Project details

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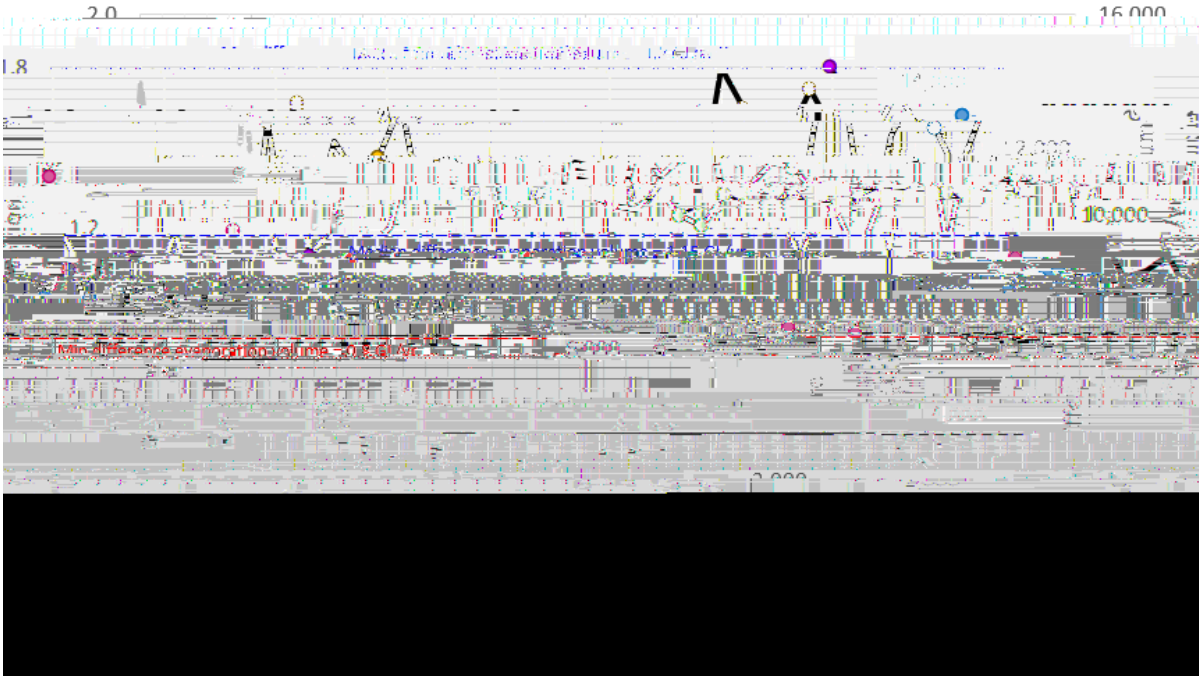

Figure ES2 Yearly difference of evaporation volume with and without the weir, plotted with annual flow.

Figure ES3 presents a box plot of the monthly difference in the evaporation volume. The monthly analysis showed higher evaporation volumes during warm months, highlighting higher water-saving opportunities would occur during the summer periods. Higher variability was also observed during the warmer months, while winter months presented more constant values.

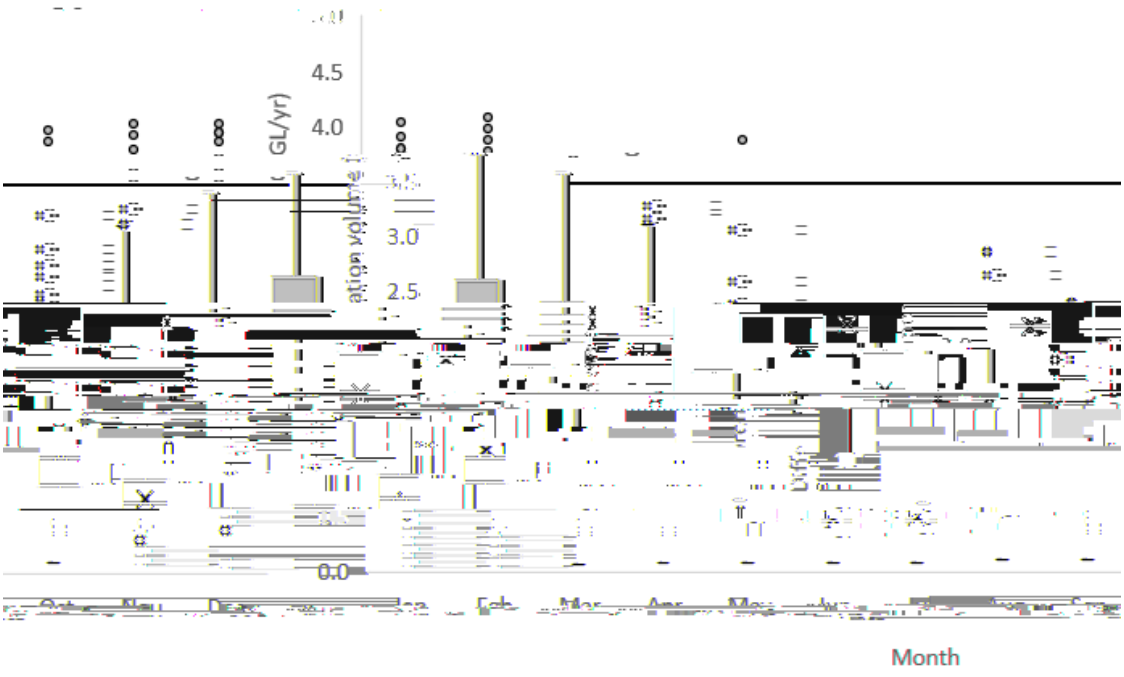

Figure ES3 Box plot of volume of evaporation difference per month, including mean (X), median (horizontal line), 25th and 75th percentiles (rectangle limits)

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1 Background

The analysis was conducted in Weir 20A, located in the Darling River, upstream of Louth town (- 30.4766 S, 145.2594 E). It has a width of 60 m and a height of 4 m. The crest of the weir is located at 88.5 m AHD, and the upstream river bed is at 84.5 m AHD (WaterNSW, 2020). There are no bathymetric

3 Results

3.1 Daily historical data of flow rates and flow depths

The flow duration curve and the statistical assessment of daily flow rates at Louth Weir are presented in Figure 3.1 and Table 3-1. Flow rates at the Louth Weir have a median value of 1302 ML/day, with an increase to 2,751 ML/day during summer months and a drop to 733 ML/day during winter months.

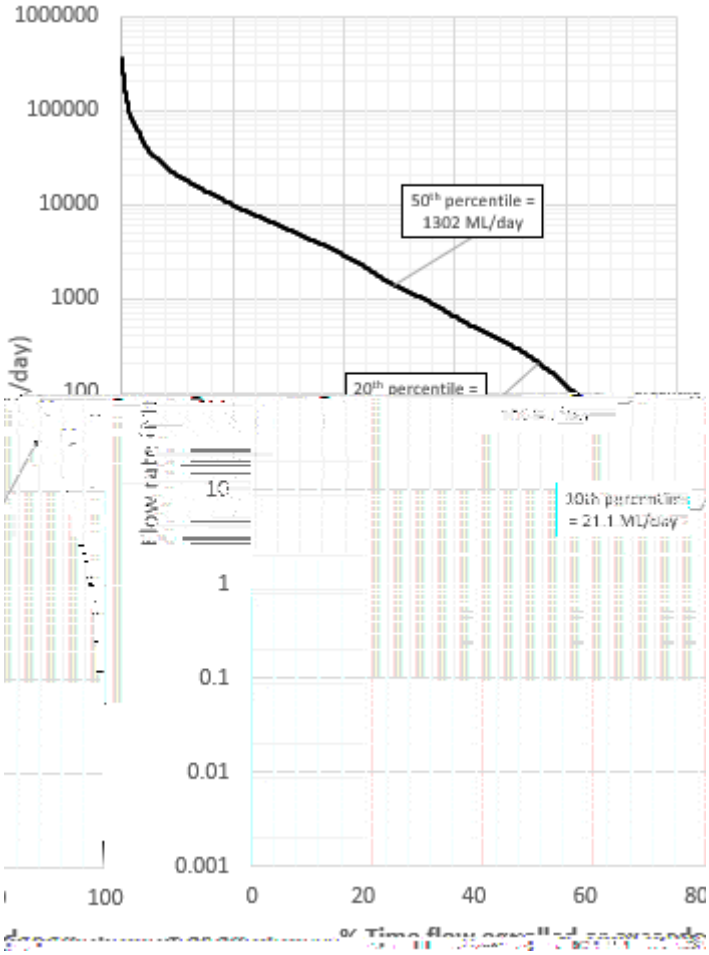


Figure 3.1 Flow duration curve at Louth Weir (Data from 1904 to 2024)

Table 3-1 Statistical data of flow rates in ML/day at Louth Weir (Data from 1904 to 2024)

Percentile	All year	Summer (Dec - Feb)	Winter (Jun - Aug)
5th	3.8	14.2	1.8
10th	21.1	78.2	10.8
20th	119.0	284.2	67.7
30th	318.3	578.1	185.2
40th	639.4	1,353.0	394.3
50th	1,302.2	2,751.2	733.5
60th	2,874.2	4,728.8	1,229.2
70th	5,361.9	8,155.0	2,726.5
80th	9,853.9	14,358.5	5,843.7
90th	20,300.8	26,593.1	13,390.8
100th	359,979.9	327,034.9	260,786.3

The statistical assessment for the flow depth is presented in Figure 3.2 and Table 3-2. Median flow depths at Louth Weir are 3.2 m. Similar flow depths are observed for the summer and winter months.

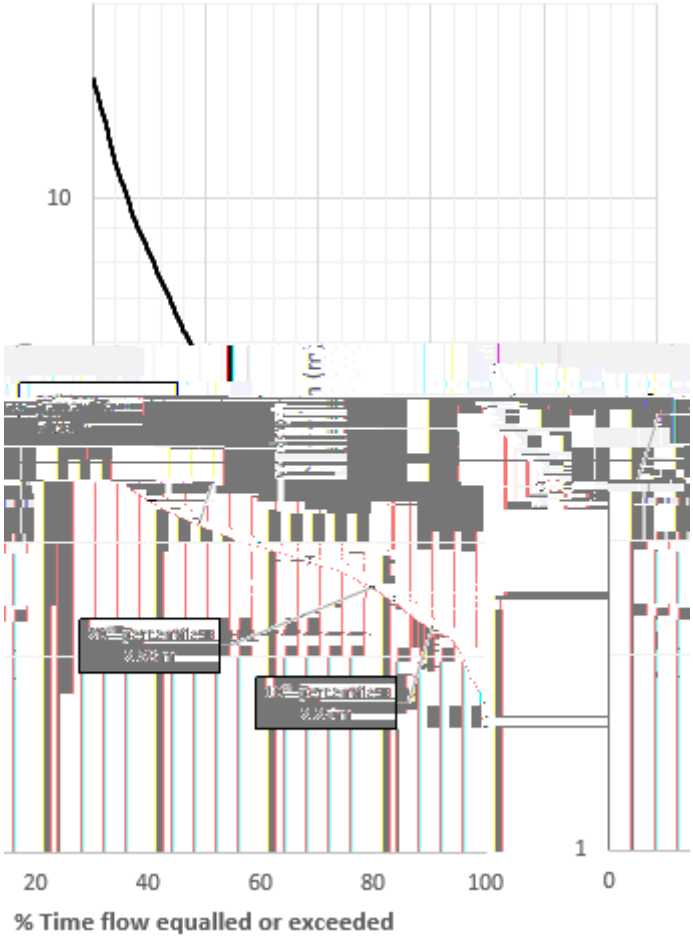


Figure 3.2 Flow depth duration curve at Louth Weir (Data from 1904 to 2024)

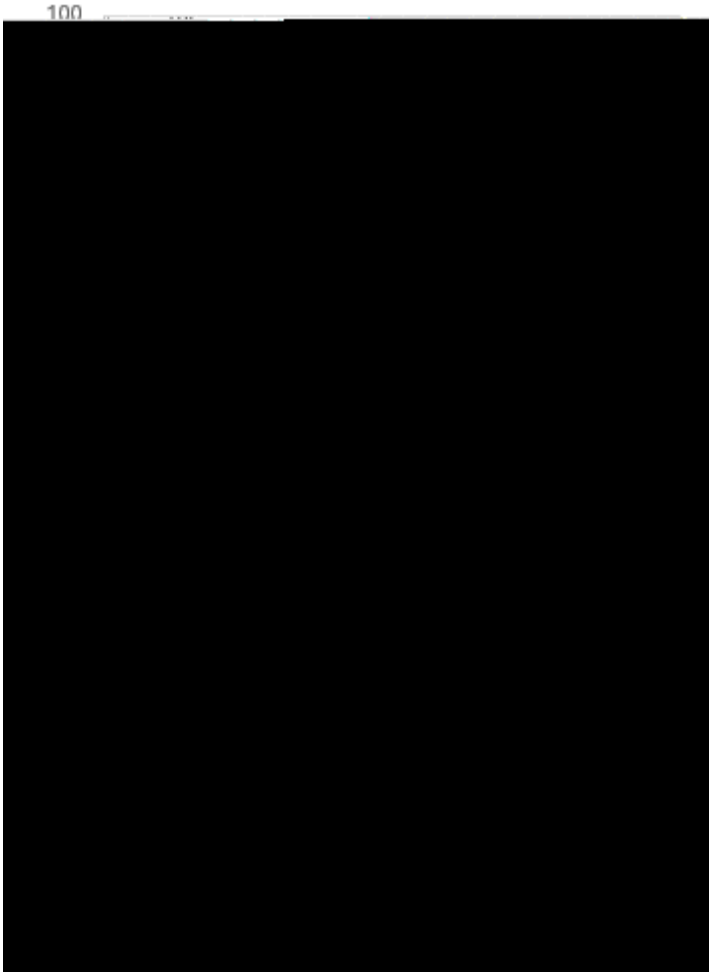


Figure 3.3 Daily evaporation duration curve at Bourke station (Data from 1967 to 2009)

Table 3-3 Statistical data of daily evaporation at Bourke station (Data from 1967 to 2009)

Percentile	All year	Summer (Dec ±Feb)	Winter (Jun ± Aug)
5th	0.6	1.8	0.4
10th	1.6	5.3	1.2
20th	2.2	6.8	1.4
30th	3.0	7.6	1.8
40th	4.0	8.0	2.0
50th	4.8	8.6	2.0
60th	6.0	9.2	2.4
70th	7.2	10.0	2.6
80th	8.0	10.8	3.0
90th	10.0	12.0	3.8
100th	13.8	15.0	6.6

A comparison between the evaporation data and the flow rates is shown in Figure 3.4. Note the weather data (evaporation data) was collected at Bourke station, and it may not represent the weTT0 9.96 Toras collt esmohe

3.3 Flow depth and weir pool estimation

Weirs are artificial barriers across rivers impacting the hydraulics of the riverine system, such as flow depths and velocities. For certain flow rate conditions, the flow depth could be flat some kilometres upstream of the weir. This region is defined as the weir pool. The length of the weir pool is a function of the flow rates, channel roughness, river bathymetry and river slope. Figure 3.5 presents the elevations upstream of Weir 20A for a flow rate of 864 ML/day and a river slope of 0.02%, including the current condition (Weir 20A) and the natural flowing river condition (considering uniform flows). For this condition, the weir pool is extended approximately 20 km upstream. The weir pool area is characterised by slower flow velocities, deeper flow depths, larger surface area and therefore, higher evaporation potential. An approximated weir pool length for different flow rates is included in Figure 3.6. For the flow rates analysed in the present study, weir pool length are between 20 km for typical flow rates and up to 30 km for extreme flood conditions.

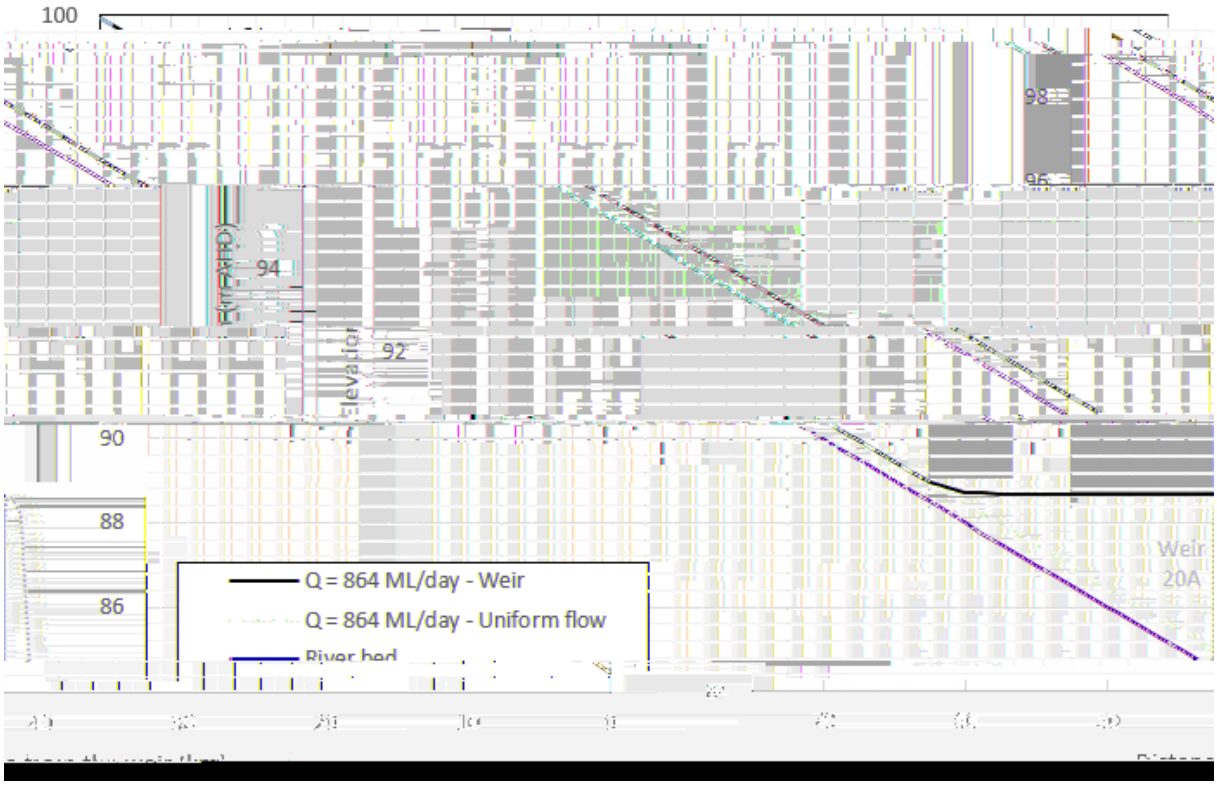


Figure 3.5 Estimated flow depths for a flow rate of 864 ML/day and a river slope of 0.02%

Figure 3.6 Weir pool lengths as a function of flow rates

3.4 Surface area estimation

The surface area was estimated as the product between the width of the river (function of the flow depth and the flow rate) and the weir pool length. Figure 3.7 present the surface area change between current condition(t)26resoesetwe1574/.369 (enh.02 (ur.(w)23.99 (as)-3.13n(n(t)26).675 b-3.6768 (wi8reW* no/5v2v13 (0m4f)-

4 Summary

The present study estimated the flow depths and evaporation volumes at Weir 20A based on a simplified one

Appendix A Sensitivity analysis

The difference in the evaporation volume is significantly impacted by the river slope and cross-sections. Considering the limited bathymetric information in the Darling River, a sensitivity analysis of different slopes and cross-sections was conducted to identify the change in evaporation volume considering:

- River slope of 0.02%, 0.01% and 0.0036%
- Channel width of 45 m and 73 m
- Bank slope of 4:1 and 9:1 (H:V)

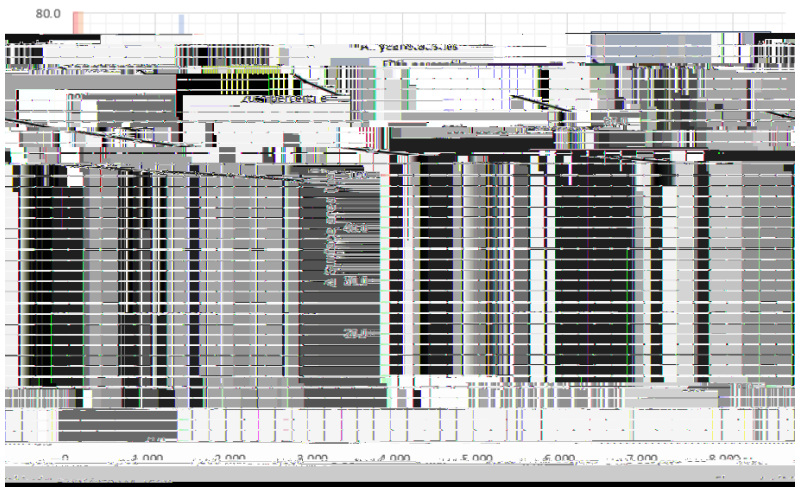
A summary of the sensitivity analysis options and results is presented in Table A-1.

Table A-1 Sensitivity analysis scenarios

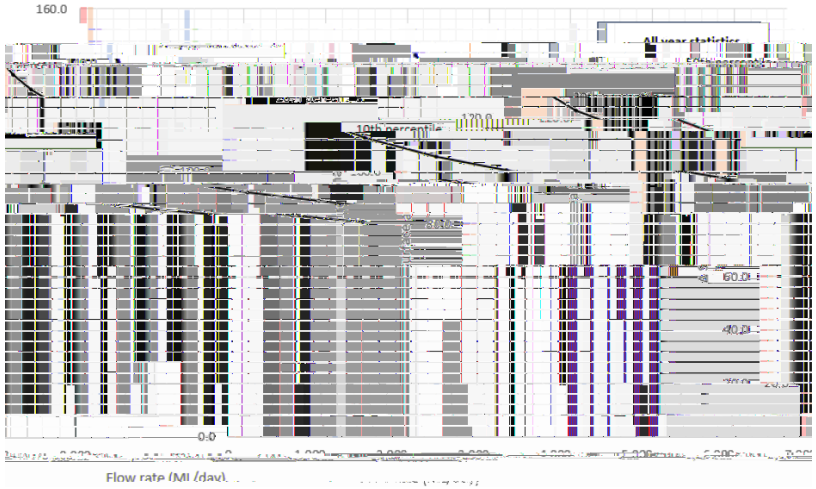
Scenario	River slope (%)	Channel width (m)	Bank slope (H:V)	Roughness coefficient

- River slope and bank slope are significantly influencing the surface area and evaporation potential, and should be carefully identified before proceeding with a detailed numerical assessment.

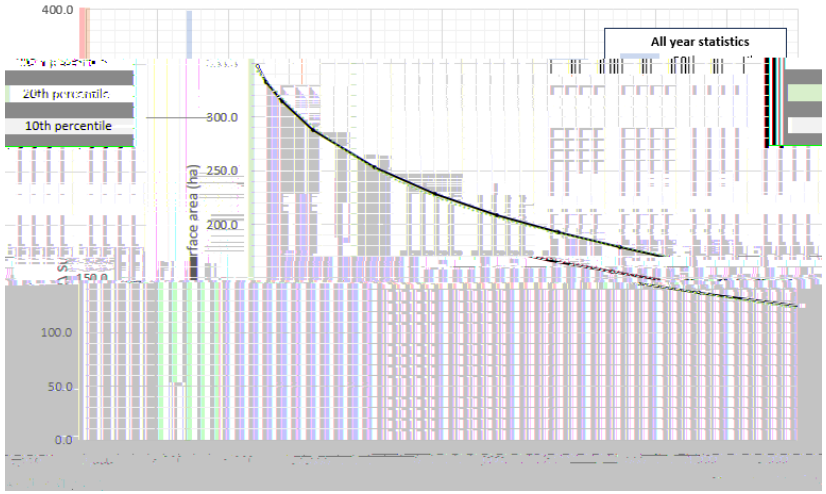
Table A-2 Sensitivity analysis of surface area difference



Scenario 001



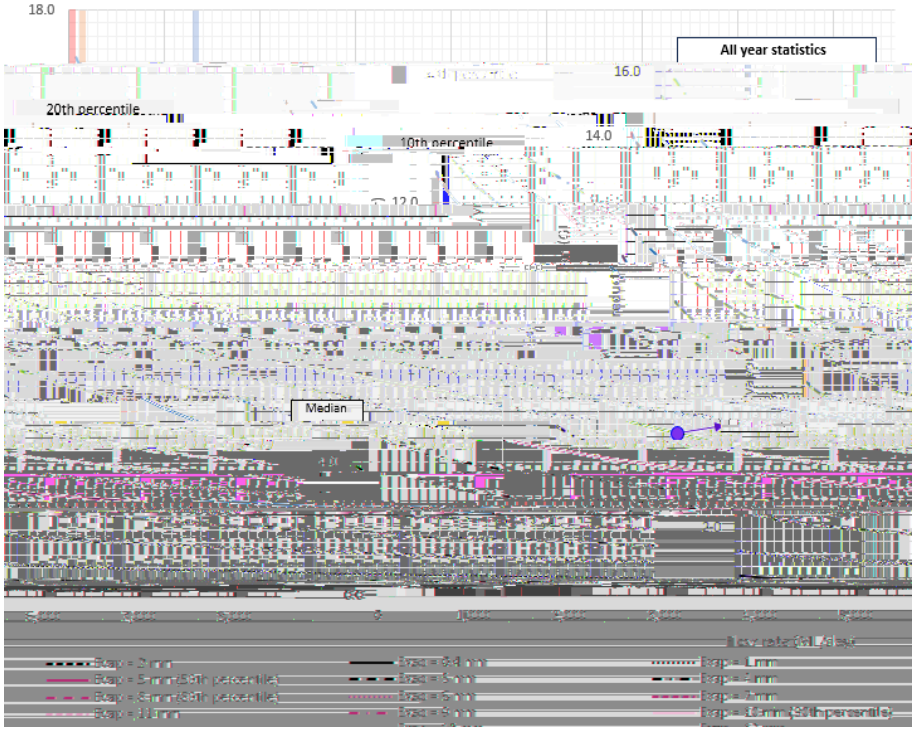
Scenario 002



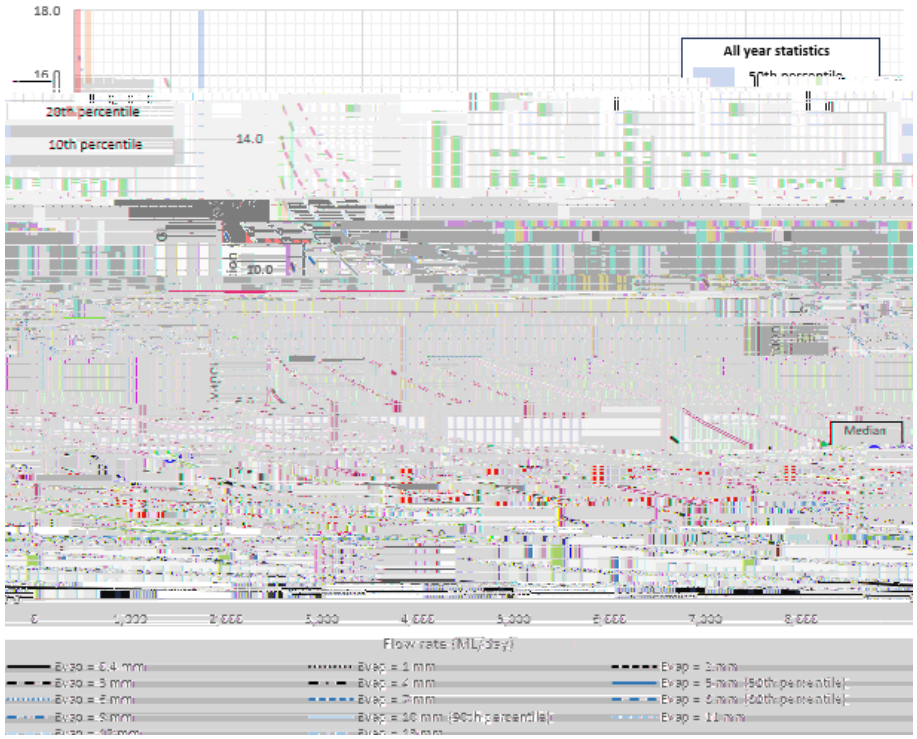
Scenario 003

Scenario 004

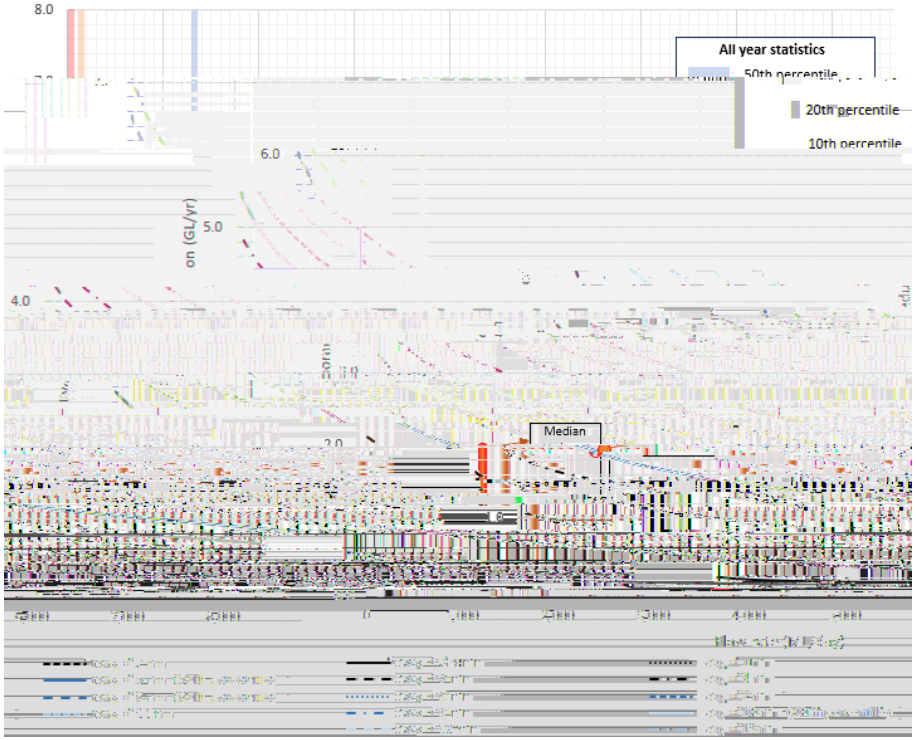
Pilot model comparing evaporation from a weir pool vs a natural flowing river



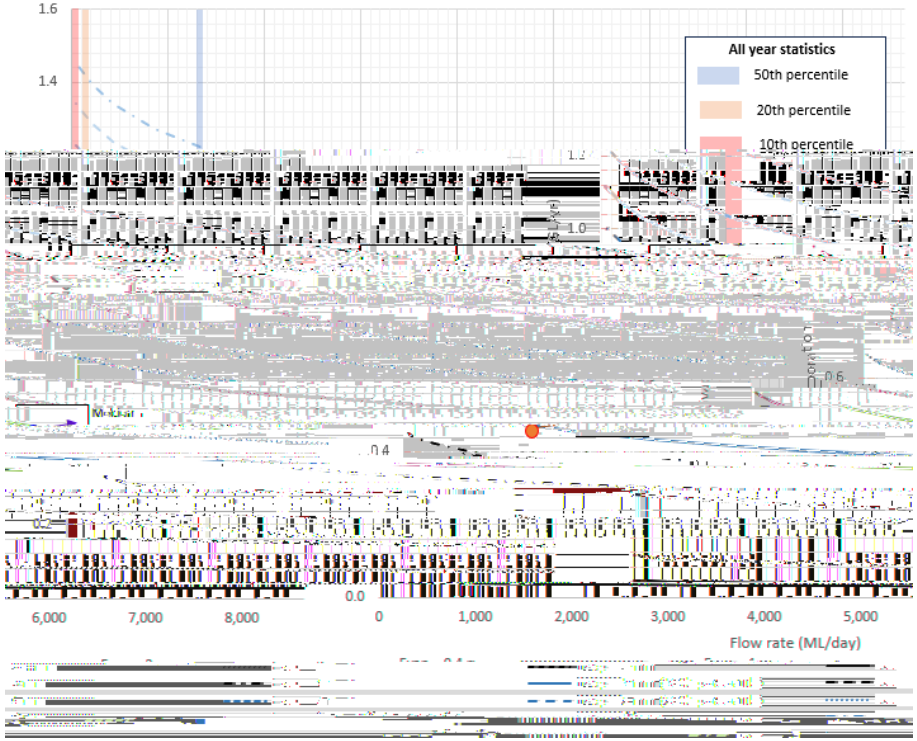
Scenario 003



Scenario 004



Scenario 005



Scenario 006

C2 Potential impacts of SW-GW interactions by removing the weir

The present study also evaluated potential impacts of weir removal on the SW-GW interactions.

C2.1 Long-term impacts

Considering a steady state surface water level (i.e. no temporal effects due to floods), the regional groundwater level will determine the SW-GW interaction. If the weir is removed, the interaction may change according to three possible scenarios. The three scenarios are illustrated in Figure C-1.

1. **Gaining ±gaining scenario:** If the steady state groundwater level is above the stream level, the stream would be **gaining** prior to the weir removal. Once the weir is removed, the **gaining** conditions would be maintained and the increasing hydraulic gradient towards the stream (with the lower surface water level) would lead to higher groundwater discharge.
2. **Losing ±gaining scenario:** If the steady state groundwater level is below the stream level, the stream would be **losing** prior to the weir removal. Once the weir is removed, if the surface water level falls below the regional groundwater level, the stream would become a **gaining** stream.
3. **Losing ±losing scenario:** If the steady state groundwater level is below the stream level, the stream would be **losing** prior to weir removal. Once the weir is removed, if the groundwater level is maintained below the surface water level, the stream would continue as a **losing** stream, but possibly losing surface water at a lower rate due to a smaller gradient.

Figure C-1 SW-GW interactions; a. gaining ±gaining condition; b. losing - gaining condition; losing ±losing condition

C2.2 Transient impacts

Immediately after the weir is removed, the surface water level will decrease rapidly resulting in a transient period of water balance adjustment between the SW-GW levels. This adjustment leads to:

- Increased surface water flow-rates and velocities in the section which used to be the weir pool (i.e. stagnant and slow flows). Such increased flow may lead to erosion of fine grained low-permeable sediments accumulated in the former weir pool section, resulting in an increase in the permeability and hence, an increase in the exchange rate between surface water and groundwater.
- Temporarily or permanently evapotranspiration changes from vegetation near the stream. Since the groundwater level near the stream would decrease, the riparian vegetation, which was able to access the groundwater prior to weir removal, may lose access to groundwater. This will lead to lesser evapotranspiration. The impact in evapotranspiration changes may be temporary (if the vegetation is able to extent their roots deeper over time) or permanent resulting in riparian vegetation decline (if the roots cannot reach the new groundwater level).

C2.3 Comparison surface water loss by groundwater and evaporation

The surface water loss for the losing stream condition could be substantial compared to the water lost by evaporation, depending on the streambed sediment hydraulic conductivity, and the hydraulic gradient. An assessment of the groundwater flow rate considering different water elevations (from 4 m (weir condition) to lower water levels) and sediment types is presented in Table C-1. The groundwater flow rate was estimated using Equation C1:

$$\}_{sf} \; L \; w \; H \; m_{sf} \; H \frac{¿t}{¿,} \qquad \textbf{(C1)}$$

where K is the hydraulic conductivity in m/s, A_{GW} is the cross-sectional area in m^2, 4H is the hydraulic head in m and 4 is the distance in direction of the flow in m (4H/ 4 is also know and the hydraulic gradient). The assessment assumed a perennial and connected stream with the same sediment type throughout the entire bed, no groundwater extractions along the water table, same river width along the different elevations equal to 100 m and the same hydraulic gradient for different water surface elevations equal to 0.005 (Figure C-2). It is important to note here that the hydraulic gradient (4H/ 4) will change with a change in the surface water level. It has been kept the same here to illustrate the effect of the changes in surface water level (contact area) and sediment type.