Attachment B

Pacific National

Little River Logistics Precinct —

Flood Assessment

FOR / Civil Engineering Services

CLIENT / Pacific National

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bgeeng.com—

Document *Control*

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CONTENTS

Appendices

1 INTRODUCTION

1.1 Purpose of Report

This Flood Assessment is being undertaken in parallel with a land rezoning (Planning Scheme Amendment) and has been prepared to:

- Provide a Flood Assessment for a parcel of land that is proposed for Rail Intermodal and freight forwarding purposes;
- Summarise the flood modelling developed for the site including available data, modelling methodology and assumptions;
- Describe the existing flood behaviour at the site;
- Summarise potential post-development flood behaviour;
- Determine the potential flood impacts as a result of development and strategies to mitigate flood impacts where necessary; and
- Demonstrate how the flooding requirements of Melbourne Water as an approval authority will be addressed through design development.

This Flood Assessment intends to provide a strategy for managing external and internal catchment flows and to demonstrate that flood criteria can be met at the conceptual level. Further refinement of the flood modelling and Flood Assessment will be carried out alongside the development of the terminal. This report is not the final assessment and will be updated as design development continues.

This report should be read in conjunction with the stormwater management report (VE22064_RPT_WA-001).

1.2 Terminology

The flood terminology adopted in this report is consistent with the Australian Rainfall and Runoff 2019 (ARR2019) terminology.

The frequency of a flood event is expressed in terms of its Annual Exceedance Probability (AEP); the probability of an event being equalled or exceeded within a year. Smaller magnitude events are described by Exceedances per Year (EY); the average number of times a year in which the event is likely to be equalled or exceeded. Previously flood probabilities have been described by the Average Recurrence Interval (ARI); the average time period between occurrences equalling or exceeding a given value.

For example, a 1% AEP event has a 1% chance (i.e. a 1 in 100 chance) of being equalled or exceeded in any one year and is equivalent to a 100 year Average Recurrence Interval (ARI) event. In the same way, a 5% AEP event is the equivalent of a 20 year ARI event.

1.3 Standards and Guidelines

- Australian Rainfall and Runoff 2019 (ARR2019)
- Melbourne Water standards for infrastructure projects in flood-prone areas (Melbourne Water, August 2021, version 2.3.1)

- Melbourne Water Land Development Manual (available online)
- Melbourne Water Constructed Waterway Design manual (online version – December 2019)
- Guidelines for Development in Flood Affected Areas (DELWP, February 2019)
- Austroads Guide to Road Design Parts 5, 5A, 5B (2021) and the VicRoads Supplement to the AGRD, Part 5, 5A and 5B (2013)
- Melbourne Water: AM STA 6200 Flood Mapping Projects Specification

1.4 Available Data

1.4.1 Available Flood Data and Advice from Melbourne Water

Formal advice from Melbourne Water is included in Appendix A and is based on the Little River Flood Study. A summary of the advice is discussed in Section 2.3.2 and the data received includes:

- Flow hydrographs for Little River at Princes Freeway for the 1 in 5 year ARI (approximate 20% AEP), 10% AEP, 5% AEP, 2% AEP and 1% AEP events.
  - These were established using ARR1987 methodology. For each AEP event flow hydrographs were provided for 36 hour storm durations.
- PDF map of flood extent and flood level contours for Little River.
  - Melbourne Water was only able to provide this for the 1% AEP event and other events were not available.
- Hydrology for climate change or extreme event scenarios were not available from Melbourne Water.

1.4.2 Other Data

The following data has been used in the assessment:

- LiDAR data from the 2017-18 Greater Melbourne LiDAR Project. GDA2020 MGA Zone 55. The LiDAR data has an accuracy of 0.2 m horizontal and 0.1 m vertical.
- 1 to 5 m elevation contours: EL_CONTOUR_1TO5M (DELWP, 2020).
- Available cadastral, transport and hydro data from DataShare (DELWP, 2020).
- Measurements of hydraulic structures taken during site inspection.
- Detailed survey of the existing rail corridor.
- Concept bulk earthworks design and drainage concept provided by civil designers.

1.4.3 Data Gaps

The following data is not available at the time of preparing this report. If necessary, flood modelling may need to be updated once the following data is received.

- Full site survey data (in lieu of this LiDAR data has been used).
- Survey of key hydraulic structures on Little River Road (in lieu of this site measurements and estimation of visual observations and LiDAR data has been used).

2 SITE CHARACTERISTICS

2.1 Existing Site

2.1.1 Summary

The site is located on Little River Road in Little River, south of the main interstate freight and passenger rail lines. The unsealed Narraburra Road runs parallel to the rail to the north. It is a rural site with elevations ranging between 15 mAHD and 32 mAHD.

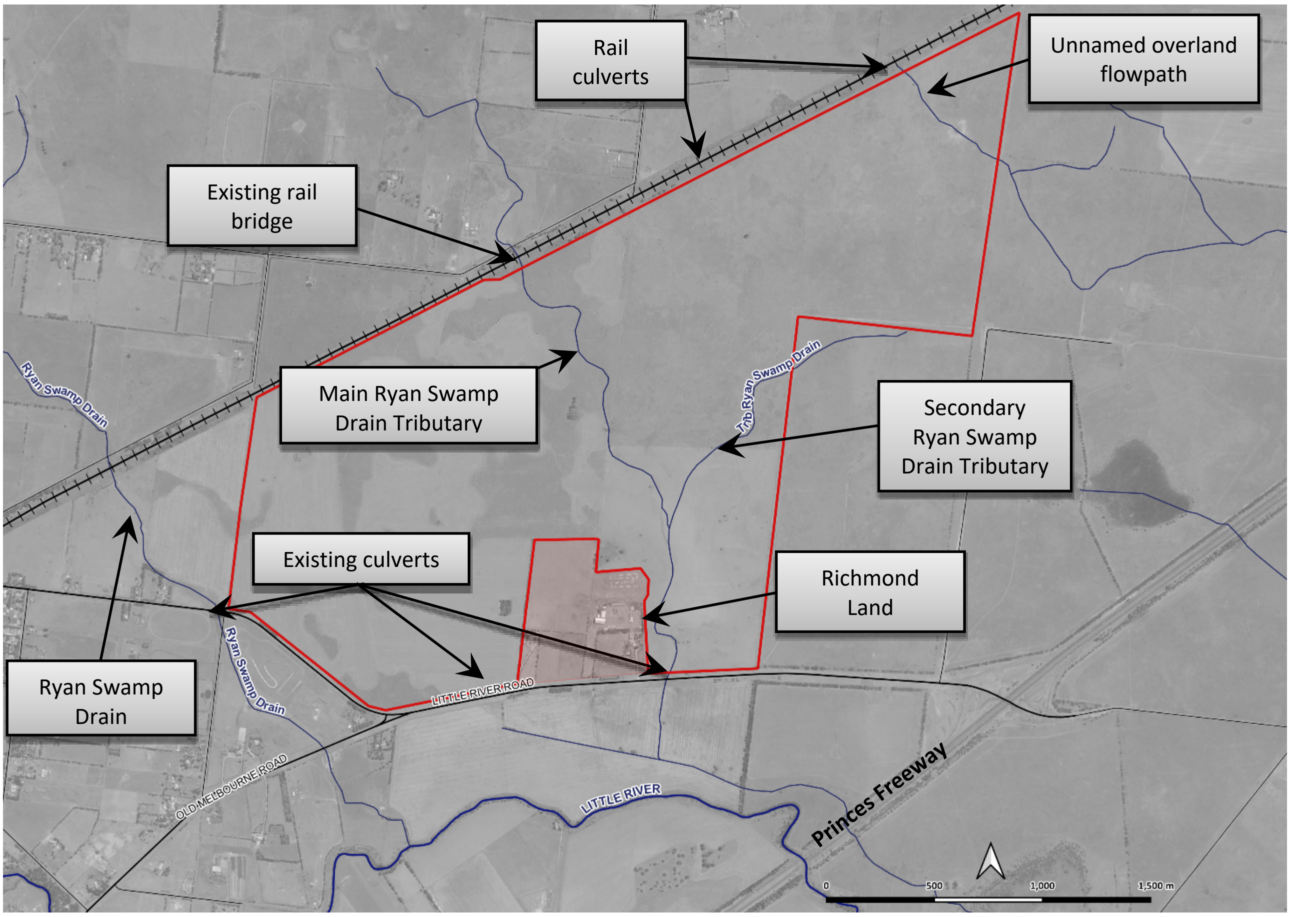


Figure 2-1 – Site Location and Features

2.1.2 Watercourses

As shown in Figure 2-1, Little River is located to the south of the site and flows west to east. At the Princes Freeway crossing, Little River has a catchment area of about 460 km^2 and it largely rural/undeveloped land.

Ryan Swamp Drain runs north to south to the west of the site. The Drain has a catchment area of about 20 km^2 to its confluence with the Little River floodplain near the south-west corner of the site.

The site is traversed by two tributaries of Ryan Swamp Drain (referred to herein as the main tributary and the secondary tributary as per Figure 2-1). The main tributary flows towards Little River floodplain, via culverts at Little River Road. The main tributary catchment area upstream of the rail bridge is approximately 16km

[2]. At the northern portion of the site, the main tributary sits within a valley line with steady grades from north to south, however the southern portion of the site has flatter terrain.

An unnamed overland flow path from a small catchment passes through the north-east corner of the site, entering the site through a culvert crossing of the rail corridor.

2.1.3 Site Discharge Locations

The main point of discharge from the site is the main tributary to Little River via 4x 1.2m x 0.45m box culverts under Little River Road. There are three other points of discharge as shown in Figure 2-2:

- Unnamed flow path in northern corner which enter sites through culvert and discharge from the site on the eastern boundary;
- Approximate 52 ha catchment including a portion of the site which drains to Ryan Swamp Drain wets of the site; and
- A local catchment of about 1 km^2 in the western portion of the site draining to the south of the site and discharging 2x 0.6 m x 0.3 m box culverts crossing Little River Road towards Little River.

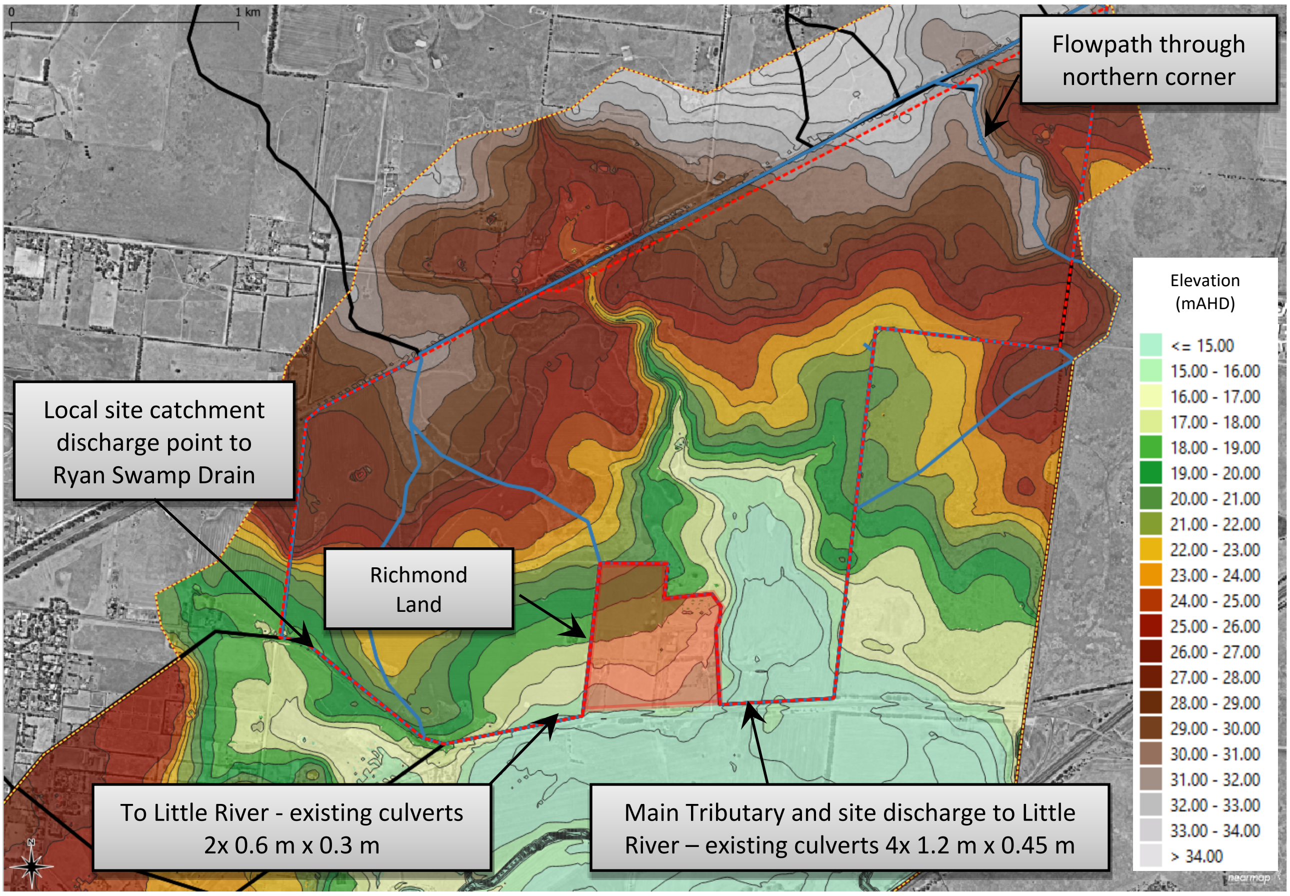


Figure 2-2 – Existing Internal Catchments and Site Discharge Locations

2.1.4 Hydraulic Structures

The main tributary enters the site via a rail bridge at the northern boundary (refer Figure 2-3). A small culvert is located immediately downstream in the rail access track, but the capacity is likely to be exceeded frequently. Two smaller structures convey flow across the rail corridor from the smaller catchments to the east of the main tributary.

Figure 2-3 – Ryan Swamp Drain Main Tributary Bridge *(source: Google)*

The main tributary exits the site via 4x 1.2 m wide x 0.45 m high culverts at Little River Road. Other culverts along Little River Road convey flows from the internal site catchments but do not drain to the main tributary.

Detailed survey for the existing rail corridor was conducted in January 2023. Hydraulic structures outside this area were estimated based on available information such as site observations and LiDAR data (See Table 2-1).

Table 2-1 – Hydraulic Structures

Structure	Details	Source of Data
Rail bridge on main tributary	Spans – 4.5 m and 5.4 m openings Pier Width ~0.5 m Flow length = 10.5 m Distance between invert of creek and soffit – 1.8 m	Rail detailed survey Site Inspection LiDAR Aerial imagery
Rail maintenance track over main tributary, downstream of rail bridge.	2x 0.6 m diameter	Rail detailed survey Site inspection
Mid-catchment rail culverts – located approximately 1.15 km east of rail crossing of main tributary.	Box Culvert 1.2 m wide x 0.9 m high	Rail detailed survey Site Inspection
Eastern rail culverts – located near the north-east corner of the site	Box Culvert 3.5 m wide x 3.75 m high	Rail detailed survey Site Inspection
Ryan Swamp Drain crossing of Little River Road near the south-west corner of the site	5x 0.9 m wide x 0.65 m high Approximate 45° wingwalls	Site Inspection Inverts and length adopted from LiDAR

Structure	Details	Source of Data
Culvert under Little River Road near the west of the private property	2x 0.6 m wide x 0.3 m high	Site Inspection Inverts and length adopted from LiDAR
Main tributary crossing of Little River Road at the southern boundary of the site	4x 1.2 m wide x 0.45 m high	Site Inspection Inverts and length adopted from LiDAR

2.1.5 Available Flood Mapping

Pre-planning advice has been sought from Melbourne Water (refer Appendix A). The 1% AEP flood extent as detailed by Melbourne Water (refer Figure 2-4) encroaches into the site. Backwater from Little River occurs in the southern portion of the main tributary. The flood extent of Little River also encroaches into the southern boundary of the western side of the site.

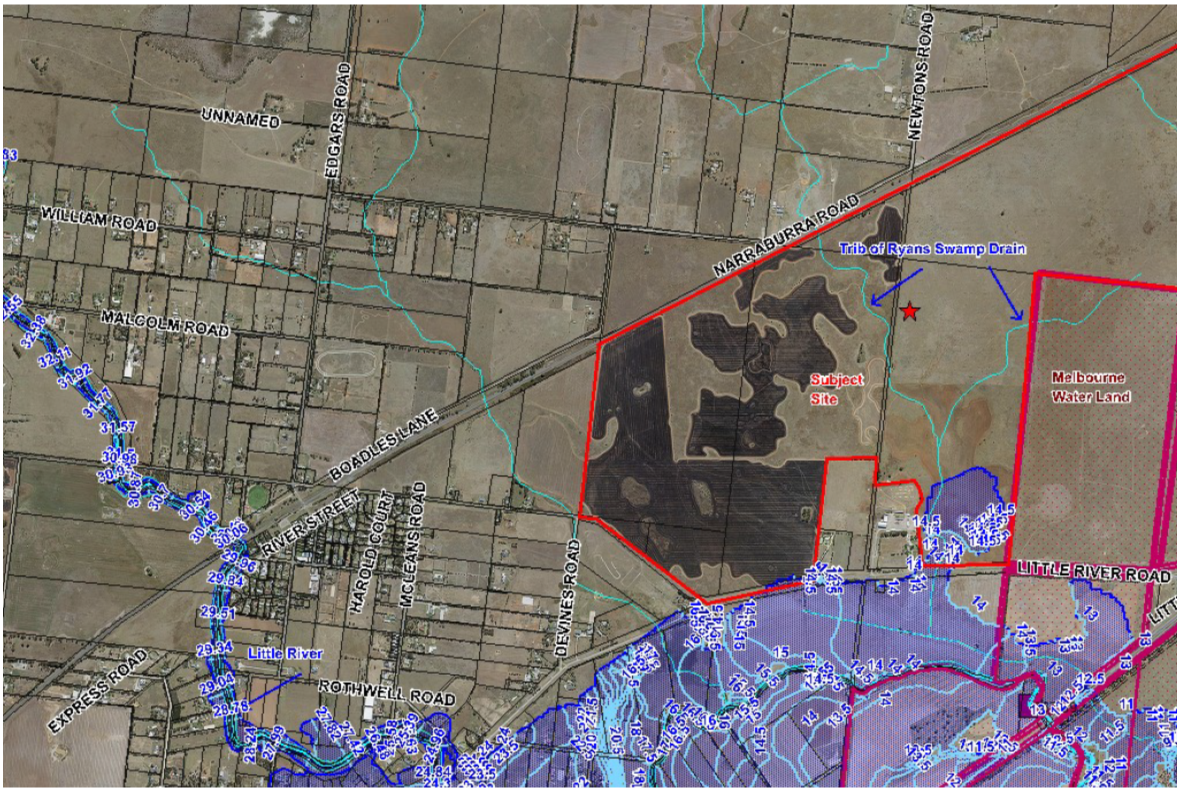


Figure 2-4 – 1% AEP Flood extent and contours – *supplied by Melbourne Water*

2.2 Proposed Development

2.2.1 Concept Design

The proposed concept design is shown in Figure 2-5 and the associated stormwater management plan is provided in Appendix B.

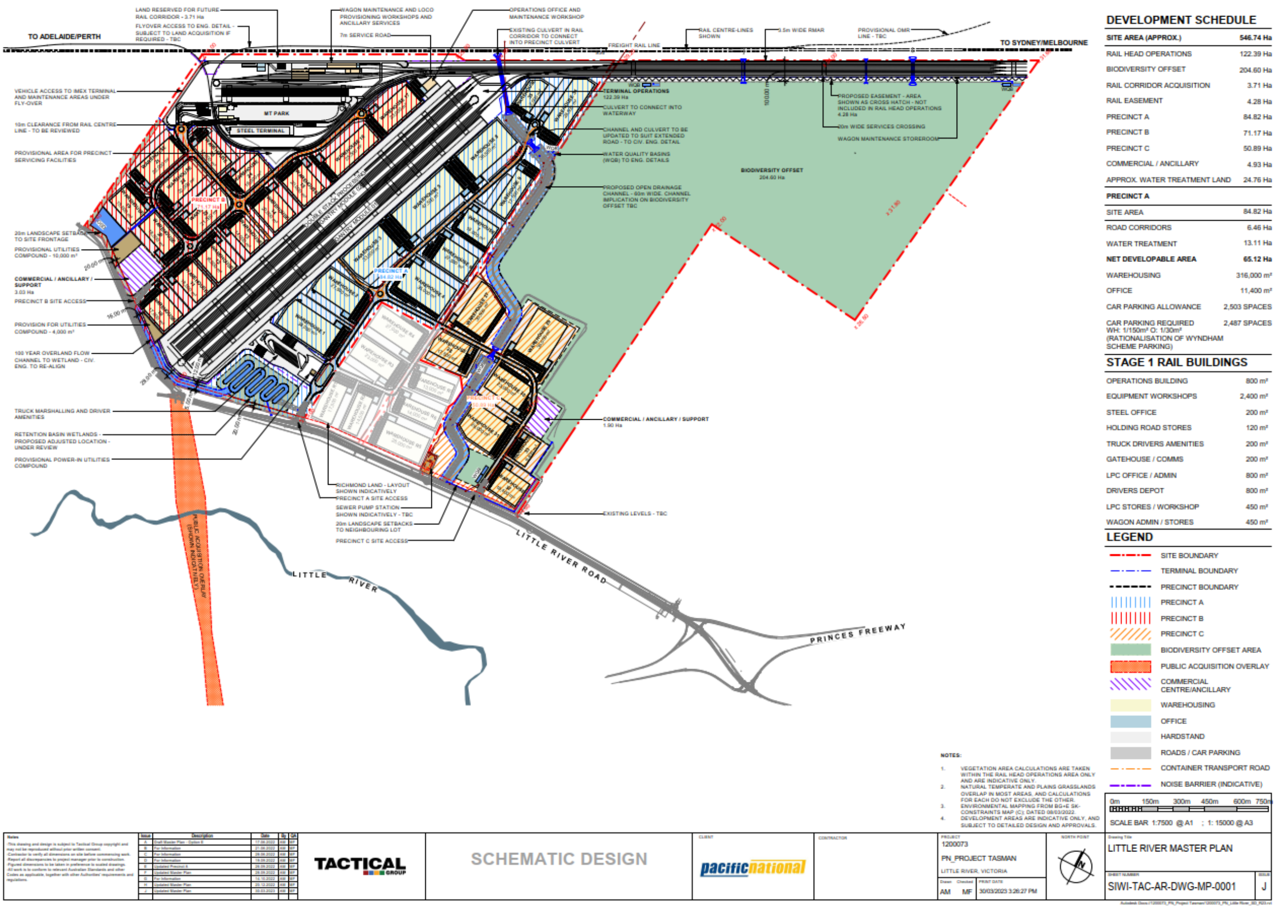


Figure 2-5 – Concept Site (Rev G)

The proposal is for an intermodal and freight forwarding terminal that includes new rail adjacent to the main Sydney to Adelaide interstate rail line and rail terminal with rail head operations. The rail terminal will ultimately include holding lines, double-stack processing lines and gantry modules, truck processing administration and operations, over 50 warehouses, a new interior road layout and a commercial precinct.

The full details of the terminal are still subject to design development and this Flood Assessment has been prepared for the Planning Scheme Amendment only. As further stages of design are developed the Flood Assessment will be updated to incorporate design changes.

2.2.2 Site Access

Primary vehicular site access is proposed to be via a new entry on Little River Road in the south-east corner in Stage 1 with a new secondary road access from Little River Road in the south-west corner to be developed in Stage 2.

2.2.3 Flooding and Drainage

The main tributary will be piped via a box culvert as it enters the site. The concept design incorporates 5x 3.0 m x 1.2 m RCBCs (Reinforced Concrete Box) culverts to convey the critical 1% AEP event. Culvert sizes were selected based on providing an equivalent opening area as the upstream railway bridge.

The proposed culvert continues through the rail head operations and daylights into a realigned open channel that runs along the east side of proposed development area. Two proposed culvert crossings within the site will allow for crossing of the diverted channel. The channel will discharge from the site the site via the existing 4x 1.2 m x 0.45 m box culverts at Little River Road (refer concept stormwater plan in Appendix B).

Additional culverts are provided in to convey flows underneath the proposed railway embankment and to discharge to their natural drainage paths. Details of the proposed structures are reported in Section 5. Preliminary culvert sizes were based on providing an equivalent opening area as the upstream rail culverts. Additional barrels were added where needed to minimise afflux or flood levels.

This Flood Assessment focussed on the tributaries of Ryan Swamp Drain. The drainage scheme (Appendix B) aims to separate the internal site runoff from the flows entering the site from external catchments. Internal catchment flows will be directed via the stormwater drainage network to the main flow path via water quality treatment. Where stormwater drainage is required for local catchment runoff, drainage will be designed to the 10% AEP event with local catchment flows for events greater than the 10% AEP to the 1% AEP event conveyed via the internal road and swale network. Further details are provided in the stormwater management report (VE22064_RPT_WA_001).

2.3 Applicable Flood Criteria

2.3.1 Victoria Planning Provisions Flood Overlays

Specific requirements apply in flood related overlays:

- Floodways Overlays (FO) – These apply to land that is identified as carrying active flood flows associated with waterways and open drainage systems. According to VicPlan mapping there is no FO affecting the site. More generally, the DEWLP Guidelines for Development in Flood Affected Areas (2019) defines a Floodway Overlay as that part of the floodplain that is important for the conveyance or storage of water during major floods. It is usually aligned with naturally defined waterways, channels and depressions and often carries relatively deep and high velocity flows. The FO is usually calculated using some combination of depth and velocity or mapping a flood extent to a corresponding major flood, such as a 10% AEP (DEWLP, 2019).
- LSIO (Land Subject to Inundation Overlay) – These are planning scheme controls under section 44.04 of the Victoria Planning Provisions Planning Scheme, that apply to land affected by flooding associated with waterways and open drainage systems; typically defined as land affected by the 1% AEP flood. These overlays require a planning permit for buildings and works.
  - LSIO mapping for Wyndham City Council is not included the VicPlan LSIO mapping. However, the *Little River Development of Land Subject to Inundation Overland* document (Melbourne Water, March 2008) Melbourne Water includes a portion of the site within the Little River LSIO. Melbourne Water provided mapping for the site (refer Appendix A).
- SBO (Special Building Overlay) – These are planning scheme controls that identify areas prone to overland flooding. The purpose of these overlays is to set appropriate conditions and floor levels to address any flood risk to developments. These overlays require a planning permit for buildings and works. VicPlan mapping shows no SBO affecting the site.

2.3.2 Melbourne Water

Melbourne Water advise that the development proposal must achieve five core flood protection criteria as a minimum. The development must:

- not affect floodwater flow capacity

- not reduce floodwater storage capacity
- meet minimum floor level height (above flood level) relevant to development location (freeboard)
- not occur where the depth and flow of floodwaters would create a hazard
- not occur in circumstances where the depth and flow of floodwater affecting access to the property is hazardous.

A response for pre-development advice was received from Melbourne Water on Monday 28th March 2022. The response is summarised below and attached in Appendix A.

In addition, the Tasman Terminal Development will be assessed against Melbourne Water's *Standards for Infrastructure Projects in Flood-Prone Areas* (2021). The following Guiding Principles apply:

i. Risk to people and property must not increase as a result of the development.
ii. Development within a flood-prone area must be designed:
   a. For conditions that might be experienced, and
   b. To reduce the reliance on emergency service personnel with flood events occur.
iii. Climate change must be accounted for in the design.
iv. Existing flood risk must be identified, and projects must work with Melbourne Water to identify opportunities to reduce these risks.
v. Flood risk must be assessed at least at the local scale

Changes to flood behaviour with the site may be acceptable on the grounds that there is no increased risk to site occupants. Melbourne Water requires safety criteria to be achieved for Infrastructure projects but does not specify values in the Infrastructure Projects Guidelines. It is therefore assumed that the DEWLP values will apply. The access and safety criteria outlined by the DEWLP Guidelines specifies the following criteria for industrial lots for both site and access safety (lots and accessway) where:

- Depths < 0.5m; and/or
- Velocities < 2.0 m/s; and/or
- Velocity-Depth product < 0.4 m^2/s.

ARR2019 also provides hazard criteria based on flood depth and velocity curves with hazards classified from low to high over six categories, H1 being the lowest and H6 being the highest. The above DELP maximum hazard criteria equivalent to H1 and H2 ARR2019 hazard; that is "generally safe for vehicles, people and buildings" and "unsafe for small vehicles".

2.3.3 Climate Change

As per Melbourne Water – Constructed Waterways Design Manual (2019), climate change scenario has been modelled to reflect a 19.5% increase in rainfall intensity (predicted under a 2100 climate scenario). The 2019 design rainfall depths have been increased by a factor that scales rainfall intensity.

3 FLOOD MODELLING METHODOLOGY

3.1 Sources of Flooding

The site is affected downstream by flooding from backwater from Little River. Flood model outputs from Little River were available from Melbourne Water (refer Section 1.4.1). As no flood modelling has previously been completed for the main tributary, a model was developed to allow for assessment of the current flood behaviour at the site and to assess flood management options.

The smaller catchments within the project site are not considered to cause flooding and can be managed through the drainage design.

3.2 Hydrology

3.2.1 Little River

Melbourne Water provided flow hydrographs for Little River at Princes Freeway for the 1 in 5 year ARI (approximate 20% AEP), 10% AEP, 5% AEP, 2% AEP and 1% AEP events. These were established using ARR1987 methodology. For each AEP event flow hydrographs were provided for 36 hour storm durations and this is therefore assumed to be the critical duration.

3.2.2 Main and Secondary Tributaries – RORB Model

A rainfall-runoff model was developed in the Victorian industry standard runoff-routing software, RORB, for the main and secondary tributary that flow through the site. RORB is a runoff and streamflow routing program that calculates streamflow hydrographs resulting from rainfall events and/or other forms of inflow to channel networks.

The catchments delineation used available 10 m contoured elevation data, ensuring a minimum of five catchments as required by RORB, upstream of the main tributary location used for input into the TUFLOW hydraulic model. Catchments were treated as rural farmland with natural (Type 1) reaches throughout for existing conditions. The parameters used for the hydrology modelling and the catchment delineation is included within Appendix C.

The hydrology model was run for the 1% Climate Change, 1%, 2%, 5%, 10% and 20% AEP events and the results were post-processed to determine the mean temporal pattern for every duration from 10 minutes to 72 hours.

RORB simulations were carried out adopting the ARR2019 ‘ensemble’ approach which samples ten different temporal patterns for each storm duration. For each event, the critical duration was selected from the maximum of the median temporal pattern peak flows for each duration. Two different critical duration were identified for each design event, one for the main catchment (Main Ryan Swamp Drain Tributary) and one for the local catchments. Peak flows extracted from RORB for each event and critical duration are shown in Table 3-1.

Table 3-1 – RORB Model Outputs – Existing Conditions

Event	Tributary to rail			Local catchments		
	Peak Flow Main Tributary – U/S rail bridge (m^3/s)	Critical Duration	Selected Temporal Pattern	Peak flow Main Tributary downstream (m^3/s)	Critical Duration	Selected Temporal Pattern
1% AEP CC	43.4	540 min	TP 03	14.6	60 min	TP 08
1% AEP	33.5	720 min	TP 10	11.6	60 min	TP 08
2% AEP	28.5	720 min	TP 10	9.3	60 min	TP 07
5% AEP	22.4	540 min	TP 02	7.5	90 min	TP 06
10% AEP	17.9	540 min	TP 02	5.9	90 min	TP 06
20% AEP	13.3	540 min	TP 04	4.3	60 min	TP 04

For the post-development flood assessment, the RORB model was updated to refine the subareas within the site boundary. The fraction impervious values were updated to represent a high imperviousness for roads, rail, railhead operations and the warehouse precincts. It is to be noted that internal site drainage basins have not been included in the post-development model in this design stage and therefore there is a minor increase in a minor increase in discharge from these catchments. However, in the critical duration storm for the Main Tributary there are no notable offsite increases in flow.

Table 3-2 shows RORB results for the post-development model.

Table 3-2 – RORB Model Outputs – Developed Conditions

Event	Tributary to rail			Local catchments		
	Peak Flow Main Tributary at rail bridge (m^3/s)	Critical Duration	Selected Temporal Pattern	Peak flow Main Tributary downstream (m^3/s)	Critical Duration	Selected Temporal Pattern
1% AEP CC	43.4	540 min	TP 03	16.1	60 min	TP 08
1% AEP	33.5	720 min	TP 10	11.9	60 min	TP 08
2% AEP	28.5	720 min	TP 10	11.0	60 min	TP 07
5% AEP	22.4	540 min	TP 02	8.7	90 min	TP 06
10% AEP	17.9	540 min	TP 02	7.2	90 min	TP 06
20% AEP	13.3	540 min	TP 04	5.9	60 min	TP 04

3.3 Hydraulic Modelling

3.3.1 Existing Conditions

A TUFLOW hydraulic model was developed for the site and Little River as it passes the site. Key assumptions of the model are summarised in Table 3-3 and model schematics in Appendix D.

Table 3-3 – Hydraulic Modelling Parameters and Assumptions

Feature / Parameter	Value / Comment
TUFLOW version	Build: 2020-10-AB-iSP-w64 – HPC
2d Grid Size	4 m with sub-grid sampling was used to capture the 1m LiDAR DEM terrain rotated to align with the existing rail line.
Timestep	2 seconds. Initial timestep = ½ cell size. Adaptive time-stepping in HPC was used.
Inflow Boundaries	Little River and Ryan Swamp Drain – Hydrographs provided by Melbourne Water were adopted. As the hydrographs provided were located at the Princes Freeway, the hydrograph was split proportional to catchment areas to allow for flows to be input into Ryan Swamp Drain and Little River boundaries in the TUFLOW model. In addition, the flow was scaled to allow for the difference in catchment area between the location of the provide hydrographs and the actual model inflow boundaries. Tributaries and local catchments – from RORB model
Outflow Boundaries	Automatically generated level-flow boundary has been used, with the slope based on the tailwater levels provided by Melbourne Water.
Design events assessed	1% AEP with climate change and 1% AEP events have been assessed in the hydraulic modelling as design criteria events. Other rainfall events will be considered in the hydraulic modelling at a later stage.
Critical Storm Duration	Enveloped maximum flood behaviour grids from 1 hour, 1.5 hour, 9 hour, 12 hour. Little River – 36 hours (All events) Main tributary – 9 hours (1% AEP CC) and 12 hours (1% AEP) Local Catchments – 1 hour (1% AEP CC, 1% AEP) The timing of site peak flows were adjusted to coincide with the peak flows from Little River to provide a conservative assessment of peak flood flows and levels affecting the proposed development.
Base Digital Terrain Model	Derived from 1m LiDAR and detailed survey of existing railway line

Feature / Parameter	Value / Comment
Mannings Roughness – 'n' values	The following Manning's values have been adopted as per guidance of ARR2019 and Melbourne Water and based on aerial imagery and site inspection. • Residential rural: 0.10 • Roads: 0.02 • Default/ Minimal vegetation: 0.03 • Gravel roads: 0.035 • Railway line: 0.05 • Waterways channel vegetated: 0.06 • Moderate vegetation: 0.06
Existing farm dams and water storages	Assumed full.
Structures	Details assumed form site observation and LiDAR as per Table 2-1. Main tributary rail crossing – 2d layered flows constriction with form loss coefficients (0.0047 for layer 1 and 0.1 layer 2) and blockage (4.8 % for layer 1 and 100% layer 2)) as per the Hydraulics of Bridge Waterway Guidelines (Bradley, 1978) Culverts: Embedded as 1d elements. Proposed site drainage – only major trunk drainage and the watercourse diversion have been modelled. Local catchment drainage is to be considered in the Stormwater Management Plan.
Blockage factors	No blockage has been included at this stage. This provides a conservative estimate of flows from the upper catchment entering the site. *Blockage sensitivity modelling will be undertaken at a later stage. Some blockage allowance may need to be included in the design culverts which may increase size requirements.*

3.3.2 Model Validation

The 1% AEP model results were validated against the PDF maps supplied by Melbourne Water (refer Appendix A). In the backwater area at the south-east of the site, peak flood levels from the TUFLOW model were a reasonable match to the Melbourne Water contours around 14.0 to 14.5 mAHD.

The TUFLOW model resulted in some differences to the Melbourne Water flood level contours elsewhere in the Little River floodplain. However, as the flood extents do not affect the site elsewhere this was considered acceptable for the purpose of the planning proposal assessment.

3.3.3 Post-Development Conditions

The flood model was amended to assess the post-development conditions by incorporating the proposed earthworks, Main Tributary diversion and culverts.

Modifications to the existing model and modelling assumptions are summarised in Table 3-4 and are shown in Appendix D.

Table 3-4 – Amended Hydraulic Modelling Parameters and Assumptions – Post Development

Feature / Parameter	Value / Comment
Inflow Boundaries	Inflow hydrographs amended to represent post-development conditions RORB model. In determining the peak post development flow rates, drainage basins have not been modelled at this stage and the warehouse precinct areas have been treated as impervious areas. This is conservative assumption with regard to peak flows. The stormwater management plans details the proposed basins and the restriction of runoff from the site.
Base Digital Terrain Model	Updated to include proposed earthworks.
Mannings Roughness – 'n' values	Updated for post-development scenario to include areas of hardstand and proposed vegetated channels.
Structures	Proposed main tributary culverts, and overland flow path culverts modelled as embedded 1d elements.

3.4 Flood Modelling Assumptions

- It is assumed that the flow hydrographs provided by Melbourne Water are suitable for use. The Little River hydrographs provided use ARR87 methods. It is unclear if data was available to calibrate the models. The main tributary and site catchments have been assessed using ARR2019 as is current best practice. Therefore, the modelling uses as combination of both methods. However, this is considered a theoretical assessment of the 1% AEP event and allows for the most recent approach to be used for managing the flow paths within the site.
- The accuracy of flood levels is dependent on the accuracy of the data used to build the model. LiDAR is typically only accurate to +/- 0.15 m and in some areas (especially vegetated channels) can be several hundred mm.
- Dimensions at some structures have been assumed from site observations where survey was not available. Detailed survey may cause a change in the predicted flood behaviour.
- The post-development hydrology scenario assumes that the development increases impervious area for the main facilities including the proposed rail, rail terminal including the rail head operation area, internal roads and precinct areas for the future warehouses. Proposed drainage basins have not been modelled to provide a worst case scenario of peak discharge from the site. The drainage basins have been considered in the stormwater management report (VE22064_RPT_WA_001) and seek to minimise any increase in discharge from the site.

4 EXISTING (PRE-DEVELOPMENT) FLOOD BEHAVIOUR

4.1 Flood Behaviour

Flood mapping for the pre-development scenario is included in Appendix E.

Flood modelling shows that Little River impacts the site in the 1% AEP event at two locations; a minor area where the waters spill over Little River Road into the southern boundary of the south-western portion of the site and a large area in the south-eastern portion of the site where there is little variation in flood levels between the Little River flood levels and flood levels within the site.

At the rail bridge, approximately 34 m^3/s enters the site via the main tributary in the 1% AEP event and 40 m^3/s in the 1% AEP CC event. The main tributary is generally confined to the natural valley area and the flow path widens as flows reaches the confluence with the secondary tributary. Once flows have passed the confluence, the terrain becomes broad and flat and is subject to the backwater flooding from Little River.

The secondary tributary has a wider flow path although flows are typically shallow; less than 100 mm in the upper reach and less than 400 mm in the lower reach. The upper reach can be considered as local catchment runoff rather than land subject to flooding.

An overland flow path from the smaller mid-catchment rail culverts through the western part of the site drains towards the secondary tributary. Again depths are shallow being typically less than 50 mm, and are considered as catchment overland runoff rather than flooding.

The overland flow path from the box culverts in the easternmost part of the site is also shallow and does not cause significant flooding. Although about 60m wide in places depths are typically not more than 200 mm with the exception of the existing farm dam. This is outside the proposed extent of works.

The smaller catchments in the western portion of the site would experience shallow sheet overland runoff. Depths are shallow and this is not considered as flooding.

Given its larger catchment area, Little River has a significantly longer critical duration storm than main tributary and therefore the downstream portion of the site subject to backwater flooding will likely have be subject to a longer duration inundation than the rest of the site.

4.1.1 Flood Levels

Flood levels within the site vary with the natural gradient of the terrain.

As shown in Figure 3 the 1% AEP flood levels are about 24.6 mAHD where the Main Tributary enters the site. At the confluence of the main and secondary tributaries flood levels are about 15.3 mAHD and at the boundary with Little River are about 14.4 mAHD.

4.1.2 Flood Depths

In the 1% AEP event, the maximum flood depth throughout the northern part of the main tributary is about 1.4m reducing to about 0.9 m as the flow path widens at the confluence of the two tributaries.

At the southern boundary of the site, where the flooding is primarily Little River backwater, flood depths are up to about 1.2 m in the 1% AEP event.

4.1.3 Flood Velocities

Velocities in the main channel can be as high as 3 m/s and are typically fast due to conveying a high volume in a defined channel with a steep gradient. Velocities in the secondary tributary are generally low in the upper reaches where flows travel in a shallow overland flow path. Velocities in the Little River backwater area are generally low due to the flood storage nature of the flooding.

4.1.4 Flood Hazard

Flood hazard mapping is presented in Appendix E and show hazard categories between H1 and H3 for most of the site, except for the main tributary channel that shows hazard of H4 category.

5 POST-DEVELOPMENT FLOOD ASSESSMENT

5.1 Assessment of Trunk Drainage

5.1.1 Main tributary culvert

As described in section 2.2.3, the main tributary will be piped via a box culvert as it enters the site. Approximately 35 m^3/s entering the site in the 1% AEP (40 m^3/s in the 1% AEP climate change event) at the rail bridge will be conveyed via 5x 3m x 1.2m RCB culverts were incorporated to provide an equivalent opening area as the upstream rail bridge and to convey the 1% AEP flows.

The proposed culvert daylights into a realigned open channel that runs along the east side of proposed development area. The proposed channel downstream the culvert has been modelled as vegetated 50 m wide box channel as shown in Appendices B and C and in accordance with the drainage design. The possibility of reducing the channel dimensions will be explored in the next design stage.

Two proposed culvert crossings within the site will allow for crossing of the diverted channel.

The proposed realigned channel will discharge from the site the site via the existing 4x 1.2 m x 0.45 m box culverts at Little River Road (refer concept stormwater plan in Appendix B).

5.1.2 Management of flows from local catchment rail culverts

Additional culverts are provided in to convey flows underneath the proposed railway embankment and to discharge to their natural drainage paths. Details of the proposed structures are reported in Section 5. Preliminary culvert sizes were based on providing an equivalent opening area as the upstream rail culverts. Additional barrels were added where needed to minimise afflux or flood levels.

The overland flow path entering the site through the existing 1.2m x 0.9m box culvert crossing the rail will also be culverted under the proposed railway line via 4x 1.2 by 0.9m box culvert. This culvert conveys flows to the secondary tributary through an undeveloped portion of the site to the realigned main tributary channel.

Downstream of the existing 3.5 x 3.7 m box culverts, a 6 x 2.4m x 0.9m RCB is proposed. The proposed culvert is 103 m long and ~5° skewed in order to connect the existing flow path low points. These culverts convey an overland flow path which drains from the eastern boundary of the site. The remainder of this flow path is not affected by the site proposals.

5.1.3 Management of flows in the southern section

The flows coming from the main and secondary tributaries join into a vegetated 50 m channel and into a 5 x 3 m x 1.2 m culvert under the proposed local road as shown in Figure 5-1. This proposed culvert is 30 m long and the size is consistent with the upstream proposed culverts.

Local catchment flows (overland runoff) from a small catchment east of the area will be captured in a drainage channel and also piped via a 1500 mm diameter drain to the discharge point (refer Appendix B).

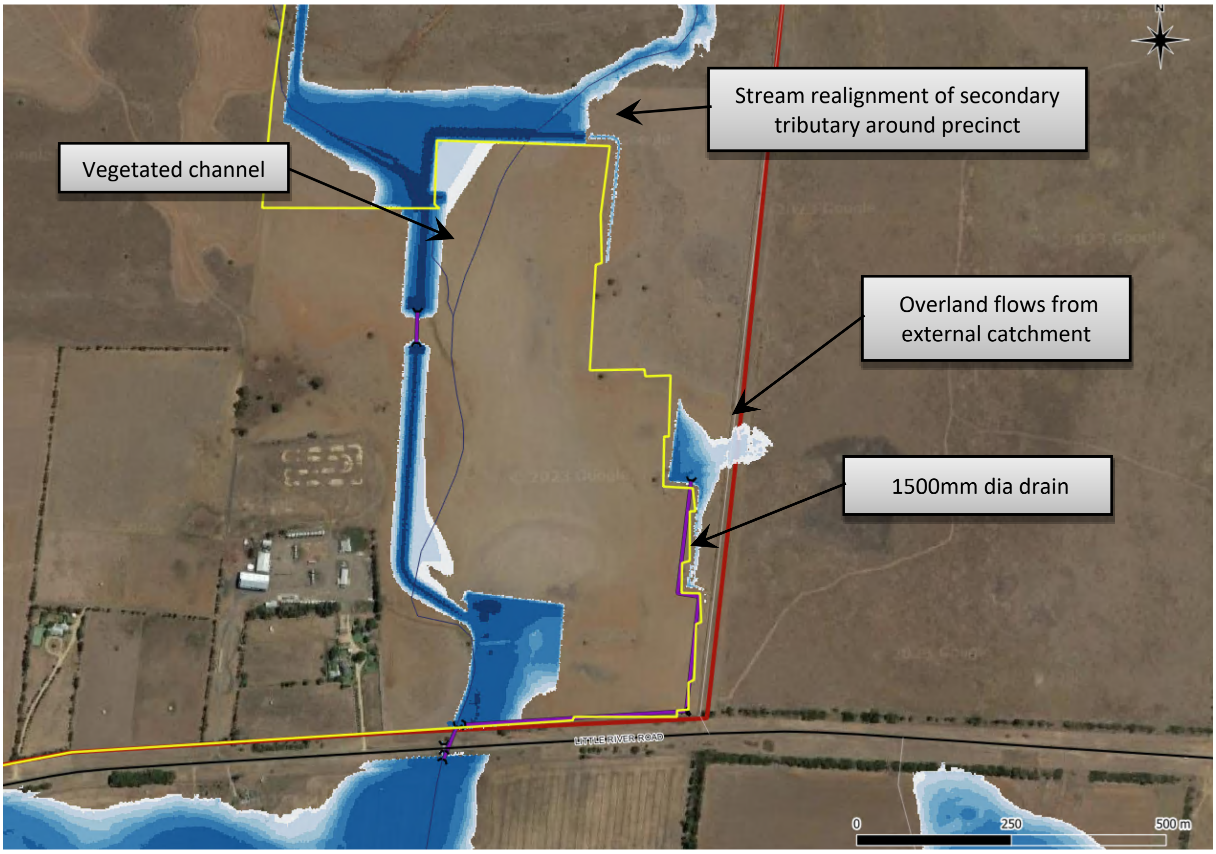


Figure 5-1 – External catchment diversion at the southern area

5.2 Post-Development Flood Behaviour

1% AEP and 1% AEP Climate Change design events have been modelled and flood mapping for the post-development scenario is included in Appendix F.

The flows through the proposed crossing are maintained the same as pre-development (Section 4.1). From the main tributary proposed box culverts, downstream the rail bridge, the flow path gets channelised through a vegetated channel that connects the flow to the existing flow path. The main and secondary tributaries join in the same location as the existing scenario to enter another 50m vegetated channel that connects the wetland areas to Little River Rd culverts.

5.2.1 Flood Levels

As shown in Appendix F, the 1% AEP and 1% AEP CC flood levels are range from about 25.2 m AHD in the upstream of the site to 17.2 m AHD when the main and secondary tributaries converge, and 14.5 mAHD at the southern boundary of the site.

There are minor changes in flood level compared to existing conditions and this is explained in Section 6.

5.2.2 Flood Depths

In the 1% AEP and 1% AEP CC events, the maximum flood depth throughout the realigned main tributary channel is about 1.6 m, increasing to about 1.9 m at the confluence of the two tributaries.

There is negligible change to flood depths external to the site area.

5.2.3 Flood Velocities

In the 1% AEP event, the velocity ranges from a maximum of about 3 m/s within the realigned channel.

There is no change to flood hazard external to the site area.

5.2.4 Flood Hazard

Flood hazard mapping presented in Appendix F shows hazard categories between H1 and H2 for the eastern side of the project site and between H3 and H4 along the proposed channels with peaks of H5 category along the channel.

There is no change to flood hazard external to the site area.

5.3 Culvert Blockage

As per Melbourne Water Guidelines – Constructed Waterways Design Manual (2019), hydraulic analysis based upon a 50% blockage scenario for the 1% AEP event should be considered to check that potential flood levels induced by such a blockage is contained within the freeboard provisions adjacent to private allotments.

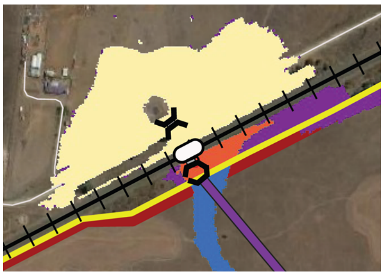
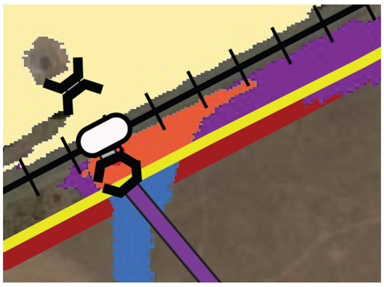
A culvert blockage sensitivity assessment has not been carried out at this stage. A blockage assessment will be required in the next design stage.

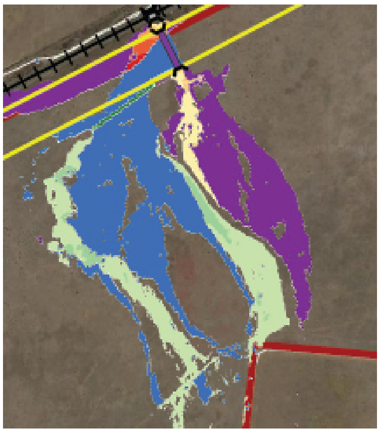
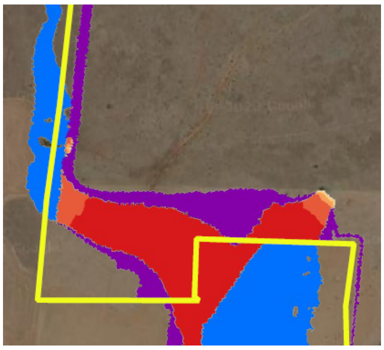
6 FLOOD IMPACT ASSESSMENT

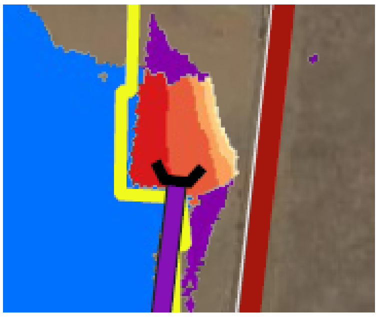
6.1 Change in Flood Behaviour

As shown in the afflux maps in Appendix F, several locations are affected by flood level differences in the 1% AEP event.

Table 6-1 – Flood Impacts – 1% AEP event

Location	Description of Impact	Proposed Management
External to site: Small catchment discharging from west of site 	Increase in flood level of less than 30 mm caused by the proposed earthworks in the site near this location. This impact is localised. There is a general decrease in levels in Ryan Swamp Drain as flows which previously ran off the site in the western corner are now retained in the site. It is also of note that this is conservative estimate of flood level impact as the proposed drainage basin at this location is not included in the flood assessment.	This can be addressed through revised earthworks.
External to site: Upstream of the existing rail bridge 	Flood level increases of up to 17 mm. This is caused by the reduction in efficiency as flows enter the proposed culverts at the site boundary. The rail is not overtopped and therefore there is no impact on the serviceability of the rail line. There is no change in the flood hazard between pre- and post- development scenarios.	Future design stages will consider improving efficiency at the culvert inlets to reduce flood level impact.
External to site: Area between existing rail bridge and northern site boundary (draining to proposed 5x 3m x 1.2m RCB) 	Maximum increase of 0.55 m in flood level. This is caused by the reduction in efficiency as flows enter the proposed culverts at the site boundary. However there are also works proposed in the rail corridor at this location which adjust the terrain levels. The additional flows from the culverts to the east also cause flood level increases here (see comment below).	Future design stages will consider improving efficiency at the culvert inlets to reduce flood level impact and considering what earthworks can be undertaken to minimise flood level increases. Future stages will also include works in the rail corridor and the flood level impact is expected to be addressed at this time.

Location	Description of Impact	Proposed Management
External to site: Area along site boundary and rail corridor between main tributary culvert and culvert conveying local overland flow catchment 	Flood level increases are caused by flow from the existing local catchment culverts moving south-west along the site boundary and rail corridor towards the main tributary. Not all flows are conveyed in the proposed culverts.	The proposed culverts (4x 1.2 x 0.9m) are larger than the existing culverts (1.2 m x 0.9 m). Design development will consider improving the efficiency of flow enerting the proposed culverts. It is also expected that some of the impacts are as a result of the flood model configuration at this location and therefore can be addressed at future stages.
Within Site: Overland flow paths within east portion of site 	There is some change in the direction of the shallow overland flows due to the culverts crossing the rail embankment. However depths in this area less than 50 mm and considered typical of sheet runoff.	None – within the total site area although there may be refinment to this are during design development.
Within Site: Confluence of the main and secondary tributaries 	Flood level impacts are a maximum of 450 mm in the 1% AEP event. Impactsa re out of the proposed development area but within the overall site area. Local stream realignment was needed to convey the flow from the secondary tributary in this area.	Refinement to this area will be made during design development to reduce spill from the proposed channels to minimise risk to potential future development.

Location	Description of Impact	Proposed Management
Within Site: upstream of proposed 1500 mm diversion pipe 	Up to 900 mm increase in peak flood level. However this is localised and contained within the site.	None – within the total site area although there may be refinment to this are during design development.
External to site: Little River Road 	There is reduced overtopping of the road.	None – positive benefit.

6.2 Freeboard

As per Melbourne Water Guideline 'Constructed Waterway Design manual' a minimum of 300 mm of freeboard from the 1% AEP flood level must be provided to the top of the high flow channel and a minimum of 600 mm freeboard must be provided from the 1% AEP flood level to adjacent lot floor levels.

The ultimate design (post approval of the Planning Scheme Amendment) will ensure that FFL of all buildings satisfy the freeboard criteria. Generally where the main tributary is contained within the realigned channel this can be achieved. In addition, developed areas are to be located out of the 1% AEP flood extent and therefore this is not applicable for much of the site.

6.3 Melbourne Water Flood Protection Criteria

The development seeks to achieve the five core flood protection criteria (refer section 2.3.2).

Table 6-2 – Melbourne Water Flood Protection Criteria

Criteria	Comment
The development must:	
not affect floodwater flow capacity	Diversion culverts for waterways and overland flow paths crossing the site have been sized to convey the existing flow through the site and to maintain existing discharge points from the site. Further revision and development of the design will address areas where off-site positive afflux was shown.
not reduce floodwater storage capacity	There is no loss of flood storage that leads to adverse offsite flood behaviour impacts.

Criteria	Comment
meet minimum floor level height (above flood level) relevant to development location (freeboard)	Developed areas are to be located out of the 1% AEP flood extent and therefore this is not applicable for most of the site. For warehouses near to the Little River backwater area finished floor levels will be set accordingly with appropriate freeboard. This is not part of this planning application and will be considered in the planning application for each precinct. For commercial and industrial properties, a maximum of 300 mm freeboard is recommended.
not occur where the depth and flow of floodwaters would create a hazard	Culverts and diversion drains have been sized to convey the 1% AEP design event. Development is located outside of the 1% AEP flood extent and not subject to flood hazard.
not occur in circumstances where the depth and flow of floodwater affecting access to the property is hazardous.	Safe access to the site is available from Little River road from areas not subject to hazardous flooding in the 1% AEP event.

7 CONCLUSION

This flood assessment has been prepared for the Planning Scheme Amendment to demonstrate the potential flood risk to the site and management measures which will be assessed through further design development.

A concept for managing external flows through the proposed development site has been provided. It demonstrates that with design elements such as culverts, channels and internal drainage, the site could safely and reasonably comply with flood guidelines described by Melbourne Water, ARR2019 and DEWLP.

The main tributary flow, entering the site through an existing rail bridge, will be conveyed through a series of box culverts and vegetated channels towards the site outlet at the southern boundary at Little River Road. This main channel follows the existing flow path as much as possible and is joined by the secondary tributary from the project sites north-east catchment.

Areas affected by off-site positive afflux are minor and can be addressed as the design progresses.

Melbourne Water Correspondence

Appendix B

Concept Design Stormwater Plan

Appendix C

Adopted Hydrology Modelling Parameters

Table A 1 – Hydrology Paramaters

Parameter	Pre-Development		Post-Development	
Fraction Impervious	EXG - 0.05 DES – 0.05 grasslands, 0.9 roads and rail	Rural catchment, majority homogeneous, farm dams assumed full.	Grasslands/rural – 0.05 Warehouses – 0.05 Roads, rail and railhead operations – 0.9	The warehouse precincts have been assumed impervious as the proposed basins have not modelled at this design stage
Reach Types	1 and 2 as required	All of the reach types are in natural condition with slopes < 2%. One reach had a slope greater than 2% slope, which will have less attenuation, thus Type 2 was selected.	Within the site boundary: Piped Flow – Reach Type 3 Flow over roads or constructed channel – Reach Type 2	Updated for design conditions.
Nodes	Placed at centroid	Standard modelling procedure.	Placed at centroid	Standard modelling procedure.
Kc	7.17	Regional RORB equation $k_c = 1.25 * D_{av}$ Victoria data (Pearse et al, 2002)	7.17	Regional RORB equation $k_c = 1.25 * D_{av}$ Victoria data (Pearse et al, 2002)
m	0.8	As per the RORB manual guidance	0.8	As per the RORB manual guidance
Losses (for impervious areas)	Initial Loss - 8.0 mm Continuing Loss - 1.3 mm/hr	Losses obtained from the Data Hub	Initial Loss - 8.0 mm Continuing Loss -1.3 mm/hr	Losses obtained from the Data Hub
Pre burst	Median	As per latest ARR2019 Victorian Guidance, to be adopted with Data Hub losses.	Median	As per latest ARR2019 Victorian Guidance, to be adopted with Data Hub losses.

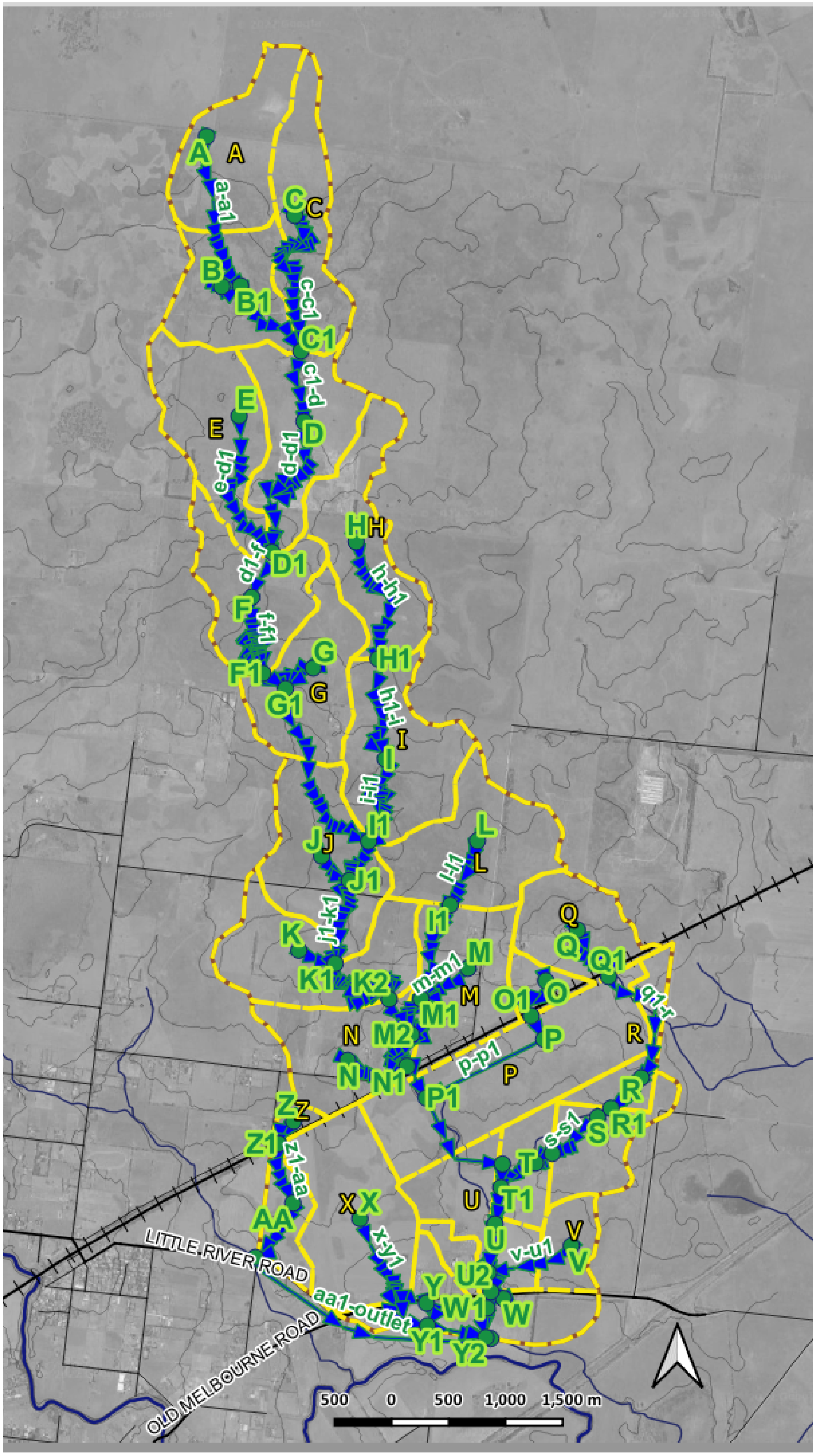


Figure A 1 – RORB model sub-catchments

Appendix D

TUFLOW Models Set-Up

Flood Mapping – Existing Conditions

Appendix F

Flood Mapping – Developed Conditions and Afflux