ROUS
COUNTY COUNCIL

BULK WATER SUPPLY | WEED BIOSECURITY | FLOOD MITIGATION

Reardon's Drain
Active Floodgate Management Plan

2020-2023

Management Plan operational summary

Reardon's drain is located 6 kilometres west of Woodburn in Northern NSW. The approximately 3.5-kilometre-long drain enters Swan Bay on its western bank. The system drains a low-lying area that sits between Bungawalbyn Creek and Swan Bay. Reardon's drain is a constructed drainage system that shows no natural characteristics and is surrounded by agricultural land used for grazing, tea tree and sugar cane. However, the drain discharges into Swan Bay, which has been identified as key fish habitat by the Department of Primary Industries.

The drain has been floodgated at its junction with Swan Bay, with two pipes installed through the man-made Swan Bay levee and floodgates installed on the downstream side. One floodgate has been modified with a sluice window to allow tidal exchange. It is that modification to which this Plan applies. The term 'floodgate' within this Plan refers to the sluice window that is opened and closed to allow tidal exchange between the drain and Swan Bay.

Active floodgate management has occurred at Reardon's drain since 2003. Opening the sluice window to allow tidal exchange, during non-flood periods, has improved water quality within the drain. The frequency and magnitude of acidic discharge has been reduced, as has the accumulation of Mono-sulfidic Black Ooze (MBO) within the drainage system.

Although monitoring has not occurred, it is reasonable to expect that tidal exchange has improved water quality discharging from Reardon's drain. Research has shown that tidal exchange can improve water quality through dilution and naturalisation of acidity. It is important to acknowledge that active floodgate management does not resolve all water quality issues in the system, e.g. tidal exchange does not reduce deoxygenation (blackwater) events after flooding.

While acknowledging the limitations, the environmental impact of Reardon's drain floodgates has been reduced through active management and it continues to be an important on-going strategy. This Plan outlines how tidal exchange will continue and suggests additional management strategies to reduce the system's impact further.

Environmental goals and strategies

The goals and strategies listed here specifically relate to Reardon's drain and identify the desired outcome from actively managing the floodgates. Goals are listed in priority order.

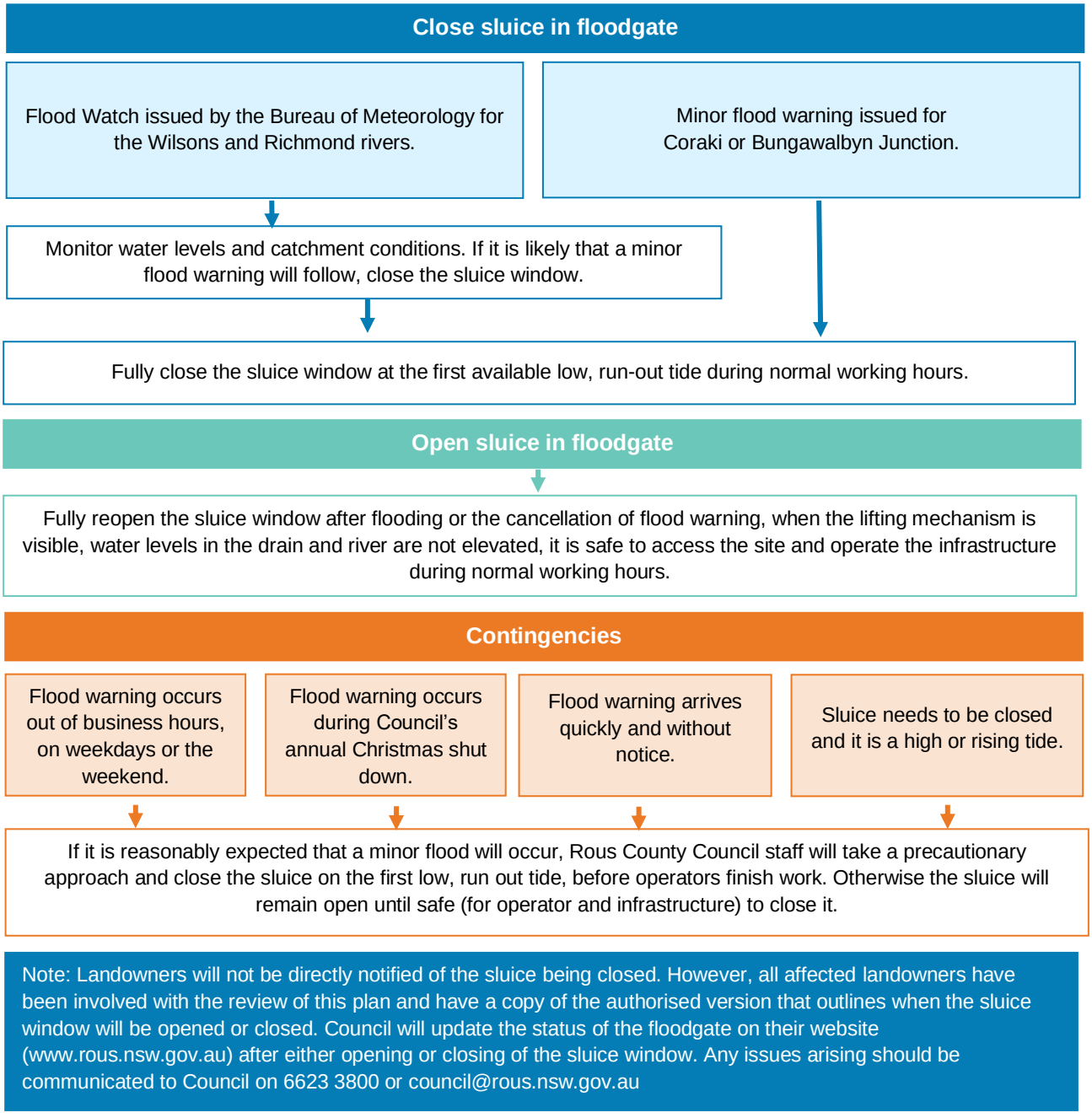
Goals	1. Reduce the frequency and magnitude of acidic discharge from Reardon's drain.
	2. Reduce the accumulation of Mono-sulfidic Black Ooze within the system.
	3. Reduce the impact of Reardon's drain on Swan Bay.
Strategies	Formalise the current opening strategy for the system's floodgate.
	Encourage best management practices and additional remediation strategies to further reduce the impact of Reardon's drain.

Opening strategy for floodgate

A floodgate on Reardon's drain is fitted with a sluice window, which can be winched open. In more recent times, the sluice window has remained fully open all year, and only lowered before flood events to protect upstream areas from riverine inundation. Land ownership has changed in recent years and the review of this management plan is an opportunity to confirm how the sluice window will be managed into the future.

The sluice window will remain fully open all year and will only be lowered before flood events. This is the optimal strategy for the existing floodgate structure and no improvement is suggested at this time for its future management. This degree of tidal exchange improves the environmental condition of the canal while having minimal impact on surrounding land use.

The sluice window will be opened and closed, in accordance with the details below by Rous County Council staff. Council acknowledge there are many variables during flood events and will be guided by the details below. This Plan will not restrict Council from taking emergency actions outside of those listed, taking into consideration safe work procedures.



Note: Landowners will not be directly notified of the sluice being closed. However, all affected landowners have been involved with the review of this plan and have a copy of the authorised version that outlines when the sluice window will be opened or closed. Council will update the status of the floodgate on their website (www.rous.nsw.gov.au) after either opening or closing of the sluice window. Any issues arising should be communicated to Council on 6623 3800 or council@rous.nsw.gov.au

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Authorisation

This Plan has been endorsed by the landowners within the immediate catchment, whose land is influenced by the management of floodgates. Those landowners have signed a letter of endorsement stating they understand the management strategy for the floodgates, including the triggers for opening and lowering into the operational position.

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Version control

Version	Description	By	Date
0.1	Draft developed before landowner consultation	Chrisy Clay	02/04/20
0.2	Final draft incorporating landowner feedback	Chrisy Clay	23/04/20
1.0	Final version – issued to landowners	Brenda Ford	03/06/20

Rous County Council File 2547.1

Contents

1. Overview

The majority of coastal floodplains in NSW have been extensively modified for flood mitigation. Networks of drains have been constructed, natural water courses altered and floodgates installed to mitigate the impacts of floods and large rainfall events.

Constructed drains reduce inundation after flooding and floodgates prevent flood and tidal water from inundating low areas of the floodplain. This in many cases has converted prior wetlands and low-lying floodplain areas into dryland farming areas. While these developments have enhanced rural settlement and agricultural industries, they have also caused unintended adverse impacts to downstream water users, fisheries and the ecology of estuaries.

Rous County Council ('Council') is the Flood Mitigation Authority operating across the local government areas of Ballina, Lismore and Richmond Valley. Council is responsible for the construction, replacement and routine maintenance of flood mitigation infrastructure, including floodgates and some pipes, levees, rural drains and canals. Council's natural resource management function relates to the environmental consequence resulting from the operation of this infrastructure. Council is responsible for reducing the environmental impact of these floodgates and other infrastructure, while retaining their benefits for flood mitigation.

The flood mitigation directive that Council operates under in the *Local Government Act 1993* is *'Prevent and mitigate menace to the safety of life or property from floods and natural resource management issues arising therefrom'.*

Purpose of a Floodgate Management Plan

Council has an Active Floodgate Management Plan ('the Plan') for each of its floodgates that are actively managed. Active management is the opening of floodgates during non-flood periods when the floodgate is otherwise operating passively. Opening floodgates and allowing tidal exchange can reduce their environmental impact by improving water quality and enhancing aquatic habitat and fish passage. Opening a floodgate for tidal exchange can occur by modifying a floodgate with a sluice window or an automatic, tidally operated float system or the floodgate can be winched opened.

These plans document and communicate:

- how active management can assist in reducing the environmental impact of the floodgate,
- a strategy for how that will be monitored and achieved,
- appropriate and consistent strategy for opening the floodgate and returning it to the operational position or state and by whom,
- safe operating procedures for volunteers and Council staff,
- how adverse effects on current land use will be identified and prevented, and
- additional management strategies for the drainage system that would further reduce the environmental impact of flood mitigation.

Each plan is tailored for the system and its floodgates, considering their location, purpose and function.

Guiding principles for management

- Rous County Council is the Flood Mitigation Authority and acts in consultation with stakeholders on the management of its infrastructure.
- The primary function of Council's infrastructure is for flood mitigation.
- The intention of active floodgate management is to reduce environmental impact without causing adverse effect on current land use.
- All landowners behind the floodgate whose property may be impacted will be invited to participate in reviewing and updating the Plan and will be sent a final version of the Plan for their records. Where property ownership changes, the new landowner will be involved at the time the Plan is reviewed unless their location and role are critical to the management strategy.
- Active floodgate management is a cooperative exercise between Council, as the Flood Mitigation Authority, and the surrounding landowners. Council appreciates landowners' continued support of this important activity.

Stakeholder involvement

This Active Floodgate Management Plan is a formal agreement between Rous County Council and landowners on how tidal exchange will occur on the identified drainage system. The Plan has been developed in consultation with landowners whose property may be impacted from the floodgate's operation.

Rous County Council seeks the input and support of other stakeholders for their Active Floodgate Management program and its delivery.

Organisation	Role
Rous County Council	Owns, develops and uses individual Active Floodgate management plans.
Relevant landowners	Endorses and uses individual Active Floodgate management plans.
Lismore City Council Ballina Shire Council Richmond Valley Council	Supports active floodgate management and provides input on general program where relevant.
NSW Department of Primary Industries	Supports active floodgate management and provides input on general program where relevant. Regulatory role under *Fisheries Management Act 1994*

Plan review frequency

The Plan will be formally reviewed every three years (from the date of adoption) and the effectiveness of the outlined strategy assessed.

Feedback on the Plan and active floodgate management matters

Feedback and comments should be referred to Council by telephone on (02) 6623 3800 or by email: council@rous.nsw.gov.au

2. Reardon's drainage system

Asset number and description

A reference in this section to 'asset number' is to a unique reference that Council has assigned to the specified asset.

Asset number 1820 – Reardon's drain

- Two round 1,800mm floodgates, one with a sluice window operated with a winch.

Asset No.	Description
1820-031-01	Aluminium floodgate (1800mm round)
1820-031-02	Aluminium floodgate (1800mm round) with sluice window
1820-060	Lifting gear
1820-610	Handrail
1820-261	Canal
1820-290	Outlet
6570-410	Swan Bay levee
1830-120	Culvert (x2)
5960-120	Bridge

Aerial photograph of asset location and images of asset

1: Reardon's drain locality map.

2: Reardon's drain floodgates, showing sluice window in a fully open position.

3: Aerial shot of Reardon's drain, looking upstream from floodgates after minor flooding in February 2020.

Drainage system characteristics

Location in estuary.	Mid-estuary.
Location in landscape.	Riverine natural levee and floodplain.
Land elevation.	0.89m – 1.98m AHD.
Land use.	Agriculture: grazing, tea tree and sugar cane
Vegetation.	Grasses and pastures. Nearby are *Casuarina glauca* and *Melaleuca quinquenervia,* which are trees associated with Endangered Ecological Communities under the *NSW Biodiversity Conservation Act 2016*.
Salinity levels and estuary dilution capacity.	Low.
Tidal range.	Low.
Land elevation adjacent to drains.	High, graduating from natural levee along Richmond River.
Soil type.	Likely to be alluvial sediment overlaying estuarine clay.
Acid sulfate soils.	High risk, areas of sulfuric sediments (actual sulfate soils). Present in low-lying areas. MBOs present in drain.
Hydraulic conductivity.	Unknown. Based on chronic acid conditions observed in drain, likely to be medium-high in places.
Acid export.	System is known to export acid after heavy rain and for acidic conditions to persist for some time afterwards.
Water quality issues.	Prolonged acidification after rain. Chronic acidic discharge with low dilution capacity within Swan Bay. Can discharge deoxygenated water (blackwater) after flooding.

Water quality

Historic spot water quality readings and observations indicate the drain can be acidified for a prolonged period after rainfall. Chronic acid conditions are often observed within the drainage system.

In 2018, Rous County Council had drain sediment samples collected from along the bottom of the channel and analysed for the presence of acid sulfate soil material. Analysis showed extremely elevated levels of acidity within the sediment and sludge in the bottom of the drain. This indicates the system is located through areas of high-risk acid sulfate soils and Mono-sulfidic Black Ooze (MBOs) can be present in the drain.

After major summer floods, the system does discharge deoxygenated water (blackwater). Low-lying areas within the drainage system can be inundated for lengthy periods, until water levels in Swan Bay and the Richmond River drop allowing water to drain away.

In 1996, after heavy rain and flooding, Reardon's drain and Swan Bay were photographed by local resident Rick Bowie. The photograph below shows Swan Bay acidified and discoloured with aluminium floc (from acid sulfate soils) and Reardon's drain discharging blackwater.

4: Aerial of Reardon's drain and Swan Bay in 1996,
simultaneously experiencing both acidic and blackwater conditions.

Aquatic habitat values

Reardon's drain is a constructed drainage system that shows no natural characteristics. The drainage system provides little aquatic habitat however, it discharges into Swan Bay. Swan Bay has been identified as key fish habitat by the Department of Primary Industries. Active floodgate management at Reardon's drain aims to reduce the system's impact upon Swan Bay and downstream aquatic habitat.

Apart from acidic runoff and deoxygenated blackwater, Reardon's drain may also contribute to the prolific growth of aquatic weeds in Swan Bay. Swan Bay frequently experiences large and prolonged infestations of aquatic weeds like high priority weed Alligator Weed (*Alternanthera philoxeroides*) and environmental weeds like Water hyacinth (*Eichhornia crassipes*) and Salvinia (*Salvinia molesta*). Swan Bay is a sheltered waterway, with little flow, and any nutrients discharged into it from surrounding land are likely to accumulate and provide an ideal environment for aquatic weeds to grow. Reardon's drain is one of four main systems that drain nearby land into Swan Bay.

Whole of system management

The following table outlines what management changes have already been made within Reardon's drain system and what could be explored in the future. A cooperative approach that balances the needs of current land use and environmental benefits is promoted by Council. Reardon's drain has benefitted from the willingness of previous landowners to trial and adopt different management strategies to its environmental condition and Council acknowledges their efforts.

Council provides this information for landowners and other organisations that are responsible for promoting and facilitating natural resource management on private freehold land. This information identifies a range of relevant strategies for improving water quality based on the characteristics of the system and are consistent with current best management practice.

Management strategy	Works	Undertaken	Location	Recommendation	Responsibility
Acidic groundwater containment	Reducing drainage density – removing drains or reshaping so shallow and wide to only drain surface water.	No.	Could apply to both private drains entering Reardon's Drain and the main canal itself.	Explore possibility with relevant landowners.	Private landowners. Local Government: • Rous County Council • Richmond Valley Council. State Government: • North Coast Local Land Services. • Department of Primary Industries. • Department of Planning, Industry and Environment (previously Office of Environment and Heritage) • Marine Estate Management Authority.
	Laser levelling of paddocks to enhance drainage of surface water and remove the need for field drains that can drain groundwater.	Likely to have on cane farms as this is a widespread industry practice.	Land growing sugar cane and tea tree.	Explore with landowners whether laser levelling and reduction of field drains can occur.	Private landowners. Local Government: • Richmond Valley Council. State Government: • North Coast Local Land Services. • Department of Primary Industries. • Department of Planning, Industry and Environment (previously Office of Environment and Heritage) • Marine Estate Management Authority.
Tidal flushing for dilution and buffering of acidification.	Actively manage floodgates.	Yes, by RRCC in 2003.	Sluice window installed on main floodgate.	Continue with current management strategy.	Private landowners Rous County Council.
Reduce impact of deoxygenation events.	Reducing drainage density – removing drains or reshaping so shallow and wide to only drain surface water.	No.	All drains in grazing land.	Explore possibility with landowners. Assess cost versus benefit.	Private landowners. Local Government: • Rous County Council • Richmond Valley Council. State Government: • North Coast Local Land Services.
	Explore further management strategies for lowest lying areas.	No.	All drains in grazing land.	Explore possibility with relevant landowners.	

Management strategy	Works	Undertaken	Location	Recommendation	Responsibility
					• Department of Primary Industries. • Department of Planning, Industry and Environment (previously Office of Environment and Heritage) • Marine Estate Management Authority.
Reduce nutrients discharged into Swan Bay.	Industry best management practices for using nutrients.	On-going.	Surrounding sugar cane and tea tree farms.	Support industry extension programs.	Private landowners. Industry • NSW Sugar Cane Industry. • Australian Tea Tree Industry Association. Local Government: • Rous County Council • Richmond Valley Council. State Government: • North Coast Local Land Services. • Department of Primary Industries. • Department of Planning, Industry and Environment (previously Office of Environment and Heritage) • Marine Estate Management Authority.
	Installation of vegetative filter strips alongside drain.	No.	Along the drain through sugar cane and tea tree farms.	Explore possibility with relevant landowners.	
Water quality monitoring.	Monitoring program to identify any water quality issues and confirm benefits of managing floodgate.	No, only spot samples and observations.	Main floodgates.	That a program be developed to determine success of Active Floodgate Management Plan. Identify resources required and assess cost versus benefit.	Local Government: • Rous County Council.

RRCC = Richmond River County Council, former Flood Mitigation Authority on the Richmond.

3. Risks of actively managing floodgates

Work Health and Safety

- The sluice window is fitted with a winch and large forces can be involved in winch systems.
- The sluice window should only be opened on a low or falling tide. This will reduce the risk of the wire rope breaking and the floodgate bowing.
- The sluice window is opened and closed by Council operators, who must consult and follow the approved Safe Work Procedure relevant for the activity.
- Operating the sluice window during and after heavy rain or flooding can require working in wet and slippery conditions. Safe access to the site should be assessed after events.

Environmental / Agricultural

Flooding

There is a risk of flooding to land upstream of the floodgate and surrounding areas, if the sluice window is not closed before a flood arrives and floodwater from Swan Bay enters the drainage system.

Increased salt levels in drainage system

Salinity levels are low in this part of the Richmond River estuary, even during droughts and periods of low flows. There is no risk posed by tidal water overtopping banks in low-lying areas or of lateral salt seepage into the banks.

4. Monitoring, evaluation and reporting

Council will explore whether water quality monitoring can occur at Reardon's drain. However, if resources are not available for monitoring, scientific principles and visual observations support the assumption that implementing the outlined management strategy will improve water quality.

An evaluation of the success of the Plan will be made at the 3-yearly review, and a report provided by Council to landowners and relevant stakeholders.

5. Historical context

History of when and why asset was installed

It is not known when Reardon's drain itself was constructed, but an article in the Richmond River Herald newspaper stated that in December 1928 it and other drains in the Swan Bay area already existed. The article reported on the installation of floodgates on William's, Robinson's, Thompson's and Thearle's drains. This is likely to be the four main drainage systems that still enter into Swan Bay, and it is possible that Reardon's drain previously went by the name of either Robinson's or Thompson's. The article praised the construction of the floodgates and associated structures "These are massive works for ordinary drains and are built to stand for all time, while the big 6ft pipes should deal easily with the immense quantity of water that will pour through after the torrential rains".

Reardon's drain and the nearby Lane were both eventually named after the Reardon family, who were among the first European landowners in the area.

Reardon's drain reduces inundation in an area well known for flooding. The system drains a low-lying area that sits between Bungawalbyn Creek and Swan Bay. This area has been historically problematic as drainage is reliant on the level of the Richmond River and the area is denied drainage for long periods until the river level drops.

Complaints appear in historical newspapers in the early 1920s, and again in the 1950s when broken floodgates and a damaged levee along Bungawalbyn Creek caused floodwater from Bungawalbyn to flow across the flats. The article reported that floodwaters at Swan Bay were still rising, although upstream Coraki had started to recede.

In 1996 landowners and industry representatives raised concerns with Richmond River County Council on the length of inundation and how water could not get away through Reardon's drain floodgates. They asked to have the floodgate structure enlarged. In the same year, a performance assessment was completed on Reardon's floodgates for Richmond River County Council, which determined that enlarging the floodgate structure would not reduce inundation times.

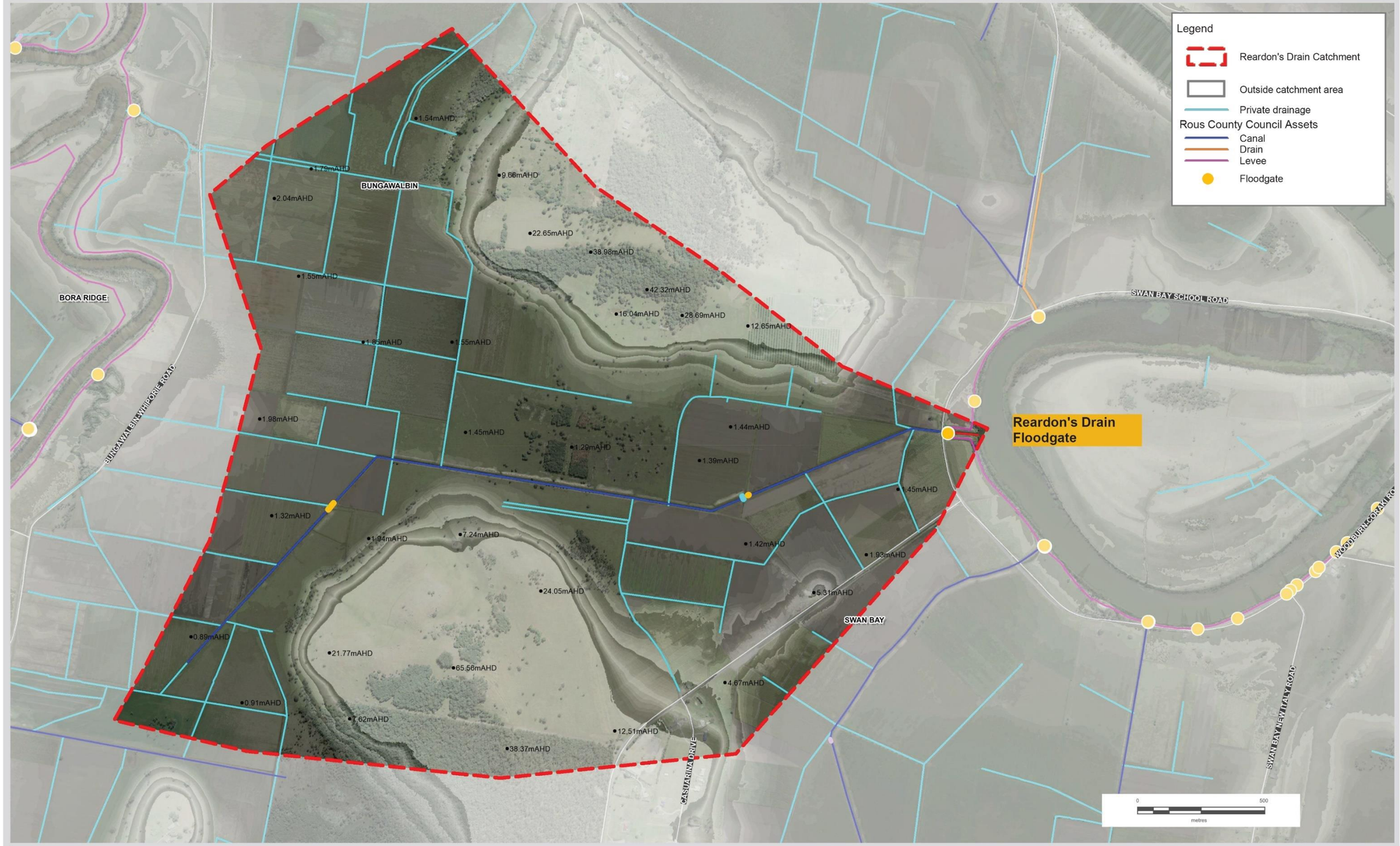
History of active floodgate management

Active floodgate management commenced at Reardon's drain in 2003. Initially the sluice window was often closed when sugar cane was planted during spring. This was dependent on weather conditions but occurred to reduce salinity within the drain, so the planted cane could be watered in.

In more recent times, the sluice window has remained fully open all year, and only lowered before flood events to protect upstream areas from riverine inundation. Land ownership and land use has changed in recent years and the review of this management plan is an opportunity to confirm how the sluice window will be managed into the future.

The sluice window will remain fully open all year, and only lowered before flood events to protect upstream areas from riverine inundation. The sluice window will be operated by Rous County Council Operators in accordance with this Plan.

Appendix: Reardon's drainage system



Reardon's Drain Catchment

THE INFORMATION ON THIS MAP MAY NOT BE ACCURATE.

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