**Contents**

**Summary**
- Background 2
- Operations 2
- Water Loss Claims 2

**Introduction**
- 4

**Regulated and unregulated system flow trends**
- 5

**Rainfall trends**
- 5

**Water Supply Operation 2017 to 2019**
- Key Operation Points 6
- Storage Inflows/Evaporation 7
- Transmission Losses 2018/2019 7
- 8
- 9
- Storage Release and End of System Flow Pattern 9
- End of System Flows 10
Summary

Background
The Peel River is 210kms long and 40kms below Tamworth the river joins the Namoi river. The Peel River catchment and river basin is influenced through releases from both Chaffey Dam, managed by Water NSW, and 8 tributaries that are unregulated that join the Peel River including Goonoo Goonoo Creek, Cockburn River and Moore Creek.

Operations
Releases from Chaffey Dam by WaterNSW are determined by orders placed by customers (Tamworth Council, environmental waterholder and farmers) along the peel river who have entitlement to that water. Water is then released to meet these orders along with scheduled planned environmental flow to support the downstream riverine environment. Water leaving the Peel River System is measured at Carrols Gap downstream of Tamworth prior to entering the Namoi River.

Water Loss Claims
There have been local claims that the water balance for the Peel Valley, which is publicly reported (as is all WaterNSW data), suggests that 6GL of water went missing or unaccounted for in 2018/19. This claim is based on a simple assessment of releases from Chaffey, extractions and water leaving the system. Unfortunately, the flow of water through the valley is not simple, especially when you factor in all inflows, extractions by consumptive users, plus losses to seepage and evaporation.

Not all the water entering and leaving the system can be directly measured (metered), which means that some water movements need to be calculated based on a water balance by expert operators. Inflows to the Peel River from six of the eight tributaries, transmission losses to the groundwater and evaporation are not direct measurement but calculated based on observed flows in the river. The report shows that these unmeasured flows have varied significantly over the last 20 years from 160 GL of gains (2011/12) to 6 GL of losses (2018/19). In the water balance reports, gains are recorded as tributary flow while losses are reported as unaccounted for water, which is not necessary an accurate term but is used as a reference for losses through evaporation and movement of water to the groundwater aquifer. Unaccounted for water is a term used to describe losses to the environment and we appreciate that the public could infer that this is “lost water” due to river operations or management when, in fact, it is simply the water calculated to be lost to seepage and evaporation, which is particularly high during drought periods.

Another example of the complexity of water measurement in the Peel system is the Cockburn River, just above Tamworth, contributes approximately 40% and other tributaries contribute another 10% of the long-term average annual discharge at Carrols Gap. Put simply, half the water passing through Carrols Gap in an average year is not from Chaffey Dam. In addition to this, the Peel River is characterised by highly variable inflows and a riverbed structure that is conducive to high rates of water losses through seepage and evaporation due to the sandy and shale soils in the valley. To demonstrate this point, the current drought has exacerbated these losses (known as transmission losses or in water accounting terms as unaccounted for water). Current water losses in the Peel system due to severely dry catchments, which now measure the worst on record, are as high as 50%. This
means for every 10 ML of water released from a dam 5ML doesn’t make it to the point of extraction for Tamworth Council.

Data which is also publicly available shows this strong correlation between current and previous droughts in terms of depth of water table, losses and water that leaves the Peel system. All these factors need to be measured and accounted for in the Peel Catchment. Back of the envelope maths of dam releases and Carrol Gap flows are in themselves only half of the data.

WaterNSW accounting takes into account all these factors through a team of industry leaders and experts in this field and our detailed reports show there has been no water “lost” in the Peel but do rightly show a system where transmission losses, evaporation, tributary inflows and groundwater levels are highly variable and interconnected meaning when its dry, losses are high and when its wet there is an increase in water passing Carro’s Gap and into the Namoi. All data sets show a strong correlation between rainfall events and increases in flows.
Introduction

This report covers Peel River operations from 2017 to 2019. While this report references data for the period 2019/2020, please note that any data referenced is only up to 2 January 2020 and not for the full 2019/2020 period.

The Peel River flows from its eastern source in the Great Dividing Range, through the Peel Valley in a westerly direction to its confluence with the Namoi River, approximately 40 kilometres downstream of Tamworth. Multiple tributaries enter the Peel River as it travels through the valley including:

- Duncans Creek
- Dungowan Creek
- Cockburn River
- Goonoo Goonoo Creek
- Moore Creek
- Timbumburi Creek
- Tangarratta Creek
- Attunga Creek
Regulated and unregulated system flow trends

Carroll Gap represents the end of the regulated system. Regulated and unregulated flows from the Peel River at Carroll Gap contribute to an average total annual discharge of 252,900 megalitres (ML). This amount fluctuates significantly, which illustrates the significant variability in flows between wet and dry years. Variability in flow levels also occur across the valley and between seasons due to summer being the predominante time for rainfall and irrigation use.

Flows originating from the Cockburn River catchment contribute to approximately 40% of the average annual discharge measured at Carroll Gap. Other significant contributors include Goonoo Goonoo and Dungowan Creeks, both contributing approximately 10% to the average annual discharge. The Peel River above Chaffey Dam is best described as a minor contributor to discharge at Carroll Gap.

Chaffey Dam captures water during times of high flow and releases it when natural Peel River flows are insufficient to meet demands for water. The overall effect of this is to reduce flow variability immediately downstream of the dam. In addition to the Peel River, the Cockburn River, Goonoo Goonoo Creek and Dungowan Creek exhibit perennial flows in most years.

All other creeks and streams within the Peel Valley are less permanent in nature, and the flows from these systems are not monitored and are usually estimated based on measured flow in the main river.

Rainfall trends

The Peel Valley has experienced below average rainfall since late 2016. Prior to this period the valley experienced a high rainfall period for 6 months, which resulted in Chaffey Dam filling.

For the period April 2017 to March 2019, lowest-on-record rainfall has been observed over southern inland Queensland and areas of north western New South Wales. Over most of this area, rainfall for the period was less than 50% of the 1961–1990 average. Large areas from central to southwestern Queensland, and northcentral and north western New South Wales, into north eastern South Australia, have seen rainfall totals between 40% to 60% of this average, implying that nearly one year’s worth of average rainfall has been missed over this two-year period.

The recent dry periods have been especially severe during the cooler months of April to September, an important time for agriculture and the replenishment of surface and groundwater storages across southern Australia. Averaged over the Murray-Darling Basin (MDB), the total rainfall over two consecutive April to September periods was the lowest on record, at 217.5 millimetres (mm). This is around 15% below the previous record, which saw 255.7 mm over the 1940–41 April to September period. It was also the only instance of an April to September rainfall total below 125mm in two consecutive years.

Rainfall for the combined two-year 2017 and 2018 April to September period was the lowest on record and very much below average (lowest 10% of all such periods) for large parts of
south eastern and southwestern Australia. Around 50% of New South Wales was lowest-on-record for these two periods combined. The winter of 2019 again saw continuing dry conditions, which now means three consecutive winters of below average rainfall. Over the 24-month period, there has been a large decline in water resources in the northern half of the MDB, including over the Namoi and Upper Macquarie catchments. The Namoi has had the second lowest-on-record rainfall for equivalent 24-month periods, with rainfall around 62% of the 1961–1990 average. Rainfall in the Upper Macquarie catchment is around 71% of the average.

Water Supply Operation 2017 to 2019

The recent dry weather patterns across the northern parts of NSW has impacted the volume of water in storages across the region including Chaffey Dam in the Peel. Since late 2017, water demands in the Peel have been mainly met through releases from Chaffey dam, this is unusual with flows from the tributaries in the valley usually being used to meet demands of Tamworth and the irrigation community along the river.

Key Operation Points

- Chaffey was at 96,285ML, 93.5% at the start of the 2017/18 water year with a 100% allocation for town water supply and general security irrigation.
- Chaffey dam releases of 73,708 ML for the period (1 July 2017 – 2 January 2020, 914 days).
- The difference between inflows and evaporation in Chaffey Dam is 6,410 ML.
- Chaffey ended the period at 16,167 ML (14%) (2 January 2020), inflows to the dam have been very low, with evaporation levels higher than inflows adding to additional losses.
- Not all tributary inflows are metered but inflows are calculated by operators based on measured inflow from the GooNoo Creek and Cockburn River and gains in river sections identified by operators attributed to tributaries. Estimated tributary inflows for 2017/18 -12,546 ML, 18/19 - 2,644 ML and 19/20 – 3,000ML.
- In 2018/19, parts of the river were identified to be losing water through transmission losses which equated to 6,070 ML meaning more water was being lost from the river in these sections than was being topped up from tributary inflows.
- 44,564 ML of water was delivered to customers – 22,023ML (17/18), 18,602 ML (18/19), 3,939 ML (19/20).
- 35,468 ML of gauged flow past Carroll Gap for the period from 1 July 2017 to 2 January 2020, with 25,394 ML (17/18), 8,941 ML (18/19), and 1,133 (19/20).
Storage Inflows/Evaporation

The table below shows that the volume of water lost through evaporation has exceed the inflows over the past 2.5 years. The inflows of 2,095 ML to Chaffey Dam over the past 24 months are the lowest recorded and are well below the historical lowest inflows record over 24 months of 13,000 ML between 1964-66.

<table>
<thead>
<tr>
<th>Water Year</th>
<th>Inflow (ML)</th>
<th>Net Evap Loss (ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017/2018</td>
<td>1,763</td>
<td>3,900</td>
</tr>
<tr>
<td>2018/2019</td>
<td>332</td>
<td>2,300</td>
</tr>
<tr>
<td>2019/2020</td>
<td>0</td>
<td>2,305</td>
</tr>
</tbody>
</table>

Transmission Losses 2018/2019

While WaterNSW meters releases from the storages, extractions by customers and some of the tributary inflows, there are a number of tributaries and also the movement of water into and out of the groundwater that can’t be directly measured.

Transmission losses along the river are associated with two forms of losses. Water moves in both directions from the groundwater alluvium. The flow of water into and out of the groundwater aquifer cannot be directly measured and the river operators estimates the water flow based on water budgets within individual sections of the river.

During wet periods, the groundwater alluvium provides a flow into the river and this water is picked up as an increase in river flows along with ungauged tributary flows. In the annual water budget reports these increased flow of water is recorded as tributary inflows.

During dry periods when the groundwater table drops, and there are minimal inflows from the ungauged creeks, water will flow out of the river and into the groundwater aquifer and this water is seen as a loss. The river operators record these flows as unaccounted for water.

Over the last 18 months, with the dry condition being experienced across the valley, the upper sections of the Peel River has moved from a gaining system, where water flows into the river from the groundwater system and creeks, to a losing river where water is being lost from the river to the groundwater aquifer.

The table below shows the volume of water being released from Chaffey, compared to volumes extracted and what flow pasts Tamworth. While the total unaccounted for difference in the valley was 6,070 ML, the unaccounted for difference in the upper section of the valley was actually higher at 6,132 ML. This indicates that the Peel River is recharging the groundwater system in the upper section, with the small volumes of groundwater re-entering the system in the lower sections.
2019 is not the first year where the Peel River has experienced loses in the upper sections. The Peel also had losses in 2003, 2007, 2014. The figure below shows that the river goes through significant variation in relation to gaining water and losing water, and clearly shows the movement of water into and out of the system varies significantly over time based on climatic conditions.

![Figure 1: River gains and losses in the upper section of the Peel since 2001](image)

The variation of flows into and out of the river also align with the variation in the height of the groundwater table. Figure 2 below shows the changes in the height of the groundwater table at Piillumare, just upstream of Tamworth. The change in the river from a gaining river to a losing aligns with the changes in the groundwater table height. During very wet periods 2011-12 and 2017 the groundwater table increases in height during the period when we see the Peel gaining flow and as the groundwater table drops we see the gains reduce to a point where the system starts to lose water. Over the past two years the water table has dropped significantly with the extremely dry conditions over the catchment.
The data above shows that water movement into and out of the groundwater aquifer is extremely dynamic. A key driver for the water security projects in the Peel are to reduce the losses in the upper section of the River that have a significant impact on delivering water to Tamworth.

Water movement out of the Peel into the groundwater is not likely to improve until significant rainfall is experienced across the catchment.

Storage Release and End of System Flow Pattern

At the start of 2017/18 the Peel system was just coming out of a wet period, which saw Chaffey Dam being filled and the tributaries in the valley providing significant inflows to the Peel River. During the first half of 2017, the flow at Carrol Gap and demands along the river were being met by these tributary inflows with little discharge from Chaffey occurring.

Except for an environmental release in June/July 2017, releases from Chaffey did not commence until the start of the irrigation season in September 2017. The tributaries continued to supply inflows to the system throughout 2017 providing additional resource for the Peel. Since the end of 2017 the tributary inflows have become very sporadic and only small inflows after rainfall events have been recorded.
End of System Flows

Water flowing out of the Peel River into the Namoi is recorded at the Carrol Gap gauging station the lowest point in the Peel valley. Over the period of 2017 to 2019 the flow at Carrol Gap has continued to decrease with the increasing intensity of the drought. During the period from January 2017 to July 2017, prior to the 17/18 water year, 33,441ML was measured flowing past Carrol Gap over the 6 month period. Over the last 2.5 years (July 2017 to December 2019) a total of 35,468 ML has been measured at Carrol Gap.

Flows at this point in the system are impacted by a number of sources, including releases from Chaffey, the delivery of environmental flows and rainfall events which result in water flowing out of the main tributaries and also the smaller creeks.

The graphs below show the flow at Carrol Gap during the last three water years, as can be seen in the flow at Carols Gap spikes after rainfall events. Rain in the valley has two impacts on increasing flow at the end of the system. One, it reduces the demand for water and also increases inflows from small creeks. In relation to the demand for water, if the water has already been released from Chaffey to meet irrigation or urban demands, the water stays in the river and flows out of the valley.

Flows at the Carrol Gap over the past three years have slowly declined due to the dry conditions intensifying and inflows from smaller creeks reducing. Releases for town water supply and irrigation purposes have also reduced as the drought continues. As can be seen in Figure 6, flow past Carrol Gap has reduced to a minimum in the second half of 2019 with very low rainfall being recorded.
Figure 4: Flow comparison at Carrol Gap and rainfall in the valley for 2017-18

Figure 5: Flow comparison at Carrol Gap and rainfall in the valley for 2018-19
Figure 6: Flow comparison at Carrol Gap and rainfall in the valley for 2019-20

The table below show in more detail the volume of flow out of the valley during different periods and the reasons.

<table>
<thead>
<tr>
<th>Year</th>
<th>Period</th>
<th>Description</th>
<th>Carroll Gap Flow (ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>1 Jan – 1 July</td>
<td>During this period end of system flow were generally above 100ML/day with this flow coming into the Peel River from downstream tributaries. The main release from Chaffey was during June 2017 which was an environmental release.</td>
<td>33,441</td>
</tr>
<tr>
<td>2017</td>
<td>1 July – 6 Oct</td>
<td>During this period there was limited releases occurring from Chaffey Dam with tributaries still providing sufficient flow to meet customer demands. End of system flows started to decline during this period due to drier conditions as the drought in the valley started to impact on natural river flows. This volume of end of system flow was unavoidable and is not attributed to dam releases.</td>
<td>12,830</td>
</tr>
<tr>
<td>2017</td>
<td>6 Oct – 6 Nov</td>
<td>In early October rainfall occurred around Tamworth with 30mm on the 9th and 39mm on the 12th. The 70 mm of rain over this period saw a spike in flows at Carrol Gap of 350ML/day and this flow slowly receded during October.</td>
<td>2,771</td>
</tr>
<tr>
<td>2017</td>
<td>Nov – Dec</td>
<td>During this period there was three rainfall events from early November through to early December with approximately 170mm falling across the lower sections of the valley. The events occurred on the 8th (14mm) and 18th/19th</td>
<td>2,172</td>
</tr>
</tbody>
</table>
During this period water was being released from Chaffey to meet town water supply and general security requirements. During this period there was a plan to target an end of system flow to ensure the river was running to meet customer requirements. A number of small rainfall event occurred during this period leading to small inflows but also a reduction in demand (rejection of water ordered) which saw a number of spikes in water flow at Carrol Gap. The end of system flow during this period was likely to be an equal sharing of targeted flow and inflow/rejected water from customers due to rainfall events.

### 2018 June

Environmental water order was released from Chaffey in early June arriving at Carrols Gap on the 10 June. Flow at Carrols prior to the environmental flow arriving was in the order of 20 ML/day.

### 2018 July - Sept

End at system flows during this period was generally low (17 ML/d) with only a few small rainfall events around 10mm.

### 2018 Oct – Dec

There was a number (10) of wet weather events during this period which saw the end of system flows increase. While there was a number of small events during October and November, flows at Carrol Gap were still in the order of 20 ML/d for the period. However, after a significant rainfall event on the 22 November (60mm) and smaller event on the 29/11, 16 and 20/12 flows at Carrol Gap increased during the month to an average of 47 ML/d.

### 2019 Jan – March

The first few months of 2019 were extremely dry, and, with reduced irrigation demand, the end of system flows during this period was reduced to around 12 ML/d.

### 2019 April – May

There were two significant rainfall events one on the 30 March (80mm) and another on the 4 May (40mm) which provided a flow out of the Peel. In the days after these first event flows past Carrol Gap of 1,675ML and 450ML respectively.

### 2019 June

Conditions returned to dry during June with end of system flows being maintain at less than 10 ML/d. During this period flows were higher at
Carrol Gap than at Bective which is the next gauging station upstream, indicating that the flows at Carrol Gap was being impact by groundwater recharge to the river.

<table>
<thead>
<tr>
<th>Year</th>
<th>Period</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>July – Dec</td>
<td>The second half of 2019 was extremely dry with only 2 rainfall events of greater than 20mm recorded (14/10, 4/11). Over this period flows at Carrol Gap was less than 10ML/d.</td>
<td>1,130</td>
</tr>
</tbody>
</table>