

Water Research Laboratory Memorandum

To: OzFish
From: Will Glamore & Duncan Rayner
Subject: Draft Modelling Scenarios for the Tuckean
WRL Ref: 2014129 M20181115

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Background

Previous research and recent observations show that Tuckean Swamp is an acid sulfate soil (ASS) hotspot and that poor water quality adversely impacts the floodplain and the greater Richmond River (for more information, see the accompanying document “Conceptual Understanding and Prioritisation of Tuckean Swamp”). Remediation and rehabilitation of ASS affected areas has been well studied and there are a number of general techniques that are used to improve the environmental outcomes of such sites (which are summarized in the accompanying document “Generalised Strategies for Remediation and Rehabilitation of AAS Affected Areas”). However, it is important to recognize that any changes to the drainage system has the potential to impact the social and economic uses of the floodplain and that on-ground works should not be undertaken without sufficient understanding of the site-specific consequences and benefits.

WRL is presently building a computer model of the Tuckean floodplain and drainage system. Field data has been collected and is input into the model and is used to verify the model's ability to replicate the present (often referred to as the “baseline”) day to day conditions. The results of the model provide information on water levels in the drains and around the floodplain, how often specific areas are wet and how quickly the floodplain drains after rainfall.

Once the model is developed, modifications can be made within the model and the model is re-run to test what impacts any possible on ground works might have (referred to as “modelling scenarios”). These modelling scenarios provide answers to “what if?” questions that might be asked when considering the consequences of any changes to the drainage system. Running a modelling scenario is not a commitment to pursue any on-ground work, but allows for options to be discussed with a full understanding of what impacts it might have. In fact, in some cases the model is used to test extreme scenarios which are unlikely to be pursued to understand the “worst case” impacts.

In the case of Tuckean, the type of impacts that will be quantified will include:

- Does salt water enter the system, and how far up does it penetrate during large tides? Would there be any changes to vegetation in the drains as a result of saltwater infiltration?
- How often and for how long does each area of the floodplain get wet?
- How do water levels in the drains change, and what impact does this have on groundwater levels?
- Are there any changes to drainage times during nuisance catchment scale floods? (this model is not designed to model large floods which are typically driven by water levels and drainage in the greater Richmond River)

In each case, the modelling scenario results will be compared to the results of the baseline modelling to understand what has changed and what additional measures (e.g. installation of floodgates or building levies) might be required to mitigate these changes.

This document outlines a series of modelling scenarios that WRL recommends for the Tuckean floodplain. These scenarios are broad ranging and are intended to provide information on how each option would impact the floodplain, surrounding landholders and water quality in the region. These scenarios are draft suggestions only, based on our conceptual modelling of the site and modelling to date. The description of the scenarios refers to the management sections and general remediation strategies that are outlined in the accompanying documents.

Scenarios

There are seven (7) main types of scenarios that WRL recommends for consideration at Tuckean Swamp. However, for each main scenario, there a number of variations or combinations that would also be beneficial. Each main scenario has been outlined and described in detail. At the bottom of selected scenarios, a number of variations have also been briefly described as additional scenarios that could be run to better understand the management options available on the Tuckean floodplain.

Potential scenarios include:

1. Optimise the current management of the three existing sluice gates on Bagotville Barrage
2. Existing sluice gates, with water levels in Tuckean Broadwater increased to include a +0.2 m water level variation
3. Installation of weir structures at the end of Slatteries Drain or Meerschaum Vale Drain
4. Reshaping of major drains: Target Slatteries Drain, Meerschaum Vale Drain, Jumbo Drain
5. Diversion of small to medium catchment inflows at Slatteries Drain onto the floodplain
6. Hinge open Bagotville Barrage during optimal periods
7. Optimise remediation of Nature Reserve Area, while minimising upstream impacts

Combinations of the major options

In practice, it is often practical to pursue a number of different rehabilitation strategies in tandem to optimise the environmental, social and economic outcomes ASS affect floodplains. The options above essentially each just investigate one strategy in isolation. There are several feasible combinations that could be modelled to understand the impacts on the site, for example allowing the barrage gates to be open during select periods at the same time as reshaping Slatteries Drain. This would increase the effectiveness of both individual scenarios by reducing acid export through increase groundwater levels and harnessing the neutralizing the capacity of tidal inflows.

1. Optimise the current management of the three existing sluice gates on Bagotville Barrage

Remediation Strategy: Limited Tidal Manipulation and Increased Flushing

Areas Targeted: Lower Stibbards – Lower Hendersons – NPWS (5)

Description: There are three ~1m wide sluice gates currently on the Bagotville Barrage. These are operated by Rous County Council, however the Council has little guidance on when the gates should be opened and closed. This scenario would allow Rous to gain an understanding on how to best optimise the use of these gates, without having to change any assets on the floodplain. This may allow some limited tidal flow into the floodplain, while maintain the flood mitigation capacity of the system (see Figure 1). This option is likely to have the most minimal impact on the wider swamp.

Benefits:

- Some limited buffering capacity available from the bicarbonates in the tidal flows.
- Better flushing.
- Increase the average water level in the Nature Reserve, thereby holding up groundwater table and inundating ASS in the lower Hendersons region.

Potential Impacts:

- Tidal (salt) inundation on the floodplain beyond NPWS area.
- Increased average water levels downstream decreases the flood storage available to mitigate nuisance flood effects.

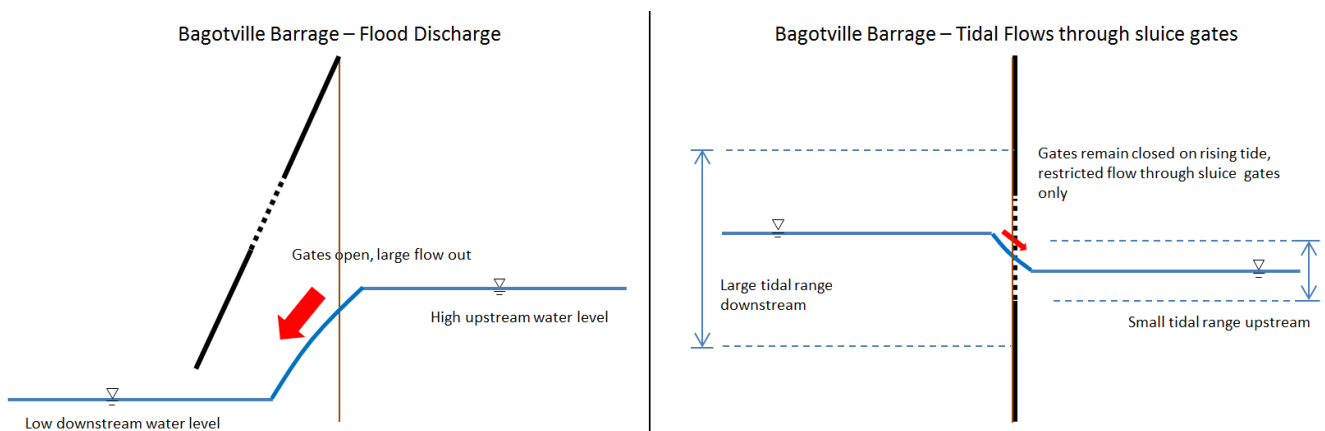


Figure 1: Flows through Bagotville Barrage with sluice gates open

Possible Variants: The flow conveyance of the three sluice gates is unlikely to be sufficient to impact the water quality in the swamp on a broad scale. A possible variation would be to increase the number and/or widen the existing sluice windows. This would increase the potential for tidal inflows into the floodplain, thereby increasing the potential for remediation through tidal flushing. This option would consider safe passage for aquatic life through the sluice gate openings.

2. Existing sluice gates, with water levels in Tuckean Broadwater increased to include a +0.2 m water level variation

Remediation Strategy: Groundwater manipulation/ Tidal Manipulation

Areas Targeted: Whole Site

Description: This scenario would test the sensitivity of the present day site to changes in the downstream water levels. At present, the low tide level in the Tuckean Broadwater is a primary driver of water levels in the greater Tuckean area during periods of limited rainfall. This scenario would be utilised to test how the floodplain drainage might be affected by an increase in the water levels downstream.

Benefits:

- An increase in the surface water levels in the drains would increase the groundwater table and decrease acid transport.

- More potential for effective tidal inundation.

Potential Impacts:

- Increased inundation during dry periods.

- Loss of flood storage.

- Increase in nuisance flooding.

3. Installation of weir structures at the end of Slatteries Drain or Meerschaum Vale Drain

Remediation Strategy: Groundwater manipulation

Areas Targeted: Upper Slatteries (1)
Meerschaum Vale/Jumbo (2)

Description: Installing weirs at the end of the two highest priority areas which contribute a significant portion of the acid discharging from the Tuckean will hold the groundwater table up in the ASS hotspot area. This will reduce the acid drainage from the north-eastern former of the site

Benefits:

- Hold groundwater table higher, reduce acid drainage from the highest priority areas of the floodplain.
- Better downstream water quality.

Potential Impacts:

- Increases the surface water levels upstream of the weir.
- Reduced drainage capacity near the structure.
- Potential to increase inundation around the north-eastern corner and increase drainage times.

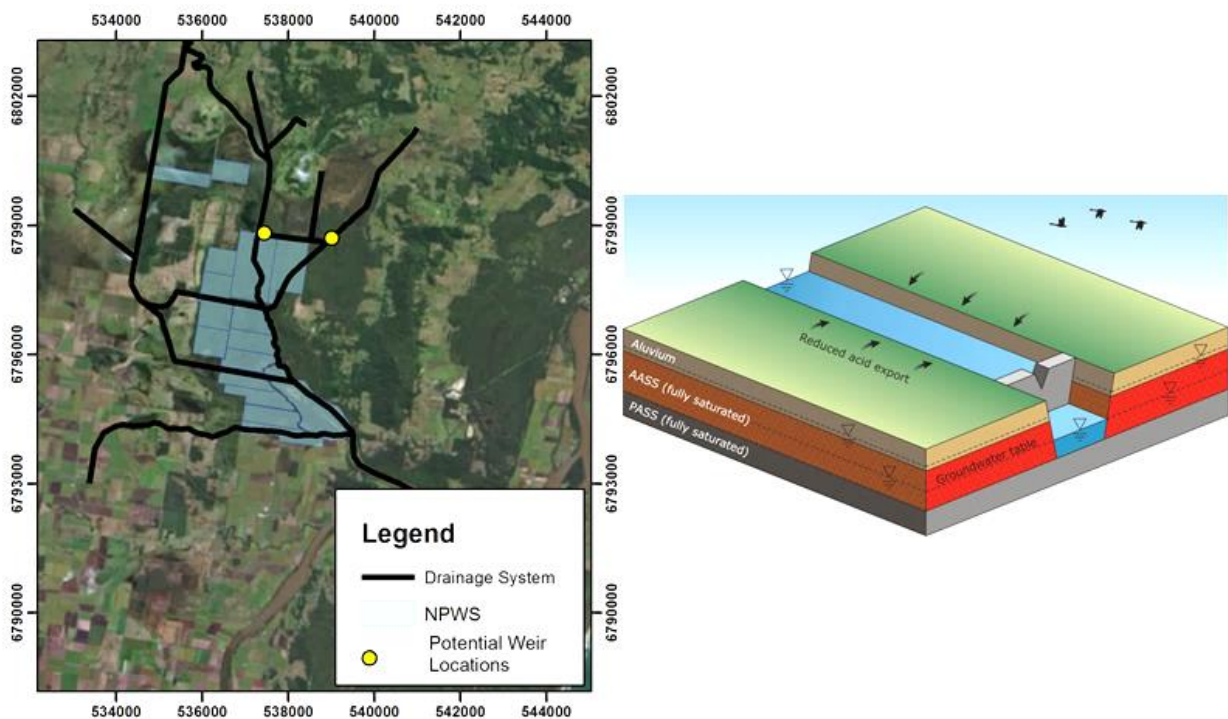


Figure 2: Left – Potential locations for weir structures, Right - Reduced acid export as a result of a weir structure holding up water levels

4. Reshaping of major drains: Target Slatteries Drain, Meerschaum Vale Drain, Jumbo Drain

Remediation Strategy: Drain Reshaping

Areas Targeted: Upper Slatteries (1)
Meerschaum Vale/Jumbo (2)
(Variants could include only one or any combination of the above)

Description: Most of the major drainage paths in the high priority areas of the Tuckean are deep, artificial drains with a bed well below the ASS layer. Reshaping the drains to a wider and shallower profile will reduce acid export from the site. By carefully designing the reshaped drains and increasing the width, drain reshaping can be undertaken while maintaining flood mitigation capacity. This will assist in holding the groundwater levels up near the altered drains. This would be particularly useful in the north-east section of the floodplain, including Jumbo, Meerschaum Vale and Slatteries Drains.

Benefits:

- Hold groundwater table higher, reduce acid drainage.
- Less diffusive acid generation into the surface water drains.

Potential Impacts:

- Any impacts to flood conveyance needs to be assessed.
- Increase groundwater table may reduce drainage on the lowest lying paddocks.
- Increases the foot print of the drains, which will require land.

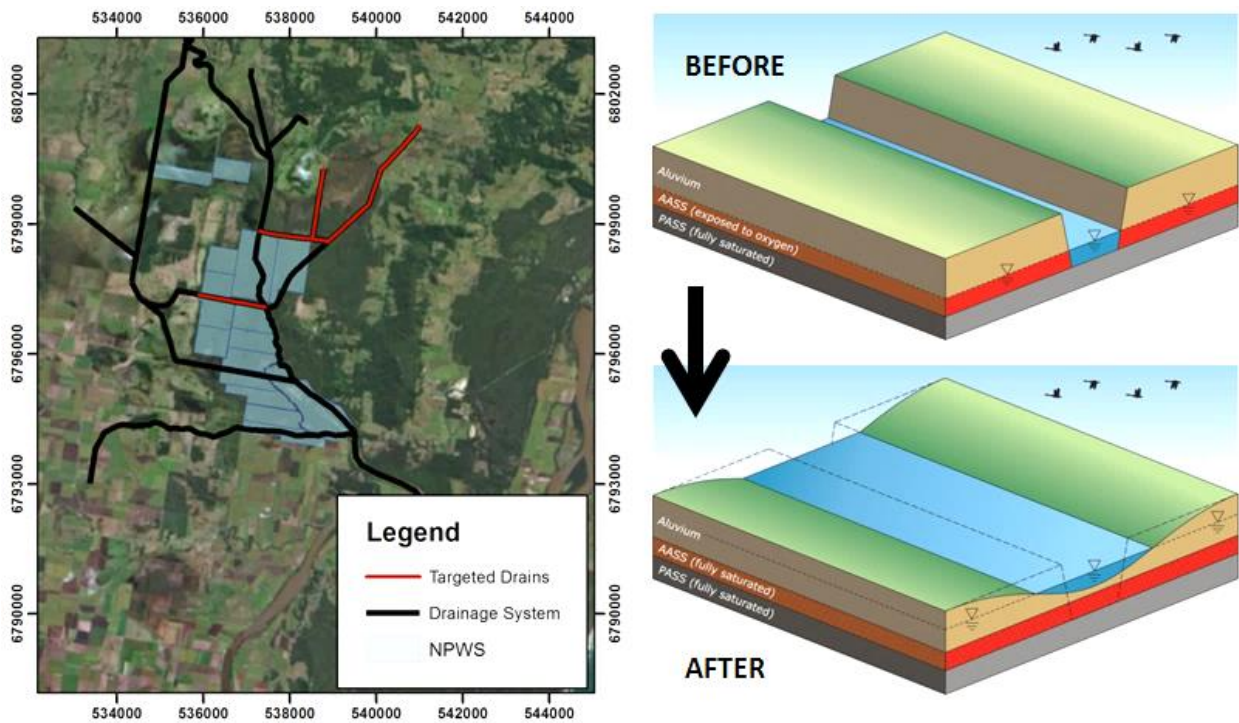


Figure 3: Left – Drains that could be target for drain reshaping, Right – example of new profile sitting above the ASS layer after the drain reshaping

Potential Variants: Reshaping the drains in the Tuckean is a viable option in all of the high priority areas. Separate scenarios could be run based on reshaping of individual drains, or any combination of the following drains:

- Meerschaum Vale Drain
- Jumbo Drain
- Slatteries Drain
- Nature Reserve Drain
- Hendersons Drain within the Nature Reserve

Some recommended variations of the reshaping scenario include:

- Reshaping of Jumbo Drain and Slatteries drain to target the two highest priority sites
- Reshaping Slatteries Drain, Meershaum Vale Drain and Jumbo Drain to target the north-east corner of the floodplain

5. Diversion of small to medium catchment inflows at Slatteries Drain onto the floodplain

Remediation Strategy: Wet Pasture (Freshwater re-flooding)

Areas Targeted: Upper Slatteries (1)
Meerschaum Vale/Jumbo (2)

Description: Flows from the upstream catchment into Slatteries Drain are conveyed relatively quickly from the floodplain through the drain. Except during larger rain events, the catchment inflows only typically inundate a small portion of the land. If additional land was acquired, a bund or weir could be constructed to divert flows on to the floodplain to increase the amount of time the acid hotspot remains inundated. The level and location of the bund could be optimised to ensure there is still sufficient flood conveyance through the main drain during larger flooding events to manage impacts further upstream. The location of the bund, and the areas to be targeted for reflooding would be based on previous modelling but is likely to include areas shown in Figure 4.

Benefits:

- Increase groundwater table to reduce acid export.
- Substantial increases in flooding time for the worst areas of the swamp.

Potential Impacts:

- Increase drainage times upstream.
- Reduced flood capacity to convey water upstream.

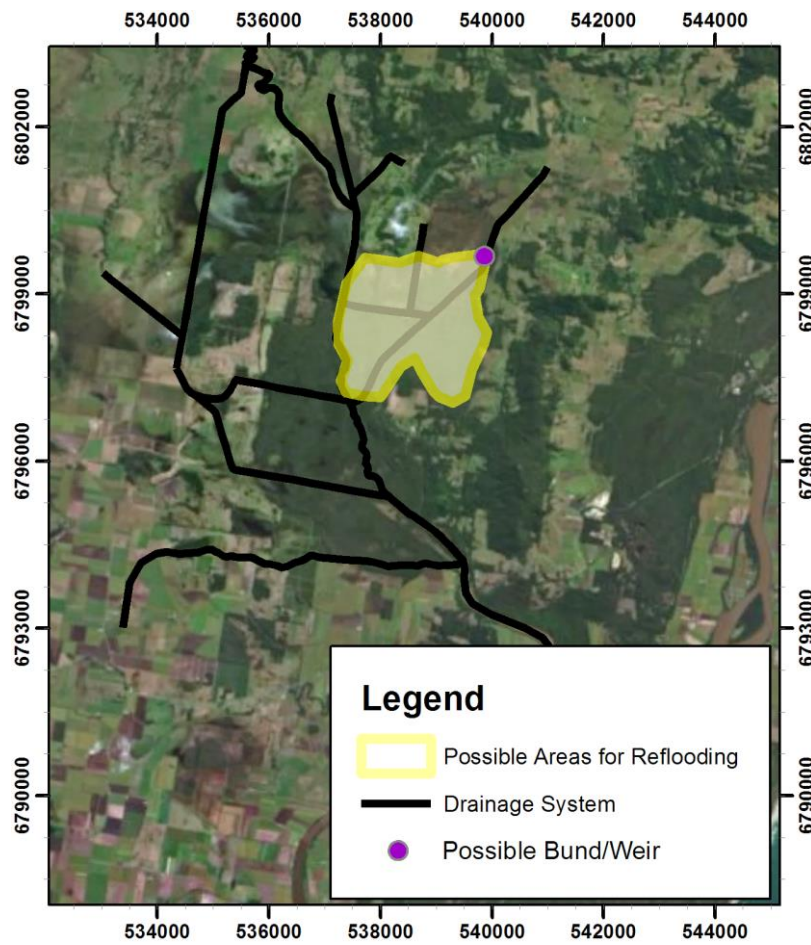


Figure 4: Possible areas to be targeted for re-flooding

6. Hinge open Bagotville Barrage during optimal periods

Remediation Strategy: Tidal Manipulation and Increased Flushing

Areas Targeted: Lower Stibbards – Lower Hendersons – NPWS (5)
 Tucki Canal – Central Hendersons – NPWS (4)
 Nature Reserve Drain – Central Hendersons (3)

Description: There are eight 3m x 3m one-way flood gates on the Bagotville Barrage that allow flows to discharge into the Richmond River, but prevent tidal flows into the swamp. This option would investigate the impacts of hinging open the gates and reintroducing tidal flows during targeted periods when the Richmond River water levels are within a prescribed range. When water levels in the Richmond River get above a specified trigger level, the gates would be closed to prevent backwater flooding of the Tuckean floodplain.

Benefits:

- Buffering capacity available from the bicarbonates in the tidal flows.
- Better flushing.
- Saltwater infiltration will assist in the management of in-drain vegetation.
- Increase the average water level in the Nature Reserve, thereby holding up groundwater table and inundating ASS in the lower Hendersons region.

Potential Impacts:

- Tidal (salt) inundation on the floodplain beyond NPWS area, particularly off Stibbards Creek .
- Increased average water levels downstream decreases the flood storage available to mitigate nuisance flood effects.
- Reduced flow conveyance.

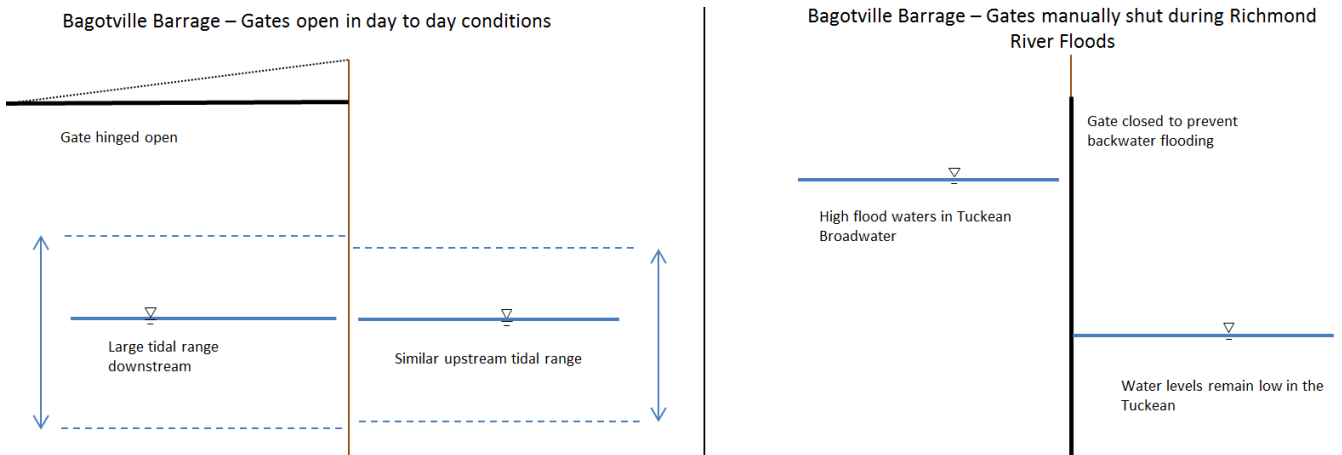


Figure 5: Hinging open the barrage gates to allow normal tides, but still preventing backwater flooding

7. Optimise remediation of Nature Reserve Area, while minimising upstream impacts

Remediation Strategy: Tidal Manipulation and Increased Flushing, with additional structures to prevent upstream impacts

Areas Targeted: Lower Stibbards – Lower Hendersons – NPWS (5)
 Tucki Canal – Central Hendersons – NPWS (4)
 Nature Reserve Drain – Central Hendersons (3)

Description: Using the results of Scenario 3 (above), another scenario could be developed where by the extent of tidal inundation is limited by the installation of new one-way flood gates at the edges of the Nature Reserve (or other appropriate location). This would allow salt water inundation of very low-lying areas in the NPWS owned land, while minimizing the risk of salt water infiltration on surrounding paddocks. This scenario may also include levies around the edge of the Nature Reserve to prevent overland flow from extending beyond the desired region. The locations of the floodgates and the requirement for the levy would be based on the results of the previous scenario; however, some preliminary possible locations are depicted in Figure 6. Note that the levy would only be considered on an as needs basis to prevent saltwater infiltration.

Benefits:

- Buffering capacity available from the bicarbonates in the tidal flows.
- Better flushing.
- Saltwater infiltration will assist in the management of in-drain vegetation in Hendersons drain.
- Increase the average water level in the Nature Reserve, thereby holding up groundwater table and inundating ASS in the lower Hendersons region.

Potential Impacts:

- Increased average water levels downstream decreases the in-channel storage available to mitigate nuisance flood effects.
- Reduced flow conveyance.

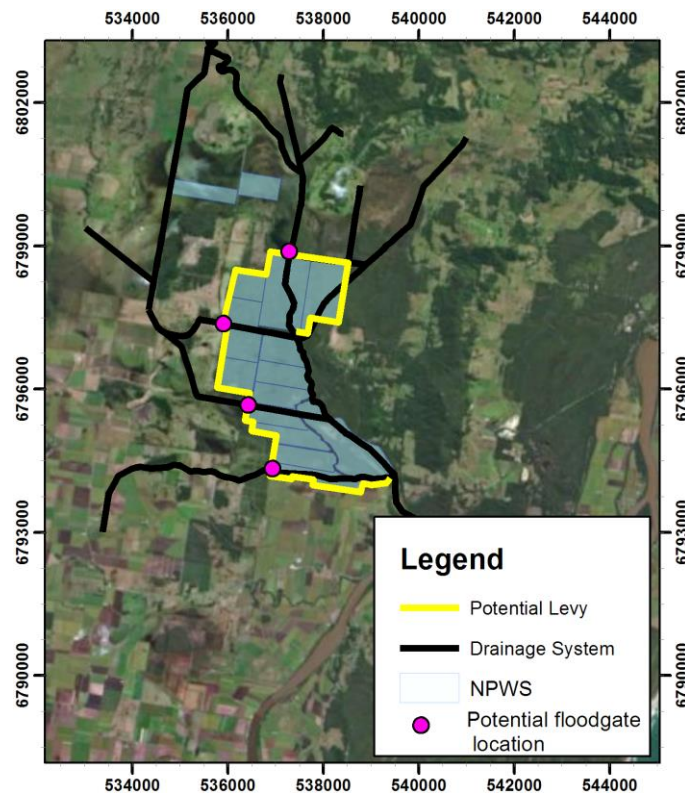


Figure 6: Potential floodgate locations and edge of parks area to be assessed for requirement of a levy