CHAPTER 9: FLOOD RISKS

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The Flood Threat

A simple definition of flooding is *water where it is not wanted* (Chapman, 1994). Four different mechanisms can cause flooding including heavy rainfall, storm surge, tsunami and dam failure (ARMCANZ, 2000). In this chapter we discuss flood risk associated with heavy rainfall, and briefly, flood risk associated with dam failure.

Riverine flooding occurs when the amount of water reaching the watercourse or stream network exceeds the amount of water which can be contained by the network and subsequently water overflows out onto the floodplain. Several factors influence whether or not a flood occurs, including:

- the total amount of rainfall falling over the catchment;
- the geographic spread and concentration of rainfall over the catchment, i.e. spatial variation;
- rainfall intensity, duration and temporal variation;
- antecedent catchment and weather conditions;
- ground cover;
- the capacity of the watercourse or stream network to carry the runoff; and,
- tidal influence.

This complex set of factors influences whether or not flooding occurs in a catchment, consequently it is difficult to define the causes or the impacts of an 'average' flood. Put simply, no two floods in the same catchment are ever identical. To overcome this problem, floodplain managers and hydraulic engineers rely on a series of design flood events and historical rainfall and flood level information. It is upon these that this report is based.

Localised and/or flash flooding typically occurs when intense rainfall falls over a small sub-catchment which responds to that rainfall in six hours or less. In urban or rural areas where drainage is poor, the risk of localised flooding is high under such circumstances. Widespread flooding, by contrast, occurs following rainfall of high intensity or long duration over the whole, or a large proportion of a catchment. Runoff is typically less in areas where the percentage of vegetation is high, as vegetated areas allow high infiltration until the earth is saturated. Where the ground is pre-saturated, such as following a long wet period, medium rainfall events may then cause flooding as runoff begins almost immediately. Flood levels in urban areas quickly rise where the percentage of impermeable surfaces in the local catchment, such as buildings, roads and car parks, is high. On sloping concrete and bitumen surfaces, for example, runoff is almost immediate.

Average recurrence interval (ARI) or annual exceedance probability (AEP) are statistical benchmarks used for flood comparison. ARI is the average, or expected, value of the number of years between exceedances of flood events of a given magnitude (gauge height or discharge volume). AEP is the probability of a flood event of a given magnitude being equalled or exceeded in any one year. The Probable Maximum Flood (PMF) is the limiting-value flood which can reasonably be expected to occur. It is usually perceived as having an ARI of between 10 000 and 10 000 000 years (Nathan & Weinmann 1999, Laurenson 1994 in ARMCANZ, 2000).

Flood levels are typically related to the Australian Height Datum (AHD), which is approximately Mean Sea Level (MSL). Accordingly, the 'gauge height' of floods varies depending on the location of the gauge and its relative elevation in the floodplain. The depth of any flood is then calculated as the difference between the flood water level elevation and the local ground elevation relative to the AHD.

Cost of flooding

Major flooding causing inundation of large areas, isolating towns and disrupting road and rail links occurs on average about every ten years somewhere in the South-East Queensland region. Smith (1998) estimated that around 35% of the buildings at risk from flooding in Australia are located in Queensland, with 21% being in the South-East Queensland region. The large numbers of buildings at risk of flooding in South-East Queensland is exacerbated by the absence of State-wide floodplain management regulations which might typically aim to preclude residential development in areas subject to flooding up to the 1% AEP (100 year ARI) level. In Queensland such regulations are left to individual Local Government Authorities (LGAs) to establish.

The average economic cost of **urban** flooding (stormwater and mainstream flooding[1]) in Australia is estimated to be in the order of $200 million per year at 1998 dollar terms (ARMCANZ 2000). The estimate is however based on the DPIE (1992) study and significantly underestimate flood damage. The more recent study by Smith (1998) estimated annual average **urban** flood damage in Queensland alone at about $100 million.

Economic loss due to flooding varies widely from year to year and is dependent on a number of factors, for example, flood severity and location. During the 1974 Brisbane floods, for example, the flood damage in 1998 values was $700 million, however, damage was much lower in both previous and subsequent years (ARMCANZ, 2000).

In recent years good work has been undertaken by a number of local governments to minimise flood risk through stringent development application guidelines, however, flooding remains a large problem for many areas across the region.

The Flood Phenomenon

Heavy rainfall capable of causing flooding (flash and non-flash) in South-East Queensland can arise from a number of different meteorological mechanisms, as described below:

Severe Thunderstorms

- isolated storms typically cause flash flooding in relatively small catchments
- organised systems may extend to affect more than one catchment

Tropical Cyclones

- capable of causing widespread flooding across the South-East region
- typically heaviest rainfall is associated with coast-crossing and decaying phases

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[1] The dollar loss to buildings affected by mainstream flooding is significantly larger though the number of properties affected are less than for stormwater flooding.

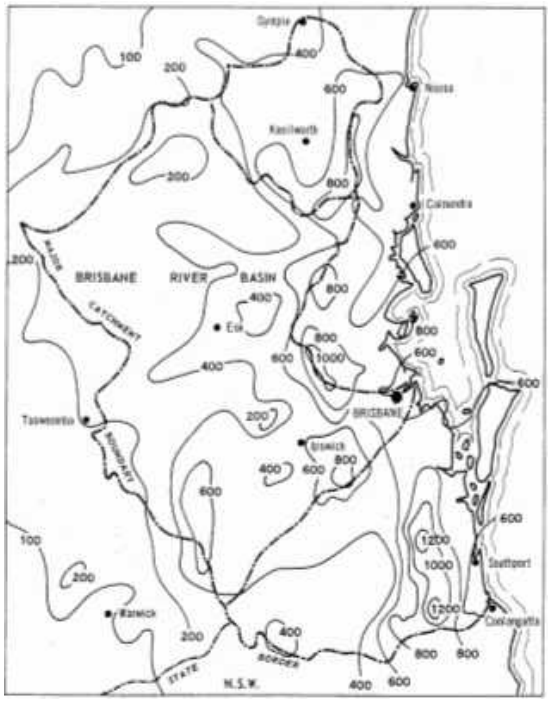
- may interact with and draw the monsoon trough southwards creating an extensive rainfall event over the whole state (e.g. BoM, 1974 - refer to Figure 9.1)

East Coast Lows

- capable of causing widespread flooding across the South-East region (e.g. BoM, 1996)
- more common in autumn and early winter
- establish large scale moist onshore flow conditions
- heavy rainfall triggered by upper level coupling creating large scale lifting of the onshore flow

Other

- fronts and troughs
- low pressure systems
- coastal convergence
- high pressure intensification in the Tasman Sea, combined with upper trough interaction.



All of these events are also influenced by the regional topography which provides significant orographic lift to assist the creation of favourable conditions for heavy rainfall. The detailed characteristics of these meteorological situations is discussed in Chapters 4 (cyclones), 5 (east coast lows) and 6 (thunderstorms).

Figure 9. 1 Rainfall isohyets (mm) over the five day period of the January 1974 floods

Major river systems in South-East Queensland

South-East Queensland is crossed by a number of major river systems and numerous creeks. Typically the headwaters rise in the Great Dividing Range to the west and the rivers traverse the coastal plains in a generally eastward direction, emptying into Moreton Bay, The Broadwater or the Pacific Ocean. The rivers are fed by an average annual rainfall which varies between 800 mm

and 1500 mm across the region and has helped create a particularly fertile region which, prior to European settlement, supported a large number of aboriginal communities. From the earliest days of European settlement, many rivers provided not only abundant fresh water supplies and fertile adjacent lands but also served as important transportation corridors. In the past 100 years the extensive urban development of the region has impinged onto many areas of the floodplains and several river courses have been altered through the creation of water storages in their upper reaches and dredging or reclamation works in their lower reaches.

An overview of the major river catchments in South-East Queensland was shown in Figure 2.3 and in more detail in Figures 9.2 – 9.7. The northern coastal region is drained by the Caboolture River, Burpengary Creek, North and South Pine Rivers and the northern creeks of Brisbane which flow to Moreton Bay. The Brisbane-Bremer River system is the major catchment in the region and includes a number of urban creeks including Oxley and Bulimba Creeks on the southern side and Moggill and Enoggera Creeks in the north. The southern coastal region is traversed by the Logan River and its major tributary, the Albert River, which empties into the southern extent of Moreton Bay, whilst the Pimpama, Coomera and Nerang River systems empty into The Broadwater. An extensive network of rainfall and river height reporting stations cross the region that provide data on flood events used for both operational warnings and investigations into the probability of occurrence of extreme floods.

Caboolture River and Burpengary Creek System

The Caboolture River is situated about 40 km north of Brisbane and has a total catchment area of 370 square kilometres (CSC 1994a). It rises in the D'Aguilar Ranges and flows in an easterly direction towards the coast, passing through Caboolture and entering Deception Bay (the northern part of Moreton Bay) near the township of Beachmere. Its major tributaries include Wararba, Sheep Station, King John and Lagoon Creeks. The topography is steep in the upper portions but flattens out progressively towards the coast, forming a mature floodplain in the middle and lower reaches. Downstream of Caboolture, the floodplain is very flat and consists of scattered swamps and extensive areas that are highly floodprone. Other than the townships of Caboolture (12 km from the mouth) and Morayfield, Beachmere is the only other significant urban area on the lower floodplain, which is otherwise characterised by rural industry, pastures and pine forest plantations. Figure 9.2 indicates the extent of the Caboolture River catchment.

Burpengary Creek, the creek system immediately to the south of the Caboolture River catchment, also flows in a general easterly direction to the northern end of Deception Bay, just south of the Caboolture River mouth (Figure 9.2). The topography is generally flat and, other than the township of Burpengary which has some flood-affected residential properties, the land use is largely rural industry.

Pine River System

The Pine River catchment drains in a generally easterly direction from the relatively steep D'Aguilar Ranges towards the flat coastal plains of Bramble Bay between Sandgate and Redcliffe. North Pine River and South Pine River join some 7 km upstream from the mouth, where the combined system forms an extensive coastal estuary. The tidal influence extends upstream in the North Pine to Young's Crossing, and in the South Pine to the Bald Hills Railway Bridge. The major river catchments of Pine Rivers are shown in Figure 9.3.

The North Pine rises near Mt Pleasant towards the northwest corner of the catchment while its major tributary Laceys Creek flows from the south. Approximately 18% of the North Pine

catchment consists of State forest, 1% is national park and the remainder is rural. The North Pine Dam was constructed 5 km upstream of Petrie in 1976 and forms the 2000 hectare Lake Samsonvale. The dam provides water supply to Brisbane, Pine Rivers and Redcliffe. Just downstream, Sideling Creek was also dammed for water supply purposes in 1959 and forms the smaller Lake Kurwongbah. The main urban areas of the North Pine catchment are located downstream of the dam and include Petrie, Lawnton and Strathpine.

The South Pine River rises in the D'Aguilar Ranges to the south and flows in an easterly and northeasterly direction towards Bramble Bay. Cedar Creek is the major tributary which joins the river 4 km upstream of Cash's Crossing. At this point the river forms an extensive floodplain area which extends through the urban areas of Albany Creek, Strathpine and Bald Hills. Grazing and rural residential are the major land uses in the catchment.

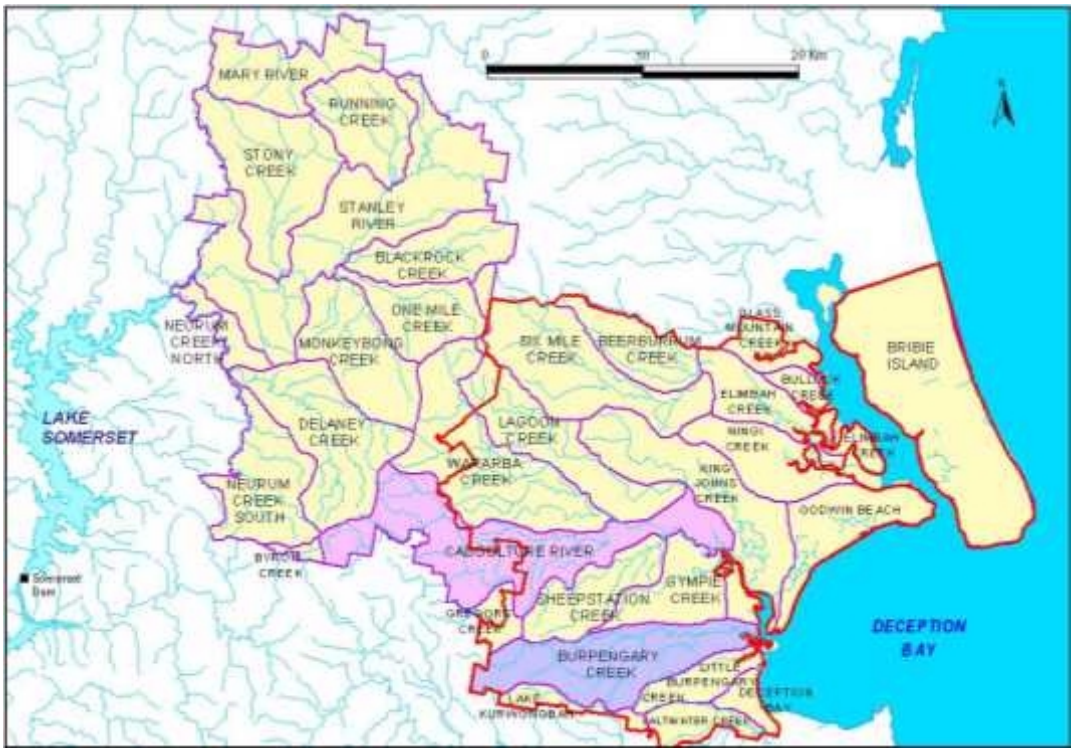


Figure 9. 2 Caboolture River catchment

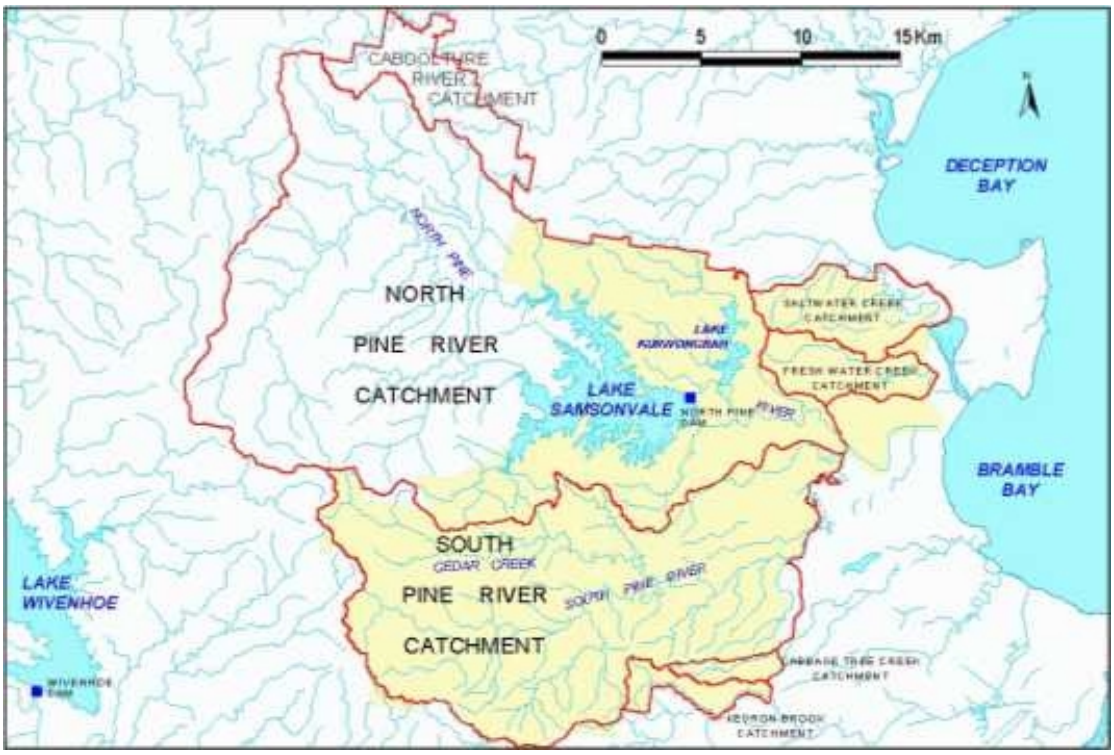


Figure 9. 3 Pine Rivers catchment

Brisbane and Bremer River System

The Brisbane River catchment (Figure 9.4) is the largest in the region and covers an area of 13 570 square kilometres (BCC 1998). The catchment is bounded to the west by the Great Dividing Range and by a number of smaller coastal ranges to the east and north. Most of the catchment comprises of forest and grazing land, with the exception of the Brisbane – Ipswich metropolitan regions and numerous small rural townships. The headwaters are at the northerly extent of the catchment bounded by the Brisbane Range. The overall length of the main stream is approximately 300 km.

The major tributaries of the Brisbane River are best summarised in terms of its principal sub-catchments, which include:

Upper Brisbane

This comprises Cooyar and Emu Creeks which have their headwaters in the Great Dividing Range to the northwest. This area has the lower average annual rainfall.

Somerset

This is formed by the Stanley River, which rises in the foothills of the Conondale and D'Aguilar Ranges to the northeast. Somerset Dam, a major water supply and flood mitigation dam, is located just upstream of the junction of the Stanley and Brisbane Rivers.

Wivenhoe

Consists of Cressbrook Creek, bounded by the Great Dividing Range to the west. This catchment is dominated by Wivenhoe Dam, the largest dam in the South-East, which when filled extends upstream to Somerset Dam.

Lockyer

The Lockyer Creek is bounded by the Great Dividing Range to the south and west and represents the largest of the sub-catchments of the Brisbane River. Other major tributaries include Laidley and Tenthill Creeks. The lower floodplains of the Lockyer Valley support intensive agriculture, including vegetables and small crops.

Bremer

The Bremer sub-catchment occupies 1500 square kilometres of the southernmost corner of the Brisbane River catchment (IRIT 2000) and is bounded by the Macpherson Ranges to the south. The Bremer River flows through the City of Ipswich and joins the Brisbane River near Moggill. Warrill Creek, the major tributary, accounts for almost two-thirds of the catchment area and joins the Bremer approximately ten kilometres upstream of Ipswich. Heavy rainfall in the Bremer-Warrill headwaters can cause major flooding of Ipswich as well as agricultural and rural areas throughout the catchment. Localised flooding in the Ipswich area can also be caused by the Bundamba and Woogaroo Creeks. During heavy rainfall, these small creeks rise very quickly and can cause significant flooding in urban areas. Flooding in the Ipswich area can also occur due to backwater flooding from the Brisbane River when it is in major flood. Tidal effects from Moreton Bay are still felt at Ipswich, some 80 km from the mouth of the Brisbane River.

Lower Brisbane

This covers the catchment from the confluence with the Bremer, through to the river's mouth into Moreton Bay. Much of this is within the metropolitan regions of the City of Brisbane. Flooding in the Brisbane City area can also be caused by local tributaries including Oxley and Bulimba Creeks on the southside, and Moggill and Enoggera Creeks in the western and northern suburbs. During intense rainfalls, the suburban creeks rise very quickly and can cause significant flooding of streets and houses.

Major Brisbane Creeks

Brisbane City is traversed by many creeks (Figure 9.5), some of which cause local flash flooding problems. Approximately six to twelve hours of rain in excess of 100 mm on an already wet catchment is typically needed to cause significant flooding. Some of the larger creeks are also subject to backwater effects from the Brisbane River.

The following creeks flow through the northern suburbs of Brisbane into Moreton Bay:

Kedron Brook

The headwaters of Kedron Brook are in the Ferny Hills area but it is also fed from Cedar Creek which rises in the Upper Kedron area near Brisbane Forest Park. The creek flows through Keperra, Stafford, Enoggera, Grange and Toombul before entering Shultz Canal adjacent to the airport and flowing into Moreton Bay at Nudgee.

Cabbage Tree Creek

This small creek has its headwaters near Arana Hills and flows eastwards through Bridgeman Downs, Carseldine and Zillmere, entering Moreton Bay near Shorncliffe. Little Cabbage Tree Creek rises in West Chermside and flows through Aspley, joining the main stream at Carseldine.

Downfall – Nundah Creek

This small creek rises near McDowall and flows through Chermside and Virginia. It then becomes Nundah Creek at Zillman Waterholes and passes through the Boondall Wetlands to enter Moreton Bay at Shorncliffe, joining with Cabbage Tree Creek.

The following creeks flow into the Brisbane River and are usually subject to backwater effects when the Brisbane River is in flood:

Enoggera Creek

The headwaters of Enoggera Creek are in the D'Aguilar Ranges near Mt Nebo. It flows through Brisbane Forest Park into the Enoggera Reservoir, then via The Gap, Bardon and Ashgrove. It is joined by Ithaca Creek at Kelvin Grove, which rises near Mt Cootha and passes through Bardon and Ashgrove. In the lower reaches Enoggera Creek becomes Breakfast Creek and continues on through Herston to enter the Brisbane River at Newstead.

Moggill Creek

The headwaters of Moggill Creek are on the southern side of Mt Cootha. The creek flows through Brookfield and Kenmore and enters the Brisbane River just upstream of Jindalee Bridge.

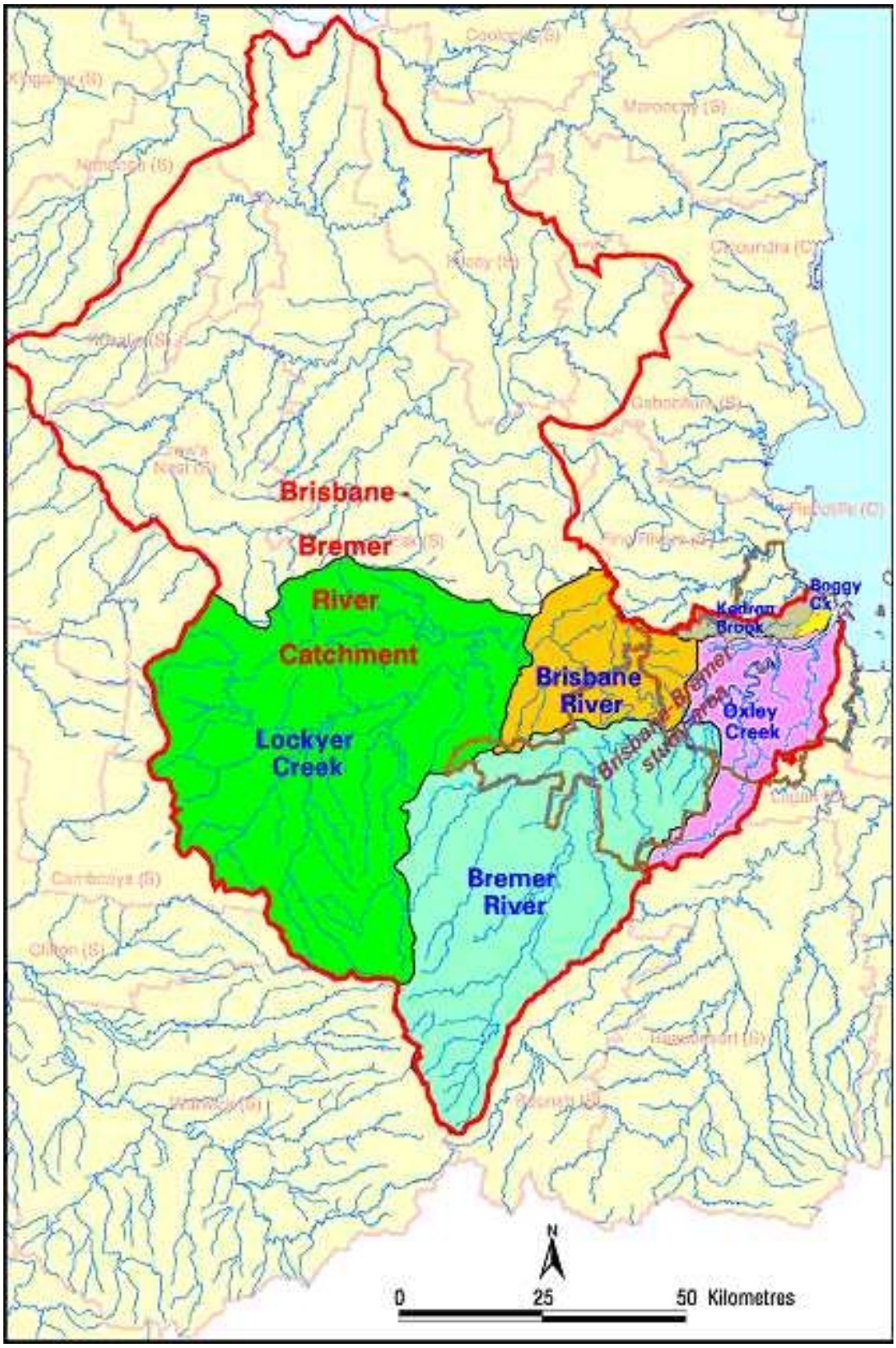


Figure 9.4: Brisbane-Bremer River catchment

Figure 9.5: Brisbane major creek catchments

Bulimba Creek

The headwaters of Bulimba Creek are in the Eight Mile Plains area. It flows through the suburbs of Wishart and Carindale before entering the Brisbane River near Hemmant.

Oxley Creek

Oxley Creek is the largest of the metropolitan creeks and has a relatively long flood concentration time. It rises in the area south of Greenbank Military Training Area and flows through the suburbs of Forestdale, Acacia Ridge and Rocklea. The main flooding problems are in the lower reaches around Rocklea and Corinda.

Logan - Albert River System

The Logan-Albert River system has a total catchment area of 3875 square kilometres and lies in the southeast corner of Queensland. The catchment extends from the McPherson Ranges in the south on the Queensland-NSW border, north to the Logan City - Beenleigh area. The major tributaries are the Albert River and Teviot Brook. Smaller tributaries include Running, Christmas, Burnett and Canungra Creeks in the headwaters. Major flooding is experienced in both rural and urban areas of the catchment. Scrubby and Slacks Creeks in the lower reaches of the Logan River can be subject to flash flooding as well as backwater flooding during major river flood events. The Logan-Albert River system is shown in Figure 9.6.

Pimpama, Coomera, Nerang, Tallebudgera and Currumbin catchments

The Pimpama River catchment (Figure 9.7) is located to the south of the Logan River and has an area of about 130 square kilometres, with about 60% of the area to the east of the Pacific Highway (GCCC 1999a). West of the highway the catchment is bounded by the Albert River catchment. The catchment is relatively undeveloped.

The Coomera River catchment is located immediately south of the Pimpama River (refer to Figure 9.7). It rises in the McPherson Ranges, passing around Canungra, Coomera and Oxenford and entering the northern Broadwater through Hope Island (GCCC 2000). There are a number of major tributaries and the lower reaches of the river are tidal, dividing into several channels forming islands on the lower floodplain. The land use distribution varies from rural in the upper reaches to large scale resort and residential along the lower floodplain tributaries. These include The Anabranch and Saltwater Creek. Coombabah Creek is another tributary which flows northwards into the Coomera from Coombabah Lake, an area of ecological importance.

The Nerang River catchment is located in the southeast corner of Queensland and covers an area of 480 square kilometres (Figure 9.7). From its headwaters in the McPherson Ranges, the Nerang River flows in a northeasterly direction, through the Numinbah Valley, before entering Advancetown Lake created by the Hinze Dam where the Little Nerang River joins it. Downstream from the dam, it passes Nerang before turning eastwards to Benowa, Broadbeach Waters, Bundall and Surfers Paradise, entering the Pacific Ocean via The Broadwater and the Gold Coast Seaway. Mudgeeraba Creek drains a catchment of about 100 square kilometres extending south to Springbrook and enters the Nerang River only a few kilometres from its mouth. Mudgeeraba Creek is subject to flash flooding. Approximately two thirds of the catchment for the Nerang River is rural, mostly forested, open space with some grassland open space, such as golf courses and rural residential areas (GCCC 1997a & 1999b). The remainder of the catchment is urban, comprising residential, high density residential, commercial and industrial areas. The Nerang River floodplain system has an area of about 65 square kilometres,

much of which has been subject to development over many years and now consists of an extensive network of tidal canal estates. The only remaining undeveloped region is the Merrimac/Carrara floodplain comprising about 22 square kilometres between the Nerang River in the north and Mudgeeraba Creek in the south. Depending on the flood situation, the Hinze Dam, which commands about 42% of the total catchment area, reduces the severity of downstream flooding of the Nerang system, although a recurrence of rainfalls similar to, or higher than, those in the 1974 record flood would still cause significant flooding.

In the southern Gold Coast area, Tallebudgera and Currumbin Creeks are adjacent catchments of 97 square kilometres and 63 square kilometres respectively. The headwaters are towards the southwest near Springbrook and flow essentially northeast to the sea. Both catchments are rural in the upper reaches but heavily developed in the lower reaches and floodplains with several lake/canal developments. Tallebudgera Creek is tidal for approximately 10 km upstream while Currumbin Creek is tidal downstream of a weir about 8 km from the mouth.

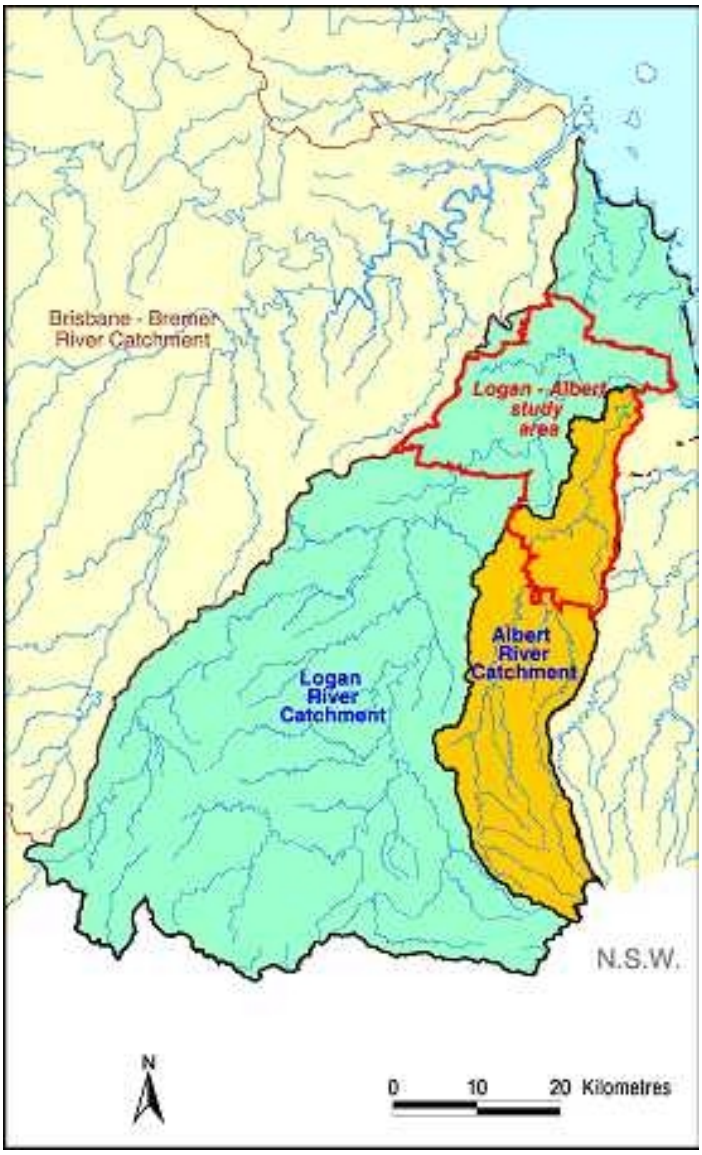


Figure 9.6: Logan-Albert River system

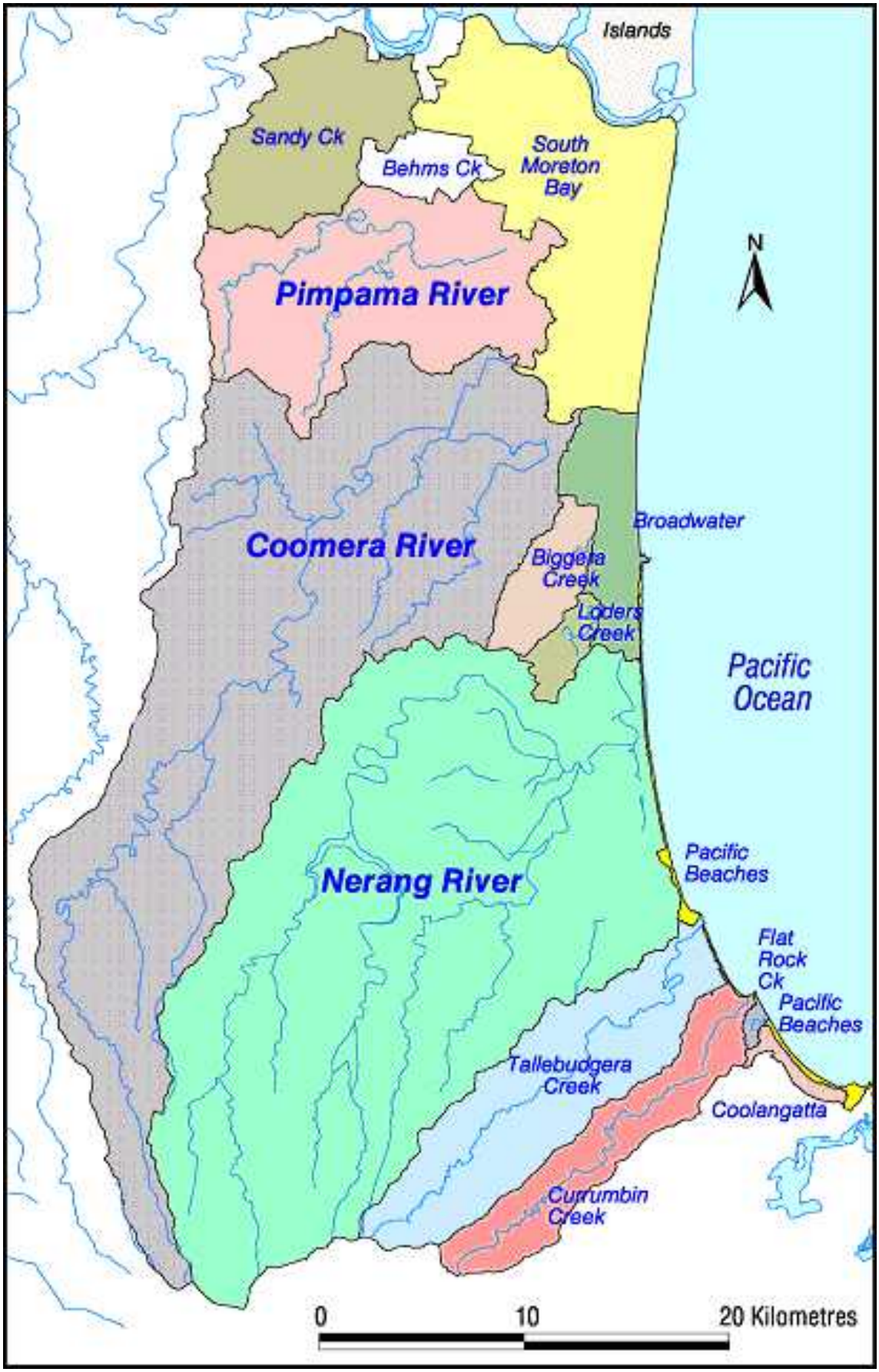


Figure 9.7: Pimpama, Coomera, Nerang, Tallebudgera and Currumbin catchments

Major Dams

There are 16 major dams and reservoirs throughout the South-East Queensland region which act either to provide water supply storage, irrigation, or to assist in flood mitigation. A summary of the dam characteristics are given in Table 9.1 and are derived from various sources (mainly R. Ash, 2000, personal communication, and DNR, 2000a). The effectiveness of their mitigation capacity is a function of the inflow rate to the reservoir and the regulatory controls (gates, valves etc) available, which varies significantly from dam to dam. Wivenhoe Dam (on the Brisbane River) is the principal flood mitigation control in the Brisbane River system, followed by Somerset Dam (located on the Stanley River immediately upstream of Wivenhoe). Jointly, these dams have a major impact on the hydrology of the system but their presence alone is not sufficient to prevent major flooding in some situations. Other than the Hinze Dam on the Nerang River, the remaining dams throughout the South-East region have, by comparison, only a minor flood mitigation capability and the majority have unregulated spillways.

Dam break is an emergency response issue which cuts across LGA boundaries and is the responsibility of the Department of Natural Resources (DNR) or the South-East Queensland Water Board (SEQWB).

A series of detailed operational plans are maintained by the dam operators that generally seek to optimise the design water supply level with regard to the expected inflow of flood waters. Controlled water releases are then made based on inflows and the flood mitigation capacity of the dam, but may also need to consider impacts on communities from other uncontrolled downstream tributaries.

Table 9. 1 Dams in South-East Queensland

Damsite	River/Creek	Type	Completion (year)	Full Supply Capacity (ML)	Crest Capacity (ML)
Wivenhoe	Brisbane	Rock fill	1985	1 150 000	2 930 000
Somerset	Stanley	Concrete gravity	1959	369 750	893 950
North Pine	North Pine	Earth and rock embankment	1976	200 000	295 000
Hinze	Nerang	Earth and rock embankment	1976 and 1989	164 969	310 190
Moogerah	Reynolds	Concrete arch	1961	83 700	139 000
Cressbrook	Cressbrook		1982	78 300	n/a
Maroon	Burnett	Earth and rock embankment	1973	37 500	86 400
Atkinson	Buaraba		1970	31 300	n/a
Perseverance	Perseverance		1965	30 300	n/a
Lake Manchester	Cabbage Tree		1916	25 700	n/a
Clarendon	Lockyer		1992	24 300	n/a
Lake Kurwongbah	Sideling		1958	15 400	n/a
Leslie Harrison	Tingalpa	Concrete		13 000	n/a
Little Nerang	Little Nerang		1961	8 400	n/a
Bill Gunn	Laidley			6 940	n/a
Enoggera	Enoggera		1866	4 500	n/a

The operation of all major dams is strictly controlled and is subject to regular detailed inspection and monitoring to ensure that the structural integrity of the dam is maintained at all times (SEQWB, 1998 a & b). The principal threat to any dam's integrity occurs when the inflow of floodwaters exceeds the combined storage and outflow available, and the dam is subjected to overtopping in an uncontrolled manner. In extreme situations, the priority of preventing overtopping will override the flood mitigation objectives at regulated dams and result in large controlled releases of flood waters. In these cases, procedures are in place to alert the relevant emergency authorities to ensure the public are adequately warned; flood-prone low level crossings are closed and if necessary, evacuations are undertaken. Normally, these impacts are relatively minor and there is more than adequate time available to issue warnings and make special arrangements. However, due to the need for extreme caution, not all of the ultimate capacity of the dams will normally be available for flood mitigation purposes.

Somerset Dam is a concrete gravity structure and is presently rated to withstand overtopping at the estimated PMF. Wivenhoe Dam is a central core rockfill dam, which is not resistant to overtopping, and operational procedures are designed to ensure that water releases will be scheduled to enable the dam to pass the PMF without overtopping. If necessary, Somerset Dam will be allowed to be overtopped to assist in preserving the structural integrity of Wivenhoe Dam (SEQWB 1998b). North Pine dam has similar structural characteristics to Wivenhoe Dam but is principally designed for water supply needs.

If overtopping or unexpected structural failure was to occur (e.g. extreme earthquake and/or undetected faults) then there exists a possibility that a dam will fail. The probability of this occurring is expected to be generally lower than the probability of a PMF occurring. The exact manner of the failure may vary widely and the consequences of the failure downstream will depend upon the floodplain characteristics and whether or not a flood is currently in progress.

Contrary to the popular perception, flood waves from dam breaks travel relatively slowly - at only a few kilometres per hour - except in close proximity to the dam. In particularly steep catchments, such as below the Hinze Dam, the flood wave celerity may be quite high attenuating down to Nerang township, making it unlikely that residents would have plenty of warning in the event of dam failure. Emergency Action Plans are available for all the major damsites which document procedures to be followed in the unlikely event of a severely overtopped dam or a dam failure (e.g. DNR, 2000 b; SEQWB, 1993 a, b, c & d). These plans also identify critical hazard locations in the region and are used by emergency services under the coordination of State and Local Government officers.

Studies have been undertaken for a number of dams in South-East Queensland which estimate the extent of possible downstream impact of a dam break flood wave and include the predicted depth of inundation and the time of arrival, which can be several hours after the dambreak. Table 9.2 summarises the estimated extent of impacts of dam break for the major South-East Queensland dams. For example, Wivenhoe Dam is predicted to be able to fully contain an unexpected breach of Somerset Dam under non-flood conditions. Under extreme flood conditions, it becomes more vulnerable to overtopping if a Somerset dambreak occurs and the operational procedures are designed to minimise that possibility. North Pine Dam is the only major dam immediately upstream of an urban area. Hinze Dam on the Nerang River is owned by Gold Coast City Council and is currently being reassessed for dam break impacts. Under the *Queensland Water Act 2000*, all authorities are now on notice and where dams fall into specified criteria, than a dam failure impact assessment must be undertaken and the dam licensed.

Table 9. 2 Approximate extent of the estimated impact of dambreaks

Damsite	Downstream Impacts		Furthest Locality Affected
	Km	hr	
Wivenhoe	150	30 - 36	Brisbane Port
Somerset	75	10	Wivenhoe Dam
North Pine	10	0 - 3	Petrie
Moogerah	35	10 - 20	Harrisville
Maroon	60	15 - 19	Beaudesert

The South-East Queensland flood experience

Floods are classified by the Bureau of Meteorology (BoM, 1999b) depending on the local flood gauge height and the resulting level of local community impact as follows:

1. **Minor flooding:** *This causes inconvenience such as closing of minor roads and the submergence of low level bridge.*

2. **Moderate flooding:** *This causes the inundation of low lying areas requiring the removal of stock and/or the evacuation of some houses. Main traffic bridges may be closed by floodwaters.*

3. **Major flooding:** *This causes inundation of large areas, isolating towns and cities. Major disruptions occur to road and rail links. Evacuation of many houses and business premises may be required. In rural areas widespread flooding of farmland is likely.*

This classification is a measure of a particular community's vulnerability to flooding and does not necessarily mean that a major flood has a low probability of occurrence (see the later section of this chapter, on flood prediction). Only those rivers which are a part of the Bureau of Meteorology warning system are subject to this standard classification. Many rivers which represent relatively lower flooding hazards are separately monitored by the respective LGAs.

Figure 9.8 summarises the historical record of highest annual floods for a number of long term gauge sites on the major river systems in the southeast region, derived from Bureau of Meteorology and DNRs records. As Figure 9.8 shows, the record for Brisbane (159 yr) is the longest in the region, followed by Ipswich (107 yr), the Nerang (80 yr) and the Logan (53 yr). The records are, however, incomplete, with many sites having less than 30 years of recorded levels.

In the last century, the Australia Day floods of 1974 were the worst period of flooding across the South-East Queensland region, although the 1931 flood was probably more severe locally in the Caboolture and Pine Rivers catchments. The floods of the mid to late 1800s recorded higher levels than the 1974 flood, however, a lower population, fewer buildings and less infrastructure in the region in the 1800s suggest that damage losses were much smaller despite a sparsity of information on the early events. Plates 9.1-2 depict flooding in Melbourne St., South Brisbane in February 1893 and January 1974. The following discussion provides some further insight into historical flooding episodes in the southeast.

(a) Caboolture River and Burpengary Creek

Caboolture has always experienced nuisance flooding affecting properties along the Caboolture River, King John Creek and Lagoon Creek, as well as closing local roads (CSC 1994a) (Plate 9.3). Burpengary Creek at Burpengary has historically suffered reasonably consistent low-level

flooding problems in areas around Dale St, Henderson Rd, Springfield Dr and Mathew Crescent (Plate 9.4). Table 9.3 summarises selected flood levels in the Caboolture region.

The 1931 flood event (Plates 9.5-6) was probably the most severe in the Caboolture catchment, followed by the 1972 flooding. The floods of December 1991 and January 1974 were also severe floods. A further flood in 1951 is remembered by some local residents. Beachmere is also subject to storm surge flooding.

In addition to nuisance flooding affecting buildings, flooding has caused agricultural losses and disrupted transport and communication links in the region as indicated by *The Brisbane Courier* (7 February, 1931).

> *Great losses in stock and farm produce have occurred in various parts of the district. The train services have again been restored. A rail motor arrived at 1.30 p.m. from Brisbane with passengers, mails and papers. The Gympie mail train departed for its destination shortly after the arrival of the rail motor.*

Table 9. 3 Selected flood levels in the Caboolture region (from CSC 1994a)

River	Height Station (m AHD)	Feb 1931	Dec 1970	Feb 1972	Jan 1974	Apr 1988	Apr 1989	Dec 1991	Mar 1992	May 1996	Feb 1999
Burpengary Ck	Rowley Rd		13.10	13.75	13.36	12.95	13.28	13.65		13.40	13.61
	Morayfield Rd			7.54		6.56	6.97	6.90			6.95
Caboolture	Litherland's X-ing			21.60			20.05	21.47			20.02
	Caboolture River s/g			18.71			17.42	18.89			
	Morayfield Rd		7.39	8.62	8.14	7.39	7.92	8.03	7.16	7.67	7.42
	Dux St		6.50	7.88	7.42		6.97	6.92		6.60	6.56
	Beachmere Rd/Rv	3.40	2.80	3.30	3.17		2.81	2.66		2.59	
King John Ck	McConachy Rd		15.21	14.91		15.40	15.25	14.85			14.78
	Bribe Is Rd		3.98	4.49?			3.65	3.71		3.86	4.26
	Beachmere Rd		2.07	2.33			1.93	1.18			
Lagoon Ck	Bruce Highway u/s		6.04	6.98		6.80	7.08		6.65		6.82
Sheepstation Ck	Morayfield Rd		6.00	7.72			6.77				6.62

(b) Pine River System

Anecdotal evidence suggests that the flood of February 1931 was the largest known flood also in the Pine River system, followed by the flood of February 1893. Unlike the 1931 flood, *The Brisbane Courier* (10 February, 1893) indicates that flood damage in 1893 was confined to the agricultural district of Pine though the bridge over Cash's Crossing was completely washed away. Of the floods recorded, only those of January 1974 and 1972 were smaller than the 1931 and 1893 floods. In the last two decades, the floods of December 1991 (Plate 9.7) and 1989 have been the largest. The relative magnitude of each flood however varies from creek catchment to catchment and from river reach to reach. Table 9.4 shows selected flood levels in the Pine Rivers region.

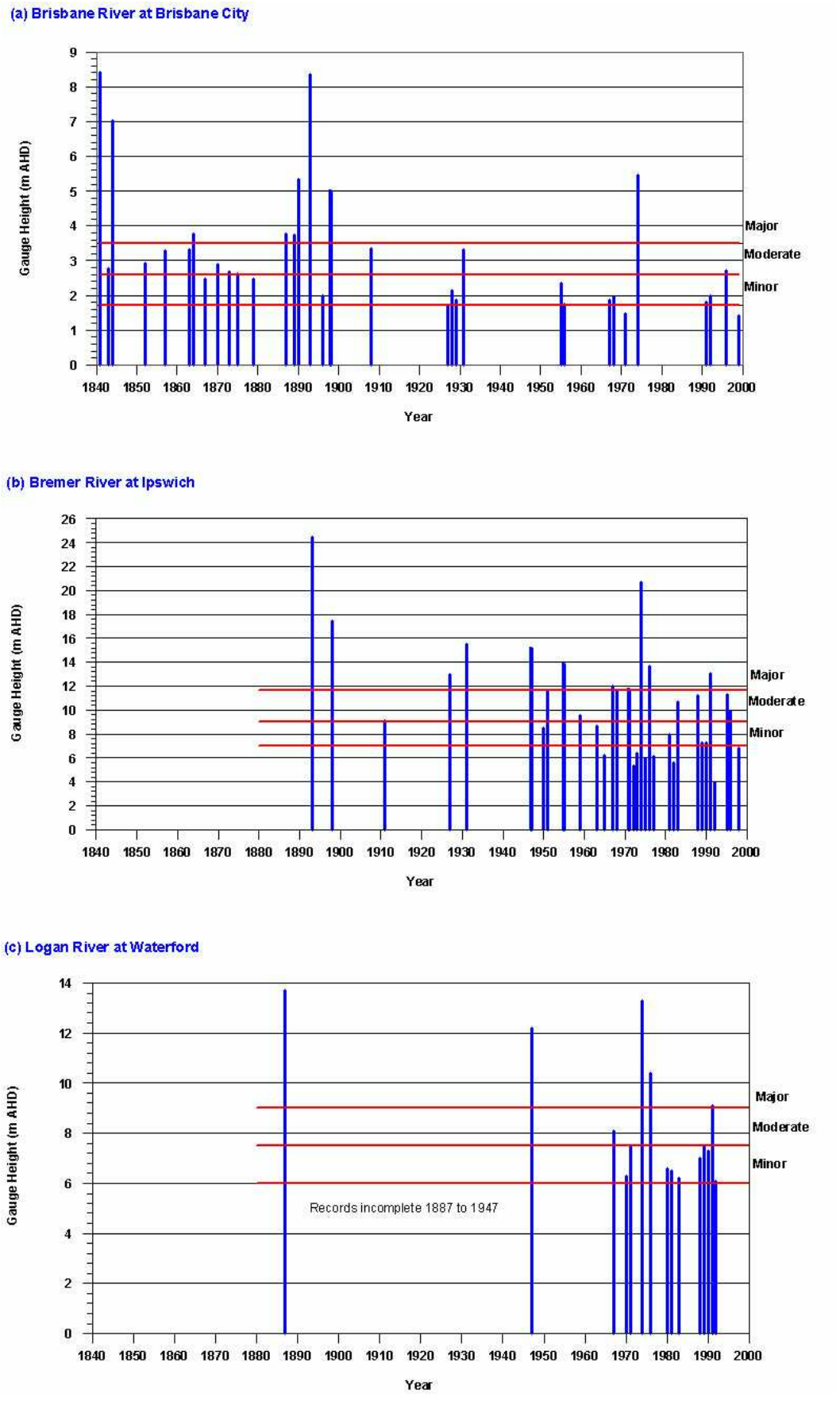
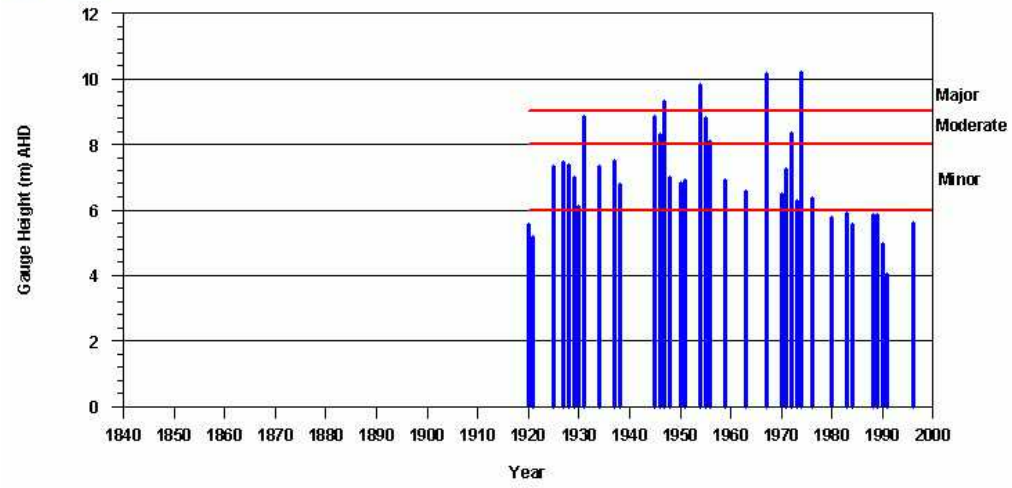
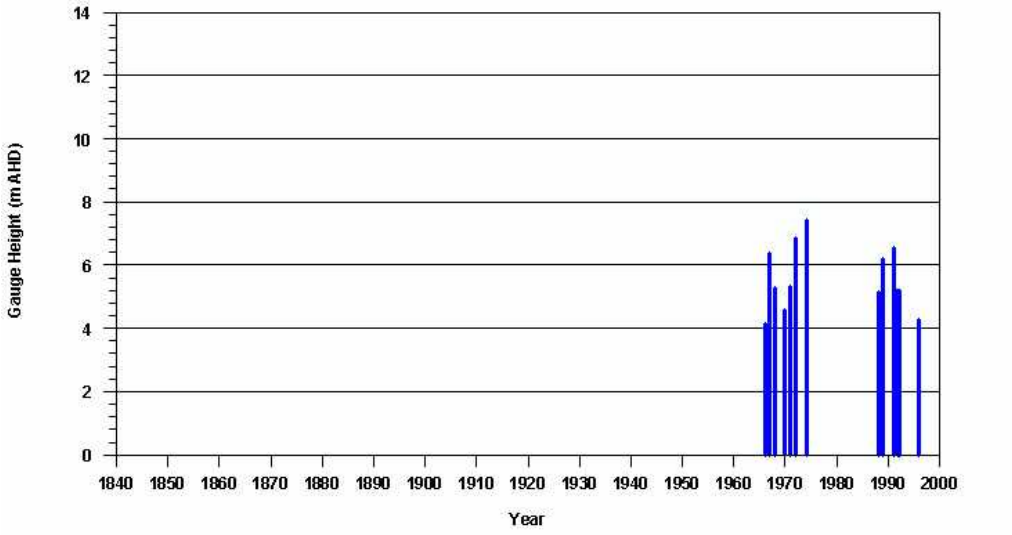


Figure 9.8: Historical floods in the South-East Queensland region

(d) Nerang River at Clearview



(e) Pine River at Drapers Crossing



(f) Caboolture River at Upper Caboolture

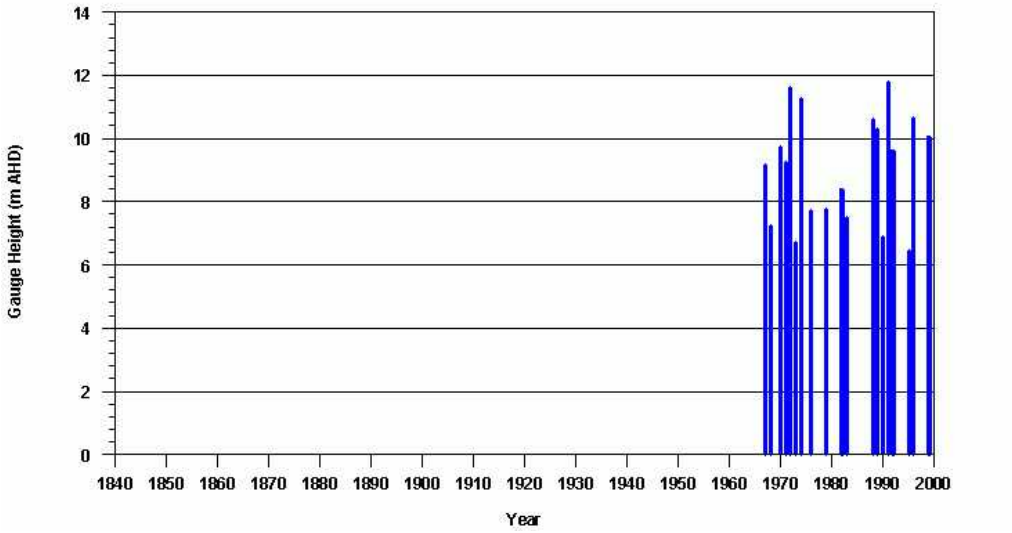


Figure 9.8: Historical floods in the South-East Queensland region (cont'd)

A report of the 1931 flood from *The Brisbane Courier* (7 February, 1931) indicates flood damage to agriculture and buildings in Pine Rivers as well as disruptions caused by flooding, as follows:

> ***Petrie, February 6***. *Nearly 30 in. of rain has fallen since the early part of last week, over 19 in. being recorded in the 24 hours ending 9 a.m. today. The Pine River reached its highest during the early part of last night, when a height of 4 ft. above the 1893 level was touched. Cultivation paddocks have been ruined, whole flats being washed bare, while tons of sand and gravel have covered lucerne paddocks. Losses of stock have occurred, and fencing has been swept away. All the buildings of the Wembley Kiosk, on the River Reserve, have been swept away, even the bowser being destroyed. The flood waters on the north side rose so rapidly that the house of Mr W. Barber was surrounded before he and his family could escape, and it was only by firing a rifle that he was able to let neighbours know his plight. Boats had to be procured before they could be rescued. Other residents took refuge in the Show Hall. The kiosk at Cash's Crossing was destroyed, and practically every culvert in the district has been washed away. Milk suppliers have been held up, and all the traffic at Whiteside and Dayboro-road was washed away yesterday.*

Table 9.4 Selected flood levels in the Pine Rivers region

Creek/River	Height Station (m AHD)	Apr 1989	Apr 1988	Jan 1974	Feb 1972	Dec 1970	1967	1966
Conflagration Creek	South Pine Rd	9.2	8.9	9.7			8.8	6.5
Freshwater Ck North	Old Gympie Rd	16.1		16.7			16.2	
Freshwater Ck	Goodfellows Rd		16.5	16.8			17.4	17.3
Albany Ck	Albany Ck Rd			16.2			15.7	
Sandy Ck	Albany Ck Rd			16.1			15.3	
Colthards Ck	Harvey St	4.7	4.2	4.6			4.1	
Saltwater Ck	Anzac Ave			2.8				
Yebri Ck	Gympie Rd						8.9	
One Mile Ck	Yebri St						10.1	
Todds Gully	Todds Rd						7.2	7.1
Four Mile Ck	Samsonvale Rd			19.8			19.2	
Kedron Brook	Dawson Pde			42.6	41.7	41.6		
North Pine R	Gympie Rd bridge Petrie	5.7		5.1				
South Pine R	Gympie Rd between Mott and Kremzow	5.2	4.1	5.2				
	South Pine Rd	11.9	10.1	12.5		8.5	9.6	

(c) Brisbane – Bremer River system

Flood records held by the Bureau of Meteorology and DNR extend back as far as the 1840's for Brisbane, and as far back as the 1893 floods for Ipswich. Selected flood levels on the Brisbane River are shown in Table 9.5 and for the Bremer River in Table 9.6.

Like most cities, Brisbane and Ipswich are subject to i) river flooding, ii) creek flooding and iii) flash flooding. For instance, the numerous creek systems (e.g. Warrill, Purga, Bundamba, Six Mile, Goodna and Woogaroo Creeks) which feed into the Bremer and Brisbane Rivers can result in severe flooding. These systems have a response time of less than six hours, which places them in the 'flash flood' category. For example, flooding in Bundamba Creek in 1991 caused extensive damage to industrial and residential buildings in the suburb of Bundamba (K. Durham, 2001, written communication).

Table 9. 5 Selected flood levels on the Brisbane River

River Height Station (m AHD)	February 1893	February 1931	March 1955	January 1974	May 1996	February 1999
Gatton	16.33	9.14	9.14	14.63	11.40	8.50
Laidley	-	-	-		8.50	-
Lyons Bridge	-	-	17.46	16.54	16.41	12.55
Lowood	26.39	18.44	18.14	22.02	12.38	10.87
Mt Crosby	32.00	21.78	20.72	26.74	14.10	-
Ipswich	24.50	15.50	13.80	20.70	11.30	6.85
Moggill	24.50	15.40	13.70	19.93	7.10	3.58
Jindalee	17.90	9.60	7.30	14.10	4.55	2.25
Brisbane City	8.35	3.32	2.36	5.45	2.70	1.41

Table 9. 6 Selected flood levels on the Bremer River

River Height Station (m AHD)	January 1974	February 1976	May 1983	December 1991	May 1996
Harrisville	6.18	5.95	5.65	5.90	5.91
Amberley	10.18	8.60	6.34	7.53	6.75
Rosewood	7.62	6.00	5.60	6.04	6.33
Walloon	8.70	5.08	6.56	7.30	7.60
Ipswich (David Trumpy Br)	20.70	13.65	10.65	13.10	11.31

1800s

The floods of 1841 and 1893 reached over 8 m AHD on the Brisbane City Gauge at the river end of Edward Street. This represented a depth above highest tide level of approximately 6.5 m. On the Bremer River, the February 1893 flood measured 24.5 m at its peak.

Three separate flood events occurred in February 1893 in Brisbane. The first flood event was the largest, peaking at 8.43 m at Brisbane City on the 5 February and resulted in substantial flood losses. The second flood was minor, peaking on 12 February. The third flood peaked on 19 February and registered 8.09 m at Brisbane City. At Bulimba, New Farm, Fortitude Valley, Breakfast Creek road, and the Hamilton, the third flood was several inches higher than the peak of the first flood (*The Telegraph,* 20 February, 1893), though flood damage across Brisbane was considerably less from the third flood because of the extensive damage already suffered in

earlier floods. Figure 9.9 shows the extent of inundation in Brisbane during the February 1893 floods.

Figure 9.9: Map showing the extent of inundation in Brisbane during the February 1893 floods (Irrigation and Water Supply Commission, Queensland; courtesy of John Oxley Library)

A contemporary account (*The Brisbane Courier*, 6 February, 1893) illustrates the impact of flooding in Brisbane in 1893 as follows:

> *A number of lives have been lost; hundreds of persons have been deprived of their homes and of their little possessions, and the loss of merchantable goods cannot at present be estimated….Brisbane was last night without communication by road, rail or telegraph with any of the outlying districts, as indeed it has been since Friday night, so that the facts procurable were simply those relating to the immediate vicinity of the capital…*
>
> *Last night the water was between 11 ft. and 12 ft. above the flood mark of 1890……..No gas has been available since an early hour on Saturday night, and though some lamps in the Queen and George streets were lit by Messers. Barton, Whit and Co. from electricity generated at the Government Printed Office, this served to light but a small portion of the inundated streets……*
>
> *In the list of public disasters must be placed the destruction of the Indooroopilly Railway Bridge…..Apart from the national disaster, the sense of which was appreciated by all, there was the sentiment that one of the most picturesque of the local landmarks had gone.*

The Brisbane Courier and *The Telegraph* of 6 February 1893 provide detailed descriptions of the sequence and depths of flooding during the period of inundation, particularly in Brisbane City. Depths of up to 15 – 16 ft. were reached in areas between Queen and Alice streets and the river on the one side and Albert Street on the other (*The Brisbane Courier*, 6 February, 1893). The papers also describe in detail other flooded areas (including evacuation details), in particular, Kangaroo Point, South Brisbane, New Farm, Milton, North Quay, Fortitude Valley, Newstead, Toowong, Indooroopilly, Rocklea, Sherwood, St Lucia and Oxley Point. A contemporary account from *The Telegraph,* Monday Evening, 6 February, 1893, follows.

> *…….all that portion of the city bounded by George and Ann streets and the river was yesterday submerged to a varying extent, except as regards the hill on which the Post Office stands, the west end of Queen Street…and the high portion of Elizabeth, Charlotte, Margaret, Mary and Alice Streets.*
>
> *On Friday, Saturday and Sunday, crows of people watched the progress of events at Victoria Bridge* (Plate 9.8)*, a structure that was at once invaluable as a means of communication between North and South Brisbane and admired by the reason of the manner in which it withstood the attacks of the objects large and small which every minute struck it throughout its entire length. Dwelling houses commenced to come down the river in earnest at about 3.30 p.m. on Saturday, and from that time on to Sunday night fully 100 houses and large sheds must have passed the bridge. It was marvellous to see the way in which even the largest dwellings were crushed up against the piers and girders. All the houses which had previously been wreaked floated down square, with their corrugated iron roofs showing. On contact with the bridge the edifices were crushed up instanter. The crushing sound – heard for a mile – tole its own tale of misfortune. So continuous and terrible was the crashing of houses on Saturday night that many persons living near the bridge found it impossible to sleep, what with the noise and the consciousness of others people's misfortune. Most of the houses were furnished and no-one could say with certainty that some of them were not occupied by human beings, who were thus hurled to eternity without the power to make the slightest effort to save themselves. At Toowong on Saturday night screams were frequently heard from across the river. A resident of Toowong informs us that from Emma Street a row of three houses could be seen on the south side. Loud noises as of timber collapsing were heard at about 10 p.m. on Saturday, and a light was seen in one of the houses. A minute later the three houses had gone. Many residences are known to have been swept away*

from the Orleigh Estate, West End, in addition to others from various riverside positions between the bridge and the up-county limit of the flood…

Numerous and varied were the things piled against Victoria Bridge on Saturday and Sunday by the current, but for size, as well as by reason of circumstances of the affair, the collision with the Stanley Street west swimming bath takes the lead. Etc etc

On Sunday at 9.30 am, a big barn filled with hay went down the stream. It struck the second pier from Queen Street and burst. For about half an hour a good deal of the barn and its contents hung against the pier, but the wreckage then disappeared.

No less than three large punts fouled the bridge, one on Saturday at about midnight, and the others on Sunday at about noon. The first remained fast for over an hour, and its great lifting power must have caused a considerable straining of the bridge. The two punts which came down on Sunday hung on the bridge, and did not disappear till some time during the night……..

In addition to houses and sheds, there came down the stream live stock, farm produce, furniture, fencing, trees, and pieces of land held together be reeds and scrub, and having the appearance of miniature islands. At about 4 p.m. on Saturday no less than seven ricks of new hay floated past the bridge in a cluster, a sure sign of a rising river. Numbers of the animals were alive when they passed the bridge. Snakes were plentiful among the debris and specimens of very strange species were secured.

The end, so far as the bridge was concerned (Plate 9.9*), came at about 1 am today, when nearly half of the structure on the northern side gave way, but the explanation of this is no doubt that the current being stronger and deeper there, gradually washed out the piers at the base. The bridge was also slightly damaged by the flood of March 1890 at the end which has now give way…*

Drinking water shortages in Brisbane and the resumption of communications within Brisbane and with the surrounding region and are described in *The Brisbane Courier* (10 February, 1893):

Many portions of South Brisbane and Kangaroo Point have been put to great straits on account of the almost total absence of drinking water. The waterworks authorities ascribe this almost solely to the particularly heavy demand on the mains at present, and do not know of any bursts which could cause the difficulty. As a matter of fact there was no water in the taps on Kangaroo Point last night. A thorough inspection is being made by the board's engineer and foreman with a view of arriving at a method of reducing the inconvenience. As the health of many parts depends on obtaining water for scouring and general cleansing just at present, it is hoped that those who make use of the water will be as careful as possible. It is said that all regulations regarding the use of the water are being set aside, in some cases people not even taking the trouble to put nozzles on their hoses.

Queen Street yesterday presented a very animated appearance contrasted with that of the past few days. Communication with the south side of the river by means of the ordinary steam and boat ferries was opened; railway communication restored for several miles around the city; and hundreds of visitors had apparently flocked into town from the surrounding districts to obtain a glimpse of the scene which had been depicted in the morning and evening papers and also with an eye to business.

Communication has now been restored with Rockhampton and North Gympie, Maryborough, Bundaberg, Beenleigh, Nerang, Southport, all stations on Bay-line as

> *well as Sydney. Business to the North still considerably delayed, but 'urgent' messages can be sent.*

An extract from *The Brisbane Courier* (8 February, 1893) details the impact of the 1893 floods on Ipswich:

> *The flood at Ipswich* (Plates 9.10-11)*, as in Brisbane, has been terribly disastrous, an enormous amount of damage being done and loss and suffering caused* (Plate 9.12)*. The flood reached its maximum height about three o'clock on Sunday morning, being then fully 16 ft. above the previous highest record of 1890. Three-fourths of Ipswich was then under water, and hundreds of homeless people had to take refuge in the churches, schools, and other buildings above floodmark* (Plates 9.13-14)*.*
>
> *North Ipswich was almost entirely submerged, the railway workshops and the woollen and cotton mills flooded. The Bremer Bridge was some feet under water, but the structure is believed not to have been injured.*
>
> *Four members of the family of Mr Peter Jackson, an engine-driver, who was himself absent at the time, were drowned at Blackwall, about five miles from Ipswich. They were endeavouring to escape from their house in a boat, when the craft capsized, and Miss Katie Jackson and three younger children were drowned. Miss Mary Jackson and a Mr Rowe remained in the house, which was shortly afterwards swept away and dashed against a tree, into the branches of which they succeeded in climbing. They were rescued with great difficulty and danger after being twenty-two hours in the tree, and the heroic conduct displayed throughout by Miss Jackson has excited great admiration. Constable Sangster was drowned while attempting to rescue them.*
>
> *At Blackstone and Bundamba the full effects of the flood were felt, the latter place being almost entirely under water……*.[there has also been a] *disaster at the Tivoli Colliery, by which seven persons were drowned.*

1974

Since 1893, the largest flood in the Brisbane-Bremer system was in January 1974 (Plates 9.15-16), and although a flood of smaller magnitude than the 1893 floods, it is the most severe example of urban flooding in Australia to date (Plates 9.17-19). The 1974 flood rose to a height of 5.45 m at Brisbane City and to a height of 20.7 m on the Ipswich flood gauge located at David Trumpy Bridge (Plates 9.20-22). The Bremer River flooded ahead of the Brisbane River. Creek flooding (Bundamba, Six Mile, Goodna and Woogaroo), had the effect of dividing the eastern part of Ipswich into five separate isolated communities. As the Brisbane River flooded it dammed the Bremer and compounded creek flooding. This kept the flood level in Ipswich at a record height for four to five days (K. Durham, 2001, written communication).

The 1974 flood caused widespread damage in Brisbane (Plate 9.23) and Ipswich (Plates 9.24-25). Flooding from the Brisbane River alone resulted in at least an estimated $200 million worth of damage at the time (based on SMEC 1995 flood study). At least 13 000 properties were affected (Cities Commission 1975). This excludes flood losses in Brisbane resulting from the Brisbane Creek catchments, and the severe flooding of the Bremer River affecting Ipswich (Smith 1998). Although the Wivenhoe Dam (completed in 1985) is capable of significantly attenuating some events in the Brisbane River, widespread flooding across the lower reaches of the Brisbane River remains a real threat for at least 18 000 property owners in Brisbane during an event with a 1% AEP. This includes flooding from the Brisbane River and the major creeks. Wivenhoe Dam has no mitigating effect on the Bremer River, acting only to control the downstream level of the Bremer River as it joins the Brisbane River.

A number of contemporary accounts follow, which indicate the impact of the 1974 flood in the Brisbane-Bremer catchment and on the region as a whole:

> *The Telegraph,* 26 January, 1974: *Floodwaters lapped the main Brisbane Airport runways today….trains did not run….the Brisbane City Council has appealed to people not to use buses because services might be cancelled…….Brisbane airport is closed with no indication of when it might open….Floodwaters have cut the Bruce Highway, isolating Gympie from the south. A Gympie police official said the only way out of the city was to the north….No trains would be running for an indefinite period, a spokesman for the Railways said today. He said that railway lines at Mayne and at Albion were completely under water with depths of more than 1.2 m (4 ft.). A bridge has collapsed between Wacol and Darbra. Both suburban and country trains have been discontinued* (Plate 9.26)*….Hundreds of people were evacuated from rooftops by a fleet of speedboats. Record flooding was reported in the Enoggera Creek at the Enoggera Reservoir. Most suburbs were blacked out during the night…..Flooding is expected to increase to record levels in all creek systems today as the rain keeps falling. The worst hit are Mogill Creek, Enoggera-Breakfast Creek, and Kedron Brook.*
>
> *The Queensland Times*, 28 January, 1974*: A handful of Council workers assisted by a small army of volunteers evacuated scores of Leichhardt families from their homes early yesterday morning as waters reached a new peak in the suburb* (Plates 9.27-28). *To worsen matters, the entire suburb was blacked out late Saturday night and this was the situation yesterday……Worst affected were the Queensland Housing Commission estates and some private homes in the lower Chubb Street area. Floodwaters, which were over a kilometre wide at One Mile yesterday* (Plates 9.29-30)*, completely swamped dozens of Housing Commission homes around Denman, McNamara, and Casey streets.*
>
> *Floodwaters which surged through backyards and under homes in Coleman Street created a health hazard when they flooded outhouses. Debris and raw effluent floated on relatively still floodwater. In most cases, only the tops of homes were visible. A few were completely submerged while only the roofs of others were above the raging Bremer which flowed at about twenty knots throughout the day……Stock as well as houses was threatened when floodwaters from the Warrill Creek surged up to threaten homes in Phillip Street, lower Chubb Street and Cafferky Street. Several houses on the Amberley side of Warrill Creek were completely submerged or only visible by their roofs when the flood peaked at about 2 p.m. Another peak was expected about 2 a.m. today……RAAF Amberley runways were completely submerged, forming a sea of water at least three kilometres wide.*
>
> *The Courier-Mail,* 29 January, 1974: *The raging Brisbane River continued to rip the heart out of the near-crippled city, tearing vessels from their moorings and washing into more than a dozen suburbs causing disruption to essential services. Several areas were without electricity, water and gas. The flood virtually paralysed the city, cutting most major roads and badly damaging scores of others. The city's commuters face a grim task this morning getting to work because bus and rail services are restricted severely…..Some major city department stores have told their employees to stay home. There were fears last night that the floods may cause food shortages. Huge quantities of food were lost yesterday when waters swamped warehouses in the Brisbane and Ipswich areas. Water feet deep flowed through parts of the inner city causing huge losses to stores and warehouses in the Mary Street - Albert Street area* (Plate 9.31)*. Soldiers and firemen worked for hours pumping water from the main Edison telephone exchange in Elizabeth Street where floodwater threatened to ruin equipment……The Weather Bureau expects the Brisbane River to flow at its flood height of 6.7 m (22 ft.) for 16*

hours until about 4 p.m. today. The level will be about 2.7.m (9 ft.) below the record height in 1893…….State Government authorities estimated last night that about 5000 people are homeless in the city. The worst hit suburbs yesterday included Jindalee, Sherwood, Indooroopilly, Yeronga and Milton. But police said most southern and western suburbs had been affected. Some of the people moved by boat during the day had only just returned to their flood ravaged homes when the waters rose again, trapping them. More than 30 relief centres operated in the city last night to house and feed the flood victims.

The Australian, 31 January, 1974*: The death toll mounted to 15 yesterday in the worst floods in Brisbane and the Gold Coast this century. Police fear more bodies will be uncovered as the massive clean up begins. Police yesterday recovered three bodies in the South Brisbane area, one of the worst hit parts of the flood-torn city.*

Another body was found in floodwaters near Chinderah, on the Gold Coast. Included in the 15 are an Army rescue worker and an Ipswich chemist, both missing, believed drowned. Police are still searching for two people missing in the Taringa and Indooroopilly areas. Officials said last night it will be months before a final figure could be placed on the cost of flood devastation throughout the State.

Because milk supply is still in jeopardy, despite daily consignments from Nambour, Caboolture, Southport, and Booval. Wholesalers said that despite heavy losses, millions of dollars worth of foodstuffs had been saved……Rescue helicopters yesterday ferried food, medical supplies, soft drinks for children and pumps to Jindalee and Jamboree Heights, which are still isolated by floodwaters…..He said about 50 homes had been washed down the Bremer and Brisbane rivers. About 12 000 people were facing destitution. Yesterday, the RAAF airlifted pumps, medical supplies and food to Ipswich and a large repair gang from the Amberley air base today will help with the clean up. Ipswich council will give top priority to opening the Brisbane-Ipswich road today.

The Telegraph, 1 February, 1974*: Fifty houses were washed away* [this number appears to vary depending on the source] *at Ipswich by the Bremer River flood. Many disappeared leaving no trace. Stumps of others only remained after the floodwater receded. The worst hit areas are Sydney Street, Brassall, Keong Street, Ipswich and Woodend Road, Woodend. At Sydney Street fourteen houses have been washed down the river and another three had been badly damaged…..Mrs Fullerton was only one of the fourteen families who on Sunday night watched as their homes were picked from their stumps and smashed into pieces on the Hancock Bridge which separates Brassall from Ipswich City. Mr G. Bryne was luckier than his neighbours. Today his brick house still stands but walls have been gouged out and most of the furniture washed downstream.*

The Telegraph, 4 February, 1974*: Flood clean-up work at the weekend had allowed 6000 families to move back to their homes in Brisbane and Ipswich, the Premier, Mr Bjelke-Peterson, said today. But 2000 houses in Brisbane and 700 in Ipswich still were unfit for habitation……Mr Bjelke-Petersen said the survey showed that some 8000 houses in Brisbane had been damaged, submerged or destroyed. Proportionately, Ipswich had suffered far worse, with 4000 houses damaged or destroyed, he said. The Lord Mayor, Alderman Clem Jones, said yesterday 13 750 Brisbane houses were affected by the floods. This figure would include houses that ranged from destruction to slight damage and houses that had water only under them…..The State Government had distributed almost $3 million for food, clothing, bedding and cooking utensils to alleviate immediate hardship. He said the area - by area totals of flood - ravaged houses remaining included: Ipswich 719, Ashgrove 164, Indooroopilly 18, Red Hill two, Taringa 116, Toowong 38, Torwood 309, South Brisbane 63, Fairfield 326, Oxley 231,*

> *Valley 162, Rocklea 148, Sherwood 139, Graceville 138, Chelmer 149, Waterford 11, and Woodridge seven.*
>
> *A total of 94 flats and four home unit blocks also had been damaged and still were affected. Mr Bjelke-Petersen said the Woogaroo Creek Caravan Park, Goodna, was a grim story on its own. "There were 91 caravans in the park the day before the floods," he said. "Of these, 85 were occupied. After the area around the part emerged from the flood, only 17 of the caravans were left."*

Though reliable records of flooding in the Bremer River affecting Ipswich date back to only 1893, other sources refer to floods dating back to as early as 1839:

> *according to the statement of one who resided here* [Ipswich] *at the time, the river overflowed its banks* [in 1839] *to the extent of 54 ft, completely filling all the gullies leading from the Bremer to the main streets of the town, and inundating the country to the eastward of the Main Range for many miles* (*Moreton Bay Courier*, 30 May 1857 in Mills, 1992).

An extract from *Australian Pioneers and Reminiscence* (Bartley, 1896, p. 271 in Mills 1992) briefly describes other early major floods:

> *1841 – Bremer, Purga and Warrill Creek in full flood. The water rose 70 ft. at Ipswich and no such flood again seen until the 1893 trouble* [94 ft. 4 in. at Ipswich port station]. *In the floods of 1857, 1863, 1864, 1870 the water rose 45 ft to 50 ft in Ipswich. The 1887 flood is said to have risen 50 ft in Ipswich which is 5 ft above 1864 and 1870. The flood of May 1857 was the outcome of six weeks long continued rather than heavy rain. That of 1863 was February autumn one 15.14 in of rain fell in sixteen days. In March 1864 an equinoctial gale brought the floods. The night of the eighteenth was terrific. A hurricane blew. The river rose 50 ft in twelve hours at Ipswich. The deluge of March 1870 consisted of 24.25 in of rain in a little of four days; 8.20 in being the maximum fall in twelve hours.*

The flood of 1890 appears to have been slightly higher than the 1841 flood with the Ipswich port station recording 73 ft. 4 in (*Queensland Times,* 17 March, 1908, in Mills 1992). The floods of 1898 and 1908 recorded 60 ft. 0 in. and 52 ft. 0 in. respectively at the Ipswich port station (*Queensland Times,* 17 March, 1908, in Mills, 1992).

(e) Logan and Albert River system

Reliable records of large floods in the Logan-Albert Rivers extend back as far as 1887 - the largest known flood in the Logan-Albert. *The Brisbane Courier* (26 January, 1887) describes some of the impact of the 1887 flood on the local communities:

> *On Friday both the Logan and Albert rose with fearful rapidity in the early morning between one and three. A great number of the residents at Alberton, Beenleigh Pocket, and Bethania, and on the other side of the Logan, were with difficulty rescued some, from housetops or out of the gable window of the houses……..The S.S. Fanny which was moored at Yatala was a godsend. Captain John Burke and his men rendered noble service as they rescued and took aboard fifty-four souls, who would have perished without their timely assistance…… At Yatala and Beenleigh the river was fully a mile wide. At Loganholme and Waterford it was considerably wider, nearly the whole cultivation of the district being underwater. The following fatalities have been reported: A young man named W. Eggersdorff, his wife, and three children are drowned. Mr John Brown, of Yatala Saw-mills, and a kanaka are drowned, and it is feared Mr and Mrs Walls and family, State school, Loganlea, are also lost, considering that only two or*

three boats were available when the crisis came. It is believed that no lives have been lost at Pimpama Island, Alberton, Beenleigh, Waterford, or up to the Logan Village, except those mentioned. The rivers are now falling and therefore no further fatalities are expected. There are fully sixty or seventy families washed out of their homes……On Sunday last, according to what the Waterford people state and to judge by the flood marks, the water had certainly been about 12 ft. higher than it had ever been before within the recollection of any resident. All Waterford was flooded, and on the south side of the river the scene was one of desolation. Places I know on which houses had stood were now quite bare, and from the appearance of the surroundings I believe that the railway bridge has been washed away……..Telegraphic communication is completely stopped. It will be impossible to tell the extent of damage done until the water subsides completely, but I should judge that desolation stretches away far beyond Yatala. The persons whom I saw yesterday had scarcely any clothes, and were homeless. The water rose, it seems, in the night so suddenly that the occupants of houses had only time to save themselves in what they stood. Food must be scarce, and when I left the Morning Star Hotel it was full of refugees. Those who know the high position of that hotel can judge what sort of a flood this has been when I say that the water was nearly 2 ft. high at one time in the bar.

Since 1887, there have been several major flood events. The flood of January 1974 (Plate 9.32) was the most severe in the lower reaches of the Logan-Albert River system in the twentieth century, as well as the most severe flood in the Brisbane–Bremer and Nerang River systems. It has been estimated that the 1974 event had an ARI of greater than 100 years (1% AEP) in the Logan and Albert Rivers (Smith 1998). Selected flood levels on the Logan and Albert River system are shown in Table 9.7.

Table 9. 7 Selected flood levels on the Logan and Albert River system

River	Height Station (m AHD)	Jan 1887	Feb 1893	Jan 1947	Jan 1974	Feb 1976	Feb 1991	May 1996
Logan R	Dulbolla		15.24		10.06	12.00	14.40	11.80
	Round Mountain				15.33	16.12	16.85	13.20
	Yarrahappini				20.75	18.54	18.78	14.85
	Macleans Bridge	22.30			21.67	18.18	18.50	15.00
	Waterford	13.70			13.28	10.38	9.06	7.50
	Eagleby	7.58			7.25	5.28	5.00	3.94
Albert R	Lumeah			10.06	8.04	9.25	9.01	9.95
	Bromfleet				16.36	14.88	9.53	13.97
	Wolffdene				13.69	9.77	4.86	8.73
Teviot Brook	Boonah				-	8.16	8.50	6.77
	The Overflow			14.30	12.90	12.50	13.42	8.66

The impact of the floods on roads in the South-East Queensland region is indicated in a report from *The Courier-Mail* (1 February, 1974), as follows:

The Main Roads Department warned motorists last night to use the Pacific Highway between Brisbane and the Gold Coast, with 'extreme caution.' The Acting Commissioner (Mr J. Andrews) said floods had damaged approaches and abutments of three bridges - the Logan and Albert, at Beenleigh, and the Coomera at Oxenford. There were a number of other weak spots on the highway…..

The second largest flood in the last century in the Logan-Albert River system, that of January 1947, also flooded the Pacific Highway, and cancelled bus and train services to Brisbane.

Destruction of the Waterford Bridge (Plate 9.33) also affected goods transport (*The Courier-Mail,* 29 January, 1947). More recently, severe floods have occurred in the upper reaches of the Logan River in February 1976 and February 1991.

(f) Pimpama-Coomera-Nerang-Tallebudgera-Currumbin River/Creek System

Since river height records began in 1920, there have been six floods which have caused moderate to major flooding. Four of these, 1931, 1947, 1954 and 1974, were the results of cyclonic activity. The 1967 event resulted from a moist tropical low-pressure system and the 1974 event was the result of thunderstorm activity associated with a trough extending through the area. Table 9.8 provides a summary of some recorded levels. The raising of the Dam in 1987-1989 has improved flood mitigation in the catchment but has not removed the threat during a 1% AEP flood to some 21 000 properties in the region, of which about 40% of the properties would have overfloor flooding.

Table 9. 8 Selected flood levels on the Nerang River system

River Height Station (m AHD)	Feb 1931	Jan 1947	Feb 1954	Jun 1967	Jan 1974 (1)	Jan 1974 (2)	Apr 1988	May 1996
Hinze Dam	n/a	n/a	n/a	n/a	n/a	n/a	4.28	3.24
Clearview	8.84	9.32	9.83	10.18	10.22	9.16	5.86	5.48
Evandale	2.85	2.62	2.87	2.25	-	2.87	-	-

Of the floods in the last century, the January 1974 flood was the largest (Plate 9.34). For the Nerang River System, an ARI of about 1 in 65-70 years has been applied. For the Coomera River an ARI of greater than 100 years (1% AEP) has been estimated (Smith 1998). The flood is estimated to have directly affected at least 1000 residential dwellings (Smith 1998).

The following newspaper reports give an indication of the impact of the 1974 floods on the Gold Coast area:

> *The Telegraph,* 31 January, 1974*: Gold Coast City Council and Albert Shire Council probably will complete collection of mountains of discarded furniture, carpet underlay and other effects by the end of this week. Ruined by floods, this is piled on footpaths now. Telephone services are returning to normal and roads are opening up quickly in the Gold Coast hinterland. I arrived in Surfers' Paradise yesterday on one of the first buses to get through the flood-scarred Pacific Highway. There are many detours where the highway has been washed away, and my coach tore off its muffler in a deep rut. In two days, 1250 mm (50 in.) of rain fell in the mountain area, behind the Gold Coast, and floodwaters raced down the valleys tearing through hundreds of homes. The Nerang River rose from a quiet 4.3 m (14 ft.) to a raging 9.5 m (31 ft.) in less than a day. Little Tallebudgera Creek, a tributary, became a wild torrent. In twenty minutes it gouged thousands of cubic yards of soil from the garden which separated Tom Sumpton's home from the creek and began eating away the foundations of the house.*
>
> *The Australian,* 31 January, 1974: *The death toll mounted to 15 yesterday in the worst floods in Brisbane and the Gold Coast this century……Another body was found in floodwaters near Chinderah, on the Gold Coast…..*
>
> *The Courier-Mail,* 1 February, 1974: *Queensland's floods are expected to wipe tens of millions of dollars off real estate values and to put into question some planned projects .....On the Gold Coast, the floods in canal estates* [Plate 9.34] *have involved some of the most expensive land in Australia, where single lots were changing hands at $100 000 and more….Gold Coast houses involved in the flooding were generally in the upper*

> *bracket - up to $250 000, with $85 000 not uncommon. Some may be total write-offs, according to preliminary information. Internal damage has been colossal*.

Though no official records are available for the flood of 1887, it was of greater magnitude than the 1974 flood (Smith 1998). A report from *The Brisbane Courier* (27 January, 1887) follows:

> *The creek on Saturday was a surging mass of discoloured water, travelling about eight miles an hour and carrying down with it huge trees, logs and all descriptions of farm produce - pumpkins, passionfruit, water-melons; two horses were seen, a calf or two, five or six boats….The water rose at Nerang up to the back of the houses in the main street. The storehouse on the wharf was submerged. A valuable piano belonging to Mr Philpott was stored in it. The water was, when at its highest, washing over the bridge at the township. The mouth of the creek has been altered to some extent. At the bathing-houses there is now 6 ft. of water at the doors; several of them were overturned. The end of the old jetty was carried away and the pile-driver used for the erection of the new one was also washed away. This will be a heavy loss to the contractors. No mails reached us on either Friday or Saturday. Cobb and Co's driver, Charlie, got through with one on Sunday at considerable risk to himself, but the postmaster declined to relieve the anxiety of those who were anxious about friends in town by opening the mail until his regular time on Monday morning. Considering that telegraphic communications had been interrupted from Friday morning, this showed a great want of consideration for the public…… Another informant says……..The Bay was all discoloured with flood water from the Coomera and Nerang rivers, the latter of which was within 2 ft. of the 1868 flood which residents remember nineteen years ago.*

A report of the June 1967 flood (Plate 9.35), the second largest flood of the twentieth century, indicates some of the areas particularly badly affected by the inundation:

> *The Courier-Mail,* 14 June, 1967: *Canal development estates of the Pacific Highway were among the worst hit during the floods. Some of them - Santa Barbara, Rio Vista, Miami Keys, and Rialto Estates - had families evacuated when the flood approached its peak. Homes on these estates were among those suffering high damage from the flood.*
>
> *As the waters fell yesterday morning, the full extent of road damage became apparent - and it was enormous. Cavill Avenue, Surfers' Paradise, had been transformed into a 300 yard long pothole with the bitumen almost entirely ripped away. The main one-way sections of the Pacific Highway were also badly damaged and there was scarcely a road or street of the Gold Coast unscathed.*

Information on floods in the Coomera River is less extensive, especially in the floodprone lower reaches, but significant floods are known to have occurred in 1967, 1974, 1976 and 1989.

Flood Prediction, Planning and Mitigation

Throughout Queensland, local governments are responsible for establishing regulations in regard to land use planning and approvals. Whilst there is no State legislation ensuring consistency in approach to flood risks, many local governments have adopted similar guidelines and procedures through the exchange of professional engineering and planning advice and knowledge gained from the flood management experience in other states. Stormwater and small catchment flooding standardised design needs have been addressed for a number of years by the Queensland Urban Drainage Manual (QUDM, 1994). In regard to broader floodplain management issues, a national guideline has only recently been completed (ARMCANZ, 2000). Currently DNR is working with representatives of various local governments and other interested parties to establish total management planning (TMP) guidelines for floodplain and stormwater management for adoption by all Queensland authorities over time.