Technical Memorandum

Preliminary response to potential causes of Melaleuca dieback within the Belongil Catchment	
To:	Scott Moffett
From:	Damian McCann
Date:	30th July 2021
Pg/Attach.:	14
Job ref:	1-211444

Introduction and background

Significant dieback within Swamp Paperbark Forest has occurred within private land in a portion of the Belongil Creek Catchment and has been reported to Council by the President of Belongil Drainage Union. The Union asserts the dieback is a result of Council's mismanagement of the catchment hydrology which will lead to ecological collapse within the catchment. In response Council have requested AWC prepare a preliminary assessment of the potential causes of the dieback along with any knowledge gaps and need for additional investigations.

There are two key aspects of the Belongil Creek catchment hydrology which Council controls: discharge from the Byron STP and the Belongil Creek entrance opening. Both are licensed activities guided by plans of management developed in consultation with regulatory bodies and other stakeholders.

The Byron STP operating license (3404) permits wastewater to be discharged into the upper Union Drain. The current average daily discharge to the drain (excluding urban reuse) as noted in the 2020 Annual Return (NSW EPA, 2020) is approximately 3.6 ML/day. This includes flows from the decommissioned South Byron STP, which were transferred to West Byron STP in 2005. In recognition of potential impacts upon adjoining farm land (properties becoming wetter), an alternative flow path is being commissioned through the Byron Arts and Industrial Estate but will not be operational until 2022. The option to discharge into the Upper Union Drain will be maintained after this new discharge arrangement is in place.

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The Belongil Creek estuary entrance has been mechanically opened under a conditional interim licence since 2001 based on the draft Belongil Estuary Study and Management Plan (2001). The Plan was originally developed in response to environmental impacts within the catchment including fish kills, acid sulfate soil production and peat fires, which resulted from prevailing land use and an ad hoc opening regime. A condition of the interim 2001 licence requires Council to develop a sustainable long-term Opening Strategy based on a comprehensive understanding of the system, conditions and processes. In 2019, Council engaged Alluvium Consulting to prepare a long-term and sustainable Entrance Opening Strategy and associated Environmental Management Plan (collectively called an Opening Strategy) for Belongil Creek (Alluvium, 2019). The Opening Strategy seeks to minimise the impacts on natural littoral processes and the fragile ecosystems which exist within the Belongil Creek catchment, while also protecting the community and existing built assets from flooding. It aims to provide a balanced approach to managing the entrance for flood mitigation purposes while supporting the many key values of the catchment.

The Opening Strategy was developed in consultation with numerous agencies and key stakeholders (National Parks, Marine Parks Authority, Arakwal, Department of Planning Industry and Environment, Belongil Drainage Union) and guides decisions of when and how to open the Belongil Creek mouth.

The current regime outlines a decision support framework which guides entrance management decision making based on the estuary water level, the rainfall forecast, ocean levels and berm heights. There is some flexibility in the framework with a 'watch' level of 1.0m AHD and 'act' level of 1.1m AHD. The EOS is about to undertake a minor review to incorporate more recent information regarding ICOLLs and State-wide best practice management in relation to accompanying rainfall being used as a measure to reduce the possibility of fish kill; and lessons learnt thus far from the implementation of the current strategy.

Extensive monitoring of hydrology, water quality and hydrology occurs in support of STP discharge and entrance opening events with the results of monitoring reported to State agencies and the Wastewater Steering Committee and are publicly available.

Scope of this report

Management of the Belongil Creek catchment is complex. While there is a desire to maintain a natural opening regime and estuarine processes, substantial catchment changes (construction of the Union Drainage scheme, agriculture and urban development) make some degree of active management unavoidable. Consideration of all these issues is beyond the scope of this preliminary report which will focus on potential causes for dieback of Paperbark Swamp Forest within the Vidal property.

This report considers the following:

- The nature and extent of the dieback occurring
- Possible causes of dieback
- Historical photos and other records which provide historical context and potential duration over which dieback has been occurring
- The assertion by the Drainage Union that the dieback results from elevated STP discharge and the new Entrance Opening Strategy (2019)
- Gaps in knowledge and data and suggestions for additional monitoring

Areas considered in this report are shown in Attachment 2.

Nature and extent of dieback occurring

The area of dieback extends from the southern boundary of Lot 181 DP 755695 (268 Ewingsdale Road) the former chicken abattoir south east through Lot 11, DP1143215 (Tom Vidal's land) before meeting the Union Drain. The extent of dieback is shown in aerial imagery from July 2021 in

Figure 1. LiDAR shows this extent to be generally lower than surrounding lands and is an overland flow path. There has been extensive tree fall through the area along with loss of foliage. The vegetation in this area generally comprises a dense canopy of semi-mature Paperbark (*Melaleuca quiquenervia*) a sparse mid-storey and dense ground cover comprising a mosaic of wetland plants (*Phragmites australis, Eleocharis equisetina, Typha orientalis*), ferns (*Pteridium esculentum, Hypolepis muelleri*) and non-native grasses (*Urochloa mutica, Setaria sphacelata*). Council's mapping shows this area is Class 2 acid sulfate soils.

Processes for acid production on coastal floodplains

Coastal floodplains comprise mosaics of sedimentary deposits high in iron sulfides. These soils produce sulfuric acid when subjected to periods of wetting and drying which is then washed into waterways and is toxic to plants and aquatic life (Tulau, 2007). The acid dissolves iron and aluminium, also toxic to downstream aquatic environments, with the iron flocculating under certain conditions smothering plants and waterways.

Wetting and drying of potential and actual acid sulfate soils will move sulfuric acid to the soil surface and laterally through soils, leading to export downstream. These two pathways are shown in *Figure 2*. These processes are accelerated when floodplains are drained and developed for agriculture and urban development (Anorov et al., 2008). It appears that a prolonged dry period in 2018-2019 in which the watertable lowered and oxidised acid layers, followed by rain mobilised large quantities of sulfuric acid and dissolved iron which turned Belongil Creek a reddish colour (See Plate 1). Review of aerial imagery

from this time suggests acid export occurred between at least March and May, 2019. Attachment 1A is from March 2019.

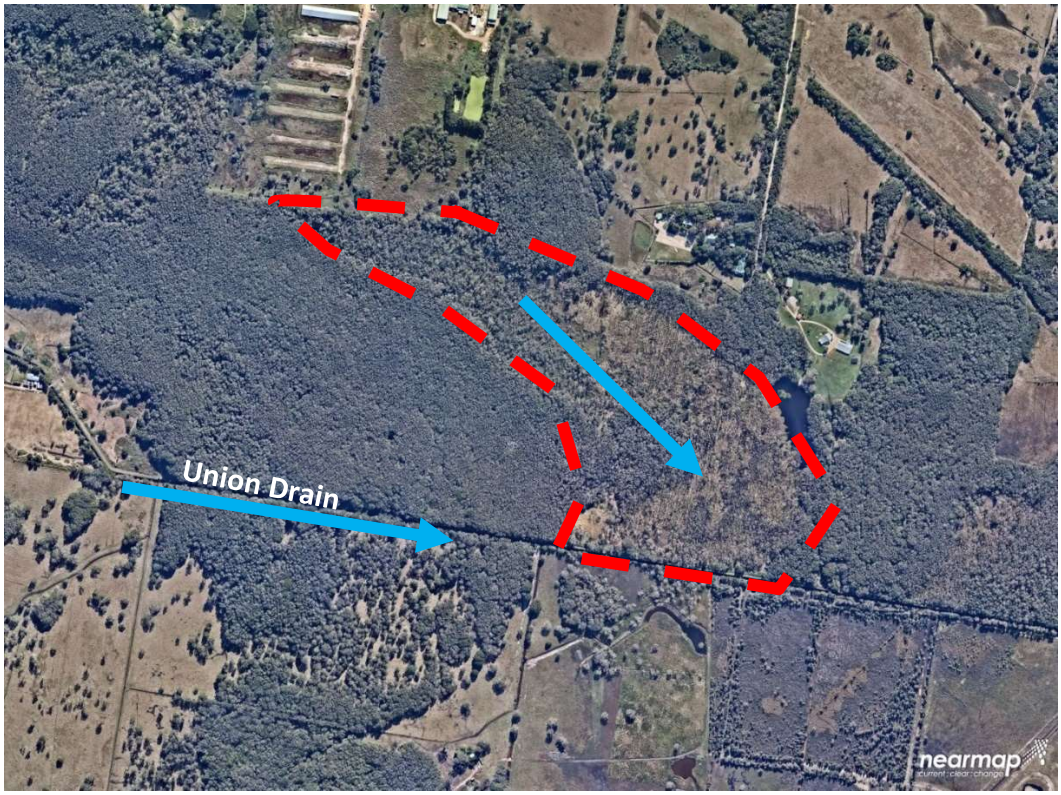


Figure 1 Area of dieback and general direction of flow. Source Nearmap July 2021

Plate 1: Belongil Creek at Ewingsdale Bridge in May 2019, with iron rich flows

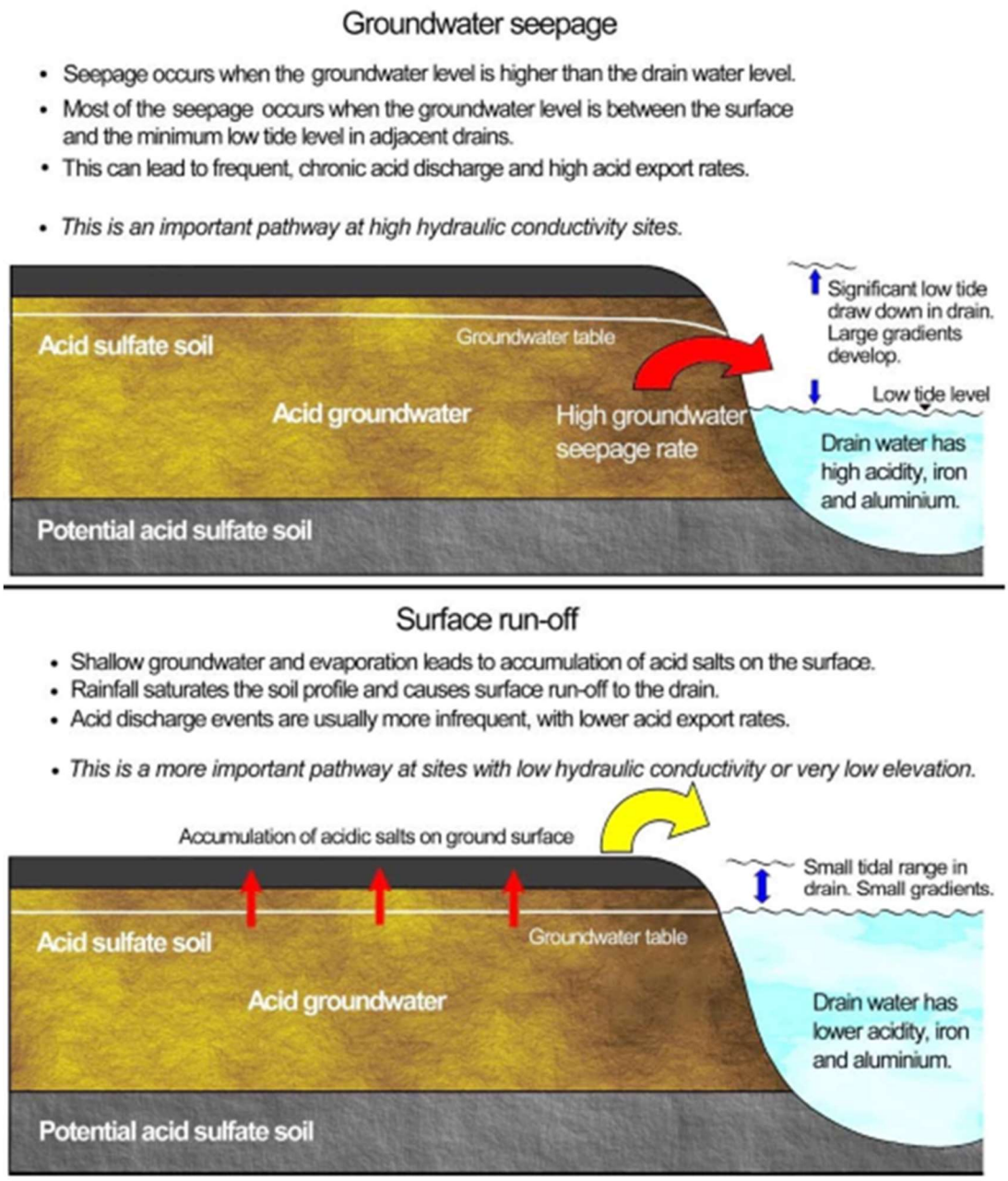


Figure 2 Two pathways for acid export – lateral groundwater seepage and surface run-off. Processes occurring within the dieback area require confirmation. (Source, Tulau, 2007).

Potential for impact by Council activities - drain conveyance capacity and hydraulic loading of the catchment

A review of historical imagery suggest that tree dieback has been occurring through this location for at least 30 years. Attachment 1B shows the subject area in 1997 with the same general pattern of impact being visible. Attachment 1C shows the area in 1987 with the same shape of dieback clearly identifiable.

Attachment 1D is from 1965 and shows the affected area and the broader floodplain context and how the Union Drain has dissected the original creek flowpath which includes the subject area.

The dieback in the subject location is possibly episodic, triggered by a combination of processes and factors including drain management, prevailing rainfall, and prolonged groundwater lowering. The location corresponds with a localised flow path originating in the Arts and Industrial Estate, through Lot 181 DP755695 which for over 30 years has delivered elevated and eutrophic stormwater downstream (See Attachment 2). The area was historically cleared for sand mining and grazing with the vegetation in the area generally less than 30 years old. Further interrogation of historic photographs may assist in confirming when the impact first began and what sequence of land use activities has occurred.

Discharge into the upper Union Drain flows south under Ewingsdale Road through Lots 181 DP755695, 10 and 11 DP114345 (See Attachment 2). The average STP discharge rate of 3.8ML/day corresponds to around 44L/s or 0.044m^3/s. Past survey completed by AWC shows the Union Drain (prior to enlargement in 2020 by the Drainage Union) had a cross sectional area of around 5.8m^2 when flowing past the Vidal property (see *Figure 3*) and a theoretical conveyance capacity of between 4m^3/s and 5m^3/s. At 4m^3/s, the discharge from the STP is less than 1% of drain conveyance capacity and could not conceivably inhibit drainage of the area in question sufficient to cause stress and dieback of Melaleucas due to prolonged inundation.

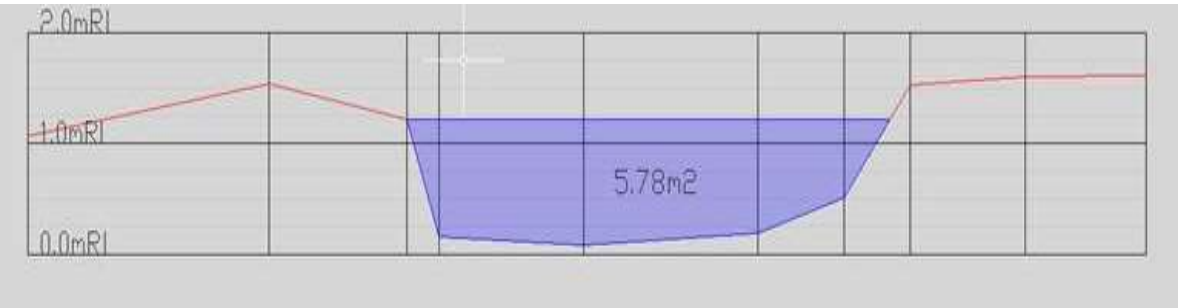


Figure 3 Surveyed cross section of the Union Drain flowing past the Vidal property prior to enlargement in 2020 (Source, AWC)

The Belongil Entrance Opening Strategy prohibits entrance openings in the absence of rainfall however STP discharge always occurs meaning this water is held in the catchment and will create wetter conditions compared to if there was no STP discharge. This will be detrimental for terrestrial plants such as pasture grasses and allow water tolerant plants to establish. *Melaleuca quiquenervia* is highly tolerant of prolonged inundation - as evidenced by the Melaleuca wetland cells within the Byron STP and the 24 hectare irrigation area, suggesting the dieback is caused by other factors.

The area of dieback is in a discreet location and there is no evidence of a similar process occurring on other parts of the Vidal property or the catchment (though this should be investigated and confirmed). In fact there is increased Melaleuca recruitment in the property immediately south of the Union Drain, opposite the Vidal property and in paddocks to the north of Ewingsdale Road possibly due STP discharge in combination with the Entrance Opening Strategy facilitating Melaleuca recruitment as the catchment becomes wetter.

One possible means of rehabilitating the area in question is to top up the groundwater (possibly with treated wastewater) and improve drain management to prevent oxidation of acid layers as is done within the Byron STP 24 hectare irrigation area. This approach is consistent with recommendations within the Estuary Management Plan (Parker and Pont, 2001) and the Acid Sulfate Soils Remediation Guidelines for Coastal Floodplains in NSW (Tulau, 2007).

Conclusion and additional investigations

There are competing objectives within the Belongil Creek catchment with farmers needing to drain their lands efficiently to enable cropping and grazing however historically this has come at a cost of poor water quality, fish kills, acid events and peat fires (Parker and Pont, 2001). Council is required to manage entrance openings under strict criteria including prevention of flooding in town and avoidance of poor water quality and fish kills. Via ongoing ecological monitoring Council must also demonstrate that vegetation health is not declining.

Dieback of vegetation within the Vidal property is likely the result of historic disturbance – land clearing, drainage works in combination with seasonal rainfall patterns which continue a cycle of wetting and drying and acid production. There is no clear hydraulic connection between STP discharge and the affected area, however the Entrance Opening Strategy maintains a higher creek level than occurred in the past, with creek water levels routinely above 1.0mAHD. This current regime is potentially facilitating the spread of wetland vegetation into former grazing and cropping lands, though the full extent of this spread has not been investigated. The catchment is not on the verge of ecological collapse but a holistic approach to managing catchment health is required (Anorov et al. 2008). Council intends to prepare a holistic plan for the Belongil Catchment via the preparation of a Coastal Zone Management Plan (CZMP) which will develop strategies for sustainable catchment management.

The combination of STP discharge into the Upper Union Drain and the current entrance opening strategy is creating a wetter catchment compared to the past 50 to 80 years, but still not as wet as prior to the drainage network being constructed in the early 1900s to 1950s when the Belongil floodplain would be inundated for weeks and months at a time. The area of dieback within the Vidal property is a

legacy issue which should be addressed – possibly through the addition of recycled water and construction of drainage controls such as floodgates to raise groundwater levels.

Additional Investigations

While the observed dieback is likely not caused by Council operations, the dieback and associated acid production is cause for concern. Better understanding of the causes for the acid production could allow the area to be rehabilitated which would benefit land holders and the Belongil estuary. The following investigations are suggested:

- Review historic aerial photographs to confirm how long the dieback has been occurring
- Carry out soil and groundwater testing and monitoring to understand operating conditions.
- Confirm the extent of wetland recruitment in the catchment within former farming and grazing lands
- Complete a catchment assessment to confirm the preliminary observation that dieback is not occurring elsewhere in the catchment
- Consider options for rehabilitation of the affected area including improved drain management and additional flooding to avoid prolonged drawdown of the water table.

References

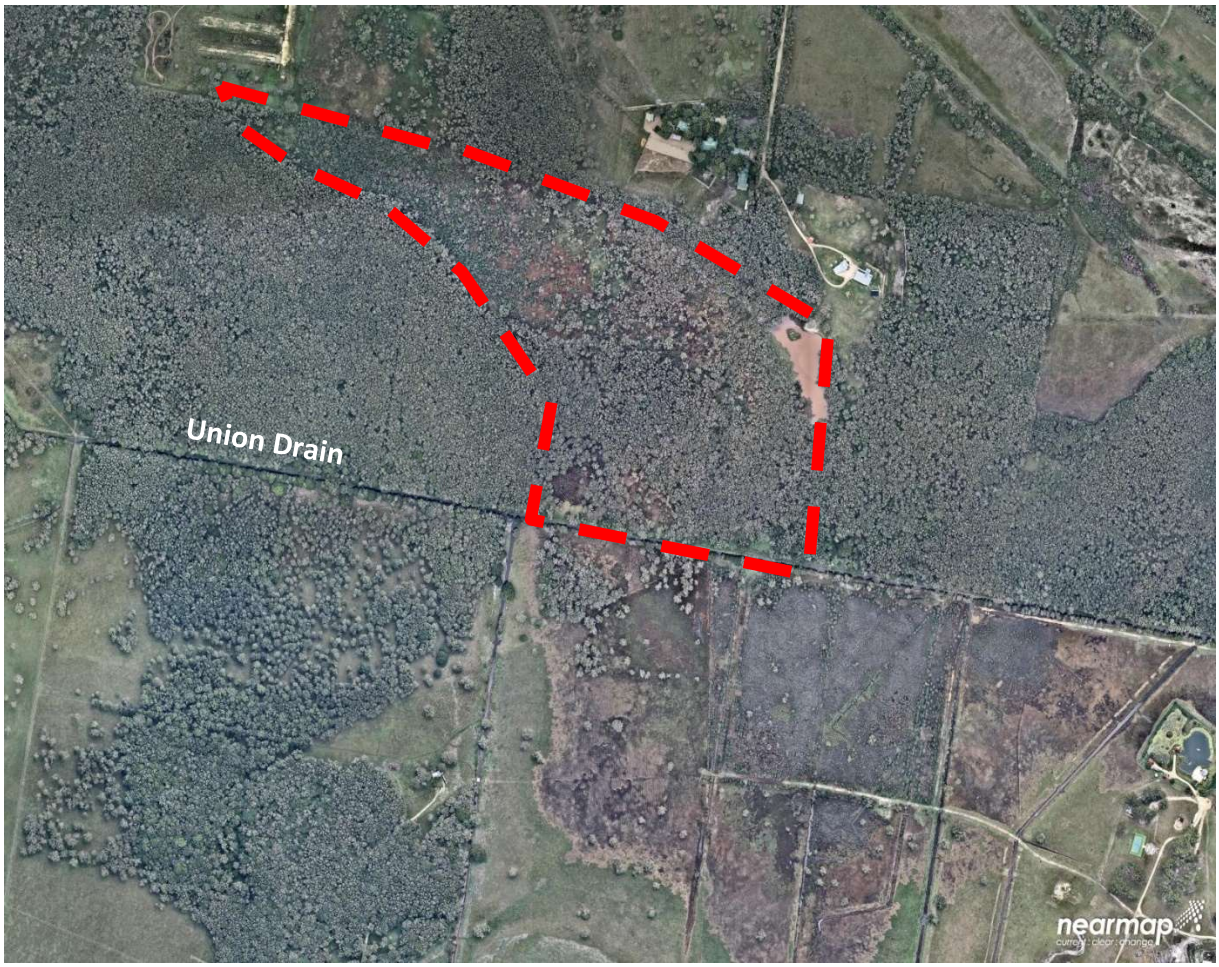
Anorov, J. M., Dale, P. E., Powell, B. and Greenway, M. (2008) 'An Interdisciplinary Approach for Understanding and Managing a Sub-tropical Coastal Wetland Ecosystem: Native Dog Creek, Southeast Queensland, Australia', *The Proceedings of the Royal Society of Queensland. Royal Society of Queensland, 114*, pp. 19–32.

Alluvium (2019). *DRAFT Belongil Creek entrance opening strategy.* Prepared for Byron Shire Council

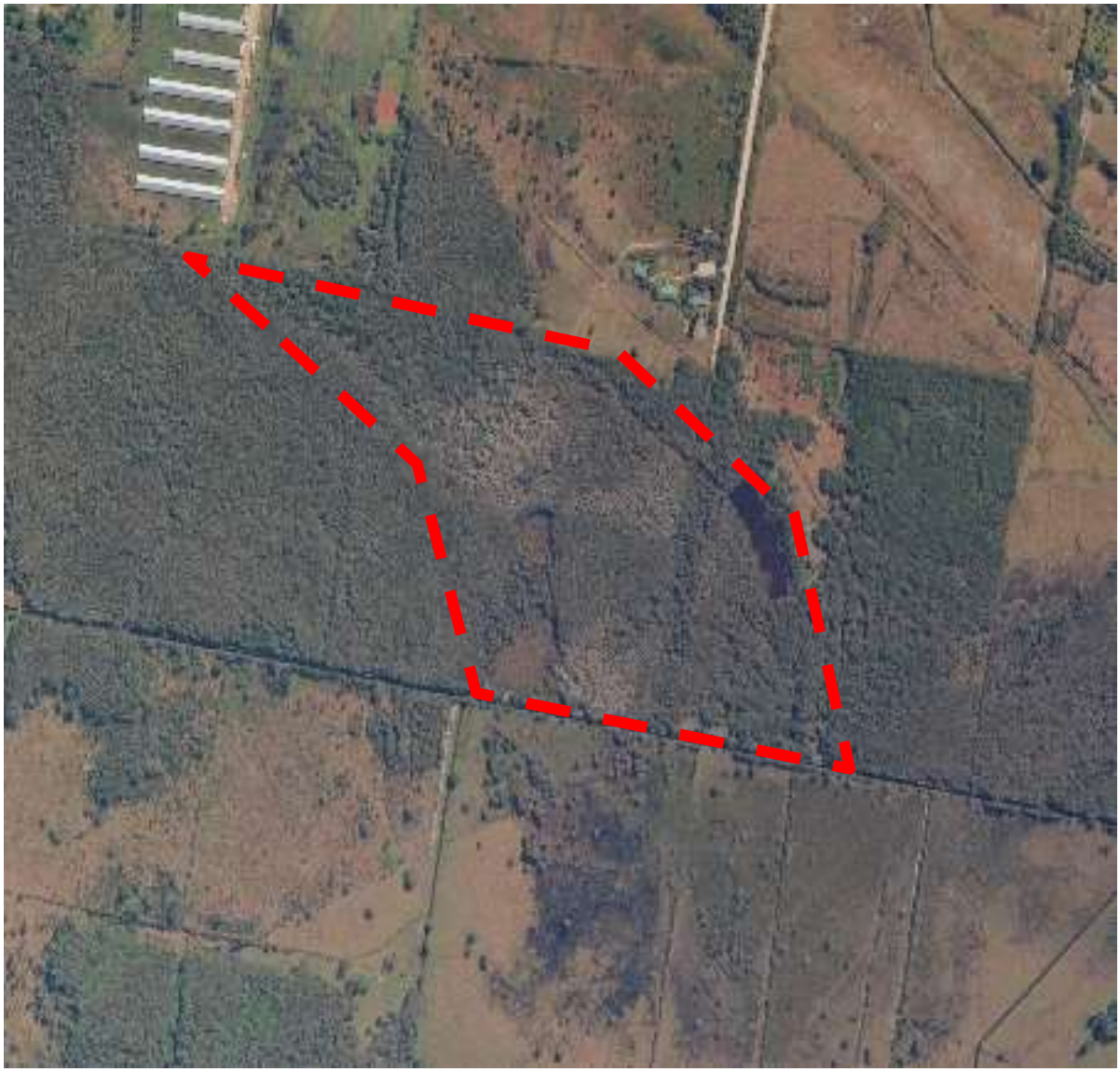
Environment Protection Authority – NSW (2020). *Byron sewage treatment works, Statement of Compliance – Licence 3404 Annual Return, : 27-4-2019 To: 26-4-2020*.

Parker, P. and Pont D. (2001). *Belongil Estuary Study and Management Plan.* Prepared for Byron Shire Council.

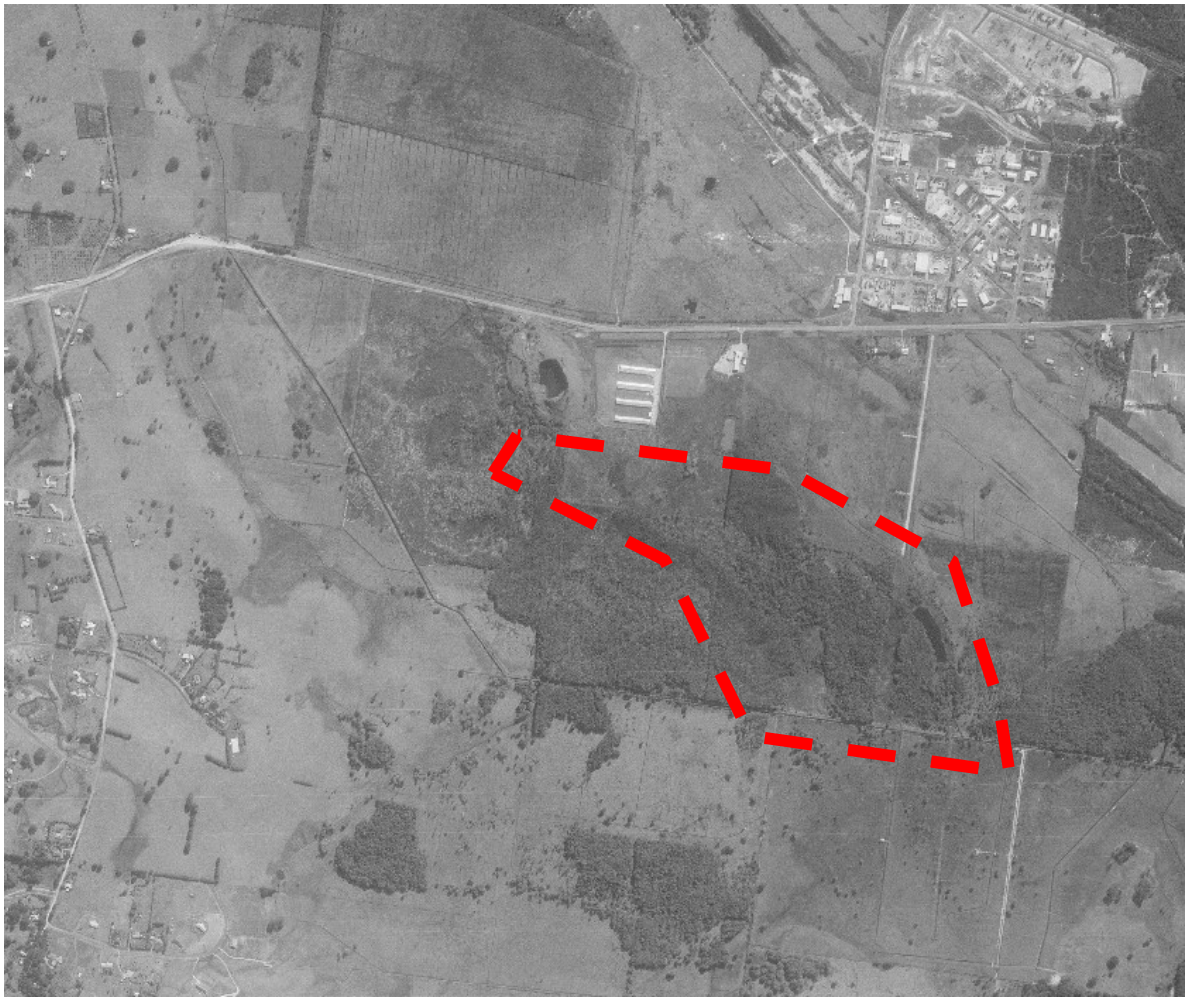
Tulau, M.J. (2007). *Acid Sulfate Soils Remediation Guidelines for Coastal Floodplains in New South Wales.* Department of Environment and Climate Change.



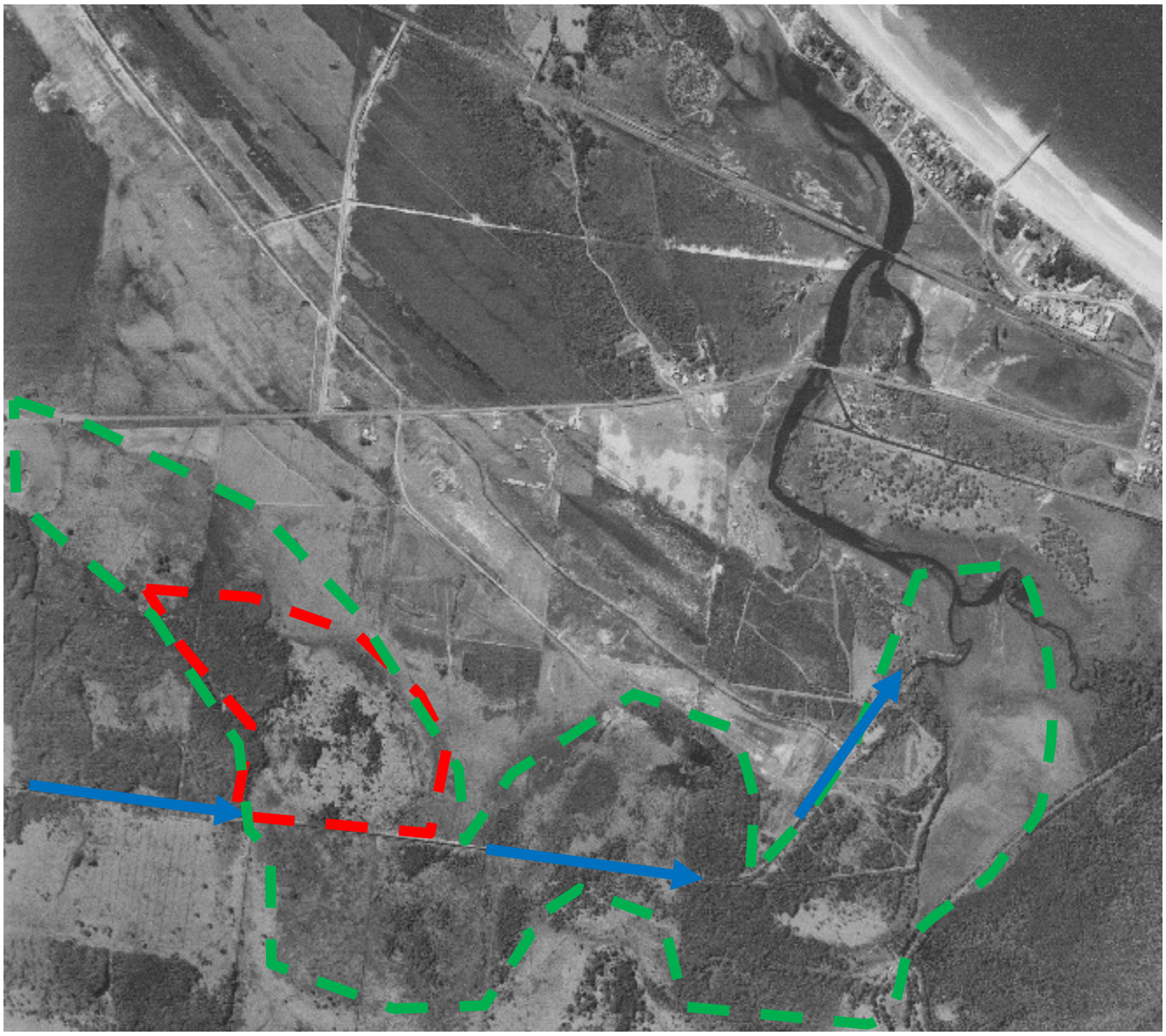
Attachment 1A: Subject Area in March 2019 with export of sulfuric acid apparent on the northern and southern side of the Union Drain



Attachment 1B: The subject area in 1997 showing substantial regrowth but also canopy discolouration.

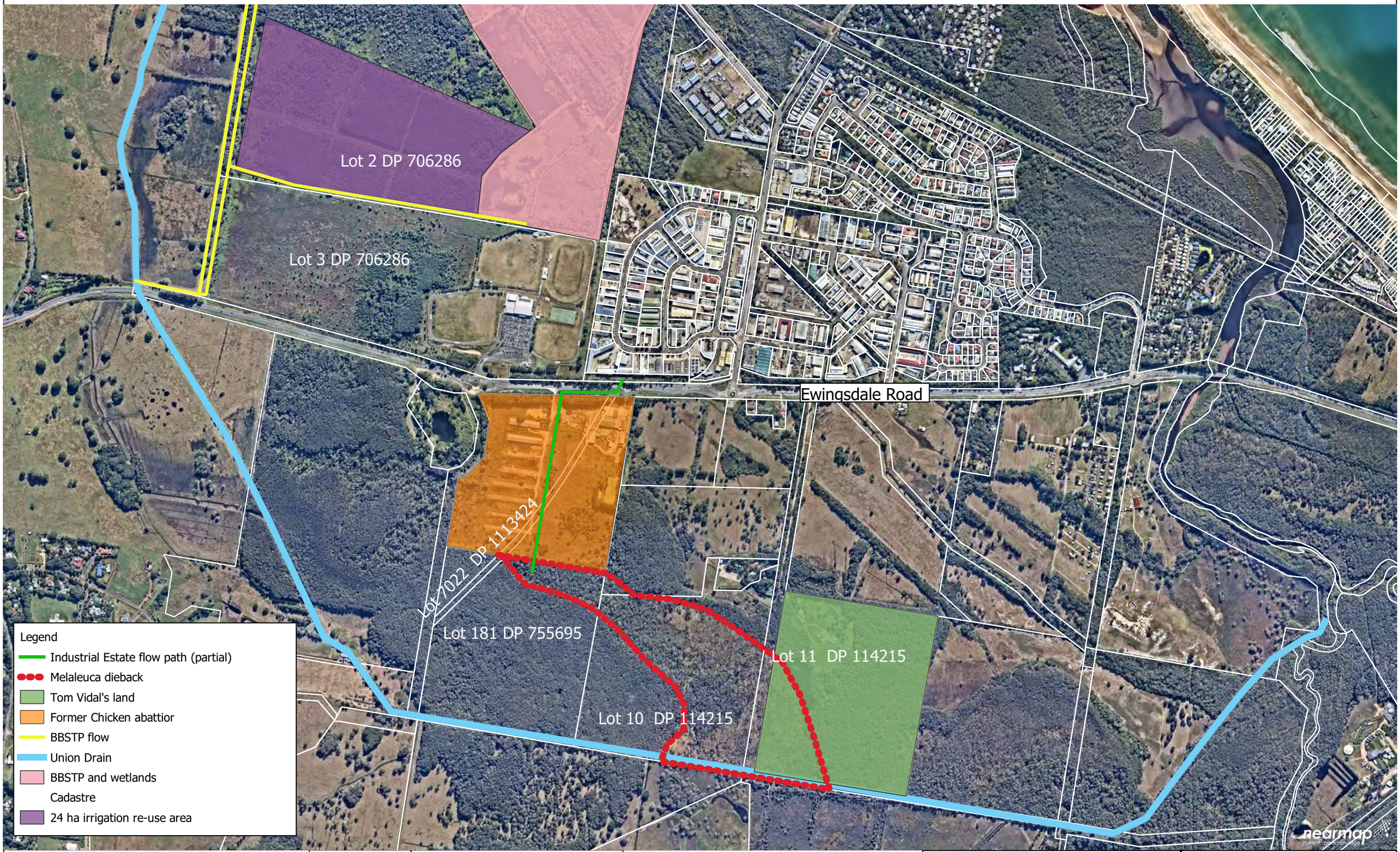


Attachment 1C: The subject area in 1987 showing the same extent and regenerating vegetating



Attachment 1D: Subject area in 1965 clearly showing a flow path and broader floodplain wetland complex (green hatch) dissected by the Union Drain (blue arrows).

Attachment 2



AWC

Source:	Cadastral Boundaries: NSW Land & Property Information 2019 Aerial Photo: NearMap 2021
Disclaimer:	Care was taken in the creation of this map. AWC should be consulted as to the suitability of the information shown here in prior to the commencement of any works based on the information provided. AWC cannot accept any responsibility for errors, omissions or positional accuracy. There are no warranties expressed or implied as to the suitability of this map for a particular purpose. However, notification of any errors will be appreciated.
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Coordinate System: MGA 56 Projection: Transverse Mercator

Attachment 2:

General layout