Our Ref: SP476931
Your Ref: P/2021/6170
23 August 2021

[redacted]

Dear [redacted]

PLANNING PERMIT APPLICATION: P/2021/6170
ADDRESS: 621 Burwood Highway, KNOXFIELD
PROPOSAL: Utility installation, removal of native vegetation and associated buildings and works

Thank you for your email on 25 June 2021 referring the above application to the Department of Environment, Land, Water and Planning (DELWP) pursuant to section 52 of the Planning and Environment Act 1987 (the Act). I apologize for the delay in this response.
The application proposes to remove native vegetation to establish a storm water treatment series of ponds and wetland areas. The total area of native vegetation proposed to be removed is 2.174 hectares within location category 2 triggering the detailed assessment pathway of the Guidelines for the removal, destruction or lopping of native vegetation (DELWP 2017) (Guidelines).
After reviewing the Ecological Assessment: Stage 1 - 7 Development Area 609-619 & 621 Burwood Highway, Knoxfield (March 2021). DELWP notes a scenario test-native vegetation removal report has been attached which does not meet the planning permit application requirements under Clause 52.17 of Knox Planning Scheme and the Guidelines.

Before DELWP can further consider the above application, the following additional information is required to support the application:

1. Information about the native vegetation to be removed for this permit application, the Native Vegetation Removal Report is to provide the wetland construction offset requirements to correspond with the appropriate planning application, as well as the total vegetation removal and offset requirements for the full extent of the project. A Scenario Testing Report is not able to be accepted with a planning application. The report is to provide the below:

Ecocentric response:
An NVR report for native vegetation losses (both direct and TPZ impacts) for the project is provided. Please note however that the detail engineering plans for Stages 1 and 2 of the proposed development are yet to be finalised, and that we expect minor variations in actual losses and impacts. In the interim we propose that we continue to use EnSym analyses until a Planning Permit is issued and a detailed engineering plan can be finalised (also in order to reduce unnecessary requests for NVR reports from DELWP).

We have also requested that the Planning Permit make provision, as a secondary consent trigger, for an Offset Management Strategy (OMS). The OMS will provide details of the final native vegetation losses, requisite Offset targets, 3rd-party Credit sources (see also response to Q11 below), Allocation of Offset Credits during staged development works, and will facilitate opportunities to further avoid impacts on the ground (through micro-alignment of services and provision for TPZ impact minimisation) during the construction phase.

We note that, based on the current proposed development plans, the total native vegetation losses equates to 2.7353 hectares being removed (including 1.6810ha (52.1%) within the dam, 1.0543ha (32.7%) as patches and scattered trees, plus 0.4925 ha (15.3%) north of the dam which is assumed lost due to TPZ impacts associated with altered soil hydrology). If permitted, these losses would trigger a Detailed Referral Pathway with no Species Habitat Unit Offsets required. This Offset will be purchased as Unallocated Credits *prior* to

commencement of works, and allocated, via the OMS, for each of the development stages as detailed engineering plans are finalised and endorsed by Council.

As noted above, an NVR report is supplied for the project based on the current development proposal, and further responses are also provided for the items in question below.

a) The assessment pathway and reason for the assessment pathway. This includes the location category of the native vegetation to be removed.
- Detailed, Location 2

b) A description of the native vegetation to be removed that includes:

i) whether it is a patch or a scattered tree (or both) - both

ii) the extent (in hectares) – 3.228ha (including 1.6810ha (52.1%) within the dam (unavoidable loss), 1.0543ha (32.7%) as patches and scattered trees (unavoidable TPZ losses plus some scattered patches within the development area), plus 0.4925 ha (15.3%) north of the dam which is assumed lost due to TPZ impacts associated with removal of the dam (these areas will be retained but are Offset as a precaution against altered soil hydrology).

iii) the number and circumference (in centimetres measured at 1.3 metres above ground level) of any large trees within a patch – large trees are measured as 70cm or greater (as based on the Valley Heathy Forest EVC 127 – endangered, and Swampy Woodland EVC 937 - endangered); further details of tree losses are provided in Section 3.1 of the Biodiversity Assessments.

iv) the number and circumference (in centimetres measured at 1.3 metres above ground level) of any scattered trees, and whether each tree is small or large – large trees are measured as 70cm or greater (as based on the Valley Heathy Forest EVC 127 – endangered, and Swampy Woodland EVC 937 - endangered) ; further details of tree losses are provided in Section 3.1 of the Biodiversity Assessments.

v) the strategic biodiversity value score – SBV values ranged from 0.123 – 0.270; see also attached NVR report.

vi) the condition score – VQA values as follows: dam (Aquatic Herbfield EVC 653 - endangered; VQA 0.67), planted trees at property boundaries (Valley Heathy Forest EVC 127 within southern sector of the property; VQA 0.14 in patches and 0.20 as scattered trees), planted trees and understorey north of the dam which are retained, but Offset as a precaution (Swampy Woodland EVC 937; VQA 0.14 on boundaries to 0.55 north of the dam).

vii) if it includes endangered Ecological Vegetation Classes – all three EVCs are endangered

viii) if it includes sensitive wetland or coastal areas. – the dam is included in the wetland_current layer (with a modelled conditions score of only 0.446 but was assessed on site as Aquatic Herbfield EVC 653 with a VQA of 0.670).

c) Maps showing the native vegetation and property in context and containing:

i) scale, north point and property boundaries – see NVR report and mapping in Biodiversity Assessment.

ii) location of any patches of native vegetation and the number of large trees within the patch proposed to be removed – see NVR report and mapping in Biodiversity Assessment.

iii) location of scattered trees proposed to be removed, including their size – see NVR report and mapping in Biodiversity Assessment.

d) The offset requirement, determined in accordance with section 5 of the Guidelines, that will apply if the native vegetation is approved to be removed. – The total Offset (based on current development proposal) = 1.388 General Habitat Units (no Species Habitat Units required); see also NVR report attached.

2. The Arborist report that is referred to in the Ecological Assessment (Ecocentric, March 2021). Report to detail reason for removal of vegetation, i.e. if it is part of the residential development site, or part of the wetland construction. Also include if the vegetation is deemed lost for offsetting purposes due to encroachment into TPZ but will be protected and retained on site.

Ecocentric response:

A tree census spreadsheet has been generated from the arborist report. The census identifies which trees are native, and of these, which are identified as canopy trees in the Valley Heathy Forest and Swampy Woodland EVCs. Any of these that are lost (and which will be physically removed), or considered lost due to TPZ impacts (but which will be retained on site) are identified for Offsetting. In addition, there are several native canopy trees north of the dam that are offset as a precaution against changes to soil hydrology associated with decommissioning of the dam, but which will be retained on site and incorporated in the wetland habitat precinct (see also Q7 response).

3. Provide advice on the timing of works associated with the removal of the current wetland. Currently the Ecological Assessment has provided advice that the timing of the removal/infill of the dam will be 12 months after the planting of the constructed stormwater treatment wetlands. Timing of removal of the existing waterbody should be determined based on the establishment and functionality of the newly constructed storm water treatment wetlands.

Ecocentric response:
Outlined below is the proposed timeline for the construction of the open water wetland habitat area and the sediment pond and WSUD reed-beds. Please note that this timeline is indicative only, and that the construction program(s) will be dependent on weather conditions and geologies encountered on site. Please also note that this timeline may have to be adjusted to accommodate BBD breeding activity if observed on site.

Open water wetland
March 2022 - finalise detailed design of the open water wetlands (including revegetation templates and schedules)
May 2022 - order open water wetland plants
March 2023 - start construction of open water wetland
June 2023 - finish construction of open water wetland
July 2023 - survey and make level corrections of open water wetland
August 2023 - 150mm top soil and geotextile, start filling of open water wetland from dam

- fill from existing dam ensuring dam levels do not drop significantly
- enable waters to settle and temperatures to regulate

September 2023 - November 2023 - revegetation of open water wetland

- revegetation of batters in stages including lowering of water levels to 200-300mm depth for each strata
- netting of vegetation and infill planting

Terrestrial revegetation
March 2023 - finalise detailed design of terrestrial revegetation / supplementary planting program (including revegetation templates and schedules)
April 2023 - order plants
April 2024 - site preparation and weed control
June 2024 - revegetation / supplementary planting works

Sediment pond and WSUD treatment system
April 2024 - finalise detailed design of the Sediment pond and WSUD treatment system (including revegetation templates and schedules)
June 2024 - order plants for Sediment pond and WSUD treatment system
November 2024 - BBD surveys for breeding in dam and open water wetland
March 2025 - Decommissioning of dam, including flora and fauna salvage
April 2025 - Sediment pond and WSUD treatment construction
June 2025 - finish construction of Sediment pond and WSUD treatment system
July 2025 - survey and make level corrections of Sediment pond and WSUD treatment system
August 2025 - 150mm top soil and geotextile, start filling of Sediment pond and WSUD treatment system from subdivision
September 2025 / November 2025 - revegetation of Sediment pond and WSUD treatment system

November 2027 - handover to Council

Metrics on the success of the new wetlands must be incorporated into the CEMP and detail what these are; i.e. plant establishment and recruitment, fauna activity and breeding and water quality from a habitat point of view (comparable to the existing wetland habitat), prior to the removal of the existing waterbody. Concerns with constructed wetlands are that the nutrient level/microb density that are important for the success of a wetland systems are often diminished compared to long established water systems.

Ecocentric response:
The timing and implementation of the open water wetland construction and establishment, followed by the decommissioning of the dam and construction of the sediment pond and WSUD reed-bed will be managed through a Construction Environmental Management Plan (CEMP) once a Permit for the development plan is issued and prior to commencement of works. We have also requested that the Planning Permit make provision, as a secondary consent trigger, for a CEMP to be developed by DV and the appointed contractors for endorsement by the Responsible Authority.

It is expected that the CEMP will include metrics for monitoring the wetland establishment success and functionality, such as (but not limited to) revegetation rates and planting success, as well as water quality parameters such as EC, turbidity, pH and temperature. The monitoring parameters will be generally in line with Melbourne Water guidelines for WSUD assets. The wetland asset will eventually be handed over to Council, the details of which, such as maintenance period and responsibilities, will be developed once a Planning Permit is issued.

4. Providing time after the establishment of the flora in the new system, will allow mobile fauna to relocate themselves if habitat is appropriate.

Ecocentric response:
The open water wetland area will be constructed once Permitted and as soon as practicable in order to maximise time available for stabilisation of the system, aquatic margin establishment and provision of habitat. It is expected that BBD and other waterbirds will utilise the open water wetland area once the basic habitat provisions are met. It is not possible to predict with certainty how long this establishment phase will be, however, we have specified a minimum period of 12 months in the Biodiversity Assessment report.

It is also our experience that wetlands and associated habitat can be rapidly established, as evidenced at Gum Scrub Creek, Officer, where Stripped Marsh Frog (*Limnodynastes peronii*) and Common Froglet (*Crinia signifera*) were recorded in high numbers (greater than 50 adults) within 18 months of completion of construction of wetlands.

5. Detail the maintenance schedule of the storm water treatment wetland pond system, the various maintenance activities for each pond system, what the system will be maintained for; i.e stormwater treatment, wildlife habitat etc. This is to include if siltation removal be required, what impact maintenance activities will have on flora and fauna under each system. What access and utilities will need to be constructed for this to occur.

Engeny response:
- sediment pond clean out
- open water wetland cleanout
- water flow control structured to facilitate maintenance

6. Provide a comparison of habitat that the existing water body provides vs the proposed new wetland system. Include slope embankment and depth of water. The newly constructed wetland systems need to incorporate comparable habitat structure, preferred habitat of the Blue Billed Duck (as demonstrated by breeding success on site), is recreated in the manmade wetland system.

Ecocentric response:

The Biodiversity Assessment notes that the existing dam, with steep embankments that support little to no aquatic margin, provides suboptimal habitat for BBD nesting requirements. Aquatic margin macrophytes are currently limited to a narrow band of Cumbungi (*Typha* spp.) in the southwest corner of the dam.

Despite these limitations however a single BBD duckling was recorded late in the 2020 breeding season (10th March 2021); it is our understanding that this duckling fledged successfully (last observed 24th March). A further clutch of 4 ducklings was observed on 18th January 2022 (reported by the local community on 16th January 2022 as 5 ducklings); of which 3 have survived to adult plumage and were observed on 24th February 2022; two are presumed lost, monitoring of the three juveniles is on-going. Another duckling to a different female was observed on 24th January 2022, this duckling was last observed on 29th January 2022 and is presumed lost.

The limited success of BBD breeding on site further emphasises the requirement for more suitable nesting habitat provisions. The current extent of Cumbungi (*Typha* spp.) (up to 5m width – 120m2) is dominated by Purple Swamphen (*Porphyrio porphyrio*), also coots and moorhens, with little to no opportunity for BBD nesting. The proposed staged development program will redress this by providing up to 5,000m2 of reed habitat in the WSUD treatment pond, plus 1,500m2 in the sediment pond, plus the vegetated margin around the open water wetland (approximately 1,875m2; being 375m around the edge of the open water wetland x 5m wide band of sedges); a total of over 8,000m2 of nesting habitat.

It is not possible to predict with any certainty whether the reduction of total 'open-water' foraging habitat at the site will have an appreciable or significant impact on BBD. We note however, that the provision of a more diverse suite of habitat which meets not only the foraging requirements of this species but also its breeding habitat requirements will benefit BBD, as well as Hardhead and other reed-nesting species. The total area of the sediment pond, WSUD reed-bed (also suitable for BBD nesting requirements) and the open water wetland area equates to 1.7 hectares, being equivalent to the current dam on site. In addition, the staged development program as proposed will ensure that we can retain the northern dam embankment and the remnant, regenerating and planted Swampy Woodland habitat therein, thereby avoiding native vegetation losses while conserving the most significant terrestrial habitat values on site.

7. The concerns raised regarding the retention of the current dam, focuses on the inability of the dam to function as a storm water treatment area, and its safety concerns around public access. Please detail why this dam could not be retained for habitat purposes only, and then a separate water treatment area and wetland area be established to provide storm water treatment. Options for public safety of fencing this area are to be explored. This forms part of the minimisation statement, as highlighted within the Ecological Assessment there are important flora values that are both State and locally significant and attempts should be made to retain this vegetation. This vegetation if possible, to be retained, should be enhanced and verge vegetation incorporated into the landscape plan.

Collie response
The dam cannot be retained because the land is set aside under the incorporated comprehensive development plan (CDP) under the Knox Planning Scheme, for other land uses including part residential. This was determined as a result of amendment C160 to the Scheme.

Ecocentric response:
Given that the dam cannot be retained in its current state, and as noted above, the staged development program will enable us to retain the Swampy Woodland habitat at the northern extent of the property. This area will also be improved through supplementary planting of Swampy Woodland appropriate flora (from local provenance seed sources). Much of the vegetation around the dam, as well as the Eel Grass (*Vallisneria australis*) within the dam will be relocated to the open water wetland area, or, tubestock will be propagated from plants present on site for later re-introduction to the wetland habitat precinct area.

8. Provide detail around the timing of works, timing of works to be incorporated into the Construction Environmental Management Plan (CEMP). Timing of works need to avoid impact on waterfowl utilising the site for breeding. It is recommended that a draft CEMP is provided to DELWP for comment and advice as soon as possible, to limit time delays if a planning permit is

issued.

Ecocentric response:
An outline of the proposed staged development of the wetlands is provided above in Q3. In addition, Section 5.1.2 *BBD and Hardhead monitoring* of the Biodiversity Assessment notes that the following is to be incorporated in the CEMP (see also details of the CEMP in Q3):

Monitoring measure 1
The Site Manager and/or appointed Environmental Officer is to conduct regular monthly (at minimum) monitoring of Blue-billed Duck activity on the dam for the duration of the Stage 1 – 7 construction program (except at any time that observation is occurring under monitoring measure 2 as detailed below). If the project ecologist confirms that Blue-billed Duck pairing activity is evident, monitoring measure 3 will apply (see below). If the project ecologist confirms that Blue-billed Ducks or any other fauna are displaying signs of disturbance / distress that might be attributable to construction activity, then major construction works within a 50m buffer of the dam are to be halted whilst appropriate mitigation measures are developed by the project ecologist in consultation with Development Victoria.
Monitoring measure 2
In addition to monitoring measure 1 above the project ecologist is to conduct fortnightly (at minimum) monitoring for Blue-billed Duck pairing behavior commencing no later than the beginning of October annually. Fortnightly monitoring is to continue until it can be confirmed that pairing and/or incubation and/or nesting behavior has ceased, and/or until any Blue-billed Ducklings are fledged (no longer under the care of a female) and/or absent from the site.
Monitoring measure 3
If Blue-billed Duck pairing behavior is observed, all major construction works within a 50m buffer of the dam are to be ceased for a minimum period of 6 weeks in order to accommodate an incubation period of 24-26 days (see Section 2.3.3 for details). Light work activity - works not involving the use of heavy machinery such as revegetation of the open water wetland and Swampy Woodland habitat areas, water filling and maintenance of erosion control geotextiles within wetland habitat areas, slashing/mowing of open space areas, and minor utility works of this nature - are permitted unless such works are observed to be affecting Blue-billed Duck behavior on the dam.

9. Detail on effects the effects of the change in hydrology of the site to the health of the nearby waterway and waterway/embankment flora. The sites drainage will be significantly altered with the considerable reduction in permeable surface, with storm water collection centralised. Please provide advice on the impact that this change in water collection and quality will have on the nearby creek and flora.

Engeny response:
- water quality and release rates/patterns will be improved.

10. A Wildlife management plan that specifically provides protocols that will be put in place to protect fauna, must include specific mitigations and protections for the Blue Billed duck. This may form part of a permit application under the Wildlife Act 1975.

Ecocentric response:
The relocation or removal of any native wildlife from the wetlands development area will be conducted by a qualified, licenced and experienced contractor with Permits as required to conduct these works as part of the CEMP. This includes the salvage and relocation of any wildlife from tree hollows that may be encountered during construction, and the relocation of wildlife from the dam before, during and after it is drained.

Alternatively, it may be necessary for Council make provision in the Planning Permit, as a secondary consent trigger, for a Flora and Fauna Environmental Management Plan (FFEMP), which could be a component of the CEMP for the project. The FFEMP would likely include mitigation measures as outlined in Section 5 of the Biodiversity Assessment including (but not limited to):

- monitoring for BBD pairing activity and modification of works as outlined in section 5.1.2 of the Biodiversity Assessment;
- aquatic fauna transfer to open water wetland habitat area;

- seed collection and transfer (where practicable to do so) of significant indigenous flora identified on site as being impacted by the proposed development;
- salvage and transfer of indigenous fauna from the dam to the open water wetland habitat area;
- identification of tree hollows and the salvage and transfer (if appropriate) of arboreal fauna to alternate habitat areas.

Detail on how fauna will be protected on site from pedestrian and domestic animal interaction, include off limit areas, fenced areas, boardwalks etc. Also, detail what lighting will be introduced in these areas, if any.

Ecocentric response:
Pedestrian access will be limited to the constructed walkways and proposed bird-hide as detailed in the Landscape Plans.

MDG response
- pathways, railings, 'prickly' plants, etc.

11. An offset statement providing evidence that an offset that meets the offset requirements for the native vegetation to be removed has been identified and can be secured in accordance with the Guidelines. A suitable statement includes evidence that the required offset:

a) is available to purchase from a third party, or

b) will be established as a new offset and has the agreement of the proposed offset provider, or

c) can be met by a first party offset.

Ecocentric response:
The current Offset target, 1.388 GHUs (no SHUs) with a minimum SBV of 0.212, is readily available from 3rd party Offset Sites listed on the DELWP Offset Credit Register. Section 6.3.3 of the Biodiversity Assessment further notes that a suitable Offset Site, listed on the DELWP Native Vegetation Credit Register (TFN-C1763_3), has been identified, and the Offset target has been reserved from that site for this project. The Offset Credits will therefore be purchased and secured with an Allocated Credit Extract prior to the commencement of native vegetation clearance works.

Flora and Fauna Guarantee Act 1988 (FFG Act) requirements

The Flora and Fauna Guarantee Act 1988 (FFG Act) has recently undergone legislative changes and there are now requirements for public authorities to demonstrate Public Authority duty (Biodiversity duty of care), this is a statutory requirement and is applicable to this proposal. This requirement does not remove the need for a permit under the FFG Act to destroy or take FFG listed species if a planning permit is issued.
In accordance with these requirements, any proposal that has the potential to impact on any protected flora species or species listed under FFG Act within the works/ project area must consider:

- long and short term impacts
- detrimental and beneficial impacts
- direct and indirect impacts
- cumulative impacts
- potentially threatening processes

These considerations should be based on a current ecological assessment of the site.
Given that there are potential impacts to protected species listed under FFG Act, as part of the planning permit application the proponent (as a public authority) should provide a report to DELWP (as a regulatory authority under the P&E Act and FFG Act) that outlines:

1. How the proposed works including any "take" of the protected/ listed species may impact the ability for the species to persist in the wild (locally or state-wide) or is consistent with the management actions identified in any relevant Action Statement, management or recovery

plan.

2. How the proposed works, including the "take" of the protected flora, will impact the quality or structural composition of the vegetation community, affect the habitat values for listed flora or fauna or be contrary to the management actions identified in any relevant Action Statement, management or recovery plan.

3. Whether any activity associated with the proposed works will have an impact on a potentially Threatening Process (positive or negative). And, if the activity will cause or increase the impact of a potentially threatening process, how the impact will be mitigated.

4. The effect the works, including the "take" of Protected/ Listed Flora or associated activities, will have on any other environment values (positive or negative) that should be considered as part of the development of project/ works plans and associated construction activities.

Ecocentric response:
There are no flora listed under the FFG Act that are proposed for removal, and it is considered highly unlikely that any listed flora exist within the proposed development area attributable to the highly disturbed nature of native vegetation areas on site (see also Section 3.2 of the Biodiversity Assessment).

DV is also not proposing to take any fauna listed under the FFG Act, given that BBD would readily walk or fly to the open water wetland area proposed to be developed under a staged process. Nonetheless, we acknowledge that there may be some residual impacts on BBD as a result of the proposed development, and DV are therefore prepared to seek a Permit under the FFG Act if it is deemed necessary. We refer also to our query to DELWP on this issue, and the response as follows.

[redacted] of DELWP has advised by email (21 July 2021): "In regard to the need for an FFG permit, this is a little unclear as it will depend on the extent of impact on habitat for BBD. I would hold off on applying for such a permit until we can provide you with clearer advice on these potential impacts. My opinion is that the development of a management plan agreement that ensures the long-term protection and enhancement of BBD habitat on the site will negate the need for an FFG permit. Note that should an FFG permit be necessary it is likely that we would be requiring such a management plan be developed anyway".

Wildlife Act 1975 (Wildlife Act) requirements
A permit under the Wildlife Act will be required to disturb wildlife or cause wildlife to be disturbed, this permit is issued by DELWP. A Wildlife management plan is required as part of the permit application under the Wildlife Act, it is to be approved by DELWP.

Ecocentric response:
As above, we propose that a qualified, licenced and experienced contractor with Permits under the Wildlife Act be engaged to conduct native fauna salvage and relocation works from any tree hollows or canopy habitat within areas being cleared as part of the CEMP to be implemented on site. Aaron Jenkin of Aquatica Environmental has also been engaged by DV to oversee the decommissioning of the dam and the relocation of native aquatic fauna to the open water wetland area or Blind Creek as appropriate to the species and staged works development program. These works will also be implemented as part of the CEMP, or, if required, under the FFEMP as outlined in Q10 above.

More information about meeting the information requirements to support an application to remove, destroy or lop native vegetation is available on the DELWP website at:
http://environment.vic.gov.au/native-vegetation
If you have any queries regarding this matter, please contact me on telephone [redacted] or email to [redacted]@delwp.vic.gov.au.

Yours Sincerely,
[redacted])

[redacted]

[redacted]

From: [redacted]
Sent: Friday, 25 February 2022 12:30 PM
To: [redacted]
Cc: [redacted]
Subject: FW: Response to RFI2_2021/6170 - 621 Burwood Highway KF - Utility Installation Application
Attachments: DELWP Letter to KCC (Wetland Permit) dated 23 August 2021 (PG response v2.0).pdf; 000318 _RPT_DV_Knox Dwarf Galaxias Survey_15022022.pdf; Engeny Response MW Letter to KCC (Wetland Permit) dated 9 June 2021.pdf; Knoxfield Development Stormwater Management Rev 13.pdf

All,

Please see responses below to RFI2 (Greg Kent email dated 8 October 2021 at 1613) from Knox City Council (KCC), incorporating requests to KCC from Melbourne Water and DELWP.

These responses have been documented to enable efficient review with bold and green highlighted wording from Council in its RFI2 followed by responses from Development Victoria (including those from its relevant specialists) but not highlighted.

Regards,

[redacted]

Ps. Please note my new email and the change of office address following our move in January 2022. It would be appreciated if you could update your records accordingly.

[redacted]

From: [redacted]
Sent: Friday, 8 October 2021 16:13
To: [redacted]
Subject: Further information Review 2021/6170 - 621 Burwood Highway KF - Wetlands application

Attention: Collie

Please note the points raised in the correspondence relate to items raised in Council's further information request dated 14 July 2021 that remain outstanding or are unsatisfactory. It is advised that this correspondence is not an assessment of the issues also raised in the further information letter and their absence in this correspondence does not indicate that they have been resolved. Rather they will be considered at the time of further assessment.

Further the application and information provided to date is under assessment by Council's consulting Ecologist and that further information may be required once the assessment has concluded.

The response to further information submitted by Collie on 24 August 2021 which require further action are highlighted in green below.

Sensitive biodiversity exists on the site and must be retained, protected, and enhanced. Ultimately, it is important that the existing biodiversity be retained, and that the biodiversity overlay controls need to ensure the preservation and enhancement of the biodiversity values of the site.
Council is concerned about the lack of detail in addressing the Blue Billed Duck and other flora and fauna, and how the design, construction and transition of the wetland will consider the presence of the local bioidversity, including the recent nesting and breeding of this the Blue Billed duck on this site.
It is important to note the proposed wetland site is covered by an Environmental Significance Overlay 2 and the environmental objectives must be considered.
In relation to Biodiversity Council the following further information is required:
1. A further ecological report or statement, prepared by a suitably qualified person, to include the following specific assessment and considerations:
a) Clarification of approvals required under the Flora and Fauna Guarantee Act 1988, along with copies of all relevant consultation with Authorities;
Development Victoria understands that the northern portion of its site is covered by both the ESO2 and the LSIO. It must be noted however, that ESO2 and LSIO were amended as part of Knox Planning Scheme amendment C160 to match the boundary of the "WDRP" (Waterway / drainage / Retardation / Public Open Space) as identified in the incorporated Burwood Highway and Scoresby Road Knoxfield Comprehensive Development Plan (CDP).

The CDP requires the existing dam to be removed and replaced as part residential development and use and part WDRP development and use. The existing dam is not in accordance with the CDP and is not to be retained. This decision has been made and tested as part of the amendment C160 considerations including a public hearing.

On the basis of the above, it is not relevant to deal with the existing dam and its biodiversity but it is relevant to test and ensure that the new WDRP area is designed and developed to recognise / enhance the biodiversity values of the area.

Development Victoria is confused about the role of Melbourne Water Corporation (MWC) in the utility installation application. It is not a referral authority under clause 66.02 of the Scheme in terms of the proposed development and use. The proposed utility installation will not be a MWC asset. It is not a referral authority in terms of native vegetation removal. Furthermore, there is nothing in the ESO / ESO2, which specifies a role in this case (a proposed Knox City Council asset) for MWC.

Development Victoria does acknowledge that under the LSIO, applications must be referred to the floodplain management authority under section 55 of the Act and that this will involve MWC. The 'decision guidelines' in clause 44.04-8 require the responsible authority to consider any "comments from the relevant floodplain management authority", which we assume should relate to floodplain management and not the ecological aspects of a previous farm dam or a proposed utility installation, other than in respect of any impact on floodplain management.

[redacted] of DELWP has advised by email (21 July 2021): "In regard to the need for an FFG permit, this is a little unclear as it will depend on the extent of impact on habitat for BBD. I would hold off on applying for such a permit until we can provide you with clearer advice on these potential impacts. My opinion is that the development of a management plan agreement that ensures the long-term protection and enhancement of BBD habitat on the site will negate the need for an FFG permit. Note that should an FFG permit be necessary it is likely that we would be requiring such a management plan be developed anyway".

Response: DELWP formal further information request dated 23 August 2021 was forwarded to Collie on 23 August 2021. To date DELWP or Council have not received any correspondence from the applicant on this request.
It is important to point out from the outset that "formal further information requests" are those received by the applicant from the responsible authority and it is up to the responsible authority to incorporate any referral authority requests into its "formal RFI".

In this case, Development Victoria was under the impression that this had been done and was responded to accordingly. Nevertheless, Development Victoria, in this response to RFI2, has endeavoured to include

responses to comments received separately from the formal RFI, where responses have not been provided to those comments. In this regard, refer to attachment (DELWP Letter to KCC (Wetland Permit) dated 23 August 2021 (PG response v2.0).pdf), which is the DELWP letter annotated (in red) with Development Victoria responses.

b) Depth comparison of the 'dam' and proposed 'wetland' waterbodies given the Blue Billed Ducks tendency to dive/forage in deep water; and assessment of suitability of any differing replacement habitat depth if proposed;
The existing dam is largely approximately 2 metres deep although its southwest corner is up to 4 metres deep. There is capacity to include areas within the 'open water wetland' habitat with water depths of up to 4 metres however, the depth of the habitat wetland is proposed to vary generally from 1.5 to 2 metres.

Blue Billed Ducks (BBD) have been observed by Ecocentric 'duck-diving' for feeding purposes across the whole of the dam wherever Eel Grass (*Vallisneria australis*) is present, and do not show any notable preference for deeper water areas in the southwest corner of the dam. The average dive time for adult males and females is 26 to 27 seconds and it is noted that this dive period is fairly consistent across the whole of the dam, suggesting that the depth of water plays little or no part in the feeding habitat requirements of the BBD.

It is not possible to observe the actual depth of dives without significantly disturbing the BBD on site however, there is no reason to suggest that depths of greater than 2 metres are required by this species.

There are water quality risks associated with depth. A depth greater than 2 metres is not recommended in the design of shallow lake systems as it increases the risk of stratification of the water and resulting poor water quality outcomes. The design intention is to provide a more varied habitat than the existing dam, which will mean not having a flat base on the habitat wetland as is currently the case in the existing dam.

Response Knox Biodiversity Team: Please provide source of this information and data provided. Unable to comment further without additional information. The information should also be referred to Melbourne Water for a response.
The depths in the existing farm dam are as surveyed by Engeny and provided in its report that accompanied the planning permit application.

Ecocentric has conducted regular observations and surveys and has observed on site duck-diving at all locations within the dam. As previously stated, they show no particular preference for any single location for feeding or pairing behaviour. Ecocentric recorded average dive times in an effort to ascertain site use and feeding habits. Blue-billed Duck (BBD) dive times were consistently recorded at 26-27 seconds. Given that feeding occurs on site at average depths of up to 2 metres, with some diving observed at up to 4 metres in the southwest corner of the dam, Ecocentric recommends that the open water wetland incorporate a variable depth of up to 2 metres in order to facilitate BBD feeding requirements whilst also protecting against adverse water quality risks associated with deep water stratification and reduced water turn-over / higher water residency levels. This is a precautionary approach which will facilitate the BBD feeding and behavioural requirements (BBD also duck-dive if startled), whilst ensuring that water quality can be maintained. Ecocentric notes also that shallow batters as proposed will facilitate establishment of vegetated aquatic margins and the maintenance of submergent flora including Eel Grass (*Vallisneria australis*).

Ecocentric notes that its ecologists have spent, to date, over 50 hours (25 surveys by one or more ecologists) observing BBD and other waterbirds and / or fauna taxa (threatened and common species) as part of this 2021 assessment; surveys are continuing on a fortnightly interval during the BBD breeding season (additional surveys conducted for the 2017 assessment are also available).

Ecocentric is in the process of putting a *survey summary report* together in order to provide Council details of BBD breeding activity and characteristics (numbers on site and any observed pairing, nesting and fledging activity), as well as observations on other fauna activity recorded on site.

As noted above, Development Victoria does not understand why these responses to RFI2 are to be referred to MWC but that is a matter for the responsible authority.

Details of proposed continuity of habitat for the Blue Billed Duck within any new proposed habitat 'wetland' including, but not limited to:
Clarification of definitive timelines for construction of any new 'wetland'.

Outlined below is the proposed timeline for the construction of the open water wetland habitat area and the sediment pond and WSUD reed-beds. Please note that this timeline is indicative only, and that the construction program(s) will be dependent on weather conditions and geologies encountered on site. Please also note that this timeline may have to be adjusted to accommodate BBD breeding activity if observed on site.

Stage 1: Establishment of the open water wetland habitat area
Earthworks for open water wetland habitat area including:
- excavation works (approximately 12 months);
- stabilisation of batters and embankments using biodegradable geotextiles (approximately 4 months).

Water inundation and filling of the open water wetland:
- fill from existing dam ensuring dam levels do not drop significantly (approximately 4 months);
- enable waters to settle and temperatures to regulate (minimum 2 months).

Revegetation works (ideally to commence in early spring):
- revegetation of batters in stages including lowering of water levels to 200-300mm depth for each strata (approximately 5 months);
- netting of vegetation and infill planting (over a 12 months period).

Stage 2: Establishment of the sediment pond and WSUD reed-bed.
Earthworks for sediment pond and WSUD reed-bed area including:
- excavation works (approximately 12 months);
- stabilisation of batters and embankments using biodegradable geotextiles (approximately 4 months).

Water inundation including:
- fill from open water wetland ensuring open water wetland levels do not drop below required levels (approximately 4 months);
- enable waters to settle and sediments to drop (minimum 2 months).

Revegetation including:
- revegetation of batters in stages (lowering of water levels to 200-300mm) for each strata (approximately 5 months);
- netting of vegetation and infill planting (over a 12 months period).

It is noted that the Ecological Assessment submitted with this application recommends: to 'minimize disturbance on site during the pairing, mating and nesting period and, if Blue-billed Duck ducklings are observed, during the raising and fledging period also…. Monitoring for Blue-billed Duck pairing and breeding behaviour should therefore be sufficient to cover the period beginning October until late March annually'. This contradicts the Stormwater Management Strategy which commits that 'From an engineering perspective it would be easier if the earth moving stages of the construction could be timed to occur in summer or autumn when ground conditions will be easier to work with than in winter or early spring.'
The Biodiversity Assessment (Section 5.1.2) identifies a BBD (and Hardhead) monitoring program that triggers restrictions if required, on the type of works that can be conducted on site if BBD are observed to be paring, mating, nesting or raising young.

In the event that BBD pairing behaviour is observed, then works within 50 metres of the dam are to be restricted to light work activity - works not involving the use of heavy machinery such as revegetation of the open water wetland and Swampy Woodland habitat areas, water filling and maintenance of erosion control geotextiles within wetland habitat areas, slashing / mowing of open space areas, and light works of this nature - unless such works are observed to be affecting Blue-billed Duck behaviour on the dam.

There is no contradiction in the two reports therefore, as it clearly would be "easier" if earth moving could be done in summer or autumn however, the biodiversity assessment provisions will apply around light work only at certain times.

Further details and clarification of the proposed habitat 'wetland' establishment.
See response above.

A Management Plan to protect the Blue Billed duck and other local fauna.

It is recommended that Council include a condition in the planning permit requiring the development of a flora and fauna environmental management plan (FFEMP), which must be included as part of a required construction environmental management plan (CEMP) for the project. The FFEMP would likely include mitigation measures as outlined in Section 5 of the Biodiversity Assessment including (but not limited to):

- monitoring for BBD pairing activity and modification of works as outlined in section 5.1.2 of the biodiversity assessment;
- aquatic fauna transfer to open water wetland habitat area;
- seed collection and transfer (where practicable to do so) of significant indigenous flora identified on site as being impacted by the proposed development;
- salvage and transfer of indigenous fauna from the dam to the open water wetland habitat area;
- identification of tree hollows and the salvage and transfer (if appropriate) of arboreal fauna to alternate habitat areas.

The CEMP would include also matters such as:

- identification of canopy trees to be retained on site and establishment of Tree Protection Zone (TPZ) fencing;
- maintenance of 'conservation area' zones and management of works and access;
- habitat revegetation programs, weed and sediment control;
- stormwater management.

A CEMP is outlined in Section 5.3 of the Biodiversity Assessment.

The submitted Ecological Assessment recommends that any new habitat 'wetland' must be "*constructed and planted at least 12 months prior to any clearance of the current dam'*. Whilst the draft Stormwater Management Strategy suggests '*It is expected that the construction and establishment period for the habitat wetland will take approximately 12 months*".

Accessibility to, and for, the habitat 'wetland' and any proposed restrictions on access to it.
As indicated on the landscape masterplan but to be expanded in the detailed landscape plans to be provided in accordance with a planning permit condition.

Details of any and all proposed fencing and other treatments like planting and vegetation to restrict and manage access to the proposed habitat 'wetland'.
As above but the intention (other than in terms of temporary fencing to enable safe vegetation establishment) is to minimise permanent fencing with appropriate design and vegetation planting.

d) Confirmation that any habitat 'wetland' is offline from the stormwater treatment 'wetland' to allow for identical depths and function to the existing 'dam';
The habitat wetland is online to the stormwater treatment wetland but flows are treated by the stormwater treatment wetland before entering the habitat wetland. A control structure with capacity to halt water flow will be included in the design in order to accommodate maintenance of the waterbodies. The habitat wetland needs to be online to this system in order to receive sufficient inflows to maintain water levels and keep residence times as low as possible.

It is noted however, that the wetland system is offline from Blind Creek.

The design intention is not to maintain depths and function identical to the existing dam as the existing depths and function are not optimal to support a wide range of wetland habitat. The habitat wetland will have similar depths but will for example, remove areas that would currently be at risk of stratification due to the depth (localised in the southwest corner of the existing dam).

The three waterbodies will be vegetated with indigenous species where appropriate, in order to integrate aquatic habitats with woodland habitat areas.

e) The effect the proposed changes to the extent conditions of the existing dam, including the reduction in total surface area of open water in the new 'wetland' (from around 15,000 sqm to approximately 11,000 sqm), may have on the Blue Billed Duck immediately and in the future.
It is not possible to predict with any certainty whether the reduction of total 'open-water' foraging habitat at the site will have an appreciable or significant impact on BBD. Ecocentric notes however, that the provision of a more diverse suite of habitat which meets not only the foraging requirements of this species

but also its breeding habitat requirements will benefit BBD, as well as Hardhead and other reed-nesting species.

2. Detailed design plans (including detailed cross sections) of the proposed sediment basin, treatment wetland and habitat 'wetlands'.
Detailed engineering plans will be provided and submitted for approval in accordance with an appropriately worded planning permit condition.

Ecocentric, Engeny and MDG Landscape Architects, have completed significant work on the planning for the wetlands system and the biodiversity proposals. This work is reflected in the reports and plans provided with the planning permit application. These reports and plans are entirely consistent with the comprehensive development plan incorporated in the Scheme.

It is too early to complete detailed design work when a planning permit is yet to be issued - a permit with appropriate conditions will ensure such detail is provided.

3. Detailed design plans and sections for existing and proposed finished conditions, for all works associated with the removal of the on-site dam, and remediation/re-instatement/re-establishment of the site.
Refer response above.

4. Council also notes that limited fauna assessment has been due of the aquatic system within the 'existing dam'. Therefore an EDNA test of species such as dwarf galaxias and eels must be undertaken to understand the full impact of the removal of the system.
Aquatica Environmental Pty Ltd (Aquatica) was engaged and has conducted an eDNA assessment of the presence of Eastern Dwarf Galaxias (*Galaxiella pusilla*). Aquatica has also conducted a dip-net and light-trap assessment within the dam to identify the presence of aquatic fauna. The findings from the surveys are:

- Dwarf Galaxias were not recorded;
- the habitat is marginal at best and Aquatica advises that it has never recorded Dwaf Galaxia in a similar dam (or any dam);
- Short-finned Eel (c. 20), Goldfish (1 juvenile) and freshwater shrimp, were recorded;
- aquatic invertebrate numbers (shrimp, damselfly larvae and such) were in very low abundance;
- no other small-bodied native fish were recorded, which Aquatica advised would have been found if present, based on the sampling methods used.

Aquatica noted that any indigenous aquatic fauna identified within the dam would be transferred to the open water wetland habitat area where practicable to do so.

Further to the points above, attached (00318_RPT_DV_Knox Dwarf Galaxias Survey_15022022.pdf) is the third and final survey report on the existing dam and Dwarf Galaxias.

Melbourne Water
Melbourne Water response to the above further information submitted:
The response to Melbourne Water's formal RFI from the applicant is insufficient.
Pursuant to Section 56(2) of the Planning and Environment Act 1987, Melbourne Water's request for further information for these two applications remain valid in their entirety. I take this opportunity to respond to some of the points raised by the applicant in their 'response' to Council (24 August 2021):

- **Reference to 'as advice sought from DELWP' is an unacceptable response to the RFI**
- **The ecological reports referenced in the response to where the depth comparison for the Blue Billed Duck was obtained must be provided to Melbourne Water**

As noted above, MWC is not a referral authority for the utility installation / native vegetation removal but is / will be for the floodplain management (particularly from 1 January 2022).

Development Victoria has seen little comment from MWC on floodplain management.

Furthermore, under section 56 of the Act, a referral authority responds to the responsible authority which considers those responses and adds them into its formal RFI, as it decides. The referral authority does not issue a 'formal RFI' to the applicant. Furthermore and again as queried above, Development Victoria seeks clarification on why MWC is providing comments on ecology matters, considering its non-existent or limited referral authority role?

In this case, Development Victoria was under the impression that this had been done and was responded to accordingly. Nevertheless, Development Victoria, in this response to RFI2, has endeavoured to include responses to comments received separately from the formal RFI, where responses have not been provided to those comments. In this regard, attached (Engeny Response MW Letter to KCC (Wetland permit) dated 9 June 2021.pdf), which is the MWC letter annotated (in red) with Development Victoria responses.

Nevertheless and as noted above, Ecocentric has conducted regular observations and surveys and has observed on site duck-diving at all locations within the dam. As previously stated, they show no particular preference for any single location for feeding or pairing behaviour. Ecocentric recorded average dive times in an effort to ascertain site use and feeding habits. Blue-billed Duck (BBD) dive times were consistently recorded at 26-27 seconds. Given that feeding occurs on site at average depths of up to 2 metres, with some diving observed at up to 4 metres in the southwest corner of the dam, Ecocentric recommends that the open water wetland incorporate a variable depth of up to 2 metres in order to facilitate BBD feeding requirements whilst also protecting against adverse water quality risks associated with deep water stratification and reduced water turn-over / higher water residency levels. This is a precautionary approach which will facilitate the BBD feeding and behavioural requirements (BBD also duck-dive if startled), whilst ensuring that water quality can be maintained. Ecocentric notes also that shallow batters as proposed will facilitate establishment of vegetated aquatic margins and the maintenance of submergent flora including Eel Grass (*Vallisneria australis*).

Ecocentric notes that its ecologists have spent, to date, over 50 hours (25 surveys by one or more ecologists) at the existing dam observing BBD and other waterbirds and / or fauna taxa (threatened and common species) as part of this 2021 assessment; surveys are continuing on a fortnightly interval during the BBD breeding season (additional surveys conducted for the 2017 assessment are also available).

Ecocentric is in the process of putting a *survey summary report* together in order to provide Council details of BBD breeding activity and characteristics (numbers on site and any observed pairing, nesting and fledging activity), as well as observations on other fauna activity recorded on site.

As noted above, Development Victoria does not understand why these responses to RFI2 are to be referred to MWC but that is a matter for the responsible authority.

Given that feeding occurs on site at average depths of up to 2 metres, with some diving observed in dam areas with a depth at up to 4 metres, Ecocentric recommends that the proposed open water wetland incorporate a variable depth of up to 2 metres, in order to facilitate BBD feeding requirements whilst also protecting against adverse water quality risks associated with deep water stratification / reduced water turn-over / higher water residency levels. This is a precautionary approach which will facilitate the BBD feeding and behavioural requirements (BBD dive if startled), whilst ensuring that water quality can be maintained.

- Further information/details on why the habitat wetland cannot be offline to the stormwater treatment wetlands (specifically – ecological reporting to substantiate)
- The full Aquatica survey report referenced in this latest response should be provided to Melbourne Water.

Engeny and Ecocentric advise that the habitat wetland is offline from the flows in Blind Creek. This meets the typical definition of and requirements for wetlands to be offline as specified in the Melbourne Water Wetland Design Manual.

The habitat wetland needs a regular source of incoming flows to ensure that water levels are maintained in summer and that turnover time is kept as low as possible. This means that the habitat wetland needs to receive flows from the stormwater wetland, making it online to the local catchment. Without inflows from the local catchment, the habitat wetland will have no source of water. The habitat wetland is also quite large relative to the catchment from which it is receiving flows and so will benefit from reduced turnover if all of the flows from the local catchment flow through it.

The utility installation design will include the ability for flows to bypass the habitat wetland when maintenance is being completed however, under normal operating conditions the habitat wetland will benefit the most by maintaining regular inflows each time there is rainfall in the catchment on which it is located. This also best matches the current hydrological setup of the existing dam as the existing dam is online to the local catchment, including the developed areas to the east of the school. The water entering the dam under existing arrangements, receives no treatment.

Landscape

The type of Park furniture and equipment and play space should be specified in the Landscape Masterplan and Concepts Wetlands Plan along with any proposed BBQ areas.

The matters listed will be addressed as is normal practise in response to an appropriate permit condition requiring a detailed landscape plan.

Response: This can be addressed at the permit stage as part of any permit issued.

All existing trees being removed or retained must be shown on the Landscape Masterplan for the Wetlands.

Separate tree removal and retention plans have been provided with the planning permit application package. This was a deliberate choice as overlaying of this information on the landscape masterplan would have resulted in illegible plans.

Response: Unsatisfactory - Trees being retained must be shown on the proposed plan.

Further to recent meetings, Development Victoria now understands that this matter is resolved as the required tree retention and removal plans were included in the original application documents. Nevertheless, the relevant plans have been attached (refer attachments xxxx).

A proposed plant schedule must be provided. The Landscape Masterplan and Concepts Wetlands Plan should acknowledge that the northern end of the site is a Site of Biological significance (Site 33. Blind Creek Corridor), covered by an ESO2 and that proposed revegetation in this area should be indigenous, predominately come from the A appropriate EVC's and the plants must be of local provenance.

Plant schedules will be developed once a detailed landscape plan is finalised in accordance with a planning permit condition, and will include predominantly taxa that are indigenous to the Knox area, appropriate to the site Swampy Woodland EVC and aquatic habitatswhere appropriate, and propagated from local provenance seed sources if possible.

A revegetation template for the establishment of appropriate Swampy Woodland canopy habitat is provided in Section 5.2.5 (Table 12) of the Biodiversity Assessment report, and revegetation templates for the establishment of five wetland habitat types are provided in Section 5.1.

Response: Landscape to respond.

The proposed stormwater management plan supporting the proposed residential subdivision appears to be reasonable and in-keeping with current best practises. However, as the stormwater management of the site is almost entirely reliant on treatment and detention assets which reside outside of the residential component, it is not possible to split the stormwater comments neatly between the residential and wetland/habitat components.

The stormwater management plan by Engeny (as submitted with the planning permit application) demonstrates that that the proposal is meeting the stormwater quality objectives for the site and contains the results modelling. This has been reviewed by the engineering team at Knox City Council but perhaps has not been seen by the ESD team.

Nevertheless, attached (Knoxfield Development Stormwater Management Rev 13) is an updated 'Preliminary Stormwater Management Strategy', February 2022 prepared by Engeny for Development Victoria.

Engeny has not assessed a "myriad of design systems" in detail, as it was determined that the most efficient solution was an integrated wetland system that also provides co-benefits for the environment, amenity and for recreation. It is the integrated wetland system that wasmodelled. Engeny believes for example, that an alternative of small raingardens throughout the development would have been unacceptable to Council due to the increased maintenance requirements for Council.

Response: Comments from the Stormwater team would be dependent and informed by the responses provided by the developer (and its consultants) to the two separate requests for further information. At this stage the responses do not provide sufficient information for Council to form further comments. We would be inclined to agree if we had seen any maturity of the design of the wetland region through either discussions with Council or the further specialist work apparently undertaken. More importantly the response provided doesn't respond to our concern. Whilst the assets proposed within the "wetland region" as detailed within the stormwater management plan appear reasonable, their size, composition and function could be significantly impacted by

competing interests in the same region. Particularly the needs of the indigenous flora and fauna and the ability of an intact aquatic ecosystem to be created and survive long term.
Development Victoria believes that a suitable level of detail has been provided to date given that a planning permit for the site has not yet been issued. The considerable ecological survey and stormwater design work thus far has demonstrated clearly that the proposed wetland treatment areas can be accommodated.

Three-dimensional terrain modelling has been completed to ensure that all batter slopes, maintenance access and sediment drying areas, can be provided and detailed design will ensure this is implemented in a safe and suitable manner. The wetland is being designed largely in accordance with the Melbourne Water Wetland Design Manual. This should provide confidence that the wetland will have the ability to support a diverse range of flora and fauna as are typically found in the many wetlands designed in accordance with these guidelines.

Specialist ecological input has also been included to help custom design the habitat wetland to suit the habitat required for the blue billed duck and other aquatics waterbirds. Development Victoria looks forward to working through the detailed design with Council. Development Victoria will also keep its specialist ecologists involved in the design process to ensure that the ecological benefits are realised.

Detailed design can be provided in response to a suitably worded planning permit condition once a permit has been issued.

As noted in the previous set of comments back to the developer, due to the sensitivity of the site it is imperative the developer provides a high level of detail in relation to the wetland and habitat components early. This includes details which would normally be resolved through detailed design such as rock placement, bed meander and general finessing of the design contours to ensure a naturalised aesthetic and promote quality habitat outcomes. Council are in support of all the comments provided by Melbourne Water in addition to those provided by Council previously.
Development Victoria is aware of the biodiversity issues at the site and in relation to the existing dam and has commissioned significant expert work in this area. This work has been combined with stormwater engineering studies to ensure an appropriate and improved wetland system to meet biodiversity and stormwater treatment.

Response: Knox Stormwater team: We are yet to see the "significant expert work" commissioned therefore Council does not know how it relates to the stormwater management plan or how it has informed the concept design of any of the water assets. The response does not provide sufficient insight.

Development Victoria is unsure what this response means as it is brief and generalised. The planning permit application package included a variety of expert study reports, as listed in the covering letter and the planning report.

In addition and in response to the previous RFI request, additional expert work has been completed and included in responses from those experts to the RFI request.

The subdivision outfalls directly to a Melbourne Water asset (Blind Creek) which results in the detention/retardation requirements for the subdivision are set by Melbourne Water. As such it is unclear to Council how, and more importantly where, the required flood storage is being accommodated.
As noted in the Engeny report, the existing catchment upstream of the dam drains either:

- directly into the dam untreated and then into Blind Creek from dam overflow; or
- directly into Blind Creek from the existing drain on the west side of the property.

This current situation exists and has done so during the history of the use of the catchment land for residential use, roads and in part as a horticultural station, presumably to the knowledge of MWC as the manager of the Blind Creek asset. The water from the relevant catchment enters Blind Creek with no designed treatment or flood mitigation.

Development Victoria proposes a new utility installation incorporating a sedimentation wetland, a treatment wetland and a habitat wetland, all in accordance with the incorporated CDP, which will address the poor existing conditions and greatly improve the quality of water entering Blind Creek.

Flood storage is to be accommodated above the normal operating levels of the sedimentation pond, stormwater treatment wetland and habitat wetland. The peak outflow rate will be controlled via a weir pit and pipe.

It is common practice to co-locate wetlands within retarding basins. It is noted for example, that the nearby Lewis Park redevelopment masterplan proposes to introduce wetlands into an existing retarding basin. The depths of flooding in the Lewis Park retarding basin above the wetland will be significantly greater than the peak depths expected within the retarding basin on the development site.

Response: Council understand and are aware of the fact that wetlands can and do exist within retarding basin floors. The request from Council clearly seeks further information on the level (volume) of flood storage provided, which assets are providing the storage and to what depth above normal water level or extended detention. In addition, how the levels will impact on the local flora and fauna. The response does not provide sufficient insight.

MWC requires that peak flow rates from the site are not increased at the point of discharge where the flows enter Blind Creek, as a result of development.

The Engeny hydrologic modelling completed as part of the stormwater management plan considers the existing catchment conditions, including the retardation that the existing dam is providing. The hydrological modelling has confirmed that there is sufficient storage within the proposed wetland system to be able to retard flows back to the pre-development levels.

Engeny advises that the flood storage is being accommodated within the utility installation as a whole. No flood storage has been accounted for below the extended detention depth of the wetland.

The flood storage is being accommodated within the entire wetland system, including the habitat wetland area. This decision has been made deliberately to minimise the increases in water levels within the whole system.

While from an engineering point of view the wetland is broken down into a stormwater treatment area and a habitat area, the stormwater treatment area will also provide excellent habitat and will have a much higher density of planting and emergent macrophytes than the habitat wetland.

The habitat weltand is deliberately being left with large areas of open water to provide habitat similar to that which the current dam provides, for the Blue-billed Duck. While the open water is important feeding habitat, the marcopythe zone provides habitat for nesting for all waterbirds, including the Blue billed Duck. Given the ducks will not know the difference between the stormwater treatment section of the wetland and the habitat section, they may nest in any part of the wetland.

Utlising the entire wetland to provide flood storage minimises the fluctuations in water levels in the entire wetland, rather than only using the stormwater treatment wetland for storage, which would result in significantly higher water levels in this area increasing the chances of disrupting nesting.

It should be noted that the current dam provides limited controls on water levels. By utilising the entire wetland area, the proposal is more closely mimicking the existing dam operation rather than concentrating the retardation to a small portion of the wetland.

Ecocentric advises that structural habitat elements, as referred to above by Council, are outlined in Section 5.1.1 of the Biodiversity Assessment provided as part of the planning permit application package for the utility installation, including the following.

- The open water habitat wetland is to have at least five vegetation zones (CSIRO 2006) for the provision of a range of habitat types based on water depth and the grading of the embankments, including:
    - **open (deep) water zone** (>1.5 metres at full capacity) - mostly open water with submerged and floating aquatics and will be the most important habitat zone for Blue-billed Duck and other threatened waterbirds such as Hardhead and Musk Duck;

- **submerged marsh zone** (0.35-1.5 metres) - largely planted with robust aquatic sedges with patches of aquatic herbs in shallower sections;
- **deep marsh zone** (0.15-0.35 metres) - mainly comprised of a band of sedges;
- **shallow marsh zone** (0–0.15 metres) - planted with a variety of sedges and herbs;
- **ephemeral batter zone -** occupying areas that are approximately 0.2 metres from the waters' edge, comprising sedgeland, grassland and rushland and will be ecotonal with the Swampy Woodland remnants and terrestrial revegetation areas.

- Terrestrial habitat areas surrounding the open water wetland, sediment pond and WSUD reed-beds are to be revegetated using species that are appropriate to the Swampy Woodland EVC (EVC 937), including Swamp Gum (*Eucalyptus ovata*) and understorey shrubs sourced from local provenance, indigenous seed sources.
- The ability to manipulate water levels is to be engineered into the inlet and outlet structures for the sediment pond, WSUD reed-bed and open water wetland area and intrinsic to the wetland design. The capacity to manage water flows is important for the following purposes:
  - management of fill rates to ensure that there is no scouring of substrates within the wetland structures and to ensure adequate water depths for the planting and establishment of vegetated aquatic margins and submergent macrophytes (CSIRO 2006);
  - facilitation of the isolation of individual pondages for maintenance purposes, and the prevention of sediment loss to down-stream structures during maintenance works (Melbourne Water 2017);
  - facilitation of natural fill and drain cycles for the maintenance of macrophyte zones through mimicking of seasonal water cycles (Wong *et al.* 1999);
  - facilitation of the management of Gambusia (*Gambusia holbrooki*), an introduced pest fish species and manipulation of water levels for weed control programs (O'Meara & Darcovich 2015).
- Emergent logs, placed at the margins, are to be utilized to provide underwater snags and basking habitat for frogs and reptiles. There are currently two standing dead trees (stags) in the northern sector of the property which will also be retained as roosting habitat, either within the open water area or at the wetland's eastern margin. Hollows suitable for waterbirds (such as Wood Duck and Pacific Black Duck, observed with young at the site) are to be installed at these stags.
- Wood Duck were observed roosting at night on the roof of a small maintenance shed at the southern margin of the existing dam (see also photographs in Section 9.5 of the Biodiversity Assessment report). There is an opportunity to accommodate this behavior through careful design of the proposed 'bird hide' with provision of a similar roosting structure and / or incorporation of suitable artificial hollows for nesting purposes. The proposed bird hide structure will be at the open water wetland margin (or overhanging the water) and is an opportunity to provide habitat diversity for this species and other hollow dependent taxa.
- Walking tracks and passive recreation (such as a viewing platform) must not be located within or directly adjacent to the created open water wetlands, to minimize disturbance to waterbirds. Shared paths should be located along the southern and western boundary of the site where possible (that is, not encircling the open water wetlands).

Details of these elements, as well as numerous additional habitat types, structures and objectives outlined in the Biodiversity Assessment, will be provided as part of the detailed design process.

Being a linked system and looking at the scale of the treatment wetland relative to the development catchment it is assumed the habitat wetland would form part of the detention system. This would not be acceptable from

Council's perspective as it would result in a fluctuating water level within the habitat wetland would impact on the fauna's (including the blue billed duck) ability to nest and breed effectively in the proposed asset.
Fluctuating water levels are a necessary part of a healthy wetland system. It allows for the regular wetting and drying of the ephemeral vegetation and promotes diversity of plant species within the wetland. The existing dam on the site would also have fluctuation in water levels, with lower levels being experienced in summer and higher levels in winter. As stated in the report, based on the MUSIC depth spells analysis a depth of 300 mm above the normal water level occurred only 13 times in a ten-year period.

Response: Knox Stormwater team: Fluctuating water levels are indeed a normal part of a healthy wetland system however the level and frequency they occur could have a negative impact on habitat value and local aquatic fauna behaviour. Whilst the MUSIC modelling suggests water levels reach 300mm in depth 13 times over a ten-year period this is based on a 10-year rainfall template which looks to represent average rainfall for the region. This is separate to assessing the impacts of storm events (ARI/AEP) and the change in water levels they produce through flood storage. Council also question why the habitat wetland as an extended detention depth of 300mm considering its intent is to provide habitat, not treatment.
Engeny advises that both the existing dam and the proposed habitat wetland are within the floodplain of Blind Creek and are inundated in a 1 per cent AEP event and also likely in more frequent flood events, although the exact AEP of inundation from Blind Creek has not been quantified. It would not be possible to exclude this flooding from the proposed habitat wetland as it would reduce the available floodplain storage of Blind Creek and likely increase flooding upstream and downstream of the development. It was a condition set by Melbourne Water that floodplain storage be maintained or enhanced on the site.

The function of the proposed wetland system as a retarding basin will mean that water levels rise above the extended detention operating level of the wetland in rare storm events. This is also true in the existing dam, which in rare storm events would have increased water depths above its normal water level. The vegetation within the wetland will be able to survive the short periods of increased inundation that are associated with flooding as the increase in water level is only temporary and rare.

By utilising the entire wetland area (habitat wetland and stormwater treatment wetland), the total increase in depth as a result of rare storm events is reduced significantly compared with containing the retardation aspect to the stormwater treatment wetland only. It is also important to note that the stormwater treatment wetland will provide additional reed-bed habitat for waterbird nesting (Blue-billed Duck and other species) which will complement the vegetated margins of the adjacent open water wetland. It is expected that Blue-billed Duck, and other threatened species, will utilise both areas for their provision of macrophyte habitat value.

Response: Knox Stormwater team: Please provide a source (report or otherwise) of the information provided above? Are the flood levels stated attributed to the development or by the area residing within the Blind Creek floodplain? Further, are the noted levels independent to the 1% AEP flood levels of the creek due to having very different peak durations?
The peak 1 per cent AEP flood level is 230 mm above the extended detention depth of the wetland, assuming that the wetland is full to the extended detention level at the time the storm occurs. If the wetland was at normal water level or below when this storm occurred, a lower level of inundation would be experienced. In the 20 per cent AEP, the peak water level is 10 mm above the extended detention depth of the wetland, assuming that the wetland is full to the extended detention level at the time the storm occurs. These levels are based on the functional design and may change slightly however, they indicate that only very small increases in water levels are likely as a result of rare storm events.

Refer to responses from Ecocentric / Engeny above. which expand on the response (to RFI1) from those same experts. In addition, Engeny provides the following response.

Melbourne Water requires that peak flow rates from the site as a result of development are not increased at the point of discharge where the flows enter Blind Creek. The hydrologic modelling completed as part of the stormwater management plan considers the existing catchment conditions, including the retardation that the existing dam is providing. The hydrological modelling has also confirmed that there is sufficient storage within the proposed wetland system to be able to retard flows back to the pre-development levels. The amount of storage required to retard the 1% AEP flows back to pre-development levels is 14,500 m^3 as set out in Appendix Table A-7 from the stormwater management plan (included below). Appendix Table A-7 from the stormwater management plan report shows the peak flood levels within the wetland

under the various AEP storm events. The data presented in this Appendix Table A-7 includes runoff from the local catchment only.

Appendix Table A- 7: RORB Storages and outflows

AEP event	Peak outflow (m^3/s)	Critical duration	Median Pattern	Temporal	Storage (m^3)	Peak Water Level (m AHD)
63 %	1.3	2 hour	Tp 4		4030	76.85
39 %	1.6	1 hour	Tp 4		3180	76.85
18 %	2.5	1 hour	Tp 5		6770	76.86
10 %	2.7	1 hour	Tp 15		6880	76.89
5 %	2.9	1 hour	Tp 15		10000	76.94
2 %	3.2	1 hour	Tp 29		12300	77.01
1 %	3.4	1 hour	Tp 27		14500	77.08

The flood storage is being accommodated within the sediment basin, stormwater treatment wetland and habitat wetland. No flood storage has been accounted for below the extended detention depth of the wetland. This decision has been made deliberately to minimise the increases in water levels within the whole system. Given the rare frequency of the flooding and the short duration of inundation, it is not expected that the flooding would significantly impact on the vegetation within the wetland system.

While from an engineering point of view the utility installation is broken down into a stormwater treatment area and a habitat area, the stormwater treatment area will also provide excellent habitat and will have a much higher density of planting and emergent macrophytes than the habitat wetland. The habitat wetland is deliberately being left with large areas of open water to provide similar habitat for the blue-billed ducks to that which the dam provides.

While the open water is important feeding habitat, the macrophyte zone provides habitat for nesting for all waterbirds, including the blue-billed ducks. Given the ducks will not know the difference between the stormwater treatment section of the wetland and habitat section, they may nest in any part of the wetland.

By utilising the entire wetland to provide flood storage, the fluctuations in water levels are minimised in the entire wetland, rather than only using the stormwater treatment wetland for storage, which would result in significantly higher water levels in this area increasing the chances of disrupting nesting.

Both the existing dam and the proposed wetland system are within the 1% AEP inundation extent from Blind Creek. It is not possible to prevent flooding from Blind Creek into either the existing dam or the proposed wetland system without significantly impacting on the flood storage available on the site. Reducing floodplain storage would be unacceptable to Melbourne Water and may increase flood levels on surrounding properties.

While the wetland system could be adjusted to contain the retardation functions of the system to the stormwater treatment wetland it would:

- significantly increase the fluctuations in water level in the stormwater treatment wetland, which is expected to provide good quality habitat for waterbird nesting;
- require the physical separation of the stormwater treatment and habitat treatment wetlands, most likely with a levee/embankment, which would need to extend to the 1% AEP flood level, which would be likely to be approximately 1.5 -2 metres above the normal water level of the wetland;
- not prevent the habitat wetland from flooding from Blind Creek (as the existing dam does) and may increase the depth of flooding from Blind Creek due to the need to physically separate flows from the local catchment to provide retardation only within the stormwater treatment wetland.

The proposed wetland system is also able to achieve significant reductions in flooding on private properties west of the development site (in the current industrial area) which is of benefit to the broader community.

The Blue-billed Duck has an average incubation period of 24 to 26 days and, while a flood event during this time may render the breeding unsuccessful, this species, if disrupted early in the nesting period, is known to attempt a second breeding cycle. To interrupt the breeding cycle a sufficiently large storm event would need to occur during the egg incubation period therefore, which would be a statistically rare occurrence. Water bird nests are also not constructed at the normal water level of a waterbody but are generally elevated to account for seasonal level fluctuations. In the case of Blue-billed Duck for example, nests are supported by a compacted platform of dead leaves 15-30 centimetres above water within reed-bed habitat areas. The likelihood of water level fluctuations impacting Blue-billed Duck and other reed nesting waterfowl is therefore, both statistically and physically unlikely.

The flood level information quoted in the previous response (above) is taken from Appendix Table A-7 in the stormwater management plan, which accompanied the utility installation planning permit application. The flood levels quoted are for local catchment inflows only with no overtopping flows from Blind Creek included.

Engeny advises that the peak flooding on Blind Creek has been modelled in TUFLOW using flows provided by Melbourne Water. This flood modelling showed a decrease in peak flood levels on the eastern part of the property and a slight increase in flood levels on the western part of the property (as shown in the flood maps in Appendix E of the stormwater management plan) compared to the existing conditions. The critical duration for flooding on Blind Creek was from the 2-hour storm, while for most AEPs the critical duration is the 1 hour storm for the local catchment. These two times of concentration are similar so it would be reasonable to assume that the peaks may coincide to some degree but likely not fully. Even if this does occur and as stated in Table 4-2 of the stormwater management plan, there is also an increase in the floodplain storage provided on the site during the 1% AEP event from 21,000 m^3 to 33,600 m^3. This is an increase of 12,600 m^3. This is almost equal to the peak 1% AEP flood storage requirement of 14 500 m^3 from the local catchment.

Under existing conditions, the dam experiences flooding in a 1% AEP to a level of 78.2 m AHD. The normal water level of the dam is 77.5 m AHD. This means that the depth of flooding is 0.7 m above the normal water level of the dam. Under the proposed developed conditions, the peak flood level in the 1% AEP event varies from 78.4 to 78.3 m AHD. This equates to a depth of 1.8 to 1.9 m above the normal water level of the wetlands. The dam normal water level quoted is from the site survey and the flood levels quoted are from the TUFLOW modelling completed as part of the stormwater management plan development. Those flood levels were not quoted in the stormwater management plan report however, the figures in Appendix E show the depth outputs from that modelling.

Response: Knox Stormwater team: Please provide a source (report or otherwise) of the information provided above? As noted nests can be constructed anywhere between 150 and 300mm above normal water level. Considering the proposed extended detention depth of the habitat wetland is 300mm, it is both statistical and physically likely that some nests would be impacted by the proposed depth of water fluctuation. The response does not provide sufficient insight.

Ecocentric advises that section 2.3.3 of the Biodiversity Assessment (provided as part of the planning permit application package) includes the following.

The Blue-billed Duck breeding period is defined by the *Handbook of Australian, New Zealand and Antarctic Birds* (HANZAB) as varied, not regularly confined to September to November, with young in November through to April within Victoria. Laying periods are varied, with some response to water levels and availability of food sources. The clutch size ranges from 3-12 eggs, but more usually consists of 5-6 eggs (Marchant & Higgins 1990; DSE 2003). Egg clutches are only attended by females, with an incubation period of 24-26 days (Marchant & Higgins 1990; DSE 2003). Ducklings stay under the care of the female duck for the first 4-5 weeks (SWIFT 2020).

Nests are generally solitary, with construction initiated in some instances by males, and completed and attended by females only; females also construct a covering dome from nearby materials when incubation is initiated (Marchant & Higgins 1990). Nests are generally constructed within dense Cumbungi (*Typha* spp.) reed-beds over water, and usually within one metre of the edge of vegetation on the deep-water side (Marchant & Higgins 1990; Garnett *et al* 2010; BirdLife International 2020; DSE 2003). Dense, old growth Cumbungi reed-beds are preferable but nesting within Spikerush (*Eleocharis* spp.) and lignum swamps is also known. New *Typha* beds, without detritus of dead leaves, are considered to be unsuitable (Marchant & Higgins 1990).

HANZAB further notes that "*Nests indistinguishable from detritus of dead leaves even at close quarters. Supported by compacted platform of dead leaves, sometimes stems; 15-30 centimetres above water. Usually of edge of vegetation on deep water side*".

Ecocentric has also observed BBD nesting within lignum swamps at the Paroo River Wetlands south of Eulo, QLD, and within macrophyte reed-beds at the Werribee Treatment Plant. There is also a historic record (Quinn, D.J. published in 1969 in *Bird Watcher*) of BBD nesting at French Island, Victoria, as transcribed below.

"*The third swamp, where two males and a female were viewed, is reasonably well-fringed with similar vegetation to that of the first, but is dominated by two dense clumps of Melaleuca, both of which thrust themselves into the water. It consists also of thousands of dead, closely-packed Melaleucas, and is carpeted with much water-ribbon and other aquatic plants*".

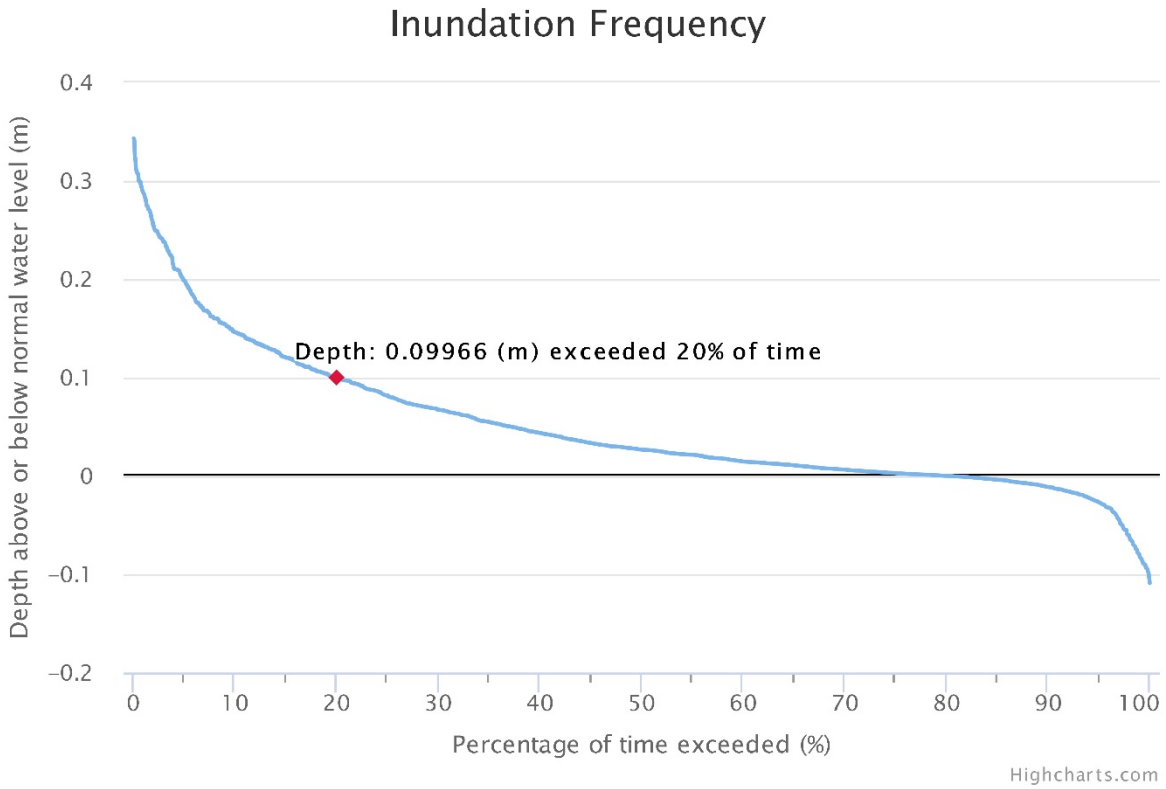
Given that BBD nesting is responsive to seasonal hydrological conditions and wetland water-levels, Ecocentric considers it likely that this species will accommodate the infrequent (1 in 100 year) flood level of 230 mm above the extended detention depths. Furthermore, given that Development Victoria is proposing to incorporate reed-bed habitat within the stormwater treatment system and at the margins of the open water wetland, Ecocentric considers it likely that BBD will have a greater chance of successful breeding (including nesting and fledging of young) when compared with the sub-optimal aquatic margin habitat within the current dam.

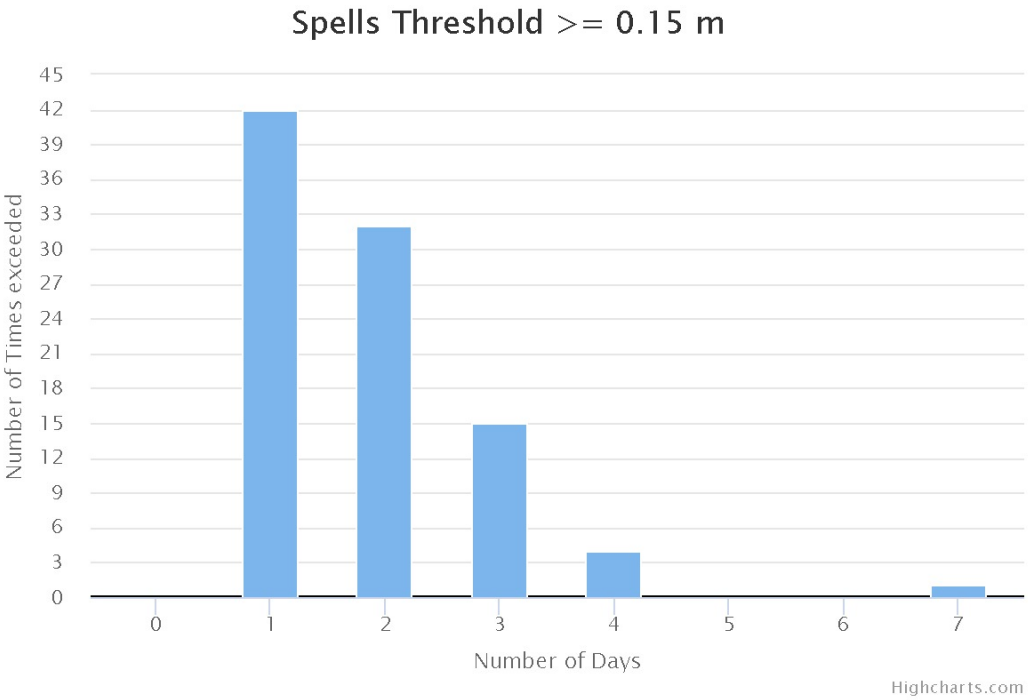
The currently proposed extended detention depth is 350 mm, not 300 mm. The following figures provide a frequency inundation curve from the wetland system and spells analysis to show how often water levels are exceeded in the wetland. This data is from MUSIC and utilises the 5-year rainfall template as required by Knox City Council.

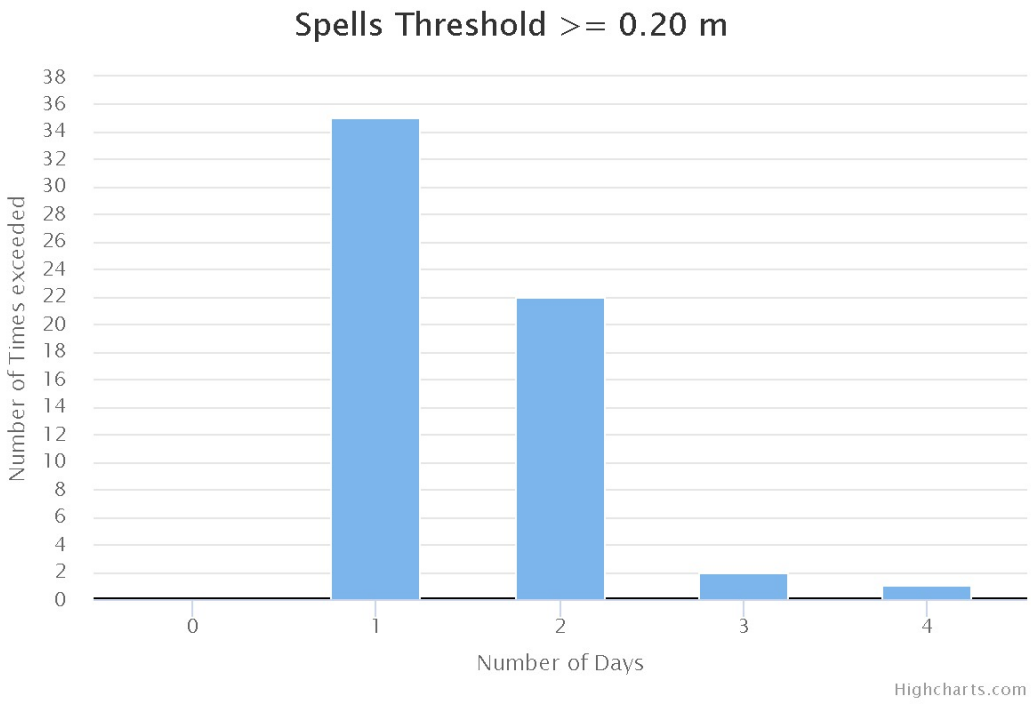
Assuming that the whole wetland system operates as a single system, the following inundation frequency curve and spells analysis apply. They show that it is relatively common for the water level to exceed 150 mm (multiple times per year) but much rarer for the water level to exceed 300 mm depth, with only nine instances over five years or roughly twice per year on average.

The water levels never exceeded 350 mm in the 5-year dataset. Given the blue-billed duck incubation period of 26 to 28 days and given that they nest for roughly 6 months of the year, it would be expected that the water level would reach the 300 mm depth once in the six-month nesting period, which would give it a less than 16 per cent chance of overlapping with the period in which the ducks were incubating the eggs. It is also understood that the nests are made in reed beds and as such are likely to rise and fall with the fluctuations in water levels as the reeds they are made from are buoyant. Within the 5-year period analysed in the MUSIC model, the water level did not reach 350 mm, which is a greater depth than the height at which the blue-billed ducks are believed to construct their nests.

Given that the proposed treatment wetland will be providing significantly better stormwater treatment, necessary to meet the best practice removal targets (table 3.3 of the Stormwater Management Plan shows that 59 per cent of nitrogen will be removed), there is scope to adjust down significantly the extended detention depth for the whole wetland. This would further reduce the risk of the water level rising to a height which could impact blue-billed duck nests. Preliminary MUSIC modelling suggests that the extended detention depth could be reduced to 150-200 mm while still meeting the treatment objectives (without including any treatment benefit from the habitat wetland as is the current assumption). This is a simple change to the design that could be made or further explored during detailed design. It would also virtually eliminate the risk of blue-billed duck nest inundation except during flood events.


Inundation Frequency
Depth above or below normal water level (m)
0.4
0.3
0.2
0.1
0
−0.1
−0.2
Depth: 0.09966 (m) exceeded 20% of time
0
10
20
30
40
50
60
70
80
90
100
Percentage of time exceeded (%)
Highcharts.com


Spells Threshold >= 0.15 m
Number of Times exceeded
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
0
0
1
2
3
4
5
6
7
Number of Days
Highcharts.com


Spells Threshold >= 0.20 m
Number of Times exceeded
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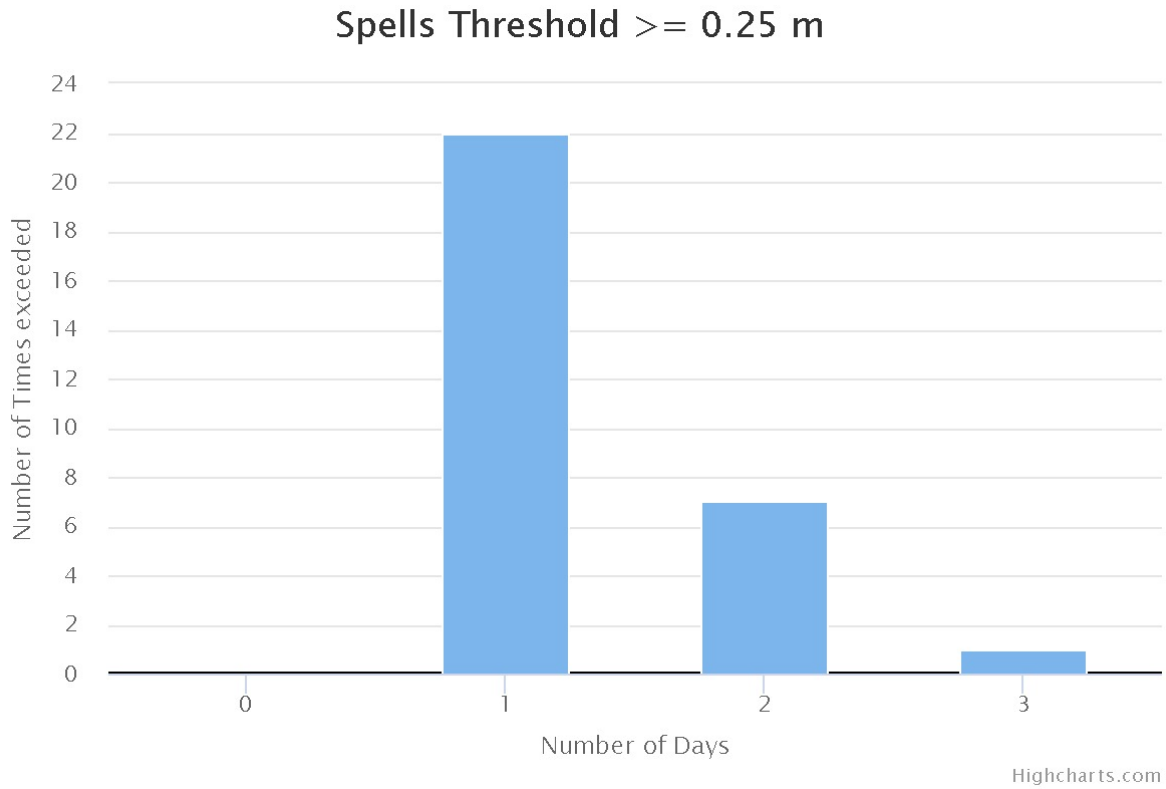
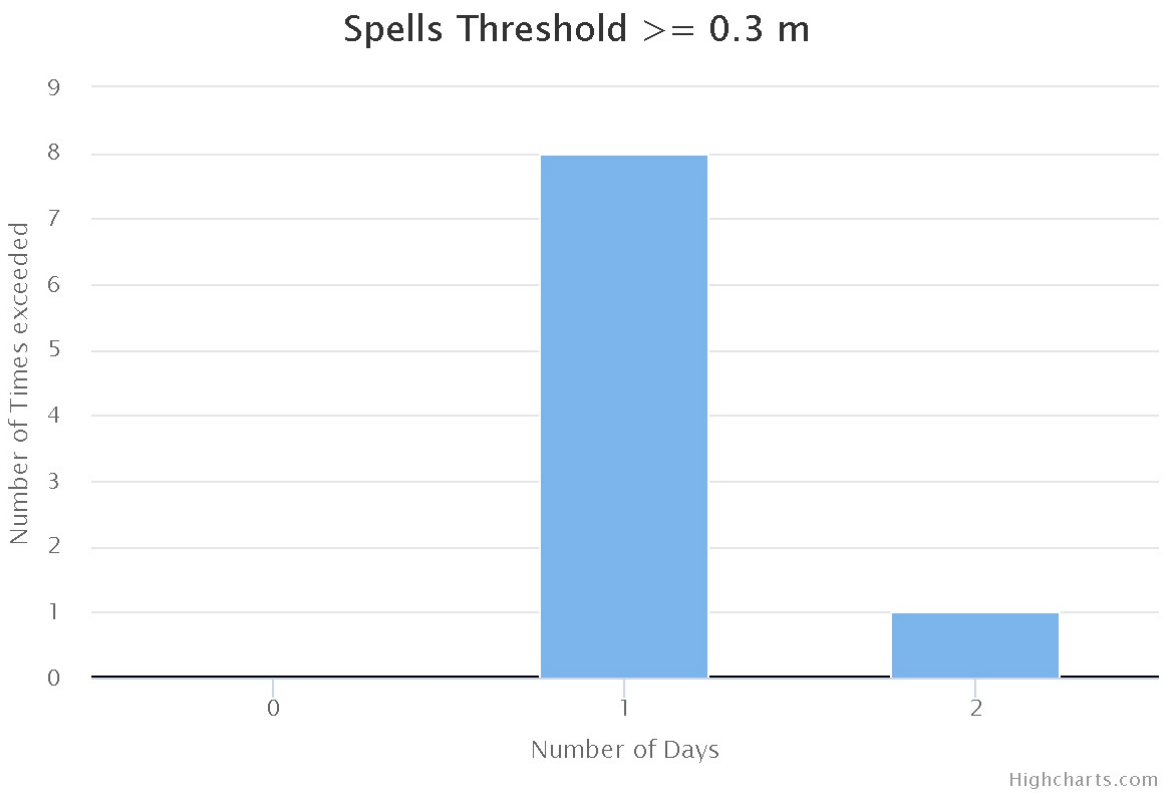
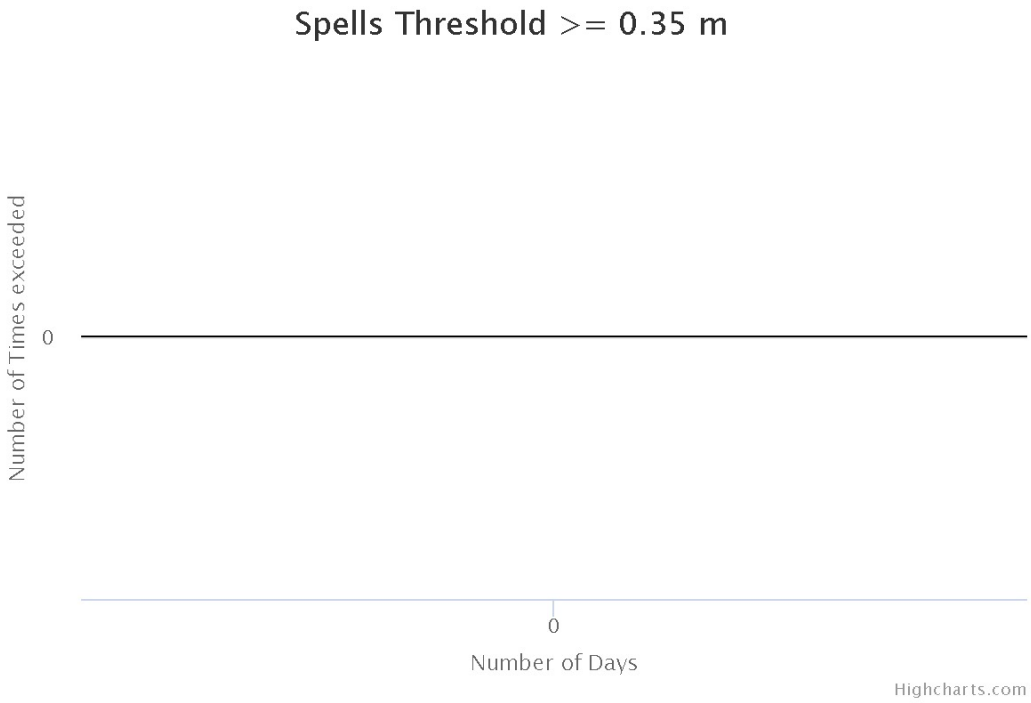
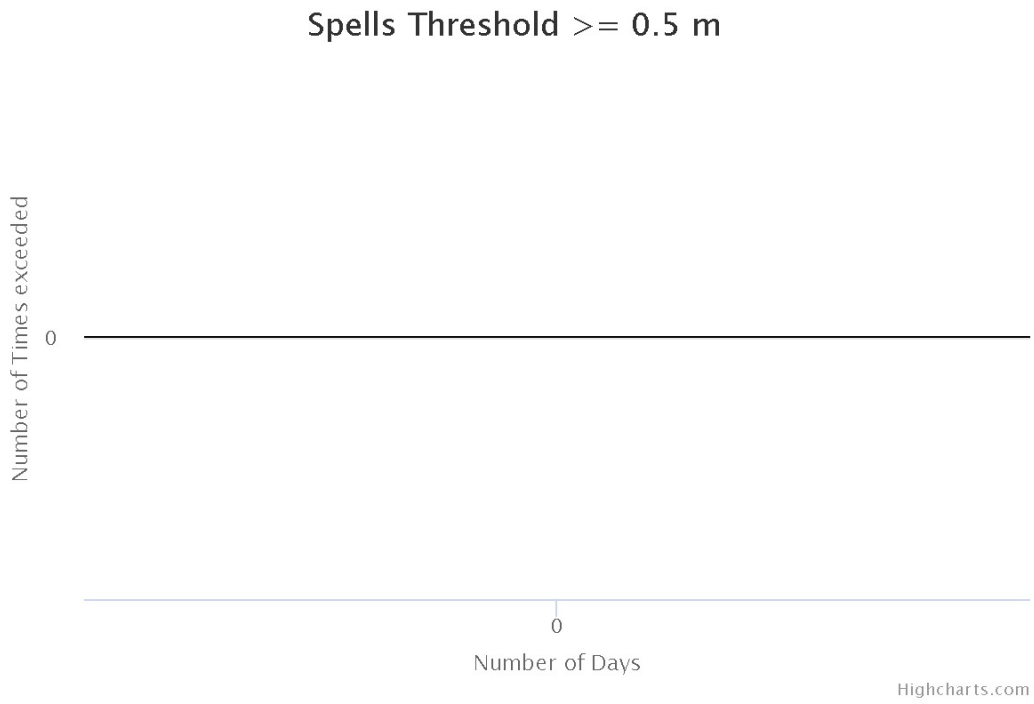
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Number of Days
Highcharts.com


Spells Threshold >= 0.25 m
Number of Times exceeded
24
22
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
Number of Days
Highcharts.com


Spells Threshold >= 0.3 m
Number of Times exceeded
9
8
7
6
5
4
3
2
1
0
0
1
2
Number of Days
Highcharts.com

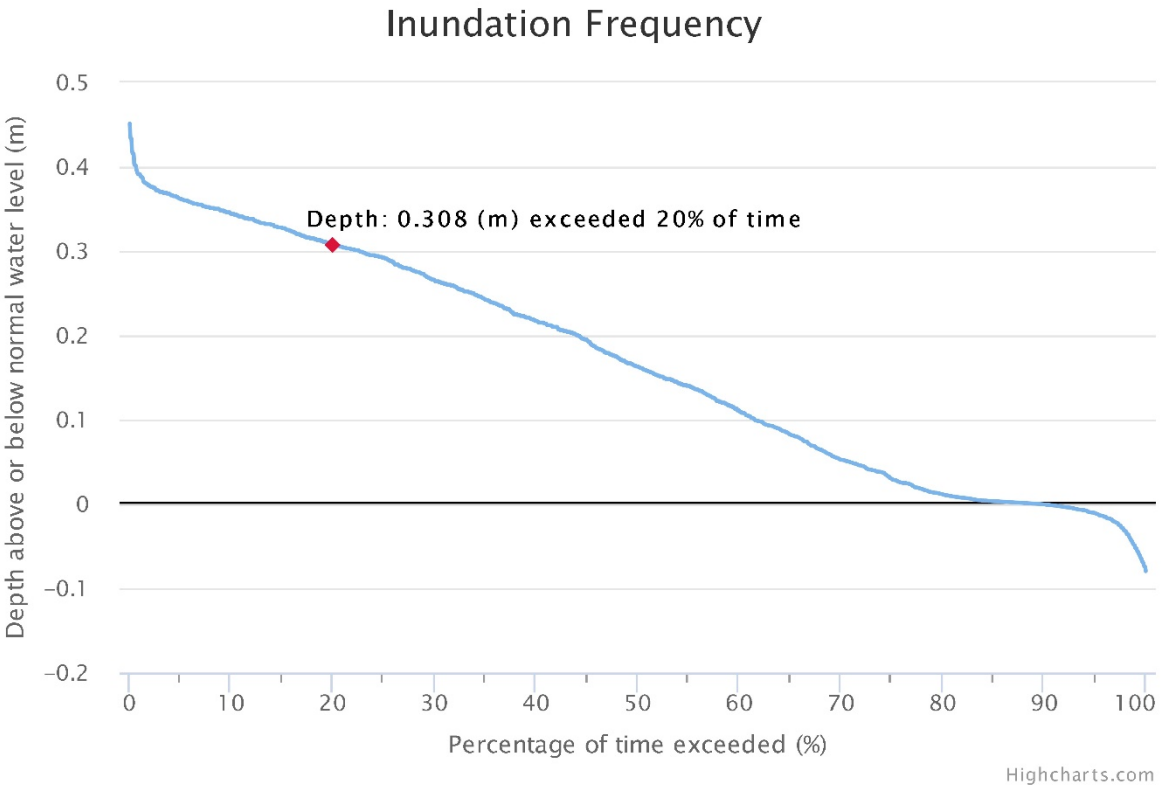

Spells Threshold >= 0.35 m
Number of Times exceeded
0
0
Number of Days
Highcharts.com

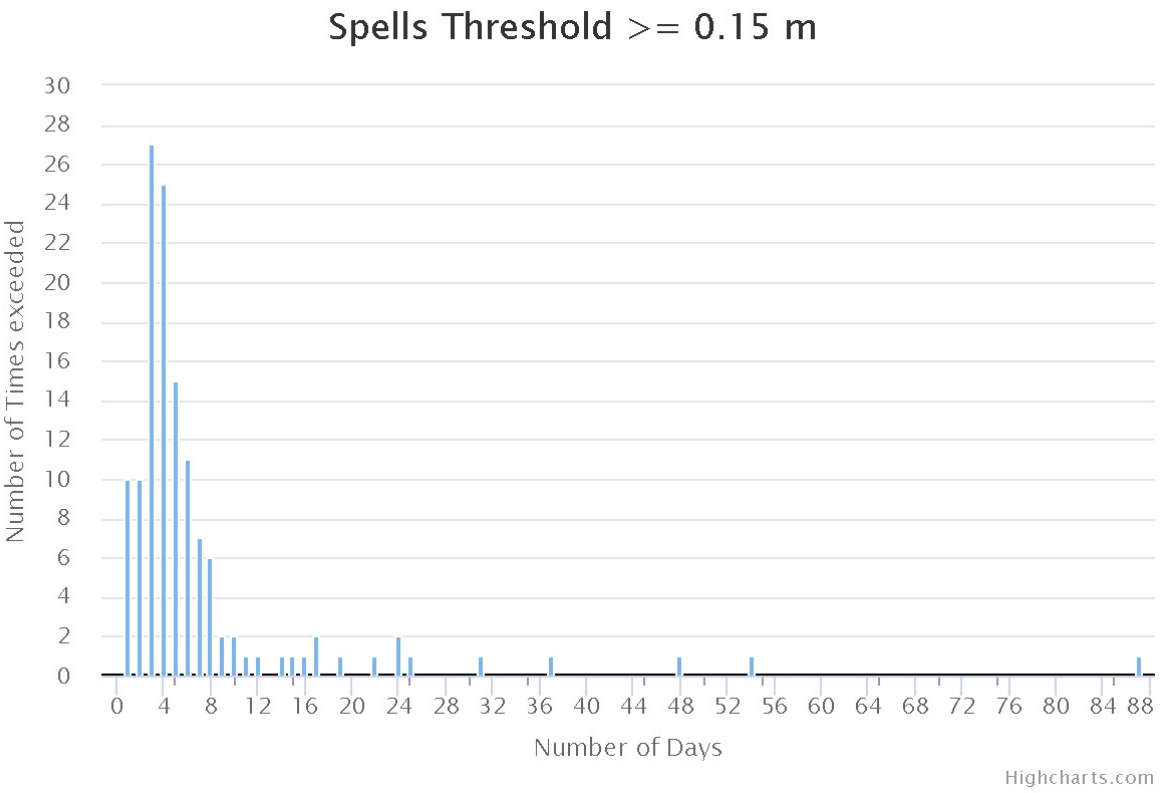


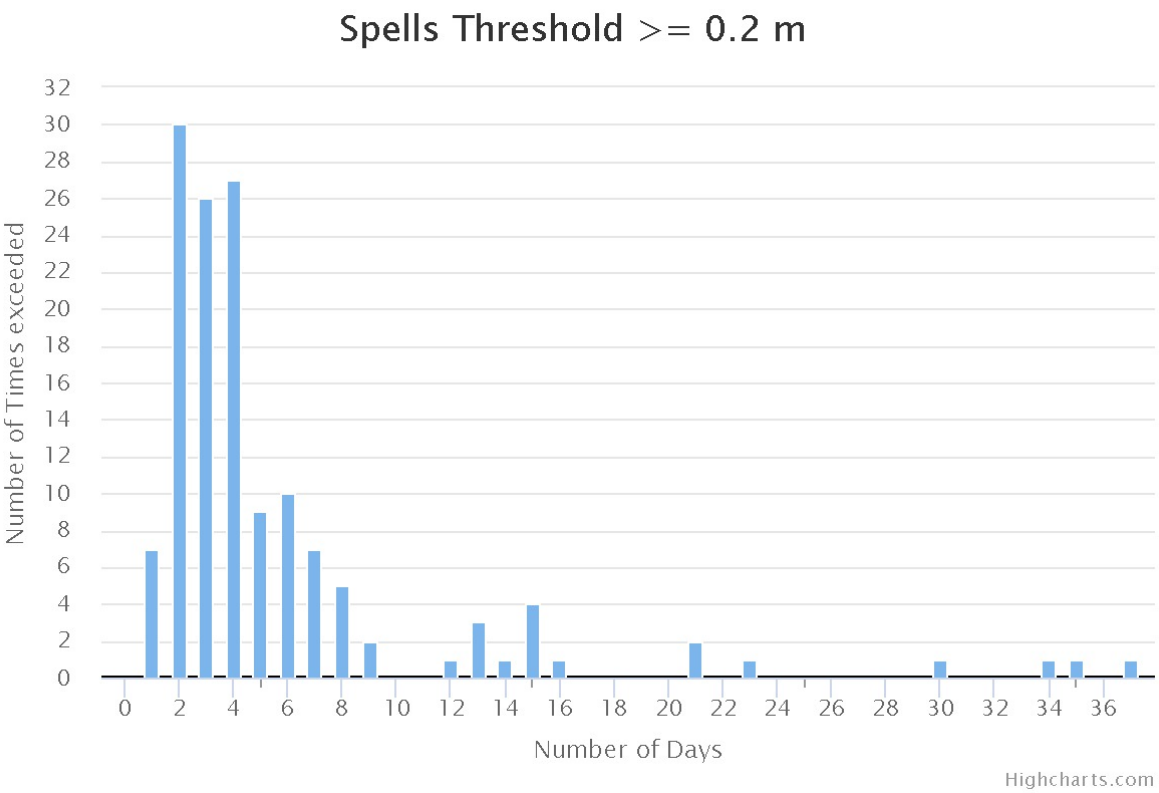
Given the discussion around the proposal of separating the water level control of the stormwater treatment wetland and the habitat wetland, Engeny completed an analysis to show what the impact would be on the stormwater treatment wetland if the water level control was solely within the stormwater treatment wetland.

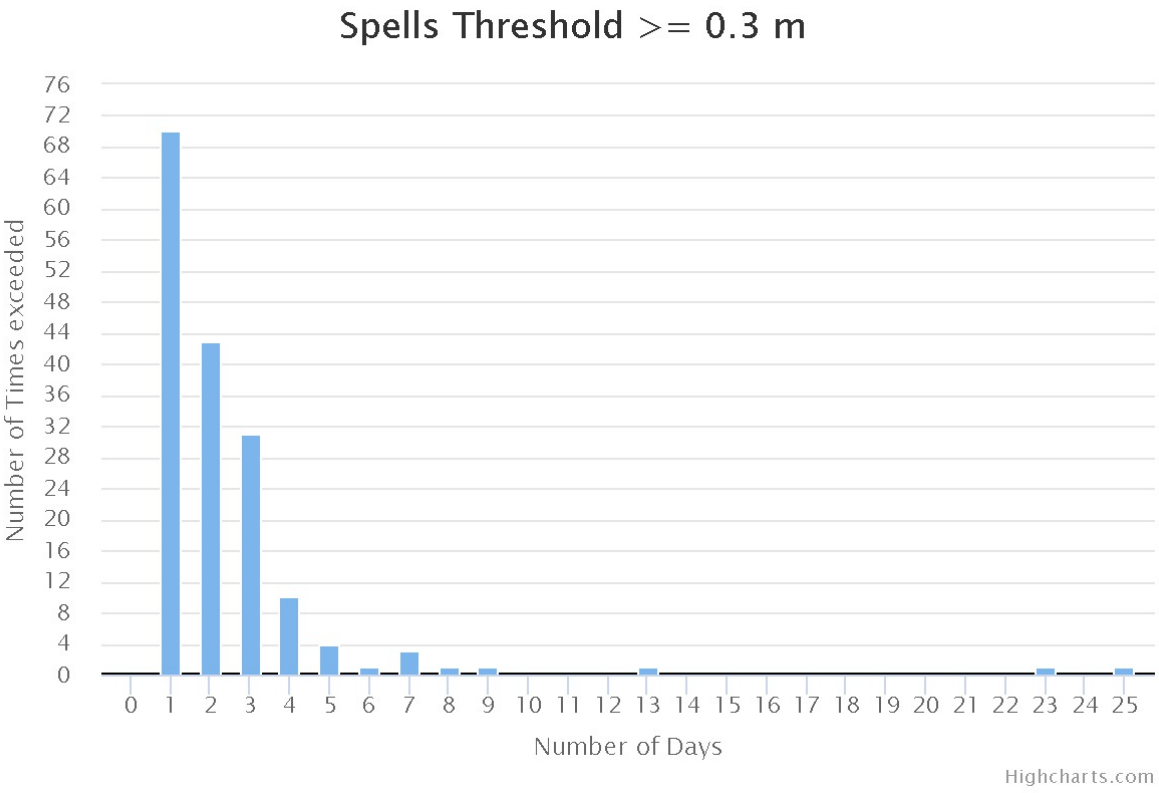
The results below show the inundation frequency curve and spells analysis for the stormwater treatment wetland acting alone to provide the extended detention control. The figures show that the 300 mm depth is exceeded on approximately 150 different occasions over the 5-year period. This equates to just above 1 a month.

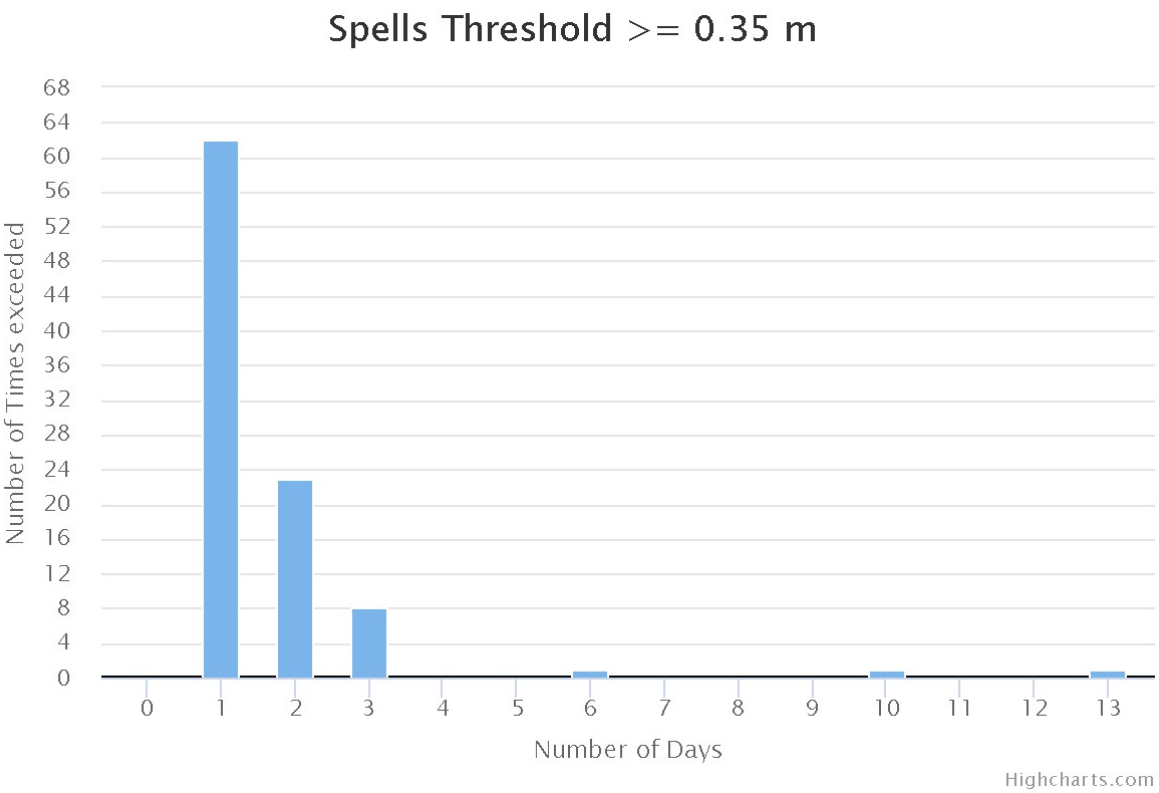
This rate of exceedance would make it highly likely that the water level would extend to 300 mm above the normal water level during the incubation period of the Blue-billed Duck. 350 mm is exceeded on 96 occasions as opposed to this depth not being exceeded once if the wetland functions as a single water body. Given that some of the best habitat (highest reed density) is likely to be within the stormwater treatment wetland, separating the wetlands and having the extended detention flow control contained to the stormwater treatment wetland only increases the risk of nesting within this section of the wetland being impacted quite significantly by higher water levels.

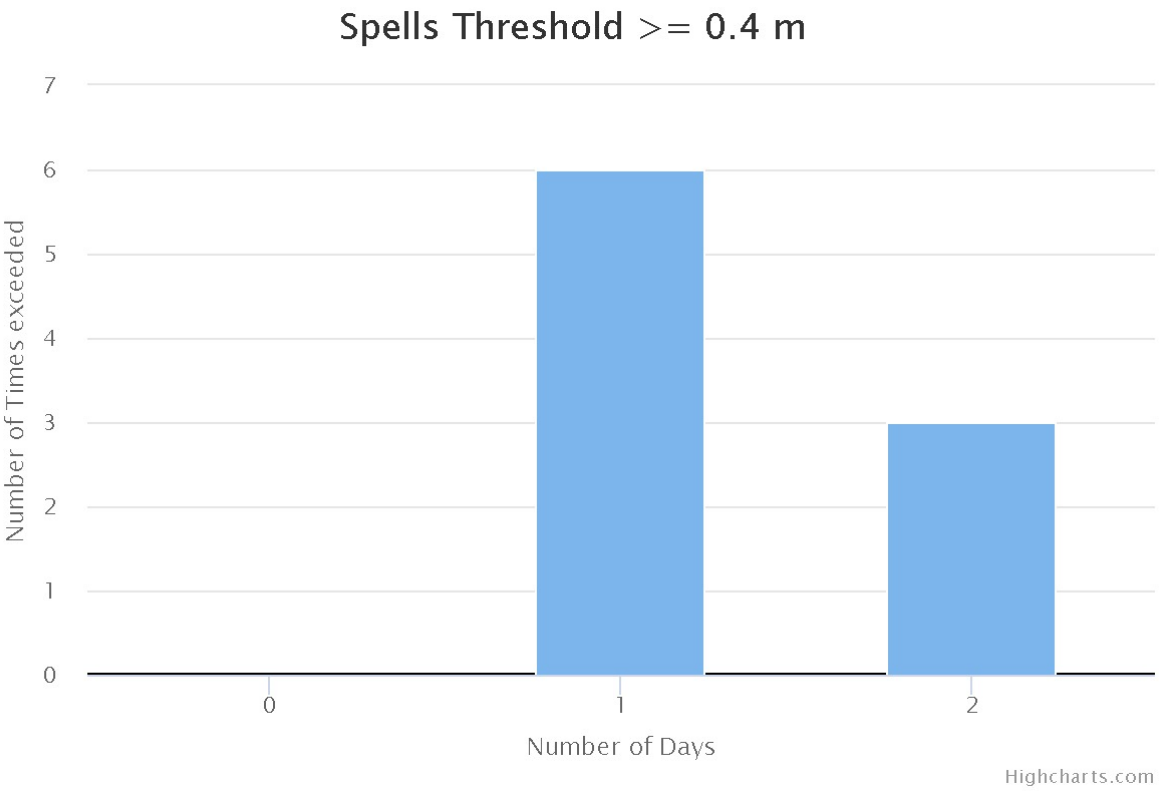

Inundation Frequency
Depth above or below normal water level (m)
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
Depth: 0.308 (m) exceeded 20% of time
0
10
20
30
40
50
60
70
80
90
100
Percentage of time exceeded (%)
Highcharts.com

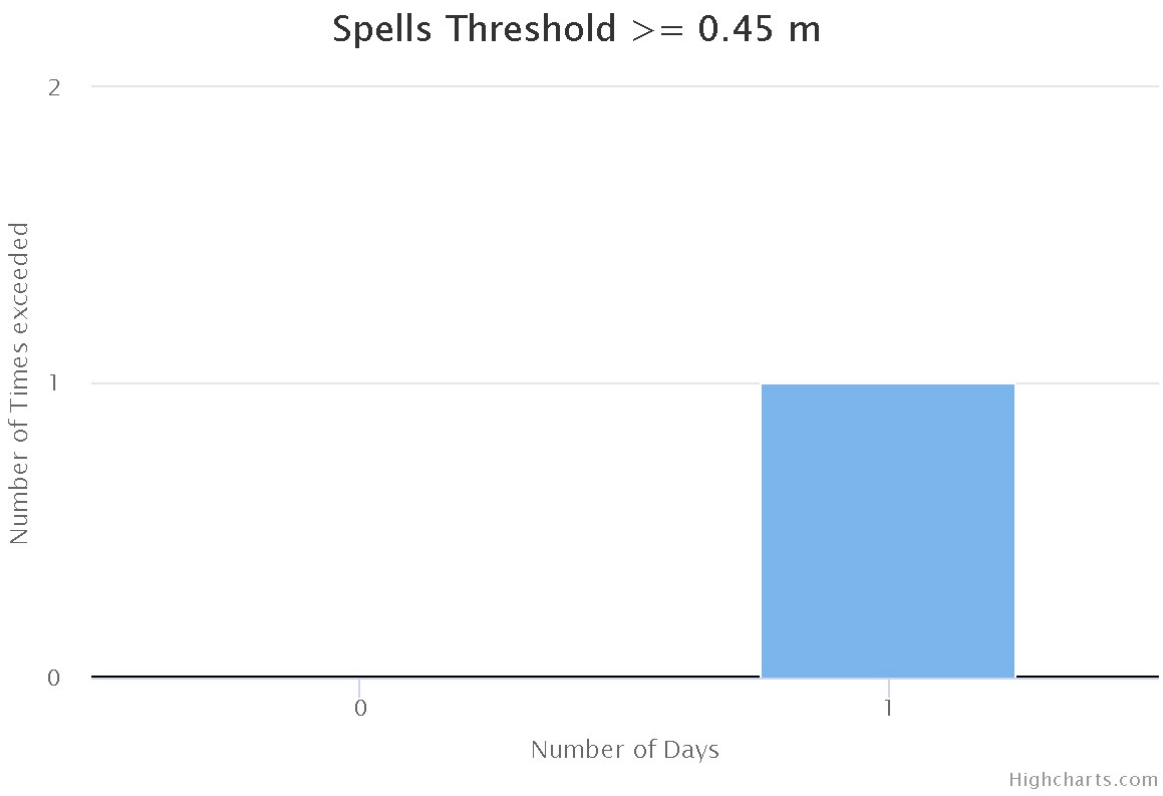

Spells Threshold >= 0.15 m
Number of Times exceeded
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
76
80
84
88
Number of Days
Highcharts.com

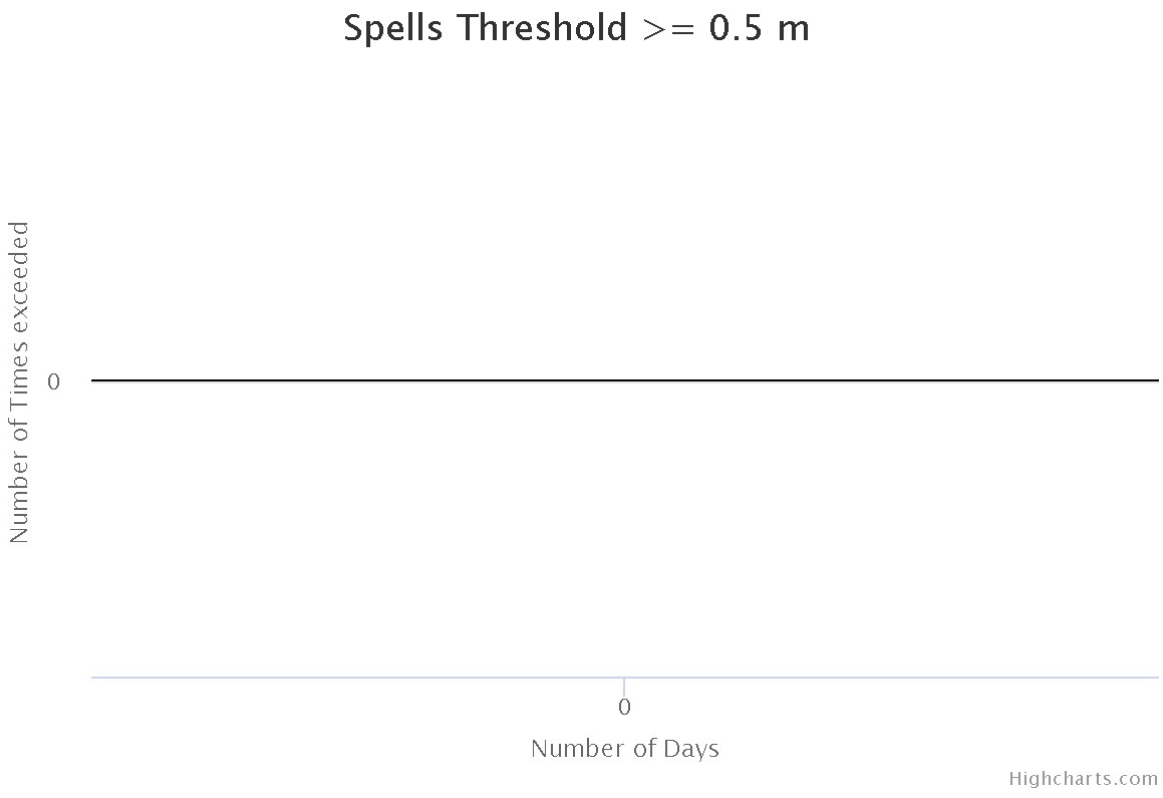

Spells Threshold >= 0.2 m
Number of Times exceeded
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
Number of Days
Highcharts.com


Spells Threshold >= 0.3 m
Number of Times exceeded
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Number of Days
Highcharts.com


Spells Threshold >= 0.35 m
Number of Times exceeded
68
64
60
56
52
48
44
40
36
32
28
24
20
16
12
8
4
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13
Number of Days
Highcharts.com


Spells Threshold >= 0.4 m
Number of Times exceeded
7
6
5
4
3
2
1
0
0 1 2
Number of Days
Highcharts.com





Kind Regards, [redacted]

[redacted]

[redacted] knox your city Knox City Council

Knox City Council acknowledges the traditional custodians of the City of Knox, the Wurundjeri and Bunurong people of the Kulin Nation.

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Nominate amazing people by 22 November 2021

knox.vic.gov.au/ausday

KNOX CITY COUNCIL

[redacted]

ENGENY
WATER MANAGEMENT

DEVELOPMENT VICTORIA

Development Victoria

621 Burwood Highway, Knoxfield

Preliminary Stormwater Management Strategy

February 2022

V6000_006-REP-001-13

Job no. and Project Name: V6000_002 621 Burwood Highway SWMP
Doc Path File: \\online.com\files\ManagementMelbourne\Projects\V6000 Places Victoria\V6000_002 621 Burwood Highway SWMP\07 Deliverables\Documents\Report\Revisions\Knoxfield Development Stormwater Management Rev 13.docx

Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
13	11/02/2022	Client Issue	[redacted]	[redacted]	[redacted]	[redacted]
Signatures			[redacted]			

DISCLAIMER

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1 INTRODUCTION

Engeny Water Management (Engeny) was engaged by Development Victoria (previously Places Victoria) to review the current onsite stormwater conditions and provide recommendations regarding the stormwater and drainage requirements of the future residential and mixed use development of the site at 621 Burwood Highway, Knoxfield. Figure 1-1 provides an overview of the development location.

621 Burwood Highway, Knoxfield is the disused Institute of Horticultural Development site. Commercial and industrial properties are located to the west and the DELWP Precinct is located to the site's immediate south-west. The Fairhills High School and residential properties lie to the east of the site.

The site is bounded to the north by the Blind Creek waterway. A large dam, spanning approximately 1.6 hectares is situated in the site's north-west corner and connects to the waterway corridor. Currently, this dam provides a water storage function, with limited treatment. The dam was built for water supply for previous use of the site for agricultural purposes. Ecological studies of the site (Ecocentric Environmental Consulting, 2015) have identified the presence of the endangered, Victorian Flora and Fauna Guarantee Act 1988 (FFG Act) listed Blue Billed Duck within this dam. Given the sizeable portion of land currently occupied by the dam and a number of significant existing problems with the dam, Engeny has considered future options for the dam as part of this study.

This report proposes a stormwater management strategy for the site that will achieve multiple benefits for the existing community, open space, the environment and future residents of the site. Aspects of the proposed layout in relation to water management that are described in this report include:

- Improved habitat
- Improved open space
- Improved public access
- Integrated water management to reduce potable water demand, reduce wastewater discharges and reduce stormwater discharges
- Improved integration of Blind Creek and it's corridor with the site
- Improved stormwater quality (the layout includes provision of a system to treat stormwater runoff from the new development, in accordance with the *Urban Stormwater Best Practice Environmental Management Guidelines* (BPEMG)).

This report was first prepared in 2017 but has been updated based on the revised design work by PGA, updated master planning and to account for the update to Australian Rainfall and Runoff. The general concept for treatment is still largely unchanged.

Figure 1-1: Knoxfield Development Locality Map

2 STORMWATER QUANTITY MANAGEMENT

The proposed development will comprise of medium density residential development mixed with open space reserves over most of the site with a mixed use precinct at its southern end and an area for water treatment and habitat adjacent to Blind Creek as shown in Figure 2-1.

Figure 2-1: Proposed Knoxfield Development

2.1 MINOR DRAINAGE SYSTEM

The minor drainage system will consist of a subsurface pipe network designed to capture and convey all stormwater runoff generated from the catchment for rainfall events up to and including the 10 % AEP (annual exceedance probability) design storm (1 in 10 year ARI).

As the local catchment is less than 60 ha, the system will be designed in accordance with the Knox City Council Stormwater Drainage Guidelines.

Allowance will be made for the conveyance of the external catchments in the pipe drainage network. There is a 28 hectare external catchment entering the development area at the rear of the Fairhills High School in an 825 mm diameter drain. The flow from this external catchment will be piped through the development area.

It is anticipated that the pipe network will discharge to Blind Creek upstream of the existing pedestrian footbridge over the creek. This discharge will be via a proposed Water Sensitive design / habitat system to treat stormwater from both the development site and the external catchment, allow for stormwater harvesting and habitat and minimise impacts on Blind Creek and downstream waterways.

2.2 MAJOR DRAINAGE SYSTEM

The primary objective of the major drainage system is to provide flood protection for the allotments based on the 1 % AEP (1 in 100 year ARI) storm event and to ensure that the overland flow can be safely conveyed through the development. This will be via overland flow paths contained within road reserves prior to discharging into Blind Creek. Flow computations indicate that overland flows generated in a major storm event can be safely conveyed within the road reserves.

The dwellings created as part of the development will also need to be constructed with 600 mm freeboard to the 1 % AEP flood levels within Blind Creek.

The existing dam provides some retardation of peak flows from the existing catchment. The effect of this dam on existing condition peak flow rates is summarised in section 2.3. When the site develops a retarding basin will be required to ensure that the peak flow discharged from the site does not increase in the 1 % AEP event based on existing conditions discharge rates, taking into account the retardation that the existing dam provides.

A catchment plan is contained in **Appendix A**.

2.3 HYDROLOGIC MODELLING

Engeny utilised the hydrologic modelling program RORB in accordance with Australian and Runoff 2019 guidelines (ARR 2019) to calculate initial and developed conditions stormwater peak flows into Blind Creek. Refer to Knoxfield Development Stormwater Management Rev 7 report for findings in accordance with ARR 87 guidelines. Three scenarios were modelled as follows:

- Existing development model with dam storage – to estimate the current level of water storage provided by the northwest dam and existing site peak discharge.
- Future development model – to estimate the increase in flow due to the Knoxfield development
- Future development model with wetland/retarding basin – to estimate the approximate storage required in a retarding basin to offset runoff from future development.

RORB simulations were undertaken for all durations of a 1 % AEP event using an initial and continuing loss model. Prebursts were applied in accordance with the updated Victorian specific ARR 2019 advice (75% percentile). **Appendix A** contains details of the parameters utilised within the various RORB models.

Table 2-1 summarises the results of the two existing development scenario models.

Table 2-1: 1 % AEP Event Existing Conditions Scenario with Dam Results

Peak Inflow into the Dam Storage (m^3/s)	Peak Outflow from existing Dam Storage Model (m^3/s)	Peak Storage Provided within Existing Dam (m^3)
9.3	5.7	7,920

Two future development scenarios were modelled to determine the increase in peak stormwater flow due to the development, and to provide preliminary estimation of the requisite sizing for water storage assets. Table 2-2 summarises the final simulation outputs for the modelled future development scenarios.

Table 2-2: 1 % AEP Event Proposed Development Scenario with Wetland/Retarding Basin Results

Peak Outflow from No Storage Model (m3/s)	Peak Outflow from Wetland Storage Model (m3/s)
10.3	5.6

Storage assets for the development scenario were iteratively sized to produce a peak outflow which was equal to or less than the existing conditions peak outflow. The modelling assumes that the wetland is full to the extended detention depth level and so no storage below this level is considered for flood mitigation purposes.

The modelling indicates that 3940 m^3 of active storage within the wetland/ retarding basin would be sufficient to meet the flow targets. This is only slightly more than is currently available in the existing dam up to its spillway level, however the wetland/ retarding basin is configured in a much more efficient manner. This allows for the lower flows to be discharged more quickly and the higher flows to be held back, so that only the peak of the hydrograph is being retarded. This can be achieved with a weir pit with a total weir length of 8 m and two 1050 mm diameter pipes discharging flows into Blind Creek.

3 STORMWATER QUALITY

The State Environment Protection Policy (Waters of Victoria) defines the required water quality conditions for urban waterways. The aim of stormwater quality treatment is to reduce typical pollutant loads from urban areas to Best Management Practices as defined in Table 3-1 and as required by Clause 56.07-4 of the Victoria Planning Provisions.

Table 3-1: BPEMG Environmental Management Objectives for Stormwater (CSIRO, 1999)

Pollutant	Performance Objective
Total Suspended Solids (TSS)	80 % reduction from typical urban load
Total Phosphorous (TP)	45 % reduction from typical urban load
Total Nitrogen (TN)	45 % reduction from typical urban load
Gross Pollutants (GP)	70 % reduction from typical urban load

Source: Urban Stormwater: Best Practice Environmental Management Guidelines – Victorian Stormwater Committee, 1999.

To meet these objectives, Engeny propose a stormwater treatment train comprising a sediment pond and wetland, with treated stormwater flowing into a new waterbird habitat for the FFG Act listed Blue Billed Duck and other waterbirds.

The MUSIC model was designed with input parameters generally in accordance with Melbourne Water MUSIC Guidelines (2016), however the rainfall template used has been adjusted to one provided by Knox Council. **Appendix B** details the parameter inputs utilised within the MUSIC Model. The Fair and Geyer equation was used to size the sedimentation pond.

From this, it was determined that the combination of a 1,100 square metre sediment pond plus a 4,500 square metre wetland was sufficient to meet the water quality objectives for the development, as outlined in Table 3-2. The treatment system is designed to treat all runoff from the development site and has been sized to achieve best practice as if there are no external catchments flowing into the wetland. The results in Table 3-2 demonstrate that the wetland is achieving this objective. The proposed arrangement of the wetland system is shown in **Appendix C**.

Table 3-2: Treatment Train Effectiveness Development area only

Pollutant	Source (kg/yr)	Residual (kg/yr)	Percentage Removed
Total Suspended Solids	20100	3700	81.6%
Total Phosphorus	42.7	13.2	69.1%
Total Nitrogen	311	164	47.2%
Gross Pollutants	3840	5.03	99.9%

The wetland system will actually treat all of the runoff from the entire catchment, which includes existing developed catchments. There is no legislative requirement to treat runoff from any of the existing development catchment, however given the wetland is being constructed in a location where it can capture this flow easily, it will be treated by the wetland. Table 3-3 shows the pollutant removal that the stormwater treatment wetland and sedimentation basin achieve relative to the amount of pollutants generated by the development site. This tables shows that the development is removing significantly more pollutants than is required under the BPEMG Environmental Management Objectives.

Table 3-3: Treatment Train Effectiveness including external catchments

Pollutant	Pollutants generated by development site (kg/yr)	Pollutants removed by treatment system (kg/yr)	Percentage removed from development site
Total Suspended Solids	47200	26500	132%
Total Phosphorus	101	45.6	108%
Total Nitrogen	748	198	64%
Gross Pollutants	9620	9492	248%

A complementary treatment option that could be considered within the development area is the use of rainwater tanks to help to reduce the total volume of runoff from the development. Rainwater tanks could be installed or mandated on some or all dwellings and plumbed to the toilets and other appropriate locations where potable water is not required, like garden taps. This provides a constant reuse demand which reduces the total amount of stormwater runoff. By reducing the total amount of stormwater entering the drainage system there is also a corresponding decrease in the total amount of nutrients and sediment being discharged into the receiving waterways. The rainwater tanks are not proposed to be relied on to provide any flood mitigation storage and have not been included in the MUSIC modelling to date to ensure that they are not being relied upon to meet the performance targets.

3.1 WETLAND

A sedimentation basin of 1100 square metres and a stormwater treatment wetland of 4500 square metres are currently proposed. In addition to the stormwater treatment area of the wetland an additional 10,400 square metres of habitat wetland is proposed. This will provide a total wetland and sedimentation pond area with a footprint at the normal water level of 16,000 square metres. The current design allows for all of these areas to function as one large wetland area with a uniform normal water level. Water will enter the sedimentation basin in the east and then flow through the treatment wetland before passing through into the habitat wetland. This will deliver treated stormwater to the habitat wetland, improving the quality of water for the waterbirds currently using the site. The proposed wetland arrangement is shown in the functional design plans in **Appendix C.**

The sedimentation basin is separated from the wetland area to allow for more frequent maintenance without the need to disturb the wetland. A sedimentation laydown and drying area is also provided within the design. The stormwater treatment and habitat wetlands will appear to be the same continuous wetland area. A cutoff weir will be built at extended detention level of the stromwater treatment wetland to allow for the treatment area of the wetland to be maintained without the need to drain the habitat wetland. Balance pipes with gate valves are also proposed between the two wetland areas to allow for even water levels to be maintained and to allow for either of the waterbodies to be drained independently of the other. The low flow and high flow controls on the water levels will occur in the habitat wetland near the creek to ensure that the wetland system does not short circuit (i.e. water will flow through the entire wetland system).

The design has been undertaken to minimise the required cut volume onsite while maximising the wetland surface area available. Care has also been taken to minimise the impact on the larger living trees within the northern area of the site. Two dead trees which have been identified as large or old trees will be impacted by the design. It is proposed to relocate these two dead trees into the habitat area of the wetland as part of the construction process. This would have significant habitat benefits and in the opinion of Ecocentric would actually increase the habitat value of the dead trees. As standing stags they would provide habitat for the birds using the site and even as the trees degrade further and eventually collapse would create habitat for native fauna such as frogs.

The stormwater treatment wetland will be heavily vegetated with 80 % macrophyte cover and 20 % open water. The sedimentation basin and habitat wetland area will be mainly open water. The first 2.4 meters (horizontally) from the normal water level will grade at 1 in 8 and will be vegetated with macrophytes. Beyond this all areas will be deeper open water. The sediment basin will be up to 1.5 metres deep whilst the habitat wetland will be 1.5 to 2 metres deep. This depth of water is proposed to ensure that an open waterbody is maintained and to allow for aquatic vegetation to establish and not be outcompeted

by the vegetation planted on the shallow edges. Shallower water in the habitat wetland would run the risk of vegetation cover increasing in this area.

3.1.1 Inundation Frequency

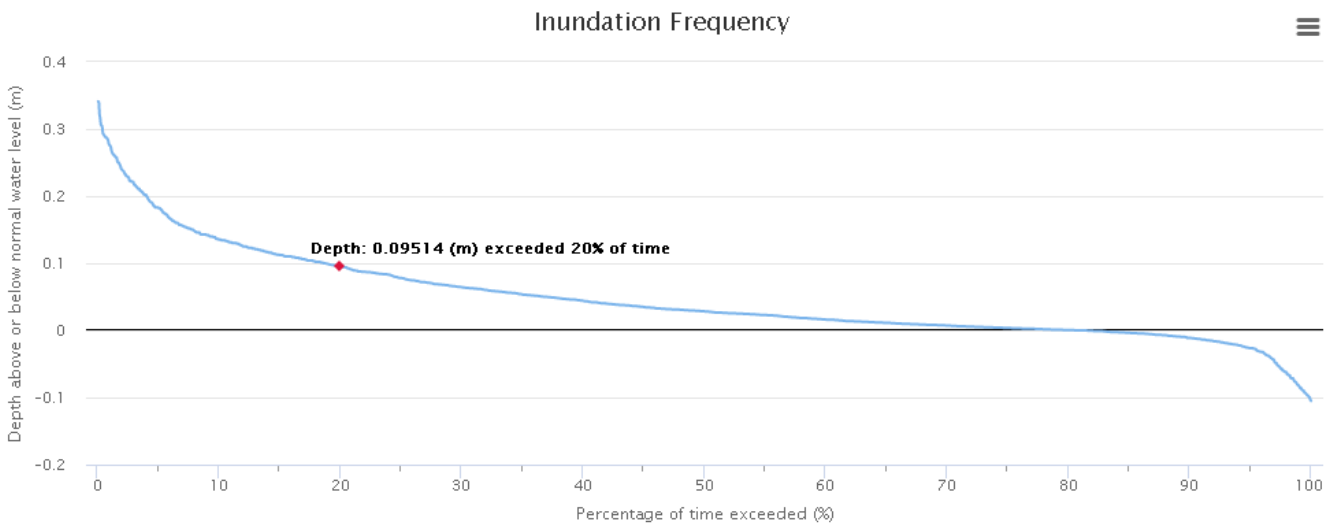
It is estimated that the total permanent pool volume of the wetland will be approximately 21,300 cubic metres. Analysis of the bathymetric survey data suggests that the volume of water storage in the current dam to spillway level is approximately 31,000 cubic metres. The existing dam is generally approximately 1.5 to 2 m deep but is over 4 metres deep in in the south west corner. Depths greater than 2 metres are not desirable in wetland systems. Additional information on the existing dam can be found in section 5.

A preliminary inundation frequency assessment has been undertaken on the whole wetland using cut volumes above normal water level from 12d and estimated permanent pool volumes based on proposed depths. The inundation frequency was assessed using Melbourne Water's MUSIC Auditor. A daily flux file was output for the wetland system which produced the results shown in Figure 3-1. In addition to the information displayed in the figure the:

- Water level exceeded for 20 % of time: 0.095 m
- Water level exceeded for 50 % of time: 0.023 m. Effective water level is within 50 mm of normal water level and is acceptable
- 90th Percentile Residence Time: 9 days
- 300 mm depth in the wetland was exceeded on seven occurrences for one day data set (5 years) analysed.

These results show that the proposed wetland setup provides an acceptable inundation frequency to provide conditions for healthy plant growth.

Figure 3-1: Inundation Frequency analysis



3.1.2 Construction staging

It is proposed that the construction of the habitat wetland occurs before the existing dam onsite is decommissioned. An establishment period would also be allowed so that the vegetation within the deeper waters of the habitat wetland are confirmed to be growing well and are healthy. This will allow the water birds that are currently using the site to transition from the existing dam to the new habitat wetland and will ensure that they will not be left without habitat during the construction process. It is expected that the construction and establishment period for the habitat wetland will take approximately 12 months. Ideally the construction would be timed to minimise the disruption to the breeding water birds at the site, however it is understood that not all water birds breed at the same time of the year and that disruption to some species is likely to be unavoidable. From an engineering perspective it would be easier if the earth moving stages of the construction could be timed to occur in summer or autumn when ground conditions will be easier to work with than in winter or early spring.

3.2 HABITAT CREATION

The existing dam on the site provides habitat for water birds and aquatic vegetation. The Ecocentric report (2017) notes that, *"water quality appears to vary at the site based on prevailing conditions, and was ostensibly relatively poor during winter surveys. Waters were very turbid during field surveys, and a thin 'slick' of a contaminant (i.e. hydrocarbon) was observed on part of the water surface on 5 July 2017".* Currently the water in the dam receives no treatment prior to entering the dam. It is currently fed by an urbanised catchment of approximately 25 ha and approximately 20 ha of the existing horticulture site. The proposed wetland setup should improve the quality of stormwater entering the habitat wetland.

The Ecocentric report (2017) states that two Blue-billed Ducks, a listed species, are residing permanently at the site. It also notes that *"the site lacks the dense marginal vegetation and reed beds (i.e. for nest-building) that are generally associated with the successful breeding of this species (Marchant & Higgins 1990)"*. The report also states that Australian Wood Ducks and the Pacific Wood Ducks are breeding at the site. The proposed wetland system will significantly improve the available breeding habitat for waterbirds, with significantly more dense marginal vegetation and reed beds to be provided within both the treatment and habitat areas of the wetland. Dense screening vegetation would also be planted on the embankment batter slopes to discourage access to the wetland. This vegetation will also provide good habitat for native fauna.

3.3 ADDITIONAL BENEFITS OF WETLAND ASSETS

3.3.1 Integration and public use

The proposed sedimentation basin, stormwater treatment wetland and habitat wetland should be integrated into the development area. Consideration has been given as to how to encourage safe use of the wetland area for the public. There is currently a dual purpose access and maintenance path running between the sedimentation basin and the stormwater treatment wetland. This access path will provide an active link to the Blind Creek corridor. An additional path is also proposed on the western side of the sedimentation basin to provide another link to Blind Creek. A road will run along the southern boundary of the wetland and the existing Blind Creek Trial runs along the northern boundary. It is not proposed to provide a link along the eastern edge of the habitat wetland. This is at the advice of Ecocentric ecologists who have highlighted that providing a path in this location would increase the disturbance of the water birds that this habitat wetland is aiming to attract.

The advice from Ecocentric has been that minimising public access to the wetland will be beneficial for encouraging use of the area by waterbirds. The existing dam on the site currently has no public access and so the development of the site will inherently bring people and their pets closer to the proposed wetland. Using dense vegetative screening around the edge wetland will help to minimise this disturbance and also create habitat for waterbirds and other animals.

3.3.2 Integrated Water Cycle Management

Consideration could be given to allowing harvesting from the wetland system. The total volume of water stored by the wetlands is very large (approximately 21 ML) and a small portion of this could be used for reuse in surrounding areas. A detailed water balance study would be needed to quantify the amount of water that would be harvested without negatively impacting on the function of the wetland area and to determine the reliability of supply to determine if this is feasible. The current design of the wetland would allow for stormwater harvesting if it is deemed feasible.

Possible demand for use of treated stormwater in the adjacent area could come from:

- third pipe system through the development
- Fairhills High School playing fields
- existing community garden on the northern side of Blind Creek
- open spaces within the development area.

In order to safely reuse the stormwater some additional treatment may be necessary.

4 FLOOD MODELLING OF BLIND CREEK

Blind Creek is a Melbourne Water managed waterway. Melbourne Water has indicated that flood modelling of Blind Creek for existing conditions and developed conditions of the site was required.

Melbourne Water provided Engeny with a RORB model and details of the Melbourne Water drainage infrastructure within the creek corridor to use in the flood modelling. Using this information and Lidar data Engeny has created a Tuflow model of Blind Creek from Scoresby Road to Lewis Road. Details of the RORB modelling and the Tuflow modelling techniques are contained in **Appendix D.**

The RORM model shows that the peak flows on Blind Creek occur in the 2 hour event. The peak 1 % AEP flow is 41.8 m^3/s. The full hydrograph from RORB has been used in the Tuflow modelling for both the existing and developed Tuflow models.

A fixed tailwater level was used for the modelling set at the 1 % AEP flood level supplied by Melbourne Water downstream of the development site. This boundary condition provides a conservative estimate of downstream flood levels.

4.1 EXISTING CONDITIONS

For the existing conditions model it was assumed that the existing dam was full to its spillway level of 77.54 m AHD.

Appendix E shows the results from the Tuflow flood modelling for the existing conditions.

The Tuflow modelling results show that the dam embankment is overtopped and that there is flooding in the neighbouring industrial precinct to the west. There is a significant hydraulic control at the point where the Blind Creek Trail crosses over Blind Creek. At this point there is a drop structure and the low flows in the waterway are piped downstream of this point.

The estimated total volume of floodplain storage on the site is 21,000 m^3.

Melbourne Water has provided flood levels for the subject property. These flood levels are recorded in the north west and north east corners of the property. Table 4-1 shows the flood levels provided by Melbourne Water and a comparison to the results from the Engeny flood modelling. The table shows that there is a good match between the two sets of flood levels.

Table 4-1: Flood level comparison

	North West Corner (m AHD)	North East Corner (m AHD)
Melbourne Water flood level	77.0	78.85
Engeny existing conditions flood level	77.06	78.88

4.2 DEVELOPED CONDITIONS

The same base Tuflow model was used for the developed conditions as the existing conditions. The hydrology was unchanged, as were the Manning's n roughness values in Blind Creek and all other areas not impacted by the development works.

The proposed wetlands were modelling using a design DEM from 12d to represent the surface of the proposed wetland. It was assumed that the wetland was full to normal water level at the start of the flood simulation. It was also assumed that all areas of the development site south of the proposed wetland would be filled at least 600 mm above the flood level.

Appendix E shows the results from the Tuflow flood modelling for the developed conditions and also shows an afflux map showing the differences in flood levels between existing and developed conditions.

The modelling shows that there is no change in flood levels upstream of the development area. This includes the neighbouring residential area directly to the east of the development area. The modelling also shows that there is a reduction in flood levels in Blind Creek adjacent to the development area, as a result of the increased storage provided in the floodplain by the new wetland. Downstream of the proposed wetland the modelling shows that there is an increase in flood levels within the waterway

and a decrease in both the flood level and the area flooded in the adjacent industrial areas. Directly downstream of the sedimentation basin there is a moderate increase in flood level over up to 0.2 metres but this is contained to the waterway corridor and dissipates back to zero within 75 metres.

In their predevelopment advice Melbourne Water stated that no increase in flood levels and no net loss of floodplain storage would need to be demonstrated for developed conditions. The proposed works increase floodplain storage but do increase flood levels in Blind Creek downstream of the site. Table 4-2 compares the floodplain storage during existing and developed conditions. It shows that available floodplain storage on the site is proposed to be increased by 12 600 m^3.

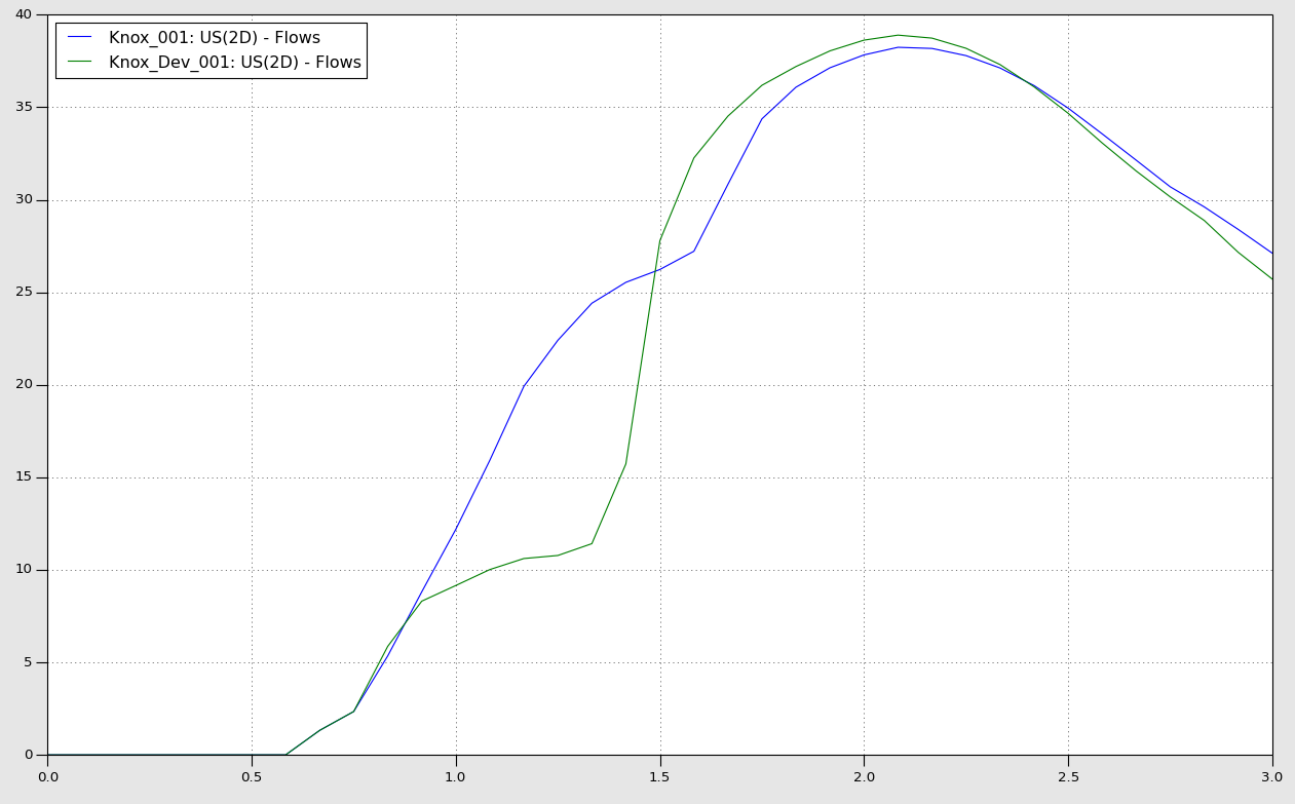
Table 4-2: Floodplain storage in 1 % AEP

	Floodplain storage (m^3)
Existing conditions	21 000
Developed conditions	33 600

The increase in flood levels in Blind Creek is occurring is due to a reduction in flooding of the industrial areas adjacent to the creek. In Engeny's view this is an improvement on existing conditions as more water is being contained within the waterway corridor and additional properties are being protected from flooding by narrowing the flow path and preventing spills into the neighbouring industrial areas. It should be noted that the dam on the site is not a naturally occurring structure and that it is directly contributing to the flooding of some of the adjacent properties by artificially raising flood level upstream of the existing dam embankment wall.

Despite the increase in total floodplain storage there is also a slight increase in the peak flows recorded downstream of development area. Figure 4-1 shows the difference in the existing conditions hydrograph (blue line) and the developed conditions hydrograph (green line). The comparison shows that there is a slight increase in peak flows as a result of reshaping the floodplain, but that the total volume of flow discharging downstream is reduced (i.e. the area under the hydrograph is less under developed conditions).

Figure 4-1: Hydrograph from Tuflow modelling 360 m downstream of the development site



It is noted that the developed conditions flood modelling is based on a DEM from the Engeny 2017 wetland design. This developed case flood mapping will be updated once the current PGA design has been further progressed. It is not expected that there will be any significant changes once the updated design is modelled as the design concept is very similar and achieves similar volumes of excavation and cut within the site.

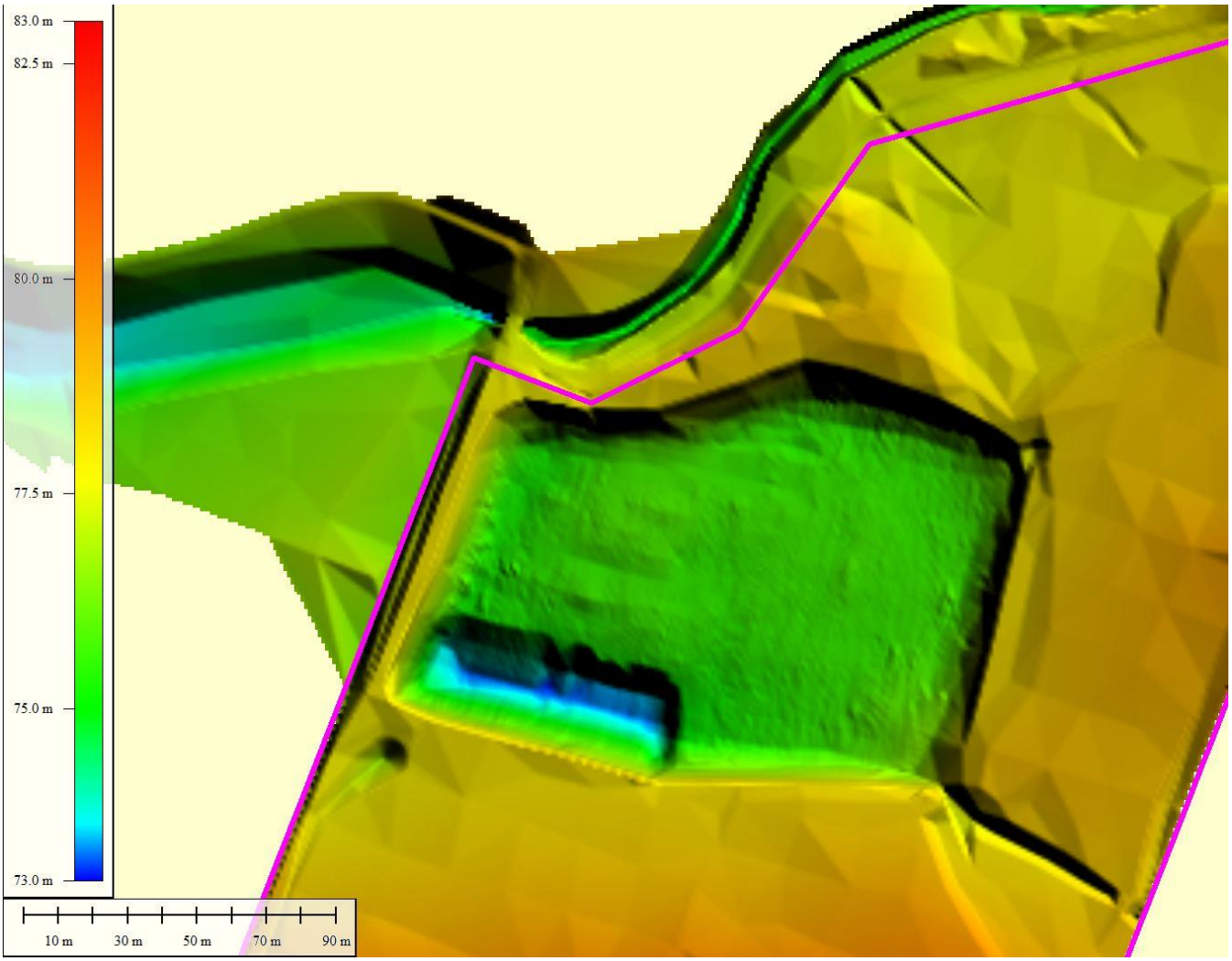
5 EXISTING DAM

A preliminary biodiversity assessment was undertaken by Ecocentric Environmental consulting (2015). The report found that *"the wetland at the site is large in area and provides habitat for wetland birds, including the threatened Blue-billed Duck, which was recorded on site during the current assessment. Any proposal to impact the wetland at the site, through the compete removal, re-design or any other wetland modification, should be undertaken with careful consideration, and planning and in consultation with an ecologist in order to avoid and minimise impacts to significant wetland species (both flora and fauna taxa)".*

In its current form the existing dam is not engineered to provide stormwater treatment. It also currently receives untreated stormwater from the upstream urban catchment. Stormwater treatment wetlands require large areas of shallow water with a high proportion of vegetation cover. They also require gently sloped ephemeral banks which can be subject to regular wetting and drying to assist in sediment and nutrient removal. Given that the dam is over 4 m deep in some parts regrading the internal floor of the dam to be in the order of 1 - 0.5 m deep will require significant filling. Figure 5-1 shows the topography and bathymetry of the dam and surrounding area based on survey undertaken in July 2017.

Maintaining the dam on the site poses a number of challenges and it is likely that better environmental outcomes could be achieved through the removal of this dam and construction of water bird habitat in the adjacent area rather than retrofitting the dam to provide stormwater treatment.

Figure 5-1: Topography and bathometry of the existing dam based on survey data



5.1 CURRENT CONDITION OF THE DAM

The Dam Condition Assessment Report by Engeny 2017 provides details on the current condition of the dam. The condition of the dam is summarised in that report as follows:

Based on the site inspection observations the dam is currently considered to be in fair to poor condition. A number of existing defects / deficiencies were identified which have the potential to lead to dam failure in time if left to progressively deteriorate without intervention.

The desktop failure modes assessment identified that the existing spillway doesn't have capacity to pass even the 63 % AEP event. This is significantly lower than the minimum spillway capacity of 1 % AEP recommended by industry guidelines (ANCOLD) for even low consequence category dams. Overtopping of the dam embankment crest would be expected to occur on a regular basis, which significantly increases the likelihood of dam failure.

The conclusions and recommendations of the dam conditions report state the following:

The Dam is not currently considered fit for purpose and would only be considered to be suitable for on-going use if the following upgrades / remedial works are completed:

- *Upgrade the spillway to provide capacity to convey, as a minimum, the 1 % AEP rainfall event plus the 10 % AEP wave freeboard. To provide the recommended spillway capacity will require raising or relocation of the existing dam embankment. Raising the embankment to ensure that it is not overtopped in a 1 % AEP event may impact on flooding behaviour within Blind Creek and could increase flood levels within the creek in a 1 % AEP event. This would need to be investigated and any increase in flood levels approved by Melbourne Water*
- *Undertake the following remedial works to repair existing dam embankment defects:*
  - *Modify existing uneven embankment surface levels (ruts, depressions, etc) to reduce the likelihood of rill erosion due to concentrated runoff*
  - *Repair longitudinal cracks*
  - *Repair void in downstream shoulder adjacent to pit*
  - *Repair existing erosion on downstream batter in north-west corner of dam and stabilise embankment*
  - *Protect the upstream batter slope from further erosion / steepening / slumping.*
- *Develop an operational plan for the Dam which defines roles and responsibilities, surveillance, monitoring and maintenance requirements.*

5.2 REMOVAL OF THE EXISTING DAM

The key reasons for removing the dam are that the:

- Embankment is of unknown construction materials and quality
- The current condition of the dam is fair to poor. It is unlikely that Council would consider accepting the dam as their asset to manage in its current condition
- The dam does not have a spillway with adequate capacity to pass even moderate rainfall events, with the capacity estimated to be exceeded a 63 % AEP event (1 year ARI)
- The dam embankment is very close to the existing development to the west and the water level is above some of the development, creating a potential issue should the dam embankment fail
- The dam fills with untreated stormwater and its current design is not suitable to provide stormwater treatment. Retro fitting the existing dam to provide stormwater treatment will have a significant detrimental impact on the existing fauna and flora current at the site during construction as heavy earth moving equipment will be required to be used in the dam to flatten the batters on the dam edges. The existing normal water level of the dam (77.54 m AHD) and the incoming invert of the pipe for Fairhills High School (77.88) will make it difficult to provide stormwater treatment upstream of the existing dam but within the development area as there is very little fall between these two points
- The dam provides limited flood storage as it is usually full to full supply level

- The steep batter slopes of the dam below the normal water level do not comply with safety requirements for urban public water bodies. Guidelines from the Royal Life Saving Society Australia (2004) state that safety benches with a maximum grade of 1:8 (V:H) for the first 1.5-3.0 m from the edge of the bank are required prior to transitioning to steeper grades. It also states that the *"safety bench shall be densely planted such that casual entry will be difficult and that depths gradually increase beyond 150-200 mm before deepening."*

Engeny has discussed the existing dam with [redacted] from Ecocentric Environmental Consulting. [redacted] agreed that the current dam is not configured to provide stormwater treatment, and that the works that would be required on the dam to retrofit it to be able to provide the necessary stormwater treatment would be a significant disturbance to the existing fauna and flora. Heavy earthmoving equipment would be required to operate in and around the edge of the dam to create safer shallower batter slopes and the water quality within the dam would be significantly impacted during this works period. The option of constructing a new stormwater treatment and wetland habitat adjacent to the existing dam has the potential to minimise the disturbance to the existing fauna on the site as the construction will be staged so that the new wetland is built before the existing dam is filled in.

6 STORMWATER MANAGEMENT PLAN

This stormwater management plan for 621 Burwood Highway Knoxfield has been developed following discussions with Development Victoria, Knox City Council, Melbourne Water and Ecocentric Consulting. This plan represents a considered design response, however additional minor changes to the operation scheme of the wetlands may be required within the proposed footprints. The review and changes will consider the relevant planning controls, both zoning and overlays, along with the requirements needed to meet the best practice targets for stormwater management.

The stormwater management plan for the site has been designed to:

- Achieve multiple benefits for the environment and the community
- Comply with all environmental requirements
- Solve a number of problems with the existing dam on the site, including the existing dam embankment, poor water quality in the dam, limited flood mitigation effect of the dam, proximity of the dam to Blind Creek and safety problems with the dam water body
- Provide improved habitat compared with the existing dam for all flora and fauna
- Provide public access to a significant new open space area within the site
- Treat runoff to significantly exceed the Best Practice target requirements for treating runoff from the site
- To provide an Integrated Water Management system for the site to reduce potable water demand, wastewater discharges and stormwater runoff.

7 CONSIDERATIONS FOR STAGE 1 AND 2

The initial planning permit for subdivision is for stages 1 and 2 of the development as shown in the plan in **Appendix F**. This section of the report addresses specific issues related to these stages of the development and any associated staging issues. This section also aims to address the queries raised in the letter dated 9 June 2021 from [redacted] of Melbourne Water to [redacted] of Knox City Council in relation to plan number TP 961547B. This letter is attached to this report as **Appendix G**.

7.1 FLOODING

Stages 1 and 2 are the occurring on the areas of the site furthest away from Blind Creek. The applicable 1% AEP flood level of the site as provided by Melbourne Water in the letter dated 9 June 2021 from [redacted] of Melbourne Water to [redacted] of Knox City Council (plan number TP 961547B) range from 78.75 m AHD to 77.0 m AHD. The lowest part of the site being developed as part of stages 1 and 2 has an elevation of approximately 89.0 m AHD (as shown on the contours in the plan in **Appendix F**), indicating that there is over 10 m freeboard between the 1% AEP flood level in Blind Creek and the proposed development.

7.2 OVERALL STAGING AND TIMELINES

There are two planning permit applications which have been lodged, one relating to stages 1 and 3 of the subdivision and the other relating to the development of the wetland. Under this proposed stormwater management plan all of the runoff from the site will be treated in a sedimentation basin and stormwater treatment wetland, prior to flowing into the habitat wetland and then discharging to Blind Creek. As the existing dam provides habitat for waterbirds on the site the proposed construction of the new wetland system is proposed to be staged. This would involve constructing the habitat wetland first and allowing the vegetation to establish. Once established the dam would be drained and animals residing within it could be transferred to the new habitat wetland (or could move themselves in the case of waterbirds). Once the dam was decommissioned the sedimentation basin and stormwater treatment wetland could then be constructed.

This timing is proposed to prioritise providing habitat for the waterbirds currently using this site. It does however mean that the proposed stormwater treatment infrastructure on the site will be constructed later rather than earlier in the development sequence. To address this issue, temporary measures have been proposed and are discussed further in section 7.3 below.

It is currently estimated that it would take approximately 12-18 months to design and construct the habitat wetland and a further 12-18 months for the vegetation to establish to a point where it provides suitable replacement habitat for the waterbirds currently utilising the dam. These estimates do not account for the time that may be required to obtain the planning permit for the wetland. The sedimentation basin and stormwater treatment wetland would be constructed once the habitat wetland has sufficiently established vegetation with an estimated design and construction period of 6-12 months. There is some uncertainty in the construction timeline estimates as the intention is to avoid undertaking construction works during the Blue Billed Duck breeding season where possible and limiting or stopping works if chicks or fledglings are found on the site.

The temporary sedimentation basin and retarding basin are located within stage 6 and so no stages beyond stage 5 can be delivered without the stormwater treatment wetland being constructed.

7.3 INTERIM STORMWATER QUALITY AND QUANTITY MANAGEMENT

The layout plan in **Appendix F** shows the proposed temporary retarding basin and sedimentation basin location. This basin has been sized to provide detention of peak flows up to the 1% AEP event for stages 1-5 of the proposed development. While the first planning permit application is only for stage 1 and 2 Development Victoria is proposing to construct a single temporary basin for stages 1-5 in one instance, rather than building multiple or separate temporary basins to facilitate the initial stages of development. The basin will outfall to an existing drainage swale on the site, which then conveys flows to an existing drainage pipe which discharges into Blind Creek. The retarding basin storage was sized in RORB using ARR 2019 methodologies. It was

determined that 1350 m³ of storage would be required to retard the 1% AEP flows back to predevelopment flow rates. This is the volume that is provided by the temporary retarding basin.

The proposed sedimentation basin was sized using the Fair and Geyer equation based on the catchment area which would be treated. A copy of the calculations is included in **Appendix H**. MUSIC modelling of the sedimentation basin was also undertaken to determine its treatment performance. Table 7-1 shows the treatment performance which the sedimentation basin provides for stages 1 and 2 of the development. Table 7-2 shows the treatment performance which the sedimentation basin provides for stage 1 to 5 of the development. In each of the scenarios the proposed superlot on the corner of Burwood Highway and Scoresby Road remains undeveloped, however the runoff from this undeveloped area is assumed to flow into the sediment basin and retarding basin as the natural topography would make it quite difficult to separate the runoff from this area from the rest of the development area runoff. Runoff from part of the existing DELWP site is also assumed to be captured in this basin once stage 5 is developed.

Table 7-1 shows that the treatment targets are met for suspended solids, total phosphorous and gross pollutants. Total nitrogen removal is 39% compared with a target of 45%.

Table 7-1: Stages 1 and 2 Stormwater Quality Treatment

	Source Loads	Residual Loads	Amount removed	Source Loads less superlot loads	Removal Targets	Percentage removed from development stages
Flow (ML/yr)	31.9	31.4	0.5	27.37	N/A	1.8%
Total Suspended Solids (kg/yr)	6030	1070	4960	5480	80%	90.5%
Total Phosphorus (kg/yr)	12.4	4.88	7.52	11.02	45%	68.2%
Total Nitrogen (kg/yr)	89.8	58.8	31	78.2	45%	39.6%
Gross Pollutants (kg/yr)	1150	0	1150	1020	70%	112.7%

Table 7-2 shows that the treatment targets are met for suspended solids, total phosphorous and gross pollutants. Total nitrogen removal is 27% compared with a target of 45%.

Table 7-2: Stages 1 to 5 Stormwater Quality Treatment

	Source Loads	Residual Loads	Amount removed	Source Loads less superlot and DELWP loads	Removal Targets	Percentage removed from development stages
Flow (ML/yr)	80	79.6	0.4	69.35	N/A	0.6%
Total Suspended Solids (kg/yr)	15300	4310	10990	13670	80%	80.4%
Total Phosphorus (kg/yr)	32	15.2	16.8	28.29	45%	59.4%
Total Nitrogen (kg/yr)	227	172	55	198.4	45%	27.7%
Gross Pollutants (kg/yr)	2930	0	2930	2574	70%	113.8%

Under both of these scenarios, stages 1 and 2 and stage 1 to 5 being developed there is a shortfall in pollutant removal of nitrogen compared to the best practice targets. The reason for the shortfall is that the temporary sedimentation basin, which has been sized in accordance with Melbourne Water's guidelines utilising the Fair and Geyer calculation and not oversized to improve MUSIC modelling performance, is not able to meet the best practice targets alone and at this stage no additional treatment measures are proposed. Typically in a development of this size the permanent stormwater treatment assets would be constructed alongside some of the initial stages of development. As discussed in section 7.2 that is not proposed to occur on this site due to the proposed staging of the wetland construction which provides for continual habitat for the waterbirds on the site. The trade off for being able to do this is that the permanent stormwater treatment assets are delivered alongside later stages of the development. Engeny believes that this is a reasonable trade off given that total phosphorus targets are met under for stages 1 to 4 and total suspended solids are also close to being met for those stages too. These two pollutants are typically more critical to waterway health than total nitrogen, on which the shortfall is greater. The shortfall is also only temporary and the permanent works easily exceed the treatment targets. Table 3-3 shows that the stormwater treatment wetland and sedimentation basin remove 132% of the total suspended solids, 108% of the phosphorus, 64% of the total nitrogen and 248% of the gross pollutants generated by the site. This modelling also assumes that there is no stormwater treatment occurring within the habitat wetland, if even some moderate level of treatment was assumed these removal numbers would be even higher.

Given that the temporary assets are located in stage 6, no development can proceed beyond stage 5 without the permanent works being established on the site which gives Council and Melbourne Water a clear limit to the development before the ultimate works are established but also allows Development Victoria to sell approximately half of the lots on the site to fund the construction costs for the habitat wetland and stormwater treatment wetlands which are significant and expensive assets.

7.4 WETLAND ONLINE/OFFLINE CLARIFICATION

The proposed ultimate sedimentation basin, stormwater treatment wetland and habitat wetland (the wetland system) are all offline to low flows on Blind Creek. Given their proximity to the creek they are located within the floodplain of Blind Creek and will be inundated during flood events, with the degree of inundation varying depending on the AEP of the event (minor inundation in the 20% AEP event to significant inundation in the 1% AEP event. The existing dam on the site is also within the Blind Creek floodplain and is also subject to inundation from Blind Creek, although as it is located slightly higher on the site than the proposed wetland, and thus the frequency of inundation is slightly less than for the proposed wetland (it also provides worse flooding outcomes on neighbouring properties than the proposed wetland system).

The wetland system is online to all flows from the local catchment, which includes all of the development site, areas of the remaining DELWP site fronting Burwood Highway and an existing developed catchment which includes Fairhills High School and an area of residential development to the east of Scoresby Road. Appendix Figure A- 1 in **Appendix A** shows the catchment layout plan. The wetland system needs to be online to this entire local catchment to provide the runoff necessary to keep the wetlands full (wet) throughout the year and to keep the residency time of the water to a minimum to help maintain good water quality. This is the same hydrological setup as the existing dam on the site, which receives runoff from the development site and the external developed catchment. It should be noted that the runoff currently entering the dam from the existing developed areas does not receive any pre treatment before entering the dam.

Within the wetland system water will first flow into the sedimentation basin and then into the stormwater treatment wetland. The current proposal is for these two waterbodies to operate with the same normal water level and extended detention depth (however with the ability to drain the sedimentation basin without draining the wetland below normal water level), however the operating levels of sedimentation basin can be raised slightly if required. It is also currently proposed to have the stormwater treatment wetland and habitat wetland operating at the same normal water levels with balance pipes linking the stormwater treatment and habitat wetlands would be linked via a control pit. A physical bund can be included between the two wetlands, however the preference is to maintain as close as possible to a continuous wetland system and also to avoid creating a high enough bund or wall which could be used as an informal "bridge" or access path through the wetland. The exact details of the separation between the two wetlands can be discussed with Council and Melbourne Water during the detailed design, however the habitat wetland will need to obtain its water from the treatment wetland so water will need to be able to flow from the treatment wetland, through the habitat wetland and out into Blind Creek.

7.5 HABITAT WETLAND DEPTHS

Figure 7-1 shows the digital elevation model and elevation contours of the existing dam. The levels within the dam are of the floor of the dam and were captured via bathymetric survey. Figure 7-2 and Figure 7-3 show two cross sections through the dam along the lines AA and BB shown in Figure 7-1. The figures show that the average depth of the dam, when full is approximately 1.5 to 2 m. There is a small section in the south west corner of the dam which is up to 4 m deep. This area was likely constructed as a sump in the dam and may have been used as a borrow pit to extract material to construct the dam wall. The previous utility for the dam and its intent when it was constructed (prior to the acquisition of the site by Development Victoria) was to provide irrigation water for the horticultural activities which were a significant use of the site.

The proposed habitat wetland will aim to mimic but improve on the bathymetry of the existing dam. The habitat wetland will feature safe batter slopes of 1 in 8 extending at least 2.4 m from the normal water level into the waterbody. This will also provide for dense fringing reed beds around the edge of the wetland, a habitat feature which is missing from the majority of the existing dam as the banks are quite steep. After the safety bench the habitat wetland will transition to a depth of 1.5 to 2 m at slopes of up to 1 in 3 to maximise the area of deep water. An undulating base is proposed to try and mimic a more naturalised system and avoid a largely flat engineered base. This will mean that the majority of the habitat wetland will remain as open water and will be planted with the same species of plants which currently occur in the base of the dam. If possible, some plants will be relocated from the dam to the habitat wetland.

Figure 7-1: DEM and contours of existing dam

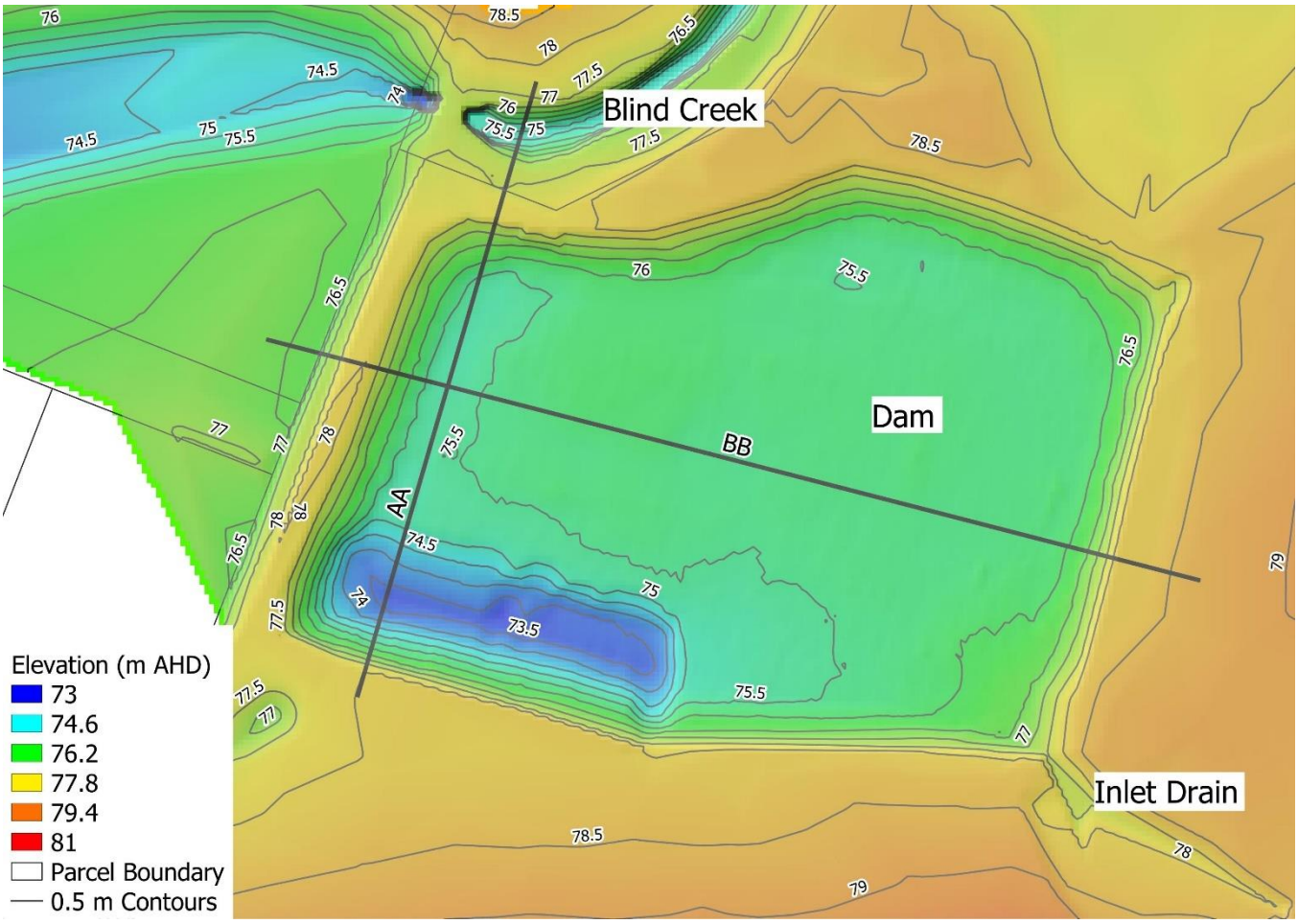


Figure 7-2: Cross section AA

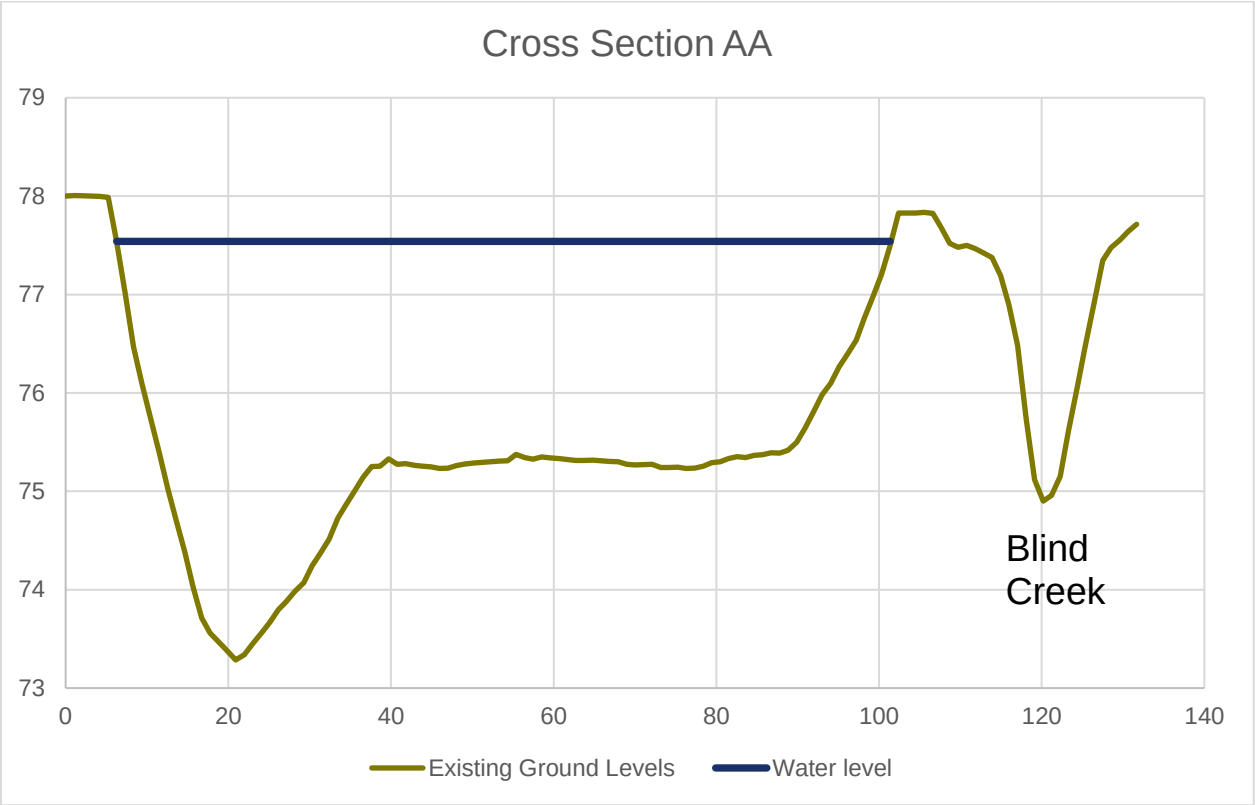
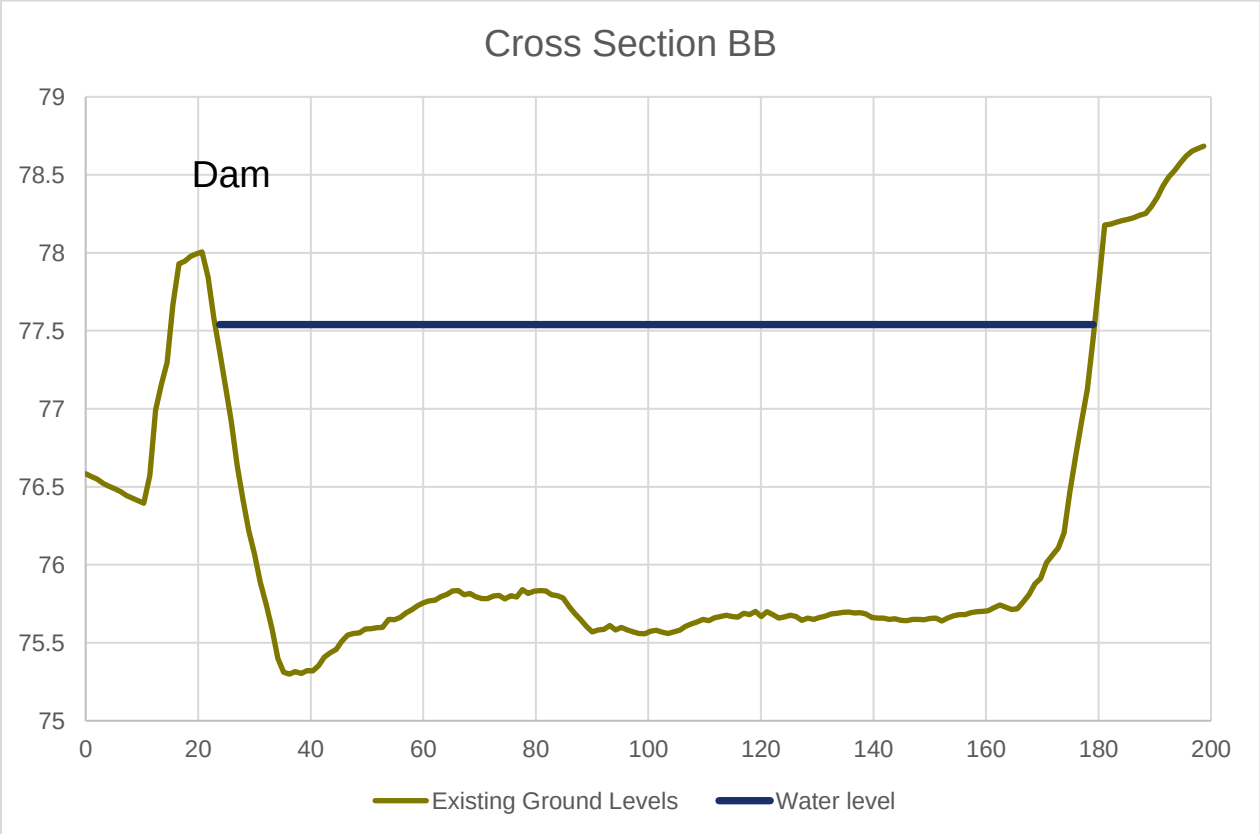


Figure 7-3: Cross section BB



8 CONCLUSIONS AND RECOMMENDATIONS

Engeny has assessed the extent of works that are required to manage the stormwater quantity and quality issues associated with the development of the property at 621 Burwood Highway in Knoxfield.

The developer will be required to limit the peak outflows from the site to the current existing condition flows. This will require the construction of a retarding basin with approximately 3,000 m^3 of active storage. The most logical location for this retarding basin is in the north of the site adjacent to Blind Creek as all of the site can be drained to this location. At this location it could also be co-located with a wetland to provide stormwater treatment.

The developer will also be required to treat the stormwater runoff from the site to meet best practice environmental guidelines. The most cost effective and lowest maintenance way to achieve this would be with a single wetland and sedimentation basin system located adjacent to Blind Creek. The design work undertaken in MUSIC suggests that a 1100 m^2 sedimentation pond and a 4500 m^2 wetland will meet this best practice targets.

The existing dam on the site has been identified as having environmental values, in particular as a habitat for waterbirds including the blue billed duck. Despite its environmental values it poses a management challenge as it was originally constructed as a dam and not designed as an urban water body with unrestricted public access. Engeny recommend removing the dam and constructing a stormwater treatment wetland and waterbird habitat wetland on the adjacent vacant land to the north east of the existing dam. The construction of the habitat wetland will be staged so that the current dam is maintained in its existing condition throughout the construction period. A consequence of staging the construction in this way is that the permanent treatment assets will be built after the habitat wetland. Temporary treatment and retardation works are proposed in the form of a sedimentation basin and retarding basin which are able to fully retard the 1% AEP flows to predevelopment levels and meet fully or partially meet the treatment targets.

Flood modelling has been undertaken to model the impact of the development on upstream and downstream flood level. Net floodplain storage is increased under the currently proposed wetland system. Flood levels upstream of the development area are not increased and while flood levels downstream do increase within a localised area of Blind Creek, there are significant reductions in flood levels in the adjacent industrial area which offsets those minor increases which are contained to the waterway corridor.

9 QUALIFICATIONS

a) In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

   i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or

   ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

d) Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the works, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works. All limitations of liability shall apply for the benefit of the employees, agents and representatives of Engeny to the same extent that they apply for the benefit of Engeny.

e) This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this Report.

f) If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the Report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.

g) This Report does not provide legal advice.

10 REFERENCES

CSIRO 1999, *Urban Stormwater Best Practice Environmental Management Guidelines (BPEMG).*

Ecocentric Environmental Consulting 2015, *Preliminary Biodiversity Assessment 609-619 & 621 Burwood Highway Knoxfield.*

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Engeny, 2017 *Dam Condition Assessment Report – 621 Burwood Highway, Knoxfield.*

Marchant, S. & Higgins, P. J. (eds) (1990). *Handbook of Australian, New Zealand & Antarctic Birds*. Vol 1A: Ratites to Ducks. Oxford University Press: Melbourne.

The Royal Life Saving Society Australia, 2004, *Royal Life Saving Guidelines for Water Safety in Urban Water Developments*.

GHD 2015, *621 Burwood Highway, Knoxfield Development Assessment.*

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Appendix A:
Hydrologic Calculations and RORB Model Parameters

A.1 RORB MODEL SUBCATCHMENT PARAMETERS

Subcatchments within the development area were delineated using local elevation contours and the proposed development densities (Figure 2-1). An additional subcatchment was drawn over the existing dam, with the model assuming the relocation of this waterbird habitat. Catchments were also delineated to represent external inflows from the existing residential area to the east and the DELWP Precinct to the south, using elevation contours and the existing drainage network. An overview of the RORB Model layout utilised is provided in Appendix Figure A- 1.

Fraction impervious values for these subcatchments varied across the modelled scenarios. Appendix Table A- 1 summarises the fraction impervious values applied within the various models. Aerial imagery and planning zones were utilised to calculate these values in the existing development scenarios. The Development Masterplan (Figure 2-1) was utilised to assign representative fraction impervious values to select subcatchments within the future development scenarios.

Appendix Table A- 1: RORB Subcatchment Area and Fraction Impervious Values (Existing Conditions)

Subcatchment	Area (km^2)	Existing Conditions		
		Direct Fraction	Indirect Fraction	Total Fraction Impervious
A (Proposed Wetland)	0.012	0.166	0.834	0.277
B (DELWP Precinct)	0.019	0.152	0.848	0.253
C (Fairhill High School)	0.020	0.014	0.009	0.023
D (Existing Residential)	0.023	0.192	0.808	0.32
E (Existing Residential)	0.011	0.361	0.639	0.601
F (Existing Residential)	0.024	0.031	0.021	0.052
G (Existing Residential)	0.017	0.010	0.006	0.016
H (Proposed Wetland)	0.022	0.000	0.000	0
I (Development)	0.034	0.367	0.633	0.612
J (Development)	0.059	0.36	0.64	0.6
K (Development)	0.071	0.36	0.64	0.6
L (Development)	0.058	0.37	0.63	0.616
M (Development)	0.061	0.25	0.75	0.423
N (Development)	0.008	0.00	0.00	0
O (Development)	0.021	0.00	0.00	0
P (Former Dam – Development and Wetland)	0.011	0.00	0.00	0
Q (Former Dam – Proposed Wetland)	0.016	0.00	0.00	0

Appendix Table A- 2: RORB Subcatchment Area and Fraction Impervious Values (Developed Conditions)

Subcatchment	Area (km^2)	Developed Conditions		
		Direct Fraction	Indirect Fraction	Total Fraction Impervious
A (Proposed Wetland)	0.000	0.06	0.04	0.1
B (DELWP Precinct)	0.000	0.361	0.639	0.601
C (Fairhill High School)	0.000	0.25	0.75	0.423
D (Existing Residential)	0.000	0.37	0.63	0.616
E (Existing Residential)	0.000	0.367	0.633	0.612
F (Existing Residential)	0.000	0.36	0.64	0.6
G (Existing Residential)	0.000	0.36	0.64	0.6
H (Proposed Wetland)	0.000	0.06	0.04	0.1
I (Development)	0.000	0.577	0.423	0.961
J (Development)	0.000	0.535	0.465	0.891
K (Development)	0.000	0.508	0.492	0.847
L (Development)	0.000	0.482	0.518	0.804
M (Development)	0.000	0.494	0.506	0.823
N (Development)	0.000	0.538	0.462	0.896
O (Development)	0.000	0.462	0.538	0.77
P (Former Dam – Development and Wetland)	0.000	0.43	0.57	0.724
Q (Former Dam – Proposed Wetland)	0.000	0.06	0.04	0.1

A.2 RORB MODEL STANDARD PARAMETERS

Local rainfall IFD data for the Knoxfield area was sourced from the Bureau of Meteorology. Prebursts were also applied to the rainfall burst to model complete storms. The preburst patterns were applied using the default patterns built into the RORB model. For durations less than 1 hour, 1 hour preburst depths were adopted (as no specific data for those durations is available from the datahub). For events for frequent that the 50 % AEP the 50 % AEP ratio of preburst to burst was adopted (as no specific data for those events is available on the data hub). In line with the Victorian specific ARR loss guidance note the 75% percentile preburst depths were applied as the catchment falls within loss zone 3.

Standard parameters utilised across the various RORB models are sourced from ARR Data Hub, outlined in Appendix Table A-3. 4 shows the loss values used for the rural, effective impervious and indirectly connected areas. The same loss values were used for all scenarios of the model and are based on the ARR datahub losses and guidance provided within ARR 2019.

Appendix Table A- 3: RORB Model Parameters

Model Scenario	k_c	m
Existing Conditions	1.03	0.8
Developed conditions no wetland	1.00	0.8
Developed Conditions wetland included	1.00	0.8
Stage 1-5 Developed	1.02	0.8

Appendix Table A- 4: RORB Model Losses

Loss	Loss
Rural initial loss (IL)	23 mm
Rural continuing Loss (CL)	3.8 mm/hr
Indirectly connected area initial loss (70% of rural IL)	16.7 mm
Indirectly connected area continuing loss	2.5 mm/hr
Effective impervious area initial loss	1.5 mm
Effective impervious area continuing loss	0 mm/hr

The k_c was calculated using the Dandenong Valley Authority (DVA) k_c Equation. The catchment being modelled falls within the greater Dandenong Creek catchment. The kc was adjusted to for the development runs to maintain the same k_c/d_{ave} ratio as in the existing conditions model as some reaches were removed or realigned as part of the changes of the proposed development.

Appendix Table A- 5 and Appendix Table A- 6 shows the stage storage relationships used in the RORB modelling and the overflow weir details respectively of the developed conditions retarding basin.

Appendix Table A- 5: Stage Storage curve for RORB model

Elevation (m AHD)	Storage Volume (m3)
76.850	0
76.900	912.8
77.000	2828.1
77.100	4868.0
77.200	7013.4
77.300	9229.9
77.400	11492.1
77.500	13795.9
77.600	16140.8
77.700	18526.8
77.7500	19734.3

Appendix Table A- 6: RORB outflow setup details

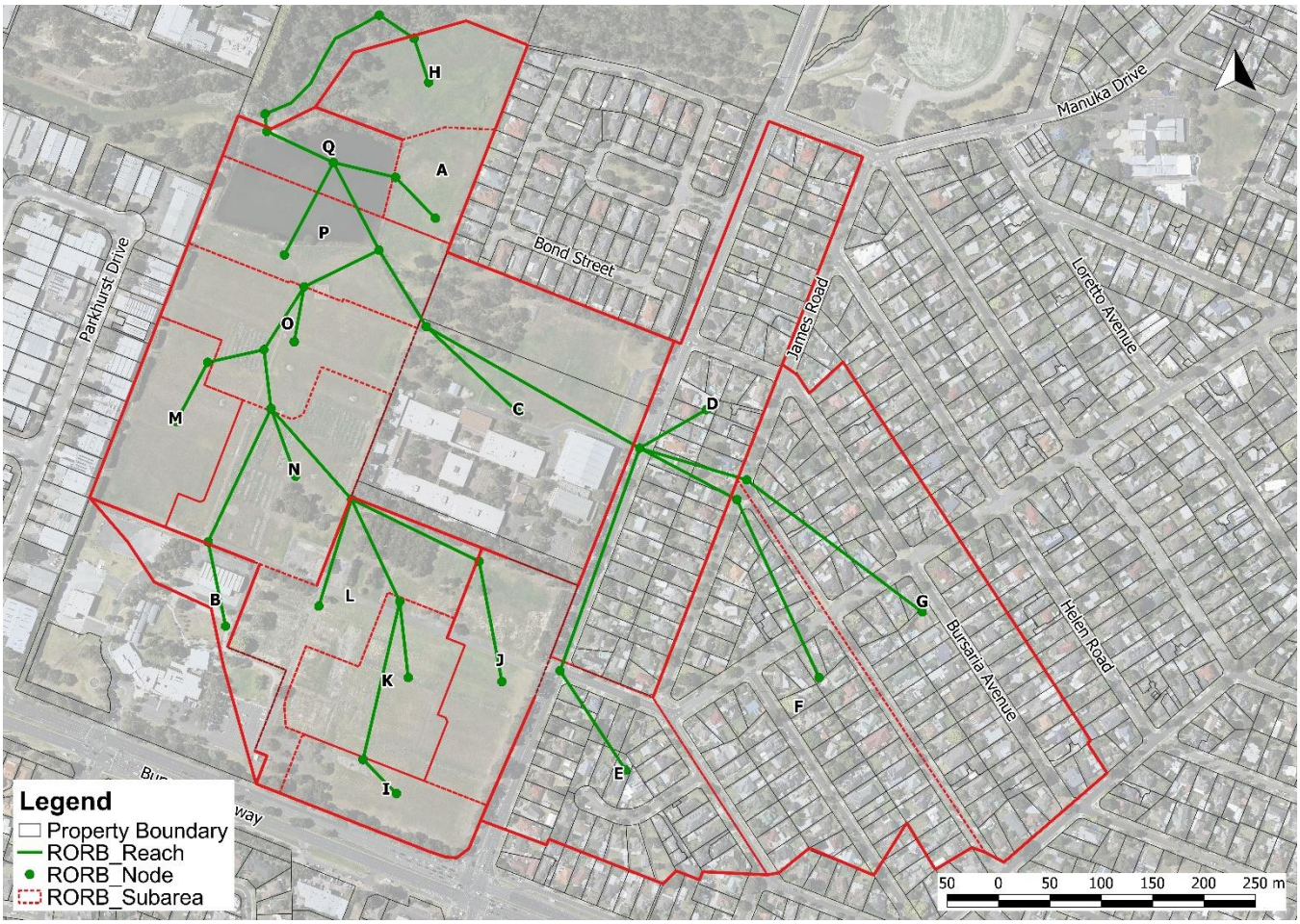
Crest Elevation (m AHD)	Weir Length (m)
76.85 (at EDD level)	8.0
77.70 (blockage or extreme event overflow only)	20.0

Appendix Table A- 7 shows the peak discharge and storage above the extended detention depth achieved in each AEP event under developed conditions.

Appendix Table A- 7: RORB Storages and outflows

AEP event	Peak outflow (m^3/s)	Critical duration	Median Temporal Pattern	Storage (m^3) (above EDD)	Peak Water Level (m AHD)
0.5	3.0775	1 hour	tp4	0	76.85
0.2	4.5543	15 min	tp5	92.2	76.86
0.1	4.7874	30 min	tp12	976	76.9
0.05	5.0625	15 min	tp13	1660	76.94
0.02	5.4496	30 min	tp28	3030	77.01
0.01	5.5778	30 min	tp24	3940	77.05

Appendix Figure A- 1: Existing Conditions RORB Model Layout



Appendix Figure A- 2: Developed Conditions RORB Model Layout

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Appendix B:
Water Quality Calculations and MUSIC Model Parameters

B.1 MUSIC MODEL PARAMETERS

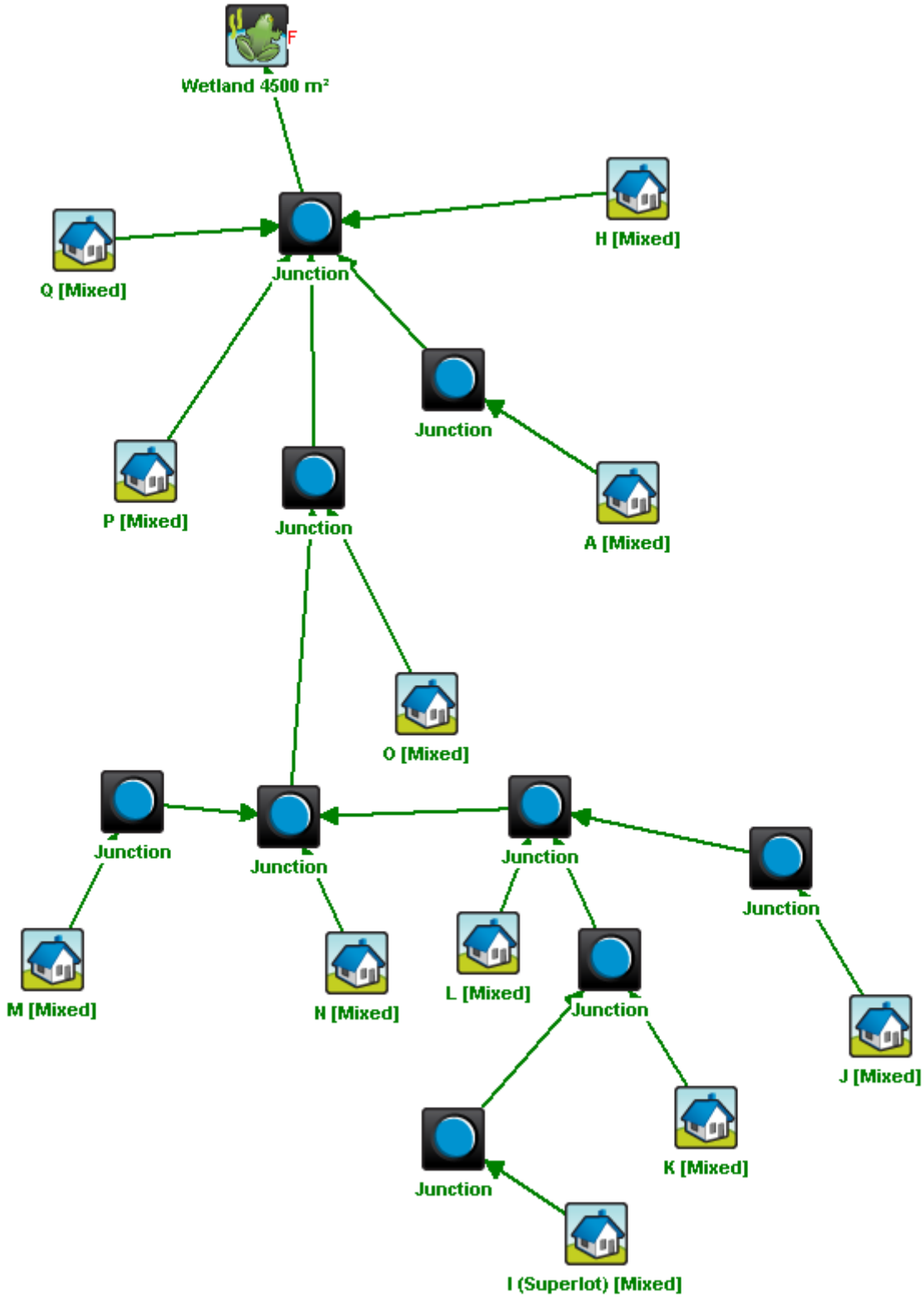
The MUSIC model was designed and input parameters specified as generally as per the Melbourne Water MUSIC Guidelines (2016). The rainfall template utilised was supplied by Knox City Council and includes five years of rainfall data.

A simplified version of the RORB subcatchment layout was used to develop the MUSIC model, external catchments with similar fraction impervious values were merged. The catchment was modelled with seven urban nodes to represent the varying residential housing densities within the Knoxfield Development, the DELWP Precinct to the south and the established residential area to the east. Appendix Figure B- 1 provides an overview of the MUSIC model setup that was used to assess the treatment for development areas. Appendix Figure B- 2 shows the MUSIC model setup for the whole catchment that was used to assess the inundation frequency of the wetland system.

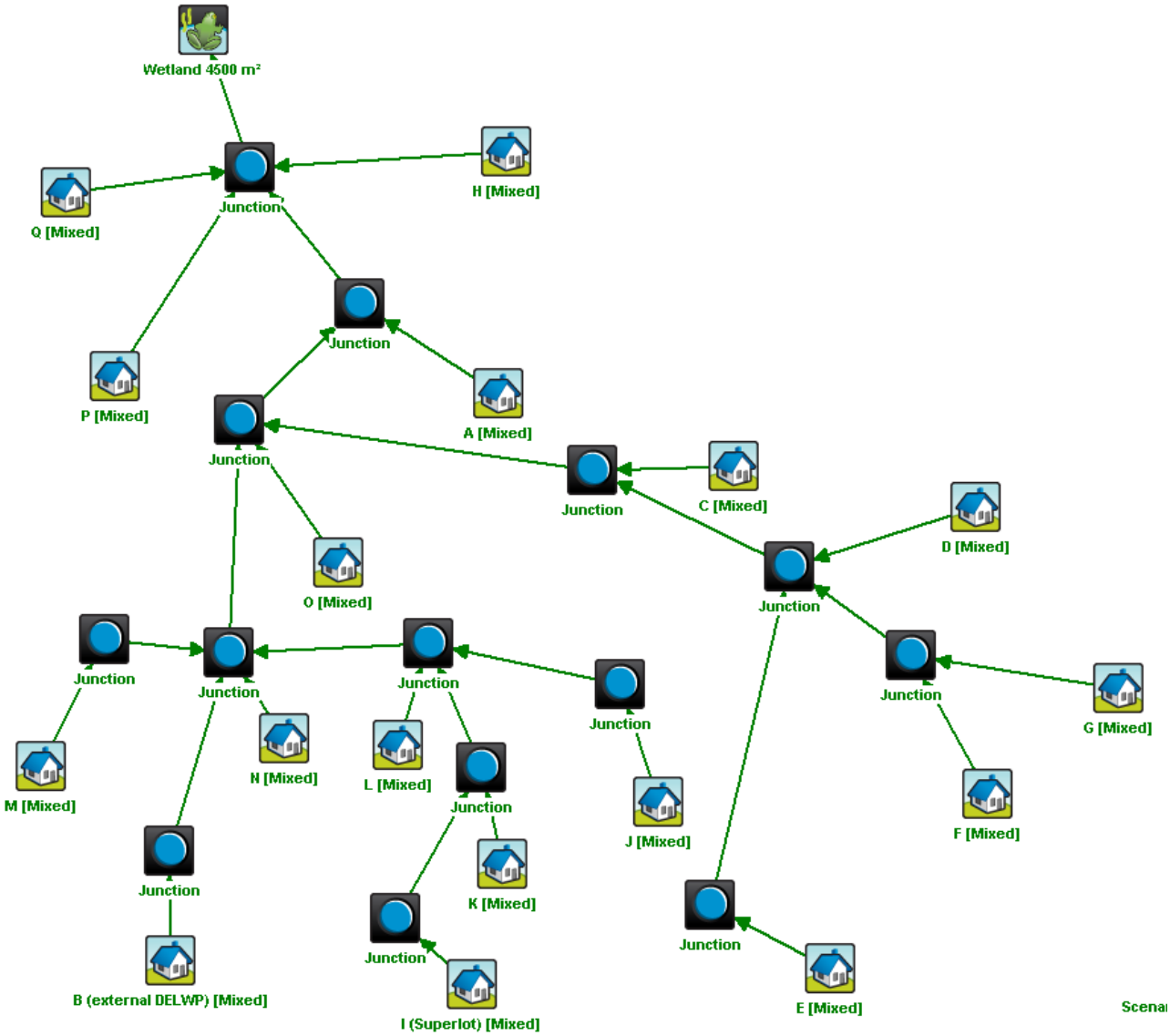
The sediment pond was sized using the Fair and Geyer Equation. A 1,100 square metre basin was calculated to meet the target of 95 % particle capture efficiency, for combined inflows from the Site and the neighbouring residential and commercial areas.

The sediment basin was subsequently modelled as an inlet pond of 707 cubic metres in volume, assuming a rectangular shape incorporating safety benches. The wetland was sized using an iterative process to achieve the BPEMG targets outlined in Table 3-1.

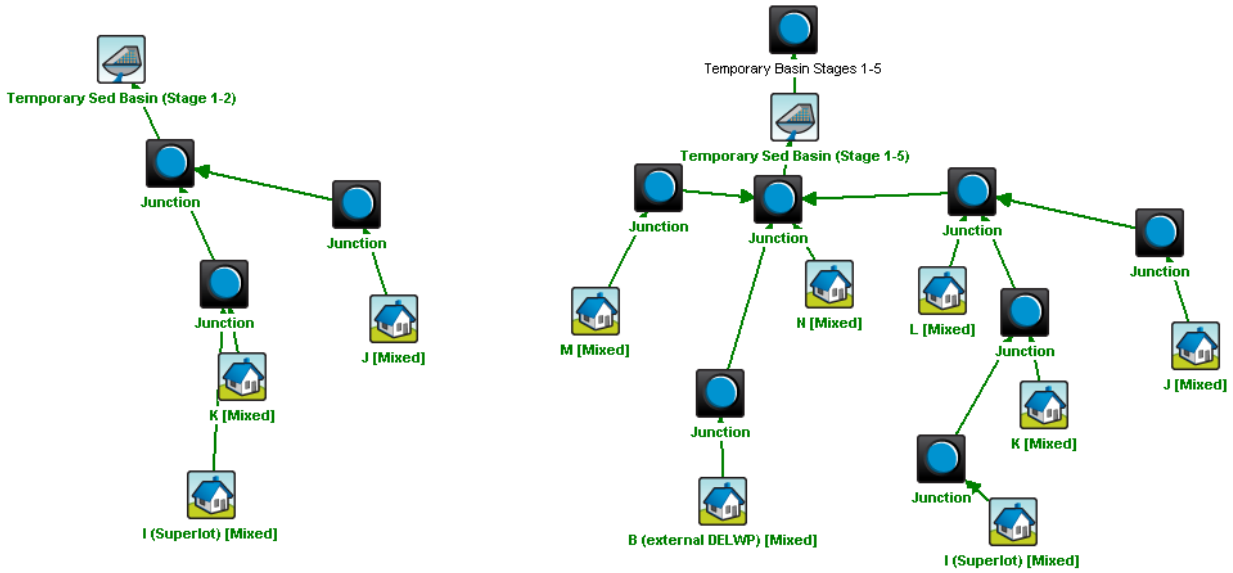
Appendix Figure B- 1: MUSIC Model Layout for Development Area



Appendix Figure B- 2: MUSIC Model Layout for Whole Catchment



Appendix Figure B- 3: MUSIC Model Layout Temporary Sedimentation Basin



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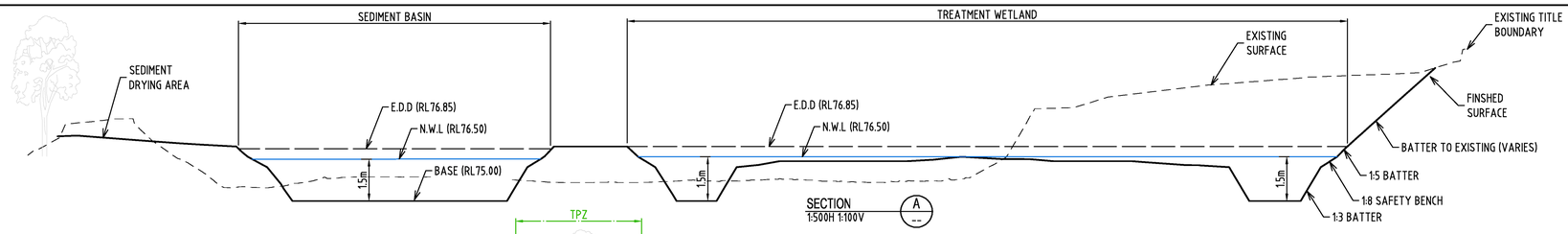
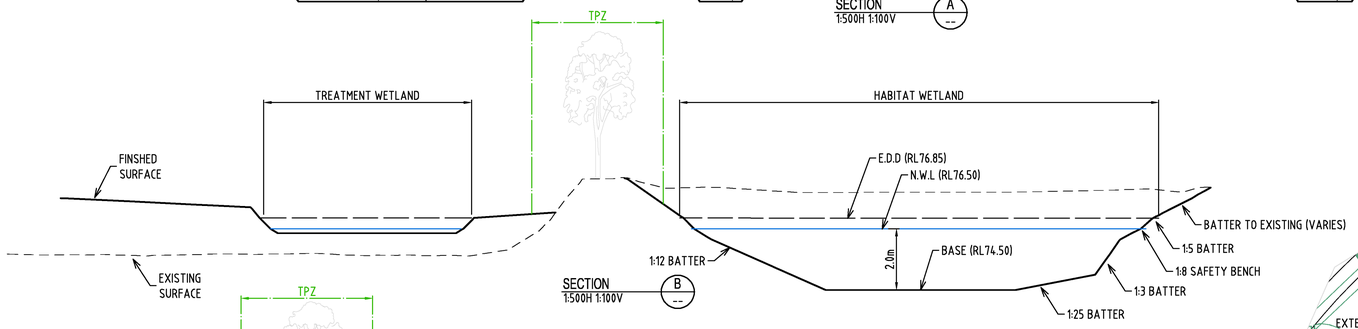
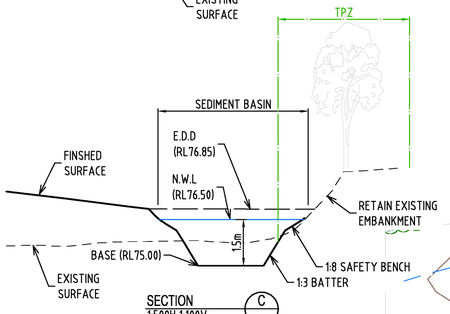
Appendix C:
Proposed Wetland Design Plans







NOTE:
WETLAND SECTIONS INCLUDE A FIVE TIMES VERTICAL SCALE EXAGGERATION FOR CLARITY OF DESIGN ELEMENTS. ALL BATTERS ARE IN ACCORDANCE WITH MELBOURNE WATER DEEMED TO COMPLY GUIDELINES FOR WETLAND CONSTRUCTION (BEST PRACTICE). WETLAND BATTER SLOPES SHOWN ARE INSTANTANEOUS AND VARY THROUGHOUT THE WETLAND TO CREATE DETAILED UNDULATIONS.

LEGEND

- TOP OF EXTENDED DETENTION (T.E.D) (RL76.85)
- NORMAL WATER LEVEL (N.W.L) (RL76.50)
- TOE OF SAFETY BENCH (76.15)
- BASE OF HABITAT WETLAND (RL74.50)
- BASE OF WETLAND/SED BASIN (RL75.00)
- TOP OF DEEP MARSH ZONE (RL76.35)
- TOP OF SHALLOW MARSH ZONE (RL76.40)
- CONSTRUCTION LEVEL LINE

PRELIMINARY
NOT FOR CONSTRUCTION

REV	DESCRIPTION	CHECKED	APPROVED	DRAFTED	DATE
3	AMENDED TO ADDRESS RFI RESPONSES	[redacted]			10.02.2022
2	CONSULTANT COMMENTS ADDRESSED				09.11.2020
1	WETLAND AMENDED				02.11.2020
0	ISSUED FOR COMMENT				02.11.2020

SCALE 1:1000 @ A3
1: 500 @ A1
0 5 10 15 20 25m

PGA REF: E20101
DESIGN BY: [redacted]
SURVEY BY: CRA SURVEYORS
APPROVED FOR CONSTRUCTION BY: –
APPROVED DATE: –

[redacted]

KNOXFIELD
CNR BURWOOD HWY & SCORESBY ROAD
KNOX COUNCIL

SED BASIN & WETLAND LAYOUT PLAN & SECTIONS

DEVELOPMENT VICTORIA

SCALE @ A1:	DRAWING No.:	REV.:
1:500	E20101 - FP-01	3

FILE: E:\ULC\KNOXFIELD\E20101 – WETLAND RB\1.DRAWINGS\2.2D CAD (DWG)\3.CURRENT\WETLAND LAYOUT.DWG

PLOT INFO: [redacted] @ 2:47 PM ON February 10, 2022

ENGENY
WATER MANAGEMENT

Appendix D:
Blind Creek RORB and Tuflow modelling

D.1 RORB MODEL

Melbourne Water provided Engeny with a RORB model for the Blind Creek catchment. The RORB model was run in accordance with the parameters specified in the model and as confirmed with Melbourne Water. These key parameters were:

- Kc = 19.83
- m = 0.8
- Initial Loss (IL) = 10 mm
- 1 % AEP event Runoff Coefficient = 0.6
- Filtered Temporal patterns
- Uniform Aerial Pattern
- Areal Reduction Factor in accordance with ARR87 Book 2 (replace total catchment area with a value of 20 km^2)

Appendix Table D- 1: Blind Creek RORB IFD data

Variable	Blind Creek Values
2 year 1 hour intensity	18.5
2 year 12 hour intensity	4.9
2 year 72 hour intensity	1.4
50 year 1 hour intensity	36.5
50 year 12 hour intensity	8
50 year 72 hour intensity	2.5
Skew	0.36
F2	4.28
F50	15
Zone	1

The model was run for the full range of 1 % AEP storms from 10 minute to 72 hour using Australian rainfall and runoff 1987 intensity frequency duration data (as shown in Appendix Table D- 1). The 2 hour event was identified as having the greatest peak flow just upstream of the development site and so this event was used in the assessment of both existing and developed conditions.

The flow input to the Tuflow model were taken from the RORB hydrograph identified in the RORB model outputs as “59 Calculated hydrograph, Downstream Scoresby Rd”.

D.2 TUFLOW MODELLING

A Tuflow model was developed for the study area. The layout of the model is shown in Figure 1-1. The model extents from Scoresby Road to Lewis Road and was wide enough to encompass the entire floodplain. A flow vs time inflow boundary was used at the upstream end of the model to insert flows into the model and a fix level head vs time boundary was used at the downstream end of the model to drain the water out. The head level was based on Melbourne Water’s 1 % AEP flood level at Lewis Road. The Mannings roughness values were assigned back on inspection of an aerial photograph from NearMap and on observations made on the site visit. All areas were initial assigned a value corresponding to remainder of parcel (representing gardens and fences in backyards of properties) and individual values were applied based on the land use as per the aerial photography. Appendix Table D- 2 shows the Mannings n values used in the Tuflow modelling.

Appendix Table D- 2: Mannings n values used in Tuflow model

Mannings value	Material designation in Tuflow	Land use description
0.35	1	High Density Residential
0.2	2	Low Density Residential
0.035	3	Open Paddock
0.06	4	Open Paddock with moderate Trees
0.5	5	Commercial & residential building footprints
0.03	6	Car Park/Road
0.09	7	Paddock with high density trees
0.08	8	Remainder of parcel (Residential high density)
0.12	9	Railway line

The model was run on a 2 metre grid with a 0.5 second time step. The ground surface levels were based on LiDAR data of the site for the existing conditions model. In the developed conditions model the a design DEM of the proposed wetland was input to the model from 12d and all areas on the development site south of the wetland were raised above the flood level.

An initial water level was applied to the dam in the existing model to represent that it could be full to spillway level (77.54 m AHD) in a flood level. In the develop scenario modelling the initial water level in the wetland was set to 75.85 m AHD, which matches the extended detention depth of the wetland.

Melbourne Water confirmed during a meeting in November 2020 that the flows utilised in the original TUFLOW modelling in 2017 and documented in this appendix are still the current flow estimates for Blind Creek despite the fact that they are calculated using ARR 1987 methodology.

Legend

- Development Site Boundary
- 2d Boundary Condition
- Pits
- Pipes
- 1d Boundary Condition
- 2d Loc Line Orientation
- Plot Output Line
- Model Code Boundary

Mannings Land Use Roughness

- Open Paddock
- Open Paddock Moderate Trees
- Building Footprint
- Road/Carpark
- Paddock with High Density Trees
- 2d Initial Water Level

[redacted]

100 0 100 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

Data Source: DELWP: VicMap - Sep 2016

621 Burwood Highway Knoxfield

Tuflow model setup

Job Number: V1158_003
Revision: 0
Drawn: [redacted]
Checked: [redacted]
Date: 25/7/2017

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WATER MANAGEMENT

Appendix E:
Flood Maps

Legend

Change in Flood Level

- <= -0.09 m
- -0.09 - -0.07 m
- -0.07 - -0.05 m
- -0.05 - -0.03 m
- -0.03 - -0.01 m
- -0.01 - 0.01 m
- 0.01 - 0.03 m
- 0.03 - 0.05 m
- 0.05 - 0.07 m
- 0.07 - 0.09 m
- > 0.09 m
- Was flooded, now not flooded
- Was not flooded, now flooded
- Flow comparison location

PARKHURST DRIVE

WHITEHALL TERRACE

BOND STREET

BOND STREET

[redacted]

DEVELOPMENT VICTORIA

50 0 50 m

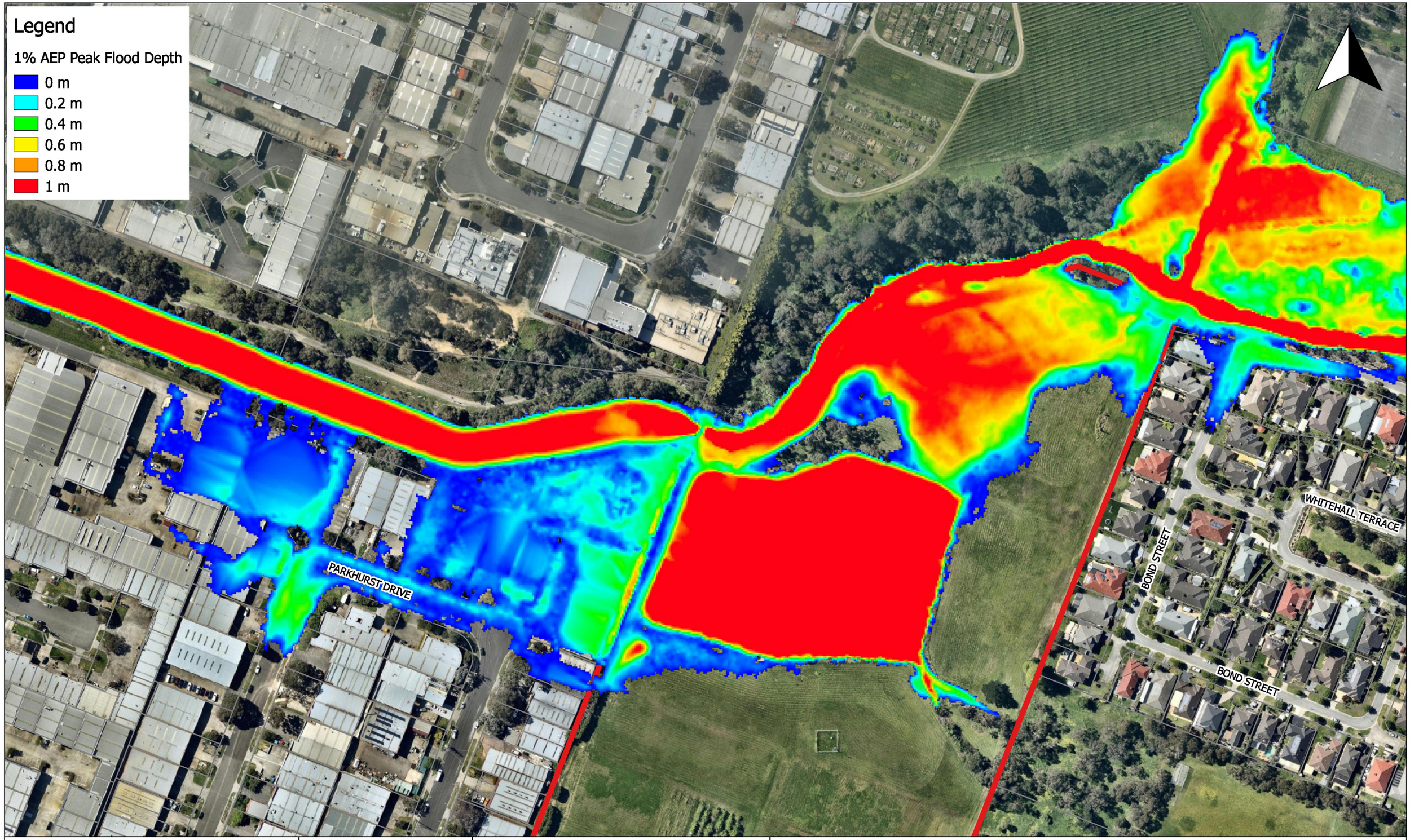
1:2,000

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55
Data Source: DELWP: VicMap - Sep 2016
NearMaps Aerial Photography Dec 2017

621 Burwood Highway Knoxville

1% AEP Peak Flood Depth Comparison Map

Job Number: V6000_002
Revision: 0
Drawn: [redacted]
Checked: [redacted]
Date: 24/7/2017



[redacted]

DEVELOPMENT VICTORIA

50 0 50 m

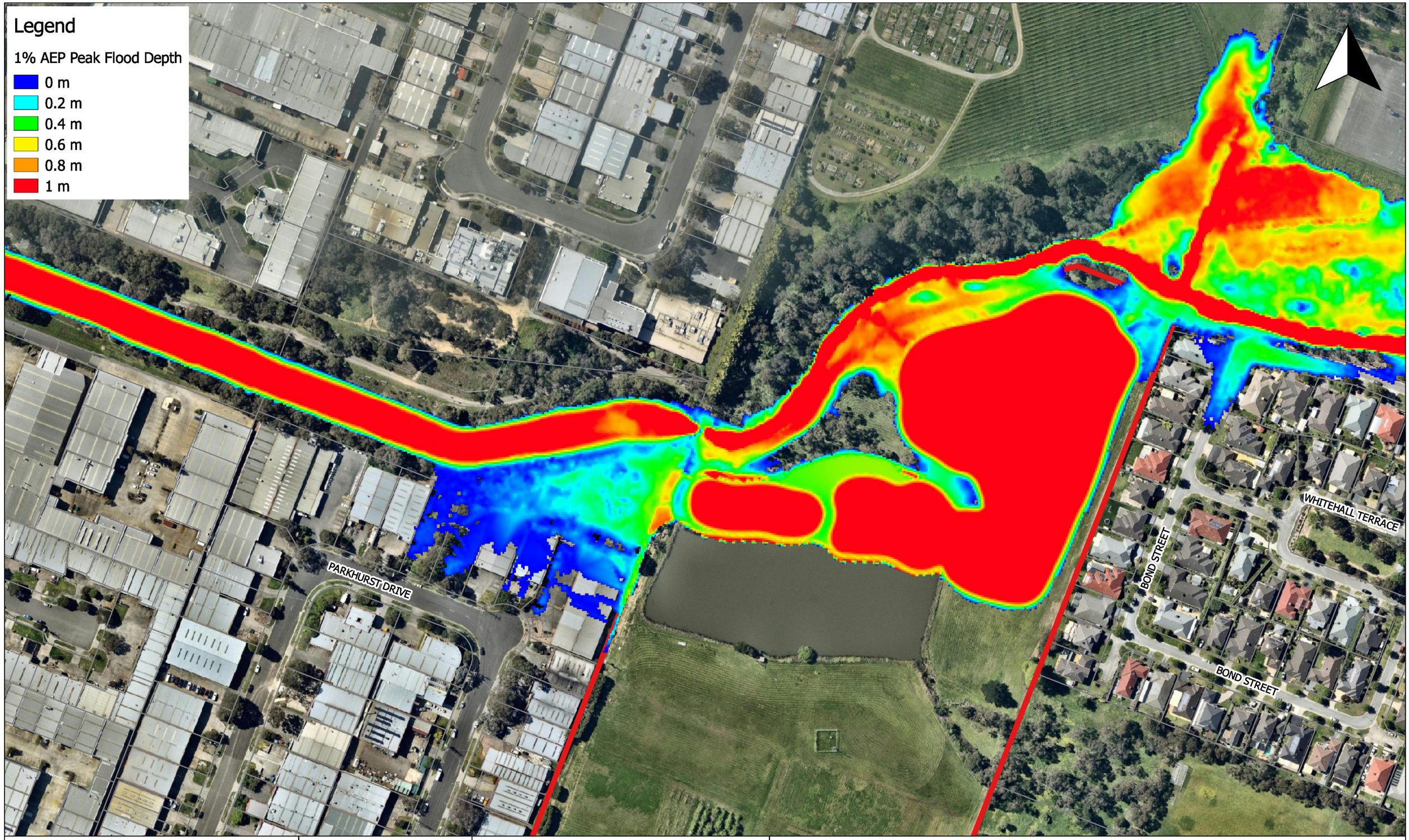
1:2,000

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55
Data Source: DELWP: VicMap - Sep 2016
NearMaps Aerial Photography Dec 2017

621 Burwood Highway Knoxville

1% AEP Existing Conditions Peak Flood Depth

Job Number: V6000_002
Revision: 0
Drawn: [redacted]
Checked
Date: 24/7/2017



[redacted]

DEVELOPMENT VICTORIA

50 0 50 m

1:2,000

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55
Data Source: DELWP: VicMap - Sep 2016
NearMaps Aerial Photography Dec 2017

621 Burwood Highway Knoxville

1% AEP Developed Conditions Peak Flood Depth

Job Number: V6000_002
Revision: 0
Drawn: [redacted]
Checke
Date: 24/7/2017

ENGENY
WATER MANAGEMENT

Appendix F:
Staging Plan

BLIND CREEK

PROPOSED
HABITAT WETLAND

EXISTING DAM
EXTENTS

FUTURE
SEDIMENT BASIN

EXISTING DAM

FUTURE
TREATMENT
WETLAND

EXISTING DAM
EXTENTS

STAGE 7

TEMPORARY SEDIMENT BASIN
OUTFALL TO BLIND CREEK.
DISCHARGE TO EXISTING SITE
DRAINAGE PIT VIA BASIN
CONTROL PIT AND OUTFALL PIPE.

TEMPORARY
RETARDING BASIN
APPROX AREA =1200m2
DEPTH = 1.35m
AVAILABLE STORAGE =1700m3

STAGE 6

STAGE 5

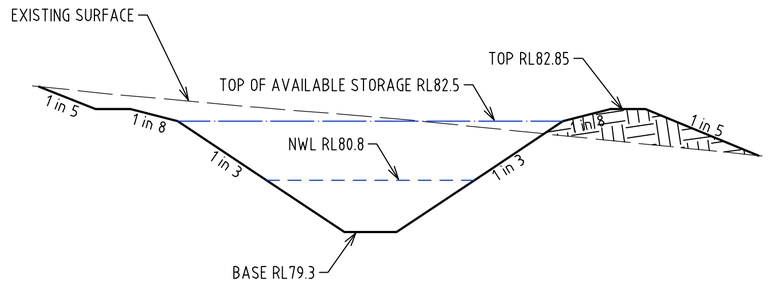
TEMPORARY
SEDIMENT BASIN
APPROX AREA =680m2
MAX DEPTH = 1.5m (BELOW NWL)

STAGE 4

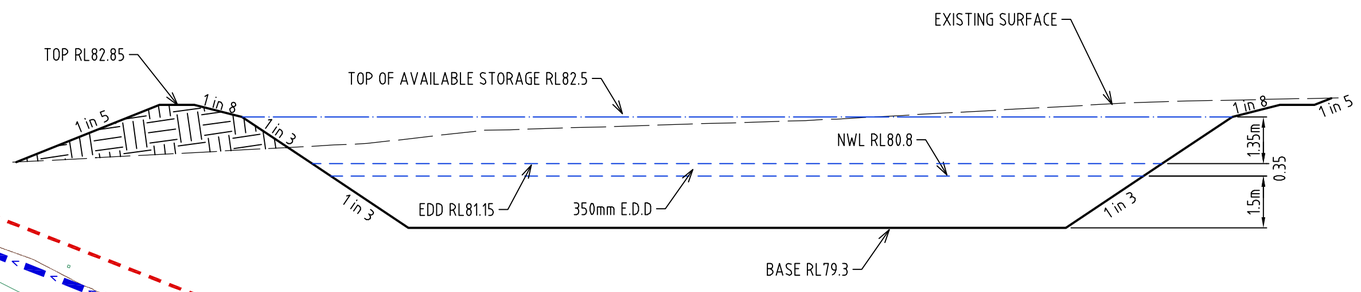
STAGE 3

STAGE 1

STAGE 2



TEMPORARY SEDIMENT / RETARDING BASIN TYPICAL
SECTION A-A
H1:250 V1:125



TEMPORARY SEDIMENT / RETARDING BASIN TYPICAL
SECTION B-B
H1:250 V1:125

TEMPORARY STORMWATER MANAGEMENT PLAN

1:1250 @ A1

REV	DESCRIPTION	DATE
5	AMENDED TO ADDRESS COUNCIL RFI RESPONSES	14.02.2022

KNOXFIELD DEVELOPMENT
609-621 BURWOOD HWY
KNOXFIELD

[redacted]

DRAWING No. 19095 - SM1 Rev. 5

PROPOSED SUBDIVISION - TEMPORARY STORMWATER MANAGEMENT PLAN

ENGENY
WATER MANAGEMENT

Appendix G:

Letter dated 9 June 2021 from Ashley Gaunt of Melbourne Water to Domenic Petrilli of Knox City Council in relation to plan number TP 961547B

9 June 2021

[redacted]

Dear [redacted]

Proposal: Planning permit for subdivision – Two lot subdivision (+ a balance lot), removal of associated native vegetation and creation of access to a road in a Road Zone
Site location: 609-619 BURWOOD HIGHWAY KNOXFIELD (Lake Knox Development)
Melbourne Water reference: MWA-1206879
Council reference: P/2021/6169 **Date referred:** 13/04/2021
Plan number: TP961547B

Our Decision
Melbourne Water, pursuant to Section 56 (2) of the Planning Environment Act 1987, requires the submission of the following additional information to be able to respond to the referred application:

1. An updated/amended Stormwater Management Strategy (latest revision 'Knoxfield Development Stormwater Management Rev 7') must be submitted for review and acceptance by Melbourne Water. The revised must include:

a) Sections demonstrating that all lots within Stages 1 and 2 are filled 600mm above the identified applicable flood level;
b) Details that the proposed stormwater runoff for the proposed Stages 1 and 2 achieves State Environment Protection Policy (Waters of Victoria) objectives for environmental management of stormwater as set out in the 'Urban Stormwater Best Practice Environmental Management Guidelines (CSIRO) 1999';
c) Confirmation that the habitat 'wetland' for the broader site is offline;
d) Confirmation that having only one treatment 'wetland' online is acceptable for stormwater runoff and treatment associated with Stages 1 and 2 of this subdivision application;
e) The details of any outfall/s for the development and calculations of the flows, volumes and flood levels for the 1% AEP storm event within the property, and how they will service the proposed Stages 1 and 2.

2. An ecological report, prepared by a suitably qualified person, to include the following specific assessment and considerations (Melbourne Water notes that an ecological assessment was submitted with planning permit application P/2021/6170 for the subject site as a whole):

a) Clarification of approvals required under the Flora and Fauna Guarantee Act 1988, along with copies of all relevant consultation with Authorities;

b) Depth comparison of the 'dam' and proposed 'wetland' waterbodies, given the Blue Billed Ducks tendency to dive/forage in deep water; and assessment of suitability of any differing replacement habitat depth if proposed;
c) Details of proposed continuity of habitat for the Blue Billed Duck within any new proposed habitat 'wetland';
d) Clarification of definitive timelines for construction of any new treatment 'wetland' required for Stages 1 and 2 of this subdivision application.

Advice
This application relates to the south-east portion of the broader subject site only and does not consider any works to the dam at the rear of the site.
The subdivision area is located within the floodplain of the Blind Creek (within the broader Dandenong Creek catchment). The applicable 1% Annual Exceedance Probability (AEP) flood level for the property, grades from 78.75 metres to Australian Height Datum (AHD) at the north-eastern corner down to 77.0 metres to AHD at the north-western corner of the site.
Melbourne Water notes that this proposed 'planning permit for subdivision' application seeks to formalize Stages 1 and 2 of the Knoxfield development proposal in accordance with the previously approved Knox Planning Scheme Amendment C160 and the associated development Masterplan.
The above advice is provided by Melbourne Water as a recommending Referral Authority for this 'planning permit for development' application under the provisions of the Knox Planning Scheme. We note Knox City Council are the Responsible Authority for administering the planning scheme, including deciding whether to issue a planning permit.
To find out more information in regards to building in flood prone areas please visit our [redacted] for more information. For general development enquiries contact our Customer Service Centre on [redacted]
Regards,
[redacted]
[redacted]

ENGENY
WATER MANAGEMENT

Appendix H:
Temporary Sedimentation Basin Sizing Calculation

Knox Stages 1-5 Temporary Sedimentation Basin

Surface Area:	calculated using Equation 4.3 of WSUD Engineering Procedures	
R (removal fraction)	0.95	change A below to achieve 0.95
hydraulic efficiency	0.11	see Fig 4.3 of WSUD Engineering Procedures, design objective is this value should be 0.5 or higher where possible
n (number of CSTRs)	1.1	calculated using Equation 4.2 of WSUD Engineering Procedures
v_s (m/s)	0.011	settling velocity for 125 micrometre particle size, otherwise see Tabl 4.1 of WSUD Engineering Procedures
d_e (m)	0.35	extended detention depth
d_p (m)	1.5	depth of the permanent pool volume
d* (m)	1.0	sediment can accummulate up to 0.5m below normal water level
A (m^2)	660	SA of the sediment pond
Side lenth:width ratio 1:	1	
Q (m^3/s)	0.66	4EY
Required volume:		
S	72	
C (ha)	12.6	catchment Area (Stages 1-5)
R	0.95	capture efficiency from above equation (not less than 0.95)
L (m^3/ha)	2	sediment loading rate (1.6m3/ha is typical loading rate for developed catchments) (0.4 m³/ha for gross pollutants)
Fr (years)	3	desired clean out frequency, should be 3 years or greater
Permanent Pool Volume (PPV)		
PPV Req:	108	accumulated sediment not to exceed 2/3 of available storage volume within 5 years (MW Constructed Wetlands Guidelines)
Estimated minimum PPV	527	Assumes rectanglular shape with ratio specified above and saefty bench specified in dam capacity calcs
	OK	

ENGENY
WATER MANAGEMENT

engeny.com.au

[redacted]

9 June 2021

[redacted]

Dear [redacted]

Proposal: Planning permit for development – Utility installation, removal of native vegetation and associated buildings and works
Site location: 621 Burwood Highway, KNOXFIELD VIC 3180
Melbourne Water reference: MWA-1208799
Council reference: P/2021/6170
Date referred: 29/04/2021

Our Decision
Melbourne Water, pursuant to Section 56 (2) of the Planning Environment Act 1987, requires the submission of the following additional information to be able to respond to the referred application:

1. A further ecological report or statement, prepared by a suitably qualified person, to include the following specific assessment and considerations:
a) Clarification of approvals required under the *Flora and Fauna Guarantee Act 1988*, along with copies of all relevant consultation with Authorities*;*
[redacted] of DELWP has advised by email (21 July 2021): "In regard to the need for an FFG permit, this is a little unclear as it will depend on the extent of impact on habitat for BBD. I would hold off on applying for such a permit until we can provide you with clearer advice on these potential impacts. My opinion is that the development of a management plan agreement that ensures the long-term protection and enhancement of BBD habitat on the site will negate the need for an FFG permit. Note that should an FFG permit be necessary it is likely that we would be requiring such a management plan be developed anyway".

b) Depth comparison of the 'dam' and proposed 'wetland' waterbodies given the Blue Billed Ducks tendency to dive/forage in deep water; and assessment of suitability of any differing replacement habitat depth if proposed;
Refer responses below and in the RFI response to Knox City Council.

c) Details of proposed continuity of habitat for the Blue Billed Duck within any new proposed habitat 'wetland' including, but not limited to:

- Clarification of definitive timelines for construction of any new 'wetland'.

Melbourne Water notes that the Ecological Assessment submitted with this application recommends: to '*minimize disturbance on site during the pairing, mating and nesting period and, if Blue-billed Duck ducklings are observed, during the raising and fledging period also…. Monitoring for Blue-billed Duck pairing and breeding behaviour should therefore be sufficient to cover the period beginning October until late March annually'.* This contradicts the Stormwater Management

Strategy which commits that '*From an engineering perspective it would be easier if the earth moving stages of the construction could be timed to occur in summer or autumn when ground conditions will be easier to work with than in winter or early spring.'*
The ecological needs can be prioritised. The key word in the Stormwater Management Plan description is "easier". It will still be possible to construct the wetland outside of the summer and autumn period.

Further details and clarification of the proposed habitat 'wetland' establishment. Melbourne Water notes that the submitted Ecological Assessment recommends that any new habitat 'wetland' must be '*constructed and planted at least 12 months prior to any clearance of the current dam'.* Whilst the draft Stormwater Management Strategy suggests '*It is expected that the construction and establishment period for the habitat wetland will take approximately 12 months'.*
Both of these time estimates are similar. There is also uncertainty around exactly how long it will take for the vegetation to establish as it si dependant on a wide range of variables, including time of planting, weather over a 12 month period and the health of plant stock when planted. A suitably worded planning permit condition can be used to mitigate the risk that the dam is removed before the flora in the habitat wetland is suitably established to support aquatic bird life.

- Accessibility to, and for, the habitat 'wetland' and any proposed restrictions on access to it.
  These details can and will be proposed as part of the detailed design. There will need to be a balance between providing access to a recreational area with the needs to protect the birds and animals in the dam. At this stage the plans produced show limited access on the northern (existing Blind Creek Trail), southern (proposed open space adjacent) and western side (proposed walking trail) and no access along the eastern of the habitat wetland. Dense planting would be proposed to limit access especially along the northern and southern sides of the habitat wetland.

- Details of any and all proposed fencing and other treatments like planting and vegetation to restrict and manage access to the proposed habitat 'wetland'.
  These details can and will be provided as part of the detailed design. They are not required to be provided before the issue of a planning permit.

d) Confirmation that any habitat 'wetland' is offline from the stormwater treatment 'wetland' to allow for identical depths and function to the existing 'dam';
The habitat wetland is offline from the flows in Blind Creek. This meets the typical definition of and requirements for wetlands to be offline as specified in Melbourne Water's Wetland Design Manual. The habitat wetland needs a regular source of incoming flows to ensure that water levels are maintained in summer and that turnover time is kept as low as possible. This means that the habitat wetland needs to receive flows from the stormwater wetland, making it online to the local catchment. Without inflows from the local catchment the habitat wetland will have no source of water. The habitat wetland is also quite large for the catchment from which it is receiving flows and so will benefit from reduced turnover if all of the flows from the local catchment flow through the habitat wetland.

The wetland design will include the ability for flows to bypass the habitat wetland when maintenance is being undertaken, however under normal operating conditions the habitat wetland will benefit the most by maintaining regular inflows each time there is rainfall in the catchment on which it is located. This also best matches the current hydrological setup of the existing dam as the existing dam is online to the local catchment, included the

developed areas to the east of the school. The water entering the dam also currently receives no treatment.

The dam also contains sections of water up to 4 m deep (in the southwest corner). It would not be recommended to recreate water this deep due to the risks of stratification and poor turnover. The proposed habitat wetland will have depths of between 1.5 and 2 m with an undulating base. The current dam has a largely flat base and is generally around 2 m deep. By creating an undulating base, a broader variety of habitat can be provided for and one that is more natural than the current dam.

e) The effect the proposed changes to the extant conditions of the existing dam, including the reduction in total surface area of open water in the new 'wetland' (from around 15,000 sqm to approximately 11,000 sqm), may have on the Blue Billed Duck immediately and in the future.
Refer to detail provided in the response to the RFI issued by Knox City Council.

2. Detailed design plans (including detailed cross sections) of the proposed sediment basin, treatment wetland and habitat 'wetlands'.
The detailed design will be completed once a planning permit for the site has been issued. The plans provided with the stormwater management plan included 3D terrain modelling which has demonstrated that the proposed wetlands, sediment ponds, maintenance access paths and sediment drying areas can all be accommodated. This is an appropriate level of design to have completed before the issue of a planning permit.

3. Detailed design plans and sections for existing and proposed finished conditions, for all works associated with the removal of the on-site dam, and remediation/re-instatement/re-establishment of the site.
The detailed design will be completed once a planning permit for the site has been issued. The plans provided with the stormwater management plan included 3d terrain modelling which has demonstrated that the proposed wetlands, sediment ponds, maintenance access paths and sediment drying areas can all be accommodated. This is an appropriate level of design to have completed prior to the issuing of a planning permit.

Advice
The above advice is provided by Melbourne Water as a recommending Referral Authority for this 'planning permit for development' application under the provisions of the Knox Planning Scheme. We note Knox City Council are the Responsible Authority for administering the planning scheme, including deciding whether to issue a planning permit.
To access more information regarding other services or online applications that Melbourne Water offers please visit our [redacted] For general development enquiries contact our Customer Service Centre on [redacted]
Regards,
[redacted]

AQUATICA ENVIRONMENTAL

Aquatic fauna and targeted Dwarf Galaxias survey of former DELWP research site irrigation dam, Knoxfield, Victoria

Report Prepared for Ecocentric Environmental Consulting

on behalf of Development Victoria

February 2022

AQUATIC ECOSYSTEM & ENVIRONMENTAL MANAGEMENT

Aquatica Environmental
The trading name for Aquatica Australia Pty Ltd as trustee for Aquatica Trust
ACN 601 326 416
ABN 83 572 211 867
[redacted]

Cover Photograph: Former DELWP research site irrigation dam. 4 August 2021 [redacted]

Citation: *Aquatica Environmental (2022). Aquatic fauna and targeted Dwarf Galaxias survey of former DELWP research site irrigation dam, Knoxfield, Victoria. Report Prepared for Ecocentric Environmental Consulting on behalf of Development Victoria. February 2022.*

Version	Author	Reviewer	Issued To	Date Issued
Draft	[redacted]	[redacted]	Development Victoria	24 January 2022
Final	[redacted]	[redacted]	Development Victoria	15 February 2022

CONTENTS

Tables

Figures

Photos

Appendices

Appendix A Aquatic Fauna species recorded within 20km of the project area (the study area)

Appendix B eDNA Reports

1. INTRODUCTION

1.1 Background

Aquatica Environmental was engaged by Ecocentric Environmental Consulting (Ecocentric) on behalf of Development Victoria (DV) to undertake targeted Dwarf Galaxias (*Galaxiella pusilla*) and aquatic fauna survey at the site of proposed wetland development located at 609-619 and 621 Burwood Highway, Knoxfield (the site).

DV have been working through permits and approvals for the development and subdivision of the former Department of Environment, Land, Water and Planning (DELWP) research site. Development of the site will include the decommissioning of a disused irrigation dam (Figure 1) and the construction of three new waterbodies including one habitat and two sediment and stormwater treatment wetlands.

Ecocentric's ecological assessment (Ecocentric 2021) concluded that Dwarf Galaxias were a 'low' likelihood of occurrence on the site. There are aspects of Dwarf Galaxias habitat present, however, the dam is not the habitat type the species is typically associated with, there is a lack of direct connectivity to other waterways and habitat that would have facilitated the inbound migration of the species into the dam and there is a lack of nearby/recent records.

However, the potential presence of the species has not been completely eliminated and if resident may require species-specific consideration with regards to planning, permits, approvals and wetland design. Accordingly, it was deemed prudent that a survey for the species be undertaken to provide a further line of evidence and confidence in the assessment of the species' potential presence in the dam.

In pre-survey planning discussions with Ecocentric and DV it was agreed that while undertaking targeted Dwarf Galaxias survey there was an opportunity to survey the range of aquatic fauna present in the dam to further inform the project on the potential aquatic values and assist with project planning and approvals.

1.2 Objectives

In accordance with the may similar aquatic fauna and targeted Dwarf Galaxias surveys we have undertaken the primary aims of the survey were to:

- Determine the likelihood of Dwarf Galaxias being present in the dam, and if present, determine the size of the population;
- Determine the range of other aquatic fauna that is present in the dam;
- Explore the potential implications for the project based on the findings of the survey; and
- Provide recommendations for 'next steps' (if required).

1.3 Project Area

The project area for this assessment was the existing dam only (Figure 1).

Two rounds of physical sampling was undertaken in the dam along the wetted wadeable perimeter.

Three rounds of environmental deoxyribonucleic acid (eDNA) sampling for Dwarf Galaxias was also undertaken in the dam (two sites) plus an additional two sites on Blind Creek and one at a Dwarf Galaxias refence site in Narre Warren.

The study area for the desktop review included the dam plus a 10 kilometre search radius.

1.4 Assumptions and Limitations

This assessments have been undertaken to provide an overview of aquatic biodiversity values within the project area. The assessment methods, effort, combined with information available from other sources, is considered suitable to assess the overall aquatic biodiversity values of the site.

2. METHODOLOGY

2.1 Desktop Review

In order to gain an understanding of the aquatic biodiversity values of the dam (i.e. aquatic flora and fauna species, communities and their habitats) Aquatica Environmental undertook a desktop review of the project area, plus a 5 km search buffer to cater for more mobile species (the study area). The desktop review included a review of the following sources of information:

- The Commonwealth Department of Environment's Protected Matters Search Tool (PMST) for aquatica matters of national environmental significance (MNES) using a 10 kilometre search radius on the dam (DAWE 2021);
- DELWP's Victorian Biodiversity Atlas (VBA) for aquatic fauna using a 10 kilometre search radius on the dam (DELWP 2021);
- The site's Wetland Development Area Ecological Assessment (Eccentric 2021).

2.2 Aquatica Fauna and Dwarf Galaxias Survey

Aquatica Environmental undertook two, two-day catch and release surveys for aquatic fauna and Dwarf Galaxias in wadeable aquatic habitat at the dam. Active sampling was be undertaken during daylight hours, with passive nets and traps set overnight.

The surveys included Dwarf Galaxias-specific survey methods in accordance with the Survey Guidelines for Australia's Threatened Fish (DSEWPaC 2004) and Biodiversity Precinct Structure Planning Kit (DSE 2010) including:

- Hand-held dip-netting, sampling for adult fish in and around areas of suitable habitat;
- Bait-traps set overnight and baited with phosphorescent baits (i.e. glowsticks); and
- Fyke nets set overnight (first round of sampling only).

The surveys commenced with a reconnaissance of the dam to determine where potential aquatic fauna and Dwarf Galaxias habitat occurs that would warranty surveying. Where suitable habitat was identified the range of permitted survey methods were deployed including hand-held dip-net, bait traps and fyke nets. Entry screens (50mm) were added to the fyke nets to prevent larger fauna, such as turtles and waterbirds, from entering and becoming trapped. Backpack electrofishing was also initially proposed, however, due to the presence of many waterbirds, was deemed inappropriate.

The surveys were undertaken in accordance with the following approvals and permits held by Aquatica Environmental:

- DEDJTR[1] Wildlife and Small Institutions Animal Ethics Committee (WSIAEC approval No. 11.18);
- Scientific Procedures Fieldwork Licence (No. SPFL20394);
- *Fisheries Act 1995* General Research permit (No. RP1312);
- *Flora and Fauna Guarantee Act 1988* permit to take protected fish (No. 10010108); and
- *Wildlife Act 1975* research permit (No. 10010109).

[1] *Department of Economic Development, Jobs, Transport and Resources*

2.3 eDNA Sampling

Three rounds of eDNA sampling, specifically targeting Dwarf Galaxias, were also undertaken to determine the potential presence/absence of the species in the dam and provide a further line of evidence to the physical survey results.

EnviroDNA's eDNA test kits were used for a total of 28 samples collected in pairs from five locations (Figure 1), including:

- 2x sites in the irrigation dam collected at the northeast corner near a drain inlet and centre of the southern bank;
- 1x site in Blind Creek collected just upstream of the irrigation dam discharge point;
- 1x site in Blind Creek, downstream of the site at the approximate location of historical Dwarf Galaxias records; and
- 1x site at one of Aquatica Environmental's long-term Dwarf Galaxias monitoring sites to act as control samples (e.g. Dwarf Galaxias known to be currently present in good numbers) (NB: This site was only sampled twice).

At each location and for each sample, water was drawn from the waterway into the supplied eDNA filter using the supplied sterile gloves, filter and syringe. Table 1 details the locations of each sample pair.

Following sample collection, the samples were stored on ice and delivered to the laboratory for analysis the following morning. EnviroDNA were also engaged to undertake the third round of eDNA sampling in order to maintain a direct chain-of-custody with the laboratory and thereby limit (eliminate) the possibility of sample errors.

In the laboratory DNA was extracted from the samples using a commercially available DNA extraction kit (Qiagen DNeasy Blood and Tissue Kit). Real-time quantitative Polymerase Chain Reaction (qPCR) assays were used to amplify the target DNA of the species (Dwarf Galaxias), using species-specific markers targeting a small region of the mitochondrial DNA. The lab also elected to run probes for two different mitochondrial gene regions of the DNA to compare the sensitivity between the two probes, but therefore offing further confidence in the findings. These markers were previously developed and assessed for specificity and sensitivity by EnviroDNA. Assays were also performed in triplicate on each sample. Negative controls were included for the DNA extraction and qPCR steps.

Table 1 Survey site locations

Site Code	Waterway	Coordinates (Lat, Long)	Location
DV1	Irrigation Dam	-37.870563, 145.256767	South east corner of dam, near the primary inlet drain.
DV2		-37.869860, 145.255275	Central southern edge of dam
DV3	Blind Creek	-37.868549, 145.257883	Blind Creek approximately 50 metres downstream of Bond Street (upstream of dam discharge)
DV4	Blind Creek	-37.872109, 145.224908	Blind Creek @ Timothy Drive bridge (location of historical records)
DV5	Roadside drain	-38.037203, 145.301958	Centre Road eastern roadside drain near Melbourne Water wetland (control site with known resident population)

0 10 20 40
Metres

Spatial Reference
Name: GDA2020 MGA Zone 55
PCS: GDA2020 MGA Zone 55
GCS: GDA2020
Datum: GDA2020
Projection: Transverse Mercator

N

Site locations

Waterway

Connector or drain

Stream

Netting area

Knoxfield

Targeted Dwarf Galaxia Survey

AQUATICA ENVIRONMENTAL

Date Exported:
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3. RESULTS

3.1 Desktop Review

The desktop review returned 61 aquatic fauna species as either occurring, potentially occurring or potentially having habitat within 10 kilometres of the project area including 27 fish, 17 amphibians, two aquatic mammals, 12 aquatic invertebrates and three aquatic reptiles (Appendix A). All of the amphibian, mammal, invertebrate and reptile species were native/indigenous species, whereas the fish consisted of 17 native and ten introduced species, of which two are listed as a 'noxious aquatic species' under the Victorian *Fisheries Act 1995* (European Carp *Carpio Cyprinus* and Mosquitofish *Gambusia holbrooki*).

Within the results were 14 state and/or commonwealth protected species including five fish, three invertebrates, three amphibians, one mammal and two reptiles. These species are detailed below with a high level assessment of their likelihood to occur in the dam:

Fish

- Australian Grayling (*Prototroctes maraena*) – EPBC Act Vulnerable and FFG Act listed, no records, no suitable habitat, highly unlikely to occur.
- Dwarf Galaxias (*Galaxiella pusilla*) – EPBC Act Vulnerable and FFG Act listed, recorded in Blind Creek, marginal habitat in dam, likely occurs (see eDNA results Section 3.4).
- Macquarie Perch (*Macquaria australasica*) – FFG Act listed, 3 pre-1940 historical records, unlikely to occur unless deliberately stocked into dam.
- Murray Cod (*Maccullochella peelii*) – EPBC Act Vulnerable and FFG Act listed, 2 pre-1923 historical records, unlikely to occur unless deliberately stocked into dam.
- Yarra Pygmy Perch (*Nannoperca obscura*) – EPBC and FFG Act listed, no records, unlikely to occur.

Invertebrates

- Dandenong Burrowing Crayfish (*Engaeus urostrictus*) – FFG Act listed, 10 records to 2019 but not related to Blind Creek or the dam, unlikely to occur.
- Foothill Burrowing Crayfish (*Engaeus victoriensis*) – FFG act listed, 12 records to 2011 but not related to Blind Creek or the dam, unlikely to occur.
- Tubercle Burrowing Crayfish (*Engaeus tuberculatus*) – FFG act listed, 10 records to 2019 but not related to Blind Creek or the dam, unlikely to occur.

Amphibians

- Brown Toadlet (*Pseudophryne bibronii*) – FFG Act listed, single historical record from 1980, no evidence of presence;
- Growling Grass Frog (*Litoria raniformis*) – EPBC and FFG Act listed, 8 historical records to 2012 but unrelated to project area/Blind Creek, no evidence of presence;
- Southern Toadlet (*Pseudophryne semimarmorata*) – FFG Act listed, 41 records to as recent as 2021, but unrelated to project area and Blind Creek, no evidence of presence;

Mammals

- Platypus (*Ornithorhynchus anatinus*) – FFG Act listed, 79 records to 2015 but unrelated to project area/Blind Creek, unlikely to occur.

Reptiles

- Broad-shelled Turtle (*Chelodina expansa*) – FFG Act listed, 2 records from 2012 nearby at Lakewood so plausibly could occur.

- Murray River Turtle (*Emydura macquarii*) – FFG Act listed, records unrelated to project area and Blind Creek, unlikely to occur.

The VBA returned four Dwarf Galaxias record locations approximately 2 kilometres downstream of the dam and associated most with off-stream water bodies near Blind Creek. The most recent two records, from 1995 and 1997, were in off-stream dams and wetlands. The other two were earlier, 1989 and 1990, from within Blind Creek. There are also numerous VBA records of field surveys having been undertaken in Blind Creek since those dates, none of which detected Dwarf Galaxias. It is also understood that Melbourne Water have no additional recent records or information on Dwarf Galaxias in Blind Creek, with the exception of a circa 2010 record of the species in a dam near the confluence with Dandenong Creek (Coleman, R. 2021. *pers com*, 7 September).

3.2 Dam Habitat

Dam habitat was assessed on the first day of each of the two surveys including the 4th August and 9th December 2021.

Aquatic habitat in the dam consisted of the large open water body with a firm clay and sediment base (where able to be waded) and a monoculture of Eel Grass (*Vallisnera australis*). The southern and eastern perimeter of the dam had a wide floating mat of Eel Grass fronds that had likely been dislodged by waterbirds (Photo 1a). The floating mat appears to move around the dam depending on the wind direction.

Emergent habitat was limited to the very edge of the dam consisting of steep and undercut banks, several patches of Knotweed (*Persicaria* sp.) and Cumbungi (*Typha* sp.), overhanging grasses, weeds and a small number of shrubs/trees (Photo 1b).

3.3 Dwarf Galaxias and Aquatic Fauna Survey

Two surveys were undertaken on the 4th and the August and 9th and 10th December 2021. Active dip-netting was undertaken where wadeable along the southern, eastern and north-eastern dam perimeter (Figure 1). The southwestern, western and northwestern perimeters were avoided due to a combination of deep water, steep banks, less preferential Dwarf Galaxias habitat and the presence of waterbirds. Fyke nets and bait traps were set on the first afternoon, left in situ overnight and retrieved the following morning. Table 2 identifies site survey dates and methods deployed.

Table 2 Survey method details

Site Code	Waterway	Method
4th & 5th August 2021		
DV1	Irrigation Dam	Dip-netting margins (approx. 270m) Bait traps (x12) Fyke nets (x4) eDNA
DV2		
DV3	Blind Creek	Not sampled
DV4		Not sampled
DV5	Roadside drain	Dip-net
9th & 10th December 2021		
DV1	Irrigation Dam	Dip-netting margins (approx. 270m) Bait traps (x12)
DV2		
DV3	Blind Creek	Not sampled
DV4		Not sampled
DV5	Roadside drain	Not sampled

The following common aquatic fauna species were recorded across the two surveys:

- Eastern Short-fin Eel (*Anguilla australis*): approximately 20 medium to large adults

- Goldfish (*Carassius auratus*): 1 juvenile
- Freshwater Shrimp (*Paratya australiensis*): 10s
- Other common freshwater invertebrates including Damselfly larvae (suborder *Zygoptera*) and Boatmen (family *Corixidae*): 10s to 100s

No Dwarf Galaxias or other significant aquatic fauna species were recorded in the dame or Blind Creek during the surveys. Dwarf Galaxias were recorded at the control site 9DV5) during both surveys.

a b

Photo 1 Floating Eel Gras Fronds (a) and fingering Persicaria and overhanging grasses and weeds (b)

a   b

Photo 2 Short-finned Eel and freshwater shrimp (a) and Goldfish (b)

3.4 eDNA Sampling

Three rounds of eDNA sampling were undertaken on the mornings of 16th August and 9th December 2021 by Aquatica, with a third independent round undertaken at the same locations by EnviroDNA on the 5th January 2022. Sampling was undertaken at the five survey locations, including two within the dam, as detailed in Table 3 and Figure 1.

The EnviroDNA analysis and reports are provided as attachment A and summarised below in Table 3.

Table 3 eDNA analysis results

Site Code	Waterway	Sample Code (2x samples per site)	Sample Score (3x replicates per sample)	Total Site Score[2]	Test Results for Dwarf Galaxias Present (Positive = species DNA present)
4th August 2021					
DV1	Irrigation Dam	DV1.1	3/3	5/6	Positive
		DV1.2	2/3		
DV2		DV2.1	2/3	4/6	Positive
		DV2.2	2/3		
DV3	Blind Creek	DV3.1	2/3	3/6	Positive
		DV3.2	1/3		
DV4		DV4.1	3/3	6/6	Positive

[2] A score of 2/6 or great is considered as the DNA is positive or 'present'

Site Code	Waterway	Sample Code (2x samples per site)	Sample Score (3x replicates per sample)	Total Site Score[2]	Test Results for Dwarf Galaxias Present (Positive = species DNA present)
		DV4.2	3/3		
DV5	Roadside drain (reference site)	DV5.1	3/3	6/6	Positive
		DV5.2	3/3		
9th December 2021					
DV1	Irrigation Dam	DV1.1	0/3	0/6	Negative
		DV1.2	0/3		
DV2		DV2.1	0/3	0/6	Negative
		DV2.2	0/3		
DV3	Blind Creek	DV3.1	0/3	0/6	Negative
		DV3.2	0/3		
DV4		DV4.1	0/3	0/6	Negative
		DV4.2	0/3		
DV5	Roadside drain (reference site)	Not sampled			
5th January 2022[3]					
DV1	Irrigation Dam	DV1.1	0/3	0/6	Negative
		DV1.2	0/3		
DV2		DV2.1	0/3	0/6	Negative
		DV2.2	0/3		
DV3	Blind Creek	DV3.1	0/3	0/6	Negative
		DV3.2	0/3		
DV4		DV4.1	0/3	0/6	Negative
		DV4.2	0/3		
DV5	Roadside drain (reference site)	DV5.1	3/3	6/6	Positive
		DV5.2	3/3		

The results of the first round eDNA samples analysis returned as 'positive' for the presence of Dwarf Galaxias DNA at all five sampling sites. However, this is contrasted with no Dwarf Galaxias being detected during the aquatic survey.

The eDNA result, Dwarf Galaxias 'present', was considered to be incongruous with the site survey result, with Dwarf Galaxias not detected and the habitat considered sub-optimal. It was therefore determined, in consultation with species' specialists from Melbourne Water and DELWP (Coleman, R. and Raadik, T. 2021. Pers Comm. 16 September and 20 October) that a second round of sampling be undertaken to provide further evidence of possible Dwarf Galaxias presence, and if present, the population size and dynamics.

The results of the second round eDNA samples analysis returned as 'negative' for the presence of Dwarf Galaxias DNA at the four dam and Blind Creek sampling sites (noting the control site was not sampled). Again, no Dwarf Galaxias were detected during the aquatic survey

Due to the inconsistent eDNA results, it was determined, in consultation with EnviroDNA, that a third round of eDNA sampling should be undertaken to resolve the incongruous nature of the first and second eDNA results. EnviroDNA were engaged to undertake the third round of eDNA sampling themselves, independent of Aquatica, and in order to maintain a direct chain-of-custody with the laboratory thereby limiting the potential for sampling errors. EnviroDNA conducted independent surveys at all five sample locations using the same sample and laboratory assessment

[3] The refence site sample (DV5) was taken on 23rd January as the incorrect location was sampled during the 5th January sampling.

methodologies. The results of the third round of survey again returned as 'negative' for the presence of Dwarf Galaxias DNA at the four dam and Blind Creek sampling sites and 'positive' for their presence at the control site.

The results of the second and third rounds of eDNA sampling suggest that the first round of sampling results were anomalous for Site DV1-DV4. The reason for the anomalous results is unclear, as the sampling protocols were strictly adhered to during all three rounds of sampling. However, the most reasonable explanation is that inadvertent sample contamination occurred to the sampling equipment, samples or analysis during the first round of sampling.

4. SIGNIFICANT IMPACT ASSESSMENT

Although a Dwarf Galaxia population is unlikely present within the dam, as Dwarf Galaxias is identified as a Vulnerable species under the EPBC Act, it was considered precautionary that a 'self-assessment' against the EPBC Act 'Matters of National Environmental Significance - Significant Impact Guidelines 1.1' (DEWHA 2013) be undertaken. The results of this self-assessment process are used as a guide for referral requirements to the Commonwealth's DAWE under the EPBC Act.

This assessment was undertaken based on the assumption that Dwarf Galaxias was 'possibly' present the dam but in very low abundance and with sub-optimal habitat and in consideration of DV's proposal for the site.

Criteria - An action is likely to have a significant impact on a Vulnerable species if there is a real chance or possibility that it will:	Risk(s) to MNES without mitigation measures	Likelihood of significant impact (mitigation measures implemented)
lead to a long-term decrease in the size of an important population* of a species An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.	If present a DG population within the dam would not be considered an important population as it is isolated and not directly connected to Blind Creek* and, if present, would likely be in very low abundance (as identified above). ** The National Recovery Plan (Saddlier et. al. 2010) makes no mention of Blind or Dandenong Creek regarding any population. The FFG Act species Action Statement (DELWP 2015) does mention Dandenong Creek (including Blind Creek) as an 'important population'. However if it was present (unlikely) a Blind Creek population would likely be considered important.*	UNLIKELY Not a significant impact
reduce the area of occupancy of an important population	Unlikely an important population and the total habitat area proposed to be created will be at least equivalent to the existing dam and potentially of higher quality for the species.	UNLIKELY Not a significant impact
fragment an existing important population into two or more populations	Decommissioning of the dam will not lead to fragmentation of any potential Blind/Dandenong Creek populations as the dam is a disconnected watery body. If Dwarf Galaxias were encountered in the dam they would relocated to the open water wetland where they can be managed as a single population.	UNLIKELY Not a significant impact
adversely affect habitat critical to the survival of a species	Habitat within the dam is sub-optimal for supporting a population and would not be considered 'critical to the survival of the species'.	UNLIKELY Not a significant impact
disrupt the breeding cycle of an important population	Unlikely an important population, however if present, any dam decommissioning work and relocation program will be timed to ensure that it is outside of the species' key breeding period.	UNLIKELY Not a significant impact
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Habitat within the dam is sub-optimal and it is highly unlikely its removal would result in the likely decline of the species, if present.	UNLIKELY Not a significant impact

Criteria - An action is likely to have a significant impact on a Vulnerable species if there is a real chance or possibility that it will:	Risk(s) to MNES without mitigation measures	Likelihood of significant impact (mitigation measures implemented)
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The open water wetland will be filled with pest-free water from the sediment pond and where practicable pest species controls will be in place (e.g. such as for goldfish which we know are present within the dam). If necessary, signage can be used to limit the risk associated with the public releasing feral species into the open water wetland.	UNLIKELY Not a significant impact
introduce disease that may cause the species to decline	There are no currently know Dwarf Galaxias-specific disease of concern, however, a threatened species management plan will set out procedures to ensure that other disease risk, such as chytrid fungus, is minimised.	UNLIKELY Not a significant impact
interfere with the recovery of the species	The open water wetland habitat area is considered likely, through provision of improved habitat values, to aid the recovery and improve the long-term viability of any Dwarf Galaxias that may be present at the site.	UNLIKELY Not a significant impact

5. CONCULSION AND RECOMMENDATIONS

Overall and on the sum of the evidence, it appears that Dwarf Galaxias are unlikely present in the dam based on the following key evidence:

- There were no historical records of the species in the dam.
- There were no recent records of the species in Blind Creek (i.e. all where >20 years old) and none were from at or upstream of the dam.
- Habitat in the dam was sub-optimal, missing many of the key aspects required to support a population of the species (e.g. ephemerality, dense and shady overstory vegetation, etc).
- Lack of seasonal connectivity to the Blind Creek (which itself appears unlikely to support a population upstream of the dam) .
- Lack of detection of the species during two rounds of intensive netting and trapping (noting Dwarf Galaxias are not a difficult fish to detect when present).
- Lack of detection of the species' DNA in ther dam and Blind Creek during two rounds of sampling, including the species being positively detected at a control site (excluding the first likely anomalous round of sampling).

The survey also detect the presence of native Short-finned Eel, freshwater shrimp, a range of other common aquatic invertebrates and introduced Goldfish. Given the size and age of the dam, the potential for historical natural or deliberate stocking/introduction of other species is high. It is known the dam connects to Blind Creek during occasional flooding events. Accordingly, it is possible there is a range of other common aquatic fauna present in the dam that was not detected during the survey.

It is understood the dam with be decommissioned as part of development of the site. It is assumed decommissioning will include dewatering the dam. During dewatering it is highly likely fish and other aquatic fauna will be encounter and, if not properly managed, stranded. It will be essential to salvage any trapped fauna in order to comply with the relevant animal ethics requirements, Fisheries Act, Flora and Fauna Act, etc. Based on Aquatica Environmental's previous experience with fauna salvage there are a number of scenarios that will need to be catered for including:

- Relocation of native fauna (i.e. eels, turtles, etc) to suitable habitat on or off the site. This could include any newly constructed on-site water body or off-site to Blind Creek.
- Humane euthanasia of species listed as 'noxious' under Section 75 of the Fisheries Act (e.g. European Carp if present).
- Humane euthanasia of other non-native/pest species that cannot be relocated (e.g. Goldfish).

The following 'next steps' are suggested:

- Engage with Dwarf Galaxia species experts at Arthur Rylah Institute (ARI, DELWP's research division) and Melbourne Water to gain their input and position on the results of the survey work to date.
- Develop a salvage and translocation plan detailing the process and protocols for salvaging and relocating aquatic fauna that may be encountered during dewatering of the dam.

6. REFERENCES

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Appendix A Aquatic Fauna species recorded within 10km of the project area (the study area)

Common Name	Scientific Name	Status		Count of Sightings	Last Record	Record Source
		EPBC Act	FFG Act			
FISH						
Australian Grayling	*Prototroctes maraena*	VU	L	-	-	PMST
Brown Trout *	*Salmo trutta*	-	-	26	7/03/2002	VBA
Chinook Salmon *	*Oncorhynchus tshawytscha*	-	-	1	01/01/1760	VBA
Climbing Galaxias	*Galaxias brevipinnis*	-	-	13	9/03/2006	VBA
Common Galaxias	*Galaxias maculatus*	-	-	44	2/04/2019	VBA, PMST
Dwarf Galaxias	*Galaxiella pusilla*	VU	L	25	23/07/2009	VBA
Eastern Gambusia **	*Gambusia holbrooki*	-	-	114	2/04/2019	VBA
European Carp **	*Cyprinus carpio*	-	-	17	6/12/2017	VBA
Flatheaded Gudgeon	*Philypnodon grandiceps*	-	-	14	2/04/2019	VBA
Galaxias	*Galaxias spp.*	-	-	1	1/01/1988	VBA
Goldfish *	*Carassius auratus*	-	-	55	2/04/2019	VBA
Macquarie Perch	*Macquaria australasica*	-	L	3	1/04/1938	VBA
Murray Cod	*Maccullochella peelii*	VU	L	2	11/02/1922	VBA
Oriental Weatherloach **	*Misgurnus anguillicaudatus*	-	-	76	2/04/2019	VBA
Ornate Galaxias	*Galaxias ornatus*	-	-	2	3/02/1990	VBA
Pouched Lamprey	*Geotria australis*	-	-	2	15/10/1985	VBA
Rainbow Trout *	*Oncorhynchus mykiss*	-	-	3	26/03/1997	VBA
Redfin *	*Perca fluviatilis*	-	-	21	2/04/2019	VBA
River Blackfish	*Gadopsis marmoratus*	-	-	1	19/08/1953	VBA

Common Name	Scientific Name	Status		Count of Sightings	Last Record	Record Source
		EPBC Act	FFG Act			
Roach *	*Rutilus rutilus*	-	*	45	4/03/2015	VBA
Shorthead Lamprey	*Mordacia mordax*	-	-	4	2/04/2019	VBA
Southern Pygmy Perch	*Nannoperca australis*	-	-	37	4/08/2009	VBA
Southern Shortfin Eel	*Anguilla australis*	-	-	107	2/04/2019	VBA
Spotted Galaxias	*Galaxias truttaceus*	-	-	6	2/04/2019	VBA
Tench	*Tinca tinca*	-	*	1	1/01/1988	VBA
Tupong	*Pseudaphritis urvillii*	-	-	1	01/01/1868	VBA
Yarra Pygmy Perch	*Nannoperca obscura*	VU	L			PMST
AMPHIBIANS						
Brown Toadlet	*Pseudophryne bibronii*	-	L	1	1/01/1980	VBA
Common Froglet	*Crinia signifera*	-	-	500	13/10/2020	VBA
Eastern Dwarf Tree Frog	*Litoria fallax*	-	-	2	8/01/2019	VBA
Growling Grass Frog	*Litoria raniformis*	VU	L	8	3/10/2012	VBA
Haswell's Froglet	*Paracrinia haswelli*	-	-	1	22/03/1981	VBA
Peron's Tree Frog	*Litoria peronii*	-	-	17	3/11/2019	VBA
Pobblebonk Frog	*Limnodynastes dumerilii dumerilii*	-	-	1	3/10/2012	VBA
Southern Brown Tree Frog	*Litoria ewingii*	-	-	568	13/10/2020	VBA
Southern Brown Tree Frog SOUTHERN	*Litoria ewingii SOUTHERN*	-	-	24	3/01/2016	VBA
Southern Bullfrog (ssp. unknown)	*Limnodynastes dumerilii*	-	-	101	27/01/2021	VBA
Southern Toadlet	*Pseudophryne semimarmorata*	-	L	41	1/05/2021	VBA
Spotted Marsh Frog (race unknown)	*Limnodynastes tasmaniensis*	-	-	80	13/10/2020	VBA
Spotted Marsh Frog SCR	*Limnodynastes tasmaniensis SCR*	-	-	27	23/05/2014	VBA
Striped Marsh Frog	*Limnodynastes peronii*	-	-	100	13/10/2020	VBA

Common Name	Scientific Name	Status		Count of Sightings	Last Record	Record Source
		EPBC Act	FFG Act			
Unknown Tree Frog	*Litoria verreauxii*	-	-	6	25/10/2017	VBA
Verreaux's Tree Frog	*Litoria verreauxii verreauxii*	-	-	15	21/01/2020	VBA
Victorian Smooth Froglet	*Geocrinia victoriana*	-	-	37	21/04/2019	VBA
MAMMALS						
Water Rat	*Hydromys chrysogaster*	-	L	79	1/10/2015	VBA
Platypus	*Ornithorhynchus anatinus*	-	-	10	12/04/2018	VBA
INVERTEBRATES						
Burrowing Crayfish	*Engaeus spp.*	-	-	7	9/06/2011	VBA
Central Highlands Burrowing Crayfish	*Engaeus affinis*	-	-	1	6/03/1910	VBA
Central Highlands Spiny Crayfish	*Euastacus woiwuru*	-	-	14	26/01/2020	VBA
Common Freshwater Shrimp	*Paratya australiensis*	-	-	22	20/07/2009	VBA
Common Yabby	*Cherax destructor destructor*	-	-	25	20/07/2009	VBA
Dandenong Burrowing Crayfish	*Engaeus urostrictus*	-	L	10	18/07/2019	VBA
Foothill Burrowing Crayfish	*Engaeus victoriensis*	-	L	12	19/05/2011	VBA
Freshwater Crayfishes	*Parastacidae spp.*	-	-	2	8/12/2000	VBA
Granular Burrowing Crayfish	*Engaeus cunicularius*	-	-	8	9/06/1982	VBA
Spiny Crayfish	*Euastacus spp.*	-	-	2	17/06/1999	VBA
Tubercle Burrowing Crayfish	*Engaeus tuberculatus*	-	L	10	25/07/2019	VBA
Ubiquitous Pea Shell	*Pisidium casertanum*	-	-	2	23/02/1994	VBA
REPTILES						
Broad-shelled Turtle	*Chelodina expansa*	-	L	2	14/12/2012	VBA
Eastern Snake-necked Turtle	*Chelodina longicollis*	-	-	139	13/10/2020	VBA
Murray River Turtle	*Emydura macquarii*	-	L	8	5/12/2018	VBA

EPBC Act Status: VU = Vulnerable; N = Nominated
FFG Act Status: L = Listed, N – Nominated
* *Fisheries Act 1995* listed noxious species

Appendix B eDNA Reports

Project number 2133CR1
September 3, 2021

Determining the presence of dwarf galaxias (*Galaxiella pusilla*) using environmental DNA (eDNA)

Prepared for:

[redacted]

Aquatica Environmental

[redacted]

Prepared by:

[redacted]

EnviroDNA

[redacted]

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Summary

A key challenge for biodiversity conservation is understanding species occurrence or distribution. Determining the presence or absence of a species is integral to making informed management decisions. Unfortunately, detecting species, particularly in an aquatic environment, can often be difficult, time consuming, expensive, and highly invasive. Analysis of environmental DNA (eDNA) is a relatively new, cheap, quick and non-invasive method for detecting species (Rees *et al.* 2014; McColl-Gausden *et al.* 2019; Thomsen and Willerslev 2015). As the name suggests, eDNA refers to the genetic material that an organism leaves behind in its environment. Quantitative comparisons with traditional sampling methods indicate that eDNA methods can be superior in terms of sensitivity and cost efficiency, particularly for scarce, elusive or cryptic species (Biggs *et al.* 2015; Smart *et al.* 2015; Thomsen *et al.* 2012; Valentini *et al.* 2016; Lugg *et al.* 2018), enabling effective detection of species at low densities.

On 16th August 2021, water samples were collected from 5 sites by Aquatica Environmental staff following sampling protocols developed by EnviroDNA. At each site, 2 samples were collected by passing 100-280 mL water (average 180 mL) through a 0.22 μm filter (Sterivex) on site. Filtering on site reduces DNA degradation that may occur during transport of water (Yamanaka *et al.* 2016). Clean sampling protocols were employed to minimise contamination including new sampling equipment at each site, not entering water, and taking care not to transfer soil, water or vegetation between sites. Filters were stored out of sunlight and refrigerated or on ice before being transported to the laboratory for processing.

DNA was extracted from the filters using a commercially available DNA extraction kit (Qiagen DNeasy Blood and Tissue Kit). Real-time quantitative Polymerase Chain Reaction (qPCR) assays were used to amplify the target DNA, using a species-specific probe targeting a small region of the mitochondrial genome of the target species. Assays were performed in triplicate on each sample. Positive and negative controls were included for all assays as well as an Internal Positive Control (IPC) to detect inhibition (Goldberg *et al.* 2016). Two positive PCR's (out of six assays undertaken for each site) were required to classify the sample as positive for the presence of the target species. To minimise false positives, samples were considered equivocal if only 1 assay returned a positive result, indicating very low levels of target DNA. While trace amounts of DNA may indicate the target species is actually present in low abundance, it may also arise from sample contamination through the sampling or laboratory screening process (minimised through strict protocols and negative controls), facilitated movement of DNA between waterbodies (i.e. water birds, recreational anglers, water transfers, predator scats), or dispersal from further upstream in lotic systems. If greater confidence is required, further sampling is recommended at equivocal sites to confirm the presence or absence of the target species. Repeat sampling is also recommended to help determine the tenure of the species at a site (i.e. resident or transient).

Results are summarised in Table 1 below. Dwarf galaxias eDNA was detected at all sites tested.

Table 1. Results for eDNA screening of water samples for dwarf galaxias (*Galaxiella pusilla*).

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Site Code	Waterway	Latitude	Longitude	Date sampled	qPCRs +ve	Test Result
DV1	Knox Dam (NE)	-37.87095	145.256610	16/8/21	5/6	Positive
DV2	Knox Dam (S)	-37.869761	145.255232	16/8/21	4/6	Positive
DV3	Blind Creek	-37.868594	145.257049	16/8/21	3/6	Positive
DV4	Blind Creek	-37.872108	145.224725	16/8/21	6/6	Positive
DV5	Centre Rd Drain	-38.033704	145.302667	16/8/21	6/6	Positive

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Biggs J., Ewald N., Valentini A. *et al.* (2015) Using eDNA to develop a national citizen science-based monitoring programme for the great crested newt (*Triturus cristatus*). *Biol. Conserv.* doi: 10.1016/j.biocon.2014.11.029. [online].

Goldberg C. S., Turner C. R., Deiner K. *et al.* (2016) Critical considerations for the application of environmental DNA methods to detect aquatic species. *Methods Ecol. Evol.* **7** , 1299–1307.

Lugg W. H., Griffiths J., van Rooyen A. R., Weeks A. R. & Tingley R. (2018) Optimal survey designs for environmental DNA sampling. *Methods Ecol. Evol.* **9** , 1049–1059.

McColl-Gausden E. F., Weeks A. R. & Tingley R. (2019) A field ecologist's guide to environmental DNA sampling in freshwater environments. *Aust. Zool.* doi: 10.7882/az.2019.025.

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Thomsen P. F., Kielgast J., Iversen L. L. *et al.* (2012) Monitoring endangered freshwater biodiversity using environmental DNA. *Mol. Ecol.* **21** , 2565–2573.

Thomsen P. F. & Willerslev E. (2015) Environmental DNA - An emerging tool in conservation for monitoring past and present biodiversity. *Biol. Conserv.* doi: 10.1016/j.biocon.2014.11.019. [online].

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Yamanaka H., Motozawa H., Tsuji S., Miyazawa R. C., Takahara T. & Minamoto T. (2016) On-site filtration of water samples for environmental DNA analysis to avoid DNA degradation during transportation. *Ecol. Res.* **31** , 963–967.

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Project number 2133CR1
December 20, 2021

Determining the presence of dwarf galaxias (*Galaxiella pusilla*) using environmental DNA, December 2021

Prepared for:

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Aquatica Environmental

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Prepared by:

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Summary

A key challenge for biodiversity conservation is understanding species occurrence or distribution. Determining the presence or absence of a species is integral to making informed management decisions. Unfortunately, detecting species, particularly in an aquatic environment, can often be difficult, time consuming, expensive, and highly invasive. Analysis of environmental DNA (eDNA) is a relatively new, cheap, quick and non-invasive method for detecting species (Rees *et al.* 2014; McColl-Gausden *et al.* 2019; Thomsen and Willerslev 2015). As the name suggests, eDNA refers to the genetic material that an organism leaves behind in its environment. Quantitative comparisons with traditional sampling methods indicate that eDNA methods can be superior in terms of sensitivity and cost efficiency, particularly for scarce, elusive or cryptic species (Biggs *et al.* 2015; Smart *et al.* 2015; Thomsen *et al.* 2012; Valentini *et al.* 2016; Lugg *et al.* 2018), enabling effective detection of species at low densities.

On 9-10th December 2021, water samples were collected from 5 sites by Aquatica Environmental staff following sampling protocols developed by EnviroDNA. At each site, 2 samples were collected by passing up to 700 mL water (average 358 mL) through a 1.2 μm syringe filter. Filtering on site reduces DNA degradation that may occur during transport of water (Yamanaka *et al.* 2016). Clean sampling protocols were employed to minimise contamination including new sampling equipment at each site, not entering water, and taking care not to transfer soil, water or vegetation between sites. A preservative (approx. 0.5 ml 10xTris-EDTA) was added to the filters after filtering to minimise DNA degradation. Filters were stored out of sunlight and at ambient temperature before being transported to the laboratory within 48 hrs for processing.

DNA was extracted from the filters using a commercially available DNA extraction kit (Qiagen DNeasy Blood and Tissue Kit). Real-time quantitative Polymerase Chain Reaction (qPCR) assays were used to amplify the target DNA, using a species-specific probe targeting a small region of the mitochondrial genome of the target species. Assays were performed in triplicate on each sample. Positive and negative controls were included for all assays as well as an Internal Positive Control (IPC) to detect inhibition (Goldberg *et al.* 2016). Two positive PCR's (out of six assays undertaken for each site) were required to classify the sample as positive for the presence of the target species. To minimise false positives, samples were considered equivocal if only 1 assay returned a positive result, indicating very low levels of target DNA. While trace amounts of DNA may indicate the target species is actually present in low abundance, it may also arise from sample contamination through the sampling or laboratory screening process (minimised through strict protocols and negative controls), facilitated movement of DNA between waterbodies (i.e. water birds, recreational anglers, water transfers, predator scats), or dispersal from further upstream in lotic systems. If greater confidence is required, further sampling is recommended at equivocal sites to confirm the presence or absence of the target species. Repeat sampling is also recommended to help determine the tenure of the species at a site (i.e. resident or transient).

Results are summarised in Table 1 below. No dwarf galaxias eDNA was detected at any of the sites sampled.

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Table 1. Results for eDNA screening of water samples for dwarf galaxias (*Galaxiella pusilla*).

Site Code	Waterway	Latitude	Longitude	Date sampled	qPCRs +ve	Test Result
DV1	Knox Dam (NE)	-37.87095	145.256610	9/12/21	0/6	Negative
DV2	Knox Dam (S)	-37.869761	145.255232	9/12/21	0/6	Negative
DV3	Blind Creek	-37.868594	145.257049	9/12/21	0/6	Negative
DV4	Blind Creek	-37.872108	145.224725	10/12/21	0/6	Negative
DV5	Centre Rd Drain	-38.033704	145.302667	10/12/21	0/6	Negative

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References

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Project number 2133CR1
January 24, 2022

Determining the presence of dwarf galaxias (*Galaxiella pusilla*) using environmental DNA, January 2022

Prepared for:

[redacted]

[redacted]

Prepared by:

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During January 2022, water samples were collected from 5 sites following standard sampling protocols developed by EnviroDNA. Sampling was undertaken by EnviroDNA staff using site coordinates provided by Aquatica Environmental. At each site, duplicate samples were collected by passing up to 350 mL water (average 217 mL) through a 1.2 μm syringe filter. Previous research has demonstrated such a sampling effort yields very high detection probability (>0.95; Tingley *et al.* 2021). Filtering on site reduces DNA degradation that may occur during transport of water (Yamanaka *et al.* 2016). Clean sampling protocols were employed to minimise contamination including new sampling equipment at each site, not entering water, and taking care not to transfer soil, water or vegetation between sites. A preservative (approx. 0.5 ml 10xTris-EDTA) was added to the filters after filtering to minimise DNA degradation. Filters were stored out of sunlight and at ambient temperature before being transported to the laboratory within 48 hrs for processing.

DNA was extracted from the filters using a commercially available DNA extraction kit (Qiagen DNeasy Blood and Tissue Kit). Real-time quantitative Polymerase Chain Reaction (qPCR) assays were used to amplify the target DNA, using a species-specific probe targeting a small region of the mitochondrial genome of the target species. Assays were performed in triplicate on each sample. Positive and negative controls were included for all assays as well as an Internal Positive Control (IPC) to detect inhibition (Goldberg *et al.* 2016). Two positive PCR's (out of six assays undertaken for each site) were required to classify the sample as positive for the presence of the target species. To minimise false positives, samples were considered equivocal if only 1 assay returned a positive result, indicating very low levels of target DNA. While trace amounts of DNA may indicate the target species is actually present in low abundance, it may also arise from sample contamination through the sampling or laboratory screening process (minimised through strict protocols and negative controls), facilitated movement of DNA between waterbodies (i.e. water birds, recreational anglers, water transfers, predator scats), or dispersal from further upstream in lotic systems. If greater confidence is required, further sampling is recommended at equivocal sites to confirm the presence or absence of the target species. Repeat sampling is also recommended to help determine the tenure of the species at a site (i.e. resident or transient).

Results are summarised in Table 1 below. No dwarf galaxias eDNA was detected at any of the impact sites sampled (DV1-4) but were detected at a positive control site (DV5).

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Table 1. Results for eDNA screening of water samples for dwarf galaxias (*Galaxiella pusilla*).

Site Code	Waterway	Latitude	Longitude	Date sampled	qPCRs +ve	Test Result
DV1	Knox Dam (NE)	-37.87095	145.256610	05/01/22	0/6	Negative
DV2	Knox Dam (S)	-37.869761	145.255232	05/01/22	0/6	Negative
DV3	Blind Creek	-37.868594	145.257049	05/01/22	0/6	Negative
DV4	Blind Creek	-37.872108	145.224725	05/01/22	0/6	Negative
DV5	Centre Rd Drain	-38.033704	145.302667	23/01/22	6/6	Positive

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