Flood Impact Assessment

200 Aldington Road Industrial Estate

NW30034

Prepared for
Fife Kemps Creek Pty Limited

16 September 2021

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Shaping the Future

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Executive Summary

This report has been prepared to inform a State Significant Development Application (SSDA) for the staged development of the 200 Aldington Road Industrial Estate at Lots 20-23 and Lots 30-32 Aldington Road in Kemps Creek.

The Project description for SSD-10479 as lodged (11 November 2020) and publicly exhibited and subsequent amendments to the project to address issues raised by the DPIE and in submissions from agencies, Penrith City Council and the public are summarised.

The purpose of this report is to assess the impact of amended development which it is proposed to undertake in the 200 Aldington Road Industrial Estate.

The flood impact assessment was informed by the assessment of design flood levels, velocities and hazards under Benchmark Conditions as described in Cardno, 2020b.

This report supports an Environmental Impact Statement (EIS) prepared in respect of the proposal and should be read in conjunction with the amended reports and plans submitted with the SSDA.

Hydrology

Hydrological modelling of the upper Ropes Creek catchment under Benchmark Conditions is outlined in Section 1.4.1 and described in detail in Cardno, 2020b.

The intent is that the peak outflows from Basin A and Basin B not exceed the 2 yr ARI and 100 yr ARI peak flows from the same catchment areas under Benchmark Conditions.

A detailed assessment of the size of basin needed to mitigate the impact of development on 2 yr ARI and 100 yr ARI runoff from the 56 ha Aspect Industrial Estate (which is located 1 km west of Aldington Road, Kemps Creek and drains to South Creek) is described by Cardno, 2020a. This estate is of comparable size to the section of the 200 Aldington Industrial Estate which drains to Kemps Creek.

The Site Storage Requirements for 2 yr ARI and 100 yr ARI events determined for Aspect Industrial Estate (AIE) were applied to the area of the 200 Aldington Industrial Estate draining to Basin B and gave estimate of the required basin size as detailed in **Table 1**. The concept Basin B sizing by AT&L of 17,527 m^3 (refer **Figure 3**) is in agreement with the size determined under ARR1987 given in **Table 1**. It is also concluded that the unit SSR and PSD values identified in **Table 1** above are comparable to the unit SSR and PSD given in Table 6 from Sydney Water, 2020.

Stream Erosion Index

A recent assessment of the SEI at Mamre Road for the 56 ha Aspect Industrial Estate (which is located 1 km west of Aldington Road, Kemps Creek and drains to South Creek) disclosed:

> *The SEI has been assessed at Mamre Road under Future Conditions without a Basin and Future Conditions with a Basin based on continuous (6 minute) MUSIC modelling. It was calculated that the SEI under Future Conditions without a Basin and Future Conditions with a Basin would be 5.65 and 1.0 respectively. It is concluded that this demonstrates the impact uncontrolled development can have on the SEI and the effectiveness of a basin which includes a control on frequent flows is able to manage the adverse impacts of development on stream forming flows.*

On the basis that Basins A and B will include controls on frequent flows it is expected that these basins will mitigate the adverse impacts of development on downstream stream forming flows.

Hydraulics

The assessment of flooding under Future Conditions was undertaken by modifying the local TUFLOW model of Benchmark Conditions described in Cardno, 2020b to represent the planned earthworks and development.

The approach adopted by GHD, 2008, Cardno, 2016, 2019 and Lyall & Associates, 2020 when assessing the proposed development under Future Conditions (as discussed in **Appendix B** of Cardno, 2016, 2019) was also adopted for this study, namely, that post-development peak flows will not exceed the 2 yr ARI and 100 yr ARI peak flows from the same catchment areas under Benchmark Conditions.

The TUFLOW floodplain model was run for the critical storm burst durations for the 2 yr ARI, 20 yr ARI, 100 yr ARI and PMF events.

Flood levels and extent, depths, velocities and hazards under Future Conditions are plotted for each of these events.

Flood Impact Assessment

The estimated impact of the proposed 200 Aldington Road Industrial Estate on 2 yr ARI, 20 yr ARI, 100 yr ARI flood levels and PMF levels (in comparison to Benchmark Conditions) are plotted respectively in **Figures 10, 16, 22** and **29**. These Figures disclose minor local adverse impacts on flood level in the vicinity of the NE corner of the 200 Aldington Road Industrial Estate and negligible incremental impacts further downstream of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events. The impacts on the PMF levels are confined to the NE corner of the 200 Aldington Road Industrial Estate and environs and are minor.

It is noted that 28.42 ha of the site which drains into or upstream of the existing farm dam under Existing Conditions will be re-directed into Basin B under Future Conditions. While the intent is that the peak outflows from Basin B not exceed the 2 yr ARI and 100 yr ARI peak flows from the same catchment areas under Benchmark Conditions the outlet to Basin B will discharge outflows downstream of the existing farm dam embankment. Consequently, while there is no increase in peak runoff under Future Conditions runoff a significant proportion of the Basin B outflows will not be further attenuated by flowing through the farm dam. The minor impacts in the Northeast corner of the Estate are attributed to the re-direction of site runoff into Basin B and the location of its outlet downstream of the retained farm dam.

The estimated impact of the proposed 200 Aldington Industrial Estate on 2 yr ARI, 20 yr ARI and 100 yr flood velocities and PMF velocities (in comparison to Benchmark Conditions) are plotted in **Figures 11, 17, 23** and **30** respectively. The 100 yr ARI velocity differences are also reported as percentage differences in **Figure 24**.

Figures 11, 17, 23 disclose local minor impacts on flood velocities in the vicinity of the Basin B outlet and the northeast corner of the Estate and negligible incremental impacts downstream of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events. **Figures 29** discloses local minor impacts on PMF flood velocities in the vicinity of the northeast corner of the Estate and immediately downstream of the Estate and negligible incremental impacts further downstream of the Estate.

Planning Considerations

The site is located within the Mamre Road Precinct (MRP) which was rezoned on 12 June 2020.

The State Environmental Planning Policy (Western Sydney Employment Area) 2009 (SEPP (WSEA)) was also amended and the Mamre Road Structure Plan was introduced.

It is noted that the while the 2020 WSEA Maps includes a map of 1 in 100 AEP Flood Extent it does not include a map titled flood prone land. However, the site is partially located within Council's Flood Planning Area as defined under Penrith LEP 2010 consequently development is occurring on flood prone lands for the purpose of the SEPP (WSEA).

The relevant primary considerations are set out in Clause 33I Development on flood prone land under Part 6 Miscellaneous provisions of the SEPP (WSEA).

As stated also in the 2020 Draft Mamre Road Precinct DCP:

> *This DCP has been prepared in accordance with the EP&A Act and provides additional objectives, controls and guidance to applicants proposing to undertake development in the Mamre Road Precinct, and to guide the assessment of DAs. It should be read in conjunction with State Environmental Planning Policy (Western Sydney Employment Area) 2009 (the WSEA SEPP), in particular the Mamre Road Precinct Structure Plan (Figure 2). The WSEA SEPP and Mamre Road Precinct Plan provide the statutory planning controls for development in the Precinct*

Section 2.7 Flood Prone Land sets out relevant requirements.

It is concluded that this Flood Impact Assessment and the companion Flood Risk Assessment satisfy the relevant flooding requirements of the SEPP (WSEA) 2009 and the 2020 Draft Mamre Road Precinct DCP.

It is further concluded that this Flood Impact Assessment and the companion Flood Risk Assessment satisfy the SEARs requirement for a detailed flooding impact assessment.

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1 Introduction

1.1 Purpose of this Report

This report has been prepared to inform a State Significant Development Application (SSDA) for the staged development of the Fife Kemps Creek (FKC) Estate at Lots 20-23 and Lots 30-32 Aldington Road in Kemps Creek.

The purpose of this report is to assess the impact of development which it is proposed to undertake in the 200 Aldington Road Industrial Estate.

The flood impact assessment was informed by the assessment of design flood levels, velocities and hazards under Benchmark Conditions as described in Cardno, 2020b (refer Section 1.3).

This report supports an Environmental Impact Statement (EIS) prepared in respect of the proposal and should be read in conjunction with the EIS, Civil Infrastructure report and development plans submitted with the SSDA.

1.2 Location

The site address is known as 106 – 142 (Lots 30-32) and 144 – 228 (Lots 20-23) Aldington Road, Kemps Creek.

The location of the site is indicated in **Figure 1**.

1.3 Project Description

This section provides a summary of the Project description for SSD-10479 as lodged (11 November 2020) and publicly exhibited and subsequent amendments to the project to address issues raised by the DPIE and in submissions from agencies, Penrith City Council and the public.

This section concludes with a description of the SSDA for which development consent is now sought.

1.3.1 Summary of project as lodged and publicly exhibited (October 2020)

As lodged and exhibited, the SSDA sought approval for the following development:

- A concept masterplan with an indicative total building area of 375,755 sqm, comprising:
  - 357,355 sqm of warehouse gross floor area (**GFA**)
  - 18,200 sqm of ancillary office GFA
  - 200 sqm of café GFA
  - 13 individual development lots for warehouse buildings with associated hardstand areas and two lots for drainage infrastructure purposes
  - Internal road layouts and road connections to Aldington Road
  - Provision for 1700 car parking spaces
  - Associated concept site landscaping.

- Detailed consent for progressive delivery of site preparation, earthworks and infrastructure works (i.e., Stage 1 works) on the site, including:
  - Demolition and clearing of all existing built form structures
  - Drainage and infill of existing farm dams and any ground dewatering
  - Clearing of all existing vegetation
  - Subdivision of the site into 15 individual lots
  - Construction of a warehouse building with a total of 50,930 sqm of GFA, including:
  - 48,430 sqm of warehouse GFA
  - 2,500 sqm of ancillary office GFA
  - 231 car parking spaces
  - Bulk earthworks including 'cut and fill' to create flat development platforms for the warehouse buildings, and site stabilisation works (if required)
  - Roadworks and access infrastructure
  - Stormwater and drainage works including stormwater basins, diversion of stormwater lines, gross pollutant traps and associated swale works
  - Sewer and potable water reticulation
  - Inter-allotment, road and boundary retaining walls.

1.3.2 Response to Submissions (March 2021)

Following the public exhibition of the Project, changes were undertaken in response to the issues raised during the public exhibition. This included a full assessment of the Project against the Draft Mamre Road Precinct Development Control Plan (**draft MRP DCP**) which was released subsequent to lodgement of the SSDA.

The key changes and additional information on the Project included:

- A revised riparian solution in the north east corner of the site which relocated the existing first order water course and re-established the riparian corridor with a 10-metre buffer on each side in accordance with the Natural Resources Access Regulator (NRAR) guidelines.
- An evidence-based case for the proposed location of the high order road south of the site's northern boundary which was seen to provide a more logical and feasible road network outcome (for both FKC and its northern neighbour) compared to that envisioned under the draft MRP DCP.
- Revised technical inputs for the flood assessment to address the submissions raised, including Figures which addressed post development conditions in the 2-, 20- and 100-year ARI events, and providing further commentary on the flooding impacts of surrounding and downstream land.
- An integrated water management solution which can effectively allow the progressive redevelopment of the site to occur while still recognising and meeting stormwater runoff targets set out in the draft and eventual final MRP DCP.
- A revised Visual Impact Assessment showing the impact of proposed landscaping mitigation over time.

- Rationale for minor departures from the draft MRP DCP in relation to building design and sitting, pylon signage and retaining walls.

1.3.3 Request for Additional Information (April 2021)

Further changes to the Project (which are the subject of this RTS Report) are the result of further correspondence received by DPIE (dated 28 April 2021). The changes to the Project further align the proposed development with the relevant provisions of the draft MRP DCP (especially in relation to the proposed road network) and exclude prohibited components of development from the RE2 Private Recreation zone.

The Summary of key changes to the project are:

- Concept Master Plan:
  - Reconfiguration of the internal road network and external road connections to be generally consistent with the draft Mamre Road Precinct DCP including:
    - Provision of a land reservation corridor along the northern boundary to facilitate half the required future DCP road and intersection with Aldington Road;
    - Inclusion of the open space edge road in the north-east section of the site with connections through to the adjoining properties to the north and east; and
    - Intersections with Aldington Road; signalised south intersection and roundabout northern intersection; and
    - Amendments to road corridor widths.
  - Reconfiguration of Lot G to facilitate the open space edge road to the adjoining eastern property and to locate the proposed warehouse footprint wholly within the IN1 zone
  - Relocation of on-site detention basin within Lot D to be outside the RE2 Private Recreation zone in within the IN1 zone;
  - Retention of existing farm dams within the RE2 zoned area in the north-east corner of the site;
  - Consequential amendments to bulk earthwork pads, retaining walls, lot and future warehouse layout, car parking and landscaping.

- Stage 1 works:
  - Overall revisions to site preparation, earthworks and infrastructure consistent with the revised concept master plan;
  - Inclusion of an interim access road and temporary junction connecting to Aldington Road in the northern portion of the site to facilitate site access prior to the implementation of the northern boundary road;
  - Revision to the internal road network in line with the concept master plan revisions with the provision of temporary turning heads at the site boundary where those roads will connect to properties to the east and north in the future. The road levels at the boundary interface of the site will align with existing ground level (or as required to contain stormwater).

1.3.4 Description of Project, as amended, for which development consent is now sought

The amended SSDA seeks approval for the following development:

- A concept masterplan with an indicative total building area of 347,955 sqm (refer **Figure 2**) comprising:
  - 330,950 sqm of warehouse gross floor area (**GFA**)
  - 17,005 sqm of ancillary office GFA
  - 13 individual development lots for warehouse buildings with associated hardstand areas and two lots for drainage infrastructure purposes (each including a bio-retention basin)
  - Roads, including:
    - Internal road layouts
    - Southern road connection to Aldington Road
    - Northern boundary road (half road corridor) connecting to Aldington Road
    - Road connections to adjoining landholdings to the north and east
  - Provision for 1549 car parking spaces and
  - Associated concept site landscaping

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- Detailed consent for progressive delivery of site preparation, earthworks and infrastructure works (i.e., Stage 1 works) on the site, including:
  - Demolition and clearing of all existing built form structures
  - Drainage and infill of existing farm dams and any ground dewatering
  - Clearing of all existing vegetation
  - Subdivision of the site into 15 individual lots
  - Construction of a warehouse building with a total of 50,930 sqm of GFA, including:
    - 48,430 sqm of warehouse GFA
    - 2,500 sqm of ancillary office GFA and
    - 219 car parking spaces
  - Bulk earthworks including 'cut and fill' to create flat development platforms for the warehouse buildings, and site stabilisation works (if required)
  - Roadworks and access infrastructure, including an interim access road and temporary junction with Aldington Road
  - Stormwater and drainage works including stormwater basins, diversion of stormwater lines, gross pollutant traps and associated swale works
  - Sewer and potable water reticulation and
  - Inter-allotment, road and boundary retaining walls

The concept details of the proposed stormwater management measures for 200 Aldington Road Industrial Estate are given in **Figures 3** and **4**.

1.4 2020 Flood Risk Assessment

The 2020 Flood Risk Assessment report provides a high-level understanding of the opportunities and constraints of the site due to flooding and informed the development of a stormwater strategy/management plan for the 200 Aldington Industrial Estate based on the assessment of flooding under Benchmark Conditions (Cardno, 2020b).

This assessment is outlined as follows.

1.4.1 Hydrology

Hydrological modelling of the South Creek catchment was undertaken at the catchment scale using XP-RAFTS.

A comparison of the 2008/2016/2019 GHD/Oakdale South/Oakdale West assessments with other studies highlighted significant differences in the peak flow estimates. Comparisons of the catchment area to the Sydney Water Pipeline and the catchment boundaries and the peak flows led to a re-discretisation of the upper Ropes Creek catchment in the 2008/2016/2019 GHD/Oakdale South/Oakdale West model and a review of the adopted levels of imperviousness as well as the partitioning of the site based on the local subcatchments under existing conditions.

An assessment of the sensitivity of 100 yr ARI peak runoff to storm burst rainfall losses, model parameter values and version of ARR was undertaken in order to identify the benchmark conditions for this study.

These cases which were reviewed and/or assessed were:

- The 2008/2016/2019 GHD/Oakdale South/Oakdale West model (GHD, 2008; Cardno, 2016, 2019) (Case 1)
- The 2015 Ropes Creek model (Worley Parsons, 2015) (Case 2)
- The Southern Link Road model (Lyall & Associates, 2020) (Case 3)

The re-discretised GHD model (this study) for three scenarios:

- ARR1987 IDF + Rainfall losses and roughness values and BX value from GHD, 2008; Cardno, 2016,2019 (Case 4)
- ARR1987 + Rainfall losses and model parameter from Worley Parsons, 2015 (Case 5)
- ARR2019 + ARR2019 rainfall losses + and roughness values and BX value from GHD, 2008: Cardno, 2016, 2019 (Case 6)

It was concluded that:

(i) The 100 yr ARI peak flows under Case 4 are far closer to the Worley Parsons (Case 2) peak flows than the previous Oakdale South/Oakdale West/GHD (Case 1) estimates;

(ii) A change in the critical storm burst duration to 9 hours with the1.5 hour and 2 hour peak flows being not too much lower (under ARR1987); and

(iii) The adoption of ARR2019 would reduce the critical storm burst duration to 6 hours and would further reduce the 1% AEP peak flows.

For assessment purposes, Case 4 was adopted for the assessment of the Benchmark Conditions.

1.4.2 Hydraulics

The assessment of flooding in Ropes Creek floodplain was undertaken using a TUFLOW model of the upper Ropes Creek floodplain.

An assessment of the sensitivity of 100 yr ARI flood levels under pre-development conditions was undertaken in order to identify the benchmark conditions for this study. The cases which were reviewed and/or assessed were:

- The 2008 GHD model of Existing Conditions (GHD, 2008)
- The 2015 Ropes Creek model (Worley Parsons, 2015)
- The 2016 GHD model with Oakdale South Cardno, 2016)
- The 2019 GHD model with Oakdale South and Oakdale West (Cardno, 2019)
- The 2008 GHD model of Existing Conditions with revised hydrology (Case E1)
- The 2019 GHD model with Oakdale South and Oakdale West and revised hydrology (Case E2)

The following was concluded from these results:

(i) The 2015 Worley Parsons 100 yr ARI flood levels under Existing Conditions are significantly lower than the 2008 GHD 100 yr ARI flood levels under Existing Conditions (0.2 m – 0.73 m lower);

(ii) The revised 100 yr ARI flood levels under Existing Conditions (this study – Case E1) are significantly lower than the 2008 GHD 100 yr ARI flood levels under Existing Conditions (0.1 m – 0.39 m lower) but remain higher than 2015 Worley Parsons 100 yr ARI flood levels under Existing Conditions (0.14 – 0.36 m higher)

(iii) While the impact of Oakdale South and Oakdale West under revised Existing Conditions (this study - Case E2) in comparison to 2019 GHD model with Oakdale South and Oakdale West are increases of up to 0.21 m this is in an area where the 2019 lowered the 100 yr ARI flood level by 0.19 m – consequently the net effect is a flood levels which is the same as under Case E1;

(iv) The incremental impacts of Oakdale South and Oakdale West under revised Existing Conditions (this study - Case E2) in comparison to revised Existing Conditions are increases of up to 0.05 m (but in locations where the revised flows have lowered the 100 yr ARI flood level);

Based on this comparative assessment, Case E2, which incorporates Oakdale South and Oakdale West which are currently under construction, was adopted as the Benchmark Conditions.

The TUFLOW floodplain model was run for the critical storm burst durations for the 2 yr ARI, 5 yr ARI, 100 yr ARI and PMF events under Benchmark Conditions. Flood levels and extent, depths, velocities and hazards under Benchmark Conditions are plotted for each of these events in Cardno, 2020b.

1.5 Terminology

Book 1, Chapter 2, Section 2.2.5. Adopted Terminology in Australian Rainfall & Runoff, 2016 describes the adopted terminology as follows:

> *To achieve the desired clarity of meaning, technical correctness, practicality and acceptability, the National Committee on Water Engineering has decided to adopt the terms shown in Figure 1.2.1 and the suggested frequency indicators.*

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI
Very Frequent	12			
	6	99.75	1.002	0.17
	4	98.17	1.02	0.25
	3	95.02	1.05	0.33
	2	86.47	1.16	0.5
	1	63.21	1.58	1
Frequent	0.69	50	2	1.44
	0.5	39.35	2.54	2
	0.22	20	5	4.48
	0.2	18.13	5.52	5
	0.11	10	10	9.49
Rare	0.05	5	20	20
	0.02	2	50	50
	0.01	1	100	100
Very Rare	0.005	0.5	200	200
	0.002	0.2	500	500
	0.001	0.1	1000	1000
	0.0005	0.05	2000	2000
Extreme	0.0002	0.02	5000	5000
			↓	
			PMP/ PMPDF	

Figure 1.2.1. Australian Rainfall and Runoff Preferred Terminology

Navy outline indicates preferred terminology. Shading indicates acceptable terminology which is depends on the typical use. For example, in floodplain management 0.5% AEP might be used while in dam design this event would be described as a 1 in 200 AEP.

As shown in the third column of Figure 1.2.1, the term Annual Exceedance Probability (AEP) expresses the probability of an event being equalled or exceeded in any year in percentage terms, for example, the 1% AEP design flood discharge. There will be situations where the use of percentage probability is not practicable; extreme flood probabilities associated with dam spillways are one example of a situation where percentage probability is not appropriate. In these cases, it is recommended that the probability be expressed as 1 in X AEP where 100/X would be the equivalent percentage probability.

For events more frequent than 50% AEP, expressing frequency in terms of annual exceedance probability is not meaningful and misleading, as probability is constrained to a maximum value of 1.0 or 100%. Furthermore, where strong seasonality is experienced, a recurrence interval approach would also be misleading. An example of strong seasonality is where the rainfall occurs predominately during the Summer or Winter period and as a consequence flood flows are more likely to occur during that period.

> *Accordingly, when strong seasonality exists, calculating a design flood flow with a 3 month recurrence interval is of limited value as the expectation of the time period between occurrences will not be consistent throughout the year. For example, a flow with the magnitude of a 3 month recurrence interval would be expected to occur or be exceeded 4 times a year; however, in situations where there is strong seasonality in the rainfall, all of the occurrences are likely to occur in the dominant season.*
>
> *Consequently, events more frequent than 50% AEP should be expressed as X Exceedances per Year (EY). For example, 2 EY is equivalent to a design event with a 6 month recurrence interval when there is no seasonality in flood occurrence*

The terminology adopted herein depends on the edition of Australian Rainfall and Runoff provide the IFD data. In the case of assessments based on ARR1987 the ARI terminology was adopted design floods. In the case of assessments based on ARR2019 the AEP terminology was adopted design floods.

2 Hydrology

Hydrological modelling of the South Creek catchment was undertaken at the catchment scale using XP-RAFTS.

2.1 Benchmark (Pre-Development) Conditions

Hydrological modelling of the upper Ropes Creek catchment under Benchmark Conditions is outlined in Section 1.4.1 and described in detail in Cardno, 2020b.

2.2 Future (Post-Development) Conditions

The local subcatchment layout under Future Conditions is given in **Figure 4**.

The intent is that the peak outflows from Basin A and Basin B not exceed the 2 yr ARI and 100 yr ARI peak flows from the same catchment areas under Benchmark Conditions.

2.2.1 Future Conditions with a Basin

A detailed assessment of the size of basin needed to mitigate the impact of development on 2 yr ARI and 100 yr ARI runoff from the 56 ha Aspect Industrial Estate (which is located 1 km west of Aldington Road, Kemps Creek and drains to South Creek) is described by Cardno, 2020a. This estate is of comparable size to the section of the 200 Aldington Road Industrial Estate which drains to Kemps Creek.

The concept sizing of a basin for Aspect Industrial Estate was undertaken for ARR1987 conditions. A similar concept sizing of a basin to mitigate the impact of development on 50% AEP and 1% AEP runoff from the Aspect Industrial Estate was undertaken for ARR2019 conditions.

The basin assessments included.

- An ARR1987 assessment which targeted the 2yr ARI (12 hour) and 100 yr ARI (2 hour) peak flows under benchmark conditions in the local catchment draining to South Creek; and
- An ARR2019 assessment which targeted the 50%AEP (6 hour) and 1% AEP (45 minutes) peak flows under benchmark conditions in the local catchment draining to South Creek.

The Site Storage Requirements for 2 yr ARI and 100 yr ARI events determined for Aspect Industrial Estate (AIE) were applied to the area of the 200 Aldington Road Industrial Estate draining to Basin B (refer **Figure 4**) and gave estimate of the required basin size as detailed in **Table 1**. The concept Basin B sizing by AT&L of 17,527 m^3 (refer **Figure 3**) is in agreement with the size determined under ARR1987 given in **Table 1**.

Table 1 Indicative Sizing of Basin B based on AIE Unit SSR Values

		SSR (m^3)			SSR (m^3/ha)	
ARR		2 yr ARI / 50% AEP	100 yr ARI / 1% AEP	2yr / 100 yr SSR Ratio	2 yr ARI / 50% AEP	100 yr ARI / 1% AEP
1987	2 yr ARI (12 hr) & 100 yr ARI (2 hr)	7,753	16,195	48%	201	420
2019	50% AEP (6 hr) & 1% AEP (45 mins)	11,592	19,786	59%	301	514

As described by Sydney Water, 2020:[1]

> *This Integrated Water Cycle Management study has been prepared to inform and support the rezoning of the Mamre Road Precinct. Controls prescribed by this study will inform the Precinct DCP and ensures that:*
>
> - *Land use is compatible with flood risk*
> - *Flood management approaches are effective and consistent across the catchment*
> - *Water sensitive urban design approaches achieve pollution reduction targets and contribute to emerging waterway health targets in a flexible and cost-effective way*
> - *Sufficient land is allocated for stormwater and flood management on private lots and in the public domain*
>
> *…….*
>
> *An assessment of flood constraints associated with the land use change includes:*
>
> - *defining flood behaviour within the Precinct's unnamed tributaries*
> - *an assessment of flood behaviour post-development and the impacts the change in land use will have on local catchment flood behaviour, including impacts on existing infrastructure and lands outside the Precinct*
> - *an assessment of the flood mitigation requirements for the Precinct*
>
> *…. The local XP-RAFTS model was run for the 1EY, 5% AEP, 1%AEP, 0.2% AEP and PMF events for all durations between 15 minutes to 36 hours.*

Mapping of hydraulic modelling results is only reported for 5% AEP, 1% AEP and 0.2% AEP events.

The mapping disclosed that the Ropes Creek floodplain that this was not the focus of the assessment. Rather the focus was on the unnamed overland flowpaths. Consequently, there are no flows reported for the main watercourses only for the flowpaths.

The extents of overland flow flooding through the site under Existing Conditions mapped in 2006 are given in Figure B-1 in Cardno, 2020b. More recently mapping of the overland flowpaths within the site has been presented by Sydney Water, 2020.

Overland flows within the site under Existing Conditions informed the drainage strategy described in the related Stormwater Management Report prepared by AT&L. Under the proposed development 100 yr ARI runoff upstream of Aldington Road is collected and conveyed through the development in a dedicated pipe with 100 yr ARI capacity while runoff from within the site is directed to basins.

[1] Sydney Water (2020) "Mamre Road Flood, Riparian Corridor and Integrated Water Cycle Management Strategy", *Final Report*, October, 61 pp + Apps

In Section 6.4.2 Detention Strategy of Sydney Water, 2020:

> *It is recommended that each industrial lot implements on-site stormwater detention as prescribed by Table 6.*

Table 6 OSD requirements on industrial lots within Mamre Road Precinct

Zone	50% AEP SSR (m^3/ha)	50% AEP PSD (l/s/ha)	1% AEP SSR inclusive of 50% AEP SSR (m^3/ha)	1% AEP PSD (l/s/ha)
East Catchments draining towards Ropes Creek	190	40	393	150
North Catchment draining towards WaterNSW Warragamba Pipeline	190	40	393	150
West Catchments draining towards Ropes Creek	190	40	393	150

It is also concluded that the unit SSR and PSD values identified in **Table 1** above are comparable to the unit SSR and PSD given in Table 6 from Sydney Water, 2020.

2.3 Stream Erosion Index

It is anticipated that the Stream Erosion Index will be of interest to Council. Council typically requires:

> *An assessment to show that the post development duration of stream forming flows is no greater than 3.5 times the pre-developed duration of stream forming flows.*

This is interpreted to be a requirement that the Stream Erosion Index (SEI) be no greater than 3.5.

The stream erosion index is a value that can describe the impact of development on a watercourse in terms of erosion potential. It is defined as the number of occasions the Developed Conditions flow exceeds the 'stream forming flow', divided the number of occasions the Benchmark Conditions flow exceeds the 'stream forming flow'.

Stream forming flow is defined as 50% of the 2 year ARI flow under Benchmark Conditions.

A recent assessment of the SEI at Mamre Road for the 56 ha Aspect Industrial Estate (which is located 1 km west of Aldington Road, Kemps Creek and drains to South Creek) disclosed:

> *The SEI has been assessed at Mamre Road under Future Conditions without a Basin and Future Conditions with a Basin based on continuous (6 minute) MUSIC modelling. It was calculated that the SEI under Future Conditions without a Basin and Future Conditions with a Basin would be 5.65 and 1.0 respectively. It is concluded that this demonstrates the impact uncontrolled development can have on the SEI and the effectiveness of a basin which includes a control on frequent flows is able to manage the adverse impacts of development on stream forming flows.*

On the basis that Basins A and B will include controls on frequent flows it is expected that these basins will mitigate the adverse impacts of development on downstream stream forming flows.

3 Flooding Assessment

The assessment of flooding under Future Conditions was undertaken by modifying the TUFLOW model of Benchmark Conditions described in Cardno, 2020b to represent the planned earthworks and development as follows.

The DEM of flood prone land was updated based on the proposed platform levels and proposed Basin B works as disclosed in **Figure 3.**

The roughness zones under Future Conditions are mapped in **Figure 5**.

Inflows to the TUFLOW model were exported from the hydrological model and input at the locations of the subcatchment outlets (nodes). The basin was not explicitly modelled rather the outflow from the basin was input just downstream of the existing farm dam wall.

The approach adopted by GHD, 2008, Cardno, 2016, 2019 and Lyall & Associates, 2020 when assessing the proposed development under Future Conditions (as discussed in **Appendix B** of Cardno, 2016, 2019) was also adopted for this study, namely, that post-development peak flows will not exceed the 2 yr ARI and 100 yr ARI peak flows from the same catchment areas under Benchmark Conditions.

When assessing the potential impacts of the proposed Southern Link Road which traverses Oakdale West and crosses Ropes Creek, Lyall & Associates, 2020, in part, stated:

> *While several large-scale commercial/industrial develops are presently being constructed in the immediate vicinity of the future road corridor, for the purpose of the present investigation it was assumed that the detention basins which form part of these developments would limit the rate at which runoff discharges to the various drainage lines to no greater than pre-developed conditions. On this basis, the land use in the sub-catchments within which these developments are located were modelled as being rural in nature.*

3.1 Future (Post-Development) Conditions

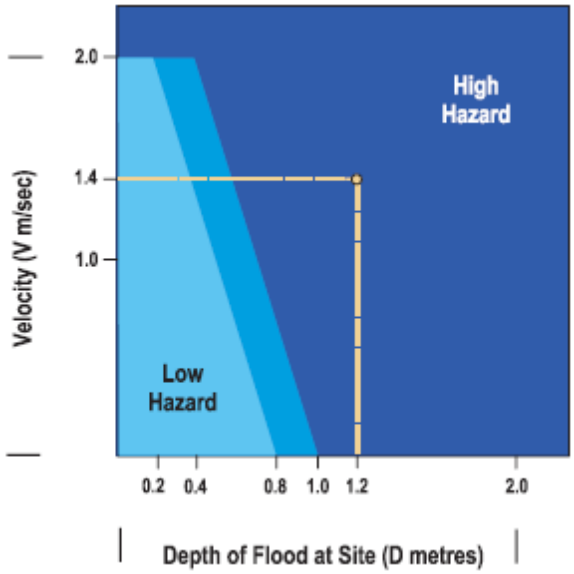
The TUFLOW floodplain model was run for the critical storm burst durations for the 2 yr ARI, 20 yr ARI, 100 yr ARI and PMF events.

3.1.1 2 yr ARI

The estimated 2 year ARI flood levels and extent, depths and velocities under Future Conditions are plotted in **Figures 6, 7** and **8** respectively.

Experience from studies of floods throughout NSW and elsewhere has allowed authorities to develop methods of assessing the hazard to life and property on floodplains. This experience has been used in developing the NSW Floodplain Development Manual to provide guidelines for managing this hazard. These guidelines are shown schematically below.

To use the diagram, it is necessary to know the average depth and velocity of floodwaters at a given location. If the product of depth and velocity exceeds a critical value (as shown below), the flood flow will create a high hazard to life and property.



Provisional Hazard Categories (after Figure L2, NSW Government, 2005)

There will probably be danger to persons caught in the floodwaters, and possible structural damage. Evacuation of persons would be difficult. By contrast, in low hazard areas people and their possessions can be evacuated safely by trucks. Between the two categories a transition zone is defined in which the degree of hazard is dependent on site conditions and the nature of the proposed development.

This calculation leads to a provisional hazard rating. The provisional hazard rating may be modified by consideration of effective flood warning times, the rate of rise of floodwaters, duration of flooding and ease or otherwise of evacuation in times of flood. The estimated 2 year ARI provisional flood hazard under Benchmark Conditions are plotted in **Figure 9**.

3.1.2 20 yr ARI

The estimated 20 year ARI flood levels and extent, depths, velocities and hazards under Future Conditions are plotted in **Figures 12, 13, 14** and **15** respectively.

3.1.3 100 yr ARI

The estimated 100 year ARI flood levels and extent, depths, velocities and hazards under Future Conditions are plotted in **Figures 18, 19, 20** and **21** respectively.

3.1.4 PMF

The estimated PMF flood levels and extent, depths, velocities and hazards under Future Conditions are plotted in **Figures 25, 26, 27** and **28** respectively.

4 Flood Impact Assessment

The impacts of the proposed 200 Aldington Road Industrial Estate are described as follows.

4.1 Flood Level Impacts

The estimated impact of the proposed 200 Aldington Road Industrial Estate on 2 yr ARI, 20 yr ARI, 100 yr ARI flood levels and PMF levels (in comparison to Benchmark Conditions) are plotted respectively in **Figures 10, 16, 22** and **29**.

These Figures disclose minor local adverse impacts on flood level in the vicinity of the NE corner of the 200 Aldington Road Industrial Estate and negligible incremental impacts further downstream of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events. The impacts on the PMF levels are confined to the NE corner of the 200 Aldington Road Industrial Estate and environs and are minor.

It is noted that 28.42 ha of the site which drains into or upstream of the existing farm dam under Existing Conditions will be re-directed into Basin B under Future Conditions. While the intent is that the peak outflows from Basin B not exceed the 2 yr ARI and 100 yr ARI peak flows from the same catchment areas under Benchmark Conditions the outlet to Basin B will discharge outflows downstream of the existing farm dam embankment. Consequently, while there is no increase in peak runoff under Future Conditions runoff a significant proportion of the Basin B outflows will not be further attenuated by flowing through the farm dam. The minor impacts in the Northeast corner of the Estate are attributed to the re-direction of site runoff into Basin B and the location of its outlet downstream of the retained farm dam.

Table 2 summarises the available 2 yr ARI, 20 yr ARI and 100 yr ARI flood levels extracted at 11 reference locations (0, 1, 2, 3, …10) identified in **Figure 31** for the cases including:

- The 2008 GHD model of Existing Conditions (Existing - 2008 GHD)
- The 2015 Ropes Creek model (Existing - 2015 Worley Parsons)
- The 2008 GHD model of Existing Conditions with revised hydrology (Case E1)
- The 2019 GHD model with Oakdale South and Oakdale West and revised hydrology (Case E2)
- The 2021 Future Conditions for 200 Aldington Road Industrial Estate (Case F1)

The following was concluded from these results:

(i) The 2015 Worley Parsons 100 yr ARI flood levels under Existing Conditions are significantly lower than the 2008 GHD 100 yr ARI flood levels under Existing Conditions (0.2 m – 0.73 m lower);

(ii) The revised 100 yr ARI flood levels under Existing Conditions (this study – Case E1) are significantly lower than the 2008 GHD 100 yr ARI flood levels under Existing Conditions (0.1 m – 0.39 m lower) but remain higher than 2015 Worley Parsons 100 yr ARI flood levels under Existing Conditions (0.14 – 0.36 m higher)

(iii) While the impact of Oakdale South and Oakdale West under revised Existing Conditions (this study - Case E2) in comparison to 2019 GHD model with Oakdale South and Oakdale West are increases of up to 0.21 m this is in an area where the 2019 lowered the 100 yr ARI flood level by 0.19 m – consequently the net effect is a flood levels which is the same as under Case E1;

Table 2 Comparison of 2 yr ARI, 20 yr ARI and 100 yr ARI Flood Levels at Reference Locations

2 yr ARI

Reference Location	Existing - 2008 GHD (mAHD) (a)	Existing - 2015 WP (mAHD) (b)	FL Difference (cm) (b) - (a)	Reference Location	Case E1 (mAHD) (f)	FL Difference (cm) (f) - (a)	FL Difference (cm) (f) - (b)	Case E2 - Adopted Benchmark (mAHD) (g)	FL Difference (cm) (g) - (c)	FL Difference (cm) (g) - (f)	Case F1 (mAHD) (h)	Incremental FL Difference (cm) (h) - (g)
0								63.93		6393	63.93	0
1								63.81		6381	63.81	0
2								63.76		6376	63.76	0
3								63.73		6373	63.73	0
4								62.52		6252	62.52	0
5								62.19		6219	62.22	3
6								61.10		6110	61.10	0
7								-			-	
8								57.05		5705	57.04	-1
9								56.23		5623	56.23	0
10								54.12		5412	54.12	0

20 yr ARI

Reference Location	Existing - 2008 GHD (mAHD) (a)	Existing - 2015 WP (mAHD) (b)	FL Difference (cm) (b) - (a)	Reference Location	Case E1 (mAHD) (f)	FL Difference (cm) (f) - (a)	FL Difference (cm) (f) - (b)	Case E2 - Adopted Benchmark (mAHD) (g)	FL Difference (cm) (g) - (c)	FL Difference (cm) (g) - (f)	Case F1 (mAHD) (h)	Incremental FL Difference (cm) (h) - (g)
0								64.22			64.22	0
1								63.96			63.96	0
2								63.85			63.85	0
3								63.79			63.79	0
4								62.60			62.63	3
5								62.58			62.62	4
6								61.46			61.46	0
7								60.09			60.09	
8								57.37			57.37	0
9								56.48			56.48	0
10								54.28			54.29	1

100 yr ARI

Reference Location	Existing - 2008 GHD (mAHD) (a)	Existing - 2015 WP (mAHD) (b)	FL Difference (cm) (b) - (a)	Reference Location	Case E1 (mAHD) (f)	FL Difference (cm) (f) - (a)	FL Difference (cm) (f) - (b)	Case E2 - Adopted Benchmark (mAHD) (g)	FL Difference (cm) (g) - (c)	FL Difference (cm) (g) - (f)	Case F1 (mAHD) (h)	Incremental FL Difference (cm) (h) - (g)
0	64.61	64.41	-20	0	64.30	-31	-11	64.30	-26	0	64.30	0
1	64.05	63.80	-25	1	64.07	2	27	64.07	21	0	64.07	0
2	64.01	63.68	-33	2	63.91	-10	23	63.91	6	0	63.91	0
3	63.90	63.64	-26	3	63.83	-7	19	63.83	4	0	63.83	0
4	63.12	62.47	-65	4	62.75	-37	28	62.76	-8	1	62.78	2
5	63.10	62.37	-73	5	62.73	-37	36	62.74	-8	1	62.77	3
6	62.02	61.41	-61	6	61.63	-39	22	61.65	-19	2	61.65	0
7	60.26	60.00	-26	7	60.14	-12	14	60.16	-9	2	60.16	0
8	57.67	57.27	-40	8	57.48	-19	21	57.53	-13	5	57.54	1
9	56.68	56.26	-42	9	56.57	-11	31	56.62	-10	5	56.62	0
10	54.52	54.24	-28	10	54.40	-12	16	54.41	-10	1	54.41	0

(i) The incremental impacts of Oakdale South and Oakdale West under revised Existing Conditions (this study - Case E2) in comparison to revised Existing Conditions are increases of up to 0.05 m (but in locations where the revised flows have lowered the 100 yr ARI flood level);

(ii) The local adverse impacts on in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events in the vicinity of the northeast corner of the Estate are minor; and

(iii) The incremental impacts downstream of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events are negligible.

4.2 Flood Velocity Impacts

The estimated impact of the proposed 200 Aldington Industrial Estate on 2 yr ARI, 20 yr ARI and 100 yr flood velocities and PMF velocities (in comparison to Benchmark Conditions) are plotted in **Figures 11, 17, 23** and **30** respectively. The 100 yr ARI velocity differences are also reported as percentage differences in **Figure 24**.

Figures 11, 17, 23 disclose local minor impacts on flood velocities in the vicinity of the Basin B outlet and the northeast corner of the Estate and negligible incremental impacts downstream of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events.

Figures 29 discloses local minor impacts on PMF flood velocities in the vicinity of the northeast corner of the Estate and immediately downstream of the Estate and negligible incremental impacts further downstream of the Estate.

5 Planning Considerations

The site is located within the Mamre Road Precinct (MRP) which was rezoned on 12 June 2020.

5.1 SEPP (WSEA) 2009

The State Environmental Planning Policy (Western Sydney Employment Area) 2009 (SEPP (WSEA)) was also amended and the Mamre Road Structure Plan was introduced.

The aims of the SEPP (WSEA) are set out in Part 1 Preliminary as follows:

3 Aims of Policy

*(1) This Policy aims to protect and enhance the land to which this Policy applies (the **Western Sydney Employment Area**) for employment purposes.*

(2) The particular aims of this Policy are as follows—

(a) to promote economic development and the creation of employment in the Western Sydney Employment Area by providing for development including major warehousing, distribution, freight transport, industrial, high technology and research facilities,

(b) to provide for the co-ordinated planning and development of land in the Western Sydney Employment Area,

(c) to rezone land for employment, environmental conservation or recreation purposes,

(d) to improve certainty and regulatory efficiency by providing a consistent planning regime for future development and infrastructure provision in the Western Sydney Employment Area,

(e) to ensure that development occurs in a logical, environmentally sensitive and cost-effective manner and only after a development control plan (including specific development controls) has been prepared for the land concerned,

(f) to conserve and rehabilitate areas that have a high biodiversity or heritage or cultural value, in particular areas of remnant vegetation.

The relevant primary considerations are set out in Clause 33I Development on flood prone land under Part 6 Miscellaneous provisions. How the proposed development addresses each of these considerations is outlined as follows:

33 Infrastructure development and use of existing buildings of the Crown

33I Development on flood prone land

(1) This clause applies to development requiring consent that is carried out on flood prone land.

The SEPP (WSEA) defines ***flood prone land*** means land impacted up to the level of the probable maximum flood and identified in a map adopted by the relevant council or published by the Government.

It is noted that the while the 2020 WSEA Maps includes a map of 1 in 100 AEP Flood Extent it does not include a map titled flood prone land.

The Penrith LEP 2010 also includes Flood Planning Land Maps defining the Flood Planning Area (FPA) (refer Section 1.3.2 in the companion Flood Risk Assessment prepared by Cardno, 2020b). It is noted that the site is partially mapped within Council's Flood Planning Area.

Given the site is partially mapped within Council's Flood Planning Area it is considered that development is occurring on flood prone lands for the purpose of the SEPP (WSEA).

Chapter C3 Water Management of the Penrith Development Control Plan (DCP) 2014 outlines the controls on flooding constraints on developments in Chapter 3.5. As stated in Chapter 3.5:

13 Overland Flow Flooding

a) Council has undertaken a Penrith Overland Flow Flood 'Overview' Study. Consideration must be given to the impact on any overland flow path. …….

The mapped extents of overland flow flooding through the site under existing conditions are given in **Figure B-1** in the companion Flood Risk Assessment prepared by Cardno, 2020b.

(2) Consent is not to be granted to the carrying out of development to which this clause applies unless the consent authority has taken into consideration whether or not

(a) the development will adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and

The estimated impact of the proposed 200 Aldington Road Industrial Estate on 2 yr ARI, 20 yr ARI, 100 yr ARI flood levels and PMF levels (in comparison to Benchmark Conditions) are plotted respectively in **Figures 10, 16, 22** and **29**.

These Figures disclose minor local adverse impacts on flood level in the vicinity of the northeast corner of the Estate and negligible incremental impacts further downstream of the Estate. The impacts on the PMF levels are confined to the NE corner of the 200 Estate and environs and are minor.

The estimated impact of the proposed Estate on 2 yr ARI, 20 yr ARI, 100 yr flood velocities and PMF velocities (in comparison to Benchmark Conditions) are plotted in **Figures 11, 17, 23** and **29** respectively.

Figures 11, 17, 23 disclose local minor impacts on flood velocities in the vicinity of the Basin B outlet and the northeast corner of the Estate and negligible incremental impacts downstream of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events.

Figures 29 discloses local minor impacts on PMF flood velocities in the vicinity of the northeast corner of the Estate and immediately downstream of the Estate and negligible incremental impacts further downstream of the Estate.

(b) the development will alter flow distributions and velocities to the detriment of other properties or the environment of the floodplain, and

The impacts on flood levels and velocities are summarised under (a) above.

A recent assessment of the SEI at Mamre Road for the 56 ha Aspect Industrial Estate (which is located 1 km west of Aldington Road, Kemps Creek and drains to South Creek) disclosed:

The SEI has been assessed at Mamre Road under Future Conditions without a Basin and Future Conditions with a Basin based on continuous (6 minute) MUSIC modelling. It was calculated that the SEI under Future Conditions without a Basin and Future Conditions with a Basin would be 5.65 and 1.0 respectively. It is concluded that this demonstrates the impact uncontrolled development can have on the SEI and the effectiveness of a basin which includes a control on frequent flows is able to manage the adverse impacts of development on stream forming flows.

On the basis that Basins A and B will include controls on frequent flows it is expected that these basins will mitigate the adverse impacts of development on downstream stream forming flows.

(c) the development will enable safe occupation of the flood prone land, and

The flood hazards experienced on the 200 Aldington Road Industrial Estate in 2 yr ARI, 20 yr AR and 100 yr ARI floods and PMF are plotted in **Figures 9, 15, 21** and **28** respectively.

These Figures disclose that there would be nil flood hazard experienced in the developed areas of the Estate in all assessed floods up to the PMF.

The overland flows across the Estate generated by local runoff in a PMF has been separately assessed and reported by AT&L. It is noted that the Annual Exceedance Probability (AEP) of the PMF is around 0.0001% to 0.00001% AEP (1,000,000 to 10,000,000 yr ARI).

(d) the development will detrimentally affect the floodplain environment or cause avoidable erosion, siltation, salinity, destruction of riparian vegetation or a reduction in the stability of the riverbank/watercourse, and

The impacts on Stream Erosion Index (SEI) are discussed under (b) above.

On the basis that Basins A and B will include controls on frequent flows it is expected that these basins will mitigate the adverse impacts of development on downstream stream forming flows.

(e) the development will be likely to result in unsustainable social and economic costs to the flood affected community or general community, as a consequence of flooding, and

The development will not result in unsustainable social and economic costs to the general community.

The industrial development would be exposed only to potential flood risks and damages due to overland flooding in extreme storms approaching a PMF. The overland flows across the Estate generated by local runoff in a PMF has been separately assessed and reported by AT&L. It is noted that the Annual Exceedance Probability (AEP) of the PMF is around 0.0001% to 0.00001% AEP (1,000,000 yr ARI to 10,000,000 yr ARI).

(f) the development is compatible with the flow conveyance function of the floodway, and

The mapped 1% AEP hydraulic categories in the vicinity of Lots 31 & 32, Aldington Road, Kemps Creek within the 200 Aldington Industrial Road Estate are plotted in **Figure B-5** in the companion Flood Risk Assessment prepared by Cardno, 2020b. It is noted that the mapped floodway is located just outside the boundary of the 200 Aldington Road Industrial Estate.

The development responds to the overland flows which enter the site from the small upstream catchment. These flows are captured and conveyed safely through the site in all events up to the 100 yr ARI flood. In a PMF, upstream overlands flows will be conveyed through the site both by the drainage system and as overland flows. The proposed drainage system works preserve the flow conveyance function through the site.

(g) the development is compatible with the flood hazard, and

The flood hazards are summarised in (c) above. The development is compatible with the flood hazards.

(h) in the case of development consisting of the excavation or filling of land, the development—

(i) will detrimentally affect the existing drainage patterns and soil stability in the locality, and

The impacts on Stream Erosion Index (SEI) are discussed under (b) above.

(ii) will adversely impact or alter flood behaviour.

The impacts on flood levels and velocities are summarised under (a) above.

5.2 2020 Draft Mamre Road Precinct DCP

As stated in the 2020 Draft Mamre Road Precinct DCP:

This DCP has been prepared in accordance with the EP&A Act and provides additional objectives, controls and guidance to applicants proposing to undertake development in the Mamre Road Precinct, and to guide the assessment of DAs. It should be read in conjunction with State Environmental Planning Policy (Western Sydney Employment Area) 2009 (the WSEA SEPP), in particular the Mamre Road Precinct Structure Plan (Figure 2). The WSEA SEPP and Mamre Road Precinct Plan provide the statutory planning controls for development in the Precinct

Section 2.7 Flood Prone Land sets out relevant requirements.

The objectives of Section 2.7 are as follows.

Objectives

a) To ensure development in the floodplain is consistent with the NSW Flood Prone Land Policy and the principles in the NSW Government Floodplain Development Manual.

b) To ensure floodplain risk management minimises the potential impact of development and other activity upon the aesthetic, recreational and ecological value of the waterway corridors.

c) To maintain the existing flood regime, velocities and flow conveyance and stream hydrology.

d) To avoid significant adverse effects on the floodplain environment that would cause erosion, siltation, destruction of riparian vegetation or a reduction in the stability of the riverbank/ watercourse.

e) To ensure the development does not alter flood behaviour that results in adverse impacts to surrounding properties.

f) To reduce the impact of flooding and flood liability on individual owners and occupiers.

g) To limit the potential risk to life and property resulting from flood events.

h) To enable safe occupation and evacuation of flood prone land.

i) To apply effective planning and development controls to ensure all new developments do not result in flood losses

j) To apply a "merit approach" to all development and building decisions, which takes account of social, economic and ecological factors as well as flooding considerations.

k) To ensure development is compatible with the flood hazard and flood behaviour.

l) To consider adaptability to changing flood risks due to a changing climate.

m) To ensure the development is in accordance with the principles contained in the Floodplain Development Manual, issued by the NSW Government.

How the proposed development and this flood impact assessment address the requirements of Section 2.7 are discussed as follows:

Controls

Submission Requirements

1) Where relevant, a comprehensive Flood Impact Risk Assessment (FIRA) is to be submittedwith any development application on land identified as fully or partially flood affected. The FIRA should utilise Council's existing data and is to provide an understanding of existing flooding condition and developed conditions consistent with the requirements of the NSW Flood Prone Land Policy and Floodplain Development Manual. The FIRA shall determine:

- *A detailed flood behaviour for existing and developed scenarios for the full range offlooding including the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF. FloodFunction (floodways and flood storage areas);*

  A detailed assessment of flood behaviour in Ropes Creek and its tributary upstream of the Sydney Water pipeline under Existing Conditions is presented in the 2020 Flood Risk Assessment Report (Cardno, 2020b).

A detailed assessment of flood behaviour in Ropes Creek and its tributary upstream of the Sydney Water pipeline under proposed Future Conditions is presented in this report.

Flooding in 39% AEP (2 yr ARI), 5% AEP (20 yr ARI), 1% AEP (100 yr ARI) floods and the PMF is assessed under Existing and Future Conditions. The results which are presented in all assessed floods include:

- Flood Extents and Flood Levels
- Flood Depths,
- Flood Velocities
- Flood Hazards

The fill platforms typically have 4+ m freeboard to the PMF level consequently flooding in the 0.5% AEP and 0.2% AEP events have no influence on the proposed development. Consequently, these events have not been assessed. Flooding in the 0.5% AEP and 0.2% AEP events in the upper Ropes Creek floodplain under Existing Conditions has been previously assessed by Worley Parsons, 2015 and Advisian, 2020.

Flood function (hydraulic categories) were not mapped in these assessments because mapping of floodways, flood storage and flood fringe have been previously reported in the 2015 Updated South Creek Flood Study(Worley Parsons, 2015) Most recently this mapping was updated in the 2020 Wianamatta (South) Creek Catchment Flood Study – Existing Conditions (Advisian, 2020).

The mapped 1% AEP hydraulic categories in the vicinity of Lots 31 & 32, Aldington Road, Kemps Creek within the 200 Aldington Road Industrial Estate are plotted in **Figure B-5** in the 2020 Flood Risk Assessment (Cardno, 2020b). It is noted that the mapped floodway is located just outside the boundary of the 200 Aldington Road Industrial Estate.

This was confirmed in the hydraulic category mapping presented in the updated in the 2020 Wianamatta (South) Creek Catchment Flood Study – Existing Conditions (Advisian, 2020).

- *Flood Hazard; and*

Flood hazards under Existing Conditions are mapped in in Cardno, 2020b for the 39% AEP (2 yr ARI), 5% AEP (20 yr ARI), 1% AEP (100 yr ARI) floods and the PMF in Figures 8,14, 20 and 26 respectively.

Flood hazards under Future Conditions in for the 39% AEP (2 yr ARI), 5% AEP (20 yr ARI), 1% AEP (100 yr ARI) floods and the PMF are mapped respectively in **Figures 9, 15, 21** and **28**.

- *Flood constraints including evacuation constraints (if applicable).*

Safe evacuation and egress from floods is not an issue for floodwaters on the Ropes Creek floodplain. The fill platforms typically have 4+ m freeboard to the PMF level consequently any impact of climate change or floodplain revegetation on mainstream flood levels would have no impact on the development. There are no crossings proposed on the floodplain consequently culvert blockage is not a concern

2) *The levels on the survey are required to be verified during construction by a survey certificate. The study shall incorporate:*

- *A survey of the main watercourse;*
- *A survey of the site; and*
- *A detailed flood and drainage investigation which establishes the estimated 20% AEP, 1% AEP (100 year ARI) 0.2% AEP and Probable Maximum Flood levels including overland flow paths.*

A detailed assessment of flood behaviour in Ropes Creek and its tributary upstream of the Sydney Water pipeline under Existing Conditions is presented in the 2020 Flood Risk Assessment Report (Cardno, 2020b) and in this report. The fill platforms typically have 4+ m freeboard to the PMF level consequently flooding in the 0.2% AEP events has no influence on the proposed development.

The mapped extents of overland flow flooding through the site under existing conditions are given in **Figure B-1** in Cardno, 2020b. More recently mapping of the overland flowpaths within the site has been presented by Sydney Water, 2020.

Overland flows within the site under Existing Conditions informed the drainage strategy described in the related Stormwater Management Report prepared by AT&L. Under the proposed development 100 yr ARI runoff upstream of Aldington Road is collected and conveyed through the development in a dedicated pipe with 100 yr ARI capacity while runoff from within the site is directed to basins.

An assessment of overland flows within the proposed development under the PMF has been undertaken by AT&L and is reported separately.

3) *The applicant shall demonstrate to the satisfaction of the consent authority (on the basis of a qualified consultant report) that:*

- *The development will not increase the flood hazard, flood levels or risk to other properties;*

  The estimated impact of the proposed development to other properties is described in **Section 4**. It is concluded that the minor local adverse impacts on flood level in the vicinity of the NE corner of the Estate and negligible incremental impacts further downstream of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events. The impacts on the PMF levels are confined to the NE corner of the Estate and environs and are minor.

- *The development has incorporated appropriate measures to manage risk to life from flooding;*

  The fill platforms typically have 4+ m freeboard to the PMF level consequently flooding on the Ropes Creek floodplain poses no risk to life. Overland flows within the site under Existing Conditions informed the drainage strategy described in the related Stormwater Management Report prepared by AT&L.

- *If the development is to be located within the PMF, a flood evacuation plan will be required;*

  The fill platforms typically have 4+ m freeboard to the PMF level consequently this requirement does not apply.

- *The structure of the proposed building works shall be adequate to deal with the flood behaviour for a full range of floods identified in control 1;*

  The fill platforms typically have 4+ m freeboard to the PMF level consequently this requirement does not apply.

- *The proposed building materials are flood compatible with a full range of floods identified in control 2.7(1);*

  While this requirement is noted it does not apply to the proposed development.

- *The buildings and their access are sited in the optimum position to avoid flood waters and allow optimal vehicular flood access from the site for evacuation;*

  The fill platforms typically have 4+ m freeboard to the PMF level consequently this requirement does not apply.

- *That the impacts of climate change on flood behaviour has been considered;*

  The fill platforms typically have 4+ m freeboard to the PMF level consequently any impact on mainstream flood levels of climate change or of floodplain revegetation will have no impact on the development.

- *The proposed redevelopment will not expose any persons to unacceptable levels of risk or any property to unreasonable damage;*

  The proposed development does not any persons to unacceptable levels of risk or any property to unreasonable damage.

- *Compliance of any existing buildings with the Standard - Construction of Buildings in Flood Hazard Area and the accompanying handbook developed by the Australian Building Codes Board (2012);*

  While this requirement is noted it does not apply to the proposed development.

- *The proposed development will limit impact on riparian corridors and be designed and maintained to allow for natural stream processes; and*

  It is our understanding that this consideration is discussed by others elsewhere in the EIS.

- *Fencing does not impede the flow of flood waters/overland flow paths.*

  This requirement is noted.

Flood Hazard Classifications

4) *Council will consider development on land subject to the full range of flooding based on understanding of flooding in accordance with the NSW Flood Prone Land Policy and the principles of the Floodplain Development Manual. New development in floodways and flood storages or in high hazard areas in the 1% AEP flood event considering climate change should be avoided.*

5) *Consideration will be given to such matters as depth and nature of flood waters, whether the area forms flood storage, the nature and risk posed to the development by flood waters, the velocity of floodwaters and the speed of inundation, and whether the development lies in an area classed as a 'floodway', 'flood fringe area' or 'flood storage area'*

The mapped 1% AEP hydraulic categories in the vicinity of Lots 31 & 32, Aldington Road, Kemps Creek within the 200 Aldington Industrial Estate are plotted in **Figure B-5** in the 2020 Flood Risk Assessment (Cardno, 2020b). It is noted that the mapped floodway is located just outside the boundary of the 200 Aldington Industrial Estate. This was confirmed in the hydraulic category mapping presented in the updated in the 2020 Wianamatta (South) Creek Catchment Flood Study – Existing Conditions (Advisian, 2020).

New Development

6) *Floor levels shall be at least 0.5m above the 1% AEP (100 year ARI) flood.*

The fill platforms typically have 4+ m freeboard to the PMF level consequently this requirement is exceeded.

7) *Flood safe access and emergency egress shall be provided to all new and modified developments.*

While this requirement is noted it does not apply to the proposed development given the 4+ m freeboard to the PMF level.

Extensions and Infill Development

8) *Where the application is for an extension to an existing building on land at or below theflood planning level or for new development that can be classed as infill development, Council may approve of the development with floor levels below the 1% AEP (100 year ARI) flood if it can be demonstrated by the applicant that all practical measures will be taken to prevent or minimise the impact of flooding. In considering such applications anddetermining the required floor level, Council shall take into account such matters as:*

- *The nature of the business to be carried out;*
- *The frequency and depth of flooding;*
- *The potential for personal and property loss;*
- *The utility of the building for its proposed use;*
- *Whether the filling of the site or raising of the floor levels would render the development of the property unworkable or uneconomical;*
- *Whether the raising of the floor levels would be out of character with adjacent buildings; and*
- *Any risk of pollution of water from storage or use of chemicals within the building.*

9) *Any portion of the proposed building extension subject to inundation shall be built fromflood compatible materials.*

These requirements are not applicable

Subdivision

10) *Generally, subdivision of land below the flood planning level will not be supported. Further provisions relating to the proposed subdivision of such land can be found in the Subdivision Section of this Plan.*

This requirement is not applicable

11) *Subdivisions must comply with 'Designing safer subdivisions guidance on subdivision design in flood prone areas, 2007' Hawkesbury-Nepean Floodplain Management SteeringCommittee'.*

While this requirement is noted it does not apply to the proposed development

Storage of Potential Pollutants above 1% AEP (100 year ARI) Flood

12) *All potential pollutants that are stored or detained on-site (such as on-site effluent treatment plants, pollutant stores or on-site water treatment facilities) should be stored above the 1% AEP (100 year ARI) flood. Details must be provided as part of any development application.*

The fill platforms typically have 4+ m freeboard to the PMF level consequently this requirement is exceeded.

Overland Flow Flooding

13) *Consideration must be given to the impact on any overland flow path. Generally, Council will not support development obstructing overland flow paths. Development is required to demonstrate that any overland flow is maintained for the 1% AEP (100 year ARI) overland flow with consideration for failsafe of flows up to the Probable Maximum Flood (PMF). A merit based approach will be taken when assessing development applications that affect the overland flow.*

Overland flows within the site under Existing Conditions informed the drainage strategy described in the related Stormwater Management Report prepared by AT&L.

Under the proposed development 100 yr ARI runoff upstream of Aldington Road is collected and conveyed through the development in a dedicated pipe with 100 yr ARI capacity while runoff from within the site is directed to basins.

An assessment of overland flows within the proposed development under the PMF has been undertaken by AT&L and is reported separately.

14) *Council's Stormwater Drainage Specification for Building Developments provides information on the details required in the preparation of an overland flow study.*

15) *Where existing natural streams do not exist, naturalised drainage channels are encouraged to ensure overland flows are safely conveyed via vegetated trunk drainage channels systems with 1% Annual Exceedance Probability capacity plus 0.5m freeboard. Constructed trunk drainage systems potentially increase peak flows by removing flood storage and increase conveyance. Any increase in peak flow must be offset using on-site stormwater detention (OSD) basins.*

16) *All required flood detention is to be accommodated, on-lot, within the development site.*

17) *OSD must be sized to ensure no increase in 50% and 1% Annual Exceedance Probability peak storm flows at the Precinct boundary or at Mamre Road culverts. An allowance shall be made for any local roads that bypass OSD or any vegetated trunk drainage systems thatincrease peak flows through the precinct.*

The intent is that the peak outflows from Basin A and Basin B proposed for the development not exceed the 2 yr ARI (38% AEP) and 100 yr ARI (1% AEP) peak flows from the same catchment areas under Benchmark Conditions.

The sizing of Basin B is discussed in **Section 2.2.1** above.

Filling of Land At or Below the Flood Planning Level

18) *Earthworks up to the PMF must meet the requirements of Clauses 33H and 33J of the WSEA SEPP as well as Sections 2.7 and 4.4 of this DCP.*

The compliance of the proposed development with the requirements of Clause 33I is covered in detail in Section 5.1.

It is our understanding that the compliance of the proposed development with the requirements of Clause 33H is discussed by others.

19) *Development consent will not grant consent to filling of floodways and /or critical flood storage areas in the 1% AEP flood. The filling of other land at or below the 1% AEP but outside the floodways and critical flood storage will generally not be supported. In particular, an application to fill land shall also describe the purpose for which the filling is to be undertaken. Council may consider such an application when the following criteria are met:*

- *Flood levels are not increased by more than 10 mm by the proposed filling on surrounding properties;*
- *Downstream velocities are not increased by more than 10% by the proposed filling;*
- *Proposed filling does not redistribute flows by more than 15%;*
- *The potential for cumulative effects of possible filling proposals in that area is minimal;*
- *There are alternative opportunities for flood storage;*
- *The development potential of surrounding properties is not adversely affected by the filling proposal;*
- *The flood liability of buildings on surrounding properties is not increased;*
- *No local drainage flow/runoff problems are created by the filling; and*
- *The filling does not occur within the drip line of existing trees.*

The estimated impact of the proposed development to other properties is described in **Section 4**.

While the intent is that the peak outflows from Basin B not exceed the 2 yr ARI and 100 yr ARI peak flows from the same catchment areas under Benchmark Conditions the outlet to Basin B will discharge outflows downstream of the existing farm dam embankment. Consequently, while there is no increase in peak runoff under Future Conditions runoff a significant proportion of the Basin B outflows will not be further attenuated by flowing through the farm dam. The minor impacts in the northeast corner of the Estate are attributed to the re-direction of site runoff into Basin B and the location of its outlet downstream of the retained farm dam and not filling;

It is therefore concluded that in a 1% AEP flood:

(i) The impact of filling on surrounding properties is negligible.

(ii) Downstream velocities are not increased by more than 10% by the proposed filling;

(iii) Proposed filling leads to a negligible redistribution of flows ie. less than 15%;

(iv) The potential for cumulative effects of possible filling proposals in that area is minimal if the same minimal intrusion into the 1% AEP flood extent is followed;

(v) The development potential of surrounding properties is not adversely affected by the filling proposal;

(vi) The flood liability of buildings on surrounding properties is not increased; and

(vii) No local drainage flow/runoff problems are created by the filling because measures to collect and convey runoff to a basin prior to discharge onto the floodplain in a controlled manner is incorporated into the development.

20) The above criteria can only be addressed and satisfied by the submission of a detailed flood study report by a qualified engineer. The flood study report would involve both hydrologic and hydraulic analysis of the watercourse and the effects of the proposed filling on flood levels, flow velocities and distribution of flows as listed above. The report needs to address items listed above. Any filling of land also needs to be in accordance with the other provisions in this DCP.

A detailed assessment of flood behaviour in Ropes Creek and its tributary upstream of the Sydney Water pipeline under Existing Conditions is presented in the 2020 Flood Risk Assessment Report (Cardno, 2020b).

A detailed assessment of flood behaviour in Ropes Creek and its tributary upstream of the Sydney Water pipeline under proposed Future Conditions is presented herein.

It is concluded that this Flood Impact Assessment and the companion Flood Risk Assessment satisfy the relevant flooding requirements of the SEPP (WSEA) 2009 and the 2020 Draft Mamre Road Precinct DCP.

6 References

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AT&L (2020) “Aldington Road, Lots 20-23 DP255560 and Lots 30-32 DP258949, Kemps Creek”, *Civil Infrastructure Report*, prepared for Fife Kemps Creek Pty Ltd, September.

Babister, M., Trim, A., Testoni, I. and Rettalick, M. (2016) “The Australian Rainfall & Runoff Datahub”, *Proceedings*, 37th Hydrology and Water Resources Symposium, 28 November - 2 December 2016, Queenstown, New Zealand.

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Lyall & Associates (2020) “Southern Link Road Flooding and Drainage Investigation, *Draft Report,* 2 Vols, prepared for Transport for NSW, May, 17 pp

NSW Government (2005*). Floodplain Development Manual, The management of flood liable land*, April, 29 pp + Apps

Sydney Water (2020) “Mamre Road Flood, Riparian Corridor and Integrated Water Cycle Management Strategy”, Final *Report*, October, 61 pp + Apps

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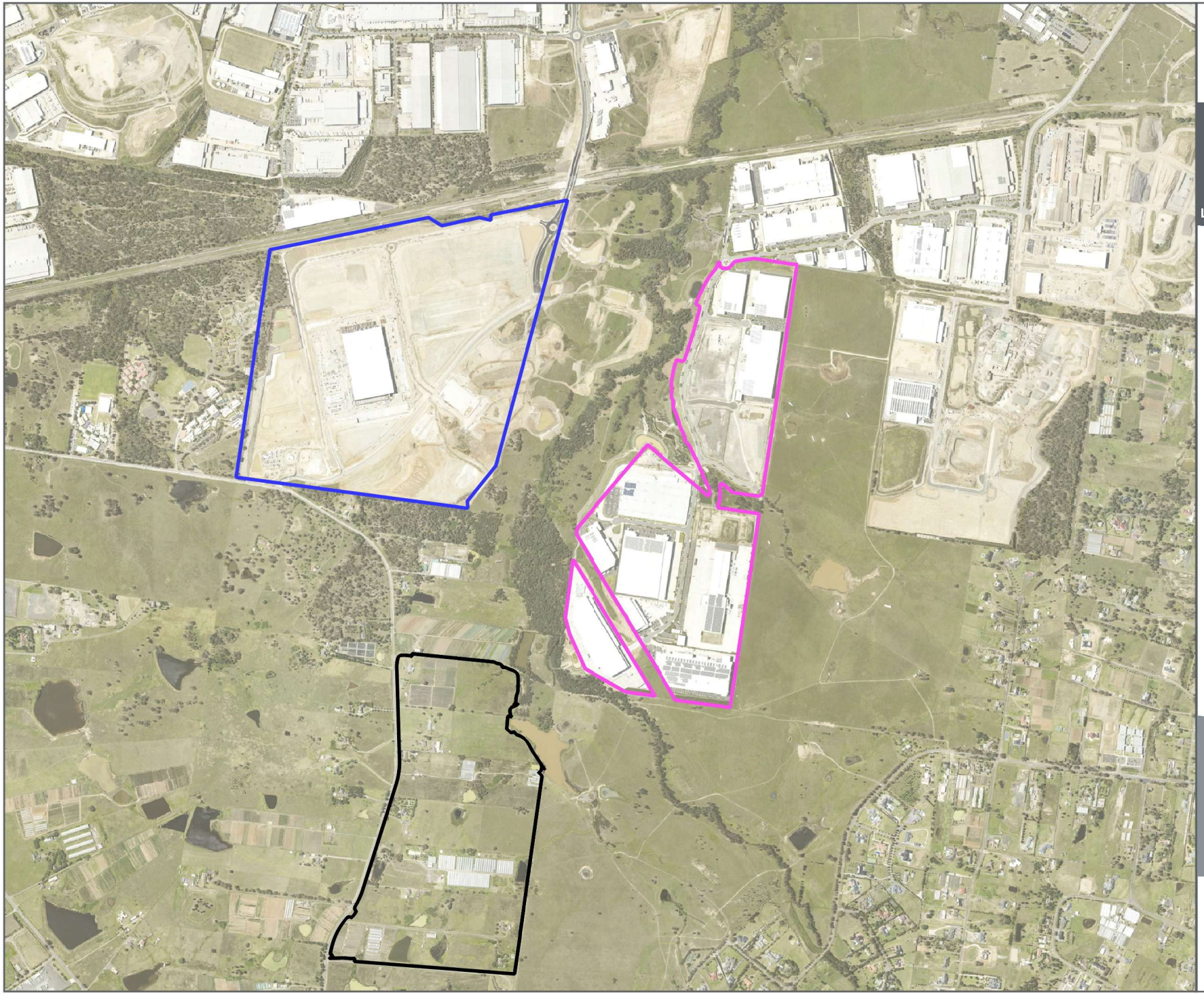
APPENDIX A
FIGURES

Cardno
Shaping the Future



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Location of Proposed Industrial Estate

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

FIGURE 1

1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz

AREA SCHEDULE	
SITE AREA	720,906 m²
BASIN LOT L	2,261 m²
FLOODBASIN LOT D	32,516 m²
ESTATE ROAD RESERVE	64,425 m²
ROAD WIDENING (Aldington Rd)	3,886 m²
NET DEVELOPABLE SITE AREA	597,807 m²
WAREHOUSE (Approx. 5% WH)	330,950 m²
OFFICE	17,005 m²
TOTAL BUILDING AREA	347,955 m²
CARPARKING REQUIRED (RMS WH1/300 OFFICE1/40)	1530
PROVIDED	1549
SITE PERMEABILITY	22.4%
SITE COVERAGE	59.0%

LOT A	
LOT AREA	12,135 m²
WAREHOUSE - W1	3,125 m²
OFFICE - W1	195 m²
GFA	3,320 m²
CARS PROVIDED	17

LOT B	
LOT AREA	49,696 m²
WAREHOUSE - W2	20,260 m²
OFFICE - W2	900 m²
GFA	21,160 m²
CARS PROVIDED	90

LOT C	
LOT AREA	37,153 m²
WAREHOUSE - W3	21,115 m²
OFFICE - W6	1,210 m²
GFA	22,325 m²
CARS PROVIDED	101

LOT D - Not Developable	
LOT AREA	52,517 m²

LOT E	
LOT AREA	34,002 m²
WAREHOUSE - W4	17,745 m²
OFFICE - W4	900 m²
GFA	18,645 m²
CARS PROVIDED	82

LOT F	
LOT AREA	73,691 m²
WAREHOUSE - W5	48,430 m²
OFFICE - W5	2,500 m²
GFA	50,930 m²
CARS PROVIDED	219

LOT G	
LOT AREA	42,816 m²
WAREHOUSE - W6	23,880 m²
OFFICE - W6	1,200 m²
GFA	25,080 m²
CARS PROVIDED	110

LOT H	
LOT AREA	47,988 m²
WAREHOUSE - W7	29,035 m²
OFFICE - W7	1,500 m²
GFA	30,535 m²
CARS PROVIDED	141

LOT I	
LOT AREA	40,672 m²
WAREHOUSE - W8	23,700 m²
OFFICE - W8	1,200 m²
GFA	24,900 m²
CARS PROVIDED	110

LOT J	
LOT AREA	123,590 m²
WAREHOUSE - W9	75,000 m²
OFFICE - W9	3,750 m²
GFA	78,750 m²
CARS PROVIDED	344

LOT K	
LOT AREA	36,756 m²
WAREHOUSE - W10	20,920 m²
OFFICE - W10	1,200 m²
GFA	22,120 m²
CARS PROVIDED	103

LOT L - Not Developable	
LOT AREA	12,262 m²

LOT M	
LOT AREA	26,953 m²
WAREHOUSE - W11	14,075 m²
OFFICE - W11	750 m²
GFA	14,825 m²
CARS PROVIDED	70

LOT N	
LOT AREA	30,877 m²
WAREHOUSE - W12	16,930 m²
OFFICE - W12	900 m²
GFA	17,830 m²
CARS PROVIDED	83

LOT O	
LOT AREA	31,483 m²
WAREHOUSE - W13	16,735 m²
OFFICE - W13	800 m²
GFA	17,535 m²
CARS PROVIDED	79

Assumptions

01 ALDINGTON RD RESERVE - 25.4m DISTRIBUTOR ROAD
02 INTERNAL ESTATE ROAD 01 RESERVE - 25.2m INDUSTRIAL ROAD
03 INTERNAL ESTATE ROAD 02, 03, 04, 05 RESERVE - 24m INDUSTRIAL ROAD
04 PARKING RATE PROVIDED RMS WH 1 SPACE PER 300sqm / OFFICE 1 SPACE PER 40sqm
05 BUILDING SETBACK TO ALDINGTON RD - 12m
06 LANDSCAPE SETBACK TO ALDINGTON RD - 6m
07 BUILDING SETBACK FROM ESTATE RD - 7.5m
08 LANDSCAPE SETBACK FROM ESTATE RD - 3.75m

LEGEND

- Site Boundary
- Lot Boundary
- Road Boundary
- Building Setback
- Landscape Setback
- RE2 Zone
- Building Outline
- Easement
- RW Retaining Wall
- FS Fire Services
- Existing Farm Dam
- RE2 Zone
- E2 Environmental Conservation Zone

SBA ARCHITECTS

F K C E S T A T E

200 ALDINGTON ROAD, KEMPS CREEK NSW

SSDA ESTATE MASTER PLAN

01.09.2021 | 1:2000@A1 1:4000@A3 | 20111 | MP04

Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

SSDA Estate Masterplan

FIGURE 2

Not on Scale

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-14| Project: NW30034
Coordinate System: MGA Zone 56
Map: FKC Figures - Copy.qgz

Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Basin B Layout

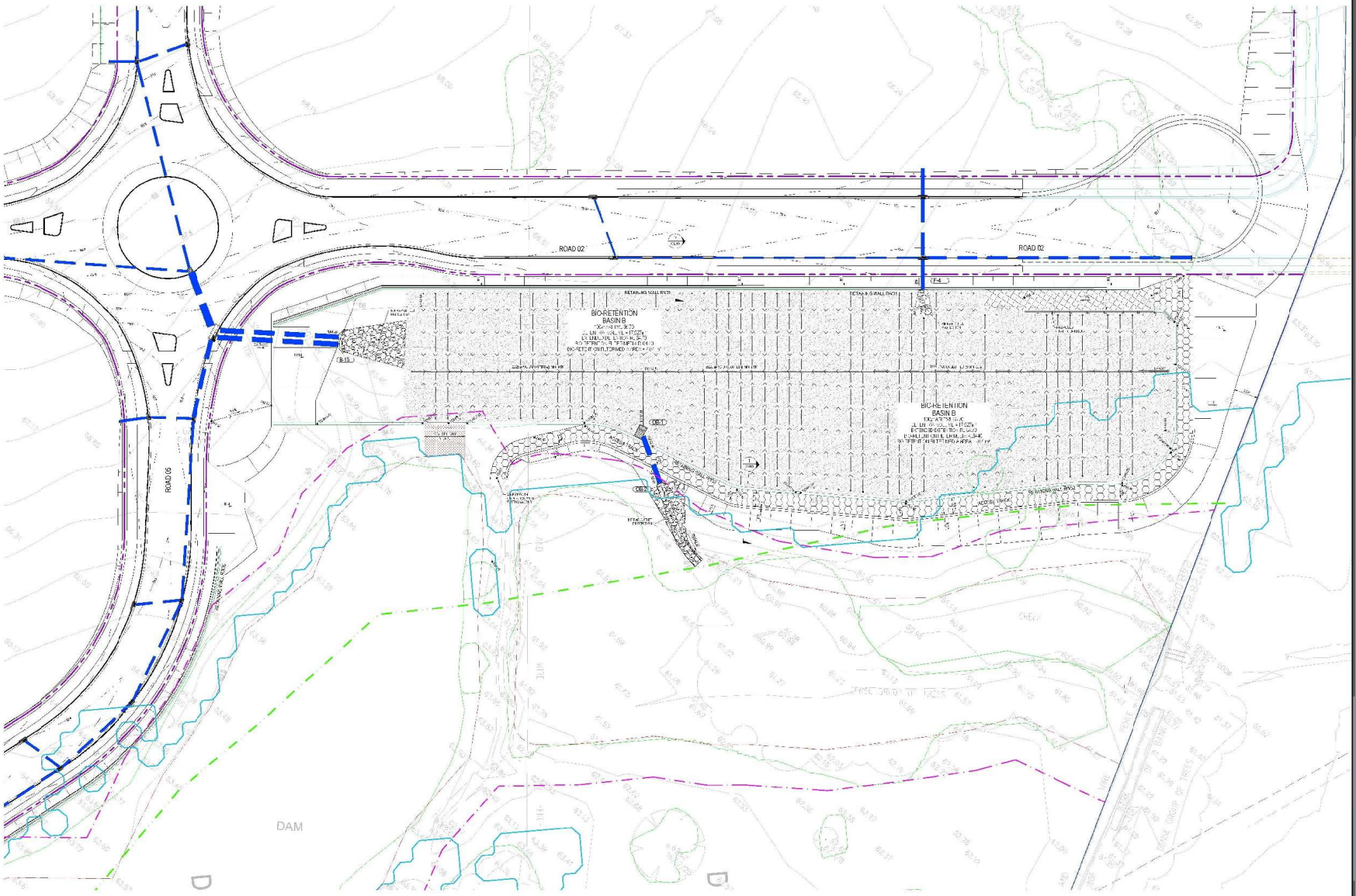


FIGURE 3

Not on Scale

Cardno

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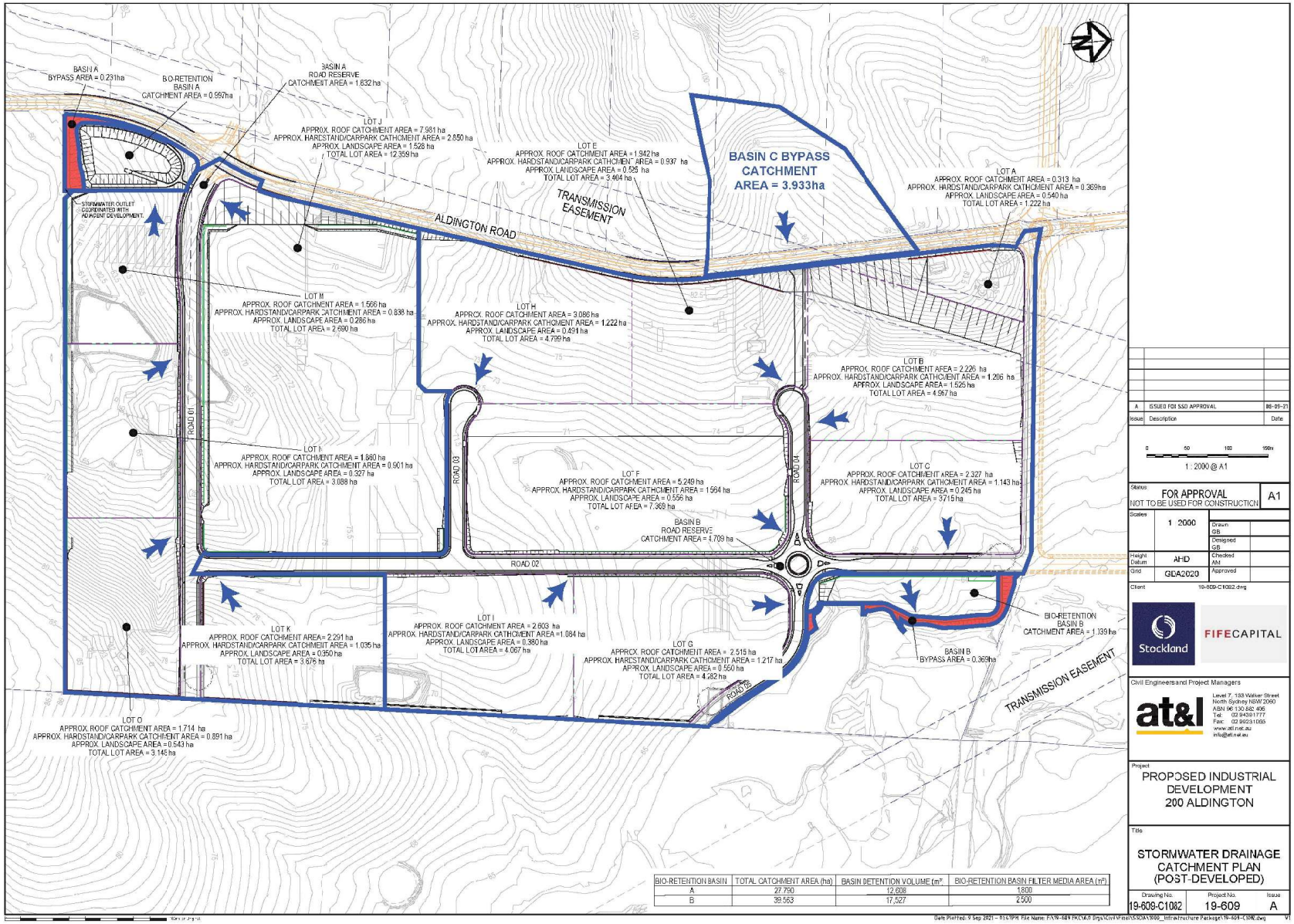
Coordinate System: MGA Zone 56
Map: FKC Figures - Copy.qgz

Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Local Subcatchment Boundaries under Future Conditions



BIO-RETENTION BASIN	TOTAL CATCHMENT AREA (ha)	BASIN DETENTION VOLUME (m³)	BIO-RETENTION BASIN FILTER MEDIA AREA (m²)
A	27.790	12,608	1,800
B	39.563	17,527	2,500

Issue	Description	Date
A	ISSUED FOI SSD APPROVAL	06-09-21

1 : 2000 @ A1

Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION
A1

Scales: 1 : 2000
Drawn: GB
Designed: GB
Height Datum: AHD
Checked: AM
Grid: GDA2020
Approved:
Client
19-609-C1082.dwg

Stockland FIFECAPITAL

Civil Engineers and Project Managers
at&l
Level 7, 133 Walker Street
North Sydney NSW 2060
ABN 94 130 882 496
Tel: 02 94391777
Fax: 02 99231055
www.atl.net.au
info@atl.net.au

Project
PROPOSED INDUSTRIAL DEVELOPMENT
200 ALDINGTON

Title
STORMWATER DRAINAGE CATCHMENT PLAN (POST-DEVELOPED)

Drawing No.	Project No.	Issue
19-609-C1082	19-609	A

Date Plotted: 9 Sep 2021 - 01:47PM File Name: F:\19-609 FKC\4.0 Dgn\Civil\Final\SSDA\1000_Infrastructure Package\19-609-C108[.dwg] V1

FIGURE 4

Not on Scale

Cardno

Map Produced by St Leonards Water (AWE)
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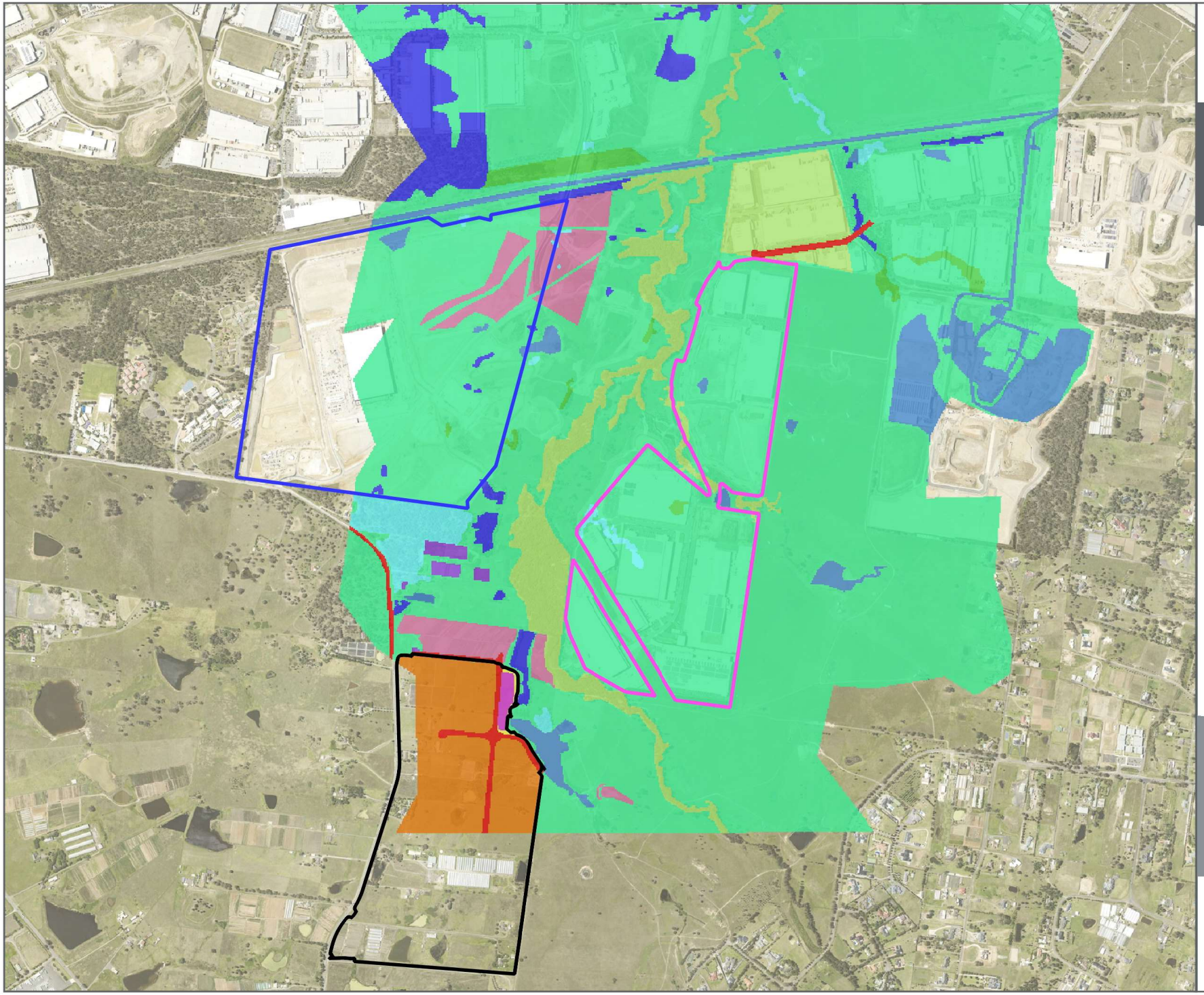
Coordinate System: MGA Zone 56
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Adopted Roughness Zones under Future Conditions

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Roughness Zones

- Dense vegetation flooded branches (n=0.12)
- Dense vegetation (n=0.10)
- Medium Vegetation (n=0.08)
- Light Vegetation (n=0.05)
- Floodplain High Grass (n=0.035)
- Floodplain Short Grass (n=0.03)
- Unsealed Road (n=0.022)
- Sealed Road (n=0.017)
- Houses or Fenced Areas (n=4)
- Commercial Lots (n=0.1)
- Basin (n=0.02)
- Basin Embankment (n=0.03)

FIGURE 5

1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

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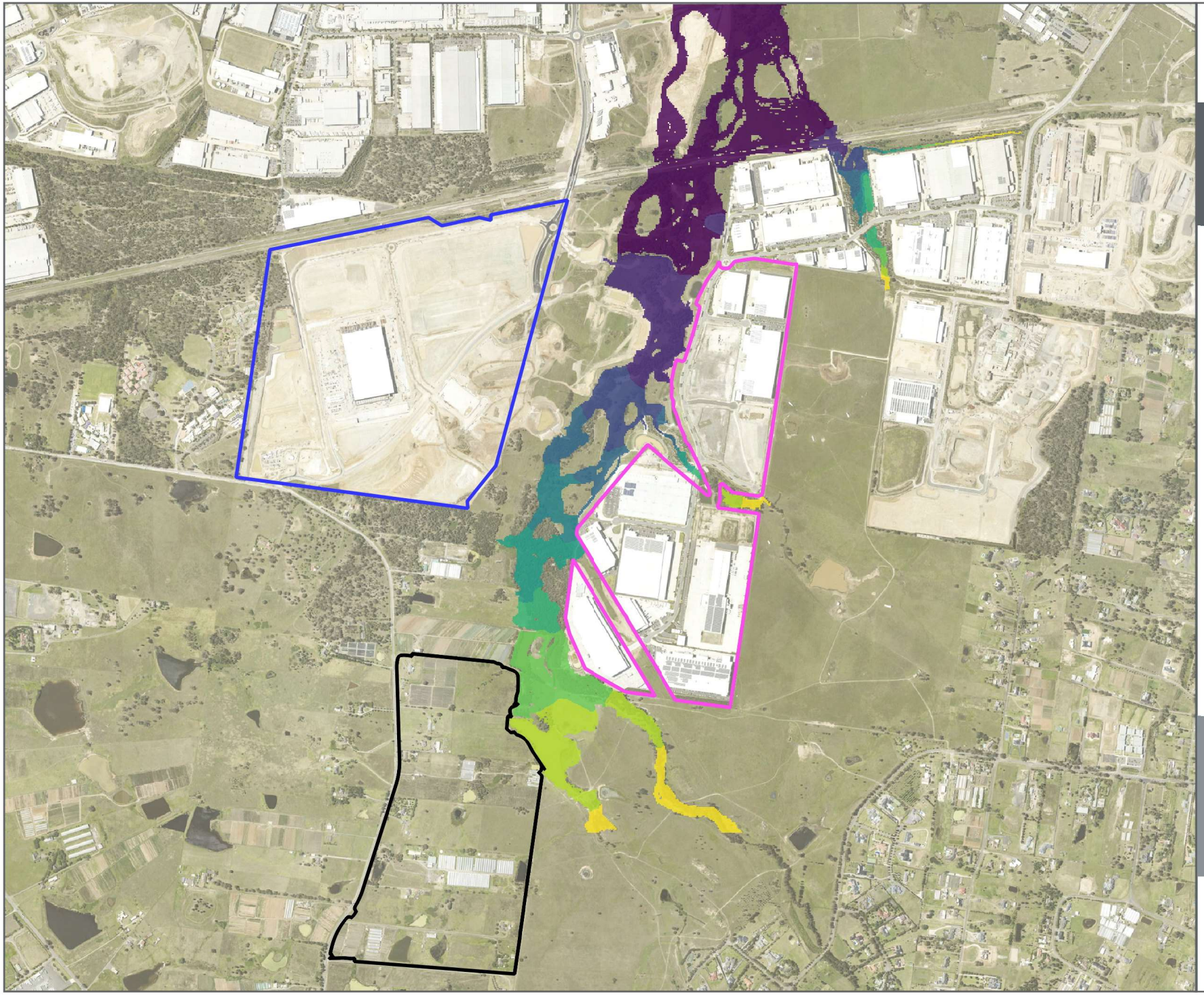
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
2 yr ARI
Flood Extents and Flood Levels

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

2yr
Future 2yr ARI
Water Level (mAHD)

- <= 56
- 56 - 57
- 57 - 58
- 58 - 59
- 59 - 60
- 60 - 61
- 61 - 62
- 62 - 63
- 63 - 64
- > 64

FIGURE 6

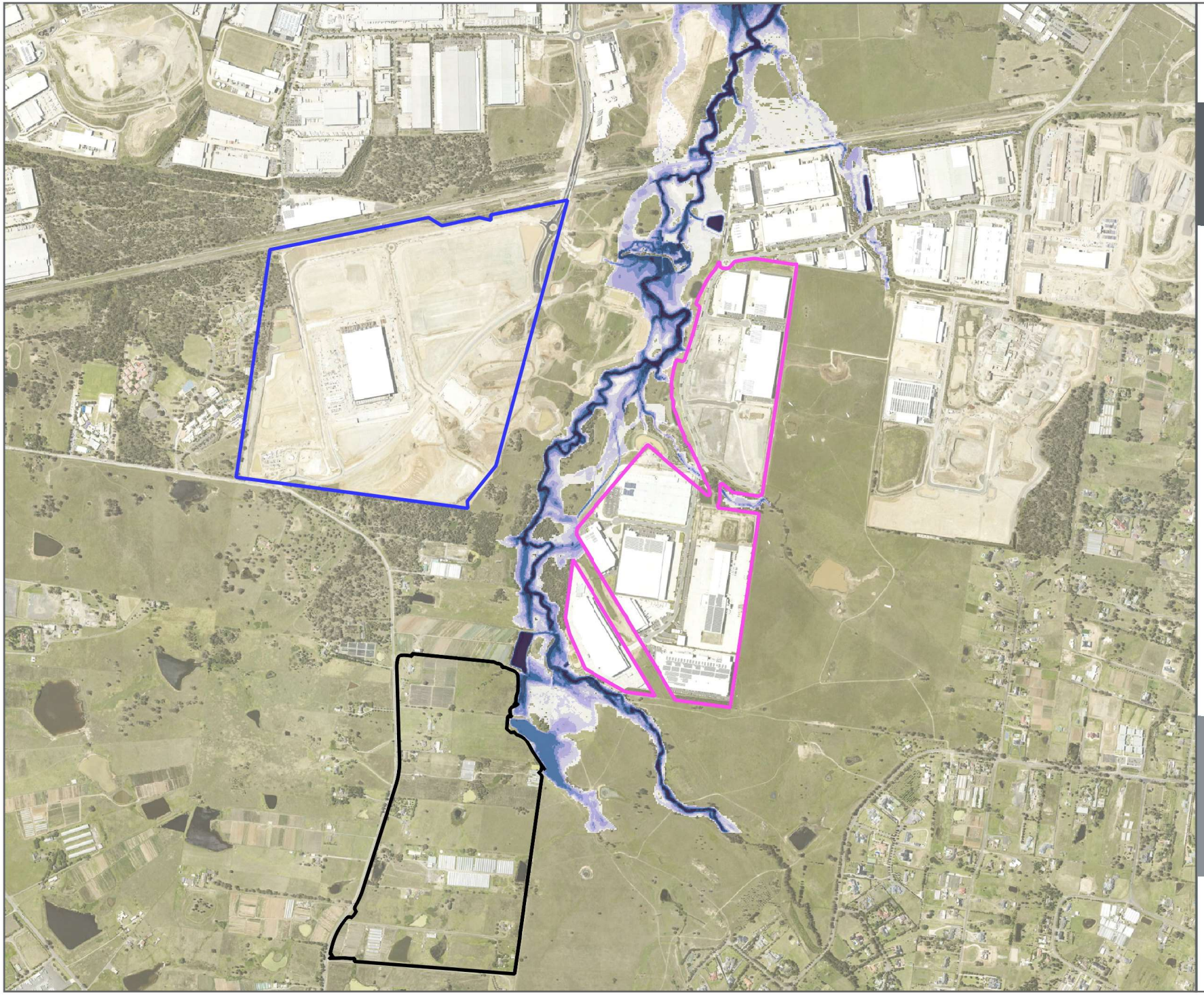
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
2 yr ARI
Flood Depths

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

2yr

Future 2yr ARI Depth (m)

- 0.00 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

FIGURE 7

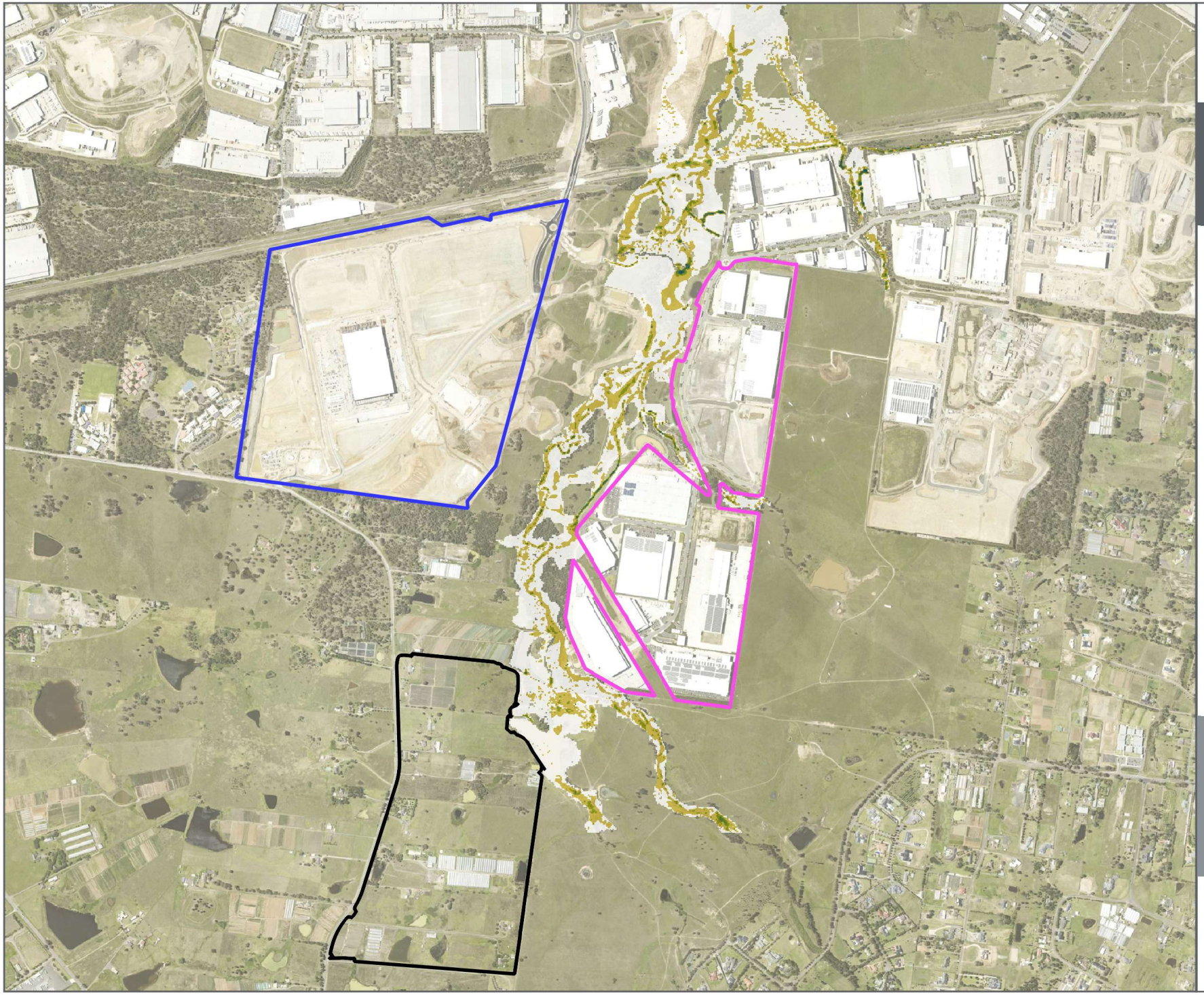
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
2 yr ARI
Flood Velocities

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

2yr

Future 2yr ARI Velocity(m/s)

- 0.00 to 0.50
- 0.50 to 1.00
- 1.00 to 1.50
- 1.50 to 2.00
- 2.00 to 3.00
- > 3.00

FIGURE 8

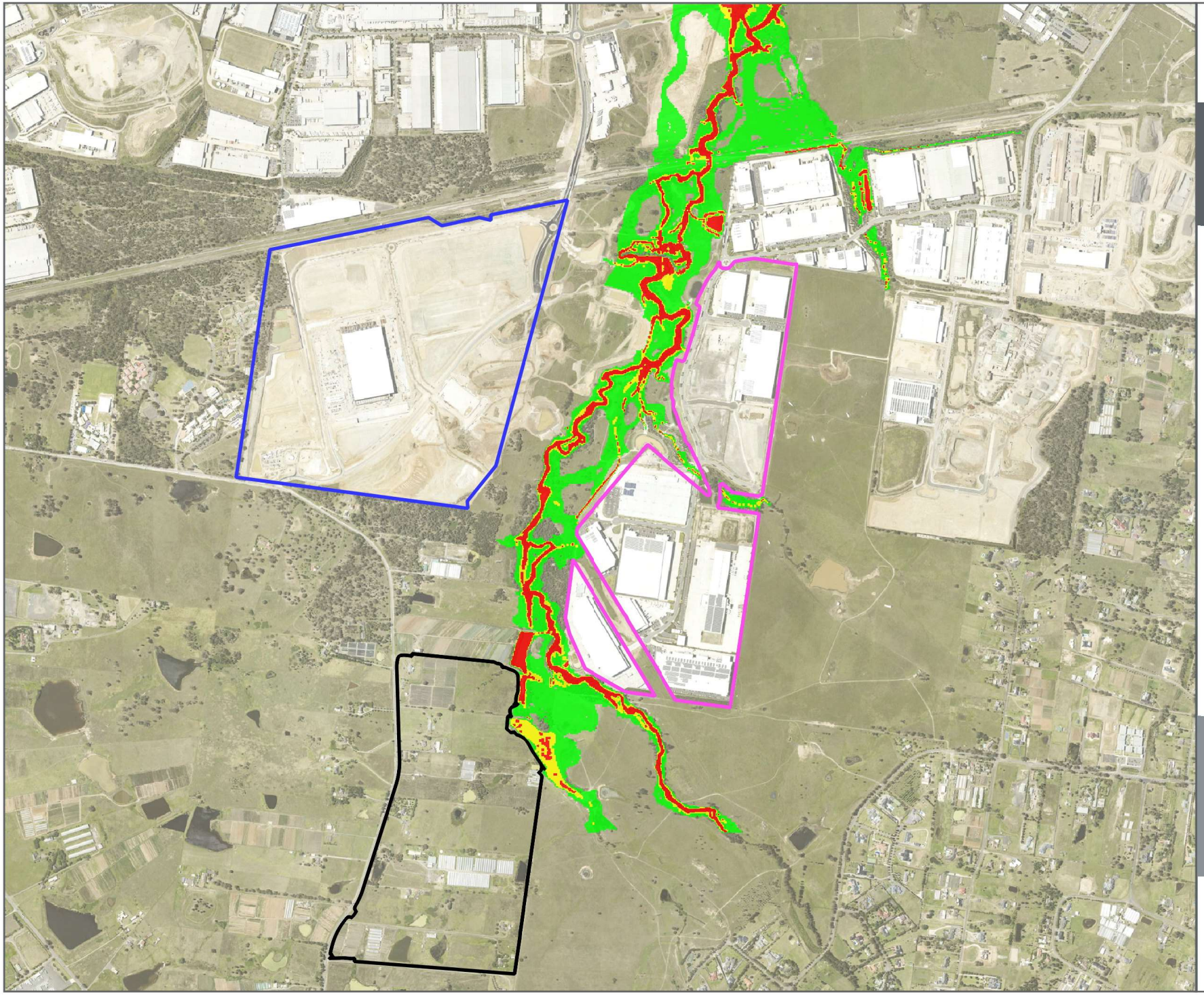
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
2 yr ARI
Flood Hazard

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

2yr
Future 2yr ARI
Provisional Hazard

- Low
- Transitional
- High

FIGURE 9

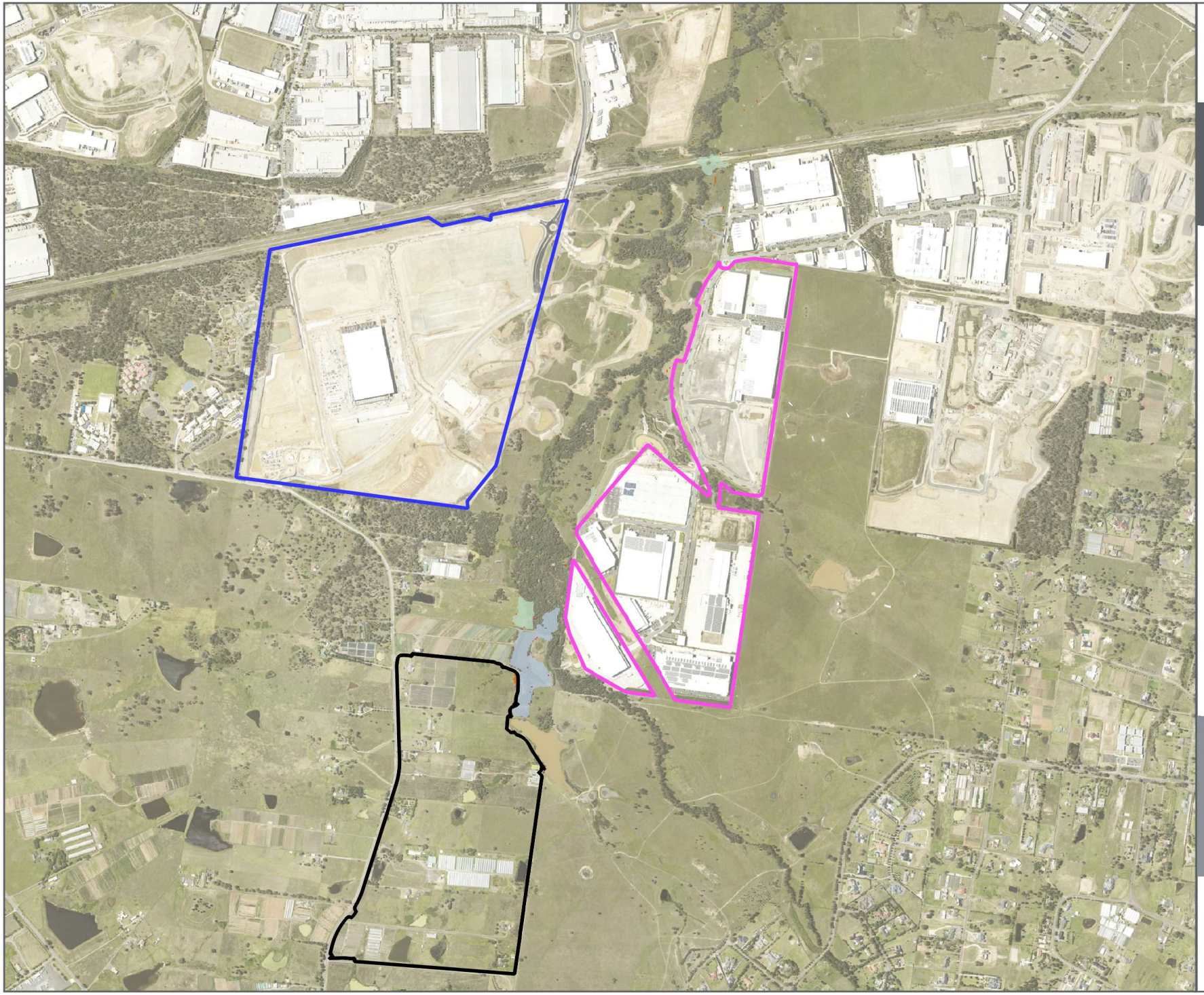
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

(Future Conditions – Benchmark Conditions)
2 yr ARI
Flood Level Difference (m)

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future Less Benchmark 2yr ARI Water Level Difference (m)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

Future Less Benchmark 2yr ARI Wet Dry

- Was Wet, Now Dry
- Was Dry, Now Wet

FIGURE 10

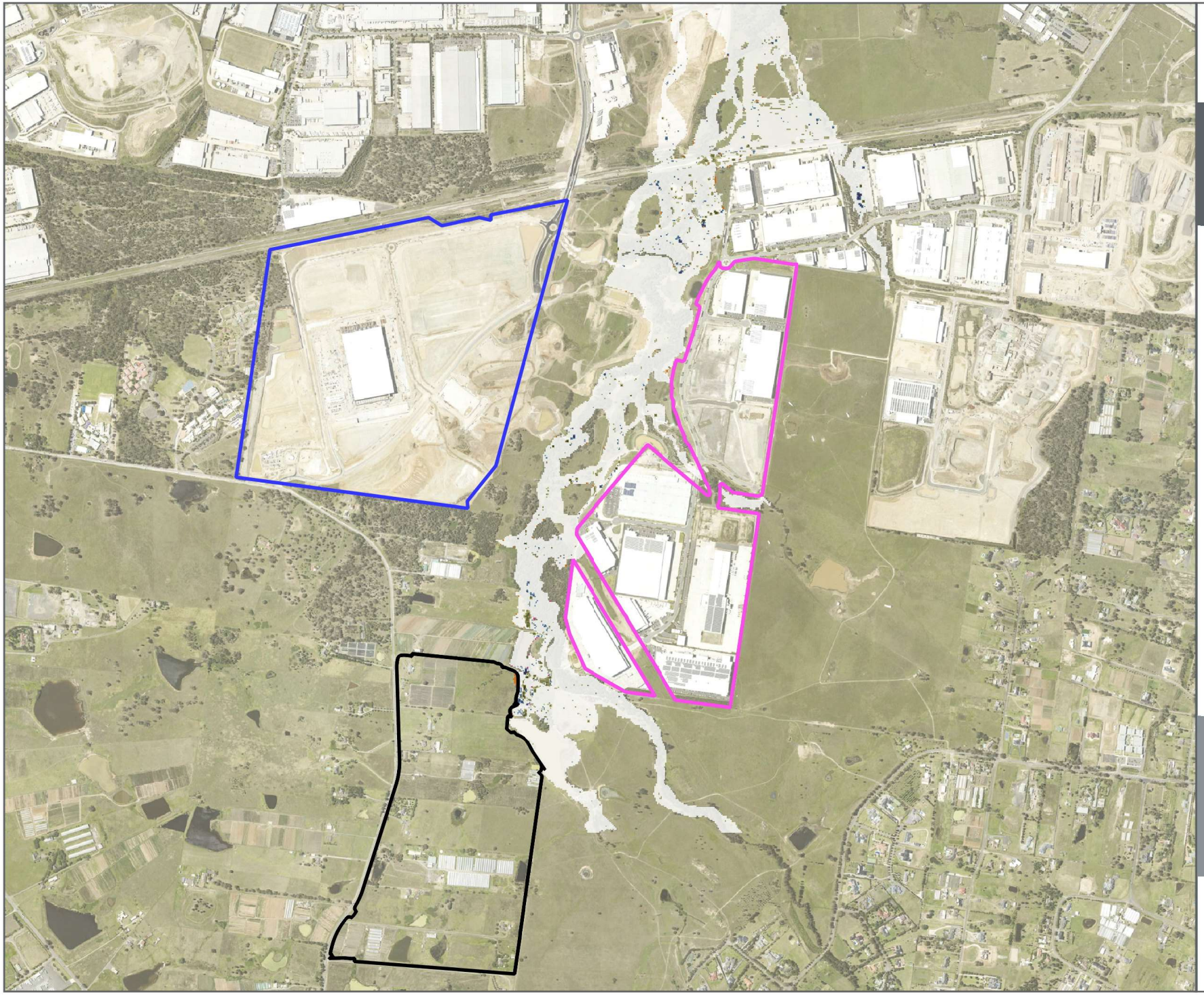
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

(Future Conditions – Benchmark Conditions)
2 yr ARI
Flood Velocity Differnces (m/s)

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future Less Benchmark 2yr ARI Velocity Difference (m/s)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

Future Less Benchmark PMF Velocity Wet Dry

- Was Wet, Now Dry
- Was Dry, Now Wet

FIGURE 11

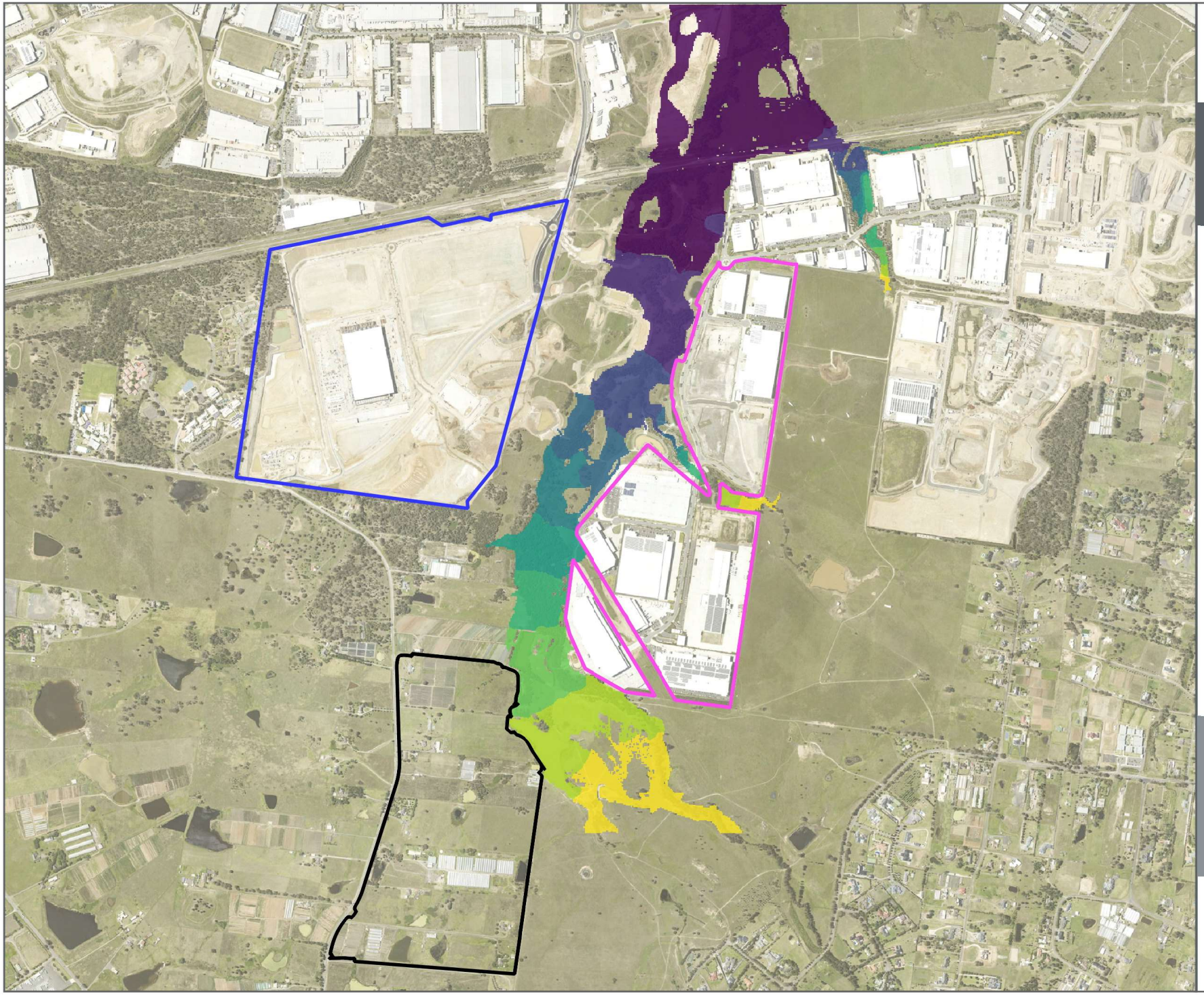
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
20 yr ARI
Flood Extents and Flood Levels

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future 20yr ARI
Water Level (mAHD)

- <= 56
- 56 - 57
- 57 - 58
- 58 - 59
- 59 - 60
- 60 - 61
- 61 - 62
- 62 - 63
- 63 - 64
- > 64

FIGURE 12

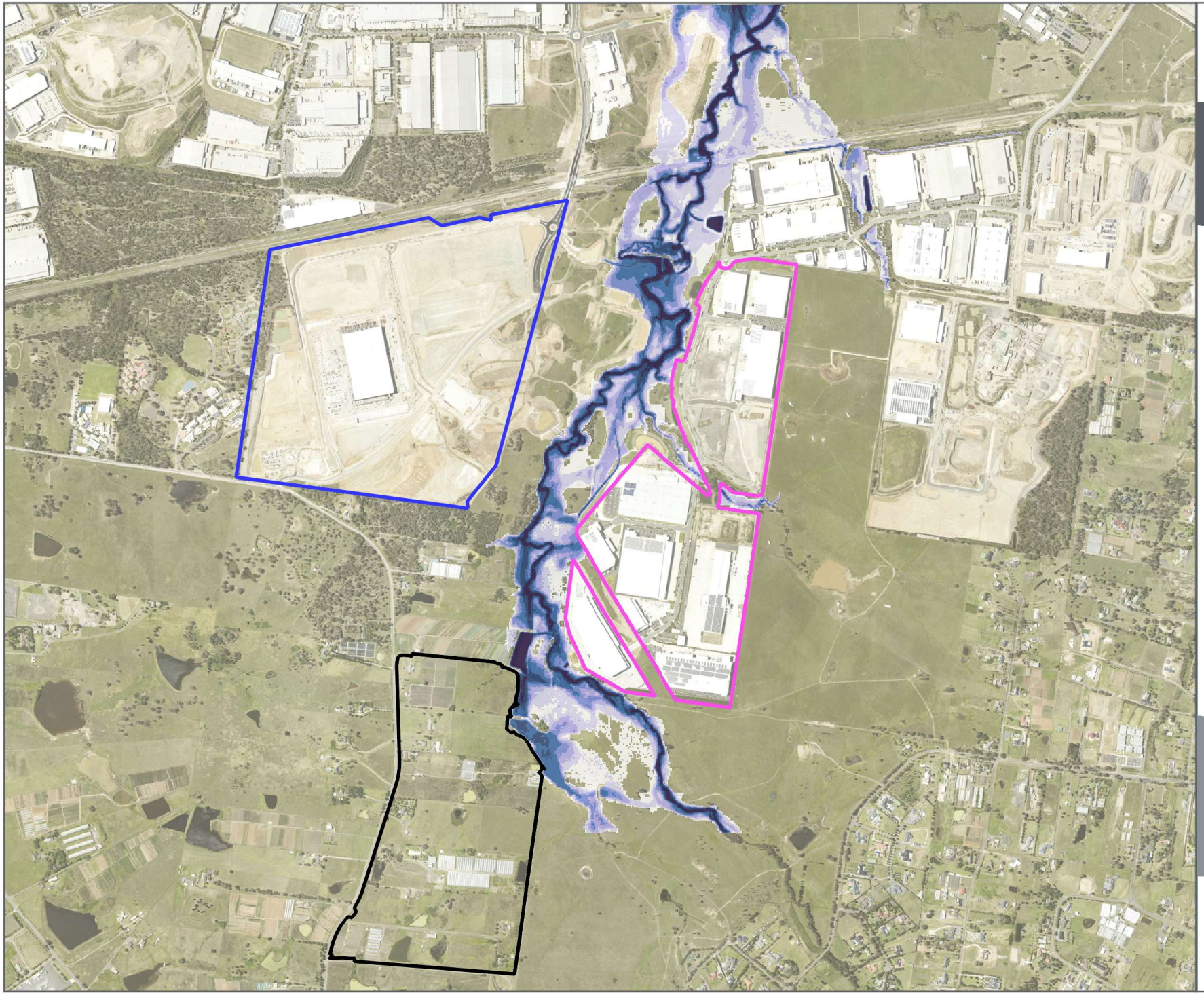
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
20 yr ARI
Flood Depths

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future 20yr ARI Depth (m)

- 0.00 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

FIGURE 13

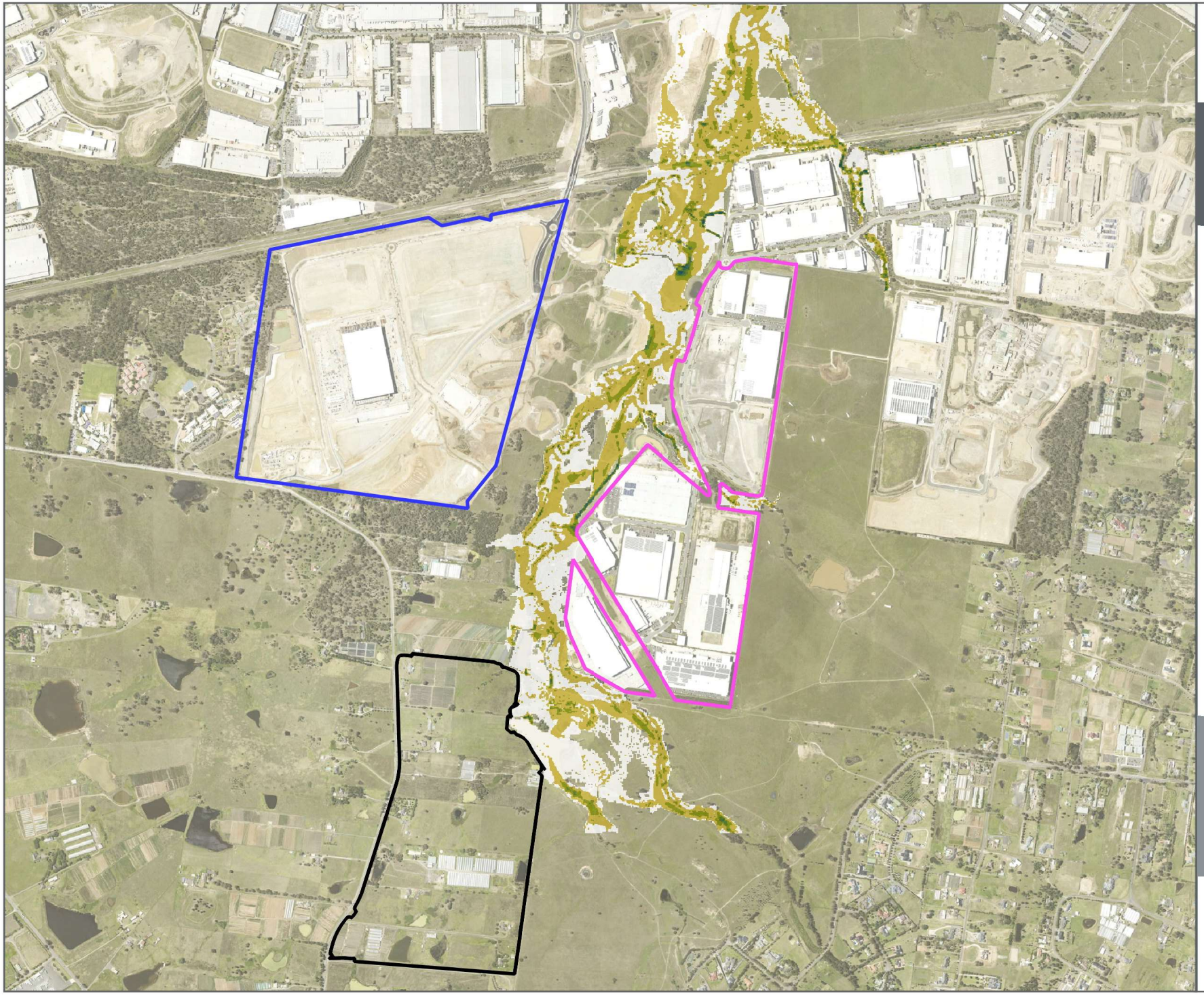
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
20 yr ARI
Flood Velocities

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future 20yr ARI Velocity(m/s)

- 0.00 to 0.50
- 0.50 to 1.00
- 1.00 to 1.50
- 1.50 to 2.00
- 2.00 to 3.00
- > 3.00

FIGURE 14

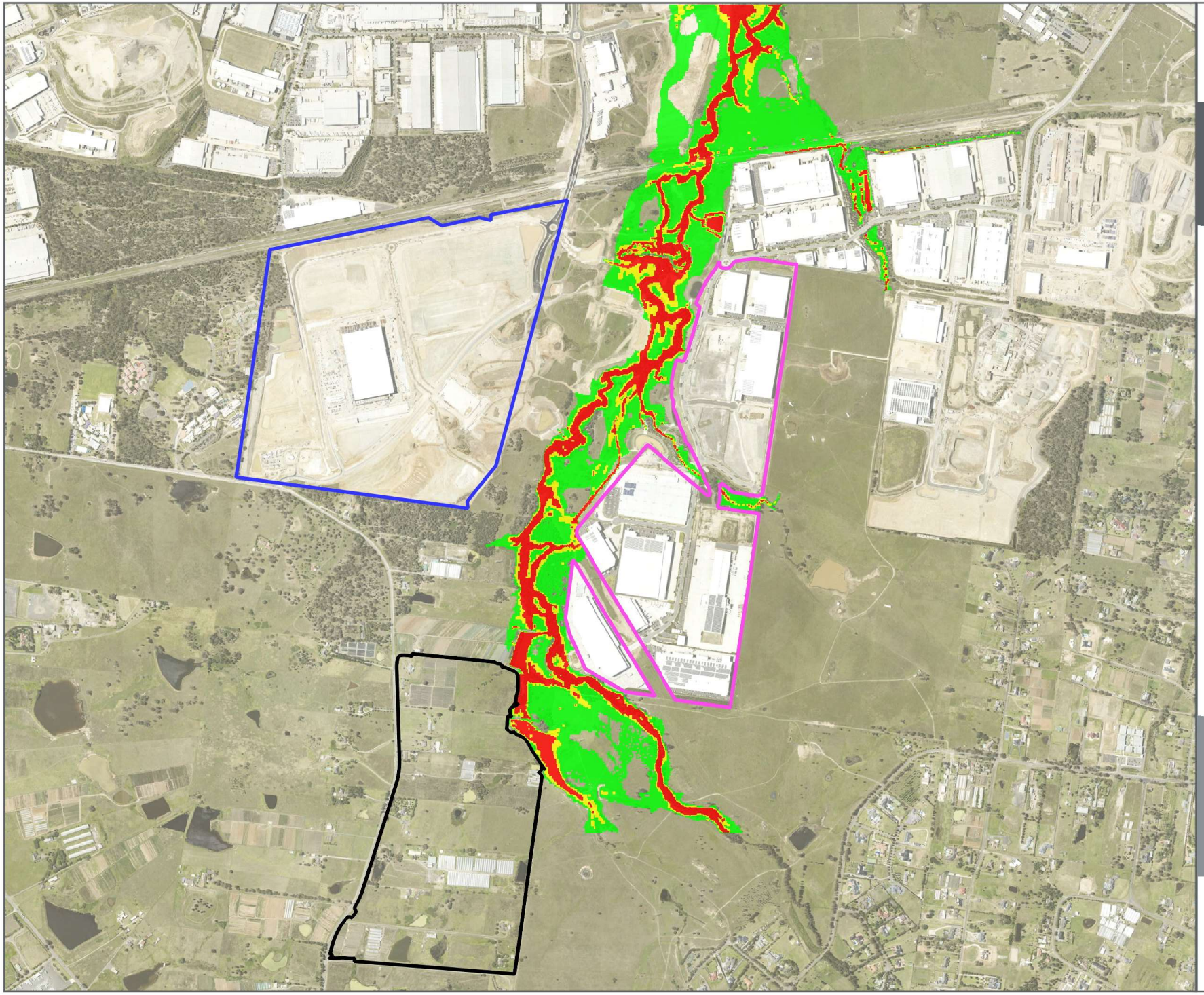
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
20 yr ARI
Flood Hazard

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future 20yr ARI
Provisional Hazard

- Low
- Transitional
- High

FIGURE 15

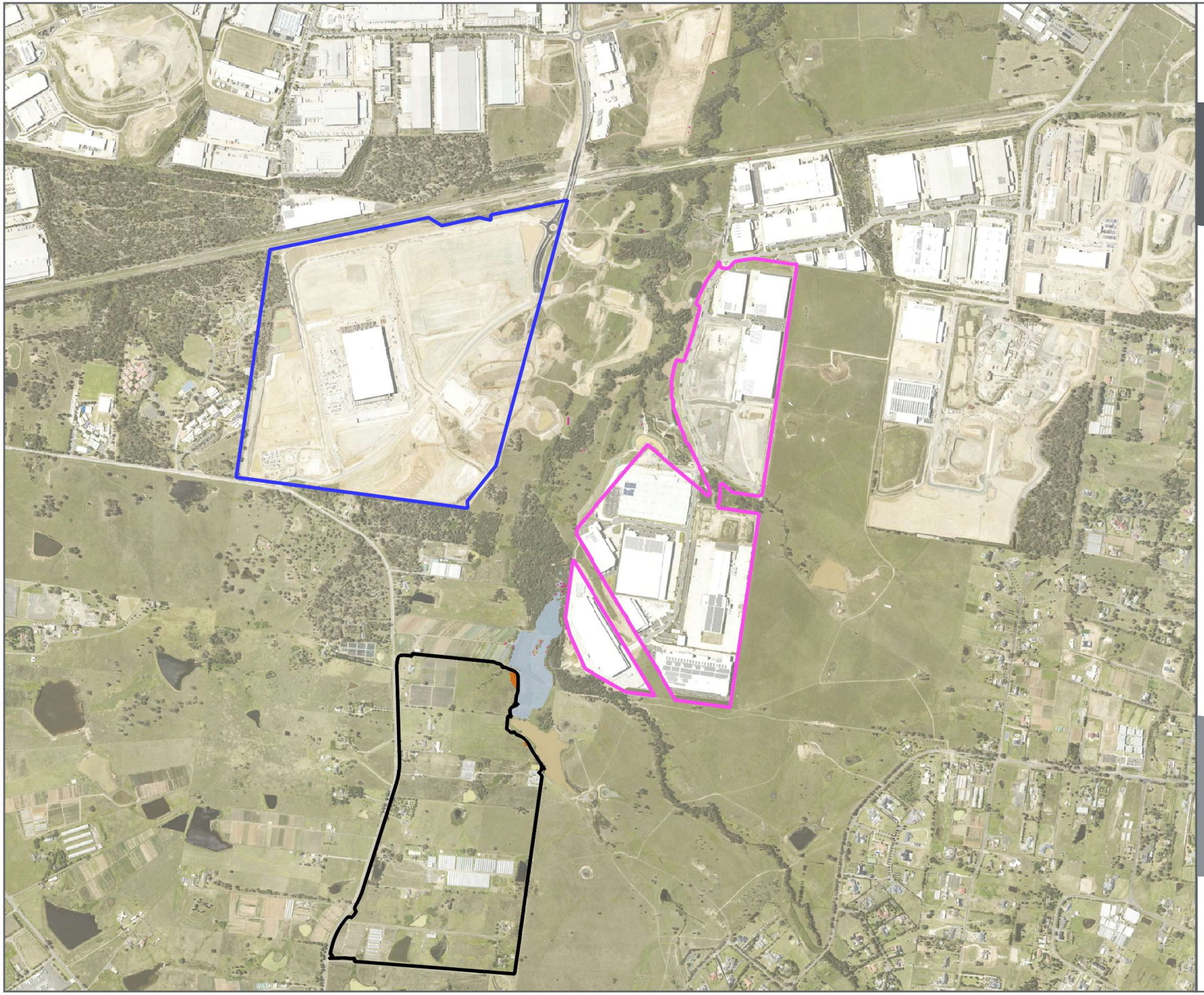
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

(Future Conditions – Benchmark Conditions)
20 yr ARI
Flood Level Difference (m)

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future Less Benchmark 20yr ARI Water Level Difference (m)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

Future Less Benchmark 20yr ARI Wet Dry

- Was Wet, Now Dry
- Was Dry, Now Wet

FIGURE 16

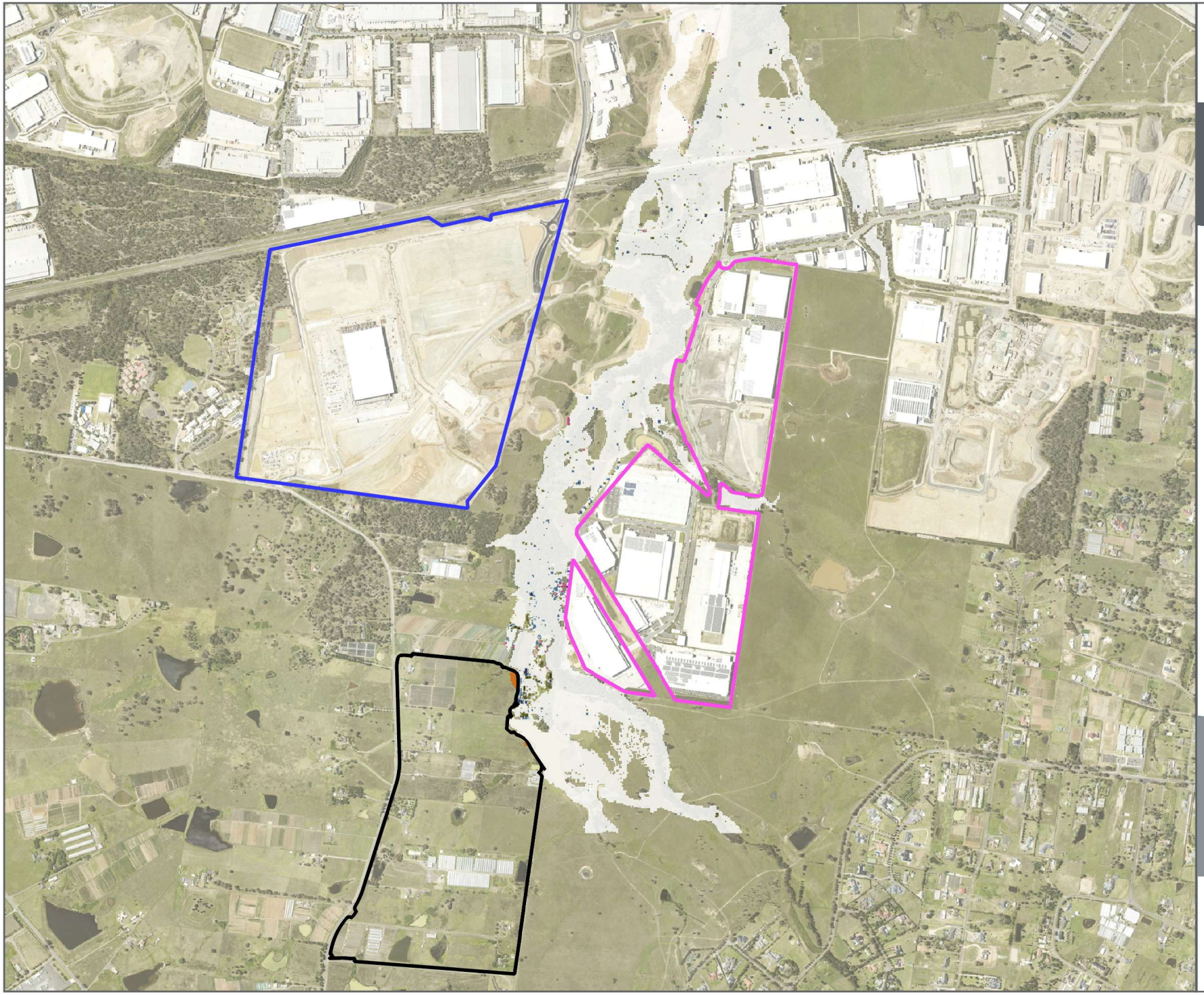
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

(Future Conditions – Benchmark Conditions)
20 yr ARI
Flood Velocity Differnces (m/s)

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future Less Benchmark 20yr ARI Velocity Difference (m/s)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

Future Less Benchmark 20yr ARI Velocity Wet Dry

- Was Wet, Now Dry
- Was Dry, Now Wet

FIGURE 17

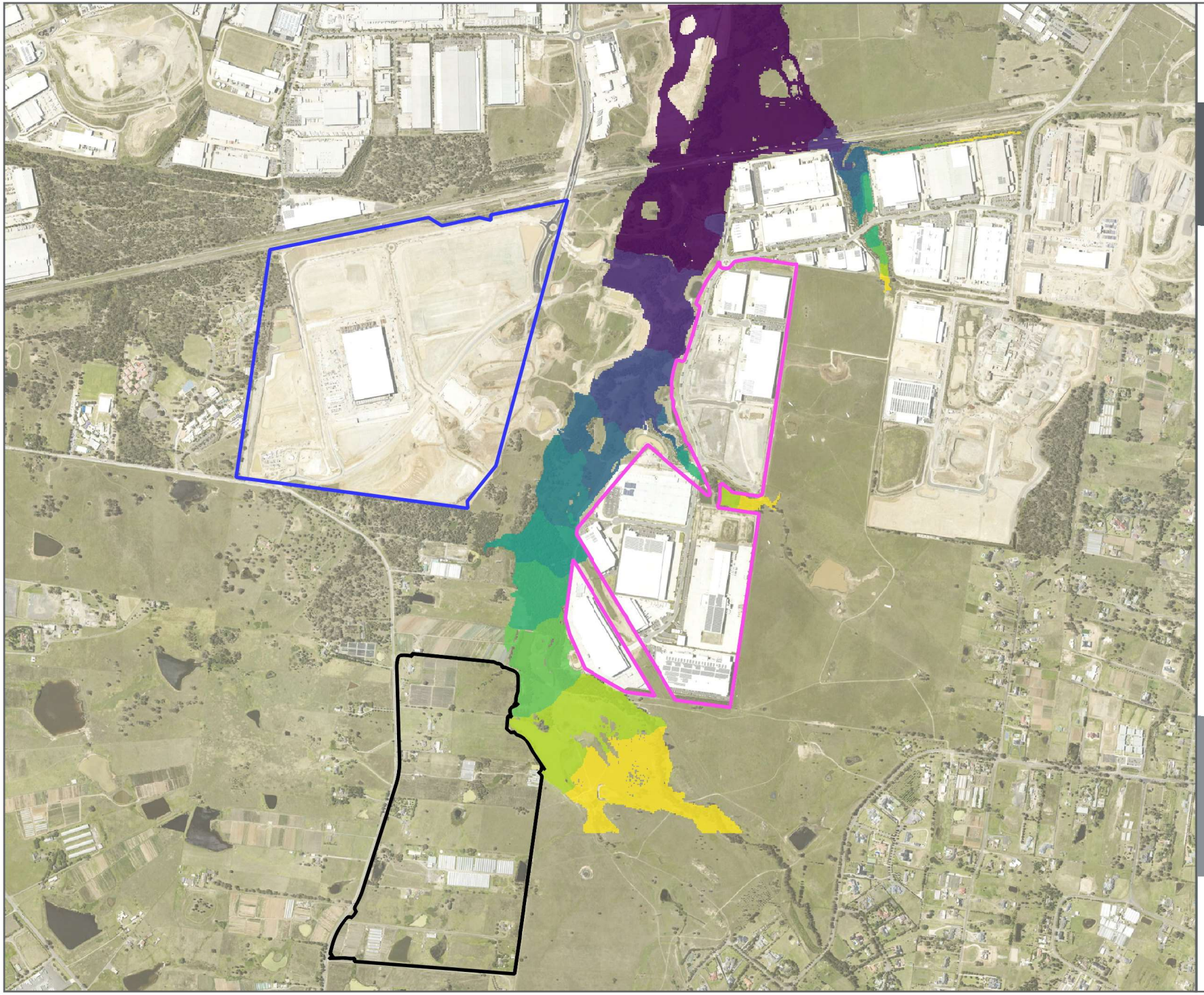
1:14,000 Scale at A3

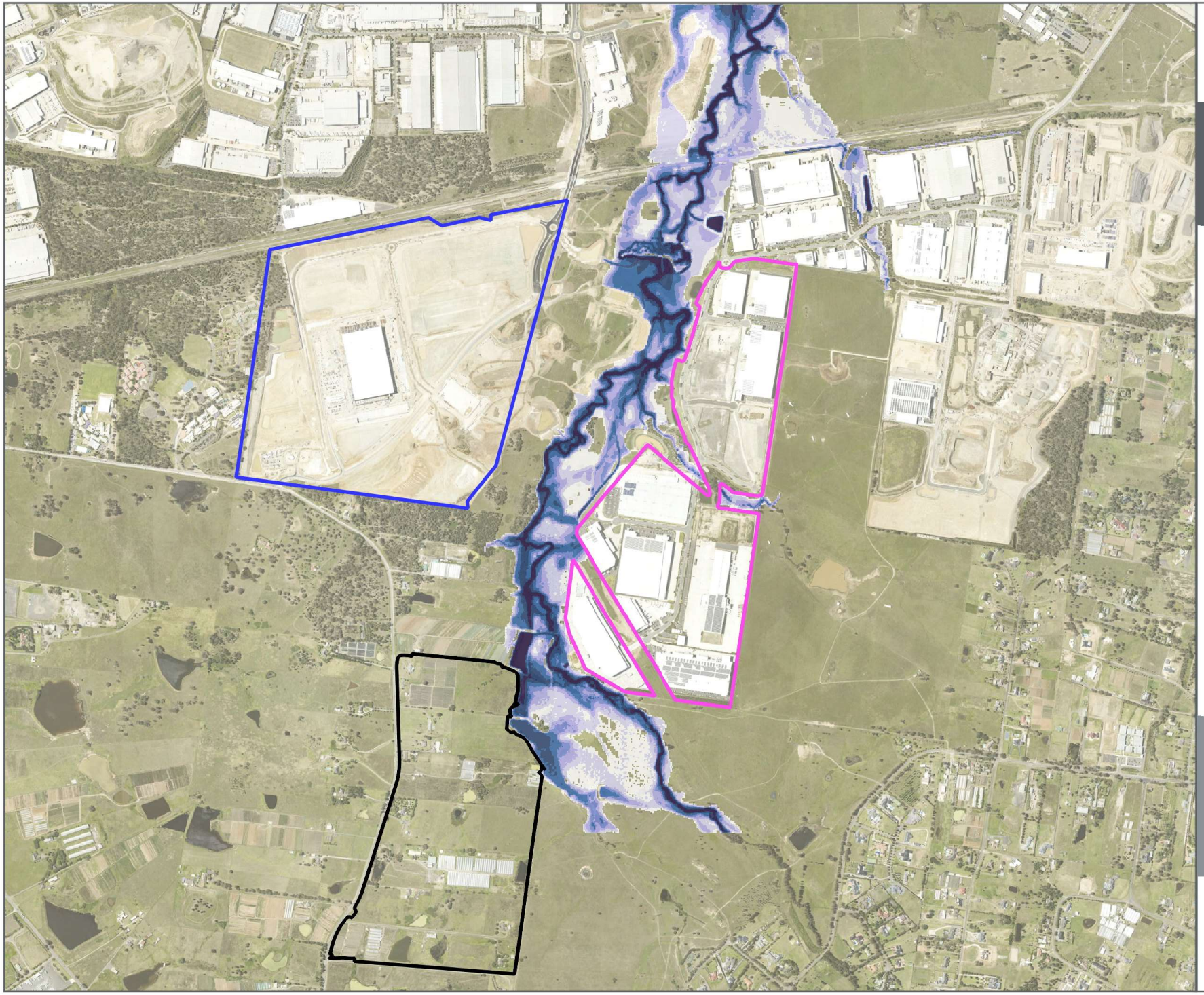
0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz


Fife Kemps Creek Pty Limited
200 Aldington Road Industrial Estate
Future Conditions
100 yr ARI
Flood Extents and Flood Levels
Legend
FKC Study Area
Oakdale West Study Area
Oakdale South Study Area
Future 100yr ARI
Water Level (mAHD)
<= 56
56 - 57
57 - 58
58 - 59
59 - 60
60 - 61
61 - 62
62 - 63
63 - 64
> 64
FIGURE 18
1:14,000 Scale at A3
0 100 200 300 400 500 m
Cardno
Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
100 yr ARI
Flood Depths

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future 100yr ARI Depth (m)

- 0.00 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

FIGURE 19

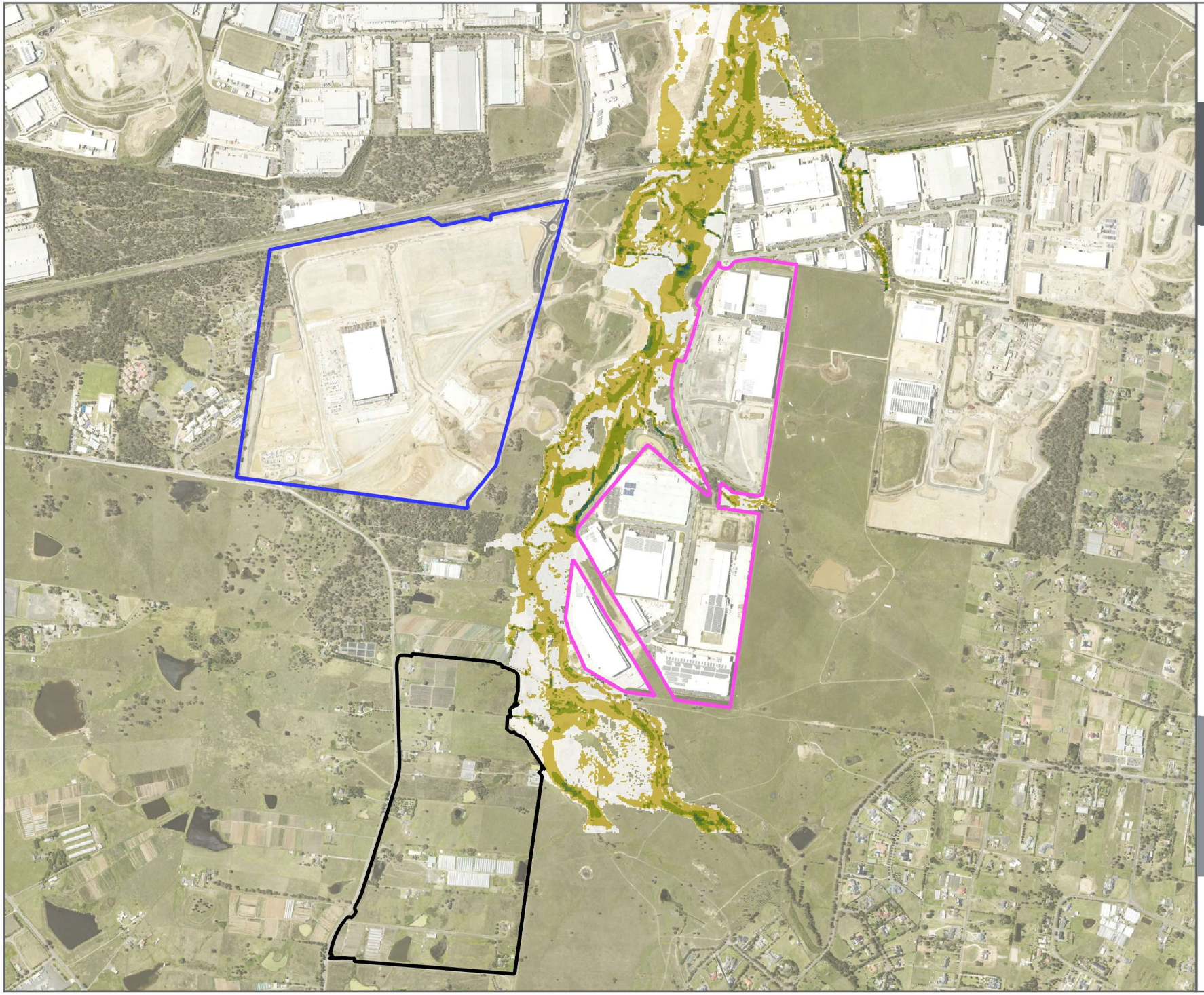
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
100 yr ARI
Flood Velocities

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future 100yr ARI Velocity(m/s)

- 0.00 to 0.50
- 0.50 to 1.00
- 1.00 to 1.50
- 1.50 to 2.00
- 2.00 to 3.00
- > 3.00

FIGURE 20

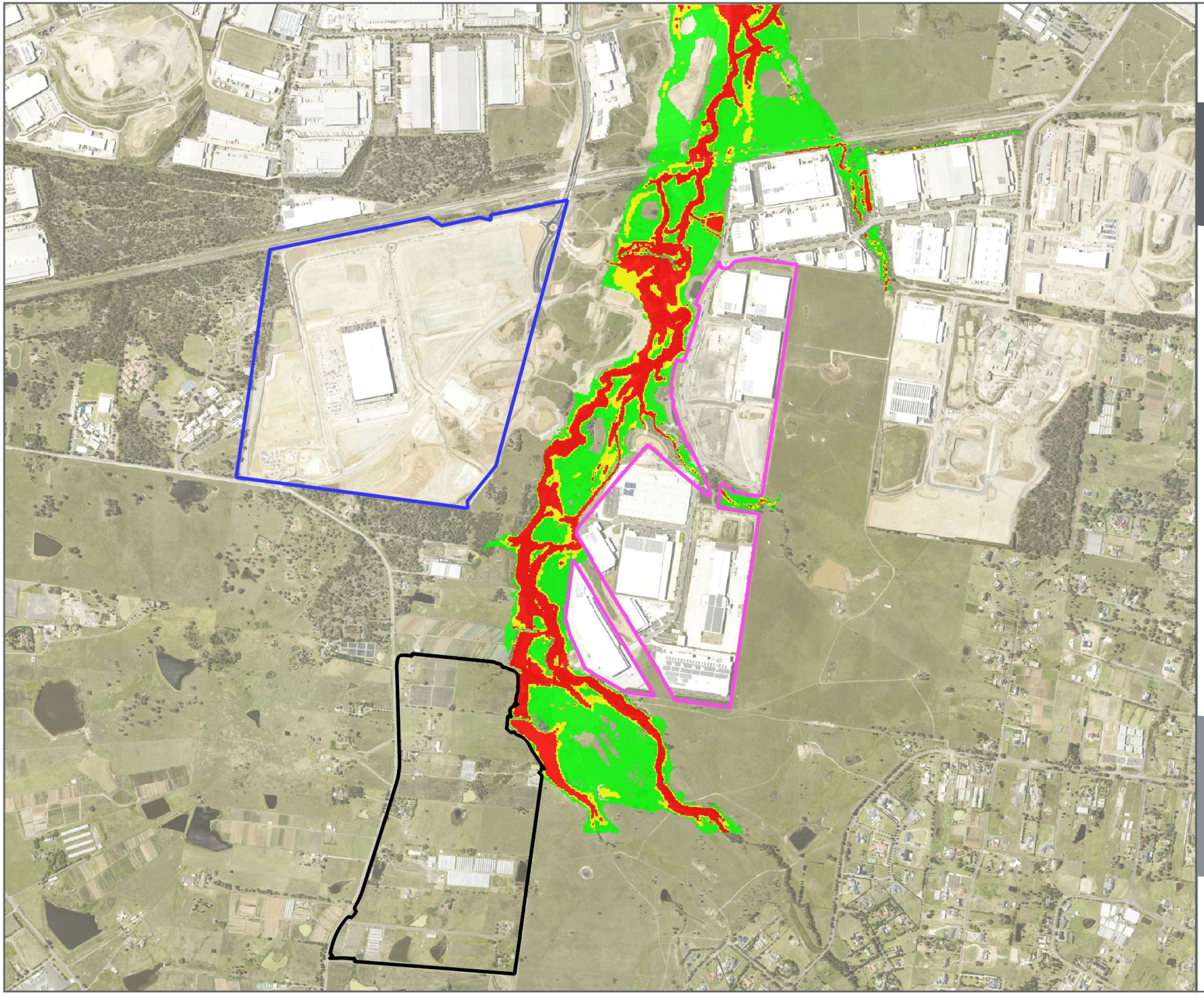
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
100 yr ARI
Flood Hazard

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future 100yr ARI
Provisional Hazard

- Low
- Transitional
- High

FIGURE 21

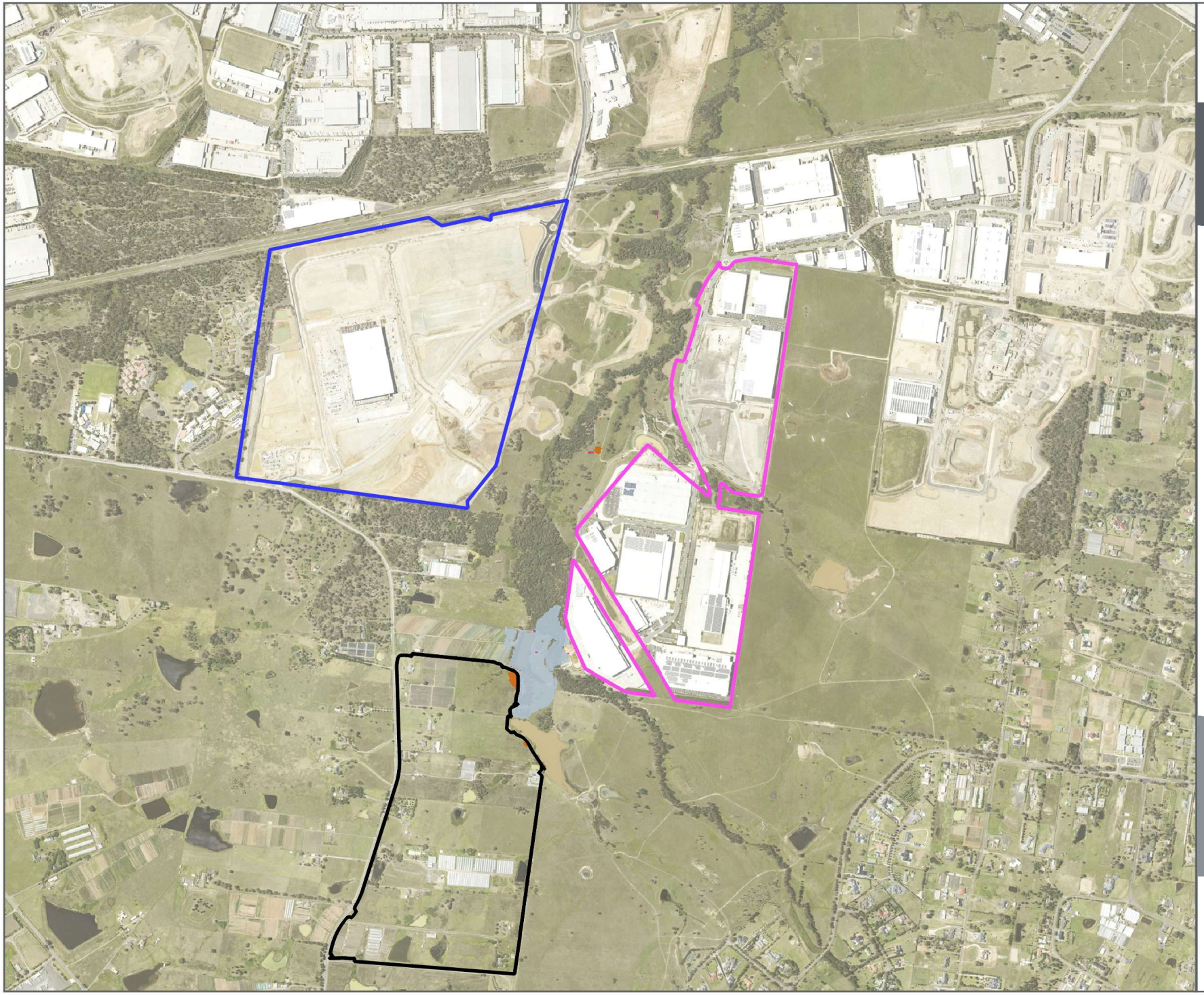
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

(Future Conditions – Benchmark Conditions)
100 yr ARI
Flood Level Difference (m)

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future Less Benchmark 10Cyr ARI Water Level Difference (m)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

Future Less Benchmark 10Cyr ARI Wet Dry

- Was Wet, Now Dry
- Was Dry, Now Wet

FIGURE 22

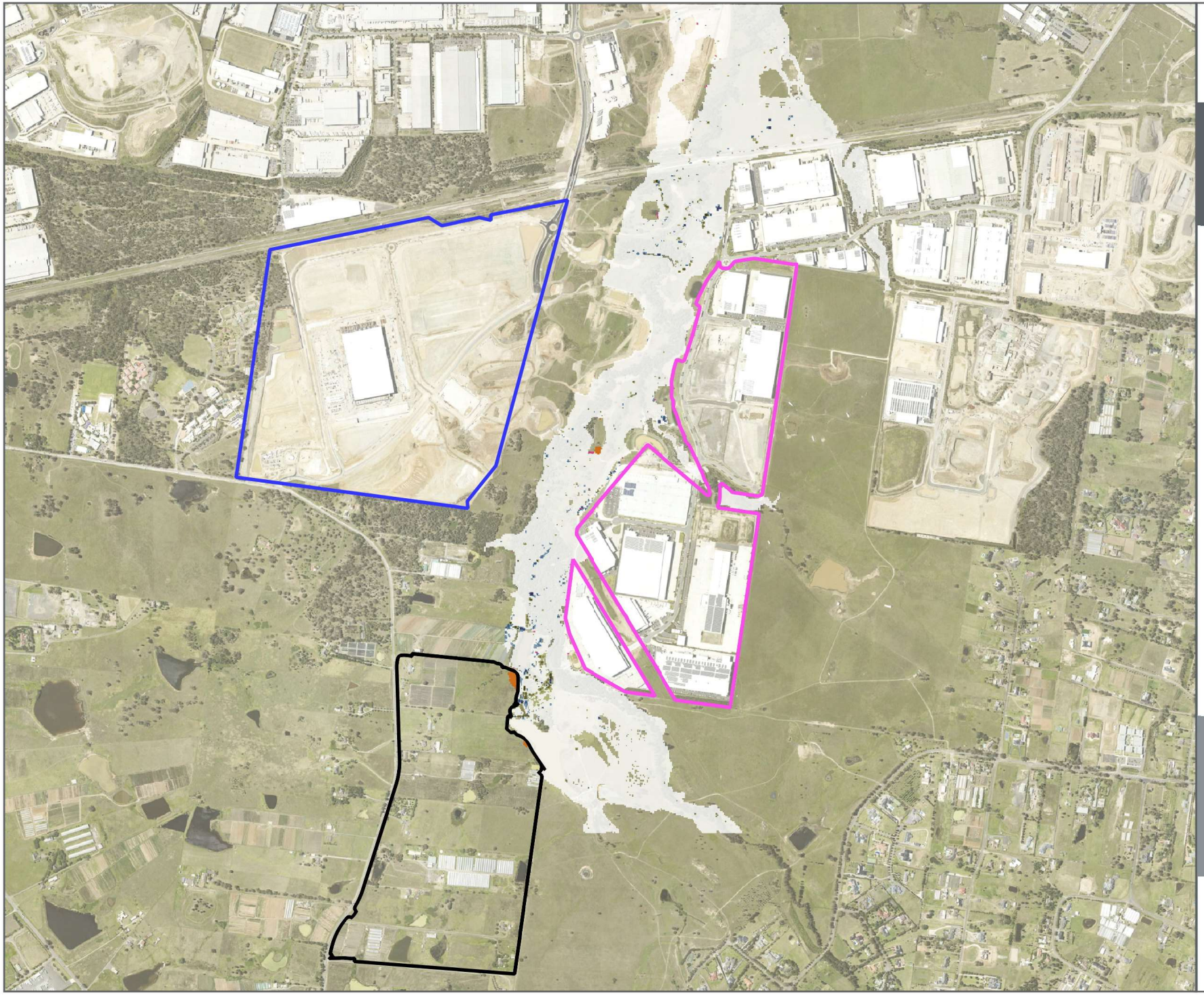
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

(Future Conditions – Benchmark Conditions)
100 yr ARI
Flood Velocity Differnces (m/s)

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future Less Benchmark 10Cyr ARI Velocity Difference (m/s)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

Future Less Benchmark 10Cyr ARI Velocity Wet Dry

- Was Wet, Now Dry
- Was Dry, Now Wet

FIGURE 23

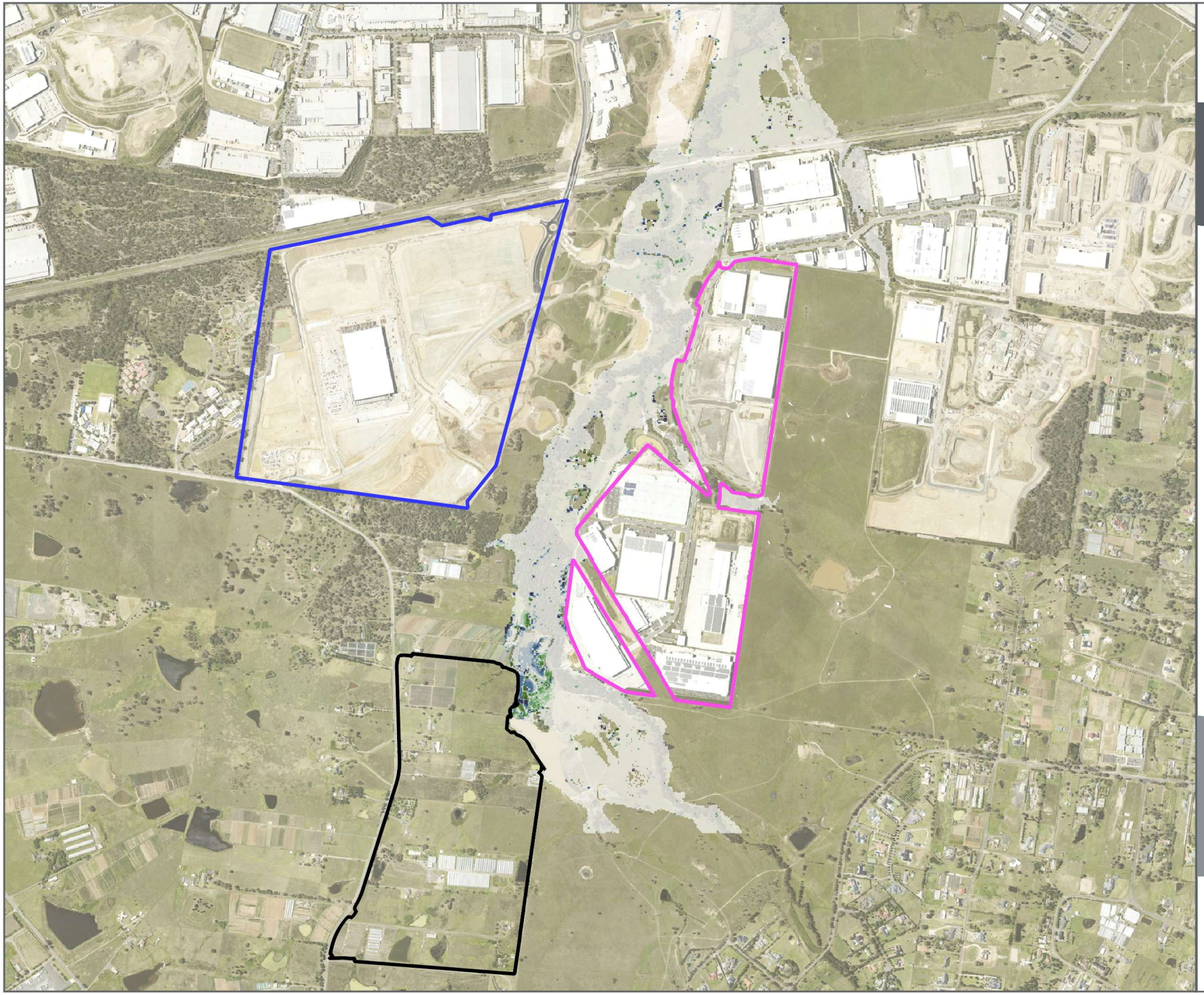
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

(Future Conditions – Benchmark Conditions)
100 yr ARI
Flood Velocity Differnces (%)

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future Less Benchmark PMF Velocity Difference (%)

- <-50%
- -30% to -50%
- -15% to -30%
- -10% to -15%
- -5% to -10%
- -5% to 5%
- 5% to 10%
- 10% to 15%
- 15% to 30%
- 30% to 50%
- >50%

FIGURE 24

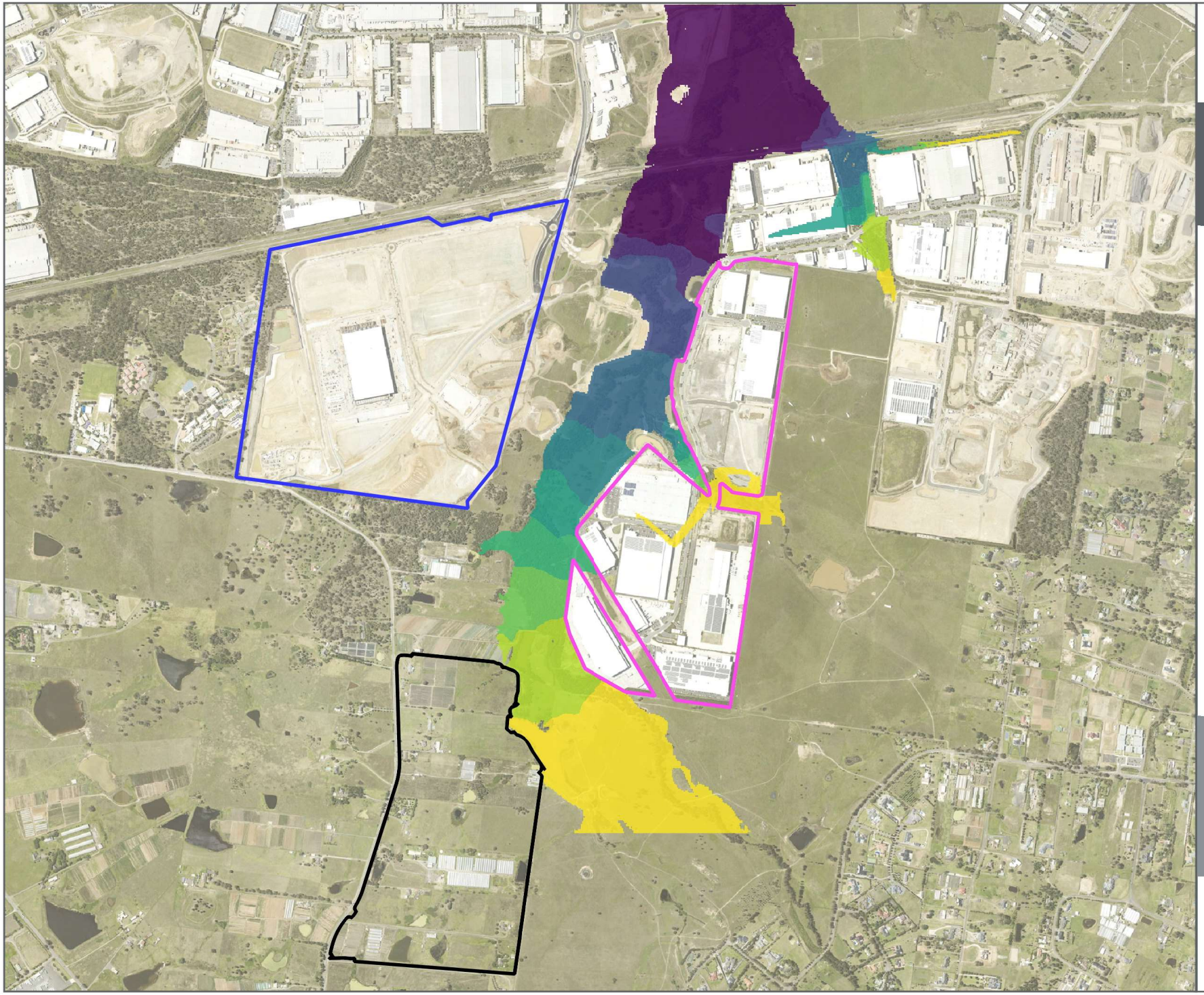
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
PMF
Flood Extents and Flood Levels

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future PMF
Water Level (mAHD)

- <= 56
- 56 - 57
- 57 - 58
- 58 - 59
- 59 - 60
- 60 - 61
- 61 - 62
- 62 - 63
- 63 - 64
- > 64

FIGURE 25

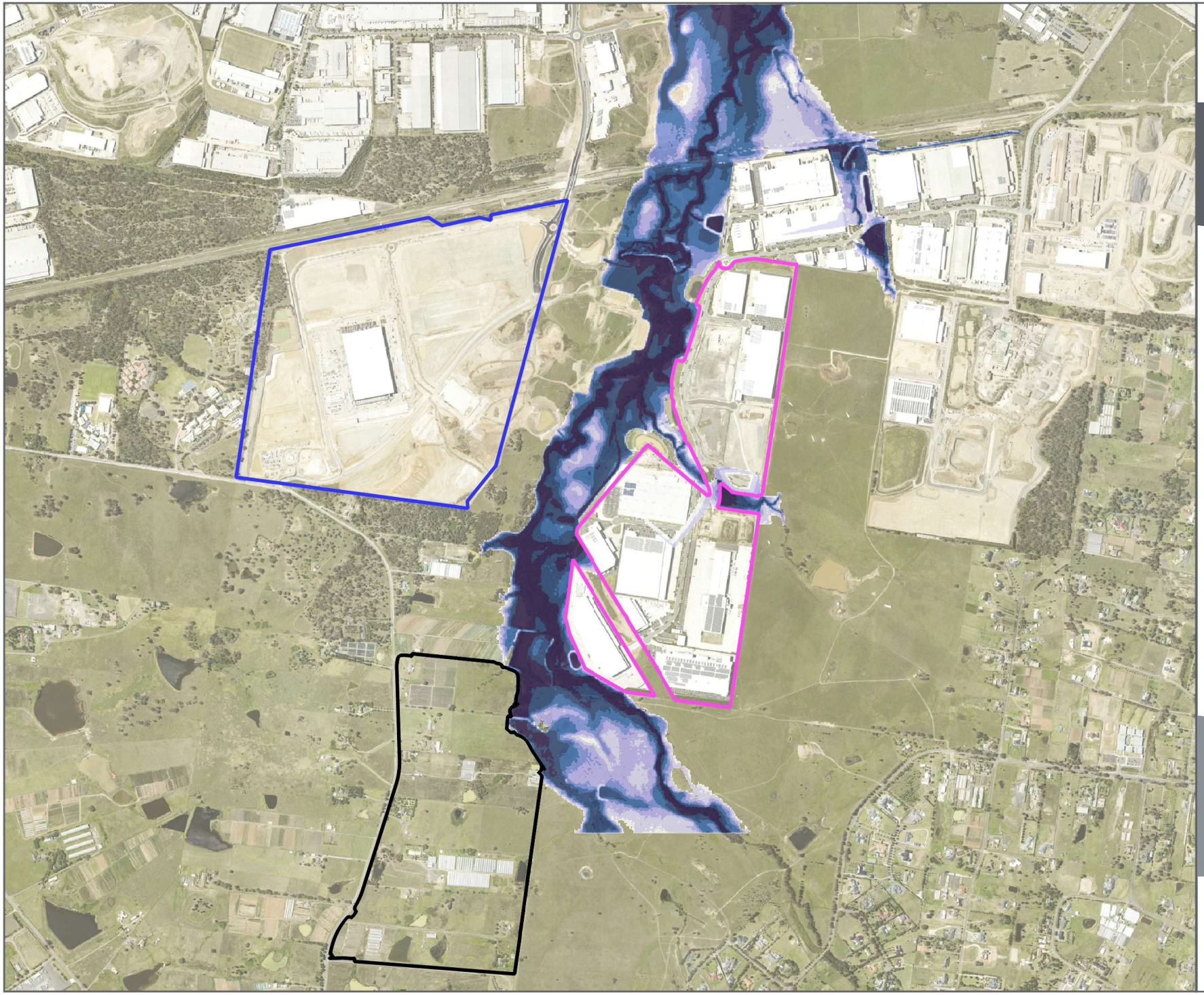
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
PMF
Flood Depths

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future PMF ARI Depth (m)

- 0.00 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

FIGURE 26

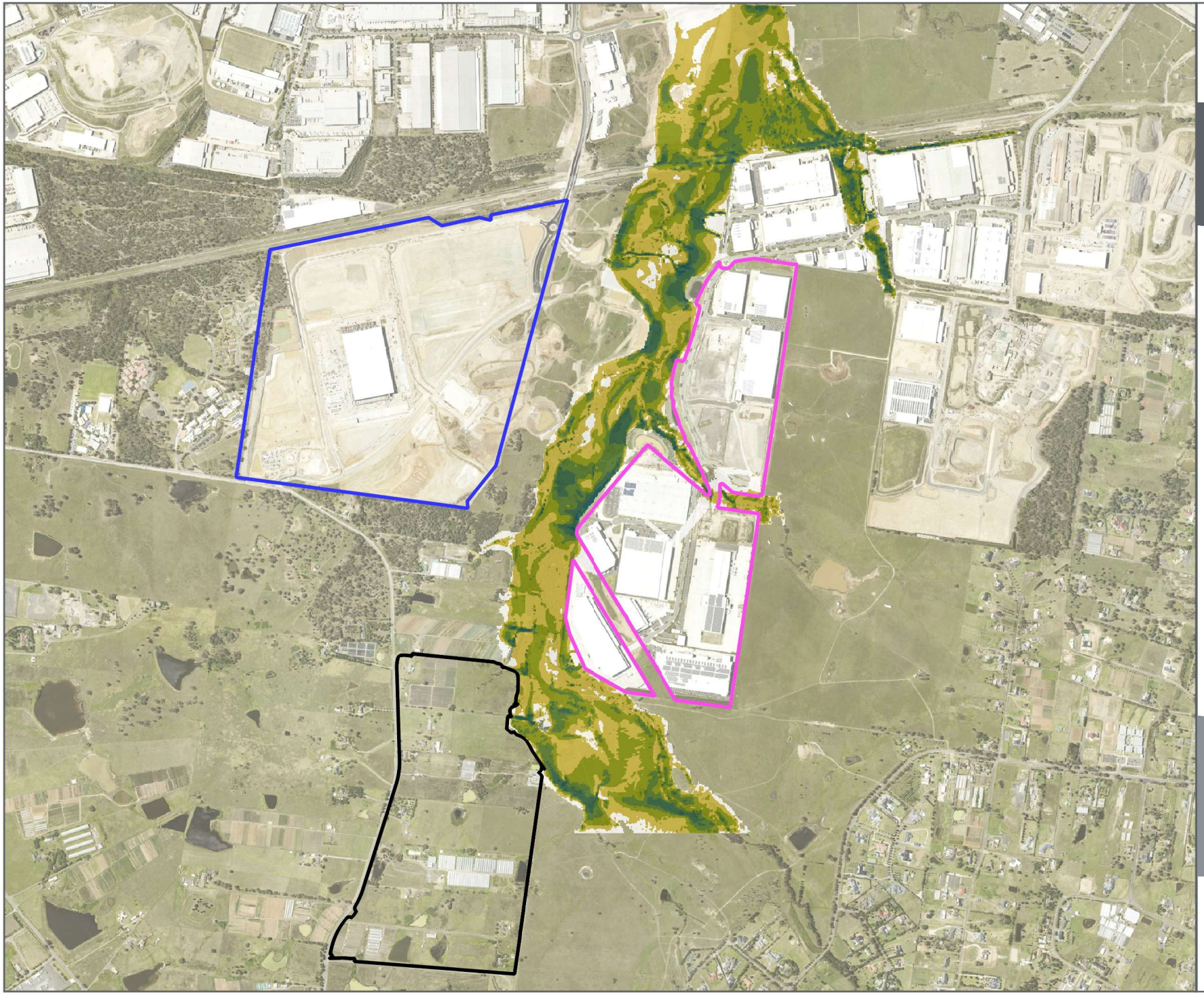
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
PMF
Flood Velocities

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future PMF Velocity(m/s)

- 0.00 to 0.50
- 0.50 to 1.00
- 1.00 to 1.50
- 1.50 to 2.00
- 2.00 to 3.00
- > 3.00

FIGURE 27

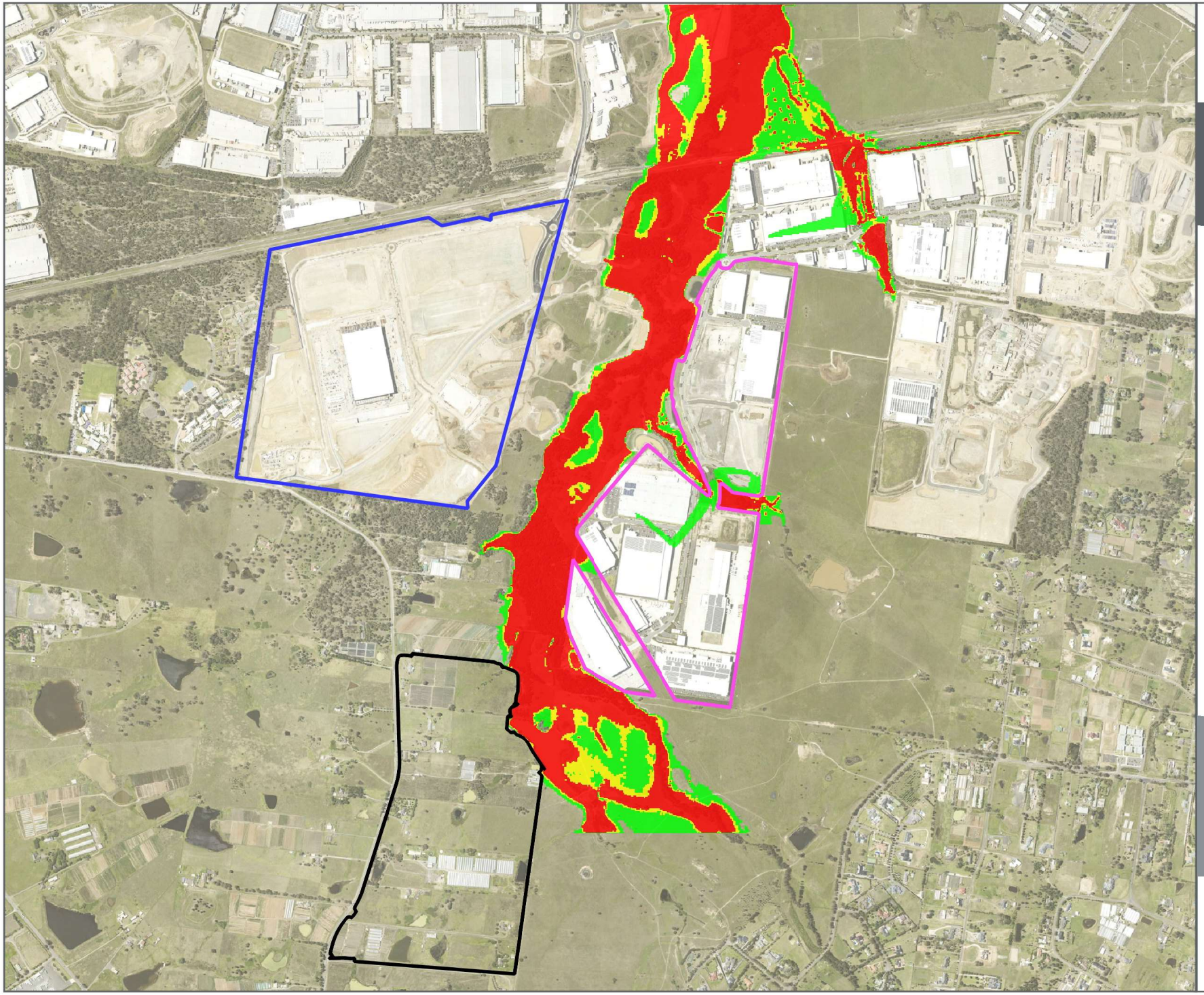
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Future Conditions
PMF
Flood Hazard

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future PMF
Provisional Hazard

- Low
- Transitional
- High

FIGURE 28

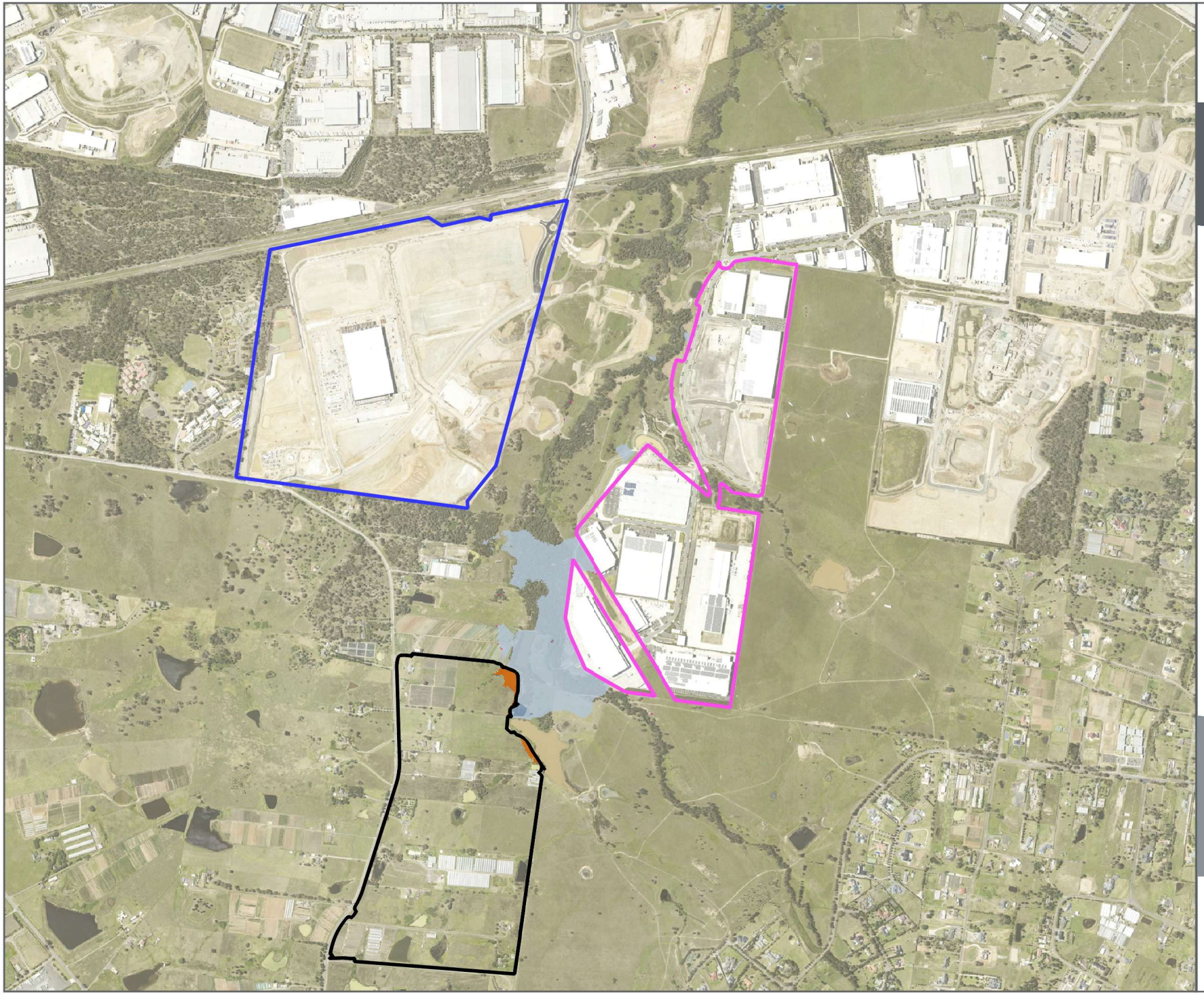
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

(Future Conditions – Benchmark Conditions)
PMF
Flood Level Difference (m)

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future Less Benchmark PMF
Water Level Difference (m)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

Future Less Benchmark PMF
Wet Dry

- Was Wet, Now Dry
- Was Dry, Now Wet

FIGURE 29

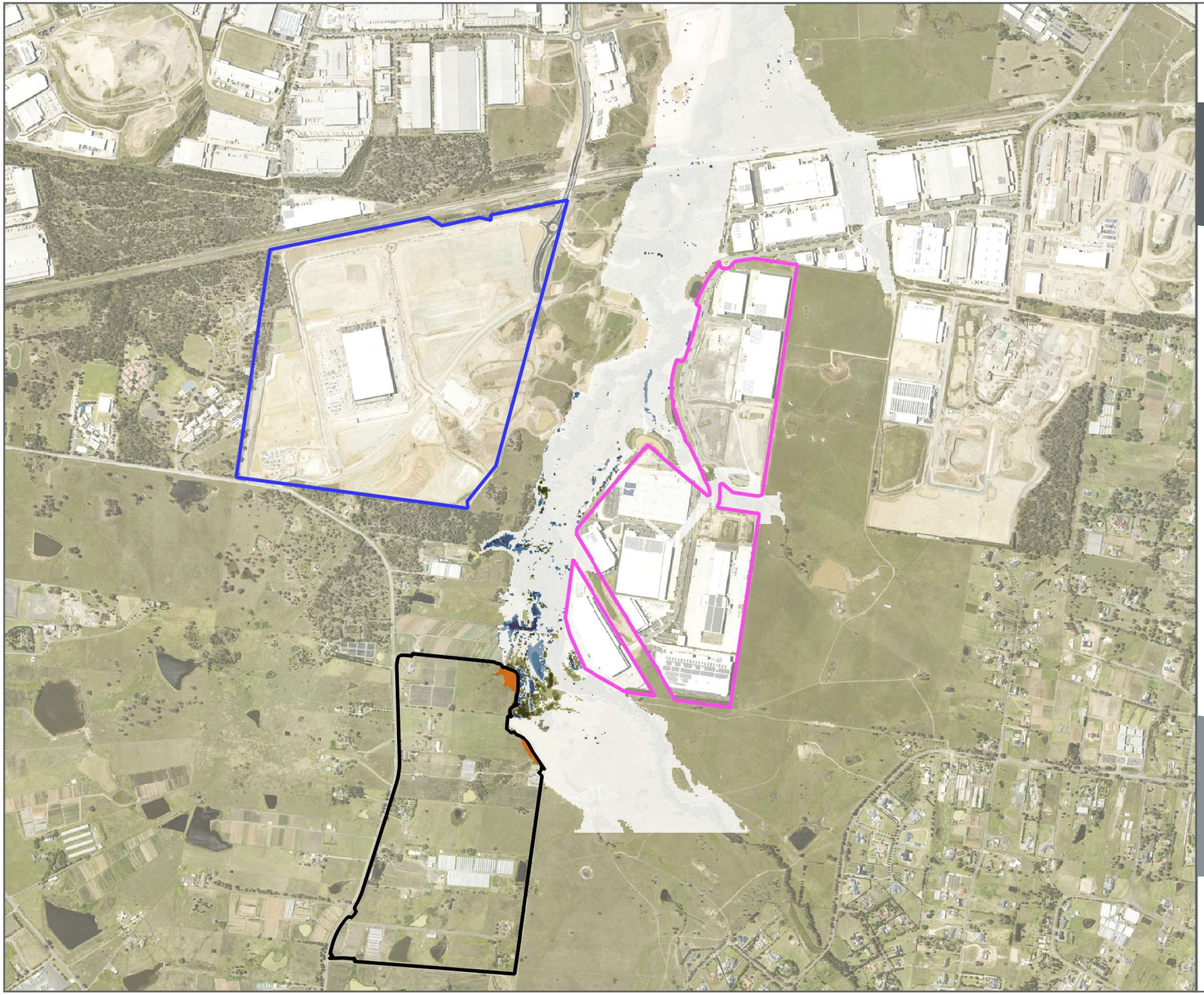
1:14,000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

(Future Conditions – Benchmark Conditions)
PMF
Flood Velocity Differnces (m/s)

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area

Future Less Benchmark PMF Velocity Difference (m/s)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

Future Less Benchmark PMF Velocity Wet Dry

- Was Wet, Now Dry
- Was Dry, Now Wet

FIGURE 30

1:14,000 Scale at A3

0 100 200 300 400 500 m

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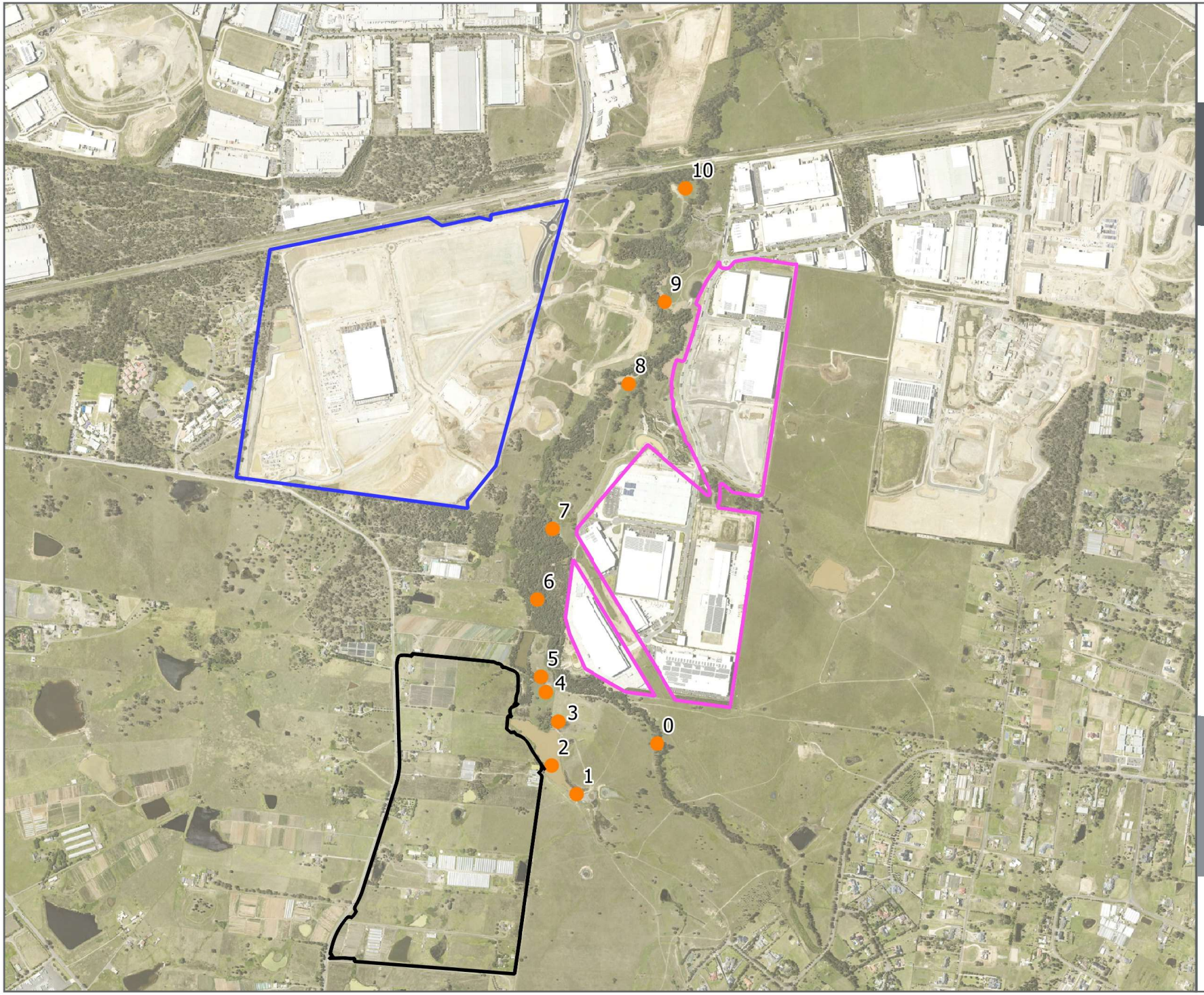
Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz



Fife Kemps Creek Pty Limited

200 Aldington Road Industrial Estate

Reference Locations

Legend

- FKC Study Area
- Oakdale West Study Area
- Oakdale South Study Area
- Reference Points

FIGURE 31

1:14,000 Scale at A3

0 100 200 300 400 500 m

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2021-9-15| Project: NW30034
Coordinate System:GDA2020/MGA56|
Map: FKC Figures - Copy.qgz