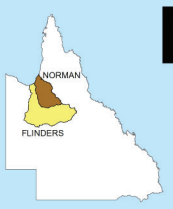
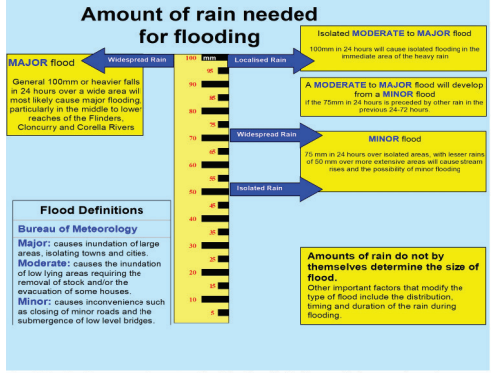
Flinders River Catchment Flood Rules of Thumb



How is this wall chart meant to be used?
This wall chart provides a catchment-wide overview of flooding patterns and the factors that influence the size, behaviour and impact of a flood. This chart is designed to be studied in detail. Information has been combined from local knowledge, historical records, available data, scientific articles, engineering equations and available mapping.

Amount of rain needed for flooding

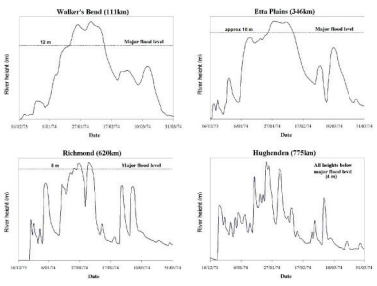


Local flooding is an annual event north of the Canobie-Saxby constriction once the wet season rains begin. The rains generally fall in these mid down-stream sections of the catchment before the upper catchment. Fifty to 75mm of rain spread across Canobie, Warren Vale and Normanton produces minor to moderate localised flooding. Such local flooding is part of the regular wet season and is generally beneficial as the native pastures respond as the waters recede. The flood water usually drains slowly across the flat floodplains and away through the River or Creek channels over a couple of weeks. There can be a second flood peak as the waters from upstream (Hughencen, Richmond, Julia Creek or Cloncurry) rains arrive.

Major localised flooding north of the Canobie-Saxby constriction can occur during periods of extended local rainfall in excess of 100mm. These floods last longer as local rains continue or as water arrives from upstream faster then it can drain away. Major localised flooding north of the Bang Bang-Glenore constriction may be influenced by king tides in the gulf, potentially stopping water from draining away for short periods of time.

Major widespread flooding can develop when fresh floodwaters from upstream back up behind floodwater at the Canobie-Saxby constriction. The risk is especially high when there is general rain or high rainfall totals in the harder country, which keep floodwaters flowing in from upstream. Major floods—especially when the peak stays up for more than three weeks—pose a serious threat to pastures, soils, cattle and infrastructure. The floods in early 2009 stayed up over the major flood level for six weeks and caused extensive damage and stock losses.

It's not the same flood all along the river. As flood water moves down the Flinders it joins flows from other tributaries and moves into climatically wetter catchments. This results in more gradual changes in water level but potentially longer periods of inundation during floods along the lower reaches. The graphs (right) show this by comparing flood levels at four locations during the 1974 flood—the further a location is from the river mouth (in brackets) the more flood levels fluctuate.



Why is flooding important in the Flinders River catchment?
Livestock losses and damage to fences, roads and structures can be severe along the floodplains of the Gulf Rivers. Some properties have enough high ground to shift stock onto at the start of every wet season. Other properties have enough high ground for stock to take refuge during a normal wet season or minor floods but not a major flood. Predicting a major flood is difficult and predicting such floods with enough time for landholders to move stock to safety is especially difficult. The greatest flood risk tends to be downstream (north) of the Canobie-Saxby restriction, where there is inadequate high ground in a major flood. Other important areas can be seen on this map, such as the Corella River floodplains north-west of Kalmeta homestead.

Reducing flood risk of livestock losses
Experienced producers and helicopter pilots have offered the following advice to reduce the risk of stock loss to floods.

If you are new to the area, seek advice from experienced locals to judge how much country can flood, how deep it can flood, where the floodwaters flow and where the high ground is.

Provide stock with access to high ground for the wet season. Many producers move their stock into the paddocks with the highest ground ready for every wet season. This provides access to the high ground during a flood and reduces the need to try and muster stock through floodwaters. It also rests the pastures in the flood-prone areas for the wet season and maintains their health. Some properties have no country above major flood height. Consider increasing the height of existing elevated areas and widening the bank of dams and turkey nests.

Maximise your access to stock for the wet season. There are situations where on-ground access will be impossible once the creeks and rivers start to flow. Move livestock to accessible areas before the only option left is more expensive aerial mustering. 'Murphy's Law' suggests that a helicopter will not be available when urgently needed.

Develop flood management plans based on all the available information including; your own property infrastructure plan, your knowledge of how much country can flood, how deep it can flood, where the floodwaters flow and where the high ground is. Consider how existing or planned turkey's nests and other high structures can be used as livestock flood refuges. Use the latest technology such as satellite images of previous floods and Global Positioning Systems to mark the high ground.

Plan your forage availability. There will be occasions e.g. following drought, that there is insufficient pasture on high country to support large numbers of cattle for more than a few days—or even hours. Conduct a forage budget for the high country and estimate how many livestock each area can support and for how long. Consider how fodder could be delivered to—or perhaps stored on—high ground during a flood. Incorporate this into your flood management plans.

Plan your fencing to reduce the number of cattle trapped in corners or along fence-lines during floods. Cattle can be trapped by fences when they are travelling to high ground or when they are swimming downstream. Suggestions to reduce this risk include: installing gateways every 1-2km to allow cattle to move to safety prior to and during floods; open gates prior to the wet season to provide access to high ground; build gates that allow for easy opening from a helicopter e.g. platforms to sit the chopper skids on during floods; rectify fence-lines and corners with a high risk of trapping cattle e.g. a boundary corner on the wrong side of high ground.

Livestock type and class. Larger cattle have a better chance of surviving a flood. Consider if the timing of calving maximises calf/weaner size by the wet season. Water of a depth greater than 1-1.5m will prevent calves from suckling their mothers. If water stays at these depths for more than a couple of days, calf losses will be high.

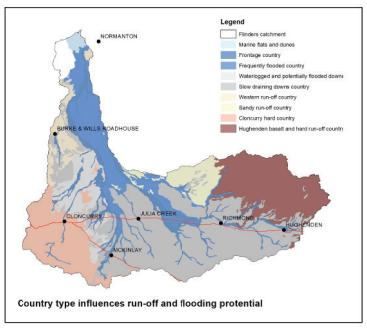
Cattle condition. Be aware that cattle in poor condition going into the wet season will be at greater risk of exposure and fatigue should temperatures drop and cattle have to swim or walk through heavy mud.

During a flood regular information is the key to estimating how deep the water might become and how far it might flood out. Track the progress of a flood by communicating with people on the river upstream, through the Bureau of Meteorology flood and rainfall web site, ABC Radio and other available sources.

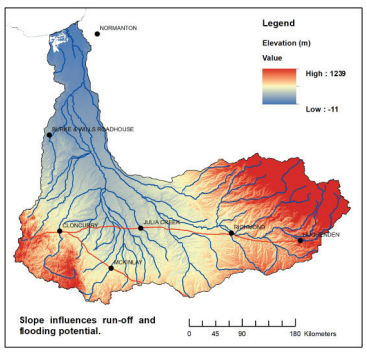
During a flood muster cautiously. Cattle will tend to know where the high ground is. Often it is best to leave them alone to find the high ground rather than trying to push them through floodwaters or across main channels.

Main factors affecting flooding in the Flinders River catchment
- The major flood prone area is downstream from about Canobie.
- Flood prone areas exist further upstream to about Consentes.
- The major flood prone area also receives high rainfall—local flooding rains occur most wet seasons but the water drains away before causing problems.
- Three major river systems—the Flinders, Cloncurry and Saxby—all join within the major flood prone area. When all three of the rivers are flowing through the flood prone area, local floodwaters from rainfall drain away slowly.
- The Flinders River headwaters are in a large area of hard and steep run-off country with relatively higher rainfall. It flows every year and has the highest chance of flooding.
- The Cloncurry River headwaters are in hard and steep country, but rainfall is relatively low and variable—this makes flooding difficult to predict. A reasonably large catchment ensures flows in most years but these may not always reach the Flinders River.
- The Saxby River headwaters are in sandy and relatively flat country with intermediate rainfall and a smaller catchment than the other Rivers—it is likely to flow regularly but for less time than the Flinders River.
- Widespread above average rains lead to major floods—all three rivers flood preventing local floodwaters from draining away from the flood prone areas. The water becomes deeper the longer it keeps raining.
- Records suggest the probability of widespread above average rainfall is greatest when the SOI is consistently positive in September-October.

The floodplains downstream of Canobie comprise flat areas of clay soils with natural drainage channels formed during floods. This photograph shows braided channels—running in the direction of view, shallow channels—at right angles, and scour marks where floodwater has sheeted over the top of the whole landscape.



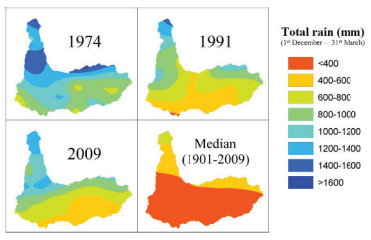
Country type influences run-off and flooding potential



Slope influences run-off and flooding potential.

Rainfall pattern

The rainfall patterns which produced the major floods of 1974, 1991 and 2009 were all different—one indicator of how difficult it is to predict which rivers will run first and where the majority of the floodwater will come from.



Slope and type of country

Slope and country type have a major bearing on how much rain it takes for water to start running into streams—and how fast it runs.
The steepest area in the Flinders River catchment is to the east, with the Great Dividing Range forming the eastern watershed. The Flinders River starts at an elevation of 825m and drops down to 320m at Hughenden over a distance of 100km. Steep slopes lead to fast run-off, fast stream flows and natural erosion. Porcupine Gorge to the north of Hughenden provides one example of how much erosion has been caused from high volumes of fast flowing water coming out of this area. The area south-west of Cloncurry also has steep slopes and gorges, and the western margin of the catchment has slopes which can result in localised flash-flooding. The slopes of these run-off areas are in contrast with the last 280km of the Flinders, with a fall of only 100m. Instead of eroding, much of this flooded area generally receives a top-dressing of silt from upstream.

There are 14 main Grazing Land Management Land Types within the Flinders River catchment (https://futurebeef.com.au/knowledge-centre/). In terms of their role in flooding these can be broadly grouped into run-off and flooded country.

Hughenden basalt and hard run-off country covers an area of 19,000km^2 to the north and east of Hughenden and is dominated by red and black basalt, sandy forest, ironbark and rough spinifex hills at high elevations. The harder country only needs about 50mm of rain on a dry catchment to start streams flowing, whilst the basalt may be a recharge area for underground aquifers. Coupled with a relatively high average rainfall and steep slopes, the area is a regular contributor to Flinders River flows.

Cloncurry hard run-off country covers an area of 14,000km^2 to the south-west of Cloncurry and is dominated by rough spinifex hills. This country only needs about 25mm of rain to start streams flowing on a dry catchment. It receives generally low and variable rainfall which makes it difficult to predict when the Cloncurry River will flood.

The western run-off country covers 8,000km^2 along the western margin of the catchment and is dominated by silver-leaved box with spinifex, open red country and rough spinifex hills. This area needs 25-50mm of rain to start streams flowing on a dry catchment. It mostly contributes to localised flooding downstream of Canobie due to its location and average annual rainfall of 400-600mm.

The sandy run-off country covers 5,000km^2 to the north-west of Richmond and is dominated by sandy forest and silver-leaved box. It forms a low water-shed dividing the Saxby and Norman Rivers. This area may start running water with 50mm of rain, but the drainage lines are often indistinct with water ponding locally. The soils can become very boggy when wet.

Slow draining downs country covers 40,000km^2 along the southern portion of the catchment. There is a further 7,000km^2 adjacent to the Cloncurry, Dugald and Corella Rivers on the western side of the catchment. The downs are dominated by Mitchell grass and include locally important areas of gidgee. The downs country consists of heavy clay soils with little slope which generally need 100-150mm of rain to start running water when dry. Once fully saturated these soils will run with as little as 10mm of rain. Downs country can contribute substantial amounts of water in above average rainfall years.

The flooded country covers 12,500km^2 and starts near Sedan Dip where the Gilliat Channels and Cloncurry Rivers join. The extensive floodplains start around Canobie where the Corella and Cloncurry Rivers join, and the Flinders is close enough for the floodwaters of both systems to mix. The broad floodplains are dominated by bluegrass browntop plains with major channels fringed by frontage country. There are areas of Mitchell grass—often on slightly higher ground—within the floodplains which can also flood but for a shorter duration. Flooding occurs along all major drainage lines, being confined to frontage country in the upper reaches but breaking out into floodplains in flatter areas. Mitchell grass country to the south also floods during major events. Marine flats along the northern margin are seasonally flooded.

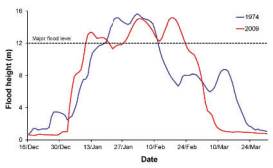
Examples of major floods

River height station	1974 Jan/Feb	1981 January	1984 January	1991 January	1991 February	2009 January	2009 February
Mt Emu Plains	4.00	**4.79****	3.21	4.55	3.41	-	-
Glendower	5.34	5.54	4.37	4.42	**7.00**	3.32	-
Hughenden	2.05	2.6	2.1	2.4	3.9	2.80	**2.90**
Marathon	-	10.8	**11.6**	9.5	10.3	-	-
Richmond	**8.47**	7.8	8.4	7.4	7.5	8.13	8.21
Hulberts Bridge	**12.5**	12.05	12.6	12.0	11.3	-	-
Etta Plains	**11.30**	10.72	10.94	-	-	10.67	10.05
Julia Creek	**5.43**	-	3.16	4.82	3.85	3.98	-
Landsborough Highway Cloncurry*	-	-	-	-	-	6.33	**6.41**
Carsland	-	**6.0**	-	5.2	3.72	-	-
Dugald River	5.67	4.15	3.16	-	-	**6.08**	4.61
Canobie	**11.10**	8.0	7.6	8.5	7.0	8.15	8.55
Walkers Bend*	**15.67**	12.74	11.95	15.23	11.57	13.36	15.06

* automated station ** bold indicates highest flood on record

The table (above) shows heights for some of the major floods from recording stations within the Flinders catchment. This table provides a useful reference point for anticipating the depth of water—and how far cut it may flood—for these locations.

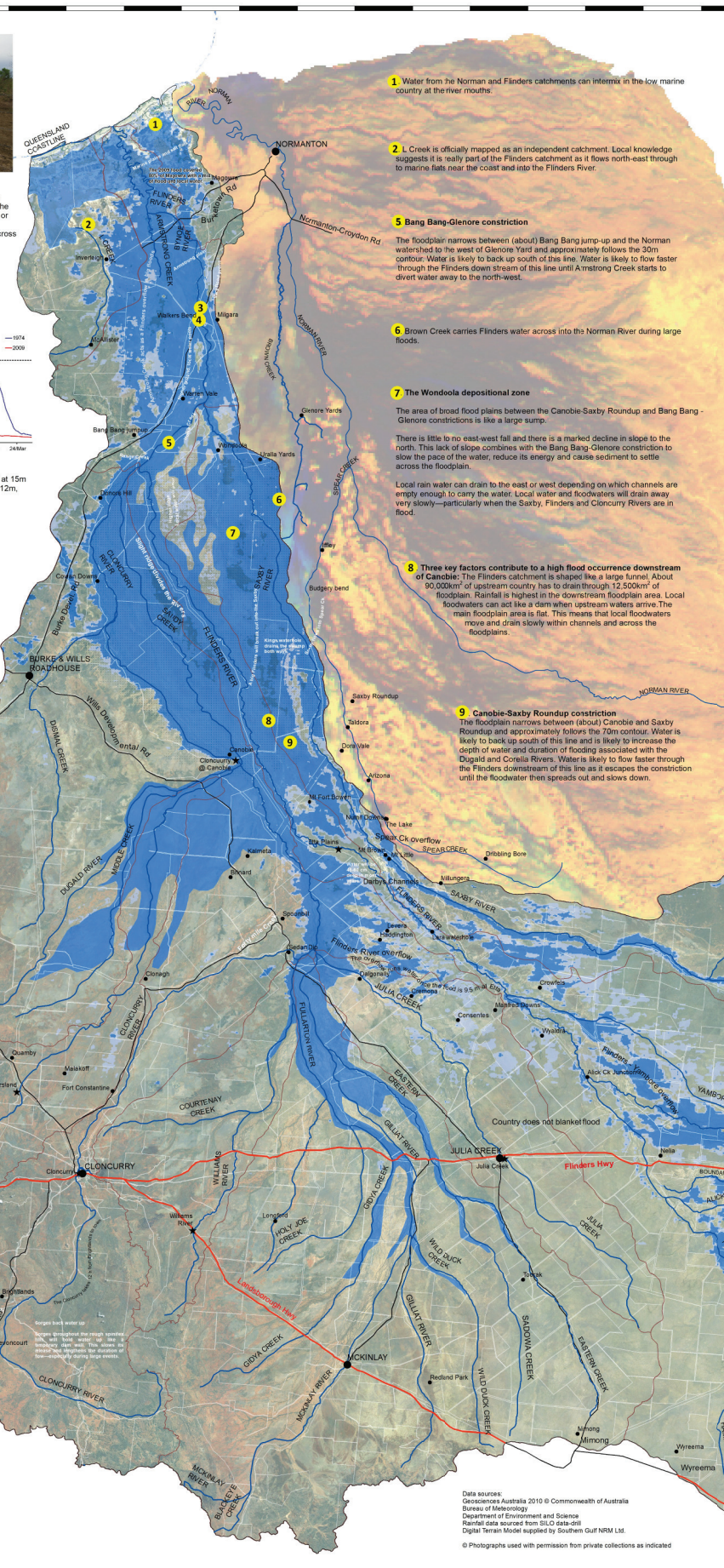
3 The 15m height marker for Walkers Bend is located a distance of 7.7km from the bridge. If you stand next to the road at this marker, floodwater will be about waist high, or up to the third wire in the fence opposite the marker (see photo above). The floodwater will be spread out across the floodplains and also areas that don't usually flood at this level.



4 The largest recorded floods at Walkers Bend peaked at 15m in 1974 and 2009 (see graph). The major flood level is 12m, which is about 2m over the bridge.

When the upper catchment is bare, floods will develop faster and potentially be larger and so carry more sediment. When the upper catchment has good ground cover, run-off and erosion are reduced.

Water colour The Cloncurry River near Brightlands, showing its red colour as a result of draining out of the red spinifex soils and hills. The colour is in contrast with the milky grey waters of the Flinders and Saxby which drain mainly Mitchell grass downs



1 Water from the Norman and Flinders catchments can intermix in the low marine country at the river mouths.

2 L Creek is officially mapped as an independent catchment. Local knowledge suggests it is really part of the Flinders catchment as it flows north-east through to marine flats near the coast and into the Flinders River.

5 Bang Bang-Glenore constriction
The floodplain narrows between (about) Bang Bang jump-up and the Norman watershed to the west of Glenore Yard and approximately follows the 30m contour. Water is likely to back up south of this line. Water is likely to flow faster through the Flinders down stream of this line until Armstrong Creek starts to divert water away to the north-west.

6 Brown Creek carries Flinders water across into the Norman River during large floods.

7 The Wondoola depositional zone
The area of broad flood plains between the Canobie-Saxby Roundup and Bang Bang - Glenore constrictions is like a large sump.

There is little to no east-west fall and there is a marked decline in slope to the north. This lack of slope combines with the Bang Bang-Glenore constriction to slow the pace of the water, reduce its energy and cause sediment to settle across the floodplain.

Local rain water can drain to the east or west depending on which channels are empty enough to carry the water. Local water and floodwaters will drain away very slowly—particularly when the Saxby, Flinders and Cloncurry Rivers are in flood.

8 Three key factors contribute to a high flood occurrence downstream of Canobie: The Flinders catchment is shaped like a large funnel. About 90,000km^2 of upstream country has to drain through 12,500km^2 of floodplain. Rainfall is highest in the downstream floodplain area. Local floodwaters can act like a dam when upstream waters arrive. The main floodplain area is flat. This means that local floodwaters move and drain slowly within channels and across the floodplains.

9 Canobie-Saxby Roundup constriction
The floodplain narrows between (about) Canobie and Saxby Roundup and approximately follows the 70m contour. Water is likely to back up south of this line and is likely to increase the depth of water and duration of flooding associated with the Dugald and Corella Rivers. Water is likely to flow faster through the Flinders downstream of this line as it escapes the constriction until the floodwater then spreads out and slows down.

Floodwater behaviour
Prior to flooding water flows through major channels as a run in the river. If there has been local rain, runoff flows through anabranches and braided channels into larger channels and is drained away. As the depth (and hence volume) of floodwater increases, local water can no longer be drained away and minor flooding commences.
During minor floods water is pushed back through anabranches, braided channels and some shallow channels. Some water will break the banks and flow across the floodplain where it generally follows the direction of the channels. Local floodwater can't drain away until the water level drops below the height of the channel banks.
During moderate floods water flows through anabranches, braided channels, smaller channels and sheets across the floodplain close to the channels. The width of the floodplain covered will vary and water tends to follow the direction of the major watercourses. The duration of the flood depends on the volume of water upstream and the time it takes to flow through.
During major floods water flows through anabranches, braided and smaller channels and sheets across the floodplain. The width of floodwater is at its maximum during a major flood. There are two systems of flow, with broad expanses of floodwater only constrained by the outer limits of the floodplains, and sheeting over the top of water which is still flowing within the channels.
Local floodwater is unable to drain away during major floods and may be pushed uphill in unexpected ways. If rain continues locally the depth of the local water continues to rise—making flooding more severe.
Natural constrictions act like a temporary dam. Large volumes of water can be backed up, raising the upstream water level. The water then flows over many of the small rises in this flat landscape and drains through alternative streams.

Pasture damage

Local experience suggests pastures can be fully submerged for 10 days without damage but if fully submerged for 20 days pastures will be killed. Research in other areas suggests Mitchell grass dies after 14 days of flooding.

Pastures will also suffer if covered in silt by receding floodwaters unless the silt is washed off by rain.

The Flinders and Norman Catchments interact...but it is nearly all one way
Water from the Flinders catchment can flow into Spear Creek—and on into the Norman River—during large floods. Most of this water comes from the Saxby River or the eastern watershed. Water from the Flinders River may be pushed far enough East to flow into the Saxby and then Spear Creek. In rare instances water from the Cloncurry may flow into Spear Creek through the Flinders and Saxby Rivers.
Spear Creek may deliver small amounts of water into the Saxby River through a watercourse at Numil Downs.
Water from the Norman and Flinders catchments can intermix in the low marine country at the river mouths.

Water flow

Water speed: Rivers in the north-east of the catchment run fast as they start in relatively high and hard country e.g. the Stawell (Cambridge) River is reported by locals as travelling up to 20km/h. It takes 1-2 days for Cambridge water to travel the 240km from its headwaters to the Flinders River junction. The speed of the Flinders River slows as the land it flows through flattens out—by the time it is flowing past Warren Vale it has slowed to about 1km/hr. Cambridge crossing is shown with the river in flood during February 2009 (photo below left).

River junctions are important modifiers of flood size and behaviour. When new floodwaters join a river already in flood it can: add extra water to existing flows and make floods bigger downstream; slow the rate water drains away and make the flood last longer upstream; and push the flow of water in a new direction—depending on which river has the most energy and is carrying the greatest volume of water.

For example, Cambridge River water dominates the flow when it joins the Flinders River to the west of Richmond (photo below right). The Cambridge can push Flinders water far to the south - west and influence how much water crosses the highway near Nonca and pushes back up into Alick Creek. Water from the larger Cambridge channel (left hand side of photo) contributing substantially to the smaller Flinders channel (in the background) in February 2009.

Estimated Flinders River travel times

Flinders headwaters to Hughenden
1-2 days

Hughenden to Richmond
3-4 days

Richmond to Hulbert's Bridge
1-2 days

Hulbert's Bridge to Alick Creek junction
2-3 days

Alick Creek junction to Darbys Channels
3-4 days

Darbys Channels to Canobie
2-3 days

Canobie to Warren Vale
5-8 days

Warren Vale to the mouth
5-8 days

Overall—from source to mouth
22-35 days

Estimated Saxby River travel times

Headwaters to Darbys Channels
4-7 days

Darbys Channels to Saxby Roundup
1-2 days

Saxby Roundup to Flinders junction
4-7 days

Overall—from source to junction
9-15 days

Flood travel times*
Travel times in any tributary vary between flood events. They can be estimated from the speed of water flows and the length of the tributary. This has been done where gauged flows are not available based on assumed water speeds and checked against local experience.
The median and range values below, measure time between upstream and downstream flood peaks.

Agate Downs to Cloncurry
Median: 1 day
Range: <1-3 days

Canobie to Walker's Bend
Median: 3 days
Range: 1-7 days

Etta Plains to Walker's Bend
Median: 4 days
Range: 1-8 days

Cloncurry to Canobie
Median: 3 days
Range: 1-6 days

Corella River Bridge to Canobie
Median: 3 days
Range: 1-5 days

Dugald River rail crossing to Canobie
Median: 2.5 days
Range: <1-4 days

Hughenden to Richmond
Median: 1 days
Range: <1-3 days

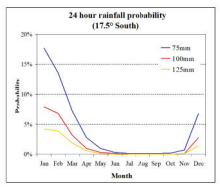
Julia Creek to Canobie
Median: 3 days
Range: 1-5 days

Richmond to Etta Plains
Median: 4.5 days
Range: 2-8 days

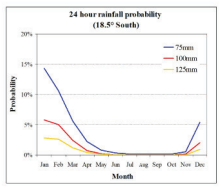
*Travel times on this map should be treated as best estimates and used cautiously.

The chance of rainfall in the Flinders catchment is strongly influenced by time of year and latitude (distance from the equator).

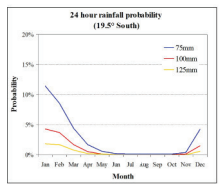
Find the chart that aligns best with the latitude of your property to see the chance of receiving a 24 hour rainfall total in excess of 75, 100 or 125 mm. This is also influenced by the SOI e.g. a consistently positive SOI generally improves the chances of higher rainfall.



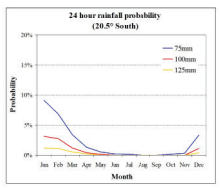
17.5° S



18° S 18.5° S



19° S

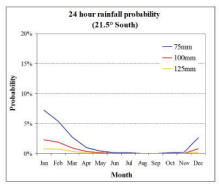


19.5° S

20° S

20.5° S

21° S



21.5° S

10 .Flinders water regularly floods across into Alick Creek through Boundary and Nonda Creeks. The photograph (left) is looking from Nonda towards Maxwelton and shows Flinders water flooding out across the Flinders Highway towards Alick Ck.

The land is so flat that water can also be carried from Alick Ck into the Flinders River. The direction of flow depends on which system is carrying the most water at the time.

Legend
- Towns
- Gauging stations
- Highways
- Major roads
- Flinders and Norman catchment rivers
- Subcatchment contours
- Property boundaries (white)
- Imagery - SPOT 2013-15 1.5m

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

140° E 140.5° E 141° E 141.5° E 142° E 142.5° E 143° E 143.5° E 144° E 144.5° E 145° E

Data sources:
Geosciences Australia 2010 © Commonwealth of Australia
Bureau of Meteorology
Department of Environment and Science
Rainfall data sourced from SILO data-drill
Digital Terrain Model supplied by Southern Gulf NRM Ltd.

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