in the 1% AEP flood. Properties butt up to this reach of the creek on both sides. Ground levels vary from approximately RL 3m to RL 5 m AHD. The main north arm of the Kahibah Creek system includes the culverts at Brisbane Avenue and Calypta Road. The Albany Square area is subject to occasional flooding.

KC2.2 Discussion

Flood levels along this reach have been reduced by channel enlargement, construction of the new Mt. Ettalong Road bridge and could be further reduced by culvert amplification works at Calypta Road and Brisbane Avenue. Land within the drainage reserve is to be dedicated as floodway. Filling may be permitted outside the floodway boundaries at some time in the future with additional channel and culvert works to compensate, if funding can be provided through a contribution scheme. Floor level control is necessary.

KC2.3 Description of the Proposal

New buildings and extensions to existing buildings will not be permitted to extend within the 1% AEP flood limit. Extensions to existing buildings may be approved by Council if that portion of the plan area of the building which extends within the 1% AEP flood limit does not increase. The footprint of the building within the 1% AEP flood limit must not increase. It is proposed that floor level control apply, whereby, for those lots shown on the Plan as being included within the limit of the Floodplain Management Plan, the minimum floor level will be required to be at least 500mm above the 1% AEP flood level as shown on the Plan. It is further proposed that filling not be permitted within the 1% AEP flood limit. Top dressing of lawns may be undertaken only to fill minor depressions and only to a total depth of 50mm. No fences, including pool safety fences, are to be erected which would either interfere with the free passage of flood waters or reduce the available volume of flood storage.

It is proposed that special conditions apply to Lot 35 in DP10080 and Lot 1 in DP 530885 (Bena Road) and Lot 561 in DP 3010 (Elanora Road). One single dwelling only is to be permitted on these lots. No more than half of the plan area of any dwelling constructed is to extend within the 1% AEP flood limit and any portion of the dwelling which extends within the 1% AEP flood limit is to be of pier and beam construction, to a structural engineer's design, so as not to provide obstruction to flood flows or reduce flood storage. However the clear spacing between a row of piers within the 1% AEP flood extent and lateral to the main direction of flow should not be less than 1600mm. Offsets for individual piers in rows parallel to the flow should be no more than ± 100mm. Cladding below floor level, irrespective of its type, is not permitted to extend below flood level. No filling will be

permitted within the 1% AEP flood limit. Flood free vehicular access is to be provided and garaging is to be located on flood-free land. Council's normal setback provisions apply.

KC2.4 Economic Analysis

The development controls proposed are at no capital cost to Council. Widening of the north arm of Kahibah Creek is estimated to cost $90,000, and augmentation of the Calypta Road and Brisbane Avenue culverts is estimated to cost $104,000 and $109,000 respectively. This should be funded by a contribution scheme.

KC2.5 Conditions

- Floor levels of new buildings and extensions to existing buildings are to be at least 500 mm above 1% AEP flood level.

- No filling within the 1% AEP flood limit except for top dressing of lawns which is not to exceed a total depth of 50mm and which is to be used only for filling of minor depressions.

- No swimming pools are permitted within the 1% AEP flood limit.

- Fences must neither impede flow nor reduce flood storage. Pool safety fencing would not be permitted within the 1% AEP flood limit.

- No building to extend within the 1% AEP flood limit except where included in these conditions and no extensions to existing buildings are to encroach further within the 1% AEP flood limit.

- Only one dwelling is to be placed on Lot 35 in DP 10080 (Bena Road), Lot 1 DP 530885 (Bena Road) and Lot 561 in DP 33010 (Elanora Road).

- Any redevelopment of Lot 35 in DP 10080 (Bena Road), Lot 1 DP 530885 (Bena Road) and Lot 561 on DP 533010 (Elanora Road) is to have a building footprint area no greater than the existing and no more than half of the building is to extend within the 1% AEP flood limit and providing only that portion of the building within the 1% AEP flood limit is of pier and beam construction to a structural engineer's design and that no significant obstruction occurs to flood flow or flood storage. However the clear spacing between a row of piers within the 1% AEP flood extent and lateral to the main direction of flow should not be less than 1600mm. Offsets for individual piers in rows parallel to the flow should be no more than ± 100mm. Cladding below floor level, irrespective of its type, is not permitted to extend below flood level.

- New building development on Lots 162 to 167 on DP 53595 inclusive and Lot 2 on DP 220466 (Calypta Road) will be restricted to the existing building footprint area and only providing that the building shall be of pier and beam construction to a structural engineer's design and that no significant obstruction occurs to flood flow or flood storage. Flood free vehicular access is to be provided and garaging is to be located on flood-free land. Council's normal setback provisions apply.

KC2.6 Concise Description of the Plan

- The buildings in this area have been made flood-free by construction of the proposed bridge and channel works at Mt. Ettalong Road.
- Filling will not be permitted within the 1% AEP flood limit.
- Filling will not be permitted on the floodplain until channel and culvert works in the main north arm of Kahibah Creek are carried out.
- Flood Levels for new developments are shown on the Plan.

KC2.7 Priority of Work

Implementation of the development controls is of high priority because it will provide some safeguards for life and property. Culvert and channel works in the main north arm of Kahibah Creek are only required if filling of the floodplain is proposed and this will be permitted only if funding for further works can be provided through a contributions scheme and so are of low priority for the time being.

GREENHAVEN DRIVE ARM — KC3

FLOOR LEVEL CONTROL
NO EXTENSION OF BUILDING FOOTPRINT WITHIN 1% AEP FLOOD LIMIT

KAHIBAH CREEK - MAIN NORTH ARM — KC2

LONG TERM: IMPROVE CULVERT CAPACITY
IMPROVE CHANNEL CONVEYANCE
(SUBJECT TO CONTRIBUTION SCHEME)

SHORT TERM: CONTROL FLOOR LEVELS

ILUKA CREEK AND LAGOON — KC8

RETAIN AND ENHANCE FLOOD STORAGE
RETAIN EXISTING CREEK CAPACITY
FLOOR LEVEL CONTROL

ELANORA ROAD FLOOD STORAGE AREA — KC5

NO FILLING RETAIN STORAGE VOLUME
FLOOR LEVEL CONTROL

COWPER ROAD TO McLAURIN ROAD — KC9

DEEPEN AND WIDEN CHANNEL
NO FILLING OF PROPERTIES
FLOOR LEVEL CONTROL

LAKEVIEW ROAD AND KAHIBA ROAD AREA — KC11

MAINTAIN THE FLOODWAY
FLOOR LEVEL CONTROL
MAINTAIN FLOOD STORAGE UPSTREAM OF NORTH PEARL ESTATE

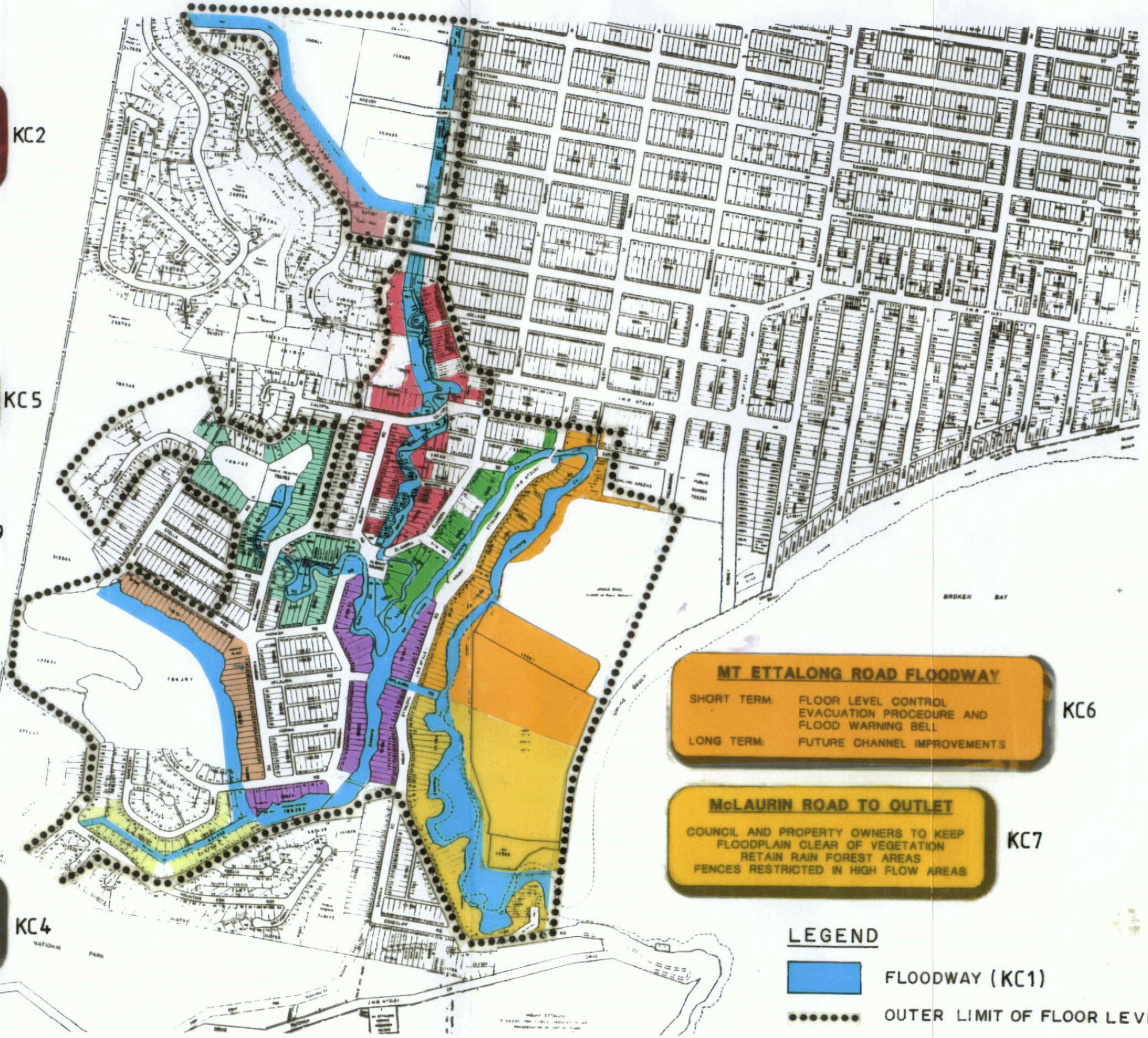
NEERA ROAD BRANCH — KC10

FLOOR LEVEL CONTROL
DAM SAFETY EDUCATION

AUSTRALIA AVENUE ARM — KC4

SHORT TERM: FLOOR LEVEL CONTROL

LONG TERM: CULVERT AND CHANNEL AUGMENTATION AND DEEPENING



MT ETTALONG ROAD FLOODWAY — KC6

SHORT TERM: FLOOR LEVEL CONTROL
EVACUATION PROCEDURE AND FLOOD WARNING BELL

LONG TERM: FUTURE CHANNEL IMPROVEMENTS

McLAURIN ROAD TO OUTLET — KC7

COUNCIL AND PROPERTY OWNERS TO KEEP FLOODPLAIN CLEAR OF VEGETATION
RETAIN RAIN FOREST AREAS
FENCES RESTRICTED IN HIGH FLOW AREAS

LEGEND

FLOODWAY (KC1)

OUTER LIMIT OF FLOOR LEVEL CONTROL

DRAWING No.	SUBJECT	AMDT.	DESCRIPTION	DATE	INIT.
ASSOCIATED DRAWINGS		AMENDMENTS			

0 100 200 300 400m
1:10 000

WILLING & PARTNERS CONSULTING ENGINEERS
621 PACIFIC HIGHWAY
ST. LEONARDS, N.S.W. 2065 TELEPHONE 439 8546

PRINCIPAL DATE

FOR GOSFORD CITY COUNCIL

KAHIBAH CREEK

FLOODPLAIN MANAGEMENT PLAN

SCALE AS SHOWN
DATE NOV 1993
DESIGNED J.B.
DRAWN S.T.
CHECKED

FIGURE 1

KALAROO ROAD

ALBANY ROAD

DORA ROAD

CALYPTA ROAD

YORK ROAD

SYLVAN CLOSE

FITZROY STREET

ELANORA ROAD

BENA ROAD

N

LEGEND

- MANAGEMENT AREA
- SPECIAL CONDITIONS APPLY
- EXISTING BUILDING ON LOT
- 1% AEP FLOOD EXTENT
- 500 mm FREEBOARD EXTENT
- (4.7) 1% AEP FLOOD LEVEL

40 20 0 40 80 120 160 200

metres

AMDT.	DESCRIPTION	DATE	INIT.
	AMENDMENTS		

WILLING & PARTNERS
CONSULTING ENGINEERS

PRINCIPAL DATE:
DATE: DEC'95 DESIGNED:
DRAWN: VERIFIED:

FOR GOSFORD COUNCIL

PROJECT
KAHIBAH CREEK
FLOODPLAIN MANAGEMENT PLAN

KC 2
KAHIBAH CK - MAIN NORTHERN ARM
FLOODPLAIN MANAGEMENT AREA

DRAWING No.
FIGURE 2

KC3 Greenhaven Drive Arm

KC3.1 Description of the Problem

The Greenhaven Drive arm runs from the Kahibah Swamp outlet to the confluence with the Australia Avenue arm upstream of Brisbane Avenue. Flooding of dwellings is expected to occur in floods greater than the 1% AEP flood. Freeboard in the 1% AEP flood at three dwellings is minimal. Properties abut the creek on the southern side; the northern side of the creek is public reserve.

KC3.2 Discussion

Flood levels along the Greenhaven Drive reach have been reduced by the replacement of the culvert at Mt. Ettalong Road by a bridge and enlargement of the channel at various locations. It could be further reduced by augmentation of the culverts at Calypta Road and Brisbane Avenue. Raising of houses along the Greenhaven Drive arm if required would be difficult and expensive since brick construction has generally been used. Land within the drainage reserve should be preserved as floodway; however filling may be permitted outside the floodway limits at some future time if culvert works at Calypta Road and Brisbane Avenue and channel works in the main north arm of Kahibah Creek funded by a contribution scheme are provided to compensate. Floor level control is necessary. The works which have been carried out were designed on the basis of vegetation in the form of reeds and rushes being present in the channel; however, regular thinning of vegetation will improve the hydraulic efficiency of the channel and so reduce flood levels.

KC3.3 Description of the Proposal

New buildings and extensions to existing buildings will not be permitted to extend within the 1% AEP flood limit. Extensions to existing buildings may be approved by Council if that portion of the plan area of the existing building which extends within the 1% AEP flood limit does not increase. The footprint of the existing building within the 1% AEP flood limit must not increase. It is proposed that floor level control apply, whereby, for those lots shown on the Plan as being included within the limit of the Floodplain Management Plan, the minimum floor level will be required to be at least 500mm above the 1% AEP flood level as shown on the Plan. It is further proposed that filling not be permitted within the 1% AEP flood limit. Top dressing of lawns may be undertaken only to fill minor depressions and only to a total depth of 50mm. No fences, including pool safety fences, are to be erected which would either interfere with the free passage of flood waters or reduce the available volume of flood storage.

If at some time in the future further development is proposed, channel widening in the main north arm of Kahibah Creek and enlargement of the Calypta Road and Brisbane Avenue culverts would be required. This is envisaged as a long-term measure and will be funded by a contribution scheme.

KC3.4 Economic Analysis

The development controls proposed are at no cost to Council. The cost of channel works in the main north arm of Kahibah Creek and culvert augmentation at Brisbane Avenue and Calypta Road are included in KC 2.4.

KC3.5 Conditions

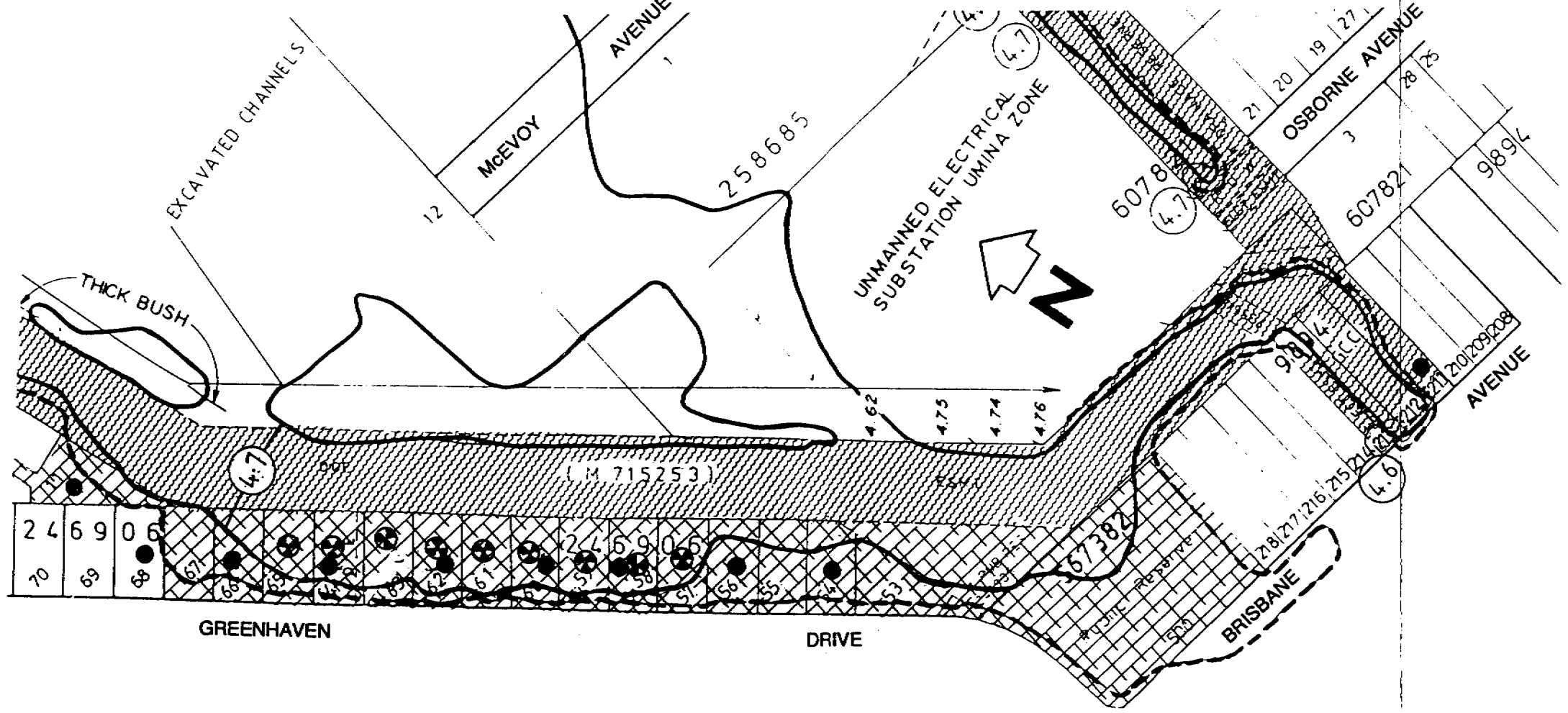
- Floor levels of new buildings and extensions to existing buildings to be at least 500 mm above 1% AEP flood level.
- No filling within the 1% AEP flood limit.
- No new building to extend within the 1% AEP flood limit except where noted.
- Extensions to existing buildings not to encroach further within the 1% AEP flood limit.
- Building footprint may extend to a 20m limit line from the front boundary on Lots 57 to 65 inclusive on DP 246906 (Greenhaven Drive), provided building within the 1% AEP flood limit is of pier and beam construction to a structural engineer's design so no significant obstruction occurs to flood flow or flood storage. However the clear spacing between a row of piers within the 1% AEP flood extent and lateral to the main direction of flow should not be less than 1600mm. Offsets for individual piers in rows parallel to the flow should be no more than ± 100mm. Cladding below floor level, irrespective of its type, is not permitted to extend below flood level.
- Top dressing of lawns not to exceed a total depth of 50mm, and to be used only for filling of minor depressions.
- Fences must neither impede flow nor reduce flood storage. Pool safety fencing would not be permitted within the 1% AEP flood limit.
- No swimming pools permitted within the 1% AEP flood limit.

KC3.6 Concise Description of the Plan (Greenhaven Drive Arm)

- Additional freeboard can be provided in the long term to meet the exigencies of development pressure by widening the main north arm of Kahibah Creek and augmenting the culverts at Calypta Road and Brisbane Avenue.
- Filling will not be permitted within the 1% AEP flood limit.
- Building will not be permitted within the 1% AEP flood limit.
- Flood levels for new developments are shown on the Plan.

KC3.7 Priority of Work

Implementation of the development controls is of high priority because it will provide some safeguards for life and property. Further culvert and channel amplification is envisaged as a long-term measure subject to funding from a contributions scheme and is of low priority.



LEGEND

- MANAGEMENT AREA
- SPECIAL CONDITIONS APPLY
- EXISTING BUILDING ON LOT
- 1% AEP FLOOD EXTENT
- 500 mm FREEBOARD EXTENT
- (4.7) 1% AEP FLOOD LEVEL

40 20 0 40 80 120 160 200
metres

AMDT.	DESCRIPTION	DATE	INIT.
	AMENDMENTS		

WILLING & PARTNERS CONSULTING ENGINEERS

PRINCIPAL DATE:
DRAWN: DEC '95 DESIGNED:
VERIFIED:

FOR GOSFORD COUNCIL

PROJECT: KAHIBAH CREEK FLOODPLAIN MANAGEMENT PLAN

TITLE: KC 3 GREENWOOD DRIVE ARM FLOODPLAIN MANAGEMENT AREA

DRAWING No. FIGURE 3

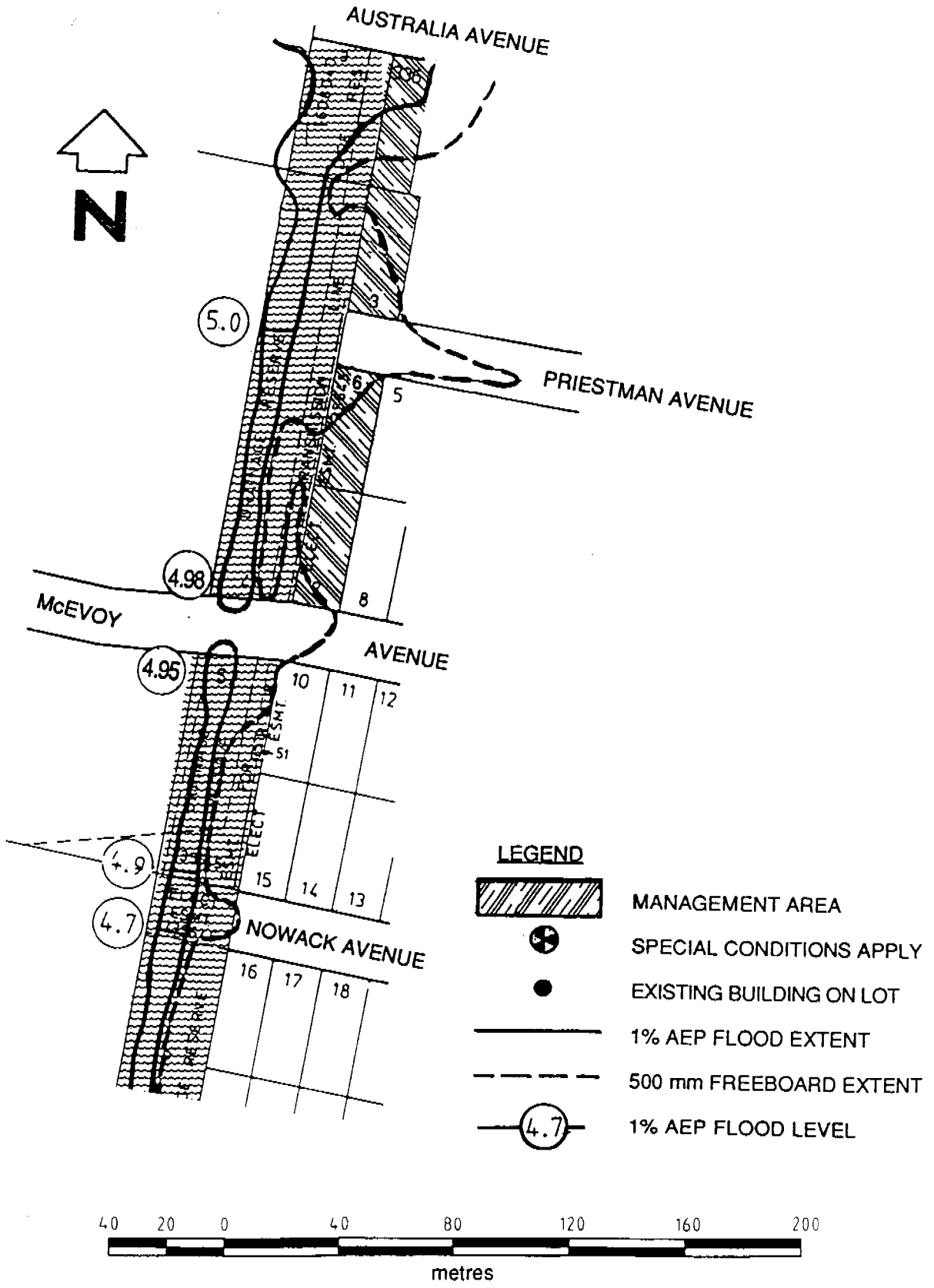


Figure 4 Australia Avenue Arm Floodplain Management Area

KC4 Australia Avenue Arm

KC4.1 Description of the Problem

The Australia Avenue arm runs from upstream of Australia Avenue to its confluence with the Greenhaven Drive arm upstream of Brisbane Avenue. The houses on the eastern side of the channel are built at fairly high levels, and are estimated not to be flood liable in any flood which has been investigated. The land on the western side of the channel is mostly public reserve, with a recent subdivision to the north of the reserve. To the east of the creek is a large area of the sandplain, possibly extending as far east as Ocean Beach Road, which is undrained. The grounds of four of the properties on the eastern side of the Australia Avenue arm fall within the surveyed limit of the 500mm freeboard allowance above the 1% AEP flood level.

KC4.2 Discussion

The area to the east of the Australia Avenue arm could be drained to the channel if the invert were lowered and if the culvert at McEvoy Avenue were augmented. The Osborne Avenue culvert forms a considerable constriction; however, it need not be enlarged to keep water levels upstream below house floor levels, even if the proposed drainage system for the area to the east were connected into the channel.

KC4.3 Description of the Proposal

It is proposed to drain the area between the Australia Avenue arm and Bapaume Avenue into the Australia Avenue channel, and to deepen the channel to permit the connection of drainage lines at the appropriate level. In order to do this, it will be necessary to lower the culverts at Australia Avenue and McEvoy Avenue and to enlarge the McEvoy Avenue culvert. This is envisaged as a long-term proposal. It is also proposed that floor level control apply to dwellings constructed adjacent to the Australia Avenue arm.

KC4.4 Economic Analysis

The estimated cost to lower the invert of the Australia Avenue arm, including replacement and augmentation of the McEvoy Avenue culvert, is $290,000. Flood levels along the Australia Avenue arm would not be significantly affected and the beneficial effect would accrue to the dwellings between Bapaume Avenue and the creek as they would be served by formal street drainage. Development controls would be at no capital cost to Council if Section 94 contributions for the area are used to fund creek channel works.

KC4.5 Conditions

- Floor levels of new dwellings and extensions to existing dwellings to be at least 500 mm above 1% AEP flood level.

KC4.6 Concise Description of the Plan (Australia Avenue Arm)

- Floor levels of new dwellings and extensions to existing dwellings to be at least 500 mm above 1% AEP flood level.

- Undertake channel deepening and widening with culvert augmentation to allow street drainage work to be implemented to the east, in the long term.
- Flood levels for new developments are shown on the Plan.

KC4.7 Priority of Work

Structural works are of low priority, since these are not intended to rectify mainstream flooding and no houses would be rendered flood-free by virtue of their proceeding. Development controls are of high priority.

KC5 Elanora Road Flood Storage Area

KC5.1 Description of the Problem

This area includes the western side of the northern loop of Ettalong Creek and the properties bounded by Albany Square, Elanora Road and Mt Ettalong Road fronting the creek. No dwellings which back onto the northern loop of the creek west of Mt. Ettalong Road are estimated to be flooded in the 1% AEP flood; however, freeboard is limited. Flooding of Elanora Road properties does occur from the main north arm of Kahibah Creek. This loop of the channel stores water during periods of high flow.

KC5.2 Discussion

This loop of Ettalong Creek is now a billabong but, before the creek cutting was excavated in the McLaurin Road reserve, it was the main creek channel. No culvert or channel augmentation works are proposed in this area, but it is very important that its capacity for storage of flood flows be maintained, so no filling can be permitted. One property has been identified where special conditions are necessary. Floor level control will be implemented in Elanora Road and Albany Square to ensure that at least 500 mm freeboard for new dwellings is provided above the 1% AEP flood level.

KC5.3 Description of the Proposal

New buildings and extensions to existing buildings will not generally be permitted to extend within the 1% AEP flood limit unless special conditions apply. Extensions to existing buildings may be approved by Council if that portion of the plan area of the building which extends within the 1% AEP flood limit does not increase. The footprint of the building within the 1% AEP flood limit must not increase. It is proposed that floor level control apply, whereby, for those lots shown on the Plan as being included within the limit of the Floodplain Management Plan, the minimum floor level will be required to be at least 500mm above the 1% AEP flood level as shown on the Plan. It is further proposed that filling not be permitted within the 1% AEP flood limit. Top dressing of lawns may be undertaken only to fill minor depressions and only to a total depth of 50mm. No fences, including pool safety fences, are to be erected which would either interfere with the free passage of flood waters or reduce the available volume of flood storage.

It is proposed that special conditions apply to Lot 182 in DP625096. One single dwelling only is to be permitted on this lot. No more than half of the plan area of any dwelling constructed is to extend within the 1% AEP flood limit and any portion of the dwelling which extends within the 1% AEP flood limit is to be of pier and beam construction, to a structural engineer's design, so as not to provide obstruction to flood flows or reduce flood storage. However the clear spacing between a row of piers within the 1% AEP flood extent and lateral to the main direction of flow should not be less than 1600mm. Offsets for individual piers in rows parallel to the flow should be no more than ± 100mm. Cladding below floor level, irrespective of its type, is not permitted to extend below flood level. No filling will be permitted within the 1% AEP flood limit. Flood free vehicular access is to be provided and garaging is to be located on flood-free land. Council's normal setback provisions apply.

KC5.4 Economic Analysis

No economic analysis has been prepared for this proposal, since no capital expenditure would be incurred, and benefits would accrue elsewhere in the system.

KC5.5 Conditions

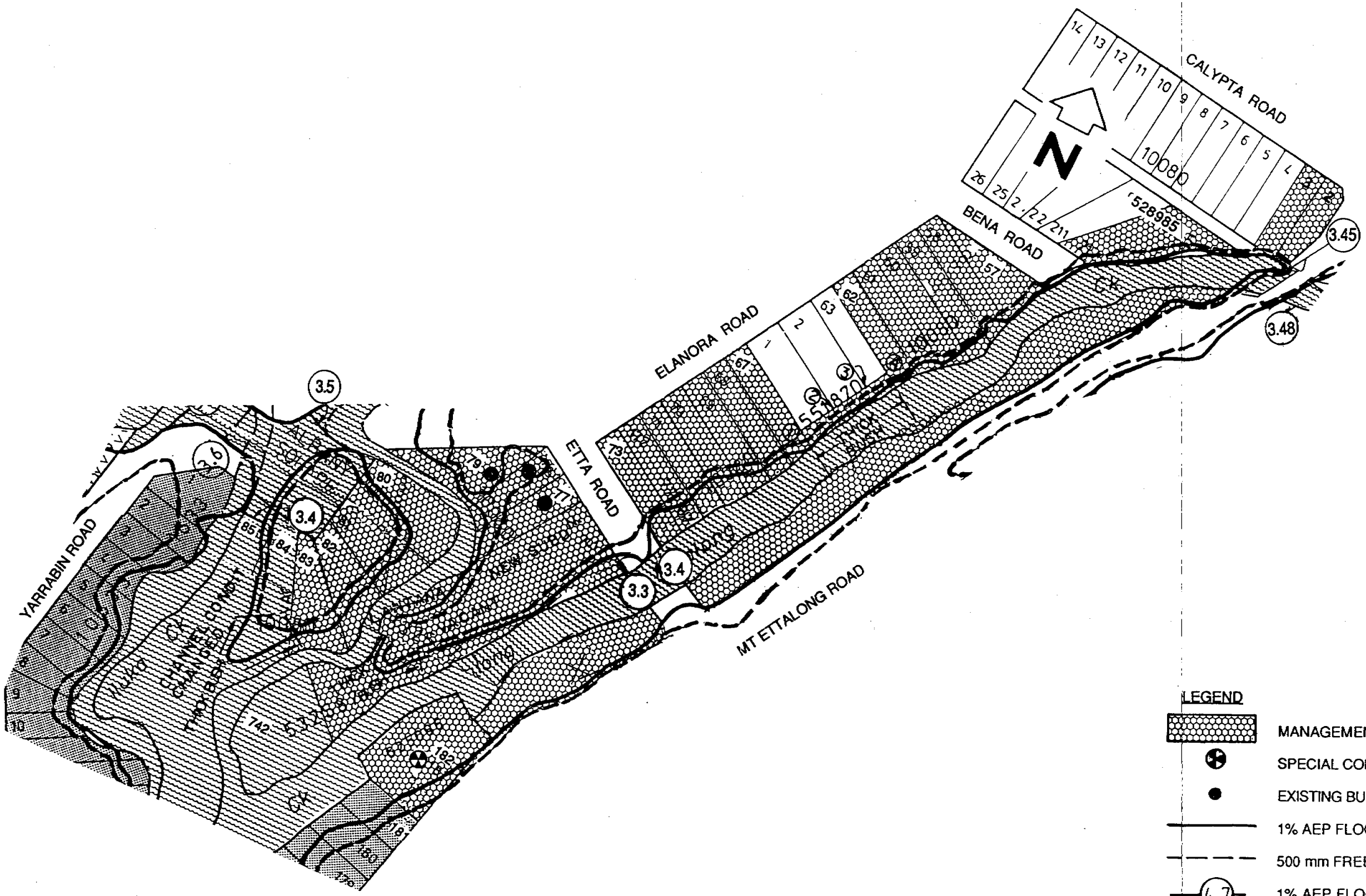
- Floor levels of new buildings and extensions to existing buildings to be at least 500 mm above 1% AEP flood levels.
- No filling in the flood storage area.
- No building to extend within the 1% AEP flood limit, unless special conditions apply.
- Only one dwelling is to be placed on Lot 182 in DP625096 (Mt. Ettalong Road), and no more than half of the building is to extend within the 1% AEP flood limit, provided building within the 1% AEP flood limit is of pier and beam construction to a structural engineer's design and no significant obstruction occurs to flood flow or flood storage. However the clear spacing between a row of piers within the 1% AEP flood extent and lateral to the main direction of flow should not be less than 1600mm. Offsets for individual piers in rows parallel to the flow should be no more than ± 100mm. Cladding below floor level, irrespective of its type, is not permitted to extend below flood level.
- Extensions to existing buildings not to encroach further within the 1% AEP flood limit.
- Top dressing of lawns not to exceed a total depth of 50mm, and to be used only for filling of minor depressions.
- Fences must neither impede flow nor reduce flood storage. Pool safety fencing would not be permitted within the 1% AEP flood limit.
- No swimming pools permitted within the 1% AEP flood limit.

KC5.6 Concise Description of the Plan (Elanora Road Flood Storage Area)

- Filling will not be permitted within the 1% AEP flood limit.
- Building will not be permitted within the 1% AEP flood limit.
- Flood levels for new developments are shown on the plan.

KC5.7 Priority of Work

This is considered to be of high priority since it would be easy to implement, and would require no capital expenditure.



LEGEND

- MANAGEMENT AREA
- SPECIAL CONDITIONS APPLY
- EXISTING BUILDING ON LOT
- 1% AEP FLOOD EXTENT
- 500 mm FREEBOARD EXTENT
- (4.7) 1% AEP FLOOD LEVEL

0 20 0 40 80 120 160 200

metres

AMDT.	DESCRIPTION	DATE	INIT.
	AMENDMENTS		

WILLING & PARTNERS
CONSULTING ENGINEERS

PRINCIPAL | DATE:
DATE: DEC'95 | DESIGNED:
DRAWN: | VERIFIED:

FOR GOSFORD COUNCIL

PROJECT: KAHIBAH CREEK FLOODPLAIN MANAGEMENT PLAN

TITLE: KC 5 ELANORA ROAD FLOOD STORAGE FLOODPLAIN MANAGEMENT AREA

DRAWING No. FIGURE 5

KC6 Mt Ettalong Road Floodway

KC6.1 Description of the Problem

This area comprises the eastern side of the northern loop of Ettalong Creek. Flooding of dwellings is expected to occur in floods greater than the 1% AEP flood. Freeboard in the 1% AEP flood is minimal in several dwellings. The problem is caused partly by the size of the culvert at Etta Road East.

Ground levels are generally about RL 3m to RL 5m (AHD). Properties along the eastern side of Mt Ettalong Road have their rear boundaries along the proposed floodway limit.

KC6.2 Discussion

Water levels have been reduced, and freeboard improved by construction of the new Mt. Ettalong Road bridge and downstream channel works. In the long term, if areas to the north of the loop were to be developed further and especially if it were desired to drain these areas directly to the northern loop of Ettalong Creek, culvert upgrading at Etta Road East would be required. This is however, not considered necessary in the short term because the Mt Ettalong Road culvert and downstream works should suffice for existing catchment conditions. Floor level control is necessary. The properties at the northern end of this reach have low floor levels and no flood free access therefore an evacuation procedure should be implemented to safeguard the residents.

KC6.3 Description of the Proposal

New buildings and extensions to existing buildings will not be permitted to extend within the 1% AEP flood limit. Extensions to existing buildings may be approved by Council if that portion of the plan area of the building which extends within the 1% AEP flood limit does not increase. The footprint of the building within the 1% AEP flood limit must not increase. It is proposed that floor level control apply, whereby, for those lots shown on the Plan as being included within the limit of the Floodplain Management Plan, the minimum floor level will be required to be at least 500mm above the 1% AEP flood level as shown on the Plan. It is further proposed that filling not be permitted within the 1% AEP flood limit. Top dressing of lawns may be undertaken only to fill minor depressions and only to a total depth of 50mm. No fences, including pool safety fences, are to be erected which would either interfere with the free passage of flood waters or reduce the available volume of flood storage.

If, in the future, it is desired to join in street drainage lines from the area north of the northern loop of Ettalong Creek, it is proposed to augment the culvert at Etta Road East. This is envisaged as a long term measure. It is proposed that an evacuation procedure including a flood warning alarm be implemented for residents of dwellings on Lots 1, 2, 3, 4, 5, 6, Pt7, Pt8, Pt10 and Pt11 in DP 11184 and lot 1 in DP 119154, off Mt Ettalong Rd between Etta Road and Caraway Street.

KC6.4 Economic Analysis

The development controls proposed are at no capital cost to Council. The cost for upgrading the Etta Road culvert is estimated to be $38,000. The cost of implementing the evacuation procedure and installing a flood warning system is estimated to be $5000.

KC6.5 Conditions

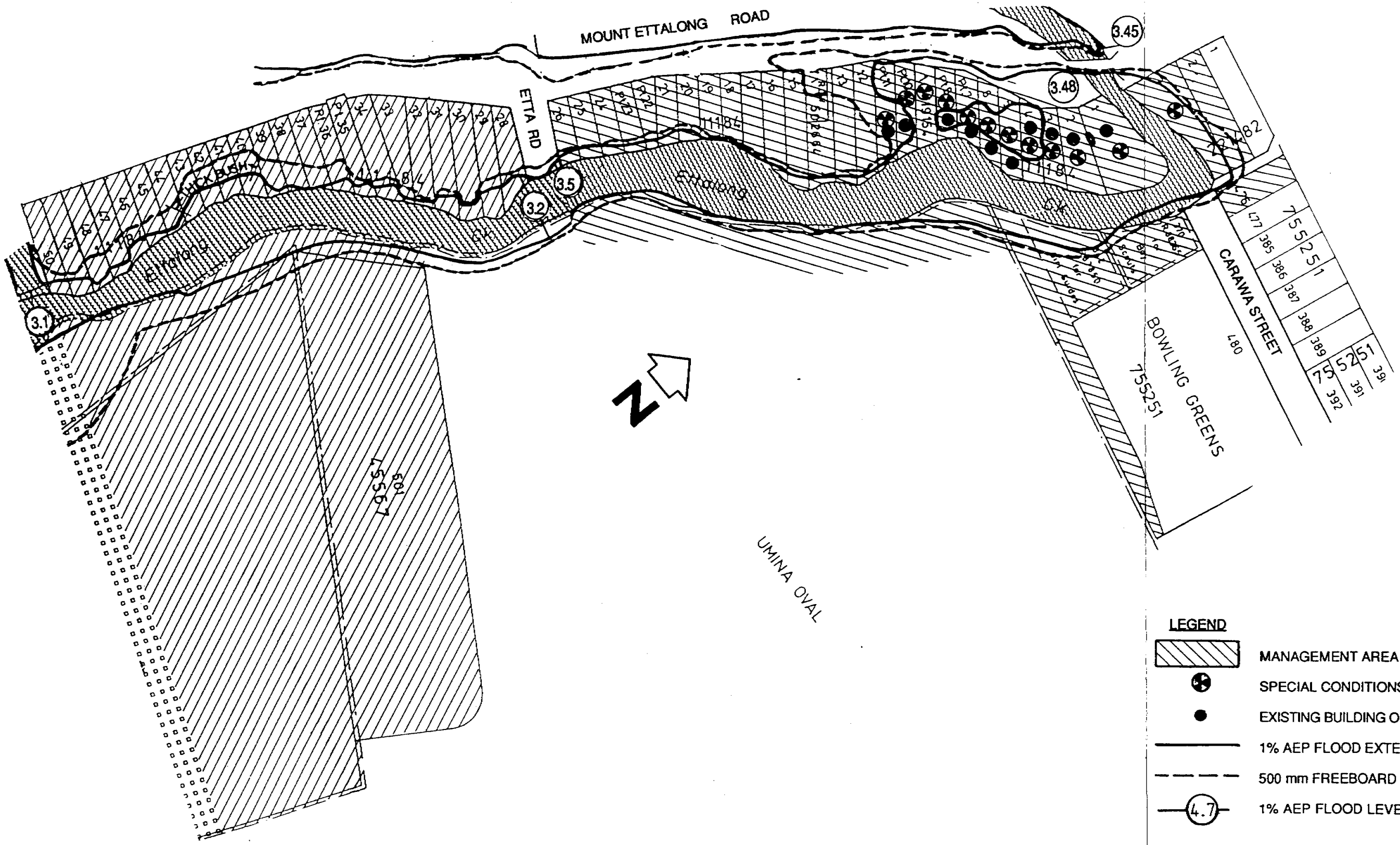
- Floor levels of new buildings and extensions to existing buildings to be at least 500 mm above 1% AEP flood level.
- No filling within floodway limits.
- No extra main piped drainage systems connected into channel unless culvert works at Etta Road East are undertaken.
- No building to extend within the 1% AEP flood limit.
- Extensions to existing buildings not to encroach further within the 1% AEP flood limit.
- Top dressing of lawns not to exceed a total depth of 50mm, and to be used only for filling of minor depressions.
- Fences must neither impede flow nor reduce flood storage. Pool safety fencing would not be permitted within the 1% AEP flood limit.
- No swimming pools permitted within the 1% AEP flood limit.

KC6.6 Concise Description of the Plan (Mt Ettalong Road Floodway)

- Filling will not be permitted within the 1% AEP flood limit.
- Increases in the existing building footprint will not be permitted within the 1% AEP flood limit.
- Flood levels for new developments are shown on the plan.
- An evacuation procedure will be implemented for the eleven properties at the northern end of the northern loop of Ettalong Creek.
- No connection of piped street drainage from the area to the north until Etta Road East culvert is upgraded.

KC6.7 Priority of Work

Implementation of the development controls and evacuation procedure is of high priority because it will provide some safeguards for life and property at minimal cost to Council. Enlargement of the Etta Road east culvert is of lower priority, and need not proceed unless it is desired to drain further urban areas to the northern loop of Ettalong Creek.



AMDT.	DESCRIPTION	DATE	INT.
	AMENDMENTS		

WILLING & PARTNERS
CONSULTING ENGINEERS

PRINCIPAL DATE:
DATE: DEC '95 DESIGNED:
DRAWN: VERIFIED:

FOR
GOSFORD COUNCIL

PROJECT
KAHIBAH CREEK
FLOODPLAIN MANAGEMENT PLAN

TITLE
KC 6
MT. ETTALONG ROAD FLOODWAY
FLOODPLAIN MANAGEMENT AREA

DRAWING No.
FIGURE 6

KC7 McLaurin Road to Outlet

KC7.1 Description of the Problem

This reach of the creek system runs from the upstream end of the McLaurin Road cutting to the outlet at Broken Bay. The McLaurin Road cutting contains the Mt Ettalong Road bridge. The lower level of one house located on Lot 1 DP 223480 (Mt. Ettalong Road) on the southern side of the southern most bend in the creek is flood liable in the 1% AEP flood but this is due to the effect of high ocean levels at the mouth of the creek rather than high creek levels.

KC7.2 Discussion

The replacement of the culvert at Mt Ettalong Road by a bridge has reduced flood levels considerably in all branches of the Kahibah Creek system. Channel works in the McLaurin Road reserve cutting and downstream to the outlet have been implemented to eliminate scouring problems and improve the hydraulic efficiency of the channel. Floor level control is necessary, as are measures to maintain the storage and flow capacity of the floodplain and to protect the SEPP 19 urban bushland.

The lower floor of the residence on Lot 1 DP 223480 (Mt. Ettalong Road/Berrima Crescent) is currently used for habitable purposes. Council should consider whether or not this area should continue to be used for habitation and whether it should be flood proofed. Where the lower floor is to be flood proofed this should be achieved by suitable sealing of the external walls and flooring, provision of door and window seals and reflux valves on sewerage and drainage fittings as appropriate. Flood proofing should extend to a minimum height of 500 mm above the adopted 1% AEP flood level. The use of external bunding including masonry boundary fencing or any other measure which reduces the floodway or flood storage area is not permitted. Where development including re-development occurs special conditions will apply. One single dwelling only is to be permitted on each lot. The footprint area is not to exceed that of the existing building as at 1 January 1995 and any portion of the dwelling which extends within the 1% AEP flood limit is to is to be of pier and beam construction, to a structural engineer's design, so as not to provide obstruction to flood flows or reduce flood storage. However the clear spacing between a row of piers within the 1% AEP flood extent and lateral to the main direction of flow should not be less than 1600mm. Offsets for individual piers in rows parallel to the flow should be no more than ± 100mm. Cladding below floor level, irrespective of its type, is not permitted to extend below flood level. No filling will be permitted within the 1% AEP flood limit. Flood free vehicular access is to be provided and garaging should be no lower than the 1% AEP flood height. Council's normal setback provisions apply.

Lot 2 DP 223480 (Berrima Crescent) is vacant but equally susceptible to flooding and it would be preferable for Council to include Lot 2 in a voluntary purchase scheme. At the very least special conditions similar to those for Lot 1 will apply to development.

KC7.3 Description of the Proposal

New buildings and extensions to existing buildings will not be permitted to extend within the 1% AEP flood limit. Extensions to existing buildings may be approved by Council if that portion of the plan area of the building which extends within the 1% AEP flood limit does not increase. The footprint of the building within the 1% AEP flood limit must not increase. It is proposed that floor level control apply, whereby, for those lots shown on the Plan as being included within the limit of the Floodplain Management Plan, the minimum floor level will be required to be at least 500mm above the 1% AEP flood level as shown on the Plan. It is further proposed that filling not be permitted within the 1% AEP flood limit. Top dressing of lawns may be undertaken only to fill minor depressions and only to a total depth of 50mm. No fences are to be erected which would either interfere with the free passage of flood waters or reduce the available volume of flood storage.

It is proposed that the floodplain be kept clear of vegetation by Council and property owners to maintain hydraulic efficiency where shown on the plan. This will require under scrubbing on a regular basis. Fences which either impede flow or reduce storage will not be permitted. Pool safety fencing would not be permitted. The rainforested areas on the western bank downstream from McLaurin Road will be retained and protected.

KC7.4 Economic Analysis

The cost to Council is the recurrent cost of maintaining vegetation on the floodplain at acceptably low levels and policing development controls.

KC7.5 Conditions

- Floor levels of new buildings and extensions to existing buildings to be at least 500 mm above 1% AEP flood levels.
- No new building to extend within 1% AEP flood limit except where noted. Increases in the existing building footprint area will not be permitted.
- No filling within floodway limits.
- Fences must neither impede flow nor reduce flood storage. Pool safety fencing would not be permitted within the 1% AEP flood limit.
- Top dressing of lawns not to exceed a total depth of 50mm, and to be used only for filling of minor depressions.
- No swimming pools permitted within the 1% AEP flood limit.
- Floodplain to be kept clear of understorey vegetation in the designated area indicated on the plan.
- Creek bank habitat and rainforest to be retained.

- New building development on Lot 1 DP 223480 (Mt. Ettalong Road/Berrima Cres.) will be restricted to the existing building footprint area as at 1 January 1995 and only providing that the building shall be of pier and beam construction to a structural engineer's design. The clear spacing between a row of piers within the 1% AEP flood extent and lateral to the main direction of flow should not be less than 1600mm. Offsets for individual piers in rows parallel to the flow should be no more than ± 100mm. Cladding below floor level, irrespective of its type, is not permitted to extend below flood level. Notwithstanding the above minimum requirements, a flood management report, prepared by a competent engineer, will be required which demonstrates to Council's satisfaction that there will be no significant adverse impact on flood flows or flood storage and that there will be negligible risk to the occupants during a flood.

- New building development on Lot 2 DP 223480 (Berrima Crescent) will be restricted to a single dwelling of pier and beam construction to a structural engineer's design and that no significant obstruction occurs to flood flow or flood storage. However the clear spacing between a row of piers within the 1% AEP flood extent and lateral to the main direction of flow should not be less than 1600mm. Offsets for individual piers in rows parallel to the flow should be no more than ± 100mm. Cladding below floor level, irrespective of its type, is not permitted to extend below flood level. Notwithstanding the above minimum requirements, a flood management report, prepared by a competent engineer, will be required which demonstrates to Council's satisfaction that there will be no significant adverse impact on flood flows or flood storage and that there will be negligible risk to the occupants during a flood.

KC7.6 Concise Description of the Plan (McLaurin Road to Outlet)

- Filling will not be permitted within the 1% AEP flood limit.

- Fences which would restrict flood flows or flood storage will not be permitted.

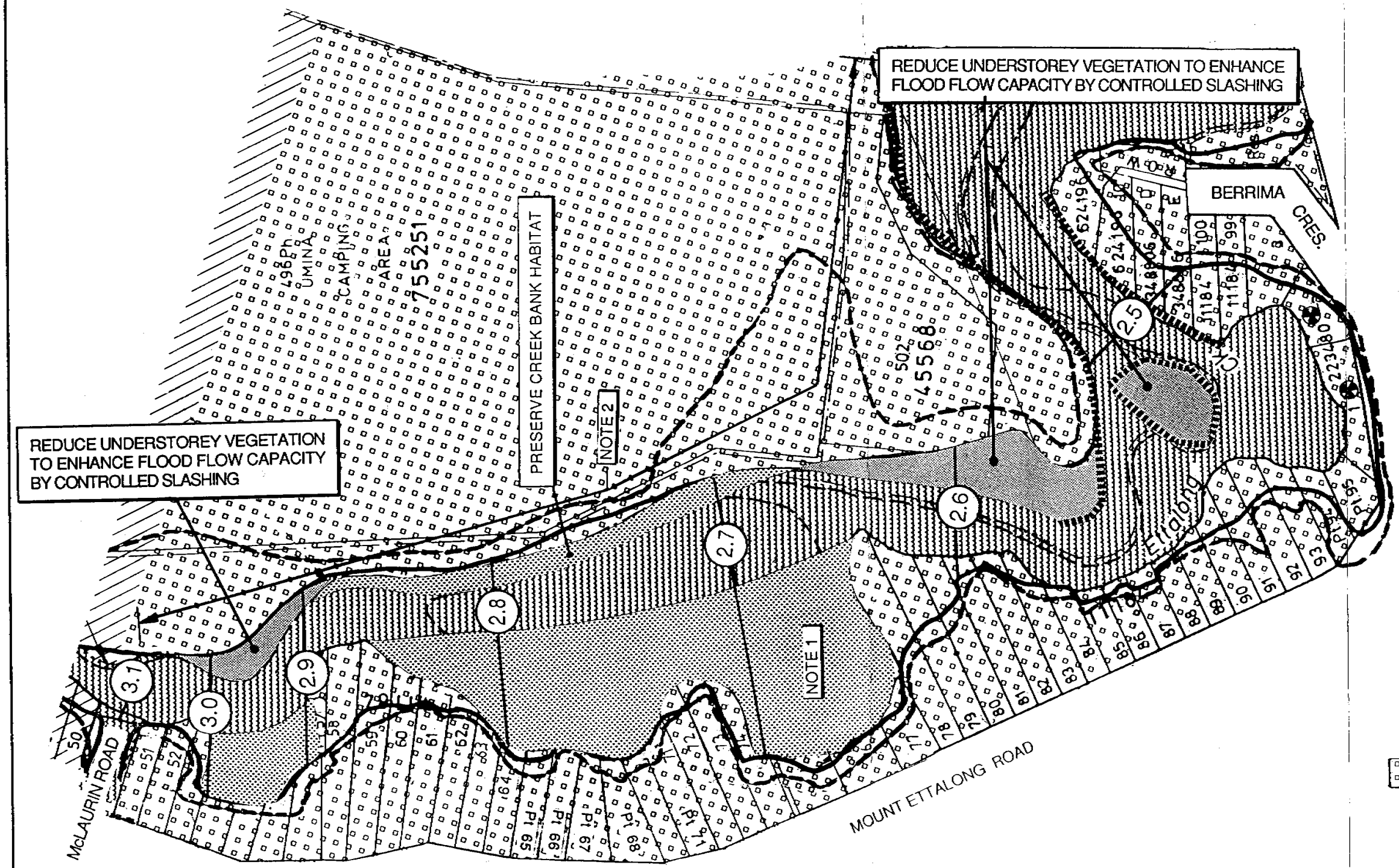
- Flood levels for new developments are shown on the plan.

- Floodplain to be kept clear of understorey vegetation in the designated area.

- No works will be allowed to take place which would compromise the integrity of the rainforest.

KC7.7 Priority of Work

This work is of high priority because it provides safeguards for life and property.



LEGEND

- MANAGEMENT AREA
- SPECIAL CONDITIONS APPLY
- EXISTING BUILDING ON LOT
- 1% AEP FLOOD EXTENT
- 500 mm FREEBOARD EXTENT
- 4.7 — 1% AEP FLOOD LEVEL
- EXTENT OF ROCK LINING

NOTE 1. RAIN FOREST AREA TO BE RETAINED

NOTE 2 THE VEGETATIVE UNDERSTOREY IN THE OVERBANK CHANNEL TO BE CLEARED AND MAINTAINED AS SHOWN BUT THE CREEK BANK HABITAT DOWNSTREAM OF McLAURIN ROAD IS TO BE RETAINED

40 20 0 40 80 120 160 200
metres

AMDT.	DESCRIPTION	DATE	INIT.
	AMENDMENTS		

WILLING & PARTNERS CONSULTING ENGINEERS

PRINCIPAL DATE:
DATE: DEC '95 DESIGNED:
DRAWN VERIFIED:

FOR GOSFORD COUNCIL

PROJECT: KAHIBAH CREEK FLOODPLAIN MANAGEMENT PLAN

TITLE: KC 7 McLAURIN ROAD TO OUTLET FLOODPLAIN MANAGEMENT AREA

DRAWING No. FIGURE 7

KC8 Iluka Creek and Lagoon

KC8.1 Description of the Problem

Iluka Lagoon is one of the three swamps which lay at the foot of the escarpment and is the only one of the three which retains its integrity as a wetland, although it is subject to degradation by siltation. No houses along Iluka Creek are flood affected in the 1% AEP flood but nuisance flooding of backyards has been reported on several occasions. An extreme flood could cause flooding of houses.

KC8.2 Discussion

1% AEP flood levels along Iluka Creek have been reduced by the construction of the Mt. Ettalong Road bridge and channel works. Under normal operating conditions, the water level in Iluka Lagoon is not expected to be affected by the works which have been carried out. Iluka Lagoon is quite severely degraded by silt deposits which should, if possible, be removed without adverse impacts on the wetland ecosystem. Further study is recommended to identify the extent of sediments which can safely be removed. Future siltation of the wetland can be minimized by implementing controls, under Council's adopted "Erosion, Sedimentation Control Code of Practice", to prevent erosion of sediment from building sites. This will include the implementation of soil and water management plans for all building development within the catchment. The provision of a sediment trap/basin at the head of the wetland will facilitate the removal of sediments. Floor level controls are necessary. Filling within the 1% AEP flood limit should generally be prohibited, but there are three lots identified in Section KC8.6 where loss of storage due to filling would have no significant effect and these lots are exempted from the general prohibition.

KC8.3 Description of the Proposal

New buildings and extensions to existing buildings will not be permitted to extend within the 1% AEP flood limit. Extensions to existing buildings may be approved by Council if that portion of the plan area of the building which extends within the 1% AEP flood limit does not increase. The footprint of the building within the 1% AEP flood limit must not increase. It is proposed that floor level control apply, whereby, for those lots shown on the Plan as being included within the limit of the Floodplain Management Plan, the minimum floor level will be required to be at least 500mm above the 1% AEP flood level, as shown on the Plan. It is further proposed that filling not be permitted within the 1% AEP flood limit. It is proposed that three lots, identified in Section KC8.6, be exempted from the prohibition on filling because loss of flood storage on these lots would have no significant effect on the overall flooding problem.

It is proposed that special conditions apply Lot 962 in DP554182 (Kallaroo Road). One single dwelling only is to be permitted on this lot. No more than half of the plan area of any dwelling constructed is to extend within the 1% AEP flood limit and any portion of the dwelling which extends within the 1% AEP flood limit is to be of pier and beam construction, to a structural engineer's design, so as not to provide obstruction to flood flows or reduce flood storage. However the clear spacing between a row of piers within the 1% AEP flood

extent and lateral to the main direction of flow should not be less than 1600mm. Offsets for individual piers in rows parallel to the flow should be no more than ± 100mm. Cladding below floor level, irrespective of its type, is not permitted to extend below flood level. No filling will be permitted within the 1% AEP flood limit. Flood free vehicular access is to be provided and garaging is to be located on flood-free land. Council's normal setback provisions apply.

Top dressing of lawns may be undertaken only to fill minor depressions and only to a total depth of 50mm. No fences, including pool safety fences, are to be erected which would either interfere with the free passage of flood waters or reduce the available volume of flood storage.

Also, it is proposed to de-silt Iluka Lagoon if possible and to implement control measures, such as silt fences, to prevent erosion of sediment from building sites. (Currently covered by Council's Code of Practice Erosion and Sedimentation Control). The flood storage available in Iluka Lagoon should be retained and enhanced.

KC8.4 Economic Analysis

Dredging to remove silt could cost up to $70,000. The development controls proposed are at no cost to Council.

KC8.5 Conditions

- Floor levels at least 500 mm above 1% AEP flood level.
- No filling within the 1% AEP flood limit unless special conditions apply.
- Control to prevent erosion of sediment from building sites upstream.
- No building to extend within the 1% AEP flood limit.
- Extensions to existing buildings not to encroach further within the 1% AEP flood limit.
- Top dressing of lawns not to exceed a total depth of 50mm, and to be used only for filling of minor depressions.
- Only one dwelling is to be placed on Lot 962 in DP554182 (Kallaroo Road), and no more than half of the building is to extend within the 1% AEP flood limit, provided building within the 1% AEP flood limit is of pier and beam construction to a structural engineer's design so that no significant obstruction occurs to flood flow or flood storage. However the clear spacing between a row of piers within the 1% AEP flood extent and lateral to the main direction of flow should not be less than 1600mm. Offsets for individual piers in rows parallel to the flow should be no more than ±100mm. Cladding below floor level, irrespective of its type, is not permitted to extend below flood level.

- Filling will be permitted within the 1% AEP flood limits on Lots 174, 175 and 176 in DP10633 (Stella Road).

- Fences must neither block or impede flow nor reduce flood storage. Pool safety fencing would not be permitted within the 1% AEP flood limit.

KC8.6 Concise Description of the Plan (Iluka Creek and Lagoon)

- Flood levels for new developments are shown on the Plan.

- Filling will not be permitted within the 1% AEP flood limit, except as set out below.

- Building will not generally be permitted within the 1% AEP flood limit unless special conditions apply.

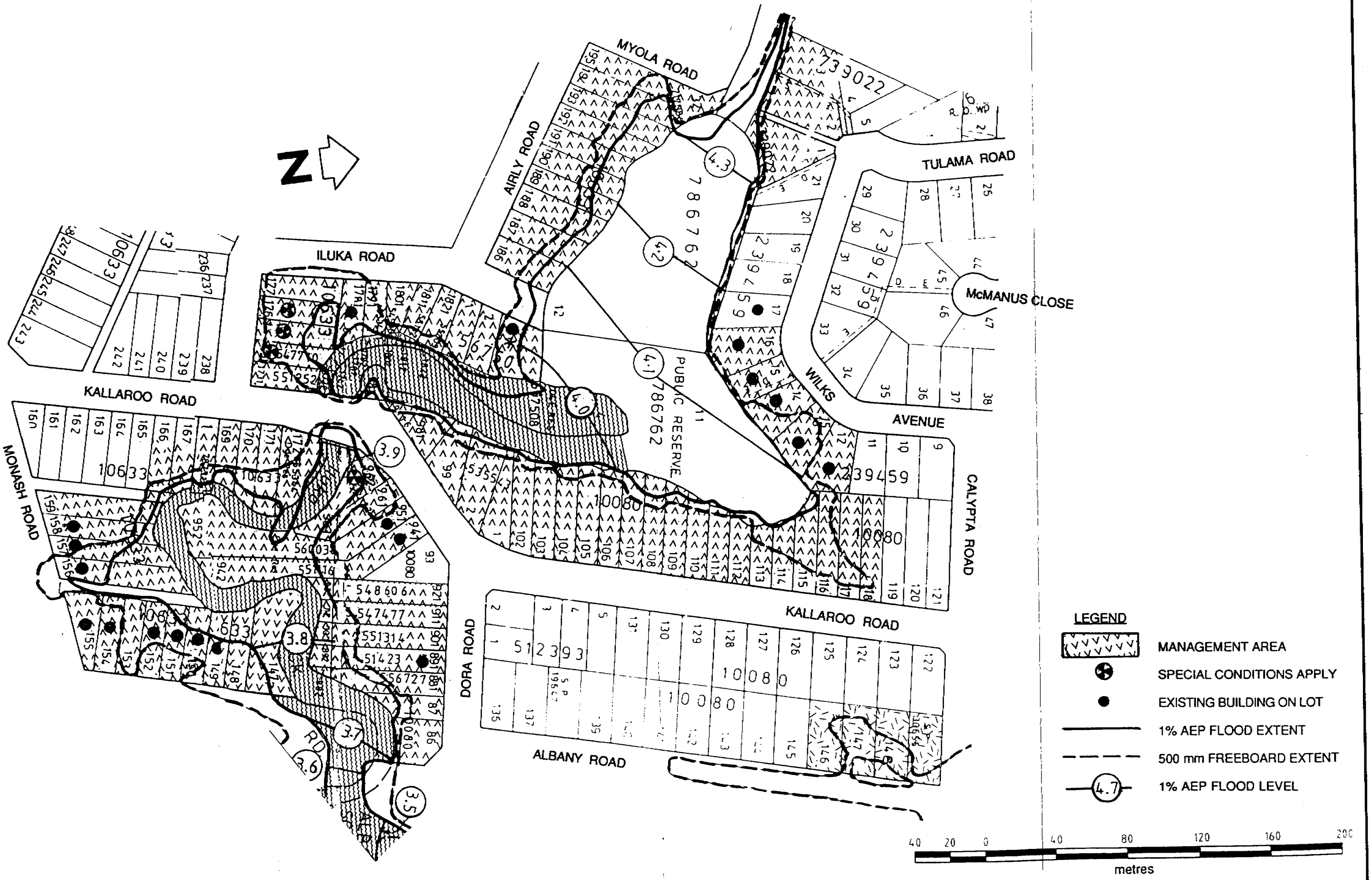
- Reduction of the storage capacity of Iluka Lagoon will not be permitted.

- Works will be undertaken to control sediment deposit in Iluka Lagoon.

- Filling will be permitted within the 1% AEP flood limits on Lots 174, 175 and 176 in DP10633 (Stella Road).

KC8.7 Priority of Work

The development controls proposed are of high priority as they provide some safeguards for life and property. The Iluka Lagoon de-silting is of low priority as regards flood mitigation, since it has no significant effect on flood levels; however, it could be given some priority on environmental grounds.



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FOR
GOSFORD COUNCIL

PROJECT
KAHIBAH CREEK
FLOODPLAIN MANAGEMENT PLAN

KC8
ILUKA CREEK TO LAGOON
FLOODPLAIN MANAGEMENT AREA

DRAWING No.
FIGURE 8

KC9 Cowper Road to McLaurin Road

KC9.1 Description of the Problem

This reach of the creek system runs parallel to Cowper Road and Yarrabin Road as far as the confluence of Ettalong Creek with Kahibah Creek. All houses along this reach are now flood free in the 1% AEP flood due to the channel works and bridge works which have been carried out but several houses have less than 500mm freeboard and many properties are still flood liable.

KC9.2 Discussion

It is important that the flow capacity in this area be maximised, therefore no filling can be permitted within the 1% AEP flood limit. Floor level control would be desirable to ensure that at least 500 mm freeboard is provided in the 1% AEP flood. Encroachments into the floodway area should generally be forbidden, but several properties have been identified where it is appropriate for development to be permitted up to a limit line 20m from the front boundary. These properties are described in Section KC9.3.

KC9.3 Description of the Proposal

New buildings and extensions to existing buildings generally will not be permitted to extend within the 1% AEP flood limit. Special conditions apply to Lots 37, 38 and 39 in DP10633 (Cowper Road) and Lots 162, 163, 165 and 166 in DP11184 (Mt. Ettalong Road). It is proposed that development on these properties be permitted between the front boundary (limit of road reserve) and a limit line which is parallel to and 20m away from the front boundary (limit of road reserve). No filling will be permitted within the 1% AEP flood limit. Where building to the 20m limit line is permitted, any portion of any new building or extension to any existing building which extends within the 1% AEP flood limit is to be of pier and beam construction to a structural engineer's design so as not to provide obstruction to flood flows or reduce flood storage. However the clear spacing between a row of piers within the 1% AEP flood extent and lateral to the main direction of flow should not be less than 1600mm. Offsets for individual piers in rows parallel to the flow should be no more than ± 100mm. Cladding below floor level, irrespective of its type, is not permitted to extend below flood level. Flood free vehicular access is required to be provided by the property owner. Garaging is to be located on flood free land.

Other than for the seven lots identified as being subject to special conditions, extensions to existing buildings may be approved by Council if that portion of the plan area of the building which extends within the 1% AEP flood limit does not increase. The footprint of the building within the 1% AEP flood limit must not increase.

It is proposed that floor level control apply, whereby, for those lots shown on the Plan as being included within the limit of the Floodplain Management Plan, the minimum floor level will be required to be at least 500mm above the 1% AEP flood level, as shown on the Plan. It is further proposed that filling not be permitted within the 1% AEP flood limit, for any property in this area. Top dressing of lawns may be undertaken only to fill minor

depressions and only to a total depth of 50mm. No fences, including pool safety fences, are to be erected which would either interfere with the free passage of flood waters or reduce the available volume of flood storage.

KC9.4 Economic Analysis

Development controls proposed are at no capital cost to Council.

KC9.5 Conditions

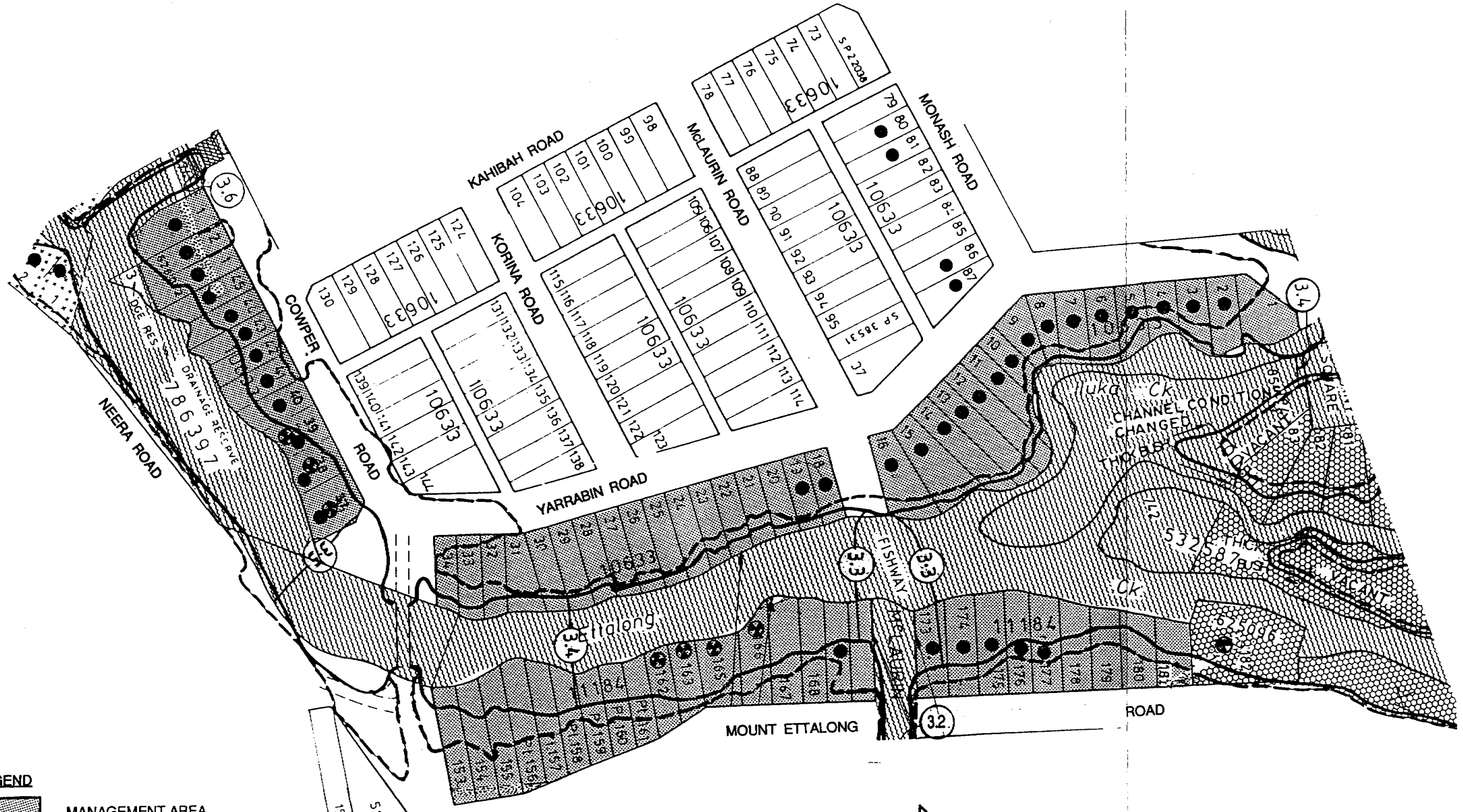
- No filling within the 1% AEP flood limit.
- Floor levels of new buildings and extensions to existing buildings to be at least 500 mm above 1% AEP flood levels.
- No building to extend within the 1% AEP flood limit unless special conditions apply.
- Building footprint may extend to a 20m limit line from the front boundary on Lots 37, 38 and 39 in DP10633 (Cowper Road) and Lots 162, 163, 165 and 166 in DP11184 (Mt. Mt. Ettalong Road), provided building within the 1% AEP flood limit is of pier and beam construction to a structural engineer's design so no significant obstruction occurs to flood flow or flood storage. However the clear spacing between a row of piers within the 1% AEP flood extent and lateral to the main direction of flow should not be less than 1600mm. Offsets for individual piers in rows parallel to the flow should be no more than ± 100mm. Cladding below floor level, irrespective of its type, is not permitted to extend below flood level.
- Extensions to existing buildings not to encroach further within the 1% AEP flood limit.
- Top dressing of lawns not to exceed a total depth of 50mm, and to be used only for filling of minor depressions.
- Fences must neither impede flow nor reduce flood storage. Pool safety fencing would not be permitted within the 1% AEP flood limit.
- No swimming pools permitted within the 1% AEP flood limit.

KC9.6 Concise Description of the Plan (Cowper Road to McLaurin Road)

- Filling will not be permitted within the 1% AEP flood limit.
- Flood levels for new developments are shown on the Plan.
- Building will not generally be permitted within the 1% AEP flood limit unless special conditions apply.

KC 9.7 Priority of Work

These works are of high priority because they will help to rectify the worst flooding problems in the catchment.



AMDT.	DESCRIPTION	DATE	INIT.
	AMENDMENTS		

WILLING & PARTNERS
CONSULTING ENGINEERS

PRINCIPAL DATE:
DATE: DEC '95 DESIGNED:
DRAWN: VERIFIED:

FOR GOSFORD COUNCIL

PROJECT: KAHIBAH CREEK FLOODPLAIN MANAGEMENT PLAN

TITLE: KC 9 COWPER ROAD TO McLAURIN ROAD FLOODPLAIN MANAGEMENT AREA

DRAWING No. FIGURE 9

KC10 Neera Road Branch

KC10.1 Description of the Problem

The Neera Road area was the area worst affected by flooding in the catchment but works carried out both in the Neera Road channel and downstream have rendered all dwellings flood free in the 1% AEP flood. However, several houses have limited freeboard and 21 properties are still estimated to be subject to flooding in the 1% AEP flood. There is a small retarding basin at the southern end of Palmtree Grove which could overtop in an extreme flood.

KC10.2 Discussion

The bridge and channel works carried out have greatly improved flooding conditions but it is vital to ensure that the capacity of the creek system is maintained. Floor level control should be implemented and encroachments onto the drainage reserve should be forbidden. A dam safety education programme should be developed and implemented for the residents of Palmtree Grove and Neera Road who are within the overflow path.

KC10.3 Description of the Proposal

New buildings and extensions to existing buildings will not be permitted to extend within the 1% AEP flood limit. Extensions to existing buildings may be approved by Council if that portion of the plan area of the building which extends within the 1% AEP flood limit does not increase. The footprint of the building within the 1% AEP flood limit must not increase. It is proposed that floor level control apply, whereby, for those lots shown on the Plan as being included within the limit of the Floodplain Management Plan, the minimum floor level will be required to be at least 500mm above the 1% AEP flood level as shown on the Plan. It is further proposed that filling not be permitted within the 1% AEP flood limit. Top dressing of lawns may be undertaken only to fill minor depressions and only to a total depth of 50mm. No fences, including pool safety fences, are to be erected which would either interfere with the free passage of flood waters or reduce the available volume of flood storage. It is also proposed to implement a dam safety programme for residents of Palmtree Grove and Neera Road who are within the overflow path.

KC10.4 Economic Analysis

The development controls proposed are at no capital cost to Council. The cost of dam safety education is expected to be minimal.

KC10.5 Conditions

- Floor levels of new buildings and extensions to existing buildings to be at least 500 mm above 1% AEP flood levels unless special conditions apply.
- No filling or development within floodway limits.
- No building to extend within the 1% AEP flood limit.

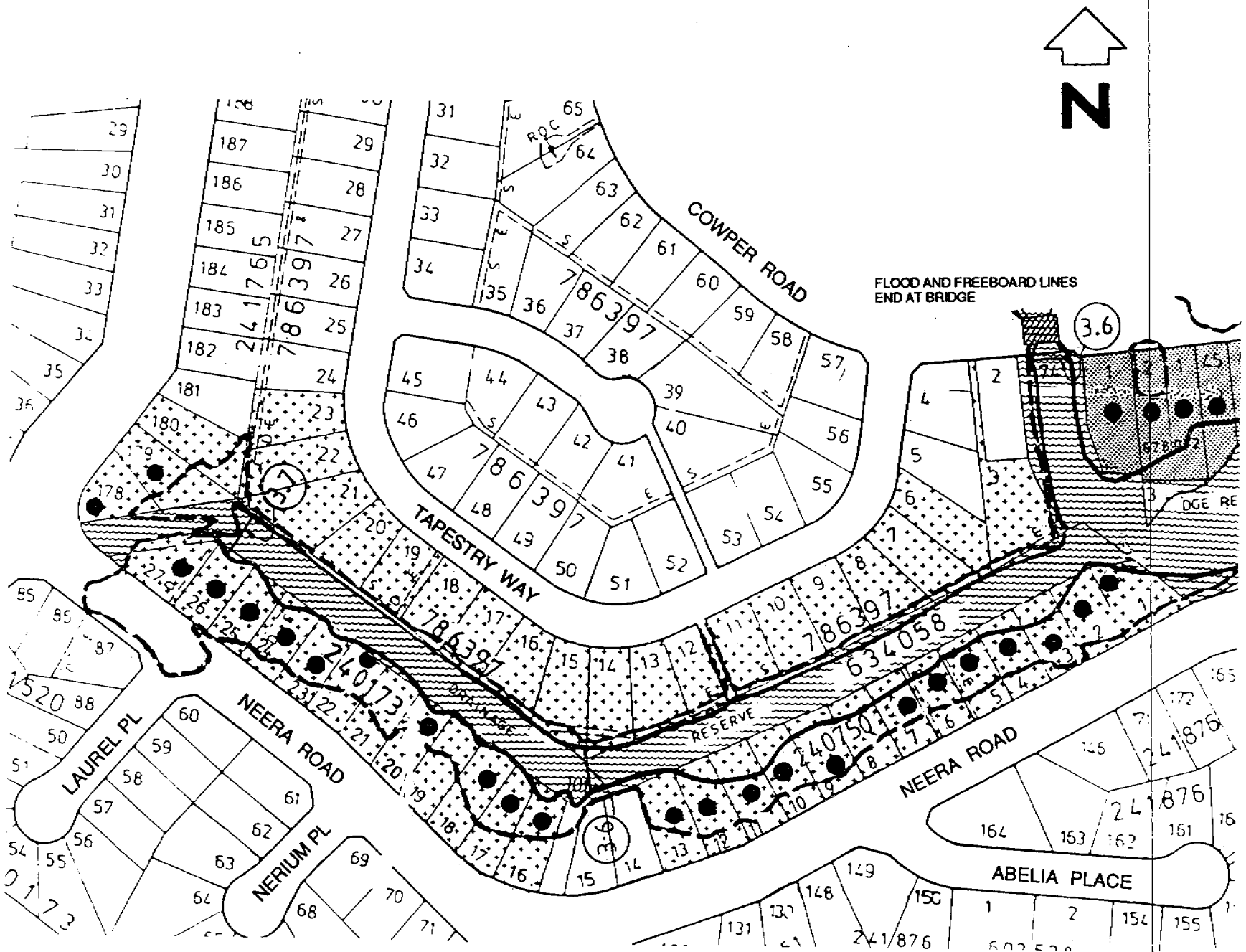
- Extensions to existing buildings not to encroach further within the 1% AEP flood limit.
- Top dressing of lawns not to exceed a total depth of 50mm, and to be used only for filling of minor depressions.
- Fences must neither impede flow nor reduce flood storage. Pool safety fencing would not be permitted within the 1% AEP flood limit.
- No swimming pools permitted within the 1% AEP flood limit.

KC10.6 Concise Description of the Plan (Neera Road Branch)

- The buildings in this area have been made flood free by channel enlargement works along Neera Road as designed by Council; channel excavation between the Cowper Road bridge and the McLaurin Road cutting and the bridge and channel works at Mt. Ettalong Road.
- Filling will not be permitted within the 1% AEP flood limit.
- Building will not be permitted within the 1% AEP flood limit.
- Flood levels for new developments are shown on the Plan.
- A dam safety education programme to be implemented.

KC10.7 Priority of Work

Implementation of these recommendations is of high priority because they will provide some safeguards for life and property.



LEGEND

- MANAGEMENT AREA
- SPECIAL CONDITIONS APPLY
- EXISTING BUILDING ON LOT
- 1% AEP FLOOD EXTENT
- 500 mm FREEBOARD EXTENT
- (4.7) 1% AEP FLOOD LEVEL

40 20 0 40 80 120 160 200

metres

AMDT.	DESCRIPTION	DATE	INIT.
	AMENDMENTS		

WILLING & PARTNERS CONSULTING ENGINEERS

PRINCIPAL DATE:
DATE DEC'95 DESIGNED:
DRAWN: VERIFIED:

FOR GOSFORD COUNCIL

PROJECT: KAHIBAH CREEK FLOODPLAIN MANAGEMENT PLAN

TITLE: KC 10 NEERA ROAD BRANCH FLOODPLAIN MANAGEMENT AREA

DRAWING No. FIGURE 10

KC11 Lake View Parade and Kahibah Road Area

KC11.1 Description of the Problem

No houses in Lake View Parade or Kahibah Road are estimated to be flooded in the 1% AEP flood, as ground and floor levels are generally quite high, except at the southern end of Kahibah Road. The problem lies in ensuring that the integrity of the floodway is maintained and that floor levels of future developments are sufficiently high.

KC11.2 Discussion

It will be necessary to ensure that encroachments onto the floodway do not occur. Dwellings in this area are not flood affected but backyards slope down towards the creek and so are inundated in large floods.

KC11.3 Description of the Proposal

New buildings and extensions to existing buildings will not be permitted to extend within the 1% AEP flood limit. Extensions to existing buildings may be approved by Council if that portion of the plan area of the existing building which extends within the 1% AEP flood limit does not increase. The footprint of the building within the 1% AEP flood limit must not increase. It is proposed that floor level control apply, whereby, for those lots shown on the Plan as being included within the limit of the Floodplain Management Plan, the minimum floor level will be required to be at least 500mm above the 1% AEP flood level as shown on the Plan. It is further proposed that filling not be permitted within the 1% AEP flood limit. Top dressing of lawns may be undertaken only to fill minor depressions and only to a total depth of 50mm. No fences, including pool safety fences, are to be erected which would either interfere with the free passage of flood waters or reduce the available volume of flood storage. It is also proposed that reduction of flood storage on the land upstream of the North Pearl Estate subdivision not be permitted.

KC11.4 Economic Analysis

There are no capital costs relating to this particular area.

KC11.5 Conditions

- Floor levels of new buildings and extensions to existing buildings to be at least 500 mm above 1% AEP flood level unless special conditions apply.
- No filling within the 1% AEP flood limit.
- No building to extend within the 1% AEP flood limit
- Extensions to existing buildings not to encroach further within the 1% AEP flood limit.
- Top dressing of lawns not to exceed a total depth of 50mm, and to be used only for filling of minor depressions.

- Fences must neither impede flow nor reduce flood storage. Pool safety fencing would not be permitted within the 1% AEP flood limit.

- No swimming pools permitted within the 1% AEP flood limit.

- No reduction of flood storage on the land upstream of the North Pearl Estate subdivision.

KC11.6 Concise Description of the Plan (Lakeview Parade and Kahibah Road Area)

- Filling will not be permitted within the 1% AEP flood limit.

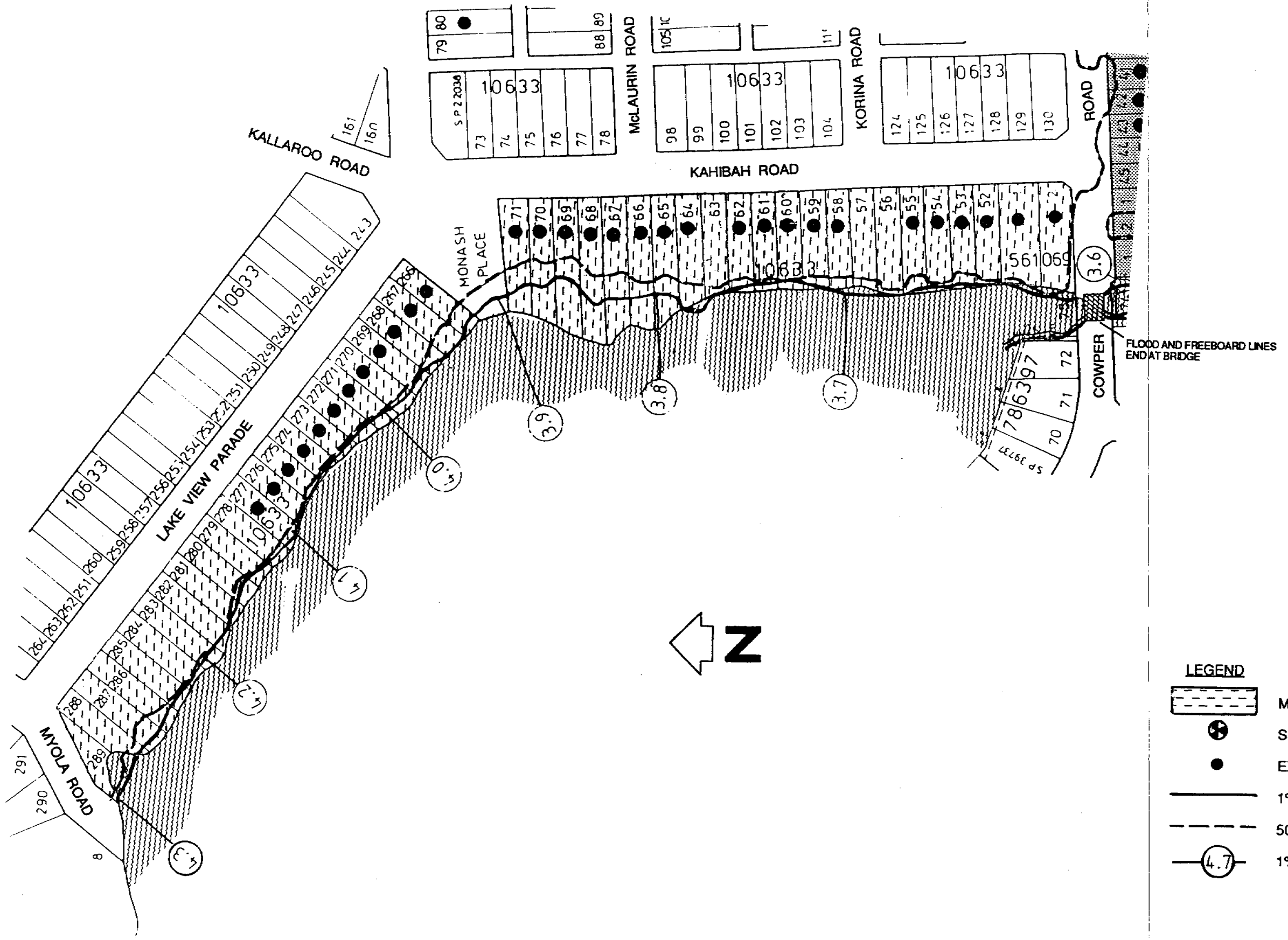
- Flood levels for new developments are shown on the Plan.

- Building will not be permitted within the 1% AEP flood limit.

- Reduction of flood storage on the land upstream of the North Pearl Estate subdivision will not be permitted.

KC11.7 Priority of Work

This is considered to be of high priority since it would be easy to implement and would require no capital expenditure.



LEGEND

- MANAGEMENT AREA
- SPECIAL CONDITIONS APPLY
- EXISTING BUILDING ON LOT
- 1% AEP FLOOD EXTENT
- 500 mm FREEBOARD EXTENT
- (4.7) 1% AEP FLOOD LEVEL

40 20 0 40 80 120 160 200

metres

AMDT.	DESCRIPTION	DATE	INIT.
	AMENDMENTS		

WILLING & PARTNERS CONSULTING ENGINEERS

PRINCIPAL: DATE:
DATE: DEC'95 DESIGNED:
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FOR GOSFORD COUNCIL

PROJECT: KAHIBAH CREEK FLOODPLAIN MANAGEMENT PLAN

KC 11
LAKEVIEW PARADE TO KAHIBAH ROAD FLOODPLAIN MANAGEMENT AREA

DRAWING No. FIGURE 11

UPSTREAM DEVELOPMENT

Description of the Problem

The effects of further catchment urbanisation and urbanisation with backyard filling, if left unchecked, will have a pronounced effect on flood levels. Increases in the 1% AEP flood level with complete urbanisation in accordance with current zonings and in areas where it seems likely that medium density development will occur are estimated to vary between 0.04 m and 0.3 m depending on the location. Significantly greater rises are predicted if backyard filling is also allowed to occur. Areas where discernible rises are predicted are summarised in Table 1.

TABLE 1
PREDICTED RISES IN 1% AEP FLOOD LEVELS
DUE TO FURTHER UPSTREAM DEVELOPMENT

Management Area		Estimated Rise in 1% AEP Flood Level (metres)	
		No backyard filling	With backyard filling
KC2	Main North Arm	0.09 - 0.29	0.31 - 0.62
KC3	Greenhaven Drive Arm	0.25	0.47 - 0.55
KC4	Australia Avenue Arm	0.28 - 0.34	0.71 -0.87
KC8	Iluka Creek and Lagoon	0.07 - 0.09	0.01 - 0.02
KC9	Cowper Road to McLaurin Road	0.06	0.24
KC10	Neera Road Branch	0.04 - 0.05	0.18 - 0.23

Discussion

The impacts of urbanisation may be minimised by both local and trunk drainage flood control structures, strict adherence to Council's adopted Code of Practice for the control of erosion and sedimentation and the implementation of an "on-site detention" policy.

The structural measures available include the following:

- A flood retarding basin constructed upstream of Ettymalong Swamp,
- Doubling the capacity of the Brisbane Avenue culvert,
- Lowering the bed of the Australia Avenue channel between Australia Avenue and Osborne Avenue together with a new lower and enlarged culvert at McEvoy Avenue,

- Dredge Iluka Lagoon and provide a sediment trap.

- Strict adherence to Council's "Erosion, Sediment Code of Practice" to prevent the removal of sediment by stormwater runoff, especially from building sites.

- Tripling the capacity of the Etta Road culvert.

However the impacts of each structural measure will generally be experienced in a localised area. For example, a flood retarding basin constructed upstream of Ettymalong Swamp will only reduce flood levels in the northern branches and generally by amounts less than 0.1 m. Tripling the capacity of the Etta Road culvert will only have benefit for properties which take in the Neera Road Branch, Lakeview Parade and Kahibah Road areas.

Therefore it is considered highly desirable to also introduce an "on-site detention" (OSD) policy for future new development and redevelopment. The basis of the policy would be to restrict discharges for all floods up to and including the 1% AEP flood to the existing (rural agricultural or natural bushland values) as appropriate. The consideration of floods with frequencies greater than 1% AEP (ie 5%, 20% and 50% AEP) in the OSD policy would ensure that the potential adverse impacts from the more frequent floods is also minimised.

The alternative to adopting an OSD policy would be to increase the size of the creek channels and road crossings over an extensive area. Such works would need to be undertaken in an environmentally sensitive manner but through necessity would reduce the extent of existing riparian habitat. The increased flows may also result in destabilization of the creek bed and banks which in turn would require further works to address either or both erosion and siltation problems.

Description of the Proposal

The preferred proposal is to adopt a mix of both structural works along the creek and tributaries together with development controls as identified for individual floodplain management areas. This would include the introduction of an "on-site detention" policy and enforcement of Council's Code of Practice for controlling erosion and siltation.

The structural creek works would comprise channel enlargement and controlled clearing of floodway vegetation in selected areas in combination with the following:

- Doubling the capacity of the Brisbane Avenue and Calypta Road culverts,

- Lower the bed of the Australia Avenue channel between Australia avenue and Osborne Avenue together with a new lower and enlarged culvert at McEvoy Avenue, and

- Tripling the capacity of the Etta Road culvert (to provide a minimum of 3 No. 900 mm diameter pipes).

The OSD policy should be such that the peak discharge from the developed site is no greater than the peak discharge from the undeveloped site for all storms of frequency up to and including the 1% AEP event. Furthermore, for all new development there should be no increase in the volume of runoff for at least the 5% AEP storm. Negation of an increase in the volume of runoff could be achieved by a requirement for a suitable pervious area with the required infiltration capacity or absorption trenches with sufficient volume to temporarily store the increase in runoff volume. It is envisaged that the OSD policy would also apply to significant extensions to existing development.

Development will be considered in the upper catchment areas only in cases where the objectives of the OSD policy can be met and the cumulative downstream effect of development can be shown not to cause a significant adverse impact on flooding for events up to and including the 1% AEP flood.

Economic Analysis

An economic analysis has not been undertaken since all costs would be borne by the developer. This includes the estimated $38,000 cost to upgrade the Etta Road culvert which should be included as part of contributions paid by all upstream developers in all relevant floodplain management areas.

The cost of dam safety education associated with construction of a retarding basin on the Council depot site west of the Ettymalong Swamp branch of Kahibah creek is expected to be minimal.

Elsewhere the development controls, including OSD implementation, are at no capital cost to the Council.

Priority of Work

Where structural creek works have been proposed these will have to be constructed prior to significant further development proceeding.

The OSD works and development controls will be implemented as and when development proceeds.

REFERENCES

1. NSW Government (1986), *Floodplain Development Manual*,

2. Willing and Partners, (1991), *Kahibah Creek Flood Study*, prepared for Gosford Council. April.

3. Willing and Partners, (1991), *Kahibah Creek Floodplain Management Study*, prepared for Gosford Council. April.

GLOSSARY

Annual Exceedance Probability (AEP)	refers to the probability or risk of a flood of a given size occurring or being exceeded in any given year. A 90% AEP flood has a high probability of occurring or being exceeded; it would occur quite often and would be relatively small. A 1% AEP flood has a low probability of occurrence or being exceeded; it would be fairly rare but it would be relatively large.
Average Recurrence Interval	refers to the long term average interval or average period between occurrences of a flood of a given size. The average recurrence interval does not imply that the flood of a given size will occur regularly.
Australian Height Datum (AHD)	a common national plane of level corresponding approximately to mean sea level.
catchment	the area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream.
design flood	a flood of known magnitude or probability of exceedance used for engineering design and planning purposes.
designated flood	(See flood standard)
development	the erection of a building or the carrying out of work; or the use of land or of a building or work; or the subdivision of land.
discharge	the rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow which is a measure of how fast the water is moving rather than how much is moving.
flood	relatively high streamflow which overtops the natural or artificial banks in any part of a stream or river.
flood hazard	potential for damage to property or persons due to flooding.

flood liable land	land which would be inundated as a result of the standard flood.
floodplain	the portion of a river valley, adjacent to the river channel, which is covered with water when the river overflows during floods.
floodplain management measures	the full range of techniques available to floodplain managers.
floodplain management options	the measures which might be feasible for the management of a particular area.
flood standard (or designated flood)	the flood selected for planning purposes. The selection should be based on an understanding of flood behaviour and the associated flood risk. It should also take into account social, economic and ecological considerations.
flood storages	those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood.
floodways	those areas where a significant volume of water flows during floods. They are often aligned with obvious naturally defined channels. Floodways are areas which, even if only partially blocked, would cause a significant redistribution of flood flow, which may in turn adversely affect other areas. They are often, but not necessarily, the areas of deeper flow or the areas where higher velocities occur.
high hazard	possible danger to life and limb; evacuation by trucks difficult; potential for structural damage; social disruption and financial losses could be high.
hydraulics	the study of water flow; in particular the evaluation of flow parameters such as stage and velocity in a river or stream.
hydrograph	a graph which shows how the discharge changes with time at any particular location.
hydrology	the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.

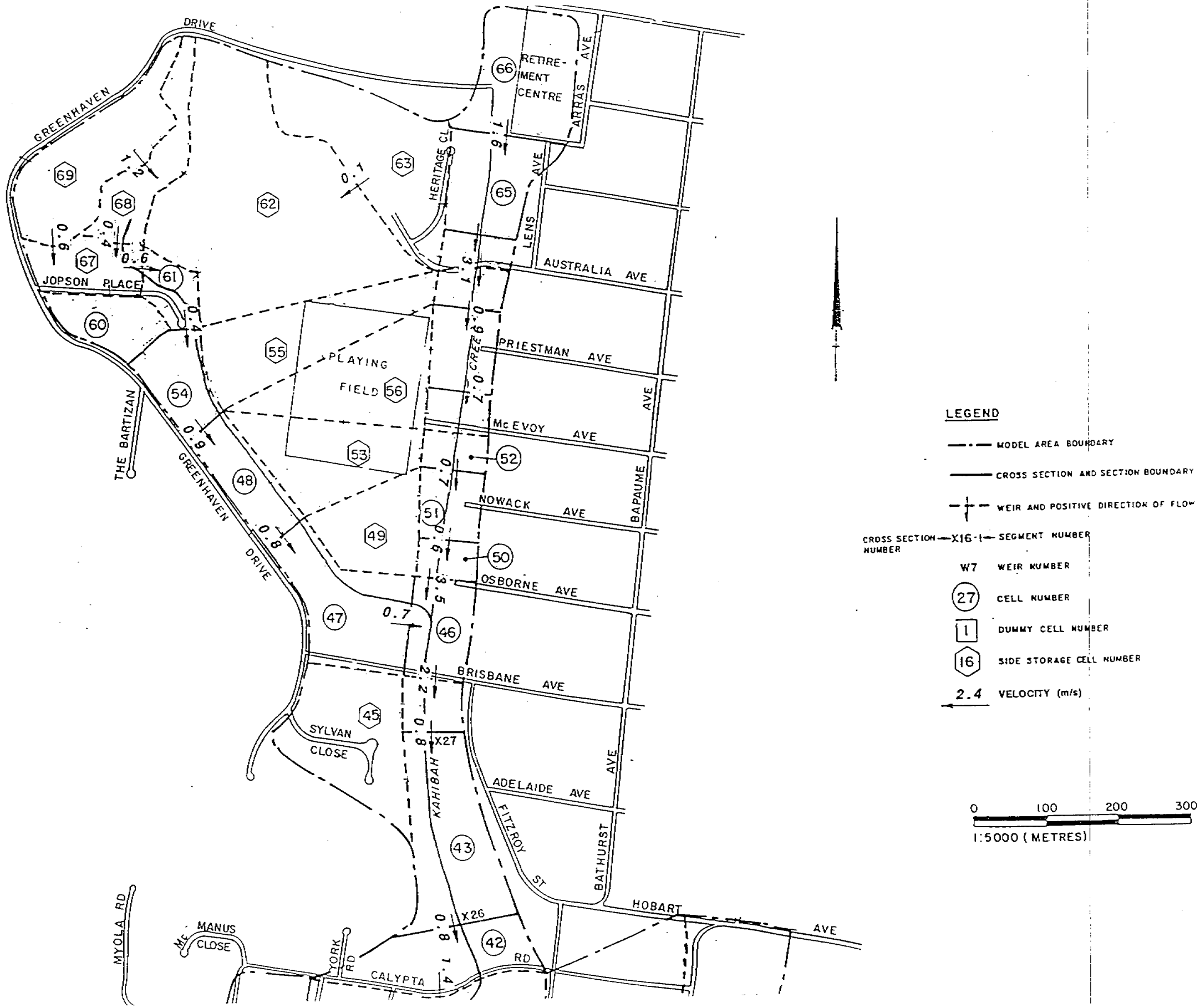
management plan	a document including, as appropriate, both written and diagrammatic information describing how a particular area of land is to be used and managed to achieve defined objectives. It may also include description and discussion of various issues, problems, special features and values of the area, the specific management measures which are to apply and the means and timing by which the plan will be implemented.
mathematical/computer models	the mathematical representation of the physical processes involved in runoff and streamflow. These models are usually run on computers due to the complexity of the mathematical relationships.
peak discharge	the maximum discharge occurring during a flood event.
probable maximum flood	the flood calculated to be the maximum which is likely to occur.
probability	a statistical measure of the expected frequency or occurrence of flooding. For a fuller explanation see Annual Exceedance Probability.
runoff	the portion of rainfall which actually ends up as streamflow, also known as rainfall excess.
stage	equivalent to 'water level'. Both are measured with reference to a particular datum and location.
stage hydrograph	a graph which shows the variation in stage with respect to time. It must be referenced to a particular location and datum.

ABBREVIATIONS

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff (1987 edition)
BOM	Bureau of Meteorology
DWR	former NSW Department of Water Resources
DUAP	Department of Urban Affairs and Planning
LAWC	Department of Land, Water and Conservation
LEP	Local Environment Plan
LEMC	Local Emergency Management Committee
RAFTS	Rainfall/runoff routing program
SES	State Emergency Services
SRA	State Rail Authority
RTA	Roads and Traffic Authority
WILCELL	Unsteady flood routing model

APPENDIX A

Peak 1% AEP Flood Flow Velocities



LEGEND

- MODEL AREA BOUNDARY
- CROSS SECTION AND SECTION BOUNDARY
- WEIR AND POSITIVE DIRECTION OF FLOW
- CROSS SECTION NUMBER — X16 — SEGMENT NUMBER
- W7 WEIR NUMBER
- (27) CELL NUMBER
- [1] DUMMY CELL NUMBER
- (16) SIDE STORAGE CELL NUMBER
- 2.4 VELOCITY (m/s)

0 100 200 300
1:5000 (METRES)

AMDT.	DESCRIPTION	DATE	INIT.
	AMENDMENTS		

WILLING & PARTNERS
CONSULTING ENGINEERS

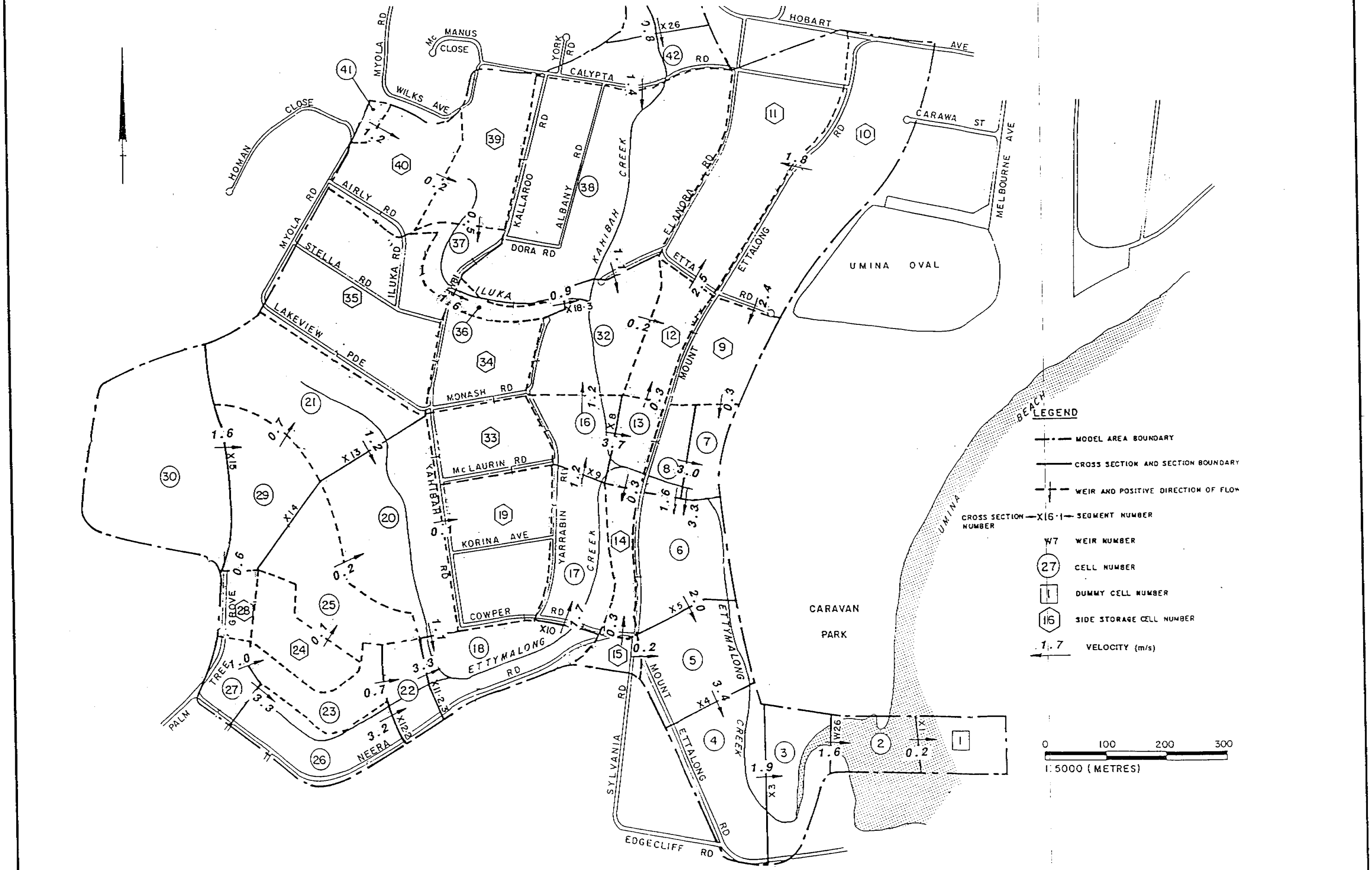
PRINCIPAL DATE:
DATE: DEC '95 DESIGNED:
DRAWN: VERIFIED:

FOR GOSFORD COUNCIL

PROJECT: KAHIBAH CREEK
FLOODPLAIN MANAGEMENT PLAN

TITLE: 1% AEP FLOOD
PEAK FLOW VELOCITIES

DRAWING No.: FIGURE A1



AMDT.	DESCRIPTION	DATE	INIT.
	AMENDMENTS		

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PRINCIPAL DATE:
DATE: DEC'95 DESIGNED:
DRAWN: VERIFIED:

FOR GOSFORD COUNCIL

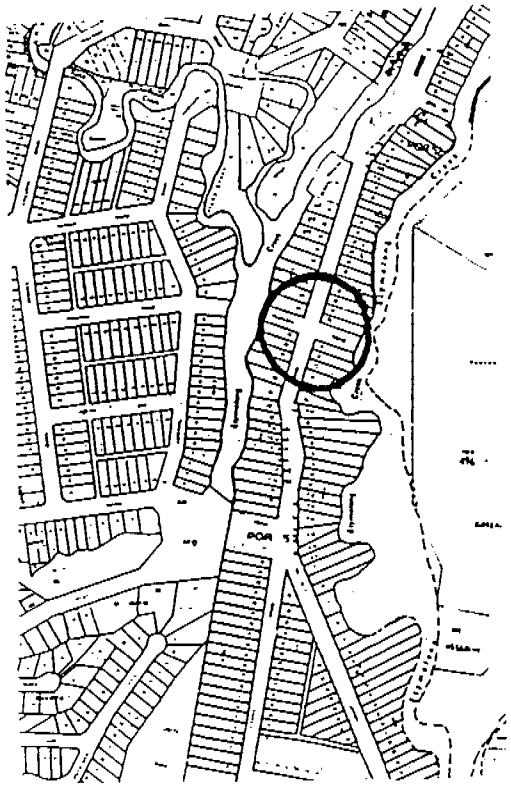
PROJECT: KAHIBAH CREEK FLOODPLAIN MANAGEMENT PLAN

TITLE: 1% AEP FLOOD PEAK FLOW VELOCITIES

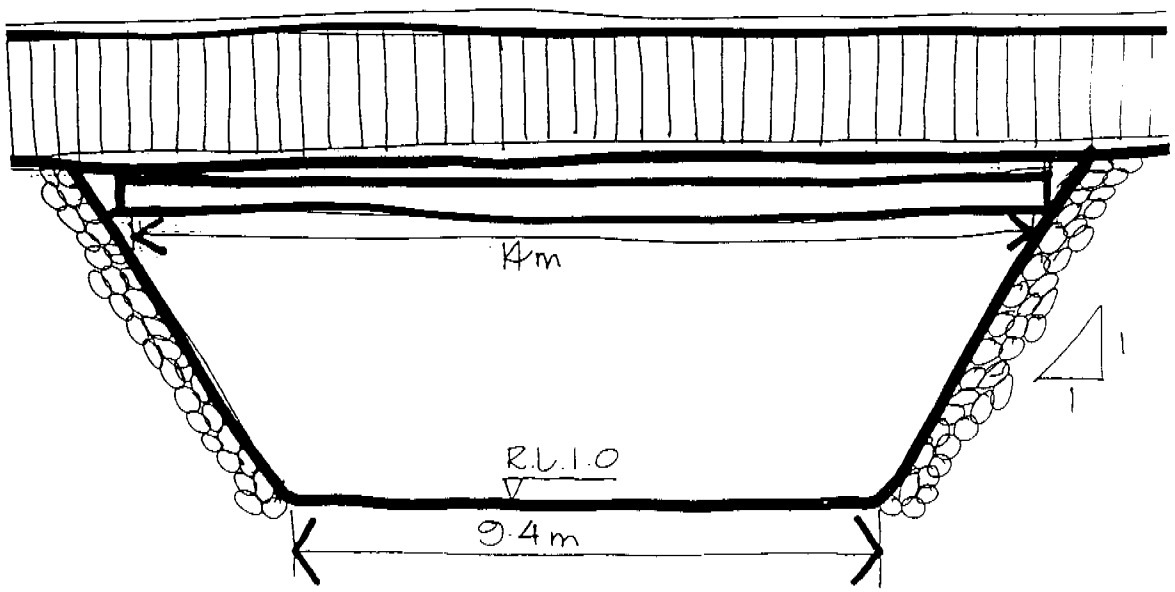
DRAWING No.: FIGURE A.2

APPENDIX B

Recommended Channel Works



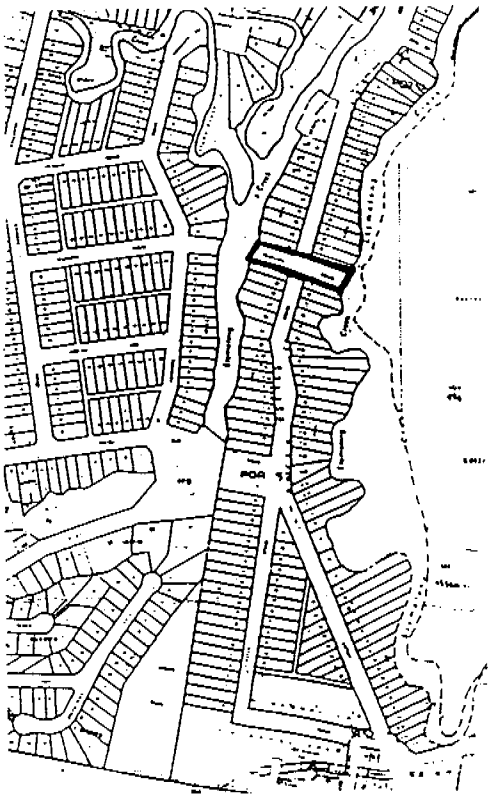
DEMOLISH EXISTING CULVERT AND CONSTRUCT BRIDGE



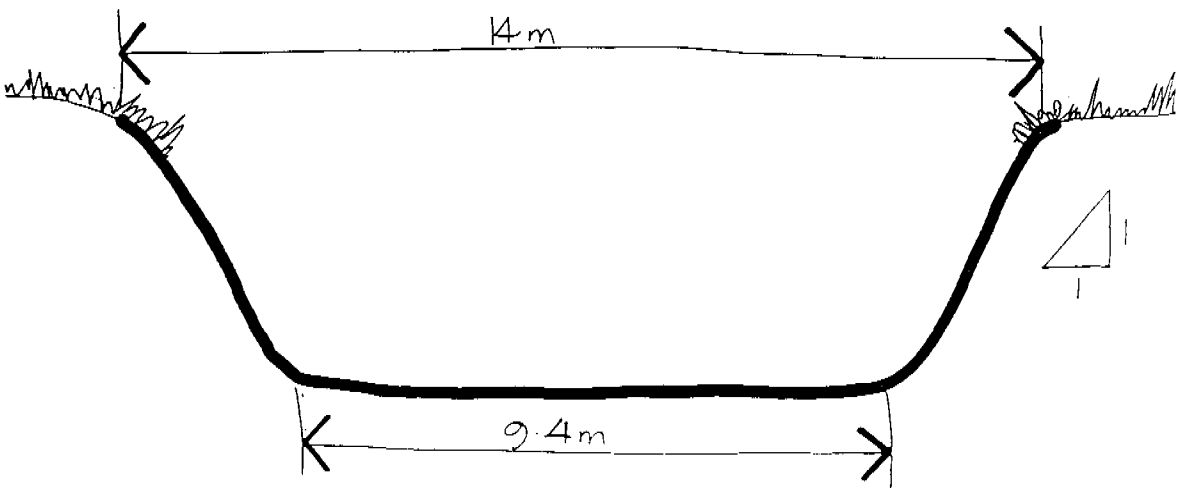
MT ETTALONG ROAD AT McLAURIN ROAD REGERVE

SCALE 1:100

Figure B1 Recommended Creek Works



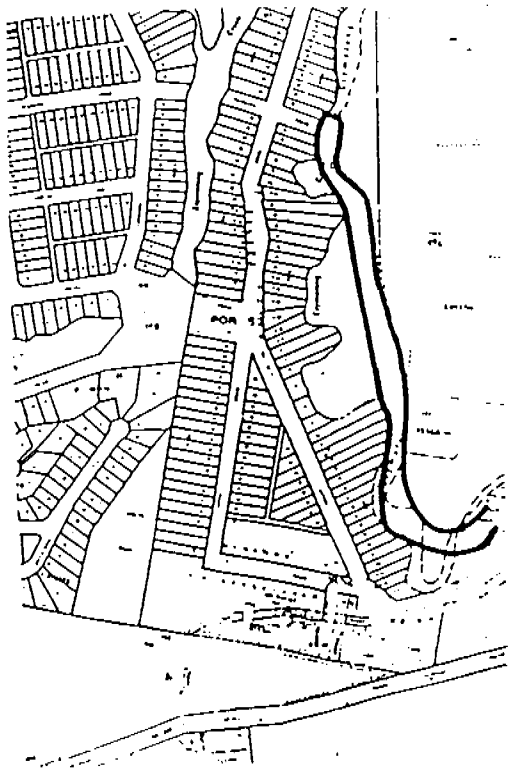
ENLARGE CHANNEL
PROVIDE SCOUR
PROTECTION



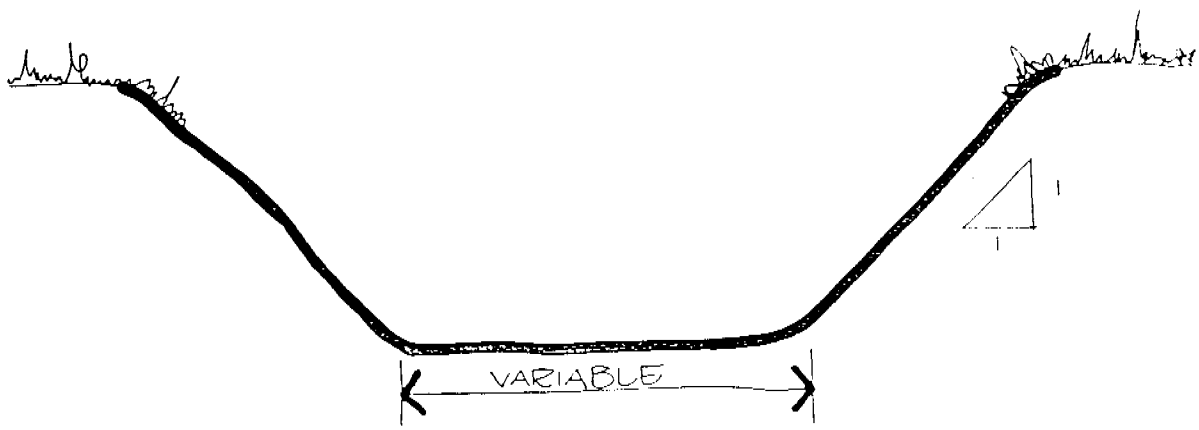
McLAURIN ROAD CHANNEL

SCALE 1:100

Figure B2 Recommended Creek Works



REALIGN CHANNEL
PROVIDE SCOUR
PROTECTION

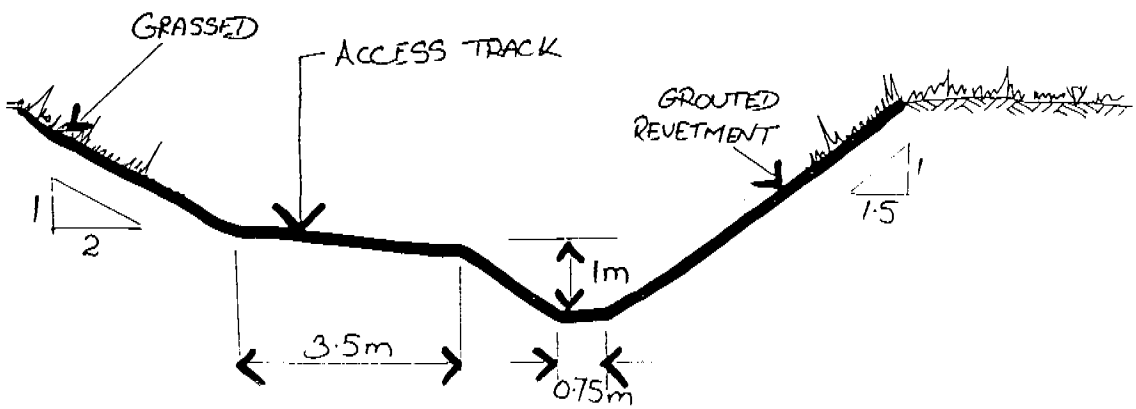


TYPICAL CROSS SECTION
DOWNSTREAM OF MT ETTALONG ROAD

SCALE 1:20

Figure B3 Recommended Creek Works

RECONSTRUCT CHANNEL



NEERA ROAD CHANNEL

SCALE 1:100

Figure B4 Recommended Creek Works

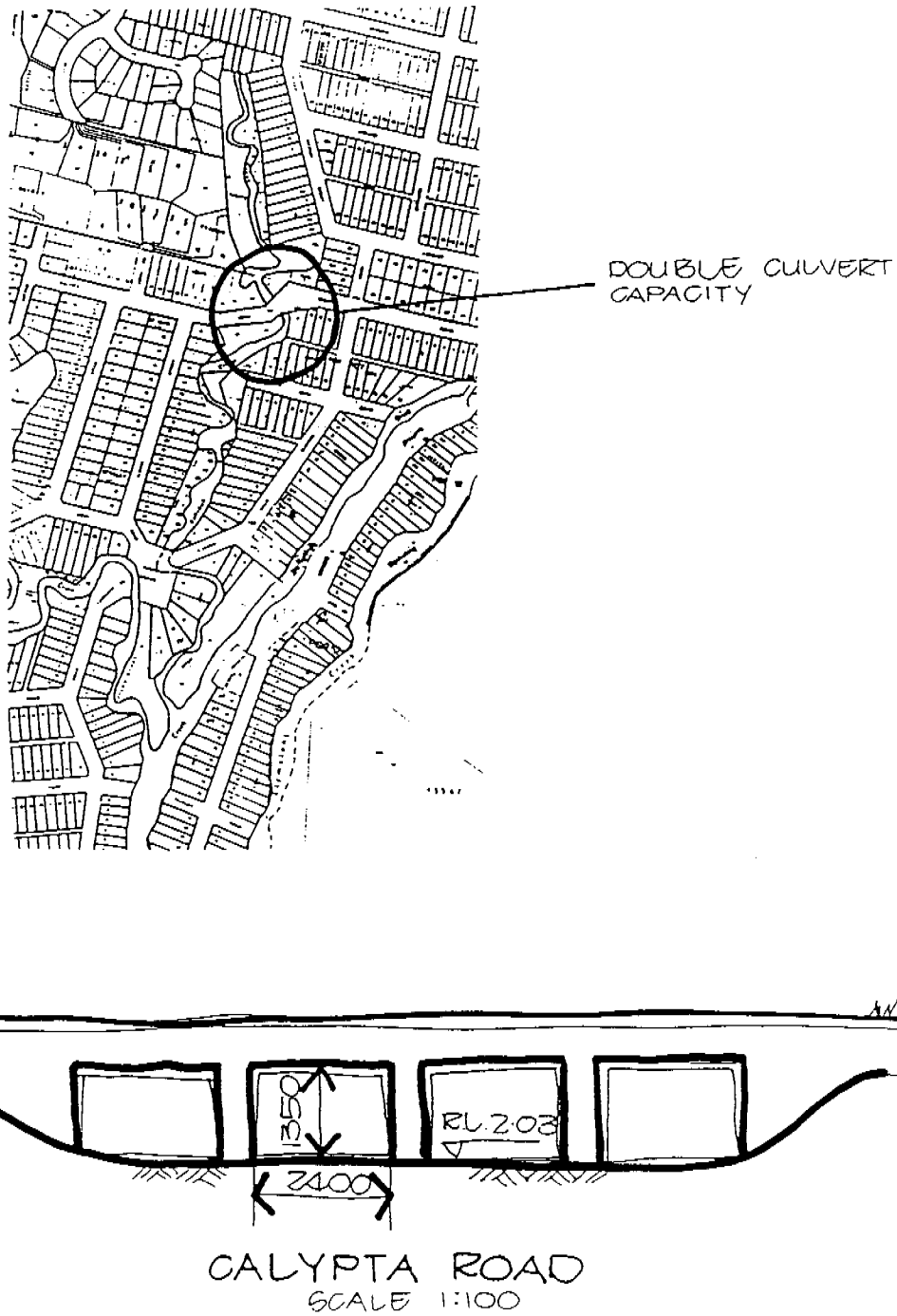


Figure B5 Recommended Creek Works

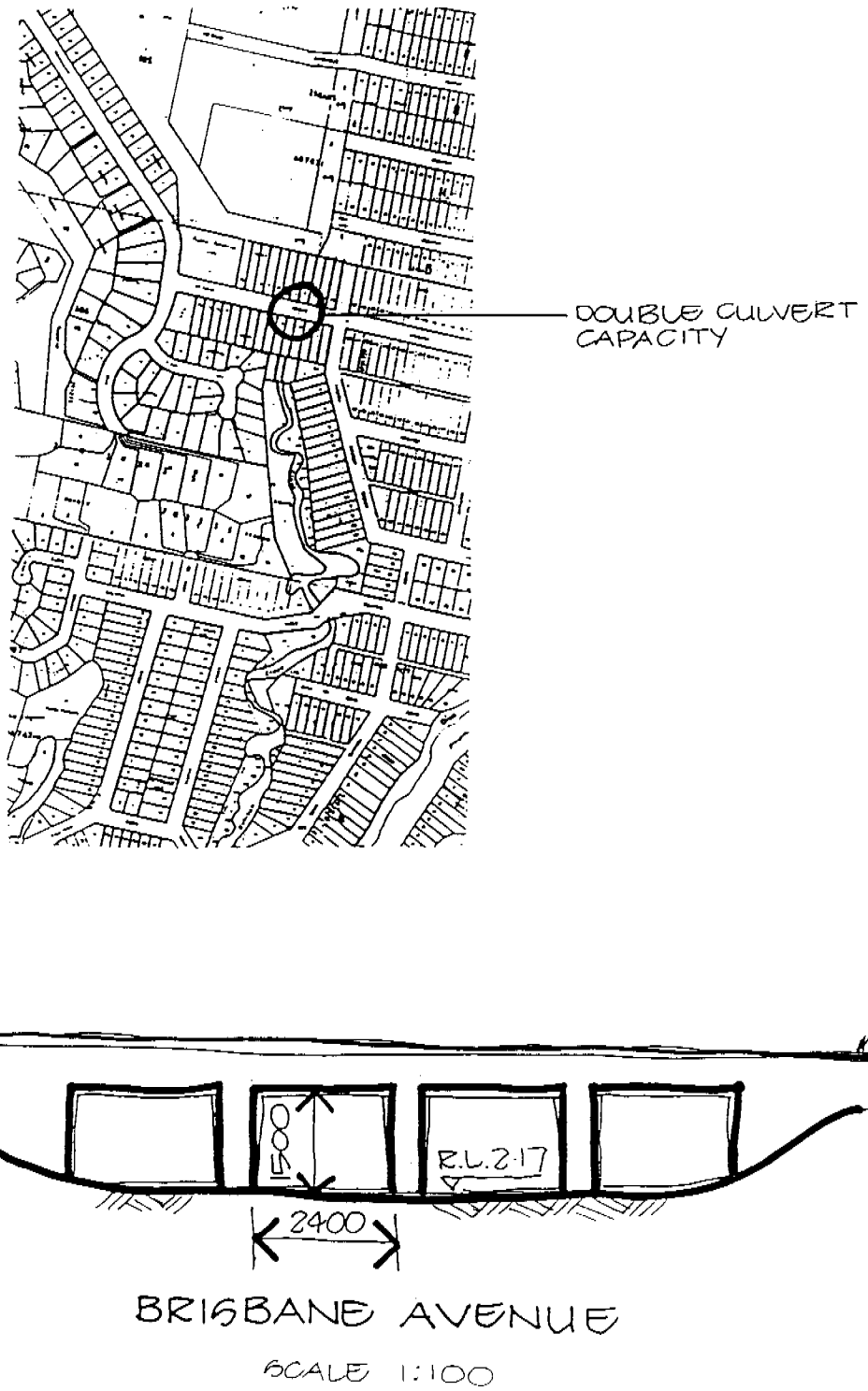


Figure B6 Recommended Creek Works

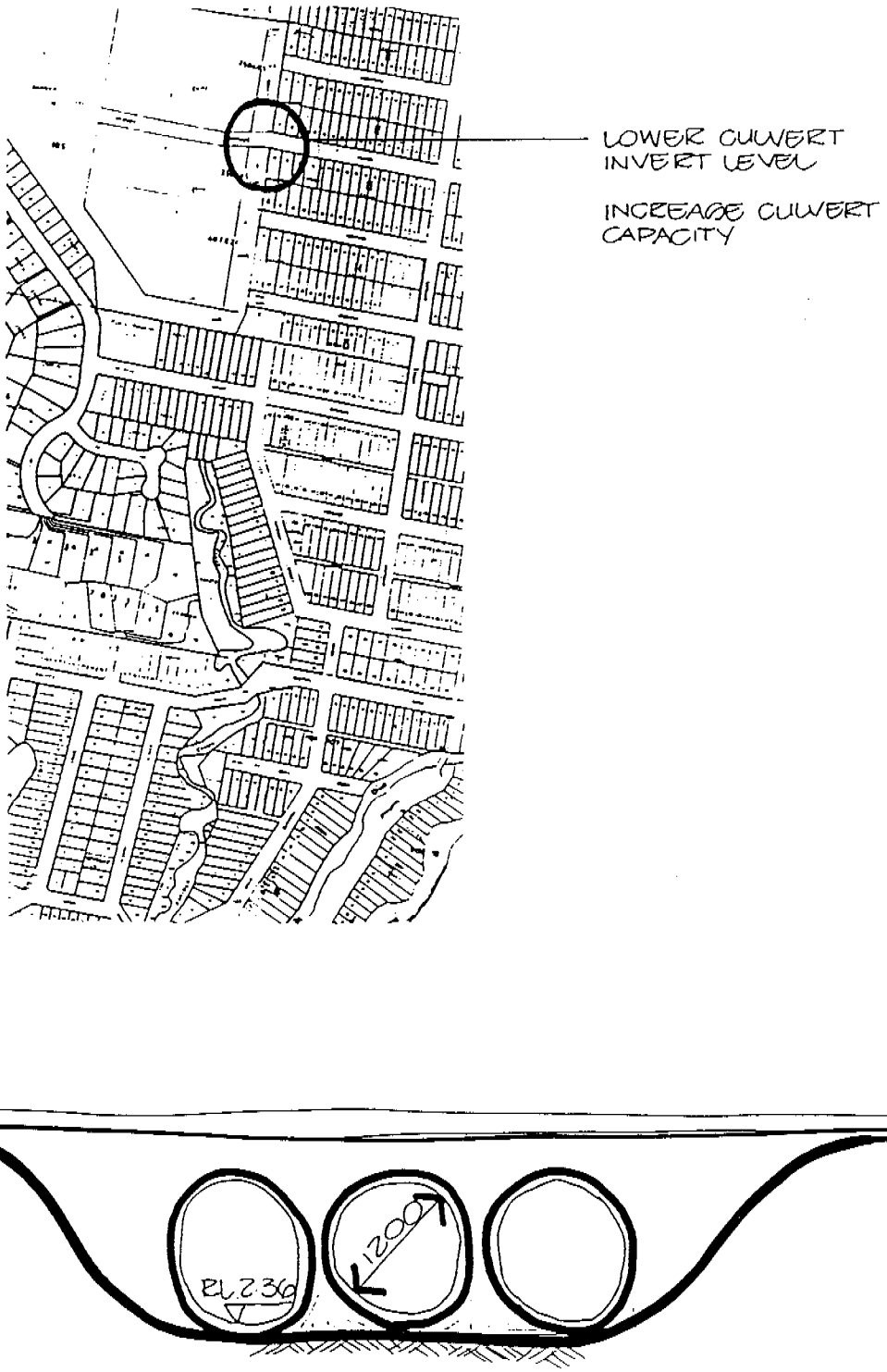
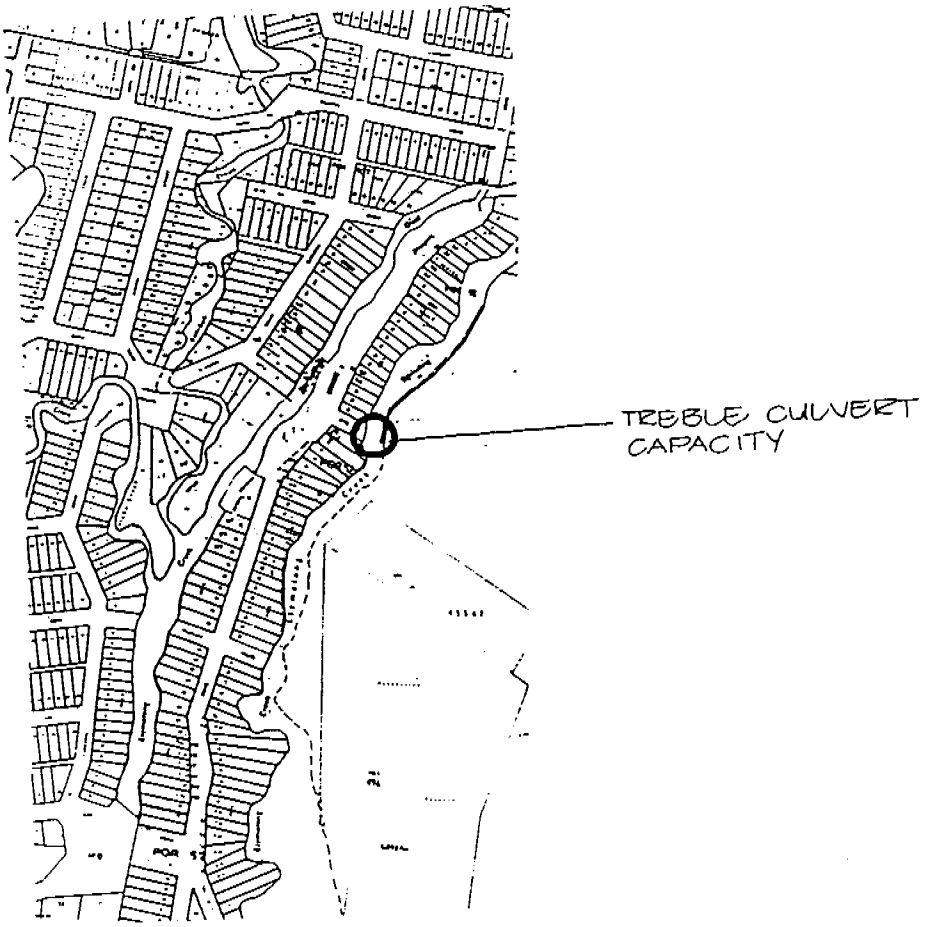


Figure B7 Recommended Creek Works



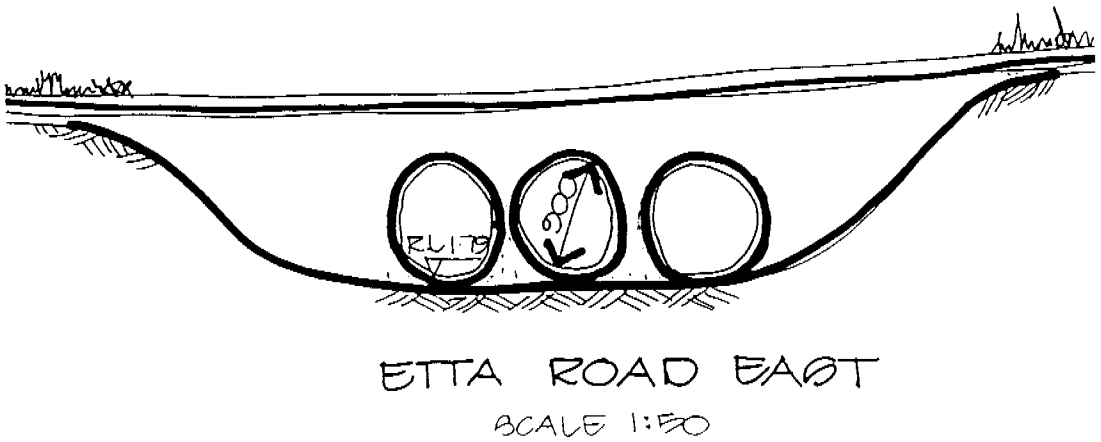
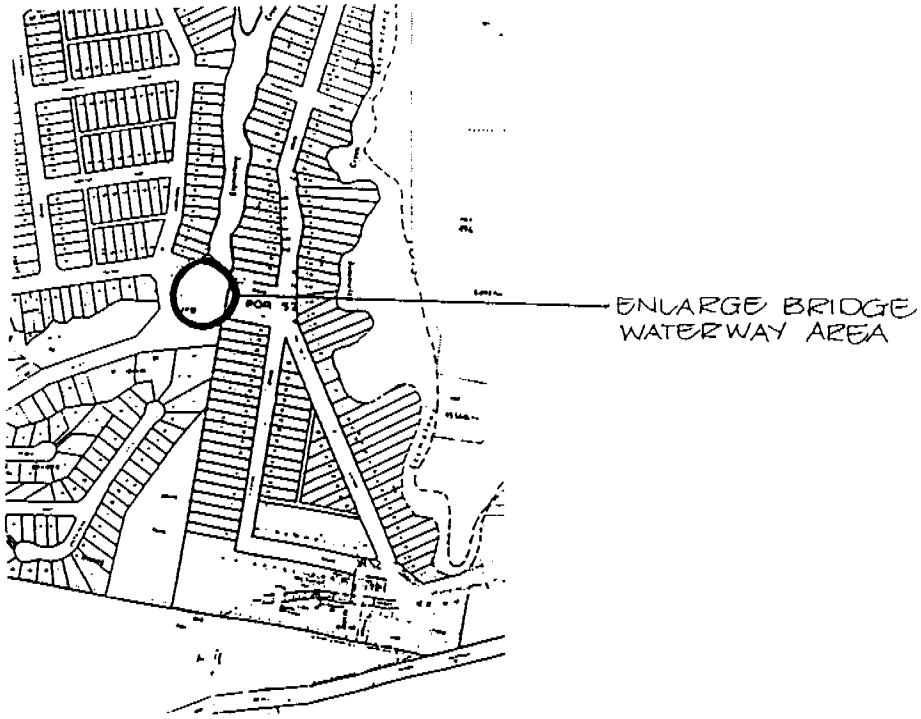
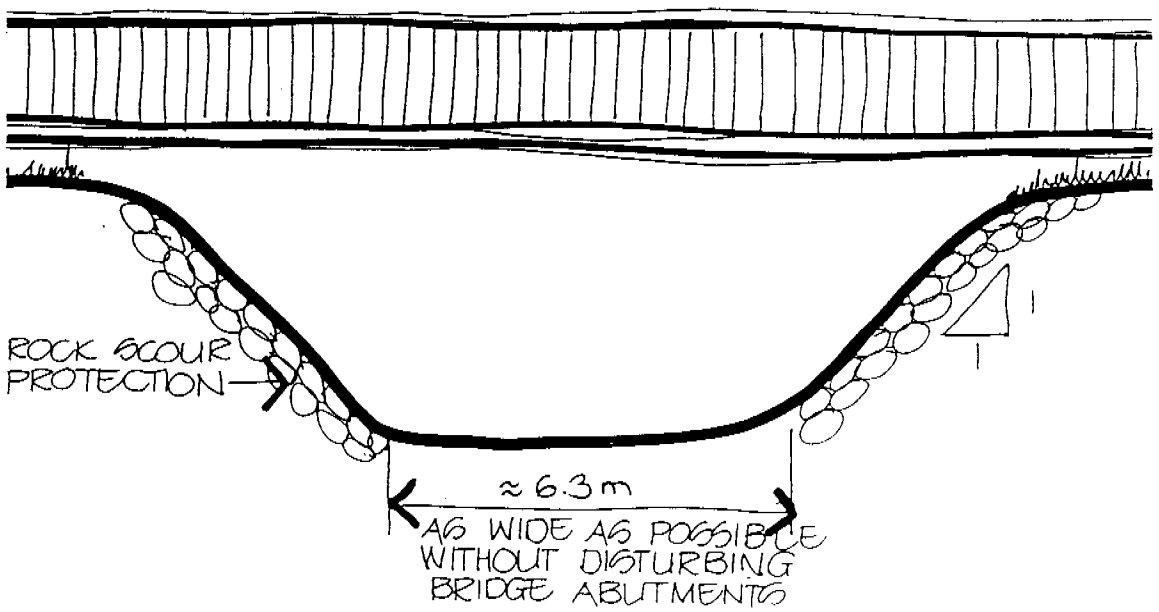


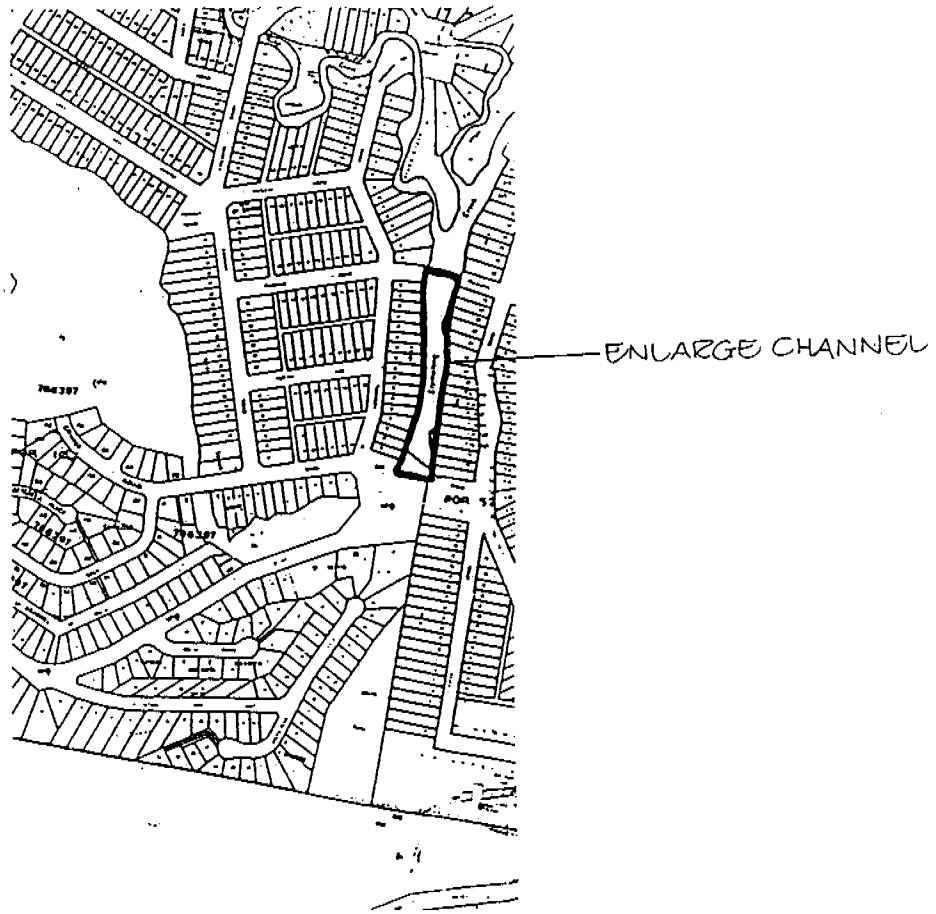
Figure B8 Recommended Creek Works

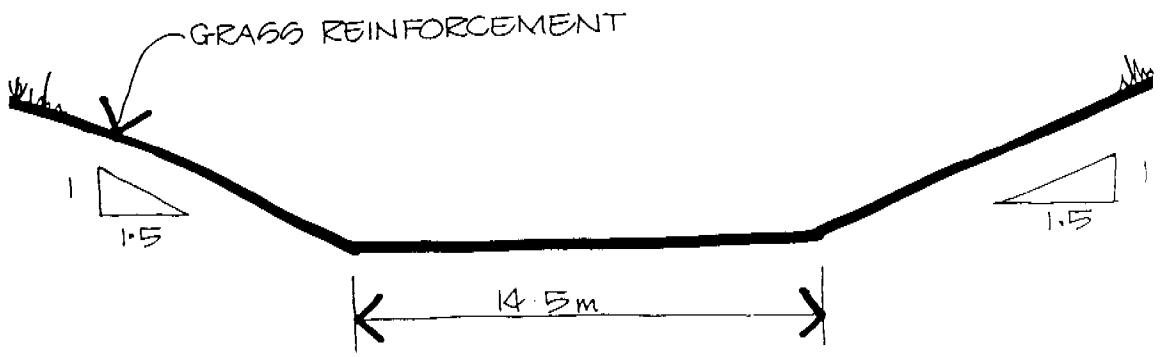




ETTYMALONG CREEK AT COWPER ROAD BRIDGE

Figure B9 Recommended Creek Works





ETTYMALONG CREEK DOWNSTREAM OF COWPER ROAD

SCALE 1:20

Figure B10 Recommended Creek Works

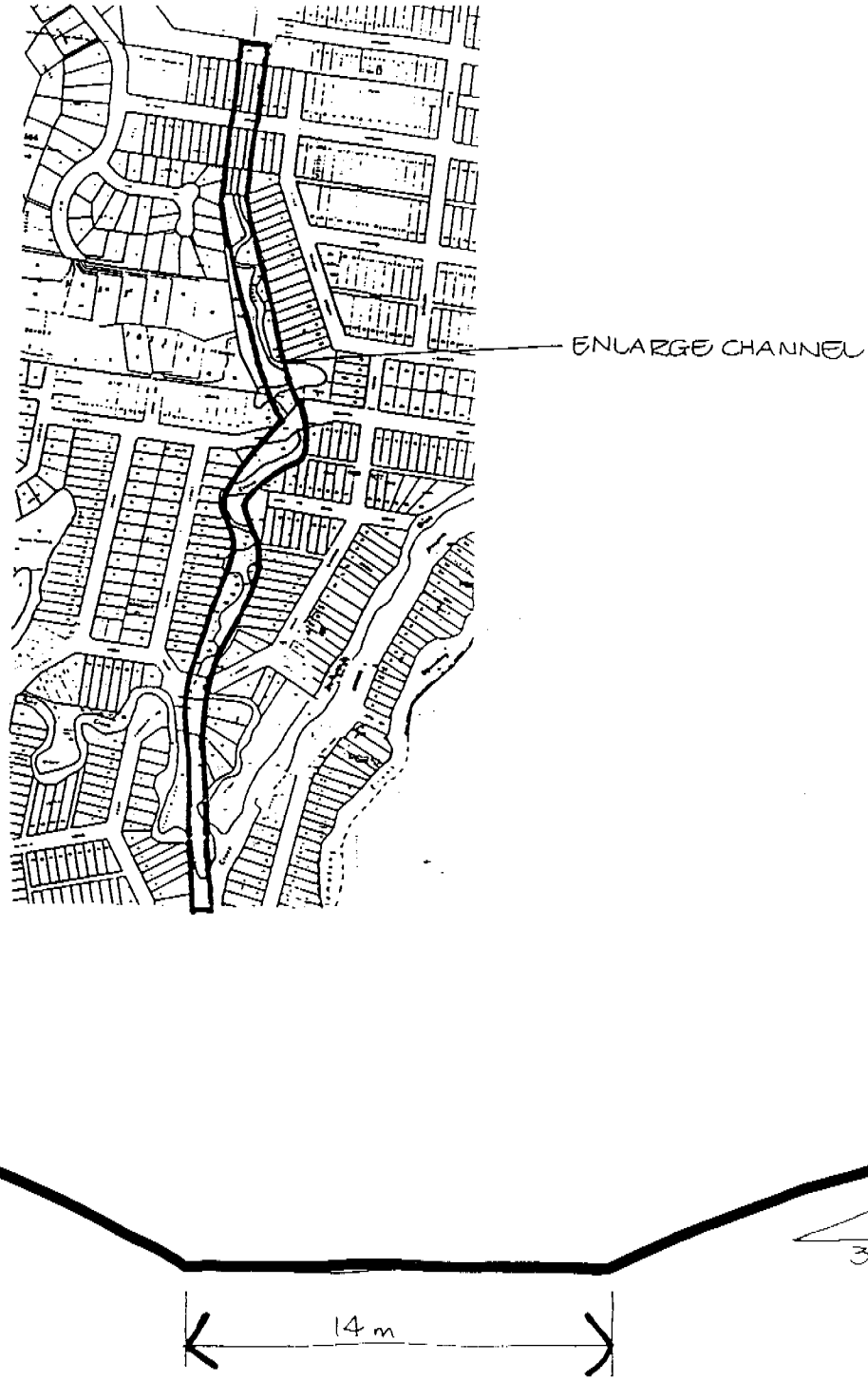
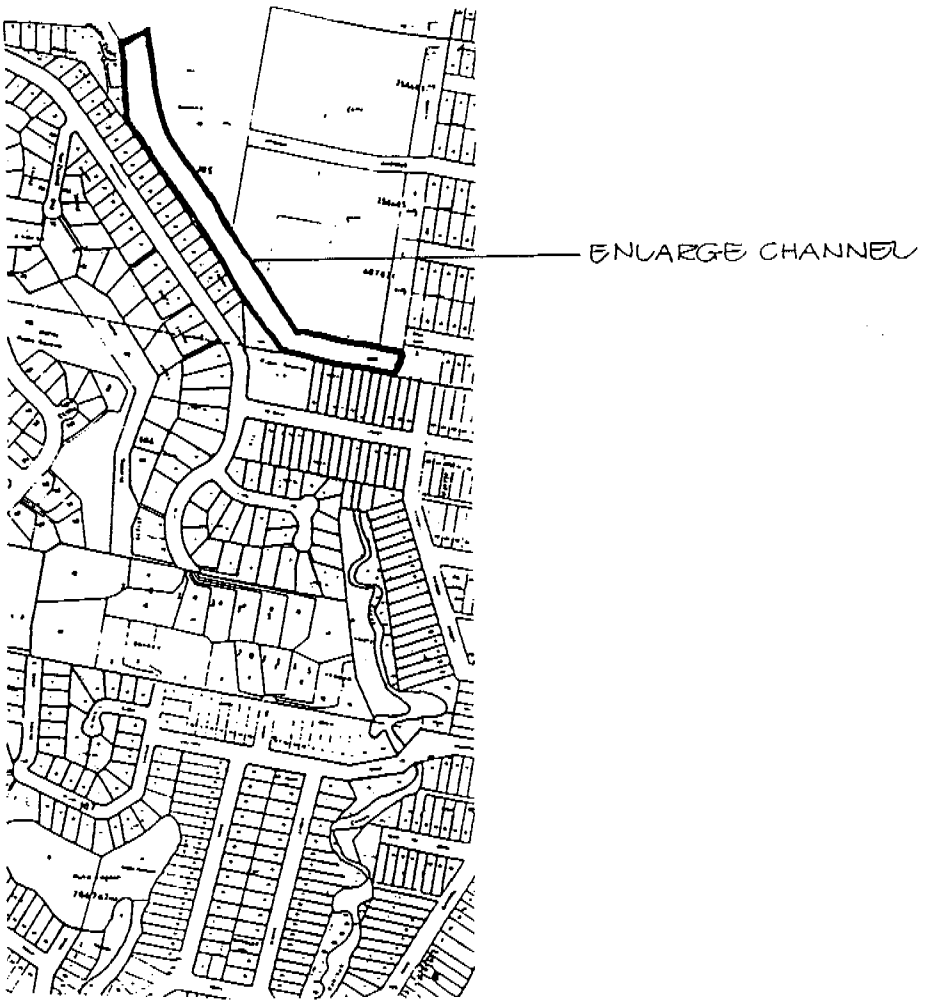
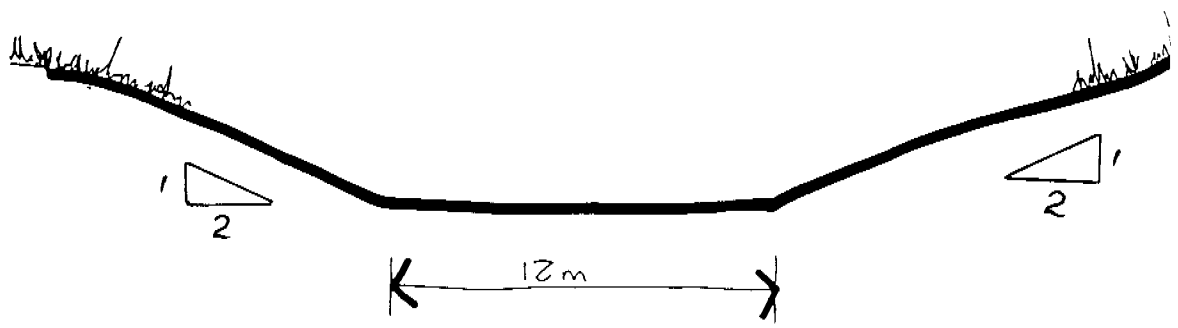


Figure B11 Recommended Creek Works

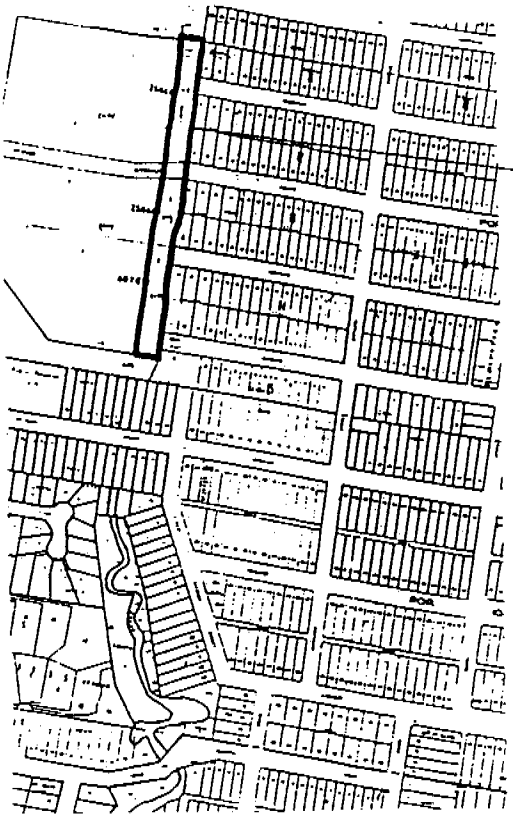


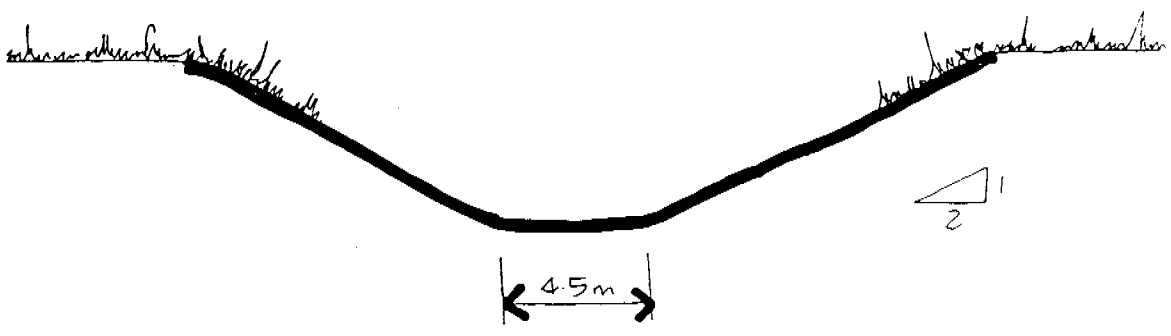


GREENHAVEN DRIVE ARM

SCALE 1:20

Figure B12 Recommended Creek Works





AUSTRALIA AVENUE ARM
(WIDTH VARIES)
SCALE 1 20

Figure B13 Recommended Creek Works

APPENDIX C

Impact of Works on an Extreme Flood (2 x 1% AEP Flood)

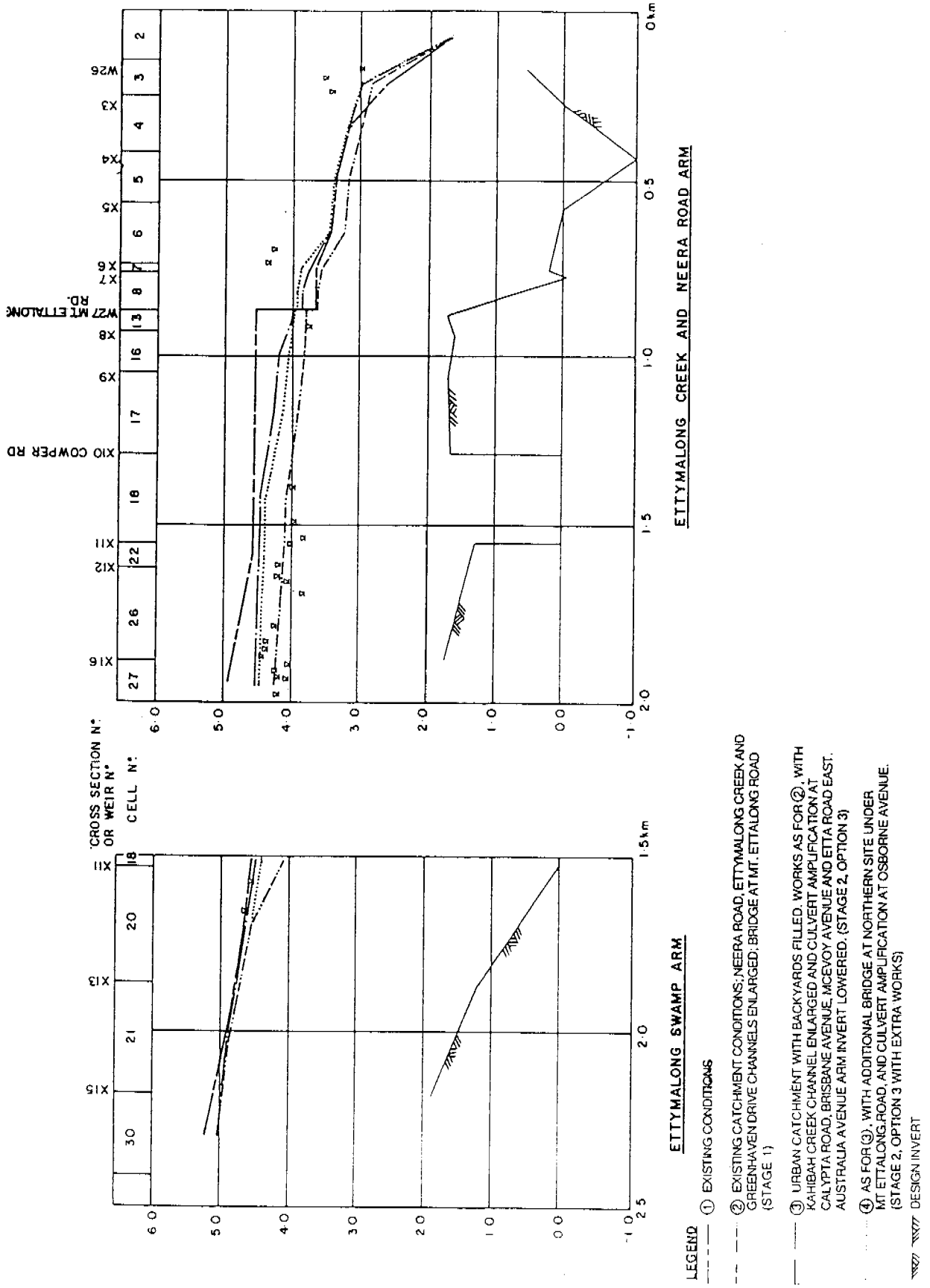


Figure C.1 Impact of Works on an Extreme Flood (2 x 1% AEP Flood)

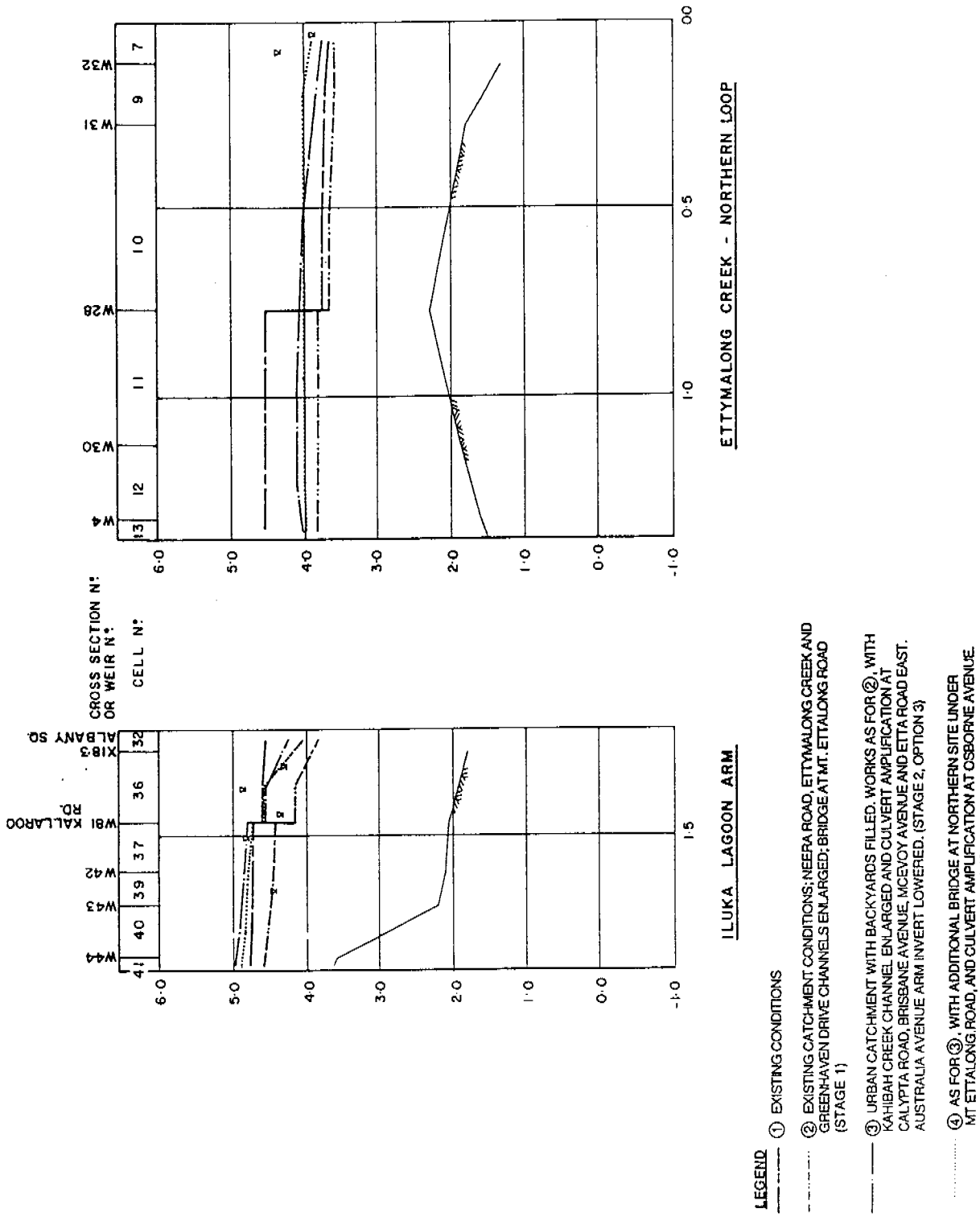
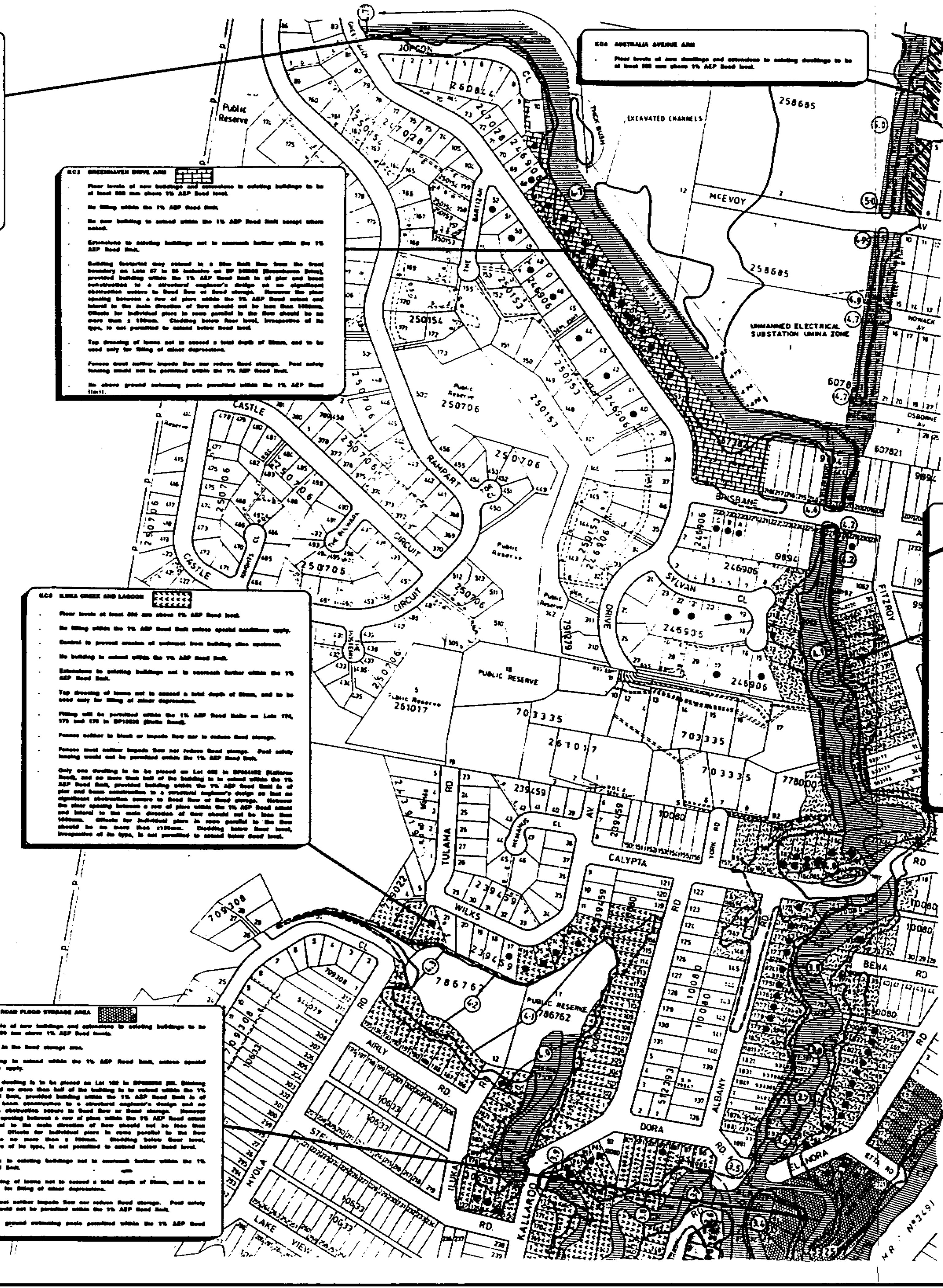


Figure C.2 Impact of Works on an Extreme Flood (2 x 1% AEP Flood)

APPENDIX D

Detail Plans 286A, 286B, 286C, 286D

GOSFORD CITY COUNCIL



WILLING & PARTNERS
CONSULTING ENGINEERS

276D	277C	277D
	286A	286B
	286C	286D

KEY TO ADJOINING SHEET

LEGEND.

- 1% AEP FLOOD CONTOUR
- EXTENT OF 1% AEP FLOOD.
- FREEBOARD LEVEL (1% AEP + 500mm)
- SPECIAL CONDITIONS APPLY
- EXISTING DWELLING ON ALLOTMENT

REFER TO PLAN 286D FOR DETAILS OF STRUCTURAL FLOODPLAIN MANAGEMENT MEASURES

KAHIBAH CREEK FLOODPLAIN MANAGEMENT PLAN ADOPTED BY COUNCIL 25 JULY 1995 (MINUTE NO. 792/95)

MAP REFERENCE
BROKEN BAY U-2782-11

SURVEY REPORT

FOR THE SAKE OF CLARITY THE 1% AEP AND FREEBOARD LINES ARE SHOWN UNIFORMLY. HOWEVER THEIR ACCURACY MUST BE WEIGHTED ACCORDINGLY. LINES IN RESIDENTIAL PROPERTIES ARE TO THE ACCURACY DETAILED IN THE ORIGINAL BRIEF 24/3/93 BY WILLING AND PARTNERS. OPEN SPACE AREAS ARE SUBJECT TO ACCURACIES DETAILED IN WILLING AND PARTNERS LETTER 16/8/93 AS A RESULT OF DISCUSSIONS WITH GOSFORD CITY COUNCIL. LINES TRAVERSING BUSH AREAS WERE PLACED BY JOINING THE NEAREST POINTS AND BY VISUAL INSPECTION.

THE INTERPRETATION OF THESE PLANS MUST BE BASED ON THE ABOVE CRITERIA AS WELL AS THE ACCURACY OF LINES PLACED AT THIS SCALE.

CHRIS ABLETT
REGISTERED SURVEYOR
WILLING AND PARTNERS

GOSFORD CITY COUNCIL

COUNTY OF NORTHUMBERLAND

PATONGA

KEY TO PARISH

UMINA

KEY TO LOCALITES

WILLING & PARTNERS CONSULTING ENGINEERS

3/346 PACIFIC HIGHWAY, CROWS NEST, N.S.W. 2065 TELEPHONE (02)9660 0662

277C	277D	278C
286A	286B	287A
286C	286D	

KEY TO ADJOINING SHEET

LEGEND

- (34) 1% AEP FLOOD CONTOUR
- EXTENT OF 1% AEP FLOOD
- FREEBOARD LEVEL (1% AEP + 500mm)
- SPECIAL CONDITIONS APPLY
- EXISTING DWELLING ON ALLOTMENT

40 20 0 40 80 120 160 200

METRES

KAHIBAH CREEK FLOODPLAIN MANAGEMENT PLAN ADOPTED BY COUNCIL 25 JULY 1995 (MINUTE NO 792/95)

MAP REFERENCE

BROKEN BAY U2782-12

SURVEY REPORT

FOR THE SAKE OF CLARITY THE 1% AEP AND FREEBOARD LINES ARE SHOWN UNIFORMLY. HOWEVER THEIR ACCURACY MUST BE WEIGHTED ACCORDINGLY. LINES IN RESIDENTIAL PROPERTIES ARE TO THE ACCURACY DETAILED IN THE ORIGINAL BRIEF 24/3/93 BY WILLING AND PARTNERS. OPEN SPACE AREAS ARE SUBJECT TO ACCURACIES DETAILED IN WILLING AND PARTNERS LETTER 16/8/93 AS A RESULT OF DISCUSSIONS WITH GOSFORD CITY COUNCIL. LINES TRAVERSING BUSH AREAS WERE PLACED BY JOINING THE NEAREST POINTS AND BY VISUAL INSPECTION.

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REGISTERED SURVEYOR
WILLING AND PARTNERS

REFER TO PLAN 2880 FOR DETAILS OF STRUCTURAL FLOODPLAIN MANAGEMENT MEASURES

REDUCED LEVELS TAKEN AT END OF FENCE LINES TOP OF BANK

- (C) 4.67
- (D) 4.62
- (B) 4.57
- (A) 4.69

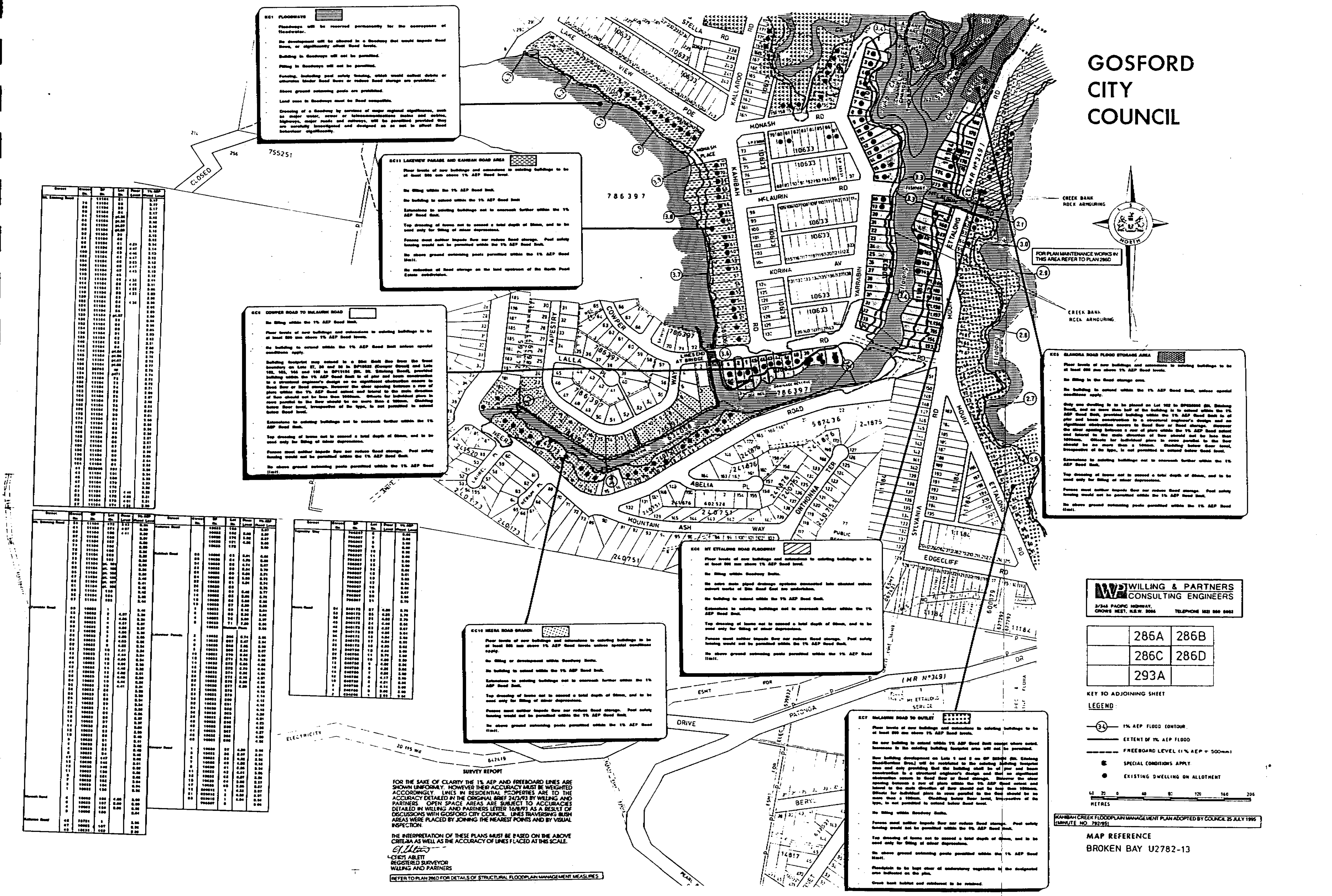
ECS KAHIBAH CREEK - MAIN NORTH ARM

ECS FLOODWAYS

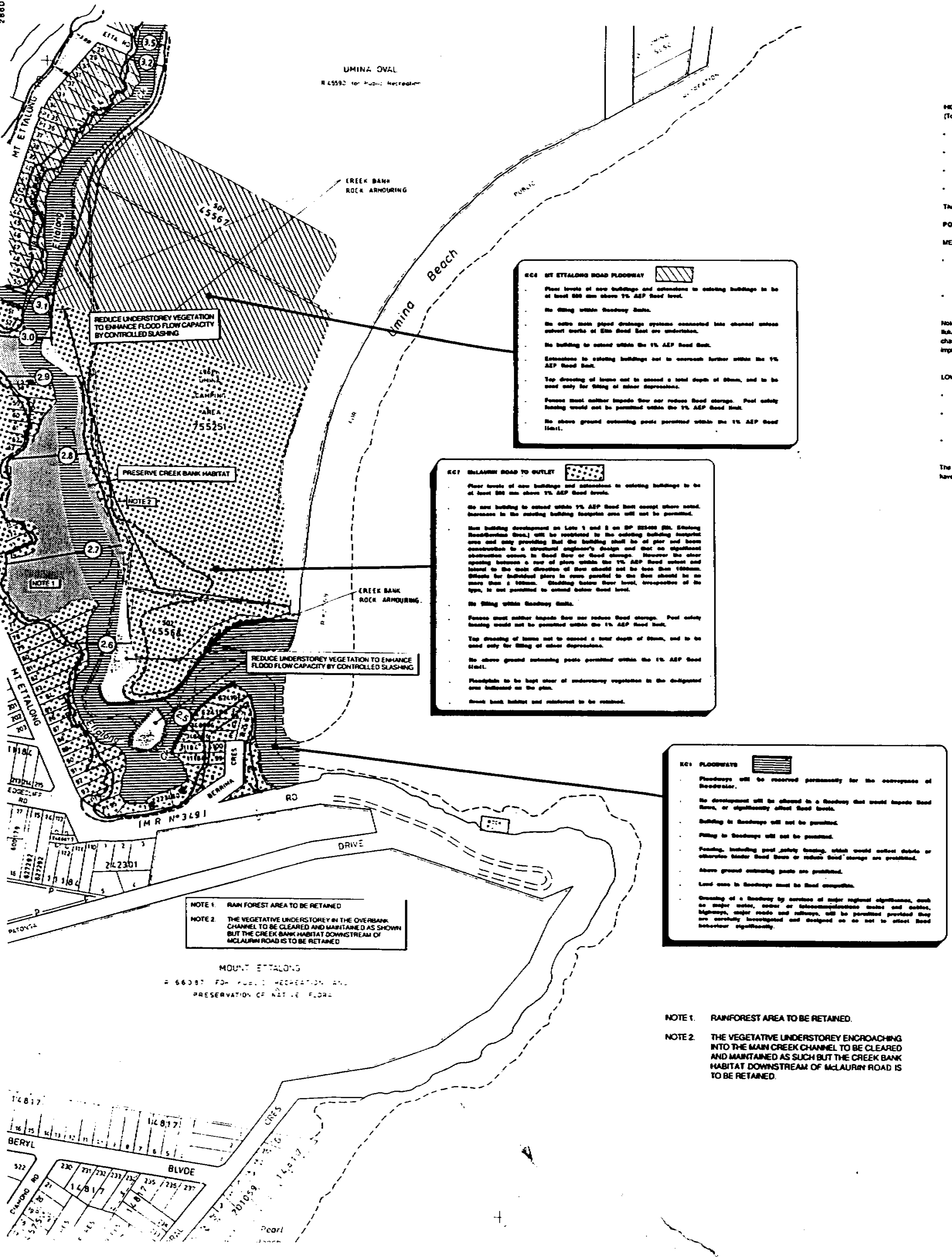
ECS BLAMEY ROAD FLOOD STORAGE AREA

ECS MT ETTALONG ROAD FLOODWAY

AUSTRALIA · PRIESTMAN · NOWACK · OSBORNE · BRISBANE · FITZROY · ADELAIDE · HOBART · CALYPSO · BENA · ELANORA · ETTALONG · BIRDWOOD · ALBION · OXFORD · NELSON · CAMBRIDGE · WELLINGTON · BEACH · OCEAN · OSLAN · ALFRED · BULLION · WEST · GROSS · HECTOR · LESLIE · MORRIS · CLIFFORD · BURRAWANG · PALM · CARAWA · MELBOURNE · SYDNEY · HERITH · NORMAN · RICKARD · AUGUSTA · ESPLANADE · THE · RECREATION · OCEAN BEACH · OCEAN BEACH SURF CLUB · BOWLING GREENS 755251 · UMINA OVAL · BROKEN BAY · KAHIBAH CREEK · ETTALONG CREEK



GOSFORD
CITY
COUNCIL
FOR PLAN MAINTENANCE WORKS IN THIS AREA REFER TO PLAN 286D
CREEK BANK ROCK ARMOURING
NORTH
WILLING & PARTNERS
CONSULTING ENGINEERS
286A 286B
286C 286D
293A
KEY TO ADJOINING SHEET
LEGEND:
1% AEP FLOOD CONTOUR
EXTENT OF 1% AEP FLOOD
FREEBOARD LEVEL (1% AEP + 500mm)
SPECIAL CONDITIONS APPLY
EXISTING DWELLING ON ALLOTMENT
METRES
KAHIBAH CREEK FLOODPLAIN MANAGEMENT PLAN ADOPTED BY COUNCIL 25 JULY 1995 (MINUTE NO. 792/95)
MAP REFERENCE
BROKEN BAY U2782-13
SURVEY REPORT
FOR THE SAKE OF CLARITY THE 1% AEP AND FREEBOARD LINES ARE SHOWN UNIFORMLY. HOWEVER THEIR ACCURACY MUST BE WEIGHTED ACCORDINGLY. LINES IN RESIDENTIAL PROPERTIES ARE TO THE ACCURACY DETAILED IN THE ORIGINAL BRIEF 24/3/93 BY WILLING AND PARTNERS. OPEN SPACE AREAS ARE SUBJECT TO ACCURACIES DETAILED IN WILLING AND PARTNERS LETTER 16/8/93 AS A RESULT OF DISCUSSIONS WITH GOSFORD CITY COUNCIL. LINES TRAVERSING BUSH AREAS WERE PLACED BY JOINING THE NEAREST POINTS AND BY VISUAL INSPECTION.
THE INTERPRETATION OF THESE PLANS MUST BE BASED ON THE ABOVE CRITERIA AS WELL AS THE ACCURACY OF LINES PLACED AT THIS SCALE.
CHRIS ABLETT
REGISTERED SURVEYOR
WILLING AND PARTNERS
REFER TO PLAN 286D FOR DETAILS OF STRUCTURAL FLOODPLAIN MANAGEMENT MEASURES
KC1 FLOODWAYS
KC11 LAKEVIEW PARADE AND KAHIBAH ROAD AREA
KC COWPER ROAD TO McLAURIN ROAD
KC6 ELANORA ROAD FLOOD STORAGE AREA
KC MT ETTALONG ROAD FLOODWAY
KC10 NEERA ROAD BRANCH
KC7 McLAURIN ROAD TO OUTLET
STELLA RD
LAKE VIEW PDE
KALLAROO RD
MONASH RD
MONASH PLACE
KAHIBAH RD
McLAURIN RD
KORINA AV
YARRABIN RD
ETTALONG RD
MOUNT ETTALONG RD
SYLVANIA RD
EDGECLIFF RD
TAPESTRY
COWPER
LALLA
NEERA
ABELIA PL
ONTHONNA TER
MOUNTAIN ASH WAY
PATONGA DRIVE
ELECTRICITY
CLOSED
786397
755251



NOTE 1. RAINFOREST AREA TO BE RETAINED.

NOTE 2. THE VEGETATIVE UNDERSTOREY ENCROACHING INTO THE MAIN CREEK CHANNEL TO BE CLEARED AND MAINTAINED AS SUCH BUT THE CREEK BANK HABITAT DOWNSTREAM OF McLAURIN ROAD IS TO BE RETAINED.

STRUCTURAL FLOODPLAIN MANAGEMENT MEASURES

HIGH PRIORITY
(To eliminate "over floor" flooding for existing dwellings during a 1% AEP Flood)

- Construct bridge and channel works at and downstream of Mt Ettalong Road
- Widen Greenhaven Drive Channel
- Enlarge Neera Road Channel
- Enlarge Ettalong Creek Channel between Cowper Road and McLaurin Road

The recommended high priority works indicated above have already been implemented by Council

POSSIBLE FUTURE WORKS

MEDIUM PRIORITY

- construction of a 50 Ml capacity retarding basin at the Council depot site west of the Ettymalong Swamp arm of Kahibah Creek. This project is also required to allow further development in the catchment
- excavation of an extra channel and bridge at Mt Ettalong Road to convey flows from Kahibah Creek to the outlet

Note that although the provision of the extra channel will lower flood levels in Ettymalong Creek, Iluka Creek and the Neera Road Channel it is predicted to increase flood levels along the main channel between McLaurin Road and the outlet and the Mt Ettalong floodway. Therefore its implementation should not occur without compensating measures in these latter areas

LOW PRIORITY

- Doubling the capacity of the Brisbane Avenue and Calypta Road culverts.
- Lower the bed of the Australia Avenue channel between Australia Avenue and Osborne Avenue together with a new lower and enlarged culvert at McEvoy Avenue, and
- Tripling the capacity of the Etta Road culvert.

The future works will not be able to proceed until their detailed physical and environmental effects have been throughly assessed and considered

SURVEY REPORT

FOR THE SAKE OF CLARITY THE 1% AEP AND FREEBOARD LINES ARE SHOWN UNIFORMLY. HOWEVER THEIR ACCURACY MUST BE WEIGHTED ACCORDINGLY. LINES IN RESIDENTIAL PROPERTIES ARE TO THE ACCURACY DETAILED IN THE ORIGINAL BRIEF 24/3/93 BY WILLING AND PARTNERS. OPEN SPACE AREAS ARE SUBJECT TO ACCURACIES DETAILED IN WILLING AND PARTNERS LETTER 16/8/93 AS A RESULT OF DISCUSSIONS WITH GOSFORD CITY COUNCIL. LINES TRAVERSING BUSH AREAS WERE PLACED BY JOINING THE NEAREST POINTS AND BY VISUAL INSPECTION.

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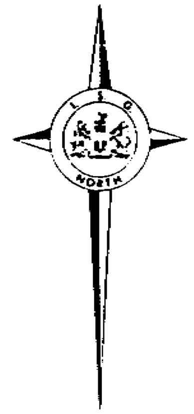
CHRIS ABLETT
REGISTERED SURVEYOR
WILLING AND PARTNERS

BROKEN BAY

GOSFORD CITY COUNCIL



COUNTY OF NORTHUMBERLAND

PATONGA

KEY TO PARISH

UMINA

PEARL BEACH

KEY TO LOCALITIES

WILLING & PARTNERS
CONSULTING ENGINEERS
3/346 PACIFIC HIGHWAY, CROWS NEST, N.S.W. 2065

286A	286B	287A
286C	286D	
293A		

KEY TO ADJOINING SHEET

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- 1% AEP FLOOD CONTOUR
- EXTENT OF 1% AEP FLOOD
- FREEBOARD LEVEL (1% AEP + 500mm)
- SPECIAL CONDITIONS APPLY
- EXISTING DWELLING ON ALLOTMENT

METRES

KAHIBAH CREEK FLOODPLAIN MANAGEMENT PLAN ADOPTED BY COUNCIL 25 JULY 1995 (MINUTE NO. 792/95)

MAP REFERENCE
BROKEN BAY U2782-14

End of Report