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AMENDMENT C301

**CITY OF GREATER GEELONG PLANNING
SCHEME**

**ARMSTRONG CREEK SOUTH PRECINCT
(ACSP)**

**STORMWATER MANAGEMENT
STRATEGY (SWMS)**

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For: Newlands Developers P/L

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1. INTRODUCTION

This report presents the Surface Water Management Strategy (SWMS) for the land covered by Amendment C301 (Armstrong Creek South Precinct-ACSP) to the City of Greater Geelong Planning Scheme. The land is at 892-990 Barwon Heads Road (currently known as Rainbow Riders and Keirl properties), which is the southwest quadrant of the intersection of Lake Road and Barwon Heads Road. The land is approximately 52 hectares in total.

Amendment C301 aims to rezone the lands to residential and ensure ACSP is an integrated component of the Armstrong Creek East Precinct (ACEP). The drainage outfall for the land is Armstrong Creek. The proponent of C301 is the Armstrong Creek Development Corporation (ACDC) which is the developer of Warralily.

The original SWMS concept layout for the lower Armstrong Creek area in ACEP is shown on Figure 1. Extensive works on the waterway system have already been implemented with the expanding development of Warralily Estate.

The Armstrong Creek linear wetland system across the north frontage of the subject land and the new waterway further west to Horseshoe Bend Road are now practically complete. Figure 2 is a current nearmap.com extract showing the subject C301 land and surrounding development.

The Armstrong Waters development abuts the western boundary. Some minor excavation work has been completed on the wetlands segment extending southerly into Armstrong Waters but the original ACEP concept layout is to be amended to ensure full integrity with the C301 ACSP proposals. This report incorporates that work with a new concept design wetland layout for both properties now being provided.

These wetlands are integral with the Armstrong Creek system and will have the same Normal Top Water Level (NTWL) of 1.00 m AHD and flood level (3.00 m AHD). The latter is fixed by the Barwon River and these levels also apply as default drainage controls for the northern part of the C301 land.

As part of C301 it is also proposed to provide the funding required to deliver the linking diversion channel from Armstrong Creek wetlands around Baensch's wetland and Hospital Swamps to the Sparrovale wetlands. Completion of this link channel will finally resolve all issues related to impacts of increased urban runoff from the entire Armstrong Creek urban area on Hospital Swamps, especially during the summer/autumn periods.

2. EXISTING CATCHMENTS AND FLOODING CONDITIONS

Existing flooding conditions have been investigated and modelled using a two-dimensional hydraulic model 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). Figure 3 is an extract from the Water Technology report of 2006, showing extent of inundation in both the Armstrong Creek floodplain and across the southeast sector of the C301 land.

In the Armstrong Creek floodplain frontage the 100 year ARI flood level is the same as for the Warralily development to the north-3.00 m AHD. However minimum floor level should have not less than 150 mm freeboard above the ultimate overtopping level of Barwon Heads Road, so as to provide emergency freeboard in case of a blockage occurring to the culverts. As-constructed plans for Barwon Heads Road show the overtopping level to be 3.50 m. Hence the minimum floor level on any lot in C301 must be not less than 3.65 m.

Available mapping and aerial photos indicate the original natural drainage outfall in the southeast sector of the land was across Barwon Heads Road and thence northeasterly to the Hospital Swamps. Approximate rural catchment to the Barwon Heads Road is some 209 ha.

Field inspection reveals no evidence of any culverts under Barwon Heads Road around the natural lowpoint in the southeast sector of the land. The road is elevated above natural surface and a narrow, steep-sided artificial drain has been constructed northwards within the road reserve, through the natural spur, eventually reaching existing culverts under Lake Road from whence a new outfall connects into the Armstrong Creek linear wetlands.

Detail site survey shows the drain grades reasonably continuously from the southeast corner of the site (Invert ~4.1 m) to Lake Road (invert ~ 3.0 m). Over the ~1 km distance this is an average grade of close to 0.11% which is very flat indeed. Drain depth is less than 0.5 m in the southeast corner of the land.

Given that no water is ponding against the road embankment, it can only be concluded that the open drain is reasonably effective in draining the tributary catchment northwards to the culverts under Lake Road, and thence into the new Armstrong Creek wetlands.

The flat drainage grade encourages dense vegetation growth in such a drain which in turn places demands for regular maintenance to maintain capacity. There are also two culvert crossings of the drain in Barwon Heads Road under private access roads to the Rainbow Riders and Keirl properties. These culverts could be subject to at least partial blockage by vegetation debris during flood events.

Given these constraints and the small drain width it is considered highly likely that the drain would not function as intended in a major flood and therefore extensive ponding

would still occur against the Barwon Heads Road embankment, despite some flows being able to pass along the open drain.

The overtopping level of Barwon Heads Road is about 5.0 m near the south east corner of the C301 land and this level matches the natural spur line which is coincident with the northern property entrance. It follows then that a level of 5.0 m or thereabouts is to be expected as the 100 year ARI flood level in the southeast sector under existing conditions.

Water Technology completed a further assessment of flooding in the southeast sector of the C301 land in 2012 (960-990 Barwon Heads Road, Flooding Investigation, September 2012). The Water Technology report nominated 4.95 m as the 100 year ARI flood level and this seems reasonable.

Figure 4 includes and extends the Water Technology flood plot to the south using the latest Lidar information. Almost 16 ha of land to the south of C301 is flooded at 4.95 m AHD.

3. PROPOSED C301 DRAINAGE STRATEGY

3.1 A Single Drainage Outfall

There is no doubt that the only available drainage outfall in the southeast sector of the estate under existing conditions is the open drain in Barwon Heads Road. This has been the case ever since Barwon Heads Road was last reconstructed. Therefore the land in C301 is situated wholly within the Armstrong Creek catchment at Barwon Heads Road. In retrospect it may have been reasonable for the C301 land to have been incorporated as developable land in the original ACEP area.

Proposals for future widening of Barwon Heads Road on its west frontage in the C301 area will result in elimination of the existing drainage line, and either a need for its replacement on a new alignment further west, or for provision of new culverts under Barwon Heads Road to restore the original valley drainage line and carry the 100 year ARI flow. Given the length of time that the original outfall has been severed it is considered that the former option is appropriate.

The C301 proposal is for retention of the entire site within the Armstrong Creek catchment and hence a new drain is to be provided along the west frontage of Barwon Heads Road.

In the southeast corner of C301 a minimum floor level recommendation of 600 mm above the future 100 year ARI flood level or 300 mm above the overtopping level of the future Barwon Heads Road (whichever is the higher) should be maintained to provide surety. In the north of the site the 100 year ARI flood level is 3.00 m and minimum floor level is 3.65 m as for the rest of Warralily and Armstrong Waters.

3.2 Overall Wetland Area

The original ACEP SWMS provided for a wetland of 1.0 ha water surface area plus a sediment basin of 0.3 ha water surface area within the Armstrong Waters property, as shown on Figure 1. These areas must be retained in any new wetland layout.

The MUSIC V6 model was then used to assess the additional C301 wetland requirements assuming:

- total C301 development catchment area of 45.7 ha (ie., not including drainage reserves or the Barwon Heads Road widening);
- average imperviousness of 60%;
- 300 mm extended detention depth (matching that of the Armstrong Creek linear wetland system);
- Geelong North rainfall 1980-89 6 minute sequence;

The MUSIC model shows that an inlet pond of 0.10 ha plus a wetland macrophyte area of 0.75 ha will be required to ensure the C301 development complies with best practice stormwater management targets as a stand-alone proposition. Hence total water surface area at NTWL is 0.85 ha for C301.

When fully integrated with Armstrong Waters, the overall water surface area at 1.00 m AHD thus needs to be not less than $1.3 \text{ ha} + 0.85 \text{ ha} = 2.15 \text{ ha}$.

Figures 5 and 6 show the proposed development layout and integrated wetland system, serving both the Armstrong Waters and C301 lands.

3.3 The Barwon Heads Road Drainage Line Connection

In the south east corner of the site a reserve is provided to allow capture of flows into the new waterway. There is no space available in the reserve shown to accommodate wetlands so all water quality treatment will be consolidated in the downstream wetlands. Under existing conditions the 100 year ARI level in the southeast corner is 4.95 m AHD.

There is sufficient grade available with a receiving wetland NTWL of 1.0 m at Lake Road to provide a pipeline and landscaped (dry) floodway channel along Barwon Heads Road in lieu of an open waterway. This should enhance safety and aesthetic values as well as better suiting the available space and minimising maintenance requirements. Additional culverts are needed under the entry road connection from Barwon Heads Road.

A 1500 mm pipe is proposed on the development side of the channel under the west batter, on a grade of 1 in 600 (between pits) starting at invert of 3.0 m in the southeast corner. Hydraulic gradeline analysis shows the pipe will be able to convey a peak flow of 3.15 m³/s with headwater level matching the existing 100 year ARI flood level of 4.95 m. Pits are assumed at 100 m spacing with 30 mm drops.

The channel will have starting invert of 4.30 m, average bed width of 4 m and 6:1 batters. The invert will be graded as a series of dips and crests from the inlet to a level of 4.0 m at the proposed entry road crossing. Although overall slope across the crest is very low at 0.05%, the use of grille inlet pits in the dips will allow good drainage to be maintained along the channel. Hydraulic analysis using pc-convey shows capacity of this reach of channel is 2.2 m³/s with 100 year ARI headwater level of 4.95 m in the southeast corner.

At the proposed new entry road crossing the finished road level will be 4.75 m so a drop inlet pit and outlet riser pit are required to achieve cover over an additional 1500 mm diameter pipe. Both pits will have grille covers and be sized at 1.8*1.8 m in plan.

North of the new entry road crossing, channel grade increases to 0.53% to a proposed 3.0 m*0.9 m RCB under Lake Road. A drop inlet pit is required to maintain cover with the culvert set at 1.5 m invert and the inlet channel at 2.3 m.

The 1500 mm diameter pipe will turn west along the frontage to Lake Road and outfall to the proposed new wetlands.

Channel reserve width along Barwon Heads Road will be no more than 15 m and the west batter could incorporate tree plantings.

Figures 7 and 8 show the concept design proposals. Section 5 provides the results of RORB hydrologic modelling to confirm flood levels and discharge capacity.

4. PROTECTION OF HOSPITAL SWAMPS

4.1 Background and History

Following on from the discussions and workshops during 2014 with CoGG, CCMA, Parks Victoria (PV), the former DSE (now Department of Environment, Land, Water and Planning-DELWP), and Mr Ian McLachlan (Geelong Field and Game), it is considered that there is a consensus in regard to the intended operation of the Sparrovale Wetlands system as the means of protecting Hospital Swamps from the impacts of increased volumes of freshwater runoff arising from urban development, not just in the local HBP catchments, but across the whole Armstrong Creek catchment.

A link connection between Sparrovale Wetlands and the terminal wetlands/reuse pond in the Armstrong Creek East Precinct is of critical importance to this primary environmental objective, given that it will enable transfer of dry season runoff events from the whole Armstrong Creek catchment around Hospital Swamps. The link connection will connect to Sparrovale Wetlands on the upstream (west) side of the proposed internal levee bank.

Sparrovale Wetlands are being delivered with the approved Horseshoe Bend Precinct and funded via its Development Contributions Plan (DCP). Once agreements are in place for the existing private landholdings to be converted to public ownership, the Wetlands in turn enable the creation of the link connection across to Armstrong Creek. It is understood that agreements regarding the land acquisition are expected to be reached in the short term (1-2 years).

A process to enable the delivery of the link connection is expected to be defined within the same timeframe. As part of the C301 SWMS it is proposed to include the costs of land acquisition and construction of the link connection, beyond the limits covered by the ACEP DCP, all the way through to Sparrovale wetlands.

There is a clear need to ensure drainage works completed in ACEP during the interim period are compatible with, and facilitate as far as practicable, establishment of the hydraulic link between Armstrong Creek and the Sparrovale Wetlands, including connection to Hospital Swamps downstream of Baensch's wetland.

Such drainage works in ACEP should also address the longer term protection of the Baensch's wetlands area and surrounding high value vegetation zones.

The existing drain and bank established by Geelong Field and Game around the north verge of Baensch's wetland needs to be relocated above the 1.00 m AHD contour to protect significant vegetation. The existing drain and bank can be locally filled/breached and left to naturally regenerate vegetation cover. The new drain/bank should then be an integral component of the ultimate link to Sparrovale Wetlands.

4.2 The Link Connection Concept Design

4.2.1 The Long Term Scenario

Under the 2100 sea level rise scenario the link connection must be capable of delivering summer flows through to Sparrovale Wetlands and out to the estuary at large with mean sea level of 0.80 m. The Sparrovale Wetlands NTWL is set at 0.95 m for the longer term to respond to this scenario.

As the link connection needs to be able to operate so that summer flows can be transferred without significantly raising water levels in Armstrong Creek wetlands at Barwon Heads Road, this implies a very flat hydraulic grade for the link connection with starting water level at the re-use storage of 1.00 m AHD.

4.2.2 The Short to Medium Term Scenario

Until such time as the 0.8 m AHD sea level rise scenario is realized there is no need to operate the Sparrovale Wetlands at an NTWL higher than 0.7 m AHD at most.

The wetlands water area created at that level far exceeds the requirements to achieve best practice stormwater treatment outcomes for the entire Horseshoe Bend Precinct. Water transferred from Armstrong Creek will already be compliant with best practice standards and no further treatment is necessary. The lower NTWL at Sparrovale also enhances diversion hydraulic capacity.

At the NTWL of 0.70 m the hydraulic structures proposed in Sparrovale Wetlands will also facilitate the works needed to protect EPBC-listed assets including Hospital Swamps from the impacts of increased freshwater discharge during dry seasons.

4.2.3 Modification of ACEP Wetlands Layout

The original ACEP wetlands design provided a re-use pond of 1.5 ha water surface area offline to the Baensch's wetland drainage lines. The opportunity is available to realign and reshape the re-use pond so that it is integrated with the link connection. That allows a significant length of the link to be formed as part of the re-use storage, with overall saving in excavation costs.

4.2.4 Link Connection Concept

There are two primary options for the link connection:

- Option 1: A conventional "wet" floor open channel;
- Option 2: A shallow, lined-invert channel.

For both options material excavated should be used to form a bank along the south verge of the channel. The bank will prevent breakaway flows returning back into Baensch's Wetland and Hospital Swamps, but will also be suitable for maintenance/recreational access. The crest level of this bank should not be less than 1.75 m AHD with crest width of 3.5 m.

Farm fencing would be required wherever public access is to be provided for safety reasons.

Control structures will be added along the channel into Sparrovale.

At the upstream (Armstrong Creek) end an adjustable weir would be provided to maintain low flow water level at 1.00 m AHD in the ACEP wetlands and facilitate diversion when desired.

Diversion of flows will be able to commence when NTWL in the ACEP wetlands exceeds 1.00 m AHD. As headwater level rises above 1.00 m AHD, diversion capacity increases by virtue of the applied hydraulic gradient over the control structure and thence along the length of the channel.

It is stressed that it is not intended to divert high peak flow rates. The objective is to ensure continuous diversion of dry season flows can occur at least until the top of extended detention depth of 1.30 m AHD is reached in the ACEP wetlands. In this way the impact of higher frequency and volumes of dry season urban drainage flows is mitigated to protect Hospital Swamps.

A stoplog arrangement set into a sheetpile wall at crest level of 1.30 m AHD is suggested as appropriate for the main upstream control structure. Crest width for the stoplog segment would be not less than 1.2 m with sill level of 0.80 m AHD. At headwater level of 1.30 m AHD and 95% submergence the discharge through this notch is 0.4 m³/s. The MUSIC model shows that this capacity is sufficient to divert 40% of the mean annual flow and 40% of the December-April flows in Armstrong Creek based on the rainfall data for the period 1980-89 inclusive.

With the minimum crest level of the flanking levee/access bank set at 1.75 m AHD there is ample scope to divert most if not all of the dry season flows if required. The sheetpile weir crest of 1.30 m AHD can be fully overtopped.

Synthetic sheetpile/stoplog products such as those produced by Vonmac could be used or other prefabricated or cast-in-situ products.

Offtake structures to deliver water when required to various drain inputs to Baensch's Wetland or Hospital Swamps can also be added along the link channel. These are matters for further consultation and detail design.

(Note: The current plotted location of the HZ3 area at the Groves Road end appears to constrain the connection alignment but it is suspected that there has been an error in plotting of this coastal saltmarsh community boundary.

The final channel alignment will be selected to ensure conformity with requirements for protection of the HZ3 area.)

At the downstream Sparrovale end, the link connection outlet needs to be made:

- to the upstream (west) side of the Barwon River levee bank, and
- on the upstream side of the proposed internal Sparrovale Wetlands levee to protect the Coastal Salt Marsh Vegetation Zone.

This connection has to pass through a ridge which rises to 2.0 m AHD.

For Option 1 the major design constraint for an open channel will be mitigating problems with macrophyte growth (phragmites and/or typha) and ongoing maintenance. To adequately suppress these tall macrophytes, a normal water depth of at least 1 m and preferably 1.5 m is needed. This implies excavation to levels of -0.5 m AHD.

With batter slopes of 3:1 and bed width of 2 m the water surface width required for depth of 1.5 m is up to 11 m. The total width of the channel and the access bank assuming 1 m offset to a farm fence on both sides is a minimum of 22 m.

It will be necessary to complete some geotechnical testing of base soils along the channel alignment to determine what, if any, design and construction responses are required to address possible soils and groundwater constraints.

Figure 9 shows a concept layout for the bulk of the link channel through to Sparrovale wetlands and typical cross-section. For a peak flow of 0.4 m³/s the average velocity is less than 0.05 m/s so the inlet structure capacity governs until the sheetpile weir crest of 1.30 m AHD is exceeded and diversion capacity increases.

The option is available to pipe through the ridgeline in lieu of that section of open channel. A 1200 mm diameter pipe is likely to suffice if that option is adopted. The culvert will probably need to extend across Groves Road to retain access. Outlet pipe invert would be 0.0 m AHD on the north side of Groves Road and 0.1 m on the south side of the ridgeline. A deep pool with base level of <=-0.5 m would be created at the pipe outlet to allow flushing of the pipe.

If adopted, this pipeline through the ridgeline will limit diversion flow capacity to about 1 m³/s. Rechecking with the MUSIC model shows that this capacity is sufficient to capture and divert 50% of the dry season flows in Armstrong Creek catchment.

For Option 2, the invert lining will effectively limit macrophyte growth so that depth, width and volume of excavation can be minimised.

A half-round pipe of 1200 mm diameter will suffice, with upstream invert level of 0.70 m AHD and downstream invert of 0.35 m AHD. Figure 9 shows a typical cross-

section for this option. The maximum capacity of the half pipe is 0.4 m³/s, which matches the stoplog weir capacity at headwater level of 1,30 m AHD.

As for Option 1 it is possible to fully pipe through the ridge and across Groves Road. In that instance the 1200 mm pipeline inverts and diversion capacity will match those for Option 1.

5. STORMWATER MODELLING

5.1 RORB Model Parameter Values

The Armstrong Creek RORB hydrologic model was originally prepared by Tony Jones of the CCMA in March 2009. That model was first modified to suit the adopted ACEP SMWS development proposals in 2010, and then again in June 2014, to reflect further changes to drainage design and construction as works were rolled out in the Warralily development.

The model has been modified again in this study to suit the C301 SWMS proposal, the key changes being:

- Diversion of all catchment flows at Barwon Heads Road back into the Armstrong Creek catchment, upstream of Barwon Heads Road;
- Provision of the upgraded pipe and channel drainage line along Barwon Heads Road and development of C301 land at 60% imperviousness;
- Incorporation of the existing flood storage capacity in the southeast corner of C301 and abutting lands.

The model was run with Geelong Airport rainfall data, the “filtered” pattern option selected, with areal reduction factors as by Siriwardena and Weinmann and the same rainfall model parameter values as listed in Table 1. The storage parameter K_c was adjusted according to the K_c/d_{av} ratio, with $m=0.80$. The original CCMA model used K_c of 14.0 with $d_{av} = 6.50$. The modified model now has $d_{av}=6.01$ so that the adjusted $K_c=12.92$.

TABLE 1 Rainfall Loss Model Parameters for Armstrong Creek		
ARI (years)	Initial Loss (mm)	Pervious Area Runoff Coefficients
1	20	0.56
2	20	0.56
5	20	0.59
10	20	0.63
20	20	0.67
50	20	0.73
100	20	0.79

5.2 Armstrong Creek Wetlands Stage-Storage Relation

The increased storage capacity of the overall Armstrong Creek wetlands system arising from the additional wetlands in C301 was included in the model as set out in Table 2.

Storage	Stage (m)	ACEP 2015 Area (m ²)	ACEP 2015+C301 Area (m ²)	ACEP 2015 Storage (m ³)	ACEP 2015+C301 Storage (m ³)	Hydraulic Controls used in RORB (no change)
Main Linear Wetland System (areas above 1.30 m are approximate only-subject to change during detail reserve design)	1.00	105,940	114,440	0	0	300 mm dia pipe to Swamp Outlet drain
	1.30	110,000	118,825	32,391	34,990	5 m weir to Swamp Outlet drain
	1.50	124,000	133,950	55,790	60,270	
	1.75	146,000	157,715	89,540	96,730	30 m wide weir
	2.00	176,700	189,200	129,880	140,100	10 yr ARI Barwon River flood level
	2.25	203,000	217,360	177,340	190,920	Free overflow along 300 m embankment
	3.00	300,000	317,650	365,965	391,550	100 yr ARI Barwon River flood level

5.3 Southeast corner Retarding Storage

A retarding storage was also added to represent the extensive ponding that currently occurs in the southeast corner of C301. This flooding will continue into the future but possibly at lower levels with the installation of the 1500 mm diameter pipe and floodway.

Available Lidar 0.5 m contour data was assessed to derive the stage-storage relation after development filling has been completed within C301. The stage-discharge relation was derived from the hydraulic gradeline and floodway analyses and assuming:

- A 7.5 m weir at crest of 4.2 m on the drop inlet to the 1500 mm pipe;
- A 20 m weir at 4.70 m crest controlling overflows to the floodway channel.

Table 3 summarises the data used.

Figure 8 shows a concept arrangement for the intake system in the southeast corner reserve.

Landscape design should focus on creation of a dry rocky streambed environment with no ponded water. Urban drainage pipelines will connect direct to the 1500 mm diameter pipe, bypassing the intake structure.

Storage	Stage (m)	Area (m²)	Storage (m³)	Pipe discharge (m³/s)	Channel discharge (m³/s)	Total Discharge (m³/s)
Flood storage in the southeast edge of C301 and abutting rural land	4.30	0	0	0	0	0
	4.40		1,000	0.40	0	0.40
	4.50	51,850	5,185	1.15	0	1.15
	4.60		14,000	2.10	0	2.10
	4.70		24,000	2.68	0	2.68
	4.80		36,000	2.90	1.08	3.98
	4.90		48,000	3.02	2.08	5.10
	5.00	169,520	60,530	3.10	2.20	5.30

5.4 RORB Model Results

Model results are summarised in Table 4.

ARI (yrs)	Armstrong Creek	Peak Water Level (m)	Peak Storage (m³)	Future Peak Discharge (m³/s)	CCMA Developed Flow Limit (m³/s)	Compliance with CCMA Constraints ?
2	Horseshoe Bend Rd			5.0 (48)		
	C301 SE corner	4.50	5,180	1.1 (48)		
	Barwon Heads Road			6.9 (48)		
	Armstrong Creek Wetlands	1.89	120,000	6.6 (36)		
	Catchment outlet			7.0 (48)		
10	Horseshoe Bend Rd			8.6 (48)		
	C301 SE Corner	4.57	11,300	1.8 (48)		
	Barwon Head Road			13.4 (30)		
	Armstrong Creek Wetlands	2.04	149,000	13.8 (48)		
	Catchment outlet			14.8 (48)		
100	Horseshoe Bend Rd			20.2 (36)	23.1	YES
	C301 SE Corner	4.78	33,200	3.7 (12)	-	
	Barwon Head Road			29.9 (48)	30.9	YES
	Armstrong Creek Wetlands	2.24	190,000	31.5 (30)		
	Catchment outlet	7.25	1,000	32.3 (48)	-	

The RORB results show that:

- CCMA 100 year ARI peak flow limits are fully complied with;
- 100 year ARI flood level in the southeast corner of C301 (and across abutting land to the south) will be reduced from 4.95 m at present to 4.80 m in future after all development is complete.

6. CONCLUSIONS

This SWMS shows that with the proposed C301 development in place:

- CCMA 100 year ARI peak flow limits in Armstrong Creek are fully complied with.
- 100 year ARI flood level in the southeast corner of C301 (and across abutting land to the south) will be reduced from 4.95 m at present to 4.80 m in future, after all development is complete.
- Best management practice stormwater quality objectives are complied with.
- A fully integrated wetland system across C301 and Armstrong Waters is created.
- The means of funding of the link connection between Armstrong Creek and the Sparrovale Wetlands is achieved.
- Two options for concept design of the link connection are presented. Both options are able to deliver a peak flow rate of 0.4 m³/s with the ACEP wetlands headwater level at 1.30 m AHD. This will suffice to ensure more than 40% of the Armstrong Creek mean annual flows and dry season flow (Dec-April inclusive) are able to be diverted around Hospital Swamps. Higher diversion capacity is able to be harnessed using the confining levee bank and overtopping of the main upstream control structure.

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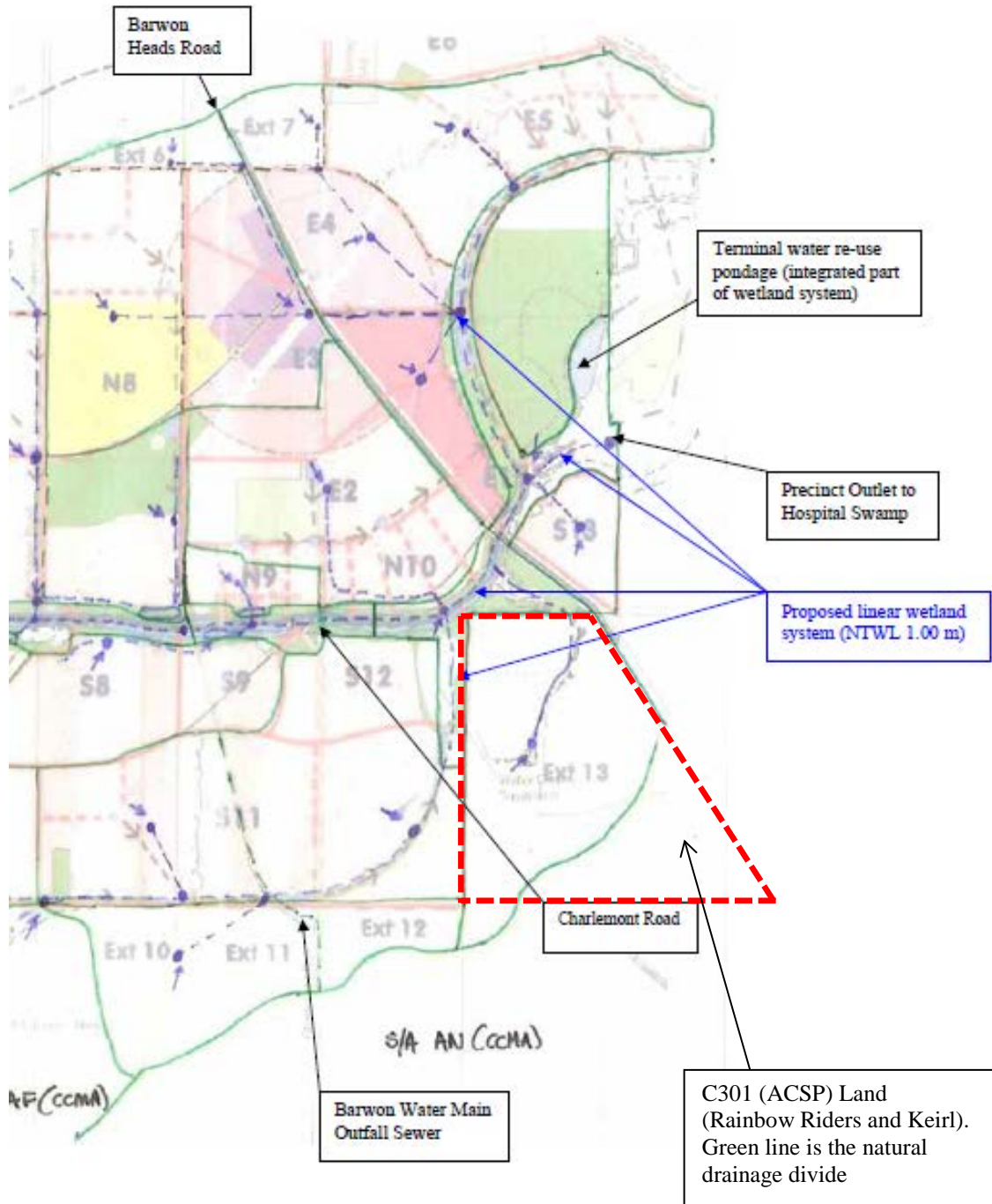


Figure 1 SWMS Concept Layout for lower ACEP showing location of C301 (ACSP) lands



Figure 2 Nearmap.com extract 16 March 2015 showing the C301 land and surrounding development and waterways

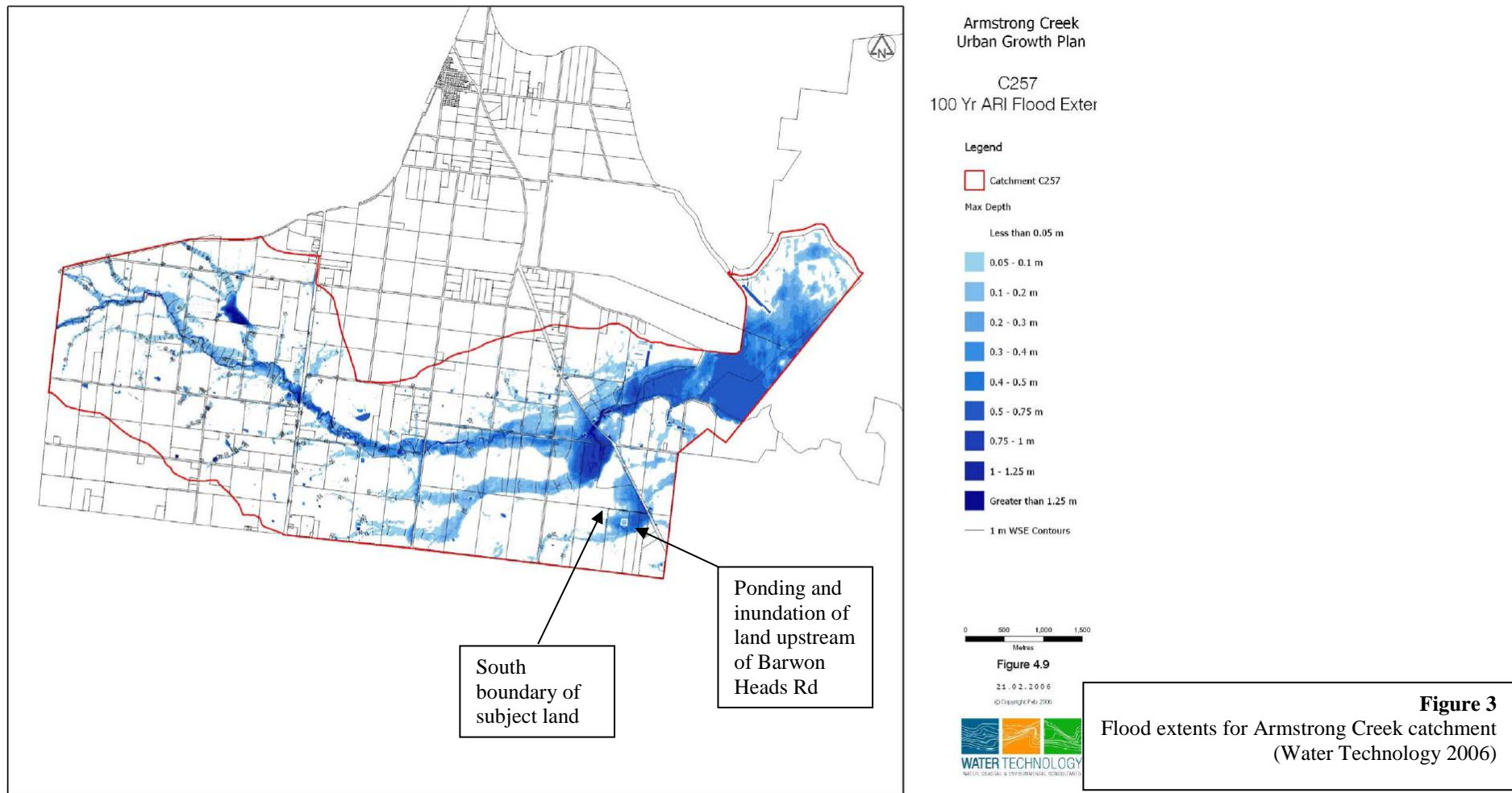


Figure 4-9 C257 Armstrong Creek: 100 year flood extent

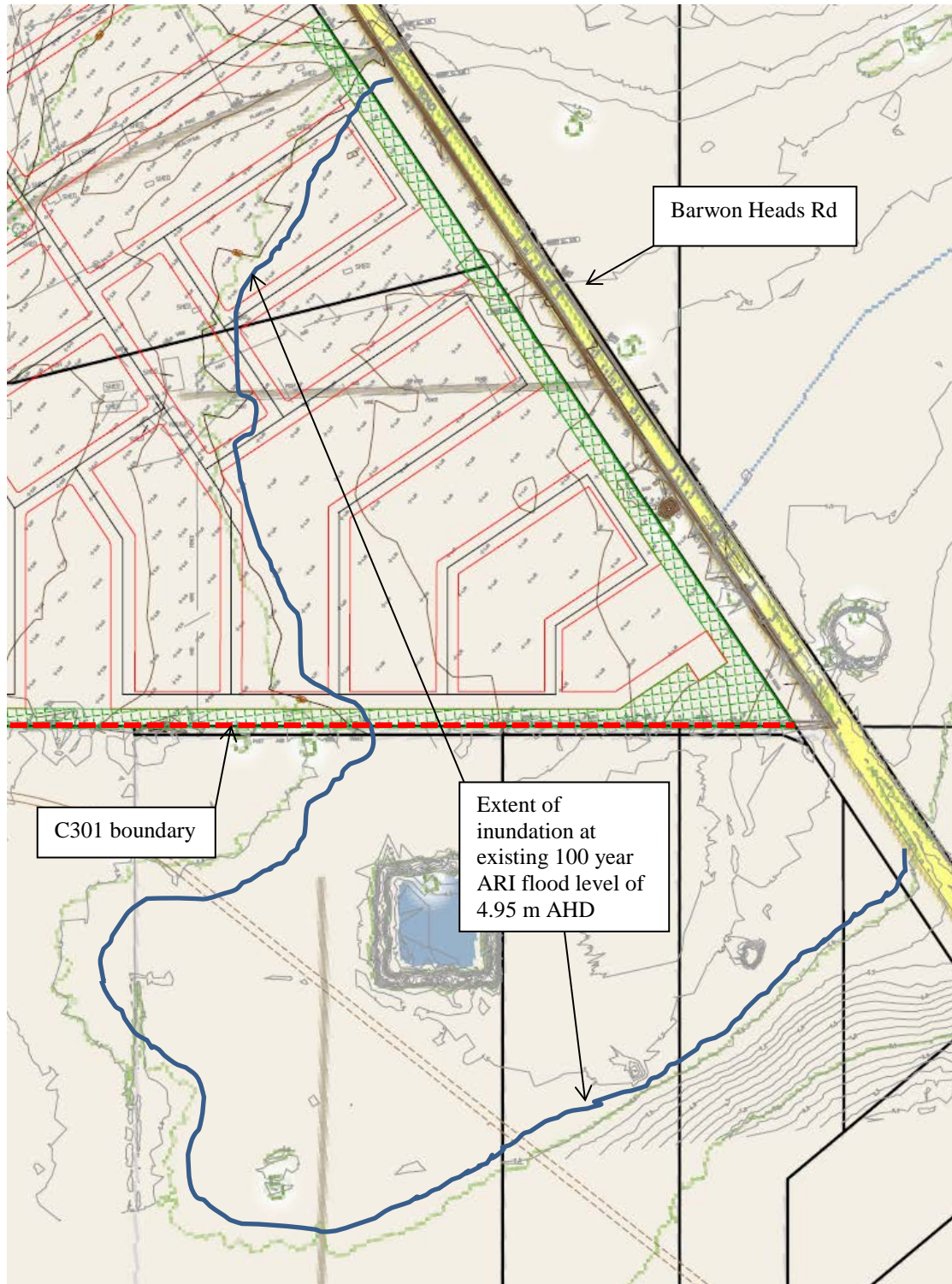
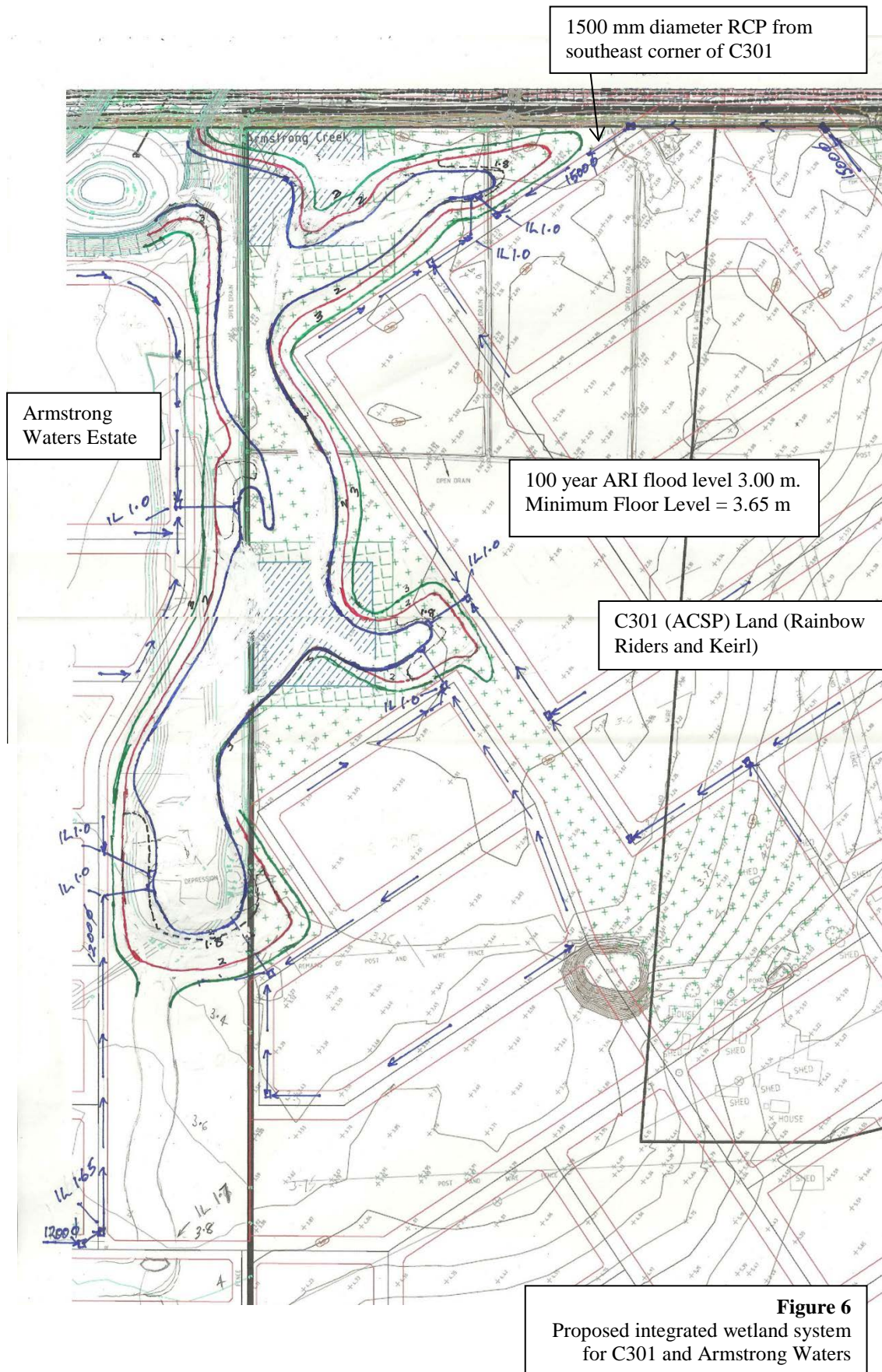


Figure 4 Extent of inundation in southeast corner of C301 under existing conditions for 100 year ARI event (4.95 m as defined by Water Technology 2012)



Figure 5 Proposed development plan show road and main drainage layouts for Armstrong Waters and C301 (ACSP) lands (see Figure 6 for wetland layout)



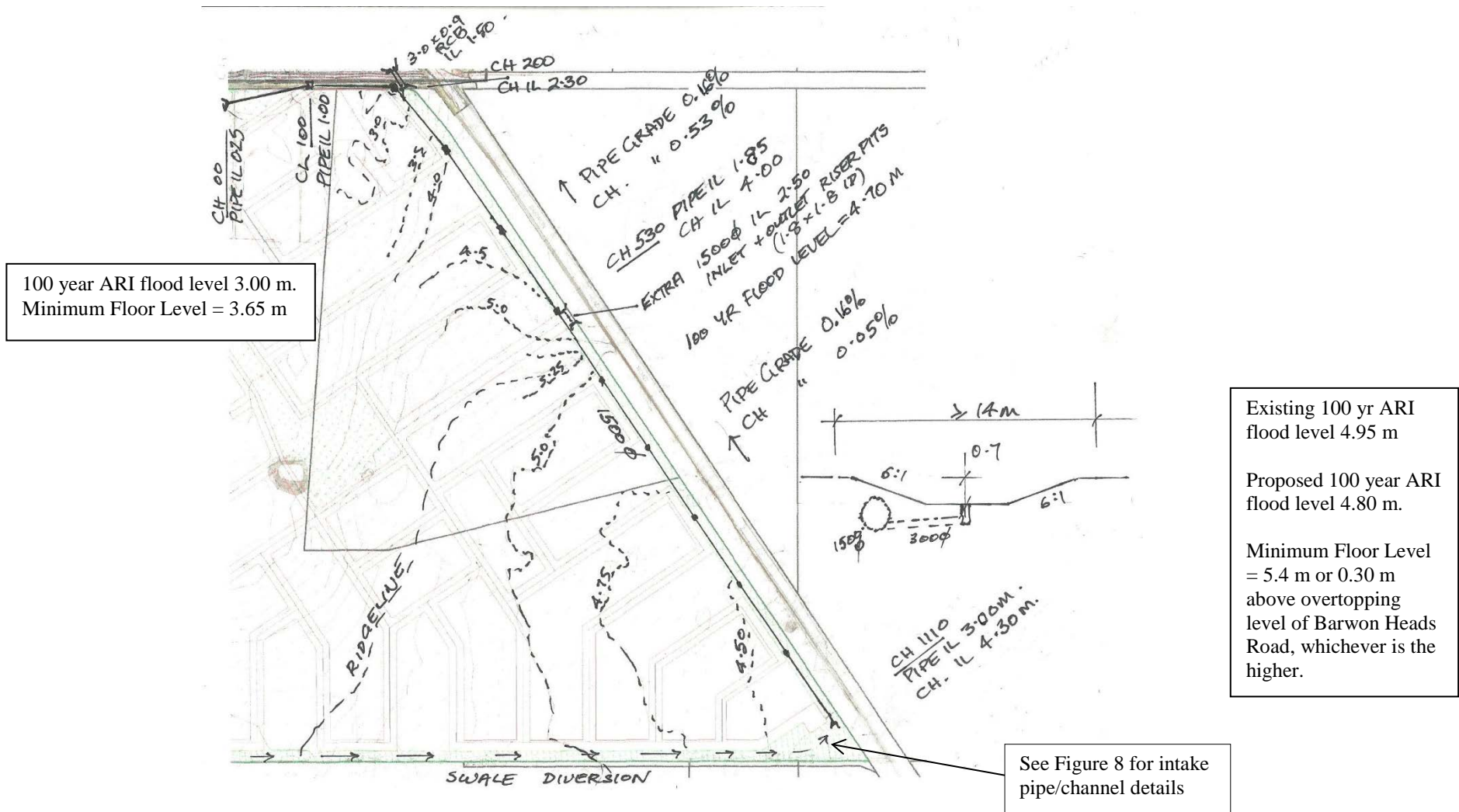


Figure 7 Proposed pipe and channel drainage along Barwon Heads Road

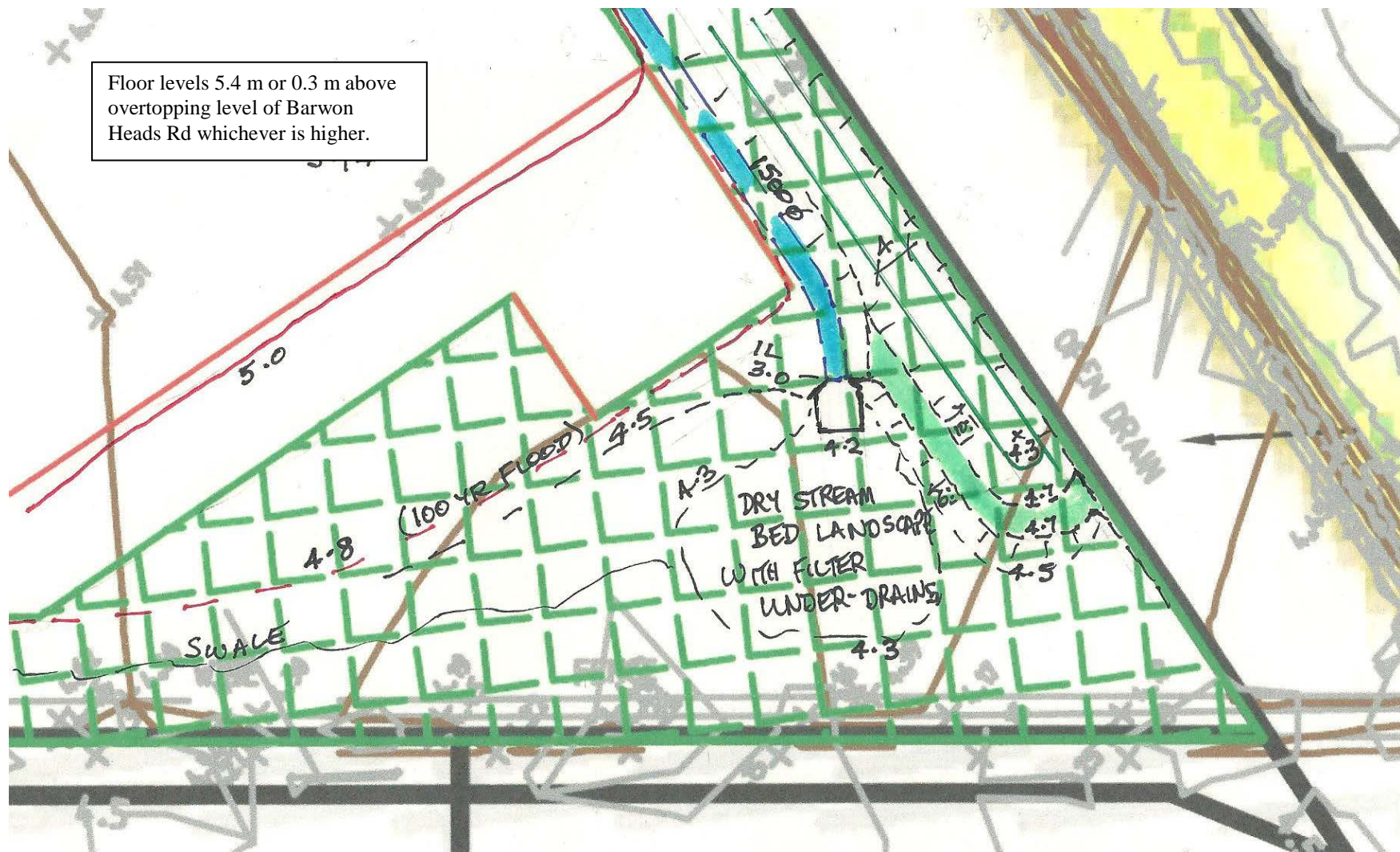


Figure 8 Proposed concept for pipe and channel intake in southeast corner of C301

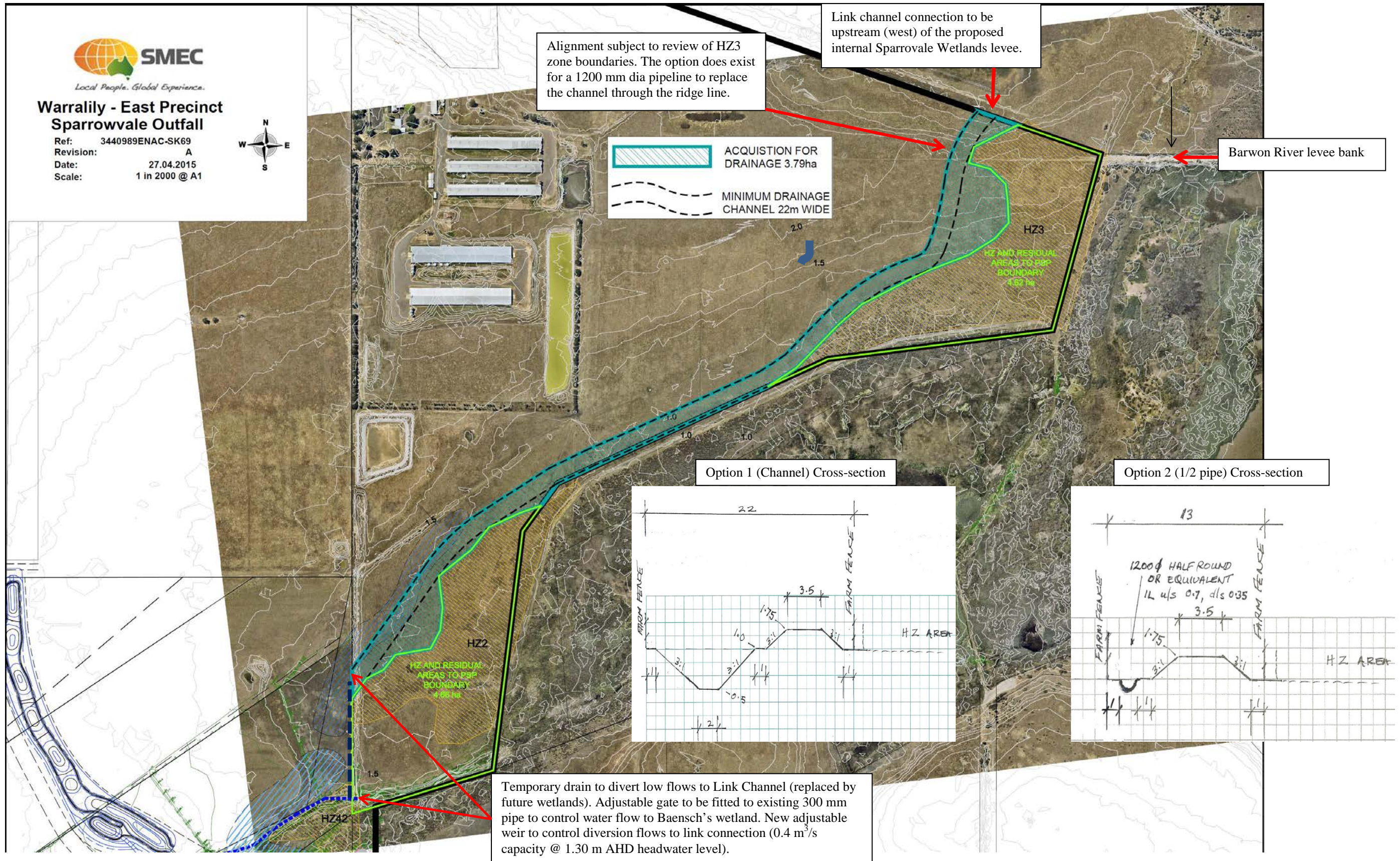


Figure 9 Proposed alignment and typical cross-section of Option 1 link channel and access bank (22 m strip between fencing). Option 2 would replace deep excavation with half-round 1200 mm pipe at higher inverts.