COSTIN ROE CONSULTING

DESIGN FLOOD VERIFICATION REPORT

45-57 MOXON ROAD PUNCHBOWL, NSW

Prepared for:

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	Name	Title
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1 INTRODUCTION

1.1 Background

Costin Roe Consulting Pty Ltd has been commissioned by Hale Capital Development Management Pty Ltd (Hale) to prepare this Design Flood Verification Report (DFVR) for the industrial development located at 45-57 Moxon Road, Punchbowl, NSW, as required by **Condition B56** of the Development Approval SSD-55266460's conditions of consent.

This DFVR;

- review the updated flood modelling results based on the latest proposed finished surface levels issued for construction;
- evaluate the impact of the suspended concrete structure, including supporting columns, on flood parameters and displacement of flood storage;
- demonstrate the design of the extended levee walls can withstand the forces of floodwaters and provides commentary on the existing levee wall; and
- demonstrate the detailed design of the suspended slab structure can adequately convey flood waters without adverse impact the function of on-site flood storage.

The requirements outlined in this report are consistent with the provisions of the Department of Planning and Environment's NSW Flood risk management guideline LU01 (Flood impact and risk assessment).

This report is an extension of, and should be read in conjunction with the following flood reports associated with this development property's approval process:

- **CO13924.01-04h.rpt** – Civil Engineering report incorporating water cycle management strategy
    - This report was submitted as part of the development application process (SSD-55266460) and approved with conditions of consent issued.
    - This report was completed in accordance with the latest **NSW Flood Impact and Risk Assessment: Flood Risk Management Guideline.**
    - The DFVR verifies that the detail design is a progression of and aligns with the flood modelling provided as part of the development application process.
- **CO13924.02-02b.rpt** – Flood Management Plan Incorporating Flood Emergency Response Plan (FERP)
    - This report is provided to address conditions B49 & B51 of SSD-55266460 by reporting on flood emergency responses for both the construction and operation stages of the project.
    - The DFVR is a separate report to verify the flood modelling against the detail design issued for construction and does not replace the FERP.

This plan addresses Canterbury Bankstown Council's comments dated 21 August 2024 shown in **Table 2** as well as the requirements of the Department of Planning, Industry and Environment Development Approval SSD-55266460 dated 19 July 2024, as included in **Table 1.**

Table 1 – Development Consent Conditions on SSD-55266460 with file reference EF23/2353 dated 19 July 2024

SSD-55266460	CC Condition	How It Is Addressed
B56	Prior to the commencement of construction of the development (with the exception of demolition and bulk earthworks), the Applicant must prepare and submit a Design Flood Verification Report to the satisfaction of the Planning Secretary. The Design Flood Verification Report must:	
	(a) be submitted to Council;	
	(b) be undertaken in accordance with the Flood Impact and Risk Assessment: Flood Risk Management Guideline LU01;	
	(c) evaluate the sensitivity of the suspended concrete slab structure, including supporting piers, on flood parameters and displacement of flood storage;	Reference should be made to Section 3.2.2 in this report for a discussion on the sensitivity of the structures located within the flood conveyance area.
	(d) demonstrate the detailed design of the reinstated and extended levee walls can withstand the forces of floodwaters; and	Reference should be made to 3.2.5 for a discussion on the proposed levee wall's structural design.
	(e) demonstrate the detailed design of the suspended slab structure can adequately convey flood waters and would not adversely impact the function of on-site flood storage.	Reference should be made to Section 3.2.2 in this report for a discussion on the sensitivity of the structures located within the flood conveyance area. Reference should be made to 3.2.5 for a discussion on the proposed levee wall's structural design. Reference should be made to 3.2.3, 3.2.4 and the flood

SSD-55266460	CC Condition	How It Is Addressed
		maps in Appendix A for a discussion on the verification of the detail design's flood behaviour.

Table 2 – Council Comments dated 21 August 2024 (Canterbury Bankstown Council Letterhead).

Key Considerations	Council Comments	How It Is Addressed
Stormwater Detailed Design	**b) Previous Response issued in November 2023:** Council notes that significant flood impacts (flood level increase >0.01m) are found on adjacent properties including 59 Moxon Road Punchbowl, properties upstream of Moxon Road and Salt Pan Creek Tributary D for the simulated flood events, i.e., 20%, 5%, 1%, 0.5%, 0.2% AEP. It was not clear why the true flood impact extent for the 1% AEP event was not shown in Afflux Map C013924.01-F03 but it can be deduced that the peak flood levels have increased, e.g. 3.16 m AHD for pre-development vs 3.22 m AHD for post-development at 59 Moxon Road. Council also notes that a further the PMF afflux map was not provided. **Response to Stormwater Detailed Design:** Council acknowledges the applicant's comments regarding the above-mentioned impacts. However, Council requests that a sensitivity modelling assessment be conducted to evaluate the impacts of the columns/piers on flood storage displacement. Additionally, the potential for the suspended slab to obstruct floodwaters during rarer events should be assessed, particularly when flood levels reach the soffit of the slab.	This Design Flood Verification Report reviews the impacts of the columns on flood storage as well as review the flood levels below the suspended car parking area for rarer flood events based on the Design Flood Verification Report model. Reference should be made to Section 3.2.2

Key Considerations	Council Comments	How It Is Addressed
		in this report for a discussion on the sensitivity of the structures located within the flood conveyance area. Reference should be made to 3.2.3, 3.2.4 and the flood maps in Appendix A for a discussion on the verification of the detail design's flood behaviour.
	i) Previous Response issued in November 2023: Council notes that it is not clear whether the columns/piers under the suspended slabs have been included in the flood model. Consideration should be given to the potential loss in flood storage displaced by the columns/piers. **Response to Stormwater Detailed Design:** Council requests that a sensitivity modelling assessment be conducted to determine the impacts of the columns/piers on flood storage displacement. Additionally, the potential for the suspended slab to obstruct floodwaters during less frequent events should be evaluated, particularly when flood levels reach the soffit of the slab.	This Design Flood Verification Report reviews the impacts of the columns on flood storage as well as review the flood levels below the suspended car parking area for rarer flood events based on the Design Flood Verification Report model. Reference should be made to Section 3.2.2 in this report for a discussion on the sensitivity of the structures located within the flood conveyance area.

Key Considerations	Council Comments	How It Is Addressed
		Reference should be made to 3.2.3, 3.2.4 and the flood maps in Appendix A for a discussion on the verification of the detail design's flood behaviour.
	k) Previous Response issued in November 2023: Considering the adverse impacts caused by the proposed development, Council notes that the proposed imported/net fill of 26,200m3 is not acceptable. **Response to Stormwater Detailed Design:** Council acknowledges the applicant's response to the above-mentioned impacts. However, Council requests that a sensitivity modelling assessment be undertaken to evaluate the impacts of the columns/piers on flood storage displacement.	This Design Flood Verification Report reviews the impacts of the columns on flood storage as well as review the flood levels below the suspended car parking area for rarer flood events based on the Design Flood Verification Report model. Reference should be made to Section 3 in this report for a discussion on the sensitivity of the structures located within the flood conveyance area

This document has been completed with consideration to the following manuals and guidelines:

- Flood Risk Management Manual (2023)
- Canterbury-Bankstown Council's Stormwater System Report (WP-SIA-1682/2020),
- Chapter 2.2 – Flood Risk Management – Catchments Affected by Stormwater Flooding, of Canterbury-Bankstown's DCP 2023 in relation to the development including review of potential impacts of the development on existing flooding, and potential impacts on the development from flooding; and
- Salt Pan Creek Flood Study (SPCFS) (September 2011) and the Salt Pan Creek Floodplain Risk Management Study (SPCFRMS) (May 2015)

- NSW Government (2023). Flood Impact and Risk Assessment. Flood Risk management guideline LU01;
- Bureau of Meteorology (2013). Service Level Specification for Flood Forecasting and Warning Services for New South Wales – Version 2.0;

2 DEVELOPMENT SITE

2.1 Site Description

The property is located within the City of Canterbury-Bankstown Council (CBC) local government area (LGA), as shown in **Figure 2.1.**

The proposal applies to land at 45-57 Moxon Road, Punchbowl, being Lots 1, B, 23, 221-222 of DP618465, DP390488, DP552521 and DP840328 (subject site).

The existing site comprises of multiple allotments located on the western side of Moxon Road, within the CBC Local Government Area (LGA), and is zoned IN2 Light Industrial, pursuant to the Bankstown Local Environmental Plan 2015 (BLEP2015).

The site generally grades down from the north-east towards the south-east. The highest level is RL 4.35 towards the north-east corner of the site. The lowest level on the site is in along the western boundary at RL 1.40m. Moxon Road, which the site fronts, falls from north (at RL 3.75) to south (RL 2.11). Reference can be made to the reports mentioned in Section 1 of this report for a detailed description of the existing pre-development site's features.

Figure 2.1. Site Location and Aerial Imagery (Source: Nearmap October 2022)

2.2 Proposed Development Description

The development involves the construction and operation of a multi-level warehouse and distribution facility at 47-57 Moxon Road, Punchbowl. The building ground floor finished floor level (FFL) is set at RL4.00, above the flood planning level specified by City of Canterbury-Bankstown in their Stormwater System Report (document ref: WP-SIA-1682/2020 dated 02/11/2020) and is noted to be approximately 700mm above the 1% AEP Flood level of RL3.30, shown on the latest Flood Map CO13924.02-F320 attached to this report under **Appendix A.**

A dedicated flood conveyance path is provided below a portion of the development to receive and convey the 1% AEP flood event into the offset flood storage areas. A portion of the proposed development, including car parking, hardstand and warehousing, is suspended above this flood conveyance area.

The suspended structure is designed by Costin Roe Consulting and the relevant structural elements forming the suspended structure (columns, steelwork and suspended slabs) can be seen in drawings CO13924.02-S005, S005a, S005b, S020, S020a, S020b and S021.

It is noted on Flood Maps CO13924.02-F300, F310, F320 and F330 that the estimated flood levels are lower than the lowest suspended finished floor levels (RL3.60) within the development site up to the 0.5% AEP storm event (Flood Level associated with the 0.5% AEP storm is approximately RL3.49). A detailed discussion around the detail design's flood behaviour within the flood conveyance area, considering the columns within the conveyance zone, can be seen in **Section 4** of this report.

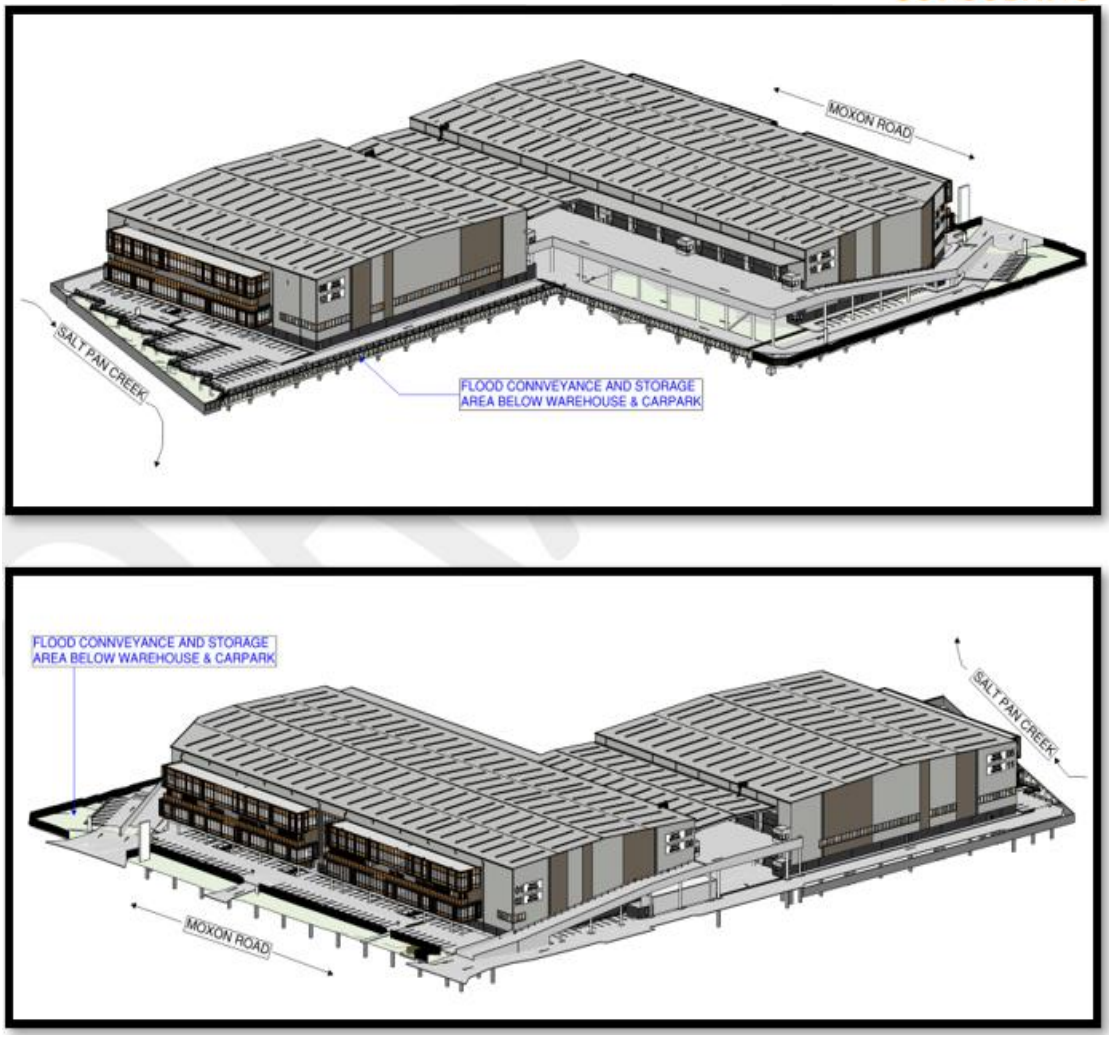


Figure 2.2. 3D depiction of development site depicting overland flow zone below suspended levels above.

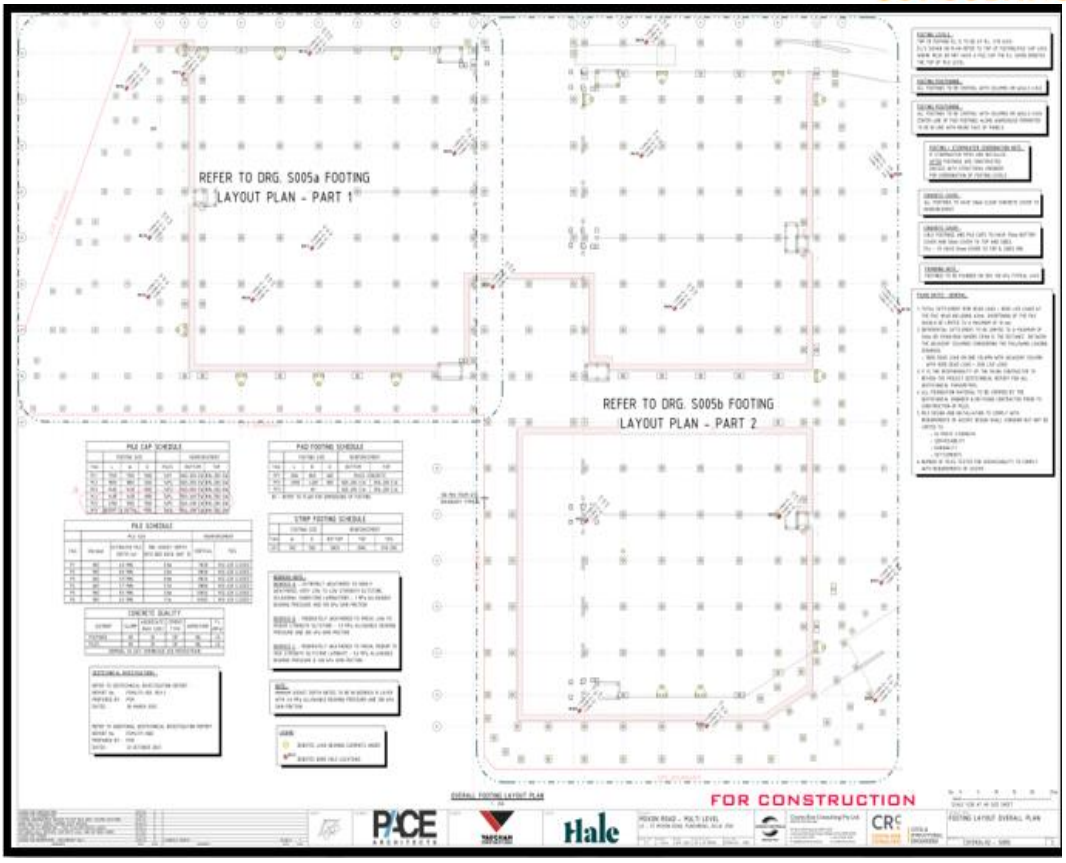


Figure 2.3. Overall Structural Footing Plan CO13924.02-S005 showing the locations of the columns within the flood conveyance zone

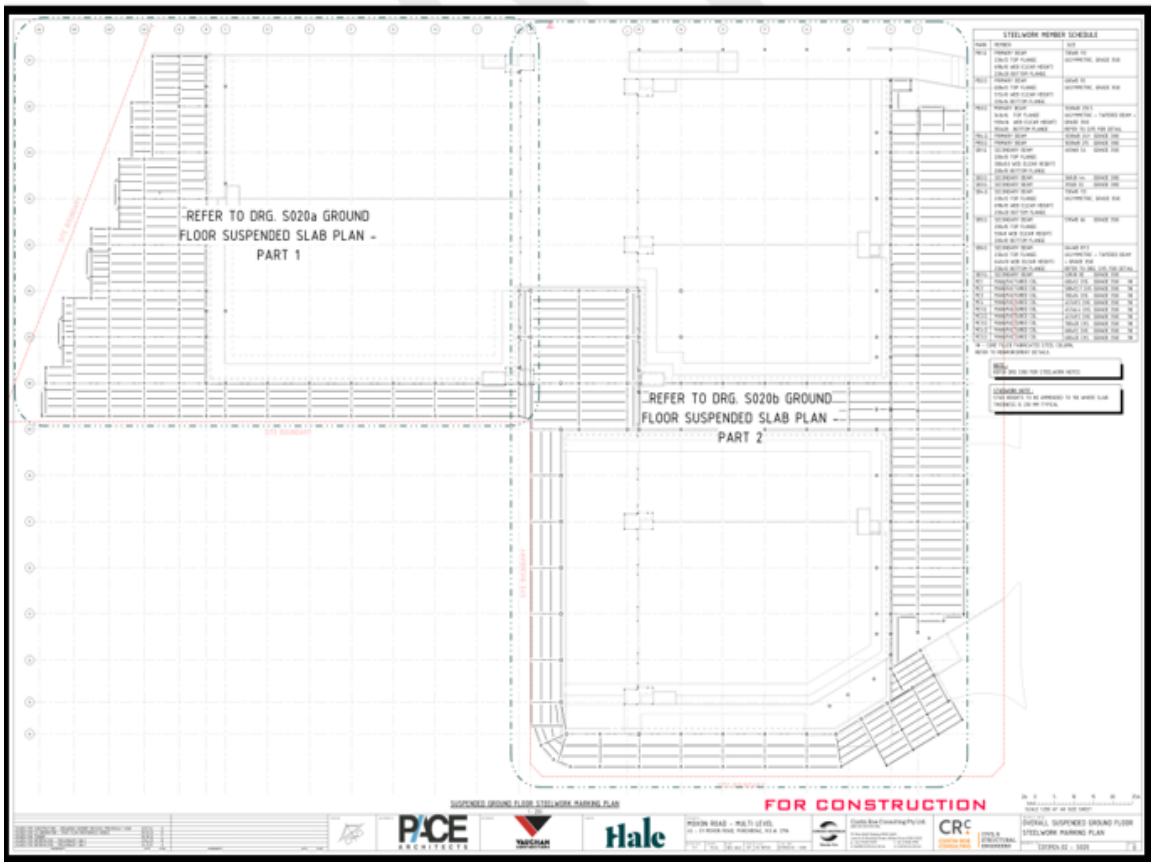


Figure 2.4. Overall Structural Suspended Ground Floor Steelwork Plan CO13924.02-S020 showing the arrangement of steel members forming the suspended structure above the flood conveyance zone

The ground floor of the development site is suspended on a grid of columns approximately 2-3m above the flood conveyance area, ensuring the building's finished floor levels are at least 500mm above the 1% AEP flood levels.

Flood waters from Moxon Road and the Wiggs Road Channel access the flood conveyance area from Moxon Road and flows to the west of the development site and is discharge to Salt Pan Creek via an appropriately sized outlet structure, water quality device and an existing formal inground drainage system, with the majority of stormwater being piped into drainage systems along Salt Pan Creek. The development site's proposed flood conveyance/overland flow path is shown in **figure 2.5** below.

The development site is also separated from the Salt Pan Creek by an existing levee wall and in addition, a system of pumps has been installed to provide flood immunity to the existing building. The proposed development requires the construction of a new levee wall to replace the sections where the existing warehouse, currently being demolished, previously served as a levee wall. The structural design of this levee wall is shown in drawing CO13924.02-C650 and is discussed further in **Section 5** of this report.

It is understood that the levee wall prevents flood waters from Salt Pan Creek from entering the property, whilst the pump and sump system removes nuisance flood water from Wiggs Road floodwater ingress.

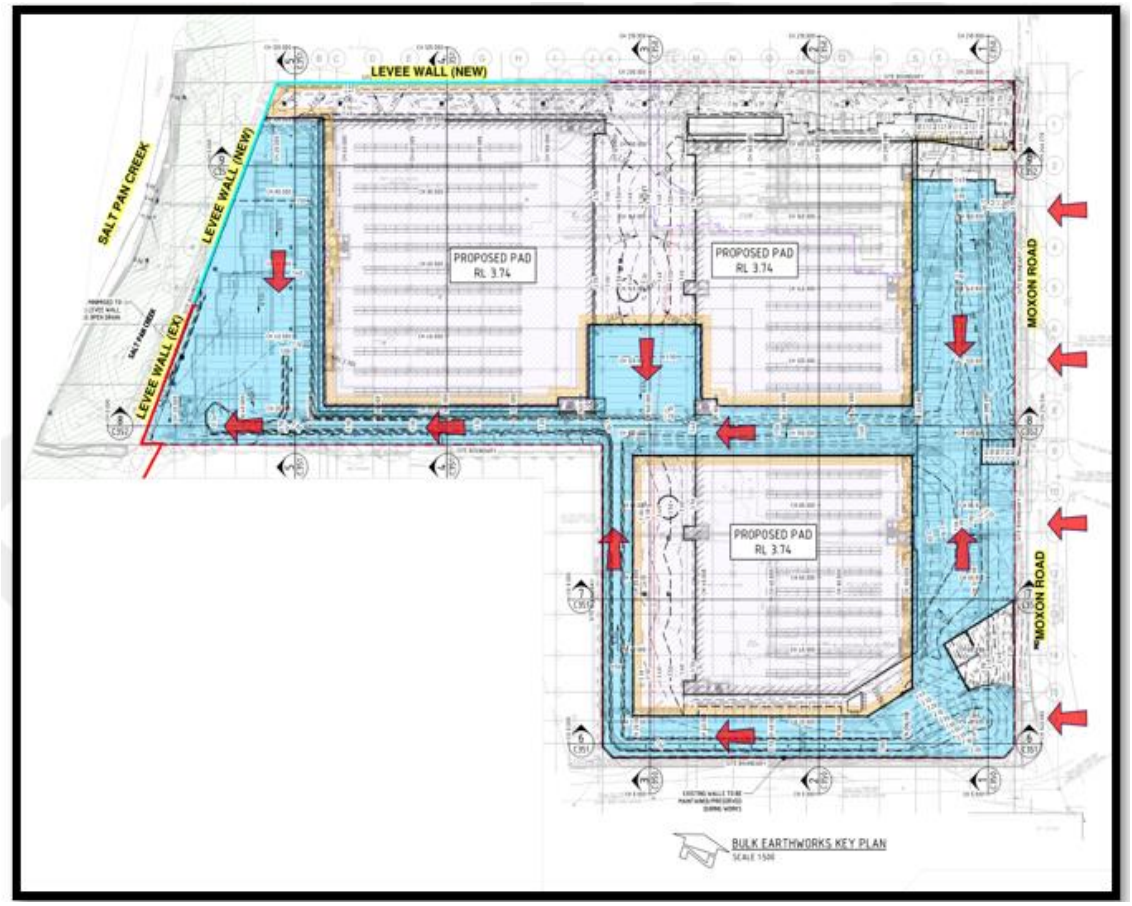


Figure 2.5. Proposed Flood Conveyance/Overland Flow Path

Figure 2.6 shows the extent of the suspended slabs located above the flood conveyance zone (hatched in orange) as well as the on-grade areas of the development (hatched in grey). The development site's proposed finished levels, issued for construction, are indicated on the civil engineering drawings C500 to C509.

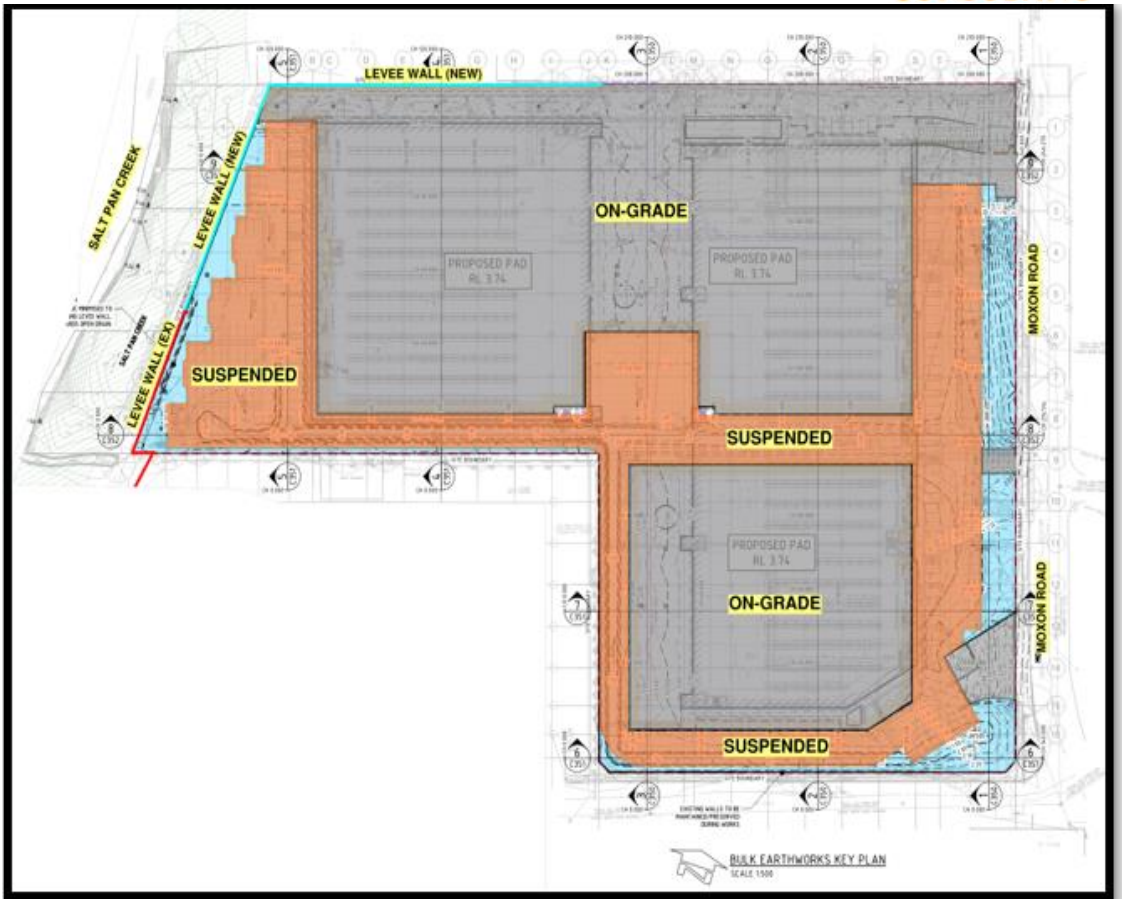


Figure 2.6. Finished Levels Plan – On-Grade and Suspended

The development site's proposed architectural layout plans are prepared by Pace Architects and is shown in **Figure 2.7 & Figure 2.8.**

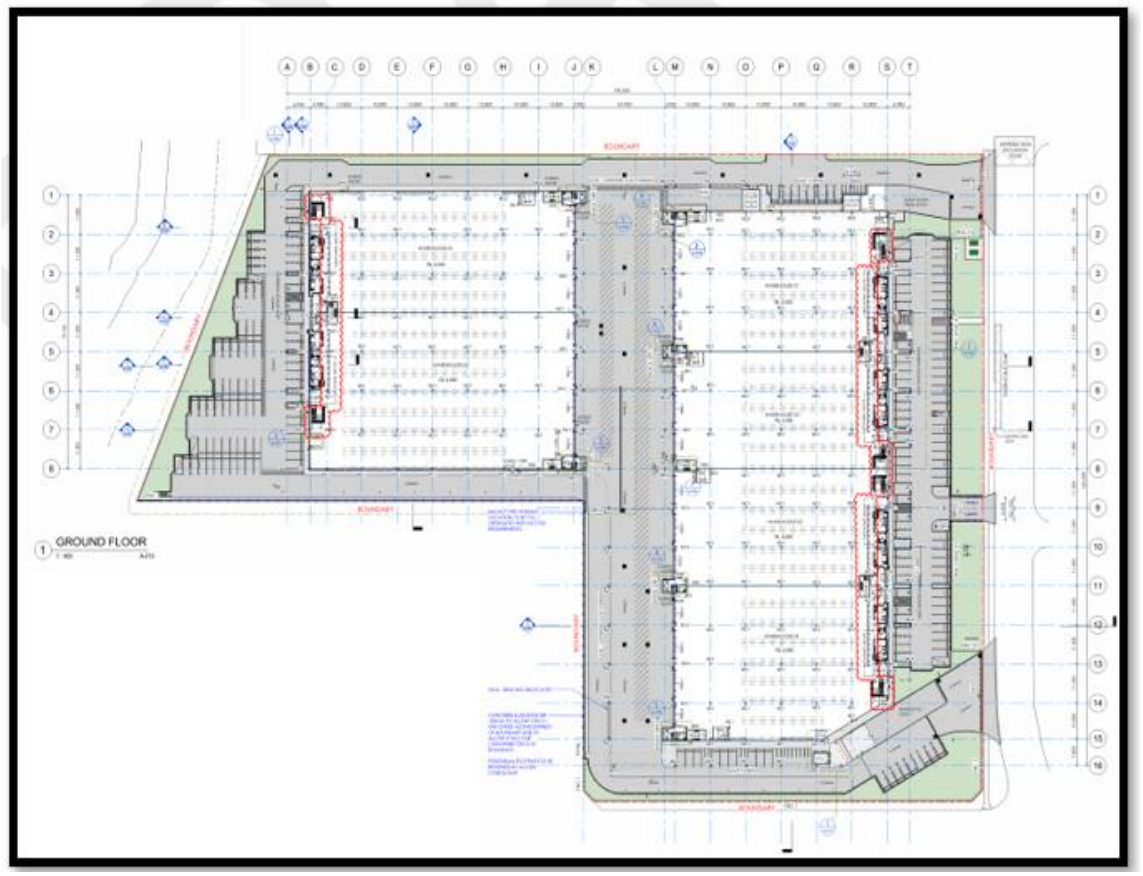


Figure 2.7. Proposed Development (Ground Level) (Reference: PACE Architects – Ground Floor Plan – drawing 23408-A-201)

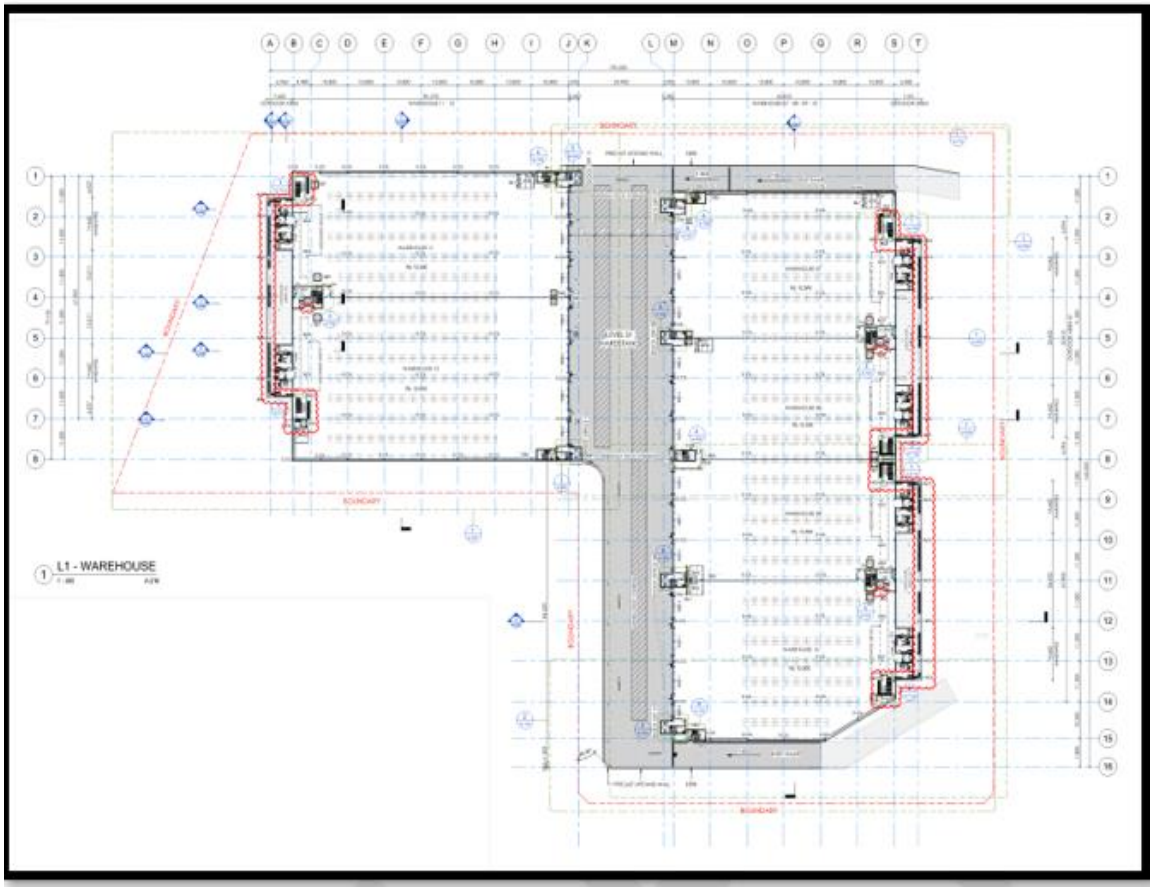


Figure 2.8. Proposed Development (First Level) (Reference: PACE Architects – Level 1 Plan – drawing 23408-A-206)

3 DETAIL DESIGN VERIFICATION – FLOOD BEHAVIOUR

3.1 Existing (pre-development) site's Flood Behaviour

The site is located around 35m east of Salt Pan Creek and 85m north of the Wiggs Road channel. The site is affected by overland flow and flooding associated with the Salt Pan Creek and the Wiggs Road Stormwater Channel.

Figure 3.1 Development Site Location between Salt Pan Creek and the Wiggs Road Stormwater Channel

Extracts from a flood study of the Punchbowl catchment was provided by Canterbury-Bankstown Council. The study involved a hydrological and hydraulic assessment of the catchment at a regional level.

We provide excerpts of flooding associated with the 1% AEP storm event (flood extent and Flood depths) from the report in **Figure 3.2** below. The contributing upstream catchment for the overland flow catchment is generally comprised of developed land (mostly residential) and roads.

Figure 3.2. CBC Stormwater System Report – 1% AEP Flood Extent & Flood Levels

The site is directly impacted by flooding on-lot, the FPL for this site is RL 3.8m AHD (as per City of Canterbury-Bankstown Stormwater System Report WP-SIA-1682/2020) and is associated with an overland flow path from the upstream catchment and drainage system (Salt Pan Main Stream) towards the south and west of the site.

The Salt Pan Creek Flood Study (SPCFS) (September 2011) and the Salt Pan Creek Floodplain Risk Management Study (SPCFRMS) (May 2015) were components of the analysis conducted during the flooding and overflow study. The adopted flood models were used as the base for the assessment of flooding under existing conditions. The City of Canterbury's Salt Pan Creek Floodplain Risk Management Study and Plan's Flood Maps was utilised as the impact study's base, as shown in **Figure 3.3 below.**

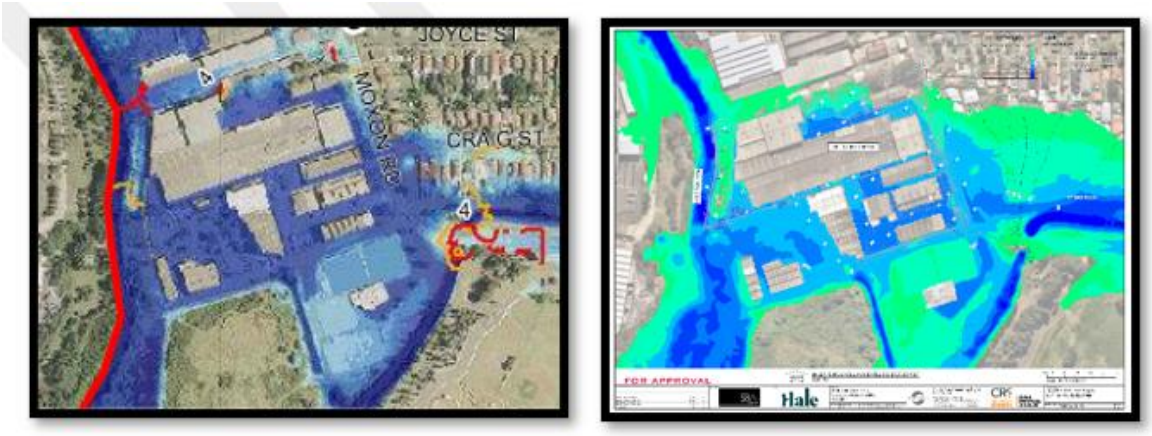


Figure 3.3. Comparison between SPCFS and CRC's 1% AEP Pre-Development Flood Levels and Depths (impact study's base)

3.2 Post-Development Detail Design Flood Behaviour

Council requires an assessment of the detail design's post-development overland flow conditions for the range of storm events evaluated as part of the approval process to verify the detail design complies with the requirements set during the approval stage.

The development application's TUFLOW model has been updated for the assessment as set out in the following sections of the report.

The proposed management strategy remains the same as per the approved application which allows for an overland flow path between Moxon Road to the Salt Pan Creek through the site.

Reference to the full set of Flood Maps, attached to **Appendix A** of this report, as well as the Civil Engineering Drawings issued for construction should be made for details of the proposed flow management strategy.

3.2.1 Design Verification Flood Modelling Introduction

A detailed site specific TUFLOW model of the pre- and post-development conditions has been completed by Costin Roe Consulting. It should be noted that the pre-development modelling was not changed from the approved flood modelling discussed in report referenced CO13924.01-04h.rpt. Reference should be made to this report for a detailed discussion of the pre-development's flood behaviour. This DFVR focus' on the **post-development's** flood behaviour considering the designs issued for construction to verify consistency with the approved flood strategy. This report also reviews the impact of the structures within the flood conveyance zone on the flood storage capacity.

The assessment being completed with consideration to City of Canterbury-Bankstown Council policy, the NSW Flood Risk Management Manual (2023).

The pre-developed model has been prepared utilising the flood levels and hydrographs as completed by our office, which has been verified against the flood information provided by City of Canterbury-Bankstown Council. Post development modelling has been completed with the introduction of the proposed development and overland flow path between Moxon Road and Salt Pan Creek.

3.2.2 1% AEP's Post Development Flood Behaviour

Below is discussion on the 1% AEP and PMF flood events. For a review of the additional flood events modelled, reference should be made to the updated flood maps attached to Appendix A of this report.

Figures 3.4, 3.5, 3.6, 3.7 & 3.8 is excerpts from the 1% AEP Levels and Depths, Velocity, Hazard Category & Afflux Flood Maps attached to Appendix A. The post-development flood extent (Shown in **Figure 3.4**) and level for the 1% AEP storm event, presented at the peak flow, can be seen to be around RL3.30m AHD at Moxon Road frontage and approximately RL3.27m at the western boundary of the property below the suspended structure.

Reference to **Figures 3.4-3.8** below should be made for the post-development flood levels and depths and velocity for the 1% AEP event.

- The detail design's flood model is confirmed to align with the approved flood modelling.
- The maximum flood level within the flood conveyance zone is at RL3.30, which is below the soffit (lowest RL3.43) of the suspended structure above.
- There is no upstream change to flood levels or velocity for any of the flow paths which enter the site;
- Flows within the site can be conveyed to Salt Pan Creek within the dedicated overland flow paths;
- Minor afflux (10-20mm) is experienced within the site is experienced at the western site boundary.

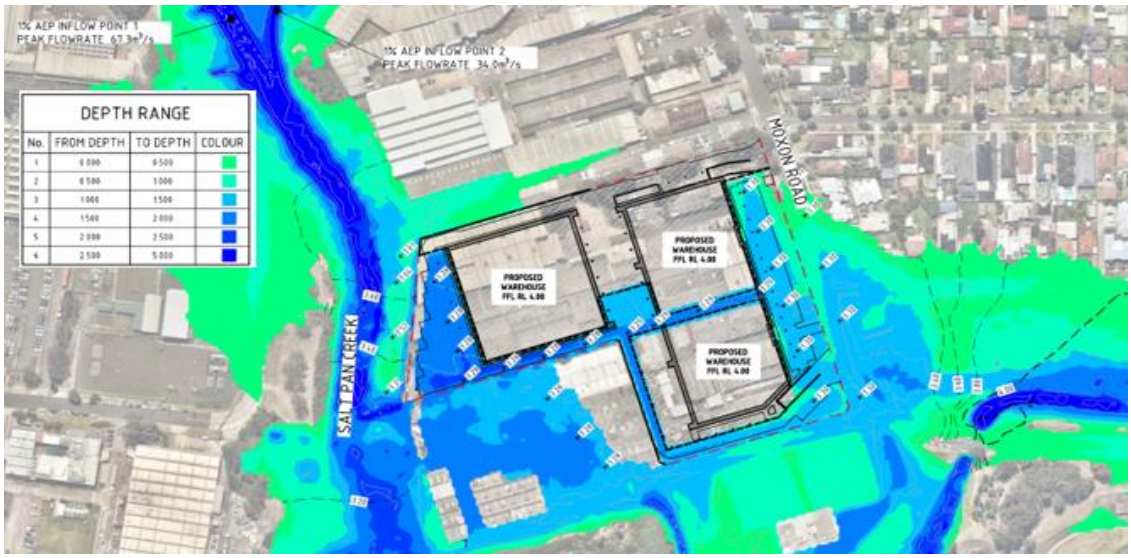


Figure 3.4 1% AEP Post-developed Level and Depth Output

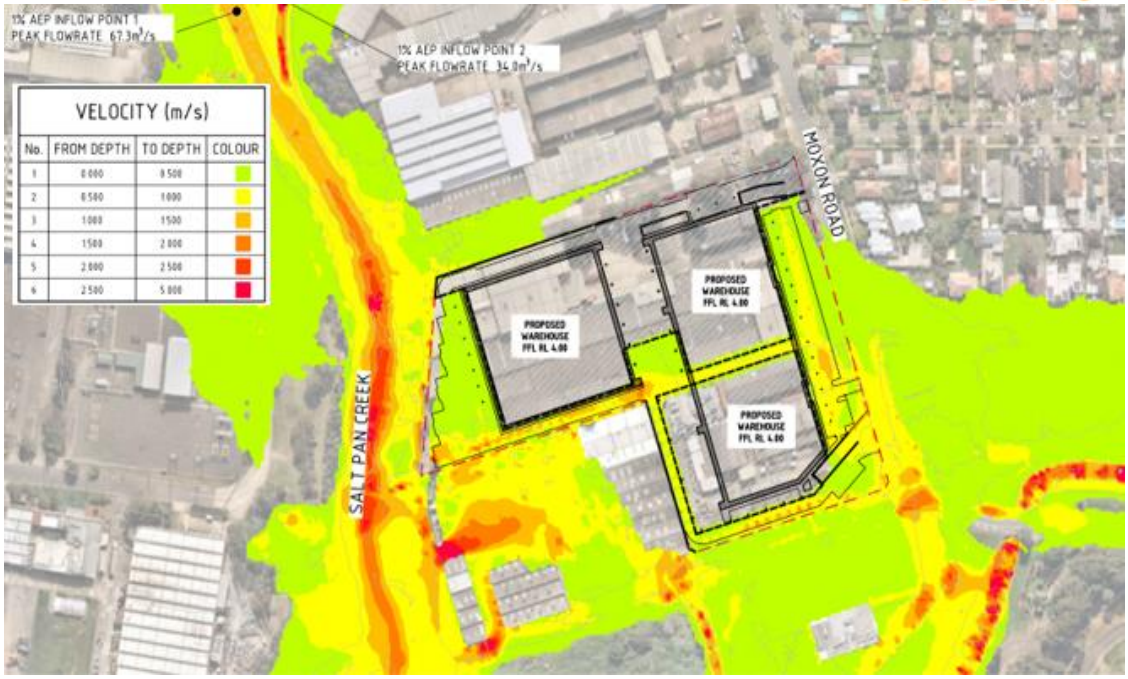


Figure 3.5: 1% AEP Post-developed Velocity

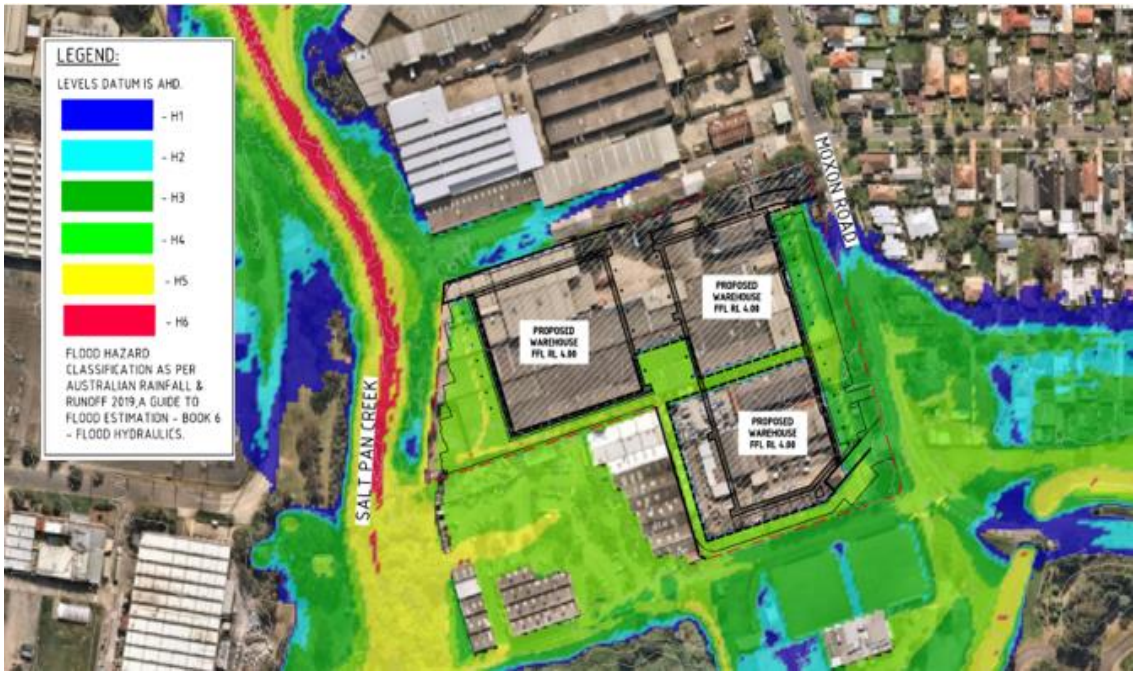


Figure 3.6: 1% AEP Post-developed Hazard

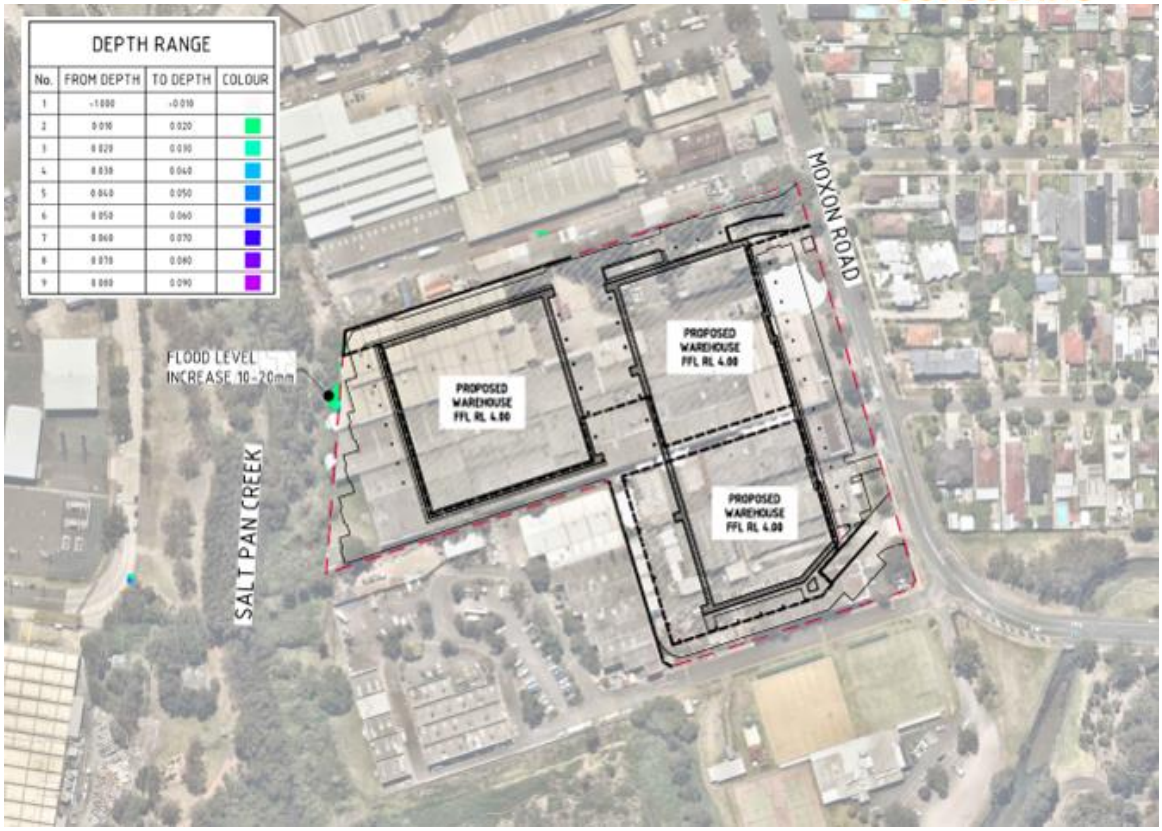


Figure 3.7: 1% AEP Post-developed Levels and Depths Afflux

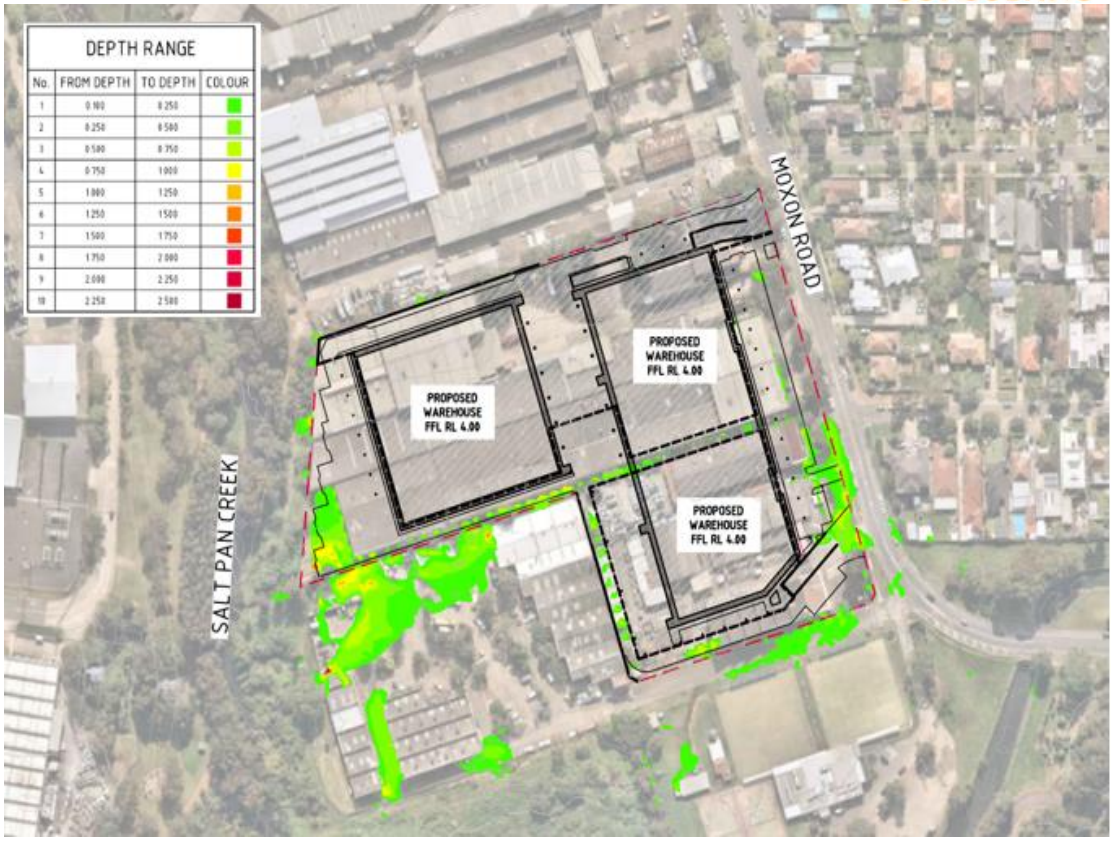


Figure 3.8: 1% AEP Post-developed Velocity Afflux

3.2.3 PMF's Post Development Flood Behaviour

Figures 3.9 & 3.10 is excerpts from the PMF Levels and Depths & Hazard Category Flood Maps attached to **Appendix A**.

The flood modelling results for the PMF flood event is consistent with the approved flood modelling. The flood level in Salt Pan Creek during a PMF event is RL 6.11m AHD, while the flood level during a local PMF event is RL 6.16m AHD. It is noted that the building, with a proposed floor level of RL 4.00m AHD, is below the PMF level relating to both Salt Pan Creek and local overland flow path. The emergency procedures have been addressed in report referenced CO13924.02-02b.rpt.

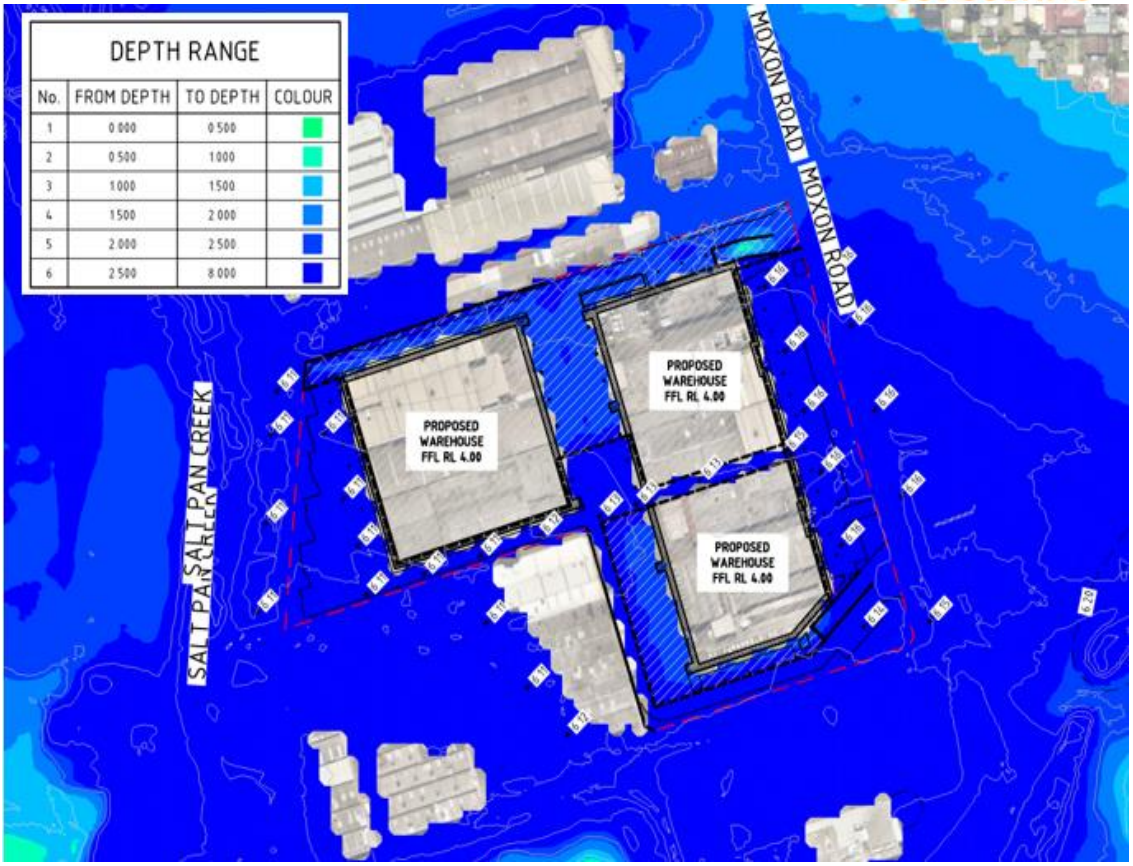


Figure 3.9: PMF Post-developed Level and Depth Output

Figure 3.10: PMF Post-developed Hazard

3.2.4 Floodplain Management Considerations

3.2.4.1 Flood Planning Level:

The introduction of a Flood Planning Level (FPL) is an important flood risk management measure. FPLs are derived from a combination of a designated flood event, which can either be a historic flood or a design flood of a certain recurrence interval, plus a nominated freeboard depth.

The NSW Flood Risk Management Manual, 2023 recommends that the FPL generally be based on the 100-year ARI event. It suggests that, whilst this event can be varied, it should only be done in exceptional circumstances. It is considered appropriate to adopt the 1% AEP event for the proposed industrial development.

The freeboard component of an FPL is the difference between the flood level that the level is based upon and the FPL itself. Freeboard is designed to provide reasonable certainty that the reduced risk exposure provided by the chosen FPL is warranted, taking into account factors such as:

- Uncertainties in the estimate of flood levels;
- Differences in water levels across the floodplain;
- Wave action resulting from wind and vehicular/marine traffic during the flood event;
- Changes in rainfall patterns due to climate change;

- The cumulative effect of subsequent infill development on existing zoned land.

The Flood Risk Management Manual recommends a freeboard of 0.5m for most new industrial developments and it is considered appropriate that this recommended freeboard be for adopted for the proposed development.

The FPL defined in the Flood Risk Management Manual is noted to be consistent with that of City of Canterbury-Bankstown Council.

The 1% AEP flood level within the development site is noted to be ~RL3.30. The site is directly impacted by flooding on-lot, the FPL for this site is RL 3.8m AHD (as per City of Canterbury-Bankstown Stormwater System Report WP-SIA-1682/2020) and is associated with an overland flow path from the upstream catchment and drainage system (Salt Pan Main Stream) towards the south and west of the site.

We note the proposed building level is RL 4.00m AHD, above the FPL with >500mm freeboard to the 1% AEP flood level.

3.2.4.2 Hydraulic and Hazard Categorisation:

Floodwaters can vary significantly, both in time and place across the floodplain. They can flow fast and deep at some locations and slow and shallow at other locations. This can result in large variations to the personal danger and physical property damage resulting from the flood.

The Floodplain Development Manual recognises three hydraulic categories of flood prone land, these being floodway, flood storage and flood fringe. These are then further separated into two hazard categories, high hazard and low hazard.

Floodways:

Floodways are those areas where a significant volume of water flows during floods and are often aligned with natural channels. They are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, which could adversely affect other areas. They can also be areas with deeper and higher velocity flow.

Flood Storage:

Flood storage areas are the parts of the floodplain that provide temporary storage for floodwaters during the passage of a flood. If a reduction in the flood storage area is experienced due to the filling of land or construction of a levee bank, it can result in adverse effects on the flood levels and peak flow rates in other areas.

Flood Fringe:

Flood fringe areas are the remaining area of land affected by flooding. The development of flood fringe land does not generally have any major impact on the pattern of flood flows and/or levels.

The preparation of a flood study is almost always required in the determination of hydraulic categories. This is so that peak depths, velocities and the extent of flooding can be determined across the catchment.

Hazard Categories:

Flood hazard categories are broken down into high and low hazard for each hydraulic category. High hazard areas are defined as those where there is a possible danger to personal safety and the potential for significant structural damage. Able-bodied adults would have difficulty in wading to safety. With low hazard areas, should it be necessary, a truck could evacuate people and their possessions, and able-bodied adults would have little difficulty in wading to safety.

Flood hazard criteria within the site has been defined as H1 in relation to the overland flow path on site.

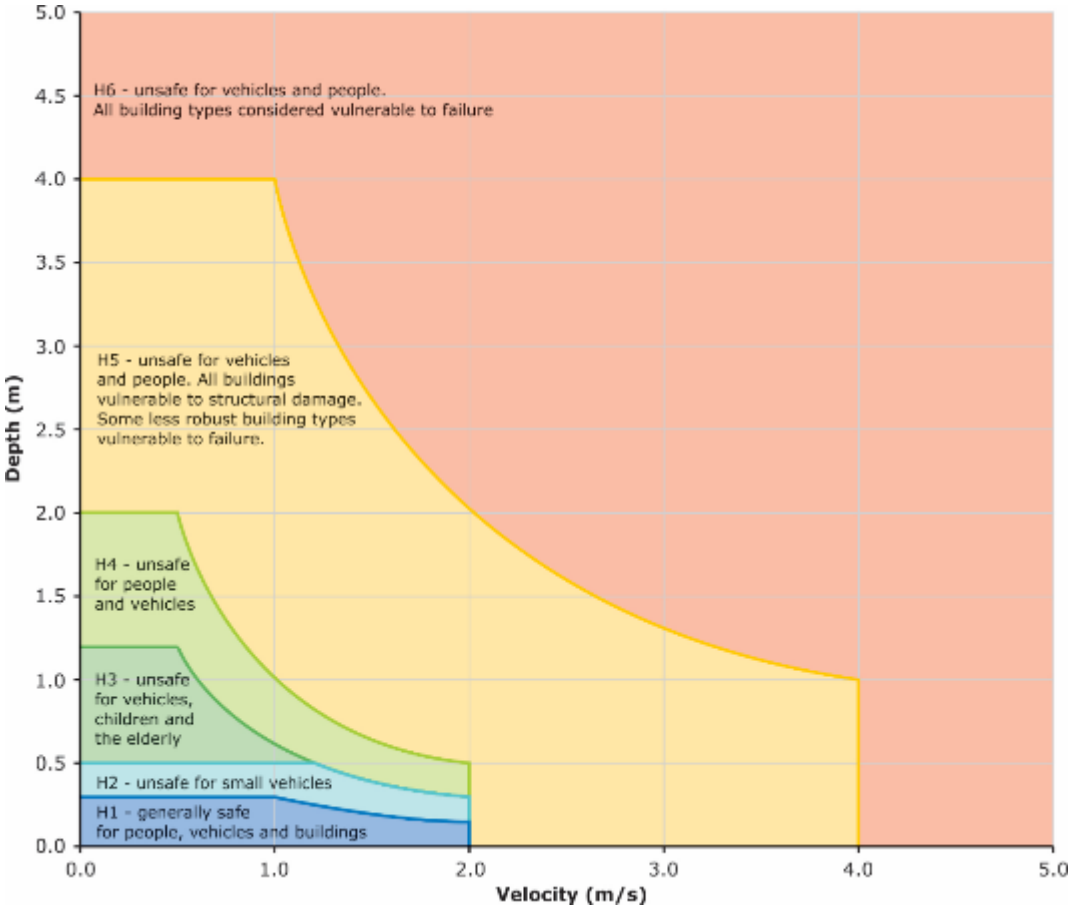


Figure 3.11. Combined Flood Hazard Curves (Smith et al., 2014)

Table 6.7.3. Combined Hazard Curves - Vulnerability Thresholds (Smith et al., 2014)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

Table 6.7.4. Combined Hazard Curves - Vulnerability Thresholds Classification Limits (Smith et al., 2014)

Hazard Vulnerability Classification	Classification Limit (D and V in combination)	Limiting Still Water Depth (D)	Limiting Velocity (V)
H1	D*V ≤ 0.3	0.3	2.0
H2	D*V ≤ 0.6	0.5	2.0
H3	D*V ≤ 0.6	1.2	2.0
H4	D*V ≤ 1.0	2.0	2.0
H5	D*V ≤ 4.0	4.0	4.0
H6	D*V > 4.0	-	-

Figure 3.12. Adopted Hazard Criteria and Provisional Flood Hazard Chart (Australian Rainfall and Runoff 2019)

3.2.4.3 *Flood Damages:*

Damage caused by floods is generally categorised as either tangible or intangible. Tangible damages are financial in nature and can be readily measured in monetary terms. They include direct damages such as damage or loss caused by floodwaters wetting goods and property, and indirect damages such as lost wages incurred during clean-up periods after the flood event. Intangible damage includes emotional stress and even mental and physical illness caused by the flood. It is difficult, if not impossible to quantify intangible damages in financial terms.

From a flood planning perspective, it is important to consider the following direct damage categories:

- Contents Damage – refers to damage to the contents of buildings, including carpets and furniture etc.;
- Structural Damage – refers to damage to the structural fabric of buildings, such as foundations, walls floors, windows, and built-in fittings; and
- External Damage – includes damage to all items external to buildings, including cars, landscaping etc.

As there is no way to prevent a flood from occurring, and it is unrealistic to exclude all development within flood-prone areas, the intent of establishing a FPL is to minimise the risk of direct damage when a flood occurs. By minimising the direct damage, there is a carry-on effect, whereby other associated indirect tangible damages and intangible damages are also minimised.

Reference should be made to **Section 3.3** and **Section 3.4** for a detailed discussion on the structural design of the proposed levee wall as well as the consideration to the impact of the proposed suspended structure and columns of the flood conveyance.

3.2.4.4 Emergency Response Planning:

Reference should be made to the development site's **Flood Management Plan Incorporating Flood Emergency Response Plan (FERP**) [ref: CO13924.02-02b.rpt] for a detailed description of the proposed development site's hazard categorisations for all storm events, flood safety and proposed evacuation procedures, flood response and response triggers.

The design flood verification models (Flood maps attached to **Appendix A**) confirmed that there were no changes in the storm events' hazard categorization. Therefore, the proposed FERP, submitted as part of the construction certification process, remains consistent.

Flood Emergency Management planning refers to the preparation of a formal community-based plan of action to deal with the threat, onset and aftermath of flooding. It involves planning for an event equal to, or greater than the event used to derive the FPL.

The plan of action should include an on-site response plan that addresses what measures should be undertaken once the threat of a flood is determined to be imminent. A flood evacuation strategy should also be included so that all persons within the precinct are familiar with the processes required if a flood occurs.

In summary, the review shows that safe access/egress (Hazard Categorisation <H1) is available to and from the northern access (operational exit) of the site in all storm events up to the 0.2% AEP storm event as shown in **Figure 3.13 and 3.14** below.

Safe evacuation routes to the north-east of the site's northern access are available and occupants would be able to move to PMF free areas (Punchbowl Train Station, Roselands Shopping Centre), at the direction of the SES or other appropriate authority. The possible evacuation route is shown in **Figure 3.15** below.

Provisions should be made during operations to facilitate sheltering in place on the upper levels of the multi-storey facility in case of a PMF event that causes total inundation of site access or if individuals on-site feel it is unsafe to evacuate. Safe refuge is available on the site in the upper levels of the hardstand, warehouse and offices. The upper levels of the warehouse are free of the PMF. However, early evacuation of the facility is advised when a more severe storm event is anticipated.

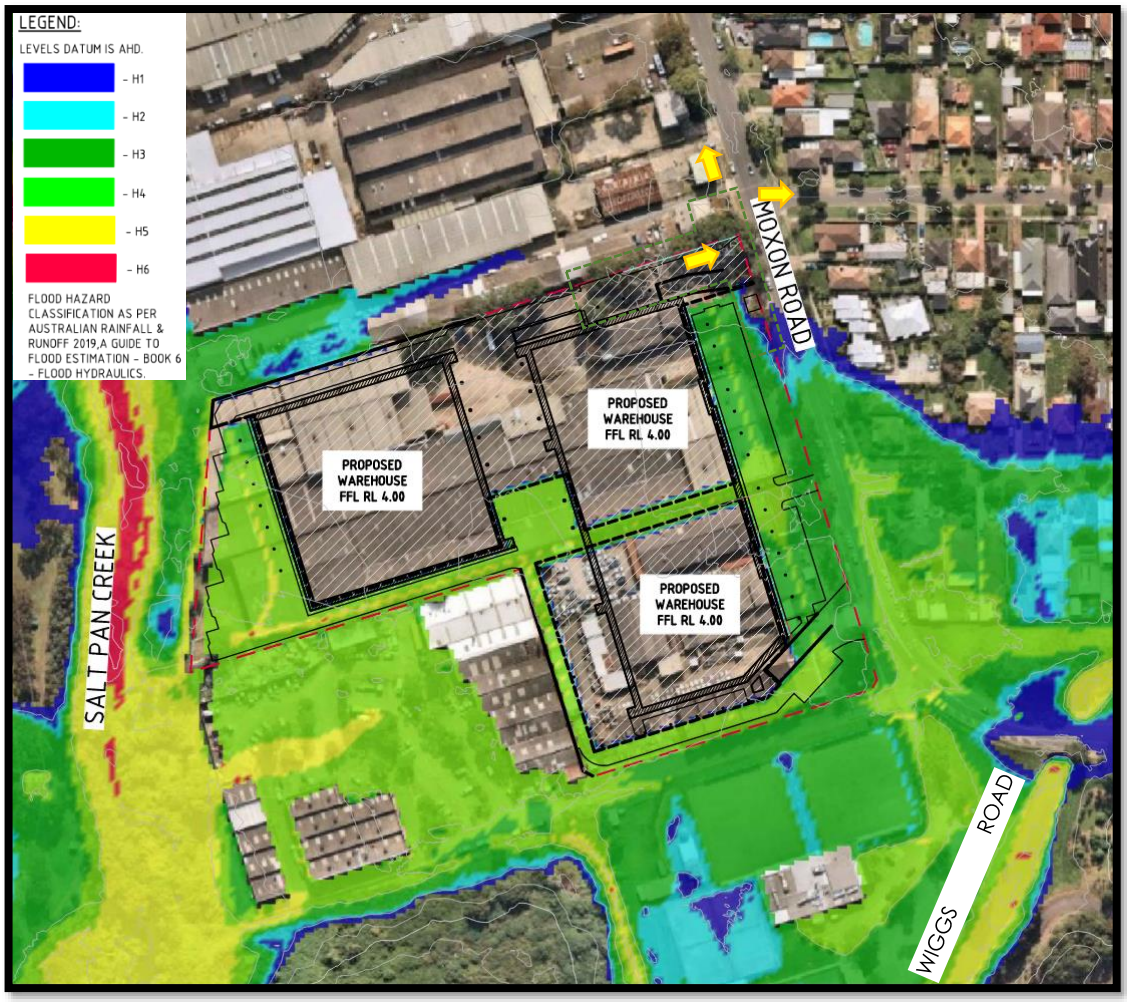


Figure 3.13 Safe access and egress to and from the Northern Entrance of 45-57 Moxon Road, Punchbowl during the 1% AEP storm event

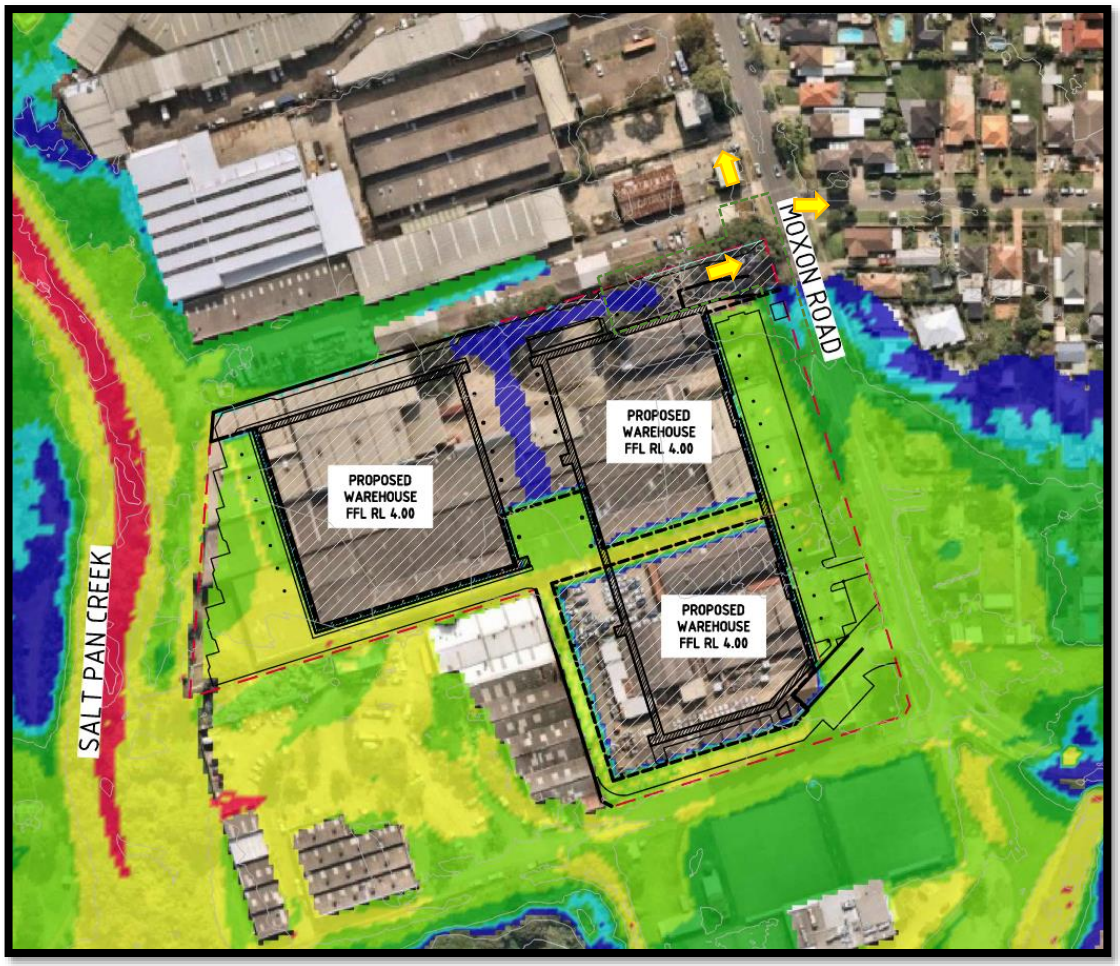


Figure 3.14 Safe access and egress to and from the Northern Entrance of 45-57 Moxon Road, Punchbowl during the 0.2% AEP storm event

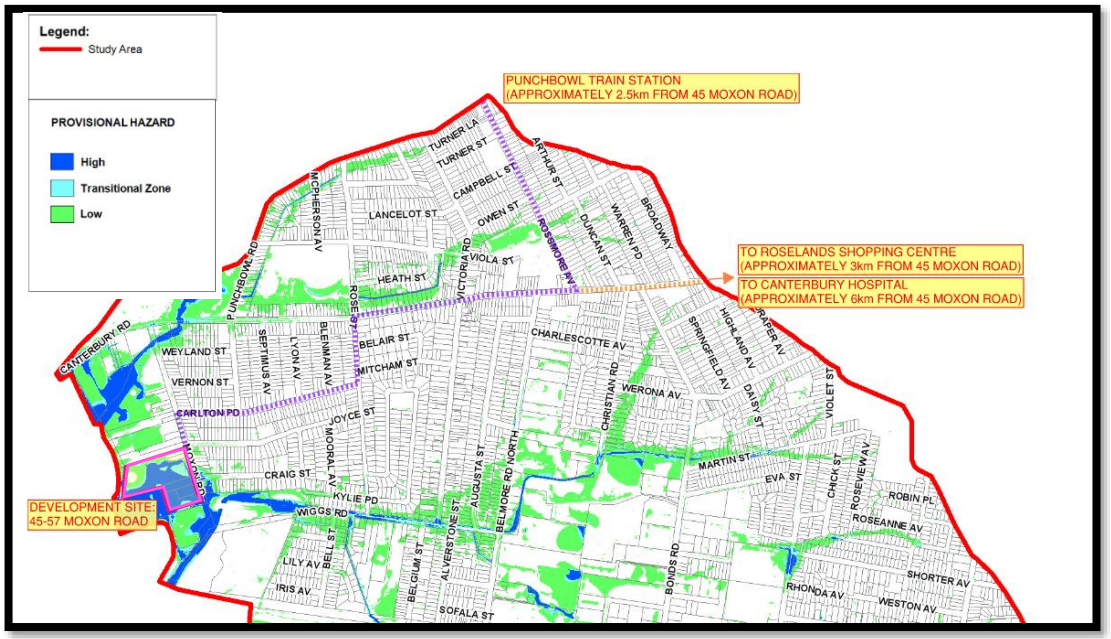


Figure 3.15 Potential Emergency Evacuation Route (Ref: Final Overland Flow Study – Canterbury LGA Salt Pan Creek Catchment – 59915011 – August 2016)

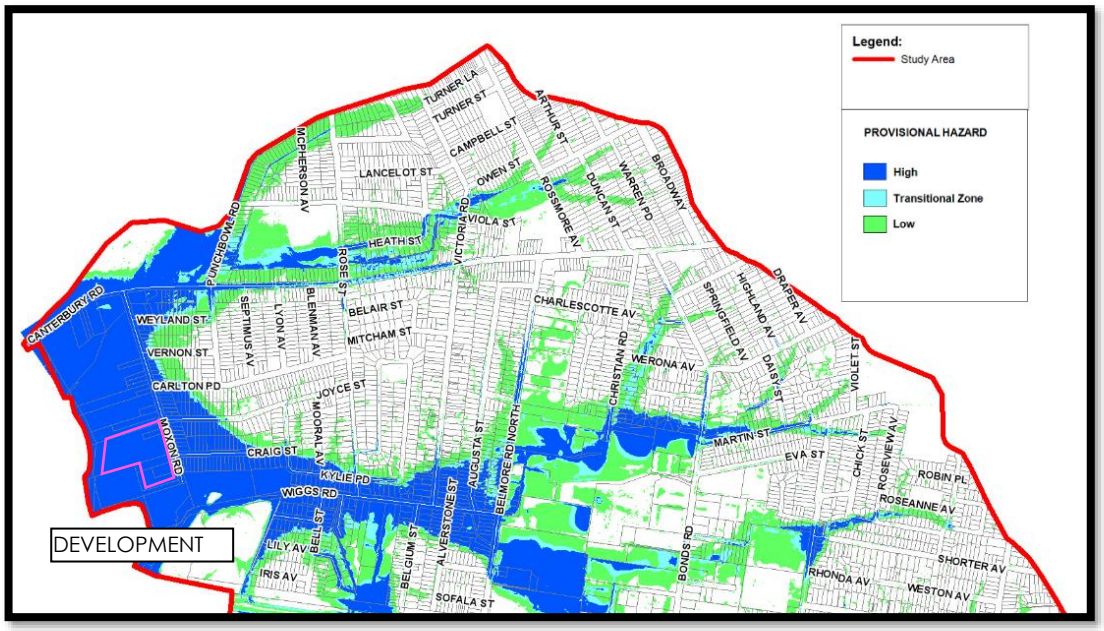


Figure 3.16 Salt Pan Creek Provisional PMF Hazard Map (Ref: Final Overland Flow Study – Canterbury LGA Salt Pan Creek Catchment – 59915011 – August 2016)

3.3 Design Verification Flood Modelling Parameters & Sensitivity of the suspended concrete slab structure, including supporting piers, on flood parameters and displacement of flood storage

Sensitivity Check of Columns and Structures in Flood Conveyance Zone:

Technical parameters and detail included in the TUFLOW model are detailed in the approved report referenced **CO13924.01-04h.rpt**, with an update made to the adopted TUFLOW Element Roughness Values within the flood conveyance zone under the suspended structure to represent the columns and structures within the flood conveyance zone.

As part of the sensitivity assessment of the columns within the flood conveyance zone, the roughness coefficient (Mannings Value) has been set to a value of 0.08 to represent the columns and structures within the flood conveyance zone. With reference to Ven Chow's Open-Channel Hydraulics (1959) (https://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Mannings_n_Tables.htm), the 0.08 value is an equivalent to a floodplain with "heavy stand of timber, a few down trees, little undergrowth, flood stage below branches".

As required by the conditions of consent's condition B56(e), the revised flood verification model, with a conservative roughness coefficient of 0.08 within the flood conveyance zone, to represent the columns and suspended structure, generally demonstrates that the flood water can be conveyed adequately as required by condition B56(e), and it is confirmed that the detailed design of the suspended slab structure would not adversely impact the function of on-site storage.

The accuracy of the flood behaviour simulation may be compromised if the columns are incorporated into the flood model using grid-based modelling software.

Additional to the amended Mannings value to consider the columns and structure's impact on flood conveyance, the impact on the storage volumes have also been reviewed, detailed below.

Table 3 – Summary of columns within the flood conveyance zone

Column	Size	No	Max Length	Volume Displaced (Worst Case)	
MC1.G	457x6.4 CHS	55	2.3	20.75	m3
MC2.G	457x9.5 CHS	52	2.3	19.62	m3
MC3.G	700x20 CHS	21	2.3	7.92	m3
MC4.G	600x12 CHS	42	2.3	15.85	m3
MC5.G	600x20 CHS	15	2.3	5.66	m3
TOTAL VOLUME DISPLACED				**69.79**	**m3**

Reference should be made to the overall Structural Footing Plan, CO13924.02-S005, showing the locations and specifications of the columns within the flood conveyance zone.

The total number of columns will displace a maximum of 70m3 of flood storage. The flood conveyance area's extent within the boundary is approximately 11,500m2. This is an equivalent displacement of approximately 6mm over the flood storage area.

The flood storage volume that the pre-development site provided was approximately 15,067m3. The post-development's design provides flood storage of 15,147m3 with the columns displacing ~70m3 of this storage space, resulting in a total of 15,077m3 of flood storage post-development, considering the structures below the suspended slab above. This verifies that the detail design provides sufficient flood storage and is aligned with the approved flood modelling.

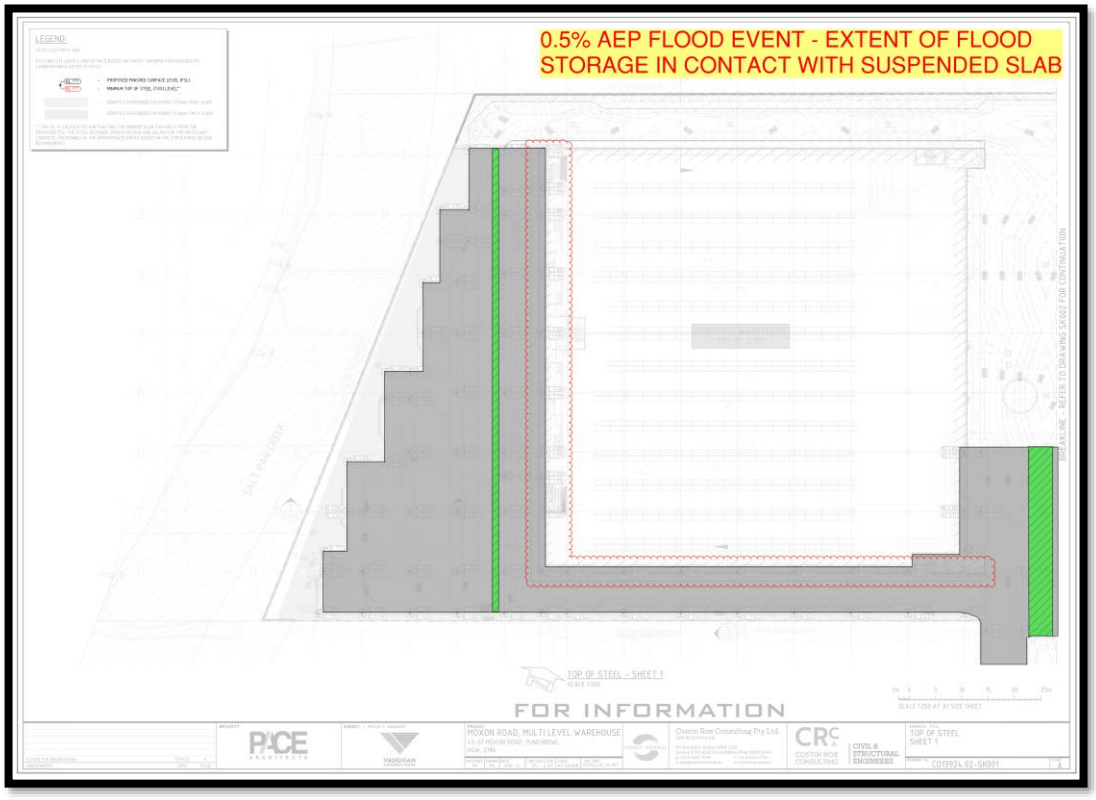
<u>0.2% AEP, 0.5% AEP and PMF flood levels interaction with suspended structure above:</u>

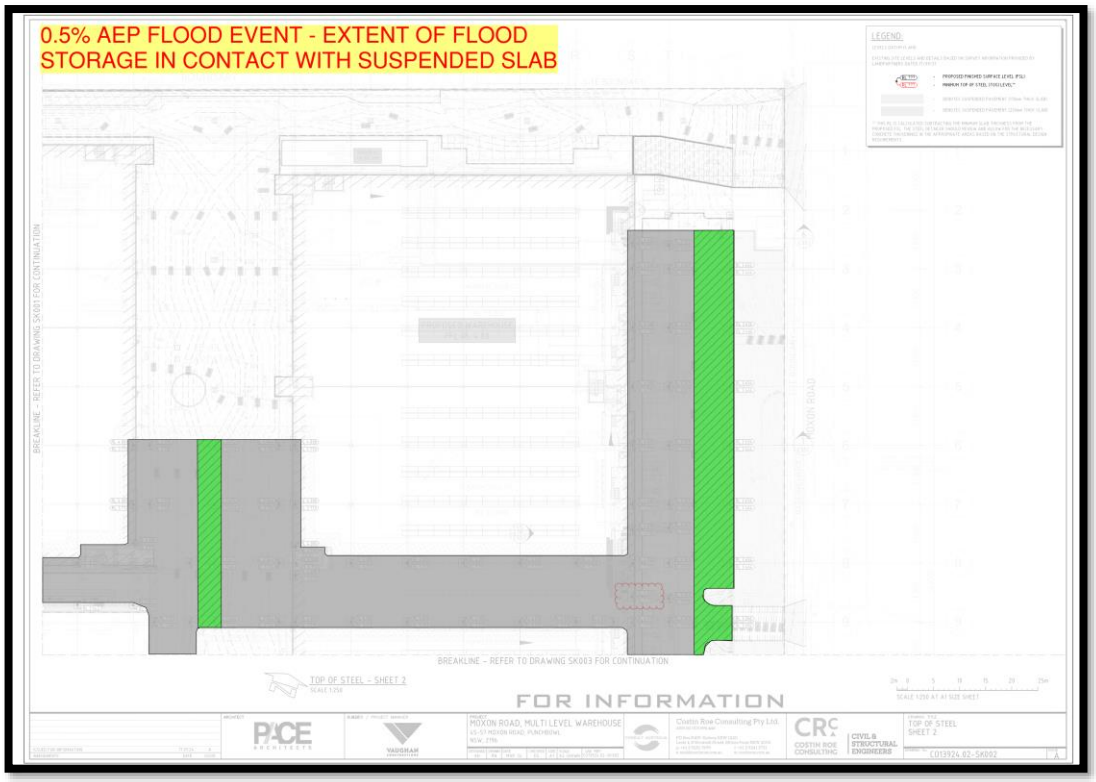
An assessment has been undertaken for the effect of climate change on the development. The assessment takes into consideration potential effect from increased rainfall intensity and sea level rise. An assessment of the less frequent storm events 0.2% AEP and 0.5% AEP was included as a proxy for the effect of climate change and is considered a conservative assessment for a 10% increase in flow to the 1% AEP event. Reference to Appendix A should be made for the post-development flood levels and depths for the 0.2% & 0.5% AEP event.

With reference to the 0.5%, 0.2% and PMF flood maps, the maximum flood levels within the flood conveyance zone are expected to be as tabled below:

Flood Event	Max Flood Level	Lowest Suspended Slab Soffit Level	Lowest FSL
0.5% AEP	RL3.47-RL3.49	RL3.43	RL3.60
0.2% AEP	RL3.73-RL3.74	RL3.43	RL3.60
PMF	RL6.11-RL6.16	RL3.43	RL3.60

It is noted that, during the 0.5% AEP flood event, the maximum flood level within the flood conveyance zone will be at approximately RL3.47, in line with the soffit of the lowest portion of suspended structure above. The flood level will only be in contact with small, approximately 1m wide area of the soffit of the suspended structure at the lowest portion of the slab **(see Figure 3.15 below).**





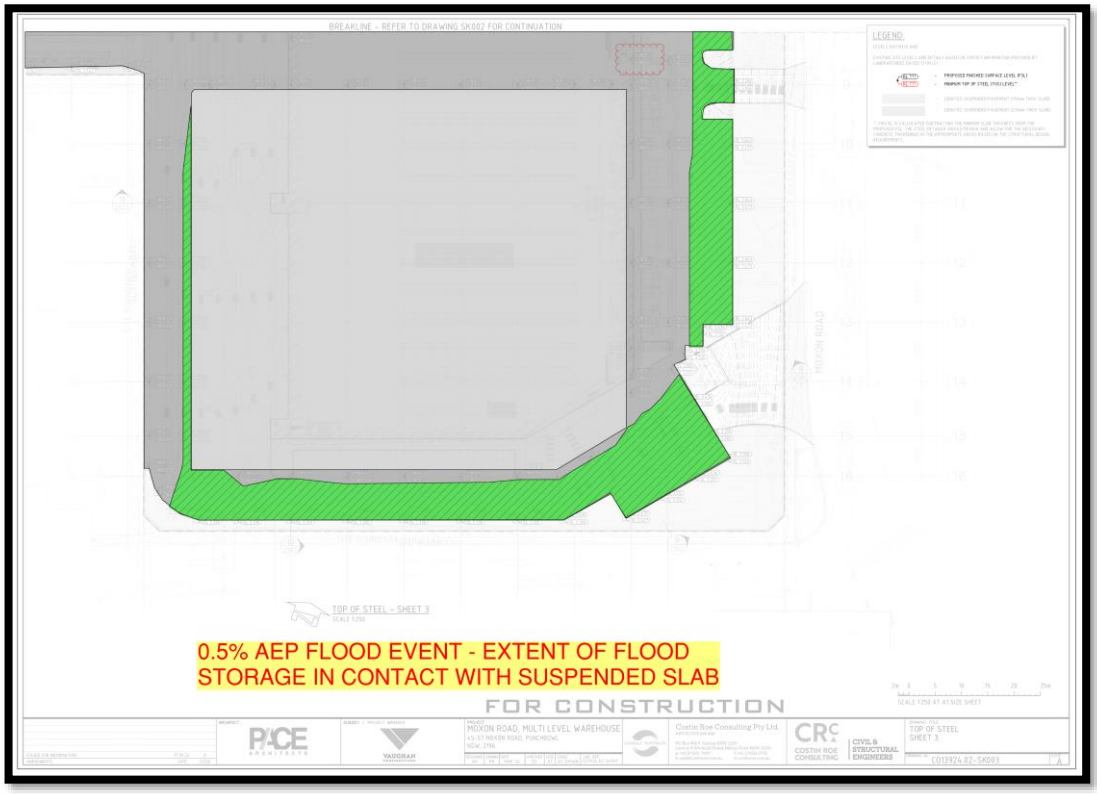
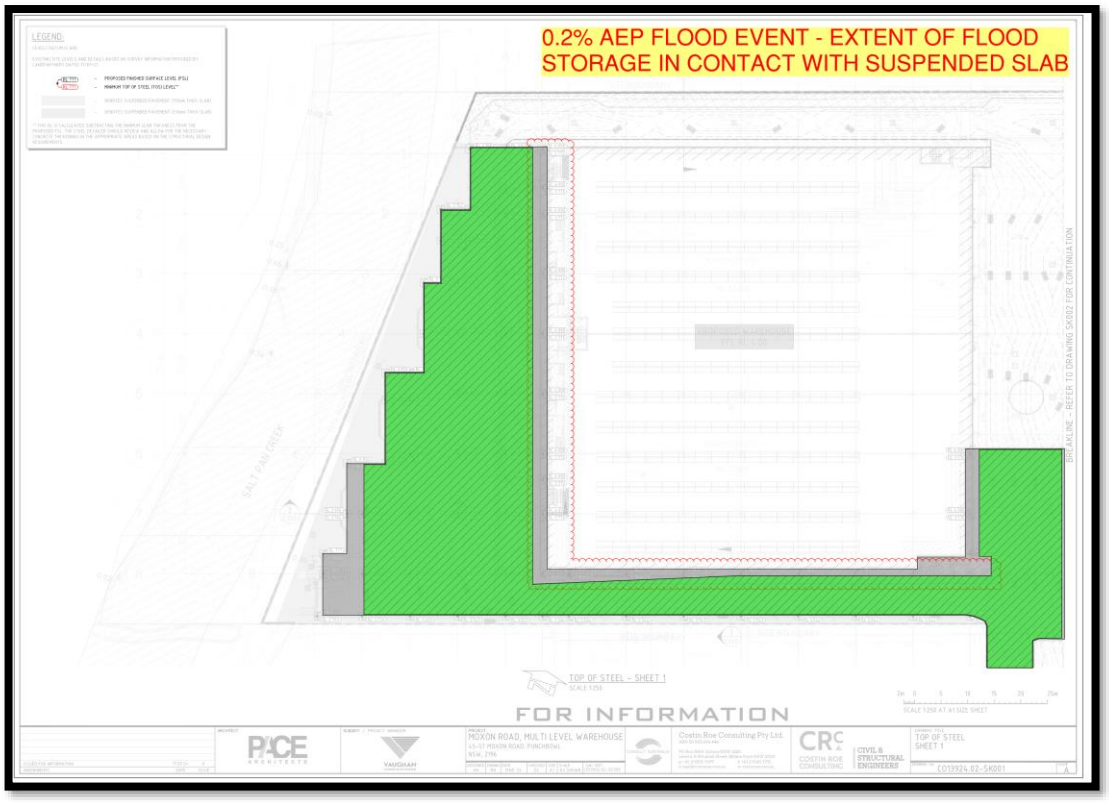
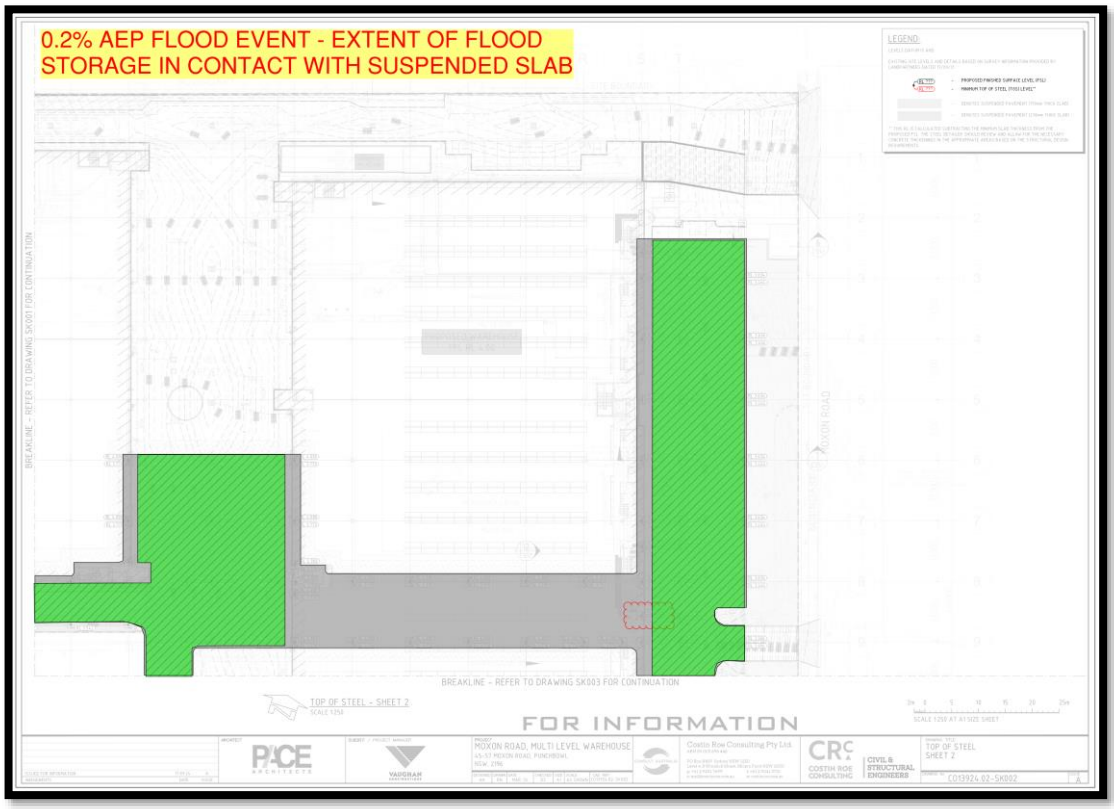


Figure 3.17 (a, b & c) Extent of the 0.5% AEP's flood levels in contact with the suspended slab's soffit above


0.2% AEP FLOOD EVENT - EXTENT OF FLOOD STORAGE IN CONTACT WITH SUSPENDED SLAB
LEGEND:
BREAKLINE - REFER TO DRAWING SK002 FOR CONTINUATION
TOP OF STEEL - SHEET 1
FOR INFORMATION
MOXON ROAD, MULTI LEVEL WAREHOUSE
TOP OF STEEL SHEET 1
C013924.02-SK001


0.2% AEP FLOOD EVENT - EXTENT OF FLOOD STORAGE IN CONTACT WITH SUSPENDED SLAB
LEGEND:
BREAKLINE - REFER TO DRAWING SK001 FOR CONTINUATION
BREAKLINE - REFER TO DRAWING SK003 FOR CONTINUATION
TOP OF STEEL - SHEET 2
FOR INFORMATION
MOXON ROAD, MULTI LEVEL WAREHOUSE
TOP OF STEEL SHEET 2
C013924.02-SK002

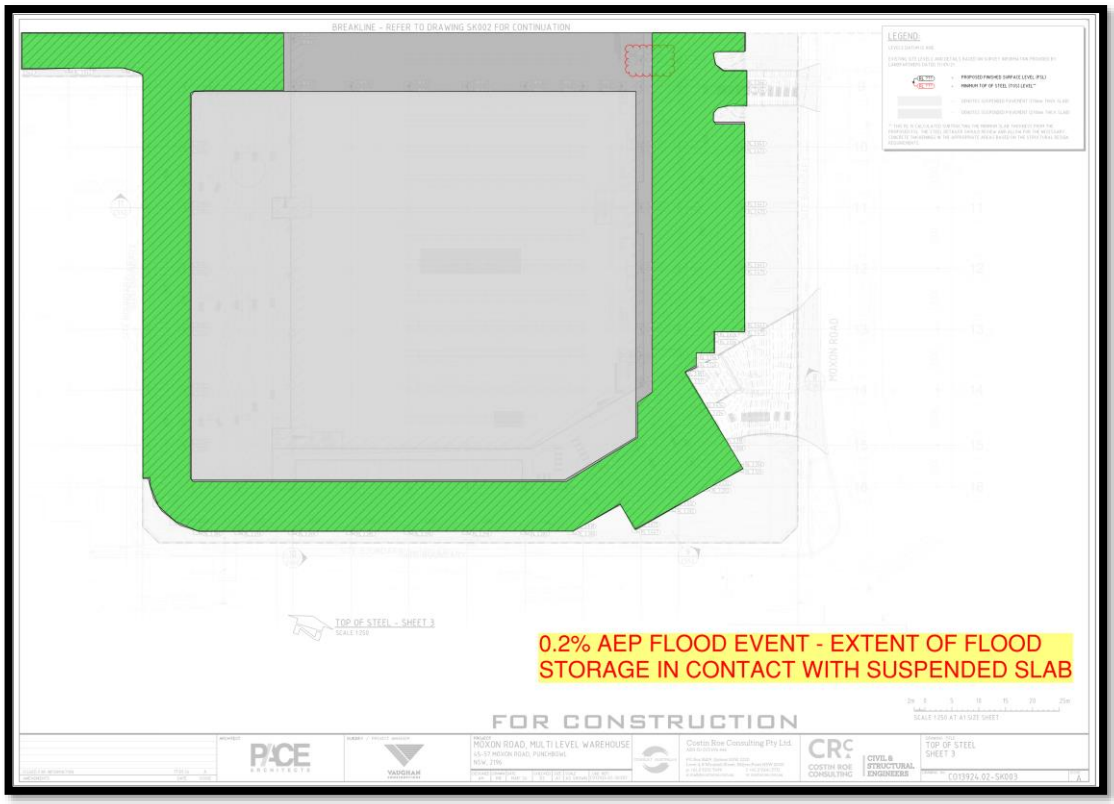


Figure 3.18 (a, b & c) Extent of the 0.2% AEP's flood levels in contact with the suspended slab's soffit above

During the 0.2% AEP flood event, the maximum flood level within the flood conveyance zone will be at approximately RL3.73. This level is approximately 130mm higher than the lowest finished surface level of the suspended structure, at RL3.60. A portion of the suspended structure will therefore be flooded, and the emergency procedures have been addressed in report referenced **CO13924.02-02b.rpt**. The structure will not have a significant impact on the flood behaviour as discussed in **Section 3.3** above.

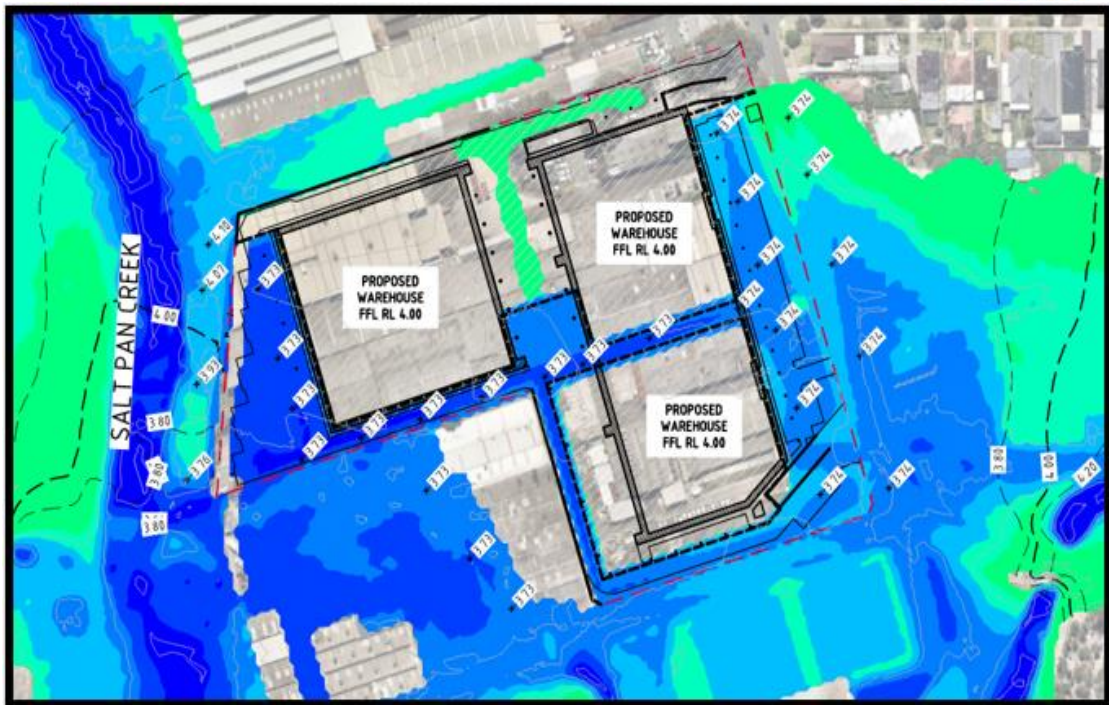


Figure 3.19 0.2% AEP Flood levels and depths showing the hardstand to be subjected to minor flooding (emergency procedures discussed in detail in report CO13924.02-02b.rpt)

3.4 Detailed design of the extended levee walls to withstand the forces of floodwaters, top of levee wall levels and the impact of the suspended slab above on the less frequent storm events

As noted in **Section 2** of the report, the development site is separated from the Salt Pan Creek by an existing levee wall. The proposed development requires the construction of a new levee wall to replace the sections where the existing warehouse, currently being demolished, previously served as a levee wall.

The existing Levee wall have been surveyed to have a top of wall level at RL4.00. The 1% AEP Flood Level on the Salt Pan Creek's side of the boundary, behind the **existing** levee wall, is set estimated to be at RL3.50. The Existing levee wall will therefore not be required to be altered to have a higher top-of-wall level.

The 1% AEP flood levels on Salt Pan Creek side varies up to RL3.73 in the North-western corner. The top-of-wall level of the proposed new levee wall will be set at RL4.30, with a 300mm step up from the existing levee wall set at RL4.00, maintaining a minimum of 500mm freeboard to the 1% AEP flood level.

As required by the conditions of consent's condition B55, the levee wall will therefore be designed and constructed to have a top-of-wall height no lower than the Salt Pan Creek mainstream 1% AEP flood level plus 500mm freeboard. Please refer to Figure 3.20 below.

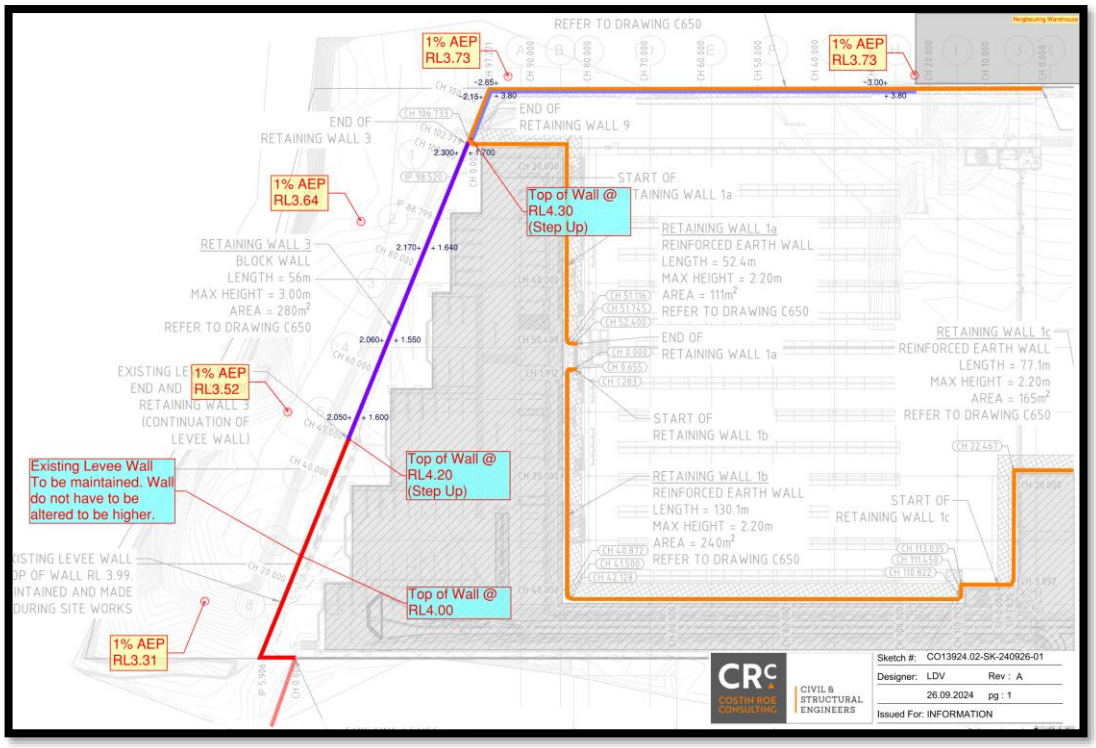


Figure 3.20 Proposed Levee wall's top-of-wall levels to be ~500mm above the 1% AEP flood levels along Salt Pan Creek (Conditions of Consent condition number B55 requirement)

The structural design of this proposed new levee wall is shown in drawing **CO13924.02-C652**. Reference should be made to **Appendix C** of this report for a summary of the Levee Wall's Structural design calculations, considering several loading scenarios, on which the levee wall's design has been based. The following scenarios was considered:

- Scenario 1: The development site is flooded and the Salt Pan Creek side is dry.
- Scenario 2: The development site is dry and the Salt Pan Creek side is flooded.
- Scenario 3: Both the development site and Salt Pan Creek are flooded (Probable Maximum Flood), OR flood level on salt pan creek exceeds height of wall and overflows into development.

The governing design scenario for strength is scenario 1 and 2 (bending alternate directions) and the governing design scenario for stability is scenario 2 where the absence of a restoring moment from water contributes to overturning.

The summary of the structural design calculations in Appendix C demonstrates that the proposed new levee wall has been structurally designed to withstand the forces of floodwaters, considering flooding from both the east (Salt Pan Creek) and west (development site) and have been designed by a suitably qualified structural engineer as required by the conditions of consent's condition B56(d).

As noted above, the Existing levee wall will not be required to be altered to have a higher top-of-wall level, and the structural capability of the existing levee wall have not been assessed.

4 CONCLUSION

Costin Roe Consulting Pty Ltd has been commissioned to develop this **DVFR** for the industrial development at 45-57 Moxon Road, Punchbowl, NSW.

This DFVR;

- reviewed the updated flood modelling results based on the latest proposed finished surface levels issued for construction and found that there were no changes compared to the approved flood modelling that formed part of the development application process;
- evaluated the impact of the suspended concrete structure, including supporting columns, on flood parameters and displacement of flood storage and have found that the impact was negligible, and demonstrated the flood behaviour and modelled results still comply with the approved flood modelling that formed part of the development application process;
- demonstrated the design of the extended levee walls can withstand the forces of floodwaters; and

Chapter 2.2, Flood Risk Management of Council's DCP provides relevant policy requirements relating to development in and around identified flood affected development sites. The intent of the document is to ensure that new developments do not experience undue flood risk and that existing development is not adversely flood affected through increased damage or hazard as a result of new development.

The flood planning level (FPL) for business/ industrial to be at or above the 1% AEP (1 in 100-year ARI) flood level plus 0.5m freeboard. The site is directly impacted by flooding on-lot, the FPL for this site is RL 3.8m AHD (as per City of Canterbury-Bankstown Stormwater System Report WP-SIA-1682/2020) and is associated with an overland flow path from the upstream catchment and drainage system (Salt Pan Main Stream) towards the south and west of the site. We note the proposed building level is RL 4.00m AHD.

Overall flood risk for the development and from the development is considered moderate. The FFL of the warehouse is proposed to be constructed 0.7m above the council's specified flood planning level. Additionally, the site is set above the 1% AEP flood level, provide adequate refuge for land users during an extreme flood event. Therefore, the development meets current council flood policy.

It is confirmed that the modelling and report has been undertaken in accordance with the Flood Impact and Risk Assessment: Flood Risk Management Guideline LU01.

This report must be submitted to Council as required by the conditions of consent.

5 REFERENCES

- Flood Risk Management Manual (2023)
- Canterbury-Bankstown Council's Stormwater System Report (WP-SIA-1682/2020)
- Chapter 2.2 – Flood Risk Management – Catchments Affected by Stormwater Flooding, of Canterbury-Bankstown's DCP 2023 in relation to the development including review of potential impacts of the development on existing flooding, and potential impacts on the development from flooding
- Salt Pan Creek Flood Study (SPCFS) (September 2011)
- Salt Pan Creek Floodplain Risk Management Study (SPCFRMS) (May 2015)
- SES (Nov 2019). Provision of and Requirements for Flood Warning
- Bureau of Meteorology (2013). Service Level Specification for Flood Forecasting and Warning Services for New South Wales – Version 2.0
- NSW Government (2023). Flood Impact and Risk Assessment. Flood Risk management guideline LU01;
- Provision and Requirements for Flood Warning in New South Wales – SES (Nov 2019);
- Costin Roe Consulting (2024), Civil Engineering Report (Co13924.01-04g.rpt)
- Costin Roe Consulting (2024), Flood Management Plan Incorporating Flood Emergency Response Plan (FERP) (CO13924.02-02b.rpt)