From: [redacted]
To: DPIE W Regional Water Strategies Mailbox
Cc: [redacted]
Subject: [redacted] Macquarie River Water Strategy Submission 25 Nov 2022
Date: Friday, 25 November 2022 11:57:34 PM
Attachments: [redacted] Macquarie River Water Strategy Submission 25 Nov 2022.pdf

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[redacted]

Please find attached my submission. If you have any questions please contact me.

Regards,

[redacted]

Dear Regional Water Strategies team,

I attended the Orange presentation of the Water Strategy on the 14 November 2022 and had a follow up phone conference [redacted] on the 16 November 2022.

My main concern with the 2nd draft of the Macquarie Water Strategy is that it does not contextualise the past impact of climate change on water security in the upper Macquarie catchment. Over the past 30 years the annual median river flow has reduced by more than 50% in both the Campbells and Abercrombie River catchments. This past reduction together with a further predicted 50% reduction over the next 50 years represents an almost existential threat to water security in the Macquarie catchment.

Additionally, rainwater harvesting is not included in the Water Strategy document. The reliability of Chifley Dam as a backup water supply for Bathurst has significant problems due to high evaporation and seepage losses during a drought. Groundwater for Bathurst has not been directly canvassed in the Water Strategy plan. The current stormwater harvesting (SWH) scheme being built in Bathurst has clashed with the proposed 20km Winburndale pipeline replacement project from Winburndale dam, with the result that this pipeline replacement project cannot proceed due to the transfer of 50% of the funds to the SWH project.

My submission below refers to my 2 recent research papers I have written on water security in Bathurst and the upper Macquarie catchment above Chifley Dam as well as the adjacent Abercrombie River catchment above Wyangala Dam. This research was discussed with DPE Regional Water Strategies team members last week.

I submitted these 2 papers to Bathurst Regional Council in February 2022 and have meetings with [redacted] to discuss my findings.

The first paper titled “Climate Change Impacts on Streamflow - a Local Bathurst Focus, February 2022” was co-authored with [redacted] The full reference for this paper is:

Paper 1 - “Climate Change Impacts on Streamflow - a Local Bathurst Focus, February 2022”
Unpublished report to Bathurst Regional Council by [redacted].

The second paper is referenced as:

Paper 2 - “Bathurst Town Water Supply – Background & Issues Paper February 2022”
Unpublished report to Bathurst Regional Council by [redacted].

These 2 papers are currently being peer reviewed prior to being published and are not authorised to be publicly released at this time. I am however happy for the parts I have included below in this submission to be made public and referenced as per above.

Submission to 2nd draft Macquarie-Castlereagh Water Strategy

1. Past streamflow reduction in the NSW Central Tablelands

Annual median river flows in the Central Tablelands have reduced by at least 50% over the past 30 years due to the combined impact of reduced rainfall and changes to local climate that has resulted in increased temperature and days over 30C that in turn has increased annual evaporation.

Figure 1 below taken from paper 1, shows this increasing annual mean maximum daily temperature over the past 60 years for the Bathurst Agriculture Research Station expressed as the deviation from the 60-year average of 20.2C. Annual mean maximum daily temperature was chosen because it was thought to be the best indicator of the influence of temperature change on increasing evaporation.

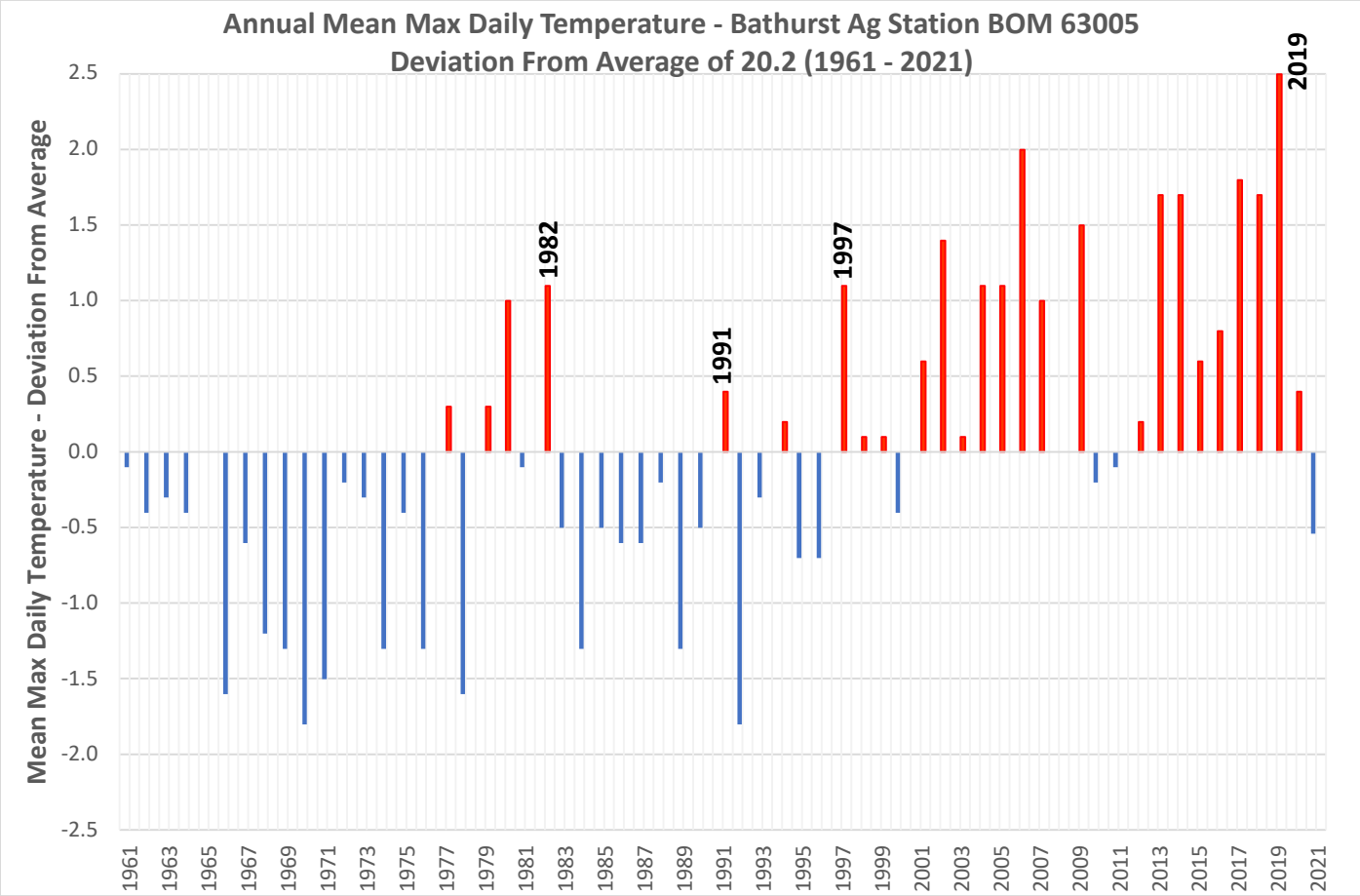


Figure 1 – Annual Mean Max. Daily Temperature Deviation Bathurst Ag. Research Stn. (1961 – 2021)

Figure 1 shows since 1997 there have been 20 out of 25 years where the maximum daily temperature was greater than the average of 20.2C. Clearly Bathurst is getting hotter!

This temperature increase has in turn impacted on the numbers of days over 30C that has risen from a trend low of 24 days in 1961 to a trend high of 46 days in 2021 (an increase of 92%) with a record peak of 75 days in 2019 as shown in Figure 4 below taken from paper 1.

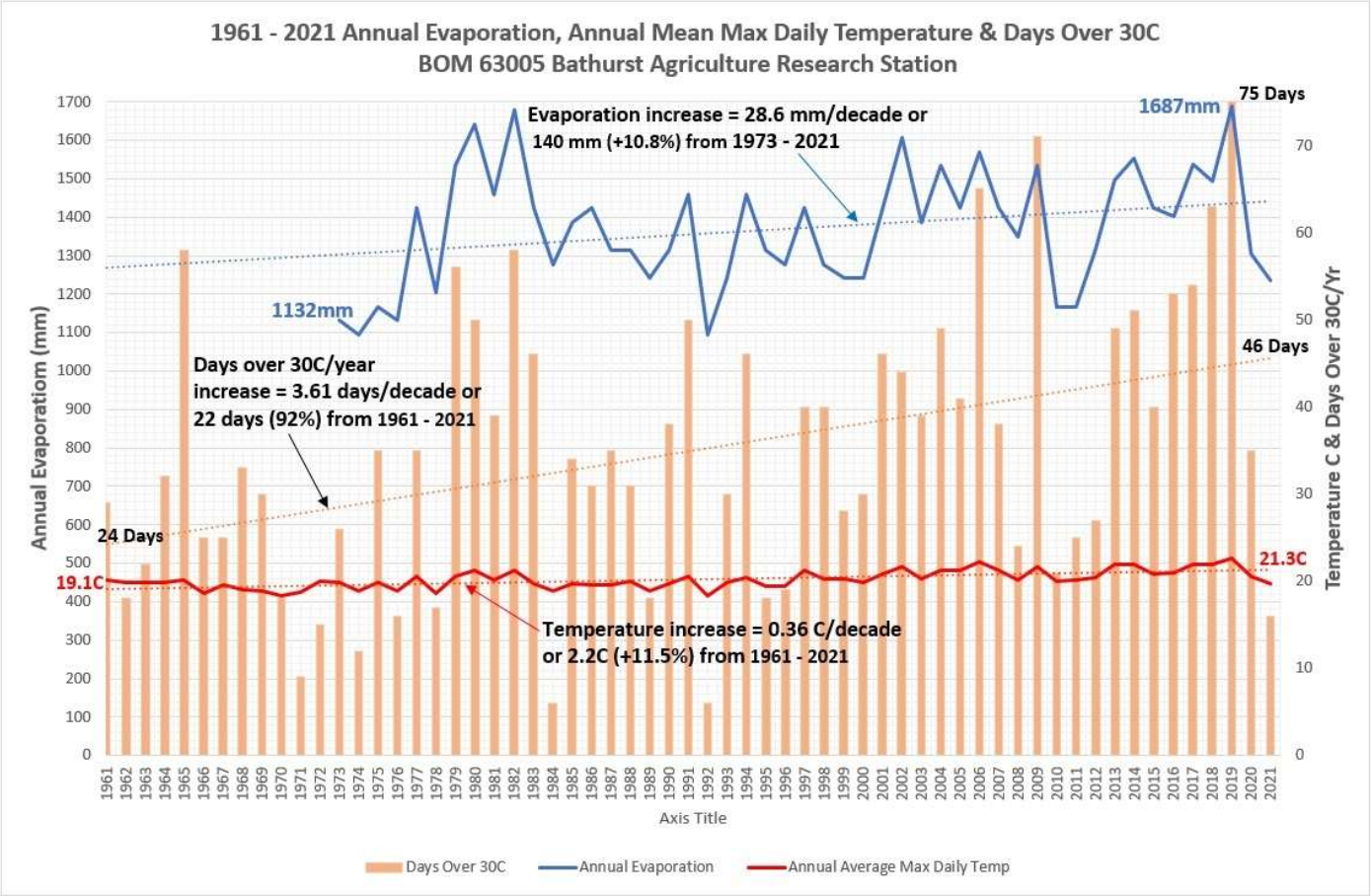


Figure 4 – Annual Max Daily Temp & Evaporation and Days Over 30C - Bathurst Ag. Research Stn. (1961 – 2021)

Figure 4 also shows how the annual mean maximum daily temperature has increased from a trend low of 19.1C in 1961 to a trend high of 21.3C in 2021, an increase of 2.2C or 11.5%. The combined effect of both the temperature increase and the number of days over 30C has been to increase the annual evaporation from a trend low of 1300mm/yr to a trend high of 1440mm/yr in 2021, an increase of 140mm/yr or 10.8% over the 49 years of measurements since 1973. This rise in evaporation is equal to an increase of 28.6mm/decade.

This impact of recent climate change has coincided with a 50 – 65% reduction in the annual median streamflow in the rivers of the Central Tablelands. The Bureau of Meteorology (BOM) has identified a set of NSW streamflow gauging stations that are suitable to analyse climate impacts on streamflows. Two of these hydrological reference stations (HRS) BOM 412028 & 412066 are located on the Abercrombie River near Tuena. These catchments lay immediately adjacent to Chifley Dam catchment. Figure 9 from Paper 1 shows these sites.

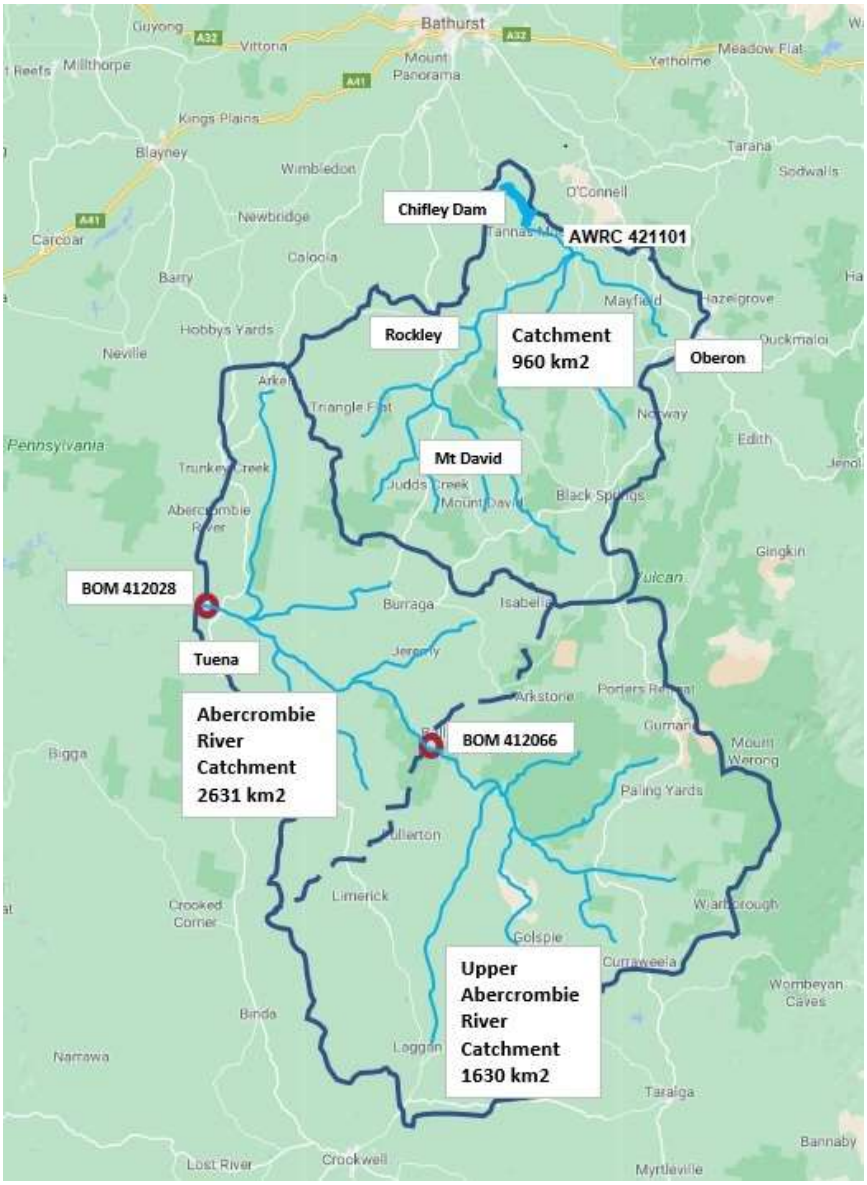


Figure 9 - Map of Abercrombie River Catchment and Chifley Dam

More details on HRS can be found at:

www.bom.gov.au/water/hrs/#id=412028

Streamflows from one of the local BOM HRS stations 412028 is shown in Figure 10 taken from Paper 1. The graph shows an almost continued decline of streamflow since 1990 (red is below average & blue above average) and the trends shown in the Abercrombie River would reflect what is also happening in the Campbell's River and the upper Macquarie catchment.

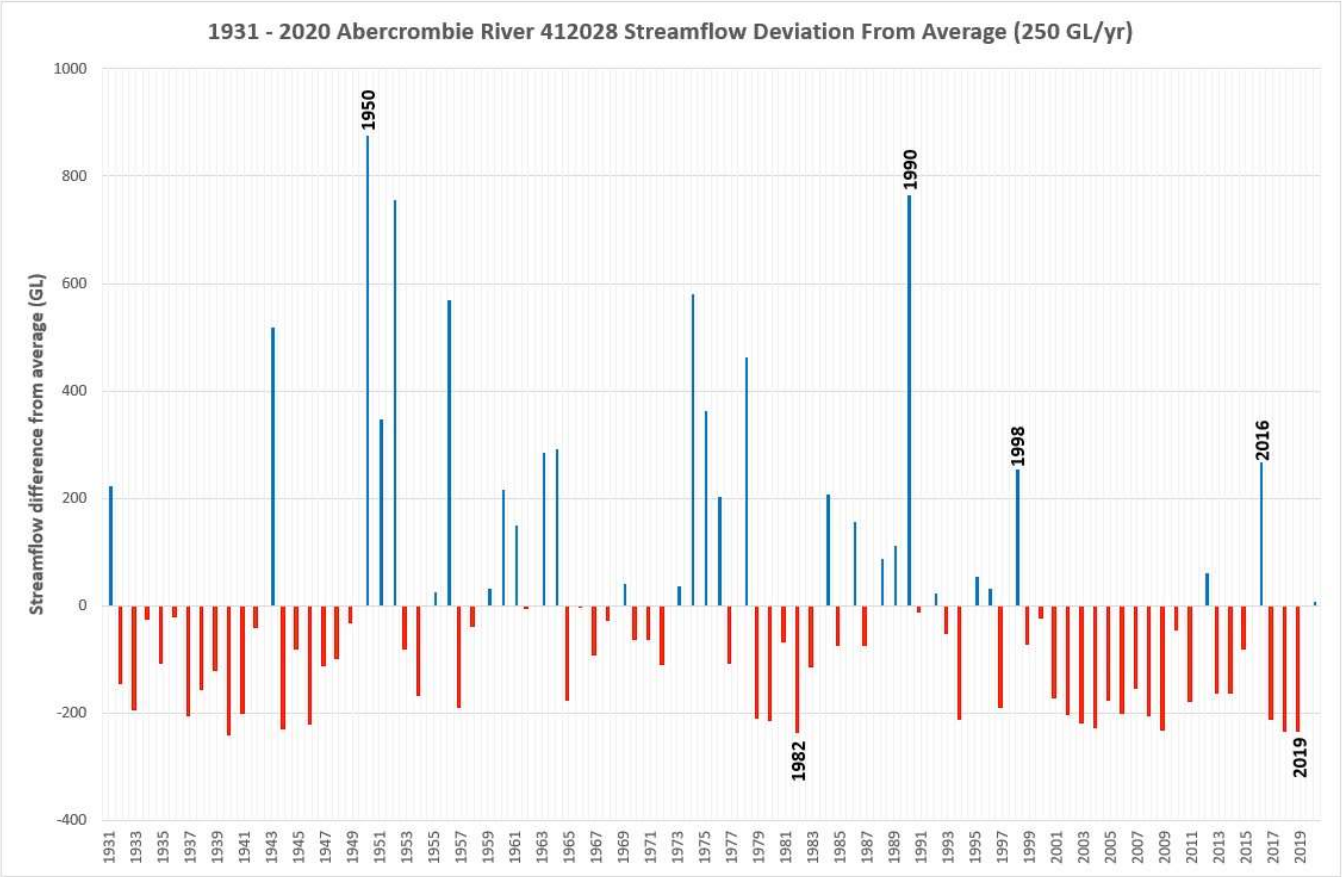


Figure 10 – Streamflow Deviation from Average - Hydrological Reference Station BOM 412028

This data has been analysed over the two 30-year periods 1961 – 1990 & 1991 – 2020. The analysis shows at river gauging station 412028 (catchment area 2631 km2) the median flow for the period 1961 – 1990 was **246** GL/yr. For the period 1991 – 2020 it had reduced by **65**% to **87** GL/yr. Of greater concern are the reductions of 69% - 73% in the lower flows i.e., D1, D2 & D3 flows that represent the 10%, 20% and 30% decile flows. These are critical flows in a drought.

Within the Abercrombie River catchment, rainfall data is collected at Tuena (BOM Station Number 63271). The median annual rainfall for this site over the 30-year period 1961 – 1990 was **792** mm/yr. For the period 1991 – 2020 it had reduced by **11**% to **708** mm/yr. It appears that a 65% reduction in median streamflow has coincided with a reduction in median rainfall of 11% together with an increase in annual temperature and evaporation.

By comparison the streamflow at BOM 412066 (catchment area 1630 km2) that is some 30km upstream of station 412028, shows the median flow for the period 1961 – 1990 was **155** GL/yr and for the period 1991 – 2020 it had reduced by **53**% to **73** GL/yr. Again, of great concern is the reduction of D1, D2 & D3 flows of 71% - 74% over the past 30 years. These are the critical flows in a drought and will significantly reduce the security of streamflow from rivers in the Central Tablelands at these times.

More local context to rainfall in the Chifley Dam catchment (area 985 km2) can be found from the records of Rockley post office BOM 63073. The annual median rainfall 1961 – 1990 was **800** mm and from 1991 – 2020 was **680** mm, a reduction of **15%** reduction over the past 30 years, slightly more than the 11% at Tuena.

Climate change will not only cause a decrease in streamflow, it is likely to cause huge fluctuations in streamflow values. Streamflows in the Abercrombie River near Hadley No.2 at BOM 412066 during the past few years were:

2016 – 309 GL/yr (the highest flow since 1991)
2017 – 28 GL/yr (a 91% drop from 2016)
2018 – 13 GL/yr (the 3rd lowest since 1991)
2019 – 12 GL/yr (the lowest since 1991 and 2nd lowest ever recorded since 1961)
2020 – 206 GL/yr (the 4th highest since 1991)

Whilst the modelled Murray Darling Basin Authority (MDBA) projections of reduced streamflow are expected to be 30% over the next 30 years (or 10% decline per decade), the research by [redacted] and myself shows that over the past 30 years the measured decline in local streamflow in the Central Tablelands has been more than 50% (or 16% decline per decade), much more than what is predicted to happen in other parts of the Basin into the future. If this past decline is projected into the future to 2070 as per the DPE Water Strategy, then the streamflow decline in the Central Tablelands could be as high as 75%. An alarming prospect!

2. Rainwater Harvesting

This topic was covered in paper 2 submitted to Bathurst Council in February 2022.

It is noted rainwater tanks are briefly mentioned in the Water Strategy Plan under Action 1.4 "Adopt a stronger focus on urban water conservation and efficiency" as part of community water conservation schemes but no further details are provided in the plan.

Rainwater harvesting is an important source of water but it is not included as part of Action 1.5 "Invest in innovative water supply options". Yet it could provide up to 1000 ML/yr into Bathurst homes continuously over the whole year. This volume of water matches the $21m proposed stage 1 storm water harvesting (SWH) project being built by Bathurst Regional Council (BRC) in 2022 that is estimated to deliver around 1000 ML/yr. However, according to the 2022 BRC Review of Environmental Factors, the SWH will only be used in a drought year for 55 days/yr or a utilisation of only 15% of the year. The current energy consumption by the Bathurst water filtration plant (WFP) is some 2500 MWH/yr. Energy consumption for the SWH scheme, detailed in the 2022 Bathurst Emissions Reduction Plan, is estimated to add another 1400 MWH/yr to the treatment of clean drinking water ie increase the water treatment energy bill by 56%. Collection of rainwater from house roofs is virtually energy free and delivered direct to the demand point.

Rainwater harvesting off house roofs, could supply a large proportion of Bathurst's town water supply to be used for non-potable purposes like gardens, outdoor cleaning and say car washing. Estimates are based on half the Bathurst houses having a large tank (bigger than 10,000L) installed that can hold at least one month's supply in a dry year, of say 480mm/yr compared to the average of 630mm/yr. There are 17,000 dwellings in Bathurst so if 8000 houses were equipped with rainwater tanks, then up to 25% of Bathurst's town water supply could be met in a drought year based on the 2019/2020 annual consumption of 3800ML.

Figures from local retail suppliers indicate up to 500 water tanks are typically supplied annually into Bathurst. If this could be increased to 1500 tanks/yr, then 8000 tanks could be installed within 5 years. The best way to increase this uptake would be to make larger rainwater tanks a greater component of the BASIX scoring and to make them a minimum size of at least 10,000L per dwelling. Currently tanks incorporated under BASIX into new homes in Bathurst are generally around 3000L.

Each year some 250 new homes are built in Bathurst. Much of the current annual supply of the 500 new tanks to Bathurst would be for these new houses as part of the BASIX requirements. But a significant number of tanks are probably going to existing homes which would indicate a community demand for a degree of backup water security. For example, in the last drought I installed 8 tanks at my home with a total capacity of 17,000L to give us better water security. In the last drought severe water restrictions in Bathurst limited water usage to 150L/person/day. Figures 5 & 6 from Paper 2 show examples of rainwater tanks.

Figure 5 – 5000L rainwater tank

Figure 6 – 2000L rainwater tank

The estimated cost of 8000 large water tanks could be as high as $40m (based on $5000/home) but if a subsidy of 50% were offered, the cost matches the SWH project.

Rainwater harvesting could also extend to public and industrial buildings. For example, the BRC Aquatic Centre has a large roof area of some 4000m2 (see Figure 7 from Paper 2) that could potentially harvest upwards of 1.8 ML/yr and would meet all of the centres demands.

Figure 7 – Bathurst Aquatic Centre Roof Area (Source NSW SIX Maps)

Another example of large-scale rainwater harvesting can be seen at Campbells Transport in Bathurst. This business has a 600m2 roof and 120,000L of storage tanks, sufficient to store 5 months of rainfall. During the last 2019/2020 drought, this business was able to continue washing trucks despite a BRC ban on washing vehicles.

Figure 8 – Campbells Transport Bathurst - Rainwater Tanks

Within the BRC shire area there are many villages with a total population of nearly 1500 people that are not connected to town water supply and rely on rainwater tanks for their sole source of both drinking and non-potable water. Additionally, every farm house in the BRC shire area relies on rainwater tanks. This lends support for the option to add rainwater tanks to the Bathurst town water supply for non-potable uses.

3. Storage Efficiency of Large Town Dams

This topic was covered in paper 2 submitted to Bathurst Council in February 2022.

Figure 9 – Chifley Dam Showing Overflow Spilling

Chifley Dam provides backup water supply for Bathurst whenever the Fish and Macquarie Rivers stop flowing during extended droughts. During the last 2019/2020 drought, water was released from Chifley Dam over the summer for a record period of 19 weeks. Bathurst Council reported that during this time the volume of Chifley Dam dropped some 5,500 ML. Of this volume some 2,500 ML (45%) was released into the Campbells River for Bathurst town water supply at the WFP. The balance of 3000 ML (55%) was lost to evaporation and seepage. Evaporation losses were calculated to be 1300 ML (from local pan evaporation data BOM 63005) applied over the dam surface area. Peak daily evaporation losses were as high as 12mm/day. Leakage losses through the floor of the reservoir therefore account for 1700 ML. Based on the changing surface area of the dam during this period, this leakage equates to a rate of 8 mm/day.

This leakage rate is significant and more than might otherwise be expected. However, the NSW Public Works Department geotechnical report from February 1990 about the foundation rocks of Chifley Dam, show the rock to be highly fractured and this could account for the high leakage rate across the reservoir floor. https://search.geoscience.nsw.gov.au/api/download/9ee1f5a8e3953a848c743c3e172b9efd/Geotechnical_report.pdf

This analysis shows just how leaky the Chifley Dam "bucket" is due to the high evaporation and leakage losses.

Of the 2500 ML released into the Campbells River, only 1500 ML was drawn into the WFP at Gormans Hill for the town's water supply. That is, another 1000 ML was lost in the river system getting to Bathurst. The overall Chifley Dam/Campbells River water system efficiency is 1500/5500 = 27% efficient. This low efficiency is probably typical of other dams across NSW and shows how investment in water security has to be more than just the headline of building more dams!

Should Chifley Dam be raised higher? Probably not as the dam losses were crucially **55%** during the last drought when the dam was the only source of water for Bathurst. The cost of raising the dam wall (probably 100s of $M) would be better spent on other water projects like groundwater, rainwater harvesting and effluent re-use that would also diversify Bathurst's water supply. Bathurst is too reliant on just natural streamflow for its water supply!

Should the pipeline be built from Chifley Dam to Bathurst at a cost of probably over $30m? It would only be used in the years Chifley Dam is supplying water to Bathurst, which is not every year. During the last drought it would have only improved the system efficiency some 6% from 27% to 33%. Chifley Dam has not been used as a source of town water over the past 2.5 years since Feb 2020 as there has been sufficient flows in the Fish & Macquarie Rivers and a pipeline would have laid idle. Any decision would need to be assessed in terms of the cost of water saved by the pipeline project and compared to other potential water savings projects that may be considered.

The current Water Strategy Plan does advocate more dams in some circumstances but the analysis of Chifley Dam shows there are significant water efficiency problems with dams and other water options may be more cost effective.

4. Groundwater Supply for Bathurst

This topic was covered in paper 2 submitted to Bathurst Council in February 2022. Groundwater for Bathurst has not been directly canvassed in the Water Strategy plan.

Historically Bathurst relied on groundwater from a tunnel built under the Macquarie River between 1889 and 1913. The 480m long tunnel was built from the water filtration plant (WFP) at Gorman's Hill, east under the Macquarie River floodplain (Figure 2). The 20m deep tunnel in the granite bedrock drew groundwater from a

deep sand and gravel layer under the floodplain formed during the last ice age some 40,000 – 15,000 years ago. The old 1903 NSW Public Works Department (PWD) Plan 1 shows the works completed and the new proposed extensions.

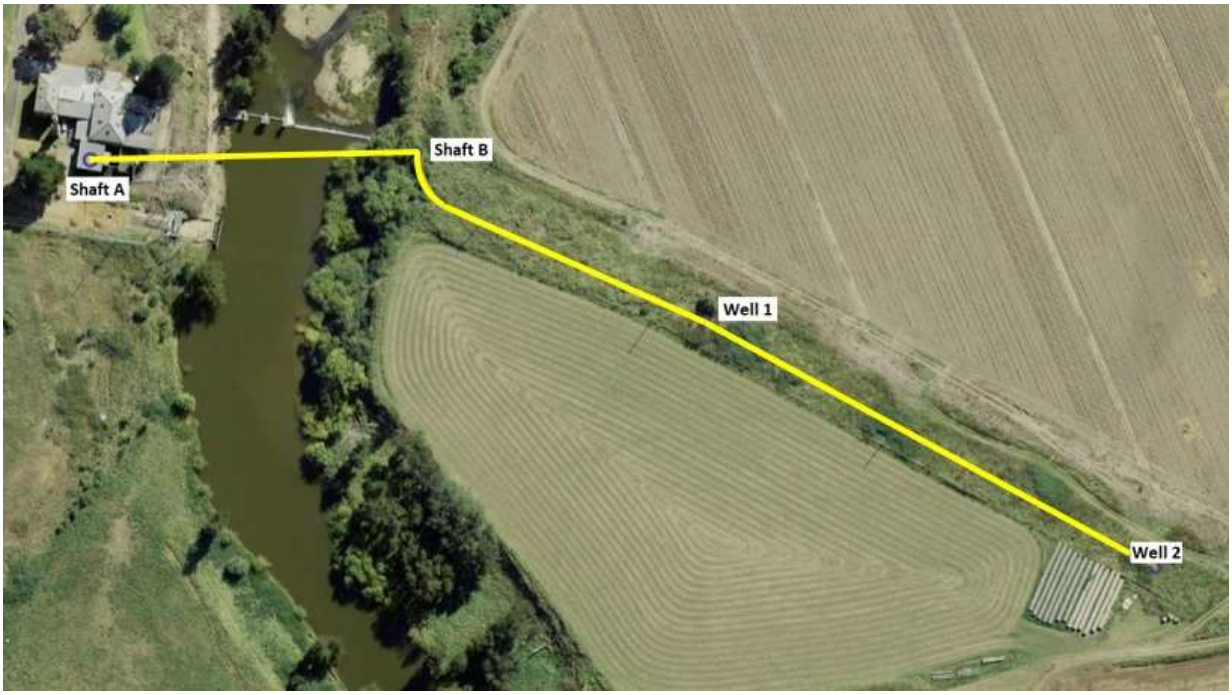
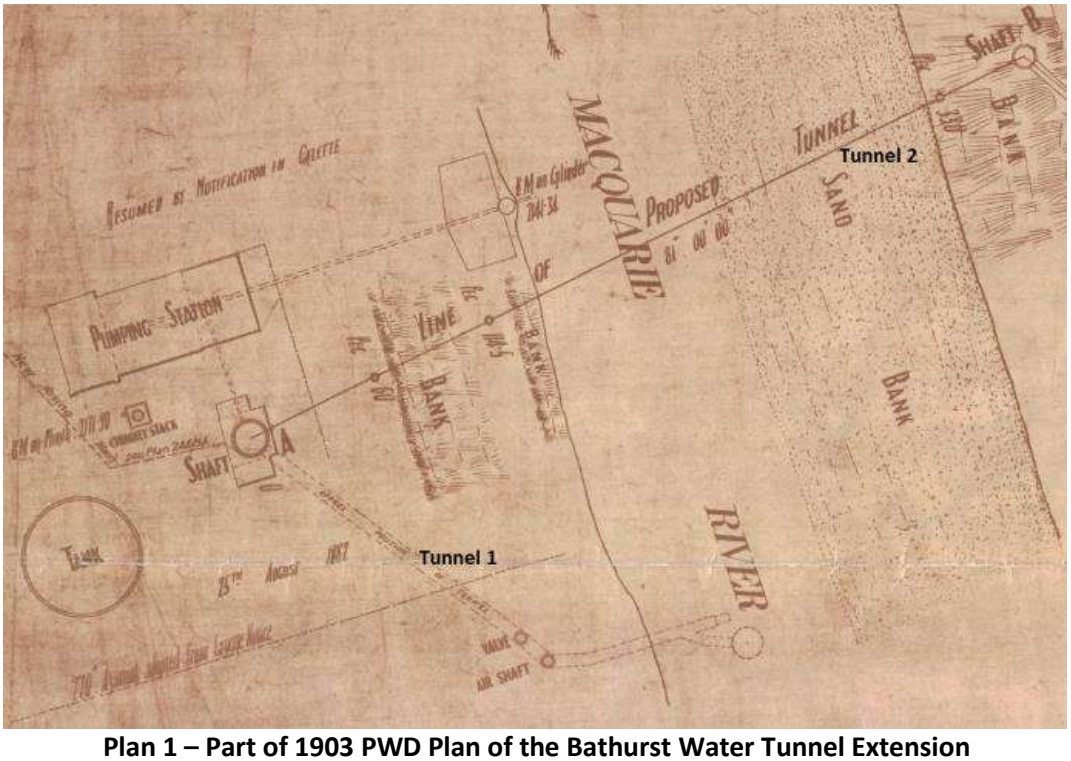


Figure 2 - Plan of the Bathurst Groundwater Tunnel Built from Shaft A to Well 2



Plan 1 – Part of 1903 PWD Plan of the Bathurst Water Tunnel Extension

Groundwater was pumped from the tunnel via Shaft A in the old river pump station (Figure 3). Figure 4 shows the tunnel air Shaft B on the east bank of the Macquarie River. Whenever the Macquarie River stopped flowing, which was often between 1889 – 1934, the groundwater from the tunnel was the only source of water for Bathurst until Winburndale Dam was built in 1934. The groundwater from the tunnel

kept Bathurst alive for 45 years till 1934! The tunnel supplied up to 3.6 ML/day and was used as a source of town water until the early 1950's when Chifley dam was built in 1956. From the 1950's till 2004 the groundwater from the tunnel was used to supplement raw water from Winburndale Dam for parks and gardens. A tunnel groundwater supply of up to 3.6 ML/day could have met up to 36% of the towns needs during the last drought.

Figure 3 – Shaft A Bathurst Old Pump Station

Figure 4 – Tunnel Air Shaft B

5. Action 3.3: Support adoption of farm climate adaptation and water efficiency measures

Irrigation farming in Bathurst is primarily used to grow vegetables for the local and Sydney markets. A 2019 report (no. 19016) to BRC by the Western Research Institute (WRI) titled "Water Infrastructure – Bathurst Regional Council" indicated the value of irrigated agriculture in Bathurst was approximately $12.5m based on data from the Aust. Bureau of Statistics.

Under the challenge of reduced streamflow due to climate change, water availability will be lower and farmers will need to do more with less water. Increased water efficiency will need to be extended for these farmers. Most farmers in Bathurst have in recent years implemented water efficiency measures, primarily by the switch from old travelling irrigators (that spray water upwards of 40m) to new lateral or pivot systems that drop water onto the crop. These conversions are estimated to have made 25 – 30% water savings. One large irrigation business in Bathurst last year converted their whole farm to the ultimate water efficient system called a solid set irrigation system consisting of small dense fixed sprays and dripper lines and tapes at a cost of many $millions, but this would be unaffordable for most family operations.

However, there is an intermediate transition that would increase the efficiency of current lateral or pivot dropper systems by integrating soil moisture probes that interface with irrigation controls. One such system has been invented and manufactured in Australia by Sentek Technologies, Adelaide. This type of water monitoring system could possibility achieve a further 25 – 30% water savings. Depending on the size and type of farming operation, the cost of such integrated monitoring systems could cost from $50,000 - $100,000.

Support by way of a water efficiency grant would help the local vegetable irrigation industry adopt these new efficiency measures.

6. Bathurst Stormwater Harvesting Project and the Winburndale Pipeline Project

The Water Strategy Plan indicates on page 27 that the Winburndale replacement pipeline project is going to be constructed as part of water security investments for Bathurst. This however is now not the case. Originally in 2020, a $10m NSW government grant was allocated to the SWH project and a further $10m grant to the 20km Winburndale pipeline project ie a total of $20m in grants. However, because of cost overruns of the SWH project, $15m of available grants have been allocated to the SWH project, thus preventing the Winburndale pipeline project proceeding. Council has contributed a further $6m to the SWH project from a bank loan. Total project cost is $21m. It is noted according to the 2022 BRC Review of Environmental Factors, the SWH will only be used in a drought year for 55 days/yr or a utilisation of only 15% of the year.

By way of background, the Winburndale pipeline was originally built in 1934 following the completion of Winburndale Dam. The pipe is built from wood of similar construction to a wine barrel, only 20km long. The pipe is now some 88 years old and well beyond its design life. The pipe is so old and fragile that it cannot be turned off for fear of it rupturing under the hydraulic pressure and is left constantly open throughout the year. Council has an allocation of 1000 ML/yr from this dam that equates to approximately 2.5 ML/d. This amount of raw untreated water is constantly released on a daily basis as a way of maintaining the pipeline and keeping the old wood wet so that it does not shrink and leak. In summer all of this water is consumed on watering parks and gardens around Bathurst and the golf course. However, in winter when there is a low demand for watering parks, the excess overflows from the Winburndale pipeline are diverted into Jordans Creek near the Bathurst golf course that then discharges into the Macquarie River. Ironically the SWH project proposes to recapture some of this water from the Macquarie River at a rate of 68 ML/yr ie 6.8% of the Winburndale licence allocation. The balance of the winter overflow (estimated to be as high as 200 - 250 ML/yr) will be lost from the storage in Winburndale Dam in winter.

During the last drought Council built a new cross-connection pipe so that the Winburndale water could be directed to the WFP for town water supply if required. This diversion to the WFP also required an upgrade to the treatment plant to remove small amounts of natural arsenic contamination in the Winburndale Dam water, sourced from its catchment rocks. This connection to the WFP effectively supplemented Bathurst's town water supply by up to 1000 ML/yr or some 25%. My concern is that the pipeline is in urgent need of replacement and should it suffer a catastrophic failure for some reason, this reliable source of water could be lost to Bathurst.

One potential benefit of the SWH pipeline that runs from the sewerage treatment plant (STP) to the WFP is that it provides key infrastructure to re-cycle effluent. If the Winburndale pipeline was replaced and re-cycle effluent was used for parks and gardens, then this could off-set the water currently used from the Winburndale dam. This in turn would allow water to be preserved in Winburndale Dam for town use and environmental flows in the Winburndale Rivulet. The issue of environmental flows in the Rivulet has been a controversial issue in recent times and has been brought before NRAR, the NSW Land & Environment Court and the Supreme Court.

I believe the replacement of the Winburndale pipeline should be a high priority because of the large amount of water that could potentially be saved and secured for the Bathurst town water supply. There is too much water being wasted from this old pipeline.

7. Conclusions

Over the past 30 years (1991 – 2020), median streamflows in the upper catchments of the Central Tablelands of NSW have decreased by 50 – 65 % compared to the 30 years from 1961 - 1990. Median rainfall for the same time period has decreased between 11 – 21%. The 2020 MDBA "Basin Plan Evaluation" report included a CSIRO forecast of a further 30% decline in streamflow of the Murray Darling Basin over the next 30 years together with a 10% decline in rainfall, so this situation is only set to get worse.

Presently Bathurst relies primarily on streamflow from the Fish, Campbells and Macquarie rivers for town water supply and climate change presents a significant risk to this supply. Town water supply needs to include groundwater, rainwater tanks, stormwater re-use, effluent recycling and also water efficiencies.

To reduce the impacts and risks of climate change, there is a need to spread the risk of water insecurity. This can be achieved by diversifying the water supply, the water sources and water infrastructure (ref NSW Legislative Council Report 5, Portfolio Committee No.7, Mar 2021, "Rationale for, and impacts of, new dams and other water infrastructure in NSW", section 2.13, Prof J. Pittock, ANU).