

Neil M Craigie Pty Ltd

ACN 074 582 282 ABN 29 074 582 282

Waterway Management Consultants

**ARMSTRONG CREEK
URBAN GROWTH AREA**

HORSESHOE BEND PRECINCT (HBP)

**STORMWATER MANAGEMENT
STRATEGY (SWMS)**

DISCUSSION PAPER

(VERSION 2)

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Neil M Craigie

Director Neil McKinnon Craigie BE(Civil), MEngSci, MIEAust, CPEng

Email: nmcraigie@bigpond.com

15 Mulawa Street Croydon, Vic. 3136, Australia

Telephone & Fax: (03) 9725 1053

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1. INTRODUCTION

This discussion paper has been prepared to provide a basis for initial planning and negotiation regarding the provision of main drainage services across the Horseshoe Bend Precinct (HBP) and into the receiving drainage/floodplain systems in Sparrowvale Farm and Hospital Swamps.

The various precincts that comprise the Armstrong Creek Urban Growth area are shown on Figure 1.

The paper firstly presents information regarding existing flooding conditions across the HBP.

It then presents a summary of the various recent studies that have been carried out to determine critical environmental flow/ecology requirements for the Lower Barwon Wetlands system which receive the surface runoff from the Armstrong Creek catchment and the HBP. Implications for surface water management strategies are then assessed, including options associated with ownership of Sparrowvale Farm.

The paper then presents initial estimates for subcatchment layouts, urban drainage system alignments, and sediment basin and wetland/retarding storage sizing and levelling, assuming all works are contained within the precinct boundaries.

The estimates have been derived using some local hydrologic and water quality modelling, but also from the authors' detailed work on surface water management strategies (SWMS) across the Armstrong Creek East and West Precincts (ACEP and ACWP).

Drainage control levels have taken into account major constraints posed by the existing main sewer which traverses the waterways across the waterway alignments, as well as proposed outfall works in the North East Industrial Precinct near the Reserve Road/Barwon Heads Road intersection. The impact of the proposed railway extension into the Activity Precinct has also been considered based on available information on vertical grading.

The paper also considers potential opportunities that may exist for relocation of some major drainage management assets out of the current precinct area and into the present area of Sparrowvale Farm, in case major changes in property ownership do eventuate in the short to medium term.

More detailed hydrologic and water quality modelling will be carried out as part of subsequent reports, to confirm compliance with best practice conditions and requirements of the relevant authorities-the City of Greater Geelong (CoGG), the Corangamite Catchment Management Authority (CCMA), Department of Sustainability and Environment (DSE) and Parks Victoria (PV).

2. EXISTING CATCHMENTS AND FLOODING CONDITIONS

Existing flooding conditions have been investigated and modelled in two studies; (a) by Water Technology (Armstrong Creek Urban Growth Plan Flooding and Drainage Study, 24 February 2006), and (b) by Bonacci Water (Stormwater Management Strategy for Armstrong Creek, July 2008).

Both studies produced similar results and there is no need to redo this task.

There are two primary catchments draining land in the HBP and the extents and levels of flooding derived for the 100 year Average Recurrence Interval (ARI) flood event have been determined by Water Technology (2006).

Figure 2 (Sheet 1 of 2) shows the catchment area and flooding extents abutting the railway line and draining northwards across Reserve Road. This is part of the overall South East Grovedale catchment. It is referred to herein as the Reserve Road catchment.

The bulk of the HBP drains easterly across Barwon Heads Road to Sparrowvale Farm and is referred to as the Sparrowvale catchment. Figure 2 (Sheet 2 of 2) refers. Flood extents shown on this figure assume local catchment runoff conditions only. Higher flood levels apply for Barwon River inundation (2.00 m/3.00 m AHD for 10/100 years ARI respectively).

Along the southerly boundary of the Sparrowvale catchment the HBP boundary straddles the catchment boundary. Small pockets of land within the HBP thus drain south into the ACEP as indicated on Figure 2 (Sheet 2 of 2). Due to elevation and slope none of these small areas is affected by waterway or floodplain inundation.

Downstream of Sparrowvale Farm the receiving environments of the Lower Barwon River Wetlands, especially Hospital Swamps, are dominant considerations for surface drainage planning. Figure 3 shows the wetland system layout with key reference points for water control structures including the farm levee and river offtakes.

Figure 4 (Sheets 1 and 2) are nearmap.com extracts showing conditions in the area downstream of the HBP during the drought (August 2009), and most recently in October 2011. Clearly under existing catchment conditions extensive areas of the farm are subject to prolonged inundation, unrelated to Barwon River flooding but clearly linked to high water levels in Hospital Swamps effectively preventing 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.

3. 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 round figures mean annual runoff for the Armstrong Creek area under existing conditions can be expected to average 1.3 ML/ha/year (obtained using the MUSIC model and Geelong rainfall for the 1980-89 period). After residential development at average imperviousness of 50%, mean annual runoff will rise to about 2.6 ML/ha/yr from the same rainfall (200% increase). For average imperviousness of 60%, mean annual runoff will rise to about 2.9 ML/ha/yr (220% increase). Since the average imperviousness of the bulk of the HBP development area will be 60%, existing conditions (mean annual) runoff will be about 45% at most, of future runoff.

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 significantly runoff from large impervious areas.

Infiltration losses cannot offset any of this increase (unless costly pressure injection schemes are found to be feasible and can be economically implemented), simply because potential infiltration areas are markedly reduced by sealing of land surfaces. The only practical ways to make some offsets against the impacts of increased surface runoff regimes are (a) reuse of water instead of discharging it, and/or (b) bypassing excess “development” flows around sensitive receiving environments, if possible.

Normally a primary opportunity is reuse of roofwater (via raintanks before it is contaminated by pavement runoff) and at the lot scale.

However Class A recycle water supply is to be provided in the HBP by Barwon Water. Class A effectively competes for the same demand uses as roofwater and stormwater. In the ACEP, Barwon Water set conditions on development that mandated connection of all lots to the Class A recycle supply and actively discouraged the effective reuse of roofwater. Such conditions are expected to be applied across the HBP and other precincts as well.

As it is a “free water supply” unlike the Class A recycle supply, it is likely that voluntary uptake of rainwater tanks by future residents will prove significant over time and such action is to be encouraged through the SWMS in order to assist with further improving stormwater management outcomes and reducing potable water supply demands for the development. Regrettably however the Barwon Water conditions rule out storage and reuse of stormwater at the allotment scale, as a formal integrated part of the SWMS (ie., it cannot be incorporated into water quality and quantity modelling as a guaranteed offset).

The Barwon Water conditions leave reuse on a precinct or regional scale as the only possible alternatives for water reuse to be incorporated into the HBP SWMS. The main opportunity within HBP will be at the downstream (eastern) end for the purposes of irrigation of the regional open space (ROS) facilities located to the south in the ACEP.

Lesser opportunities may be afforded within HBP by extraction from wetland systems. However constraints on extraction must be imposed to protect dependent aquatic plantings so that wetlands have limited ability to support extraction in dry times of the year when demand is highest.

As was concluded in the ACEP and ACWP SWMS reports, there remains the opportunity for the water authority (Barwon Water) to enter the picture and install a larger scale stormwater reuse system from a terminal wetland/storage system east of Barwon Heads Road. That opportunity is very significant, given that Barwon Water could use water generated at high reliability in winter/spring periods from HBP as well as both ACEP and ACWP lands when ROS irrigation is offline. However as an external opportunity, it is beyond the scope of this SWMS to further quantify and no further consideration is made in this report.

In light of the above constraints and unknowns regarding reuse opportunities, the adopted strategy for HBP must focus on evaporation and flow diversion systems to protect Sparrowvale Farm from increased seasonal inflow volumes that will follow on with urbanisation of the catchment.

(Note: If Sparrowvale Farm were to come under public ownership then major opportunity is afforded for regional wetlands to be established in the farm areas which are currently subject to regular inundation and waterlogging.)

3.2 Hospital Swamps Flow/Ecology Requirements

Constraints posed to Hospital Swamps environments are not so clear cut as impact on the private land holdings of Sparrowvale Farm.

There have been many major investigations and reports issued on management of the Swamps and downstream estuarine/marine environments in recent years. Those most relevant to the Armstrong Creek Urban Growth Area are:

- Lower Barwon Wetlands Flow Ecology Relationships Final Report (Lloyd Environmental et al, September 2011 for CCMA;
- Barwon River Lower Breakwater Management Options, Water Technology et al, June 2010 for CCMA;
- Lower Barwon Wetlands Hydraulic Modelling for the Environmental Entitlement, Water Technology, July 2011 for CCMA;

In regard to Hospital Swamps the reports can be briefly summarised as follows:

- Hospital Swamps comprises 5 basins which receive water from both the Barwon River and from local runoff;
- Three of the basins are at 0.5 m AHD, with the other two at 0.20 m AHD;
- As well as alternating between a flooded and a dry state on a seasonal basis, the main basin alternates between saline and fresh conditions. Hospital Swamps is adjacent to the Mt Duneed lava flow which has high groundwater salinities ranging from 20,000 EC at the western end of Hospital Swamps to 50,000 EC in the east. Saline groundwater contributes to high wetland salinities in summer and autumn when surface water levels are low. Inflows in winter and spring will flush accumulated salts and suppress groundwater discharge, creating seasonally fresh conditions.
- The hydrology of Hospital Swamps was modified in 1983 by the installation of regulators and a water supply channel from the Barwon River;
- Prior to these works Hospital Swamps would only hold water temporarily after heavy winter rain or when flooded by the Barwon River, due to drainage works many years ago;
- In the early 1980's Hospital Swamps held water for most of the year;
- The wetland complex is separated from the estuary by a bund.
- Water is diverted into the wetlands via a regulated channel through Sparrowvale Farm which has an invert of 0.30 m AHD;
- Other unregulated channels become active when the Barwon River water level exceeds 1.40 m AHD;
- The bed of the wetlands lies at 0.0 m AHD;
- The inlet regulator from the Barwon River is opened when river levels exceed 0.70 m AHD;
- Barwon River water levels greater than 0.90 m allow Hospital Swamps levels to reach 0.50 m which is the normal top water level;
- The Hospital Swamps overflow to Lake Connewarre when levels exceed 0.50 m AHD;
- Hospital Swamps can be drained using a regulated pipe with an invert of 0.20 m AHD;

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.

Vegetation, waterbird and fish-based ecological objectives and hydrological requirements for Hospital Swamps are listed in Lloyd et al (2011).

The threats to Hospital Swamps are mainly derived through potential future changes to water regime. These may come about from:

- stormwater inflows from Armstrong Creek (developments upstream are likely to produce increasing amounts of run-off);
- changes to inflows from Barwon River (these need to be secured through the bulk entitlement and access rights across the land to the Swamp through ownership or management agreements); and/or
- additional environmental flows from upstream (these would need to be managed to prevent additional inflows).

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.

The specific recommendations for water regime for Hospital Swamps were listed in Table 18 of Lloyd et al, 2011. The table is repeated on the following pages for ease of reference.

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

The main conclusions from the Lower Barwon Wetlands hydraulic modelling are as follows:

- Hydrodynamic modelling and subsequent validation from water level records available during an overbank flooding event that occurred in January 2011, determined that a flow rate of approximately 3,500ML/d initiated sustained overbank flooding into Reedy Lake and Hospital Swamp. This is far less than the 1 year ARI peak flow of 10,800 ML/d.
- Analysis of long term historical streamflow time series for the Barwon River at Geelong provided estimated annual overbank flow frequencies of approximately 3 events per year.
- The frequency of overbank flow events over the last approximate 10 years has however been well below the long term average.
- The total annual duration of overbank flows into Reedy Lake and Hospital Swamp has been estimated as 10 days historically. Overbank flow events are strongly concentrated over the months of July through to October.
- Historically, sub-overbank flow spells greater than 365 days occur on average, once every 5 years.
- The height of the natural banks separating Lake Connearre and Hospital Swamps are approximately 0.5m AHD. Based on the analysis of the storm surge planes for Lake Connearre, these banks would be overtopped on average once per year or greater to a depth of 0.1m. This would potentially enable significant inundation of these wetlands and in particular the northern most two basins of Hospital Swamp from Lake Connearre.
- The natural banks separating Lake Connearre from Reedy Lake are at their lowest point approximately 0.9m AHD. Significant overbank inundation from Lake Connearre into Reedy Lake is considered unlikely and would be an extremely rare occurrence.
- The outlet channels and regulator sill levels of both Reedy Lake and Hospital Swamp are below mean high water in Lake Connearre and inundation to a level of approximately 0.4m AHD in these wetlands could theoretically be achieved by operation of the regulators to allow the ingress of estuarine water from Lake Connearre into these wetlands.

Water Technology also 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 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.

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 Connemara 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 Swamp 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.

3.5 Implications for HBP SWMS

3.5.1 Sparrowvale Farm Retained in Private Ownership

Despite the dire longer term threats posed to Hospital Swamps if sea levels rise as predicted, the pressing need as far as the HBP SWMS is concerned is to deal with protection of Sparrowvale Farm, in a manner which complies as far as practicable with the defined flow regime requirements for protection of Hospital Swamp.

This constraint effectively rules out increased discharge of water to Hospital Swamp in the dry times of the year.

Given that the existing farm levee bank will need to be retained to protect the farm from frequent river flooding the only feasible option is to reinstate pumping over the levee to mitigate the threat of prolonged inundation within the farm.

3.5.2 Sparrowvale Farm Transferred to Public Ownership

If Sparrowvale Farm is transferred into public ownership then the area subject to prolonged inundation would be converted to a freshwater wetland system, with the levee retained.

The Normal Top Water Level (NTWL) of the wetland would be set at or close to 1.00 m AHD (as is the case for the terminal linear wetland chain in the ACEP) so as to facilitate effective gravity drainage connection out to the River for most of the year

and especially in the summer/autumn periods, using the existing farm drainage channel outlets.

It would be a simple matter to then link the ACEP wetland system through Sparrowvale Farm to allow all low flows in the summer/autumn period to be diverted around Hospital Swamp.

This solution then offers the opportunity to reduce size and land take for surface water management assets within the HBP and relocate this into Sparrowvale Farm.

With the Sparrowvale wetland NTWL also being above the longer term sea level rise predictions, this solution is sustainable. It is also the most technically robust option for management of Hospital Swamps over the next few decades at least.

Table 18: Water Regime Recommended for Hospital Swamps to meet Ecological and Management Objectives. While the whole water regime is required to meet the overall ecological outcomes, the coloured highlighting indicates the priority of each objective: Orange indicates the highest priority hydrological objectives, Green the second priority objectives and Blue indicates the third priority objectives.

Season	Typical Hydrological Environment	Hydrological Objective	Frequency	Environmental Objective
Early Winter (May to September)	Low flows in the Barwon with the possibility of minor freshes. Minor inflows from Armstrong Creek	Allow wetland to fill in sympathy with flows in Barwon River. - inlet regulator open - outlet regulator closed	9 years in 10	<ul style="list-style-type: none"> • Initiate <i>Stuckenia</i> and <i>Chara</i> growth • Initiate decomposition of organic matter on wetland bed • Dilute accumulated soil and surface water salts • Create habitat and invertebrate populations • Stimulate fish and waterbird breeding • Allow fish to colonise wetland from the river
Spring High Flow Period (September to November)	High flows in the Barwon River. Overbank flows occur intermittently. Storm flows from Armstrong Creek	Fill Hospital Swamps with main wetland filled to 0.5m AHD. - inlet regulator open - outlet regulator closed	9 years in 10	<ul style="list-style-type: none"> • Continuous flushing of salt from deep wetland basins • Inundation of reedbeds and <i>Bolboschoenus</i> beds fringing the main basin • Sustain growth of <i>Stuckenia</i> and <i>Chara</i> • Promote growth of <i>Myriophyllum</i> in southern part of main basin • Waterlog <i>Gahnia filum</i> sedgeland • Stimulate fish and waterbird breeding • Stimulate increase in invertebrate populations and biomass • Create nesting habitat colonial and other waterbirds
Spring High Flow Period (September to November)	Flow freshes in the Barwon River. Storm flows from Armstrong Creek	Flow freshes used to surcharge (to 0.7m AHD) and flush the wetland. - inlet regulator open - outlet regulator closed	9 years in 10	<ul style="list-style-type: none"> • Continuous flushing of salt from deep wetland basins • Inundate shallow wetland basins and promote growth of <i>Ruppia</i> • Inundate <i>Gahnia filum</i> sedgeland • Create additional fish and waterbird habitat and

Extract from Lloyd et al 2011

Season	Typical Hydrological Environment	Hydrological Objective	Frequency	Environmental Objective
				invertebrate populations <ul style="list-style-type: none"> • Trigger fish spawning • Provide connecting flows to the river and between wetlands
Early Summer Drawdown Period (December to January)	Moderate flows in the Barwon. Overbank flows less frequent. Intermittent minor flows from Armstrong Creek.	Drain Hospital Swamps to a level of less than 0.3 m AHD by the end of January. <ul style="list-style-type: none"> - inlet regulator closed - outlet regulator open 	9 years in 10	<ul style="list-style-type: none"> • Increase wetland salinity as groundwater discharge increases in proportion to surface water • Shallow wetland basins exposed (creates open water habitat upon refilling) • Restart wetland processes • Allow eggbanks to be produced and laid • Provide waterbird food supply from access to tubers, seeds and invertebrates in shallow water
Late Summer – Autumn (February to March/April)	Low flows in the Barwon. Overbank flows rare. Inflows from Armstrong Creek rare.	Allow wetland bed to dry. <ul style="list-style-type: none"> - inlet regulator closed - outlet regulator open 	9 years in 10	<ul style="list-style-type: none"> • Soil salinity increases in shallow wetland basins and deep wetland basin • <i>Chara</i> and <i>Stuckenia</i> die back • Limited colonisation of wetland bed by annual herbland plants • Reeds and other emergent macrophytes become dormant • High soil salinity excludes reeds • Expose mudflats for waterbird feeding • Allow nutrient re-cycling • Control carp populations
All year	Very low flows in Barwon and Armstrong Creek	Wetland bed dry or shallow flooding Salinisation of the wetland bed and limit extent of flushed soil conditions	1 year in 10	<ul style="list-style-type: none"> • Maintain vegetation structure

Extract from Lloyd et al 2011

4. SURFACE WATER MANAGEMENT STRATEGY

4.1 Objectives

The proposed strategy for management of stormwater peak flows and quality in the HBP is an integrated approach considering both quality and quantity. It is based first and foremost on ensuring:

- stormwater quality from the HBP land is treated to contemporary best practice objectives, as measured/referenced at the precinct outfall boundaries;
- no significant change to stormwater discharges for critical storm durations up to 100 years Average Recurrence Interval (ARI) events, as measured/referenced at the precinct outfall boundaries;
- as far as practically feasible, protecting Sparrowvale Farm and Hospital Swamps from the impacts of altered hydrology arising from urbanisation. For Sparrowvale Farm the primary focus will be on diversion of excess flows in winter/spring periods. For Hospital Swamps the primary focus will be on maintenance of existing summer/autumn drying periods.

In determining the most appropriate form and location of management assets the strategy has also considered the following objectives:

- integration of surface water management features with open space;
- staged implementation constraints associated with differing land ownership across the HBP;
- connection of stormwater drainage systems only to existing drainage lines in Sparrowvale Farm, Reserve Road/Drews Road and to the proposed culvert outfall under the east-west road corridor at Reserve Road/Barwon Heads Road intersection;
- creation of stormflow mitigation storages that avoid the use of high embankments (safety and cost grounds);
- protection of key flora/fauna habitat areas and sites of cultural heritage value;
- consolidation of drainage management assets wherever possible to minimise ongoing maintenance costs;
- encouragement for reuse of stormwater.

4.2 The Proposed HBP Subcatchment Drainage Systems

Definition of subcatchment drainage systems has evolved during the course of investigations, in response to emerging flora and fauna and cultural heritage constraints and in accord with evolution of overall precinct development planning. Further adjustment to layouts is likely, particularly as design proceeds for the proposed railway connection to the MAC.

Critical assumptions that have been made in deriving the layout shown on Figure 5 are as follows:

- Existing drainage crossings of the Railway line and the pipeline exiting from the ACEP at Surf Coast Highway, are the only external catchment flow inputs to the HBP.
- Existing land north of the Railway line and west of Surf Coast Highway is assumed to retain its current outfall system to Reserve Road (as shown on Figure 6) and be confined west of the future east-west road corridor so that it will be effectively excluded from the HBP drainage systems.
- The proposed east-west road corridor reservation is treated as rural land for the purposes of sizing of water quality and urban trunk drainage systems. Only that part of the corridor south of Reserve Road is considered as part of the HBP drainage system. The balance corridor along Reserve Road will continue to drain north across Reserve Road into the Marshall Precinct.
- The future MAC land will incorporate its own surface water management facilities such that existing rural flows and water quality will be effectively maintained for all events up to and including 100 years ARI.
- The proposed rail corridor will be created as proposed in cut into the MAC land.
- Lands within the HBP will be developed at average imperviousness of 60% overall.
- The boundary between the Reserve Road and Sparrowvale catchments will be retained as shown on Figure 5.
- Piped drainage connections will be provided to all separate titles within the HBP with overland flows to be conveyed in roads or reserves depending on flow magnitudes and road floodway safety guidelines. In regard to the latter the relevant guideline that has been followed is Appendix A of the Melbourne Water Land Development Manual.
- Subcatchment and piped drainage system layouts have attempted to follow land ownership and existing road boundaries as far as practicable having

regard to the natural fall of the land, so as to simplify as much possible, future implementation of works.

- The small pockets of land in the HBP which drain south into the ACEP will be required to meet best practice conditions for stormwater quality treatment and maintain existing rural runoff peak flows (for all events up to and including 100 years ARI) prior to discharge over the HBP boundary.

4.3 Primary Management Assets

The primary assets shown on Figure 5 are wetland/retarding basins (WLRB's) linked by open waterways and/or pipelines. Sediment basins will also be incorporated in these WLRB sites and at other significant pipe outfalls to open waterways.

Wetlands and sediment basins provide the required water quality treatment function and create the most land-efficient retarding storage in the airspace overhead. They also maximise evaporation losses in summer/autumn periods as is desirable for management of downstream impacts. Open waterways slow down runoff responses and encourage infiltration losses to similar effect.

The layout shown on Figure 5 assumes that:

- Sparrowvale Farm remains in private ownership,
- Pumping capacity is reinstated from the farm drainage system to the Barwon River to address the changed hydrology associated with urban development.

4.3.1 Asset Sizing

Sizing of the assets is based on the estimating relations derived in a previous detailed RORB modelling exercise completed in 2007 for the Sparrowvale North catchment, as well as the ACEP/ACWP SWMS modelling.

On average the adopted estimates are as follows:

- retarding storage capacities = 300 m³/ha of developable catchment area;
- wetland water surface areas = 2% of developable catchment area;
- Maximum active flood storage depth = 1.5 m above wetland NTWL;
- WLRB land take = 1.7* wetland water surface area.

4.3.2 Impact of the Main Sewer

The main sewer is 1650 mm in diameter and constructed in a north-south direction through the HBP as shown on Figure 5.

As-built level information shows the sewer to be a critical control on drainage levels in the Sparrowvale North subcatchment, but especially at the waterway crossing in the Sparrowvale South catchment just north of Boundary Road.

In the Sparrowvale North catchment the large flat area west of the sewer has existing surface levels of 8.0-8.5 m AHD. The lowest NTWL that can be created in a wetland is 6.75 m so as to maintain cover over the sewer with the outfall pipe or waterway. Effective drainage of this land without forcing major filling of the land requires a linear wetland system to extend west of the sewer to at least the 8.50 m contour as shown on Figure 5.

An additional outfall is proposed in the northeast corner of this catchment under the proposed east-west road corridor intersection with Barwon Heads Road. Design information shows a culvert is to be provided at invert level of 7.0 m AHD with maximum capacity of 0.68 m³/s. This means that the primary drainage direction for the Sparrowvale North catchment (wetland NTWL of 6.75 m) must be eastwards across Barwon Heads Road to Sparrowvale Road as shown on Figure 5.

In the Sparrowvale South catchment the sewer is actually partly exposed at the waterway crossing as shown in the aerial photo below (nearmap.com). Actual sewer invert level is 3.60 m with Barwon Heads Road formation just below 6.0 m at the lowpoint.



This sewer crossing structure will likely need to be retained as part of the ultimate drainage system so the effective waterway invert/wetland NTWL will match the existing pool at about 4.0 m.

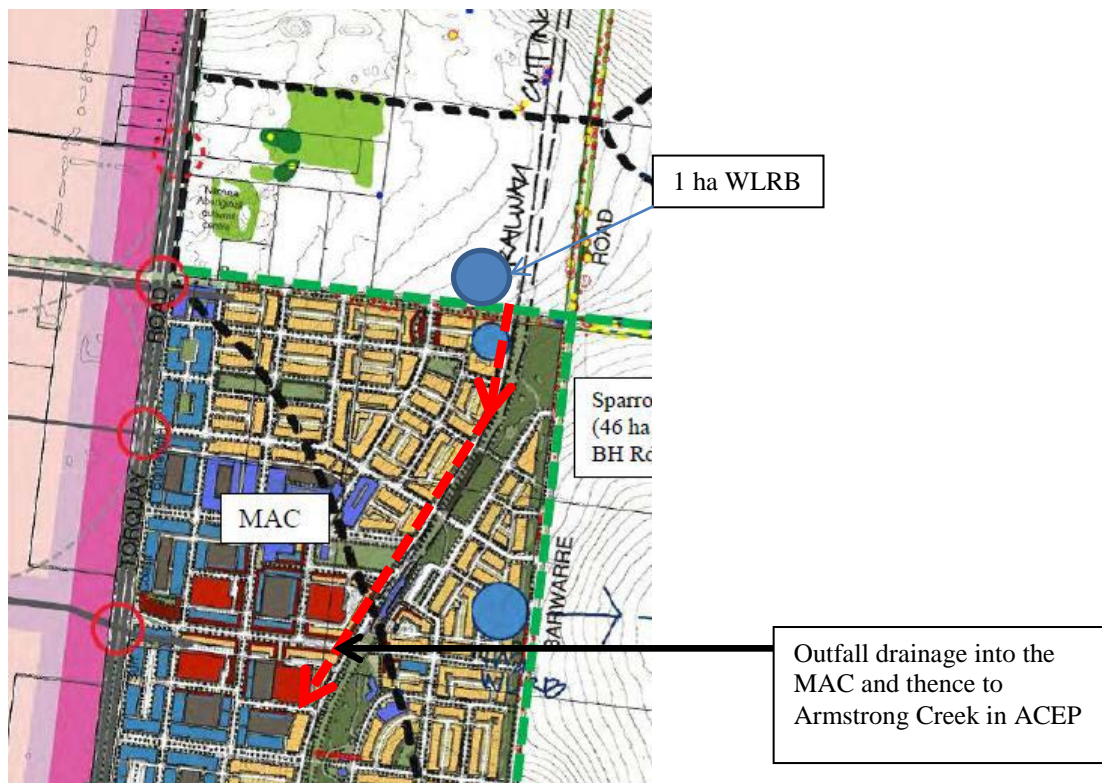
In turn this implies that the wetland system upstream of the sewer will need to straddle Barwon Heads Road with a partly submerged culvert system under the road as is shown on Figure 5. A similar setup is currently under construction on Armstrong Creek at Barwon Heads Road in the Warralily Estate.

4.3.3 Impact of a Railway Cutting

The drainage layout shown on Figure 5 around the MAC assumes that existing drainage lines can continue to cross the railway alignment generally as they do now. This may not prove to be feasible if the railway is constructed as a deep cutting well below natural surface, as is currently proposed.

For the Sparrowvale South catchment, the impacts of a deep railway cutting without drainage crossings would be to reduce catchment area as indicated on the extract of Figure 5 shown below:

- The land north of Boundary Road and west of Barwarre Road (approximately 31 ha) would likely have to be drained south into the MAC, necessitating provision of an extra WLRB of about 1 ha (recouped by reduction in assets in the Batten Road area);
- The MAC land west of the railway (approximately 21 ha) would be drained southerly downslope along the railway frontage and thence into Armstrong Creek catchment, increasing WLRB requirements therein by about 0.7 ha.



4.4 Impact of Sparrowvale Farm transferring to Public Ownership

If Sparrowvale Farm is transferred into public ownership then the area currently subject to prolonged inundation would be converted to a freshwater wetland system, with the levee retained.

The Normal Top Water Level (NTWL) of the wetland would be set at or close to 1.00 m AHD (as is the case for the terminal linear wetland chain in the ACEP) so as to facilitate effective gravity drainage connection out to the River 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.

This solution then also offers the opportunity to reduce size and land take for surface water management assets within the HBP and provide alternative facilities in the Sparrowvale Farm wetlands.

For the Sparrowvale North catchment the sewer constraint still requires a linear wetland system to be provided west to the 8.5 m contour. However the width could be reduced to an average of 60 m through to Barwon Heads Road. Downstream the reduced flood storage requires increased discharge across the road so that a waterway reserve would be needed, 30 m wide to Sparrowvale Road.

This implies a total landtake of 4.0 ha rather than 7.0 ha as currently shown on Figure 5, or a saving of 3 ha of developable land.

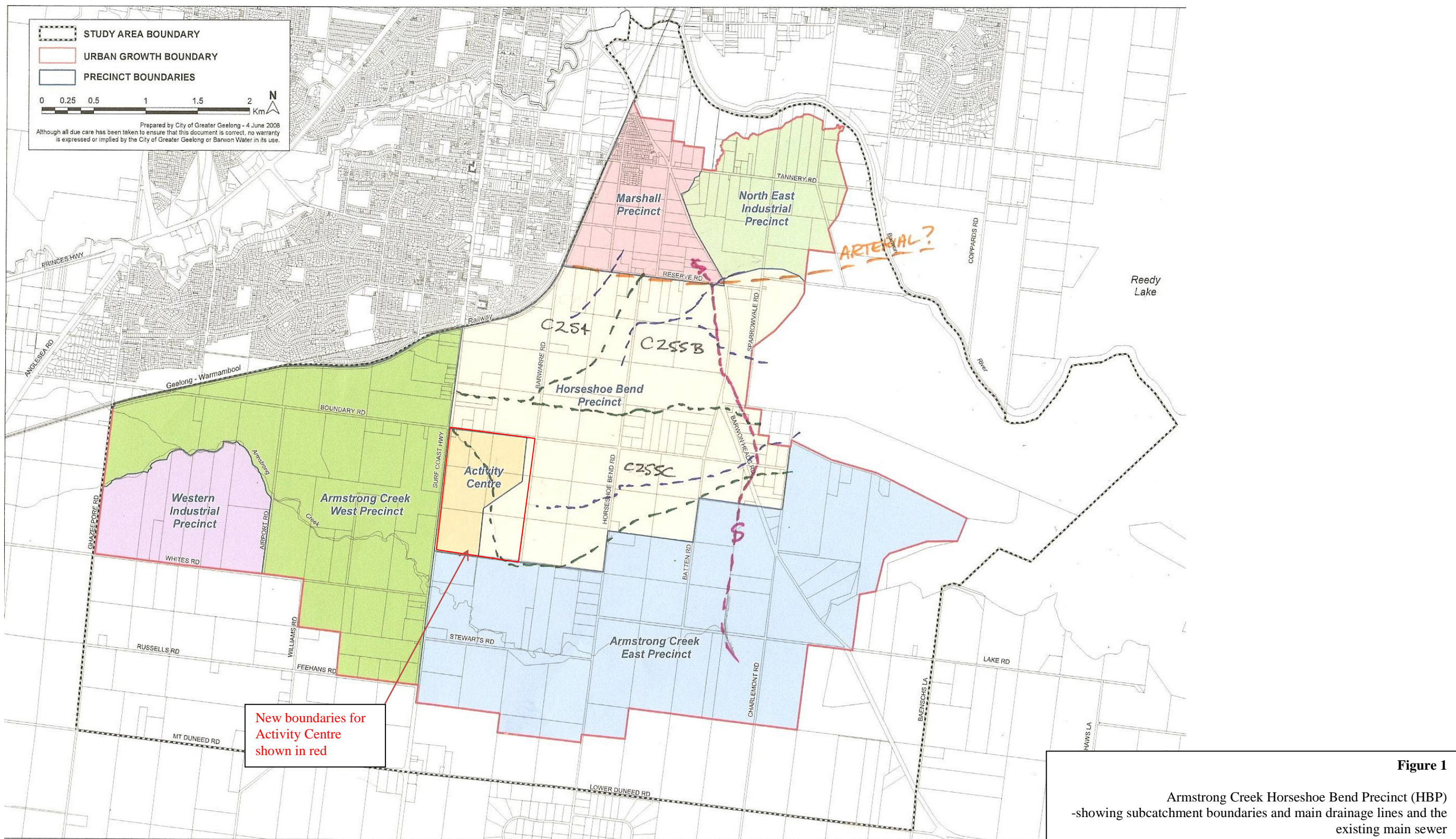
For the Sparrowvale South catchment the sewer constraint forces a linear wetland to be retained upstream of the sewer to about the 6.5 m contour. Again it could be reduced to 60 m width which implies a land take of about 1.5 ha rather than 7.0 ha as currently shown on Figure 5. Downstream of the sewer a 50 m reserve would continue for the open waterway. 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 west side of the road).

Thus landtake would reduce from 3 ha to 0.5 ha at the Horseshoe Bend Road site. In total up to 8 ha of developable land could be released.

As set out in Section 3.5.2 it would be a simple matter to then link the ACEP wetland system through Sparrowvale Farm to allow all low flows in the summer/autumn period from the whole Armstrong Creek/HBP catchment to be diverted around Hospital Swamp.

With the Sparrowvale wetland NTWL also being above the longer term sea level rise predictions, this solution is sustainable into the future. It is also the most technically robust option for management of Hospital Swamps over the next few decades at least.

Neil M Craigie



C254=Reserve Road catchment, C255B=Sparrowvale North catchment, C255C=Sparrowvale South catchment, S=existing main sewer



Figure 2 (Sheet 1 of 2)
Armstrong Creek Horseshoe Bend Precinct (HBP)
Extent and levels of inundation for 100 year ARI
(existing conditions-Water Technology 2006)
Reserve Road (Southeast Grovedale) Catchment

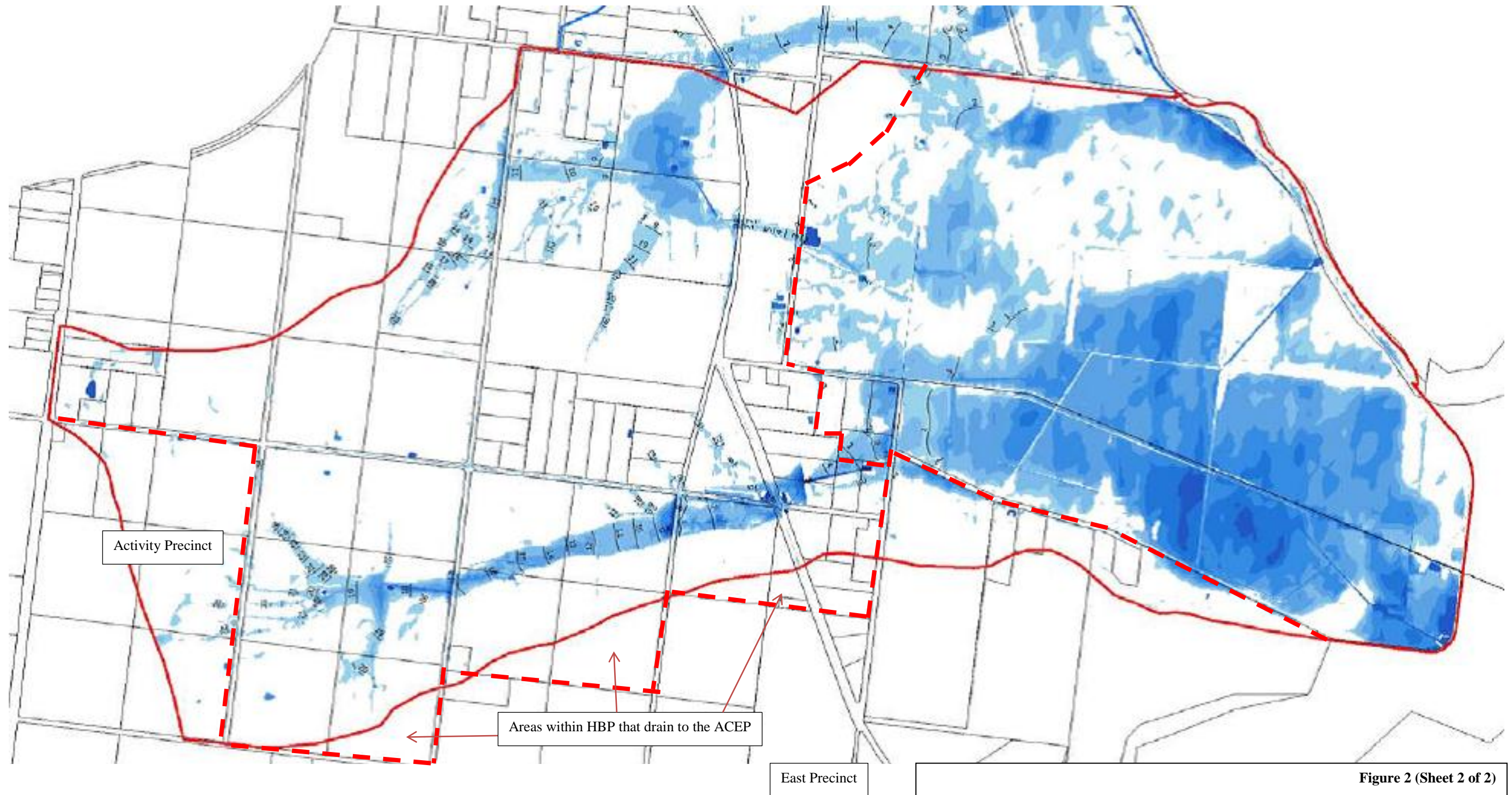


Figure 2 (Sheet 2 of 2)

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)



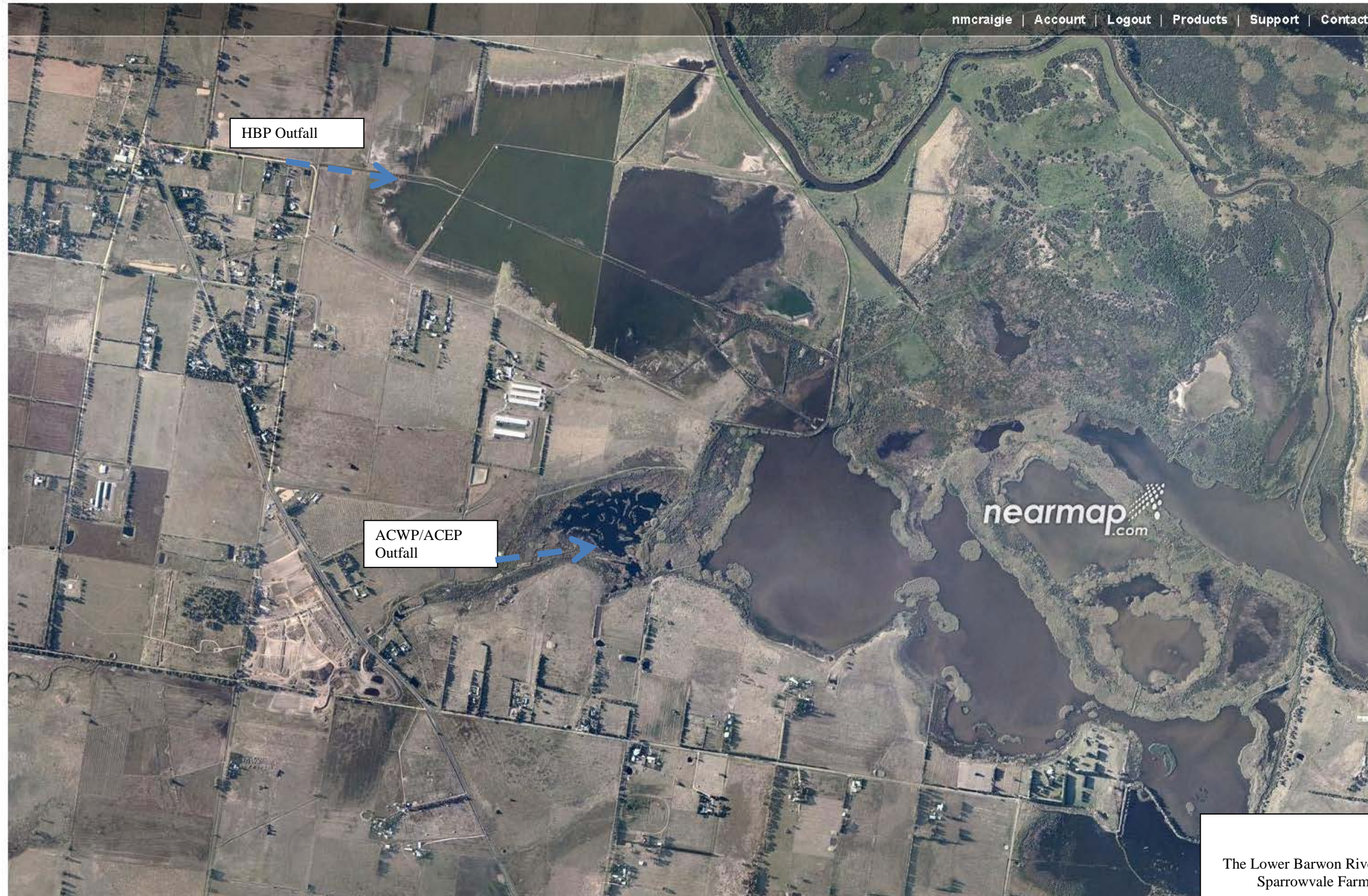
Figure 3
The Lower Barwon River Wetlands
(Sparrowvale Farm, Hospital Swamps, Reedy Lake, Lake Connewarre)

Geelong, VIC

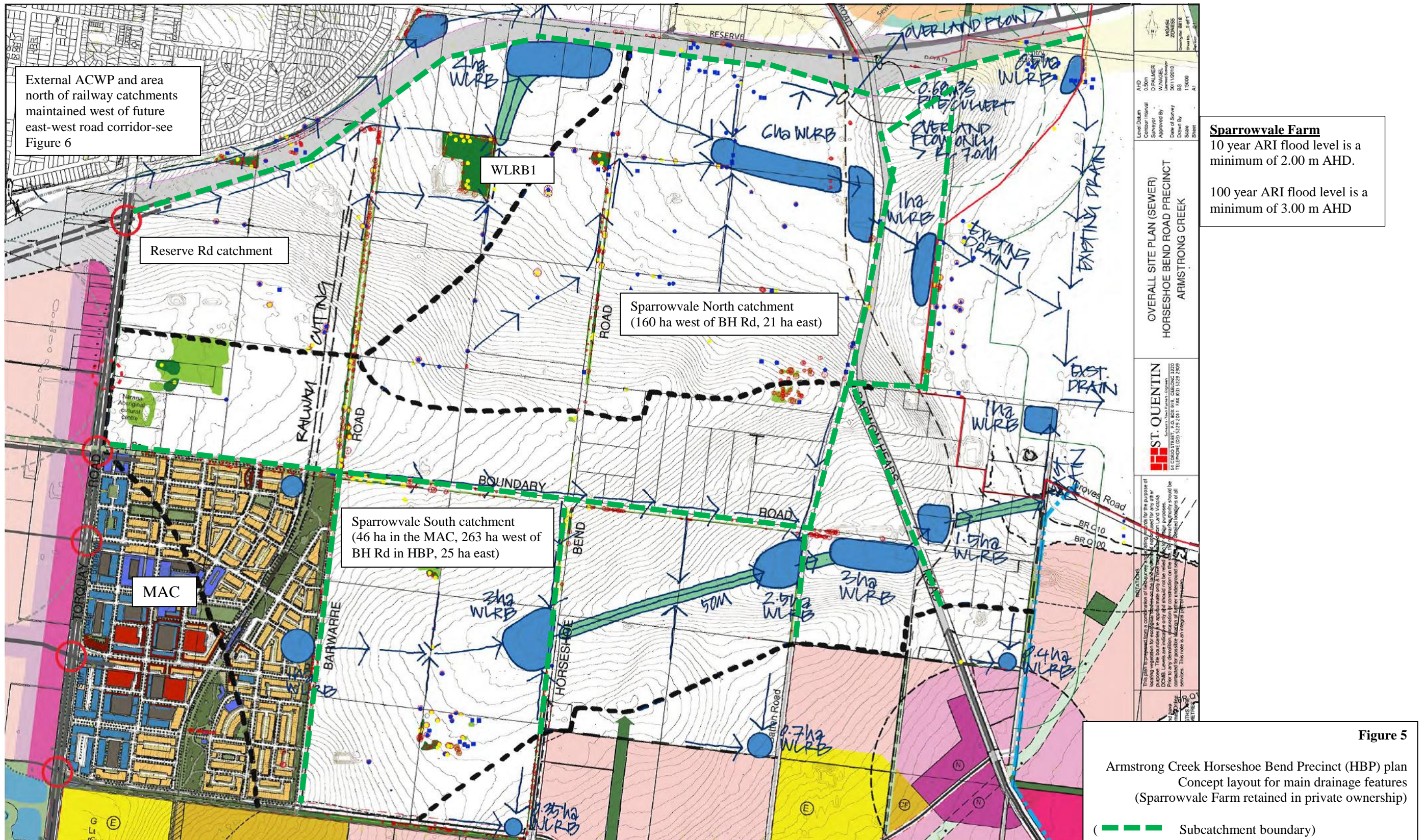


Figure (Sheet 1 of 2)
The Lower Barwon River Wetlands in August 2009
Source: nearmap.com

Geelong, VIC



October 2011



External ACWP and area north of railway catchments maintained west of future east-west road corridor-see Figure 6

Reserve Rd catchment

Sparrowvale North catchment (160 ha west of BH Rd, 21 ha east)

Sparrowvale South catchment (46 ha in the MAC, 263 ha west of BH Rd in HBP, 25 ha east)

MAC

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 5
 Armstrong Creek Horseshoe Bend Precinct (HBP) plan
 Concept layout for main drainage features
 (Sparrowvale Farm retained in private ownership)
 (--- Subcatchment boundary)

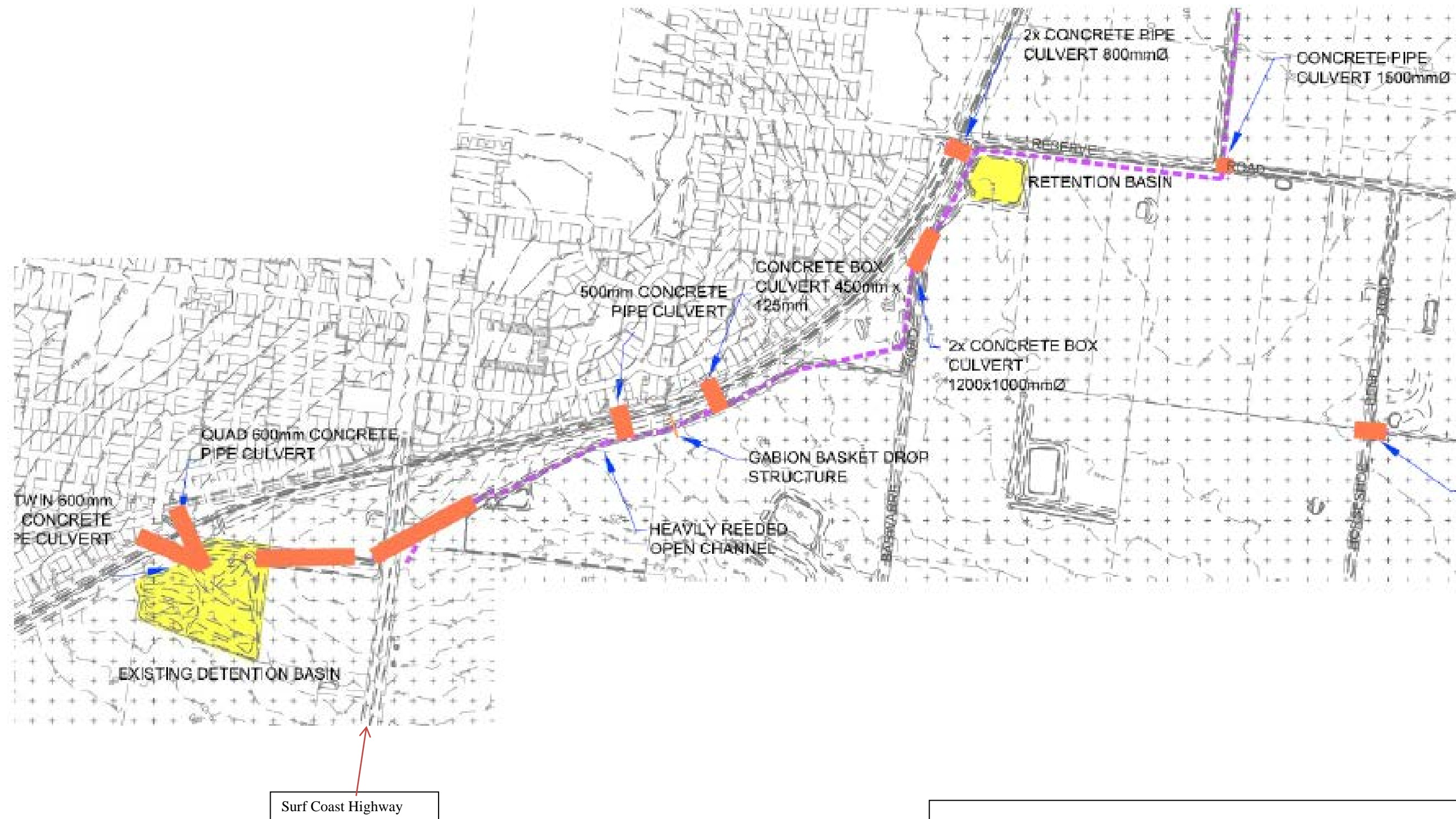


Figure 6

External catchment inputs to the HBP and existing drainage infrastructure (assumed to be kept separate from HBP drainage systems by the proposed east-west road corridor)
Source: Bonacci Water 2008