



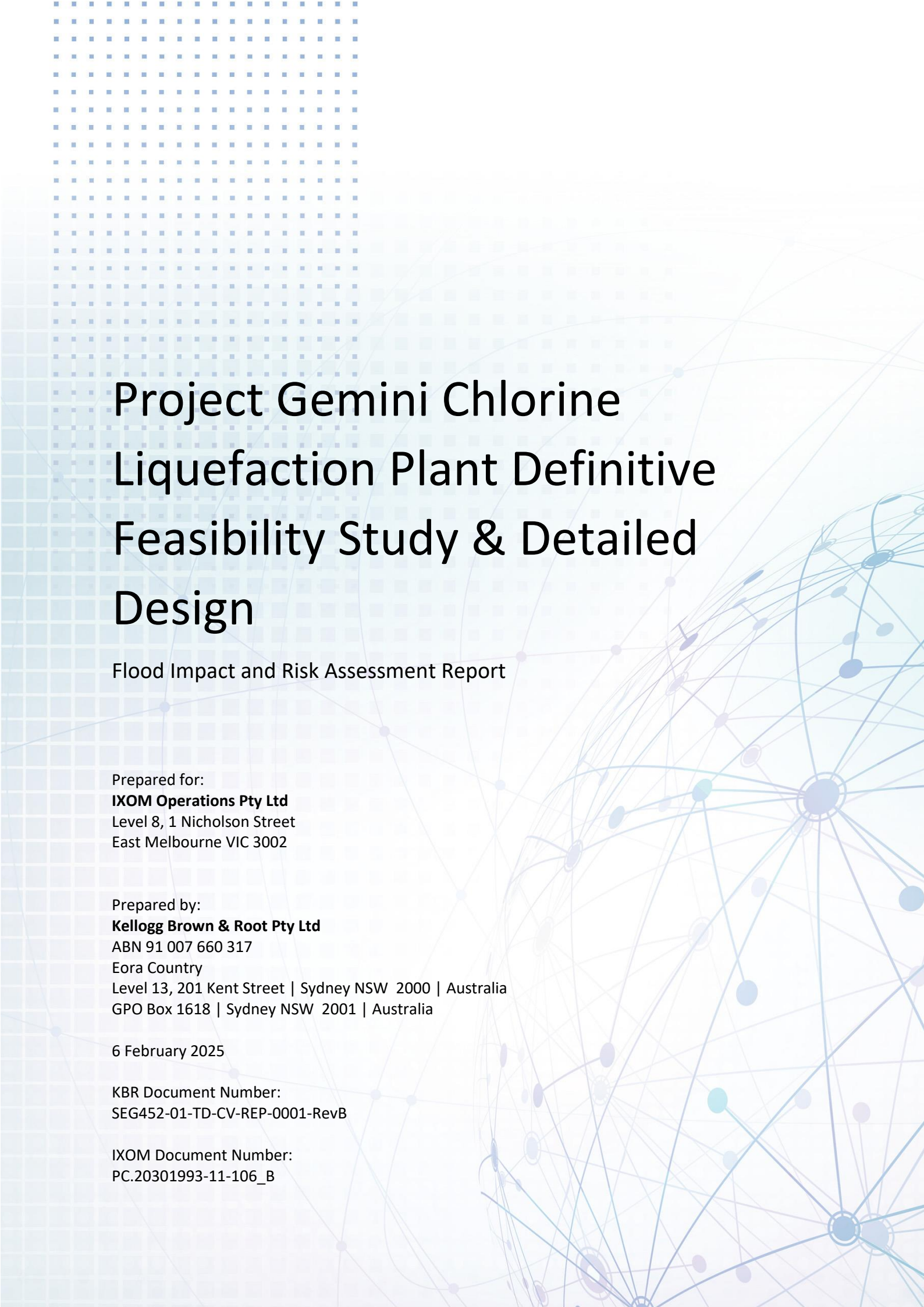
APPENDIX G

FLOOD IMPACT AND RISK ASSESSMENT REPORT



Project Gemini Chlorine Liquefaction Plant Definitive Feasibility Study & Detailed Design

Flood Impact and Risk Assessment Report



Project Gemini Chlorine Liquefaction Plant Definitive Feasibility Study & Detailed Design

Flood Impact and Risk Assessment Report

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Acknowledgments

KBR acknowledges the Traditional Custodians throughout Australia and their continuing connection to land, water, culture and community, and pays respect to their Elders past and present.

Limitations Statement

The sole purpose of this report and the associated services performed by Kellogg Brown & Root Pty Ltd (KBR) is to **perform Flooding Impact and Risk Assessment** in accordance with the scope of services set out in the contract between KBR and **IXOM OPERATIONS Pty Ltd** ('the Client'). That scope of services was defined by the request of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

KBR derived the data in this report primarily from **studies and investigations conducted during pre-feasibility study, client and vendor-provided data, and relevant Australian and International Standards**. The passage of time, manifestation of latent conditions or impacts of future events may require further exploration at the site and subsequent data analysis, and re-evaluation of the findings, observations and conclusions expressed in this report.

In preparing this report, KBR has relied upon and presumed accurate certain information (or absence thereof) relative to **site visit, and any other information** provided by government officials and authorities, the Client and others identified herein. Except as otherwise stated in the report, KBR has not attempted to verify the accuracy or completeness of any such information.

The findings, observations and conclusions expressed by KBR in this report are not, and should not be considered, an opinion concerning **additional work outside of the scope of work**. No warranty or guarantee, whether express or implied, is made with respect to the data reported or to the findings, observations and conclusions expressed in this report. Further, such data, findings, observations, and conclusions are based solely upon **site conditions, information, drawings supplied by the client** in existence at the time of the investigation.

Revision History

Revision	Date	Comment	Signatures			
			Originated by	Checked by	Technical Approval	Project Approval
A	10/01/2025	Issued for Comment	Tom Ward	Isaac Kim		John Phipps
B	06/02/2025	Issued for Comment	Tom Ward	Isaac Kim		John Phipps

Executive Summary

IXOM OPERATIONS Pty Ltd has consulted KBR to perform a definitive feasibility study & detailed design for the Project Gemini Chlorine Liquefaction Plant. The purpose of this report is to undertake the flooding impact and risk assessment component of works. The works has been conducted in accordance with the Secretary's Environmental Assessment Requirements, the Bayside Council Development Control Plan 2022 (BDCP), and the Australian Rainfall and Runoff (ARR) 2019 Version 4.2 Guidelines.

A flood advice letter was acquired from Bayside Council to determine the existing property extent of flooding and the corresponding flood-related development controls. The letter confirmed that the site is located within the extent of the Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2013). It further confirmed that the property is affected during the 1% Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF) events. The flood advice letter is provided in Appendix B.

A review of the Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2013) confirmed that a new flood model was to be built for the area of interest using updated methodologies and software capabilities. The calibrated catchment parameters from the existing 2013 Flood Study were used, and validation of the new model results against peak flood levels and extents provided in the 2013 Flood Study was undertaken. It was concluded that the peak flood levels simulated by the new flood model were consistent with the results of the Flood Study. Significantly improved representation of flow paths within the area of interest and flood extents across the upper catchment produced by the new model were identified.

The design of the Project Gemini Chlorine Liquefaction Plant consists of changes on two Blocks, Block L and Block Q, as well as components of the surrounding roadway. This includes the design of new structures, earthworks, driveways, road surface, kerbs, and gutters. Due to the nature of the storage of hazardous material and the classification of the blocks as Industrial Use facilities, stringent flood planning prescriptive controls are required by the BDCP 2022.

Compliance to the BDCP 2022 flood planning prescriptive controls were aimed to be attained for the development across varying flood events including the 1% AEP and the PMF events, as well as future climate change scenarios for the 2050- and 2100-year horizons in accordance with Australian Rainfall and Runoff 2019 (ARR) procedures. It has been determined that the prescriptive planning controls set out through SEAR's and the BDCP 2022 for this industrial development have been achieved in all clauses except for clauses A3 and E3. For clauses A3 and E3, although not compliant based on the 1% AEP and 1% AEP plus 0.5 m freeboard peak flood levels, these have been mitigated such that the property is not at risk of floodwaters in all events including the PMF event.

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1 Introduction

1.1 OVERVIEW

The IXOM Chlorine Liquefaction Plant Flood Impact and Risk Assessment report has been prepared by KBR on behalf of IXOM Operations Pty Ltd (IXOM). The report aims to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the modification of a State significant development (SSD), a chlorine liquefaction plant at IXOM's Botany Chlor-alkali Plant (CAP).

The subject site is located at 16-20A Beauchamp Road, Banksmeadow NSW 2019 in the Botany Industrial Park (BIP). The site is situated within the Springvale Drain catchment as a part of the Bayside Council Local Government Area (LGA).

In preparation of this report, KBR has relied upon specifications and information contained within the following documents:

- □ Environmental Assessment Requirements issued by the Department of Planning, Housing, and Infrastructure, dated June 2024;
- □ Flood Advice Letter issued by Bayside Council, Ref No: FA-2024/245, dated 21 October 2024 (copy enclosed under Appendix A);
- □ Bayside Council Development Control Plan, dated March 2023; and
- □ NSW Flood risk management manual, published by NSW Department of Planning and Environment, dated 2023.

The purpose of this report is to provide sufficient information to assess the flood impacts of the proposed development in accordance with the SEARs under Section 4.55(2) of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act).

1.2 PROPONENT

The company and contact details for the proponent (IXOM) are provided in Table 1-1.

Table 1-1 Proponent Details

Item	Detail
Project contact	IXOM Operations Pty Ltd
Postal address	16-20 Beauchamp Road, Banksmeadow NSW 2019
ABN	51 600 546 512 (IXOM OPERATIONS PTY LTD)

1.3 SITE DESCRIPTION

The subject site is defined as Block L and Block Q of Lot 1101 in Deposited Plan 1227173, comprising part of the IXOM Botany Chlor-Alkali facility located within Botany Industrial Park. The site is privately owned by Orica Australia Pty Ltd (Orica) and leased by IXOM. It is currently zoned as IN1 General Industrial under Chapter 5 of the State Environmental Planning Policy (Transport and Infrastructure) 2021 (TISEPP). Block L is currently occupied by a Sodium Hypochlorite (Hypo) Tanker Loading Bay. Block Q is currently occupied by a Sodium Hydroxide (Caustic) Tanker Loading Bay.

The site is bound by First Street to the west, Second Street to the east, Fourth Avenue to the south, and Sixth Avenue the north. Block L and Block Q are separated by Fifth Avenue. The site extents are indicated in Figure 1-1.

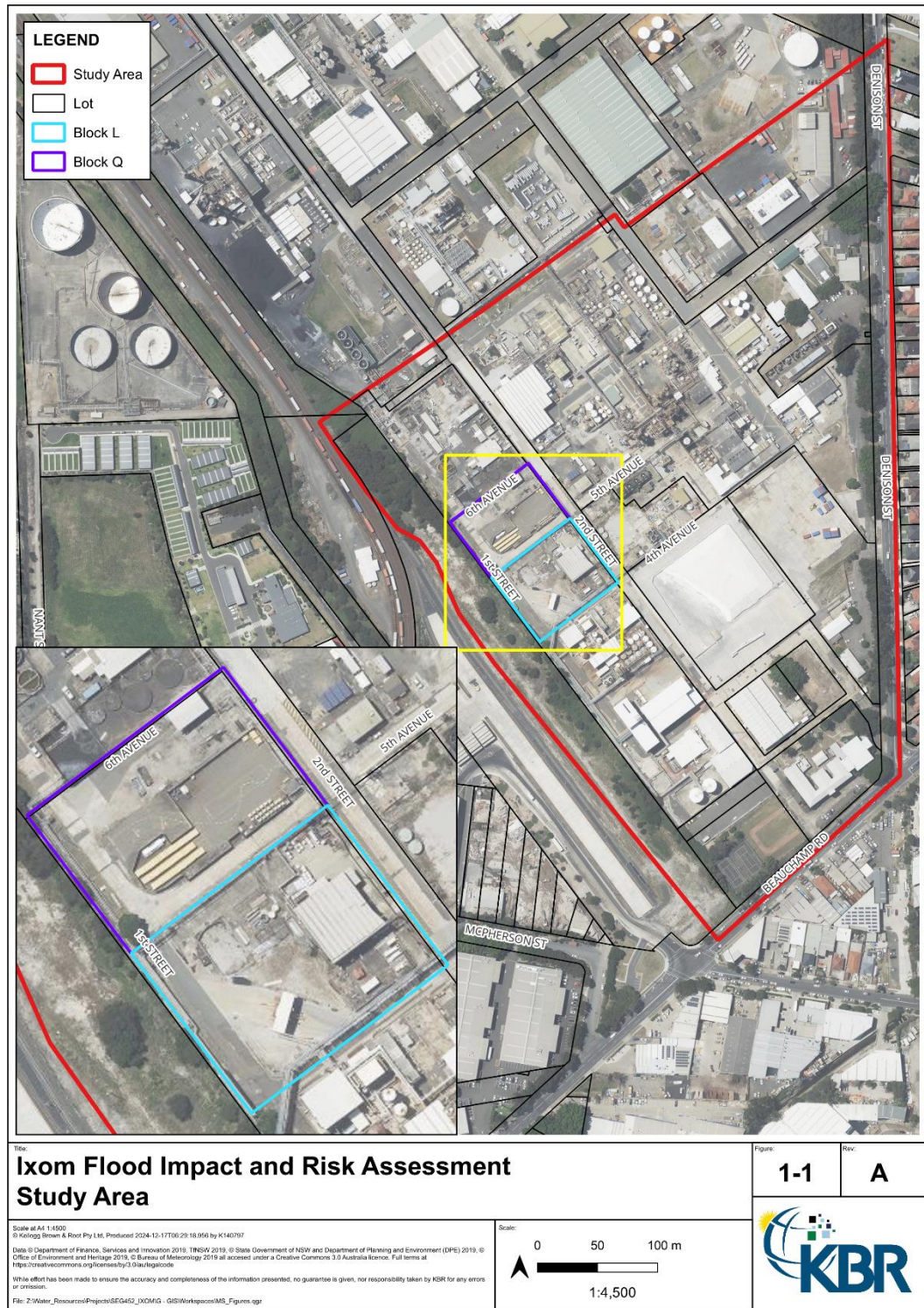


Figure 1-1 Study Area

1.4 STUDY AREA

The area of the site for development is approximately 0.82 ha, with the wider catchment encompassing an area of approximately 20 ha (refer to Figure 1-1). The catchment forms part of the larger regional combined Springvale Drain and Floodvale Drain catchment, which comprises an area of approximately 375 ha and flows from Pagewood at the northern extent to Botany Bay to the south via Penrhyn Estuary.

No waterways are present in or adjacent to the site, with Springvale Drain located approximately 400 m west of the site. Topographic site survey indicates that the topography is highest at the south-eastern end of the site (over 11.50 m AHD) and generally slopes downwards to the north and east (below 7.00 m AHD). Sub-surface flows from the local catchment are piped underneath the Sydenham to Botany Goods Railway line before discharging into Springvale Drain.

The site is predominantly sealed with hardstand or surfaced with gravel. As the local catchment is located entirely within the bounds of Botany Industrial Park, land use within the catchment is heavily urbanised and is predominantly composed of industrial development. Industrial blocks are bisected by a grid of smaller internal roads. The catchment is bounded to the south and east by Beauchamp Road and Denison Street, both identified as secondary freight roads. Patches of light to dense vegetation are located within the verge between Botany Industrial Park and the Sydenham to Botany Goods Railway line at the western catchment boundary.

1.5 PROPOSED WORKS

IXOM propose to construct and operate a new chlorine liquefaction and packaging plant at the site, which will be integrated into existing site operations with all chlorine material being sourced from the existing chloralkali manufacturing plant. The chlorine liquefaction plant will have a maximum production capacity of 50 tonnes per day.

The proposed works for the subject site include the construction of a chlorine liquefaction plant within Block L. As part of the works, the existing Sodium Hypochlorite (Hypo) Tanker Loading Bay will be re-located from Block L to Block Q, adjacent to the existing Sodium Hydroxide (Caustic) Tanker Loading Bay. This will require the construction of a new driveway and hardstand.

The construction stage will comprise:

- ☐ Block L:
 - ☐ Earthworks on Block L to remove existing surface material, level the block, excavate building footings, and install services.
 - ☐ Paving external hardstand areas and pouring of the reinforced concrete building floor.
 - ☐ Erection of the steel girt frame and portal frame roof.
 - ☐ Cladding of external walls and installation of roof sheeting.
 - ☐ Installation of internal componentry.
 - ☐ Commissioning and testing.
- ☐ Block Q:
 - ☐ Works to prepare Block Q for relocation of the sodium hypochlorite loading bay, comprising the removal of surface material and paving the access driveway and hardstand.
 - ☐ Dismantling of the Sodium hypochlorite loading bay on Block L and relocation to Block Q.

The Block L general arrangement ground plan can be seen in Figure 1-2, while the Block L and Q road surface layout can be seen in Figure 1-3.

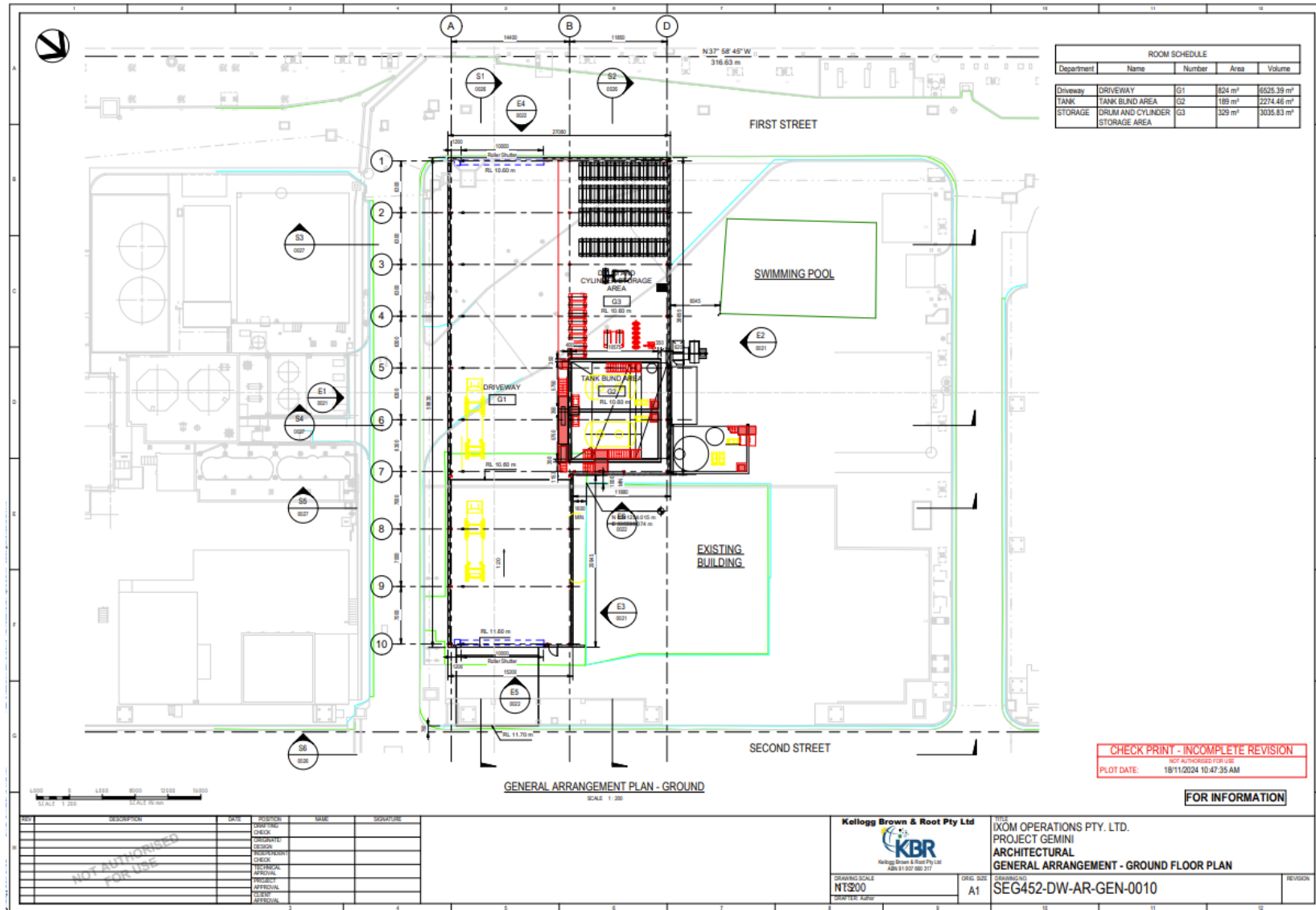


Figure 1-2 Block L Ground General Arrangement Plan – Draft

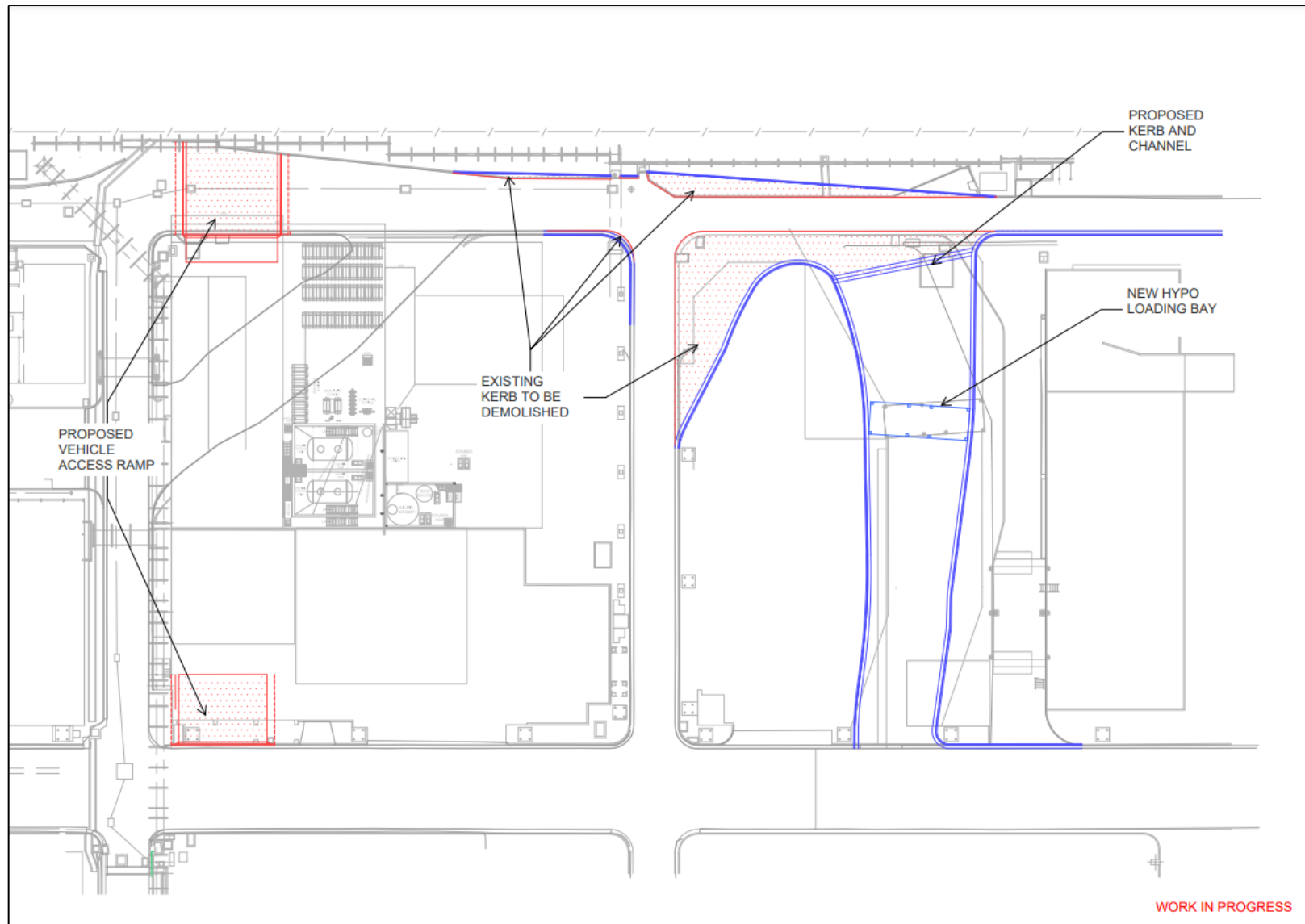


Figure 1-3 Block L & Q Road Surface Layout – Draft

2 Compilation and Review of Available Data

The review considers the available data in the following categories:

- ☐ Previous studies and investigations,
- ☐ Flood Advice Letter,
- ☐ GIS data,
- ☐ Topographic data,
- ☐ Drainage survey data,
- ☐ Design plans and drawings, and
- ☐ Hydrologic data.

2.1 REVIEW OF SPRINGVALE DRAIN AND FLOODVALE DRAIN FLOOD STUDY (BMT WBM, 2013)

The study area considered in this flood impact assessment overlaps with the extent of the Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2013).

BMT WBM was commissioned by the former City of Botany Bay Council to define the nature and extent of overland flow for existing conditions, at the time of the study, across the Springvale Drain and Floodvale Drain catchment and establish the basis for subsequent floodplain management activities. A combined hydrologic and hydraulic model was developed using the TUFLOW Rain-on-Grid functionality and in accordance with Australian Rainfall Runoff (ARR) 2001 guidelines. The model was calibrated and validated against the storm events of February 1990 and February 2010. Sensitivity analyses of hydraulic roughness, structure blockage, and design rainfall runoff were conducted.

The catchment topography was defined across the 2D model domain using a high-resolution Digital Elevation Model (DEM) derived from 2007 and 2008 LiDAR datasets with a horizontal grid resolution of 1 m. A 4 m cell size was adopted due to the size of the study area. The stormwater pipe network and network of open channels were represented in 1D, defined using data from previous studies and additional survey information provided by the City of Botany Bay Council and NSW Roads and Maritime Services (RMS). However, no drainage data is included in the model in the vicinity of the study area of the current flood impact assessment.

Flood extents, flood hazard, and hydraulic categorisation for the 0.5%, 1%, 2%, 5%, 10% and 20% AEP design rainfall events as well as the PMF were produced as outputs of the study. The potential impacts of future climate change were also considered for a range of design event scenarios. It is to be noted that the Intensity-frequency-duration (IFD) design rainfall curves have been updated since this study was issued and guidelines pertaining to the design rainfall input has also been updated with the release of ARR version 4.2 (ARR 4.2).

Parameters from the TUFLOW model were found to be largely appropriate for use in the hydraulic model developed as a part of this current study and were adopted, with minor manual adjustments required as detailed in later sections of this document. Details from the flood study report have been used to verify results in this current flood impact assessment. The TUFLOW model developed for the study has not been sourced for use in this current flood impact assessment due to the similar level of work required to review, update, and convert the model to a usable model fit for purpose and in line with the updated guidelines.

2.2 FLOOD ADVICE LETTER

A flood advice letter was acquired from Bayside Council to determine the existing property extent of flooding and the corresponding flood related development controls. The letter confirmed that the site is located within the extent of the Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2013). It further confirmed that the property is affected during the 1% annual exceedance probability (AEP) and probable maximum flood (PMF) events. The flood advice letter is provided in Appendix B.

The 1% AEP storm event resulted predominantly in shallow inundation with depths up to 0.15 m. Larger ponded peak flood depths between 0.50 m and 1.00 m were modelled within the basin on Block L. The site has been classified as a low flood hazard risk in the 1% AEP storm event with a flood hazard category of H1 (generally safe for vehicles, people and buildings) across most of the site. An isolated instance of H3 (unsafe for vehicles, children and the elderly) and H4 (unsafe for people and vehicles) is apparent within the basin in Block L. Additionally, Council's Flood Hydraulic category map classifies most of the site as flood fringe areas, whereas the basin in Block L is identified as flood storage.

The PMF causes inundation of the site at First Street and Second Street at depths between 0.15 m and 0.30 m, with maximum flood depth between 0.50 m and 1.00 m contained within the basin in Block L. Figures of both the 1% AEP and PMF Flood Extent provided in the Bayside Council Flood Advice Letter can be seen in Figure 2-1 and Figure 2-2 respectively.

In review of the flood advice letter, it can be seen that in both the 1% AEP and PMF events, no flow paths form within the blocks and the only high-risk area on the blocks is within the basin on Block L. The basin on Block L does not have a meaningful increase in extent in the PMF event and as such does not provide additional risk in the catchment due to backwatering into other areas of the block. The hydraulic categorisation of the site is classified as flood fringe for a majority of the impacted areas, indicating that minimal impact should be expected for the wider floodplain from changes made on these blocks.



Figure 2-1 1% AEP Flood Depth Map (Source: Bayside Council Flood Advice Letter, 2024)



Figure 2-2 PMF Flood Depth Map (Source: Bayside Council Flood Advice Letter, 2024)

2.3 GIS DATA

The GIS data utilised in model development is detailed in Table 2-1, including a description and application to the flood impact assessment.

Table 2-1 Summary and Intended Application of Available GIS Data

Dataset	Provider	Contents	Format	Application
2020 Sydney 1 m resolution Digital Elevation Model (DEM)	NSW Government – Spatial Services	Elevation data sourced from ELVIS with a 0.3 m vertical accuracy and a 0.8 m horizontal accuracy.	.tif	Used to define the catchment boundaries and hydraulic model elevation.
SIX Maps Aerial Imagery	Nearmap	Aerial imagery captured on 22 January 2021.	WMS	Used to delineate the hydraulic roughness, impervious ratios, and to confirm hydraulic structure locations.
Lot	NSW Government – Spatial Services	Property lot cadastres, lot numbers and Deposited Plan numbers.	.shp	Used to inform hydraulic roughness, impervious ratios, and mapping.
Road Corridor	NSW Government – Spatial Services	Road corridor extents.	.shp	Used to inform hydraulic roughness and impervious ratios.
Bing Maps Building Footprints	Bing	Building polygons.	.shp	Used to define the buildings within the hydraulic model and mapping.

2.4 TOPOGRAPHIC DATA

An airborne laser scanning (ALS) survey has been previously undertaken across the study area in 2020. The aerial dataset was publicly available on the ELVIS data portal by Geoscience Australia and consisted of a vertical accuracy of 0.3 m and a horizontal accuracy of 0.8 m. The ALS data was provided in the form of a Digital Elevation Model (DEM) with a horizontal grid resolution of 1 m. The DEM can be seen in Figure 2-3.

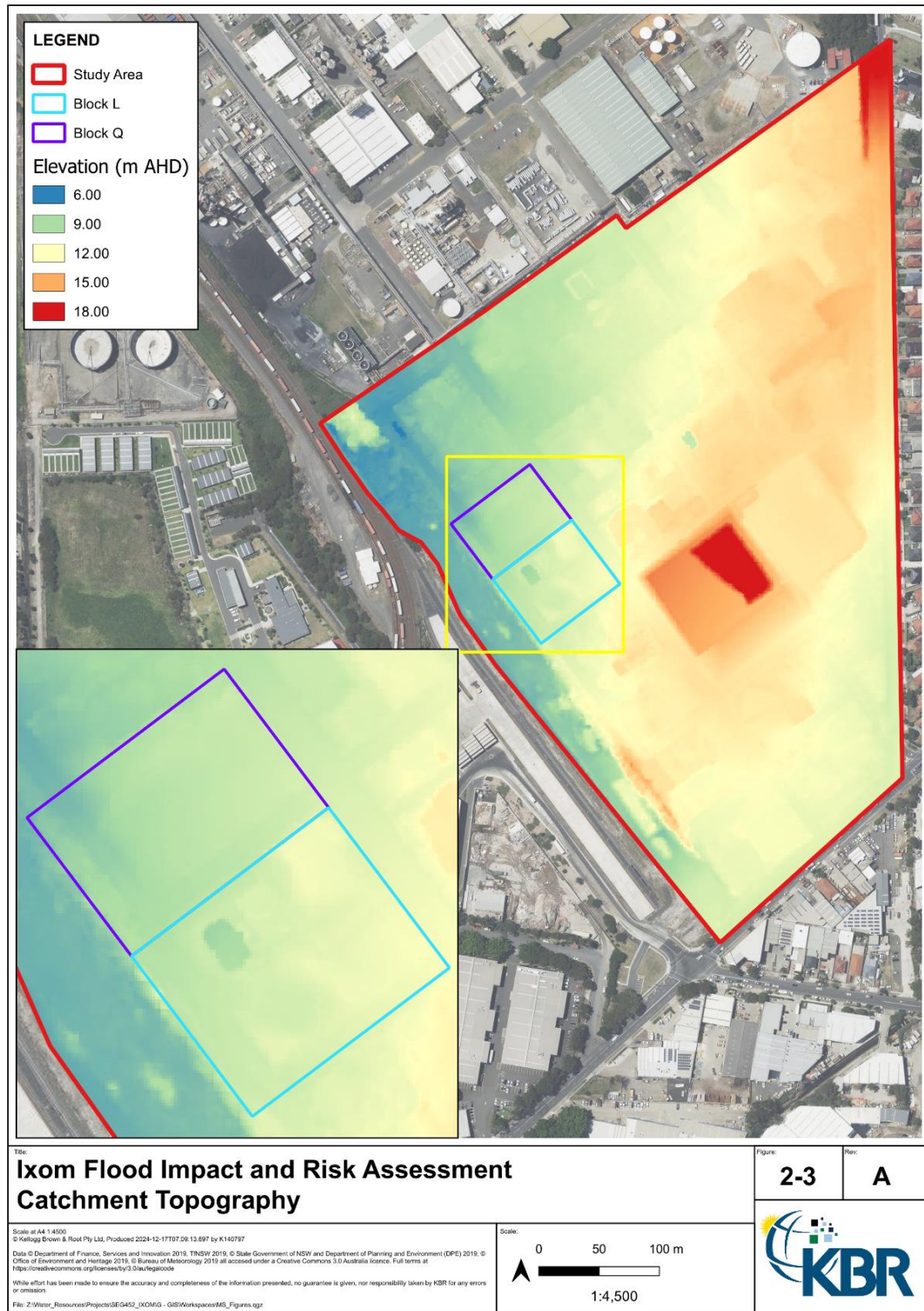


Figure 2-3 Catchment Topography

2.5 DRAINAGE SURVEY DATA

In the absence of information within the study area from Council databases and in the previous Flood Study, a request from Botany Industrial Park Pty Ltd regarding site stormwater was made. Works as Executed (WAE) drawings of stormwater site plans were provided however invert levels and dimensions were not specified. As such a sub-surface drainage infrastructure survey was conducted by Geosurv Australia in October 2024 and identified drainage assets within Blocks L and Q. Key surveyed pipe attributes included pipe dimensions, invert levels, and pipe lengths. Key surveyed pit attributes included pit dimensions.

The alignment, dimensions and invert levels of pits and pipes located directly upstream of the site were estimated based on the provided site stormwater WAE drawings listed in Table 2-2 and the Geosurv Australia surveyed dimensions.

Table 2-2 Summary of Design Plans and Drawings

Drawing	Designer	Contents	Format
2016 Botany Stormwater System Site Plan	KBR	Location of process effluent and stormwater drainage lines across Botany Industrial Park.	.pdf
2016 Area 1 Plan – Chlorine Plant Stormwater System	KBR	Location of stormwater lines and pits across Area 1 of Botany Industrial Park and outlet pipe alignment to Springvale Drain.	.pdf
2016 Master Stormwater Block Plan	KBR	Location of stormwater drainage lines across Botany Industrial Park.	.pdf

2.6 HYDROLOGIC DATA

2.6.1 ARR Datahub Data

The Australian Rainfall and Runoff (ARR) provides hydrologic input information required to undertake flood estimations in accordance with the ARR 4.2 guidelines (Geoscience Australia, 2024). The relevant data types extracted from the ARR Datahub are summarized in Table 2-3 and their application within the hydrologic model is detailed in Section 4.2.

Table 2-3 Summary of Relevant ARR Datahub Data

Data Type	Adopted Assumption
Areal Reduction Factor (ARF) Parameters	Provides information on which ARF region the queried point is located in as well as the relevant parameters required to calculate the ARFs.
Temporal Patterns	Provides the Temporal Pattern Zone that the queried point is located in as well as a link to download the Point and Areal temporal patterns in CSV format.
Storm Losses	Provides the Storm Initial Loss (mm) and Storm Continuing loss (mm/h) at the queried point.
Probability Neutral Burst Initial Losses	Provides a table with the Probability Neutral Initial Losses for a range of AEPs and durations at the queried point.
Climate Change Rainfall Factors	Provides upscaling factors between the 2030- and 2100-year horizons for the various Shared Socioeconomic Pathway scenarios across the range of durations at the queried point.

2.6.2 Bureau of Meteorology Intensity-Frequency-Duration Data

The Bureau of Meteorology (BOM) 2016 Intensity-Frequency-Duration (IFD) data was used to establish the rainfall input into the hydraulic model. Rainfall depths were extracted in the form of point rainfall depths for the model centroid of -33.95575, 151.22180.

3 Planning Controls

Planning controls have been implemented according to the Secretary's Environmental Assessment Requirements (SEARs) and the Bayside Council Development Control Plan 2022 as outlined below.

3.1 SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

Development Applications under Part 4 of the EP&A Act must be accompanied by an EIS prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs). This impact assessment, which forms part of the Environmental Impact Statement (EIS), addresses the outlined flooding requirements:

- ☐ an assessment of the potential impacts of the modification on the existing floodplain, and details of measures to ensure buildings and dangerous goods storage areas would be protected from flooding.

Council records indicate that the site is flood affected, located in a flood planning area identified by Council's flood study. Flood planning controls will therefore apply.

3.2 BAYSIDE COUNCIL DEVELOPMENT CONTROL PLAN 2022

The development is required to comply with the BDCP 2022 Section 3.10 and Section 9.5 flood related controls. This chapter of the DCP is applied to all flood-prone land within Bayside Council, being all land potentially inundated by 1% AEP event plus 0.5 m freeboard and the PMF event. The overall development aspects to be considered include:

- ☐ Floor Levels
- ☐ Car Parking
- ☐ Building Components and method
- ☐ Fencing
- ☐ Evacuation
- ☐ Earthworks and building on flood prone land
- ☐ Storage of hazardous substances

These development aspects are then turned into prescriptive controls based on their impact within the 1% AEP event flood level plus 0.5 m freeboard and the PMF event, hazard rating, and land use of the proposal. The current proposal is impacted in both the 1% AEP event flood level plus 0.5 m freeboard and the PMF event. The current proposal also consists of a high hazard rating and has a Commercial & Industrial classification for the proposed land use. The prescriptive controls for the development are outlined in Table 3-1.

Table 3-1 Planning Considerations – BDCP 2022 Prescriptive Planning Controls

Planning Consideration	Prescriptive Planning Control
Floor Level	A1: Habitable floor levels to be no lower than the 1% AEP peak flood level plus 0.5 m freeboard.
Floor Level	A3: Non-habitable floor levels to be no lower than 1% AEP flood level.
Building Components & Method	B2: All structures to have flood compatible building components below the PMF level.
Building Components & Method	B3: Flow-through open form fencing (louvres or pool fencing) is required for all new fencing and all new gates up to the 1% AEP flood level to allow floodwaters to flow through.
Building Components & Method	B4: All new electrical equipment, power points, wiring, fuel lines, sewerage systems or any other service pipes and connections must be waterproofed and/or located above the 1% AEP flood level plus 0.5m freeboard. All existing electrical equipment and power points located below the 1% AEP flood level plus 0.5m freeboard within the subject structure must have residual current devices installed that turn off all electricity supply to the property when floodwaters are detected.
Structural Soundness	C2: An engineer's report shall be provided to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to the PMF Level.
Flood Effects Caused by Development	D1: The development must not result in increased flooding elsewhere in the floodplain. A flood assessment report (refer to Schedules – Chapter 9.5.4) shall be provided to demonstrate that the development: • ☐ does not divert floodwaters to the detriment of elsewhere on the floodplain. • ☐ does not increase flood level or velocity elsewhere on the floodplain. • ☐ does not result in a detrimental loss of flood storage. • ☐ reduces the existing flood hazard, where possible. A flood impact assessment for a site is not required where the flood storage and floodway capacity are retained. For example, a building can be elevated to retain the existing floodway and flood storage to permit the free flow of water under the building
Car Parking and Driveway Access	E1: The minimum finished floor level of open car parking spaces or carports shall be at or above natural ground level. A flow-through roller door (or horizontal louvers) is permitted for a carport structure. Carports must be of open design, with at least 2 sides completely open such that flow is not obstructed up to the 1% AEP flood level. Otherwise, it will be considered to be enclosed. Open car parking areas shall not be located within a floodway.
Car Parking and Driveway Access	E2: For above ground level garages, the minimum surface level shall be no lower than the 1% AEP flood level.
Car Parking and Driveway Access	E3: Basement garages/storage/car parking, low-level driveways must be physically protected from inundation by floods equal to or greater than the 1% AEP flood level plus 0.5m freeboard. The crest of the driveway shall be located within the property boundary. All access, ventilation, driveway crests and any other potential water entry points to any enclosed car parking shall be above the 1% AEP peak flood level plus 0.5 m freeboard. Council will not accept any options that rely on the electrical, mechanical, or manual exclusion of the floodwaters from entering the enclosed carpark for new development. Flood barriers may be accepted for an existing development to improve flood protection.

Planning Consideration	Prescriptive Planning Control
Emergency Response	F2: A qualified civil engineer shall be engaged to prepare an onsite emergency response flood plan is required to detail whether evacuation procedures are required and if so, how they will be initiated, warning signs and preservation of flood awareness as owners and/or occupants change through time. Adequate flood warning systems (such as water level sensors, and alarm stations), signage, and exits shall be available to allow safe and orderly evacuation without increased reliance upon the SES or other authorised emergency services personnel. The evacuation plan shall be easily accessible to current and future occupants. If safe evacuation cannot be achieved within a sufficient response time, then a shelter-in-place refuge is required, together with a plan for self-sufficiency for up to 12 hours. This plan must consider as a minimum: sufficient area for all the occupants, adequate clean water for all occupants; portable radio with spare batteries; torch with spare batteries; first-aid kits; emergency power; and a practical means of medical evacuation. Note that in the event of a flood, occupants would be required to evacuate if ordered by Emergency Services personnel regardless of the availability of a shelter-in-place refuge.
Management and Design	G1: If a site or part of the site is affected by a Flood Hazard Category of H5 and H6, buildings and structures can be exposed to significant structural damage with a high risk to life. Intensification of existing land use in the affected area is not permitted unless it can be demonstrated to the satisfaction of the consent authority that the risk level on the property is or can be reduced.
Management and Design	G2: Storage of materials that may cause pollution or are potentially hazardous during any flood is not permitted below the 1% AEP plus 0.5m freeboard.
Management and Design	G4: Where a building is elevated to retain the existing floodway, overland flow path and flood storage, the undercroft area is to remain open to permit the free flow of water under the building. A positive covenant is required.
Management and Design	G5: Pools located within the 1% AEP flood extent are to be in-ground, with coping flush with natural ground level. Where it is not possible to have pool coping flush with natural ground level, it must be demonstrated that the development will result in no net loss of flood storage and no impact on flood conveyance on or from the site. All electrical equipment associated with the pool (including pool pumps) is to be waterproofed and/or located at or above the 1% AEP plus 0.5m freeboard level. All chemicals associated with the pool are to be stored at or above the 1% AEP plus 0.5m freeboard level.

4 Model Development

4.1 MODELLING METHODOLOGY

A TUFLOW Rainfall-on-Grid (RoG) (commonly referred to as 'direct rainfall') combined hydrologic and hydraulic model has been developed utilising the Heavily Parallelised Computing (HPC) engine (Release 2023-03-AE-ISP-w64). The RoG functionality precludes the need for a separate hydrologic model and simulates the rainfall-runoff and routing process within the TUFLOW software itself. The hydraulic model was used to determine flood levels, depths, velocities, flows, and hazard categories across the study area for the 1% AEP and the PMF design events as well as the 1% climate change events for the years 2050 and 2100.

4.2 HYDROLOGIC MODEL DEVELOPMENT

4.2.1 Design Rainfall

As per the latest ARR 4.2 Climate Change Section, design rainfall depths based on the 2016 BoM IFDs were upscaled to be reflective of 2024 conditions (the time of development of the hydrologic and hydraulic models). Adopted design rainfall depths and climate change upscaling factors were extracted for the catchment centroid of -33.95575, 151.22180 from the Bureau of Meteorology and the ARR Data Hub. The adopted upscaled design rainfall depths (as applied within the TUFLOW model) are presented in Table 4-1.

Table 4-1 Upscaled BOM IFD Data for Catchment Centroid (-33.95575, 151.22180)

Duration (min)	1% Annual Exceedance Probability (AEP)
10	36.67
15	45.72
20	52.56
25	58.13
30	62.89
45	74.15
60	82.97
90	96.61
120	107.63
180	125.97
270	149.52
360	169.36
540	205.89
720	233.87

4.2.2 Areal Reduction Factors

Application of an Areal Reduction Factor (ARF) accounts for the spatial variation of rainfall intensity, as larger catchments are less likely than smaller catchments to experience high intensity storms simultaneously over the entire catchment area. ARFs have not been applied in this study as the size of the catchment immediately local to the site is less than 1 km².

4.2.3 Temporal Patterns

Temporal patterns are used in design flood estimation to account for the variable distribution of rainfall intensity within a given rainfall duration. The ARR 4.2 guidelines prescribe an ensemble approach, whereby a suite of 10 rainfall temporal patterns is applied to the design rainfall depths for the simulated range of design events and durations. ARR 4.2 temporal patterns derived for the East Coast South region have been adopted in this study.

4.2.4 Design Rainfall Losses

Rainfall losses within the model were applied through the soil infiltration functionality of TUFLOW. The Initial Loss and Continuing Loss methodology was used to address the variability in losses depending on the surface material type.

The following calibrated initial and continuing rainfall losses for pervious areas were adopted from the Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2013):

- 1% AEP events – an initial loss of 50 mm and a continuing loss of 5 mm/hr; and
- PMF event – an initial loss of 0 mm and a continuing loss of 1 mm/hr.

For Impervious Losses, an initial loss of 0 mm and a continuing loss of 0 mm/hr were adopted in line with the Flood Study.

As per the latest ARR 4.2 Climate Change Section, the design rainfall losses were upscaled to be reflective of 2024 conditions (the time of development of the hydrologic and hydraulic models).

Varying perviousness percentages across the catchment have been accounted for by scaling down the initial and continuing losses based on the impervious percentage of the surface material type. Impervious percentages have also been adopted in line with the Flood Study.

The existing spatial distribution of the surface material types is presented in Figure 4-1. Table 4-2 presents the adopted impervious ratios and upscaled storm losses (as applied within the TUFLOW model) for each land use category.

Table 4-2 Applied Land Use Distribution, Initial Losses, and Continuing Losses

Category	Impervious Ratio (%)	20% - 0.5% AEP IL (mm)	20% - 0.5% AEP CL (mm/hr)	PMF IL (mm)	PMF CL (mm/hr)
Open Space	0	50.890	5.178	0.0	1.0
Lightly Vegetated	0	50.890	5.178	0.0	1.0
Densely Vegetated	0	50.890	5.178	0.0	1.0
Roads	100	0.000	0.000	0.0	0.0
Carparks	100	0.000	0.000	0.0	0.0
Railway	0	50.890	5.178	0.0	1.0
Buildings	100	0.000	0.000	0.0	0.0
Waterbodies	100	0.000	0.000	0.0	0.0
Industrial	90	5.089	0.5178	0.0	0.1

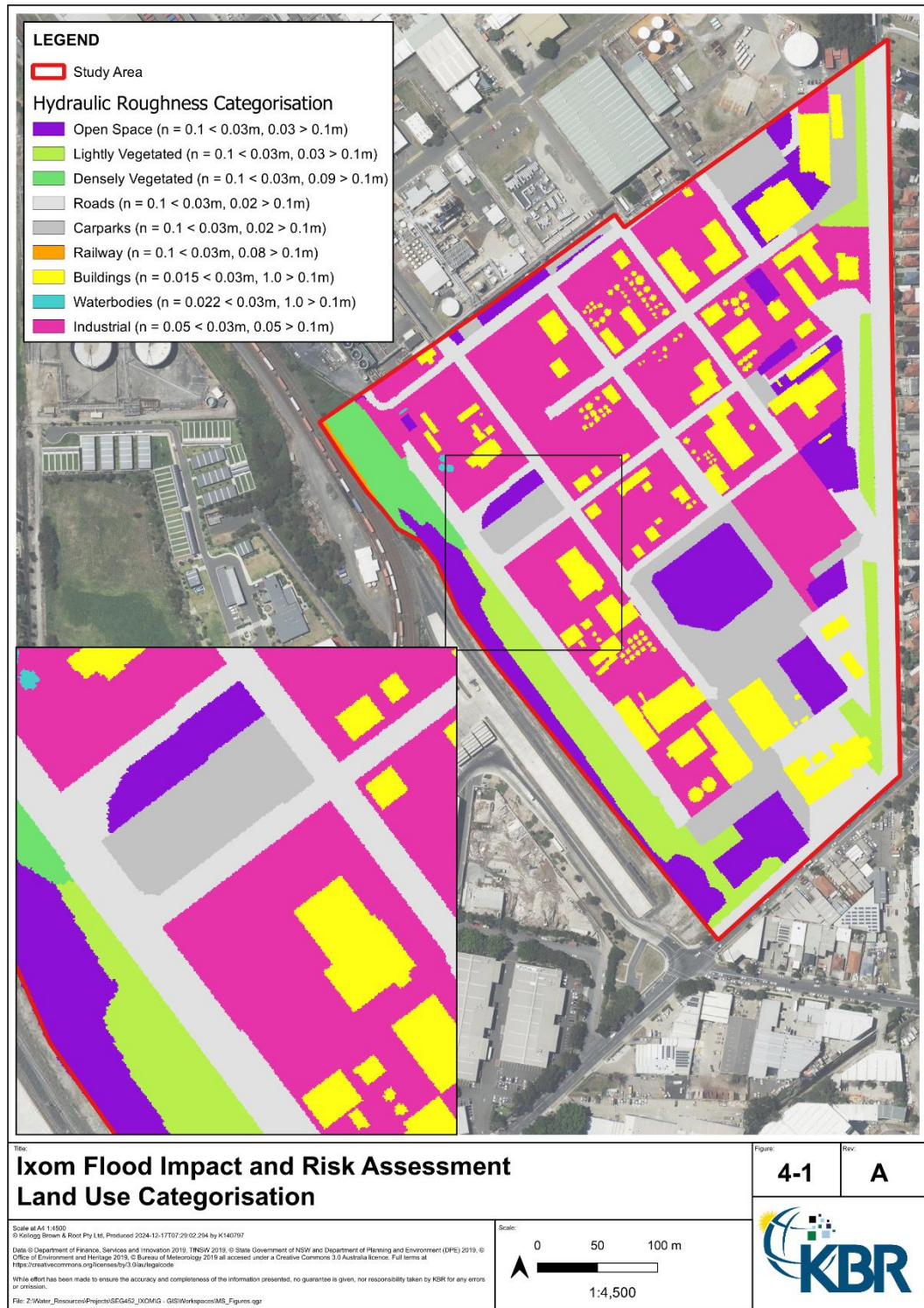


Figure 4-1 Existing Land Use Categorisation

4.2.5 Probable Maximum Flood

The Probable Maximum Precipitation (PMP) using the Generalised Short Duration Method (GSDM) is an approach used to estimate the highest possible rainfall for a given area. This method is an appropriate approach across the entirety of Australia and is outlined in “The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method.” (BOM, 2003). It derives this estimation from the maximum conceivable precipitation over short durations, ranging from 15 minutes to 6 hours. Long duration methodologies did not need to be relied upon as the critical durations within the catchment were less than 6 hours.

In Australia, this method is widely used in regions prone to intense rainfall and flash flooding, such as parts of Queensland and New South Wales. The GSDM takes into account extreme weather conditions and topographical factors to determine the most severe flood scenario, ensuring that infrastructure and emergency plans are robust enough to handle such extreme situations.

Due to the size and location of the catchment it was decided that the GSDM PMF would be the most suitable method to be adopted for this study and that no spatial distribution would be required. As per the latest ARR 4.2 Climate Change Section, the design rainfall losses were upscaled to be reflective of 2024 conditions (the time of development of the hydrologic and hydraulic models). The location information and assumptions used for the calculation are provided in Table 4-3. The adopted rainfall depths are presented in Table 4-4.

Table 4-3 Adopted GSDM Attributes and Assumptions

GSDM Attributes	Location Information/ Assumptions
Catchment Area (km ²)	0.175
Latitude	-33.956
Longitude	151.222
Mean Elevation (m AHD)	11.410
Terrain Classification	Smooth
EAF	1.000
MAF	0.700

Table 4-4 Adopted PMP GSDM Rainfall Depths (Scaled to 2024)

Duration (hours)	Rainfall Depth (mm)
0.25	197
0.50	290
0.75	360
1.00	418
1.50	530
2.00	617
3.00	742
4.00	837
6.00	963

4.3 HYDRAULIC MODEL DEVELOPMENT

4.3.1 Model Domain

The model extent considered in developing the hydraulic model includes the entire catchment immediately local to the site, as well as the nearby surrounding areas of Botany Industrial Park draining to Springvale Drain. Inclusion of these areas in the Rain-on-Grid model allows for the accurate representation of interaction between runoff generated across the study area and stormwater infrastructure.

A 1 m horizontal model cell size resolution was adopted to provide adequate definition of overland flow paths, noting TUFLOW elevation points are calculated at every half-cell size distance. The combination of the nominated 1 m cell resolution and the available 1 m resolution LiDAR data provides an optimum level of detail in modelling overland flows for the primarily urban catchment.

4.3.2 Topography

The underlying model topography was sampled from the latest 1 m resolution 2020 LiDAR dataset extracted from Geoscience Australia. The LiDAR data has an accuracy of 0.3 m vertical and 0.8 m horizontal. The model topography is displayed in Figure 2-3.

Fences and building pads that were not captured in sufficient detail by the adopted DEM but may influence runoff behaviour across the study area have been enforced in the model topography based on the information gathered during site inspection, as detailed in Section 4.3.4.

The salt storage pad located immediately east of Block L was captured as half full within the 2020 LiDAR dataset. Inspection of aerial imagery shows the salt mound to vary in size over time. Adopting a conservative approach, a topographic enforcement was applied within the hydraulic model to represent the mound as completely full.

4.3.3 Hydraulic Roughness

Hydraulic roughness represents flow resistance offered by various surface materials. In the context of the TUFLOW model, hydraulic roughness is spatially distributed to describe the variability in flow resistance across the modelled extent. Land use zones were adopted to spatially distribute hydraulic roughness in the same manner as the loss approach detailed in Section 4.2.4.

A combination of aerial imagery, cadastral information, and building footprints was used to generate land use surface types and roughness zones in the catchment area. Adopted Manning's 'n' values are in line with those from the Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2013). The adopted roughness distribution is displayed in Figure 4-1 with the applied Manning's 'n' values presented in Table 4-5. The interpolation of Manning's 'n' is conducted between 0.03 m and 0.10 m.

Table 4-5 Hydraulic Roughness Distribution and Applied Manning's 'n' Values

Hydraulic Roughness Surface Type	Manning's 'n' Depth ≤ 30mm	Manning's 'n' Depth > 100mm
Open Space	0.100	0.030
Lightly Vegetated	0.100	0.040
Densely Vegetated	0.100	0.090
Roads	0.100	0.020
Carparks	0.100	0.020
Railway	0.100	0.080
Buildings	0.015	1.000

Hydraulic Roughness Surface Type	Manning's 'n' Depth ≤ 30mm	Manning's 'n' Depth > 100mm
Waterbodies	0.022	0.022
Industrial	0.050	0.050

4.3.4 Representation of Buildings

Buildings across the model domain have been represented in accordance with the recommendations made by the TUFLOW software vendor. The following procedure has been applied:

1. ☐ Where surveyed building pad levels were provided, they were used. Where data didn't exist the building footprint was raised to the highest sampled elevation level within the footprint to model the obstruction to flow caused by the building structure itself, and
2. ☐ Applying a depth varying Manning's 'n' over the raised building footprint.

The above approach allows for flow paths to be obstructed by the building footprint itself while allowing for flood storage within or under buildings. An added benefit of enforcing building footprint levels also removes the topographic anomalies within the building polygon often observed within the 2020 LiDAR due to LiDAR filtering and tinning processes.

The Bing Maps Australia dataset of building footprints served as a basis for developing the building representation. Some infilling of the dataset was required for buildings not captured within the dataset based on Aerial survey.

4.3.5 Representation of Fences

Fences can also pose a significant obstruction to flow and influence flood behaviour at the area of interest. Representation of fences within the Blocks L and Q adopt either of the three following methodologies using layered flow constriction shapes, based on varying blockage potential observed during the site investigation:

- ☐ Concrete and brick fences have been modelled with an adopted form loss coefficient of 1.00 and blockage factor of 100%.
- ☐ Mesh wire fencing has been modelled with an adopted form loss coefficient of 0.50 and blockage factor of 50%.
- ☐ Colourbond fences have been modelled with an adopted form loss coefficient of 0.96, a blockage factor of 100%, and a 10 cm shallow opening between the ground surface and fence invert with a blockage factor of 0% and a form loss coefficient of 0.96.

All form loss coefficients have been derived in accordance with the recommendations from the latest TUFLOW guidance, accessible at TUFLOW WIKI: TUFLOW 2D Hydraulic Structures. Fences throughout the remainder of the model domain are indirectly accounted for in the Manning's 'n' value adopted for industrial areas.

4.3.6 Stormwater Drainage Network

A total of 32 stormwater pipes and 23 pits/manholes were modelled from the provided sub-surface drainage survey as described in Section 2.5. Survey data was available for assets within Block L and Block Q and provided details on pit and pipe alignment, pit and pipe sizes, and pipe invert levels. The locations of the stormwater assets can be seen in Figure 4-2.

A further 18 stormwater pipes and 14 pits/manholes were modelled to complete the drainage network immediately upstream of Block L and Block Q. In the absence of survey data, information on pit and pipe alignment was estimated based on stormwater design plans and drawings listed in

Table 2-2. A set of assumptions were applied to infill the missing pit and pipe sizes and invert levels. The general approach to the assumptions applied is recorded in Table 4-6.

Table 4-6 Stormwater Network Data Issues and Adopted Assumptions

Data Issue	Adopted Assumption
Missing pit invert levels	Pit invert levels were assumed to be the lowest invert level of the connecting pipes.
Missing pipe invert levels	Within the estimated stormwater network, missing pipe invert levels were calculated by taking the depth of the invert of the largest connecting pipe below ground surface level assuming minimum 500 mm cover.
Missing pit types	Pits throughout the model domain were categorised as comprising either a grated inlet pit, kerb inlet pit, grated kerb inlet pit or manhole, based on site inspection observations and where unavailable, assessment of aerial imagery.
Missing pipe dimensions	Within the estimated stormwater network, the dimensions of the downstream pipe were taken if located at a pipe junction, else the dimensions of the upstream pipe were adopted.

Pit inlet flow versus depth relationship curves were extracted from the Watercom DRAINS Generic Pit Inlet Capacity Relationships database (Watercom, 2020). The Watercom database, publicly available online, is embedded into the DRAINS software and widely used across Australia. In lieu of locality-specific pit inlet relationships, the Watercom database was implemented into the TUFLOW model to determine the flow rate entering pits for a combination of sag and on-grade pits including grated inlet pits, kerb inlet pits, and grated kerb inlet pits.

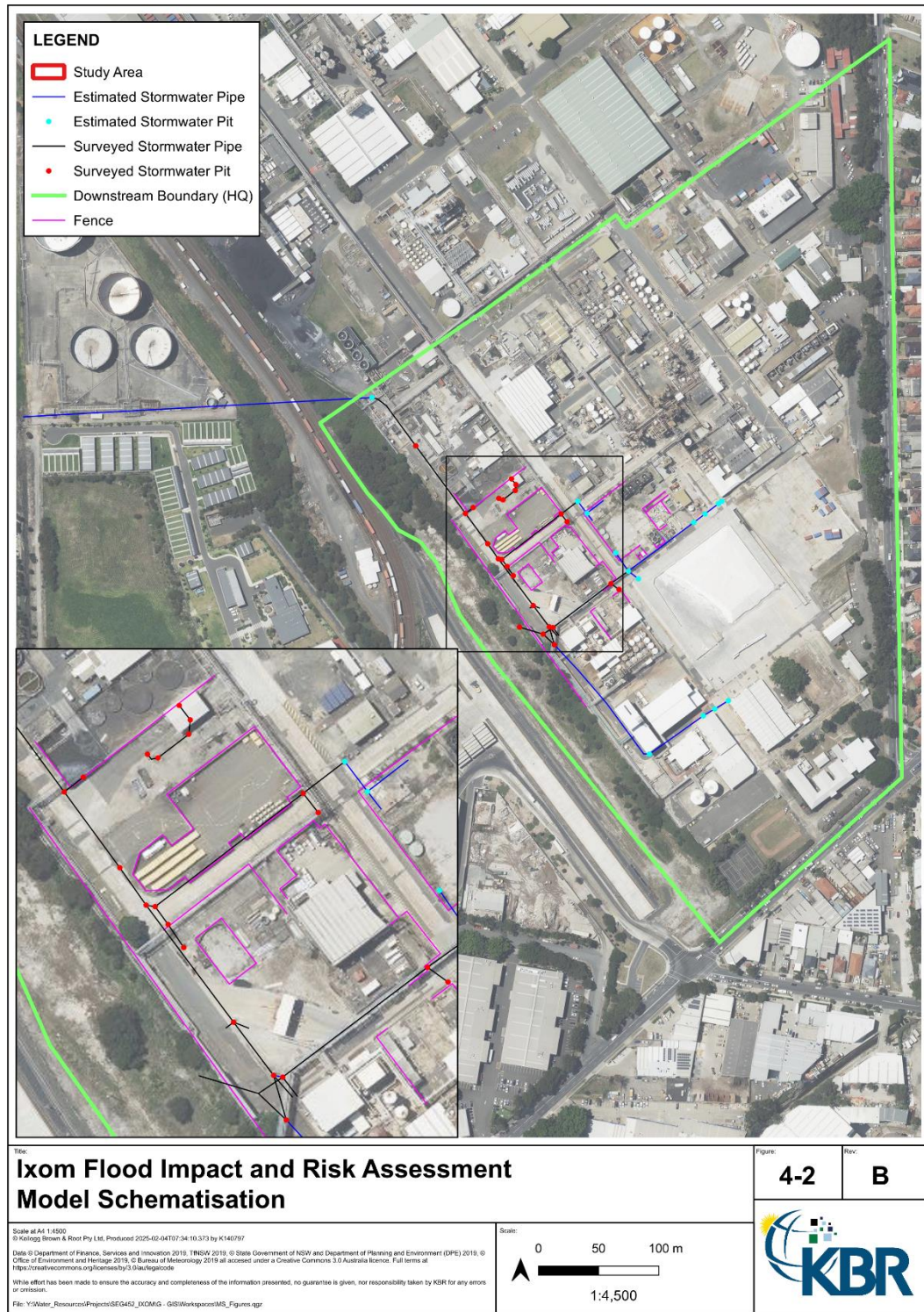


Figure 4-2 Model Schematisation

4.3.7 Structure Blockage

Structure blockage has been applied in accordance with the Bayside Council DCP 2022 for stormwater pits and pipes. The following assumptions were adopted in the model:

- ☐ Stormwater pipes equal to, or less than 450 mm diameter were modelled as 100% blocked,
- ☐ Stormwater pipes above 450 mm were modelled as 50% blocked, and
- ☐ All inlet pits were modelled as 50% blocked.

Blockage guidance prescribed by ARR 4.2 has not been applied due to the absence of cross-drainage structures within the model.

4.3.8 Model Boundaries

As the entire upstream contributing catchment to the site has been included within the Rain-on-Grid model extent, no upstream inflow boundaries have been applied within the model. Removal of rainfall within the Existing/proposed building footprint polygons has been undertaken on Block L and placement proportionally distributed around the building based on roof slopes. This acts as a conservative design approach inducing higher flows approaching the structure as overland flow and removing potential erroneous modelling outputs within the building footprint. The extent of the excluded rainfall region is shown in Figure 4-3.

An automatically generated head-flow (HQ) boundary has been applied at all downstream boundary conditions within the 2D model domain based on the slope of the underlying topography. All downstream boundaries were applied at a sufficient distance beyond the study area to prevent any artificial influence on the model results within the area of interest.

The downstream boundary of the drainage network conservatively adopts a fixed tailwater of the obvert of the outlet pipe exiting the study area. The configuration of the outlet pipe is shown in the 2016 Botany Stormwater System Site Plan, which indicates that the pipe discharges into Springvale Drain. As the outlet obvert elevation is 3.38 m AHD, it is nearly 2 metres above the maximum recorded tide of 1.40 m AHD in Botany Bay. As such, no tidal variations will be incorporated in the modelling.

Location of the downstream boundaries are shown in Figure 4-2.

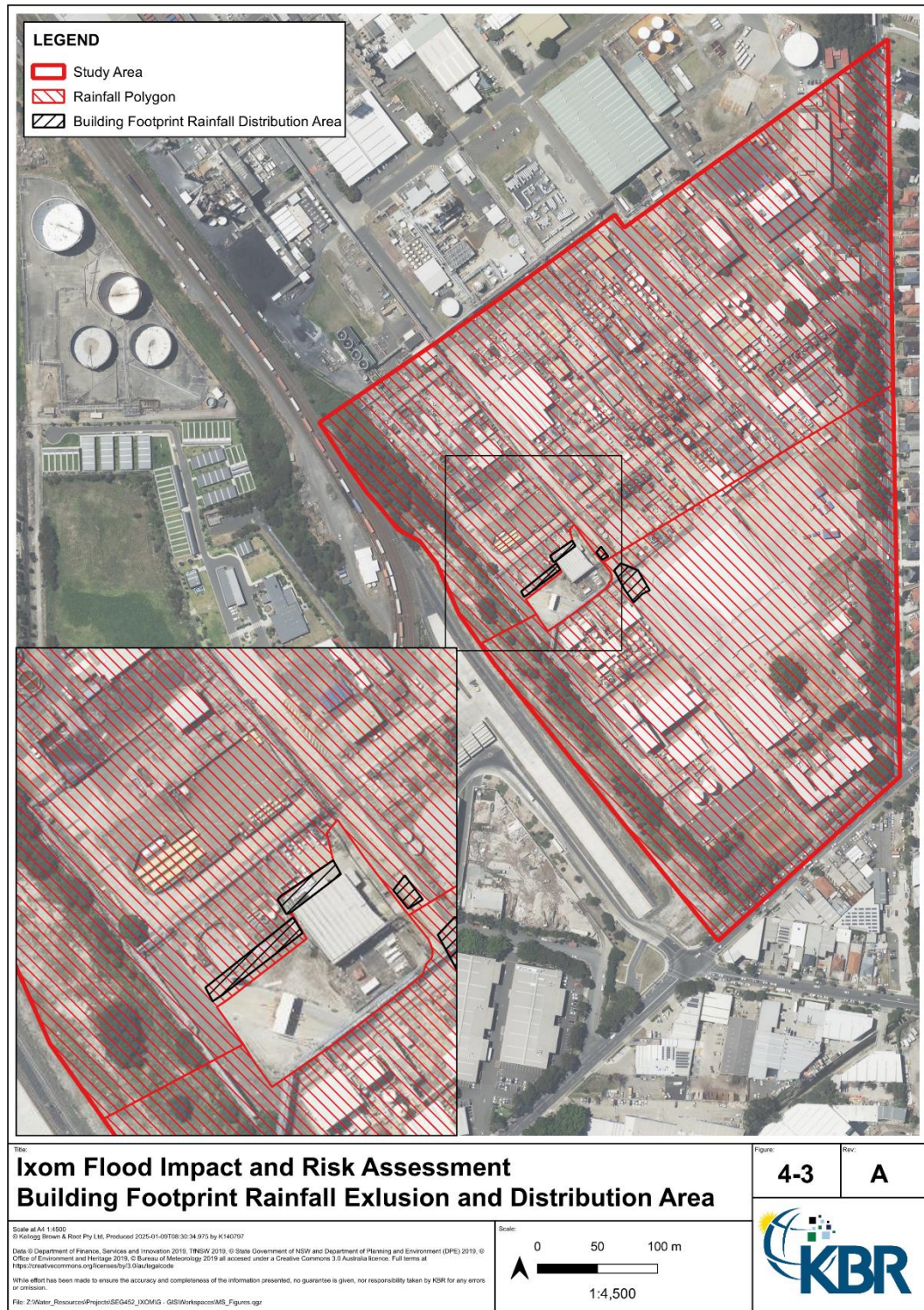


Figure 4-3 Building Footprint Rainfall Exclusion and Distribution Area

4.3.9 Critical Duration Assessment

A critical duration assessment refers to the selection of durations and temporal patterns that can best represent the flood behaviour of a specified design flood event. In accordance with the ARR 4.2 guidelines, the design events have been sub-divided into three temporal pattern bins based on the frequency of the AEP events. The rare bin is applicable to the 1% AEP, as shown in Figure 4-4.

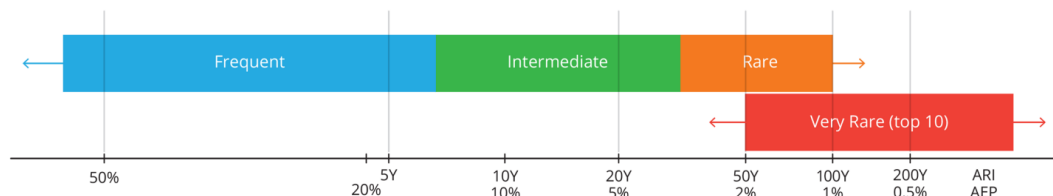


Figure 4-4 Temporal Pattern Ranges (ARR, 2019)

In order to select the appropriate critical duration and representative temporal pattern, the Rain-on-Grid TUFLOW model has been simulated for a range of durations between 15 minutes to 2 hours for the 1% event (capturing the 'rare' temporal pattern bin as described in Figure 4-4).

To select the critical duration from the simulated design events, a median peak water level grid was first produced across the ensemble of 10 temporal patterns for each duration on a model grid cell-by-cell basis. A maximum peak water level grid was then generated using the median grids produced per duration. The resulting maximum peak water level grid was interrogated to determine which duration is critical for the site. This process was repeated for each temporal pattern bin to identify the critical duration across the range of design event magnitudes.

Following the identification of the critical durations, the representative temporal pattern per duration was selected to be the temporal pattern that produced a peak flood level output that was closest to but above the median at the site.

The PMF critical duration was conducted through the selection of the duration with the maximum peak water level at the site. There is however only one temporal pattern per duration, so the selection of the median temporal pattern was not required. See Table 4-7 for the adopted critical durations and temporal patterns.

Table 4-7 Summary of Adopted Critical Durations and Representative Temporal Patterns

Event	ARR TP ID
1% AEP	20 min TP10
PMF	15 min GSDM

4.3.10 Result Filtering

Unfiltered TUFLOW RoG results depict a significant amount of 'noise' within the result due to the nature of RoG modelling injecting water across all active cells. As such, filtering of the results is a necessary step to appropriately depict developed flow paths without the shallow depths across the entire active model domain.

Sensitivity testing was undertaken adopting a range of cut off values. Generally, depths less than 0.05 m were found to be an artefact of the rainfall on grid modelling approach and not representative of flow paths or storage areas.

As such, a postprocessed map cutoff depth of 0.05m was used to provide a filtered result.

4.4 POST-DEVELOPMENT MODELLING

The model configuration adopted for the pre-development condition was modified to represent the proposed development occurring in Block L and Q. The proposed works are outlined in Section 1.5. The extent of works can be seen in Figure 4-5.

To represent the works in the hydraulic model, the works implemented have been outlined in Table 4-8. The impact of the proposed changes on the topography can be seen in Figure 4-6.

Table 4-8 Development Works Representation in the Hydraulic Model

Location	Development Works	Representation in Hydraulic Model
Block Q	Works to prepare Block Q for relocation of the sodium hypochlorite loading bay, comprising removal of surface material and paving the access driveway and hardstand. Relocation and redesign of Kerbs.	Implementation of new topographic design surface. Update to Materials layer, to driveway and hardstand. Addition of topographic adjustments representing changes to kerbs.
Block Q	Dismantling the Sodium hypochlorite loading bay on Block L and relocating to/assembly on Block Q.	Addition of building tower structure representing the flow constrictions of the hypochlorite structure.
Block L	Earthworks on Block L to remove existing surface material, level the block, excavate building footings and install services	Implementation of new topographic design surface.
Block L	Paving external hardstand areas and pouring the reinforced concrete building floor.	Update to Materials layer, to driveway and hardstand.
Block L	Erection of the steel girt frame and portal frame roof. Cladding of external walls and installation of roof sheeting. Installation of internal componentry.	Addition of Building structure representing the flow constrictions.
Block L	Kerb/ Bund requirements to mitigate flooding impacts to habitable floor levels.	Addition of topographic adjustments representing changes to kerbs or bund structures (flood proof walls).

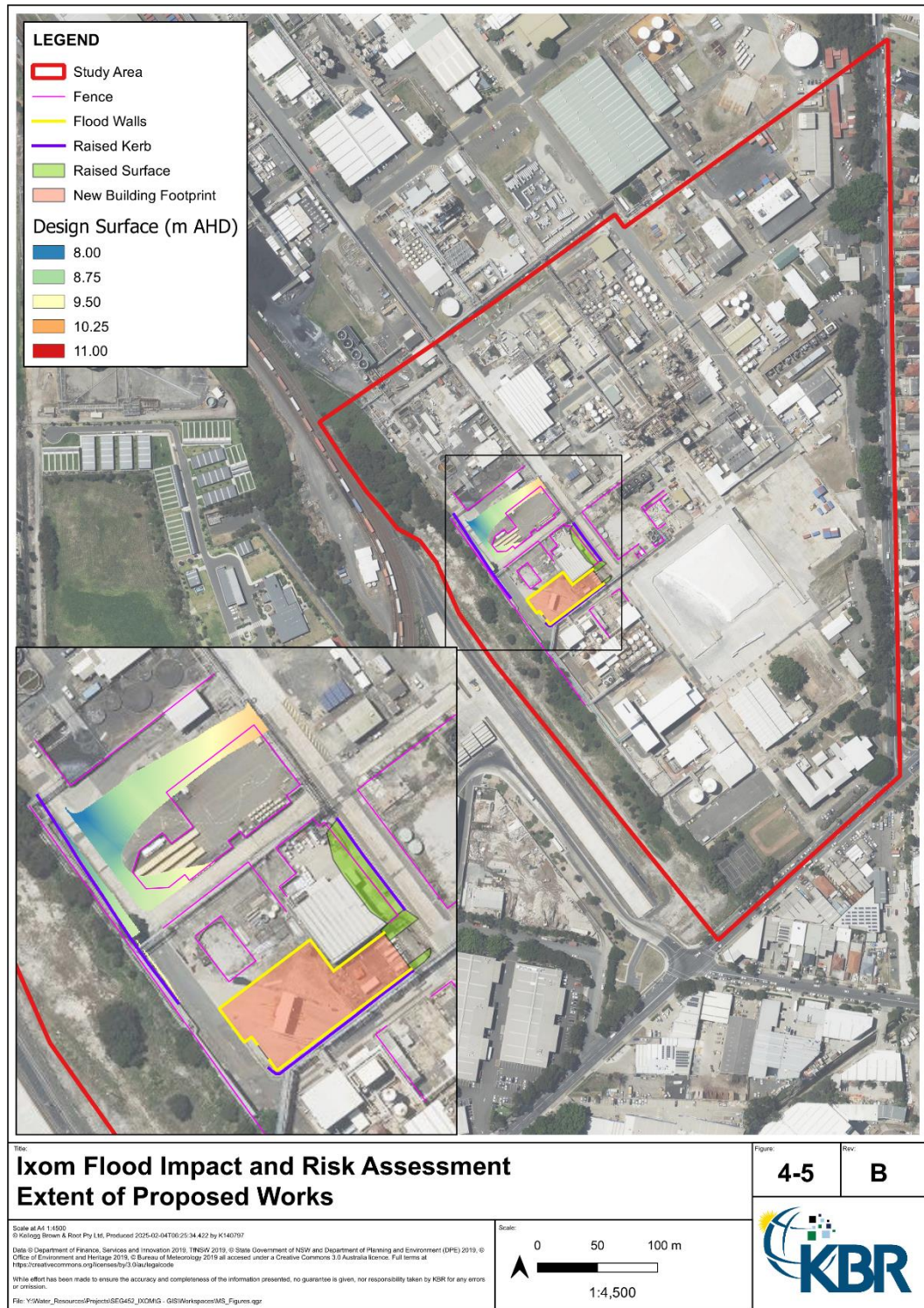


Figure 4-5 Proposed Works Extent

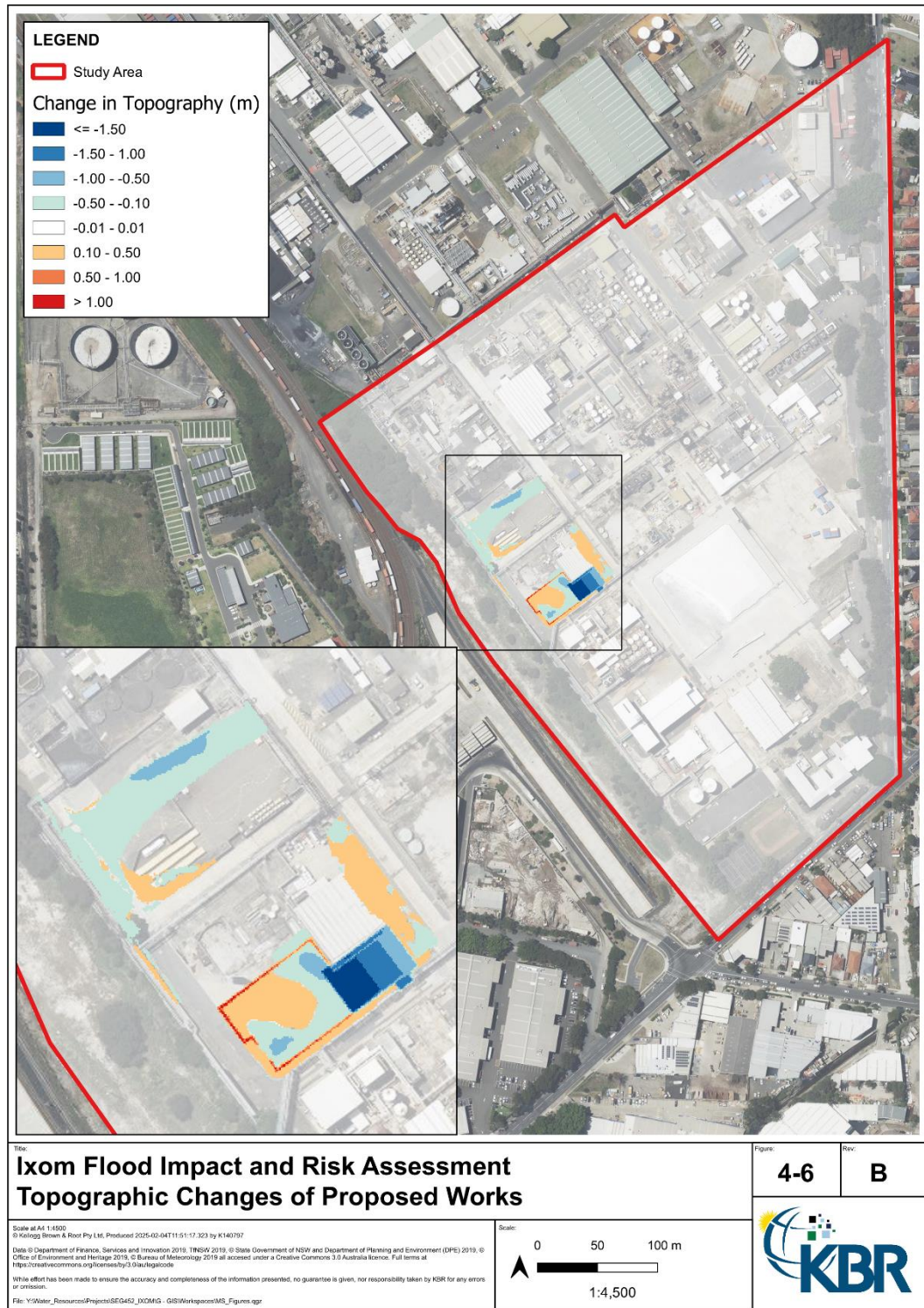


Figure 4-6 Proposed Works Topographic Changes

4.5 CLIMATE CHANGE

In accordance with the Bayside Council DCP 2022, climate change impacts were modelled to manage the risk of future climate change on the development proposal. The following scenarios are required in the BDCP:

- ☐ Scenario 1: Impacts of sea level rise in year 2050 and 2100.
- ☐ Scenario 2: Impacts of sea level rise combined with increased rainfall intensity in year 2050 and 2100.

As the outlet of the study area is significantly above the effects of tidal influence, the impacts of sea level rise have not been included in this assessment. Scenario 1 therefore has not been conducted and Scenario 2 has been implemented with only the rainfall increases to year 2050 and 2100.

The Scenario 2 increases in rainfall to 2050 and 2100 have had increases in initial loss and continuing loss applied according to ARR 4.2. The updated rainfall pathway used are the suggested medium ARR SSP 3-7.0 pathway. The rainfall and loss increase factors are presented in Table 4-9.

Table 4-9 Climate Change SSP Pathway Factors

Event Horizon	ARR SSP 3-7.0 Pathway Climate Change increase factors (for critical duration < 1.0 hour)		
	Rainfall Factor	Initial Loss Factor	Continuing Loss Factor
2050	1.29	1.04	1.07
2100	1.66	1.07	1.14

5 Model Validation

To validate the modelling undertaken for this works, the simulated results have been compared to those presented within the Springvale Drain and Floodvale Drain Flood Study. The intent of this exercise was to confirm if the modelled flood extents and levels converged with those extracted from the Flood Study as part of the Bayside Council Flood Advice Letter within a reasonable tolerance.

The key differences between the model developed for the purposes of this study and the Flood Study model have been identified:

- ☐ Updated Topography data in the region (2007/2008 vs 2020 LiDAR)
- ☐ Updates to Australian Rainfall and Runoff (ARR) methodologies
- ☐ Updates to Intensity-Frequency-Duration (IFD) Curves (Pilgrim (2001) – BOM (2016))
- ☐ Improved Software capabilities, Primarily the ability to use smaller cell sizes in TUFLOW, Increasing accuracy of Topography.
- ☐ Focal interest of the flood study was not the area of investigation of this piece of works.

In order to provide a like-for-like assessment and a fair comparison, the validation model was updated to utilise the Flood Study design rainfall depths and selected critical durations for the area of interest. It is noted that the design rainfall depth and critical durations derived in the flood study consist of:

- ☐ 1% AEP critical durations and the total rainfall depth for the area of interest are presented in Table 5-1. Critical duration maps from the flood study depicted critical duration events for the area of interest between 1 hour and 4.5-hour duration events.

Table 5-1 Flood Study Design Rainfall Intensities

Duration (Hours)	Design IFD (mm)
1.00	95
1.50	112.5
2.00	124
3.00	141
4.5	157.5

PMP critical durations and total rainfall depth for the area of interest consisted of 15 minutes to 3-hour duration events with no mapping in the area of interest. The total rainfall depths per duration are presented in

- ☐ Table 5-2.

Table 5-2 Flood Study PMP Design Rainfall Intensities

Duration (Hours)	PMP IFD (mm)
0.25	150.00
0.50	230.00
0.75	290.25
1.00	330.00
1.50	430.50
2.00	500.00
3.00	600.00

The peak flood depth, hazard, and flood function mapping as well as peak flood levels in table format from the flood study were provided within the flood advice letter from Bayside Council. The flood information points for comparison are outlined in Figure 5-1.

The corresponding Flood Study peak flood levels and simulated peak flood levels from the validation model are presented in Table 5-3 .

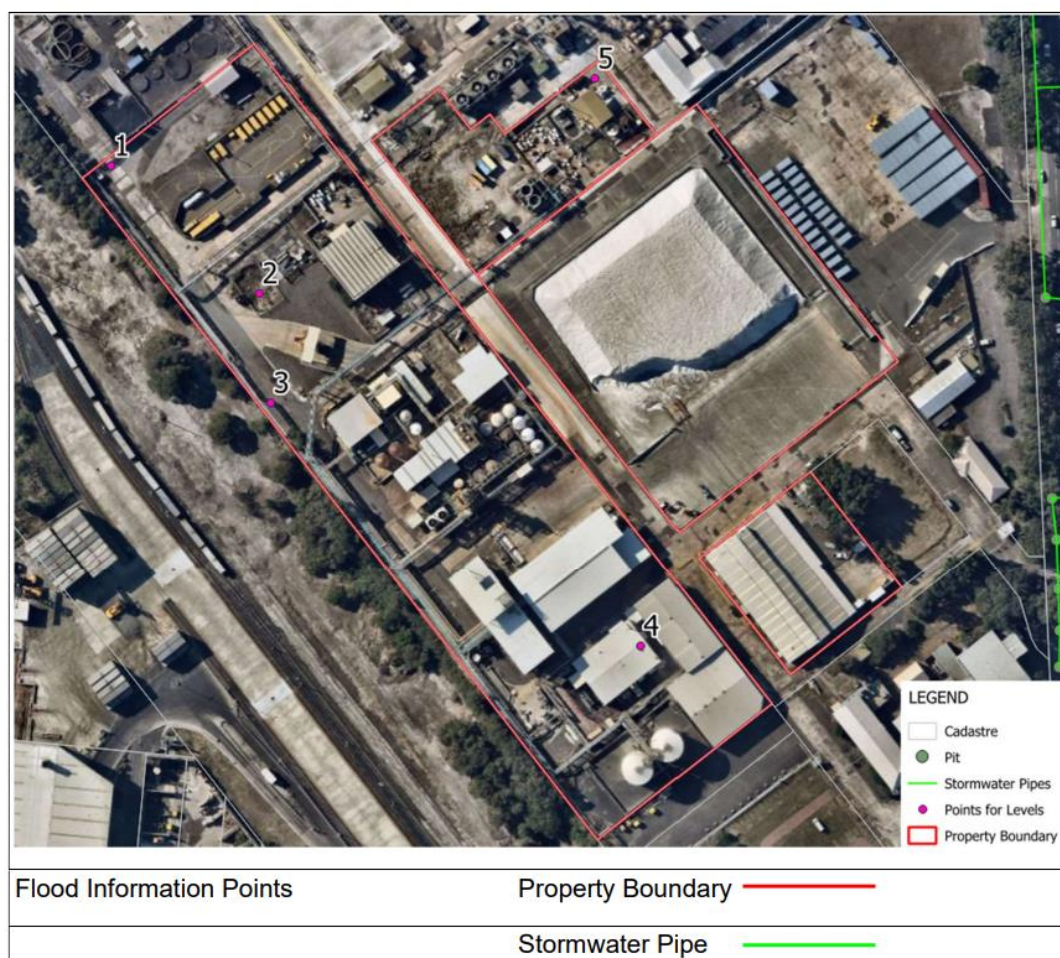


Figure 5-1 Flood Advice Letter, Flood Information Points (Bayside Council, 2024)

Table 5-3 Flood Information Points Comparison of Flood Study and Modelled Peak Flood Levels

Flood Information Point	1% AEP			PMF		
	Peak Flood Level (m AHD)		Modelled – Flood Study Peak Flood Level Difference (m)	Peak Flood Level (m AHD)		Modelled – Flood Study Peak Flood Level Difference (m)
	Flood Study	Modelled		Flood Study	Modelled	
1	8.07	8.09	0.02	8.16	8.12	-0.04
2	9.97	10.09	+0.12	10.26	10.22	-0.04
3	10.32	10.32	0.00	10.38	10.39	+0.01
4	12.66	12.68	+0.02	12.69	12.71	+0.02
5	12.86	12.87	+0.01	12.88	12.88	+0.00

At the four points of comparison within overland flow regimes (points 1, 3, 4, 5) the peak flood level differences are within 0.04 m across both the 1% AEP event and the PMF event. When the inputs adopted within the Flood Study are replicated, it can be concluded that the model developed for the

purposes of this study are sufficiently representative of the existing flood behaviour in and around the site.

A comparison of flood modelling extents between the Flood Study and the validation model is further presented in Figure 5-2 and Figure 5-3. It should be noted that the modelled results have had a cutoff depth of 0.05 m applied to the results to remove nuisance flooding and to provide a comparative data set, noting that the flood study did not report on cutoff depths applied to the results. It can be seen that the new topography and reduced cell size in the updated modelling provides significantly improved representation of flow paths along roads, while matching peak flood depths at key elements (e.g. the basin on Block L, and major flows along 1st Street). The differences in flood extent noted along the eastern portion of the study area are attributed to the difference in model domain, where the Flood Study model ends along the eastern edge of the salt mound.

The model developed for the purposes of this study have been extended further south east and west of the study area to ensure no upper catchment flow was missed and to incorporate additional stormwater drainage elements at the outset of the project.

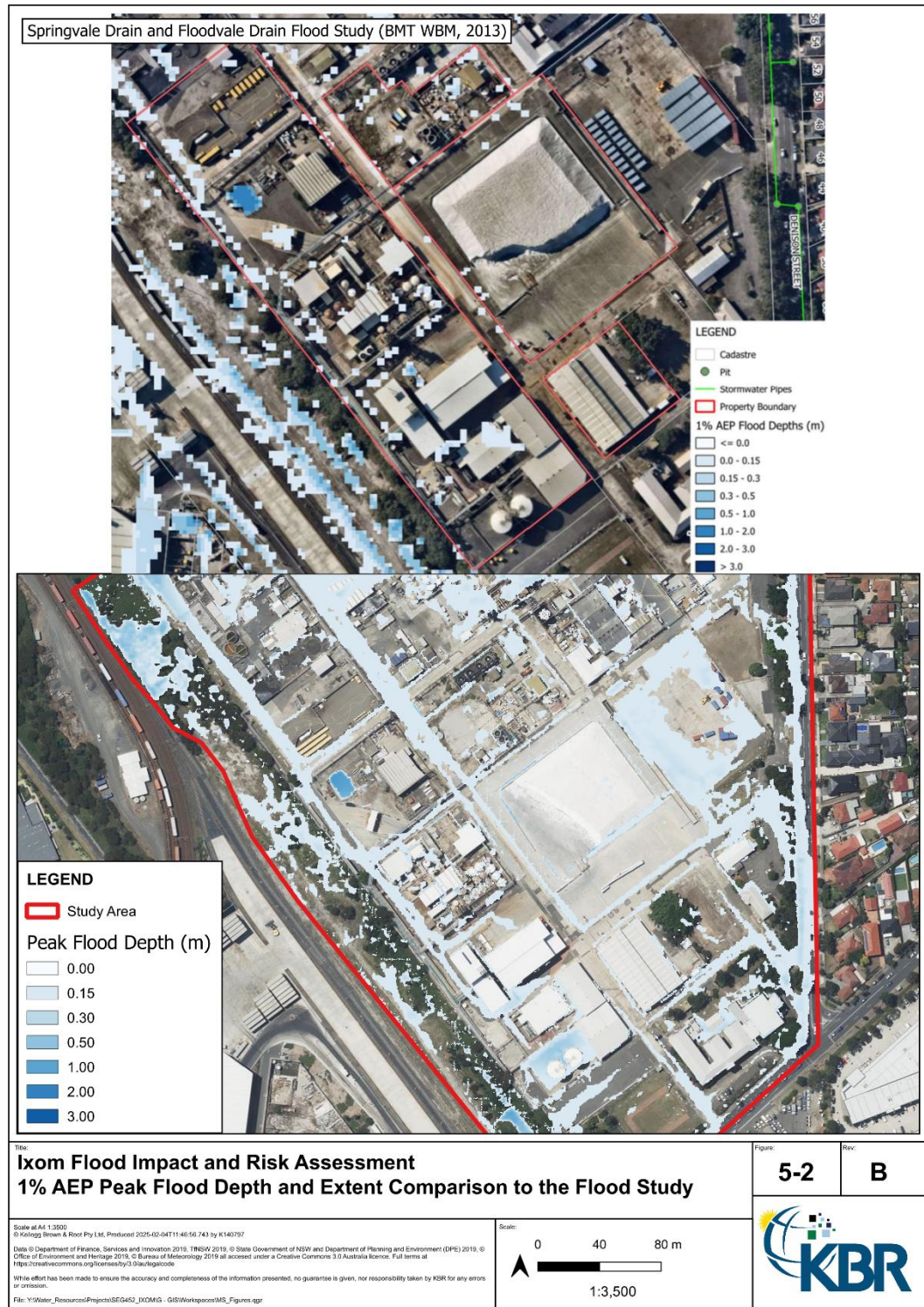


Figure 5-2 1% AEP Peak Flood Depth and Extent Comparison to the Flood Study

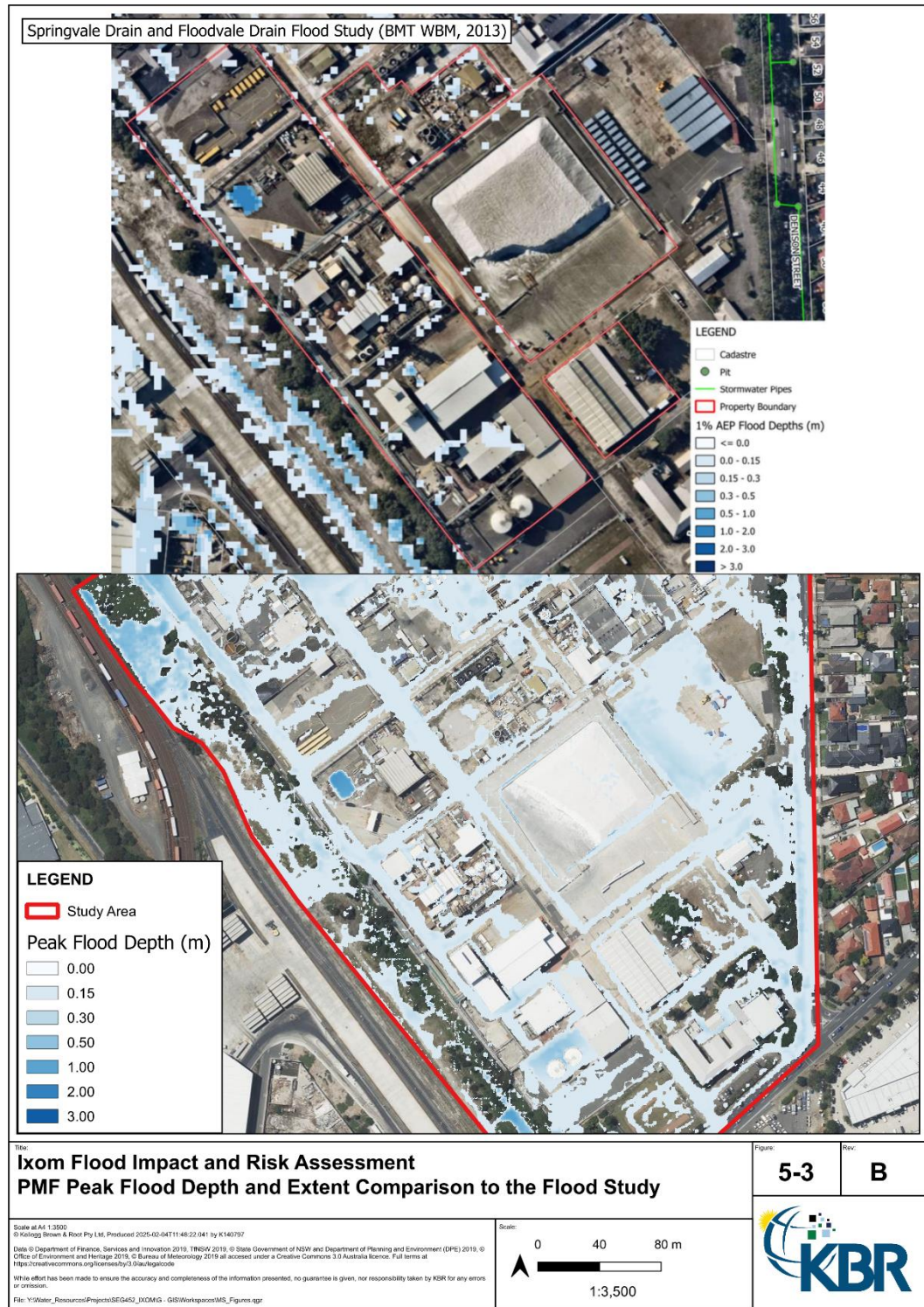


Figure 5-3 PMF Peak Flood Depth and Extent Comparison to the Flood Study

6 Results

6.1 PRE-DEVELOPMENT SCENARIO RESULTS

The pre-development scenario was simulated using the validated model in conjunction with the updated ARR 4.2 rainfall methodology including the use of the 2016 BOM IFD's scaled to 2024 and the corresponding Initial Loss and Continuing Loss. The critical durations determined for the area of interest as determined in Section 4.3.9 have been utilised.

The determined 20-minute critical duration for the 1% AEP Event is a significantly shorter duration event than the flood study (1-hour critical duration) however the difference in temporal patterns and IFD's favouring shorter durations and a scaling bias to shorter durations in the new ARR 4.2 climate change update induce shorter critical durations.

The updated hydraulic model was used to determine the flood extent, flood contour, flood depth, flood hazard (H1-H6), and velocity across the study area for the 1% AEP design event as well as the PMF event. The results indicate that the majority of the flows are contained to the roadways in the events until the PMF, in which an additional flow path is developed across Block Q.

Where flood waters in the 1% AEP event are located on Block Q and L, they are categorised with a hazard of H1, except for water located in the Basin on Block L with depth driven hazards of H2 and H3. The PMF hazard categorisation follows a similar distribution with inundation on Blocks L and Q maintained to hazard categorisation H1, except for depths located in the basin in Block L where the hazard increases up to H4. The PMF event however does have high hazard risks, up to H5, on some of the surrounding roads including 1st Street and 2nd Street.

The 1% AEP event peak flood depths can be seen in Figure 6-1 with the complete set of pre-development results included in Appendix A.

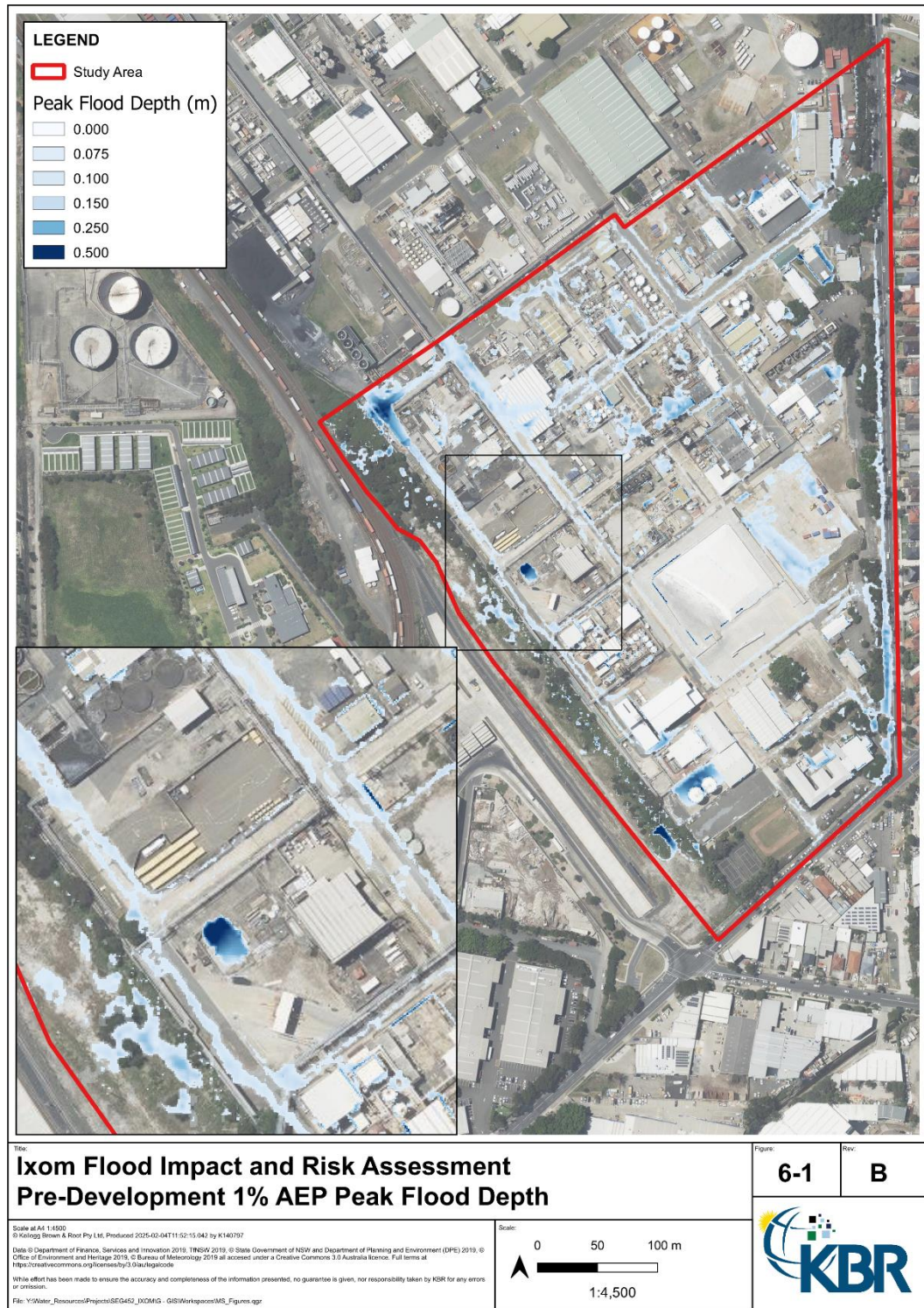


Figure 6-1 Pre-Development 1% AEP Peak Flood Depth

6.2 POST-DEVELOPMENT SCENARIO RESULTS

The post-development scenario hydraulic results operate similar to the pre-development scenario with a majority of flows contained to roadways and the only area on Block Q and L with a hazard of H2 and H3 located in the Basin in the 1% AEP. There is relocation of flow paths on roads at the corners of 4th and 5th avenue with 1st street due to changes in kerb and roadway profiles.

The changes in the PMF event are similar to the 1% AEP events in the road corridors however in the pre-development scenarios the PMF breaks out and forms flow paths across both Blocks. In the post-development scenario, there is significant differences to these cross-block flows. In Block L the cross-block flow is blocked by implementing a flood proof wall acting as a bund along the edge of 4th Avenue mitigating overtopping. The change in road profile and elevation across Block Q changes the location of the cross-block flow and forces it to run along the southside of the new road surface.

The PMF hazard distribution remains mostly unchanged in comparison to the pre-development scenario except for changes in roadway hazard location where new roadway surfaces and kerbs are implemented. The changes in PMF hazard do not induce any changes from hazard categories H5 to H6.

The 1% AEP peak flood depth can be seen in Figure 6-2 with the complete post-development results can be seen in Appendix A.

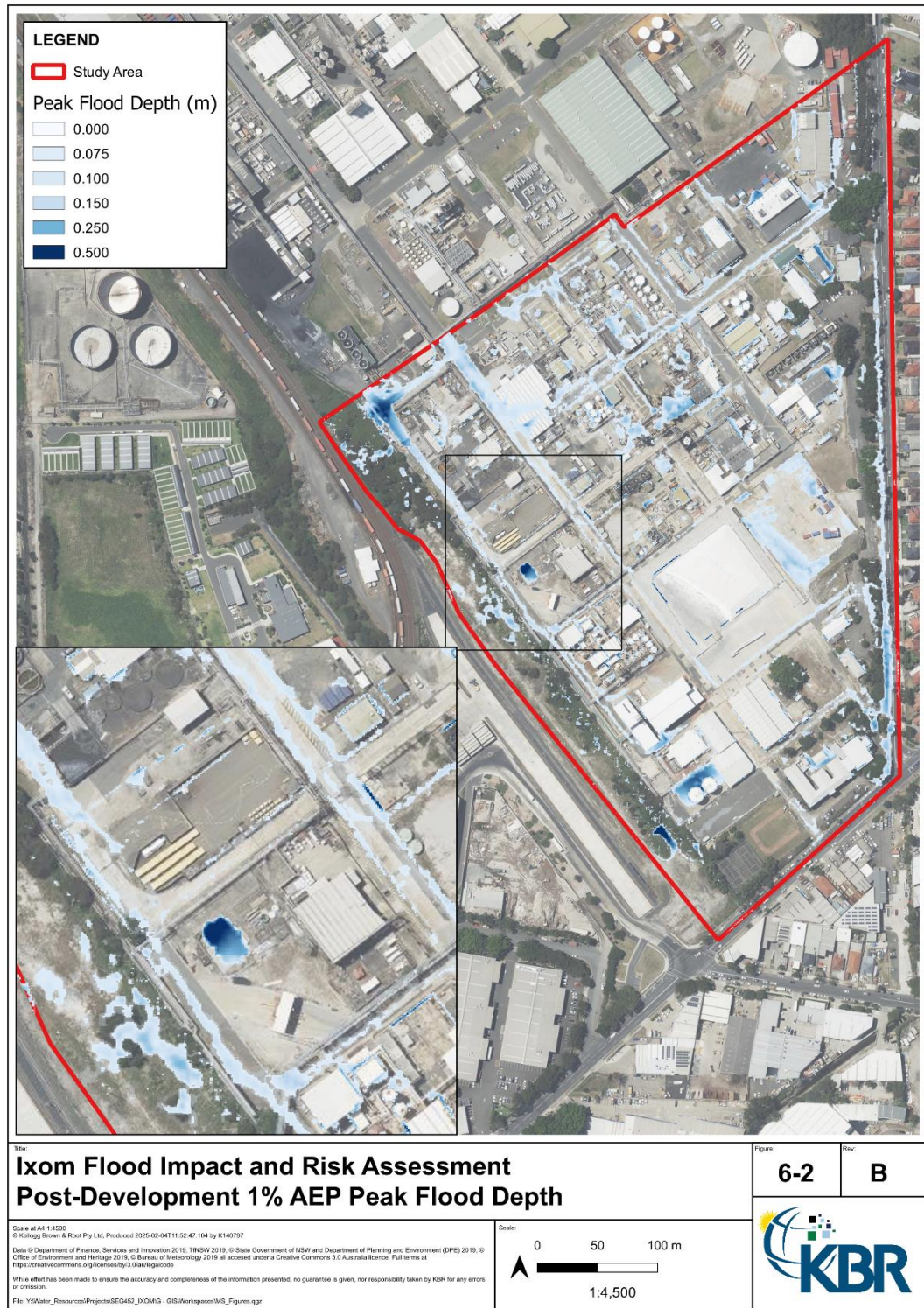


Figure 6-2 Post-Development 1% AEP Peak Flood Depth

6.3 COMPLIANCE WITH DCP FLOOD IMPACT ASSESSMENT REQUIREMENTS: DESIGN EVENTS

The flood impact assessment corresponds to BDCP 2022 flood planning prescriptive control D1:

- ☐ does not divert floodwaters to the detriment of elsewhere on the floodplain.
- ☐ does not increase flood level or velocity elsewhere on the floodplain.
- ☐ does not result in a detrimental loss of flood storage.
- ☐ reduces the existing flood hazard, where possible.

These are implemented with specific criteria in the DCP in section 9.5.4 with the below requirements:

- ☐ Less than or equal to 10mm on surrounding properties in the 1% AEP event.
- ☐ Less than or equal to 50mm on surrounding properties in the PMF event.
- ☐ Hazard shall not be increases for any development for all Design events up to the PMF.

The peak flood level difference maps between post-development and pre-development conditions can be seen in Figure 6-3 and Figure 6-4, depicting changes in peak flood levels being contained to the site and surrounding roadways. Impacts can be seen at the intersections of 4th Avenue with 1st and 2nd Street where the implemented design restricts cross-block flows and channelises the flow on the road. Additionally, impacts are seen along 1st Street between 6th and 5th Avenue where redesign of the road surface and surrounding kerbs induces repositioning of flow paths.

The 1% AEP event flood impacts are limited to Blocks L and Q and the surrounding roadways. The post-development design does not induce peak flood level differences greater than 10 mm elsewhere on the floodplain. The PMF event peak flood level differences are compliant to the DCP's 50 mm peak flood level difference requirements on all adjacent lots.

The hazard category values are maintained in the 1% AEP event, with the basin on Block L maintaining a peak hazard category of H3 and the roadway at the northwestern region of the model maintaining its hazard category of H4. This is in compliance with the BDCP.

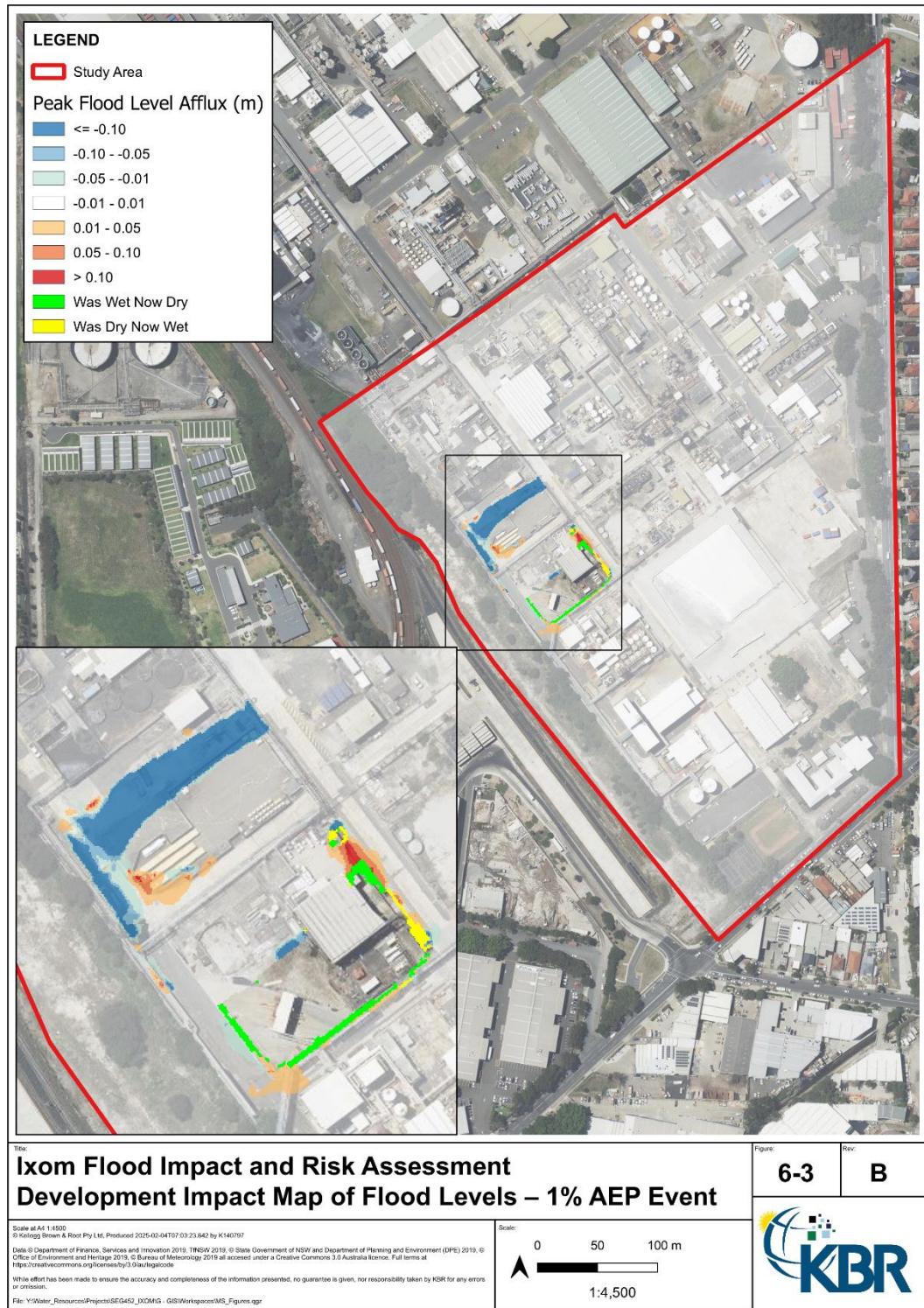


Figure 6-3 Development Peak Flood Level Difference Mapping – 1% AEP Event

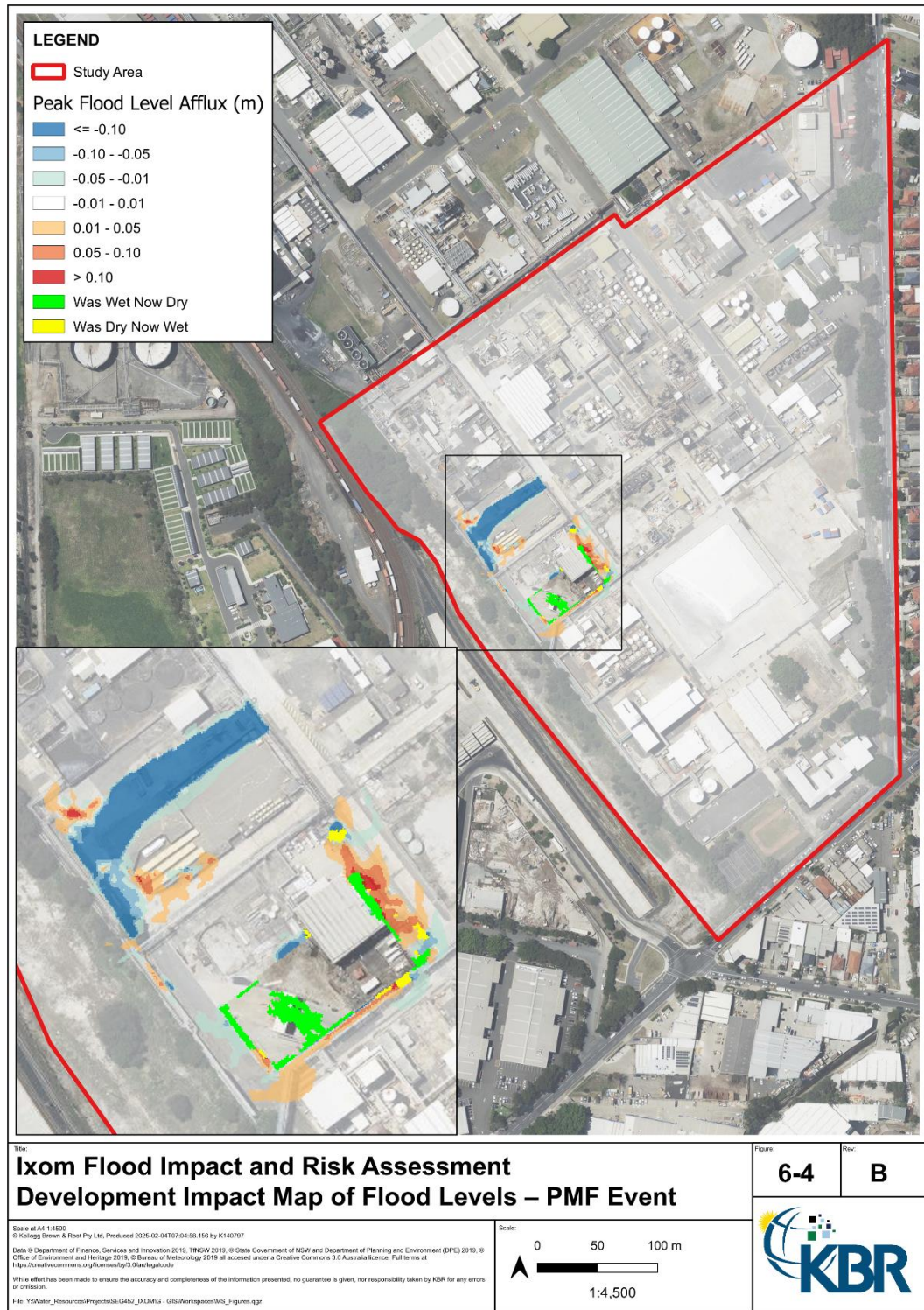


Figure 6-4 Development Peak Flood Level Difference Mapping – PMF Event

6.4 CLIMATE CHANGE

The climate change considerations include increases in rainfall intensity and losses for the 2050 and 2100 year horizons in accordance with ARR 4.2 guidance. The impacts of sea level rise were not implemented as discussed in Section 4.5

The 2050 and 2100 1% AEP events are compliant, with surrounding properties experiencing less than or equal to 10 mm peak flood level differences when compared to baseline conditions.

A review of the new climate change rainfall increases in comparison to the increases supported by ARR 2019 at the time of DCP development was undertaken. The interim climate change factors supported by ARR when the DCP was developed had a maximum increase in total rainfall depth for the 2090 horizon (Highest pathway: RCP 8.5) of 18.6 %. The SSP climate change pathways suggested by ARR 4.2 in 2024 now have the 2100 horizon suggested moderate pathway having a 66% rainfall increase for an event duration shorter than one hour. The 2050 horizon for the same suggested moderate pathway has a rainfall increase of 29% and an initial and continuing loss increase of 4% and 7% respectively.

Therefore, compliance has been achieved for the 2050 and 2100 1% AEP events with the noted rainfall increases suggested through ARR in comparison to the time of the DCP issuance.

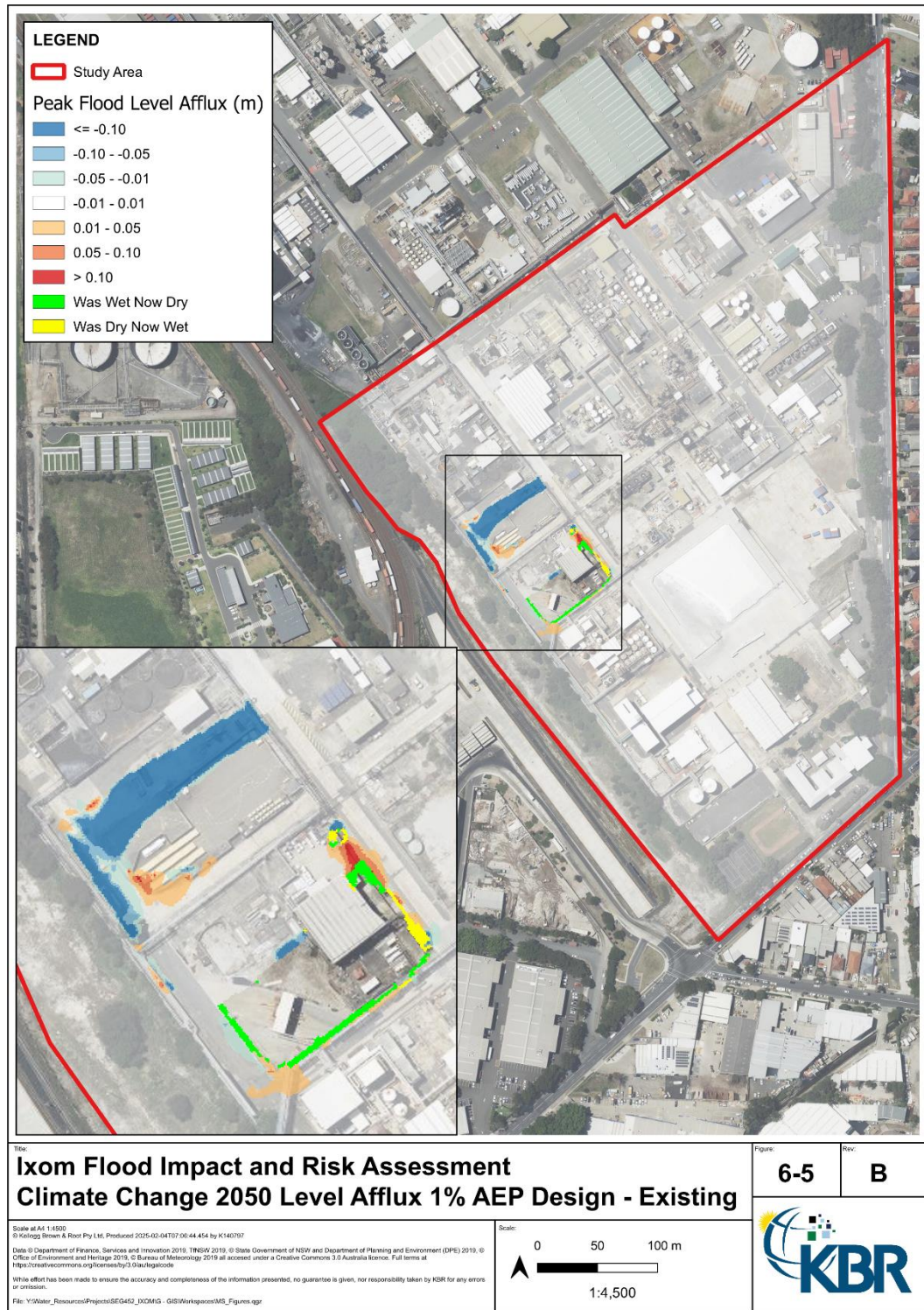


Figure 6-5 Development Peak Flood Level Difference Mapping – Climate Change 2050 1% AEP Event

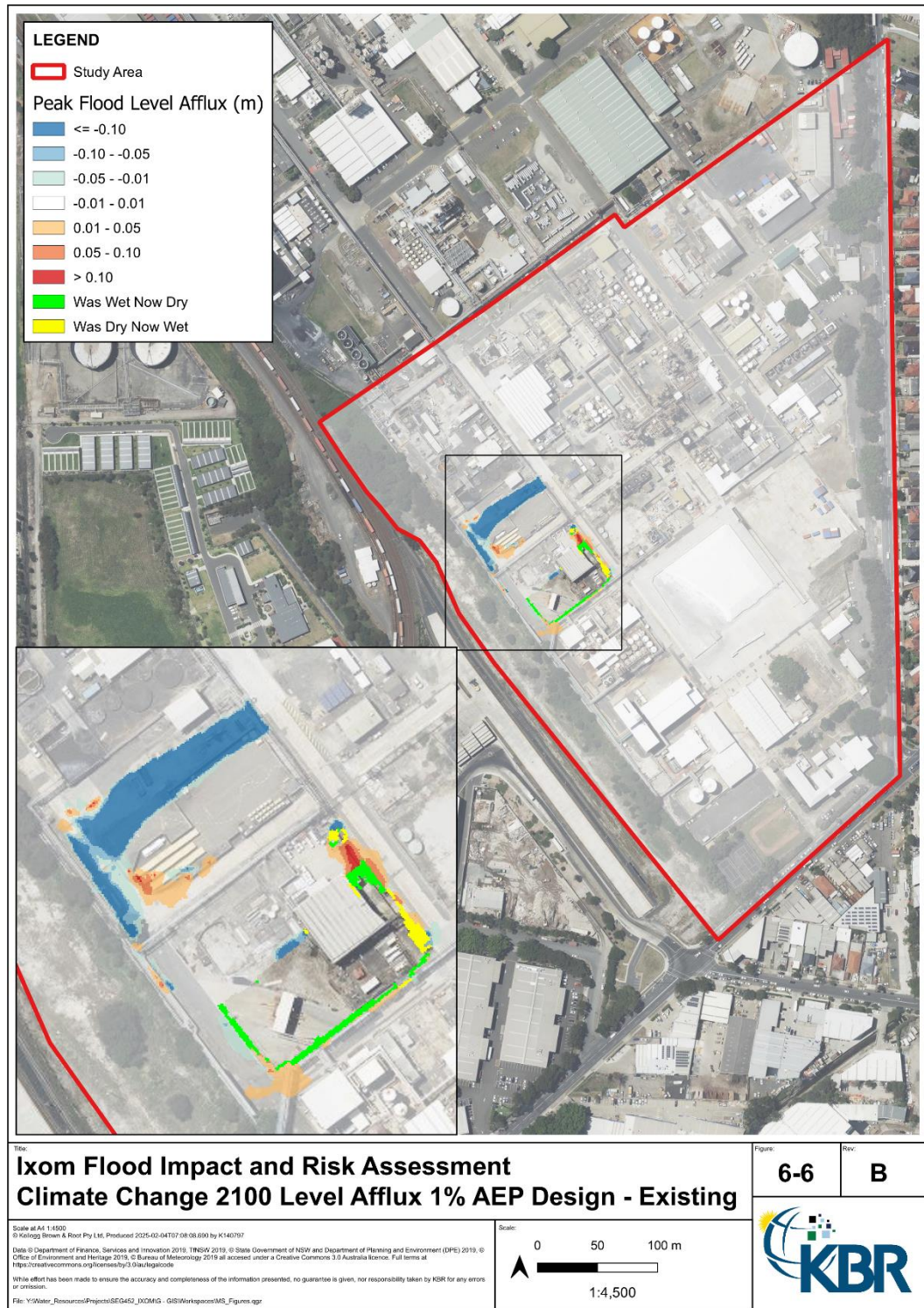


Figure 6-6 Development Peak Flood Level Difference Mapping – Climate Change 2100 1% AEP Event

6.5 COMPLIANCE TO BDCP 2022 FLOOD PLANNING PRESCRIPTIVE CONTROLS

Prescriptive planning controls are required for the development according to the BDCP as the site is an industrial use facility and is located within the extent of the 1% AEP event plus 0.5 m freeboard and within the extent of the PMF event. The prescriptive planning controls outlined in the BDCP for this development are outlined in Table 6-1.

Three changes to planning considerations, the inclusion of G1 and change of controls B1 and C1 to B2 and C2, were required due to the flood advice letter classification of high hazard prescriptive controls for the development. The high hazard classification was induced by the basin on Block L with a flood hazard category up to H4. The outcomes of the design in compliance with the planning controls are further outlined in the third column of Table 6-1.

Table 6-1 Planning Considerations – BDCP 2022 Prescriptive Planning Controls

Planning Consideration	Prescriptive Planning Control	Development Outcome
Floor Level	A2: Habitable floor level shall be no lower than the 1% AEP flood level plus 0.5 m freeboard.	Compliant: N/A. No habitable floor area.
Floor Level	A3: Non-habitable floor levels to be no lower than 1% AEP flood level.	Non-Compliant: Non-habitable floor level for industrial use is below the 1% AEP flood level. However, a bund has been implemented around the building footprint such as to mitigate all flood events including the PMF.
Building Components & Method	B2: All structures to have flood compatible building components below the PMF level.	Compliant: To design flood compatible building components below the PMF Level.
Building Components & Method	B3: Flow-through open form fencing (louvres or pool fencing) is required for all new fencing and all new gates up to the 1% AEP flood level to allow floodwaters to flow through.	Compliant: N/A. No Additional Blockage from fencing.
Building Components & Method	B4: All new electrical equipment, power points, wiring, fuel lines, sewerage systems or any other service pipes and connections must be waterproofed and/or located above the 1% AEP flood level plus 0.5m freeboard. All existing electrical equipment and power points located below the 1% AEP flood level plus 0.5m freeboard within the subject structure must have residual current devices installed that turn off all electricity supply to the property when floodwaters are detected.	Compliant: All new electrical will be designed above 1% AEP flood level plus 0.5m freeboard.
Structural Soundness	C2: An engineer's report shall be provided to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to the PMF Level.	Compliant: Zero flow in the PMF against the structure. An Engineer's report shall be developed to comply with the requirements of C2.
Flood Effects Caused by Development	D1: The development must not result in increased flooding elsewhere in the floodplain. A flood assessment report (refer to Schedules – Chapter 9.5.4) shall be provided to demonstrate that the development:	Compliant: For assessment for impact of development on the surrounding floodplain refer to section 6.3 and 6.4.

Planning Consideration	Prescriptive Planning Control	Development Outcome
	• ☐ does not divert floodwaters to the detriment of elsewhere on the floodplain. • ☐ does not increase flood level or velocity elsewhere on the floodplain. • ☐ does not result in a detrimental loss of flood storage. • ☐ reduces the existing flood hazard, where possible. A flood impact assessment for a site is not required where the flood storage and floodway capacity are retained. For example, a building can be elevated to retain the existing floodway and flood storage to permit the free flow of water under the building.	• ☐ Diversion of floodwaters was minimised where possible, maintaining flow paths. • ☐ Flood level increase in adjacent rail corridor less than required levels for the BDCP in the 1% AEP, PMF and climate change events. • ☐ No reduction in Flood storage, only region designated as flood storage in the flood study in the area of interest is the Basin located on Block L. • ☐ Existing flood hazard was not increased in the Area of Interest.
Car Parking and Driveway Access	E1: The minimum finished floor level of open car parking spaces or carports shall be at or above natural ground level. A flow-through roller door (or horizontal louvers) is permitted for a carport structure. Carports must be of open design, with at least 2 sides completely open such that flow is not obstructed up to the 1% AEP flood level. Otherwise, it will be considered to be enclosed. Open car parking areas shall not be located within a floodway.	Compliant: N/A. No Car parking spaces of carports.
Car Parking and Driveway Access	E2: For above ground level garages, the minimum surface level shall be no lower than the 1% AEP flood level.	Compliant: N/A. No above ground level garages.
Car Parking and Driveway Access	E3: Basement garages/storage/car parking, low-level driveways must be physically protected from inundation by floods equal to or greater than the 1% AEP flood level plus 0.5m freeboard. The crest of the driveway shall be located within the property boundary. All access, ventilation, driveway crests and any other potential water entry points to any enclosed car parking shall be above the 1% AEP flood level plus 0.5m freeboard level. Council will not accept any options that rely on the electrical, mechanical or manual exclusion of the floodwaters from entering the enclosed carpark for new development. Flood barriers may be accepted for an existing development to improve flood protection.	Non-Compliant: The driveway is not higher than the 1% AEP event flood level plus 0.5m freeboard. However, all driveways are located within the property boundaries and are higher than the PMF flood levels
Emergency Response	F2: A qualified civil engineer shall be engaged to prepare an onsite emergency response flood plan is required to detail whether evacuation procedures are required and if so, how they will be initiated, warning signs and preservation of flood awareness as owners and/or occupants change through time.	Compliant: A onsite emergency response flood plan will be prepared by a qualified civil engineer. There is ability for on-site shelter in place refuge area within the development above the PMF. There is existing

Planning Consideration	Prescriptive Planning Control	Development Outcome
	Adequate flood warning systems (such as water level sensors, and alarm stations), signage and exits shall be available to allow safe and orderly evacuation without increased reliance upon the SES or other authorised emergency services personnel. The evacuation plan shall be easily accessible to current and future occupants. If safe evacuation cannot be achieved within a sufficient response time, then a shelter-in-place refuge is required, together with a plan for self-sufficiency for up to 12 hours. This plan must consider as a minimum: sufficient area for all the occupants, adequate clean water for all occupants; portable radio with spare batteries; torch with spare batteries; first-aid kits; emergency power; and a practical means of medical evacuation. Note that in the event of a flood, occupants would be required to evacuate if ordered by Emergency Services personnel regardless of the availability of a shelter-in-place refuge.	shelter in place refuge in the wider site.
Management and Design	G1: If a site or part of the site is affected by a Flood Hazard Category of H5 and H6, buildings and structures can be exposed to significant structural damage with a high risk to life. Intensification of existing land use in the affected area is not permitted unless it can be demonstrated to the satisfaction of the consent authority that the risk level on the property is or can be reduced.	Compliant: No H5 and H6 within the block boundaries in the PMF.
Management and Design	G2: Storage of materials that may cause pollution or are potentially hazardous during any flood is not permitted below the 1% AEP plus 0.5m freeboard.	Compliant: Storage of Materials has been reviewed and maintained above the PMF level using a bund as no reliable basis of the 1% AEP level across the site existed to add 0.5 m freeboard. This procedure although non-compliant to 1% AEP plus 0.5m freeboard is compliant to the BDCP Table 10 methodology of placing hazardous substances within "within an area protected by bunds or levels such that no floodwaters can enter the bunded area." (BDCP, 2022).
Management and Design	G4: Where a building is elevated to retain the existing floodway, overland flow path and flood storage, the undercroft area is to remain open to permit the free flow of water under the building. A positive covenant is required.	Compliant: N/A.
Management and Design	G5: Pools located within the 1% AEP flood extent are to be in-ground, with coping flush with natural ground level. Where it is not	Compliant: N/A

Planning Consideration	Prescriptive Planning Control	Development Outcome
	possible to have pool coping flush with natural ground level, it must be demonstrated that the development will result in no net loss of flood storage and no impact on flood conveyance on or from the site. All electrical equipment associated with the pool (including pool pumps) is to be waterproofed and/or located at or above the 1% AEP plus 0.5m freeboard level. All chemicals associated with the pool are to be stored at or above the 1% AEP plus 0.5m freeboard level.	

Based on the intention of the proposed piece of development and the requirements of low gradient storage and loading areas, compliance with all elements of the prescriptive controls is not achievable. The prescriptive controls that provide challenges to the proposed development are:

- ☐ A3: Non-habitable floor levels to be no lower than 1% AEP event flood level.
- ☐ E3: Basement garages/storage/car parking, low-level driveways must be physically protected from inundation by floods equal to or greater than the 1% AEP event flood level plus 0.5 m freeboard.

A3 is unable to produce a compliant design as the site is located on a sloped plot with flows in the 1% AEP event conveyed through the surrounding roads. This requires the floor level to be elevated above the highest point of the surrounding 1% AEP event flood level, a design that does not allow for the floor slab and driveway slope requirements. As the surrounding flow regime is overland rather than riverine, the peak flood level difference between the 1% and the PMF is significantly less than a 500 mm freeboard. As such the design including elevation of driveway crests above the PMF and the use of floodproof walling (as a bund) mitigates all floodwaters from entering the building including the PMF event.

E3 is unable to produce a compliant design due to the same block characteristics as A3 as the site is not able to achieve driveway crest immunity to the 1% AEP event flood level plus 0.5 m freeboard. The crests of the driveways are located within the property boundary and provide immunity to the PMF event flood level such that no floodwaters can enter the area.

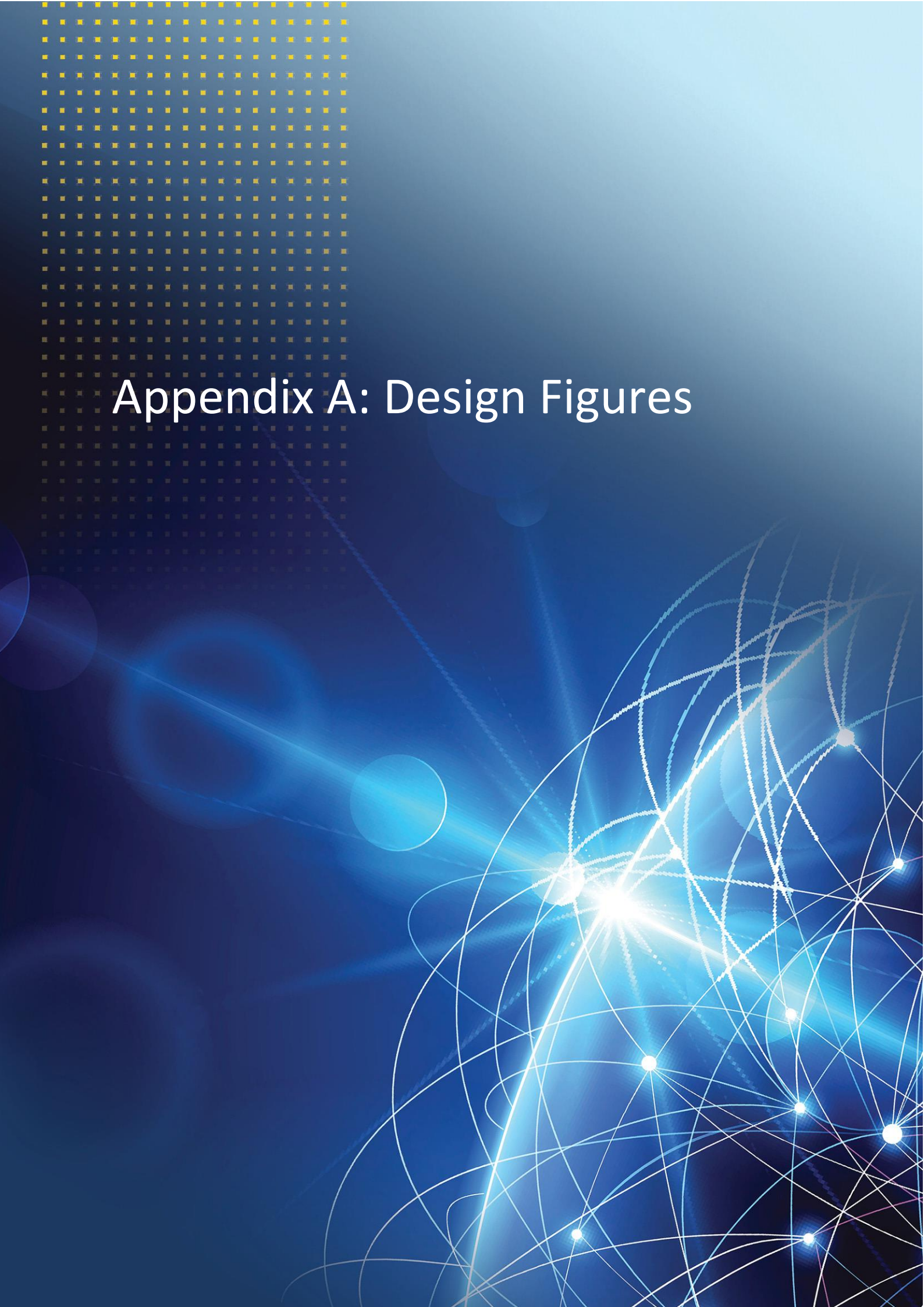
7 Conclusion

This assessment finds that overall, the proposed development complies with the requirements of the SEAR's and the BDCP 2022 with the exception of two clauses. The clauses that don't achieve compliance are A3 and E3. These compliance issues are directly related to flood level requirements that do not allow for the building requirements of low gradient loading areas, flat storage areas, and tie in with the surrounding roadways. Mitigation of the risks to the building floor level and ingress through the driveway crests has been conducted by providing immunity to the Probable Maximum Flood (PMF) peak flood levels. This has been conducted through floodproof walling (as a bund) and driveway crests elevated above the PMF level.

The intended purpose of Clause A3 is to provide immunity to the building up to the 1% AEP event through a set floor level elevation, this immunity has been achieved alternatively through flood proof walling and driveway crest elevations. Therefore, although the floor level is below the 1% AEP event it is flood free (compliant) to the 1% AEP event.

The intended purpose of Clause E3 is to provide immunity to floods equal to or greater than the 1% AEP flood level plus 0.5m freeboard. Due to the surrounding flow regime being overland flow, the use of a 1% AEP event plus 0.5 m freeboard is considerable higher than the largest event possible, the PMF. Therefore, immunity of the driveway crests has been achieved for the PMF, demonstrating compliance to the largest possible event.

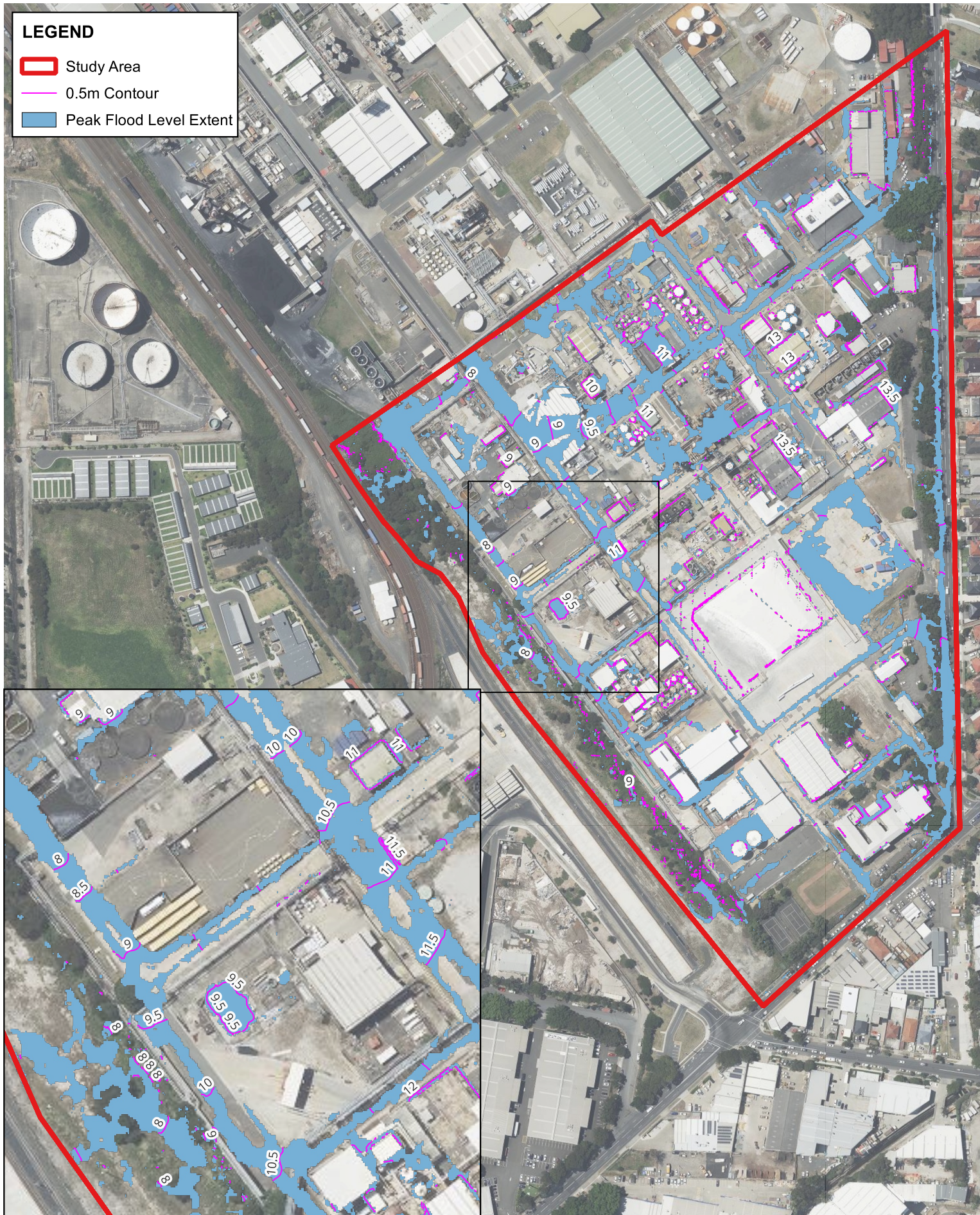
The remaining prescriptive planning controls have been achieved including mitigating impacts to the surrounding floodplain in both the design and climate change events.



Appendix A: Design Figures

LEGEND

- ▬ Study Area
- ▬ 0.5m Contour
- ▬ Peak Flood Level Extent



Title: Ixom Flood Impact and Risk Assessment 1% AEP Peak Flood Level Extent - Pre-Development

Figure: **A1**

Rev: **B**

Scale at A4 1:4500
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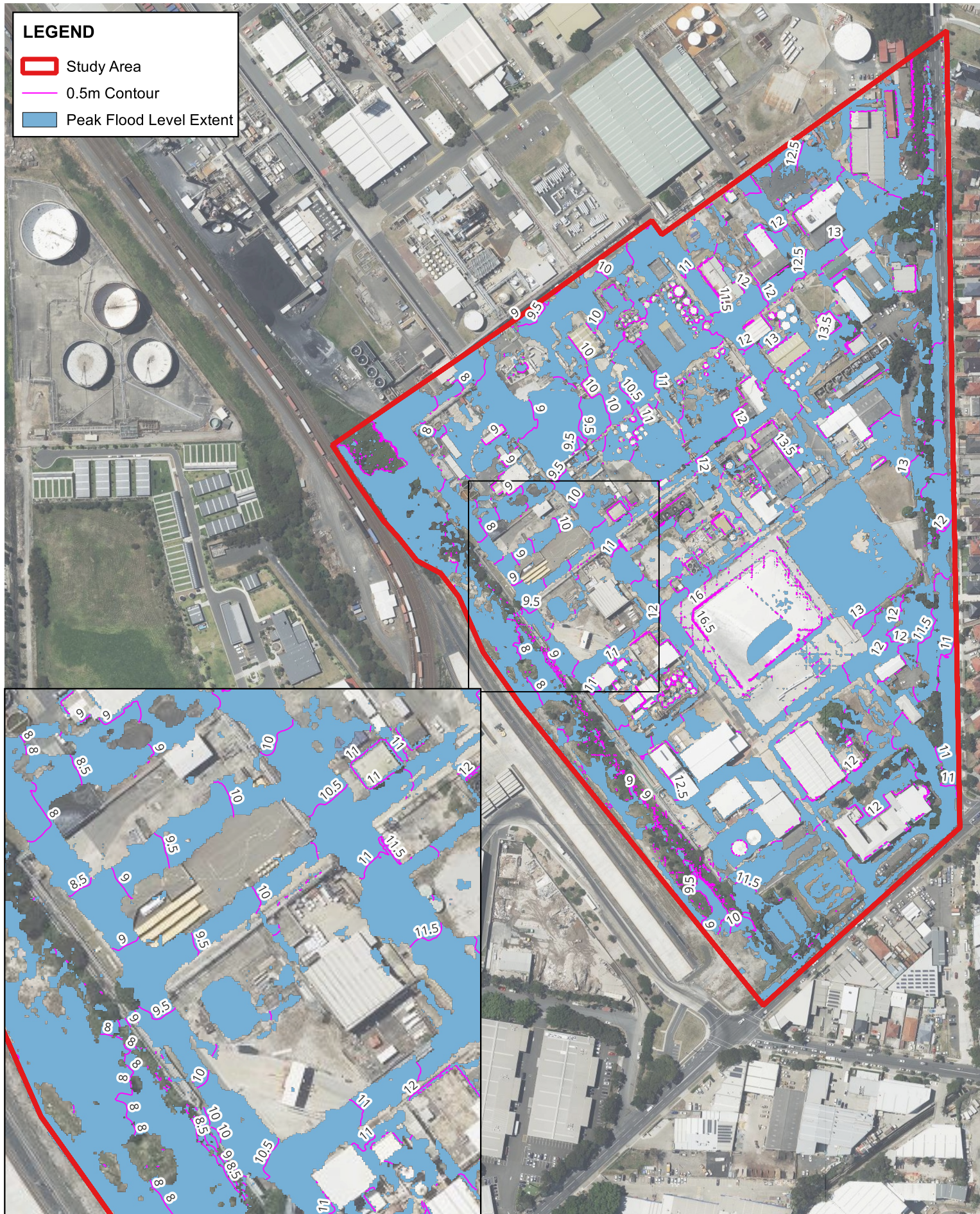
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1:4,500



LEGEND

- ▬ Study Area
- ▬ 0.5m Contour
- ▬ Peak Flood Level Extent



Title: Ixom Flood Impact and Risk Assessment PMF Peak Flood Level Extent - Pre-Development

Figure: A2	Rev: B
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Scale at A4 1:4500
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LEGEND

 Study Area

Peak Flood Depth (m)

 0.000

 0.075

 0.100

 0.150

 0.250

 0.500



Title: Ixom Flood Impact and Risk Assessment 1% AEP Peak Flood Depth - Pre-Development

Figure:
A3

Rev:
B

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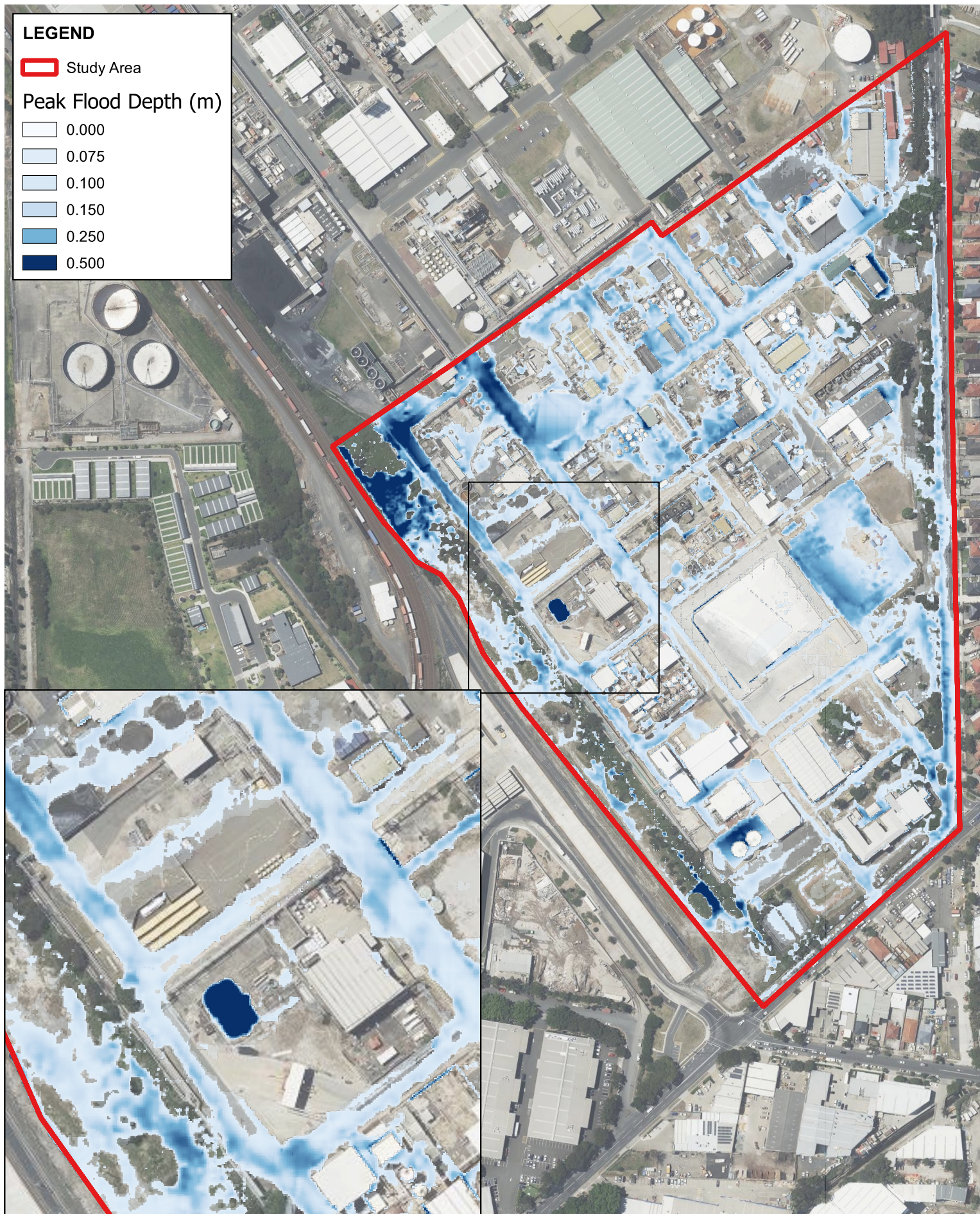


LEGEND

 Study Area

Peak Flood Depth (m)

-  0.000
-  0.075
-  0.100
-  0.150
-  0.250
-  0.500



Title: Ixom Flood Impact and Risk Assessment PMF Peak Flood Depth - Pre-Development

Figure:
A4

Rev:
B

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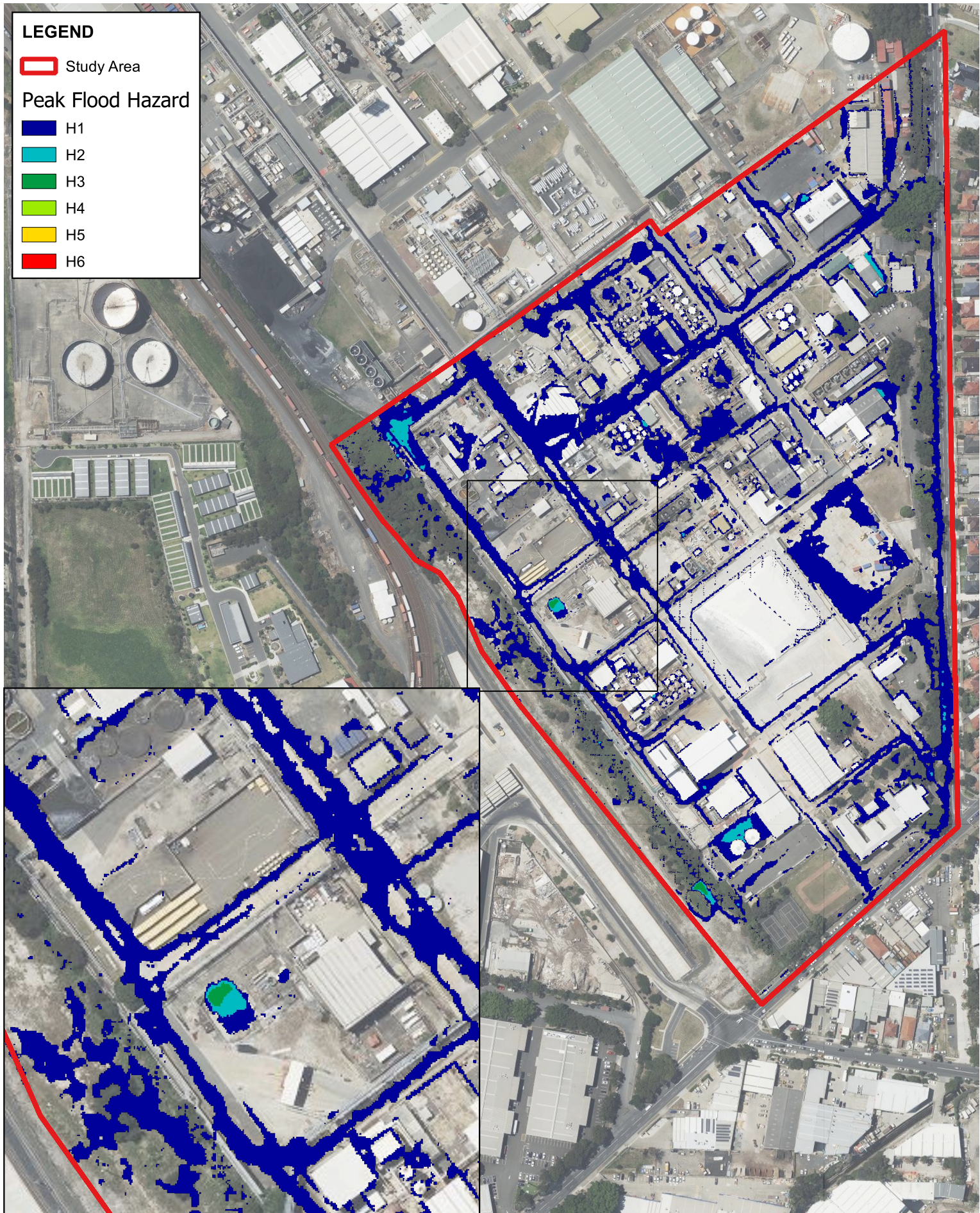


LEGEND

 Study Area

Peak Flood Hazard

-  H1
-  H2
-  H3
-  H4
-  H5
-  H6



Title: Ixom Flood Impact and Risk Assessment 1% AEP Peak Flood Hazard - Pre-Development

Figure:
A5

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B

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LEGEND

 Study Area

Peak Flood Hazard

 H1

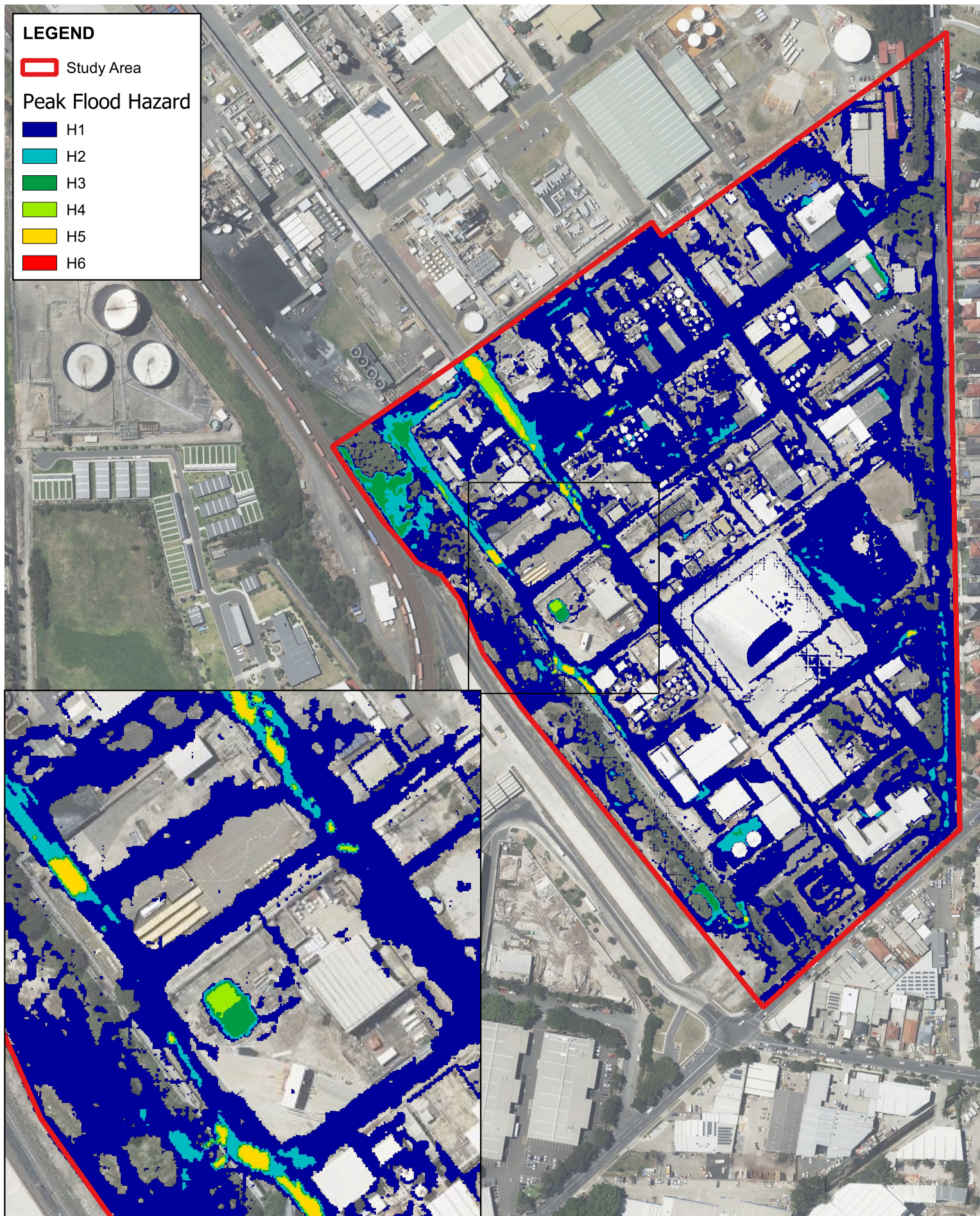
 H2

 H3

 H4

 H5

 H6



Title: Ixom Flood Impact and Risk Assessment PMF Peak Flood Hazard - Pre-Development

Figure: **A6**

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LEGEND

 Study Area

Peak Flood Velocity (m/s)

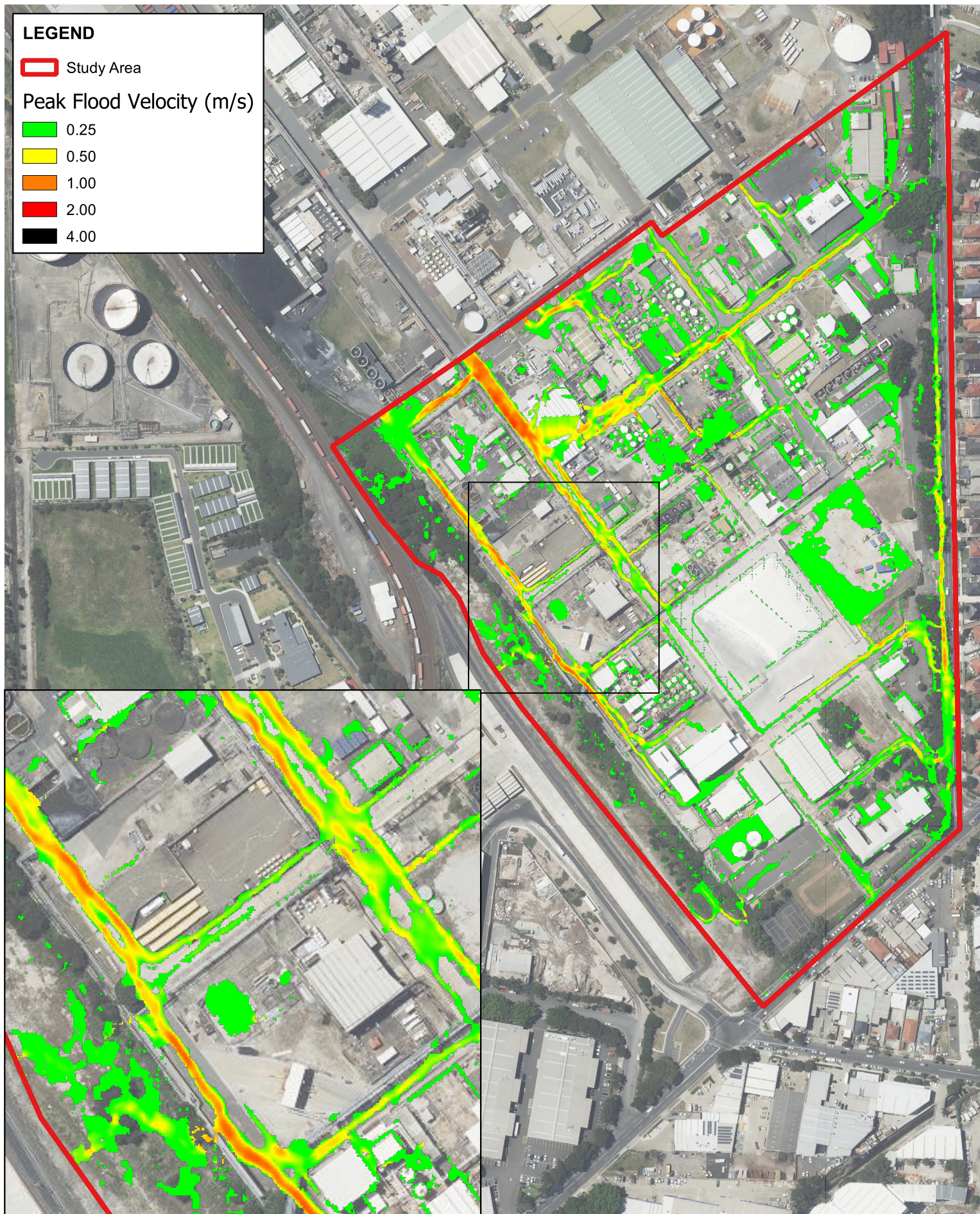
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 2.00

 4.00



Title: Ixom Flood Impact and Risk Assessment 1% AEP Peak Flood Velocity - Pre-Development

Figure:
A7

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B

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Scale:
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1:4,500



LEGEND

 Study Area

Peak Flood Velocity (m/s)

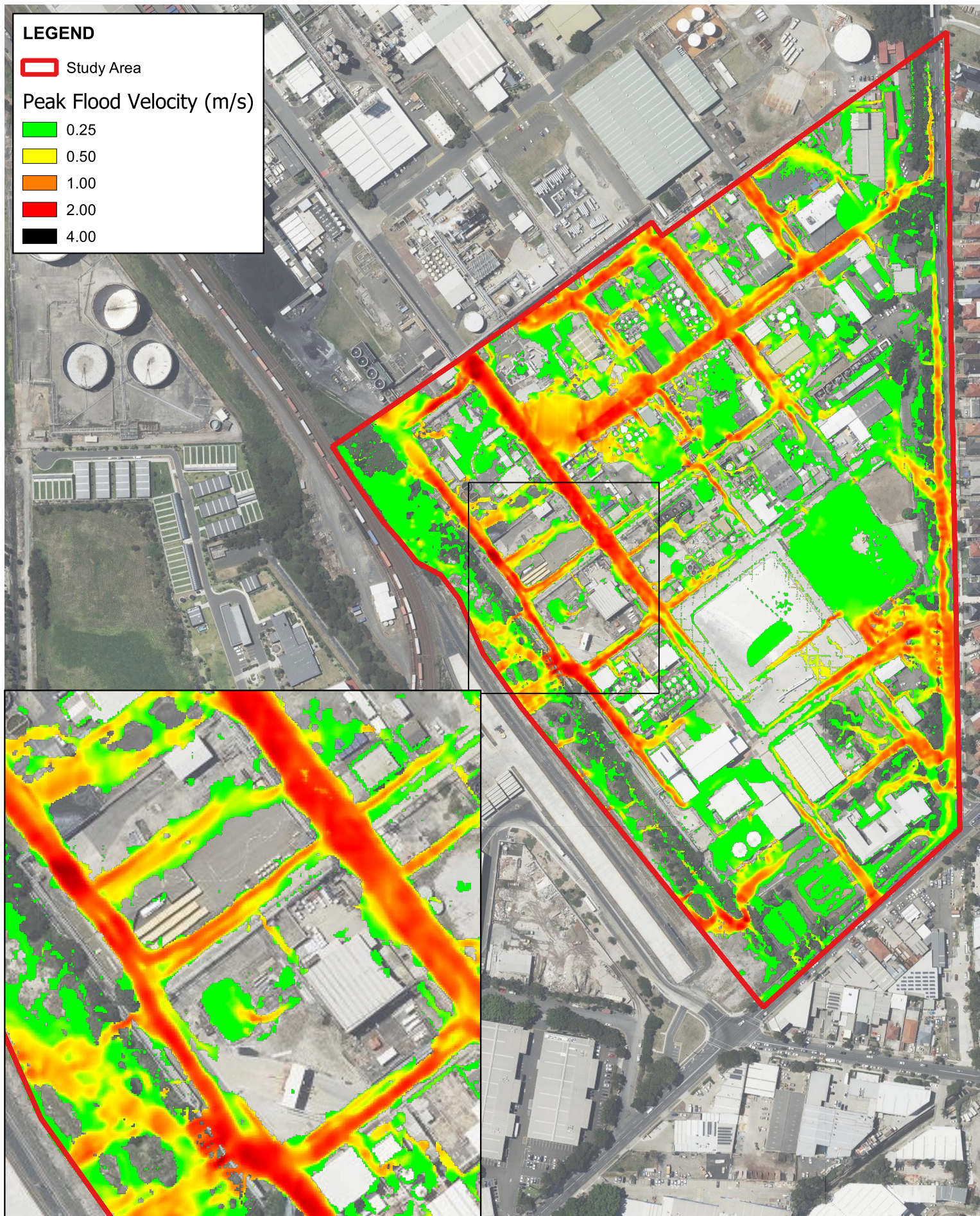
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 2.00

 4.00



Title:

Ixom Flood Impact and Risk Assessment PMF Peak Flood Velocity - Pre-Development

Figure:

A8

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B

Scale at A4 1:4500
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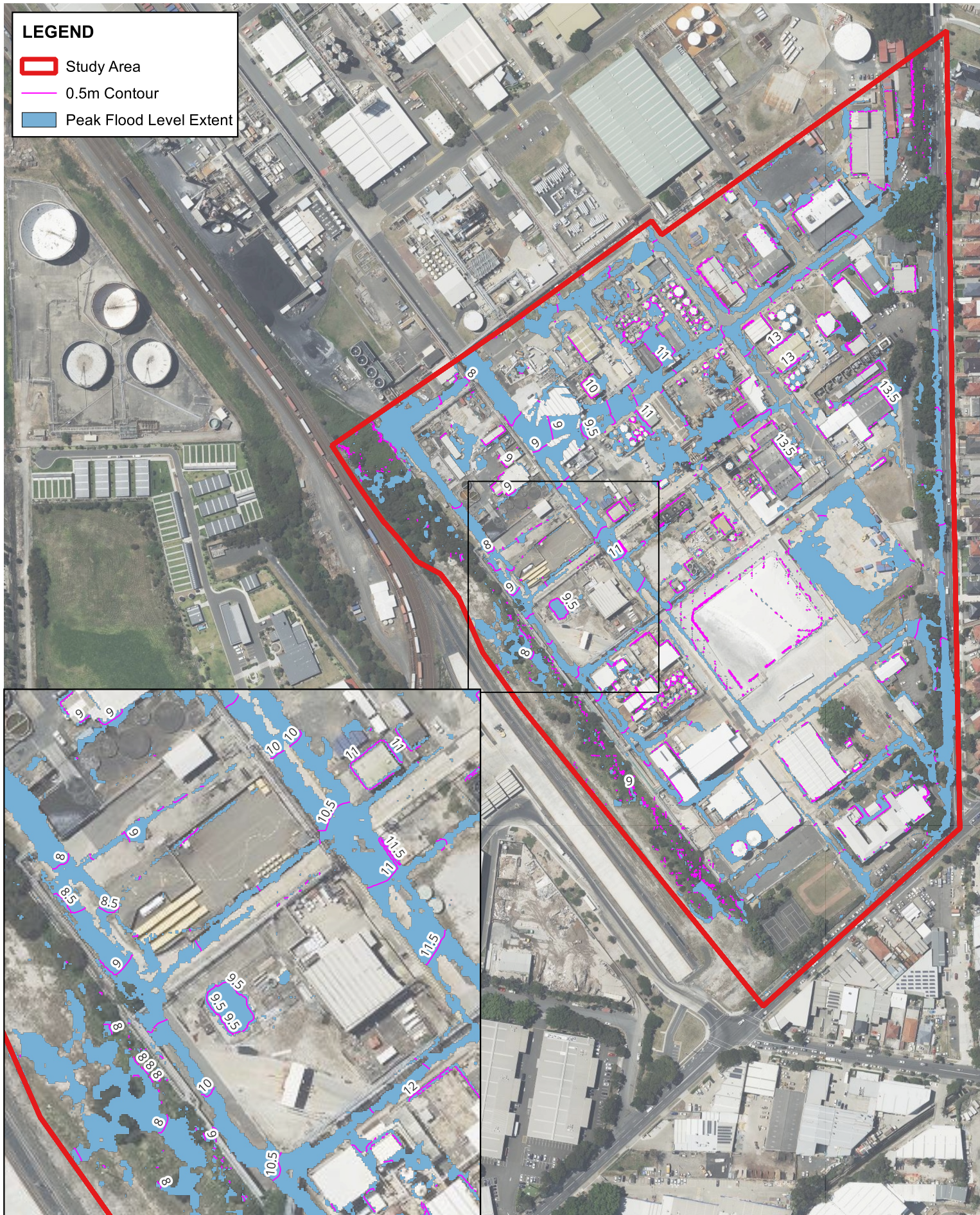


1:4,500



LEGEND

- ▬ Study Area
- ▬ 0.5m Contour
- ▬ Peak Flood Level Extent



Title: Ixom Flood Impact and Risk Assessment 1% AEP Peak Flood Level Extent - Post-Development

Figure:
A9

Rev:
B

Scale at A4 1:4500
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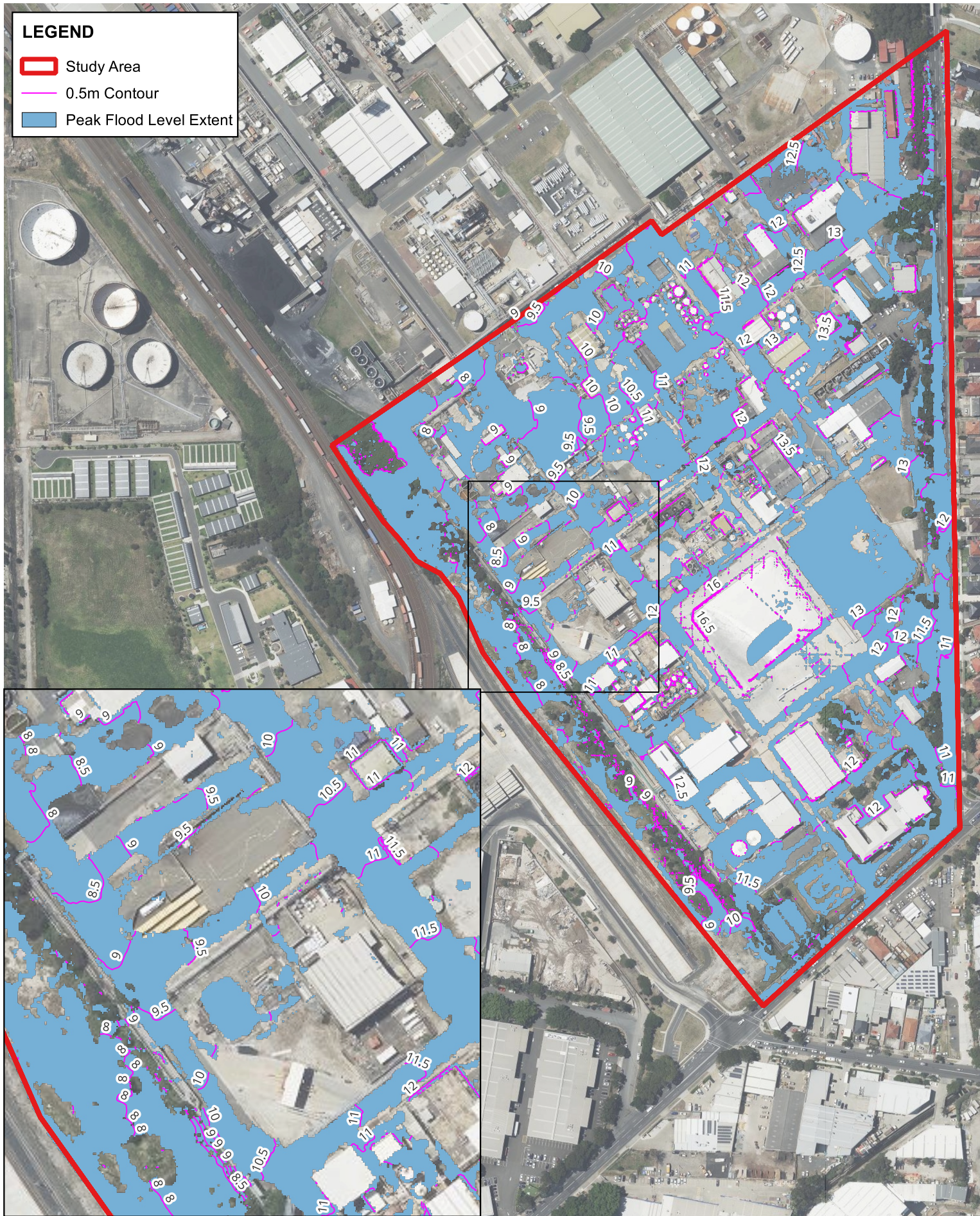
File: Y:\Water_Resources\Projects\SEG452_IXOM\G - GIS\Workspaces\MS_Figures.gqz

Scale:
0 50 100 m
1:4,500



LEGEND

- ▬ Study Area
- ▬ 0.5m Contour
- ▬ Peak Flood Level Extent



Title: Ixom Flood Impact and Risk Assessment PMF AEP Peak Flood Level Extent - Post-Development

Figure:
A10

Rev:
B

Scale at A4 1:4500
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Scale:

0 50 100 m



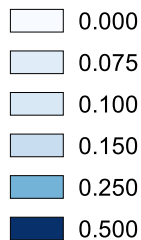
1:4,500



LEGEND

 Study Area

Peak Flood Depth (m)



Title: Ixom Flood Impact and Risk Assessment 1% AEP Peak Flood Depth - Post-Development

Figure:
A11

Rev:
B

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Scale:
0 50 100 m



1:4,500

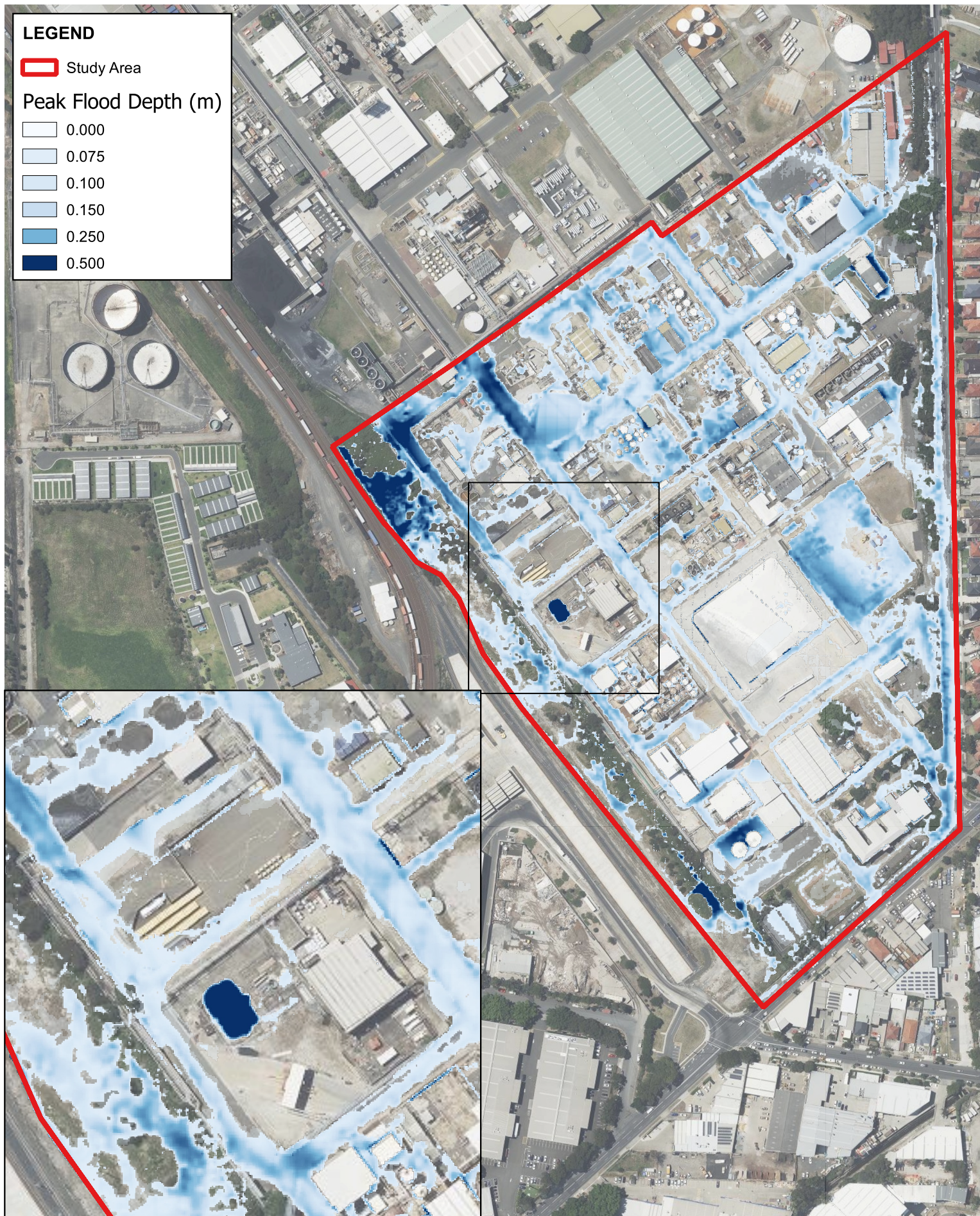


LEGEND

 Study Area

Peak Flood Depth (m)

-  0.000
-  0.075
-  0.100
-  0.150
-  0.250
-  0.500



Title: Ixom Flood Impact and Risk Assessment PMF Peak Flood Depth - Post-Development

Figure:
A12

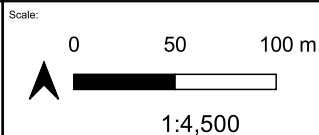
Rev:
B

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LEGEND

 Study Area

Peak Flood Hazard

 H1

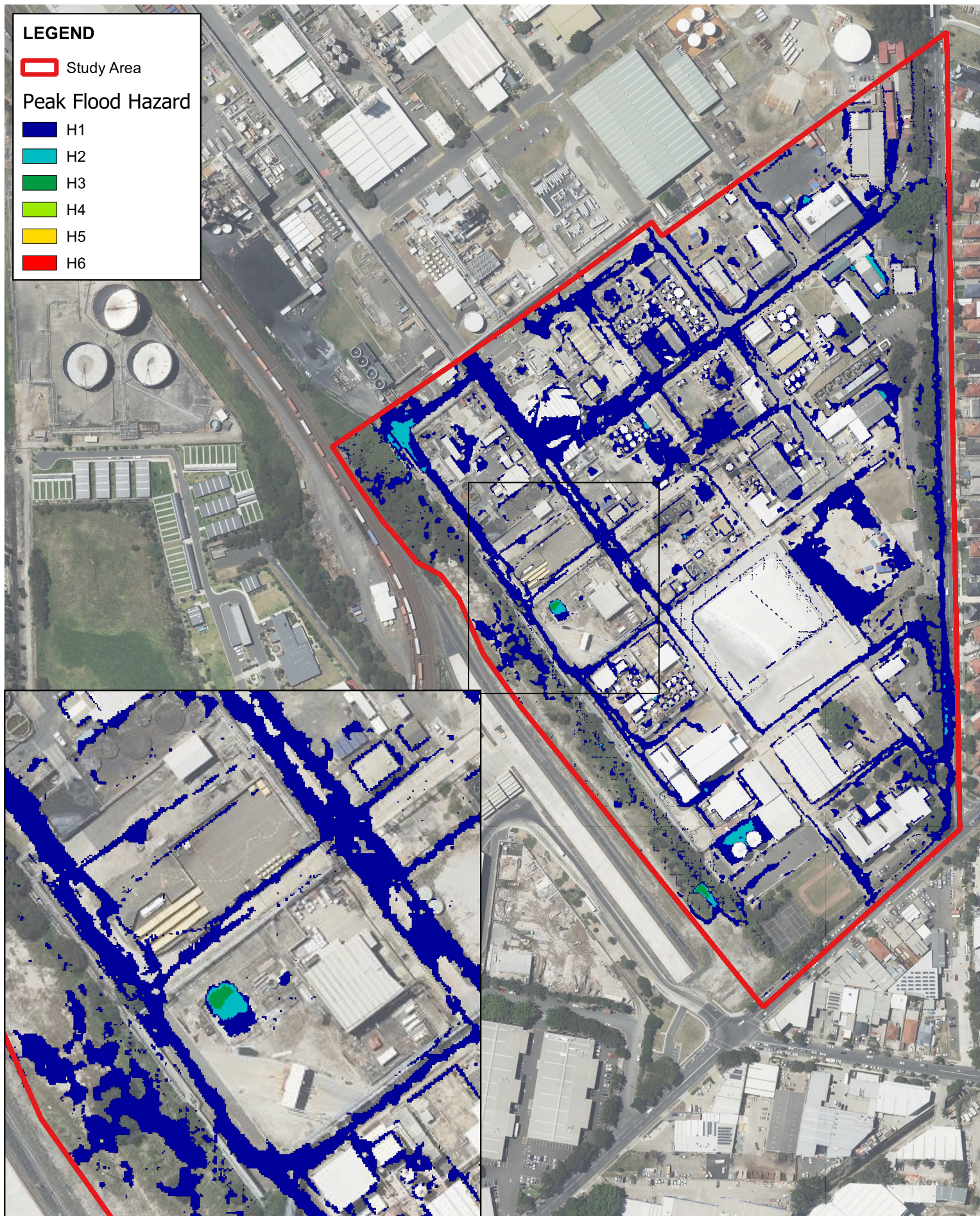
 H2

 H3

 H4

 H5

 H6



Title:

Ixom Flood Impact and Risk Assessment 1% AEP Peak Flood Hazard - Post-Development

Figure:

A13

Rev:

B

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Scale:

0 50 100 m



1:4,500

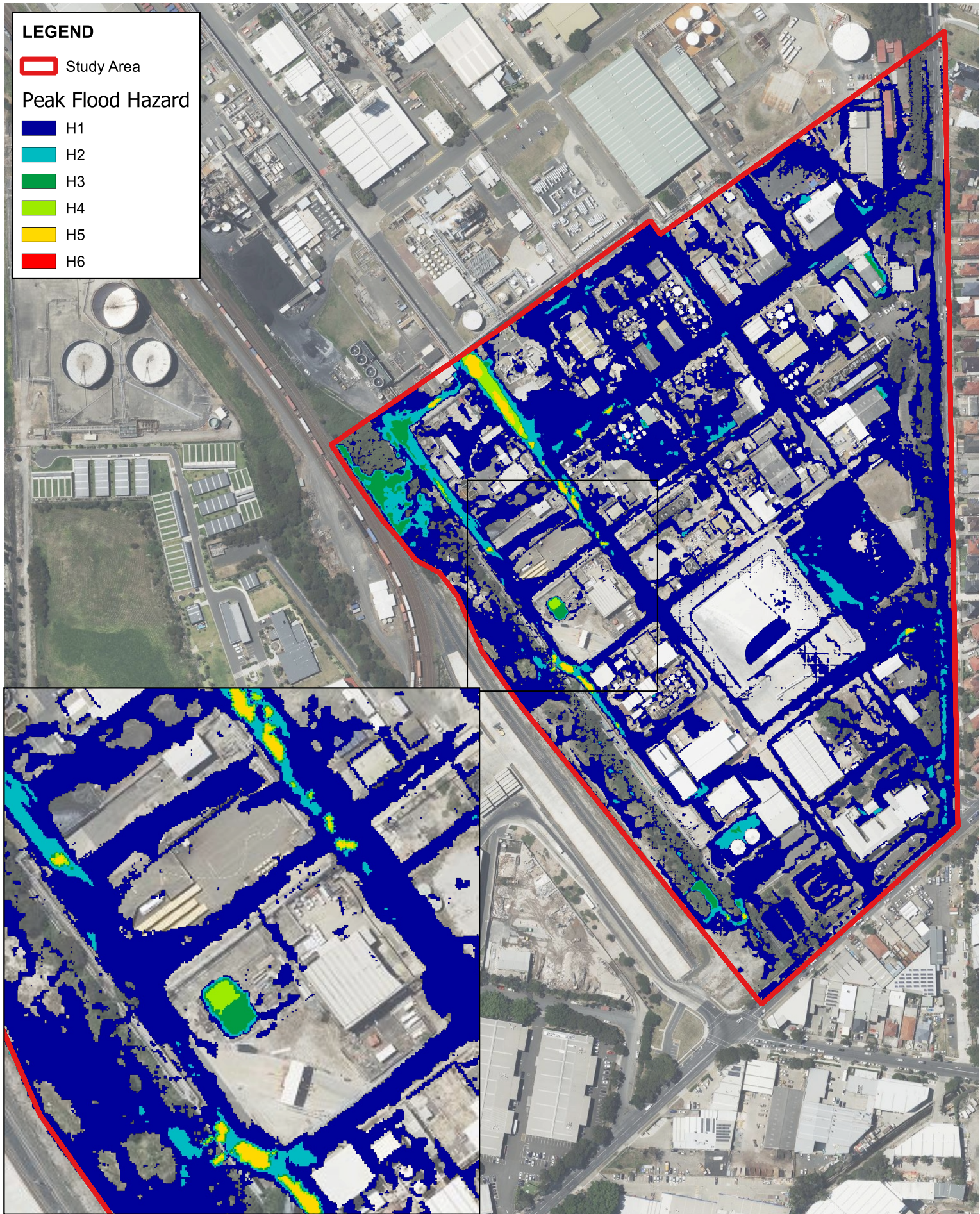


LEGEND

 Study Area

Peak Flood Hazard

-  H1
-  H2
-  H3
-  H4
-  H5
-  H6



Title: Ixom Flood Impact and Risk Assessment PMF Peak Flood Hazard - Post-Development

Figure: **A14**

Rev: **B**

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File: Y:\Water_Resources\Projects\SEG452_IXOM\G - GIS\Workspaces\MS_Figures.qgz

Scale:

0 50 100 m



1:4,500



LEGEND

 Study Area

Peak Flood Velocity (m/s)

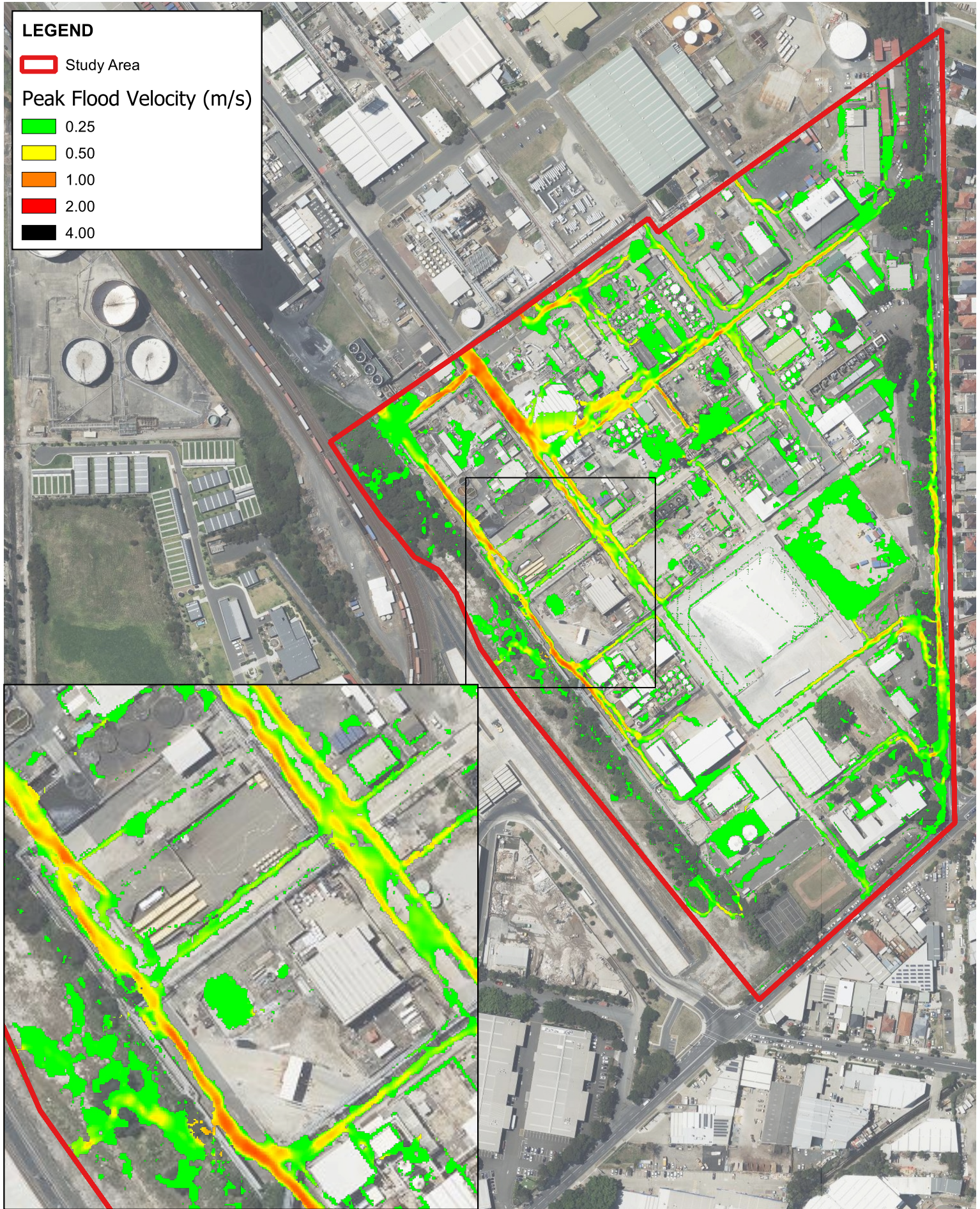
 0.25

 0.50

 1.00

 2.00

 4.00



Title: Ixom Flood Impact and Risk Assessment 1% AEP Peak Flood Velocity - Post-Development

Figure:
A15

Rev:
B

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File: Y:\Water_Resources\Projects\SEG452_IXOM\G - GIS\Workspaces\MS_Figures.gqz

Scale:

0 50 100 m



1:4,500



LEGEND

 Study Area

Peak Flood Velocity (m/s)

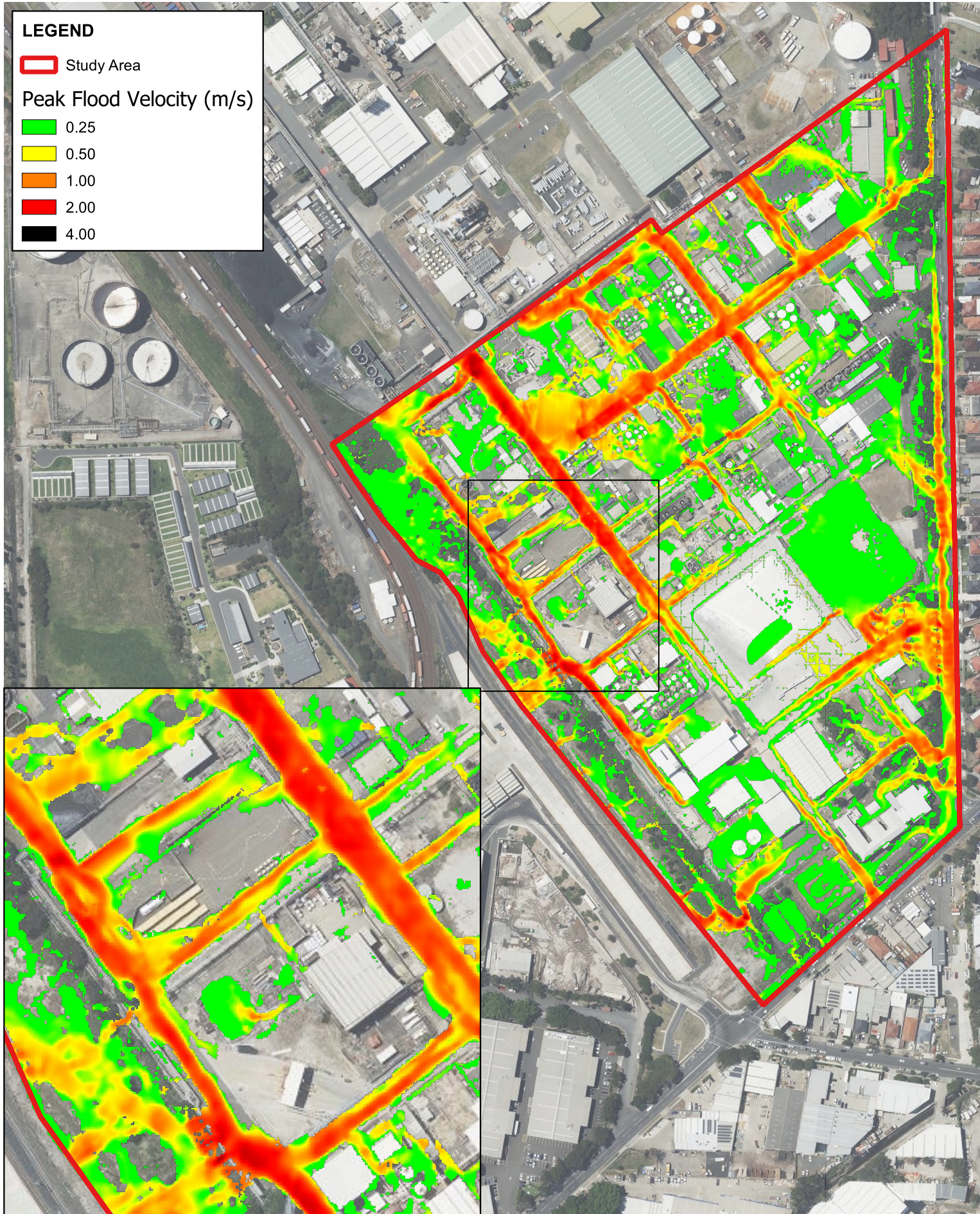
 0.25

 0.50

 1.00

 2.00

 4.00



Title: Ixom Flood Impact and Risk Assessment PMF Peak Flood Velocity - Post-Development

Figure:
A16

Rev:
B

Scale at A4 1:4500
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File: Y:\Water_Resources\Projects\SEG452_IXOM\GIS\Workspaces\MS_Figures.gqz

Scale:

0 50 100 m



1:4,500



LEGEND

 Study Area

Peak Flood Level Afflux (m)

 ≤ -0.10

 -0.10 - -0.05

 -0.05 - -0.01

 -0.01 - 0.01

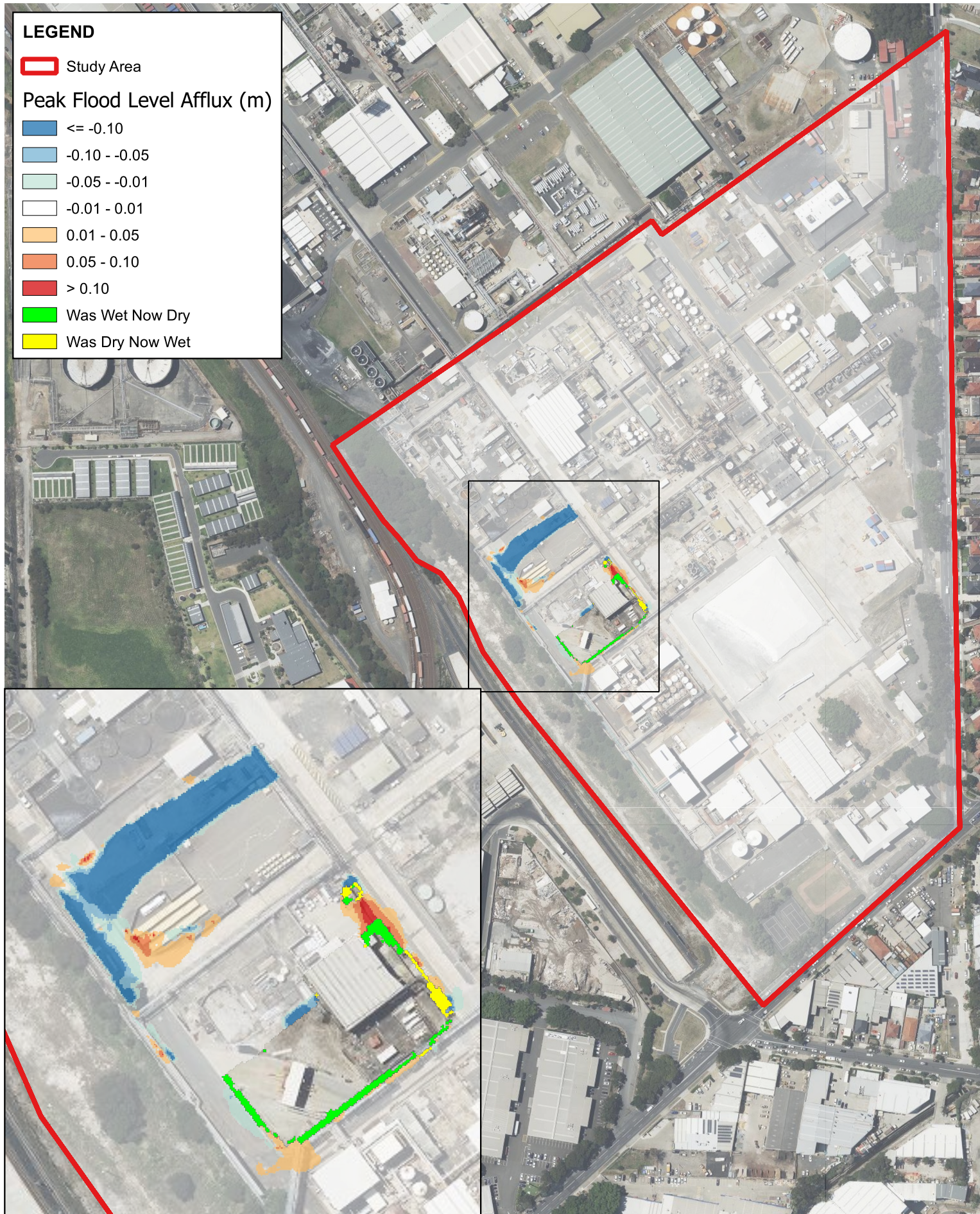
 0.01 - 0.05

 0.05 - 0.10

 > 0.10

 Was Wet Now Dry

 Was Dry Now Wet



Title: Ixom Flood Impact and Risk Assessment 1% AEP Peak Flood Level Afflux - Post-Development - Pre-Development

Figure:
A17

Rev:
B

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Scale:

0 50 100 m



1:4,500



LEGEND

 Study Area

Peak Flood Level Afflux (m)

 <= -0.10

 -0.10 - -0.05

 -0.05 - -0.01

 -0.01 - 0.01

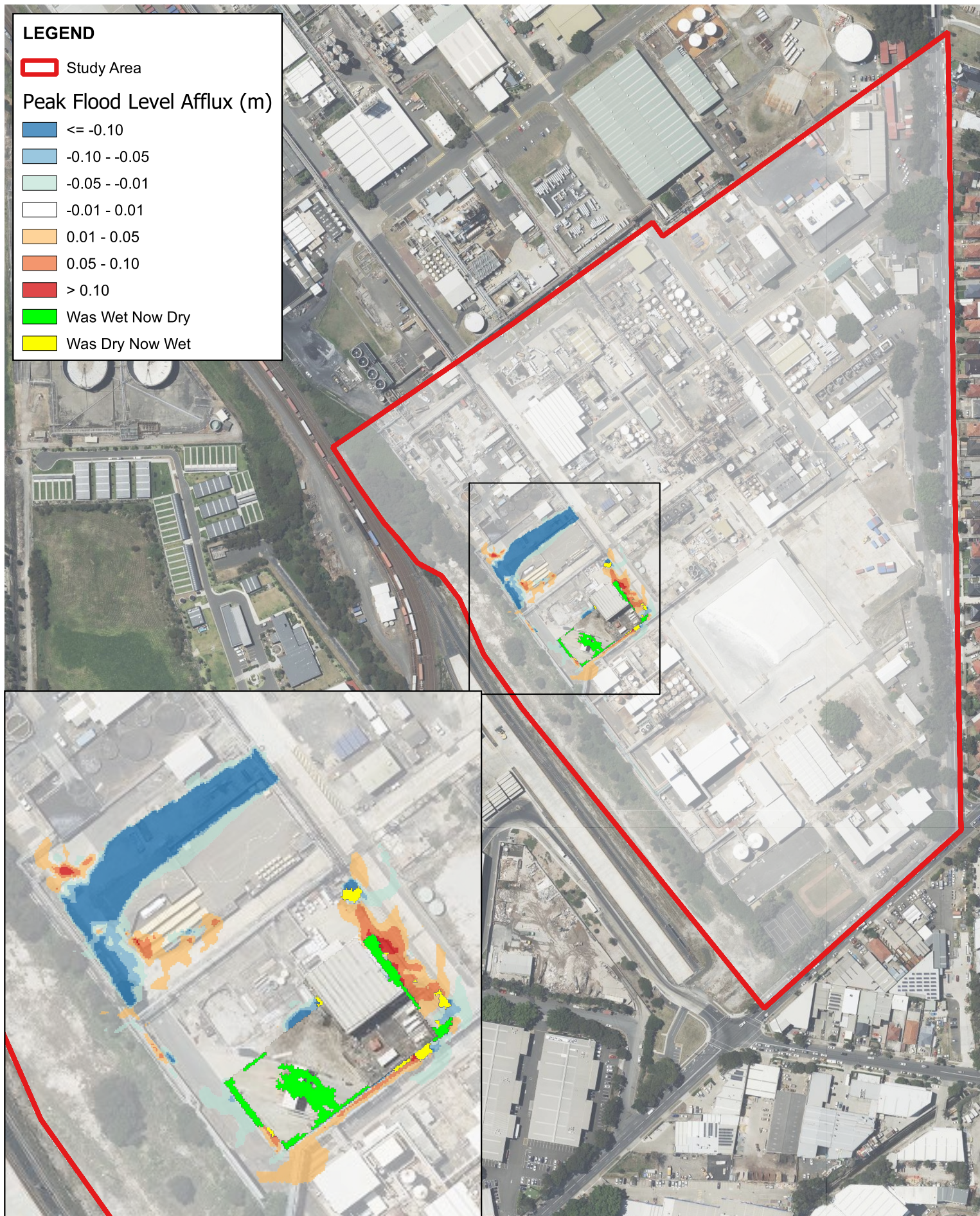
 0.01 - 0.05

 0.05 - 0.10

 > 0.10

 Was Wet Now Dry

 Was Dry Now Wet



Title:
Ixom Flood Impact and Risk Assessment
PMF Peak Flood Level Afflux - Post-Development - Pre-Development

Figure:
A18

Rev:
B

Scale at A4 1:4500
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Scale:
0 50 100 m

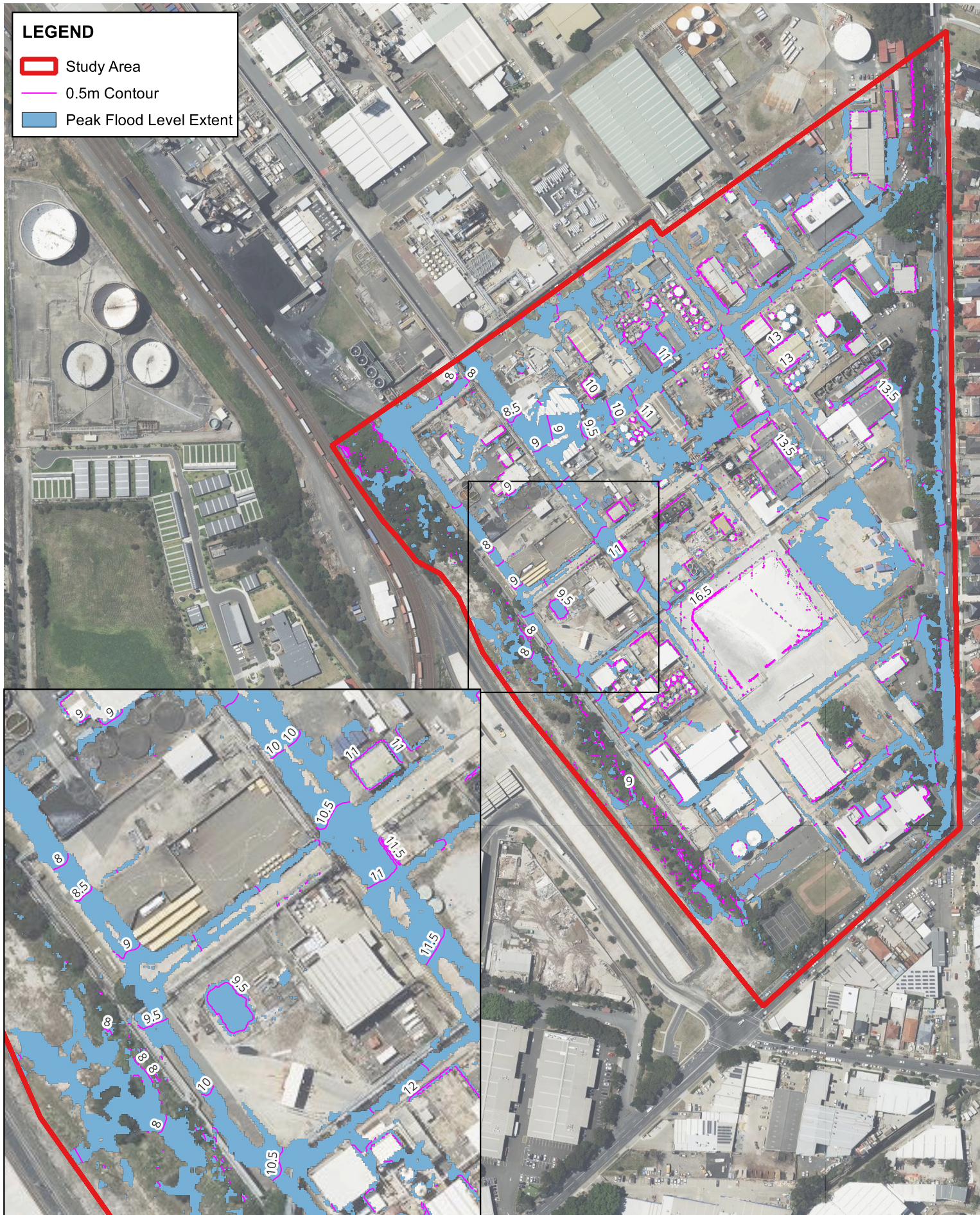


1:4,500



LEGEND

- ▬ Study Area
- ▬ 0.5m Contour
- ▬ Peak Flood Level Extent



Title: Ixom Flood Impact and Risk Assessment Climate Change 2050 1% AEP Peak Flood Level Extent - Pre-Development

Figure:

A19

Rev:

B

Scale at A4 1:4500
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File: Y:\Water_Resources\Projects\SEG452_IXOM\GIS\Workspaces\MS_Figures.qgz

Scale:

0 50 100 m

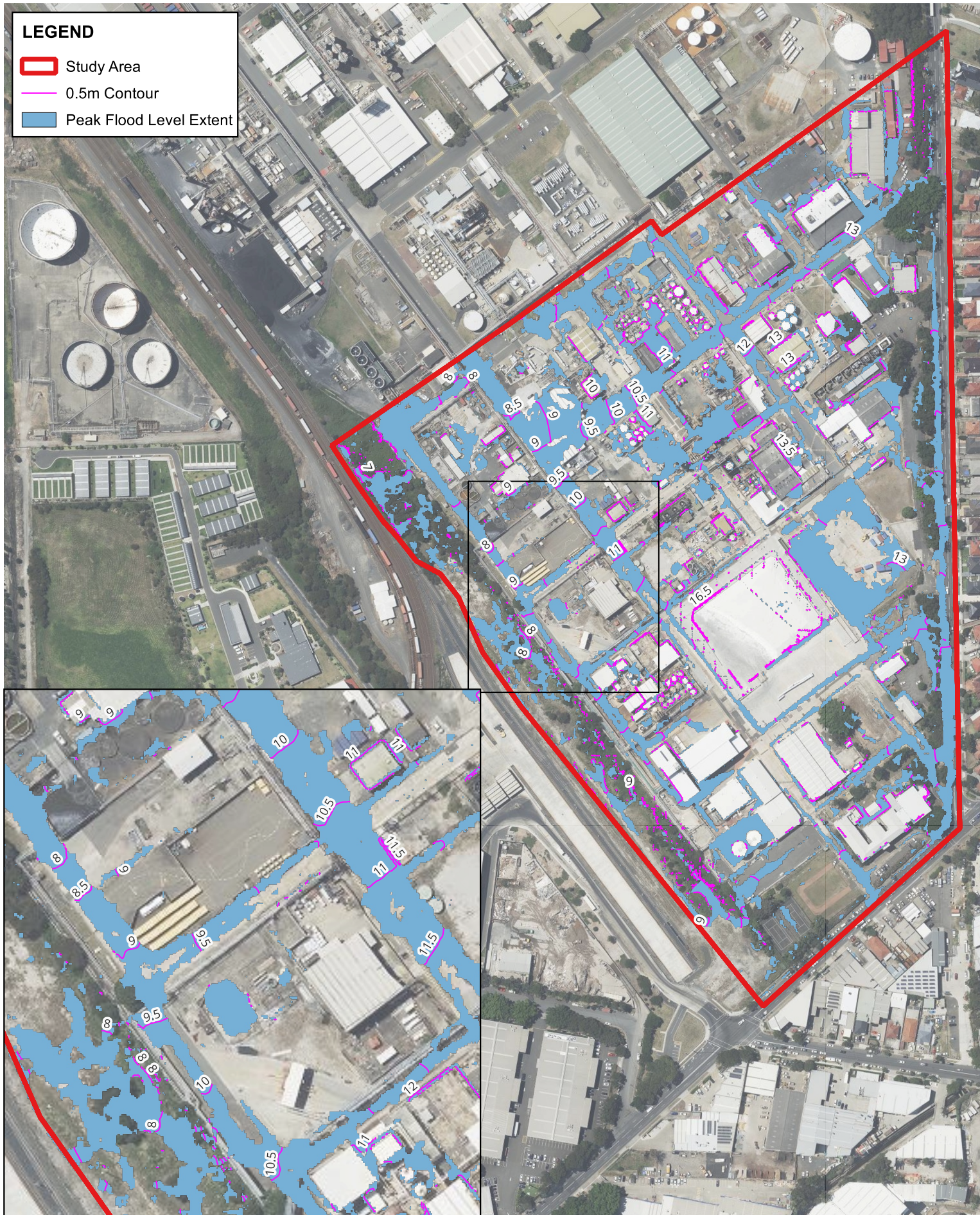


1:4,500



LEGEND

- ▬ Study Area
- ▬ 0.5m Contour
- ▬ Peak Flood Level Extent



Title: Ixom Flood Impact and Risk Assessment Climate Change 2100 1% AEP Peak Flood Level Extent - Pre-Development

Figure:
A20

Rev:
B

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Scale:
0 50 100 m
1:4,500

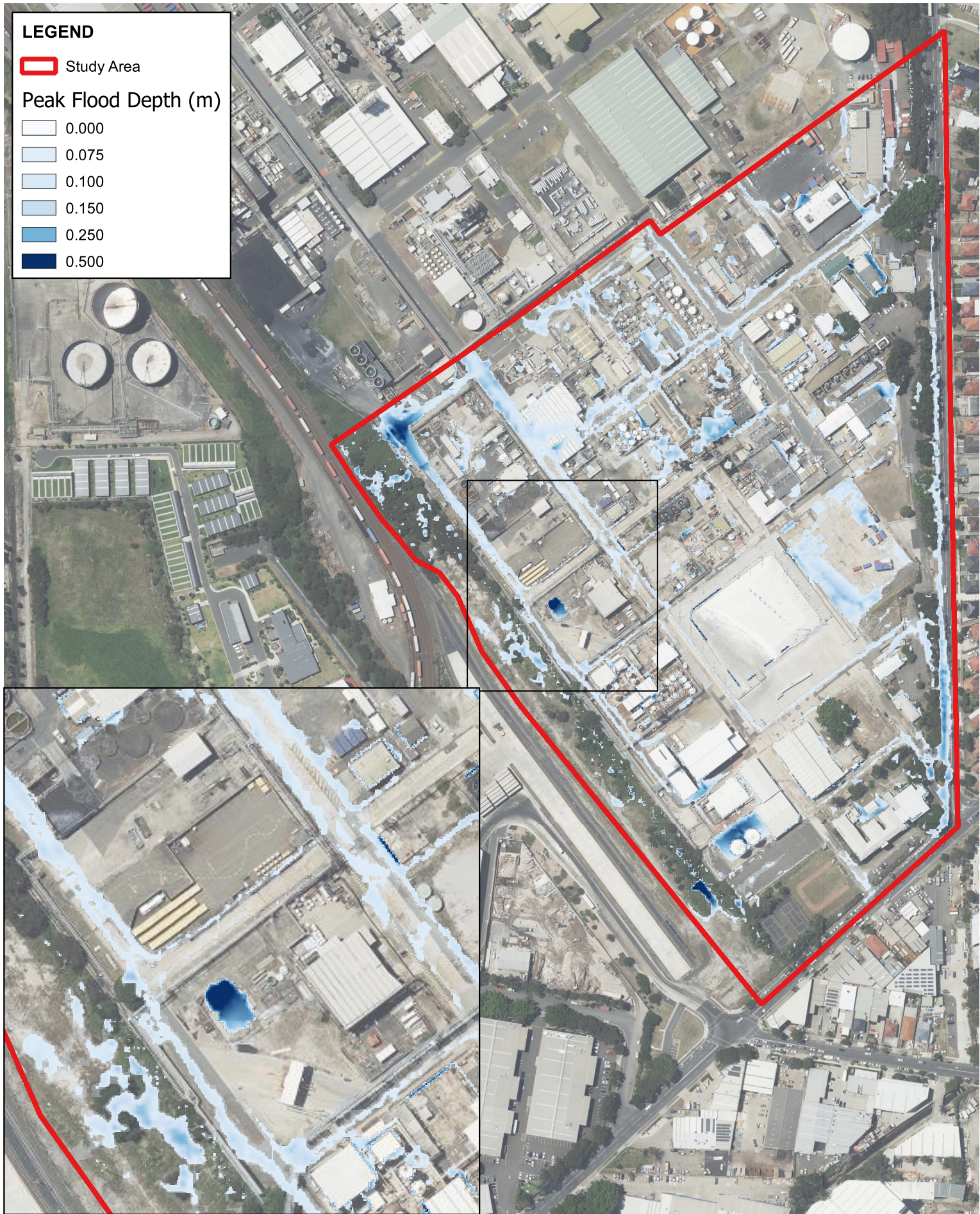


LEGEND

 Study Area

Peak Flood Depth (m)

-  0.000
-  0.075
-  0.100
-  0.150
-  0.250
-  0.500



Title: Ixom Flood Impact and Risk Assessment Climate Change 2050 1% AEP Peak Flood Depth - Pre-Development

Figure: **A21**

Rev: **B**

Scale at A4 1:4500
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File: Y:\Water_Resources\Projects\SEG452_IXOM\G - GIS\Workspaces\MS_Figures.qgz

Scale:

0 50 100 m



1:4,500



LEGEND

 Study Area

Peak Flood Depth (m)

 0.000

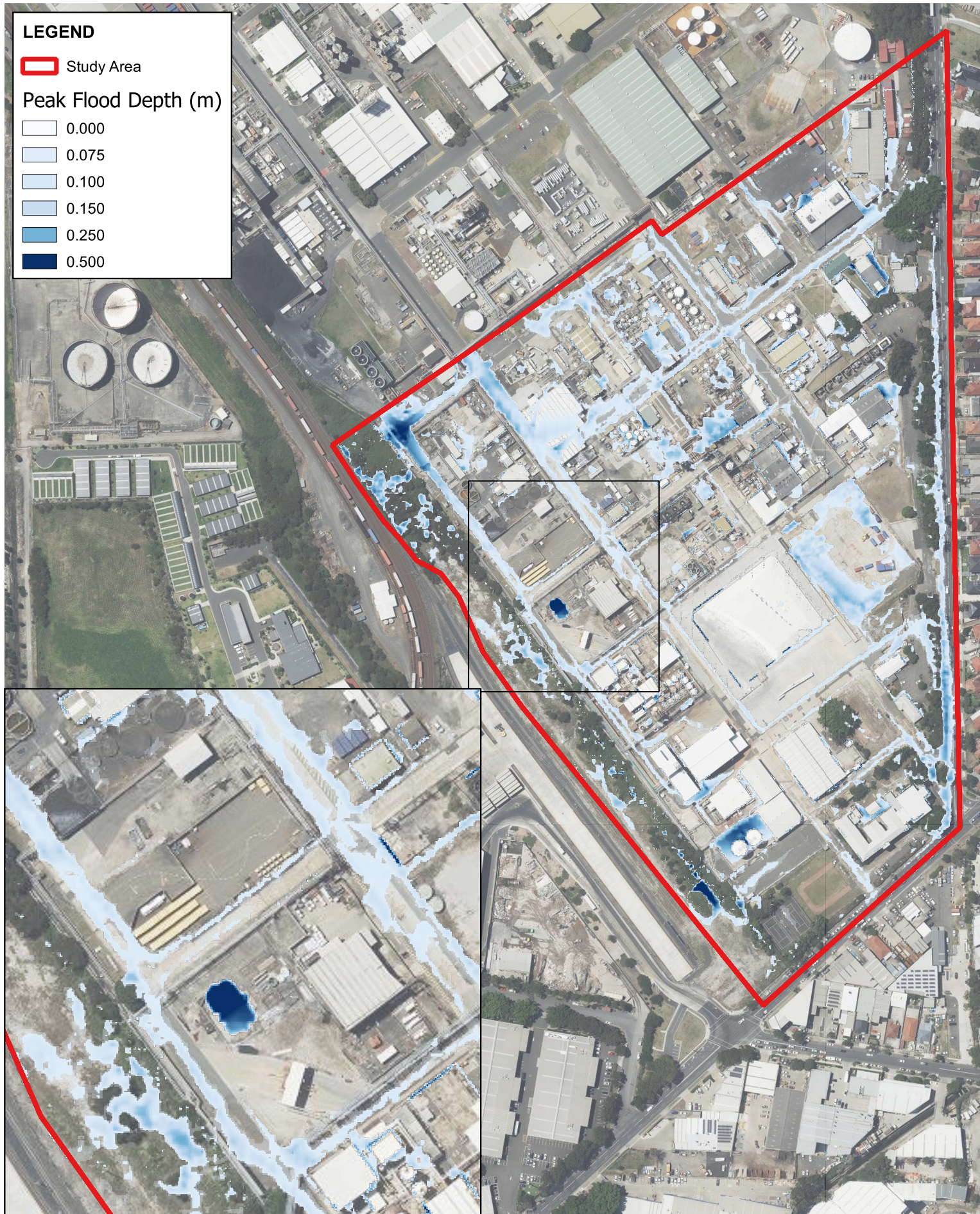
 0.075

 0.100

 0.150

 0.250

 0.500



Title: Ixom Flood Impact and Risk Assessment Climate Change 2100 1% AEP Peak Flood Depth - Pre-Development

Figure: **A22**

Rev: **B**

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File: Y:\Water_Resources\Projects\SEG452_IXOM\G - GIS\Workspaces\MS_Figures.qgz

Scale: 0 50 100 m

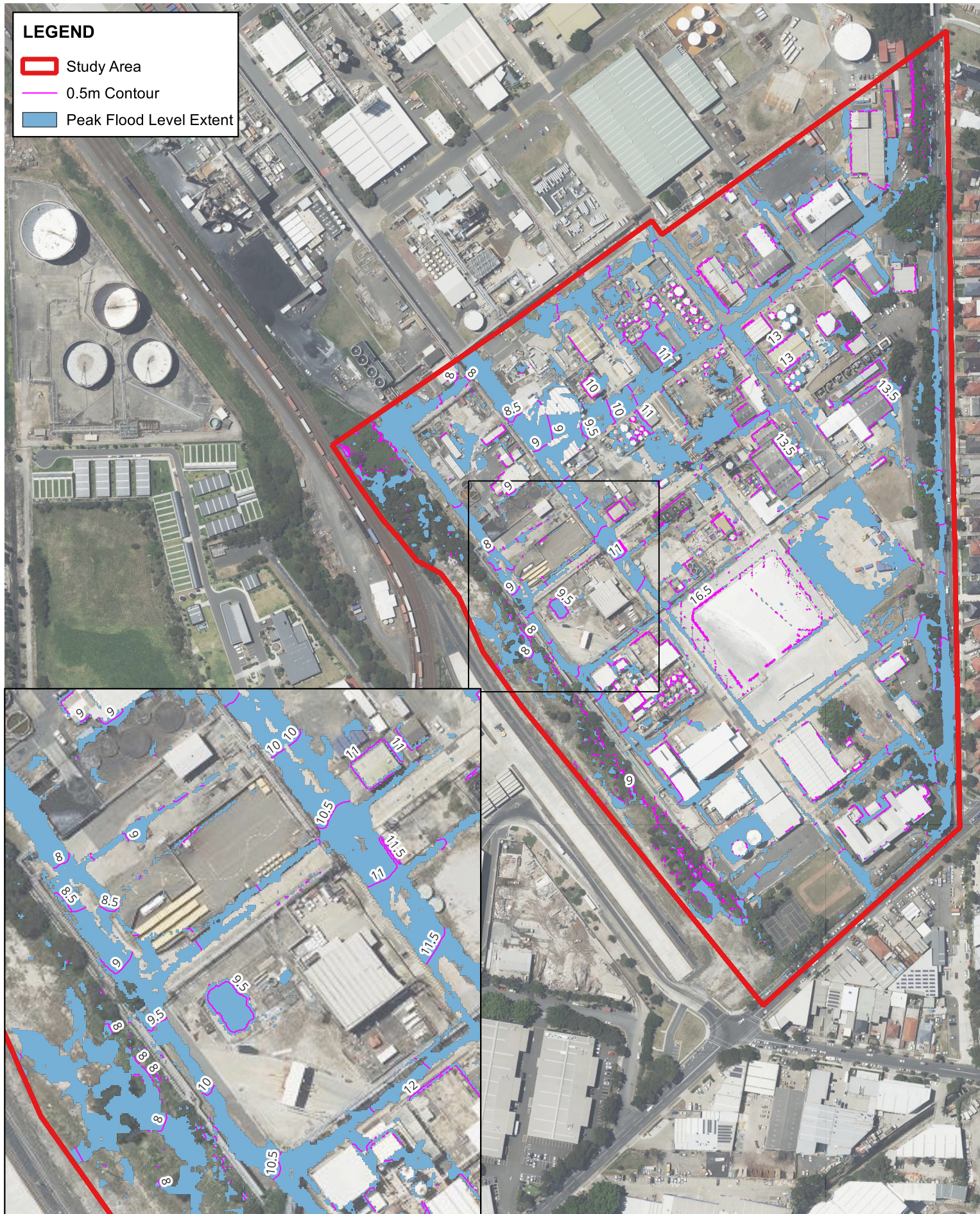


1:4,500



LEGEND

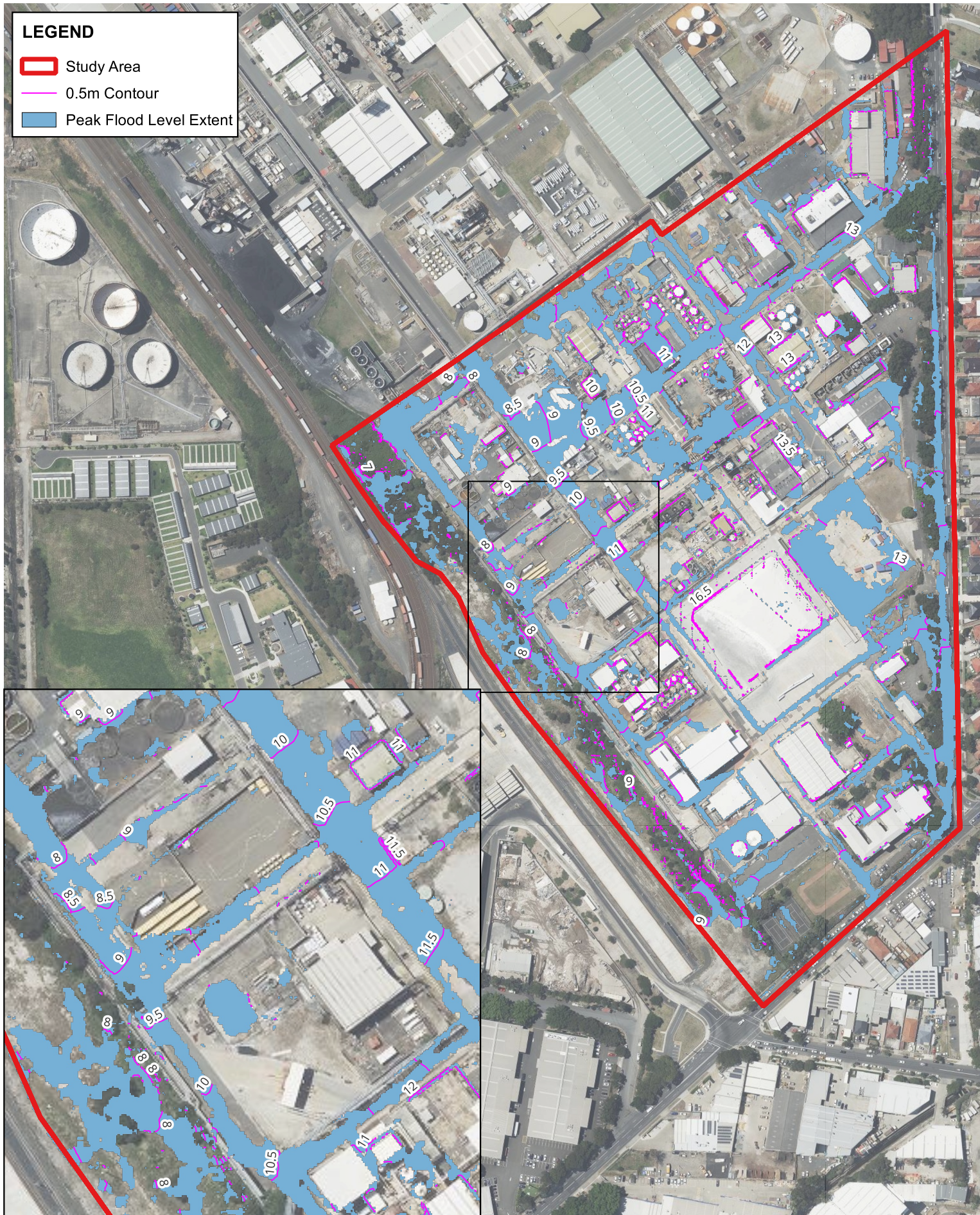
- ▬ Study Area
- ▬ 0.5m Contour
- ▬ Peak Flood Level Extent



Title: Ixom Flood Impact and Risk Assessment Climate Change 2050 1% AEP Peak Flood Level Extent - Post-Development		Figure: A23	Rev: B
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LEGEND

- ▬ Study Area
- ▬ 0.5m Contour
- ▬ Peak Flood Level Extent



Title: Ixom Flood Impact and Risk Assessment Climate Change 2100 1% AEP Peak Flood Level Extent - Post-Development

Figure: **A24** Rev: **B**

Scale at A4 1:4500
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File: Y:\Water_Resources\Projects\SEG452_IXOM\GIS\Workspaces\MS_Figures.qgz

Scale:
0 50 100 m
1:4,500



LEGEND

 Study Area

Peak Flood Depth (m)

 0.000

 0.075

 0.100

 0.150

 0.250

 0.500



Title: Ixom Flood Impact and Risk Assessment Climate Change 2050 1% AEP Peak Flood Depth - Post-Development

Figure: **A25**

Rev: **B**

Scale at A4 1:4500
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Scale:

0 50 100 m



1:4,500

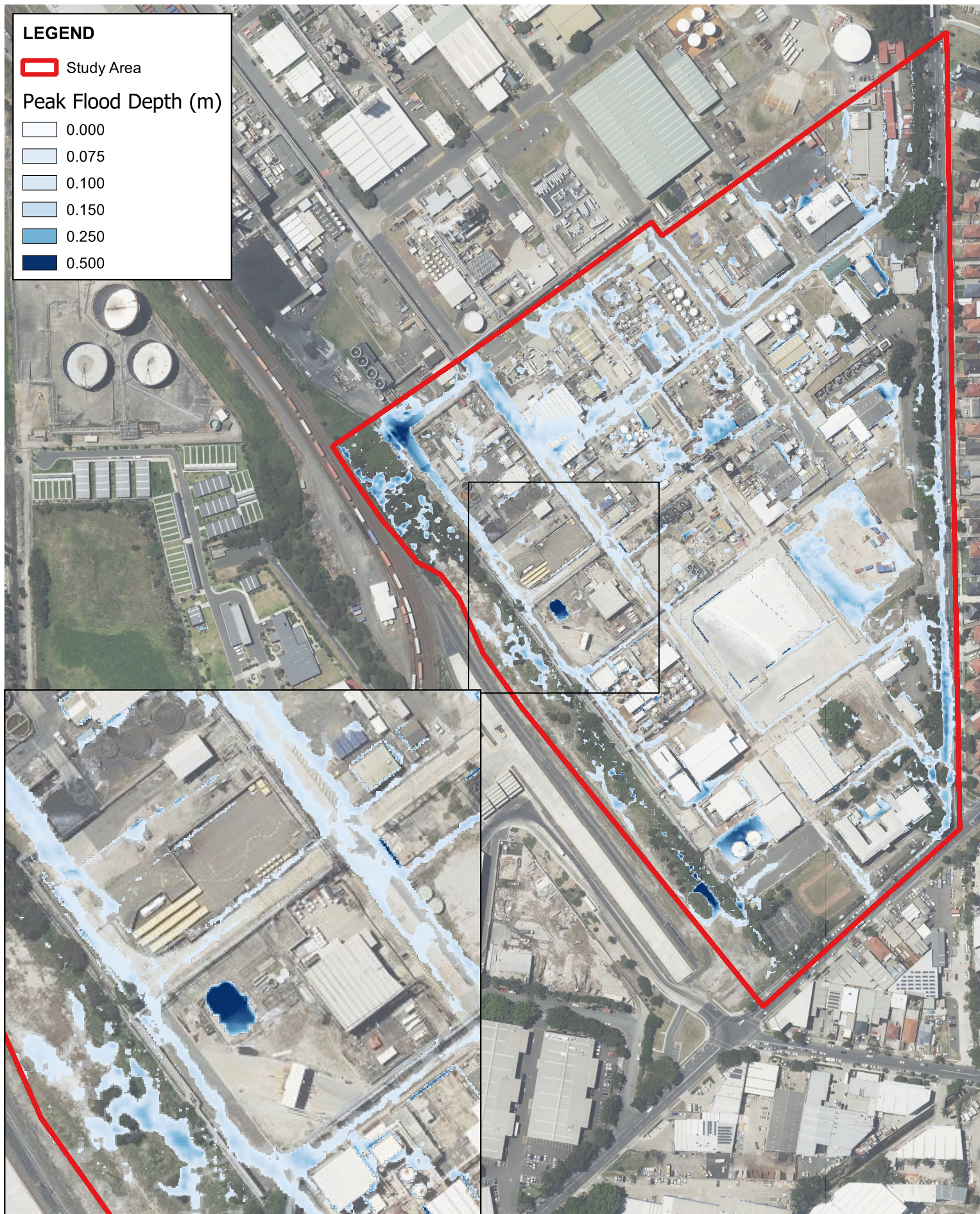


LEGEND

 Study Area

Peak Flood Depth (m)

-  0.000
-  0.075
-  0.100
-  0.150
-  0.250
-  0.500



Title: Ixom Flood Impact and Risk Assessment Climate Change 2100 1% AEP Peak Flood Depth - Post-Development

Figure: **A26**

Rev: **B**

Scale at A4 1:4500
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File: Y:\Water_Resources\Projects\SEG452_IXOM\G - GIS\Workspaces\MS_Figures.qgz

Scale: 0 50 100 m



1:4,500



LEGEND

 Study Area

Peak Flood Level Afflux (m)

 <= -0.10

 -0.10 - -0.05

 -0.05 - -0.01

 -0.01 - 0.01

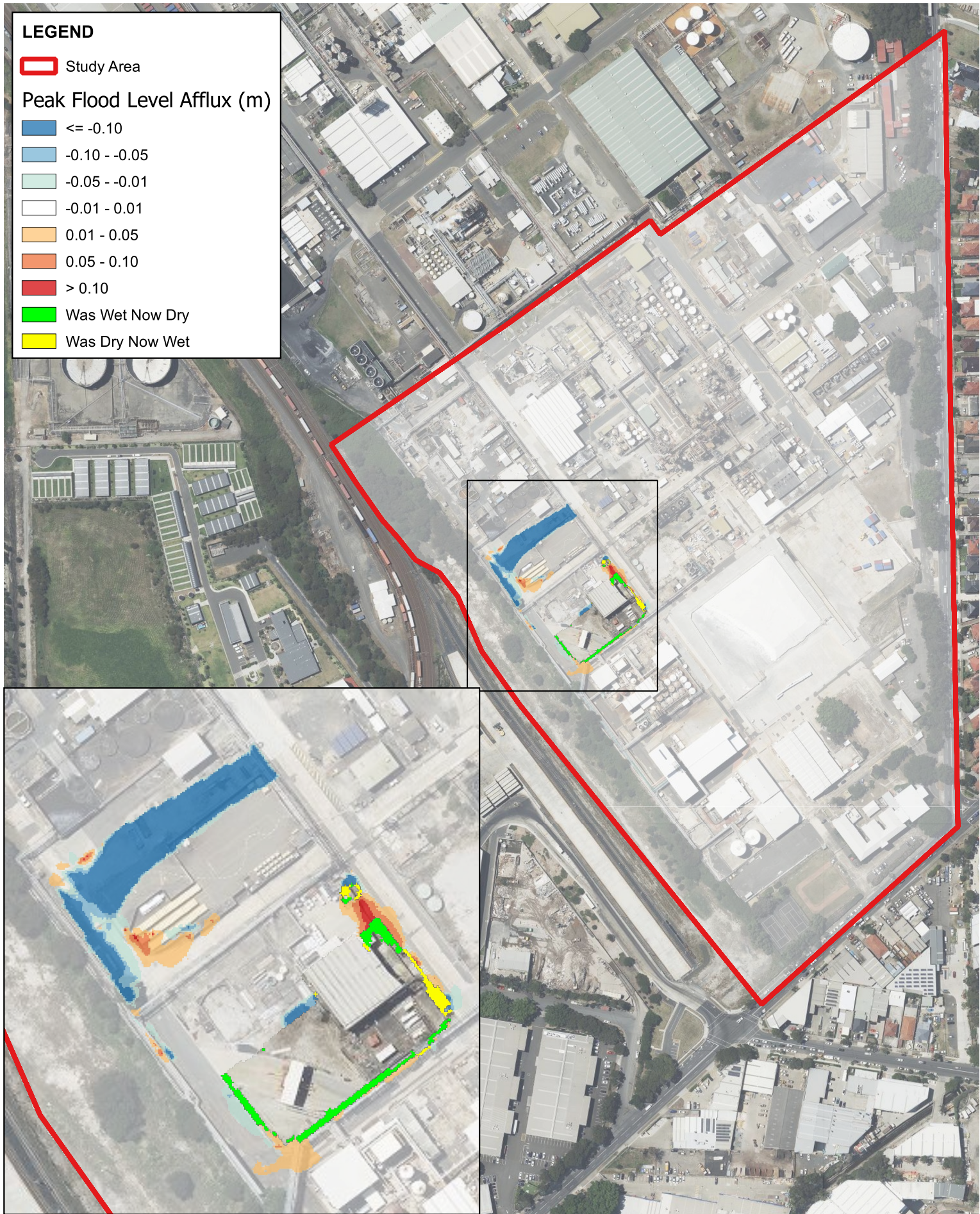
 0.01 - 0.05

 0.05 - 0.10

 > 0.10

 Was Wet Now Dry

 Was Dry Now Wet



Title:
Ixom Flood Impact and Risk Assessment
Climate Change 2050 Peak Flood Level Afflux - Post-Development -
Pre-Development

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File: Y:\Water_Resources\Projects\SEG452_IXOM\G - GIS\Workspaces\MS_Figures.qgz

Scale:

0 50 100 m



1:4,500

Figure:

A27

Rev:

B



LEGEND

 Study Area

Peak Flood Level Afflux (m)

 ≤ -0.10

 -0.10 - -0.05

 -0.05 - -0.01

 -0.01 - 0.01

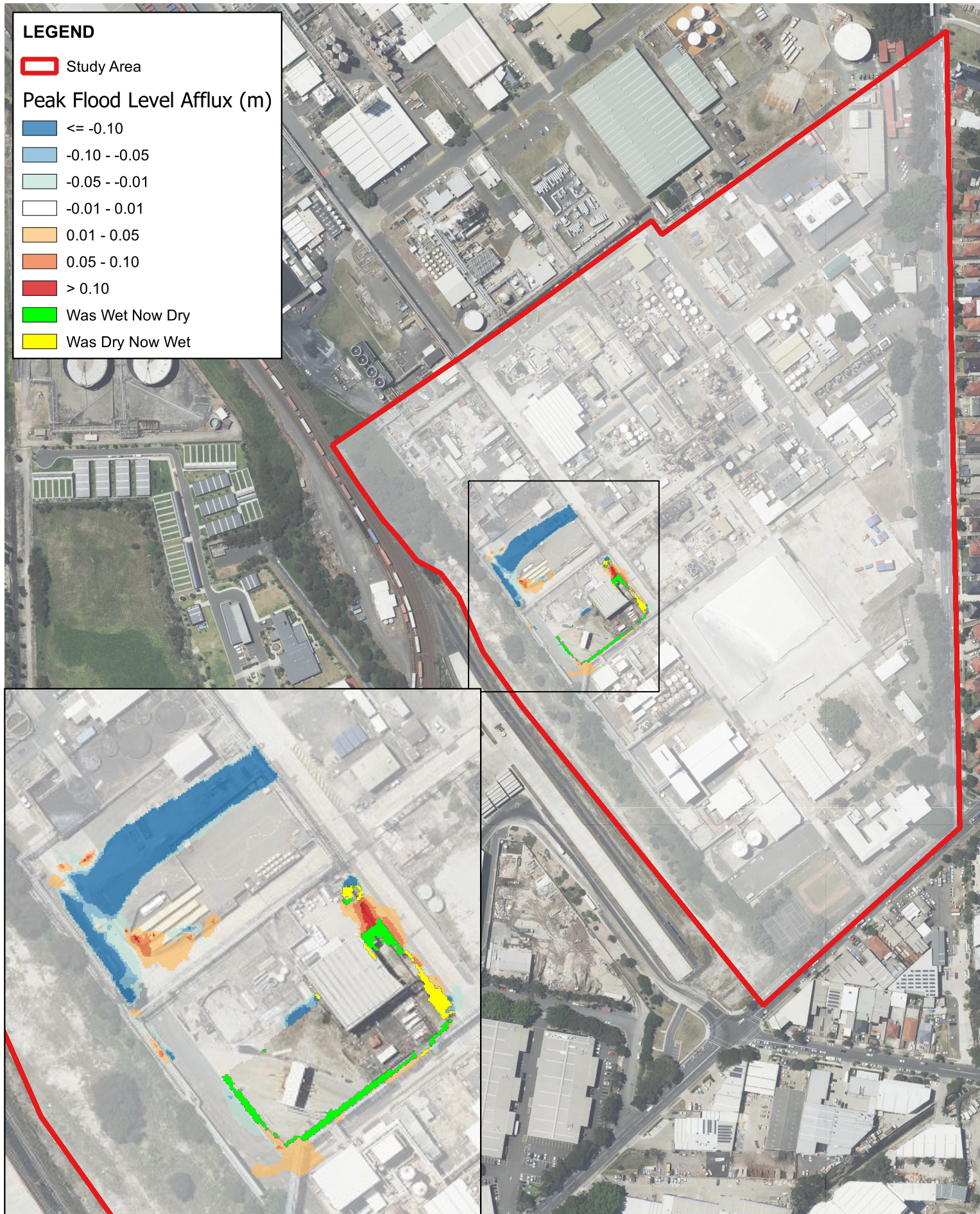
 0.01 - 0.05

 0.05 - 0.10

 > 0.10

 Was Wet Now Dry

 Was Dry Now Wet



Title:
**Ixom Flood Impact and Risk Assessment
Climate Change 2100 Peak Flood Level Afflux - Post-Development -
Pre-Development**

Scale at A4 1:4500
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File: Y:\Water_Resources\Projects\SEG452_IXOM\G - GIS\Workspaces\MS_Figures.qgz

Scale:

0 50 100 m



1:4,500

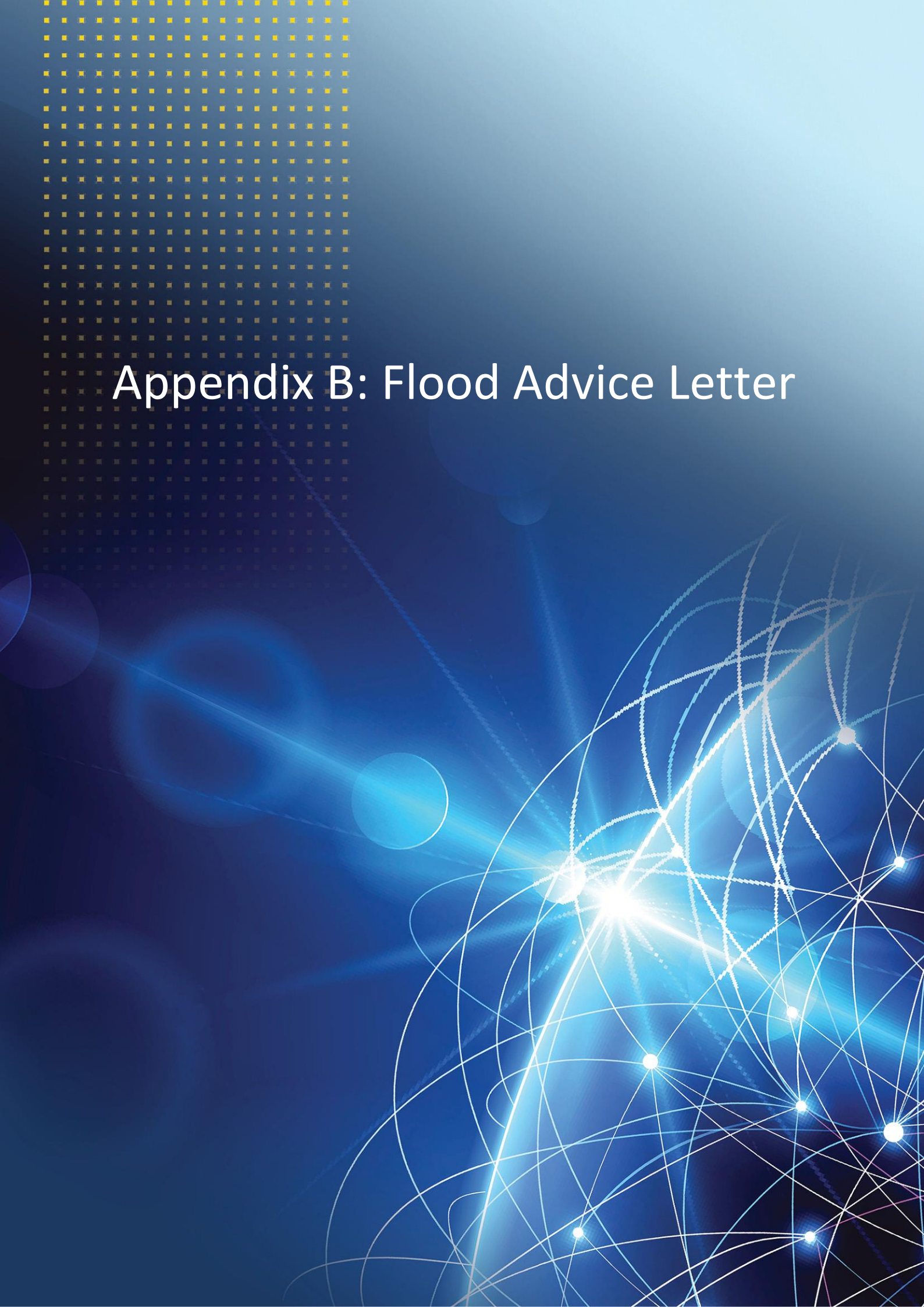
Figure:

A28

Rev:

B





Appendix B: Flood Advice Letter

Monday 21 October 2024

Our Ref: FA – 2024/245
KBR
13/201 Kent Street
SYDNEY NSW 2000



Flood Advice Certificate for 16-20A BEAUCHAMP ROAD BANKSMEADOW

This certificate is automatically generated from the information provided from the flood study identified below. Council cannot comment on the accuracy of the result.

This certificate has been generated from the following study:

Springvale Drain and Floodvale Drain Flood Study, BMT WBM Pty Ltd, 2014

The information provided can be used to assist in understanding the extent of flooding affecting this property and can be used to assist in preparation of a development application and associated flood reports. It is recommended that the information in this report be interpreted by a suitably qualified professional.

The information is provided in good faith and in accordance with the provisions of s.733 of the Local Government Act.

For the purposes of complying development, this certificate identifies if the property is:

- a) A flood storage area
- b) A floodway area
- c) A high hazard area

Flood maps are provided below. A suitably qualified engineer should be engaged to determine whether the property is:

- d) A flow path
- e) A high risk area

Is this property affected during the 1% AEP Flood Event?	Yes
Is this property affected during the PMF Event?	Yes
1% AEP Flood Hazard Note Council considers flooding H3-H6 as high hazard. See below for more information.	H3
1% AEP Flood Function	Flood Storage
1% AEP Flood Level (maximum level for property) (m AHD)	13.19

Flood related development controls are provided in Bayside Council Development Control Plan 2022, Section 3.10, and Section 9.5. Use the following link to download:

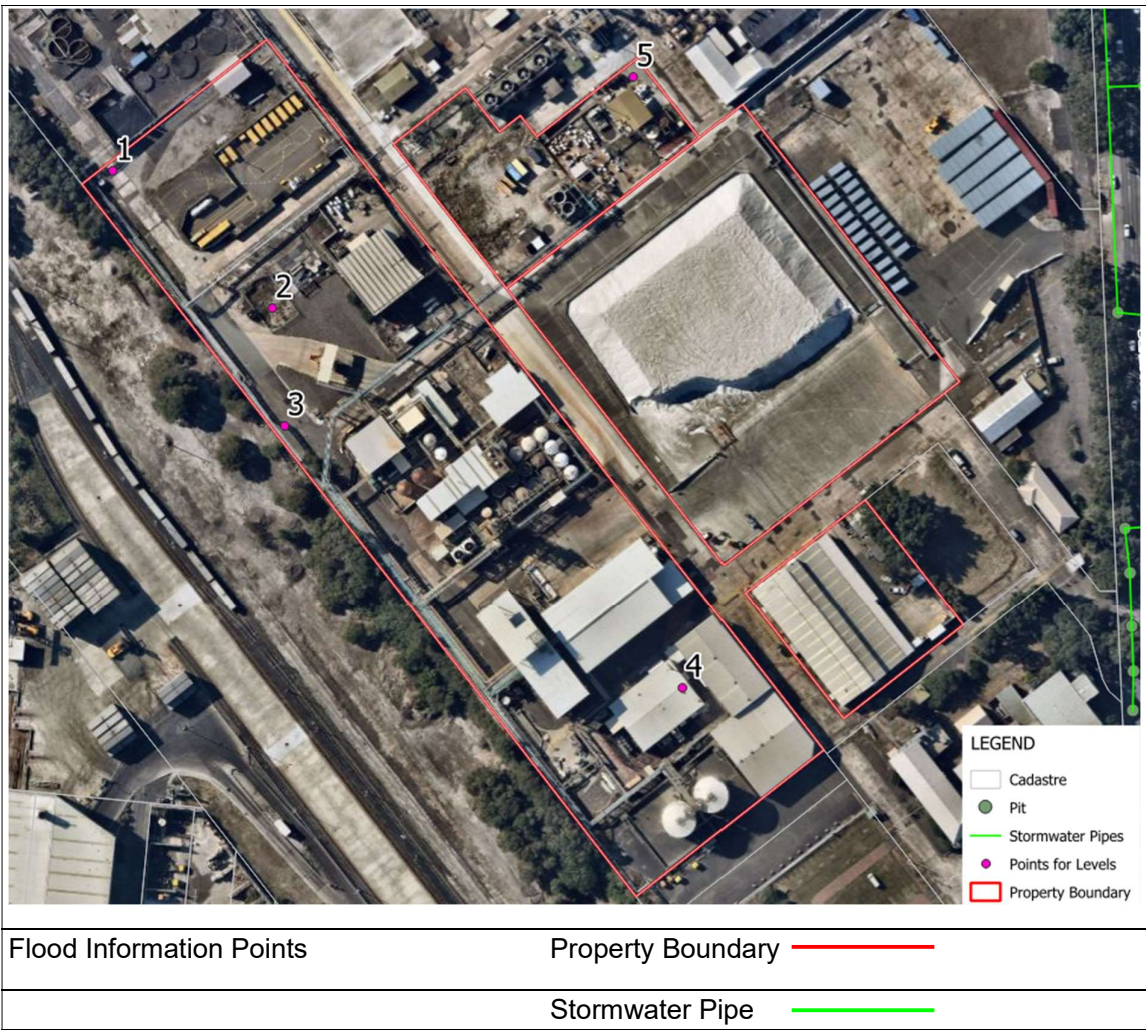
<https://www.bayside.nsw.gov.au/services/planning-and-building/development-approvals/planning-controls-and-constraints>

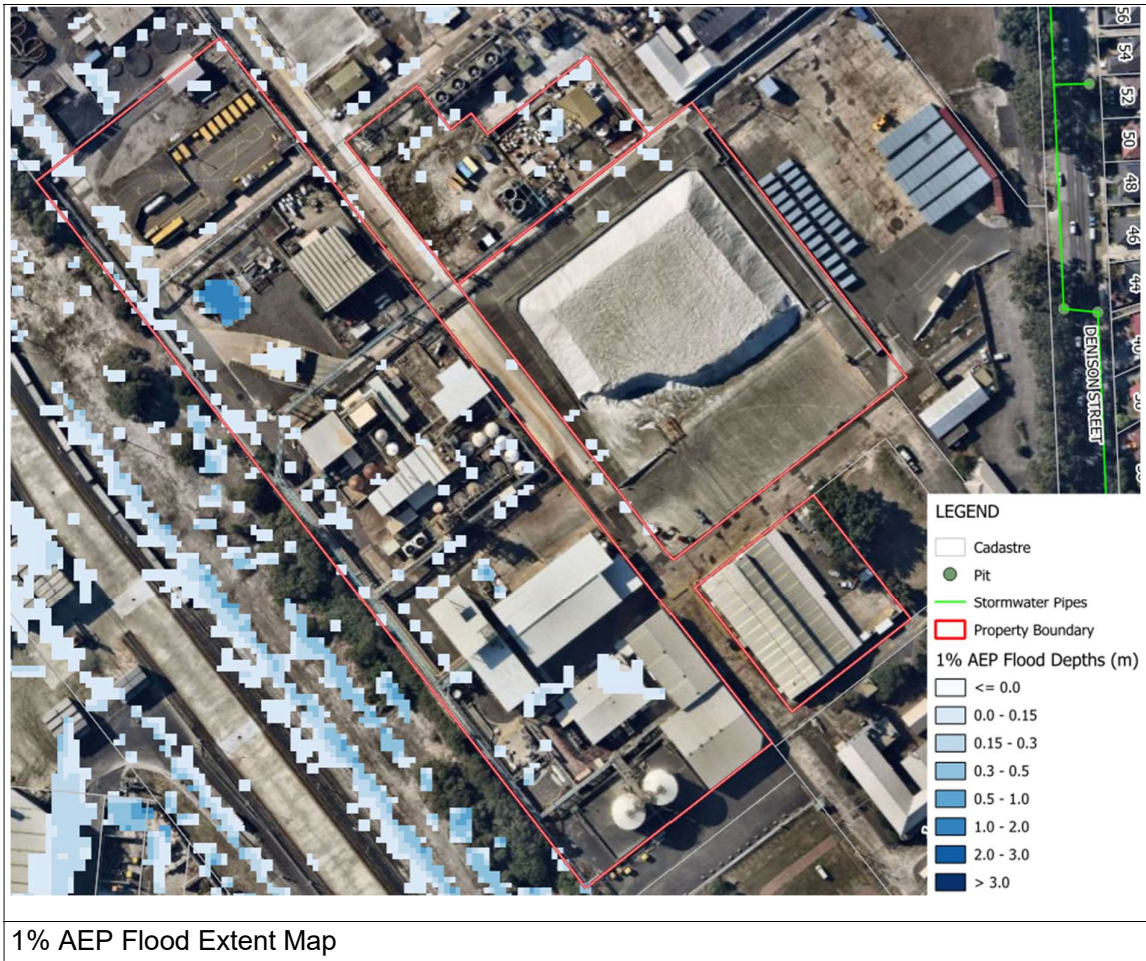
Should you require advice regarding specific development controls related to your development proposal, please contact Council's Development Engineers at devengreferrals@bayside.nsw.gov.au.

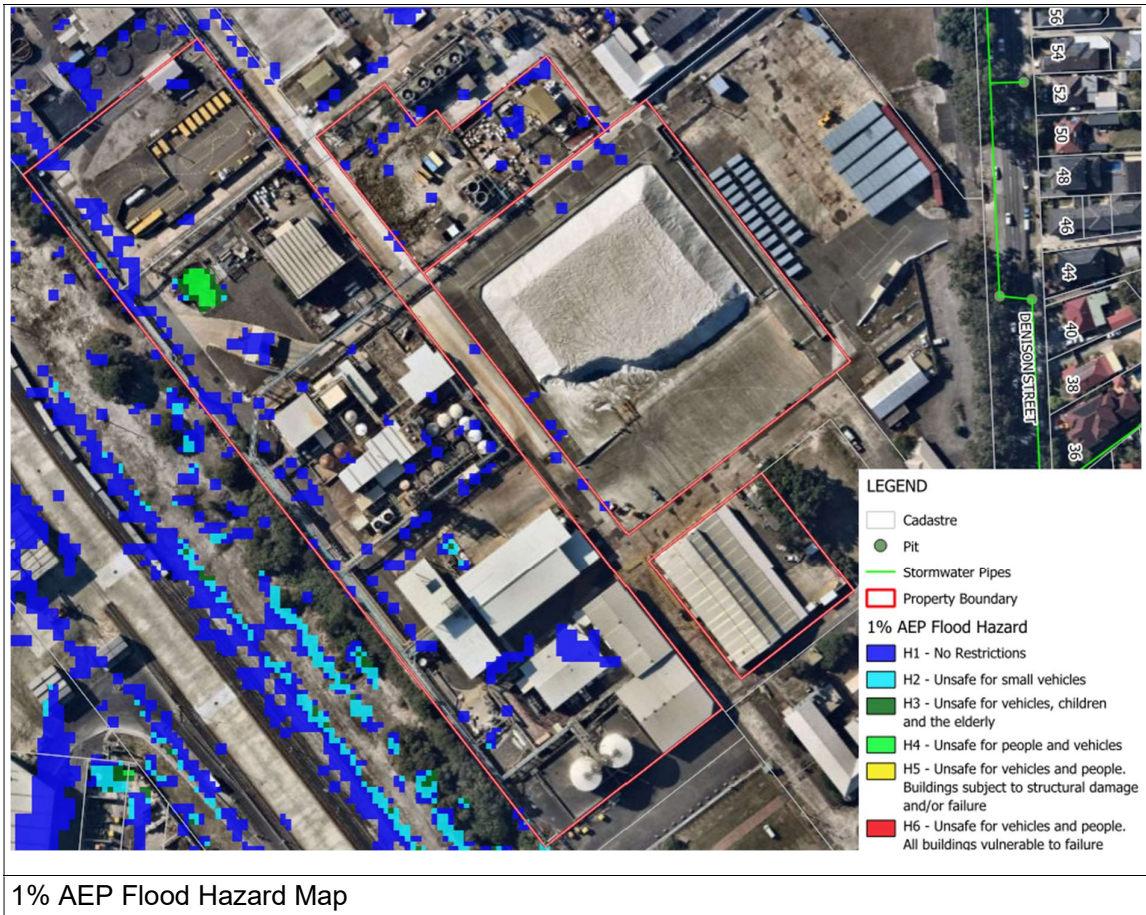
Should you require additional information regarding flooding, please contact Council's Stormwater and Floodplain Engineer, Aaron Biffin, on 02 9366 3840.

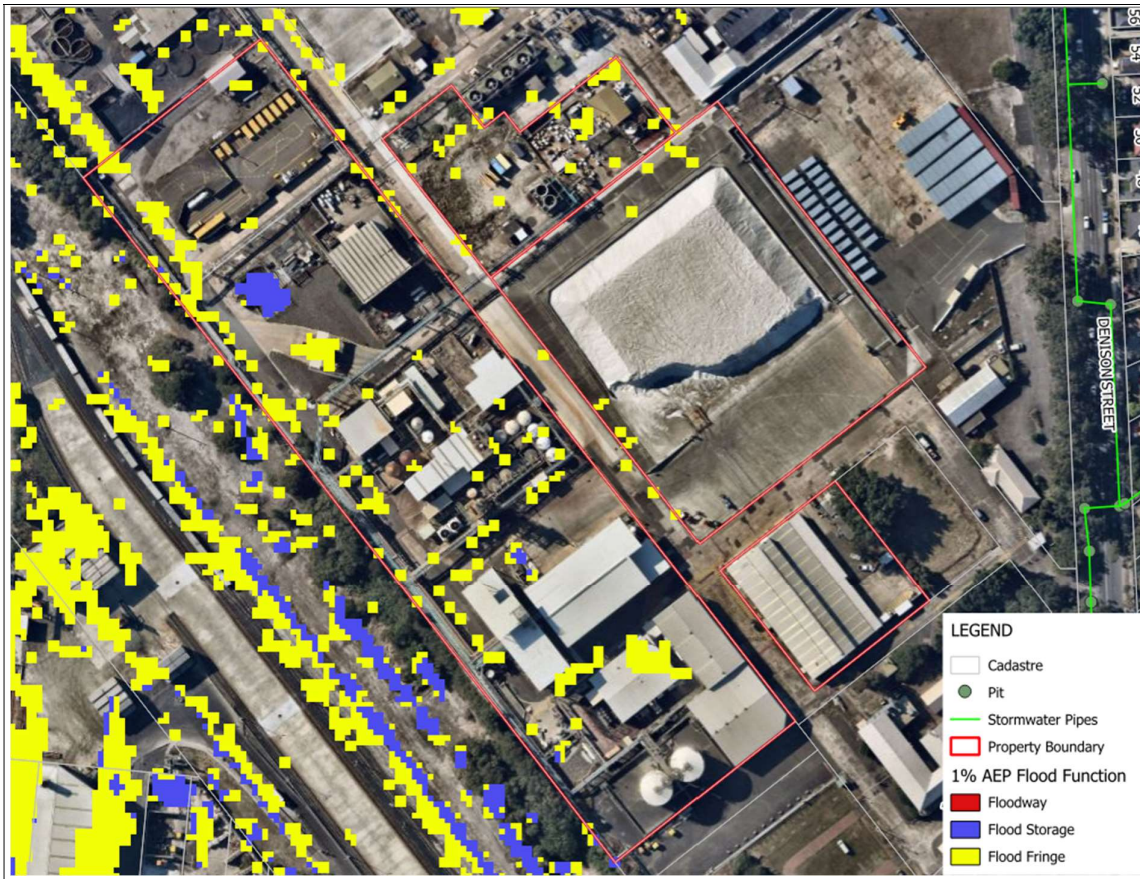
1% AEP Flood Information

Location	1% AEP Flood Level (m AHD)	PMF Level (m AHD)
1	8.07	8.16
2	9.97	10.26
3	10.32	10.38
4	12.66	12.69
5	12.86	12.88









1% AEP Flood Function Map

PMF Information

