Koondrook-Perricoota Forest
Flood Enhancement Works

Appendix B
Preliminary draft Operating Plan

Koondrook-Perricoota Forest
Flood Enhancement Works Project

Preliminary Operating Plan
Draft

Version 1
September 2009

FORESTS NSW

NSW Government
Department of Water & Energy

State Water

Australian Government

MURRAY–DARLING BASIN AUTHORITY

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A. BACKGROUND

A1. Introduction

A1.1 The Living Murray

The Living Murray (TLM) is aimed at achieving specific environmental objectives at six icon sites along the River Murray. The program seeks to achieve those objectives by investing in water recovery, building works and measures to enable the efficient and effective use of the environmental water, and then implementing an adaptive management process to implement environmental watering activities. The icon sites are:

- Barmah–Millewa Forest
- Gunbower–Koondrook–Perricoota Forest
- Hattah Lakes
- Chowilla Floodplain and Lindsay–Wallpolla Islands
- Lower Lakes, Coorong and Murray Mouth
- River Murray Channel

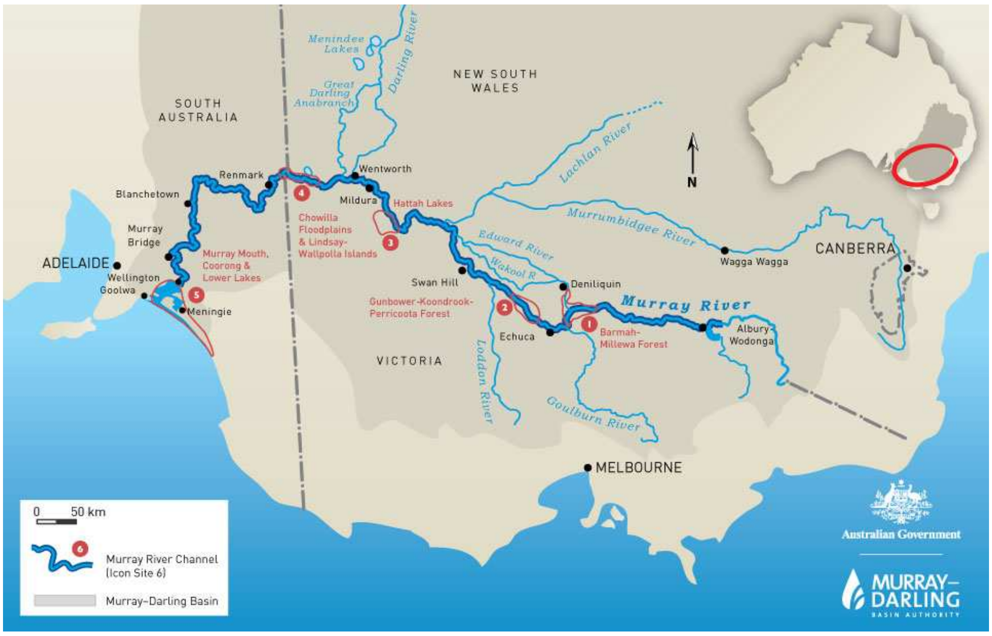


Figure A1.1: Location of Icon Sites

Naturally the wetlands and floodplains of the icon sites were watered when significant rainfall in the tributary catchments increased flows in the River Murray system, and the river overtopped its banks. River regulation, water resource use and, more recently, severe drought have all acted to significantly reduce the frequency of flooding and most of the icon sites are now severely stressed.

The Living Murray Environmental Works and Measures Program is developing and implementing projects that will construct and utilise engineering structures to direct water to the wetland and forest ecosystems without the dependency on natural high flows or floods. This will enable watering of the ecosystems at the scale, frequency, timing and duration required to achieve the environmental objectives.

Implementing this type of intervention in a regulated river system that is operated for multiple outcomes brings with it some risks and trade-offs that will need to be managed. Early awareness of this issue has lead to the projects being designed to enable highly varied and flexible operations. This flexibility enables adaptive management in response to:

- differing water availability and river conditions;
- risk management requirements; and
- the targeting of specific environment outcomes (eg vegetation response, bird breeding events) that may be required from time-to-time to achieve long term objectives.

The overarching objective for the Gunbower-Koondrook-Perricoota Forest is to maintain and restore a mosaic of healthy floodplain communities.

A1.2 Purpose of the Operating Plan

The purpose of the Operating Plan is to provide a preliminary framework for the operation of the Scheme's structures to meet key ecological objectives within the broader context of TLM Program and Scheme's governance.

Ideally, an Operating Plan consists of numerous parts focussing on the realisation of the Project's Objectives. Detailed Design and Environmental Assessment, at this stage of the project is still in progress and it is anticipated these project elements will better inform the Operating Strategy. Consequently, this Preliminary Operating Plan aims to close the gap between the Operating Strategy and the:

- Environmental objectives & requirements and management of Environmental Risks,
- Engineering & structural requirements, and,
- Operational requirements and flow event management.

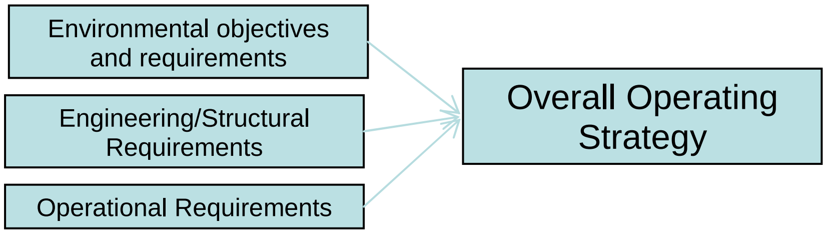


Figure A1.2: Overall Operating Strategy

The Operating Plan cannot prescribe particular watering events, rather, the Operating Plan provides an effective platform for operational decision making based on knowledge development and strong understanding of what the Scheme should aim to achieve.

A1.3 Development of the Operating Plan

The Operating Plan should be seen as a living document, which will evolve in response to changing site conditions and ongoing knowledge development. It is envisaged the Operating Plan will continually be refined in response to the Project and Scheme's needs.

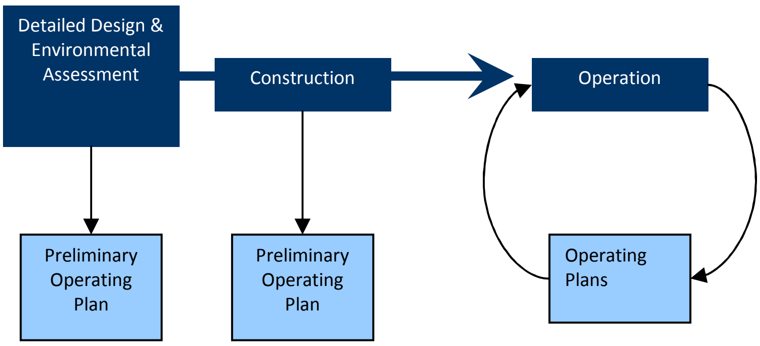


Figure A1.3: Operating Plan Development

A2 Koondrook Perricoota Forest Flood Enhancement Works Background

A2.1 Natural Water Flow Patterns

The flow of floodwater through the Koondrook forest is dominated by the Burrumbarry-Barbers Creek system. This is sourced from the Murray at a large oxbow formation known as Swan Lagoon. The first 15 km of the system comprise several deep, well-defined channels known as the Burrumbarry Creeks.

These channels then break down into a myriad of smaller, interlinked runners covering an area of approximately 4500 ha, forming a healthy Red Gum forest. These runners eventually coalesce into several defined streams, the largest of which is the Myloc Creek. The Myloc flows westward in conjunction with subsidiary runners, before becoming Barbers Creek, the primary drainage system for the western end of the forest. In addition to the Myloc, a second flow runs north-westerly, without a defined channel, eventually forming the secondary drain of the Cow Creek. The areas without defined channels (shown as dotted lines on Figure 2.1) contain known waterbird breeding areas.

The intakes from the River to Swan Lagoon commence flowing at approximately 18,000 ML/d, or 4.4 on the Torrumbarry gauge. However, the Creeks themselves do not start flowing until river level reaches around 20,000 ML/d.

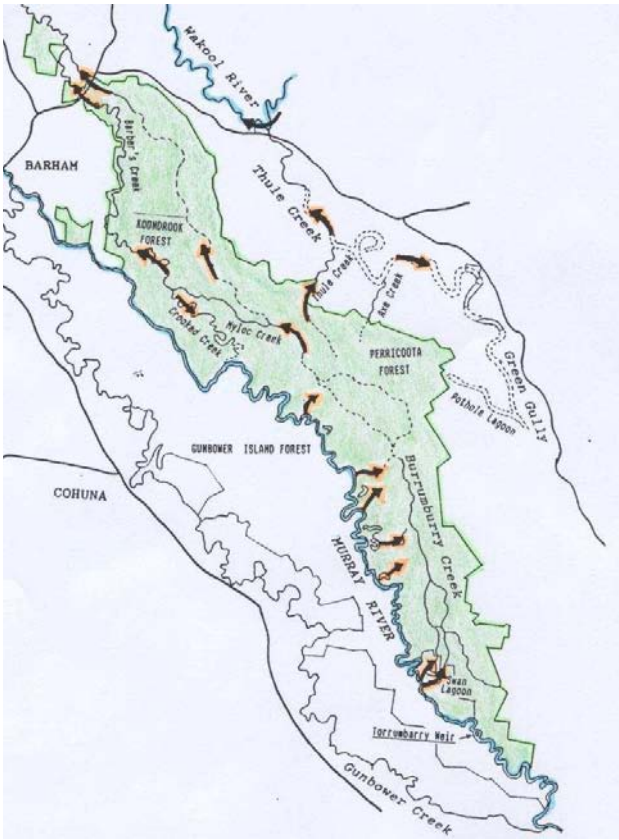


Figure A2.1. Natural inflow and outflow pattern (ref FCNSW, 1992)

There are a number of secondary water inflow points downstream of Swan Lagoon, although of much smaller scale. The most significant of these are Horseshoe Lagoon and Dead River. Additionally, there are four moderate sized, well-defined channels sourcing directly form the river; the Black Gate, Penny Royal, Thule and Crooked Creeks (see Figure A2.1 above). As river levels rise higher, above about 20,000 ML/d, an increasing number of smaller channels will begin to flow. Capacities are from 20 to 300 ML/d, and all make significant contributions to forest flooding.

Natural outflow from the forest occurs primarily at Thule Creek, about halfway through the forest, and the Barbers and Cow Creeks at the western (lower) end. During large floods water also drains out the Axe and Pothole Creeks, and floods into some adjoining private property.

The channel capacity of the Murray through Koondrook-Gunbower Forest is about 25,000 ML/d at which point overbank flows occur. Flow above 27,500 ML/d flows north through the Koondrook-Perricoota Forest and into the Wakool system. The point at which overbank flow occurs and the significant difference in flood extent is depicted in the following diagrams comprising Figure A2.2.

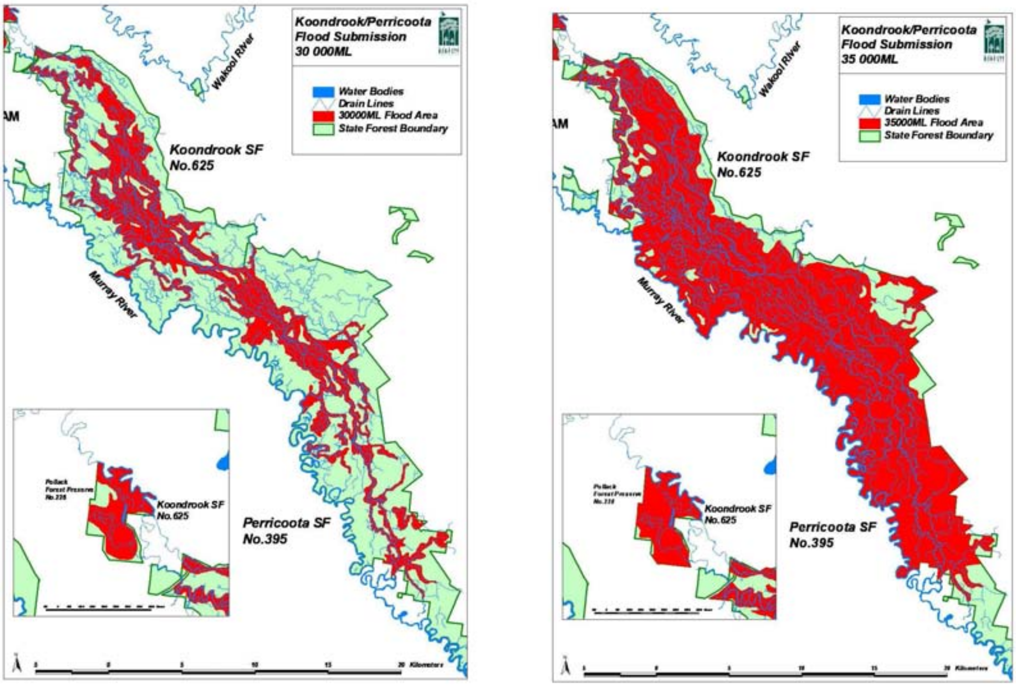


Figure A2.2. Koondrook – Perricoota Forest, Flood Area 30,000 ML and 35,000 ML

Table A2.1 compares the natural frequency of various flood events with the modelled current frequency and the expected frequency under climate change. For the purpose of the table, a flood is recorded whenever the threshold is exceeded for three months. From the table, a significant reduction in the frequency of flood events exceeding the commence-to-flow rates in the Koondrook-Perricoota Forest is evident.

Important implications for future management

The frequency of effective, large scale flooding (flows>30,000 ML/day) has reduced by 61%, and is predicted to occur in only 7% of years under climate change, an 87% reduction compared to the natural frequency.

Table A2.1: Frequency of various flood events under natural, modelled current and climate change scenarios.

River Flow (ML/d)	Flood Count (% of years flow peaks above threshold)			Effective Flood (%of years flow exceeds threshold for at least 3 months)		
	Modelled Natural	Modelled Current	Median CC Scenario @2055	Modelled Natural	Modelled Current	Median CC Scenario @2055
15 000	95	54	35	91	43	28
20 000	91	44	23	84	34	18
25 000	81	36	17	71	28	9
30 000	68	28	10	56	22	7
35 000	58	23	8	45	16	4

A2.3 Flood Enhancement Works

The Flood Enhancement Works has been designed to provide the flexibility to operate within a range of flows. This ensures that it can deliver effective and measurable environmental outcomes across a broad range of available water. The proposed scheme is capable of achieving inundation of up to 52% of the forest, but can not maintain this extent. Maximum maintainable extent is 41%, with this reducing quickly during the flood recession.

The scheme broadly falls into two categories of key infrastructure (Attachment A contains further detail on Scheme design):

Upstream Structures
Generally, upstream structures allow diversion of water into the Forest from Torrumbarry Weir and escape regulators prevent flows re-entering the Murray River, and have been designed to:

- Divert & control up to 6000ML/d from Torrumbarry Weir Pool (RL86.05 +/- 0.05)
- Contain diversion flow in U/S portion of cutting
- Distribute flow to Forest along remainder of the cutting
- In-channel flow at Bullock Head Creek around 500ML/d
- Provide required fish passage in and out of Forest
- Provide fresh water turtle escape route

- An excavated channel to connect Bullock Head Creek and the Burrumburry Creek System to the Torrumbarry Weir pool to enable the flow of water into the forest;

- Upstream structures to allow diversion of water into the forest from Torrumbarry Weir and escape regulators at Swan Lagoon to prevent flows re-entering the Murray River;

Downstream Structures
Downstream Structures to regulate water leaving the forest thus providing for the most efficient use of water. The main structural components of the proposal are summarised as;

- Downstream structures to regulate water leaving the forest and to maximise return flows back to the Murray River when required. This will include a return channel to allow return flow back to the Murray River and a floodway to increase water returns to the Murray River.

- Downstream stoplog regulators will be constructed to control the flow of the water out of the forest.

- A regulator on the Thule creek at the forest boundary to control outflow.

- A levee around the downstream perimeter of the forest is required to protect adjoining properties from flooding.

Figure A2.4 Schematic representation of the proposed structures for the Koondrook-Perricoota Flood Enhancement Works

B. OBJECTIVES

B3. Objectives

B3.1 Primary Objective

The key ecological objective is:

> *"to provide an adequate water regime to a representative area of River Red Gum forest that has, or historically supported, a flood dependent understorey (macrophytes)."*

This goal was selected for several reasons. flood dependent macrophytes are an integral component of wetland ecosystems, providing physical and structural habitat to a large variety of fauna species, including birds and fish. They also provide a crucial range of biochemical and biophysical services. These include primary production of organic material via photosynthesis; provision of biofilms enabling nutrient conversion between trophic levels; gaseous exchange and contributions to sediment/soil chemistry and facilitate carbon (energy) exchange between the floodplain and the river. A healthy water dependent macrophyte community is an essential element of a healthy floodplain ecosystem.

Furthermore, the distribution, growth and reproduction of River Red Gums and water dependent understorey plants are sensitive to the prevailing flood regime and therefore serve as valuable indicators of environmental change. Finally, a benchmark condition can be efficiently determined, as the taxonomy of vascular plants is well known, and macrophytes are relatively inexpensive to survey and monitor.

B 3.2 Secondary Objectives

A number of secondary ecological objectives have become apparent during the development of the Flood Enhancement Project. These do not drive or justify the project alone, but provide indications on how the project outcomes can be improved, where opportunities arise in the pursuit of the primary objective.

Implicit in the pursuit of an adequate water regime for River Red Gum forest supporting a flood dependent understorey, is the provision of water to shallow freshwater marshes (wetlands) within that forest. Shallow freshwater marshes require more frequent inundation than Red Gum, and benefit from more prolonged flooding and the persistence of water in pools and depressions.

A more natural frequency of flooding in wetlands that historically supported bird breeding events will inevitably provide benefits to waterbirds by improving nesting and foraging habitat, and providing cues for breeding. This benefit can be enhanced by providing for long duration flood events that support the ecological requirements for breeding colonial waterbirds. Providing a flood regime that supports occasional waterbird breeding events is therefore another secondary objective of the proposal.

Large flood events link the floodplain to the river channel, and provide breeding and foraging habitat for native fish. The ability of native fish to capitalise on the benefits of floodplain inundation is contingent on the provision of effective fish passage at critical locations. Fish passage has therefore been considered in the design of key structures, both to maximise fish outcomes, and to minimise fish-related risks that may arise through pursuit of the primary objective.

Swan Lagoon is a large, oxbow lagoon at the upstream end of the forest. The Lagoon is the primary inflow point for the forest and is a valuable wetland habitat. During feasibility investigations it became apparent that the proposal would allow for management of this Lagoon. Improvement in the frequency and duration of flooding in the Lagoon has therefore arisen as another secondary objective. Similarly, the proposal provides an opportunity to supply water to Pollack Swamp, a large wetland immediately downstream of the outflow points.

A final objective is to minimise environmental harm arising from pursuing watering objectives in the River Red Gum forest. Key risks identified include:

- over-watering other vegetation types such as Grey and/or Black Box, through excessive frequency, depth and/or duration;
- provision of breeding cues and habitat requirements for introduced species such as carp; and
- water quality risks such as the generation of anaerobic conditions (blackwater), possibly causing fish kills, or creating conditions conducive to blue-green algal blooms.
- Any additional environmental risks will be identified, and strategies for mitigation will be developed, during the Environmental Assessment process.

B3.3 Desired Watering Regime

A water regime that achieves this management goal would ensure that a significant proportion of KP Forest and a variety of ecosystems would be retained within the forest. Water regime requirements for vegetation classes and key species (taken from Icon Site EMP) to satisfy objectives is detailed in Table B3.1.

Table B3.1: Water Regime requirements for vegetation classes & key species

Vegetation class & Species	Water regime		
	Frequency	Duration	Timing
Wetland veg W'bird breeding Fish	6-9 yrs in 10 6-9 yrs in 10 6-9 yrs in 10	2-8 mths 5-8 mths 2-4 mths	August-Dec+ Sept-Feb Aug-Nov
River Red Gum forest W'bird breeding	3-9 yrs in 10 3 yrs in 10	4 mths 5-8 mths	Aug-Nov Sept-Feb
River Red Gum woodland	1-4 yrs in 10	1-4 mths	Aug-Nov
Black Box	1-4 yrs in 10	1-4 mths	Sept, Oct
Grey box, sandhills	nil		

B3.4 Secondary Outcomes, Flexibility and Adaptive Management

The natural flow regime at the Icon Site provides a guide to the water requirements of the full gamut of ecological processes and communities that exist there. This regime is highly variable, and comprises floods of various magnitudes and durations, occurring at a range of frequencies. In general, small floods occur more frequently, and larger floods less frequently. The modelled natural flow regime downstream of Torrumbarry Weir is shown in Attachment B. It is highly desirable that the Flood Enhancement Project provide a very flexible delivery mechanism that is capable of delivering a range of flood events, able to sustain a range of ecological processes and elements, for example:

- Frequent, low flows (but exceeding the commence to flow levels) to maintain the wetland habitats occurring in lagoons, depressions and flood runners;
- Less frequent floods of medium magnitude to maintain the extent of the Red Gum communities, with larger floods maintaining the extremities, and smaller floods supporting the core areas with flood dependent understorey communities (primary objective);
- Flood events of long duration to cue and facilitate bird breeding; and
- Very large, infrequent flood events to provide an occasional boost to the fringing Black Box communities.

While predictive models provide some guidance, the exact ecological outcomes arising from operation of the proposed structures will be unknown until they have been operated in real time, under a range of antecedent conditions. In line with adaptive management principles, it will be important to be able to alter the operation of the structures, both during operations and from one operation to the next, in order to react to the ecological response observed. Furthermore, the exact nature of both unregulated and regulated river flows, and the quantum of environmental water available, is unknown. Flexible operation and the ability to capitalise on a variety of flow events, is therefore an important element of structure design.

C. OPERATING CONTEXT

C4. Framework - Planning and Institutional

C4.1 The Living Murray Business Plan and Environmental Watering Plan

TLM Business Plan and overarching Environmental Watering Plan set the policy context for the TLM program. Amongst other things, the documents set out how environmental watering decisions are made, how water use is accounted, and how the outcomes are to be reported. As TLM is moving from a phase of water recovery and small scale watering activities, into a longer term program of large scale watering activities, both of these documents are to be reviewed in 2009.

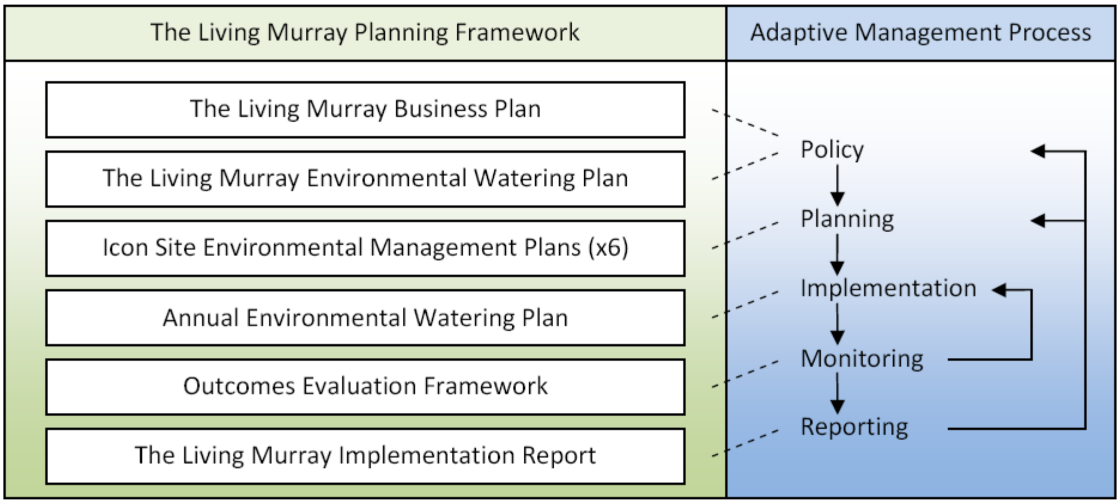


Figure C4.1: The Living Murray planning framework and links to typical adaptive management process

C4.2 Icon Site Environmental Management Plans

Each icon site has an Environmental Management Plan. The document sets out land management responsibilities, environmental objectives and targets, activities to be undertaken to achieve those objectives, consultation arrangements, complementary actions, and the monitoring framework for the site.

Since the existing plans were written there has been substantial progress on the development of the proposed environmental works and measures. It is now clear that these will become the major mechanism to achieve the environmental objectives at most sites. The current Icon Site Environmental Management Plans are therefore to be reviewed and updated during 2009. A focus of the review will be the development of operating plans for the proposed works, including the adaptive management and monitoring framework.

C4.3 Annual Environmental Watering Plan

An Annual Environmental Watering plan is prepared at the beginning of each 'water' year (the water year is from July to June, aligning with the seasons and water allocation policy in the River Murray system). The plan is typically prepared around May/June for the forthcoming year. It sets the environmental watering priorities under The Living Murray for the next 12 month period by:

- Considering current and likely water availability for the forthcoming year;
- Considering the need and priority of watering activities at the icon sites; and
- Establishing a decision making framework for watering actions for the forthcoming year, based on water availability and unfolding conditions at the icon sites.

The Annual Environmental Water plan is built up from inputs from the Icon Site Managers. The need and priority of watering activities for the individual sites considers the condition of the sites, recent watering history, ecological outcomes to be targeted in that year, and other conditions, particularly related to environmental and third-party risks.

The relative priority of the proposed watering activities across the icon sites is then compared and a hierarchy of watering actions is developed aligning with water availability thresholds and other implementation criteria. A decision making structure is established so that rapid decisions can be made during the water year as it unfolds and water becomes available.

C4.3 Implementation of Watering Actions

The Annual Environmental Watering Plan is deliberately structured to be adaptive in response to water availability and other environmental conditions. Implementation of the associated watering activities is also adaptive. Implementation commences in June-July but would continue for the whole watering year.

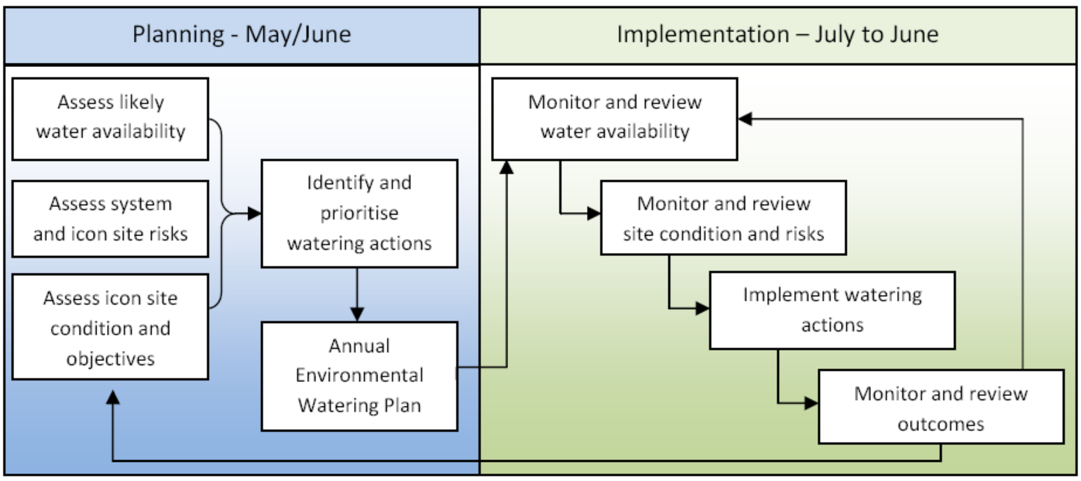


Figure C4.2 : The Living Murray environmental water planning and implementation

On an ongoing basis the MDBA and EWG review the Annual Environmental Watering Plan against the availability of environmental water. Actions are selected and approval is sought for the use of the associated water. Approval to utilise The Living Murray water is provided by the MDBA, while the use of unregulated flows may need approval from State agencies.

C4.4 Environmental Watering Group

It is envisaged that the Environmental Watering Group (EWG) would oversee the implementation of the environmental watering plan for the River Murray System each year. EWG would meet as required to provide advice and feedback to MDBA and jurisdictions regarding how environmental operations for the overall River Murray System were proceeding, as well as event planning and prioritisation for the coming weeks and months as appropriate.

C4.5 Outcomes Evaluation Framework

The Outcomes Evaluation Framework (OEF) is the framework for monitoring and evaluating the outcomes of environmental watering and the achievement of the icon site objectives under The Living Murray. The current framework was finalised in 2007. It has led to the development of condition monitoring plans for the icon sites (which feed into the annual icon site condition reports) and investment in many intervention monitoring projects that have improving understanding of ecosystem processes and the specific outcomes of watering actions.

As the proposed environmental works are nearing construction, and there is now a good understanding of the associated risks and adaptive management requirements, it was recently agreed that the OEF will be reviewed. The framework will need to accommodate and focus on the requirements for adaptive management of large scale environmental watering activities, and the need to monitor and respond to the identified risks. An updated OEF will drive the development of detailed monitoring plans for the proposed environmental works.

C5. Water Availability

C5.1 Regulated, water that is subject to an entitlement, and Unregulated

From a regulatory point of view water can be sourced from different types of entitlements that have different reliability definitions. These entitlements can be accessed at varying times because they have different triggers describing when and under what conditions they become available. Potentially the different entitlement types which could be used at the site include any entitlement that is deemed available for use in an environmental watering context. This is complex, in that within the regulated water category alone there are the following available entitlement types: NSW General Security, NSW High Security, NSW Supplementary, Victorian High Reliability Water Share, and South Australian Water Entitlement.

There are various account managers including the Living Murray (MDBA) water manager, the Commonwealth Water Manager, the States' water managers and, potentially individuals who may deem it appropriate to plan for their entitlements to be used in the Koondrook Perrricoota Forest for environmental watering purposes.

Additionally both NSW and Vicotoria have sovereign access to their own Unregulated Flows – flows that are surplus to other requirements as described in the NSW Water Sharing Plans, in the Victorian Bulk Entitlements and in the Murray Darling Basin Agreement.

C5.2 Commonwealth Water

The Commonwealth Environmental Water Holder manages the water entitlements that the Commonwealth is currently acquiring through the following programs:

- The *Restoring the Balance in the Basin* program will purchase water entitlements from willing sellers.
- The *Sustainable Rural Water Use and Infrastructure* program will be investing in infrastructure improvements and other projects to help communities make an early adjustment in anticipation of the new Murray-Darling Basin cap. Where a share of water savings is acquired by the Government these entitlements will also be managed as part of the environmental water holdings.

The amount of water available for use depends on the volumes acquired and seasonal water allocations. The role of the Commonwealth Environmental Water Holder is to protect and restore the environmental assets of the Murray-Darling Basin or assets outside of the Basin where water is held for that area. The Commonwealth Environmental Water Holder is currently developing a long-term framework for prioritising environmental watering actions.

C5.3 NSW Environmental Water

The main tool used for managing the NSW's water resources are Water Sharing Plans. These are used to set out the rules for the sharing of water in a particular water source between water users and the environment and rules for the trading of water in a particular water source. The environmental rules in the water sharing plans are designed to:

- limit extractions so that the major share of water is protected – between 56% and 80% of the average annual water in the regulated river systems will be retained in the river – amounting to over five million megalitres (a megalitre is a million litres) in the inland systems[1].
- replicate natural flow patterns or events so as to provide water when and where it will best meet environmental needs - on average the rules for the regulated rivers will return an additional 220,000 ML of water to the environment over and above that required under the Murray Darling Basin cap.
- the Water Sharing Plan for the NSW Murray - Lower Darling Regulated Rivers Water Sources has planned water that is to be provided to the Barmah Millewa Forest allocation. There can be up to 500 GL of this (half contributed from NSW and half contributed from Victoria). This water is not to be used for other purposes than to water the Barmah Millewa Forests. It also has Adaptive Environmental Allocations which can total 32,027 ML in any one year. This water is potentially available for use within Living Murray Icons Sites.

C5.4 Unregulated Flows

Unregulated flows are normally declared by the Murray-Darling Basin Commission when high flows are forecast to occur that are in excess of that required to meet South Australia's entitlement flow and cannot be captured and re-regulated in Murray System storages. This declaration triggers processes to permit use of the unregulated flows for purposes and under rules that vary between jurisdictions.

C5.2 TLM Water

The Living Murray has implemented a range of water recovery measures. The TLM water will include a range of different water entitlements with difference use provisions and reliability. The amount of water available for use will vary from year to year with changes in water availability. In relatively 'wet' years there will be much more than 500 GL available, whilst in relatively 'dry' years there may be much less than 500 GL. Based on historical climate conditions the average will be about 500 GL per annum.

[1] These are non climate adjusted figures and relate to the modelled return to NSW Water Sources at the time of the enacting of the Inland Water Sharing Plans in 2006.

The portfolio will also include ‘regulated’ water that can be ‘called’ from storages, and water that is ‘unregulated’ that is available in some higher flow situations (consequently it cannot be ‘called’ from storages – this water is sometimes called non-callable).

Some of the water will be able to be carried over from one year to the next which then means the water is in the account at the start of the new water year, this will potentially mean that in low inflow years some sites can gain access to TLM water at the start of the water year on the 1st of July. Table C5.1 outlines the likely make-up of the environmental water portfolio at the end of 2009.

Table C5.1: Likely makeup of The Living Murray environmental water portfolio at end of 2009

Type of Water	LTCE (GL)	Entitlement Volume (GL)			
		High Security	General Security	Low Security	Total
Callable	418 to 440	123	225 to 239	260 to 268	608 to 631
Non-callable	68	-	-	-	377

Figure C5.1 shows the expected variability in availability of environmental water under historical climate and 2030 median (or best estimate) climate change conditions (as per CSIRO Sustainable Yields project 2008). Only callable entitlements are shown. The data also includes an additional 70 GL of River Murray Increased Flows from Snowy Water Inquiry Outcomes Implementation Deed, which is also available for use under The Living Murray.

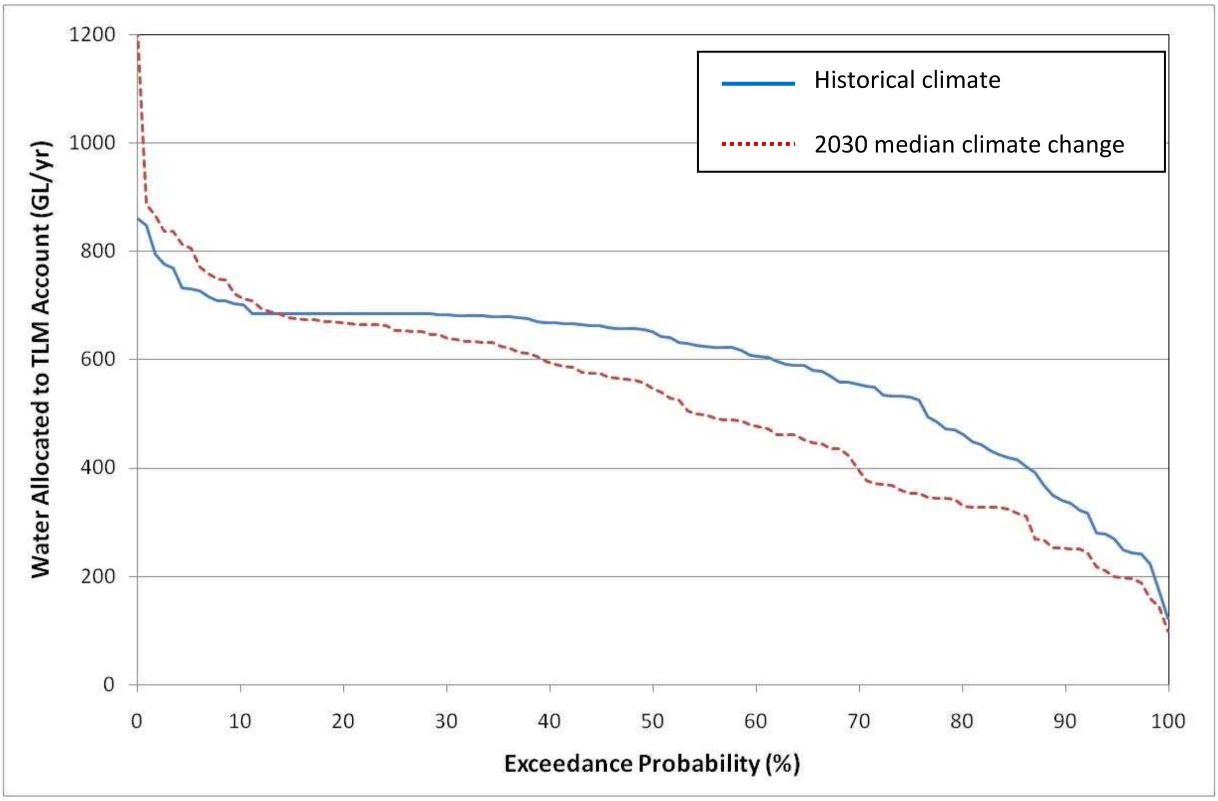


Figure C5.1: Predicted allocation to The Living Murray environmental water account under historical climate and 2030 median climate change

C6. Operational Constraints & Hydrologic Conditions

C6.1 System Constraints

The Figure C6.1 shows the schematic of the broader system and summarises the system travel time in days. It shows travel time within the Goulburn River system from Eildon Dam to Torrumbarry Weir is 11 days and similarly within the Murray system from Hume Dam to Torrumbarry Weir is 11 days.

C6.2 Hydrologic Conditions

With reference to hydrologic conditions in the River Murray downstream of Torrumbarry Weir, the operation of the proposed flood enhancement project can occur in one of three ways:

1. For flow events <18000 ML/d, water can be delivered to the forest through the inlet channel, and

2. For flow events >18000 ML/d, water can enter the forest through natural watercourses/effluents, potentially supplemented with water delivered through the inlet channel.

3. There will also be larger flood events within the forest when the flood enhancement project is not operated.

Table 6.1 explains the relationship between the river flow to the forest inflow to the % inundation.

Table 6.1 Relationship between river flow and inflows to Koondrook-Perricoota Forest

River flow	Inflow to forest	Inundated area	
ML/day	**ML/day**	**ha**	**% of total**
15,000	0	-	-
20,000	300	500	2
25,000	1,500	3520	11
30,000	3,800	10,300	33
35,000	6500	25,000	80

The in-bank capacity of Barbers Creek is significantly impacted by the presence of four constructed block banks and one debris bank downstream of the Scheme. Outflows to the Barbers Creek system are constrained to 250 ML/d, unless downstream private infrastructure is removed by prior natural flow or through a system upgrade.

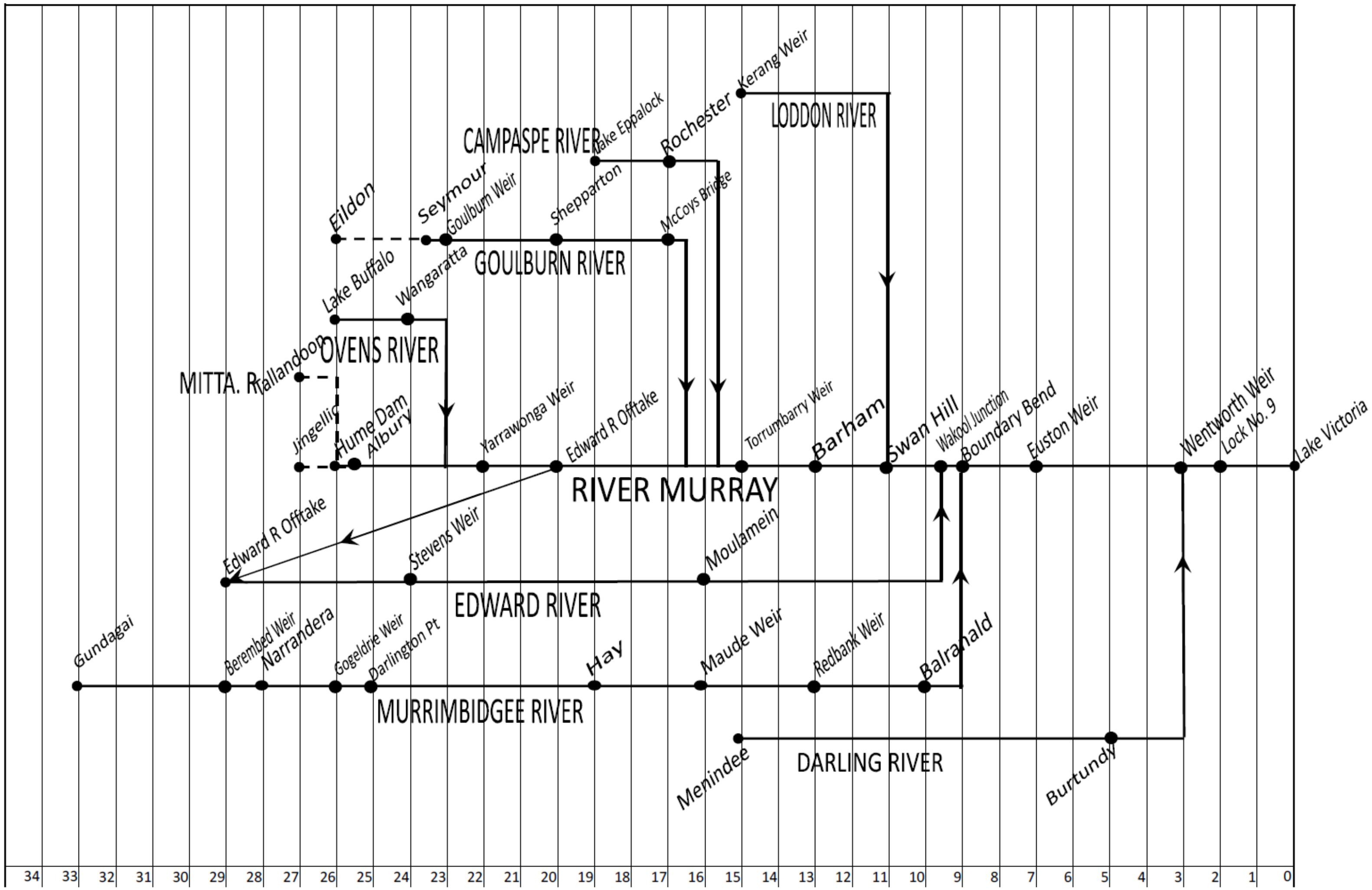


Figure C6.1 : System Travel Time in Days to Lake Victoria

C6.3 Operational Constraints

Inlet Regulator & Channel - The top of regulator gates closed will have RL 86.55 (flood of record) & diversion capacity of flows between 2000 ML/d and 6000 ML/d with a max. velocity at structure = 1.57 m/s. The inlet channel is designed for a maximum velocity of 0.6 m/s.

Swan Lagoon – A maximum velocity of 10 m/s and minimum depth of 300 mm. Waterway areas of 60% waterway at RL84 (top of sheet piling) and 80% at top of banks RL85 approximately.

Return Regulator & Channel - Ability to regulate return flows up to 1850 ML/d and contain the downstream pool to RL 78.5Up to 1,850 ML/d. Flows can be returned to down to invert level of the return channel regulator, being 77.3m AHD.

Downstream Levee & Regulators – The downstream levee will contain a maximum design pool at RL78.5. Under some circumstances, the release rate to Barbers Creek may be constrained by flooding risks to downstream landholders.

D. WATER OPERATIONS

D7. Governance

D7.1 River Murray Operations - MDBA

MDBA will be responsible for the operational control of the Koondrook-Perricoota structures, as these works will be an important component of all River Murray System works. River Murray Operations staff of MDBA oversee and co-ordinate all water deliveries along the River Murray System.

River Murray Operations staff will issue instructions on a day to day basis for regulator settings and flow releases, the same as it does for other major works along the river system. Appropriate arrangements for onsite control of the works (responding to MDBA instructions) will be put in place through the jurisdictions.

D7.2 Operations Committee

For site specific advice on watering at Koondrook/Perricoota, River Murray Operations will also establish a small 'Operations Committee' to provide advice to MDBA regarding event management and day-to-day management of the structures. Other 'Operational Committees' will also be established for other sites along the river system as required.

The Operations Committee will include MDBA and jurisdictional representatives, including the persons actually involved in day-to-day management of the structures (including Goulburn-Murray Water staff at Torrumbarry Weir), Operations Manager (State Water), the Environmental Manager (Forests NSW) and ex-officio members (Murray CMA and Victorian representatives) as required., The 'Operations Committee' will meet weekly, or as required, to provide feedback on how the operation was going and to plan ahead for the next week. Between these meetings, River Murray Operations will make the operational decisions required to implement the watering plan in the best possible way taking into consideration the other water requirements along the river system.

One member of the Operations Committee will be responsible for stakeholder management during the event. Specifically, liaising with downstream landholders, informing the wider community and managing media releases.

The Environmental Manager (Forests NSW) will be responsible for environmental monitoring, reporting and advice to River Murray Operations. A fish expert will report to the Environmental Manager and will be responsible for providing advice on fish risks and opportunities. The Operations Manager (State Water) will manage operation and maintenance of all structures within the Scheme, utilising Goulburn Murray Water and Wakool Shire Council for day-to-day operation of the Scheme.

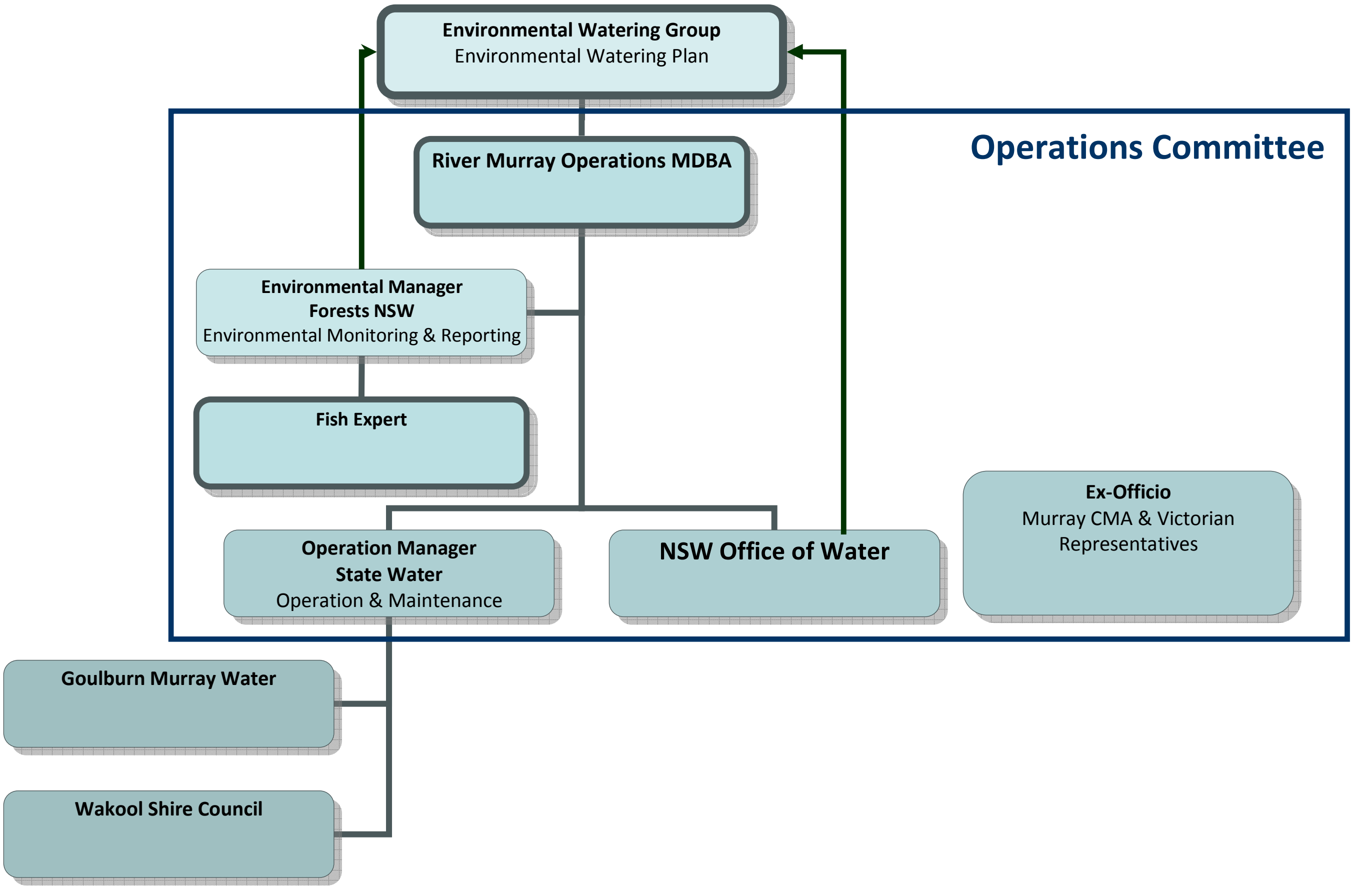


Figure C7.1 : Institutional structure water planning and implementation

To date The Living Murray has implemented relatively small watering activities, but once the water recovery program is complete and the proposed environmental works are constructed, much larger scale watering will be possible and adaptive management will become increasingly important.

The works can be operated to target specific environmental outcomes. It is likely that different events will target different outcomes (eg short duration events to maintain vegetation, longer duration events to enable successful bird breed), and to achieve long term objectives planning for future watering events will give careful consideration to the environmental outcomes of past events. Future monitoring plans will need good experimental design so that information is available to inform these decisions.

D8. Watering Principles

The Operations Committee will base decisions to initiate watering events and management of watering events, on an established set of Watering Principles, based on a heuristic rule approach.

D8.1 Watering Principles - initiation

The decision to initiate watering is based on considerations and constraints of the operating environment.

- Water availability and water requirement are the foundations for the decision to initiate a watering event.
- Clear ecological targets will be defined before initiating a watering event.
- Watering events will aim to maximise net environmental benefits.
- Early watering during cooler months (Winter and early Spring) will be favoured over Summer watering.
- Large watering events will not commence beyond October.
- Overbank flows will be favoured as a cue for initiating watering.
- Unregulated water will be used when beneficial.
- Autumn watering will be considered if environmental water is not made available until late in the season.

D8.2 Watering Principles - management

The management of a watering event will be based on the following principles:

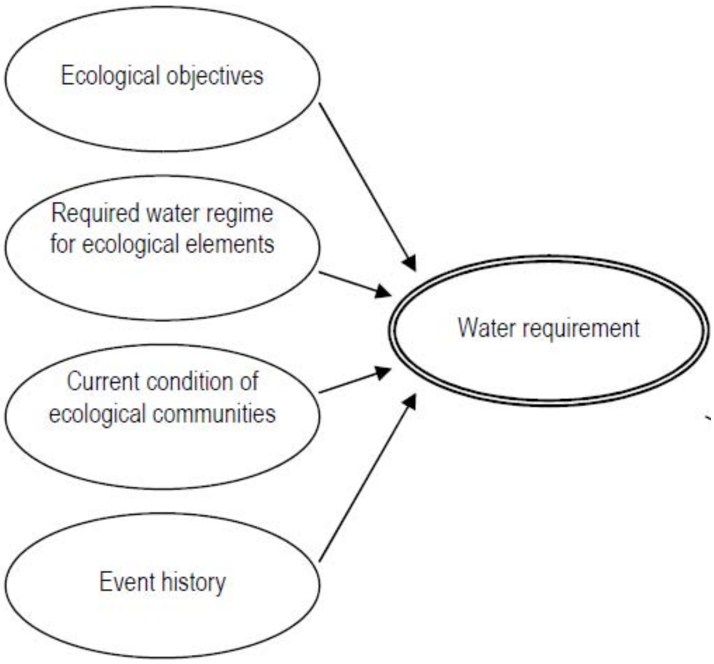
- The initial ecological target will be pursued for as long as practicable.
- Modelled natural hydrographs will be used as a guide during the management of an event.
- Where beneficial, managed watering will prolong or enhance overbank flow.
- Downstream regulators will only be used to the extent needed to achieve the required objectives.
- Watering operations will aim to minimise impacts to third party property.
- The protection of watering infrastructure overrides meeting environmental targets.
- Inflows through Swan Lagoon will be favoured over equivalent inflows through the inlet channel.
- Use of Barbers Creek will be maximised, where possible. However, very small inflow events may require as much water as possible to be retained in the forest for the achievement of ecological objectives.

D9. Decision-making

D9.1 Decision to Water

The decision to water will be based heavily on the water requirement of the ecological system and the availability of water, will be guided by the series of Watering Principles, and tempered by risk management strategies. Figure D9.1 shows the decision making process and some of the parameters that will be considered.

Water Requirement
The need for water is defined by the ecological objectives of the project, the natural water regime for the various ecological communities and processes, the condition of the site, and the recent flooding history.



The over-arching ecological objective is described in Section B3 and contributes to the maintenance and restoration of a mosaic of healthy floodplain communities by meeting the critical needs of the River Red Gum community. Further objectives refer to healthy wetlands, waterbird breeding events, native fish passage and residence, and Swan Lagoon.

The natural water regimes required by key ecological communities and processes have been described in Section B3. The water requirements specify the frequency, duration and seasonality of the required flooding regime and are a reflection of the pre-regulation flood history. Watering will aim to deliver a regime that minimises over- or under-watering, that is watering outside the natural regime. Watering will generally begin in late Winter-Spring.

The current condition of the site will be informed by a long term condition monitoring program focusing on fish, bird and vegetation. Key variables for consideration when determining the water requirement will include: recent history of successful waterbird breeding events, time since the last successful River Red Gum regeneration event, condition of bush birds (passerines – as a measure of forest health), understory condition, River Red Gum crown health, and wetland plant health including structural habitat for bird breeding.

The recent flooding history assists the determination of the water requirement. Critical parameters for consideration include: time since the last event, and recent event descriptors including duration, extent, frequency, seasonality, and variability.

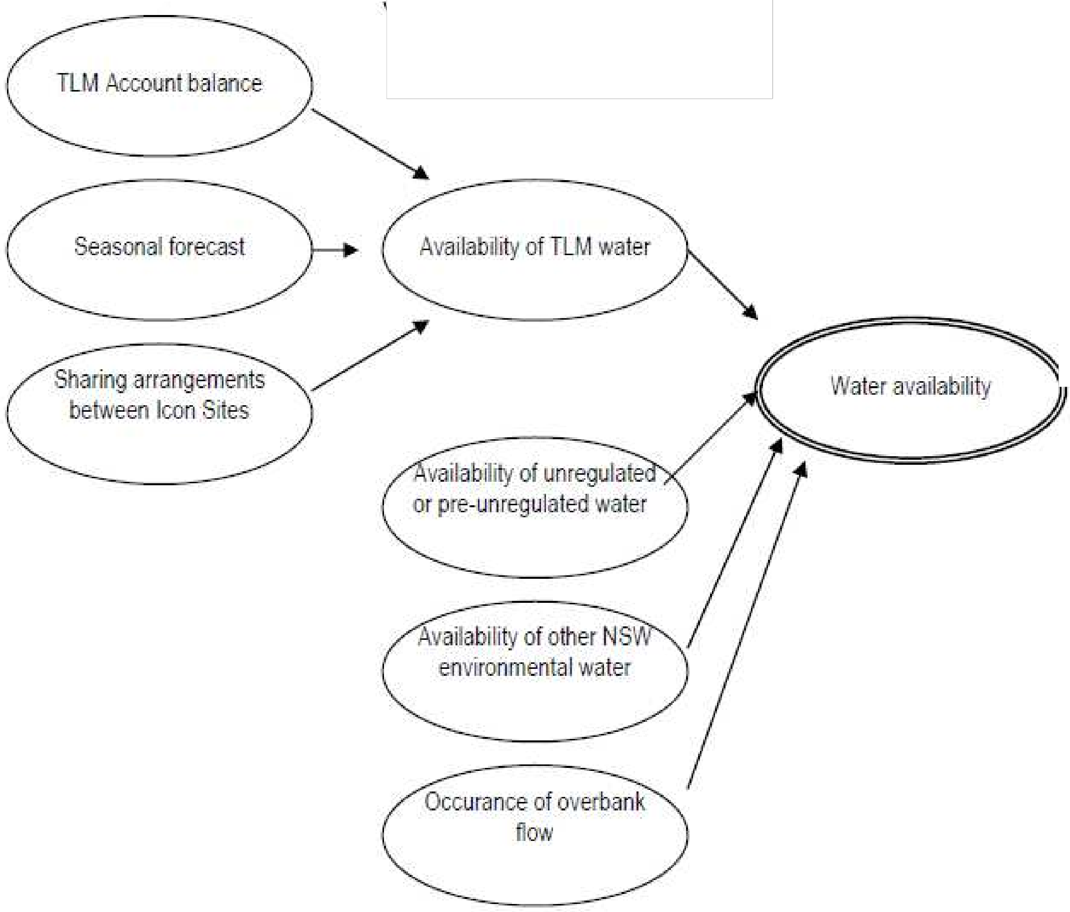
The current modelled natural hydrograph (that is, water that the site would be currently receiving if the River were unregulated) can also provide clues as to whether an event is ecologically desirable. It is understood that migratory birds, and possibly other fauna anticipate flooding in response to current inflows.

Water availability
Water availability is a function of various water account balances, the seaonal outlook, sharing arrangements with other parties, and the occurance of overbank flow.

Water accounts change throughout the water year as allocations are progressively announced. Carry-over will be available at the start of some watering years (July), but most water will become progressively available. The seasonal outlook, particularly inflow forecasts will be critical to determining the likelihood of water becoming available later in the season. In some years, the water will not become available until after Summer, necessitating consideration of Autumn watering.

TLM water is to be shared with other Icon Sites. The process for allocating TLM water is described in Section C5. This process will occur around May, and will progressively determine the distribution of TLM water as the season unfolds. Allocation of TLM water to the Koondrook-Perricoota site will include the probability of various volumes, and the triggers that will make the water available, rather than a fixed volume committed in advance. Other NSW environmental water will most likely be made available in the same manner, as will water held by the Commonwealth Water Holder.

Unregulated water will be made available as per normal declaration rules. Unregulated flows are made available on very little notice (although their occurrence can be predicted from recent and current inflows) and must be taken immediately.



The occurrence of overbank flow will provide a strong argument for initiating a managed event. Overbank flow provides an ecological cue to birds and possibly other fauna, and wets up the main distributaries, increasing the effectiveness of subsequent watering. Overbank flows may also occur during a managed event and will be carefully managed so that the Swan Lagoon regulators do not exclude small overbank events. The inflow channel may need to be shut off to enable the Swan Lagoon regulators to receive overbank flows. Natural inflows will be preferred over managed inflow because if provides for superior fish passage and may avoid excessive flooding in grey box communities.

D9.2 Decision-making during events

There is no single way to operate the proposed Koondrook-Perricoota Flood Enhancement works. The operation of the Scheme will target the long-term achievement of the environmental objectives as they respond to water availability, watering history, risks and engineering constraints. Implementation of specific watering events will need to adapt to:

- Changes in water availability that may enable the watering activity to be extended or varied to achieve additional or different environmental outcomes (eg a watering

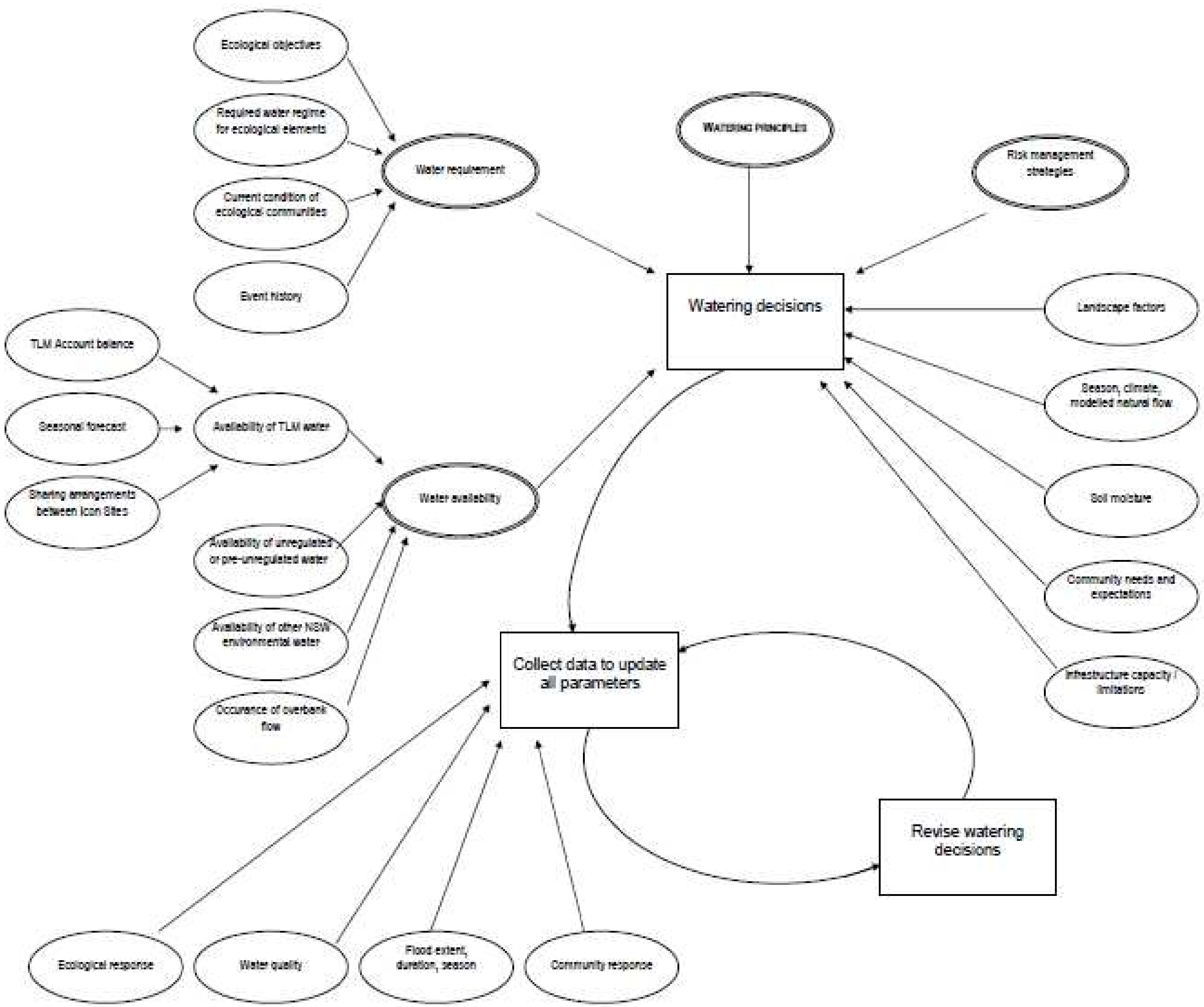


Figure D9.1: Decision making flow diagram

- event initiated to provide a vegetation response may be extended to enable colonial nesting waterbird breeding to occur);
- Monitoring of environmental outcomes (eg if a fish spawning event is observed then the event may be extended to allow this to complete);
- Monitoring of environmental risks (eg salinity, blue-green algae or blackwater); and
- Monitoring of impacts on third-parties (eg impacts on downstream landholders or other communities)

The Operations Committee will meet weekly, or as required, to provide feedback on how the operation is progressing and to plan ahead for the following week. The Committee will be responsive to changes in the operating environment, detected through both formal and informal (observation) monitoring. Figure D9.1 shows the decision making process and the key parameters that will be considered by the Operations Committee. Key parameters remain the same as when deciding to initiate an event.

The water requirement will be re-evaluated regularly throughout the operation based on monitoring of the ecological response at the site, and the flood parameters.

Key ecological response parameters include:

- Tree crown response (presence of leaf growth)
- Wetland response, including vegetation, macroinvertebrates and frogs
- Native fish behaviour, particularly passage through structures and spawning
- Waterbird behaviour, particularly mating, nesting and fledging

Key flood parameters include:

- Inundation extent
- Duration of the event so far
- Time of year/season
- The shape of the inflow hydrograph

Watering decisions will take account the changing water availability scenario, including updated account balances, forecasts, water sharing decisions, unregulated flow availability and overbank flow.

D9.3 Risk Management Strategies

Risk management strategies will be responsive to monitoring information collected in the field. Additional parameters of particular interest include:

- Water quality both within the forest and at outflow points, particularly dissolved oxygen levels and the presence of blue-green algae
- The nature of water in key terrestrial communities such as Grey Box
- Pest fish behaviour, particularly passage through structures and spawning of carp
- Public response to the event, particularly from neighbours and landholders receiving floodwaters from the forest.

Additional considerations include the physical condition of the scheme infrastructure, and estimated water use.

An ecological risk assessment has been prepared for the flood enhancement scheme. The assessment identified a number of risks and possible mitigation measures. Many of these can be managed or mitigated to varying extents by developing and implementing appropriate operating strategies, particularly for the downstream structures. Monitoring of the risks together with response plans and triggers will also assist in managing the risks. Key ecological risks that can be addressed through wise operation of the structures include:

- Damage to terrestrial communities from flood waters, especially Grey Box.
- Blackwater production in the forest and subsequent release into the Barber Creek and Wakool River.
- Algal blooms in the forest and release into the Barber Creek and Wakool River.
- Depletion of fish populations in the Murray River due to diversion of flow pulses.
- Reduced fish recruitment in the Murray River due to diversion of eggs and larvae.
- Development of pest fish populations (including carp) in the forest and and subsequent release into the Barber Creek and Murray and Wakool Rivers.

Vegetation

Grey Box is considered a terrestrial community, although it does occur in a mixed type with River Red Gum, suggesting at least a low tolerance to flooding. The Scheme has the capacity to inundate areas of Grey box in excess of natural water requirements, particularly at the upstream end of the forest where the inlet channel disperses diverted water. Water to Grey Box communities will be minimised through use of natural inflow points where conditions allow, rather than complete reliance on the inlet channel. Disbenefits to Grey Box will be weighed against benefits to other vegetation communities when making watering decisions.

The tolerance to sustained inundation of River Red Gum currently in very poor health. This risk may be managed by initially applying short duration flooding or trialling flooding of limited areas to monitor the impact. However, it is acknowledged that there is potential for this risk to occur if a natural flood event arose and that death will also result if trees are not watered.

Blackwater

Production of blackwater occurs when submerged organic matter decays, creating tannin-rich water which subsequently becomes anoxic. The anoxic conditions present a risk to fish and crayfish if they cannot find safe, alternative oxygenated habitat. The likelihood of anoxic water increases with long residence times, summer inundation and stratification in deep water.

The potential to promote anoxic conditions will be considered as part of watering decisions. Strategies to mitigate blackwater risks include:

- Water quality monitoring will inform watering decisions.
- Early watering (winter/early Spring) will be favoured to keep water temperatures low.

- Flow-through scenarios will be implemented where practicable, with due regard to downstream constraints in the Barber Creek and trade-offs with the ecological cost of reduced flood duration and/or extent in the Forests.
- The passage of natural flows through the forest will be useful for periodically flushing organic matter from the Forests.
- Outflows can be controlled to minimise the release of highly anoxic water into receiving systems, in terms of gross volume, and also by releasing water from more oxygenated parts of the pool.
- Flow rates in the Wakool and Murray Rivers may be manipulated to provide diluting flows to minimise potential impacts to these systems.

The significance of algal blooms has not yet been fully evaluated, but the risk is expected to be low. Blue-green algae more commonly form blooms in late summer and autumn, which is when the forest will generally be dry. There is some potential for small autumn watering events but these are likely to be restricted to the more permanent wetland areas and unlikely to require pooling large volumes of water. However, it is anticipated that a more detailed evaluation of this risk will be undertaken as part of the Environmental Assessment process. Mitigation measures will be developed once the risk is better understood. Monitoring for the presence of blue-green algae in the forest will be undertaken during events.

Fish Impacts

The Scheme poses a number of risks to native fish populations including depletion of spawning triggers by diverting flow pulses from the River, diversion and stranding of large native fish eggs and larvae, and an increase in exotic fish populations (including carp). A fish passage structure has been built into the scheme to allow for flexible management but mitigation measures are problematic due to knowledge gaps regarding fish behaviour.

Re-connection of the floodplain to the river system is important for fish recruitment as floodplains are the nursery for fish. In addition the return of water from the floodplain is likely to stimulate within the river ecosystem. Implementing large diversion events outside of main fish spawning times will reduce impacts on native fish spawning. There may also be opportunities to create positive fish outcomes in the Barbers, Wakool system by releasing more water through the downstream regulators, although this may have trade-offs in the Murray.

It is anticipated that the Operations Committee that makes the watering decisions will include a fish expert in order to identify ways of maximising benefits to native fish and minimising disbenefits. Monitoring of fish behaviour during watering events will inform subsequent decision making.

Land Use & Social Issues

Potential land use and social risks have been identified but are yet to be fully evaluated. Risks of this kind occur primarily as a result of modifications to the flooding regime in the Barber Creek, downstream of the Forests, where water exiting the Forests pass through private property. The Environmental Assessment process will identify any likely affected land users and the potential to cause land use conflicts with neighbouring and downstream uses as a result of the operation and recommend mitigation measures. One member of the Operations Committee will be responsible for stakeholder management during the event. Specifically, they will liaise with downstream landholders, inform the wider community and manage media releases.

Additional ecological, social and economic risks arising from the operation of the scheme will be identified and addressed during the Environmental Impact Assessment process and through environmental monitoring. The outcomes of this process will be incorporated into future versions of this plan.

D9.4 Other Considerations

The decision to water will also take account of a variety of relevant parameters including:

- Antecedent soil moisture – This will impact on infiltration rates and affect the rate of spread of flood waters, time to fill the pool, and required water volume.

- Landscape factors – Partcularly relavant to waterbird needs, the presence or recent history of waterbird breeding in Gunbower Forest, Barmah-Millewa, and other locations in the Murray Darling Basin may influence the targeted ecological objective.

- Season – Watering during cooler months is preferred. Depending on the water requirements at the site, water made available during Summer may be rejected in favour of Autumn watering.

- Climate – Watering during widespread drought will be avoided except for the maintenance of critical processes and drought refuges.

- Modelled natural flow – Flow that would have occurred at the site if there were no river regulation, provides a clue for appropriate timing of events.

- Community needs and expectations – Watering planning will take account of the projected impact on the local community in terms of forest use and off-site impacts.

- Infrastructure capacity and limitations – See section C6 for constraints posed by infrastructure limitations.

D10 Predicted Operation 1990-2005

The following provides some detail around how the scheme might have been operated had it been constructed as proposed.

D10.1 Predicted Operation

MSM-Bigmod is two computer based models that work together - output from MSM (Monthly Simulation Model) feeds into Bigmod (a daily simulation model). MSM models monthly volumes of water in the river system based on inflows (from rainfall and tributaries), storage volumes and outflows (including diversions and losses). It models the River Murray system from Dartmouth Dam to the Murray mouth, including the Lower Darling River. It is used for:

- planning seasonal allocations
- planning releases from storages
- water accounting
- salinity modelling

Utilising predicted flow under the CSIRO Median Climate Change Scenario 2030, data from 1990 – 2005 was used to predict how the Scheme would be operated in a real-time sense based on Watering Principles and with respect to water available through the TLM account and natural inflows. The years 1990 – 2005 were used as it demonstrates a relatively wet and dry periods.

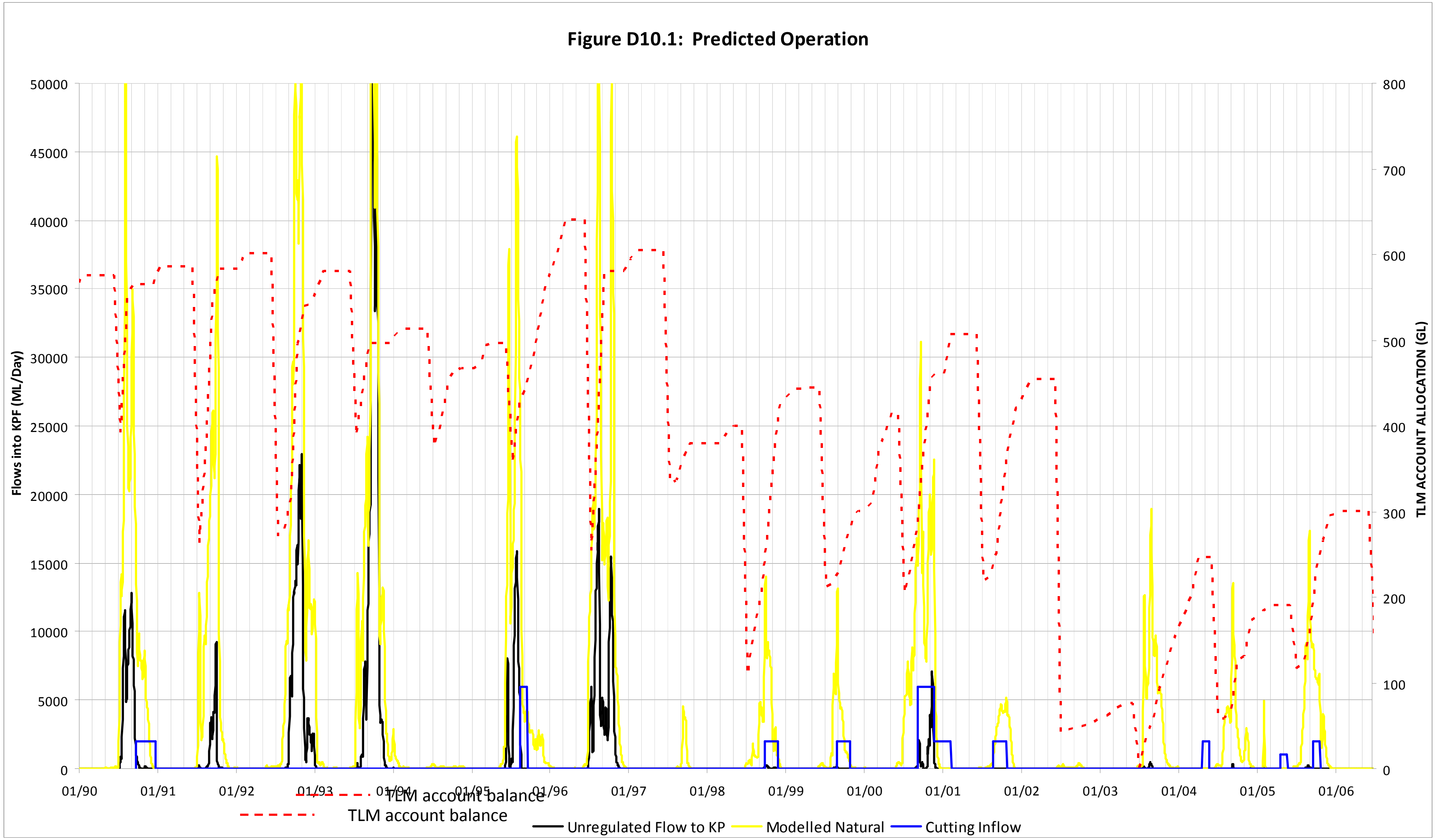


Figure D10.1: Predicted Operation
Flows into KPF (ML/Day)
TLM ACCOUNT ALLOCATION (GL)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
800
700
600
500
400
300
200
100
0
01/90
01/91
01/92
01/93
01/94
01/95
01/96
01/97
01/98
01/99
01/00
01/01
01/02
01/03
01/04
01/05
01/06
TLM account balance
TLM account balance
Unregulated Flow to KP
Modelled Natural
Cutting Inflow

Table D10.1 summarises the operation of the Scheme and the intended objective.

Table D10.1: Indicative operation of the Scheme and intended objective

Year	Scheme Operation	Intended Objective		
		Wetlands	Bird Breeding	Red Gum
1990	Extend natural inflows for bird breeding	✓	✓	✓
1991	Natural event waters wetlands, some redgum watering	✓	×	✓
1992	Natural event waters all	✓	✓	✓
1993	Natural event waters all	✓	✓	✓
1994	Do nothing, dry year	×	×	×
1995	Fill gap, extend to complete redgum	✓	×	✓
1996	Fill gap for bird breeding	✓	✓	✓
1997	Do nothing, dry year	×	×	×
1998	Water wetlands	✓	×	×
1999	Water wetlands	✓	×	×
2000	Fill gap and extend natural inflows for bird breeding	✓	✓	✓
2001	Water wetlands	✓	×	×
2002	Do nothing, dry year	×	×	×
2003	Late autumn small wetland watering	✓	×	×
2004	Late autumn small wetland watering	✓	×	×
2005	Small wetland watering	✓	×	×
TOTAL		13	5	7
%		81%	31%	44%

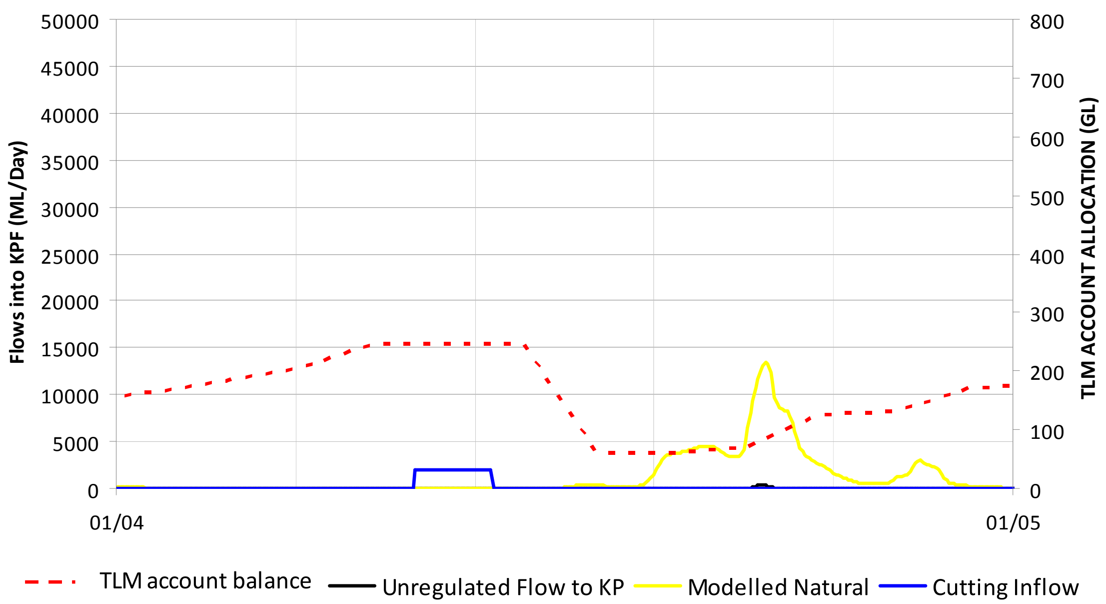
D10.2 Deconstructing two sample events, 1990 – 2005 - Hydrology

Two types of events between 1990-2005 have been deconstructed for the purpose of demonstrating inundation achieved. It should be noted that this is based on hydrology (event history, TLM water availability and overbank flow) and long term ecological water requirements – no other indicators have been taken into account.

Smaller Event (entirely managed) - 2003 watering season.

Flood History	=	Last large event occurred 2000, last small managed event occurred 2001, and a very small unregulated flow occurred early 2003 watering season totalling 6276 ML between 30 July 03 to 14 September 2003, average of 136 ML/d flow.
TLM Water availability	=	TLM account is 247 GL in April 2004. No unregulated inflows are occurring and none are predicted.
Event	=	2000 ML/d for two months (May and June 2004) totalling 122 GL use from the TLM account.

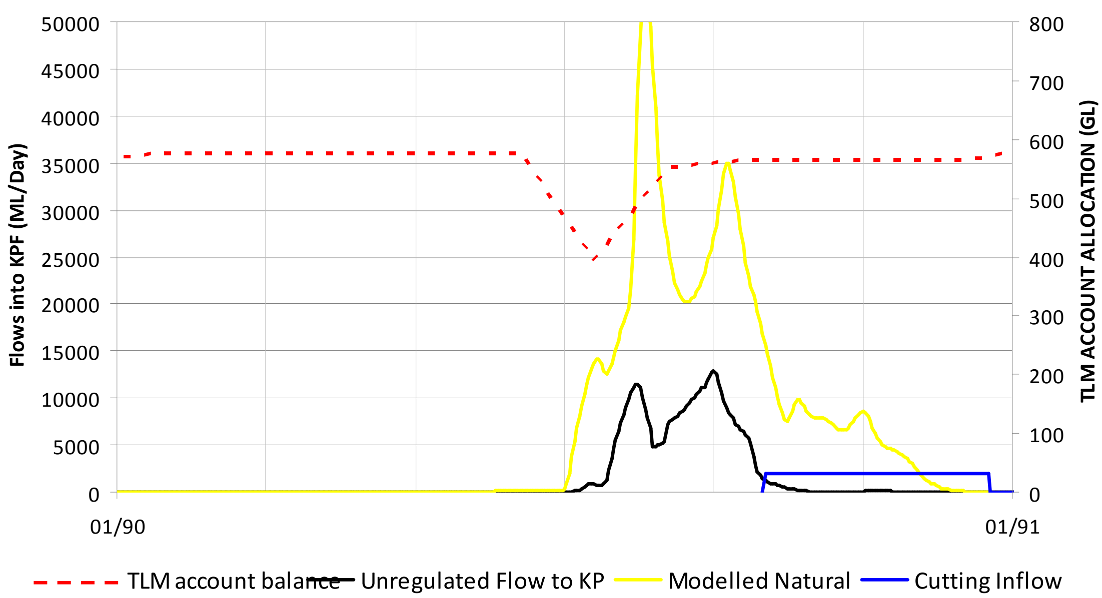
Figure D10.2: Predicted Operation - 2003 Watering Season



Larger & Longer event (Translucent) – 1990 Watering Season

Flood History	= Last large event occurred 1989– this was a completely natural event.
TLM Water availability	= TLM account is 565 GL in September 1990. Natural inflows commence on 5 July 1990 and varying daily inflow to 16 October 1990 totalling 524 GL inflow.
Event	= event extended through the TLM account, amounting to 2000 ML/d over three months totalling 180 GL use from the TLM account.

Figure D10.3: Predicted Operation - 1990 Watering Season



D10.3 Indicative Operation – Scheme Infrastructure

Broadly, Table D10.2 shows indicative operation of the Scheme's structures under a broad range of flows – natural and managed.

Table D10.2: Indicative operation of the Scheme

TYPE	YEAR	APPROXMATE FLOW ML/d @ TORRUMBARRY	UPSTREAM STRUCTURES INDICATIVE OPERATION	DOWNSTREAM STRUCTURES INDICATIVE OPERATION	DISTINCTIVES TO ASSESS
SMALL EVENTS	2001 2003/04 2004/05	**Entirely Managed Event** <18,000	• Flow enters via inlet regulator • Inlet fishway operating • Swan lagoon closed	• Return regulator open • Downstream structures may be used to temporarily regulate the flow into Barbers Creek and build pool sufficient to wet required wetlands • Flow in Barbers Creek is expected to be minimal and should not exceed 250 ML/day	• Assess downstream impact as no flow would be expected in Barbers Creek at Murray flows <18,000 under current conditions
	1998 1999 2005	**Hybrid Event** >18,000	• Water initially enters forest via Swan Lagoon and other effluents. • Inlet regulator used to supplement or prolong the flow event if required. • Inlet regulator fishway open	• Downstream structures may be used to temporarily regulate the flow into Barbers and Thule Creeks and build pool sufficient to wet required wetlands • until watering objectives assured.	• Flows in Barbers Creek could be expected at Murray flows of over 18,000 under current conditions, however the duration and overall volume of these flows in Barbers Creek may be greater if inflows are supplemented, or less due to consumption in the forest. . •
LARGE R EVENT		**Entirely Managed Event** <18,000	• Flow enters via inlet regulator • Inlet fishway open • Swan lagoon closed	• Return regulator open • Thule regulator stays closed . • Downstream structures used to regulate the downstream flow to achieve ecological objectives and stay within legal constraints.	• Assess downstream impact as no flow would be expected in Barbers Creek at Murray flows <18,000 under current conditions
	1995	**Hybrid Event** >18,000	• Flow enters forest via Swan Lagoon and other effluents and inlet regulator remains closed unless required to supplement the required flow. • Inlet regulator fishway open	• Downstream structures may be used to temporarily regulate the flow into Barbers and Thule Creeks and build pool sufficient to wet required area of the forest. • Flows may exceed capacity of Barber Creek	• Flows in Barbers Creek could be expected at Murray flows of over 18,000 under current conditions, however the duration and overall volume of these flows in Barbers Creek may be greater if inflows are supplemented, or less due to consumption in the forest..
LARGER & LONGER EVENT	1990 1996 2000	**Translucent** Flows >18,000 followed by flows <18,000 i.e prolonging a 'natural' event	• Water initially enters via Swan Lagoon, other effluents and inlet regulator. • Inlet regulator used to prolong event • Inlet regulator fishway open	• Return regulator open • Downstream structures generally open to allow unregulated water to pass. May be closed if unregulated flows are very small. • Downstream structures used to regulate the flow of diverted water into Barbers and Thule Creeks to achieve ecological objectives and to stay within legal constraints.	• Flows in Barbers Creek could be expected at Murray flows of over 18,000 under current conditions, however the duration and overall volume of these flows in Barbers Creek may be greater if supplemented, or less due to consumption in the forest.
NATURAL & FLOOD RESPONSE		**Flood Response** Pool raised to FSL followed by a flood i.e managing a large flood during an environmental watering event	If major flood is forecast or arrives then: • Inlet regulator closed • Inlet fishway closed • Swan lagoon open	• Return regulator open to draw down pool as required • Downstream regulators including Thule releasing water consistent with empting pool prior to flood reaching the Torumbarry pool	• Any impact of previous watering event is likely to be surpassed by the natural flooding event • Flows in Barbers and Thule Creeks could be higher and for longer than under current management • Downstream creek flows will be set to drain pool prior to arrival of the flood and these controlled flows will be set to not exceed those which will occur when flood arrives if possible; structure/levee safety issues will prevail • Downstream landholders to be advised of early releases exceeding channel capacity prior to arrival of flood
	1992 1993 1991	**Entirely Natural Event** Large flood event allowed to pass unhindered	• Inlet regulator closed • Inlet fishway closed • Swan lagoon open	• Return regulator closed • Downstream regulators including Thule remain open and flood allowed to pass	• Should be minimal impact if the regulators are operated to simulate pre scheme options • Flows in Barbers and Thule Creeks would exceed channel capacity but would replicate natural conditions

Attachment A

Scheme Infrastructure

Upstream Structures

Generally, upstream structures allow diversion of water into the forest from Torrumbarry Weir and escape regulators to prevent flows re-entering the Murray River, and have been designed to:

- Divert & control up to 6000ML/d from Torrumbarry Weir Pool (RL86.05 +/- 0.05)
- Contain diversion flow in U/S portion of cutting
- Distribute flow to Forest along remainder of the cutting
- In-channel flow at Bullock Head Creek around 500ML/d
- Provide required fish passage in and out of Forest
- Provide fresh water turtle escape route

Inlet Channel

The Inlet Channel is approximately 3.8 km in length with the alignment largely following low points.

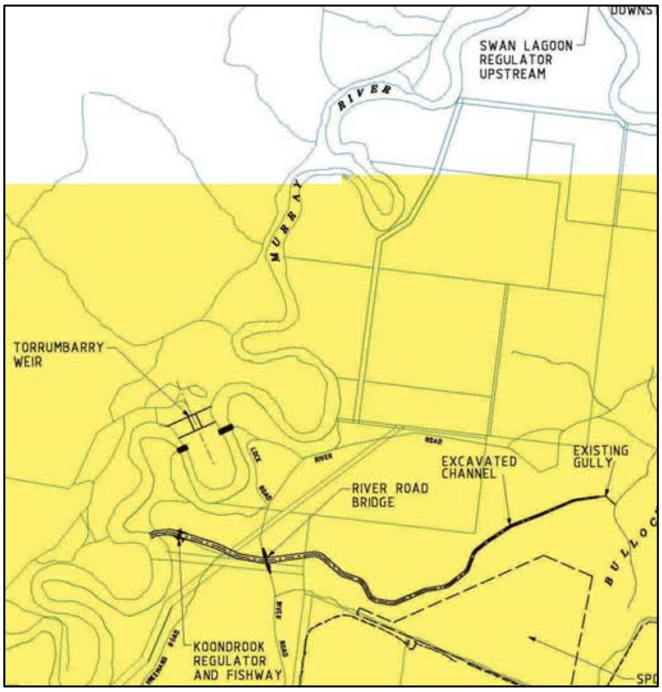


Figure i: Location of inlet channel

The channel is of standard trapezoidal cross section with side batters 1V:2H. The Channel is designed for a maximum velocity of 0.6 m/s. The flow depth varies between 2.8 m upstream to 1.2 metres downstream at Chainage 3800.

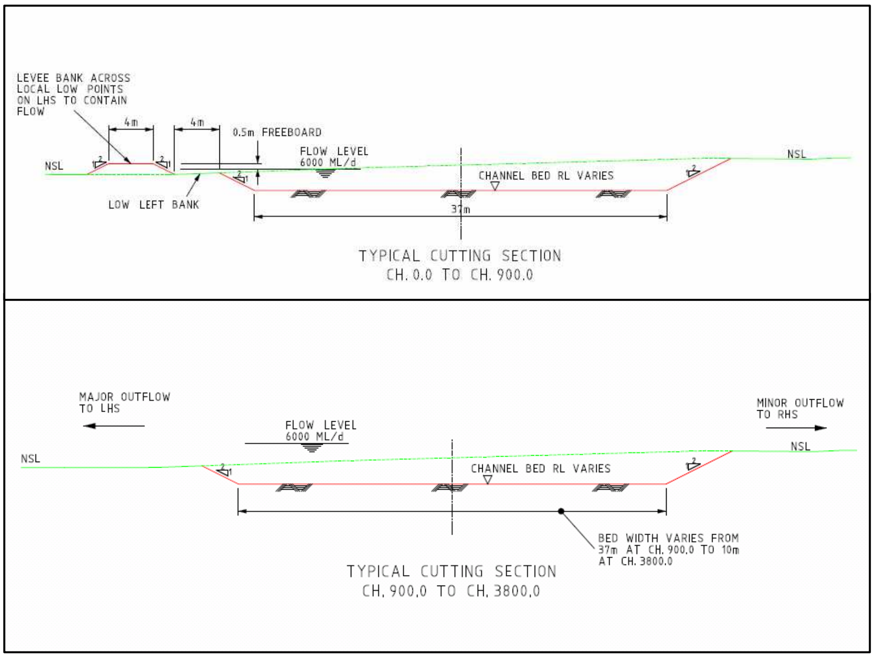


Figure ii: Typical Cross Sections Chainage 0 to 900.0 & Chainage 900.0 to 3800.0

Offtake Regulator

The Offtake regulator will provide operational flexibility for:

- Effective ramp up and ramp down for diversion discharge hydrograph
- Acceptable flow characteristics and structure profile for D/S fish passage
- Acceptable flow characteristics for U/S fish passage (via fishways)

The consist of 5 aluminium tilting gates – 3.39m high x 3.65m. The top of gates closed will have RL 86.55 (flood of record) and when open provide a maximum of 6000ML/d diversion capacity and a maximum velocity at structure of 1.57m/s.

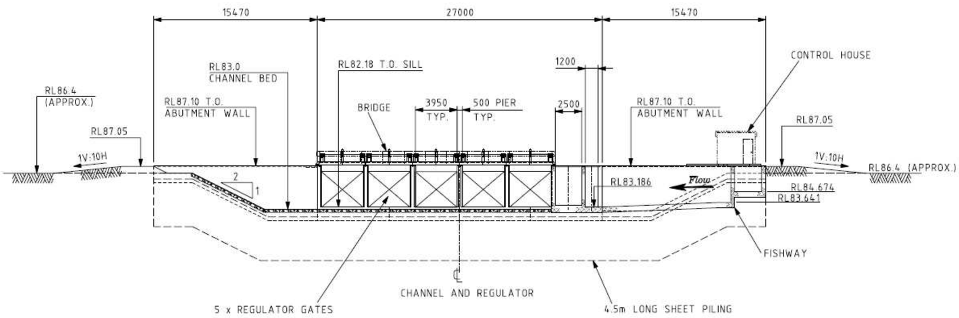


Figure iii: Typical Section Offtake Regulator

Figure iv: Photo of typical Aluminium Tilting Gate Regulator

Swan Lagoon Regulators

The purpose of the Swan Lagoon Regulators is to prevent loss of diversion flows during a watering event. The Regulators have also been designed to allow fish to evacuate during close down sequence of watering event cycle and maintain an acceptable waterway to minimise obstruction to natural floods.

The Fish evacuation criteria is targeted towards smaller fish with a maximum velocity of 10 m/s and minimum depth of 300 mm. The structures are gated sheet pile wall structures consisting of 3 gates - 2m wide x 2 to 2.5m high. Waterway areas of 60% waterway at RL84 (top of sheet piling) and 80% at top of banks RL85 approximately.

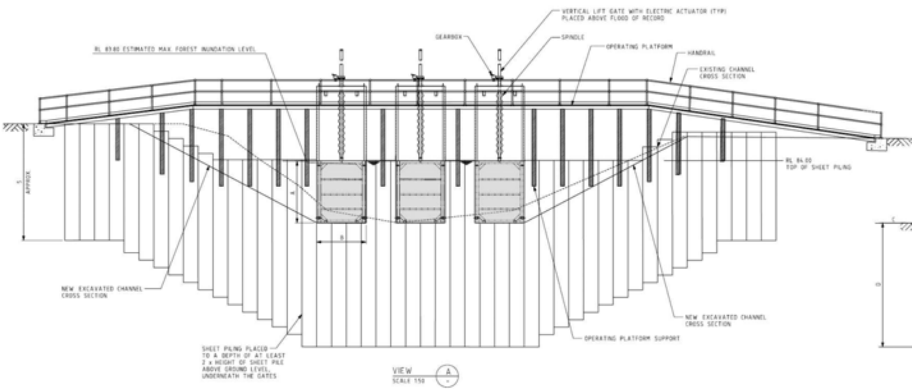


Figure v: Elevation - Swan Lagoon Structures

Fishway, Freshwater Turtle Ramp & River Road Bridge

A Denil and vertical slot fishway has been selected for large fish and small fish passage. The Freshwater Turtle Ramp is (1V: 8H ramp) located on 20 metres downstream of the regulator structure on the RHS cutting bank, and includes rock for erosion protection

Downstream Structures

Generally, downstream structures prevent uncontrolled water leaving the forest thus providing for the most efficient use of water.

Internal Floodway

The internal floodway has an average excavation depth of 0.5m, is 245 metres wide by 1 km long with a proposed constant bed of RL77.8. The design discharge is 2,000ML/d (max velocity = 0.15m/s)

Return Channel

The Return Channel has two functions: To provide water savings via direct return of flow to Murray River & provide an overflow/spillway system to protect safety of the downstream structures. The return channel is located as far downstream as possible within Forest with shortest connection to Murray River, and joins Crooked Creek System in Forest to Murray River.

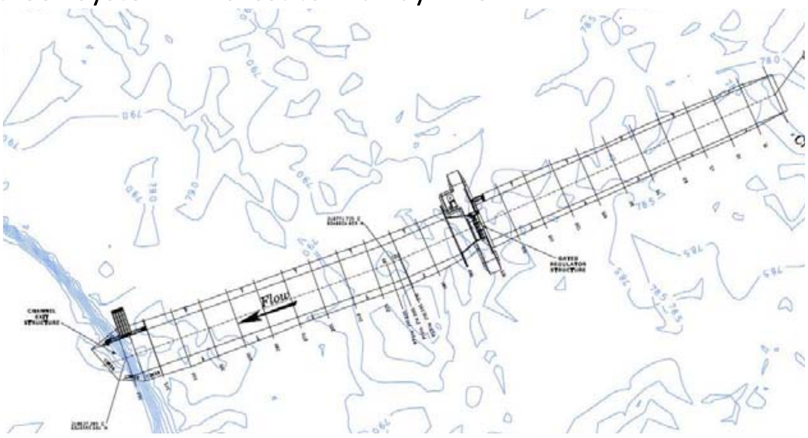


Figure vi: Plan view of Return Channel

Return Regulator Structure

The Return Regulator Structure has the ability to regulate flows up to 1850 ML/d and contain the downstream pool to RL 78.5 structure consistent with main off-take regulator. Structure will have a high operational flexibility for good control over flows returning to Murray River, acceptable flow characteristics and structure profile for downstream fish passage, acceptable flow characteristics and structure profile for upstream fish passage if required

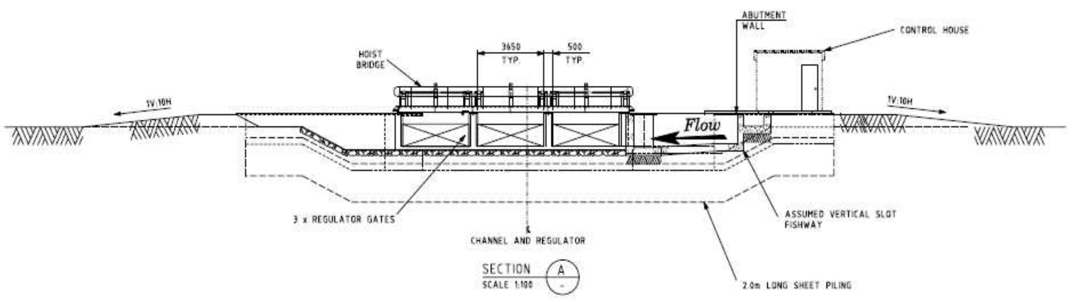


Figure vii: Elevation of Return Regulator Structure

Murray River Junction Structure

The Murray River Junction structure will safely transfer return channel flow to the Murray River. At this stage, options include standard concrete chute structure, chute protected with rockfill or rock mattresses, terraced sheet pile or gabion type structure. Fish passage will be required.

Downstream Levee

The downstream levee will contain a design pool RL78.5, which targets backup flows at the return channel. The height varies from zero to approx. 4m above flood plain (maximum at D/S regulators) and is approximately 43 kilometres in length, with a 4m crest width and 1V:2H batters. Both sides are widened at each downstream regulator to allow for Stop-log storage area & Turning circle.

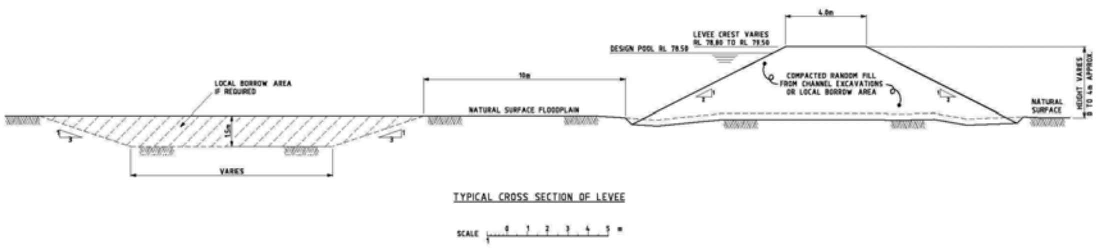


Figure viii: Typical Cross Section of Levee

Downstream Regulators

Downstream Regulators are stop log regulators and have a height proportioned for the design pool of RL78.5.

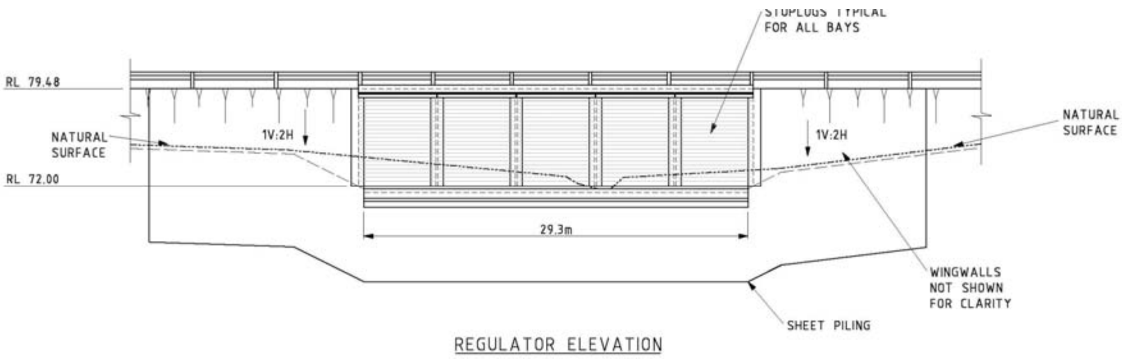


Figure : Typical Elevation of Downstream Regulators

Attachment B

Torrumbarry Weir Flows

NATURAL

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1891					9324	18200	32545	40451	29324	27590	21311	14744
1892	7491	4581	4836	4718	10530	20582	41115	27220	39895	34725	33998	24552
1893	10235	4977	4713	4345	14766	37107	41853	54657	54341	55540	35893	21768
1894	16935	7870	6467	10025	15181	20959	34983	52397	55591	56262	52738	26237
1895	11710	5887	5587	5401	8908	12588	24504	29195	43868	30025	16386	10385
1896	5106	4037	5610	6158	11095	8532	24327	14748	24500	24813	10637	10069
1897	10030	8542	6220	4080	3475	3235	15636	20578	42796	30515	18419	6578
1898	3567	4276	5274	3741	3670	16444	20959	33959	36583	24185	27454	15597
1899	6033	5203	4052	10239	8441	21630	42777	28167	16877	14936	13835	7252
1900	4069	3657	4304	13456	16153	16369	38413	33071	50510	38398	19923	10283
1901	4788	3128	2878	3769	7515	17448	15155	18198	37605	43243	39057	13567
1902	5496	3529	2862	4012	2545	5497	13426	5830	6136	11002	6140	5421
1903	5897	2762	4523	5325	9899	17440	41057	27950	31851	31716	25257	11798
1904	16242	10987	6863	3336	4616	8954	40521	41442	43854	32244	39761	13677
1905	5728	3661	3179	3258	4117	13250	39076	48851	30186	35153	40077	22004
1906	7231	3519	10950	7572	10700	25005	54374	55402	55677	56262	38785	29024
1907	19114	7474	4556	4359	6856	11994	8985	29578	23067	20092	16051	9893
1908	9818	4531	3664	2503	4704	9384	18638	20821	30816	25746	21674	8449
1909	3528	3338	4470	3521	23094	31044	50867	54963	55276	35800	18938	8048
1910	3702	3256	3794	2688	2622	8479	29962	24191	50436	47975	29750	18954
1911	10387	17908	19518	12556	8209	37380	45678	47165	26889	17185	9870	7852
1912	5598	3327	2770	2673	2755	3424	15796	15545	31696	41185	21556	28189
1913	15740	6259	6617	13824	9195	14178	18229	24386	24518	27022	25639	13040
1914	5516	4116	2764	2962	6981	7958	9607	11371	8645	6793	2988	3084
1915	3234	2041	1515	1531	4804	10074	44095	51675	43585	49191	40401	15048
1916	6239	4707	4362	3193	4585	7630	32453	40284	50630	57376	56650	51489
1917	21028	8571	10468	11274	14206	49322	54365	57449	57561	57137	52778	34332
1918	16471	11016	10517	8479	26432	44096	56397	51814	54203	29275	18771	8109
1919	5428	3936	6696	4959	5769	9572	21788	16663	22648	22338	10947	6807
1920	11071	6098	3920	3757	5171	10159	35936	48322	56343	44021	48396	16806
1921	10406	5188	5630	5680	4712	24547	23544	50630	56418	54274	33170	12230
1922	8103	4652	4911	3512	5828	5123	14770	23798	24834	32693	21290	6739
1923	4880	3499	2298	2162	3281	31031	49003	55773	34973	48987	43311	26125
1924	16935	11423	12710	15558	9760	19736	18001	24684	51537	50140	54533	34075
1925	17442	17196	11123	6375	6672	9808	13526	21984	35358	35884	17929	8309
1926	4858	3189	2989	6338	21385	26113	41236	50748	46669	40785	29801	11195
1927	6921	4855	3351	3002	5059	7451	16293	29980	30006	28636	24635	9310
1928	6758	9948	12234	16414	19715	41761	25992	22919	19075	41614	31545	10172
1929	5174	3790	4288	8704	7728	16108	19684	18615	25609	24690	17271	12987
1930	9456	4651	3635	3821	10050	8469	11811	29140	24889	37156	39938	33868
1931	23578	9702	10124	22632	36269	54026	56924	53650	53431	39453	27592	18670
1932	5869	4988	11650	24070	23971	31105	51906	44483	49279	33821	24750	11532
1933	6096	4233	3104	3256	5177	15640	29743	34191	45163	40223	18194	19212
1934	20198	9257	6869	7615	9361	5875	17776	26237	33550	39298	55311	43150
1935	16695	9284	7606	13712	25352	28637	40528	54801	46024	36404	27275	13144
1936	9346	5160	5082	5717	6777	10991	30023	51403	45671	25162	20879	15370
1937	13370	9079	5002	4403	5510	6280	7229	11379	24626	25445	15708	6724
1938	3873	3667	2826	2929	5546	8160	13909	12230	14501	10406	4580	2286
1939	1919	5025	27998	38554	33544	34627	50081	49840	56830	45070	38469	26048
1940	9055	5011	4004	4704	7900	9223	11523	12823	13038	12312	6885	5387
1941	11927	8457	8514	8424	5483	8611	21115	18358	16077	28797	15085	8033
1942	4201	3633	3639	5650	24610	34852	53663	45620	53887	40318	27753	14410
1943	6875	4736	3960	6131	12216	10780	21671	27102	28127	32192	22941	10969
1944	3979	2576	3053	3914	14717	16179	19152	14315	7687	8137	7701	4378
1945	4163	3772	1728	1975	2789	5741	14345	28303	35653	20904	23987	11543
1946	5136	6838	13013	10656	7641	12913	28648	50535	34810	24555	24917	14254
1947	7420	3832	6468	6388	5061	11519	32257	47422	45755	46635	43009	23963
1948	15298	7822	5870	5785	12471	18167	17338	19564	25300	22201	37486	20253
1949	8874	5030	9714	6522	6282	9563	13559	18803	28178	33162	51256	31713
1950	9957	9315	13269	16179	8389	12358	17632	24941	27094	31135	32145	16365
1951	7704	7266	4606	10317	20834	40110	46834	53793	39648	30156	32789	13643
1952	7356	3739	3758	9987	23564	46053	56787	51424	50718	53458	52806	45826
1953	21717	9874	5661	4750	7020	18495	30144	52362	50204	54184	49602	23186
1954	8581	10511	5316	4968	8317	12419	13931	18947	33237	21471	26312	46756
1955	15563	10678	12025	8936	12167	26288	47560	53589	56473	54124	41124	25872
1956	23397	18649	21377	38598	54244	57355	57157	56597	57112	49690	48488	31134
1957	12774	7065	6745	5516	8522	10311	22652	19746	19130	27115	21720	9605
1958	8825	5414	5173	4455	9656	27199	27905	50105	46971	46121	43030	21360
1959	8078	6379	8223	8580	5040	6308	8673	17518	22827	26206	19643	8452
1960	5215	4068	6523	6413	33353	44788	44408	54770	51849	46263	33391	20342
1961	8900	4607	4126	5462	9674	9684	19468	25780	25063	17268	10421	8218
1962	5744	5245	3042	3968	6461	27058	25978	34820	28061	28352	24047	12221
1963	9180	8074	4134	3957	11236	22270	26223	36545	40185	32257	24148	12273
1964	4635	3524	3697	3448	9724	12894	43036	55821	51368	55802	37464	18944
1965	8339	3918	2937	3130	5512	8930	11956	26166	47334	22585	12334	13680
1966	4766	3445	3838	3865	6585	8384	13903	30516	40741	43468	32761	35057
1967	20654	5872	3473	3163	2843	3796	4765	12581	15234	13255	6279	2929
1968	2047	1460	1400	2378	22576	49473	34251	48150	41256	43163	37486	20988
1969	8749	4812	5778	8824	9337	16711	22312	35819	37620	31389	18626	15034
1970	12571	8932	10167	14600	26935	22555	39724	49138	53681	37972	28649	20508
1971	9780	10475	8203	7788	20931	29304	22864	27224	34119	48905	46730	30180
1972	14894	13634	7431	5636	7101	6448	14785	20043	21137	15905	8604	4634
1973	2646	14066	15387	9475	31523	34222	48015	55416	56739	50141	41795	18724
1974	21275	15414	7464	12794	46937	35692	44710	56477	56358	56848	45760	23993
1975	9535	6810	6186	6673	11650	17804	23947	44523	53956	57619	54056	29893
1976	15261	7612	6575	5166	5335	6566	7123	16050	18372	27014	24792	11207
1977	7950	5595	5469	7090	6788	20814	31076	28971	19805	15963	8958	4842
1978	4116	3675	3879	7042	8047	19154	28815	52297	41714	38859	27727	22960
1979	11559	4720	3733	4364	5862	8452	10544	21519	44164	55772	29683	10515
1980	5039	3080	2880	3515	4585	7307	27414	34447	37525	29877	21718	13697
1981	6728	5057	3895	2648	3960	22213	50714	58103	48967	35408	23799	12161
1982	6291	5031	3738	4068	5520	8637	7215	7204	8718	8631	4202	2728
1983	1802	1012	1381	6499	11521	17872	35042	49228	54065	41879	27158	19443
1984	12811	10671	6090	5865	7314	6215	8644	32190	47984	49429	23954	8642
1985	4657	3295	3471	4264	5085	11163	12310	39928	40761	21301	17095	19084
1986	9797	5084	2658	3045	7613	12244	45619	49024	42605	50784	41551	24143
1987	12881	5235	5655	5432	9331	18922	42449	46466	30812	20451	12728	10723
1988	6281	3966	3182	3435	6988	33983	36772	42673	39911	29292	16461	23158
1989	17974	5513	6366	16877	20068	37756	47462	50394	52391	40929	36272	16950
1990	6865	5319	3949	6271	10267	13879	41780	55697	52647	36408	29849	12554
1991	6844	5982	2939	3194	3201	8659	29560	42583	54708	43045	20531	9174
1992	10042	5360	4343	3677	9646	13954	16210	31557	51561	57352	49333	45099
1993	26579	15025	10718	10585	7294	11227	29452	42720	55209	57324	41045	22907
1994	22019	13157	11188	7638	6919	12945	15520	14225	12817	14438	14753	9419
1995	6722	8806	4792	4570	13705	41588	50843	51856	28668	25815	25270	19785
1996	13032	9309	9063	10414	9966	17236	47479	56213	51265	53725	31227	16097
1997	8820	6853	4666	3606	5042	7141	7467	11256	24534	15059	9101	4531
1998	2374	2139	1546	1932	3627	5716	17940	22115	29661	39355	26040	14301
1999	5613	3788	2717	4715	4176	14804	13321	27702	34208	23586	14097	8938
2000	9607	4284	3788	4610	8430	17288	29580	35136	51204	43592	52532	23214
2001	7081	5803	4112	4711	4458	8144	10527	16397	26129	29763	26761	11564
2002	5176	5505	3674	3437	3976	8868	15376	12287	13425	15038	6744	4598
2003	2359	1963	2222	2737	4047	9428	16350	36628	43239	32273	20992	12546
2004	10675	4477	2771	2356	3893	8845	16461	26721	35424	26133	22752	16685
2005	7002	15251	5597	4034	3606	6646	15912	29806	42045	34628	26563	15558
2006	5710	3462	2644	3097	4980	4452	4009	4330	5184	3262	2402	1906
2007	1832	1476	1644	2048								
2008												
AVERAGE	9316	6331	5936	6889	10746	18017	28167	34778	37420	34468	27479	16535

RECORDED

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1891												
1892												
1893												
1894												
1895	14976	9459	8606	8377	9523	13856	24280	26360	40798	35582	16586	9464
1896	8843			9561	11024	10041	23213	15618	21397	20172	12204	9720
1897	11424	9763				3621	13215	18602	37158	26018	15814	6890
1898	2846	2751	3046	2145	2511	12906	16083	29225	33314	22765	21368	13576
1899	5959	4337	2486	7689	8057	19779	38844	27548	16220	13514	12696	7991
1900				11278	12862	15523	33754	30620	47383	37201	20255	10599
1901					10399	15846	13580	15540	31045	37829	32672	15279
1902						12674	11178	4567	5223	8578	4859	2526
1903	3829	1091	1272	2845	7860	13828	29149	24772	25297	30535	20732	10791
1904	13774	9182	4468	2200	3496	8416	28804	35310	37330	31941	34425	15609
1905	5788	2700	1796	2244	3033	10031	30878	46950	31897	30513	33214	19447
1906	8025	3251	6202	7004	10671	22391	48110	51885	57462	66676	39393	30141
1907	15783	8621	5621	5092	8071	11487	10787	24400	24079	17411	14230	9594
1908	7951	3510	2833	1934	4096	7818	14862	17236	25259	21760	18225	8103
1909	3173	2238	2956	2917	16184	27122	45524	59282	56922	36027	18021	8979
1910	5037	3678	3071	2517	2933	7583	24172	23624	42253	45131	28239	15562
1911	9646	16554	18875	14057	10912	34298	47210	43614	26635	18737	10977	7209
1912	5221	2623	1880	1911	1988	3211	11358	11048	23053	35713	16974	20744
1913	11977	4807	5285	10007	9434	14049	17448	21595	20819	20810	20227	10866
1914	4132	2465	1239	2153	5747	6481	7450	8425	5754	4090	1491	1124
1915	1055	484	124	130	1998	6334	30703	46374	42945	44204	35093	13431
1916	5774	3828	3049	2334	3867	6855	24855	42913	55111	76087	57486	50074
1917	20880	9786	9313	10854	14052	56757	62126	79803	86923	77019	65036	33718
1918	16728	11984	11591	10166	25162	49446	61799	57966	57576	29452	17034	9383
1919	5699	3666	6105	4794	5745	9046	18628	15752	18986	17525	10827	5940
1920	8889	5486	3069	2565	3399	7343	26457	46141	72877	49929	41904	13634
1921	9751	5538	5767	5898	5258	21820	19320	47323	70496	60958	31799	12452
1922	8361	4939	4628	3255	5499	5533	10861	17435	19395	25660	15963	5931
1923	3434	2071	1027	867	1803	22074	42544	53316	36237	42326	37852	18149
1924	8812	6409	7378	12938	9476	18866	18478	19485	48100	44476	49691	30204
1925	11039	11388	6814	3388	5171	10283	11388	20979	28184	28122	11973	4337
1926	1497	973	555	1329	10725	19368	33851	44177	45464	33043	23309	6524
1927	2366	871	350	295	1783	3588	7576	15886	20167	18742	17195	3279
1928	2646	6401	6013	12630	9643	34921	28149	23614	10610	33054	26989	4478
1929	1025	512	476	4282	2784	10421	16097	11030	16205	14223	6195	3621
1930	1933	796	332	266	5078	4083	2192	14357	13142	24370	25528	27547
1931	16143	2359	5209	12055	20834	43643	52382	50686	50846	39858	21932	11997
1932	2316	761	671	14042	15334	20733	45233	34126	51252	32654	18585	4434
1933	1559	748	688	1380	1827	5179	13885	17956	42380	40699	17238	12370
1934	14271	5427	4998	4269	5668	3737	8331	14562	18426	21631	48356	45559
1935	16673	5340	3442	6878	19764	19343	31398	49126	45732	37025	23884	7634
1936	7298	3872	3850	4347	6738	6268	16581	38054	48436	22021	14432	8922
1937	7535	4550	3853	3880	7000	8071	7020	5450	6689	6869	3848	3256
1938	3265	3282	3804	2877	3535	5129	5577	3165	2310	1216	728	1292
1939	1240	1301	9480	25778	19911	28388	44653	46999	58064	44948	35804	21304
1940	4191	3552	3937	2896	4768	5751	2078	2429	3936	2349	2831	1978
1941	3183	1674	2254	1685	2410	3558	3672	3029	2780	13159	5322	2455
1942	1784	2524	1849	2097	9030	17042	41888	39147	52809	38651	19846	7499
1943	3529	2733	2462	2714	4723	4965	3671	11620	16309	24210	13718	5163
1944	2404	2227	2522	3390	4529	4883	4335	2574	2020	1224	1792	1048
1945	2271	2543	1891	1052	968	2167	3262	8014	12398	2717	7479	3793
1946	2983	4806	5211	2740	4481	4369	12611	40259	30625	13515	15851	7332
1947	3305	2960	2509	2949	2575	2962	11324	34344	41879	42651	38126	20268
1948	8521	4459	3339	3627	3807	6353	10780	10555	15984	12324	26735	14968
1949	4451	2952	9868	3835	5526	4466	3906	3265	6307	19238	42435	28077
1950	4039	4684	15941	15942	5423	7182	9731	19622	21167	25876	24157	9859
1951	3128	6017	2527	2827	4606	20038	34732	58474	48872	22914	24516	7397
1952	2822	2421	2230	3292	4648	29767	59397	56421	48690	51140	52784	53912
1953	21149	5310	3218	3478	4570	4015	9072	35745	42224	55657	51495	18402
1954	2934	6475	2008	2926	5435	4012	3451	2920	18205	3882	13398	36569
1955	10110	9778	5701	4477	7471	8775	24527	45792	59095	57727	34700	22222
1956	17788	11475	8405	23754	47570	59452	60835	61816	63481	59678	57465	30093
1957	6517	3233	2985	1926	5602	9782	14281	5534	3835	5018	3652	4659
1958	6035	5486	2628	1862	3640	7367	6038	37362	44965	39628	39194	13530
1959	2175	4702	4803	5329	4288	5317	2624	3182	5243	7290	9681	2939
1960	2773	2384	1636	2875	15358	20961	22290	45631	52172	52058	25081	12553
1961	2468	2255	2694	4685	6428	4316	7385	9685	8096	2753	5515	2800
1962	2822	1864	1785	2385	2850	10258	9592	16955	7510	3338	3664	2627
1963	3320	1888	2843	2684	6100	13219	13008	17538	18595	11437	6272	2076
1964	1642	2203	2794	4981	3336	5655	22891	46981	45522	56091	38575	8709
1965	2380	1644	2455	2711	2648	5722	2315	9606	26393	4001	1705	3881
1966	4247	5288	5121	2616	2273	3636	3770	10970	15173	20142	14610	21298
1967	11441	3421	3549	2731	2612	3551	2472	3396	3370	3302	3965	4703
1968	5547	4526	3687	2886	6625	30021	17579	30092	18603	10648	13990	6785
1969	4062	5816	7240	6536	5775	11599	10396	22726	21555	16618	7576	5136
1970	6022	4139	5773	7692	14396	10164	21837	20640	49225	38649	20087	10697
1971	4110	6228	4784	4593	8537	13289	12112	6544	15980	32946	37548	19169
1972	5091	7771	3642	4551	4858	4709	3761	4717	3041	3924	5188	4113
1973	4715	10345	7874	5844	20571	20563	36245	51596	58198	50797	46068	13173
1974	19556	11794	5522	9918	40655	46801	43809	53577	55586	58247	48999	19312
1975	4908	4373	4894	5466	8598	7914	6812	28227	46683	58599	58074	27030
1976	8961	5365	4066	4764	5955	3720	3239	3421	3439	5888	7199	2926
1977	2929	4084	2709	3807	3030	5768	10863	7852	3883	2258	3449	2716
1978	3855	2551	4318	3476	4817	6350	10880	27808	15778	24020	9425	6500
1979	3551	2486	2427	4119	5113	7950	2476	5395	18705	45901	13968	2640
1980	3433	3156	3610	5266	4664	3613	7340	13955	5506	5111	5103	5617
1981	4324	5022	3876	5523	5821	8701	33389	56342	47979	24752	6527	3956
1982	4545	4136	4267	4044	5521	5869	3705	3890	4266	4404	4645	4779
1983	4703	4448	5028	4289	5742	5765	10664	30715	45777	21120	7504	5627
1984	7977	3689	3619	4218	4581	5211	3892	8494	26821	28478	7317	3734
1985	4042	4454	4155	3797	3470	4423	3059	9856	19602	3728	4487	6456
1986	4078	4299	4162	4682	5071	6300	23850	29873	25944	26513	26973	8141
1987	5112	4041	4211	4184	5515	7524	17406	28198	11280	6168	4974	5688
1988	5295	3472	4318	5246	7747	18033	16407	20015	19075	5274	5468	8976
1989	4391	3818	6556	13020	11348	28171	34453	36450	49024	21636	21266	5232
1990	4717	6310	4326	6577	5397	5698	23374	44261	49379	23877	14624	4105
1991	5502	4305	4218	5045	3332	4317	12425	11088	31484	31463	3814	4974
1992	5379	5155	4341	4480	7253	5795	6463	8619	32594	55228	44017	38909
1993	20780	8548	7448	10129	9183	8066	19495	29930	49707	58196	38359	10454
1994	7858	6944	8251	5971	6778	4925	6573	5439	6285	7381	7770	4732
1995	5246	5912	4036	5555	8113	20448	29358	43189	9204	5484	9666	4992
1996	4503	4537	4874	5481	4908	5345	24266	48169	32225	46635	24671	5897
1997	4006	4763	4498	4132	6726	4222	2267	5731	7938	3059	5964	4280
1998	4018	4390	3469	4332	2991	3410	4941	5973	5148	11300	8698	4392
1999	3719	4015	4237	4306	3422	8100	5456	7896	11273	3640	4145	4100
2000	4057	4269	3290	4672	4573	5981	9132	10084	21719	21045	37018	11059
2001	4758	4794	3849	3892	3513	3388	3941	3158	4482	5586	4464	3771
2002	4659	4392	3417	3385	4441	3968	3464	5421	6983	7488	8238	8139
2003	5321	5525	3996	3234	2746	2914	5441	12117	13780	6507	5520	6544
2004	5243	6038	4729	4157	3441	5977	8327	7507	8106	5779	7951	6489
2005	4951	10678	4310	3567	3176	3367	5867	7289	11832	7915	12337	7429
2006	5266	6082	5266	5491	6208	2181	5353	6447	5280	4591	5884	4782
2007	4876	4862	3046	2792	2042	3439	5995	4305	2002	2795	5236	6561
2008	6658	4230	2967	2079	1930	3252	2002					
AVERAGE	6268	4696	4282	5145	7206	11798	18036	24431	28043	25511	19912	11190

CURRENT

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1891					4589	4776	10426	17019	12468	9034	6830	6660
1892	6180	6493	5907	5131	4437	7368	21060	11989	15516	14437	17563	14086
1893	5805	6674	5771	5012	5427	20723	26936	41077	41597	39785	22891	10089
1894	7117	7329	5552	5375	11882	14387	21911	36203	50696	50706	41301	14530
1895	6773	7663	6288	4493	4079	5447	11015	15942	24527	13751	5305	6688
1896	6309	7466	6418	5383	4244	3542	7997	4963	7630	4047	5754	7480
1897	8024	6598	5434	4709	2970	2362	4711	7056	16441	5902	5719	6765
1898	5808	6037	4939	3867	4646	6702	8212	14728	13522	4721	6602	8214
1899	6861	6527	4627	5490	4429	8120	21006	9438	4332	5020	5713	8000
1900	6932	6151	5502	6897	6193	6481	19992	15689	21294	8145	7721	8185
1901	6134	5849	4321	4906	4314	5954	6576	8345	17909	12531	11152	8762
1902	7228	6926	5261	5203	3942	3436	3584	3738	4513	4727	6557	9887
1903	6482	7168	6366	5302	3880	7205	22396	10114	13972	6565	5594	7243
1904	8053	5879	5164	3539	3338	3796	20440	19333	18568	8343	10087	8074
1905	7648	7852	8590	7575	4154	5700	22915	25786	8495	8236	8520	8588
1906	6853	7689	7970	3698	3871	10692	38552	33857	40593	50807	19688	10596
1907	8173	7724	6255	4268	4474	4261	3322	10307	4546	4169	8022	10065
1908	7839	7819	5795	3727	4607	4543	7911	6705	11904	6360	6151	6577
1909	5913	6346	4498	4677	10330	17259	28917	48029	34186	6702	5508	7550
1910	7381	7271	6337	5026	4037	3888	12828	10707	34564	17272	8735	9314
1911	7196	10669	8766	5936	5556	23823	23228	19515	5344	4479	4406	6164
1912	6395	7864	6831	4344	3860	2488	7261	5956	17588	11848	7220	11323
1913	6661	6001	5083	7874	5957	4472	5658	9295	8195	5870	6110	8044
1914	6583	6022	5191	3939	3077	3021	2891	2514	4228	5693	6964	9756
1915	6754	7154	7184	5163	3516	6277	21549	30805	18757	22441	8441	7622
1916	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1917	9680	7574	6463	4516	7221	43632	50560	56371	56802	55170	44332	21276
1918	7854	7867	6124	5729	20862	37834	55152	47238	47525	13684	4864	6469
1919	6328	8582	6184	4731	3907	3681	5924	4483	6293	6450	7580	7596
1920	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1921	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1922	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1923	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1924	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1925	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1926	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1927	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1928	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1929	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1930	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1931	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1932	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1933	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1934	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1935	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1936	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1937	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1938	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1939	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1940	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1941	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1942	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1943	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1944	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1945	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1946	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1947	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1948	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1949	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1950	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1951	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1952	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1953	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1954	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1955	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1956	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1957	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1958	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1959	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1960	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1961	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1962	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1963	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1964	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1965	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1966	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1967	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1968	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1969	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1970	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1971	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1972	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1973	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1974	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1975	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1976	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1977	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1978	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1979	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1980	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1981	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1982	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1983	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1984	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1985	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1986	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1987	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1988	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1989	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1990	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1991	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1992	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1993	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1994	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1995	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1996	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1997	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1998	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1999	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2002	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2003	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2004	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2005	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2006	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2007	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2008												
AVERAGE	7257	7360	6361	5869	6489	9060	15608	19279	20897	17213	13469	9799

MEDIAN CASE @ 2055

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1891					6454	5490	7009	5695	5152	3562	3328	2456
1892	2980	451	3106	4771	3902	5618	10681	10867	13025	7047	4305	3138
1893	3795	4498	3017	5475	5475	9563	17816	23347	24142	22273	11738	4805
1894	3529	4388	5294	6783	5182	6447	16915	24791	35325	43270	24980	9649
1895	4747	5309	4735	5306	6023	4964	4894	7707	10429	4737	3058	3952
1896	4839	767	6043	5704	4787	4348	5261	3265	3679	4220	5502	5440
1897	6779	6383	6913	8693	5948	4444	4127	5715	6843	5809	6085	6138
1898	9239	9629	6929	4797	4611	5412	5478	5653	6445	3636	4855	7376
1899	9491	9662	7780	5517	5153	6899	8023	4317	3036	3340	7270	7120
1900	8432	9487	7144	5781	5297	5422	7019	8569	12936	5797	5008	6948
1901	8398	9679	8268	5447	2513	4066	3836	2813	10286	7395	5775	5603
1902	7721	8925	5443	2734	1832	3475	3106	1616	3884	3610	3327	3018
1903	2779	2277	2127	1275	3218	4733	9768	6340	9182	5936	4068	4884
1904	6032	5672	3619	1765	1525	3931	8482	11358	9500	6199	4804	4674
1905	7220	7240	6428	5198	4931	5124	13114	15016	7170	4125	5052	6306
1906	9545	9606	9195	7533	4613	8182	21701	23343	31009	30787	16515	7918
1907	6114	6774	4774	4315	4127	4780	4453	5037	4375	3846	6632	7224
1908	9753	9567	7761	5796	4383	4934	4515	3446	3511	5038	4224	5014
1909	8355	9798	6402	4648	6552	11400	16190	34416	25925	7214	5289	6009
1910	6773	9342	7603	6175	4763	5218	6851	7233	21209	10774	5260	4629
1911	5745	8988	7260	5437	4858	14974	18055	12293	6888	2411	4272	4841
1912	7240	8503	8654	6772	4342	4466	4556	4318	10527	8295	7741	6738
1913	6265	8624	7966	5605	5345	4863	3648	2287	4580	4773	5320	6011
1914	7961	9667	6012	2458	2908	3732	3097	1773	4482	4211	4047	3331
1915	2589	1630	1681	1040	2044	4343	10035	16114	17168	11508	6430	5734
1916	6392	9279	8913	6957	4451	4557	9281	13319	27456	33060	24144	12057
1917	7034	7599	5300	5433	6779	35564	43602	44366	52741	52731	35878	11266
1918	6095	6902	5326	5437	13117	27606	36455	30894	25490	8147	3617	4102
1919	4225	7635	5765	6473	4731	5050	6132	3660	5396	6866	6517	5883
1920	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11895	6748
1921	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4981	3020
1922	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3449	4352
1923	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7300	6185
1924	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16865	9194
1925	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6456	5725
1926	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10421	6363
1927	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7454	7487
1928	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6745	5424
1929	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5205	6498
1930	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6472	8321
1931	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5184	4194
1932	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6862	7241
1933	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5776	8760
1934	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14156	7688
1935	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4400	5903
1936	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6931	8208
1937	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6311	5773
1938	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6950	6290
1939	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13463	7990
1940	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5914	7259
1941	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5570	6474
1942	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4955	5145
1943	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4788	8184
1944	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5352	5785
1945	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6162	6379
1946	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5812	6987
1947	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7644	5559
1948	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5051	5682
1949	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11953	6523
1950	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4016	3839
1951	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9729	6224
1952	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	26615	13272
1953	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	22593	8939
1954	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5292	7589
1955	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	23796	8842
1956	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	28522	9584
1957	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4112	5886
1958	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17568	6969
1959	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4045	3489
1960	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6545	5708
1961	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7509	6494
1962	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3159	3744
1963	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4255	4457
1964	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16275	6839
1965	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4916	6084
1966	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6495	7016
1967	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5356	7322
1968	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6093	6701
1969	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4299	4237
1970	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9577	5762
1971	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	22595	10909
1972	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5029	6171
1973	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17482	6589
1974	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	29228	9966
1975	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39163	14735
1976	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4457	3746
1977	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4107	4674
1978	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3468	3843
1979	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14812	7468
1980	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5987	7085
1981	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3684	5134
1982	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5544	7918
1983	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3818	5140
1984	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6974	4308
1985	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4549	5293
1986	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10041	5877
1987	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5882	5857
1988	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4125	6286
1989	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8846	5302
1990	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3068	3562
1991	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2338	3887
1992	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	28461	19198
1993	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	25908	9254
1994	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5851	6729
1995	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8088	7544
1996	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16566	6257
1997	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3982	4393
1998	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5088	3852
1999	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5160	4719
2000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18637	9351
2001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5140	4565
2002	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6787	7647
2003	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5451	6555
2004	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5146	6171
2005	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6227	5818
2006	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]							
2007												
2008												
AVERAGE	6375	6965	6033	5786	5690	7718	10419	12461	13597	11257	8939	6456

Step Change - Continuation of Last 10 Years

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1891					6356	5273	6405	4919	4714	3532	3520	2979
1892	4016	539	3101	4838	3855	5451	8126	8687	11024	6728	4549	3619
1893	4005	4641	3348	5249	5185	8005	13936	17650	19612	17814	11135	5707
1894	3980	4618	6567	7240	4913	5974	8793	12416	27460	37481	20922	8476
1895	4806	5586	4867	5677	5999	4766	5018	6348	10632	5919	4319	5131
1896	5284	791	6337	5837	4838	4307	4495	2708	5960	4734	5526	6788
1897	7062	8162	8455	6725	4251	4121	3916	4943	5706	4080	6615	7967
1898	9527	9075	6693	5047	4534	5116	5195	4732	5337	3955	5384	6863
1899	8286	9076	7668	5690	5059	5728	7355	3813	2942	4791	6648	6903
1900	6241	7243	5393	4467	5161	5408	6458	7221	8795	4769	5623	6759
1901	8421	9831	7063	4640	2235	3727	3572	2626	7649	5985	6068	6186
1902	7190	7372	4622	2013	1748	3351	3012	1334	3620	3704	3328	2625
1903	2768	2361	1972	1041	2960	4355	7326	4746	7234	5111	4725	5960
1904	6394	4543	1805	1320	1148	3870	7578	9196	4412	4061	4981	5412
1905	7097	7247	6039	3993	3365	4476	10839	9904	4904	3787	5751	7319
1906	8702	9663	8844	7209	4379	7844	17152	17680	23714	23392	10822	6057
1907	6068	7216	4833	4614	3787	4640	4363	4370	3848	3155	7252	9047
1908	9494	9564	7998	6217	4334	4628	4229	3163	5113	4795	4984	6913
1909	6828	7329	4040	1744	4395	10233	12097	26628	20278	6439	4820	5482
1910	8064	9560	7914	6391	4573	4862	6274	5804	14655	8026	4843	5187
1911	7095	8289	6299	5836	5108	11581	13711	9378	5328	2703	4959	6474
1912	6165	8592	6589	3577	2379	3686	4376	3631	8719	6445	8339	7457
1913	6671	7188	6729	4718	3791	4309	3464	2218	4102	5102	5618	6478
1914	7116	7449	4757	2032	2440	3636	3035	1771	4502	4288	3704	2596
1915	2316	1810	1638	1586	2185	4465	8574	13116	14424	9397	5907	5114
1916	7218	9017	8475	6844	4378	4441	8545	11466	20455	25940	18327	8599
1917	6317	7459	6892	5340	6024	29930	38153	40366	45179	42070	28563	9631
1918	6207	7530	5723	5693	11505	17772	24396	22613	18146	6030	3733	4516
1919	4604	7548	6045	7022	5021	4941	5915	4600	6146	5881	6629	7122
1920	6642	6953	8919	7228	4702	4786	7557	15697	20037	11949	6593	4986
1921	4977	6394	6371	5396	3677	6146	7453	15388	25329	15636	9803	6936
1922	4934	4386	3069	4364	4874	4490	4496	2669	3480	2930	3814	4751
1923	6477	9026	7836	6202	4297	7539	13256	14247	7553	9469	7488	6348
1924	7735	8069	6461	5732	4636	5357	4440	7553	15472	9596	10179	7780
1925	6165	6829	5271	4654	4078	4879	4058	2662	6269	4352	5356	5965
1926	8823	9639	8991	7741	8337	9316	8934	14155	11560	5729	4044	4567
1927	5372	8971	8616	6973	3803	4042	4146	3841	4269	5211	7635	7424
1928	8886	7522	7285	6024	6078	8890	8308	3756	3244	5889	6426	5636
1929	7874	9770	9148	6851	5307	4635	4036	2260	4009	4078	5408	6668
1930	7703	9174	7511	6044	4609	4406	3966	3265	3581	6404	6131	7596
1931	6324	7159	7184	7881	14996	32192	32008	24635	14568	5875	4071	4568
1932	4590	6313	7094	7718	7721	12954	17823	17828	12986	8473	6891	6351
1933	6753	8057	5772	5467	4360	5312	6522	7944	11743	6266	5939	7647
1934	5792	8273	6885	5413	4463	4172	4410	4433	4742	11519	11071	6067
1935	4608	4608	4562	6522	6660	10443	16143	17165	13765	6407	4510	7016
1936	6757	6044	4717	5935	5611	4919	6585	14916	7681	3670	7687	8303
1937	6991	6152	5308	5961	3801	4367	3478	2735	4201	6750	7020	6681
1938	8072	8732	7853	6299	4149	4109	3693	2385	2541	4885	5909	5601
1939	5518	3945	5200	7468	10564	13868	19036	25974	22479	10727	9134	6659
1940	7849	7913	6250	6501	5798	4217	3234	2512	4330	3239	5369	7457
1941	9535	8766	7064	5156	4539	4609	4449	3381	2850	4218	5519	6120
1942	5563	3933	1531	1520	3625	7405	16264	14752	13960	6778	5270	5597
1943	7302	8585	8784	6800	4324	4235	3957	2444	4123	3804	4915	8259
1944	9062	9417	7979	5966	4948	4543	3316	1907	4371	4427	4878	4132
1945	3553	1628	1767	1918	1391	3537	4115	3692	4320	4879	6313	6182
1946	6192	6730	4898	2203	2888	4266	8292	8137	5275	3205	6279	6757
1947	7728	8748	8262	6572	4282	4543	7391	9294	7706	7773	7174	6129
1948	6130	8501	8615	7057	5285	4728	4146	2153	3291	4462	5352	5612
1949	8346	9187	7611	5779	4566	4719	3894	2210	3821	6945	8145	6036
1950	6200	9964	8680	7175	4848	4668	4047	2822	3186	2877	4333	4083
1951	5543	7040	5999	6474	6423	11056	15616	14336	6452	7822	9429	6981
1952	6769	5482	5083	5315	7940	18516	30844	17633	16092	13012	12848	7749
1953	5212	5624	4003	5733	3916	6048	9077	18407	16298	20298	18619	7464
1954	5132	5077	3516	5282	5282	4632	4013	2543	3995	3773	5634	7419
1955	5817	6772	5210	4957	5753	9932	19848	29010	30547	27233	17842	8132
1956	6628	5173	8455	17853	30671	41876	45895	45093	42691	37406	23401	8457
1957	5144	5155	3718	4394	4099	4687	4809	2547	3812	3694	4923	6330
1958	9362	9357	6761	6010	4984	5479	6314	24486	14651	14019	8943	6508
1959	5940	6127	5246	5998	5590	4134	3070	2328	3960	4921	4158	4574
1960	6349	7443	6280	4705	8333	12301	18225	19714	21432	7784	3323	5815
1961	6108	7831	8028	6073	4230	4202	4204	2814	3338	4448	5666	5162
1962	6695	7043	5999	4906	4580	6858	7419	6341	4740	3160	4608	4639
1963	5923	6800	6171	5458	5663	7059	7356	7588	6541	4638	4411	4763
1964	7002	7730	7845	5654	5247	4915	15434	15471	16924	22619	13210	7284
1965	5597	5485	3907	4927	5521	4502	3669	5298	8552	5513	4970	6614
1966	7306	9528	8312	6502	4522	4389	3811	4832	9012	7299	6057	6774
1967	5898	8188	6405	5926	3965	4095	3193	1994	3474	3290	6166	7616
1968	8552	7038	3222	1278	4680	12614	10681	17093	8602	4416	5797	6711
1969	8658	9295	8473	6715	4841	4658	6102	5953	6672	4769	4715	4617
1970	6519	9010	8683	7132	6565	5913	7025	10517	19203	12426	9280	6692
1971	8078	7860	4617	5891	6306	6396	5654	4049	5563	4204	8817	6901
1972	4481	6122	4833	5415	3439	4093	3494	3078	3374	2821	4820	7120
1973	9449	10457	7903	6850	9491	11770	13576	24883	30163	29758	14555	6012
1974	7888	7093	5755	9032	24417	24281	25590	33129	37904	39383	26471	9329
1975	5707	5009	4545	4774	4007	4609	5544	12166	33242	43953	31733	12048
1976	6043	4753	3828	5384	3241	4090	3266	2034	3419	4047	4663	3956
1977	4981	7035	5366	4759	4560	5115	4922	2646	3315	2870	4393	4952
1978	7069	6373	5871	5140	3283	5062	7771	12523	11107	5249	3755	4017
1979	4047	4982	3872	5604	6110	4552	3197	2729	11206	16121	8547	5251
1980	5600	9055	8048	6861	5460	4382	5293	4883	4653	4688	6177	6886
1981	8180	9376	8283	6632	4569	7371	25177	40788	20795	5475	7080	6511
1982	5435	8158	8695	6157	3652	4098	3097	2030	3827	4234	5997	7894
1983	8303	9001	6843	4046	3223	4519	7837	14910	23514	9285	4012	5399
1984	6907	5005	5369	5231	4031	4200	3683	8952	10505	5518	3931	3931
1985	5690	6812	5302	4759	3992	4540	3308	10025	9538	4358	4797	5638
1986	5586	8992	8090	6227	4383	4245	17185	15415	12947	17531	11921	7118
1987	6268	5818	6571	5018	4204	6832	9690	13235	6534	4316	5756	5759
1988	8745	9249	7954	6187	4899	7941	10783	7066	7359	3836	4180	6581
1989	5202	6951	6552	6933	6946	12300	11633	19550	16806	6761	4793	4633
1990	6891	6971	5689	3974	4948	5182	17189	26092	14308	5166	3899	4747
1991	5353	5442	4373	3839	3362	4241	5912	7631	17253	10799	5925	4612
1992	4721	5846	5266	4491	4485	5355	4864	6465	21179	28710	14437	11521
1993	7207	6008	4826	4729	4180	4817	7332	10131	32999	40075	21240	8221
1994	6069	7484	7142	6824	3558	4531	4200	3080	6584	6381	5887	6549
1995	8930	9367	6245	5700	5368	11236	21046	15002	6148	3271	8215	7742
1996	6659	5879	4443	5367	4221	5162	13282	24423	16943	17550	11258	6381
1997	5728	7231	5563	5235	3505	4377	3428	2312	6369	4165	4129	4455
1998	5939	7343	6520	6172	5053	4233	4859	4907	11053	7786	5451	3674
1999	4609	5034	4825	5935	4547	5715	5739	8996	8070	4567	5156	4813
2000	3954	5090	4573	5325	6092	5769	8282	9380	21080	26616	28232	11741
2001	5725	5843	5413	4205	3514	4505	4093	3210	4154	4102	4958	4172
2002	5439	6911	5554	4970	4439	4586	3896	3153	7580	7214	6183	5650
2003	8146	8688	7674	6284	4350	4580	7073	13305	10567	5939	7713	7244
2004	6820	7810	6424	5969	4550	4478	4631	4590	12260	6935	5621	6816
2005	6545	8471	6932	6785	4630	4707	4986	6803	14098	14504	11593	7625
2006	6010	7107	5520	4785	4378	4494						
2007												
2008												
AVERAGE	6478	7083	6111	5547	5236	6857	8851	10108	11259	9472	7883	6343

Flows < 15 000 ML/day

Flows > 15 000 ML/day

Flows > 30 000 ML/day

Flows > 55 000 ML/day