Evaluating Water Storage Requirements

for

Akaroa Treated Wastewater Irrigation System

Using Actual Flow Data from 2018-2023

27 September 2023

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Executive Summary

Christchurch City Council's resource consent application for the Akaroa Treated Wastewater Irrigation System proposes to store treated wastewater in tanks at times when its flow exceeds the amount that can be irrigated. A large volume of storage is necessary because the Akaroa network is subject to high levels of infiltration and inflow from storm water, ground water, and retentate from the water treatment plant, which together account for an estimated 60% of the total flows. As a result, wastewater flows spike during heavy or prolonged rain when irrigation is less or not possible, leading to rapid accumulation of stored wastewater, particularly in winter. The system does not include an overflow mechanism, meaning that the storage must be of sufficient size to cope with the wettest of times.

In 2017, the Council discovered that the meter measuring the amount of wastewater flowing through the Akaroa network was faulty, and had been so for many years. It therefore had no historical flow data on which to size the system, and had to rely on predictive modelling to estimate potential flows based on a very short series of actual flows, and then calculate the storage requirement from these estimates. Given high levels of infiltration and the lack of historic flow data to compare with rainfall records this is a complex task with high levels of uncertainty.

The work to estimate the wastewater flows and then calculate the storage requirement was done by consultants Beca and PDP during 2020 and early 2021. Using data from the new meter installed in mid-2017 and rainfall records, they created a model to separate out the percentage of wastewater flows attributable to the actual population, and the amounts attributable to the different forms of infiltration. They then used this modelling to estimate the daily amount of wastewater there was likely to have been over a 47 year period from 1972 to 2018, based on the daily rainfall records. Having predicted the wastewater flows, they then calculated the storage required by subtracting the daily amount that could be irrigated from the wastewater flows. From this they identified 1978 as the year with the highest storage requirement and, taking into account the Council's intention to reduce infiltration and inflow by 20% and the drinking water retentate by 75%, determined that 12,000m^3 of storage would suffice across this entire 47 year sequence.

On this basis, the Council's consent application indicates that it plans to construct 12,000m^3 of storage tanks in Robinsons Bay initially, plus a wetland capable of holding a further 2,100m^3 at Old Coach Road as extra emergency wetland storage. The Council has taken what appears to be a conservative approach by applying for a maximum of 20,000m^3 of tank storage, and would expand the system with additional tanks up to this level should it prove necessary.

Now, with 2½ more years of actual flow and rainfall data, from 2020 to mid-2023, it has been possible to compare the wastewater flows predicted by the consultants' model with the actual flows, and to examine whether the storage proposed in the application would have been sufficient. This work has been carried out by Dr. Brent Martin, a data scientist involved with the wastewater project since 2016 as a member of the Community Working Party.

The exercise has revealed that the actual wastewater flows are higher than the predicted flows particularly during wet winters, and that the storage requirements are therefore also much higher. The chart below shows the difference between the storage based on the Beca/PDP estimated flow data and storage based on the actual flows for the 5½ years for which actual flow data is available. This shows that while the consultants' model is reasonably accurate for dry years, it has substantially underestimated the storage requirement in wet years.

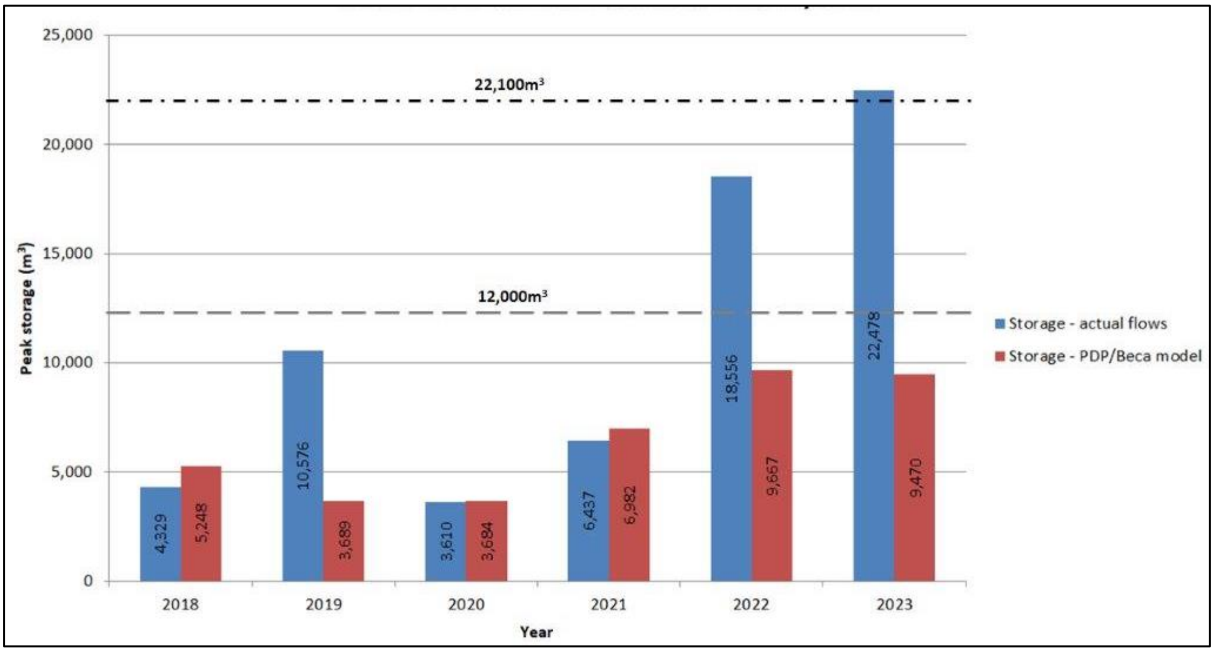

Figure 1 Storage requirement based on actual flows versus modelled flows[1]

A re-evaluation of the long series back to 1972, based on winter rainfall alone and without any provision for population growth but including the proposed I&I and retentate reductions, suggests that the peak storage required would likely be in excess of 25,000m^3.

Additional analysis testing the sensitivity of the model to other key parameters including the irrigation field size, the I&I reductions and irrigation management during very wet weather sheds further light on the risk of substantive under-sizing of the storage.

[1] The actual flows have been adjusted down for the anticipated 20% reduction in the I&I and 75% reduction in retentate which the Council has stated its intention to achieve

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1 Introduction

The Council's Akaroa Treated Wastewater Irrigation System (ATWIS) Consent Application provides for up to 20,000m^3 of storage to hold treated wastewater in tanks when inflows exceed the amount that can be irrigated. The Council plans to construct 12,000m^3 of tank storage initially. A further 2,100m^3 is to be available at a wetland at Old Coach Road for emergency situations if the tanks are full.

This large amount of storage is needed because in addition to the wastewater generated by human activities – referred to as the population flows – the Akaroa wastewater network is susceptible to storm and ground water inflow and infiltration (I&I) and is also used to dispose of the retentate generated from the Akaroa water treatment plant. Together I&I and retentate are estimated to account for 60% of the wastewater flows, causing large spikes during times of heavy rain. If these spikes occur in winter when the irrigation rate is lower, or rain is over a 50mm per day threshold when no irrigation is permitted to take place, then wastewater rapidly accumulates in the storage.

The challenge of calculating the peak storage requirement of the ATWIS system is compounded by the lack of historical wastewater flow records, as there are no records prior to mid-2017 when a working flow meter was installed. The storage requirements set out in the Application have therefore been modelled based on historical rainfall records, but without a comprehensive record of wastewater flows to compare them to. A further 2½ years have now passed since this modelling was done, so there is the opportunity to test how well the modelled flows match to the actual flows under a wider range of conditions, and therefore assess whether the storage volumes have been correctly sized.

This document sets out:

- The method used by Beca and PDP to create the model that estimated the historical wastewater flows based on the limited available real data, and from this calculate the storage requirement
- The method used by Dr Brent Martin to calculate the storage requirement using the same formula, but based on the 5½ years of actual flow data now available (from 1 Jan 2018-July 31, 2023) rather than modelled estimates, and his finding that the Beca/PDP model has underestimated the storage requirement
- An analysis of the differences, and explanation of why the Beca/PDP model appears to have underestimated the flows and storage requirement
- The sensitivity of the storage requirement to changes in other critical parameters where there is currently a lack of consistency or certainty in the application, including the irrigation field size, I&I reduction, and irrigation management during very wet weather.

The document concludes with a brief consideration of the consequences of inadequate storage capacity.

2 Method used predict storage based on estimated wastewater flows

Given the lack of historic wastewater flow data and the very high levels of infiltration, the steps taken first by Beca and then by PDP to calculate the storage requirement were as follows:

1. Beca generated indicative daily wastewater flows for past years from 2008 to February 2020 based on the limited actual flow data available when the work was done (approx. 3 years), and historical rainfall records from Akaroa. The Beca model broke down the indicative wastewater flows into the following constituents: Baseflow composed of the water treatment plant retentate flow and ground water derived inflow and infiltration (GWII); rainfall derived inflow and infiltration (RDII); population flow

2. PDP then extrapolated these daily indicative wastewater flows over a long series from January 1972 to 30 April 2021. They used Beca's assumption that Baseflow was a constant, an estimate of the future Akaroa population, seasonally adjusted to be higher in summer and lower in winter, and the rainfall records. Their modelling assumed that every millimetre of rainfall in Akaroa would generate 22.5 cubic metres of RDII. They had calculated this constant of 22.5 based on a comparison of the rainfall to Beca's short term model.
3. They then adjusted these daily flows downward for the anticipated 20% reduction in the I&I and 75% reduction in retentate which the Council has stated its intention to achieve
4. A separate exercise calculated the volume of water that could be irrigated each day, based on a field size of 40ha[2], the maximum permitted seasonal irrigation rate (higher in summer, lower in winter) and excluding days when historical rainfall records indicated that irrigation could not take place because rainfall exceeded the threshold of 50mm in a day, whereupon watering would cease until the next dry day.
5. From these two exercises - the estimated daily wastewater flow and the daily amount that could be irrigated - they calculated the daily amount that would be added to, or emptied from, the storage
6. They then extracted the peak storage requirement for each year from the long series, and used the year with the highest value (1978) to determine the figure of 12,000m^3 as sufficient to accommodate the 47 years of historic weather patterns they had examined.

3 Method used by author to calculate storage based on actual wastewater flows

In order to calculate the storage requirement based on the actual rather than modelled flows, the author assembled the relevant reports and data, built and tested the consultants model to replicate their results and then substituted the actual flow for modelled flow data in the storage calculation.

3.1 Assembling data and reports

All the relevant reports produced by the Council's consultants setting out the methodology they had used to estimate the wastewater flows and calculate the storage were acquired and referenced. These included:

- Consent application which defined the irrigation field size and that the irrigation methodology used would be Scenario 5 in the PDP letter
- Appendix U of the consent application – letter from PDP – providing the population flow, the GWII flow on a monthly basis and the assumed relationship of RDII to rainfall that underpin the storage modelling.

Data acquired included:

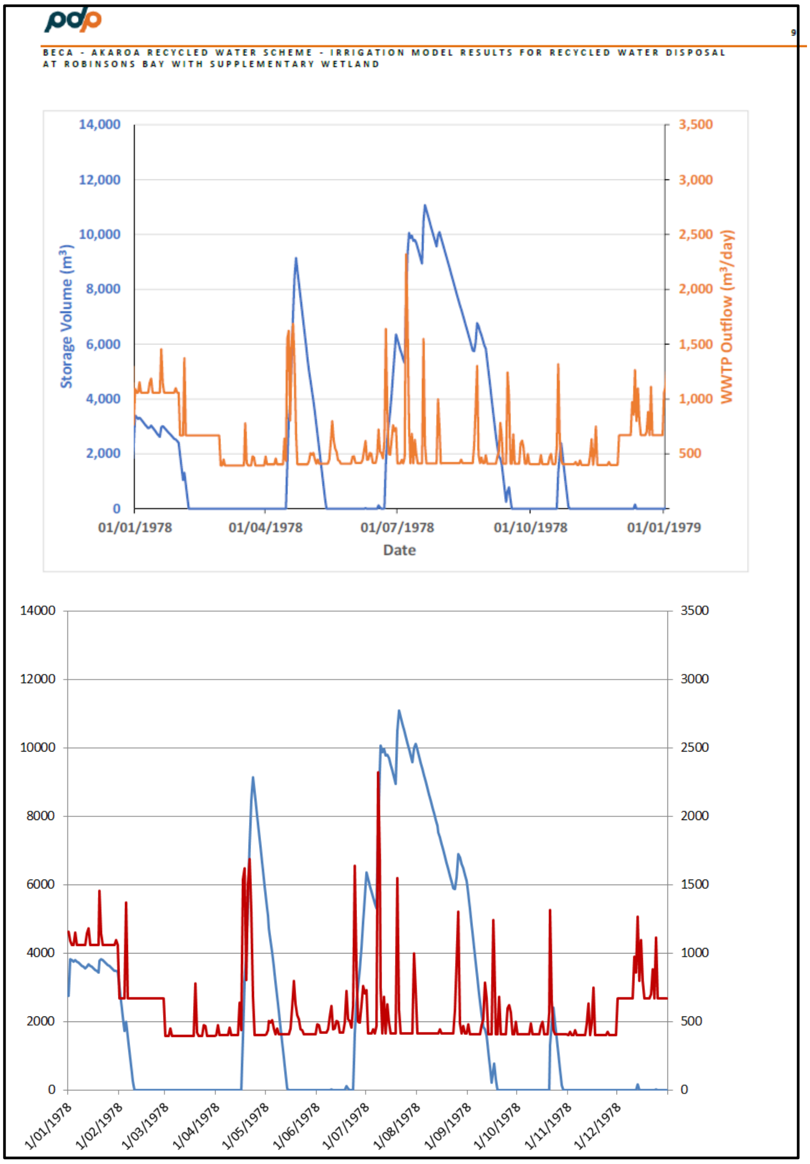
- The actual wastewater flows from 2018 to 2023 (earlier years published on the Council website and later obtained from Kylie Hills)
- Rainfall data from NIWA's CliFlo system for the period 2018-2023
- PDP model output spreadsheet 13/02/2019 – the VCSN rainfall, modelled flows and storage from 1972 to 2018 – used for the VCSN data only
- Beca Akaroa Long Time Series consolidated 2009-2020 (10 year)[3] – Network Drainage Model

[2] Appendix U, Akaroa Treated Wastewater Irrigation Scheme – Application for Resource Consents and Assessment of Environmental Effects, prepared for Christchurch City Council by Stantec May 2023
[3] The series is actually from the end of December 2008 to the end of February 2020, i.e. just over 11 years.

3.2 Building and testing the consultants model

The methodology used by PDP as described in the previous section, was applied to generate the daily indicative wastewater flows for the same long series from January 1972 to 30 April 2021, and to adjust them for the I&I reductions. The daily storage requirement was then calculated by applying the PDP irrigation model.

The daily sequence of flow and storage for the peak year (1978) published by PDP in Appendix U of the consent application[4] was compared with the daily sequence generated from the author's recreated model. This confirmed that the recreated model was working correctly, as it generated the same output for both the flows and storage.



Modelled wastewater flows and storage requirements presented by PDP Appendix U, Figure 6 model.

Modelled wastewater flows and storage requirements generated by the author's recreated version of the PDP model.

Figure 1 Comparison of modelled wastewater flows and storage requirements for 1978

These graphs both show the wastewater flows for 1978 as estimated by model (the orange line in the PDP graph and red line in the recreated graph) and the calculation of the daily storage requirement (blue line on both). As can be seen, both graphs are identical, showing that the PDP model has been successfully recreated and generates matching results.

[4] Figure 6, P9, Appendix U, ATWIS consent application

3.3 Calculating actual storage from 2018-2023

Having confirmed that the recreated model was correctly configured, it was then used to calculate the storage requirement using ***actual*** wastewaster daily flow data from 1 January 2018 to 31 July 2023. The steps were:

1. Use the parameters in the PDP report to adjust the actual flows for the anticipated 20% reduction in the I&I and 75% reduction in retentate which the Council has stated its intention to achieve.
2. Work out how much could be irrigated each day, based on the field size of 35.7ha[5], and the same seasonal irrigation rates and 50mm rainfall exclusion rule as the PDP model.
3. From this the daily amount that would be added to or emptied from the storage was calculated.
4. The peak storage requirement for each year was then extracted from the daily series to determine the amount of storage required to accommodate the actual flows in that year.

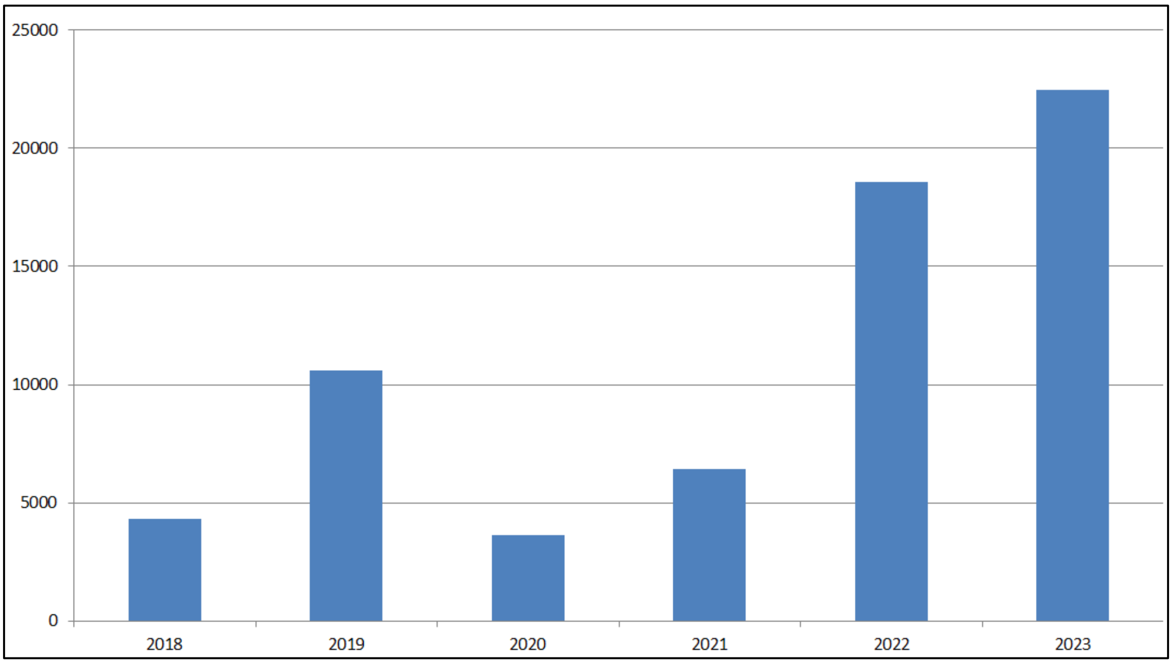


Figure 2 Peak storage requirement 2018 - 2023 based on actual flows

The chart shows that in the years 2018-2021 the 12,000m^3 storage provided would have been sufficient at all times through the year, but in 2022 and 2023[6] it would not.

3.4 Comparison of storage based on modelled and actual flows

The same method used by PDP to generate daily flows for the long series from January 1972 to 30 April 2021, was used to generate modelled flows from 1 January 2018 to 31 July 2023. From this the storage requirements were calculated based on these modelled flows. The storage requirements based on the modelled flows were then compared to the storage requirements based on the actual flows. Note that in both series, the flows were adjusted downward for the proposed I&I and

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[5] The PDP work was based on a 40ha irrigation field, however, the size of the irrigation field in the application is reduced to 35.7ha as it no longer includes land in Takamatua land, so we have used the 35.7ha size

[6] Note that during the latter part of this period, the Council was conducting work to reduce I&I. The work was completed by January 2023, but whether it has been successful is yet to be determined. Hence the I&I component has been adjusted down by 20% and retentate removed across all the years to give the benefit of the doubt. If the I&I has been successfully reduced and 20% reduction is inappropriate (because it double-counts the reductions), then the storage requirement for the years 2022 and 2023 would have been higher. See section 6.2 below for a further analysis of this issue.

retentate reductions.

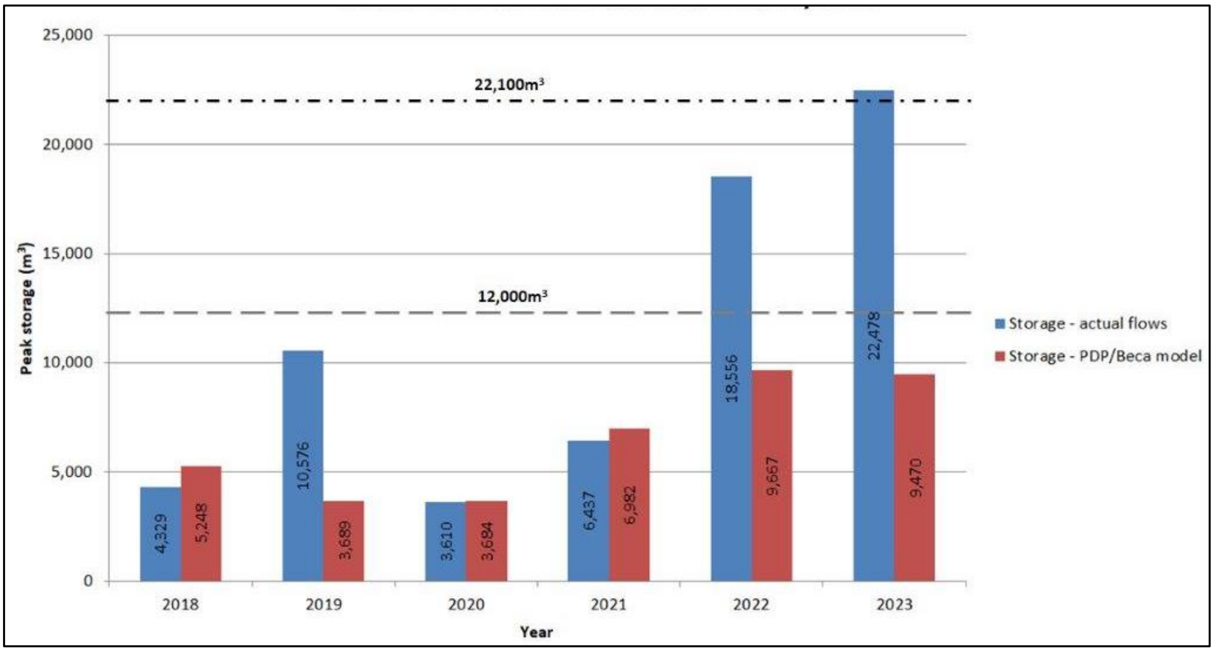

Figure 3 Storage based on actual flows versus modelled flows (includes I&I and retentate reductions)

The comparison shows that the model is fairly accurate in 2018, 2020 and 2021 but has significantly underestimated the storage required in 2019, 2022 and 2023 when compared to that required by the actual flows.

4 Analysis of the differences and why they have occurred

Having found substantive differences between the storage calculated from estimated and actual flows, the daily patterns of inflow and irrigation were examined in more detail to better understand what could be causing this discrepancy.

First the wastewater flow modelling was looked at in more detail, including the critical winter period when less irrigation is possible, and then how the differences in the flows predicted versus the actual flows impact on the storage requirement.

4.1 Assessing the consultants wastewater flow estimation modelling

Figure 4 below compares the modelled flows and actual flows for the year 2022- a year when as shown above, the Beca/PDP model substantially underestimates the storage requirement.

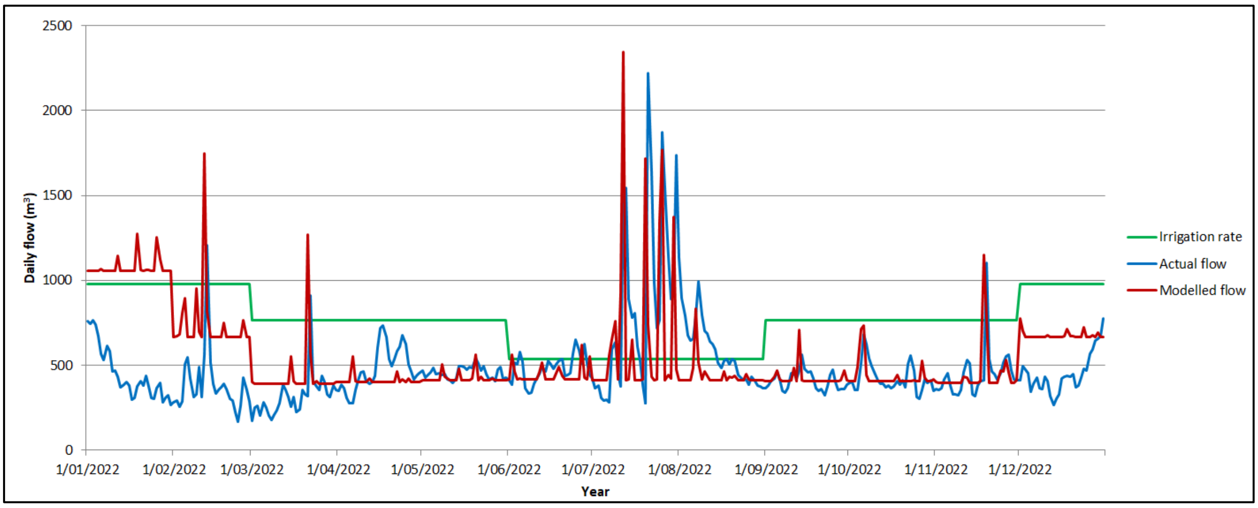

Figure 4 Modelled versus actual Flow for 2022

- The green line shows the maximum permitted irrigation volume per day across the entire field under the PDP irrigation model. There are three seasonal rates[7]. In summer up to 981m^3 per day can be irrigated, in spring and autumn 767m^3 and in winter 535m^3. If the wastewater flow volume is above the green line, then excess water is directed to the storage; if it is below, some of the stored water can be irrigated out.
- The red line shows the estimated wastewater flows generated by the re-created PDP model with the reductions of 20% of the I&I and 75% of the retentate removed.
- The blue line shows the actual wastewater flow from the meter, adjusted down in the same manner with 20% of the I&I and 75% of the retentate removed

The big spikes in the both the red estimated and blue actual lines are the rain events when I&I drastically increases the wastewater flow.

Some other matters to notice on these graphs are:

4.1.1 Flat-lining on Modelled flow

The red Modelled line bottoms out as a flat line reflecting three different levels because the population component of the wastewater flows is estimated in the model using the assumed flows from different future populations for January (894m^3), December and February (506 m^3) and March-November (236 m^3). The blue Actual flow line shows the real fluctuations caused by population changes, with weekend and holiday patterns (such as Easter and Anzac in April) apparent.

4.1.2 Summer difference

Another obvious difference between Modelled flow and the Actual flow is that the Modelled flow shows much higher rates in summer than the Actual flow. This is again attributable to the population flow component, and shows that the population constant provided in the Model for summer (both January and December/February) is higher than was actually present in 2022. However, this does not impact the peak storage requirement – although it is over the green line, 12,000m^3 of storage would accommodate the surplus.

In winter the blue and red lines are bottoming out fairly close together.

4.1.3 Winter difference

The following graph expands the winter portion of Figure 2 above. The differences here are less obvious, but more significant in terms of the impact on the storage – as much more of the flow is above the green irrigation line.

[7] Rates used are based on 35.7ha irrigation field size

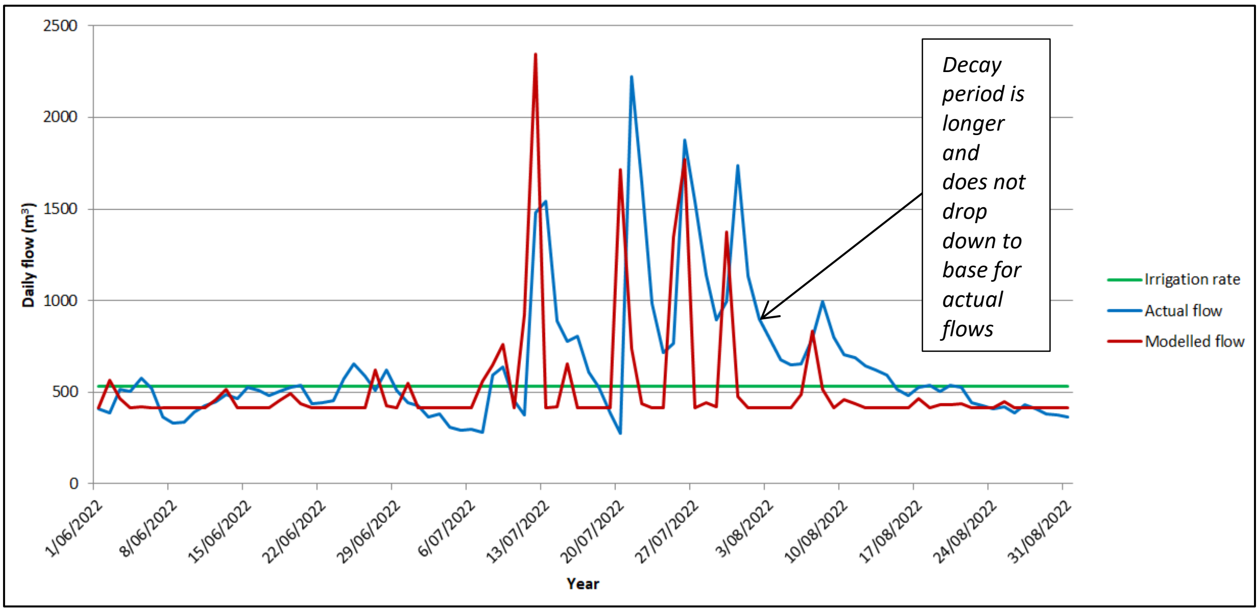

Figure 5 Modelled versus Actual Flow Winter 2022

While the rainfall peaks vary in their height, much more significant in terms of the total flow and storage requirement is the decay in these peaks. The red Modelled flow peaks reduce rapidly back to the pre-rainfall level. However, the blue Actual flow shows that RDII (the rainfall infiltration) takes more time to decay than modelled, meaning that the actual amount of water in the system is a significantly greater volume than forecast. It also shows that when several rain events are close together, the amount of RDII increases further as the decay period takes longer. Both of these taken together indicated that the model substantially underestimates the total volume of RDII generated by rainfall events.

It can be inferred from this that the model approach of multiplying every mm of rainfall by the constant of 22.5 cubic metres does not capture the entire RDII response to a rain event - because it does not include the long tail of RDII (the decay period) occurring ***after the actual rain event has ceased***. This is most pronounced during wet winters when RDII remains high for longer, as shown by the increasingly long decay period after each subsequent rain even in the graph above. Hence the modelled flow underestimated the RDII.

4.2 Impact on storage

Figure 5 shows how the difference in daily flows and the underestimate of RDII impacts the storage requirement. The graph for 2022 compares the storage based on modelled flows with that based on actual flows – again both adjusted for I&I and retentate reduction.

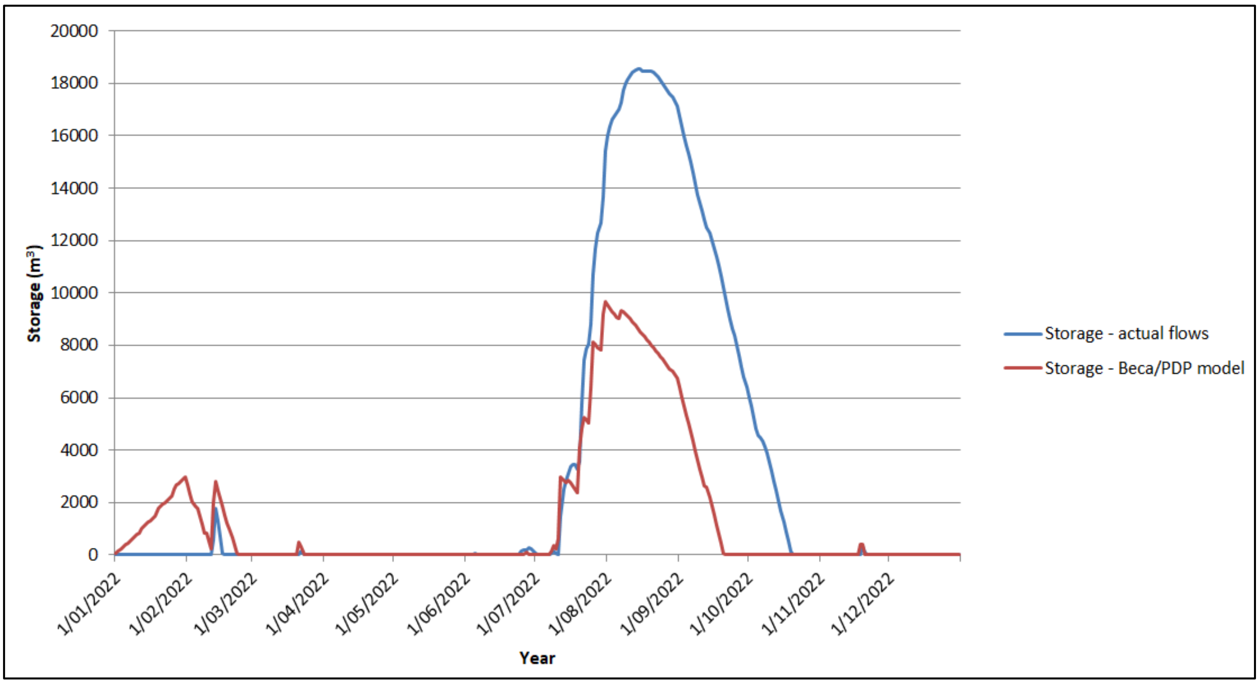

Figure 6 Comparison of storage based on actual and modelled flows

The graph shows the cumulative effect on storage of the greater volume of additional water in the actual flows than the modelled flows. The amount continuously flowing in because of the ongoing greater amount of RDII is much higher than can be irrigated during the ongoing wet period and this rapidly results in a much greater actual storage requirement than has been modelled. This is also evidenced by the patterns - the red line is jagged showing how the modelled storage begins falling immediately after a rainfall event and then climbing again with the next, whereas as the blue line shows, ***in reality the storage continues to rise because of the tail of RDII after the rainfall event itself is over***.

4.3 Relationship between storage and winter rainfall

Further examination of the 5½ years of actual flow data (2018-2023), indicated that the annual peak storage requirement is a close match to the total rainfall over the winter months of June, July and August. This is understandable, as during winter, the irrigation allowed is at its lowest per day, 535m^3, so the storage is more likely to be needed.

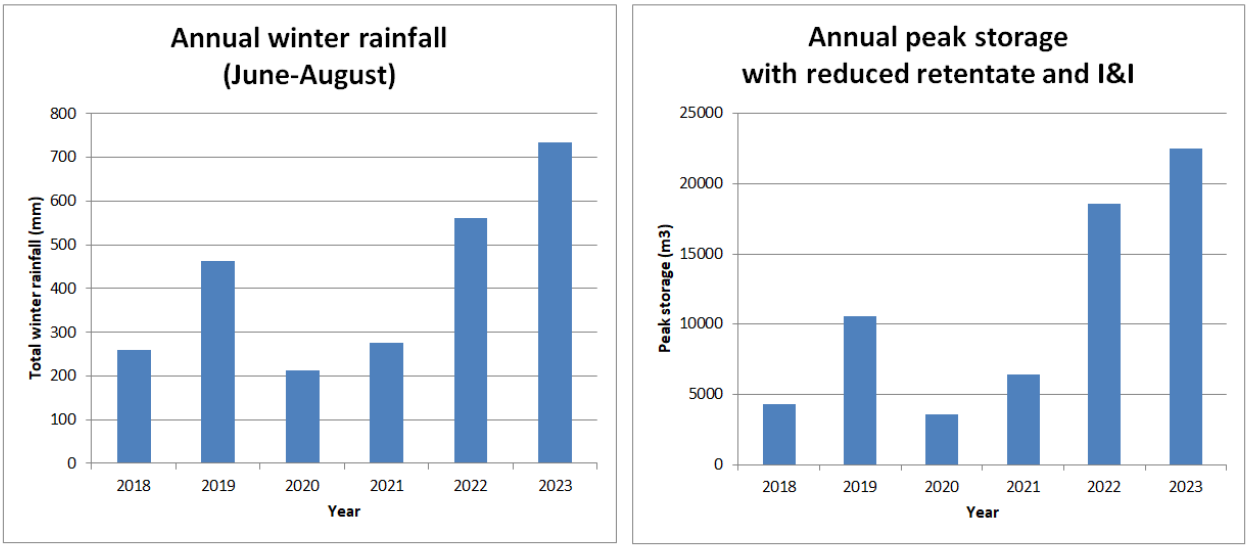

Figure 7 Visual relationship between winter rainfall and peak storage 2018-2023 based on actual data

Given the apparent correspondence between winter rainfall and the storage requirement shown in the totals for each year, a linear regression between storage and rainfall was performed. As shown in Figure 8 this confirmed a strong relationship (R^2= 0.93), and a predictive formula of storage being 39.738 times the winter rainfall less 5362.[8]

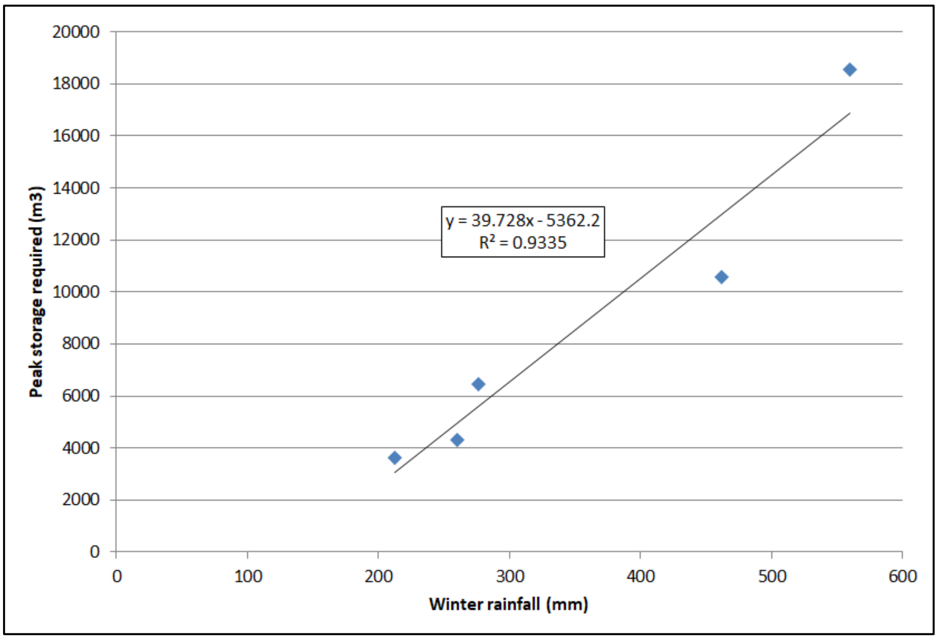

Figure 8 Peak storage linear relationship to winter rainfall

5 Recalculating the long series using winter rainfall only

On the basis of the strong correlation between storage and winter rainfall for the 5 full years of actual data, the storage requirements for the long series was estimated based on total winter rainfall[9]. The method used was to take the total rainfall for the months of June, July and August each year and apply the linear model above (Storage = Winter rainfall * 39.722 – 5362.2). Figure 9 below shows the result for each year, colour coded with red bars indicating storage requirement greater than 20,000m^3, yellow bars greater than 12,000m^3 and green bars below 12,000m^3.

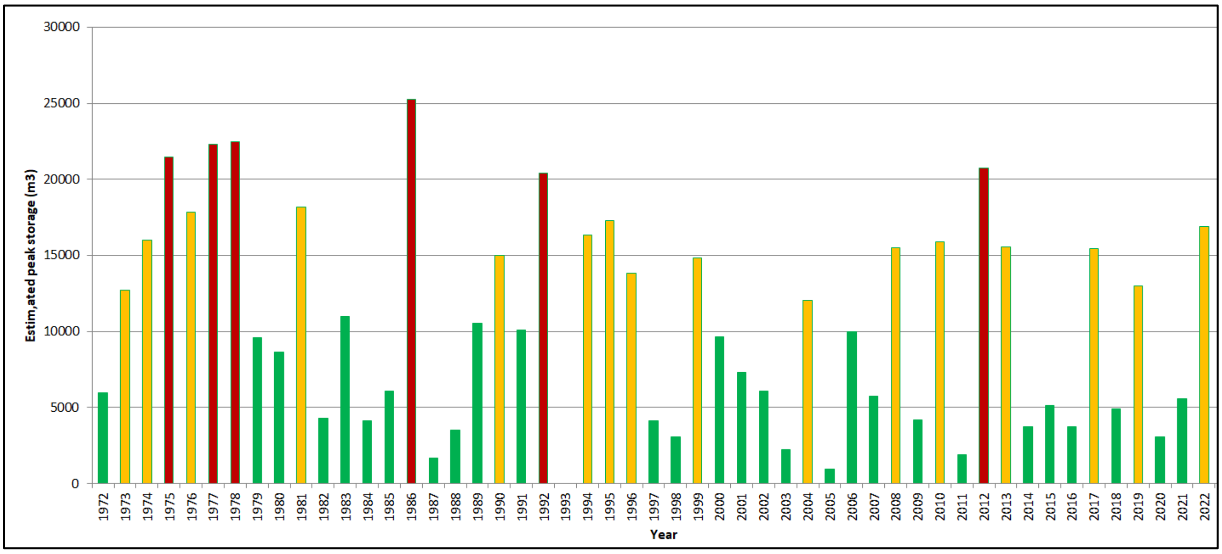

Figure 9 Peak storage requirements based on winter rainfall 1972-2022[10]

[8] Year 2023 was not included in the regression analysis as no figures for August were available
[9] Does not include any factor for population increase (10% in winter in the Beca/PDP model), so is based on the existing population level, meaning the projected storage for 2053 would be higher.
[10] No storage was required in 1993 – an exceptionally dry winter

This graph shows that when winter rain alone is used to predict storage, then in 22 of the 51 years more than 12,000m^3 would have been needed, and in 6 years, more than 20,000 m^3. In the years 1977, 1978 and 1986 the wastewater flow would have exceeded the total storage applied for including the Old Coach Road overflow and, as we have seen already, so would 2023.

1986 has the highest storage requirement, rather than 1978 as identified by PDP, because it has the highest winter rainfall.

Using winter rainfall as the predictor indicates that the long-series storage requirement in the ATWIS application is very likely to have been substantially under-estimated, and that a peak storage requirement in excess of 25,000m^3 is indicated, not 12,000m^3 as in the application.

6 Examining Storage sensitivity

Having examined the peak storage requirements using the actual flows for 2018-2023, and a revised long series, some further analysis has been undertaken to assess how sensitive the peak storage requirement is to changes in design components and management methodology, selecting those that are unclear or uncertain in the consent application and could present additional risks from undersized storage capacity.

These included the field size, I&I and retentate reduction and irrigation levels during wet periods.

6.1 Field size

The irrigation field size used by PDP to develop their storage model and define the peak storage requirement was 40ha. The field size in the consent application is 35.7ha, but the peak storage volume has not been remodelled to take account of this smaller irrigation area.

Figure 10 below shows the difference in storage requirement between the two field sizes, based on the actual flow data from the past 5½years. As previously, the flow data has been adjusted to take account of the planned I&I and retentate reductions. The storage size bars in blue are therefore the same as in Figure 2 above, which used the 35.7ha field size. The red bars result from the same storage calculation using the 40ha field size.

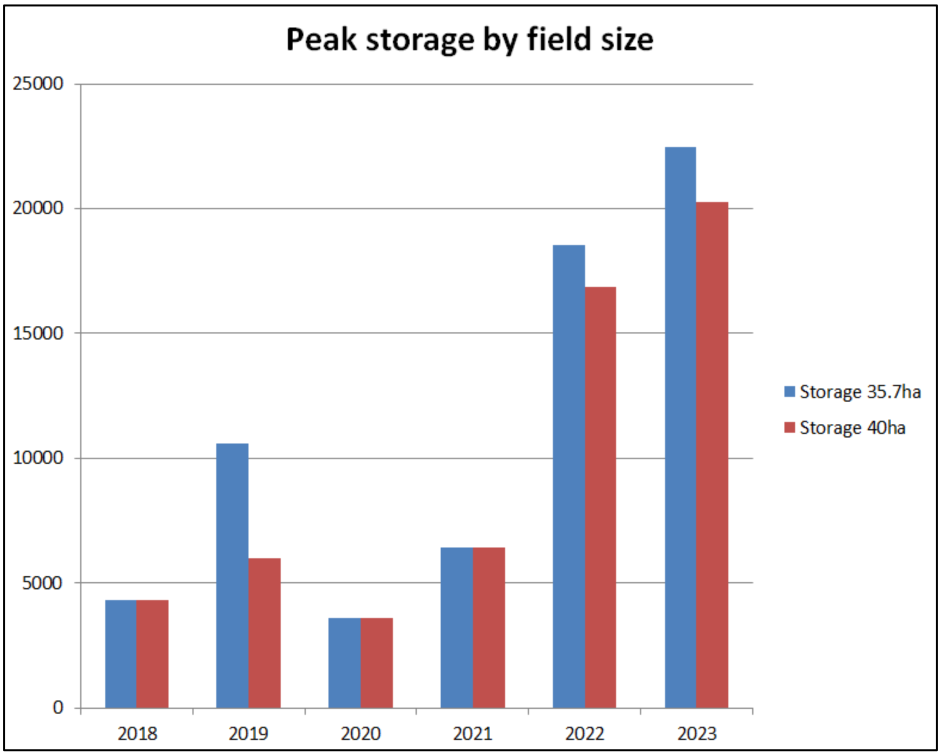

Figure 10 Peak storage with field size of 35.7ha and 40ha based on actual flows

The chart shows that the impact of reducing the field by 4.3ha is only significant in relatively wet years. In years with dry winters where the storage requirement is low, such as 2018, 2020 and 2021, the 35.7ha field irrigation capacity is not reached, so there is no difference in the storage needed. In years with wet winters, when the entire field is needed, the difference is more substantial.

Note that in 2023, even with 40ha, the storage requirement was still more than the 20,000m^3, and the emergency wetland storage at Old Coach Road would have been required. The reduction of the field size to 35.7ha means that even after filling the emergency 2,100m^3 wetland at Old Coach Road, there would have been an overflow.

Field size makes the biggest difference in 2019, which had a much wetter winter than the adjacent dry years. In the 2019 rainfall pattern, there were relatively few rain events over 50mm that would trigger the ceasing of irrigation. Since it would have been possible to irrigate on most days, a larger field paid off by enabling more water to be disposed of. Conversely, in 2022 and 2023 there is less difference because there were a substantial number of days when the rainfall threshold was exceeded, so regardless of the field size, no irrigation could have taken place and the water would have to go into storage. This illustrates that increasing field size alone is not a substitute for sufficient storage.

6.2 What happens if the I&I reductions are not achieved

The storage volume of 12,000m^3 set out in the application is predicated on achieving the 20% I&I reduction and the 75% reduction in retentate from the water treatment plant. Hence all charts and storage volumes presented so far have reduced actual or modelled figures by these amounts, on the assumption that the Council will be able to achieve these reductions before the system is operative.

The planned I&I work was completed in January 2023, and in section 4.3.1 of the Application, the Council claims to have achieved some level of success. However, wastewater flows for 2023 are the highest of the five years for which actual flow data is available, suggesting that I&I still comprises the majority of the wastewater flow.

The Council has not yet indicated how it intends to achieve the 75% reduction in retentate from the water treatment plant.

Therefore there is uncertainty at this stage as to whether the Council will be able to achieve the reductions in I&I and retentate as set out in the application.

Figure 11 below shows how the storage requirement increases if the reductions are not achieved. The blue bars are the same as Figure 2 above, with the actual flow figures reduced to remove 20% of I&I and 75% of retentate. The brown bars show the storage required if there is no further I&I reduction but the 75% retentate reduction is achieved. The red bars show the storage required if no reductions are achieved.

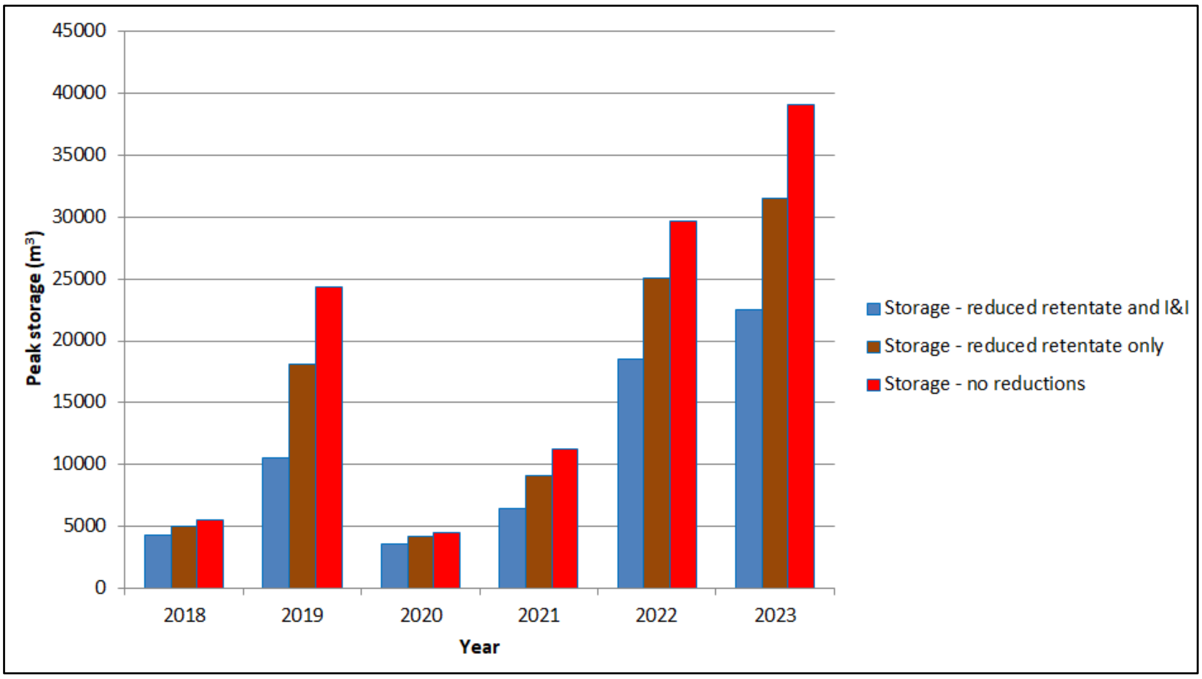

Figure 11 Peak storage requirements for actual flows with reduction scenario comparison

What this exercise demonstrates is how critical the I&I and retentate reductions are to the peak storage requirements. Without these reductions, the storage volumes in wet years are much higher and by the end of July 2023 (the wettest winter in the 5½ years of actual flow data), 39,098m^3 of storage would have been required.

6.3 Discrepancies between Storage model and irrigation management

The storage size has been calculated by PDP on the basis that irrigation will take place every day up to the seasonal threshold permitted, even if PAW (profile available water) is at field capacity. Irrigation will only cease if there has been more than 50mm of rainfall in a single day, and it will then cease until the next dry day.

However, the Application states in section 3.2.2 that irrigation will not take place *"Where rainfall exceeds 50 mm / day **and / or soil moisture conditions are unfavourable**"*, suggesting that the number of days when irrigation is not feasible may be greater than was assumed during the modelling.

This is repeated in the Aqualinc report which states: *it is our view that runoff resulting from irrigation applications can be minimised or perhaps prevented through appropriate irrigation management – not irrigating during wet periods, small application volumes at one time and pulsing of applications if necessary. As part of the operational strategy, we recommend that the operation is monitored visually in the field and the application volumes adjusted to prevent runoff*[11]

The current year, 2023, provides an example of when this type of management is likely to be necessary. Rainfall during the winter of 2023 was heavy and frequent, with relatively few dry days. During most of July and early August, the irrigation site in Robinsons Bay was saturated with ponding and runoff evident, even after several dry days.

Figure 2 earlier showed that the storage required by the end of July 2023 exceeded 20,000m^3, even with irrigation taking place on wet days and only ceasing on days with rainfall over 50mm. As the visual monitoring would have revealed sodden ground and ponding, it is likely that irrigation would in practice need to be adjusted to prevent runoff. This would in turn have increased the storage requirement. We have not attempted to estimate the impacts as they would be different every year,

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[11] Appendix A, Akaroa Treated Wastewater Irrigation Scheme – Application for Resource Consents and Assessment of Environmental Effects, prepared for Christchurch City Council by Stantec May 2023, p28

depending on rainfall patterns.

7 Lack of provision for storage overflow

The system put forward in the application is a closed system. All treated wastewater is to be released via irrigation to the 35.7ha field. While there is an additional 2,100m^3 of emergency storage provided at the wetland at Old Coach Road, **there is no apparent provision for a controlled overflow**. The application does not specify what will happen if there is more wastewater than can be stored at Robinsons Bay and the Old Coach Road emergency wetland.

This is a change from the Inner Bays Irrigation scheme proposal which the Council hearing panel adopted in 2020. Under that proposal, an overflow was anticipated on rare occasions, and this was provided for through the wetland at Old Coach Road, which it was envisaged could overflow via a channel to the stream at Children’s Bay.