SEDIMENT BASINS, WETLANDS AND PONDS DESIGN REPORT

Stormwater Trunk Infrastructure for Bradfield City Centre

28 November 2024

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Bradfield Development Authority

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Project Number:
304000968

Revision	Description	Author	Date	Quality Check	Date	Independent Review	Date
1	50% Design Submission	Catherine Duong	20/09/23	Pak Lau	29/09/23	Robert Odewahn	05/10/23
2	50% Design Re-Submission	Jamie Teck	20/12/23	Robert Odewahn	20/12/23	Robert Odewahn	20/12/23
3	50% Design Re-Submission	Jamie Teck	15/01/24	Robert Odewahn	15/01/24	Robert Odewahn	15/01/24
4	50% Design Re-Submission	Jamie Teck	02/02/24	Pak Lau	02/02/24	Robert Odewahn	02/02/24
5	Draft IFC Submission	Jamie Teck	20/11/24	Pak Lau	27/11/24	Robert Odewahn	28/11/24

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1 Introduction

Stantec Australia has been engaged by the Bradfield Development Authority (BDA) to design the trunk drainage network, including the wetlands and detention basins for the Bradfield City development.

The works to which this report relates are broadly defined below:

- Stormwater quantity control
    - The construction of a series of ponds with extended detention to attenuate flows and detain stormwater for reuse.
    - Installation and design of splitter pits to direct flows from the development and external catchments into the appropriate treatment train.
- Stormwater Quality/On Site Detention (OSD)
    - The construction of a series of sediment basins, wetlands and bio-retention basins.
    - Installation of gross pollutant traps.
- Realignment of Moore Gully and its tributary

The aim of this report is to provide an outline of:

- Design parameters
- Site constraints
- Water quantity and water quality modelling results.

1.1 Bradfield City Centre trunk drainage design overview

The Bradfield City development is located in the Western Sydney Aerotropolis Precinct and will serve as the city centre for the Western Parkland City and the Western Sydney International Airport. The city is approximately 4km to the southeast of the future airport and bounded by Thompsons Creek to the east, Moore Gully to the south, Badgerys Creek Road to the west and private properties to the east and north. Figure 1-1 shows the location of the site.

Figure 1-1 Location of Bradfield City Centre

1.2 Proposed stormwater treatment train

The proposed stormwater quality and quantity basins are part of the stormwater management framework in the Western Sydney Aerotropolis area. The treated stormwater runoff will be stored in the retention ponds, then pumped to the future Advanced Water Recycling Centre (AWRC). The AWRC is being designed and constructed by Sydney Water.

The stormwater treatment train has been designed to suit the proposed landform of the Bradfield City development. In the post development scenario, the site is divided into two (2) main catchments by the main north-south road, Innovation East. The catchments draining to the basins adjacent to Moore Gully have a total area of approximately 51.2 hectares. The Sediment ponds, Wetlands, Bio-retention basins and Ponds (SWBP) are located to the south of Bradfield City, along the northern side of the riparian corridor of Moore Gully.

The south-eastern section of Bradfield City, draining towards Thompsons Creek has a catchment area of approximately 20 hectares. The stormwater runoff will be treated by the proposed wetlands and ponds located between the proposed development and Thompsons Creek, which will be designed as part of the future development stage.

1.3 Design standards and relevant reports

The design of the proposed trunk drainage network and the realignment of Moore Gully and tributary has been informed by the following:

- Western Sydney Aerotropolis Development Control Plan 2022 by Department of Planning and Environment (November 2022);
- Bradfield City Centre Master Plan Application Integrated Water Cycle Management Plan by AECOM (August 2023);
- Draft Aerotropolis Regional Stormwater Infrastructure Design Guidelines by Sydney Water (June 2023);
- Bradfield City Centre Master Plan by Hatch Roberts Day (August 2023);
- Wianamatta South Creek Catchment Flood Study – Cumulative Impact Assessment, prepared for Infrastructure NSW by Advisian (January 2023) (as endorsed by Liverpool City Council);
- Bulk Earthwork, utility and stormwater reticulation network design for Bradfield City, prepared by SMEC;
- Stormwater Management Framework for Aerotropolis and Mamre Road Precincts prepared by Sydney Water;
- Stormwater Scheme Infrastructure Design Guidelines (Draft) for Western Sydney prepared by Sydney Water (21 December 2022);
- Bradfield Stormwater Modelling Memo prepared by Sydney Water;
- Standard Drawings prepared for Aerotropolis Regional Stormwater Infrastructure Design Guideline prepared by Sydney Water;
- 1% AEP Post development flood contours prepared by Advisian; and
- Detailed Site Investigation prepared by ERM (29 July 2022).

2 Stormwater drainage

2.1 Design criteria

BDA and Stantec have consulted with Sydney Water and Liverpool City Council during the design development of the proposed stormwater treatment train, and the following design criteria have been adopted:

- The treatable flows (4EY or 3 month ARI) are diverted to the Gross Pollutant Traps (GPT's), sediment basins and wetlands for treatment;
- Stormwater flow exceeding the treatable flow up to the 5% AEP peak flow are drained to the stormwater retention/detention ponds;
- Stormwater flows greater than the 5% AEP are drained to Moore Gully or Thompsons Creek bypassing the basin.
- Moore Gully shall contain a low flow channel to drain the 0.5 x 1EY stormwater flow.
- The ponds are designed only for on-site detention, the Bradfield City stormwater infrastructure will not be responsible for regional flood storage.
- The embankments of the basins are to be higher than the 1% AEP flood level in Moore Gully and Thompsons Creek. Stantec has adopted the flood levels from the post development 1% AEP flood contours, prepared by Advisian;
- The base of the basins shall be above the ground water table.

2.2 Design constraints

Stantec has coordinated with the input from other consultants, which includes:

- Stormwater drainage pipe outlets from the proposed road drainage network;
- Proposed wetlands and retention basins to be within the water bodies outline as shown in the Bradfield City Centre Master Plan;
- Extent of Moore Gully works are to be outside of the Existing Native Vegetation (ENV) zone;
- Proposed wetlands and retention basins are to be located within the outer 20m of the riparian corridors of the Thompsons Creek and Moore Gully;
- Similarly, for the tributary between Centre Loop West and the western edge of the proposed basin, the extent of the basins is to be in the outer 15m of the riparian corridor;
- Extent of works should not cross the existing lot boundaries along Thompsons Creek;
- Groundwater conditions.

Figure 2-1 shows areas described above and the proposed basin layout.

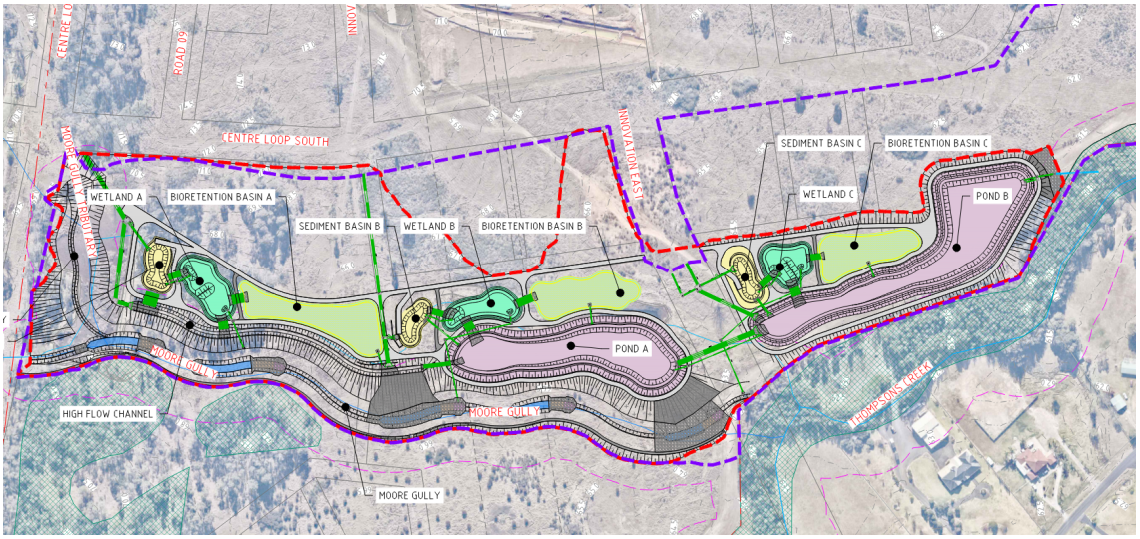

Figure 2-1 Basin layout and the site constraints

2.3 Design consultation

The design of the sediment ponds, wetlands, bio-retention basins, Moore Gully alignment and the tributary has been done in consultation with Sydney Water and Bradfield Development Authority throughout the design development phase. Design changes includes:

1. Incorporation of bio-retention basins into the stormwater treatment train: During the Masterplanning of the project, the stormwater treatment train consisted of sediment ponds, wetlands and retention ponds to treat the stormwater runoff from Bradfield. During the design development, Sydney Water requested the design be updated to adopt the approach used for Mamre Road Precinct. The updated design includes bio-retention basins in the treatment train to reduce the sediment ponds and wetland areas.
2. Open Space and natural basins: The basin footprint, Moore Gully and the maintenance access tracks have been designed in consultation with the landscape architects. The footprint of the basins has been refined to provide a more natural shape to improve aesthetics.
3. Fish Passage: The alignment of Moore Gully has been done in consultation with Ecological. The design includes natural elements such as a low flow channel, incorporating riffles and pools to create a natural waterway. The longitudinal grade of the watercourse has been designed to meet the fish passage requirements.
4. Trickle Flow: Wetland Water Level Control Pits have been designed in accordance with Sydney Water standard drawings to convey trick flows into Moore Gully.
5. Pond B Outlet:. Sydney Water preferred that the outlet be extended to the invert of Thompsons Creek, however, the pipe will need to be installed within the ENZ zone. This will be subject to a separate approval. In the interim case, a surcharge pit with scour pool has been designed to allow stormwater to spread along the site boundary before draining to Thompsons Creek.

A design register is shown in Appendix A, showing other design elements that have been incorporated in the drawings.

2.4 Existing conditions

The existing site where the basins will be located is relatively flat with approximately 1% fall. Other catchments within the Bradfield City Centre development site, have grades up to 7%. Some sections within the proposed basin areas showed signs of slow flowing water, with isolated ponding due to the irregular grading within the Moore Gully corridor.

The existing landform is mainly covered by grass and shrubs. Figure 2-2 shows the existing condition during Stantec site visit in May 2023.

There is an existing dam to the west of the proposed basin and there are some trees and shrubs on the western end of the site.

Figure 2-2 General site condition

Figure 2-3 shows the catchment areas that are draining to Moore Gully and the Bradfield Development site. Most of the Bradfield City Centre development area drains to Thompsons Creek, and there are two external catchments to the west of the site which drain to the tributary of Moore Gully.

Moore Gully has a total catchment area of approximately 85ha, which includes the area to the west of The Northern Road and Badgerys Creek Road. The land use covering the Moore Gully catchments is generally rural residential with approximately 7% grade.

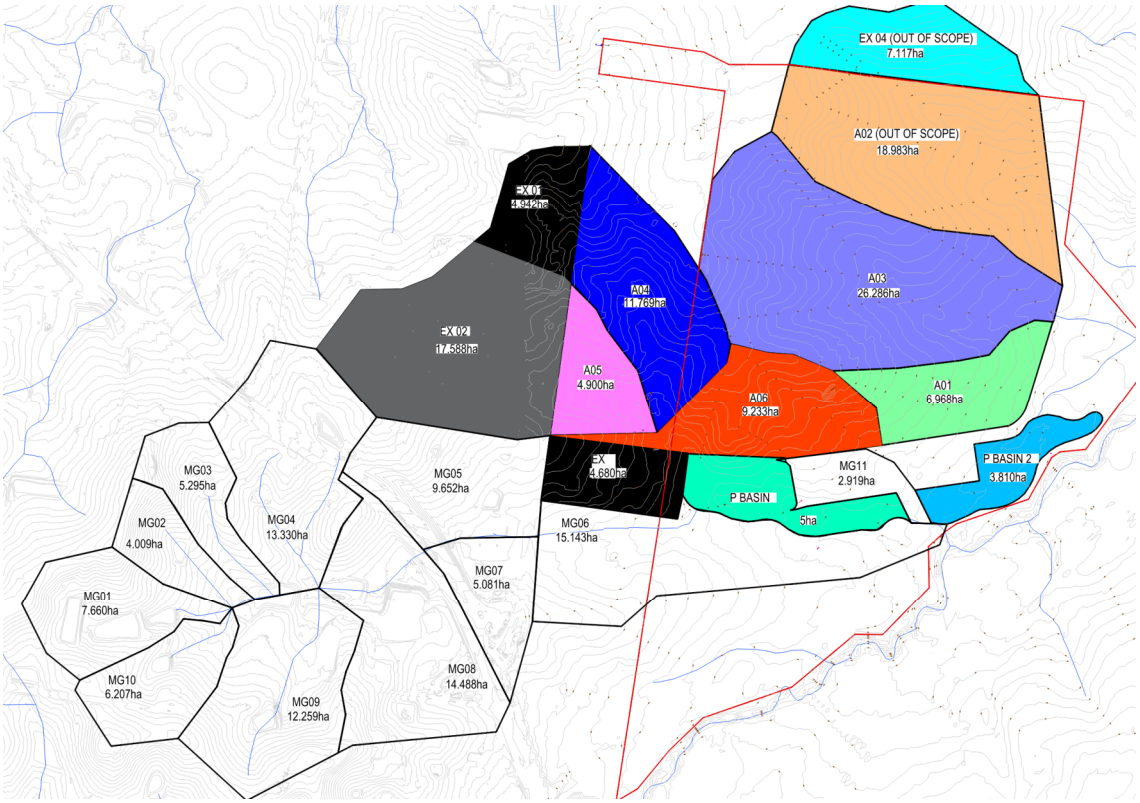

Figure 2-3 Pre-development catchment plan

2.5 Post development conditions

The post development catchments have been delineated based on the proposed grading and the stormwater drainage network in Bradfield City Centre. The post-developed catchment plan as shown in Figure 2-4 was developed based on discussions with SMEC and BDA, which was finalised on 19 July 2023.

The stormwater treatment train adopted the design outlined in the Standard Drawings prepared for Aerotropolis Regional Stormwater Infrastructure Design Guideline, which consists of sediment basins and wetlands. Gross Pollutant Traps will be sized to treat the road runoff from Bradfield City Centre as stated in Sydney Water's Bradfield Stormwater Modelling Memo, and it is assumed the future development will provide primary treatment before discharging to the Liverpool City Council's stormwater drainage system.

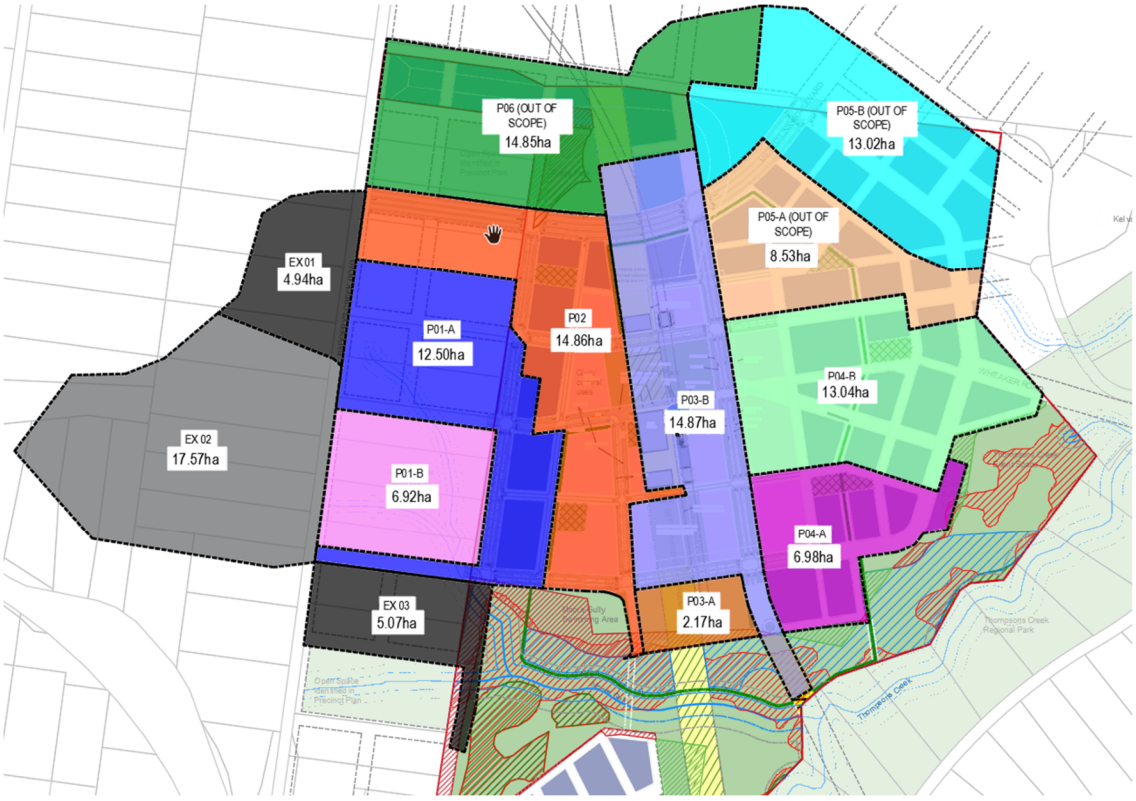

Figure 2-4 post-development catchment plan

A summary of the in-scope catchments are summarised in Table 2-1.

Table 2-1 Stormwater treatment train

Catchment type	Area	Catchment Description
P01-A	12.5ha	The catchment includes part of the future development area to the west of Bradfield City Centre. The stormwater runoff drains to Sediment Basin A,Wetland A and Bio-retention Basin A for treatment. The splitter pit and gross pollutant trap at the pipe outlet have been designed, refer to the engineering drawings produced by Stantec.
EX 01	4.94ha	The catchments consist of future developments that are located to the west of Badgerys Creek Road (Not part of Bradfield City Development). The stormwater runoff will be managed by stormwater infrastructure within catchment P01-B and discharge into Moore Gully tributary, bypassing the proposed sediment basins, wetlands, bio-retention basins and ponds.
EX 02	17.57ha	
P01-B	6.92ha	This catchment is where future drainage infrastructure to be designed by Sydney Water to treat stormwater from EX 01 and EX 02.
EX 03	5.07ha	The future development (not part of Bradfield City Development) in EX03 that will drain north towards the intersection of centre loop west and centre loop south and will ultimately drain to Sediment Basin A,Wetland A and Bio-retention Basin A. The splitter pit and gross pollutant trap at the pipe outlet have been designed, refer to the engineering drawings produced by Stantec.

Catchment type	Area	Catchment Description
P02	14.86ha	The catchment includes part of the future development area within Bradfield City Centre. The stormwater runoff drains to Sediment Basin B, Wetland B and Bio-retention Bfor treatment. The splitter pit and gross pollutant trap at the pipe outlet have been designed, refer to the engineering drawings produced by Stantec.
P03-B	14.87ha	The catchment includes part of the future development area within Bradfield City Centre. The stormwater runoff drains to Sediment Basin C,Wetland C and Bio-retention Basin C for treatment. The splitter pit and gross pollutant trap at the pipe outlet have been designed, refer to the engineering drawings produced by Stantec.
P03-A	2.17ha	The catchment includes part of the future development area within Bradfield City Centre. The stormwater runoff drains to Sediment Basin C, Wetland C and Bio-retention Basin Cfor treatment. The splitter pit and gross pollutant trap at the pipe outlet have been designed, refer to the engineering drawings produced by Stantec.
P04-B	13.04ha	The catchment includes part of the future development area within Bradfield City Centre. The stormwater runoff drains to Sediment Basin E and Wetland E for treatment. The splitter pit and gross pollutant trap at the pipe outlet to be sized in the next stage of the works.
P04-A	6.98ha	The catchment includes part of the future development area within Bradfield City Centre. The stormwater runoff drains to Sediment Basin D and Wetland D for treatment. The splitter pit and gross pollutant trap at the pipe outlet to be sized in the next stage of the works.

2.6 DRAINS modelling

For the pre-development catchments the assumptions are as per below:

- Pervious and impervious catchment areas were calculated based on aerial images from May 2023.
- The time of concentration for the external catchments were estimated using the kinematic wave equation with an adopted roughness value of 0.15 (natural bushland / lawn) considering travel time from the furthest point in the catchment.

For the post-development catchments, they have been divided based on the land use as development, road or park. Percentages of perviousness used are shown in the table below.

Table 2-2 Post-development catchment perviousness

Catchment type	% Perviousness	Source
Park	40% to 100%	Bradfield City Centre Master Plan by Hatch Roberts Day (August 2023)
Development	16%	SMEC's design, noted to achieve site overall perviousness of 40% as specified in Bradfield City Centre Master Plan by Hatch Roberts Day (August 2023).
Street	25%	SMEC's design, noted to achieve site overall perviousness of 40% as specified in Bradfield City Centre Master Plan by Hatch Roberts Day (August 2023).

There are two external catchment areas to the west of Badgerys Creek Road, we have assumed:

- The post development stormwater runoff from Ex01 and Ex02 will be treated and detained prior to draining to Badgerys Creek Road. Therefore, the model has included the pre-development flow into the basin;
- The percentage impervious was measured from Metromap aerials from May 2023.

It is assumed that P01-A, P02, P03-A, P03-B and Ex03 will drain to the regional stormwater detention train before being discharged into Moore Gully. P04-A and P04-B will drain to the proposed stormwater basins to the southeast of the site before being discharged into Thompsons Creek. It is assumed that stormwater infrastructure in P01-B will treat catchments P01-B, EX-01 and EX-02 before discharging to Moore Gully tributary. The Bradfield stormwater infrastructure will not be responsible for treating or controlling the stormwater from these catchments.

The pre-developed catchment plan was used to assess the permissible site discharge (PSD). The PSD is measured at the location where the flows from P01-A, P01-B, P02, P02, P03-A, P03-B, Ex01, Ex02 and Ex03 discharge into Thompsons Creek via Moore Gully. The PSD for P04-A and P04-B will be measured at Thompsons Creek just after the flows are discharged from the stormwater attenuation infrastructure.

Catchment P05-A and P05-B are in the northeastern section of the site, the stormwater runoff will be drained to future basins adjacent to Thompsons Creek. The stormwater treatment train will be designed as part of future stages. Similarly for Catchment P0-6, the stormwater runoff drains to the north and will be managed by the future stormwater treatment train to be designed as part of the future stages.

It should be noted that additional external catchments that drain to Moore Gully, such as the lots to the south do not form part of this scope of works. It is assumed that these external catchments will have their own stormwater management infrastructure to control run off prior to discharging to Moore Gully.

2.7 Hydrology models

Detailed catchment modelling was conducted to calculate flows generated by the site within the DRAINS software package. This software package uses the industry standard for hydrology calculation ILSAX. The following parameters were used in the model:

- Bureau of Meteorology IFD design rainfall depth 2016 data based on the geographical location of the site.
- Australian Rainfall and Runoff 2016 Data Hub temporal patterns based on the geographical location of the site.
- Depression storage:
    - 1 mm for paved areas;
    - 1 mm for supplementary areas; and
    - 5 mm for grassed areas.
- Antecedent moisture condition 3.

- The time of concentration for the undeveloped catchments are estimated using the kinematic wave equation with an adopted roughness value of 0.10 - 0.20 for short-grassed areas and 0.015 for paved areas. Stream flow velocities were measured based on the grading of the catchments and calibrated with the TUFLOW modelling result provided by BDA.

- The time of concentration for the catchment area developed within Bradfield City assumes 5 minutes travel time from the lots to nearest pits and calculates travel time from the furthest point in the catchment to the proposed basins.

- 5 mins to 3 hour storms modelled

2.8 Stormwater attenuation infrastructure design

The stormwater attenuation infrastructure is designed alongside the stormwater quality infrastructure as per Sydney Water's *Draft Aerotropolis Regional Stormwater Infrastructure Design Guidelines* received 14 June 2023 from Sydney Water.

Stormwater is directed through the Bradfield City Centre pit and pipe network where flows are separated into low and high flows via a splitter pit. Flows greater than the 5% AEP event are to flow into Thompsons Creek at the downstream end of Pond C and Pond B via pipe, this is done in order to achieve the designed flow rate to meet PSD requirements. Flows lower than and equal to the 4EY are directed into a sediment basin, then a wetland, then a pond whereas flows greater than the 4EY are directly discharged into the Ponds. As per Sydney Water feedback received 14 August 2023, the ponds will provide the bulk of the stormwater attenuation with levels above the pond extended detention depth being used for detention to store up to the 5% AEP.

The modelling results for the stormwater attenuation for flows leading to Moore Gully is shown in Table 2-3. The design of Pond C will be detailed in the next phase of works.

Table 2-3 Moore Gully DRAINS modelling results

Event	Pre-development Flow (m^3/s)	Post-development Flow (m^3/s)	Pond A (m^3)	Pond B (m^3)
0.5EY	4.21	4.05	8015.9	18017.9
0.2EY	8.62	7.46	12422.95	20672.6
10% AEP	11.6	10.3	13180.45	21354.11
5% AEP	15.4	14.6	13977.8	21841.2

2.9 Tailwater influence

Post development flood contours have been provided from Advisian and will be taken into consideration in the next stage of detailed design, The embankments of the Ponds will be raised higher than the 1% AEP flood level to prevent inundation of the ponds, wetlands, bio-retention basins and sediment basins.

2.10 Climate Change

The overflow weir and the embankment height have been designed to consider climate change with an increase in rainfall intensity by 20%. The 1% AEP + Climate Change (CC) flood levels in Pond A and Pond B are shown in Table 2-4.

Table 2-4 Spillway and Embankment Design

Ponds	1% AEP + CC Water Level	Spillway RL	Embankment RL
Pond A	65.35	65.25	65.40m Min.
Pond B	63.54	63.20	63.80m min.

3 Moore Gully design

Moore Gully is a Strahler 4th Order creek. It has a variable path each year and has no defined low flow channel in the riparian corridor. As part of the Bradfield City Centre stormwater infrastructure works, Moore Gully is to be realigned to enable a more defined channel, revegetate its riparian corridor, and enable improved flood management of the area.

The Moore Gully realignment has been generally designed in accordance with the following guidelines:

- Draft Aerotropolis Regional Stormwater Infrastructure Design Guidelines by Sydney Water (June 2023);
- Bradfield City Centre Master Plan by Hatch Roberts Day (August 2023); and
- Stormwater Scheme Infrastructure Design Guideline Draft (Western Sydney Version No. 2022-1.0) by Sydney Water (2022).

Stantec extent of works for the realignment of Moore Gully is approximately 600m in length and lies within the Bradfield City Centre extent of works until it adjoins Thompsons Creek as shown in **Figure 3-1**.

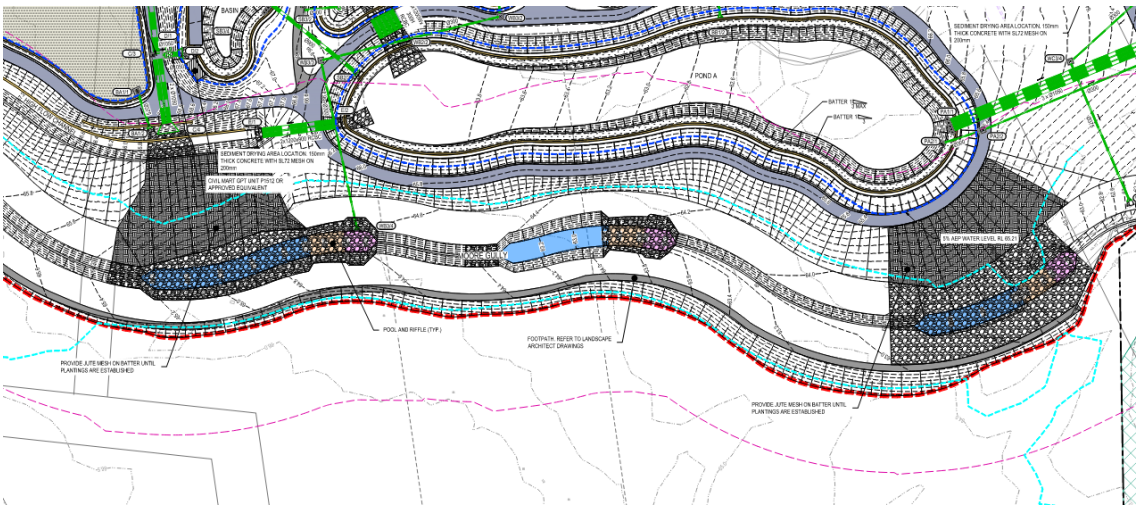

Figure 3-1 Moore Gully realignment – typical riffle and pool arrangements

The proposed watercourse has a general longitudinal grade of 1% with the low flow channel being sized to cater for 0.5 x 50% AEP storm event. Moore Gully is classified as a 4th order creek; thus its dedicated corridor will have a 40m offset from the top of the low flow channel on each side. The total dedicated width of the Moore Gully is 40m + width of low flow channel + 40m.

3.1.1 HYDRAULIC ASSESSMENT

Hydraulic modelling software, HEC-RAS, was used to analyse the flood levels and flow velocities along the designed riparian corridor alignment. The design of the watercourse is based on LIDAR survey undertaken by RPS and provided to Stantec by WPCA. Cross sections have been created at 20m intervals to represent the new alignment. These sections were imported to HEC-RAS from 12D design software. The Manning's n used in the analysis was 0.045 along the centreline of the channel and both sides of the bank to represent dense vegetation.

The upstream boundary condition for the analysis was assumed to be at normal depth, which was calculated based on the survey data. The downstream boundary condition was assumed to be based on the *Wianamatta South Creek Catchment Flood Study – Cumulative Impact Assessment*, prepared for Infrastructure NSW by Advisian (January 2023) and additional information received from Advisian via WPCA on 14 August 2023.

3.1.2 RIFFLE AND POOL DESIGN

Moore Gully and the tributary have been designed in accordance with Stormwater Scheme Infrastructure Design Guidelines for Western Sydney prepared by Sydney Water. The creek has been designed to meander through the riparian corridor. Riffle and Pools have been designed to have 3% maximum slope to meet fish passage requirements.

The dimensions of the pools have been designed based on the 300mm fall from top of riffle and the pool. The pools have been designed to be 6m wide x 0.6m deep.

3.1.3 HEC-RAS RESULTS

The flow characteristics and the flood depths are presented in Table 3-1.

Table 3-1 1% AEP flood levels and flow characteristics

Chainage	Top Water Level RL (m)	Velocity (m/s)	Depth (m)	Froude number	Description
640	69.04	0.65	0.26	0.44	Upstream end (at the Bradfield City extent of works).
620	69.01	0.47	0.76	0.17	
600	68.9	1.67	0.8	0.6	
580	68.67	1.99	0.79	0.74	Location of Sediment Basin A.
560	68.57	1.31	0.91	0.46	
540	68.38	1.99	0.94	0.69	
520	68.2	1.9	0.98	0.64	
500	67.92	2.34	0.94	0.81	
480	67.66	2.27	0.97	0.77	
460	67.38	2.35	0.94	0.81	
440	67.16	2.05	0.94	0.71	
420	66.95	2.02	0.95	0.69	
400	66.74	2.02	0.96	0.69	
380	66.55	1.95	0.99	0.65	
360	66.36	2.02	1.02	0.66	
340	66.15	2.11	1.02	0.69	
320	65.92	2.24	1.01	0.74	
300	65.7	2.14	1	0.71	
280	65.48	2.14	1	0.71	
260	65.27	2.14	1	0.72	

Chainage	Top Water Level RL (m)	Velocity (m/s)	Depth (m)	Froude number	Description
240	65.05	2.12	1	0.71	
220	64.84	2.14	1	0.71	
200	64.63	2.12	1.01	0.7	
180	64.43	2.08	1.02	0.68	
160	64.26	1.92	1.07	0.62	
140	64.15	1.67	1.17	0.51	
120	64.09	1.4	1.33	0.4	
100	64.05	1.17	1.5	0.31	
80	64.03	0.98	1.7	0.25	
60	64.01	0.89	1.89	0.21	
40	64	0.76	2.1	0.17	
20	64	0.6	2.31	0.13	Downstream end (adjoining Thompsons Creek).

The 1% AEP flow characteristics are generally under sub-critical condition and the Froude number is less than 0.8. In a 1% AEP storm event, the flow velocity through the channel is approximately 2.2m/s. The low flow channel should be protected by 250mm thick rip rap with 150mm sized rock to prevent erosion.

The flow velocities are shown in Figure 3-2. The blue, green and black lines represent the velocity at the 1% AEP event in the middle, to the right and to the left of the channel respectively.

As mentioned above, the velocities in the middle of the watercourse are generally around 2.2m/s. As a result, rock rip rap is proposed at the bottom of the channel to mitigate the risks of erosion while maintaining the natural aesthetic of Moore Gully.

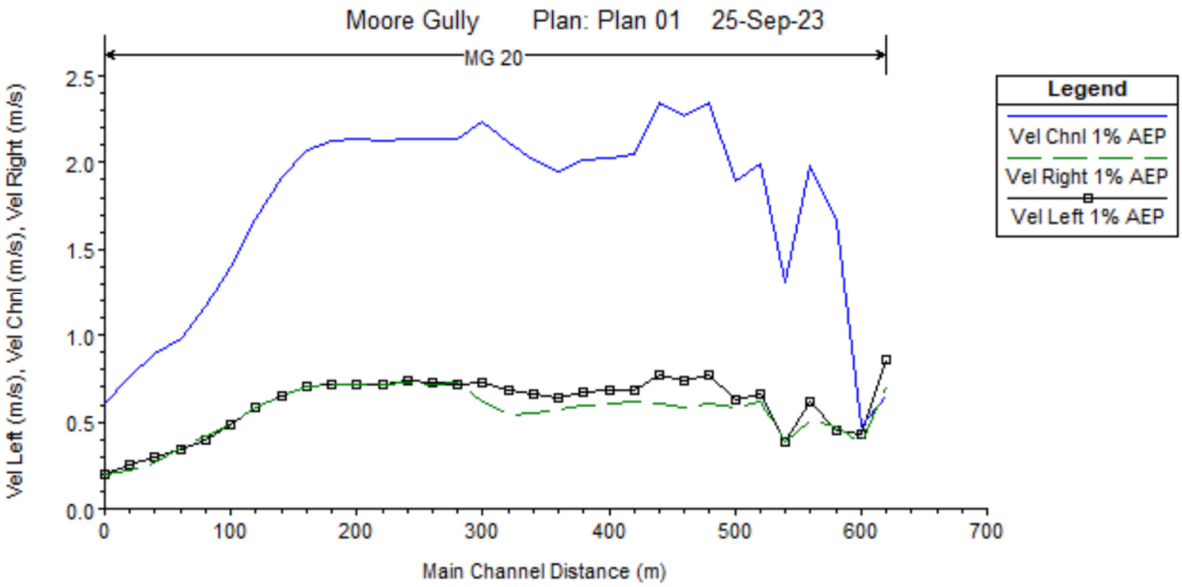

Figure 3-2 Flow velocities along Moore Gully

The flow velocity in the riparian corridor is around 0.6m/s, therefore, the corridor should be vegetated with native species to ensure adequate ground cover.

4 Stormwater quality

As the development of the subject site is expected to produce additional pollutants compared to existing conditions, stormwater quality treatment will be required to treat stormwater drainage prior to discharge off-site. The stormwater quality treatment strategy for the development will be done through a series of sediment basins, wetlands, bio-retention basins and ponds which will involve stormwater harvesting and reuse.

Stormwater quality management has been generally assessed and designed in accordance with the following guidelines as well as ongoing discussion with Sydney Water as the maintenance operators of the Sediment Basins, Wetlands, Bio-retention Basins and Ponds:

- Western Sydney Aerotropolis Development Control Plan 2022;
- Sydney Water Standard Drawings, Aerotropolis Stormwater Infrastructure Design Guideline; and
- Sydney Water Bradfield Stormwater Modelling Memo.

4.1 Water quality objectives

Stormwater quality pollutant load reduction requirements for all development during the operation phase are:

Table 4-1 PO1, Western Sydney Aerotropolis Development Control Plan, 2022

Parameter	Stormwater Quality Target (%)
Gross Pollutants	90
Total Suspended Solids (TSS)	90
Total Phosphorus (TP)	80
Total Nitrogen (TN)	65

In addition to stormwater quality pollutant load reduction, stormwater flow targets are also considered as part of the stormwater quality management. The requirements for flow targets during the operational phase are:

Table 4-2 PO2, Western Sydney Aerotropolis Development Control Plan, 2022

Parameter	Stormwater Flow Target
Mean Annual Runoff Volume	≤2ML/ha/year
90%ile Flow	1000 – 5000 L/ha/day
50%ile Flow	5 – 100 L/ha/day
10%ile Flow	0 L/ha/day

4.2 Water quality strategy

The stormwater quality management treatment train for the trunk drainage of the site has been designed in consultation with Sydney Water. The treatment measures include:

- On-Lot GPT's;
    - The high flow bypass for the GPT's has been calculated as 0.017m^3/s/ha of upstream catchment as per the Bradfield Stormwater Modelling Memo prepared by Sydney Water, received 10 July 2023.
- Passively Irrigated Street Trees;
    - Spaced at 8m centres with 4.5m^2 of infiltration area per tree as per the Bradfield Stormwater Modelling Memo prepared by Sydney Water, received 10 July 2023.
- End of Line GPT's;
    - Civil Mart CDS units have been selected as the End of Line GPT's for the project. CDS GPT units are provided after the splitter pit to treat gross pollutants prior to discharge into the sediment basins. All 3 units are model P1512.
- Sediment basins;
    - Designed based on directives from Sydney Water to meet water quality requirements.
    - A 2.4m wide safety bench is provided around the sediment basins, starting at the outskirts of the NWL and extending 2.4m towards the centre of the sediment basin.
    - Sediment basins have an EDD of 350mm.
- Wetlands;
    - Designed based on directives from Sydney Water to meet water quality requirements. Where the wetland length (direction in which stormwater travels) is short, baffles have been introduced to increase retention time and treat stormwater effectively.
    - A 2.4m wide safety bench is provided around the sediment basins, starting at the outskirts of the NWL and extending 2.4m towards the centre of the wetland.
    - Wetlands have an EDD of 350mm.
- Bio-retention Basins;
    - Designed based on directives from Sydney Water to meet water quality requirements. Bio-retention basins share the same EDD level with its corresponding wetland.
    - Bio-retention basins have an EDD of 300mm.

- Ponds
    - A 2.4m wide safety bench is provided around the sediment basins, starting at the outskirts of the NWL and extending 2.4m towards the centre of the pond basin.
    - Ponds have an EDD of 50mm.

4.3 MUSIC Modelling

Water quality treatment effectiveness has been modelled using the MUSIC software package (v6.3.0).The MUSIC model was developed in collaboration with Sydney Water's engaged consultant, Aurecon. Stantec had initially produced the MUSIC model with the local stormwater infrastructure of Bradfield City Centre, this model was then sent to Sydney Water for review. During this process it was agreed that a site-wide regional study is preferred to be conducted, thus Sydney Water had appended Stantec's model to the regional MUSIC model which included catchments and treatment trains external to Stantec's design scope. Sydney Water had also amended the treatment train strategy of Stantec's design in order to optimise the size of the sediment basins, wetlands and bio-retention basins.

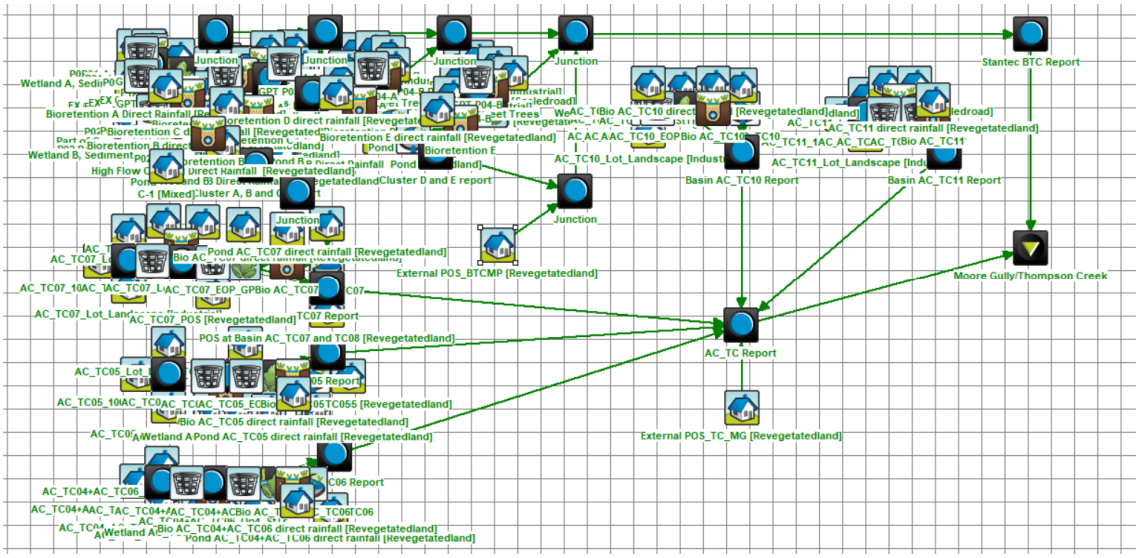

Figure 4-1 Music node diagram

4.4 Results

Based on the water quality strategy outlined in section 4.2, the tables below summarise the results in both stormwater quality and stormwater flow reduction targets. Results were measured at the "Stantec BTC Report" node.

Table 4-3 Stormwater quality reduction target results

Parameter	Stormwater Quality Target (%)	Proposed Reduction (%)	Target Met (Y/N)
Gross Pollutants	90	97.2	Y
Total Suspended Solids (TSS)	90	90.8	Y
Total Phosphorus (TP)	80	83.5	Y
Total Nitrogen (TN)	65	71.8	Y

The MUSIC model has a total catchment area of approximately of 108.8 Ha (including direct rainfall onto ponds and wetlands). For a 108.8 Ha model, the flow reductions targets are provided in table below.

Table 4-4 Stormwater flow reduction target results

Parameter	Stormwater Flow Target	Bradfield City Centre Model	Proposed Stormwater Flow	Target Met (Y/N)
Mean Annual Runoff Volume	≤2ML/ha/year	217.6 ML/year	197 ML/year	Y
90%ile Flow	1000 – 5000 L/ha/day	108830L – 544150 L/day	110592 L/day	Y
50%ile Flow	5 – 100 L/ha/day	544.15L – 10883L/day	8000.64 L/day	Y
10%ile Flow	0 L/ha/day	0 L/day	6.7 L/day	N

The area required of the sediment basins and wetlands are summarised in the table below.

Table 4-5 Sediment basin, Wetland, Bio-retention basin and Ponds basin footprint areas

Sediment Basin/Wetland/Bio-retention Basin/Ponds	Area (m^2)
Sediment Basin A	798.44
Sediment Basin B	607.93
Sediment Basin C	667.05
Wetland A	1,177.75
Wetland B	990.27
Wetland C	876.63

Bio-retention Basin A	2464
Bio-retention Basin B	1972.2
Bio-retention Basin C	1891
Pond A	5615.03
Pond B	7217

Area measurement taken at NWL (Natural Water Level) for sediment basins, wetlands and Ponds. Area measurement taken at bio-filter base level for bio-retention basins

The 100% design MUSIC modelling results have demonstrated general compliance with the required water quality targets for both pollutant and flow reduction. It should be noted however that the 10%ile flow reduction target is not being met, although the flow of 6.7L/day can be considered negligible.

4.5 Maintenance

The stormwater infrastructure (Ponds, Bio-retention Basins, Wetlands and Sediment Basins) will require ongoing maintenance to ensure that they are performing optimally. Maintenance access tracks have been provided to ensure that they can be serviced. The maintenance tracks have been documented in the engineering drawings by Stantec in consultation with Taylor Brammer Landscape Architects and Sydney Water. In addition to the maintenance access tracks, pedestrian access paths have also been provided. The general maintenance infrastructure includes:

- 3.5m wide vehicle access roads;
- 2.5m wide pedestrian paths; and
- Low flow drainage infrastructure which allows drainage of trickle flow as well as maintenance.

Refer design drawings by Stantec 1301-1304.

To extend the life of the Wetlands and Bio-retention basins, flow velocities have been reviewed to ensure that the flow velocities in between the Wetlands and Bio-retention basins do not cause erosion of the embankments and/or damage to the vegetation. The flow velocities have been limited to 0.5m/s in the 4EY (3-month treatable flow) storm event.

In addition to the maintenance infrastructure, sediment loading areas have also been provided at each of the sediment basins. Each of the sediment loading areas have been sized using MUSIC to obtain the sediment load (GP and TSS) entering the sediment basin and has assumed a yearly maintenance frequency. Assuming a silt density of 2200kg/m^3 the minimum volume required at the loading areas for a yearly cleanout are shown in Table 4-6.

Table 4-6 Annual Sediment Clean out

Sediment Pond	Sediment Volume (m^3/year)	Drying Area
Sediment Basin A	5.0	6m x 3m
Sediment Basin B	5.2	6m x 3m
Sediment Basin C	5.2	10m x 1.5m

5 Conclusion

The proposed stormwater treatment train for Bradfield City have been designed to incorporate comments from Sydney Water and other stakeholders.

The DRAINS modelling results have shown the proposed ponds have adequate storage capacity to attenuate the stormwater runoff from the proposed Bradfield development.

The MUSIC modelling results have also shown the proposed stormwater treatment train meets the stormwater quality and quantity targets.

5.1 Further Works

Flood Impact Assessment

Stantec is undertaking flood impact assessment to incorporate the proposed basins and Moore Gully design into the hydraulic model (TUFLOW). The results will be provided in a future update of this report.

Further Approval

The extension of the outlet pipe in Pond B will require separate approval before construction work can begin.

APPENDIX A SYDNEY WATER/STANTEC DESIGN REGISTER

Comment Date	Sydney Water Comments	Stantec Responses	Comment Made By	Completed?
12/07/2023	Wetland needs outlet pit to creek. 50mm of EDD above wetland to discharge directly to creek or to OSD basin outlet. Wetland should have a spillway to south rather than putting the spillway in the biofiltration. Preference for spillway to be via an overflow pit with crest cut at EDD level	Not for hydraulic modelling, however required for operational and maintenance purposes. Modelling in 3D, not part of hydraulic design.	PG (Aurecon)	☑
12/07/2023	Spillway level 50mm above NWL. Spillway to be 300mm high box culvert underneath access track	Provided.	PG (Aurecon)	☑
12/07/2023	Spillway level 50mm above NWL. Spillway to be 300mm high box culvert underneath access track. Size culvert to ensure 0.5m/s velocity through narrowest section of biofiltration zone	Flow within the culverts are in the order of 0.6 - 0.7m/s in the 4EY. Flow velocity is anticipated to slow down after leaving the culvert and spread out, not intended to revise at this stage.	PG (Aurecon)	☑
12/07/2023	Need vehicle access to one side. Show other side as 4m track if this side is a pedestrian path. Please make a concrete edge	Overwritten by current standard drawing. Concrete edge detail has been overwritten by discussion between SW, TBLA and is to be reinforced turf. Material for pavement will not be part of Stantec's scope of IFC 1 work.	PG (Aurecon)	☑
12/07/2023	Use 300x300 sandstone blocks at edge of access road to form batter to NWL/filter level. Access track + sandstone block edge will be 4.1m wide	Previously 500x500 was provided, now 300x300 is provided to limit block height to be less than 0.9m to avoid structural detailing/design. Access track of 3.5m + 1 block on each side = 4.1m. This has now been overwritten by the provided standard drawings at 27/02/24. Now is access track (3.5m wide) + a batter at 1:3 MAX (varies in width) until the 1m wide transition batter (1 in 8) until the sandstone blocks.	PG (Aurecon)	☑
12/07/2023	Please add wetland spillway to south rather than putting the spillway in the biofiltration. Preference for overflow pit with crest cut at EDD level	Previously had only one outlet at the wetland (bio did not exist during the earlier phase of design). Now there is an outlet from the wetland and from the bio-retention (bio has no formed part of the design)	PG (Aurecon)	☑
12/07/2023	Provide 150mm freeboard to vehicle access above EDD	Provided, stage storage data for sediment basins, wetlands and ponds are up to the top of bank, where the access track level is. Access track level is minimum same as top of bank or higher.	PG (Aurecon)	☑
12/07/2023	Pond internal batter schedule: a. Above EDD - 1(V):4(H) b. Below EDD - sandstone log with vertical edge c. NWL to 300mm below NWL - 1(V):8(H) d. 300mm below NWL to base - 1(V):3(H)	B C D are still generally targetted. Criteria for A is a bit difficult to achieve so this has been overwritten from the draft IFC mark up to be 1(V):3(H) MAX. This is between the access track and sandstone block.	PG (Aurecon)	☑
12/07/2023	See notes on attached sketch. Wetland and bio have the same/shared ED level. EDDepth over wetland is 350mm. EDDepth over bio is 300mm	Noted.	PG (Aurecon)	☑
21/02/2024	Wetland to have low flow discharge directly to creek, which is to bypass pond	Not for hydraulic modelling, however required for operational and maintenance purposes. Modelling in 3D, not part of hydraulic design.	PG (Aurecon)	☑
21/02/2024	Lower sed basin so that EDD matches wetland EDD. This should reduce 5% AEP flood depths in wetland and bio	Completed. Does not apply to sediment basin B due to groundwater levels as discussed with SW.	PG (Aurecon)	☑
21/02/2024	Pls adjust pond EDD as per advice 22/11/23. Pond EDD to be 0.05m	Noted. Pond A, EDD 64.35, NWL 64.3 Pond B, EDD 61.75, NWL 61.7	PG (Aurecon)	☑
27/02/2024	Email from PG had various standard drawings that are to be used to guide design. Requirements extracted from the drawings below.	Noted.	PG (Aurecon)	☑

27/02/2024	AERO-RSI-SB-SK05 Sediment basin to wetland connection, the invert level of the culvert is to be 50mm above the NWL. EDD in wetland and sediment basin is 350mm	Noted. Wetland A: NWL - 68.15m culvert IL - 68.2, EDD 68.5 from 68.15 - 350mm. Wetland B: NWL - 66,. Culvert IL - 66.05, EDD 66.35 from 66 - 350mm. Wetland B cannot share same EDD due to varying groundwater levels. Wetland C: NWL - 63.15, culvert IL - 63.2, EDD 63.5 from 63.15 - 350mm.	PG (Aurecon)	☑
27/02/2024	AERO-RSI-BIO-SK01 Wetland to Bioretention Connection, culvert IL to be 50mm above Wetland NWL and to be flush with base of Bioretention. Pit in Bioretention basin to be set at 300mm above the base of the bioretention basin.	Noted. Wetland A: NWL - 68.15, culvert IL - 68.2, Bio A Base RL - 68.2. Bio pit SL - 68.5. Wetland B: NWL - 65.45, culvert IL - 65., Bio B Base RL - 65.5. Bio pit SL - 65.8. Wetland C: NWL - 63.15, culvert IL - 63.2, Bio C Base RL - 63.2. Bio pit SL - 63.5.	PG (Aurecon)	☑
27/02/2024	AERO-RSI-PON-SK01, NWL for ponds to be 50mm above the toe of the RW. Toe refers to the bottom of the finish surface level and not the keyed in depth.	Noted. Pond A: Toe of wall - 64.25, NWL, 64.3 Pond B: Toe of wall - 61.65, NWL, 61.7	PG (Aurecon)	☑
27/02/2024	AERO-RSI-WET-SK01, NWL for wetlands to be 100mm above the toe of the RW. Toe refers to the bottom of the finish surface level and not the keyed in depth. This was also adopted for the sediment basin, as per SW's request.	Noted. Wetland A: Toe of wall - 68.05, Wetland A NWL = 68.15. Wetland B: Toe of wall - 65.35, Wetland B NWL = 65.45 Wetland C: Toe of wall - 63.05, Wetland C NWL = 63.15	PG (Aurecon)	☑
21/03/2024	Pedestrian path only needed between sediment basin and wetland	Noted.	PG (Aurecon)	☑
21/03/2024	Move wetland inlet (shown blue) to create longer flow path through macrophytes. This will make the CSTR type consistent with modelling.	Completed outlet was orginally in the middle and has now been moved to the bottom.	PG (Aurecon)	☑
21/03/2024	Add earthworks 'baffle' (shown orange) with crest tied into side and set just above EDD level to create longer flow path through macrophytes	Completed, crest of baffle set at EDD level.	PG (Aurecon)	☑
21/03/2024	Move wetland outlet (shown yellow) to create longer flow path through macrophytes	Completed for A and C, flow path for B is sufficent due to its long and skinny shape. A and C were short in length.	PG (Aurecon)	☑
21/03/2024	Open water to account for 20% of sediment basin and wetland should share/have same NWL	Need to confirm on the 20% criteria. NWL for wetland and sediment basin are generally consistent except for B due to groundwater levels. Required volumes for open water are: A: 20% x 243 = 48.6m3 B: 20% x 193 = 38.6m3 C: 20% x 187 = 37.4m3 Values obtained from PGs required volume for sediment basins (V12 MUSIC Spreadsheet) As of 06/08/2024 volumes for wetland open water zone (for the inlet only) and measured up to the toe of the safety bench, shows that is it in compliance. A: 51.6m3 B: 68.84m3 C: 60.05m3	PG (Aurecon)	☑

10/05/2024	Comments provided from Stantec for SW review		PG (Aurecon)	☑
	•Maintenance access ramps will be provided at all sediment basins;	SW agreed to these comments via email response	PG (Aurecon)	☑
	•Sediment Basin A: oThe NWL will be lowered to be 1.7m deep	SW agreed to these comments via email response	PG (Aurecon)	☑
	•Sediment Basin B: oThe depth of the sediment basin to NWL will be 1.5m deep	SW agreed to these comments via email response	PG (Aurecon)	☑
	•Sediment Basin C: oThe NWL in Basin C is 1.45m above the basin base RL.	SW agreed to these comments via email response	PG (Aurecon)	☑