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Attention: Craig Graham
Okeland Communities

Delivered by email to: CGraham@okeland.com.au

Dear Craig

BULLSBROOK LANDHOLDING LOCAL WATER MANAGEMENT STRATEGY ADDENDUM

1 BACKGROUND

Emerge Associates have prepared this local water management plan (LWMS) addendum for Kingsford at Bullsbrook Estate (Bullsbrook landholding), (herein referred to as 'the site'). The purpose of this LWMS addendum is to document changes proposed to the overall layout of the Structure Planning area and to ensure that the open spaces proposed can comply with the water management criteria accepted in the approved *Local Water Management Strategy Bullsbrook Landholding* (RPS 2018).

The site is situated 35 km north of Perth central business district within the City of Swan (CoS). This letter is an addendum to the previously approved *Local Water Management Strategy Bullsbrook Landholding* (RPS 2018) and this addendum should be read in conjunction with it as this provides the rationale for the water management criteria adopted. The site is approximately 494.5 ha and is bounded by Great Northern Highway and Chittering Road to the west and Taylor Road to the east. The total development is approximately 494.5 ha (see **Figure 1**).

The design objectives seek to deliver best practice outcomes using a water sensitive urban design (WSUD) approach, including detailed management approaches for stormwater management. Other relevant water management aspects (groundwater, water conservation, etc) have already been documented in the approved LWMS.

2 SITE CONTEXT

The site characteristics that have previously been investigated and documented in the *LWMS Bullsbrook Landholding* (RPS 2018) are summarised as:

- The area experiences an average of 671.7 mm of annual rainfall.
- Topography of the site ranges from 120 m Australian Height Datum (mAHD) in the east to approximately 50 mAHD in the south-west.
- The general soil profile comprises fine grained to coarse grain sand within the top layer (ranging between 0.5 m and 0.9m deep) and fine to medium and coarse grained rounded to sub-angular gravely sand up to the maximum depth of the test pits.

- Unsaturated soil permeabilities have been measured between 0.1 and 6.8 m/day.
- ASS risk mapping indicates that there is a little to no risk of ASS occurring within 3 m of the natural soil surface.
- There are no recorded contaminated sites within the structure planning area.
- There are no surface water features within the site (DWER 2020). Ki-it Monger Brook is located immediately adjacent to the north.
- The existing hydrological regime consists of infiltration of small rainfall events into the sandy surface soils followed by run-off flowing from most of the site to Ki-it Monger Brook during more intense or longer duration rainfall events when the infiltration capacity of the surface soils is exceeded. A lesser part of the site discharges south to adjacent land and eventually to the Nambad Brook.
- TN/NOx-N concentrations within Ki-it Monger Brook are 'high' and TP concentrations are 'low'.
- The groundwater elevation beneath the site is between 30 mAHD in the south-west of the site and 75 mAHD in the north-east. Groundwater flow is in a westerly direction.
- TN and TP concentrations of the groundwater beneath the site were generally 'low'.
- A number of geomorphic wetlands were identified within and adjacent to the western boundary of the site. A multiple use wetland (MUW) (UFI 15282) is present in the south-western part of the site as well as a conservation category wetland (CCW) (UFI 12621) associated with the Ki-it Monger Brook. This CCW consists of a flowing creek line, remnant flooded gums and the occasional marri tree with no or scattered understorey and was mapped as degraded and dominated by weeds.
- The entire site is a registered site of Aboriginal significance (site 3583) described as 'ceremonial, modified tree, mythological'.
- The site is not located in a Public Drinking Water Supply Area (PDWSA).

3 DESIGN CRITERIA

The water management criteria and design approach for the site has been documented in the approved LWMS (RPS 2018). This document does not propose to alter the approved water management objectives and design criteria.

The key stormwater management criteria are:

- Criteria 1 – Manage and treat runoff from the small event runoff (i.e. first 15 mm) as close to source as possible
- Criteria 2 - Maintain pre-development 1% AEP peak flow rates in Ki-it Monger Brook to protect downstream areas from flooding.
- Criteria 3 - Minor roads are to remain passable in the minor (20% AEP) event.
- Criteria 4 - Provide conveyance pathways (including the road reserve) for the 1% AEP event.
- Criteria 5 - Protect infrastructure and assets from flooding. Ensure that properties have a finished floor level of 500 mm above the 1% AEP flood level for the Ki-it Monger Brook.
- Criteria 6 - Provide a minimum of 300 mm clearance between FFL and adjacent flood storage area (FSA) top water levels (TWL).
- Criteria 7 - Apply appropriate non-structural measures to reduce nutrient loads.

4 STORMWATER MANAGEMENT STRATEGY

The stormwater management strategy for the site is to convey stormwater from upstream catchments, detain surface runoff flows from the site and to treat and infiltrate site stormwater runoff as close to source as possible, consistent with the existing hydrology.

Ki-it Monger Brook runs through the site, and the post-development hydrological regime will maintain its flows.

WSUD measures that will be utilised to manage stormwater, include:

- Soakwells or other storage within lots
- Bio-retention areas (BRAs)
- Flood storage areas (FSAs).

Summary of changes from approved LWMS

The main changes that have occurred since approval of the LWMS (RPS 2018) include:

- The road and lot layout has evolved to suit changes to design stages, lot product mix and POS locations.
- The approach to earthworks is to import 1.3 - 1.5 m of fill to achieve final lot levels, and this facilitates a greater level of at-lot storage of rainfall.
- Outflow to the south of the site and towards Nambad Brook is proposed to be maintained rather than redirected to Ki-it Monger Brook (which resulted in larger piped drains and changes to the site hydrology).

Inflows and discharges

Pre-development flood modelling of the Ki-it Monger Brook catchment was undertaken by RPS (RPS 2013). Pre-development outflow from the site occurs in two locations:

- Ki-it Monger Brook leaves the site through culverts under Great Northern Highway south-west of the site, at a rate 11.82 m³/s shown as Out 1 in **Figure 2**. This conveys the majority of runoff from the site.
- Runoff from the eastern part of the site as well as the upstream catchment to the east of the site discharges via a small streamline to the south at a rate of 1.37 m³/s, shown as Out 2 in **Figure 2**. Runoff from this location eventually enters Nambad Brook south of the site.

The stormwater management strategy proposes to maintain pre-development hydrological regime of Ki-it Monger Brook by conveying inflow from upstream catchments and tributaries through the existing channels and dam to protect downstream areas from flooding. Ki-it Monger Brook will discharge from the site through the existing culverts at pre-development rates.

Inflow from upstream catchments east of the site will be conveyed through the site, via a pipe or overland pathway, and discharged via the existing streamline to the south of the site at pre-development rates.

Discharging at both Out 1 and Out 2 (rather than at Out 1 only as proposed in the approved LWMS (RPS 2018)) will ensure that the pre-development hydrological regime is maintained.

Lot drainage

The natural soils beneath the site have a moderate infiltration capacity. Sand fill will be used to achieve final lot levels across the site, and soakwells will be installed mostly into the sand fill.

Residential lots will retain the first 15 mm of runoff from roofs in soakwells within the lot. Larger lots that can facilitate infiltration will also provide additional at lot retention (up to a 1% AEP event)

within pervious garden areas in accordance with the CoS guidelines (CoS 2013), and this is now accounted for in this LWMS addendum.

Lot storage is the responsibility of the lot owner and will be assessed as part of the building approval process prior to construction.

Development drainage

- Pit and pipe network

A system of pits and pipes are proposed for the site and will be sized to cater for the minor (20% AEP event). Whilst this is a traditional approach to stormwater conveyance, where possible flush kerbing and kerb breaks will be used to minimise the extent of the pipe network. Gross pollutant traps (GPTs) can be used prior to discharge to BRAs and if used these will provide an additional level of treatment. Detailed civil designs will be completed as part of the future Urban Water Management Plans (UWMPs). The retention of discharge to Out 2 (at the southern end of the site) will help to minimise pipe sizes that were otherwise required to direct all flows towards Ki-it Monger Brook.

- Co-located Bio-retention and flood storage areas (BRAs/FSAs)

All runoff from the small event that is not retained higher in catchment will be captured and retained in co-located BRAs in downstream public open space (POS). BRAs have maximum depths of 300 mm and will be densely vegetated with species known to uptake nutrients. BRAs will be underlain with 300 mm of appropriate soils with high phosphorous retention index (PRI>10) to enable nutrient removal.

BRAs will be designed to dry out within 96 hours following the small rainfall event so that is not a mosquito breeding risk.

Stormwater runoff exceeding the capacity of a BRA will overflow to the FSA portion of the basin. The total maximum depths of the co-located BRAs/FSAs are 1.2 m with side slopes of 1 in 6. Co-located BRAs/FSAs will discharge to Ki-it Monger Brook at pre-development rates to maintain pre-development 1% AEP peak flow rates within the Brook.

5 DEMONSTRATION OF COMPLIANCE

The updated Structure Plan is able to achieve the design criteria as follows:

- | | |
|--------------------------|---|
| <u>Criteria 1</u> | Manage and treat runoff from the small event runoff (i.e. first 15 mm) as close to source as possible |
|--------------------------|---|

Runoff for the small rainfall event from lots will be retained and treated within lots (pervious garden areas and soakwells). Runoff from the small rainfall event that is not retained higher in catchment may be treated by a GPT and then captured and treated in co-located BRAs/FSAs, located in downstream POS. Small event treatment requirements are provided in **Table 1** and shown in **Figure 2**.

Treatment of the small event runoff will occur via infiltration through the underlying soil profile where nutrients will be adsorbed to the sand particles and/or taken up by vegetative root systems prior to reaching groundwater.

The water management requirements have been calculated using surface runoff modelling software (XPSWMM) as part of the LWMS and updated based on proposed layout changes and corresponding catchment boundaries.

Table 1: Small event stormwater requirements

Basin	Catchment	Depth (m)	TWL surface area (m ²)	Volume (m ³)
Basin A**	A	0.3	512	142
Basin B**	B	0.3	559	130
Basin C**	C	0.32	334	91
Basin D	D1, D2 and E2	0.24	891	187
Basin E1*	E1	0.3	255	60
Basin 4*	4	0.33	121	40
Basin 5*	5	0.36	1,179	354
Basin 12A	12A	0.3	140	40
Basin 12	12B and 12C	0.30	877	249
Basin 13A	13A	0.29	945	264
Basin 14	14	0.31	471	121
Basin F1	F1	0.51	733	243
Basin F2	F2	0.3	60	21
Basin G	G	0.49	1,112	442
Basin 15	TAC1A, TAC1B, Lot5004	0.15	1,517	224
Basin TAC2	TAC2	0.3	330	80
Basin TAC3	TAC3	0.13	1,840	219
Basin TAC1_B2	TAC1b_2, TAC4	0.19	1,213	214
Basin 17A	17A, 18	0.22	3,459	712
Basin 17B	17B	0.37	348	101
Basin 17C	17C	0.33	705	200

The Structure Plan provides sufficient land area to accommodate all of the surface areas indicated in **Table 1**, and on this basis, **Criteria 1** has been achieved.

Criteria 2 Maintain pre-development 1% AEP peak flow rates in Ki-it Monger Brook to protect downstream areas from flooding.

Stormwater runoff exceeding the capacity of the BRA up to the critical duration 1% AEP event will be retained in FSAs which surrounds the BRAs to maintain discharge to Ki-it Monger Brook at pre-development rates. FSAs have maximum water depths between 700 mm and 1.2 m, side slopes up to 1:6, and will be vegetated.

Table 2 provides the 1% AEP discharge from FSAs to Ki-it Monger Brook. The combined 1% AEP discharge to Ki-it Monger Brook is 4.59 compared to the 8.66 m³/s combined 1% AEP discharge to Ki-it Moger Brook in the approved LWMS (RPS 2018). Given that the peak flow rates within Ki-it Monger Brook are lower that pre-development peak flow rates as a result of the currently proposed approach, it is acceptable for future detailed designs within future development stages to propose alternate discharge rates to Ki-it Monger Brook provided that the discharge from site at Out 1 do not exceed the modelled pre-development 1% AEP discharge rate of 11.82 m³/s to Ki-it Moger Brook (**Table 3**).

Table 2: Minor (20% AEP) and major event (1% AEP) storage requirements

Basin	Catchment	20% AEP			1% AEP			
		Depth (m)	TWL surface area (m ²)	Volume (m ³)	Depth (m)	TWL surface area (m ²)	Volume (m ³)	Modelled Discharge (m ³ /s)
Basin A [^]	A	0.39	1,270	260	1.07	1,496	889	0.16
Basin B [^]	B	0.33	1,137	305	0.7	1,420	740	0.49
Basin C [^]	C	-	-	-	-	-	-	-
Basin D	D1, D2 and E2	0.48	1,109	434	0.91	1,542	999	0.27
Basin E1	E1	0.3	255	60	0.3	255	60	0.1
Basin 4	4	0.33	121	40	0.33	121	40	0.15
Basin 5	5	0.36	1,179	354	0.36	1,179	354	0.79
Basin 12A	12A	0.69	273	114	1	411	221	-
Basin 12	12B and 12C	0.96	1,425	1,006	1	1,462	1,094	0.25
Basin 13A	13A	0.98	1,521	1,101	1	1,545	1,185	0.26
Basin 14	14	1.0	905	590	1.0	905	590	0.5 ^{^^}
Basin F1	F1	0.79	1,737	603	1.17	1,964	1,298	0.12
Basin F2	F2	0.4	268	65	0.7	523	136	-
Basin G	G	0.67	1,261	661	1.05	1,599	1,212	0.55
Basin TAC1	TAC1A, TAC1B, Lot5004	0.64	1,699	1,002	1.26	1,919	2,139	0.75
Basin TAC2	TAC2	0.5	1,675	395	0.8	1,685	725	0.62
Basin TAC3	TAC3	0.58	2,570	1,220	1.04	3,367	2,586	*
Basin TAC1b_2, TAC1_B2	TAC1b_2, TAC4	1.00	1,200	830	1.00	1,200	830	**
Basin 17A	17A, 18	1.00	4,660	3,885	1.00	4,660	3,885	**
Basin 17B	17B	1.00	1,200	830	1.00	1,200	830	**
Basin 17C	17C	1.00	690	420	1.00	690	420	**
Basin DOS FSA	17A, 17B, 17C, 18, 18A 14, TAC4, TAC1b_2	0.18	6,140	1,091	1.20	8,205	8,360	1.35
SC1		0.42	397	108	0.94	707	387	0.05
SC2		0.44	562	215	0.67	733	366	0.04

[^] Constructed

^{^^} Includes discharge from Ct 14, Ct-17B and overflow from TAC1B_2

* Discharge to TAC2

** Discharge to Basin DOS FSA

Table 3 provides the pre-and post-development discharge from site at the two outflow locations (shown in **Figure 2**).

Table 3: 1% AEP discharge from site

Location	1% AEP pre-development discharge	Modelled 1% AEP post development discharge
Out 1	11.82	9.08
Out 2	1.37	1.35

The post-development discharge from site is less than the pre-development discharge. On this basis, **Criteria 2** has been achieved.

Criteria 3 Minor roads are to remain passable in the minor (20% AEP) event.

The piped drainage network beneath road reserves will be designed to convey flows up to the 20% AEP event to co-located BRAs/FSAs in downstream POS. This will be demonstrated at detailed civil design stage.

On this basis, **Criteria 3** will be achieved.

Criteria 4 Provide conveyance pathways (including the road reserve) for the 1% AEP event.

Runoff beyond the capacity of the piped network will sheet flow directly into the adjacent road reserve and directed to co-located BRAs/FSAs in downstream POS. There are no trapped low between FSAs and the discharge locations, and on this basis, **Criteria SW4** has been achieved.

Criteria 5 Protect infrastructure and assets from flooding. Ensure that properties have a finished floor level of 500 mm above the 1% AEP flood level for the Ki-it Monger Brook.

The modelled 1% AEP flood level of the Ki-it Monger Brook ranges from approximately 46.78 m AHD south west of the site 76.171 m AHD along the northern boundary of the site (RPS 2018). The lot levels closest to Ki-it Monger Brook at these locations will have a minimum 500 mm above the 1% AEP flood level (an in most cases significantly more than this) for the Ki-it Monger Brook as discussed in the approved LWMS (RPS 2018). On this basis, **Criteria SW5** has been achieved.

Criteria 6 Provide a minimum of 300 mm clearance between FFL and adjacent flood storage area (FSA) top water levels (TWL).

Minimum habitable floor levels will have a minimum of 300 mm above the 1% AEP flood level in local drainage networks as discussed in the approved LWMS (RPS 2018). On this basis, **Criteria SW6** will be achieved.

Criteria 7 Maintain clearance between the finished lot levels and groundwater level of at least 1.2 m.

The pre-development depth to groundwater over the developable area is more than 700 mm, achieving the minimum clearance requirements (RPS 2018). Further clearance will also be provided by the fill approach that has been adopted to meet geotechnical requirements and overall catchment slopes. On this basis, **Criteria SW4** has been achieved.

Criteria 7 Apply appropriate non-structural measures to reduce nutrient loads.

A number of non-structural measures will be implemented across the site to help reduce nutrient loads within stormwater runoff.

These measures include:

- Minimising fertiliser use to establish and maintain vegetation within road verges.
- Use of drought tolerant turf species that require minimal water and nutrients.
- Street sweeping to remove sediments and gross pollutants.
- Maintenance of GPTs, co-located BRA/FSA and the pipe network to remove sediments and other pollutants.
- Education of residents regarding fertiliser use and nutrient absorbing vegetation species within lots.

On this basis, **Criteria 7** has been achieved.

6 SUMMARY AND CLOSING

This LWMS addendum has been developed to address stormwater management for Bullsbrook Landholding and presents a management approach that is consistent with the previously approved LWMS and CoS requirements, design guidelines and standards. It confirms that the spatial layout proposed in the Structure Plan, lot storage approach and catchment discharges can all meet the water management criteria from the approved LWMS.

Should you have any queries or concerns regarding the content of this letter please do not hesitate to contact the undersigned.

Yours sincerely

Emerge Associates



David Coremans

DIRECTOR, PRINCIPAL ENVIRONMENTAL CONSULTANT – HYDROLOGY

cc: Nil

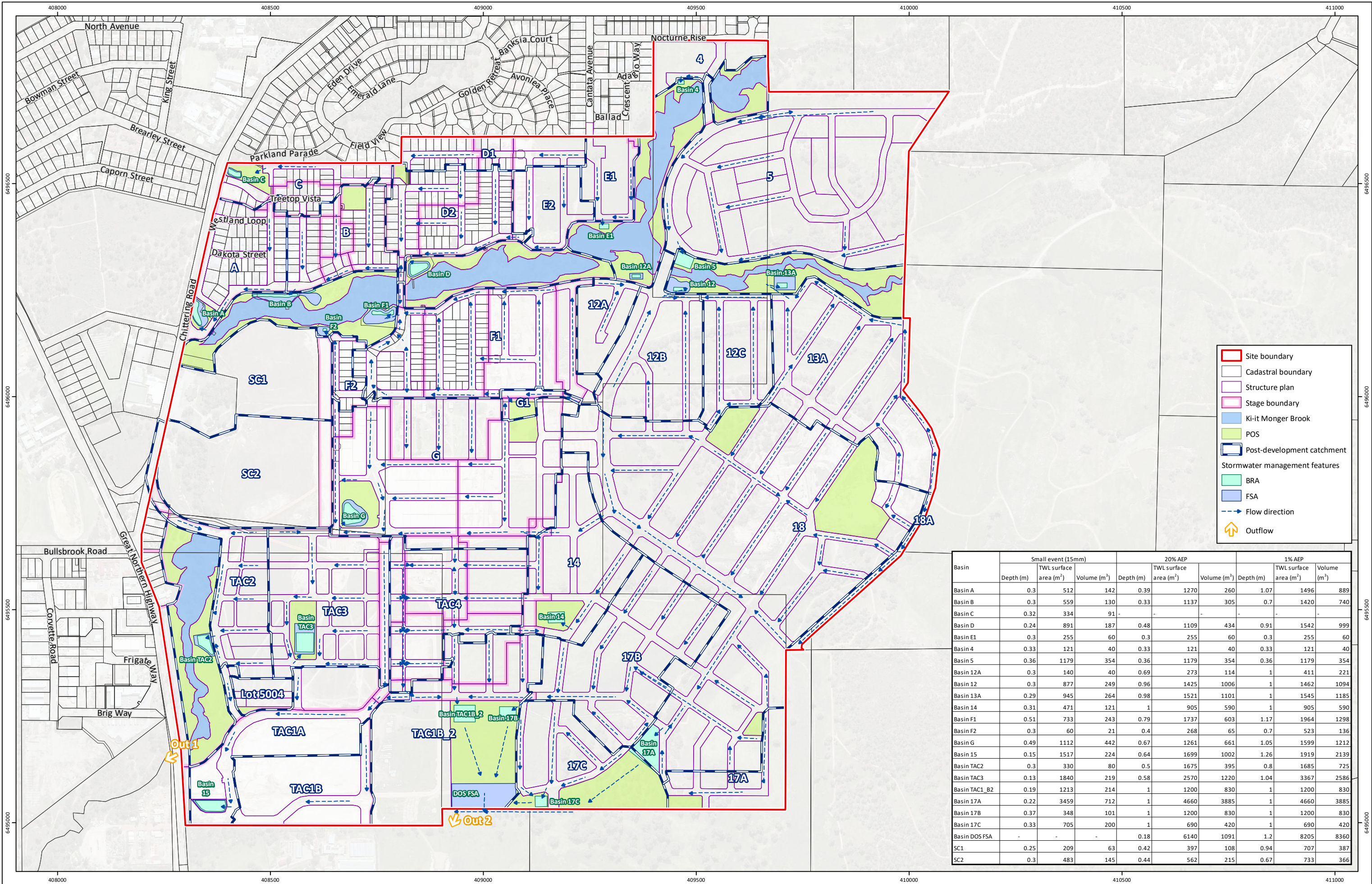
Encl: Figure 1: Site location
Figure 2: Stormwater Management Plan

General References

City of Swan (CoS) 2013, *Planning Application Stormwater Drainage Plan - Customer Checklist*.

RPS 2013, *Estimate of Flood Levels and Extent of Flooding at Ki-it Monger Brook, Bullsbrook*.

RPS 2018, *Local Water management Strategy Bullsbrook Landholding*.



Basin	Small event (15mm)			20% AEP			1% AEP		
	Depth (m)	TWL surface area (m ²)	Volume (m ³)	Depth (m)	TWL surface area (m ²)	Volume (m ³)	Depth (m)	TWL surface area (m ²)	Volume (m ³)
Basin A	0.3	512	142	0.39	1270	260	1.07	1496	889
Basin B	0.3	559	130	0.33	1137	305	0.7	1420	740
Basin C	0.32	334	91	-	-	-	-	-	-
Basin D	0.24	891	187	0.48	1109	434	0.91	1542	999
Basin E1	0.3	255	60	0.3	255	60	0.3	255	60
Basin 4	0.33	121	40	0.33	121	40	0.33	121	40
Basin 5	0.36	1179	354	0.36	1179	354	0.36	1179	354
Basin 12A	0.3	140	40	0.69	273	114	1	411	221
Basin 12	0.3	877	249	0.96	1425	1006	1	1462	1094
Basin 13A	0.29	945	264	0.98	1521	1101	1	1545	1185
Basin 14	0.31	471	121	1	905	590	1	905	590
Basin F1	0.51	733	243	0.79	1737	603	1.17	1964	1298
Basin F2	0.3	60	21	0.4	268	65	0.7	523	136
Basin G	0.49	1112	442	0.67	1261	661	1.05	1599	1212
Basin 15	0.15	1517	224	0.64	1699	1002	1.26	1919	2139
Basin TAC2	0.3	330	80	0.5	1675	395	0.8	1685	725
Basin TAC3	0.13	1840	219	0.58	2570	1220	1.04	3367	2586
Basin TAC1_B2	0.19	1213	214	1	1200	830	1	1200	830
Basin 17A	0.22	3459	712	1	4660	3885	1	4660	3885
Basin 17B	0.37	348	101	1	1200	830	1	1200	830
Basin 17C	0.33	705	200	1	690	420	1	690	420
Basin DOS FSA	-	-	-	0.18	6140	1091	1.2	8205	8360
SC1	0.25	209	63	0.42	397	108	0.94	707	387
SC2	0.3	483	145	0.44	562	215	0.67	733	366

Figure 2: Stormwater Management Plan

Project: Urban Water Management Plan
Kingsford Bullsbrook LWMS addendum

Client: Okeland Communities

Plan Number:
EP23-095(04)-F11

Drawn: GAR

Date: 03/10/2024

Checked: JB

Approved: DPC

Date: 03/10/2024



0 100 200 300

Metres

Scale: 1:8,000@A3

GDA2020 MGA Zone 50





Figure 1: Site Location

Project: Urban Water Management Plan
Kingsford Bullsbrook LWMS addendum

Client: Okelnd Communities

Plan Number:
EP23-095(04)--F16

Drawn: GAR

Date: 03/10/2024

Checked: JB

Approved: DPC

Date: 03/10/2024



0 200 400
Metres

Scale: 1:12,500@A4

GDA2020 MGA Zone 50

emerge
ASSOCIATES