

Appendix B – Monitoring activities

B.1 Critical flow gauging areas

DECC will lead the preparation and implementation of monitoring programs during major floods. Input will be sought from DWE, Narromine and Warren Shire Councils, the Central West CMA, and landholders on an as-needs basis. Monitoring activities include flow gauging, aerial and ground photography and observations and recordings of hydrologic, hydraulic and environmental aspects of flooding.

Flow gauging activities should commence when flows meet the trigger levels identified in Table B1.

Table B1 Critical flow gauging areas

Area	When to gauge (guideline only)	Where to gauge
Trangie-Collie Road	Narromine Bridge Gauge 13.0 m	<ul style="list-style-type: none"> Goan Waterhole Trangie Cowal Macquarie River Ewenmar Creek
Wambianna Road (Warren–Gin Gin, SR66)	Warren Town Gauge >8.5 m	<ul style="list-style-type: none"> Macquarie River right bank overflows Reddenville Break
Warren–Nevertire Road (Oxley Highway, SH11)	Warren Town Gauge 9.0 m	<ul style="list-style-type: none"> Sandy Creek (including overflows) Gunningbar Creek Macquarie River (Main Channel)
Warren–Collie Road (Oxley Highway, SH11)	Warren Town Gauge 9.0 m	<ul style="list-style-type: none"> Overflows (Warren to Ewenmar Creek) Ewenmar Creek Five Mile Cowal (including overflows)
Warren–Carinda Road (MR333): Marra Creek crossing	Warren Town Gauge >8.5 m	<ul style="list-style-type: none"> Marra Creek (including overflows)
Mt Harris–Gradgery Road (SR23)	Warren Town Gauge >8.5 m	<ul style="list-style-type: none"> Macquarie River (including overflows) Bulgeraga Creek (including overflows) Back Swamp (including overflows)
Warren–Carinda Road (MR333): Macquarie River left bank overflows	Warren Town Gauge >8.5 m	<ul style="list-style-type: none"> Causeways between Mt Harris and Mt Foster

B.2 Flood monitoring guidelines for landholders

The following advisory notes specify monitoring activities that can be used to guide landholders and Narromine and Warren Shire Councils during floods. The collected monitoring data will assist DECC and DWE in reviewing the performance of the FMP following major floods.

(a) Hydrologic and hydraulic data

Flood characteristics, including:

- Note rainfall depths from private rain gauges throughout the storm event in order to obtain total depth and temporal pattern;
- Note the start and finish times of flooding, as well as when the flood peak arrived;
- Note the duration of the flood peak (how long the peak lasted prior to receding); and
- Compare the flooding with other floods experienced.

Data near streamflow gauging stations, including:

- Note peak water levels from staff gauges (an average of a number of readings should be taken); and
- Take photographs illustrating flood extent and flow pattern.

Floodplain data including:

- Where possible peg flood peaks across the floodplain (eg. flood marks or debris on strainer posts, trees, farm sheds or dwellings);
- Note the extent and width of the flooding;
- Estimate surface flow velocities (usually expressed in metres per second) and where possible note flow pattern. Velocities can be estimated by timing the movement of floating debris over an approximated length of travel;
- Where possible measure flood water slope by pegging water levels over a length of 1 kilometre;
- Note any obstructions to the passage of flood flow (eg. roads, levees, banks), and where possible obtain estimated difference in water levels upstream and downstream of the obstruction; and
- Take photographs illustrating flow paths, flooded areas and dry areas, and flow near obstructions.

Note: Select floodplain monitoring sites that are near hydraulic controls such as roads, levees, major overbank flow breakouts, and at defined floodways.

Data along roads and at causeways/floodways, including:

- Where flooded – estimate flow velocities and flow width over the road, as well as the difference in water levels upstream and downstream of the road; and
- Where dry – estimate the height out of water.

(b) Flood damage

After a flood, information is normally sought to assist in determining the nature and cause of any flood damage. Notes and sketches provided by landholders can aid this process.

Farm loss incurred:

- Note the location of any damage and estimate the loss of crops and fencing.

Road damages:

- Note the location and extent of pavement damage and silt over roads; and
- Where possible estimate the length of road cuts.

Erosion and siltation:

- Symptoms of stream bed lowering include vertical headcuts in stream bed, extensive bank erosion on both side of stream, headcuts in tributary streams and gullies, exposed gravel and/or rock beds, exposed pipe capping on bridge piers, and undermining of causeways;
- Causes of stream bank erosion include flood flows and abrupt changes in channel alignment, gulying where overland flow enters streams, bed lowering, and obstructions to stream flow such as weirs or low level crossings;
- Causes of floodplain erosion include unsustainable land use practices (eg. clearing), overflows from perched streams, and/or flow concentration due to floodplain development; and
- Causes of floodplain siltation include hill-slope erosion and/or reduced capacity of the main channel (bridge crossings, excessive vegetation/ regrowth, influx of sediment), which result in instream sediment being deposited onto the floodplain.

(c) Environmental data

Wetland data, including:

- Monitor the performance of works modifications specified in Table 6.1 to reconnect wetlands to flood flows. Note whether flood flows are reaching the wetland and whether openings in existing works are of adequate size;

Table B2 environmental monitoring

Property/ Landholder	EIA	Map reference	When to monitor	What to monitor
Carinda Road (Burlong Creek)	21	Map 5 of 7	Moderate to major floods.	Monitor flood flow behaviour to determine if existing roadworks impede passage of smaller floods.
Kainga	32	Map 6 Of 7	Moderate to major floods.	Monitor during floods to determine if existing pipes allow adequate filling of wetlands.
Bibbiejiberry	4.7	Map 7 of 7	Moderate to major floods.	Monitor during floods to determine if existing pipe allows adequate filling of wetland.

- Note and photograph any changes to the flooding and drying patterns of the wetland;
- Note how long the wetland holds water after a flood;
- Measure and note how deep the water is at different times in the wetland;
and
- Note and photograph the condition and variety of wetland plant species over time.

Floodplain vegetation (black box, river red gum, lignum) data, including:

- Note and photograph the extent of floodplain vegetation regeneration over time; and
- Note and photograph the extent of flood inundation in the vicinity of floodplain vegetation.

Waterbird and fish observations:

- At key sites, such as wetlands, note the abundance and diversity of waterbird species. The easiest method is to group the waterbirds into ducks, grebes, cormorants, etc. and count by 10's, 50's or 100's; and
- At key sites, such as wetlands and waterways, note the abundance and diversity of fish species. Dip-netting is the simplest way to monitor small fish in wetlands.

For more information on monitoring wetlands, waterbirds and fish refer to the NSW Murray Wetlands Working Group (2002) document titled Wetlands Watch – A Field Guide for Monitoring Wetlands in the Southern Section of the Murray–Darling Basin.

The following questionnaire could be filled out by landholders as a means of collating information regarding the characteristics of a flood, as well as flood damage. Additional sheets could be used.

(d) Aerial and ground photography

Photographs (to be taken between identifiable points on a map)

- Areas flooded and areas not flooded;
- Areas of active flow and backwater;
- The main flow paths;
- Known earthworks such as levees, banks, channels;
- Known problem areas;
- Roads and railways;
- Environmental information, as outlined in (c) above, and,

Time and date each photograph was taken.

LANDHOLDER MONITORING QUESTIONNAIRE
Hydrologic and hydraulic data
Rainfall depths and duration (private rain gauges).....millimetres at 9:00am each day
Inundation limits – sketch on a map areas inundated, flow paths, and areas of backwater
Duration of inundation.....hours / days
Depth of inundation.....metres at location.....
Flow velocity estimates.....metres per second at location.....
Flood marks – provide location and description, mark levels upstream and downstream of structures (channels, roads, culverts, etc.)
Identify any flow obstructions – banks, channels, roads, etc.
Compare with previous floods – larger/smaller, etc.

Flood damage
Crop loss – Yes/No – If yes describe location and extent
Fence loss – Yes/No – If yes describe location and extent
Road damage – Yes/No – If yes describe type, location and extent
Erosion – Yes/No – If yes describe type, location and extent
Siltation – Yes/No – If yes describe location and extent
Environmental data
Duration of flooding in wetland.....days
Depth of flooding in wetland.....metres at location.....
Note numbers and types of waterbirds if present
Note presence of native fish in floodwaters
Note extent of regeneration of floodplain vegetation (following floods)
<i>Where works modifications are required to reconnect wetlands:</i>
Is the opening of adequate size?
Did floodwater reach the wetland?
Was floodwater backed up upstream of the opening?
Note level of floodwater through works modifications.

B.3 Narromine and Warren Council monitoring activities

These activities are similar to those listed for landholders above but in relation to council works. In particular the performance of road structures should be carefully assessed as well as the impact of all floodplain development on urban areas. With regard to the road structures, those that are of significance should be monitored over the duration of the flood. Less crucial structures could be observed at peak levels and at overtopping levels for causeways.

For road structures the following data should be collected:

- the head difference across the structure at peak and critical levels;
- depth of flow over causeways;
- estimate the flow velocity through or across the structure;
- whether the structure gets affected by debris;
- photographs of the structure in flood; and,
- time when flow starts and finishes.

Following floods, Council should assess flood damage to roads and infrastructure by:

- Noting the location and extent of pavement damage and silt over roads;
- Estimating the length of road cuts where possible; and,
- Noting damage to other infrastructure such as culverts or bridges.

B.4 DECC Monitoring activities

DECC's role in monitoring includes the following activities:

Flood photography, including:

- Undertake and obtain on-ground photography of flood;
- If thought necessary, undertake oblique aerial photography of flood;
- If found necessary, organise vertical aerial photography of flood; and,
- Obtain available satellite imagery of the study area under flood.

Obtain survey data, including:

- Collate existing survey data undertaken or organised by DECC, landholders, or local councils; and,
- If found necessary obtain additional survey data, particularly in the vicinity of new flood control works (storages, levees, channels, etc) and structures (bridges, culverts, weirs).

Consultation activities, including:

- Undertake consultation activities with stakeholder groups (landholders, government agencies, local councils, and other interest groups) to source their opinion on the flood and the performance efficiency of the FMP floodway network;
- Undertake field investigations after floods to view identified problem areas.

Collate environmental data, including:

Fish and aquatic invertebrates –

- Obtain information regarding fish abundance and diversity within the vicinity of the FMP floodplain. This data can be sourced from NSW Fisheries who undertake field sampling of fish; and,
- Obtain information regarding the abundance and diversity of macroinvertebrates within the vicinity of the FMP floodplain. This data can be sourced from existing programs such as the Sustainable Rivers Audit led by the Murray Darling Basin Commission and the Integrated Monitoring of Environmental Flows led by DWE.

Vegetation –

- Based on obtained flood photography and field investigations, assess change(s) in floodplain vegetation following floods.

Additional data –

- Approach government agencies in order to source any relevant environmental data gathered by them in response to a flood. This may include data in relation to fish, water quality, floodplain vegetation, waterbird observations and wetlands.

Review Floodplain Management Plan:

- Review hydraulic models with new data; and,
- Identify modifications to plan.

B.5 DWE monitoring activities

DWE's role in monitoring includes:

Obtain flow data, including:

- Obtain flood heights and discharge records from gauging stations within the vicinity of the study area; and,
- If necessary, obtain rainfall data from the Bureau of Meteorology and DWE records.

Appendix C – Design flood, peak flood flows and flood volumes

C.1 Design flood levels

As outlined in Section 4.2 the Macquarie FMC has adopted the 1990 flood as the design flood upstream of Warren and the 1955 flood downstream of Warren. The FMP floodway network shown on Maps 1 to 7 show flood levels that represent the design flood.

The **1990 design flood levels** have been calculated with the following parameters:

- Vegetation cover assumed as for the 2000 historical flood event;
- **1990 design peak floodway flows** calculated using the 1990 inflow flood hydrograph recorded at Narromine;
- Assuming all flood control works bordering the hatched areas upstream of Warren and shown on Maps 1 to 7, have been constructed and floodways are clear of obstruction;
- For locations between assigned **1990 design flood levels** a linear interpolation of the adjoining upstream and downstream design flood levels can be made to determine the appropriate levee and bank crest levels.

The **1955 design flood levels** have been calculated with the following parameters:

- Vegetation cover assumed as for the 2000 historical flood event;
- **1955 design peak floodway flows** calculated using the 1955 inflow flood hydrograph recorded at Narromine (with no Webbs Siding outflows) and assuming, upstream of Warren, all flood control works bordering the hatched areas shown on Maps 5 to 7 are overtopped and virtually the whole of the floodplain storage is available for floodwaters;
- Assuming all flood control works bordering the hatched areas downstream of Warren and shown on Maps 5 to 7, have been constructed and floodways are clear of obstruction;
- For locations between assigned **1955 design flood levels** a linear interpolation of the adjoining upstream and downstream design flood levels can be made to determine the appropriate level.

C.2 Peak flood flows

Modelled peak flood flows shown in Figures 4.1 to 4.3 were used to examine overall trends in peak flows on the left and right bank floodplains of the Macquarie River at Gin Gin and Warren. These trends were determined by summing individual peak flood flows along identified flow paths for the three selected floodplain conditions and 1955, 1990 and 2000 flood inflows.

Chart C.1 shows the trend in distribution of modelled peak flood flows along the Trangie – Collie Road at Gin Gin for the selected floodplain conditions. For 1955, the peak flood flow in the Macquarie River channel under developed conditions is greater than for the 'natural' floodplain scenario and this can be attributed to the closure of the Webbs Siding outflow at Narromine (refer to Section 8.1 for more

detail). Overall, the trend shown on the left and right banks for the FMP floodway network is similar to that for the 'natural' floodplain.

Chart C.2 shows the trend in distribution of modelled peak flood flows along the Oxley Highway at Warren for the selected floodplain conditions. For 1955, the peak flood flow on the right bank under developed conditions is approximately 30% greater than for the 'natural' floodplain scenario and this can be mainly attributed to the closure of Webbs Siding and the operation of Reddenville Break. In general, the relative distribution of peak flood flows for the two smaller floods is similar under all floodplain scenarios. However, the total peak flood flows under developed conditions are slightly greater than under the 'natural' floodplain scenario due to reduced floodplain storage.

C.3 Flood volumes

Modelled flood volumes shown in Figures 8.1 to 8.3 were used to examine overall trends in flood volumes on the left and right bank floodplains of the Macquarie River at Gin Gin and Warren. These trends were determined by summing individual flood volumes along identified flow paths for the three selected floodplain conditions and 1955, 1990 and 2000 flood inflows.

Charts C.3 and C.4 show the trend in distribution of modelled flow volumes along the Trangie–Collie Road at Gin Gin and the Oxley Highway at Warren for the selected floodplain conditions. At both locations the 1955 total flood volume under developed conditions is greater than for the 'natural' floodplain scenario and this can be attributed to the closure of Webbs Siding. Overall, the flood volume distribution for the FMP floodway network agrees closely with the corresponding distribution under 'natural' floodplain conditions.

Chart C.1 – Distribution of modelled peak flows along Trangie-Collie Road

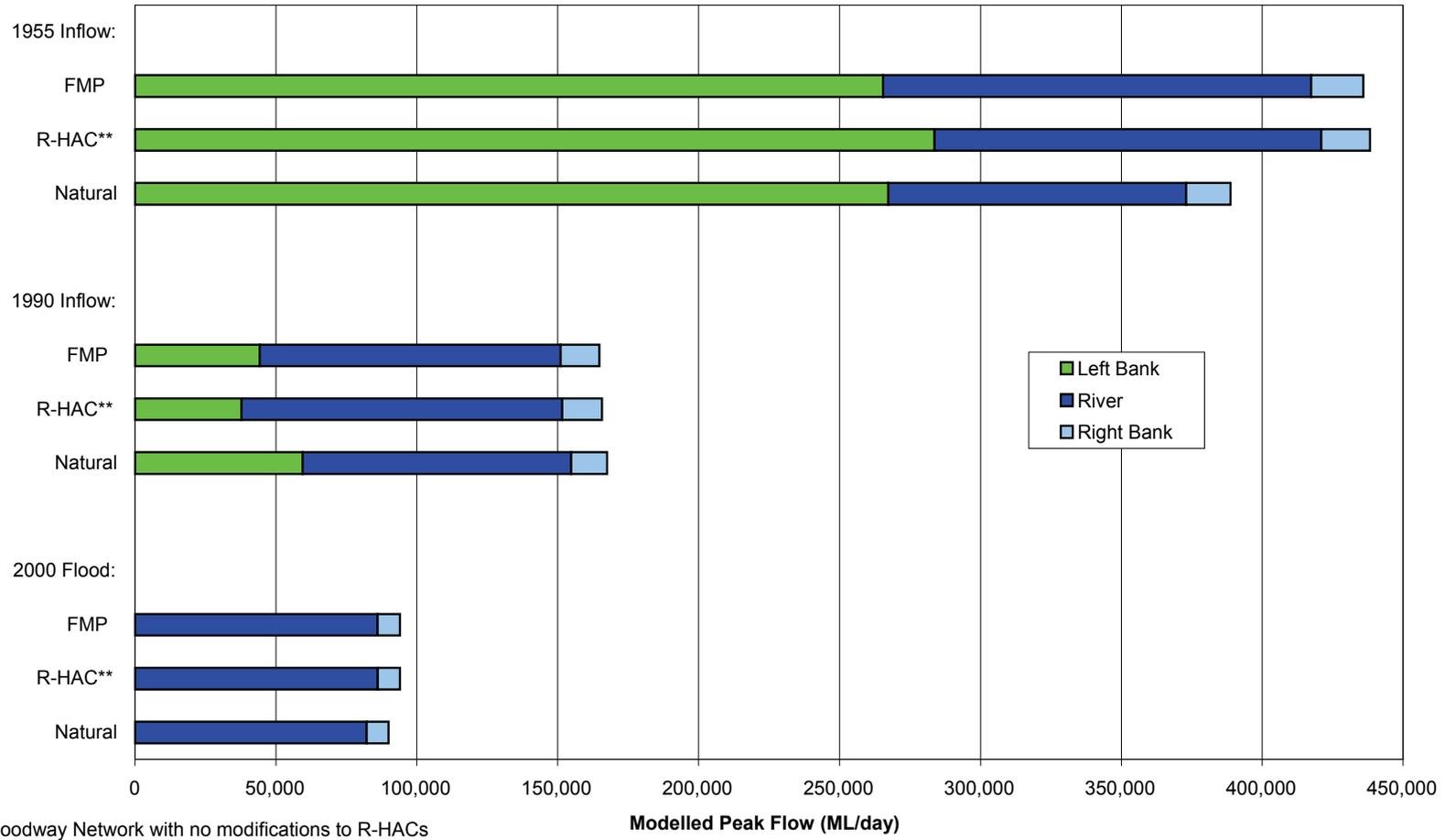
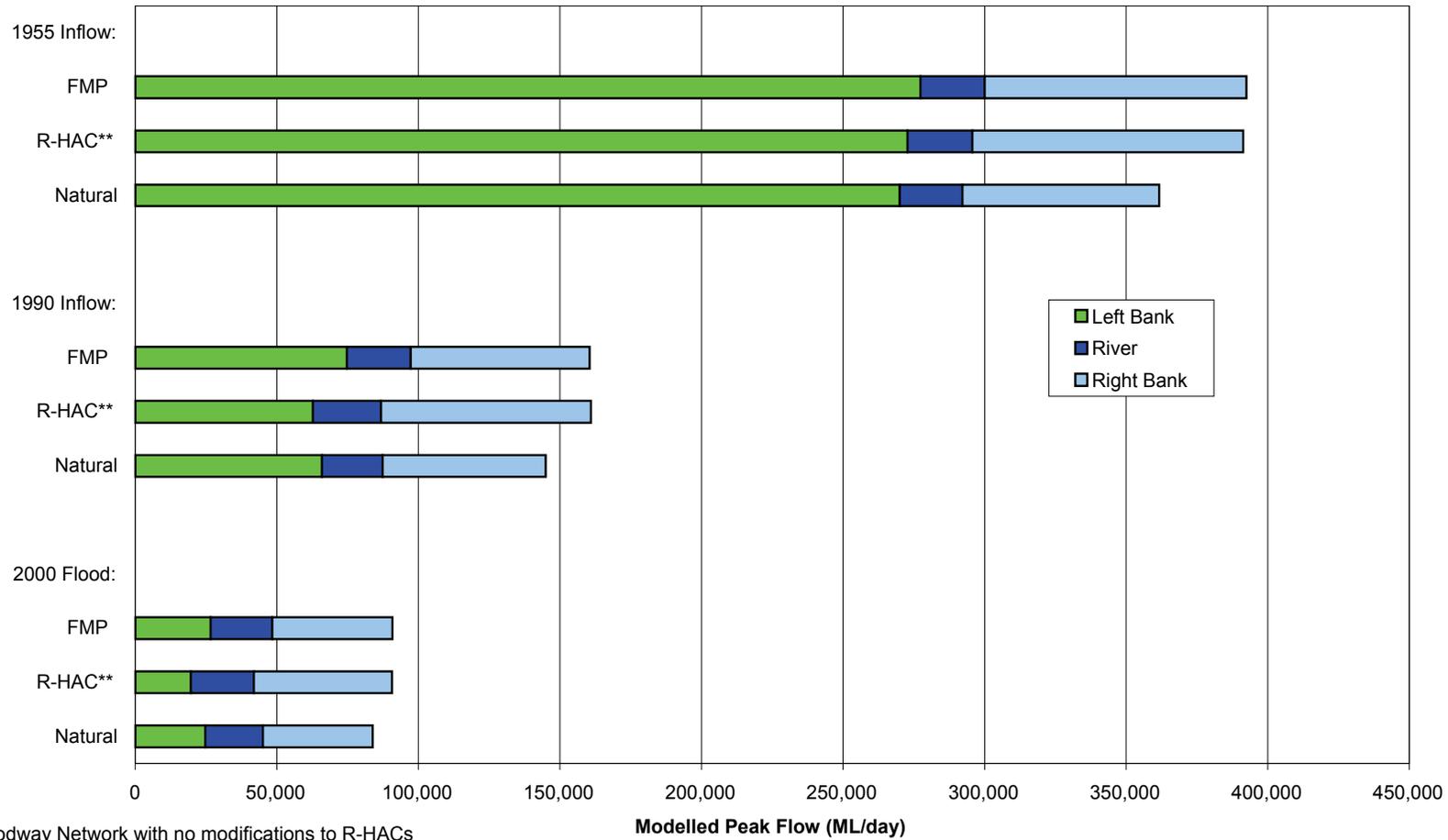
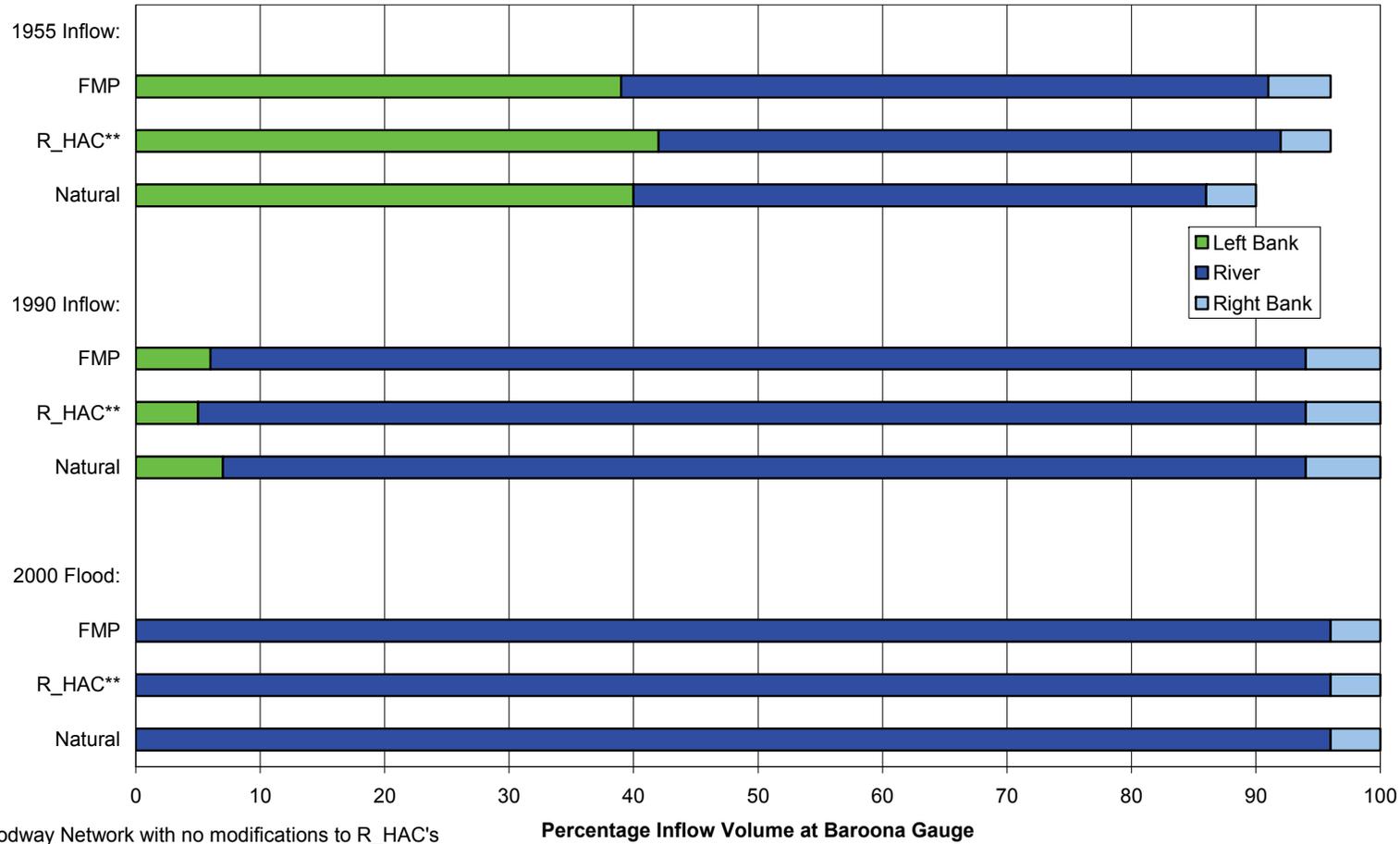


Chart C.2 – Distribution of modelled peak flows along Oxley Highway



** Floodway Network with no modifications to R-HACs

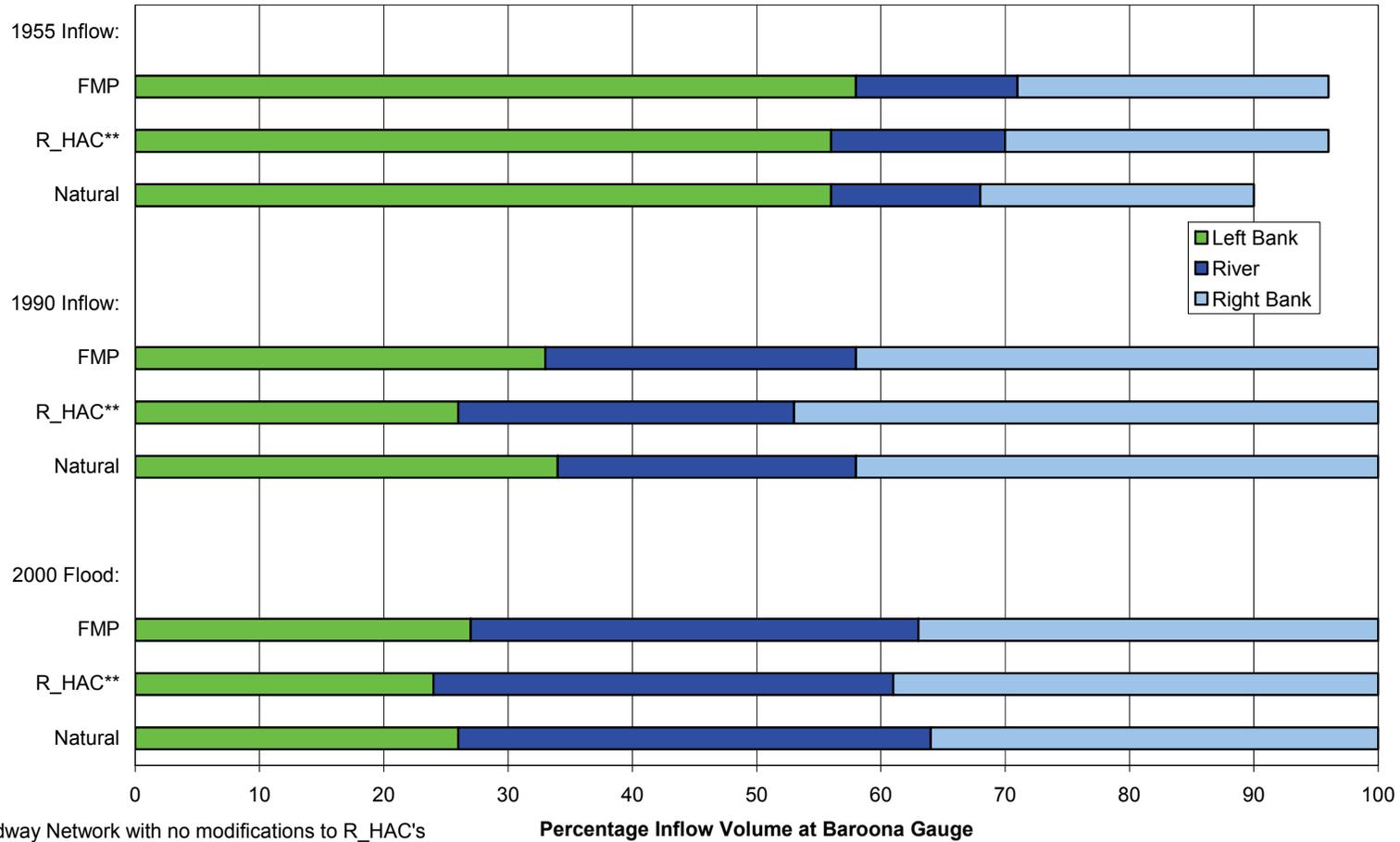
Chart C.3 – Distribution of modelled flow volumes along Trangie–Collie Road



** Floodway Network with no modifications to R_HAC's

Percentage Inflow Volume at Baroona Gauge

Chart C.4 – Distribution of modelled flow volumes along Oxley Highway



Appendix D – Application for approval of a controlled work

The following must accompany the application form:

Application fee (currently \$182, August 2006);

A detailed plan, providing full details of the proposal;

Supporting information that may assist in the determination process (Applicant to get in touch with the nearest DWE office for details).



Department of Water and Energy

209 Cobra Street, PO Box 717 Dubbo NSW 2830
 Phone: (02) 6884 2560 Fax: (02) 6884 0096

**APPLICATION UNDER SECTION 167 (1) (a) of PART 8 OF THE WATER ACT, 1912
 FOR APPROVAL OF A CONTROLLED WORK**

WHEN COMPLETING THIS FORM PLEASE READ THE NOTES ON THE REVERSE SIDE

NAME(s) OF APPLICANT(s) *(See Note 1)	SURNAME	GIVEN NAME(s)		
ADDRESS FOR SERVICE OF NOTICES			Postcode	Telephone
PROPERTY ADDRESS			Postcode	Telephone
LOCATION OF WORK (See Note 2)	LOT/PLAN/PORITION	PARISH	COUNTY	
RIVER/LAKE/ FLOODPLAIN (See Note 3)				
DESCRIPTION OF NATURE AND PURPOSE OF THE WORK (See Note 4)				(please ✓) Existing <input type="checkbox"/> Proposed <input type="checkbox"/>
RIGHT OF OCCUPANCY OF THE LAND ON WHICH THE WORK IS LOCATED (See Note 5)	(Please ✓) FREEHOLD <input type="checkbox"/> LEASEHOLD <input type="checkbox"/>		PERMISSIVE OCCUPANCY <input type="checkbox"/>	Per. Occ. No. Where applicable <input type="text"/>
	OTHER (please describe)			<input type="text"/>

*I/we declare –

- (a) that the whole of the work is situated/proposed to be constructed *on the abovementioned land and
- (b) that I am/we are* the occupier(s) of the whole of that land.

*I/we enclose –

- (a) a plan of the abovementioned land indicating the boundaries of the land and the site of the work and
- (b) the prescribed fee of \$182 (See Note 6)

(delete whichever is inapplicable)

SIGNATURE(S) OF APPLICANT(S)

Date: / /

DEPARTMENTAL USE ONLY

FEE PLAN DETAILS

APPROVAL NO.

Note 1: APPLICANT'S NAME(S)

The application must show the FULL NAMES of ALL persons who are, or propose to be for the purpose of constructing the work, in occupation of ALL the lands and properties on which the work is, or proposed to be located.

If there is not enough room for all the names please attach a separate sheet. The first name shown on the application will become the principle name for mailing and notification purposes.

Note 2: LOCATION OF WORK

The location of the work should be described by reference to the County/Parish/Lot(s) and Deposited Plan number(s) in which the work is situated or, if these details are not known or are inapplicable, in some other manner sufficient to identify its location. This information may be available from your local Council. If this information cannot be obtained please provide any other plan or title references to the land and ensure that the PLAN TO ACCOMPANY THIS APPLICATION clearly depicts property boundaries and the location of the work thereon.

Note 3: RIVER/LAKE/FLOODPLAIN

If the work is to be located near, on, or within the banks of a named lake, river or watercourse please provide its name. If the work is on a floodplain of a particular river valley please provide the name of that river valley.

Note 4: DESCRIPTION OF WORK

- Describe the nature, materials to be used, and purpose of the work; for example:
- an earthen levee, for preventing inundation of land;
- an earthen access road; with concrete piped culverts: from residence to main road;
- an earthen block dam; with wing walls for conservation of water;
- earth fill building pad;
- irrigation supply channel; with inverted siphons.

If separate structures are proposed the Department may require that separate applications be lodged. A controlled work, for which approval is required is any structure which may effect the passage, distribution or height of flood water.

Note 5: OCCUPATION

Indicate the nature of the right of occupancy at present held over the land on which the work is or proposed to be located. If the right of occupancy is yet to be obtained describe the type of occupancy right being sought.

Note 6: FEE

This application MUST be accompanied by the prescribed fee. If you withdraw this application, prior to it having been determined (Approved or Refused) by the Department may retain the fee, as is deemed appropriate, to partly or wholly offset the expenses incurred in dealing with the application. (Currently \$182, August 2006)