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Review of Consent Application Decision Making for Abstractions Affecting Mataura River Flows Upstream of Gore

Environment Southland

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Review of Consent Application Decision Making for Abstractions Affecting Mataura River Flows Upstream of Gore

Prepared for

Environment Southland

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PATTLE DELAMORE PARTNERS LTD
Level 2, 134 Oxford Terrace
Christchurch Central, Christchurch 8011
PO Box 389, Christchurch 8140, New Zealand

Tel +64 3 **345 7100** Fax +64 3 **345 7101**
Website **http://www.pdp.co.nz**
Auckland Tauranga Wellington **Christchurch**

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Prepared by

SIGNATURE 

Peter Callander

Reviewed by

SIGNATURE 

Hilary Lough

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Executive Summary

Concerns have been raised that historical decisions on consent applications involving groundwater abstractions affecting flow in the Mataura River have caused an exceedance of the allocation limits specified in the Mataura River Water Conservation Order (1997) (MCO). As a result, Environment Southland (ES) have commissioned this preliminary review of the decision-making processes on water permits that impact the allocation limits specified in the MCO. The scope of this report is to provide an understanding of how over-allocation has occurred, including the systems and record keeping for the allocated volumes of water, and to make recommendations as to how over-allocation can be avoided in the future.

Key findings from this review are.

- Based on the information provided to the 1990 Planning Tribunal hearing that established the MCO, there was no consideration given to the effects of groundwater pumping on the flow in the Mataura River and no anticipation of the significant growth that has occurred in groundwater abstractions from 2000 onwards.
- Due to that lack of detail in the MCO about these issues, ES have had to develop assessment criteria to deal with groundwater/ surface water interactions and how they should be incorporated into the MCO allocation.
- The calculation of groundwater pumping effects on surface water flows is not a precise science. It relies on estimates and assumptions about aquifer parameters, streambed conductivity and the duration and rate of pumping from a bore. There are also a variety of ways by which it can be calculated. This has contributed to variability in the calculated allocation from the Mataura River. ES have set up processes to determine the effect of groundwater pumping on stream flow which were documented in a 2004 proposed plan change to the Regional Water Plan and are currently updated, in a slightly modified version, in the proposed Southland Water and Land Plan.
- ES have established a sequence of allocation bands with differing low flow restrictions to provide a consistent framework for granting consents. The allocations within each band are cumulative, so if one band becomes over-allocated, it takes up some of the available allocation within higher flow bands. As a result, when looked at on a band-by-band basis some higher flow bands appear to be under-allocated, although this is done to avoid a worsening of the total allocation situation. This can allow the total combined abstraction number to comply with the MCO allocation limit, although an over-allocation situation still exists for some of the lower flow allocation bands.

- Based on historical consent information provided by ES there have been no obvious decisions on consent applications causing over-allocation based on the information that decision makers had at the time of making their decisions. However subsequent reviews of consented allocations indicate that that some of the allocation bands are over-allocated. This realisation appears to have come about due to differing judgements on calculation of stream depletion effects and how consented effects should be incorporated into the MCO allocation bands than had been assumed at the time of the original consent decisions. Such differing interpretations are a result of the variability that exists in calculating the effects of groundwater pumping on stream flow and in the application of the MCO allocation criteria which did not recognise these situations at the time it was established. The concern about potential over-allocation was raised in a Council workshop in 2009 and also appears to have been recognised by the commencement of new allocation bands for consents granted from 2007, 2011 and 2018 onwards.
- These over-allocation situations appear to have been recognised when periodic reviews of overall consent totals have been made and is also indicated when consent decisions utilised higher new low flow allocation bands even when more reliable bands were not fully allocated when viewed as an individual band.
- A 2018 ES review of the stream depletion calculations has resulted in a larger estimate of groundwater pumping effects on stream flow than has previously been assumed. This has arisen due to inclusion of some previously unaccounted consents and the use of the calculation methods specified in the proposed Southland Water and Land Plan and, in some cases, a revised selection of the parameters to calculate the effects of groundwater pumping on river flow. The parameters used to estimate stream depletion effects and the abstraction quantities assigned to different MCO allocation bands are not always clearly spelt out in documents from consent applications, or in consent decisions, which makes comparison with current assessments difficult.

The following recommendations are made to improve future management of consents that affect flow in the Mataura catchment:

1. Preparation of a guidance document to clearly spell out the assessment approach to be used to incorporate abstraction effects into the MCO allocation zones. This guidance document should also deal with how to manage changes to the allocation that can occur from time-to-time due to changes in the way water is abstracted, or if assessment methodologies change in the future. Such a document will help to

ensure consistent decision making and allocation accounting into the future.

2. All decisions on consent applications should clearly state how much of the consented quantity is to be incorporated into the specific Mataura River Water allocation bands. They should also clearly document the parameters and methodology used to determine these allocation quantities.
3. An up to date database of all allocated abstraction quantities that affect flows in the Mataura River is an important component of the information management that is required to support good decision making on consent applications. This should include all the details used to calculate effects on flow in the Mataura River so as to ensure that a single consistent record of allocations is utilised by ES. A requirement to update the database each time a new consent decision is made, or when consents are varied or expire, must be programmed into staff job responsibilities.
4. It would be appropriate for the list of allocation effects on the Mataura River to be published on the ES web site so that all water users and interested parties can see the current allocation status of the resource.
5. Achieving consistent technical assessments of stream depletion effects from groundwater pumping will be aided by ES always having a suitably qualified and experienced groundwater scientist (or consultant adviser) to ensure the accuracy of these evaluations.

Table of Contents

Table of Tables

No table of figures entries found.

Appendices

1.0 Introduction

The Water Conservation (Mataura River) Order 1997 (MCO) specifies limits on the amount of water that can be allocated in water permits in order to protect the outstanding fisheries and angling amenity features of the Mataura River. Specifically, Clause 4 of the MCO states:

> ***4 Rates of flow in Mataura River and Waikaia River***
> *(1) Because of the outstanding features specified in clause 3, the rates of flow in the Mataura River and in the Waikaia River must not be reduced, by the grant or exercise of water permits, below the minimum rate of flow specified in subclauses (2) and (3).*
>
> *(2) The minimum rate of flow at any point in the Mataura River and the Waikaia River above the Mataura Island Road Bridge (approximate map reference NZMS 260 F46:850158), where the flow is estimated by the Southland Regional Council from measurements taken at that point, must be 95% of—*
> *(a) the flow so estimated by the Southland Regional Council at that point; plus*
> *(b) water taken in accordance with the Act from the protected waters upstream of that point and not returned to the protected waters— less authorised inflows upstream of that point which did not have their source in the protected waters.*
>
> *(3) The minimum rate of flow at any point in the Mataura River below the Mataura Island Road Bridge (approximate map reference NZMS 260 F46:850158), where the flow is estimated by the Southland Regional Council from measurements taken at that point, must be 90% of—*
> *(a) the flow so estimated by the Southland Regional Council at that point; plus*
> *(b) water taken in accordance with the Act from the protected waters upstream of that point and not returned to the protected waters—*
>
> *less authorised inflows upstream of that point which did not have their source in the protected waters.*

Environment Southland (ES) have recently reviewed the overall abstraction effects on the Mataura River above their flow monitoring point at Gore and concluded that consents have been granted that exceed the limits specified in Clause 4 (1) and (2) of the MCO.

At the request of ES this report has been prepared to provide a review of how historical consent application assessment processes have impacted on the allocation of water that affects flow in the Mataura River upstream of Gore and to recommend future processes to minimise the risk of issuing consents that

breach the limits in the MCO. This report is of a preliminary nature, because it does not include a review of decision-making documents for each individual consent. That could be considered as a further stage of work if more historical detail is required on how allocation decisions were made on each particular consent application. However, the overview assessment described in this report should provide useful guidance on the relevant aspects of this topic in a most efficient way, such that detailed scrutiny of each individual consent application decision may not be required.

The following topics are outside the scope of this review:

- consideration of how the MCO should be interpreted, other than any direct impact that interpretations may have had on consent decision making;
- any technical review or evaluation of individual consents;
- possible methodologies to address the current over-allocation issues.

This review of consent decision making has been prepared from the following sources of information.

- The Water Conservation (Mataura River) Order 1997 and the 1990 Planning Tribunal decision that led to the Order coming into force.
- The Southland Regional Water Plan
- The proposed Southland Water and Land Plan
- Reports that include overview comments on the allocation of water from the Mataura River:
  - "Mataura River Flow Allocation Assessment" prepared by Sinclair Knight Merz, 25 August 2005
  - The 2005 Environment Court decision on an appeal by Morfield Farms Ltd and Wilkins Farming Ltd against consent decisions made by Southland Regional Council, October 2005 (C/54/2005)
  - "Water Permit Application Assessment under the Mataura Water Conservation Order", dated 19 April 2007, prepared by [redacted]
  - "Surface Water and Groundwater Relationships in the Mataura Catchment Above Gore" prepared by [redacted] February 2008
  - "Mataura Catchment Strategic Water Study" prepared by Liquid Earth, Aqualinc Research, Harris Consulting, May 2011
  - "Review of stream depletion from groundwater takes in the Mataura River catchment above Gore", ES Internal Report – prepared by [redacted] December 2018

- A schedule of past and current consent allocations provided by [redacted] ES Technical Specialist (Soils and Groundwater Quantity)
- Interviews with some of the current and former ES staff who carried out the following functions:
  - People involved with consent decisions: [redacted]
  - People involved with providing technical advice to decision makers and maintaining databases of current consents: [redacted] who was overseas at the time of this review work, although he has subsequently provided comments on this report).

This report focusses on the two key elements that determine the allocation process, namely:

- The management of surface water and groundwater abstractions within the MCO allocation framework (discussed in section 2 of this report).
- The decision making and record keeping process adopted by ES (discussed in section 3 of this report).

Based on the review of these factors, recommendations are presented in section 4 to improve the consistency of the consent decision making processes and the information management relating to water quantity allocation.

2.0 The MCO Allocation Framework

At the time of the 1990 Planning Tribunal hearing for establishment of the MCO, groundwater and surface water in New Zealand were typically managed as separate resources. It is clear from the 1990 Planning Tribunal report on the application for a MCO that there was no expectation at that time of the significant increase in groundwater abstraction that has subsequently occurred in the catchment (from 2000 onwards) and the effect it can have on flow in the Mataura River. The Planning Tribunal report notes that the evidence presented to them included the observation that groundwater supplies, *"... largely if not wholly, have no direct hydrological connection with the river system..."* (page 33 of the decision). In terms of the allocation block being 5% of the flow, so that

95% of the flow is retained in the river (clause 4(2) as quoted above), the Tribunal concluded,

> *"generally the 95% flow regime and the water quality parameters provided for by the existing classifications, should be included for the purposes of protecting the outstanding features earlier identified. We think this can be done without adversely affecting existing users, or reasonably foreseeable future users, and consequently in the interests of conservation, it should be done."* (page 51 of the decision)

and

> *"It was and still is intended that the whole of any authorised inflows that do not have their source in the protected waters, as for example groundwater, shall be available for abstraction...."* (pages 46 and 47 of the decision).

It was only during the 1990's and onwards that it became more widely recognised that the effect of groundwater pumping on surface water should be quantified and managed.

Therefore, it can be concluded that the Planning Tribunal decision did not give any consideration to the nature and extent of the groundwater pumping effects on surface flow in the Mataura River. They considered that simply specifying a 5% quantity for allocation provided a generous allowance for future demand. Those assumptions were valid in terms of the pattern of surface water takes from the river, but not for the groundwater takes that have subsequently occurred.

2.1 The Development of Abstraction Upstream of Gore

The MCO commenced in 1997 and in the early-years allocations occurred in the manner anticipated by the 1990 Planning Tribunal decision. The lowest flow at Gore is in the order of 9 m^3/s so 5% of that flow (450 L/s) could be allocated without the need for any significant low flow restrictions. In fact, right through to the present day, surface water abstractions have continued to occur at a low and steady rate (as was anticipated by the 1990 Planning Tribunal decision). However, from 2000 onwards there has been a significant increase in groundwater abstractions. These patterns of abstraction development are shown in Figure 1 below.

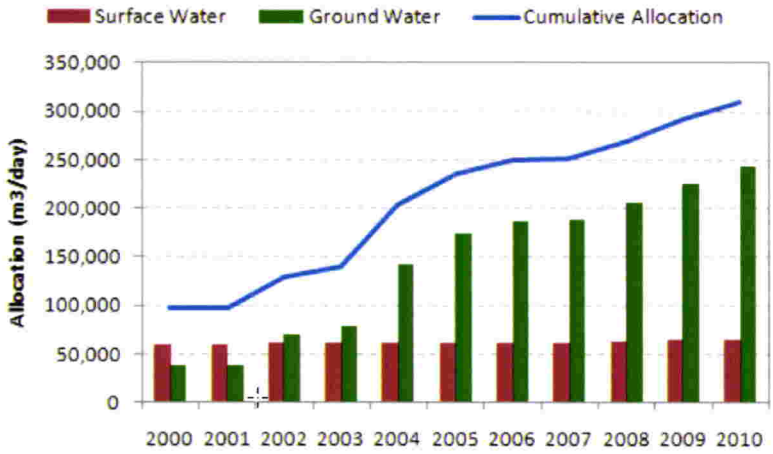

Figure 15. Cumulative allocation in the Mataura catchment, 2000-10

Figure 1. Reproduction of Figure 15 from Mataura Catchment Strategic Water Study (2011)

The Strategic Water Study explains this pattern in the following way:

> *"As illustrated in Figure 15 cumulative allocation for consumptive water use in the Mataura catchment has increased significantly since 2000, primarily driven by an increase in groundwater allocation for pasture irrigation. The graph shows a significant increase in groundwater allocation between 2002 and 2005 primarily associated with development of large-scale takes along the riparian margin of the Mataura River in the Upper Mataura, Waipounamu and Riversdale groundwater zones. The subsequent decline in the rate of increase during 2006 and 2007 is inferred to reflect the application of progressively higher minimum flow cut-offs on hydraulically connected groundwater takes from these aquifer systems. The subsequent increase in groundwater allocation from 2008 to 2010 is largely associated with development of a confined aquifer system (the Garvie Aquifer underlying the Wendonside terrace) and applications willing to accept a minimum flow cut-off (and associated supply reliability) close to or exceeding mean annual low flow (MALF) at Gore."*

That report defined the 7-day MALF at Gore as 17.6 m^3/s and ES have indicated that a low flow cut off at the MALF corresponds to a reliability of supply that is similar to what occurs elsewhere in the Southland region.

Coinciding with the increasing pattern of groundwater abstractions shown in Figure 1 above was a changing approach to the management of groundwater abstractions. During the late 1990s and early 2000s there was an increasing awareness of the effects that groundwater pumping can have on surface water flows. In 2000 the PDP/ ECan "Guidelines for the Assessment of Groundwater

Abstraction Effects on Stream Flow" (R00/11 ISBN 1-86937-387-1) were published and by 2005 these methods for quantifying and classifying stream depletion effects were incorporated into the Southland Regional Water Plan. They have recently been updated and incorporated into the pSWLP.

Consequently, Environment Southland have had to develop their approach to achieving the allocation requirements of the MCO for the abstraction situation that has evolved in a way that was not anticipated at the time the MCO was prepared.

3.0 ES Decision Making Framework

As noted above, abstractions of up to about 450 L/s could occur without the need for any significant low flow restrictions, based on flow measurements at Gore. This was a straightforward matter for surface water takes which were of relatively small magnitude and have not changed much over time, as shown in Figure 1 above. However, as the magnitude of groundwater pumping increased, so did the pressure on the 5% allocation limit which led to ES developing various approaches to consent decision making, as described below.

3.1 Allocation Bands

In recognition of the increasing effects of abstraction on the river flow, ES technical staff developed a system of allocation bands as a means of addressing the uncertainty and variability of the MCO allocation regime being specified simply as 5% of the naturalised flow. This comprises the following approach:

- Allocations up to 450 L/s can have no low flow restrictions, or a low flow restriction of 9 m^3/s (the lowest recorded river flow since a continuous flow meter was installed in May 1977 is 8.2m^3/s recorded on 17/3/1978)
- Allocation bands of 100 L/s with increasing low flow cut-offs in steps of 2 m^3/s above the 9 m^3/s cut-offs specified in the preceding bullet point.
- A pragmatic approach of using the measured flow at Gore has been adopted to determine what level of restrictions are in place at any particular time. This is because of uncertainties in the exact magnitude of groundwater pumping effects on river flow at any particular time and because the 5 % allocation is within the margin of flow measurement accuracy that can be achieved.

This allocation approach used by ES is shown schematically in Figure 2 below and helps to provide a structured allocation regime rather than a continually varying allocation block based on the percentage of flow at any particular time, as specified in the MCO.

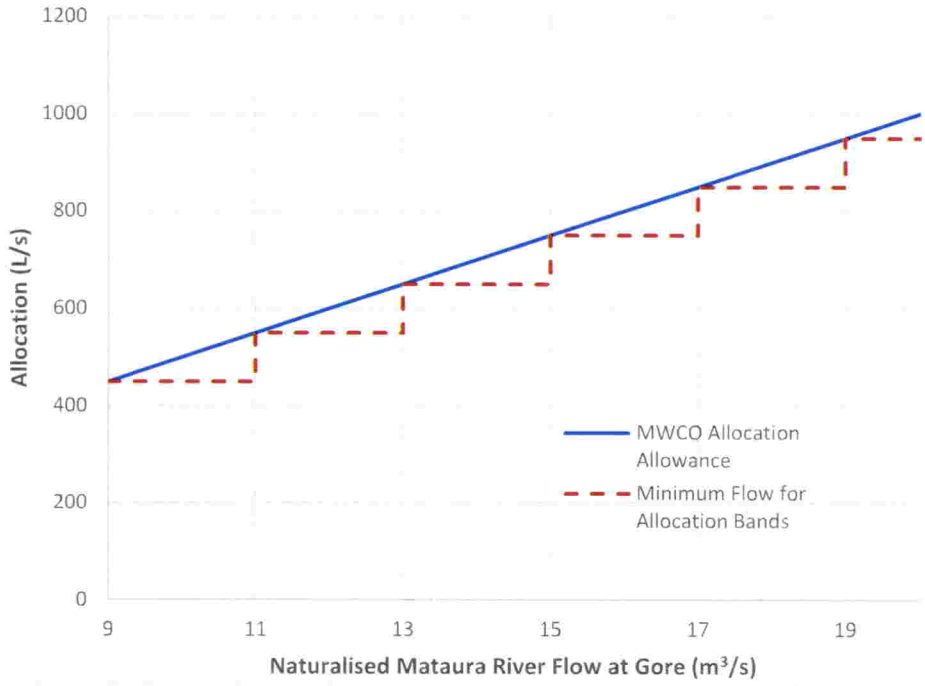

Figure 2. Schematic Representation of ES Water Allocation Bands for the Mataura River upstream of Gore

The allocations within each band are cumulative, so if one band becomes over-allocated, it fails to comply with the MCO and also uses up the available allocation in higher flow bands

3.2 Variable flow along the rivers and streams

There are natural variations in flow along the course of this river system due to interactions with groundwater, an example of which is presented in Figure 3 below (Figure 47 from the February 2008 ES report entitled, "Surface Water and Groundwater Relationships in the Mataura Catchment above Gore"). The only points where the mainstem river flow is continuously known upstream of Gore are at the ES flow monitoring sites at Parawa and Gore, although flows at other locations in the river could be inferred from intermittent gauging measurements made by ES.

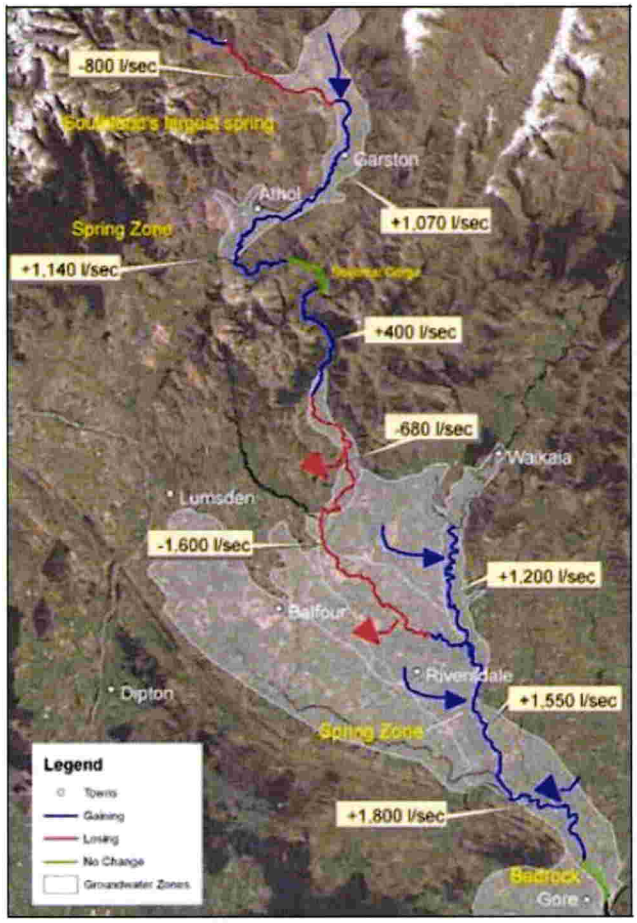

Figure 47: Net flow gains and losses in the Mataura and Waikaia Rivers (with major tributary inputs accounted for) when the flow at Gore is 13.5 cumecs

Figure 3. Reproduction of Figure 47 from Surface Water and Groundwater Relationships in the Mataura Catchment above Gore (2008)

Based on this type of flow pattern it might be possible to argue for higher minimum flow cut offs at Gore (greater than the ES classification described above) in order to maintain 95% of the flow at any point in the Mataura River. Such an approach can lead to inconsistent low flow cut offs outside of the standardised ES methodology, as has occurred on some consents, particularly those determined by Hearing panels or perhaps volunteered by applicants based on the advice they received. Previous examples of now expired consents had low flow cut-off sites at Waimea @ Mandeville and Waikaia @ Mahers Beach. The only current consent with a non-standard low flow restriction appears to be AUTH20158306-02 which has a low flow cut-off at Waimea @ Mandeville. Some consents have low flow cut-offs at Parawa which don't correspond with the ES standard allocation bands at Gore (e.g. AUTH 20158317 and AUTH 20171135).

These inconsistencies indicate some variability in consent decision making has occurred in the past.

This issue of maintaining 95% of the flow at any point in the river above Gore was one of the matters raised in the 2005 Environment Court decision (Decision No C/54/2005) which described the approach they used to deal with that issue as follows:

> *"Above the Mataura Bridge the allocation is governed by section 4(2). This introductory description indicates that the minimum rate of flow is a calculated figure. It constitutes firstly actual flow estimated by the Regional Council* ***at any point****. For the purposes of this hearing all parties agreed by the end of the hearing that relevant for this hearing was Gore measuring station. Thus it is not necessary for us to determine the meaning of* ***at any point*** *or the Regional Council discretion for fixing that for current purposes."* (paragraph 17 of that decision).

Therefore, ES have generally implemented their allocation regime based on flow measurements at their flow monitoring sites at Parawa and Gore, which helps achieve a consistent and more standardised approach to allocations. Although, as noted above, a small number of consents have been managed through low flow restrictions at other sites on tributary streams.

3.3 Stream Depletion Effects

Pumping groundwater from a bore can deplete the flow in surface waterways and is referred to as a stream depletion effect. For water allocation purposes, it is a calculated number which relies on estimates and assumptions about pumping rates and duration of pumping, aquifer parameters and the hydraulic connectivity between groundwater and the nearby streams and rivers. There are various methodologies that can be used to calculate these effects which results in a degree of uncertainty and variability in the quantification of this effect on surface waterways (i.e. different analytical equations that can be used or numerical models which can all be expected to give different quantifications of groundwater pumping effects on the flow in surface waterways).

No formalised methodology to classify the effects of groundwater abstractions on surface flows were in place for Mataura catchment assessments until the proposed variation to the RWP was prepared in 2004. Up until that point the assessment of effects on groundwater pumping relied on the expert judgement of ES technical advisors on groundwater. However, since 2004, the plans have directed how consented groundwater abstractions need to be incorporated into the water allocation regime through the methods set out in the RWP and more recently updated in the pSWLP.

Both the RWP and the pSWLP plans include classification of the differing degrees of hydraulic connection that occur between a groundwater pumping bore and a nearby surface waterway (as calculated by the time taken for the groundwater pumping to affect the surface flow and the magnitude of the effect). These effects are categorised as follows:

- "Riparian and Direct" hydraulic connection effects are managed in the same manner as surface takes
- "High" hydraulic connection effects greater than 2 L/s are also managed in the same manner as surface takes
- "Moderate" hydraulic connection effects above a specified threshold are included in surface water allocation totals, but are not controlled by low flow restrictions, which are considered to be a less effective means of controlling these abstractions due to the slow build-up of the effects (and persistence of the effect following cessation of pumping) from bores with a moderate hydraulic connection
- "Low" hydraulic connection effects are not included in surface water allocations because of their delayed and small-scale effects

Both plans note that effects on ephemeral streams[1] are excluded from a consideration of stream depletion effects, but effects on intermittent[2] water bodies are included.

This classification of groundwater pumping effects on surface waterways provides a methodology for stream depletion effects to be incorporated into the 5% allocation allowance in the MCO. In particular it determines whether the groundwater abstraction should be included in the surface water allocation band and whether that effect on surface waterways can be controlled by low flow restrictions (Riparian, Direct and High hydraulic connections) or whether it should be accommodated into the allocation band with no low flow restrictions (Moderate hydraulic connection).

In some cases, abstractions with Moderate stream depletion effects have been given consent conditions with low flow restrictions, even though the plans say these are not an appropriate means of controlling this effect, due to the very slow response time for the stream to show any benefit from the restriction. However, without any low flow control, it does raise the issue of whether consents for Moderate stream depletion effects can be granted in the future if any of the allocation bands are determined to be over-allocated.

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[1] Ephemeral rivers are defined in the pSWLP as, *"Rivers which only contain flowing or standing water following rainfall events or extended periods of above average rainfall."*

[2] Intermittent river is defined in the pSWLP as, *"A river which does not contain permanently flowing or standing water and where the bed is predominantly devoid of terrestrial vegetation and comprises sand, gravel, boulders, or similar material or aquatic vegetation."*

3.4 Ongoing variability of stream depletion effects

Even with the consistent approaches that ES have put in place to determine how consents are incorporated into the MCO allocation block, variability in the management of allocations can still arise. This review report has not included a detailed review of all consent decisions, but it is expected that the reasons for this variability include:

- When reviews of the overall consent allocation status were carried out, often as part of a s42A report for a new consent application, or as a Council initiated review of the overall allocation status (e.g. Environment Southland 2009 and 2018b), they could apply different judgements as to how allocation effects should be quantified, compared to the judgements that were made when the consents were originally granted. As discussed in section 4 and noted in Table 1 of this report, new allocation bands commenced in recognition of an over-allocation situation occurring in 2007 (13 m^3/s band), 2011 (19 m^3/s band) and 2018 (17 m^3/s band).
- When consents are varied or renewed on expiry, different effects on the river flow often occur due to changes in the bores that are used for abstraction (both in terms of depth and location), or changes in abstraction rates or annual abstraction volumes. In technical advice to ES decision makers for a consent application it is noted that application of the stepped allocation methodology, "has become increasingly complicated due to changes in allocated volumes (e.g. consents not renewed/replaced, changes to pumping rates and seasonal volumes when consents have been replaced)" (Liquid Earth, 2017).
- As new field investigation information becomes available for aquifer and streambed conductance values, or different calculation methodologies are adopted, the quantification and classification of stream depletion effects changes.
- When hearings are held to consider specific applications, they can sometimes result in decisions and low flow restrictions that are inconsistent with the standardised approach developed by the ES staff.

Examples of S42A reports on consent applications that have been provided for this review assessment, all contain a commentary on the current state of allocation effects on the Mataura River relative to the MCO allocation criteria. This indicates that decision makers were taking this into account when they made their decisions and there was no obvious error in the decision-making process. Despite this, because of the four factors listed above, over-allocation within the ES bands can be seen to have occurred.

As a result of these variations, the combined allocation within each of the standardised ES allocation bands have varied over time. To demonstrate these

changes, we have taken information from a historical record of consented allocation prepared by ES and plotted them for a selection of allocation bands to show how the consented quantities have changed over the years (although the historical information for the early years of these records may not show all the consents that were operative at those times due to some potential gaps in the older record keeping). These graphs are presented in Appendix A and use an allocation limit based on the river flow limits with the addition of the consented abstraction quantity that corresponds to those measured flow limits (as specified in clause 4(2) of the MCO). They utilise information on the abstraction effects that were assessed at the time the consents were granted, as best this can be judged from the information that is currently available. Therefore, the values may be different from assessments that would be carried out using current information and the methodology set out in the pSWLP.

These graphs show there has been no over-allocation for the lowest allocation band (9 m^3/s) and for the allocation bands with low flow cut-offs at 15, 17 and 19 m^3/s, as measured at Gore. An over-allocation of up to 15% has occurred at the 11 m^3/s low flow cut-off and a smaller over-allocation at the 13m^3/s low flow cut-off from 2013-2015, which has since been rectified[3]due to changes in the consented effects as consents expired and/ or were modified. It is important to note that the record of consents used to produce these graphs is derived from an "Allocation History" spreadsheet prepared by ES (saved as A471701 in Morf) and may include consents and stream depletion assessments that are different from the numbers that were defined when these earlier consent decisions were made.

In 2018, ES carried out a review of stream depletion assessments for the Mataura catchment upstream of Gore (ES, 2018), to determine how the proposed Southland Water and Land Plan (pSWLP) methodology for stream depletion effects impacted on the allocation quantities. This has led to a different range of calculated stream depletion effects on the Mataura River, primarily due to:

- A change in the pumping period and pumping rates used to classify the stream depletion effects
- The inclusion of effects on a second stream that bounds the abstraction bore, whereas the RWP notes that,
  "The stream depletion effect of a groundwater abstraction is directly linked to the degree of hydraulic connectivity between the aquifer the groundwater is being extracted from and the adjacent surface water body" and

[3] It is important to note that the quantities plotted in Appendix A come from a schedule of consented quantities provided by ES. If Permitted Activities are determined to be included in the allocation totals then a greater amount of MCO limit exceedance would occur.

> *"Stream depletion effects of groundwater abstractions are to be calculated in relation to the nearest permanent surface water body in hydraulic connection with the aquifer concerned".*
>
> These comments were typically interpreted as only requiring an assessment to the nearest surface water body.

Furthermore, in some cases this review exercise found that the calculation method or parameters used for previous consented effects were not well documented (for example, in some cases they are not documented in the records of the application or the S42A report) and therefore parameters needed to be assumed for the 2018 assessment that were not necessarily the same as what would have been taken into consideration for the original decision making on the consent application

In some cases, the combined effects of these changes was not simply to increase the stream depletion effect, but also to push individual abstraction effects into a higher classification zone meaning that a greater proportion of the consented abstraction had to be included in the surface water allocation block.

In terms of the future use of these reviewed stream depletion numbers, the ES 2018 report states that, *"This review is not designed to challenge conditions of existing consents, but rather to support current and future assessments of allocation and associated effects."*

The revised stream depletion numbers from this review provide a further indication of the variability in stream depletion assessments that can occur. They also significantly change the current status of the MCO 5% allocation block as shown in Figure 4 below.

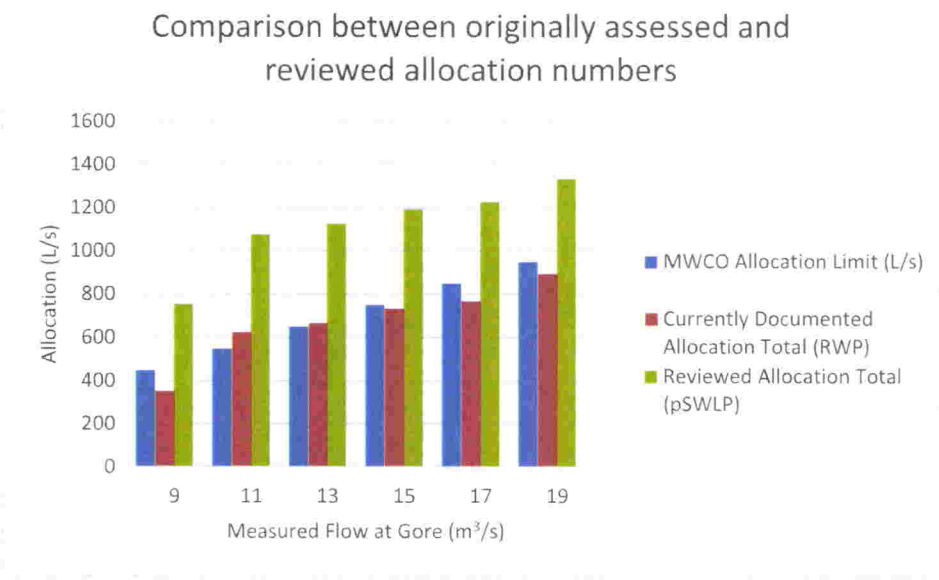


Figure 4. Changes in Allocation Quantities Based on Different Assessments

The ES (2018) report provides a standardised well-documented assessment of these newly quantified stream depletion effects, although it results in some significant increases in stream depletion rates compared to previous assessments undertaken at the time when decisions on consent applications were made.

4.0 Management of the Mataura River allocation database

An important aspect of the proper management of allocation effects on flow in the Mataura River is maintaining an accurate and up to date database of consented allocations and applications receipted by ES. This is information that consent decision makers or their technical advisers must refer to, so they are informed of the total allocation of water from the Mataura River at the time they make a decision on the granting of any new consent.

It appears that the task of maintaining this database has been undertaken by individual staff with technical responsibility for advising consent decision makers on groundwater and surface water quantity matters. The ES groundwater scientists [redacted] maintained a spreadsheet for each of the groundwater management zones defined in the RWP, which included entries for the amount of allocation assigned to surface waterways (due to the calculated stream depletion effect) and to the relevant groundwater management zone. These numbers could then be added to the surface water consented takes (which did not change greatly over time) to determine the low flow restrictions that should be imposed on any new consent. It appears that the database was not updated as each new consent was granted (or as consents expired) but rather the updating was done

on a more ad hoc basis (but generally at least once per year) and referred to on an as required basis when technical advice was being provided to decision makers. Based on discussions with ES staff, it also appears that from time-to-time, other staff have maintained their own spreadsheets to keep track of the allocation situation. This indicates there was no officially recognised reliable spreadsheet record in place.

As the number of consents affecting the Mataura River increased and changes to consents occurred, the maintenance of the database became a more time-consuming exercise. After the departure of [redacted] in 2014 the Groundwater Scientist role has remained vacant and it appears that for a period of around 2-years from around that time, the groundwater allocation database was not maintained. Despite that situation occurring, there is no indication of a particular change in the over-allocation status during that period.

In 2016, [redacted] found the ES groundwater allocation spreadsheets to be out of date and students [redacted] and [redacted] were hired by ES to update the information. [redacted] has subsequently been appointed to a full-time role as a Data Management Officer. One of her first tasks was to review the application information and decision-making reports on all groundwater consents to create an updated spreadsheet of the stream depletion calculations in the Mataura catchment. To help ensure allocation was not underestimated, it was determined that she should populate the spreadsheet with the largest stream depletion number from the information sources she reviewed. Her review also brought in more consents than those that had previously made up the spreadsheet. This involved consents that had no record of a stream depletion effect, although such an assessment was required and subsequently added into the allocation record as part of her review process.

Despite the uncertainties associated with the past maintenance of the allocation spreadsheet, the inclusion of higher low flow cut-offs in more recent decisions indicates that decision makers had knowledge of the increasing total allocation quantities in the catchment, even though some of the earlier decision making may not necessarily have been precisely aligned with the allocation bands. The following schedule shows the first time that new flow limits at Gore were introduced, based on the spreadsheet provided by ES, and an interpretation of the reasoning behind the commencement of a new allocation band.

Table 1: Commencement of New Allocation Bands (with reference to graphs in Appendix A)		
Restriction Band (L/s)	**Date when first used**	**Assumed Interpretation of the Implementation of Different Allocation Bands**
9,000	5/10/2001	This allocation band is combined with consents that have no low flow restrictions as it occurs infrequently, being close to the lowest flow ever recorded. It remained under-allocated after the 11 m^3/s band commenced to allow for Moderate stream depletion effects that are incorporated into the allocation but have no low flow restriction.
11,000	2/03/2000	Commenced before the 9 m^3/s band to allow for Moderate stream depletion effects. Appendix A graphs indicate it became over-allocated in October 2005
13,000	23/11/2007	Commenced in response to over-allocation of the 11 m^3/s allocation band
15000	1/12/2009	Commenced in response to the 13 m^3/s allocation being fully allocated. Remains not fully allocated due to later recognition that earlier bands are over-allocated.
17,000	14/12/2018	Commenced after the 19 m^3/s allocation band in recognition that some of the earlier over-allocations had decreased.
19,000	29/09/2011	Commenced in a recognition of the need to offset earlier over-allocations.

[redacted] continues to maintain the groundwater database and [redacted] maintains an equivalent surface water allocation database. The surface water take consents do not change greatly, but the Groundwater Allocation Tables (including the stream depletion numbers) are updated at approximately monthly intervals) by interrogating the ES consents database (IRIS). This is an important task that currently relies on the diligence of the individual staff who maintain the spreadsheets. They expressed concern that if they left their current role, they were uncertain if the spreadsheet would be properly maintained, which seemed to be a problem that arose when the last Groundwater Scientist left ES.

4.1 Comparison between allocation totals

ES have provided a selection of dates when various technical reports that summarised the allocation quantities from the Mataura River upstream of Gore. These are listed in the following Table, along with the corresponding values

shown by the more recently collated spreadsheet of what was allocated by consents at that time, based on currently available records.

Table 2: Comparison between historical reports on allocation and the current records of consented quantities at the corresponding time

Report	Allocation total from report[1]	ES Allocation History Spreadsheet[2]
ES 14/09/2004	527 L/s	414 L/s
SKM 25/08/2005	485 L/s from numerical model 524 L/s from analytical equations	496 L/s
ES 17/12/2007(b)	634 L/s	666 L/s
Liquid Earth 20/02/2009	720 L/s	630 L/s
Liquid Earth 10/05/2010	893 L/s	736 L/s
Liquid Earth 30/03/2017	946 L/s	741 L/s

Notes: 1. In some cases the numbers in this column have been derived from the estimate of the accumulated stream depletion number in the referenced report, with the addition of the accumulated surface water consents at that time.

2. These numbers are derived from the ES "Allocation History" spreadsheet (A471701 in Morf).

This comparison between the historical report numbers and the records based on the "Allocation History" spreadsheet again shows the uncertainty and variability in the record keeping of the total allocation that can occur, most likely due to differences in the type of consents that were included in the allocations at different times due to the differing interpretations of what should or should not be included in the Mataura allocation bands and variations in the parameters and methodology used to estimate stream depletion numbers. Although the information in Table 2 does not indicate that the historical reporting of allocation totals was under-estimating the river allocation, when compared to the "Allocation History" numbers.

Based on the review of the information and the graphs in Appendix A, it appears that an over-allocation exceedance occurred in the 11m^3/s and 13 m^3/s allocation bands and when this was recognised it was addressed by smaller allocations at the higher low flow restriction bands during the period from 2009 onwards, when use of the 15 m^3/s band commenced.

5.0 Issues and Recommendations

Based on this review and the preceding discussion (and assuming the MCO continues in its current form), the issues related to consent decision making involving the current MCO can be summarised as follows:

- The calculation of stream depletion effects from groundwater abstractions is not a precise science. As noted by the Environment Court in 2005,

  > *"All of the hydrologists accepted during the course of concurrent evidence that given the uncertainties in terms of hydrogeological connection with the river that there could be a wide range of depletion figures. The Court required several conferences between the experts. At one it was agreed between the experts that the differing assessments of stream depletion ranged between 490.8 litres per second and 562 litres per second"* (paragraph 32 of that decision)

  The more recent ES 2018 review demonstrates an even greater change in the estimated magnitude of stream depletion effects (as shown by Figure 4 in section 3.2 above) compared to what was originally assessed at the time when consent decisions were made and how those assessments are viewed now with the approach defined in the pSWLP.

  Different calculation approaches would also produce different numbers. For example, the 2005 SKM report notes that the analytical equations that are typically used indicated a depletion value of 524 L/s at that time, but a numerical groundwater model calculated an effect of 485 L/s. The difference between these two numbers is typical of the accuracy that can occur when estimating stream depletion effects, although such variations are not ideal when they are used in for determining the status of a water allocation band. It is difficult for consent decision makers and water users if the abstraction quantities in the Mataura River allocation block are changing from time to time, whether that be due to different stream depletion calculation methods or variations, cancellation or replacement of consents, particularly if these changes occur in the middle of a consent term.

- Moderate stream depletion effects have been managed inconsistently with some being subject to low flow restrictions, some having no low

flow restrictions and some applications having been declined. This variable approach appears to have been occurring since 2002 and as recently as 2018. Of the 40 "Moderate" stream depletion consents, 16 have low flow conditions and 24 do not. This inconsistent approach is likely based on the following two scenarios:

- some decision makers feeling that it would be inconsistent to grant a stream depleting consent without a low flow restriction (an approach that was sometimes supported by applicants who volunteered low flow restrictions in order to obtain a consent);
- other decision makers who followed the regional plan advice, which recognises that little practical environmental benefit is achieved by restricting moderate stream depletion effects.

- The maintenance of the database of current allocations and pending applications that affect the Mataura River flow seems to rely largely on the initiative of individual technical staff with no automated system in place. Documentation is in place describing the process for determining and documenting the quantities within allocation bands, but it still relies on the diligence of individual staff to implement this regularly. Consequently, when there is a change in staff positions, the accuracy and consistency of the database is at risk. Past reviews of allocation totals indicate that not all consents that affect stream flow have been included in the database and for those that have, some of the information is incorrectly recorded. Where these situations are discovered, future consents are assigned to allocation bands with higher flow cut-offs.

Some of these issues cannot be easily resolved but implementation of the following recommendations should improve the accuracy and consistency of decision making which should be of benefit to both ES and water users.

5.1 Guidance Document

Consistent decision making and record keeping for water allocation could be aided by the preparation of a guidance document to aid consent decision makers dealing with applications that affect the flow in waters governed by the MCO. This should include the following information.

- The allocation regime and the bands that are defined (i.e. 100 L/s of allocation for each $2m^3/s$ step in low flow restrictions).
- The flow monitoring points that ES maintain and the areas of the catchment that those flow measurements apply to for the purposes of the allocation regime.
- The calculation methodology to be used for groundwater abstraction effects on surface waterways and the way in which aquifer parameters

should be chosen to use in these calculations, including where more than one surface waterway is connected to groundwater impacted by the abstraction.

- How allocated quantities should be apportioned for consents with multiple bores, some of which may have differing degrees of hydraulic connection to a nearby surface waterway.
- How changes in the quantities assigned to individual consents are to be dealt with in terms of their implications for all consent holders arising from increases and decreases in the overall allocation total within each allocation band.
- If new methodologies are to be adopted for stream depletion effects or new calculation regimes implemented, or changes in allocation management through plan changes or implementation of new plans, a methodology for transitioning existing consent holders through such changes should be defined.

A guidance document such as this should aid in achieving consistent decisions made on applications that minimises the risk of future over-allocation. However, it must also be recognised that the approaches set out in such a document could still be subject to challenge in consent hearings and the decisions that arise from them. Consequently, adjustments may be required in the future, but if that is the case, it will be important that decision makers are made aware of the implications of changing the implementation approach for all consent holders.

5.2 Decisions on Consent Applications

A requirement that all decisions on consent applications must specify the classification and quantity of stream depletion effects, the parameters and methodology to determine those effects, the total allocated quantity in each of the allocation bands adopted by ES and the rationale for any low flow restrictions (or absence of them). This will avoid the type of uncertainty that exists for some historic decisions where it is uncertain what stream depletion quantity was intended to be entered into the allocation band or how that value was arrived at.

5.3 Database Management

There should be only one official database for Mataura water allocation (and also for all other surface water and groundwater allocation zones throughout the region). This should be jointly maintained by both the Consents and the Science team with the task being written into the job description of specific staff to ensure it is always maintained correctly.

A component of the database must be an up to date record of the allocation status within each band. This would include details of the consent decision making rationale, including the category of stream depletion effect and a clear

statement of the rationale used for the quantity assigned to each allocation band. Once this is accurately recorded in the database, it should not be altered during the term of the consent.

The database should be updated every time a change is made on a consent application that affects flow in the Mataura River (i.e. a new consent or variation or expiry of an existing consent). An ideal arrangement would be for the details and allocation quantities for any abstraction to be entered into a single database which then automatically populates the groundwater and surface water allocation records for each water management zone.

5.4 Website Information

In addition to this up to date and accurate recording of allocation, it would seem useful for the basic allocation information to be available on the ES website so that all water users and interested parties can see the state of allocation. This information could identify the consent holder, the location of the abstraction point, the quantities taken and the dates when the consent was granted and when it will expire.

Other database information, which would not necessarily need to be published on the ES website but could be recorded on an internal component of this single database should specify the parameters and methodologies used to calculate stream depletion effects, the degree of hydraulic connection for each consented bore and the calculation method to determine the stream depletion effect.

5.5 Consistent Groundwater Advice

Achieving this consistent outcome will also be aided by ES always having a suitably qualified and experienced groundwater scientist (or consultant adviser) to ensure accurate stream depletion assessments are undertaken.

6.0 References

Environment Court (2005); Morfield Farms Ltd and Wilkins Farming Ltd vs Southland Regional Council, October 2005 (C/54/2005)

Environment Southland (2004). Water Permit Application for Wilkins Farming Ltd, ES File Reference W199-001

Environment Southland (2007a); Water Permit Application Assessment under the Mataura Water Conservation Order", a memorandum dated 19 April 2007 prepared by [redacted]

Environment Southland (2007b). Riversdale Water Permit Applications. ES file no. T236-001

Environment Southland (2008); Surface Water and Groundwater Relationships in the Mataura Catchment Above Gore; February 2008; prepared by [redacted]

Environment Southland; Minimum Flows and Stream Depletion Workshop, 29th May 2009. Powerpoint presentation prepared by [redacted] for Southland Regional Council

Environment Southland (2018a); Proposed Southland Water and Land Plan – 4 April 2018 (Decisions Version)

Environment Southland (2018b); Review of stream depletion from groundwater takes in the Mataura River catchment above Gore – Internal Report, prepared by [redacted] Technical Specialist (Soils and Groundwater Quantity)

Liquid Earth (2009). Water Permit Application 206057 – Steeghs Partnership, Croydon. ES file no. S348-005.

Liquid Earth (2010). Water Permit Application 207215 – CE & HR Webber for Aylesbury Trust, Croydon. ES file no. W295-001.

Liquid Earth (2017). Water Permit Application – Wilkins Farming Limited, Athol. ES file no. A323606.

Liquid Earth, Aqualinc Research, Harris Consulting (May 2011); Mataura Catchment Strategic Water Study" prepared for Environment Southland

Planning Tribunal (1990); Report of an inquiry into a Draft National Water Conservation (Mataura River) Order pursuant to section 20C of the Water and Soil Conservation Act 1967 (reference C32/90)

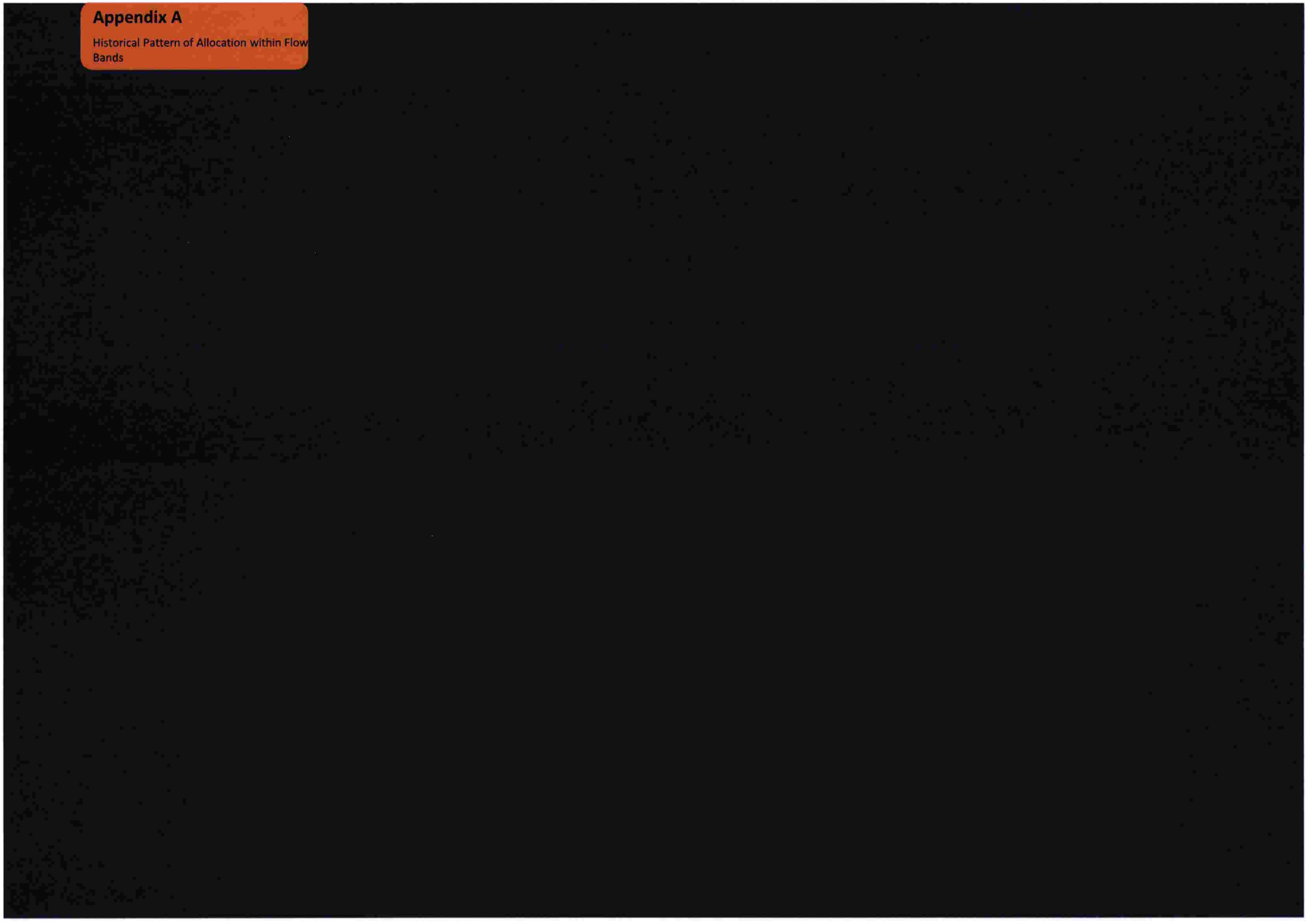
Sinclair Knight Merz(2005); Mataura River Flow Allocation Assessment", 25 August 2005

Southland Regional Council (2010); Regional Water Plan for Southland

Water Conservation (Mataura River) Order 1997

Appendix A

Historical Pattern of Allocation within Flow Bands



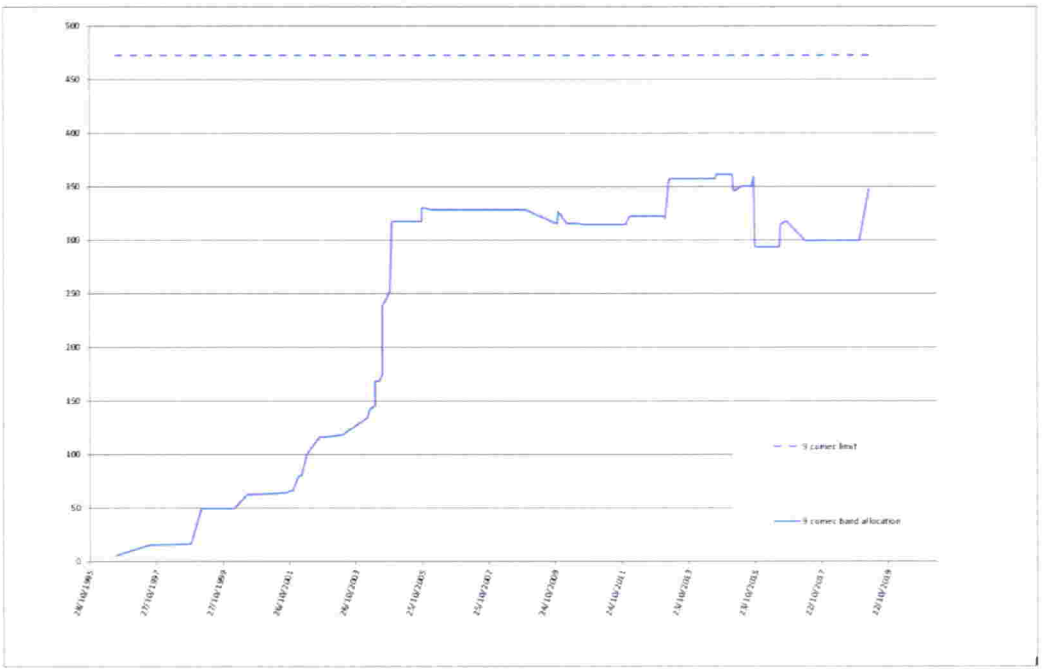


FIGURE A1. 9 M³/S ALLOCATION BAND

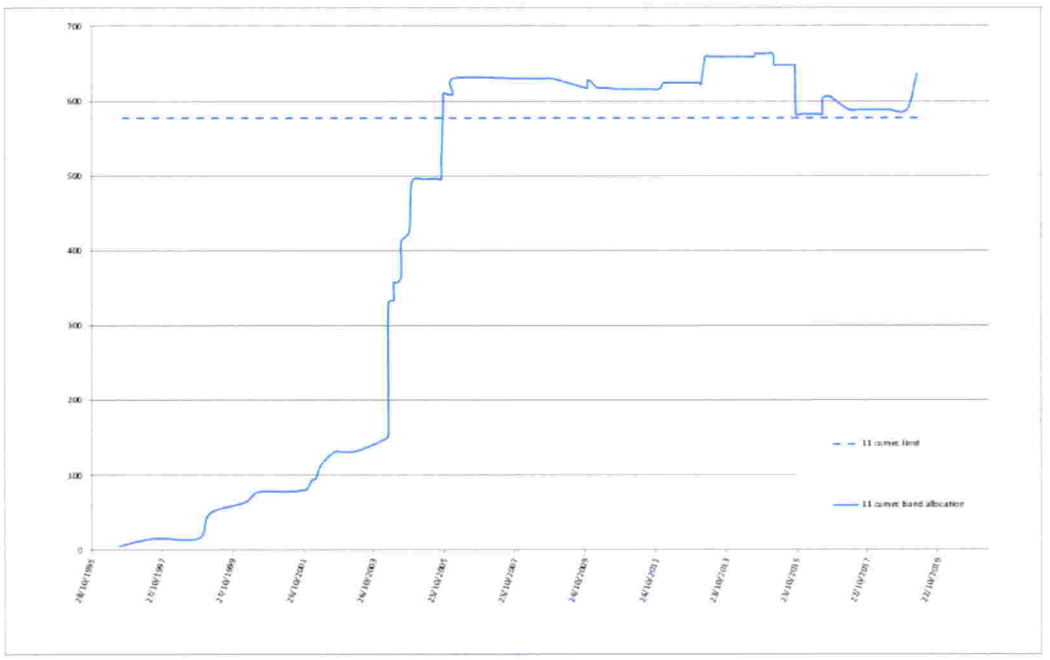


FIGURE A2. 11 M³/S ALLOCATION BAND

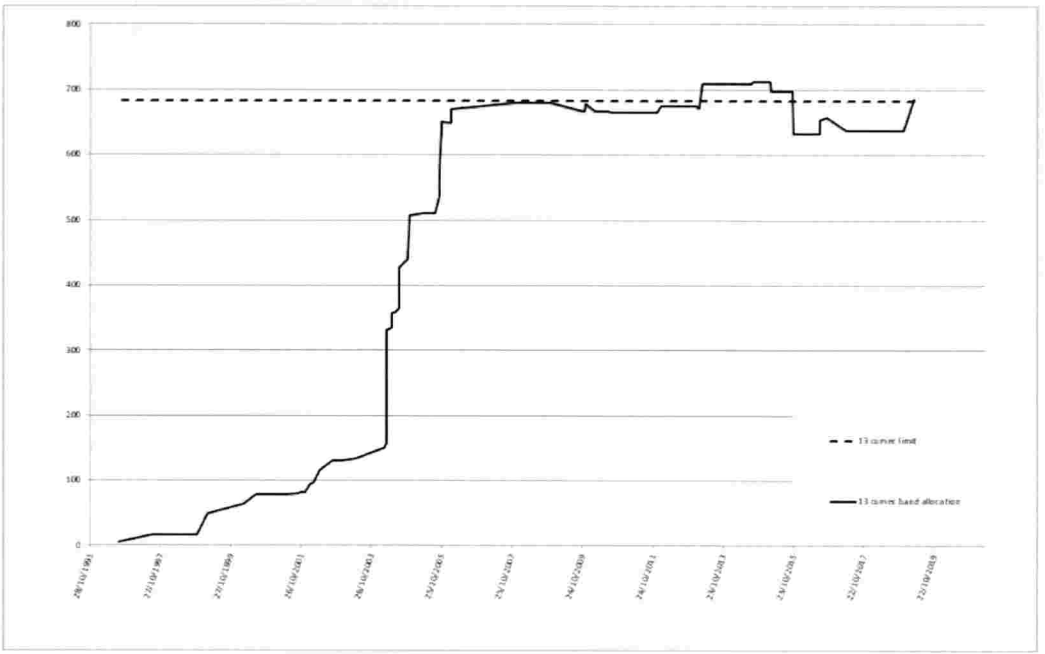


FIGURE A3. 13 M³/S ALLOCATION BAND

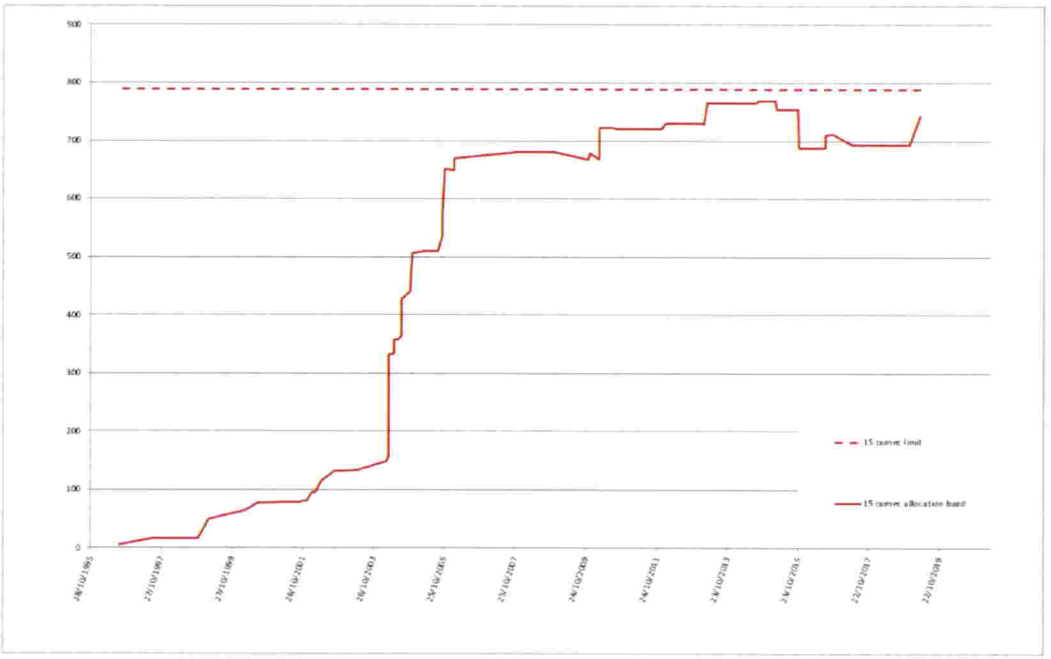


FIGURE A4. 15 M³/S ALLOCATION BAND

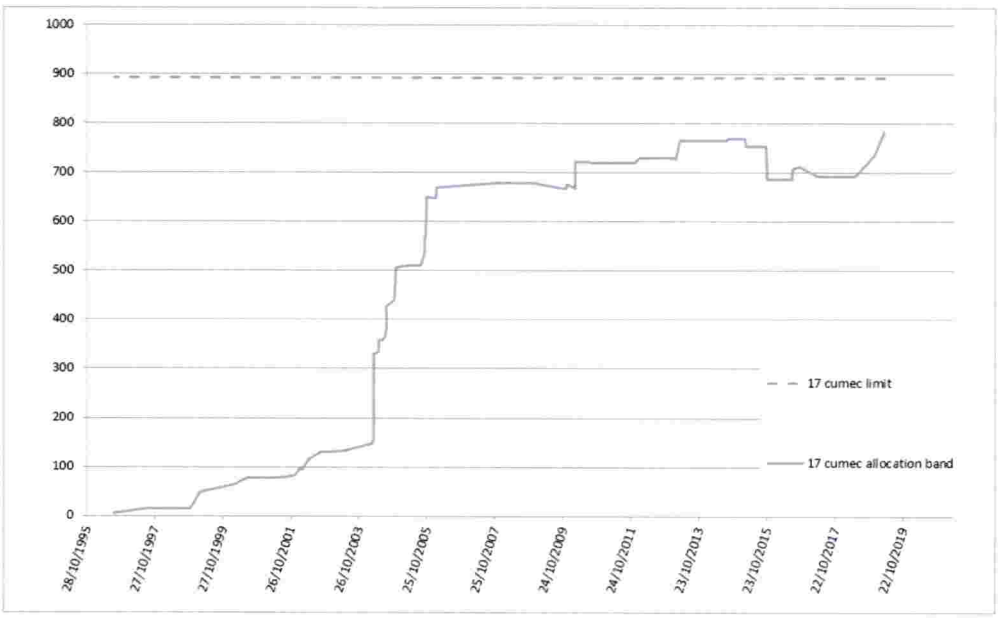


FIGURE A5. 17 M³/S ALLOCATION BAND

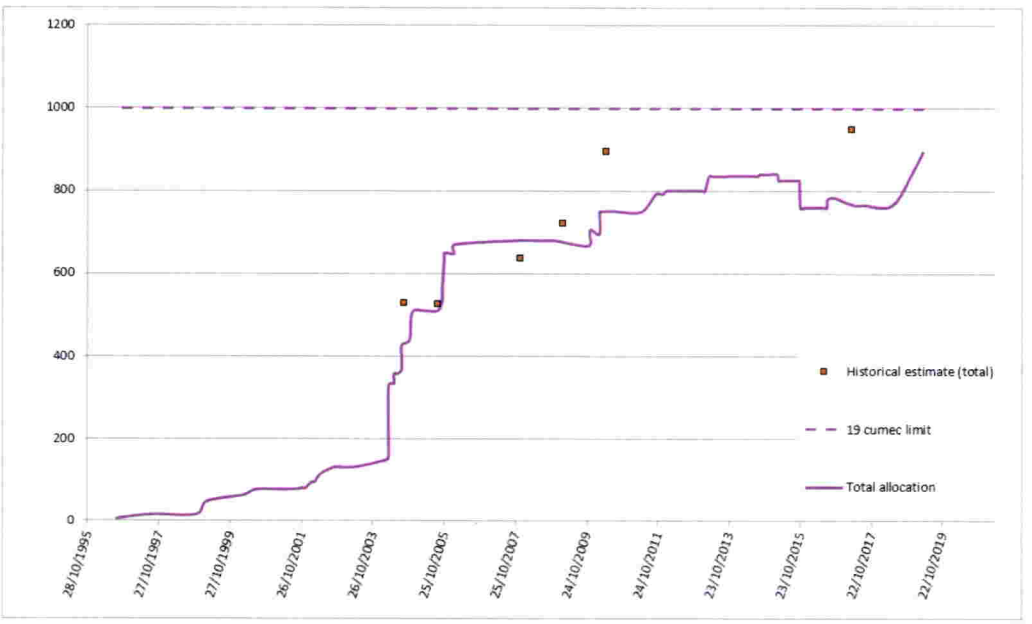


FIGURE A6. 19 M³/S ALLOCATION BAND