

Shire of Murray
January 2001

**Moama Floodplain Management
Study**

**Volume 1:
Floodplain Management Plan**

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Acronyms Used

- AEP Annual Exceedance Probability. This is the probability of a flood (of some stated magnitude or level) being equalled or exceeded in any one year. Thus, a flood of 1% AEP has a 1 in 100 chance of being equalled or exceeded in a year.
- AHD Australian Height Datum. A consistent Australian datum for elevation (approximately, above sea level).
- ARI Average Recurrence Interval. This is the average interval over which a flood (of some stated magnitude or level, or greater) would recur in the very long term. A flood of 1% AEP, for example, has an ARI of 100 years. In reality, natural variability dictates that the intervals between recurrences of such a flood will not be regular.
- DCP Development Control Plan. This is a planning document which sets out the policies and principles according to which Murray Shire Council will consider applications for development within the designated areas of the floodplain.
- EMP Environmental Management Plan. A plan which must be prepared for any major development (*eg.* construction of levee) with the intention of managing environmental impacts of works and development.
- EP&A Act The NSW Environmental Planning and Assessment Regulation (1994).
- FPL Flood Planning Level. A designated flood level used for specified or for general planning purposes within a floodplain area. More than one FPL may be nominated. Different FPLs can apply to different planning purposes. For example, different FPLs typically apply for the appropriate siting of recreation areas to those for appropriate siting of emergency services and key utilities such as hospitals and power plants.
- LEP Local Environment Plan. A plan for the protection and management of the environment within a local government area, in this case Murray Shire.
- REP Regional Environment Plan. A plan for the protection and management of the environment within a broader planning region under the NSW Planning and Environment legislation. In this case the relevant REP is Murray REP 2 for the Murray region of NSW. The REP provides general guidelines. More specific planning measures are included in the LEP, but the LEP must be consistent with the provisions of the relevant REP.

Executive Summary

Pursuant to a Flood Study that was completed in 1997, Sinclair Knight Merz were commissioned by Murray Shire to undertake necessary investigations and prepare a Floodplain Management Plan for Moama consistent with New South Wales Flood Policy, and associated recommendations for a Development Control Plan to support the Floodplain Management Plan.

Study area

The study area was confined to New South Wales, although effects of current development on the Victorian side were taken into account because the primary source of flooding is the Murray River which defines the State border. The study area included adjacent rural lands generally confined within the Kanyapella Basin in addition to the urban precincts of the town of Moama.

Moama is situated on the Murray River opposite the city of Echuca, immediately upstream of the confluence with the Campaspe River and approximately 15 river kilometres downstream of the confluence of the Goulburn River. The region supports a growing urban population based on popular tourist and recreational destinations, and a significant agricultural, timber and transport base. The population of the study area is 3 314, mostly based in Moama. Land adjacent to the river has been used extensively for caravan parks and camping grounds with some permanent or semi-permanent structures.

Flora and fauna

Although much of the study area has been cleared for agriculture and urban / industrial or tourism / recreation development, there are areas of State Forests and public reserves. In general terms, the remnant native vegetation of the area is dominated by *Eucalyptus camaldulensis* (River Red Gum). Red Gum regeneration is related to flood events which provide the necessary conditions for seed to germinate and for the growth of seedlings.

The forests and waterways of the study area provide habitat for a range of fauna species, including large terrestrial mammals such as the Eastern Grey Kangaroo (*Macropus giganteus*); small terrestrial mammals such as the Yellow-Footed Antechinus (*Antechinus flavipes*), the Australian Water Rat (*Hydromys chrysogaster*) and Platypus (*Ornithorhynchus anatinus*), arboreal mammals such as the Brush-Tailed Possum (*Trichosurus vulpecula*), Ring-Tailed Possum (*Pseudocheirus peregrinus*), Sugar Glider (*Petaurus breviceps*) and the Squirrel Glider (*Petaurus norfolcensis*); bats, reptiles, amphibians, birds, fish and crustaceans. More than 200 species of birds have been recorded, of which 75% are known to breed within the region.

Flood hydrology

The approximate catchment areas of the Murray, Goulburn and Campaspe Rivers in the vicinity of the towns are about 40 000, 18 000 and 4 000 km², respectively. The flood levels in the study area are caused by the complex interactions of floods in the three rivers. In larger Murray River floods, much of the flow in that river upstream of Barmah is naturally diverted into the Edward River and returns to the Murray downstream at Wakool Junction.

*Application and
results of
hydraulic model*

An important factor that determines the flooding pattern in the area is the geomorphology of the floodplain. Both Murray and Goulburn Rivers flow into a very large depression known as the Kanyapella Basin, in the floodplains upstream of Moama and Echuca. The system thus behaves like a large storage basin in the case of large flood events, with two inlets provided by the Murray and Goulburn Rivers and the outlet being the Murray River between Moama and Echuca.

Major flood level is defined by the Bureau of Meteorology when floods exceed 94.4 m on the Echuca Wharf Gauge. The largest flood since European settlement was in 1870, when the peak was 96.2 m on the gauge. More recently, the largest flood was in 1993 when the peak was 94.80 m.

Flood frequency analysis of the hydrological records for the Murray at Echuca provided estimates of flood peak discharges and river stage for a range of Annual Exceedance Probabilities (AEPs). The 1993 flood was estimated to have an AEP of approximately 5% at the Echuca gauge, meaning that in the long term floods of this magnitude or greater could be expected to occur about once in 20 years on average.

Hydraulic modelling was undertaken using MIKE-11, a one-dimensional numerical modelling system. The model was calibrated primarily using observed data from the 1993 flood, and the model simulation was also validated using data from other historical floods in 1974, 1981 and 1982. This model was then applied with design events for AEP of 10%, 5%, 2%, 1% and 0.5%, and an extreme event nominated as a flood with peak discharge and volume twice that of the flood of AEP 1%. This nominal extreme event was used to consider the implications of a flood large enough to overwhelm any flood mitigation measures (assessment of residual risk). A Probable Maximum Flood was not used, because apart from the usual difficulties of estimating such a flood for a very large catchment, the effect of diversion of Murray River floods into the Edward River and around the study area could not readily be determined.

The model revealed that the 1993 flood levels closely matched the 5% AEP (or 20-year) design flood profile from downstream of the Campaspe confluence, through the bridges and up to the Goulburn River confluence. Upstream of this point, they more closely matched the 2% AEP (or 50-year) design flood profile. In the flood prone lands in the Bama Forest area and the area on the eastern and western sides of the railway line north of Moama the 1993 flood levels were also closer to the 2% AEP levels. These findings were attributable to the following:

- upstream of Moama / Echuca, the Kanyapella Basin was initially partly full as a result of a lesser flood on the Goulburn River which preceded the main flood by a few weeks;
- downstream of Moama / Echuca, the tributary flood from the Campaspe was relatively low in 1993.

***Flood behaviour
and mitigation
options***

A flood of 0.5% AEP was estimated to have peak stage at the Echuca Wharf of 95.60 m AHD. Since the present planning level was 95.63 m based on previous study, the flood of 0.5% AEP was accepted as the Flood Planning Level for general planning purposes in Moama. Given the slight difference in the two levels quoted above, the old level of 95.63 m AHD was adopted for convenience. This also maintains consistency with a Flood Planning Level used in Victoria for general planning purposes in the city of Echuca.

Beyond a given depth of inundation in the Kanyapella Basin north of Moama, floodwaters cross from the east to west of the railway through the Black Bridge. Residential and industrial properties are threatened by these floodwaters, which must drain back to the river through two culverts near the town. One of the options was to block passage of floodwaters through the rail embankment. Although this would improve protection for a part of the township and some rural properties, it would however aggravate flooding in the remainder of the basin, increasing flood depths on numerous rural properties east of the railway and in East Moama. Preservation of the existing flood storage area was considered of paramount concern, and preservation of the existing capacity of the culverts under the railway is a corollary to that.

The other main option considered was to construct a levee which would keep floodwaters west of the railway out of the northern residential and industrial precincts of the town, and also protect more highly developed parts of East Moama. Preservation of the flow-path from the railway culverts back to the river at Chanter Street was essential, and not all allotments in East Moama could be enclosed by the levee. An area is to be zoned as Floodway in order to preserve the flow-path which connects from the Black Bridge and west of the railway embankment to the railway culverts near the township, and then south to the river at Chanter Street in East Moama.

Hydraulic analysis indicated flood levels north of Moama (and west of the railway) could increase by up to 100 mm because of the levee during a flood of 1% AEP. East of the railway and upstream of the Echuca-Moama bridge, flood levels could increase by up to 30 mm in a flood of 5% AEP (less during a flood of 1% AEP).

After consideration of planning, social and environmental issues and consultation with the community, a Draft Floodplain Management Plan was prepared. The principal features include:

***Features of
proposed
Floodplain
Management
Plan***

- A single, continuous town flood protection levee to the standard of the recommended Flood Planning Level for general planning purposes around the north and east sides of the township.
- A floodway with associated culverts under the railway line and around the eastern side of the levee, including expanded culverts under Chanter Street, to improve the flow of water around the town from the northern flood storage area.

-
- The designation of strategic floodways and the associated removal of physical obstructions to preserve strategic areas of flood flow distribution.
 - The designation of high hazard flood storage areas to the north and east of Moama and associated limitations on rural levees which threaten to reduce flood storage capacity and adversely affect flood heights and surrounding flood behaviour.
 - The raising of Old Barna Road in the vicinity of Horseshoe Lagoon Caravan Park, to the level of existing flanking levees, or 5% AEP, whichever is lower, to provide for 5% AEP flood-free access to/from Moama and to avoid the road becoming a channel for flood flows below this level.
 - Increasing the height of Chanter Street to provide flood-free access to the eastern area of Moama up to the 5% AEP level.

The principal planning or non-structural features of the Draft Floodplain Management Plan include:

- The identification of key flood zones (floodway and flood storage) and their associated hazard categories for a range of possible flood events.
- The identification of flood planning levels up to and including an extreme flood with the recognition that while such a flood is possible the risk of its occurrence is low. A flood planning level for general planning purposes (identifying what has become known as flood liable land) is also established based on the current application of the 95.63m AHD flood level at the Echuca Wharf Gauge.
- The development of a draft Development Control Plan (DCP) outlining the principles and policies to be applied by Murray Shire Council in the consideration of developments within the designated areas of the floodplain.
- For all approved developments, minimum floor levels for structural design purposes are to be 300 mm above the 1% AEP flood level.

A range of other general recommendations and flood response measures that would also help achieve the Draft Plan objectives include:

- revoking the previous development consent for the Edward Street caravan park;
- establishing flood spillway areas over/across Cobb Hwy for extreme flood events;
- increasing flood awareness (of the full range of flood events, up to and including the extreme flood) of all landholders through general education, signage and issuing of regular flood certificates;
- the voluntary acquisition of properties between Winall and Moama Streets, to remove dwelling entitlements and to rezone to flood compatible land uses such as open space / nature conservation;
- the voluntary acquisition of properties in the Forbes Street area of the main riverside floodway on which structures have been erected;

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- imposition of a height restriction on existing rural levees, with levee crests limited to the current height or the 1993 flood level, whichever is the lesser;
 - revoking the existing licenses for unconstructed, rural levees – however, consistent with current legislative changes to Part 8 of the NSW Water Act, applicants should have the opportunity to prove (through an hydraulic study) that the proposed work, either in isolation or cumulatively with other similar works, does not have a significant impact.

Many recommendations were also made to ensure compliance with the NSW Environmental Planning and Assessment Regulation (1994). The proposed Floodplain Management Plan was also reviewed in the context of emergency response planning.

***Costs and
benefits***

The estimated cost of the levee construction is \$1.2 million. A replacement culvert in the railway embankment in Moama is estimated to cost \$372,500. The total estimated cost of all measures exclusive of land acquisition is \$1.705 million. Annual maintenance is anticipated to be \$6,330 per annum.

Average annual damages for Moama up to the 0.5% AEP flood magnitude were estimated to be \$124,000 per annum. Economic evaluation concludes that the proposed scheme cannot categorically be shown to provide overall net benefit to the community. For quantified impacts at a 7% discount rate, the project achieves a negative Net Present Value (NPV) of \$153,000, arising from the low population protected and the low damages which occur at higher AEP (*i.e.* in more frequent flood events). Restricting capital cost by 10% would mean that a break even NPV could be achieved (at 7% discount rate). Similarly, a lower discount rate (< 6%) also provides a positive benefit being generated. This could be interpreted as representing a higher weighting for the social impacts on future generations, or for future development opportunities which might arise within the town precincts. The quantified estimates of benefit do not account for intangible social benefits of the project.

1. Draft Floodplain Management Plan

1.1 Introduction

The aim of this Floodplain Management Study was to prepare a Floodplain Management Plan which can be used by Murray Shire Council, (and others, such as the SES and DLWC), to initiate agreed flood management options in order to achieve desirable floodplain management outcomes or objectives. These objectives can be primarily defined as:

- (a) to reduce the impact of flooding and flood liability on individual property owners and occupiers;
- (b) to reduce private and public losses resulting from flooding;
- (c) to protect the natural passage, storage and quality of flood waters;
- (d) to protect the natural ecosystems of floodplains;
- (e) to help inform the community as to the extent and hazard of flood affected land in the Moama area;
- (f) to encourage the development and use of land which is compatible with the indicated flood hazard.

The principal physical features of the Draft Floodplain Management Plan are shown in Figure 1.1. These features include:

- A single, continuous town flood protection levee (200-year standard or 0.5% AEP, plus freeboard) around the north and east sides of the township.
- A floodway with associated culverts under the railway line and around the eastern side of the levee, including expanded culverts under Chanter Street, to improve the flow of water around the town from the northern flood storage area.
- The designation of strategic floodways and the associated removal of physical obstructions to preserve strategic areas of flood flow distribution – including works to lower sections of the road formations to natural surface level on Barnes Line of Road and Holmes Street.
- The designation of high hazard flood storage areas to the north and east of Moama and associated limitations on rural levees which threaten to reduce flood storage capacity and adversely affect flood heights and surrounding flood behaviour.
- The raising of Old Bama Road in the vicinity of Horseshoe Lagoon CP, to the level of existing flanking levees, or 5% AEP, whichever is lower, to provide for 5% AEP flood free access to/from Moama and to avoid the road becoming a channel for flood flows below this level.

-
- Increasing the height of Chanter Street to provide flood free access to the eastern area of Moama up to the 5% AEP level.

These physical manifestations of the Draft Plan are discussed in more detail in section 1.2.

The principal planning or non-structural features of the Draft Floodplain Management Plan include:

- The identification of key flood zones (floodway and storage) and their associated hazard categories for a range of possible flood events.
- The identification of flood levels up to and including an extreme flood with the recognition that while such a flood is possible the risk of its occurrence is low. A flood planning level for general planning purposes (identifying what has become known as flood liable land) is also established based on the current application of the 95.63m AHD flood level at the Echuca Wharf Gauge. This is consistent with a Flood Planning Level used for general planning purposes in Echuca.
- The development of a draft Development Control Plan (DCP) outlining the principles and policies to be applied by Murray Shire Council in the consideration of developments within the designated areas of the floodplain. The proposed draft DCP is presented in section 2.
- For all approved developments, minimum floor levels for structural design purposes are to be 300 mm above the 1% AEP flood level.

A range of other general recommendations and flood response measures that would also help achieve the Draft Plan objectives include:

- revoking the previous development consent for the Edward Street caravan park;
- establishing flood spillway areas over/across Cobb Hwy for extreme flood events;
- increasing flood awareness (of the full range of flood events, up to and including the extreme flood) of all landholders through general education, signage and issuing of regular flood certificates;
- the removal of dwelling rights from all vacant allotments in the designated floodway zones unless some portion of the allotment is outside the floodway zone;
- the voluntary acquisition of properties in the Forbes Street area of the main riverside floodway on which structures have been erected;
- imposition of a height restriction on existing rural levees, with levee crests limited to the current height or the 1993 flood level, whichever is the lesser;
- revoking the existing licenses for unconstructed rural levees – however, consistent with current legislative changes to Part 8 of the NSW Water Act, applicants should have the opportunity to prove (through an hydraulic study) that the proposed work, either in isolation or cumulatively with other similar works, does not have a significant impact.

1.2 Flood Mitigation Works

1.2.1 Town Levee

The key item of flood mitigation works is a levee to be constructed on the proposed alignment shown in Figure 1.2.

The total length of the levee will be 4 590 m. Over most of its length the levee would be a compacted earth embankment with a crest width of 3 m and side slopes of 2.5H : 1 V on the town side and of 3.5H : 1 V on the outside. The crest and side slopes would be topsoiled and grassed. Crest levels will generally provide a 0.6 m freeboard above the Flood Planning Level for 0.5% AEP.

The levee embankment will be used as a thoroughfare in three locations:

- the road reserve on the north boundary of the Village zone, west of the Sewerage Treatment Plant;
- Winall Street;
- Chanter Street from Winall Street to Murray Street.

In the Chanter Street segment, the crest width of the levee will be wider to accommodate the sealed street pavement. The street will be ramped up from its existing level as it approaches and leaves the levee segments and access ramps will be provided at each house driveway.

There are also locations where streets or roads will cross the levee. Approach ramps will be required for these crossings. These will be on an access track just west of the Sewerage Treatment Plant, Barnes Road, Holmes Street, Warden Street, Council Street and Murray Street.

Discussions have been held with adjoining owners in Murray and Berry Streets and are continuing.

Where the levee follows the unused portion of Berry Street along the edge of the Murray floodplain from Murray Street west towards Horseshoe Lagoon, a precast concrete wall is proposed adjacent to the school-ground. Between the school-ground and Murray Street, where the levee will follow an alignment at the rear of houses, the levee will either be an earth embankment with grassed slopes on both sides, or precast concrete wall segments. The final design will be negotiated with the respective landowners. It is desirable to reduce the width of the levee in this area to minimise encroachment on the river-side recreation reserve and the number of trees which have to be removed. Several trees will be planted away from the levee for each tree removed to make way for the levee.



Legend

- Proposed Levee
- Proposed Floodway
- Extent of Flood Storage Area
- Extent of Study Area

Figure 1.1

**FEATURES OF PROPOSED FLOODPLAIN
MANAGEMENT PLAN - STUDY AREA**



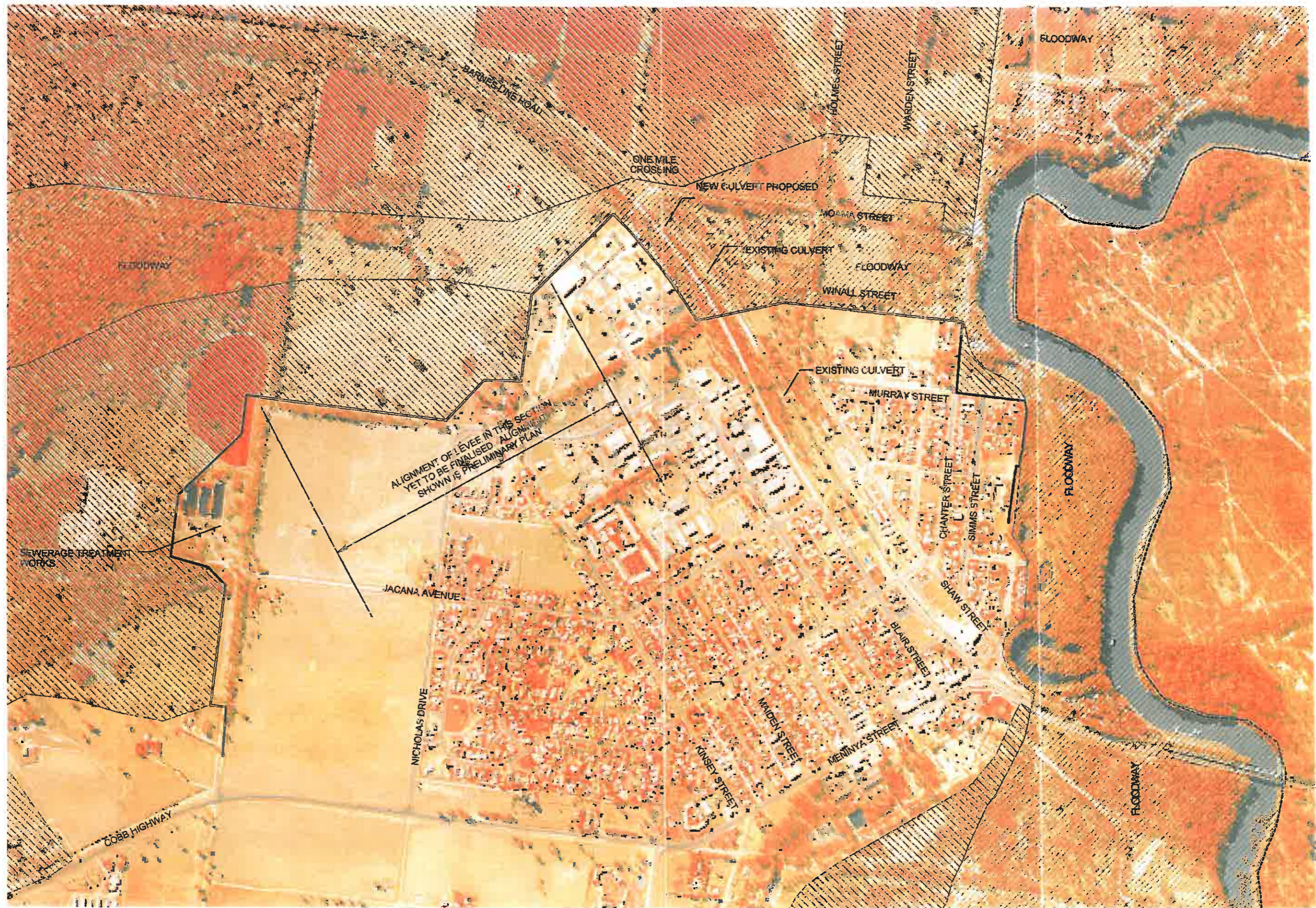
Scale 1:80,000

14

ENV



LANDINFO



Scale 1:10,000



- Proposed Floodway
- Proposed Levee
- Flood Storage Area
- Extent of Study Area

Figure 1.2
FEATURES OF PROPOSED FLOODPLAIN
MANAGEMENT PLAN - MOAMA

The height of the levee will vary, depending on the construction, location and the existing ground levels. The levee crest will be at 96.4 m AHD north and west of the railway, and at approximately 96.3 m AHD south of the railway. The crest height will be reduced by 300 mm for the Chanter Street road construction and where precast concrete walls are used. This is justified because of the more durable type of construction which minimises erosion of freeboard by wear and tear or foundation settlement of the levee. Based on topographic survey data available, this means the heights of the levee will be as summarised in Table 1.1.

It should be noted that the final alignment of the levee from the north-east corner to the Council Industrial Estate remains subject to negotiation with adjoining landholders (Messrs Kiely and Barber). The alignment is shown skirting existing road reserves, however an alternative alignment may be negotiated to pass along easements in private property. This could both shorten the alignment slightly and increase land area protected by the levee.

Table 1.1: Levee Heights Above Natural Surface

Levee Segment	Range of Height (m)
Western end north of township, around STP to north-east corner	1.3 - 1.7
From north-east corner south and then east around Industrial area to Barnes Road	1.5 - 1.7
Along Barnes Line of Road to railway	1.45 - 2.45 ⁽¹⁾
From railway south along Winall Street	1.6 - 1.8
Chanter Street between Winall and Murray Streets	1.4 - 2.0
Murray Street south of Chanter Street	1.2 - 1.6
From Murray Street west along edge of Horseshoe Lagoon Forest Reserve to Dorward Place	1.9 - 3.7 ⁽²⁾
End of levee west of Dorward Place and beside school-grounds	0.3 - 1.6
Notes:	(1) A low spot exists next to the industrial estate. (2) Levee traverses low ground at edge of forest reserve. Height of levee above adjacent ground in developed residential blocks estimated to be approx. 1.6 m.

The alternatives being considered would not affect the functionality of the levee.

Internal drainage will be provided under Chanter Street between Murray and Winall Streets through new culverts the full width of the levee which will be fitted with penstocks to prevent back flow during external floods. A smaller penstock outlet will be fitted at a low point in the Industrial Estate on Barnes Road. If storm runoff occurs while the penstocks are closed, ponded water will be pumped over the levee using portable pump sets.

1.2.2 Floodway and Other Works

Distinct from the main river floodplain, which will be a high hazard, floodway zone, a floodway is proposed to the west of the railway north of Moama linking the Black Bridge with the railway culverts on the edge of town and connecting back to the river near Winall Street. The location of this floodway is shown in **Figure 1.1** and **Figure 1.2**.

The levee alignment which defines the west side of the floodway south of the railway runs along Winall Street. This means that one of the existing culverts will be inside the levee system and one will be outside in the floodway. A new culvert opening under the railway is proposed approximately 75 m south of the One Mile Crossing in order to:

- increase the waterway opening available under the railway in the proposed floodway, and
- ensure that the size of the culvert for floodway flow is greater than the size of the Black Bridge opening further north.

In order to maintain the existing waterway capacity, the new culvert would duplicate the dimensions of the first of the two existing culverts. After levee implementation the first of the two existing railway culverts will be located inside the levee, but would remain there to provide cross-drainage of local town runoff. Although its capacity is much greater than required for that purpose, it is simpler to leave it as it is.

The capacity of cross drainage under Chanter Street should also be increased for the floodway. This will require the installation of a new large culvert set between Winall and Moama Streets.

The main cross drainage provided now is between Murray and Winall Streets, however as the levee will run along this part of Chanter Street these culverts will not service the floodway. The culverts will need to be removed and a new pipe culvert with penstock installed to close the opening during high rivers.

In the Barnes Road area, some earthworks are proposed to facilitate drainage towards the railway culverts south of One Mile Crossing. A simple sump drain the width of two grader blade cuts is sufficient to maintain a longitudinal gradient between low points in the terrain. Since the terrain is relatively flat, the depth of cut need only be minimal. There should be minimum disturbance to existing vegetation, particularly within the road reservation.

A slightly depressed, reinforced section of pavement will serve as a floodway across the road for approximately 20 m to reduce the road formation to approximate natural surface level. Flood depth markers can be erected at this point. A similar lowering of the road formation to approximate natural surface level is proposed in the floodway zone at Holmes Street, south of the railway.

An ongoing program of vegetation management is proposed for restricted zones immediately adjoining waterway openings in the main transport crossing of the Murray River and floodplain south of Moama. A management area of width extending to 30 m either side of the bridge openings will be appropriate. The area should also extend up to 50 m upstream of the bridge openings (i.e. transverse to the rail or road crossings) and up to 200 m downstream. In the confined management area, no existing mature trees should be removed under the management program. A balance should be maintained between regrowth and understorey vegetation, and the hydraulic performance requirements of the concentrated flood flow-path.

The area immediately downstream of the main bridge opening on the NSW bank is a designated conservation area. The application of the proposed vegetation management program should be very sensitive in this area, and only clearance of understorey vegetation with the potential to trap debris and create obstructions during flood flows should be permitted.

1.2.3 Recommended Modifications to Rural Levees

With a few exceptions identified below, existing rural levees may be permitted to remain subject to certain provisions. These provisions include a height restriction. Levee crest should be limited to the current height (as at December 31, 1998) or the 1993 flood level, whichever is the lesser. Levees with crest elevations higher than the 1993 flood level should be modified to reduce their crest elevations accordingly.

No extensions to existing levees should be permitted. Licences for rural levees which have not been constructed should be revoked when the licences come up for renewal.

The intention of these provisions is to preserve storage available within designated flood storage areas, and prevent erosion of the existing volume of flood storage capacity.

Spacings between levees roughly parallel (as on opposite sides of road reserves, for instance) should not be spaced closer than 100 m. As noted in section 1.1, in the case of existing rural levees flanking the Old Bama Road levees, an alternative would be to raise the road over a short distance between the levees.

Two levees which obstruct proposed floodways should be removed. These are:

- levee L10 located north of Hardings Lane to be lowered to its licensed crest height,
- an unlicensed levee immediately north of and parallel to Milgate Road (see **Figure 4.2**, volume 2) to be completely removed.

1.3 Flood Zonings and Flood Planning Levels

A range of flood hazard maps have been produced indicating flood category and hazard zones for a range of modelled flood events. See **Appendix A** in volume 2. The events modelled include:

- 10-year ARI or 10% AEP flood
- 20-year ARI or 5% AEP flood
- 50-year ARI or 2% AEP flood
- 100-year ARI or 1% AEP flood
- 200-year ARI or 0.5% AEP flood
- an extreme flood

The 1993 flood was also modelled and mapped. These maps are based on flood levels from the MIKE 11 computer flood model, and the extent of flooding and hazard categorisation is based on best available ground level survey information. The extent of the flooding shown on these flood zoning maps is indicative only due to general lack of detailed ground level information. When detailed ground level data becomes available, flood zoning boundaries will need to be further delineated from **Table A.1** (showing peak levels and average flow velocities for these design floods) in conjunction with **Figure A.8** (showing cross section locations).

Shown on these plans are the areas which can be categorised into the following three flood category/hazard zones. These zonings are broadly based on the guidelines from the NSW Floodplain Development Manual.

Low Hazard Flood Storage where flood depths are less than about 0.8 m.

High Hazard Flood Storage where the depths of flood are greater than 1 m.

Floodway where the velocities are generally between 0.5 m/s and 1 m/s and the flood depths are greater than 2 m in general for the designated flood (200-year ARI event), OR where flood-paths are critical for maintaining flood flow distribution within the floodplain.

While these zonings have been applied to a range of flood events, the principal zoning in relation to the application of the proposed Development Control Plan is based on a designated flood event for general planning purposes, being the flood of ARI 200 years or 0.5% AEP. This level, which very closely approximates the existing flood standard (95.63 m AHD on the Echuca Wharf Gauge) should remain as generally the highest flood planning level FPL for development control and will define what is recognised as the flood planning area within Moama and the surrounding area. This is consistent with the Flood Planning Level used for general planning purposes in Echuca.

As noted above, upon completion of comprehensive ground level surveys, or as survey information becomes available, a more accurate flood map should be prepared. Where the flood map for the designated flood differs from the Murray LEP 1989 Map, the LEP should be amended to accord with the flood map. In this regard it would be preferable for any amendment to the LEP to recognise the hazard categories associated with the flood map, and their associated objectives as provided for in the accompanying development control plan (DCP). This would provide the DCP with a stronger legal basis than its operation in isolation to the LEP.

Until sufficient ground survey information is available, Council should determine whether land is subject to flood inundation by the designated flood (and within what category), based on all existing information and mapping. When assessing development applications, Council may request additional survey information from the applicant to confirm the flood liability and hazard category of the subject land.

For approved developments, the recommended minimum floor level for structural design (dwelling floor levels and flood proofing) is the 1% AEP flood level plus a 300mm freeboard. The freeboard is an accepted safety factor, and such a measure will provide a consistent level of planning control and reasonable freeboard above an acceptable standard of flood risk. The implications of adopting this standard (300mm above the 1% flood level) is that new controls will be consistent with previous controls while still providing a justified measure of flood protection.

All commercial, industrial and emergency services premises should be located within the town precincts to be protected by the levee.

No flood planning level has been established for a probable maximum flood, however an extreme flood has been modelled with levels generally over 1.2 m higher than the standard flood of ARI 200 years or 0.5% AEP. Council should recognise that such a flood would breach the town levee and place both people and property within the town of Moama and the surrounding areas under significant threat. The probability of occurrence of such flood events is however quite small. No development restrictions should be applied to land subject to an extreme flood, however property owners and occupiers should be advised that such land could potentially be subject to flooding in an extreme and rare flood event.

The potential for a break out, or extreme floodway bypass through, or over the Cobb Highway, is recognised and may be considered in relation to development affecting the Cobb Highway.

1.4 Planning Controls - DCP

A Development Control Plan (DCP) - Murray Flood Prone Land Policy, has been prepared and is contained in section 2 of this volume. The DCP outlines the principles and policies that should be applied by Murray Shire Council in the consideration of developments within the designated areas of the floodplain.

The principal features of the proposed DCP include:

- Procedures to be formally adopted by Council in accordance with the Environmental Planning and Assessment Act, 1979, and the Local Government Act, 1993 as a statement of Council policy. This will help to provide some measure of planning certainty to prospective users and developers of the floodplain as to what Council's requirements and objectives are.
- A range of floodplain management objectives consistent with best practices regarding floodplain management at all levels of government.
- Consistency with the NSW Floodplain Development Manual and the Draft Floodplain Management Manual, affording Council a measure of legal liability protection in relation to decisions affecting floodplain management when carried out in accordance with the DCP.
- Consistency with higher level planning policies such as the Murray REP 2, thereby providing a measure of integrated policy and control functions beneficial to those proposing changes to floodplain development and works.

Council should have regard to the provisions of both the Environmental Planning and Assessment Act, 1979, and the Local Government Act, 1993 with respect to advertising, consideration of submissions and formal adoption of the policy. Through the requirement under these Acts to publicly advertise the DCP, the community's view can be incorporated into the final policy.

1.5 Environmental impact of Proposed Works

1.5.1 Compliance with NSW EP&A Act

The environmental impact of the proposed floodplain management option is assessed in terms of Clause 82 of the NSW Environmental Planning and Assessment Regulation (1994) in Appendix D of volume 2.

Arising from this assessment, the following recommendations are made to mitigate identified potential impacts.

Environmental Impact on the Community

Construction of the preferred option would have short and long term effects on the community. Short-term effects would arise during the construction of

the proposed levee. These effects would be primarily related to noise and dust by the construction activities and transport of fill material from off-site.

These impacts could be mitigated by:

- Restricting hours of work to comply with the guidelines of the NSW Environment Protection Authority (EPA) Environmental Noise Control Manual. Accordingly, hours of work should be restricted to 7.00 am to 6.00pm Monday to Friday and 8.00 am to 1.00 pm Saturday with no work permitted on Sunday or Public Holidays. These hours could be varied with the consent of local residents and Murray Shire Council.
- Requiring all plant and equipment to be fitted with approved silencers and maintained to manufacturers' specifications.
- Requiring adequate dust control. Monitors should be established to determine the background dust levels and volumes of dust generated during construction. Dust control could be achieved by:
 - the use of water or other suppressant during construction,
 - requiring loads with potential for dust generation to be covered,
 - requiring vehicle wheels to be cleaned of mud or dust before travelling on public roads.

Longer term impact would arise from the reduction of flood impacts on the community within the area protected by the levee banks. The reduction of flooding frequency and duration is an objective of the activity and is regarded as a positive impact.

Environmental Impact on the Ecosystems of the Locality

The most sensitive and significant ecosystems of the locality are floodplain and related communities. Other important ecosystems are associated with relatively undisturbed vegetation communities on roadside reserves.

The proposed levee bank would be located so as to minimise the extent of clearing required and, accordingly, the impact on ecosystems of the locality. Generally the proposed location would avoid the need for any clearing of floodplain or roadside vegetation. The only exception is the section parallel to, and south of, Simms Street where it would adjoin the Horseshoe Lagoon Centennial Park.

Impacts on the ecosystems could be mitigated by:

- Clear delineation of the limits of disturbance for clearing and access for construction plant and equipment. The clearing limits should be clearly marked in the field prior to commencement of disturbance.
- Avoidance of hollow-bearing trees. The clearing and levee construction should be managed as far as possible to avoid the necessity to clear any hollow-bearing trees. If any hollow-bearing trees are to be cleared, they should be inspected prior to clearing by a suitably qualified ecologist to determine if any fauna are present. If fauna are present, they should be provided with an opportunity to depart prior to clearing. If they do not

depart a representative of WIRES or other fauna carer group should be present during clearing to rescue any injured fauna. If any hollows are destroyed by the activity they should be replaced by the erection of artificial nesting / breeding boxes on appropriately sized trees adjacent to cleared area. In addition, hollows may be salvaged from felled trees and attached to nearby suitable trees.

- Location of vehicle and plant parking areas in already cleared areas.
- Avoidance of vehicle refuelling and maintenance except within designated, bunded areas.
- Location of site offices outside ecologically sensitive areas.
- Obligation on the part of the Contractor to develop an acceptable Environmental Management Plan (EMP) for the project construction phase. The EMP should include details of measures to avoid impacts on sensitive ecosystems. It should also include provision for environmental induction of staff and sub-contractors prior to commencement of site works.

Effect on a Locality, Place or Building Having Aesthetic, Anthropological, Architectural, Cultural, Historical, Scientific or Social Significance or other Special Value for Present or Future Generations.

The proposal is substantially restricted to land which is already cleared, and does not involve the demolition of any buildings or structures. The proposed alignment has been inspected with a qualified sites officer from the Yorta Yorta Local Aboriginal Land Council to check for the presence of scar trees or other items of potential importance for the local aboriginal community. None were identified.

Impact on the Habitat of Threatened Species

The proposed location of the levee bank would avoid areas with potential for significant impact on threatened species, their habitat, populations or ecological communities. The proposed levee would be largely located on previously cleared land with no potential as habitat for threatened species. The only section with any potential for impacts on threatened species of birds is the section adjoining the southern side of Moama township (west of Murray Street).

Potential impacts would be minimised by the following:

- Clearly delineating cleared and uncleared areas in the field, and prohibiting vehicle access and stockpile siting within uncleared areas.
- Locating the levee bank in previously cleared areas as far as possible.
- Restricting clearing to immature trees without hollows.
- If removal of hollow bearing trees is unavoidable conduct surveys to establish the occupancy status of hollows and only remove trees when the hollows are not occupied.

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- If removal of trees with occupied hollows is unavoidable, ensure that a representative of a fauna care group such as WIRES is present during the operation.
 - For every tree removed, several trees should be planted elsewhere.

Risk to the Safety of the Environment

Construction of the proposal would not involve the use of any chemicals or hazardous materials. Servicing and refuelling of vehicles would only be permitted within designated areas. Appropriate dust and erosion control measures would be implemented and the contractor would be required to develop and implement an acceptable environmental management plan. Accordingly, the proposal does not present any risk to the safety of the environment.

Reduction in the Range of Beneficial Uses of the Environment

Existing beneficial uses of the environment for humans include recreation and tourism, grazing, agriculture and forestry and residential, commercial and industrial development. The proposal would not prevent continuation of these uses.

Pollution of the Environment

Pollution of the environment could occur during construction as a result of excess noise, reductions in air quality or pollution of adjoining water courses. As previously outlined, a number of mitigation measures would be implemented during construction to ensure that pollution of the environment did not occur.

The range of measures would include:

- Restrictions on working hours.
- Requirement for mufflers to be fitted to plant and equipment and maintained in accordance with manufacturer's specifications.
- Dust suppression with water or other appropriate measure.
- Removal of dust / dirt from truck wheels prior to travel on public roads.
- Requirement for loads which could generate dust to be covered.
- Requirement for plant / vehicle refuelling to be carried out in designated areas.

Additional measures which would be implemented to establish and maintain sediment control and reduce the likelihood of water pollution include:

- Erection of hay bales around any stormwater inlets which are within the catchment of the works area prior to construction commencing.
- Erection of sediment control fences on downslope side of working areas adjacent to defined watercourses.
- Location of stockpile sites away from watercourses or stormwater drains.
- Regular inspection of the mitigation works to ensure that they are appropriately maintained.

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- Inclusion of requirements for pollution control in the environmental induction course for site workers.

In addition, the contractor's environmental management plan would be required to provide full details of location and responsibilities for pollution control and requirements for regular inspection and monitoring.

Disposal of Waste

Waste generated by the project would include the following:

- trees and other vegetation cleared during the course of construction,
- domestic waste from site office and crib rooms,
- tyres and oil and greases from plant and machinery maintenance,
- packaging and cardboard / paper wastes from the site office.

The following measures would be adopted for waste management:

- Inclusion of a waste management action plan in the contractor's EMP.
- Storage of domestic in covered bins approved by Murray Shire Council and disposed to the Council waste collection service.
- Disposal of recyclable materials to an approved recycler.
- Disposal of oils, greases, tyres and other industrial to approved recyclers or to an industrial collection service.

Trees and waste vegetation material would be disposed of according to the following:

- Where possible the material would be sold to commercial timber interests.
- As much of the remaining timber as possible should be utilised as firewood.
- Any remaining material should be chipped and used as mulch for landscaping of the levee.
- As a last resort any remaining material may be burnt. Any burning would be carried out in accordance with the requirements of Murray Shire Council and the Environment Protection Authority.

1.5.2 Specific Matters for Attention

A few issues arose as a consequence of inspection of the levee alignment by a biologist.

- (a) The number of trees to be removed on the edge of the forest reserve west of Murray Street could be reduced if a method of construction is employed which enables a narrower levee. Concrete or masonry walls are one solution, although some adjoining residents have expressed opposition to this prospect, and the cost would escalate. Crib walls supporting an earth embankment are another compromise which can be considered to provide a gentler aspect from adjoining properties.
- (b) The alignment runs along Winall Street. This reserve is well vegetated, and the removal of trees could be minimised by following the alignment of the existing track as much as possible.

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- (c) Remnant vegetation along the reserve of Barnes Line of Road should be preserved as much as possible. There is a good mix of native vegetation at the three levels of over-storey (trees), under-storey (shrubs) and ground cover (grasses and herbs).

The levee will have to cross the road reserve. Following the existing road alignment down from One Mile Crossing would decrease the already narrow cross-section available for flow approaching the railway culverts, which would increase both flood levels to the north and the approach velocities of flow. An alignment on the outer edge of the road reserve is preferred for hydraulic and for safety reasons, although this will involve more loss of native vegetation. Interference with this vegetation pool has been reduced by the decision to shorten this levee segment and cross the railway opposite Winall Street instead of opposite Murray Street as originally proposed. Works to improve drainage for the floodway will be kept to the minimum necessary within the road reserve. Approximately 400 m of the road reserve will be disturbed by construction of the levee.

1.6 Recommendations in Relation to Emergency Response Measures

The Local Flood Plan is comprehensive and covers such areas as organisation arrangements, communications, road closures, evacuations, logistics, flood patterns and welfare. There is a statutory and desirable requirement to review and update the plan every few years in order that it remains up to date. A review should now be carried out to integrate the findings of this Floodplain Management Study and its Draft recommendations into the Local Flood Plan, including the requirement to consider planning issues for an extreme flood.

Subjects for review could include:

- Use of FM radio to alert and inform residents during floods.
- Evacuation routes accessible during floods of different magnitudes.
- Explanation of flood warnings and interpretation of likely impacts.
- Appropriate locations of refuge.

It is suggested that practice runs be conducted at least once every year, ideally in advance of the season of greatest flood risk (say, in May). These exercises should hypothesise an impending flood, and the preliminary response measures should be tested. Such exercises will identify links in the chain of communications which may have been broken since the last exercise, such as relocation of agency personnel or death or absence of key community members. It may also identify physical impediments to effective communications and response, such as equipment or other resources which may be faulty or have been reassigned or removed from service. The communications network can then be restored to full working order.

1.6.1 Flood Preparedness and Flood Awareness

Flood preparedness is about the ability of flood-affected communities to understand, plan for and defend their communities from the threat of floods. Much of the planning for these measures is incorporated into the Local Flood Plan prepared under the auspices of the SES.

Benefits of maintaining flood awareness are very cost effective. Some five years have now passed since the last major flood of October 1993 and there is a risk that people will have forgotten the steps they need to take in preparation for floods, or new people will have moved into flood prone areas and are not aware of the procedures.

It is recommended that the following actions be taken to reinforce flood awareness in the community:

- the Draft Floodplain Management Plan be used as a catalyst to remind residents and visitors of their need to be familiar with flood levels and flood preparedness;
- consideration be given to marking the full range of flood events on permanent markers (such as telegraph poles) in all flood prone areas to remind residents of the levels of water that can be encountered in their area during flood;
- a specific responsibility be issued to caravan park and holiday lodge owners or operators within the designated floodplain (in accordance with the Local Flood Plan) to:
 - prepare or update their current Flood Plan for their park in recognition of the information contained in this Draft Plan,
 - display that plan in a prominent location(s),
 - ensure that caravan owners/occupiers and residents of lodges are aware of any current flood and evacuation warnings,
 - identify how they would evacuate their parks if required, and where suitable high ground would be available to relocate moveable structures during major floods;
- require flood indicators at all Caravan Parks and riverside accommodation be erected in prominent locations such as adjacent to the reception area and the amenities block. Flood indicators should show both AHD Datum and Flood Levels for the full range of flood events relative to the Echuca Wharf Gauge, with historical flood markings;
- the SES and Murray Shire Council to work together to actively promote flood awareness through supply of flooding data and advice to property owners in the form of Flood Certificates. Flood certificates would:
 - report information on flood levels (AHD) for all design floods as related to the Echuca gauge,

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- advise of the inherent inaccuracies in the model that derives the estimate of these levels,
 - encourage residents to feedback real flood data concerning flood levels during times of flood;
 - flood information should be continually upgraded and integrated into the Council's property data base;
 - in collaboration with the Bureau of Meteorology and the SES, Council consider preparation of a booklet for residents of Moama and district to educate residents on how to respond appropriately to floods (*e.g.* as by Delatite Shire, 1997)

1.7 Recurrent and Capital Costs of Preferred Option

1.7.1 Capital Costs

The estimated cost of the levee construction, excluding any land acquisition costs, is \$1.2 million. Whether or not the Barber-Kiely option is adopted makes little difference to length or cost of the levee.

The cost of enlargement of the railway culvert in Moama is estimated to be \$372,500.

Other costs of implementation of the Plan would be associated with the removal or modification of existing, licensed levees to comply with the requirements of section 7.2.2 in volume 2. As an approximate guide, the cost of removal of low rural levees is likely to be of the order of \$10 to \$15 per metre. Removal and reconstruction of levees (*i.e.* realignment) is likely to be of the order of \$35 to \$40 per metre. Naturally, these costs are dependent upon factors such as levee height, location of disposal site, realignment distance, *etc.* Based on these approximations, cost of lowering of levee L10 would be approximately \$20,000, to be borne by the owner.

Installation of staff gauges at four locations is estimated to cost approximately \$10,000.

1.7.2 Maintenance Costs

Maintenance costs are the costs associated with on-going maintenance of the levee. Maintenance costs are assumed to be constant over the evaluation period. Annual costs are assumed as \$4,200 per annum (0.35% of the capital cost).

Other operational costs will be associated with maintenance of the staff gauges. Apart from very occasional survey checking of the datums, maintenance costs associated with the staff gauges will be very low.

Operational costs are also associated with flood and post-flood activities such as flood pegging and survey, acquisition of satellite imagery and

compilation and storage of data acquired. These costs will arise at intervals determined by the occurrence of floods. On average in the long term, these activities will be required approximately every 6-8 years for flood level observations, and approximately every 12-20 years for flood extent records.

Costs of flood pegging and survey are estimated as up to \$10,000 per event, and acquisition of satellite imagery is likely to be approximately \$4,000. These costs will therefore average approximately \$1,700 per annum.

A summary of capital and ongoing costs of the proposed Floodplain Management Plan is presented in Table 1.2.

Table 1.2: Estimated Costs for Implementation and Maintenance

Item	Cost	Sub-total	Annual Maintenance
Town Levee			
Embankment, incl. preparation, materials, construction, topsoiling and grassing.	\$1,048,000		\$3,670 ⁽¹⁾
Flood Wall (230 m)	\$147,000		\$ 510 ⁽¹⁾
		\$1,195,000	
New waterway opening under railway	\$372,500		- ⁽²⁾
Other drainage / flood improvements for floodway, incl. Chanter Street works	\$127,500		\$ 450 ⁽¹⁾
		\$ 500,000	
Monitoring			
Installation of staff gauges	\$10,000	\$10,000	
Data collection after floods			\$1,700
Totals:		\$1,705,000	\$ 6,330
NOTES: (1) Annual maintenance assumed as 0.35% of capital cost.			
(2) Maintenance responsibility transferred after construction. No significant increase over existing maintenance costs.			

1.7.3 Acquisition of Land

Costs associated with obtaining easements or acquiring land for the levee alignment, and proposed voluntary land purchases in floodway areas are estimated to amount to \$476,000.

1.8 Implementation, Monitoring, Coordination and Revision

1.8.1 Works Program

It is proposed to stage the physical works over a period of three years. There is no technical reason why all the works could not be completed in a more compressed time frame. However, the works and the expenditure can be more conveniently accommodated within the financial and technical planning of the Shire if the works are extended over three years.

Preparations for works along the floodway should receive early attention, and these works should be completed before the levee is constructed north and

west of the railway. Floodway works include construction of the railway culvert, and forward cooperative planning with the railways authority will be necessary. Other floodway works include a low profile overflow ('floodway') section in Barnes Road and provision of a narrow graded low flow path to ensure adequate drainage along the floodway alignment (see section 1.2.2).

It is recommended that levee construction commence at the southern end, then progress east and north to the railway before commencing construction north and west of the railway. Otherwise, construction at the northern end would have potential to slightly aggravate flooding in Moama East in the interim before completion of the works.

1.8.2 Monitoring and Reviews

Flood Level Observations

Monitoring of flood behaviour during and after floods will provide valuable information for future reviews of the Floodplain Management Plan and appraisals of how well performance matched the objectives of the Plan.

Good permanent installations exist at Echuca Wharf and Lower Moira on the Murray, and Yambuna Bridge on the Lower Goulburn and other locations. Additional staff gauges should be installed and maintained at four locations to provide better information on the spatial distribution of flood peak levels. Staff gauges should be installed and their zero datums fixed against AHD at these locations:

- (i) upstream of Moama, near the main breakaway on the right bank;
- (ii) in Moama East, upstream of the bridge;
- (iii) in Moama, a short distance downstream of the bridge;
- (iv) west of Moama, nearly opposite the Campaspe confluence.

Access may be difficult to some of these sites (and particularly the first one) at the flood peak. However, even if the peak height on the gauge can be determined after the flood from debris marks or pegging of peak levels near the gauges it will provide very useful data on longitudinal flood profiles, head losses through the bridge, critical levels for emergency response and the effect of the Campaspe inflows.

Pegging of flood peak levels after floods is another data collection activity to be included in the Floodplain Management Plan. Within two or three weeks of access becoming available, levels should be pegged on the basis of debris marks, discolourations on bridges and culverts, and advice of local residents. Pegging of levels should be concentrated in Moama East and north of Moama along the proposed floodway west of the railway. However, levels should also be pegged at a lower density in the Barna Forest area as far upstream as Gilmours Road, in the Backwater Creek area, and west of Moama.

Levels of all pegged flood peaks should be surveyed to AHD as soon as possible after pegging, but at least within 3 months.

Staff gauge observations and pegging of flood levels should be undertaken whenever the stage reaches or exceeds 94.1 m AHD on the gauge at Echuca Wharf. All data collected should be carefully compiled and preserved by the Shire of Murray, and copies passed on to the Department of Land and Water Conservation for their use and storage.

Records of Flood Extent

The Shire should also acquire satellite imagery of the flood extent after major floods which exceed 94.5 m AHD on the Echuca Wharf gauge. This should also be preserved in Shire records.

In addition, the Shire could choose to organise aerial photography. This could be done in conjunction with State departments and Victorian local and State government counterparts to share costs. Prior arrangements would need to be made in advance as part of the Floodplain Management Plan.

Records of Flood Damage

The Shire should also undertake reviews of flood damages after floods which cause property damage, especially to structures. Depths of flooding below or above floor levels should be recorded when inundation occurs around buildings. Damage incurred to waterways (*e.g.* bank erosion and tree loss) and flood protection works should also be documented.

Reviews of the Plan

Data collected during and after floods should be used to compare actual Plan performance against Plan objectives and to review flood awareness in the community.

In addition to these reviews which should take place after every major flood, formal review of the Floodplain Management Plan and Development Control Plan should be scheduled every ten years and consistency with the Local Environment Plan should be checked.

2. Draft Development Control Plan

Murray Flood Prone Land Policy

DCP No.(Environmental Planning and Assessment Act, 1979
(and Local Policy No.....Local Government Act, 1993).

2.1 PART 1 - GENERAL

2.1.1 Citation

This policy may be cited as the "Murray Flood Prone Land Policy". This Policy has been adopted by Council at its meeting of in accordance with Section 72 of the Environmental Planning and Assessment Act, 1979 (Development Control Plans) and Part 3 of Chapter 7 of the Local Government Act 1993 (Local Policies).

2.1.2 Aims, Objectives, etc

This Policy aims to:-

- (a) provide detailed controls and criteria for the assessment of development applications on land affected by flooding in the town of Moama and surrounding areas as shown on the map.
- (b) consolidate existing flood planning principles and policies from relevant government agencies into a coherent framework for application at the development control level by Murray Shire Council
- (c) reduce the impact of flooding and flood liability on individual property owners and occupiers.
- (d) reduce private and public losses resulting from flooding.
- (e) restrict the intensification of development below the FPL
- (f) limit development below the FPL to those activities and works considered to have an essential relationship with the river and its floodplain
- (g) provide specific measures for the control of caravan parks and associated development types within flood affected areas
- (h) provide for the consideration of the cumulative effects of any development on flood affected land, which in or of itself may be considered to be insignificant.
- (i) provided for and protect the natural passage, storage and quality of flood waters
- (j) recognise and help sustain the natural ecosystems of floodplains and riparian zones including the protection of associated vegetation and wetlands.

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- (k) inform the community as to the extent and hazard of flood affected land in the Moama area
 - (l) deal consistently with applications for development on flood affected land, generally in accordance with the Floodplain Development Manual issued by the New South Wales Government 1986.
 - (m) encourage the development and use of land which is compatible with the indicated flood hazard.

2.1.3 Planning and Development Control

Council will take into consideration this policy when amending its planning scheme in accordance with the Environmental Planning and Assessment Act, 1979, and in determining applications for approval received in accordance with the Environmental Planning and Assessment Amendment Act, 1997, and the Local Government Act, 1993. This Policy does not purport to exempt any applications from the necessity to obtain a particular approval of the Council, where such a requirement would otherwise exist.

2.1.4 Area of Application

This Policy applies to "flood prone land" within the study area of the Moama Floodplain Management Study 1999, identified by a series of maps and flood tables associated with this DCP No., and as defined by the Draft NSW Floodplain Management Manual.

2.1.5 Flood Planning Levels

Council recognises that a flood higher than the flood planning level used to define flood liable land could potentially occur. The Extreme Flood as identified on the relevant map has been identified for the purpose of flood awareness rather than development control.

The flood planning level used to define flood liable land for the purpose of this DCP is the flood level represented by the height of 95.63 m AHD on the Echuca Wharf Gauge. This FPL represents the approximate level of a 0.5% AEP or 200 Year ARI flood as modelled in the Moama Floodplain Management Study. Council will not permit the intensification of development below this FPL which is likely to cause a significant reduction in flood storage capacity or change in flood behaviour.

The 1% AEP, as modelled, 95.34 m AHD at the gauge will represent the planning and design FPL for new development. A 300 mm freeboard, as a general safety and contingency factor will mean that design floor levels for new structures and planning controls will remain consistent with previous levels.

2.1.6 Relationship to Other Legislation and Regulations

This Policy should be read in conjunction with the relevant provisions of the Environmental Planning and Assessment Act, 1979, the Environmental Planning and Assessment Amendment Act, 1997, Murray Regional Environmental Plan No 2, Murray Local Environmental Plan 1989, the Local Government Act, 1993 and Regulations thereto, including the Local Government (Caravan Parks, Camping Grounds and Moveable Dwellings) Regulation 1995, and other relevant Development Control Plans adopted by Council.

2.1.7 Definitions

In this Plan,

- access road*** means a road (other than a public road) situated within private property such as a caravan park or camping ground, and rural, rural residential, residential, commercial and industrial allotments.
- annual exceedance probability (AEP)*** means the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage
- caravan park / camping ground*** means the use of land for caravans or other moveable dwellings requiring an approval under Part 1 of Chapter 7 of the Local Government Act 1993.
- flood prone land*** means land capable of being inundated by specified flood events measured by an annual exceedance probability (AEP) up to and including the probable maximum flood (PMF) or extreme flood. (Some land is affected by flood water inundation more frequently than other land).
- flood control works*** means works which change the natural or existing condition or topography of land (such as the construction or alteration of levees, channels and mounds) and which are likely to affect the hydrology of the River Murray system within the Moama area.
- flood liable land*** means land affected by flood water inundation below a level represented by a floodwater level at the Echuca Wharf Gauge of 95.63 m AHD, or as otherwise determined by Murray Shire Council to be flood-labile land, having regard to the principles contained in the Floodplain Development Manual, or equivalent.
- flood planning level (FPL)*** a flood level selected for planning and development control purposes in relation to specified flood event probabilities.
- flood storage area(s)*** means those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood.

<i>floodway area(s)</i>	means channels, streams and that portion of the land liable to flooding necessary to convey the main flow of floodwater. Floodways are areas where a significant volume of water usually flows during floods and are areas which, even if only partially blocked, would cause significant redistribution of flood flow or significant increase in flood levels which in turn could adversely affect other areas.
<i>high hazard</i>	means possible danger to life and limb; evacuation by trucks difficult; able bodied adults would have difficulty in wading to safety; potential for significant structural damage to buildings.
<i>low hazard</i>	means evacuation by trucks possible; able bodied adults would have little difficulty in wading to safety.
<i>moveable dwelling</i>	<ul style="list-style-type: none"> – any tent, or any caravan or other van or other portable device (whether on wheels or not), used for human habitation, or – a relocatable home.
<i>primitive camping ground</i>	means a camping ground that is specified in its approval under the Local Government (Caravan Parks, Camping Grounds and Moveable Dwellings) Regulation 1995, as a primitive camping ground.
<i>relocatable home</i>	means a manufactured home, or any other moveable dwelling, that does not include a tent, caravan or campervan or any moveable dwelling that is capable of being registered under the Traffic Act 1909.
<i>extreme flood</i>	means an extreme flood of greater magnitude than those used for flood planning levels, including up to the Probable Maximum Flood, which is the largest flood that could conceivably occur at a particular location.

2.2 PART 2 - Criteria for Determining Applications

2.2.1 Flood Planning and Development Control Principles

Proposed developments will be considered on their merits. Issues to be taken into consideration regarding the particular merits of development in flood affected areas include:

- a) that the proposed development is sensible in relation to existing resources and conditions given the flood threat and resources in the area. (In this regard, no reliance will be given on the implementation of a condition specifying a private evacuation/flood management plan as a means to overcome innately unsafe or unsound flood conditions)
- b) the need for a benefit/cost assessment which takes account of the full cost to the community of the flood response and flood damages likely to be incurred due to such development.
- c) specific principles relating to land subject to flooding contained within Murray REP No2 including:
 - i) the benefits to riverine ecosystems of periodic flooding;
 - ii) the hazard risks involved in the development of that land;
 - iii) the redistribution effect of the proposed development on floodwater;
 - iv) the availability of other suitable land in the locality not liable to flooding;
 - v) the availability of flood free access for essential facilities and services;
 - vi) the pollution threat represented by any development in the event of a flood;
 - vii) the cumulative effect of the proposed development on the behaviour of floodwater;
 - viii) the cost of providing emergency services and replacing infrastructure in the event of a flood;
 - ix) flood mitigation works constructed to protect new urban development should be designed and maintained to meet the technical specifications of the Department of Land and Water Conservation.

2.2.2 Consultation

Council will consult with relevant authorities on any development proposal received for flood liable land which, in the opinion of Council, may affect the flow of floodwaters. Consultation authorities include the Murray Darling Basin Commission (MDBC), Department of Land and Water Conservation (DLWC), Interstate Levees Committee, the North Central Catchment Management Authority (for within and downstream of Moama), the Goulburn Broken Catchment Management Authority (for upstream of Moama), the Campaspe Shire Council and the local Floodplain Management Committee.

2.2.3 Low Hazard Flood Storage Areas

2.2.3.1 General

- a) No intensification of existing development will be permitted which is likely to cause a significant reduction in flood storage capacity or change in flood behaviour
- b) Council will consult the DLWC, MDBC and the appropriate Victorian Catchment Management Authority in determining whether a development proposal is likely, either independently or in combination with other similar developments, to cause a significant reduction in flood storage capacity or change in flood behaviour.

2.2.3.2 Flood Control Works

- a) Flood control works will be referred to the DLWC for licensing and "in principle" approval prior to any development consent being issued.
- b) Construction will conform to an accredited standard approved by the DLWC.
- c) Existing flood control works will be limited to their current height or 1993 flood level (whichever is the lower)
- d) Crest levels for new flood control works will be limited to a 5% AEP flood height, and to a 2% AEP flood height for individual ring levees around existing rural dwellings and outbuildings.

2.2.3.3 Residential, Commercial and Industrial Development

- a) Floor levels will be a minimum of 0.3 metres above the 1% (AEP) flood level. Any part of the new dwelling or addition below that floor level shall be constructed from flood compatible materials.
- b) Non-habitable and minor additions may be permitted below flood liable land provided any part of the new building or structure below that level is built from flood compatible materials.

2.2.3.4 Caravan Parks and Tourism Developments

- a) Floor levels of any permanent structures/amenities will be a minimum of 0.3 metres above the 1% (AEP) flood level.
- b) Access roads will not be built up more than 100mm above natural topography
- c) All services to the development will be designed to be disengaged in times of flooding
- d) All applications shall be accompanied with a report from a suitably qualified engineer, demonstrating that all moveable dwellings can either be relocated rapidly to flood-free ground, or can withstand the force of flowing flood waters and the anticipated duration of flooding in a flood of 0.5% AEP, without significantly affecting flood behaviour or river water quality.

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- e) Existing areas liable to flooding must have the ability to be evacuated at short notice in times of flooding - a flood emergency and evacuation plan will be required to be submitted at the time of application.

2.2.4 High Hazard Flood Storage Areas

2.2.4.1 General

- a) No intensification of development below the FPL will be permitted which is likely to place the owner or occupants (including their property) at risk from flooding or generate demand for emergency services or place others involved in evacuation at risk.
- b) Council will consult the DLWC, MDBC and the appropriate Victorian Catchment Management Authority in determining whether a development proposal is likely, either independently or in combination with other similar developments, to cause a significant reduction in flood storage capacity or change in flood behaviour.
- c) Where new development has potential to cause a significant reduction in flood storage capacity or change in flood behaviour, the proponent will need to demonstrate the proposal will not cause a significant increase in flood levels or flood hazard (including its cumulative effect with future similar developments). Need to also provide adequate compensating works for flood storage, together with engineering report and a detailed environmental study to support the application.
- d) In areas identified as high hazard, the feasibility of effective evacuation is to be demonstrated to the consent authority including permanent, fail-safe, measures to ensure the timely, orderly and safe evacuation of people from the area. It is also to be demonstrated that the displacement of these people will not significantly add to the overall cost and community disruption caused by the flood. Council should also consult the SES, and be provided by the proponent with a detailed engineering report and environmental study to support the application.

2.2.4.2 Flood Control Works

- a) Existing flood control works will be limited to current height or 1993 flood level (whichever is the lower)
- b) New flood control works to be prohibited, apart from individual ring levees to 2% AEP flood protection level around existing rural dwellings and associated outbuildings.

2.2.4.3 Residential, Commercial and Industrial Development

- a) Development shall be restricted to necessary rural dwelling houses and associated outbuildings with floor levels to be a minimum of 0.3 metres above the 1% (AEP) flood level. Any part of the new dwelling or addition below that floor level shall be constructed from flood compatible materials.

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- b) Non-habitable and minor additions may be permitted below the designated flood level, provided any part of the new building or structure below that level is built from flood compatible materials.
 - c) All applications must be accompanied by a report from a practising structural or civil engineer, proving that the building or structure can withstand the force and duration of flood waters in a flood of 0.5% AEP, including debris and buoyancy forces as appropriate. As part of the consulting engineers' report, it will be necessary to demonstrate to the satisfaction of Council that fail-safe access for the evacuation of occupants is available.
 - d) The application must be able to demonstrate that the development would not impede the free flow of water so as to have an impact on adjoining properties or the distribution of floodwaters in the floodplain.

2.2.4.4 Caravan Parks and Camping Grounds

- a) Primitive camping areas will be considered provided that any permanent facilities associated with the provision of a water supply, toilet and refuse disposal are in keeping with the basic needs of the camping ground, and can be shown to withstand the force and duration of flooding in a flood of 0.5% AEP, and will not adversely impact on river water quality under flood conditions.
- b) No approval will be considered for any permanent facilities associated with caravan parks or tourist accommodation, including:-
 - i) permanent or non-flexible connection to services such as power, water and sewerage,
 - ii) permanent residency areas of caravan parks,
 - iii) relocatable homes (homes not being capable of being registered under the Traffic Act),
 - iv) the subdivision of lots for separate occupation sites
 - v) permanent flood control works.

2.2.5 Floodways

2.2.5.1 General

- a) No intensification of development will be permitted which is likely to place the owner or occupants (including their property) at risk from flooding or generate demand for emergency services and placing others involved in evacuation at risk.
- b) Council will consult the DLWC, MDBC and the appropriate Victorian Catchment Management Authority in determining whether a development proposal is likely, either independently or in combination with other similar developments, to cause a significant reduction in flood storage capacity or change in flood behaviour.
- c) This Policy does not favour new development within floodway areas. Where new development is likely to cause a significant reduction in flood storage capacity or change in flood behaviour, proponent will need to

demonstrate proposal will not cause a significant increase in flood levels or flood hazard (including cumulatively with future similar developments). Need to also provide adequate compensating works for flood storage, together with engineering report and a detailed environmental study to support the application.

- d) The feasibility of effective evacuation is to be demonstrated to the consent authority including permanent, fail-safe, measures to ensure the timely, orderly and safe evacuation of people from the area. It is also to be demonstrated that the displacement of these people will not significantly add to the overall cost and community disruption caused by the flood. Council should also consult the SES, and be provided by the proponent with a detailed engineering report and environmental study to support the application.

2.2.5.2 Flood Control Works

- a) No new levees or flood control works to be permitted within floodways.
b) Existing flood control works and impediments to flood flows to be removed and no future flood control works to be permitted.

2.2.5.3 Residential, Commercial and Industrial Development

- a) New dwellings, commercial or industrial buildings, are not permitted.
b) Internal alterations, maintenance and minor repairs to existing structures are permitted.
c) Minor additions to existing dwellings will be considered on merit for each individual application.
d) Non-habitable additions and outbuildings are not permitted.
e) Redevelopment of substantially damaged buildings by a flood event will only be permitted if the applicant is able to demonstrate that the proposed development will be reconstructed in a manner compatible with the flood risk.

2.2.5.4 Caravan Parks and Camping Grounds

- a) Primitive camping areas will be considered provided that any permanent facilities associated with the provision of a water supply, toilet and refuse disposal are in keeping with the basic needs of the camping ground, and can be shown to withstand the force and duration of flooding, and will not adversely impact on river water quality under flood conditions.
b) No approval will be considered for any permanent facilities associated with caravan parks or tourist accommodation, including:-
i) permanent or non flexible connection to services such as power, water and sewerage
ii) permanent residency areas of caravan parks
iii) relocatable homes (homes not being capable of being registered under the Traffic Act)
iv) the subdivision of lots for separate occupation sites

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- v) permanent flood control works

2.2.6 Subdivision of Flood-liable Land

2.2.6.1 General

- a) Applications for subdivision shall be accompanied by contour plans prepared by registered surveyor showing relative levels and contours to Australian height datum at 0.1 metre intervals.

2.2.6.2 Subdivision of land in low hazard flood storage areas

- a) Subdivision of land in low hazard flood storage areas will require a Restriction As To User to be placed on the title of the land advising purchasers that the habitable floor area of dwellings subsequently erected on the new allotments are to be constructed a minimum of 0.3 metres above the 1% (AEP) flood level.
- b) Council will not approve subdivision applications in low hazard flood storage land unless it is consistent with the objectives of this DCP and the principles of Murray REP.

2.2.6.3 Subdivision of floodway and high hazard flood storage

- a) Subdivision of floodway and high hazard flood storage land will not be permitted, however, subdivision of land that either consolidates or does not create additional lots will be considered on its merits.

2.2.7 Land Fill and Earthworks

2.2.7.1 General

- a) No filling or earthworks will be permitted which may cause a significant reduction in flood storage capacity or change in flood behaviour
- b) Council will consult the DLWC, MDBC and the appropriate Victorian Catchment Management Authority in determining whether such filling is likely, either independently or in combination with other works, to affect flooding and drainage of other properties, influence bank erosion, cause a significant reduction in flood storage capacity or cause changes in flood behaviour.
- c) All applications shall be accompanied by a surveyor's contour plan showing existing and proposed levels to Australian heights at 0.1 metre intervals and a geotechnical engineer's specification of the proposed filling or earthworks and the means of retention of fill and fill batters against erosion due to flooding.

2.2.7.2 Filling of low hazard flood storage

- a) Filling will be permitted to 0.3 metres above the 1% (AEP) flood level for development pads or foundations.

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- b) Filling must not occupy more than 25% of the block and not affect the flow of floodwaters in the floodplain or have a detrimental impact on other properties.
 - c) Proponents must be able to demonstrate that flood-free access is available to the filled area of the site from higher ground.

2.2.7.3 Filling of High Hazard Flood Storage

- a) Filling of land in high hazard flood storage will not be permitted apart from:-
 - i) pads necessary for rural dwelling houses and associated outbuildings.
 - ii) the filling of land within the Village zone adjacent to and connected with high ground along Meninya Street .

2.2.7.4 Filling of Floodway

Filling within a floodway will not be permitted.

2.3 PART 3 - OTHER MATTERS

- a) Development and building applications for land which is flood liable shall be accompanied by a survey plan prepared by registered surveyor showing:-
- i) the position of all structures, access and services;
 - ii) the existing ground levels to Australian height datum;
 - iii) the existing and/or proposed floor levels to Australian height datum.
- b) The applicant will be required to submit a certificate from a registered surveyor that the constructed building achieves the minimum required floor level.
- c) In addition to Council's normal advertising and notification processes for applications for approval, Council shall notify all persons of applications received which, in the opinion of Council, may affect the flow of floodwaters or drainage upon their properties.
- d) Council shall make such applications available for inspection for a period of a minimum of 14 days, during which period any person may make a submission for the consideration of Council when determining the application.
- e) All certificates issued pursuant to Section 149 of the Environmental Planning and Assessment Act, 1979, in respect of land which in the opinion of Council, is land:-
- i) which may be low hazard flood storage, shall carry an endorsement to the following effect:-
"This land may be flood liable (low hazard flood storage) and therefore subject to Council's Floodplain Management Plan and Flood Prone Land Policy."
 - ii) which may be high hazard flood storage, shall carry an endorsement to the following effect:-
"This land may be flood liable (high hazard flood storage) and therefore subject to the relevant provisions of Council's Floodplain Management Plan and Flood Prone Land Policy."
 - iii) which may be in a floodway, shall carry an endorsement to the following effect:-
"This land may be flood liable (floodway) and therefore subject to the relevant provisions of Council's Floodplain Management Plan and Flood Prone Land Policy."
- g) Where, in the opinion of Council, there is insufficient data to confirm whether land is flood liable and within which hazard category, the application shall provide sufficient additional survey information to be able to determine these matters, to the satisfaction of Council.

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- h) Permanent facilities associated with caravan parks and camping grounds should not be on flood liable land. Caravan Parks and Camping Grounds require Council consent, are required to be advertised, and a range of public authorities will be consulted including DLWC, DUAP, EPA, MDBC, NSW Tourism Commission, Campaspe Shire Council, and the appropriate Victorian Catchment Management Authority.
 - i) development consent is required for chemical, fuel or fertiliser storage on flood liable land and consultation with DLWC, EPA and MDBC.
 - j) development consent and advertising is required for flood control works and consultation will be undertaken with the MDBC, DLWC, appropriate Floodplain Management Committee, and the appropriate Victorian Catchment Management Authority.
 - k) Use of flood liable land for hazardous or offensive (or a potentially hazardous or offensive) industry, hazardous or offensive storage establishment, intensive livestock keeping, waste land-fill, and manufactured home estates is prohibited. Use of land for such works above the definition of flood liable land will require development consent and advertising.
 - l) Road and rail undertakings, and other public utility or infrastructure activities require consultation with the Murray Darling Basin Commission (MDBC) and Murray Shire Council.
 - m) Consent for the change of use of existing buildings on flood liable land, with floor levels currently below the design floor level will only be given where it can be demonstrated by the applicant that all practical measures shall be taken to minimise the risk of damage to the property including flood proofing of the building, raising the floor level of the buildings or storing equipment and machinery above the flood level.
 - n) When considering applications for new developments within flood liable land where there is special concern in regard to evacuation of the property, such as caravan parks, nursing homes, retirement villages and schools, Council will give special consideration to the establishment of appropriate evacuation procedures, when determining the application.
 - o) Council may from time to time adopt site specific Development Control Plans which provides detailed building envelopes within which development may occur in order to secure an unobstructed path for the flow of floodwaters through developing areas.