Flood Impact Assessment

200 Aldington Industrial Estate

NW30034

Prepared for
Fife Kemps Creek Pty Limited

15 October 2020

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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 Fife Kemps Creek (FKC) 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 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 EIS, Civil Infrastructure report and development 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 18,747 m^3 (refer **Figure 2**) is in agreement with the size determined under ARR1987 given in **Table 1**.

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 Industrial Estate on 2 yr ARI, 20 yr ARI and 100 yr ARI flood levels (in comparison to Benchmark Conditions) are plotted in **Figures 9, 15** and **21** respectively. These Figures disclose local adverse impacts on flood level in the vicinity of the NE corner of the 200 Aldington Industrial Estate and negligible incremental impacts downstream of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events.

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

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).

It is concluded that the proposed development addresses all of the considerations set out under Clause 33I Development on flood prone land.

The Planning Secretary's Environmental Assessment Requirement under Section 4.12(8) of the Environmental Planning and Assessment Act 1979 and Schedule 2 of the Environmental Planning and Assessment Regulation 2000 advised in part:

> *The Environmental Impact Statement (EIS) for the development must meet the form and content requirements in clauses 6 and 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000. …..*
>
> *The EIS must include an assessment of the potential impacts of the proposal (including cumulative impacts) and develop appropriate measures to avoid, mitigate, manage and/or offset these impacts.*
>
> *The EIS must address the following specific matters:*
>
> *Soil and Water – including:*
>
> *…..a detailed flooding impact assessment;*

The 2020 Flood Risk Assessment for 200 Aldington Industrial Estate describes flooding under Benchmark Conditions (Cardno, 2020b). This report describes the impact on flooding on the proposed development of 200 Aldington Industrial Estate.

It is concluded that this Flood Impact Assessment and the companion Flood Risk Assessment satisfy the SEARs requirement.

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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) 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 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**.

1.3 200 Aldington Industrial Estate Masterplan

The concept details of the proposed stormwater management measures for 200 Aldington Industrial Estate are given in **Figures 2** and **3**.

As described by AT&L, 2020

> *Due to the existing topography, site constraints and precinct requirements as discussed by AT&L, 2020, significant cut to fill operations with balance import fill material is required.*
>
> *The main objective for the stormwater drainage design of the proposed development is to ensure post-developed catchment flows do not exceed the pre-developed catchment flows. With On-Site Detention (OSD) systems in place to limit discharges to pre-developed rates, this will ensure the downstream catchments will not be inundated with flows and cause adverse flooding affects downstream of the development. Design documentation has been completed in accordance with the Penrith City Council Engineering guidelines.*
>
> *… The site is mainly divided in to two stormwater catchments – larger catchment in the north and smaller catchment to the south. The stormwater on the lots and within the road reserve for the southern catchment of the site is proposed to be collected via pits and pipes and connect into an On-Site Detention basin in the south west corner of the site – called Basin A. Stormwater on the lots and within the road reserve for the larger catchment to the north of the site is proposed to be collected via pits and pipes and connect into an On-Site Detention basin in the north east corner of the site – called Basin B*

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 3**.

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 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 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 18,747 m^3 (refer **Figure 2**) 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)	8,314	17,366	48%	201	420
2019	50% AEP (6 hr) & 1% AEP (45 mins)	12,430	21,217	59%	301	514

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 2.**

The roughness zones under Future Conditions are mapped in **Figure 4**.

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 basin.

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

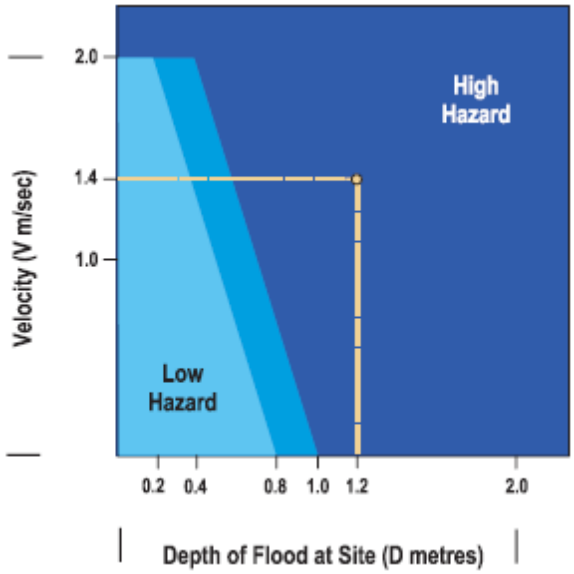
The TUFLOW floodplain model was run for the critical storm burst durations for the 2 yr ARI, 20 yr ARI, 100 yr ARI and PMF events.

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 5, 6** and **7** 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 8**.

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 11, 12, 13** and **14** 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 17, 18, 19** and **20** respectively.

3.1.4 PMF

The estimated PMF flood levels and extent, depths, velocities and hazards under Future Conditions are plotted in **Figures 23, 24, 25** and **26** respectively.

4 Flood Impact Assessment

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

4.1 Flood Level Impacts

The estimated impact of the proposed 200 Aldington Industrial Estate on 2 yr ARI, 20 yr ARI and 100 yr ARI flood levels (in comparison to Benchmark Conditions) are plotted in **Figures 9, 15** and **21** respectively.

These Figures disclose local adverse impacts on flood level in the vicinity of the NE corner of the 200 Aldington Industrial Estate and negligible incremental impacts downstream of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events.

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 27** for the cases including:

- The 2008 GHD model of Existing Conditions (GHD, 2008)
- The 2015 Ropes Creek model (Worley Parsons, 2015)
- 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 2020 Future Conditions for 200 Aldington Industrial Estate (this study)

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);

(v) The local adverse impacts on in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events in the vicinity of the NE corner of the 200 Aldington Industrial Estate are minor and confined to the RE2 zoned land;

(vi) The incremental impacts downstream of the 200 Aldington Industrial Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events are negligible.

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 Worley Parsons) (mAHD) (b)	Flood Level Difference (cm) (b) - (a)	Reference Location	Revised Existing (E1) (mAHD) (f)	Flood Level Difference (cm) (f) - (a)	Flood Level Difference (cm) (f) - (b)	Revised Oakdale South + Oakdale West (E2) - Benchmark (mAHD) (g)	Flood Level Difference (cm) (g) - (c)	Flood Level Difference (cm) (g) - (f)	Oakdale South + Oakdale West + FKC (mAHD) (h)	Flood Level Difference (cm) (h) - (f)	Incremental Flood Level Difference (cm) (h) - (g)	Flood Level Difference (cm) (h) - (a)
0								63.93		6393	63.93		0	
1								63.81		6381	63.82		1	
2								63.76		6376	63.77		1	
3								63.73		6373	63.73		0	
4								62.52		6252	62.54		2	
5								62.19		6219	62.26		7	
6								61.10		6110	61.12		2	
7								-			-			
8								57.05		5705	57.06		1	
9								56.23		5623	56.24		1	
10								54.12		5412	54.12		0	

20 yr ARI

Reference Location	Existing (2008 GHD) (mAHD) (a)	Existing (2015 Worley Parsons) (mAHD) (b)	Flood Level Difference (cm) (b) - (a)	Reference Location	Revised Existing (E1) (mAHD) (f)	Flood Level Difference (cm) (f) - (a)	Flood Level Difference (cm) (f) - (b)	Revised Oakdale South + Oakdale West (E2) - Benchmark (mAHD) (g)	Flood Level Difference (cm) (g) - (c)	Flood Level Difference (cm) (g) - (f)	Oakdale South + Oakdale West + FKC (mAHD) (h)	Flood Level Difference (cm) (h) - (f)	Incremental Flood Level Difference (cm) (h) - (g)	Flood Level Difference (cm) (h) - (a)
0								64.22			64.22		0	
1								63.96			63.98		2	
2								63.85			63.90		5	
3								63.79			63.82		3	
4								62.60			62.63		3	
5								62.58			62.60		2	
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 Worley Parsons) (mAHD) (b)	Flood Level Difference (cm) (b) - (a)	Reference Location	Revised Existing (E1) (mAHD) (f)	Flood Level Difference (cm) (f) - (a)	Flood Level Difference (cm) (f) - (b)	Revised Oakdale South + Oakdale West (E2) - Benchmark (mAHD) (g)	Flood Level Difference (cm) (g) - (c)	Flood Level Difference (cm) (g) - (f)	Oakdale South + Oakdale West + FKC (mAHD) (h)	Flood Level Difference (cm) (h) - (f)	Incremental Flood Level Difference (cm) (h) - (g)	Flood Level Difference (cm) (h) - (a)
0	64.61	64.41	-20	0	64.30	-31	-11	64.30	-26	0	64.30	0	0	-31
1	64.05	63.80	-25	1	64.07	2	27	64.07	21	0	64.09	2	2	4
2	64.01	63.68	-33	2	63.91	-10	23	63.91	6	0	63.99	8	8	-2
3	63.90	63.64	-26	3	63.83	-7	19	63.83	4	0	63.88	5	5	-2
4	63.12	62.47	-65	4	62.75	-37	28	62.76	-8	1	62.78	3	2	-34
5	63.10	62.37	-73	5	62.73	-37	36	62.74	-8	1	62.76	3	2	-34
6	62.02	61.41	-61	6	61.63	-39	22	61.65	-19	2	61.65	2	0	-37
7	60.26	60.00	-26	7	60.14	-12	14	60.16	-9	2	60.16	2	0	-10
8	57.67	57.27	-40	8	57.48	-19	21	57.53	-13	5	57.54	6	1	-13
9	56.68	56.26	-42	9	56.57	-11	31	56.62	-10	5	56.62	5	0	-6
10	54.52	54.24	-28	10	54.40	-12	16	54.41	-10	1	54.41	1	0	-11

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 (in comparison to Benchmark Conditions) are plotted in **Figures 10, 16** and **22** respectively.

These Figures disclose local minor impacts on flood velocities in the vicinity of the NE corner of the 200 Aldington Industrial Estate and negligible incremental impacts downstream of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events.

5 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.

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 Industrial Estate on 2 yr ARI, 20 yr ARI and 100 yr ARI flood levels (in comparison to Benchmark Conditions) are plotted in **Figures 9, 15** and **21** respectively.

These Figures disclose local adverse impacts on flood level in the vicinity of the NE corner of the 200 Aldington Industrial Estate and negligible incremental impacts downstream of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events.

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

These Figures disclose local minor impacts on flood velocities in the vicinity of the NE corner of the 200 Aldington Industrial Estate and negligible incremental impacts downstream of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI, events.

(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 Industrial Estate in 2 yr ARI, 20 yr AR and 100 yr ARI floods and PMF are plotted in **Figures 8, 14, 20** and **26** respectively.

These Figures disclose that there would be nil flood hazard experienced in the developed areas of the Estate in the 2 yr ARI, 20 yr ARI and 100 yr ARI floods.

In the PMF the industrial development would be likely exposed to low hazard overland flows generated by local runoff. 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 in extreme floods approaching a PMF. In the PMF, the industrial development would be likely exposed to low hazard overland flows. 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 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 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 hazard

(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.

The Planning Secretary's Environmental Assessment Requirement under Section 4.12(8) of the Environmental Planning and Assessment Act 1979 and Schedule 2 of the Environmental Planning and Assessment Regulation 2000 advised in part:

The Environmental Impact Statement (EIS) for the development must meet the form and content requirements in clauses 6 and 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000. …..

The EIS must include an assessment of the potential impacts of the proposal (including cumulative impacts) and develop appropriate measures to avoid, mitigate, manage and/or offset these impacts.

The EIS must address the following specific matters:

Soil and Water – including:

…..a detailed flooding impact assessment;

The 2020 Flood Risk Assessment for 200 Aldington Industrial Estate describes flooding under Benchmark Conditions (Cardno, 2020b). This Flood Impact Assessment and the companion Flood Risk Assessment satisfy the SEARs requirement.

6 References

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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Cardno (NSW/ACT) (2016) “Flood Impact Assessment, Oakdale South Industrial Estate”, *Final Report*, prepared for Goodman, 18 October 2016, 13 pp + Apps

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GHD (2008) “Oakdale Concept Plan, Water Sensitive Urban Design Strategy”, *Final Report,* prepared for Goodman International Limited, May, 27 pp + Apps.

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Jacobs (2016) ”Appendix H Flooding Analysis”, Western Sydney Airport Gateway, Badgerys Creek: Planning Proposal Submission, prepared for the University of Sydney by Jacobs Group (Australia) Pty Ltd, Revision 5, 21 October 2016

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

Worley Parsons (2015) “Updated South Creek Flood Study”, *Final Report*, 2 Vols, prepared for Penrith City Council, acting in association with Liverpool, Blacktown and Fairfield City Councils, 74 pp + Apps.

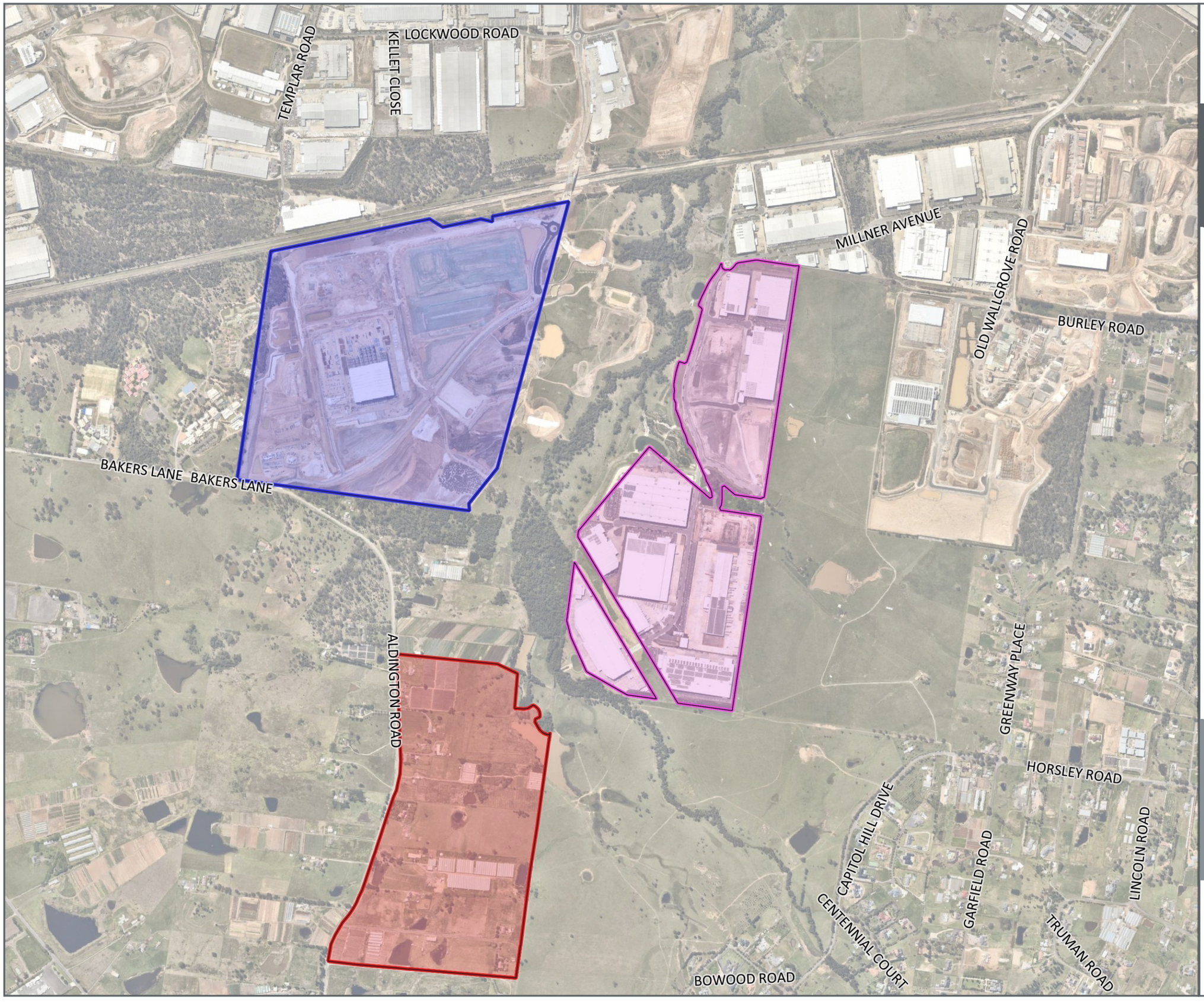
APPENDIX A
FIGURES

Cardno
Shaping the Future

Fife Kemps Creek Pty Limited

200 Aldington Industrial Estate

Benchmark
Location of 200 Aldington Industrial Estate



Legend

- Oakdale_West
- Oakdale_South
- 200 Aldington

FIGURE 1

1:14000 Scale at A3

0 100 200 300 400 500 m

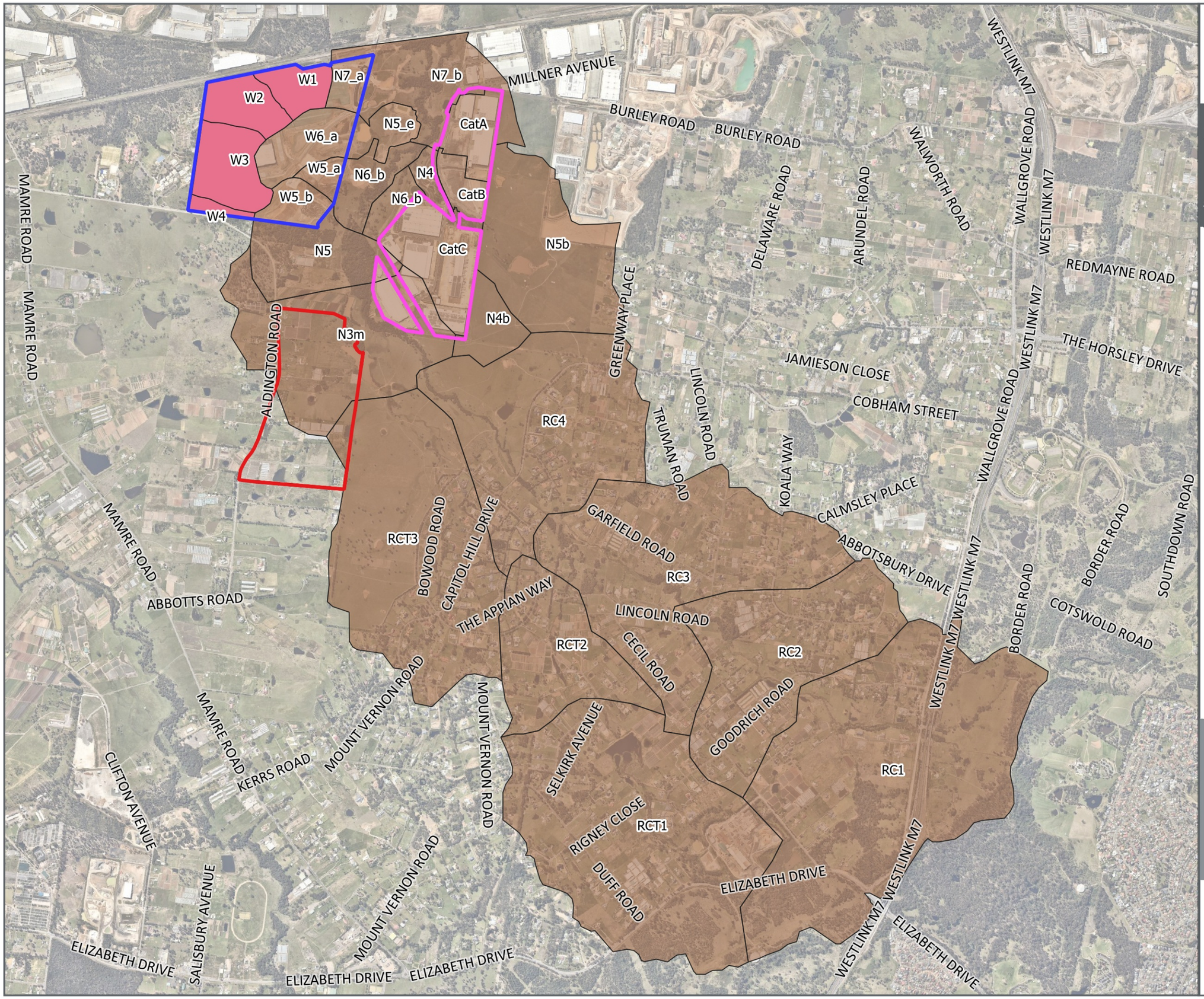
Cardno

Map Produced by St Leonards Water (AWE)
Date: 2020-10-15| Project: XXXXXXXX
Coordinate System: MGA Zone 56
Map: FKC Figures.qgz

Fife Kemps Creek Pty Limited

200 Aldington Industrial Estate

Benchmark Subcatchment Boundaries in XPRAFTS model



Legend

- Oakdale_West_Study_Area
- Oakdale_South_Study_Area
- 200 Aldington_Study_Area
- Subcatchment Boundaries West
- Subcatchment Boundaries

FIGURE 2

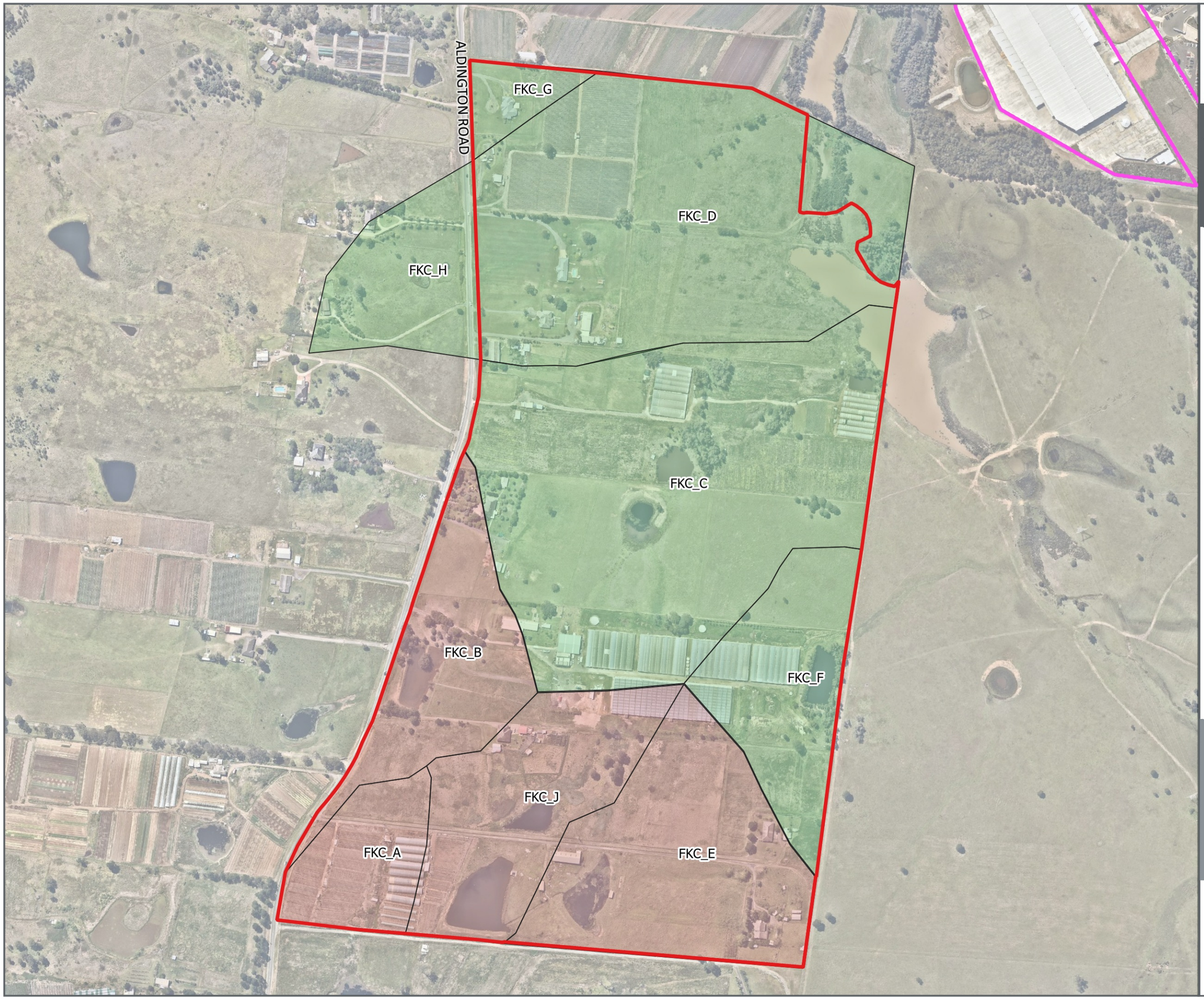
1:25000 Scale at A3

0 200 400 600 800 1000 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2020-10-15| Project: XXXXXXXX
Coordinate System: MGA Zone 56
Map: FKC Figures.qgz



Fife Kemps Creek Pty Limited

200 Aldington Industrial Estate

Benchmark
Local Subcatchment Boundaries

Legend

- 200 Aldington_Study_Area
- Local Subcatchments draining to Ropes Creek
- Local Subcatchments draining to Kemps Creek

FIGURE 3

1:5000 **Scale at A3**

0 50 100 150 200 250 m

N

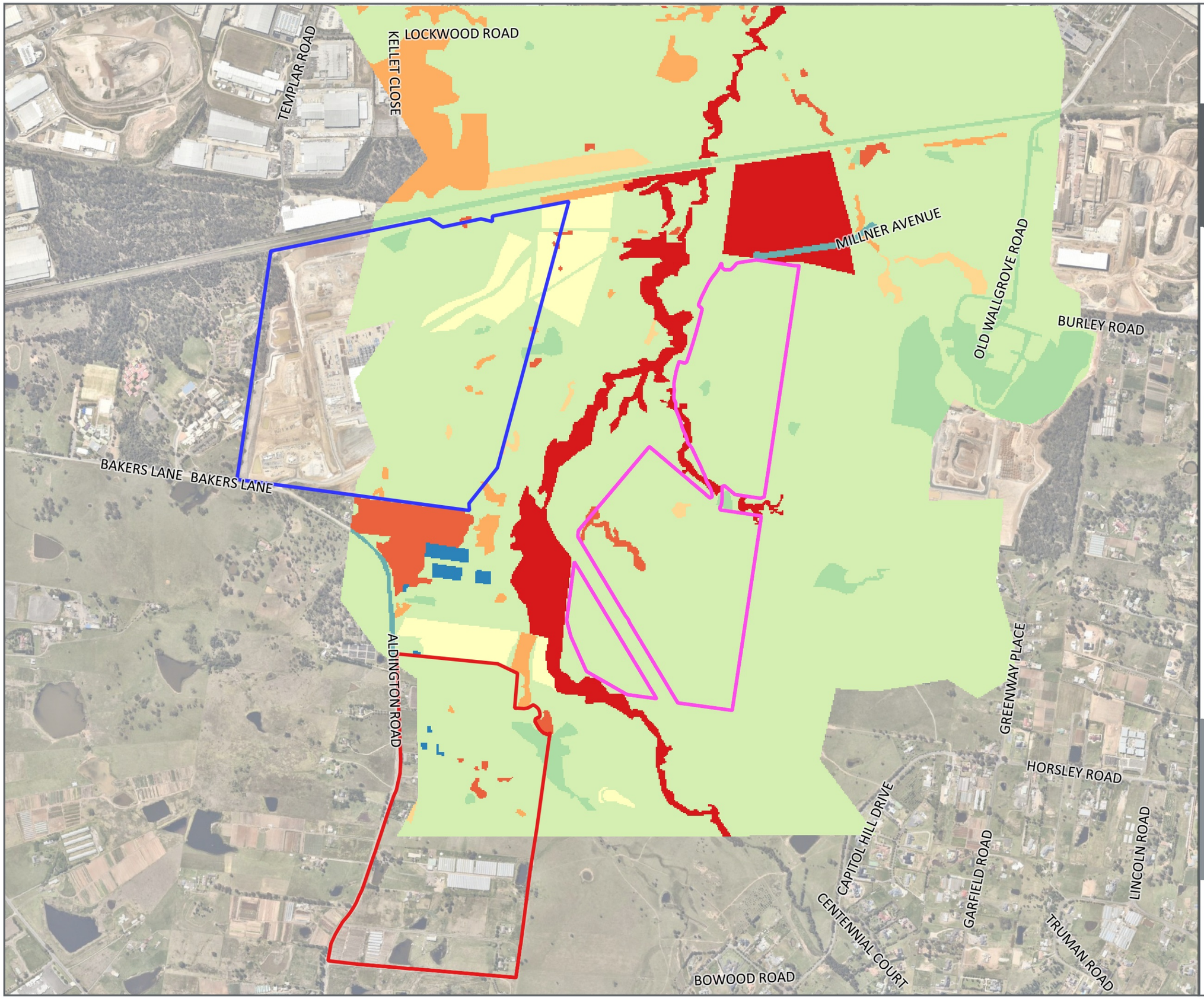
Cardno

Map Produced by St Leonards Water (AWE)
Date: 2020-10-15| Project: XXXXXXXX
Coordinate System: MGA Zone 56
Map: FKC Figures.qgz

Fife Kemps Creek Pty Limited

200 Aldington Industrial Estate

Benchmark
Adopted Roughness Zones



Legend

- Oakdale_West_Study_Area
- Oakdale_South_Study_Area
- 200 Aldington_Study_Area

Roughness Zones

- n=0.12
- n=0.10
- n=0.08
- n=0.05
- n=0.035
- n=0.03
- n=0.022
- n=0.017
- n=4

FIGURE 4

1:14000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2020-10-15| Project: XXXXXXXX
Coordinate System: MGA Zone 56
Map: FKC Figures.qgz

Fife Kemps Creek Pty Limited

200 Aldington Industrial Estate

Benchmark
2 yr ARI Flood Extents and Flood Levels

TEMPLAR ROAD
KELLET CLOSE
LOCKWOOD ROAD
MILLNER AVENUE
OLD WALLGROVE ROAD
BURLEY ROAD
BAKERS LANE
BAKERS LANE
ALDINGTON ROAD
BOWOOD ROAD
CENTENNIAL COURT
CAPITOL HILL DRIVE
GARFIELD ROAD
TRUMAN ROAD
LINCOLN ROAD
HORSLEY ROAD
GREENWAY PLACE

Legend

- Oakdale_West_Study_Area
- Oakdale_South_Study_Area
- 200 Aldington_Study_Area

Benchmark 2 yr ARI
Water Level (m)

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

FIGURE 5

1:14000 Scale at A3

0 100 200 300 400 500 m

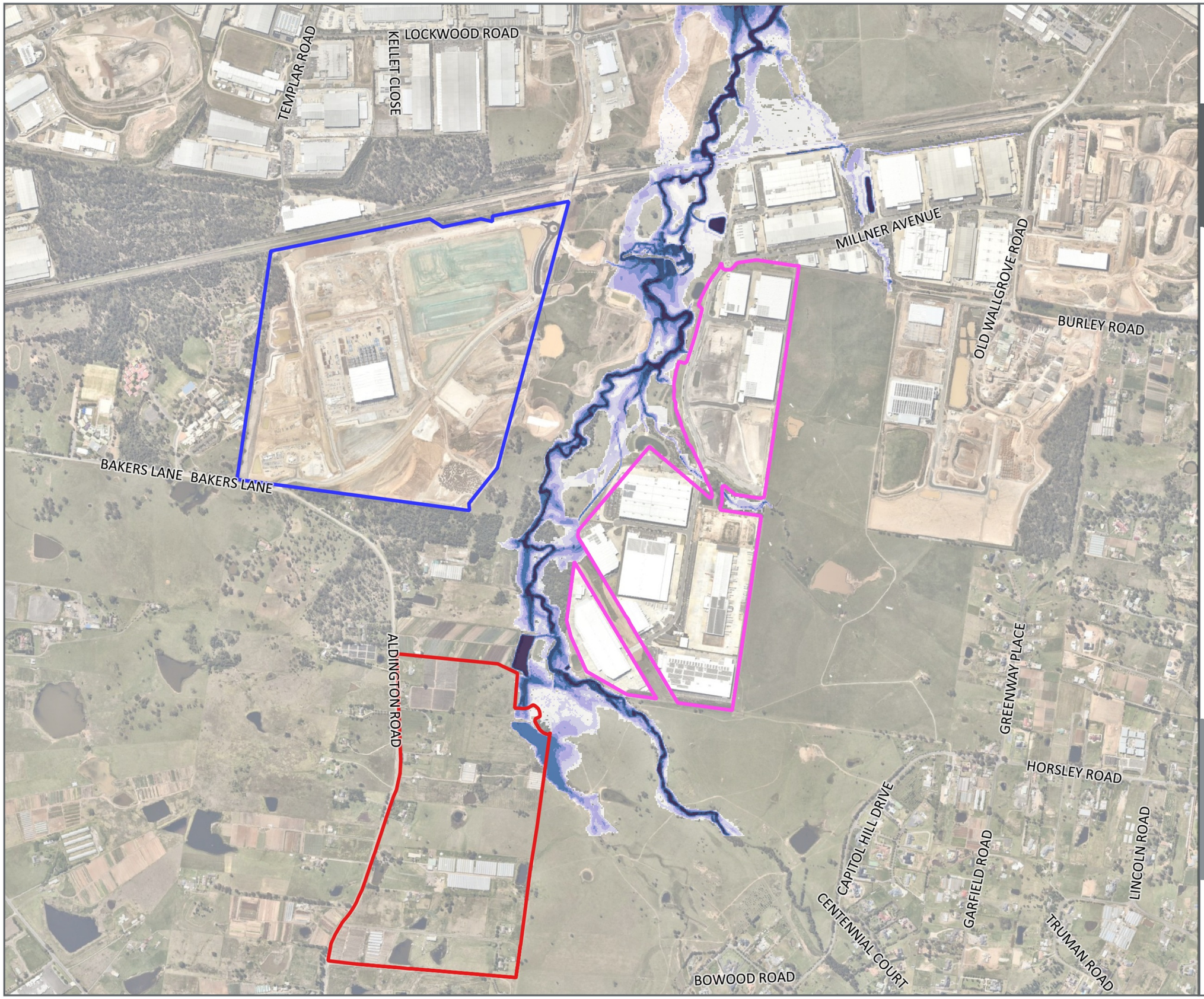
Cardno

Map Produced by St Leonards Water (AWE)
Date: 2020-10-15| Project: XXXXXXXX
Coordinate System: MGA Zone 56
Map: FKC Figures.qgz

Fife Kemps Creek Pty Limited

200 Aldington Industrial Estate

Benchmark
2 yr ARI Depth (m)



Legend

- Oakdale_West_Study_Area
- Oakdale_South_Study_Area
- 200 Aldington_Study_Area

Benchmark 2 yr 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 6

1:14000 Scale at A3

0 100 200 300 400 500 m

N

Cardno

Map Produced by St Leonards Water (AWE)
Date: 2020-10-15| Project: XXXXXXXX
Coordinate System: MGA Zone 56
Map: FKC Figures.qgz