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ARMSTRONG CREEK URBAN GROWTH AREA

HORSESHOE BEND PRECINCT (HBP)

STORMWATER MANAGEMENT STRATEGY (SWMS)

SPARROWVALE WETLAND OPTION

DISCUSSION PAPER 2

(VERSION 2)

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TABLE OF CONTENTS

1. INTRODUCTION

This discussion paper has been prepared as a follow-up to the first paper on the Horseshoe Bend Precinct Stormwater Management Strategy (SWMS) dated 31 October 2011 and should read in conjunction with that document.

The paper examines in more detail the opportunities presented by inclusion of the wetland area in Sparrowvale Farm as part of the overall Armstrong Creek Growth Area stormwater management system.

2. EXISTING FLOODING CONDITIONS

The October 2011 paper summarised what is known about flooding and drainage issues in Sparrowvale Farm and Hospital Swamps.

Flood levels for local catchment runoff conditions have been determined in earlier studies and are shown on Figure 1.

Maximum flood levels in and around Sparrowvale Farm occur during Barwon River inundation and are higher and more extensive in area than the flooding depicted on Figure 1. Levels adopted by the Corangamite Catchment Management Authority (CCMA) are (2.00 m/3.00 m AHD for 10/100 years ARI respectively.

Downstream of Sparrowvale Farm the receiving environments of the Lower Barwon River Wetlands, especially Hospital Swamps, are dominant considerations for surface drainage planning in the new urban growth areas. Figure 2 shows the wetland system layout with key reference points for water control structures including the farm levee and river off-takes.

Figure 3 (Sheets 1 and 2) are nearmap.com extracts showing conditions in the area downstream of the HBP during the recent drought (August 2009), and most recently in October 2011 after wetter than average weather conditions over the previous 12 months. Clearly under existing catchment conditions, extensive areas of the farm are subject to prolonged inundation, unrelated to Barwon River flooding but linked to very flat topography in the farm and high water levels in Hospital Swamps effectively inhibiting drainage of water through the levee via the drain/regulator.

A pump system was originally operated (with council funding assistance for fuel costs) to relieve flooding of this nature due to it being sourced from external catchment runoff. However this funding assistance apparently ceased when municipal amalgamations occurred and the prolonged inundation currently observed will continue at least until water levels are lowered in Hospital Swamps. Current information indicates that there is no intention on the part of any authority to reinstate a pumping regime.

Figure 4 shows 0.5 m contour data recently provided for use in this investigation.

Comparison of the 0.5 m contours on Figure 4 with the flood extents shown on Figure 2 and the October 2011 aerial photo on Figure 3 (Sheet 2 of 2) shows good correlation.

3. SUMMARY OF RECEIVING ENVIRONMENT FLOW REGIMES

3.1 General

Urbanisation inevitably leads to increased discharge of surface runoff and reduced accessions to groundwater and losses to evapotranspiration.

In the SWMS report it was pointed out that existing conditions (mean annual) runoff volumes will be about 45% (at most) of future post-development runoff (1.3 ML/ha/year cf. 2.9 ML/ha/yr respectively).

While annual runoff will still be strongly seasonal there is no doubt that significant increases in surface runoff will occur in the summer/autumn periods. Short duration rainfall which produces little runoff under existing conditions will produce significant runoff from large impervious areas.

3.2 Hospital Swamps Flow/Ecology Requirements

The water management cycle for Hospital Swamps which has operated over the last 25 years (with no changes in vegetation over that time) is in summary:

- Fills in spring;
- Drops to 0.30 m AHD in January;
- Usually dry by end of summer.

Hospital Swamps are vulnerable to a water regime that increases inflows over summer and autumn. Low flows or no flows in this period are important in creating saline conditions in the wetland bed which exclude emergent macrophytes and maintain a diverse community of plants that tolerate a variety of saline environments. Summer inflows will suppress groundwater discharge to the wetland and dilute surface water salinities. They may lead to an increase in the extent of reeds and a loss of a variety of salt-tolerant herbs, sedges and shrubs. In addition, nutrient run-off from stormwater, recreational ovals and irrigation upstream may change the nutrient status of the Swamp and therefore the vegetation community and the rest of the ecosystem through trophic cascades.

In regard to potential increase in freshwater volumes from the Armstrong Creek Urban Growth Area, the emphasis for surface water management design must focus on maintaining essentially the same summer/autumn conditions as have persisted for the last 25 years. Increase in volumetric throughputs in winter/spring periods would be expected to have little detrimental impact based on the writer's understandings of the flow/ecology reports.

3.3 Barwon River Flood Hydrology

Figure 4 shows that the existing levee surrounding Sparrowvale Farm has a crest level of 2.0 m AHD. This approximates the 10 year ARI flood level in the Barwon River. The existing barrage in the Barwon River has a fixed crest level of 0.85 m AHD.

Water Technology have assessed the potential impact that removal of the Sparrowvale Farm levee could have on the hydrology of the Farm and Hospital Swamps. It was found that without the levee, inundation of the Farm area would commence at a flow rate of 1,728 ML/d. Complete inundation would occur (level of about 0.9 m AHD) when the flow reaches 3,456 ML/d. This flow approximates the current threshold of protection against flooding of Hospital Swamp from the Barwon River. Overbank flooding into Hospital Swamp from the Barwon River commences at levels of approximately 1.4m AHD.

Based on the flow record, the farm land would become inundated multiple times a year and, based on the topography, maintain a pool of water at a depth of approximately 0.5 m deep across 90 ha of land after every inundation event.

3.4 Sea Level Rise Predictions

In compiling recommendations for future water regimes for Hospital Swamps, the flow/ecology reports assume current tidal regimes in Lake Connewarre are continued into the future. This would seem to be at odds with predictions for mean sea level rise from 0.0 m AHD to 0.25 m AHD by 2030 and to 0.80 m AHD by the year 2100. If such predictions do eventuate then Hospital Swamps will be effectively permanently saline and inundated above 0.5 m AHD with this outcome being realised for the lower two basins by 2030.

It would follow that increased freshwater runoff from the catchments to Hospital Swamps would then be of little practical relevance within a couple of decades.

However these predictions also confirm that a permanent water level above 0.80 m in the Sparrowvale Wetland should still sustain a freshwater environment up to the year 2100.

4. THE HBP SURFACE WATER MANAGEMENT STRATEGY INCORPORATING THE SPARROWVALE WETLAND

Assuming the inundated areas of Sparrowvale Farm are transferred into public ownership then the area currently subject to prolonged inundation would be converted to a freshwater wetland system, with the existing Barwon River levee retained.

The October 2011 paper showed the indicative layout and sizing of surface water management assets required to service full urbanisation of the HBP, assuming Sparrowvale Farm was not incorporated into the surface water management scheme.

> *(It should be noted that this scheme still required restoration of the pumping system to discharge excess volumes of catchment runoff water out to the Barwon River.)*

Adding the inundated areas of Sparrowvale Farm into the strategy offers the opportunity to reduce size and land take for surface water management assets within the HBP in favour of the Sparrowvale Wetlands.

4.1 How Much Land is Needed for the Sparrowvale Wetland?

The permanent fixed crest of the Barwon River barrage is 0.85 m. After consideration of the 0.5 m contour data, the Normal Top Water Level (NTWL) of the wetland would be set at or close to 0.95 m AHD so as to facilitate effective gravity drainage connection out to the River barrage pondage for most of the year and especially in the summer/autumn periods, using the existing farm drainage channel outlets. There would be no need to reinstate pumping to the Barwon River.

The wetland area that would be created at NTWL of 0.95 m is some 220 ha. With such a vast surface area, evaporation losses will be extensive during the summer/autumn periods and water levels can be expected to drop below NTWL at such times and with the flat topography the margins of the wetland will contract and expand over significant distances.

Extended detention depth (above NTWL) associated with use of this wetland for stormwater quality treatment will only be of the order of 50-100 mm.

The flood storage volume available above NTWL and below a level of say 1.2 m is some 330,000 m3 which is 3-4 times that required to fully mitigate impact of increased peak flow discharges in the HBP.

The Sparrowvale Wetland area is more than sufficient to provide best practice water quality and quantity treatment outcomes for the entire HBP in its own right. Therefore other assets located within the HBP can be scaled back to minimums required to suit ultimate drainage line form.

On this basis it is considered that the land area required for surface water management purposes associated with development of the HBP can be set generally as the area below 1.2 m AHD.

This does not mean that land above 1.2 is available for development-all lands below 3.00 m AHD are subject to inundation in the 100 year ARI flood in the Barwon River.

Figure 5 shows the recommended extent of land that should be set aside for management of catchment runoff for the Sparrowvale Wetland with full catchment development in place:

- the west boundary is approximated by a northwards extension of Charlemont Road;
- the south boundary is approximated in part by Groves Road;
- the balance boundaries are set by the alignment of the Barwon River levee and the 1.20 m AHD contour.

The total area of land within these boundaries is estimated to be 300 ha.

Figure 5 also shows a linear sedimentation basin to be constructed within the boundaries on the existing inlet drainage line. This would be formed as an over-excavation of the existing drainage line and would have a water surface area of not less than 7,000 m^2 at NTWL.

4.2 Other Potential Hydraulic Linkages and Funding

It may be noted that if the Sparrowvale Wetland is incorporated into overall surface water management planning for Armstrong Creek, the available capacity for management of development runoff quality and quantity far exceeds that required for the HBP catchments alone.

It is a simple matter to link the terminal wetlands exiting from the Armstrong Creek East Precinct across into the farm wetlands as indicated on Figure 5. This link would then complete the hydrologic and water quality protection for Hospital Swamps.

Funding for such a link cannot be attributed in any way to the HBP.

It would also follow that if and when such linkage is completed, that other sources of funding should contribute to the final cost of the Sparrowvale wetlands project.

4.3 What are the balance land requirements within the Sparrowvale Catchments in the HBP?

Figure 6 shows the estimated drainage area requirements within the HBP proper and extra drainage reserve areas downstream to the proposed Sparrowvale Wetland boundary.

For the Sparrowvale North catchment up to 7.5 ha of land was originally required without the Farm. The sewer constraint still requires a linear wetland system to be provided west to about the 8.5 m contour. However the width could be reduced to an average of 60 m or 2.5 ha in total. Downstream of the sewer a 30 m wide waterway reserve would be needed to Sparrowvale Road, increasing to 50 m downstream.

For the Sparrowvale South catchment the sewer constraint forces a linear wetland to be retained upstream of the sewer to near Batten Road. Again it could be reduced to 60 m width which implies a land take of about 2.25 ha. Downstream of the sewer a 50 m reserve would continue for the open waterway as before. Upstream of the linear wetland a 50 m waterway reserve would still extend through to Horseshoe Bend Road and upstream for at most 100 m (to allow for a sediment basin on the west side of the road).

Table 1 summarises the landtake for the SWMS covering the Sapprowvale catchments, incorporating the Sparrowvale Wetland option and compares it with the alternative stand-alone SWMS where all drainage assets are kept within the precinct boundaries.

It should be noted that the stand-alone option does not resolve the Hospital Swamps protection issue.

Table 1 shows that the Sparrowvale Wetland Option releases an extra 11.35 ha of developable land within the HBP boundaries, but requires an extra 4.25 ha of undevelopable land between the current HBP boundaries and the proposed Sparrowvale Wetland boundary.

TABLE 1 Comparison of Landtake Requirements to Proposed Sparrowvale Wetland Boundary					
Catchment		**Assets**	**SWMS Option**		**Land Saving with Sparrowvale Wetland Option**
			Excluding Sparrowvale Wetland	**Including Sparrowvale Wetland**	
Sparrowvale North	Within HBP	WLRB's Upstream of Barwon Heads Rd	6.0	2.5	3.5
		Drainage Reserves	-	0.9	-0.9
		Sparrowvale Rd WLRB	1.0	-	1.0
		NE WLRB	0.5	-	0.5
		Drainage Reserves			
		Total within HBP	**7.5**	**3.4**	**4.1**
	Downstream of HBP	Drainage Reserves	-	3.7	
		Total downstream of HBP	**-**	**3.7**	**-3.7**
Sparrowvale South	Within HBP	Horseshoe Bend Rd WLRB	3.0	-	3.0
		Drainage Reserves	5.0	6.5	-1.5
		Batten Rd WLRB	2.5	-	2.5
		Barwon Heads Rd WLRB (2 parts)	4.5	2.25	2.25
		Total within HBP	**16.0**	**8.25**	**7.25**
	Downstream of HBP	Charlemont Rd WLRB	1.0	-	1.0
		Drainage Reserves	-	1.55	-1.55
		Total downstream of HBP	**1.0**	**1.55**	**-0.55**
Total Catchment System			**24.5**	**16.9**	**7.1**

4.4 Land Draining North into the Marshall Precinct

For the area draining northwards across Reserve Road into the Marshall Precinct no changes accrue as a direct consequence of the inclusion of the Sparrowvale Wetland option.

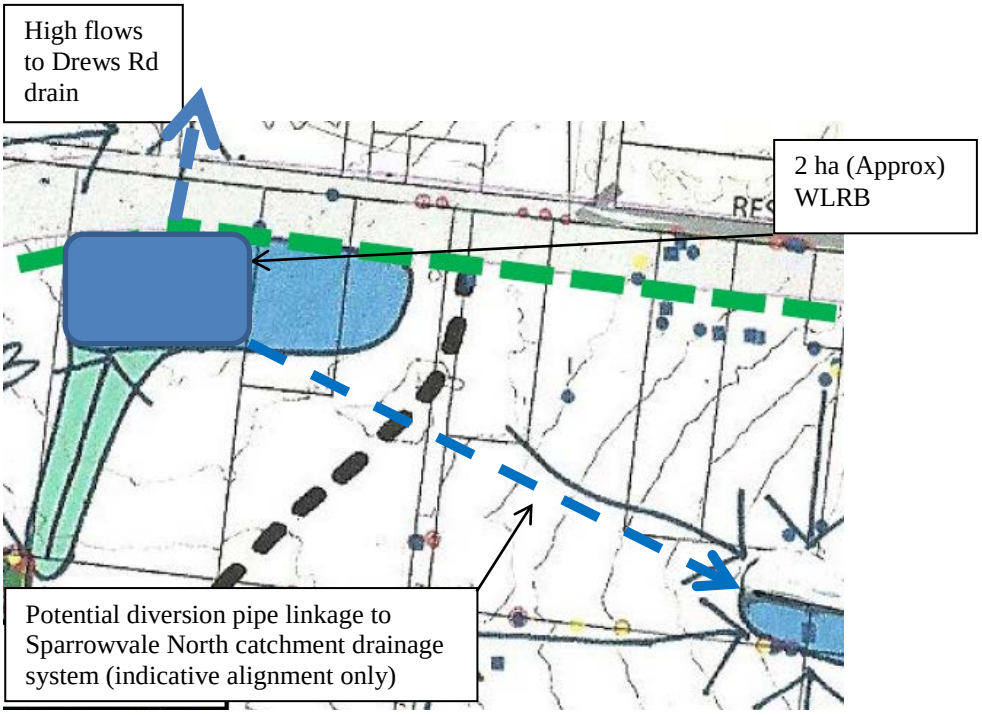
Landtake for drainage purposes remains as set out in the first report dated 31 October 2011 and shown on Figure 6. With this landtake, all development within the HBP can proceed whilst complying with best practice water quality treatment and water quantity management objectives. There would be no change to peak stormwater discharges crossing Reserve Road for all events up to and including the 100 year ARI event. All discharges would be connected to the existing drain in Drews Road via the existing 1500 mm diameter pipe under Reserve Road.

However the Sparrowvale Wetland option does present an opportunity for improved management of drainage within the Marshall Precinct.

The 0.5 m contour data shows that it would be possible to divert part or all of the piped outfall from the HBP Reserve Road WLRB eastwards into the Sparrowvale North catchment. This would mean that:

- peak discharges into the Marshall Precinct could be significantly reduced, for minor to moderate flood events at least;
- the estimated 4 ha WLRB landtake shown on Figure 6 could be significantly reduced (to at most 2 ha).

Major flood outflows from the HBP Reserve Rd WLRB which exceed the pipe diversion capacity would still be directed northwards to Drews Road drain as under existing conditions. The extract sketch below illustrates this option.



4.5 Impact of the 4C Vertical Alignment

No details are yet available on the vertical alignment of the 4C road. However it is known that the road formation will be above natural surface levels and this will influence drainage planning within the HBP because of the potential to block the passage of flood flows.

On the Sparrowvale North catchment east of Horseshoe Bend Road, the finished surface levels for all developable land along the 4C frontage will be set according to the flood levels in the WLRB to the south. That means no additional filling will be required to suit the 4C grading.

West of Horseshoe Bend Road in the subcatchment draining north across Reserve Road into the Marshall Precinct, the 4C levels will directly influence final development levels on abutting land. Good practice drainage design will result in future floor levels being kept a minimum of 150 mm above the overtopping crest level of 4C, regardless of the design 100 year ARI flood levels determined for the WLRB. This provision allows for impacts of debris blockage or over-design flood events.

4.6 Boundary Road/Barwon Heads Road Intersection

Figure 6 shows that the current intersection of Boundary Road and Barwon Heads Road conflicts with existing and proposed drainage paths.

The opportunity does exist for the western approach of Boundary Road to be realigned to create a right-angle (staggered) intersection with Barwon Heads Road. In turn this eliminates the need to provide a waterway crossing of Boundary Road and minimises the culvert length under Barwon Heads Road, as indicated on the extract sketch below.

4.7 Staging/Implementation Considerations

4.7.1 General Principles

The number and location of the stormwater management assets shown on Figure 6 has been arranged to minimise overall capital and ongoing costs and to utilise as much land which is already encumbered by flooding as is practicable (rather than otherwise developable land), having regard to other constraints such as flora/fauna values and the main outfall sewer.

It is possible to split a WLRB into two separate segments to better suit staged or "out-of-sequence" development, or to resolve property ownership demarcations. However there is an "efficiency" penalty in doing this. As storage depths are basically fixed by flood levels and creek levels, and batter lengths are increased, splitting storages directly increases land area requirements. Other studies indicate storage capacity requirements rise by about 20% on average when a WLRB is split into two segments.

Similarly there is a penalty for ongoing operation and maintenance costs with increased numbers and total areas of assets.

Subject to suitable arrangements being put in place to cover any capital cost or ongoing cost penalties and the same performance standards being met, there is no technical reason why a WLRB cannot be split to better suit development layouts or land ownership differences.

It is standard practice in urban development contributory drainage schemes across the greater Melbourne area, for any temporary management facilities that may be required to service "out-of-sequence" development (as may be required to protect downstream undeveloped land and/or the environment) to be funded by the proponents of that development without reimbursement from the scheme, or in this case the DCP.

Timing of construction of WLRB's (and connecting pipelines or waterways) is entirely governed by the progress, rate and staging of development. The need for, and extent/size of any temporary management facilities that may be required to service "out-of-sequence" development is similarly affected.

Subject to Council agreement (as the ongoing responsible body for operation and maintenance) flexibility should always be retained to allow different landowners to negotiate changes to drainage layout and design of WLRB's-with any extra capital costs outside the DCP also being negotiated between them.

4.7.2 Some Specific Requirements for the HBP

(a) Sparrowvale North Catchment

Development in this catchment area downstream of Horseshoe Bend Road will require early construction of the linear WLRB upstream of the main sewer and connection to the existing culvert under Barwon Heads Road, in order to provide an adequate depth for future urban tributary drainage systems.

Development west of Horseshoe Bend Road could proceed in advance of works downstream, subject to adequate temporary site management facilities being constructed as discussed in Section 4.7.1.

Subject to prior completion of the linear WLRB, upgrading of the culvert outfall under Barwon Heads Road can be deferred until development in the upstream catchment exceeds about 30% of the developable area. This represents about the practical limit of control that the linear WLRB can exert over peak runoff rates.

Upgrade of the Barwon Heads Road culvert will trigger the need for the Sparrowvale Wetland system to effectively come online as part of the overall drainage strategy.

(b) Sparrowvale South Catchment

Development west of Horseshoe Bend Road could proceed in advance of works downstream, subject to adequate temporary site management facilities being constructed as discussed in Section 4.7.1.

Development of land around the Barwon Heads Road/Batten Road area will require upgrade of the culverts under Barwon Heads Road, completion of the upstream part of the linear WLRB, and cleanout works downstream to the sewer crossing.

Upgrade of the culverts under Barwon Heads Road will trigger the need for the Sparrowvale Wetland to come effectively online as part of the overall drainage strategy, if upstream development has reached about 25% of the developable area.

(c) Reserve Road Catchment

If existing drainage catchment definition is retained into the future, then partial construction of the WLRB on the 4C frontage will ideally need to commence with initial stages of land development. Percentage completion of the WLRB will need to at least match development extent in the catchment.

If initial stages of land development are remote from the WLRB site then temporary site management facilities may be constructed as discussed in Section 4.7.1.

If the option to divert pipe drainage eastwards into the Sparrowvale North catchment is adopted then the smaller 2 ha WLRB will need to be completed at the time the pipe diversion is completed.

(c) The Sparrowvale Wetland System

This asset is virtually in place already as a hydrological control. To suit development management needs, modifications may be staged as follows:

The wetland will be effectively online when the outlet control structure to the Barwon River barrage pool is modified to retain all water to 0.95 m and include a one-way tideflex valve system to prevent river backflow.

Refurbishment works should also be completed as required to ensure integrity of the dropboard outlet regulator system to Hospital Swamps.

When development commences east of Barwon Heads Road, the relevant open waterway segment (north or south drainage lines) will need to be constructed, at least to a stage sufficient to complete the hydraulic linkage downstream into the Sparrowvale Wetland. The inlet sedimentation pondage for the Sparrowvale Wetland will be required to be completed in conjunction with initial drainage construction.

Aquatic vegetation is expected to naturally colonise the wetland area with time once extended inundation conditions are established. However regular maintenance attention will be required to control any weed or pest plant growth issues as they emerge (spot spraying or other approved control technique).

4.8 Future Regional Open Space Options

Between the proposed boundary of the Sparrowvale Wetland system (basically the northern extension of Charlemont Road) and the eastern boundary of the current HBP, the natural surface levels of the bulk of the land generally range between 1.5 m AHD and the 100 year ARI flood level of 3.0 m.

All land above 1.5 m AHD is considered suitable for the provision of regional open space facilities and associated landscaping.

There is ample scope for earthworks modification to create areas above specified flood levels such as 20 year ARI for oval perimeters, 100 year ARI for oval centre areas and buildings.

Earthworks modifications must be designed to maintain overall flood storage volumes at the 100 year ARI flood level, and to maintain floodway capacity for upstream catchment drainage lines.

4.9 Open Waterway Alignments

Alignment of the Sparrowvale South drainage line upstream of Barwon Heads Road is basically governed by topography but may be varied in places during detail design to best suit estate planning and transport/servicing objectives.

Alignment and shape of the linear WLRB on the Sparrowvale North drainage line is also only indicative on Figure 6.

The alignment of future open waterways on the North and South Sparrowvale catchments downstream of Barwon Heads Road may be varied to best suit vegetation retention, estate development, and recreational/open space planning objectives.

Curvilinear alignments would be favoured in lieu of the indicative straight lines shown on Figures 5 and 6, but these are matters best resolved as part of future design.

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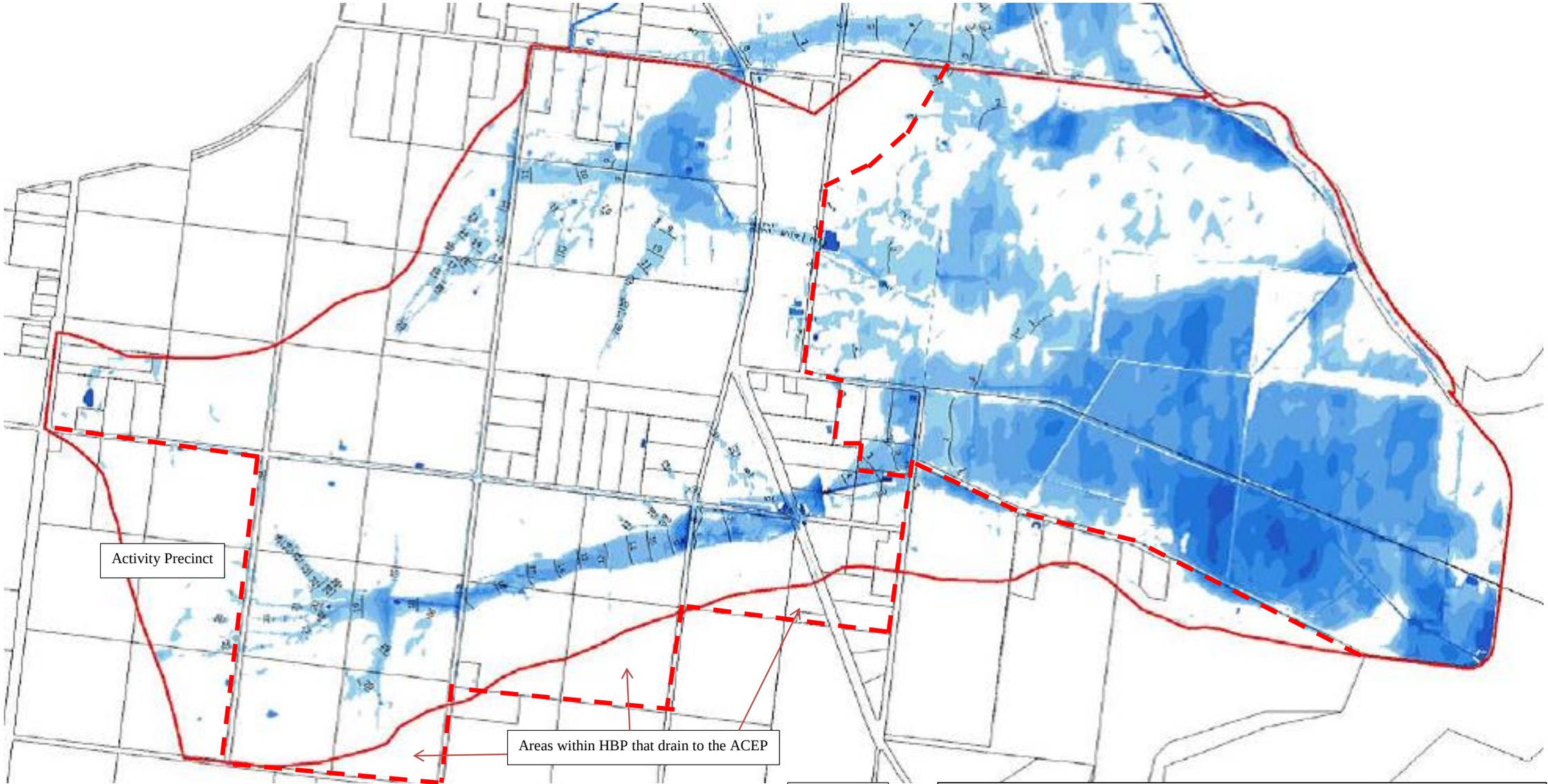


Figure 1

Armstrong Creek Horseshoe Bend Precinct (HBP)
Extent and levels of inundation for 100 year ARI (existing conditions-Water Technology 2006)-Sparrowvale Catchment (north and south).

Note: inundation is for local catchment runoff only. Higher flood levels apply for Barwon River flooding across Sparrowvale Farm (2.00 m/3.00 m AHD for 10/100 years ARI respectively)

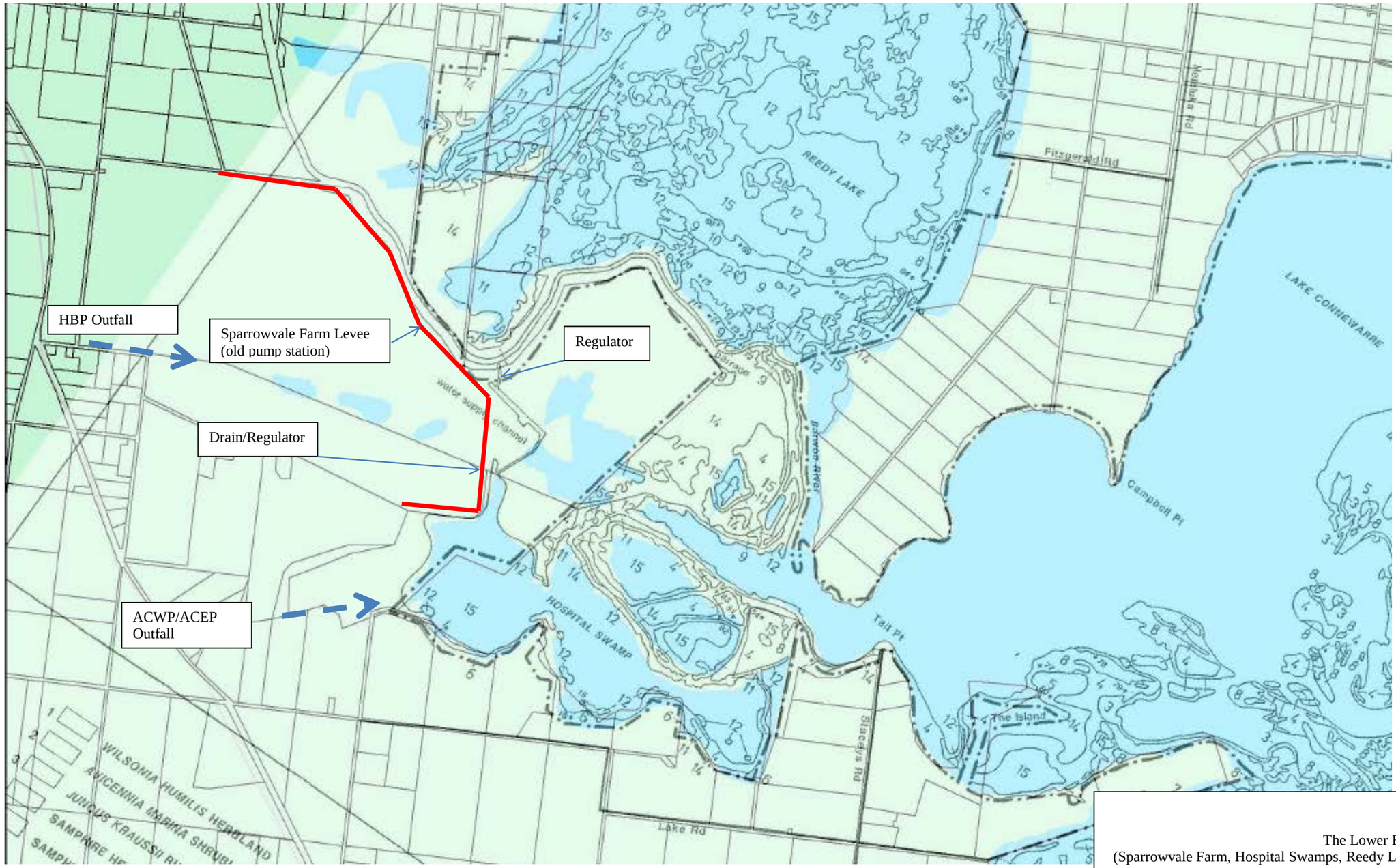


Figure 2

The Lower Barwon River Wetlands
(Sparrowvale Farm, Hospital Swamps, Reedy Lake, Lake Connewarre)

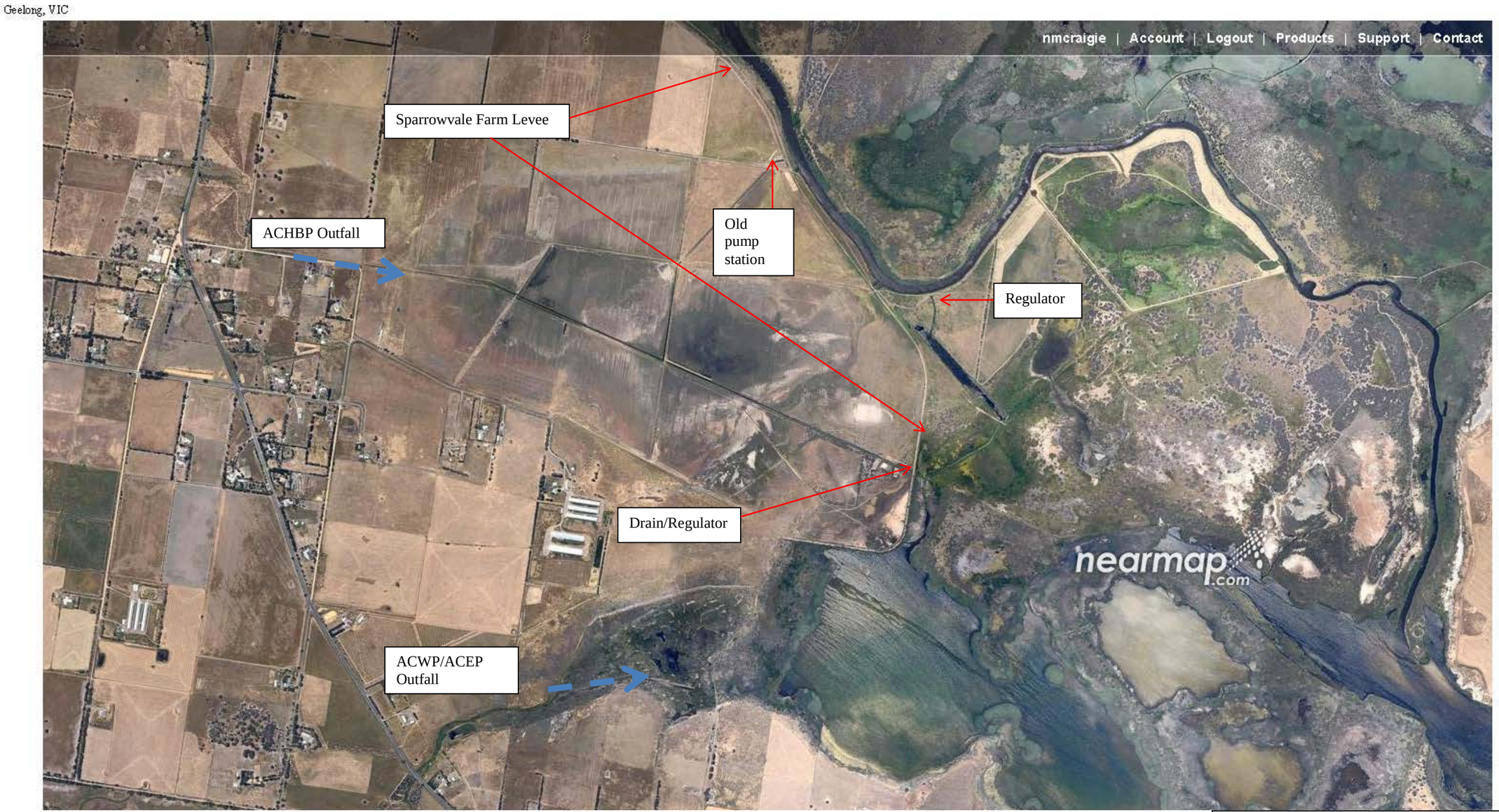


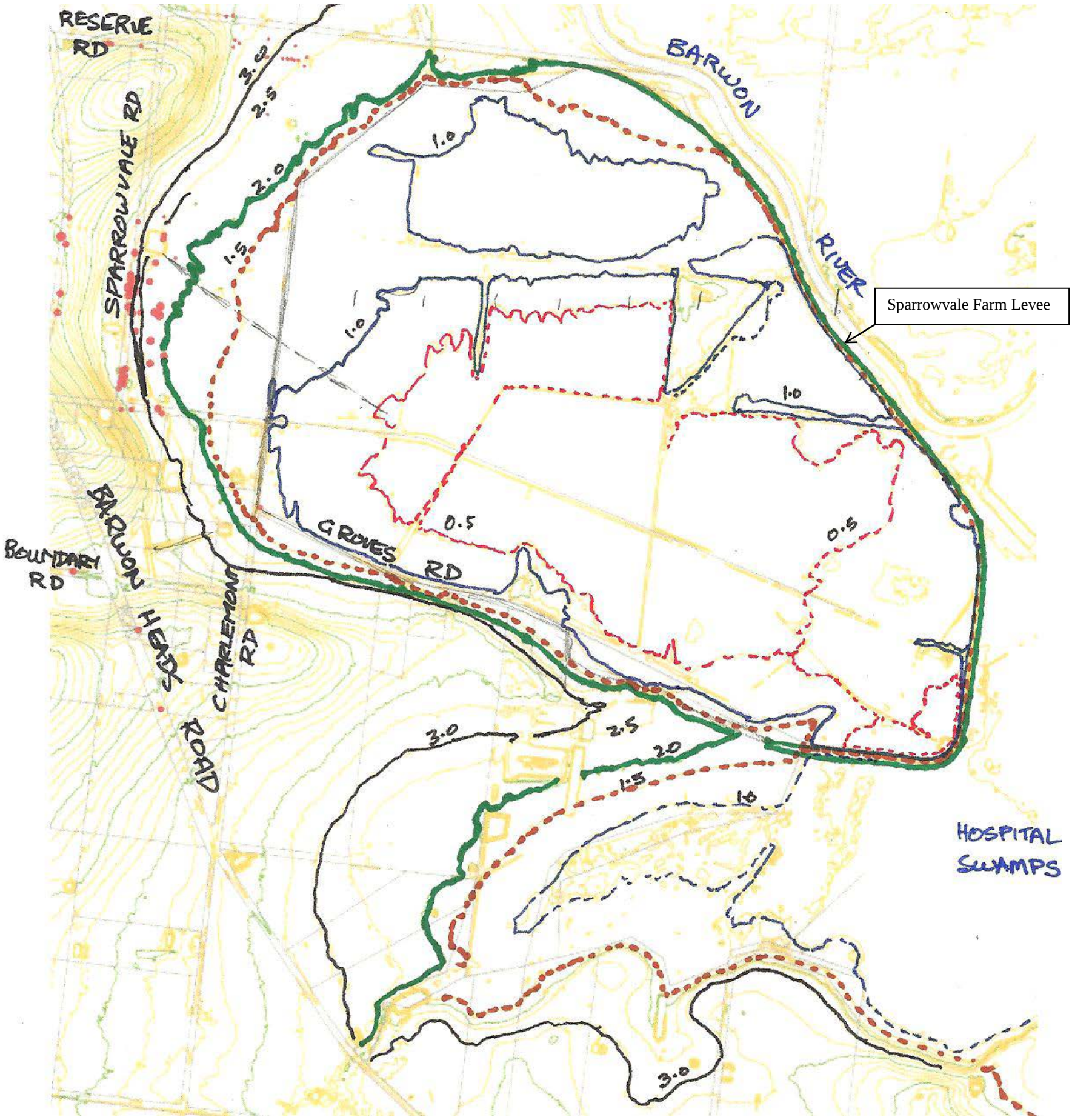
Figure 3 (Sheet 1 of 2)

The Lower Barwon River Wetlands in August 2009
Source: nearmap.com

Geelong, VIC

Figure 3 (Sheet 2 of 2)

The Lower Barwon River Wetlands in October 2011
Showing extent of prolonged inundation of Sparrowvale Farm
Source: nearmap.com



Sparrowvale Farm
10 year ARI flood level is a minimum of 2.00 m AHD.

100 year ARI flood level is a minimum of 3.00 m AHD

Figure 4

LiDAR 0.5 m contour data for Sparrowvale Farm and Surrounds

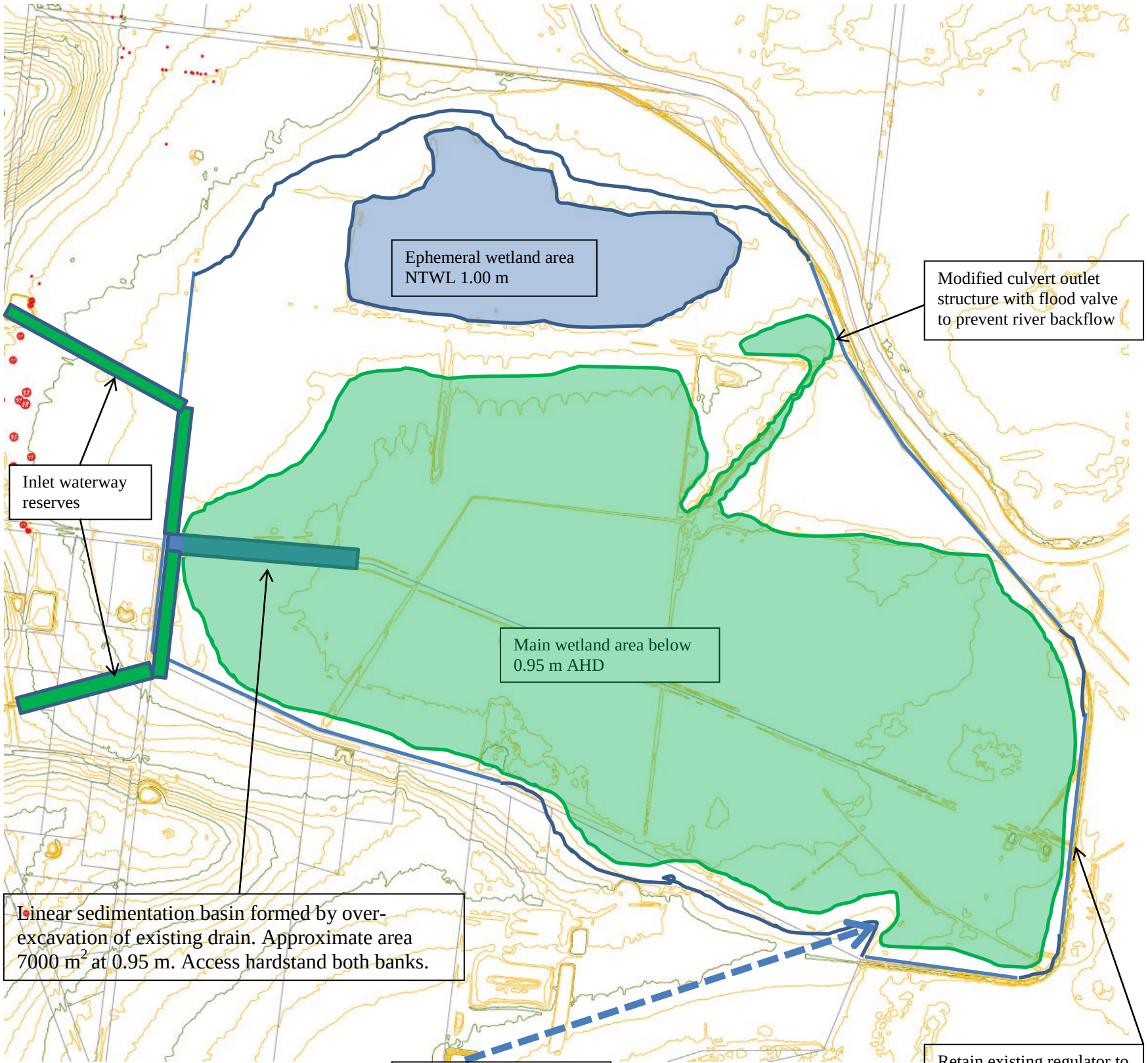
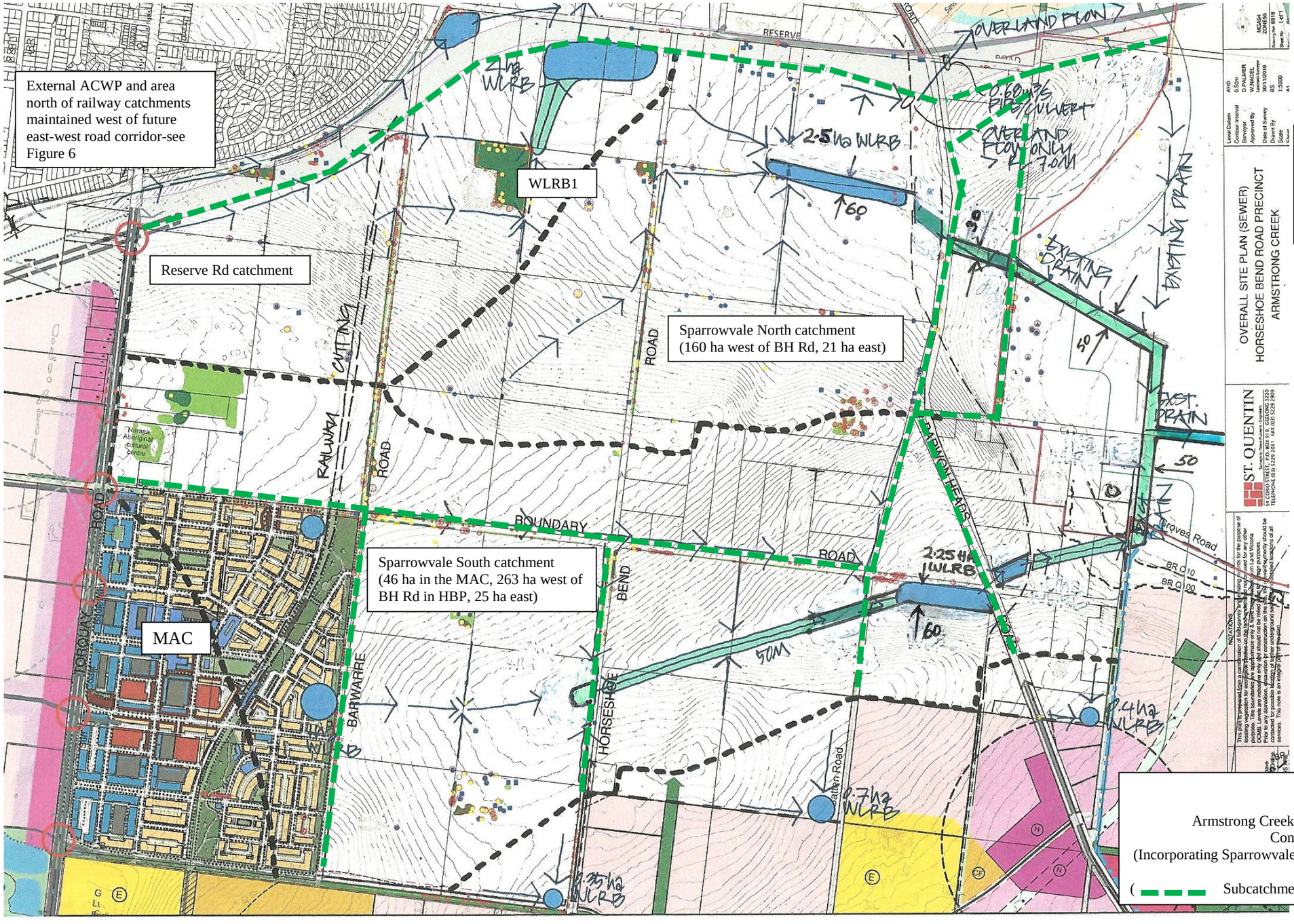


Figure 5

Recommended Boundaries of Area below 1.20 m AHD to be set aside for Armstrong Creek Growth Area Surface Water Management purposes.

Also showing inlet waterways, sedimentation basin and outlet structures



Sparrowvale Farm
10 year ARI flood level is a minimum of 2.00 m AHD.

100 year ARI flood level is a minimum of 3.00 m AHD

Figure 6

Armstrong Creek Horseshoe Bend Precinct (HBP) plan
Concept layout for main drainage features
(Incorporating Sparrowvale Farm for surface water management)

(Subcatchment boundary)