Flood Impact Assessment

Oakdale West Estate

59916062

Prepared for
Goodman Ltd

27 March 2017

Cardno
Shaping the Future

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Executive Summary

A flood impact assessment has been prepared to inform an SSD for the Oakdale West precinct which is being submitted to the Department of Planning. The following will be included in this application:

- Staged Subdivision of Oakdale West entire estate
- Staged Bulk Earthworks for Oakdale West
- Concept Master Plan / Development Controls for Oakdale West
- Stage 1 DA for Development Precinct 1 building and civil works

As part of the master planning for the precinct the existing flood modelling was reviewed, re-run and an assessment was undertaken of the impacts on flooding of the proposed earthworks and measures associated with the planned development of the Oakdale West Estate.

This flood impact assessment report should be read in conjunction with AT&L's Civil, Stormwater and Infrastructure Services Report.

It is concluded that the proposed development will have a minor impact on 100 yr ARI flooding on the Ropes Creek floodplain which will not adversely impact on any adjoining property subject to the target peak outflows at Locations A, B, C, D and E note exceeding the designated 2 yr ARI and 100 yr ARI peak flows (refer Section 2.2).

It is also concluded that the assessed impacts on 100 yr ARI and PMF flood levels and velocities are primarily associated with the Oakdale South development and the local impact of Oakdale West development is primarily created by Lot 5A and the incremental impacts are confined within the overall Oakdale precinct.

It is further concluded that the alignment of the West North South Link (WNSL) Road is expected is well away from the 1% AEP flood extent and the road will not impact on 1% AEP flood levels (on the basis that runoff will be managed by basins such that the peak flow is not increased.

A check of the PMF extents disclosed that the alignment of the WNSL Road is well away from the PMF flood extent and the road alignment will not impact on PMF flood levels.

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1 Introduction

1.1 Purpose of this Report

A flood impact assessment has been prepared to inform an SSD for the Oakdale West precinct which is being submitted to the Department of Planning. The following will be included in this application:

- Staged Subdivision of Oakdale West entire estate
- Staged Bulk Earthworks for Oakdale West
- Concept Master Plan / Development Controls for Oakdale West
- Stage 1 DA for Development Precinct 1 building and civil works

As part of the master planning for the precinct the existing flood modelling was reviewed, re-run and an assessment was undertaken of the impacts on flooding of the proposed earthworks and measures associated with the planned development of the Oakdale West Estate.

This flood impact assessment report should be read in conjunction with AT&L's Civil, Stormwater and Infrastructure Services Report.

1.2 Location

The location of the Oakdale West precinct is indicated in **Figure 1**. The eastern part of the precinct is located in the upper reach of the Ropes Creek catchment. The western part of the precinct drains to a tributary of South Creek.

1.3 Concept Masterplan

The draft Oakdale West Estate Masterplan prepared in February 2016 is given in **Figure 3**.

1.4 Previous GHD Studies

In 2008 GHD undertook hydrological and hydraulic modelling of the upper Ropes Creek catchment including the overall Oakdale development.

Hydrological modelling was undertaken at the catchment and development scale. Results for the catchment hydrological modelling were not included in the 2008 report.

Hydraulic modelling was undertaken using a 1D/2D TUFLOW model. The 100 yr ARI flood extents and flood levels estimated in the 2008 floodplain modelling are given in **Figure 2.**

An addendum to this report was produced in 2013 as part of the detailed design of Oakdale Central (GHD, 2013). This report indicated that the adopted 2D grid size was 5 m x 5 m.

1.5 2015 Cardno Study

In September 2015 Cardno prepared a flood impact assessment to address the Oakdale South – Secretary's Environmental Assessment Requirements in relation to Soils and Water which required in part:

> *An assessment of flooding impacts associated with the proposal including details of any flood liability of the site and changes to flood behaviour.*

As part of the master planning for the Oakdale South Estate the existing GHD flood modelling was reviewed, updated, re-run and an assessment was undertaken of the impacts on flooding of the proposed earthworks and measures associated with the planned development of the Oakdale South Industrial Estate.

2 Hydrology

Hydrological modelling of the upper Ropes Creek catchment was undertaken at the catchment and development scale using **xprafts**. This model was also used to assess local runoff from those subcatchments located in the western part of the precinct which drain to a tributary of South Creek.

2.1 Existing (Pre-Development) Conditions

The subcatchment boundaries under Existing Conditions in the vicinity of the Oakdale estate were updated to define in greater detail the local runoff from a number of subcatchments particularly at locations where the runoff from the Oakdale West precinct crosses the precinct boundary. The subcatchment layout is given in **Figure 4**.

The **xprafts** model was run to estimate peak flows as follows

ARI (years)	Storm Burst Durations
2, 20, 100	0.5, 1, 1.5, 2, 3, 4.5, 6, 9, 12, 18 hours
PMF	0.25, 0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4, 5, 6 hours

The estimated peak flows for the local subcatchments are summarised in **Table 1**. It should be noted that the peak flows for Subcatchment W2 given in **Table 1** are the peak flows for the combined runoff from Subcatchments W1 and W2 (refer **Figure 4**).

It was interesting to note the reduction in critical storm burst duration with increasing storm burst severity.

2.2 Future (Post-Development) Conditions

The subcatchment layout under amended Existing Conditions facilitated the identification of target peak flows under post-development conditions.

Our understanding of the target peak outflows for Locations A, B, C, D and E (refer **Figure 5**) are summarised as follows

Reference Location	2 yr ARI	20 yr ARI	100 yr ARI	
A	1.72	3.44	4.80	Basin 3 outflow + Basin 2 outflow + any local runoff which bypasses Basin 3
B	1.34	2.52	3.60	Where Basin 4 outflow + any local runoff discharges across the site boundary
C	0.70	1.48	2.01	Where Basin 5 outflow discharges across the site boundary
D	1.38	2.52	3.63	Basin 6 outflow
E	0.51	0.97	1.36	Basin 7 outflow

Table 1 Summary of 2 yr ARI, 20 yr ARI, 100 yr ARI and PMF Peak Flows (m3/s)

2 yr ARI

Storm Burst Duration

Subcatchment	0.5hr	0.75hr	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	18hr	Max	Critical
W1	0.19	0.31	0.44	0.55	0.60	0.58	0.61	0.70	0.73	0.78	0.56	0.78	12hr
W2	0.38	0.65	0.94	1.17	1.28	1.30	1.31	1.58	1.68	1.72	1.26	1.72	12hr
W3	0.31	0.48	0.67	0.83	0.97	0.98	0.93	1.21	1.33	1.34	0.98	1.34	12hr
W4	0.05	0.12	0.14	0.16	0.18	0.17	0.19	0.19	0.20	0.21	0.15	0.21	12hr
Wout	0.71	1.25	1.73	2.11	2.40	2.42	2.42	2.98	3.19	3.28	2.39	3.28	12hr
N7_a	0.11	0.15	0.20	0.26	0.31	0.30	0.31	0.38	0.45	0.44	0.31	0.45	9hr
N7_b	0.47	0.40	0.44	0.50	0.50	0.53	0.53	0.62	0.84	0.78	0.69	0.84	9hr
W6_a	0.28	0.37	0.55	0.71	0.83	0.83	0.80	1.03	1.19	1.18	0.84	1.19	9hr
N6_b	0.32	0.44	0.65	0.84	0.97	0.97	0.92	1.21	1.38	1.38	0.98	1.38	12hr
N5_e	0.12	0.18	0.24	0.31	0.36	0.36	0.34	0.45	0.49	0.51	0.36	0.51	12hr
W5_a	0.09	0.18	0.22	0.26	0.30	0.28	0.30	0.33	0.34	0.36	0.26	0.36	12hr
W5_c	0.27	0.24	0.29	0.35	0.40	0.38	0.41	0.49	0.58	0.57	0.42	0.58	9hr
W5_b	0.17	0.30	0.40	0.50	0.55	0.54	0.57	0.63	0.66	0.70	0.51	0.70	12hr
W5_d	0.63	0.53	0.58	0.70	0.78	0.79	0.85	0.94	1.12	1.13	0.87	1.13	12hr

20 yr ARI

Storm Burst Duration

Subcatchment	0.5hr	0.75hr	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	18hr	Max	Critical
W1	0.92	1.23	1.40	1.43	1.51	1.31	1.62	1.41	1.28	1.36	1.02	1.62	4.5hr
W2	1.87	2.61	2.99	3.13	3.35	3.00	3.44	3.16	2.92	3.04	2.33	3.44	4.5hr
W3	1.27	1.85	2.14	2.33	2.51	2.34	2.52	2.44	2.31	2.41	1.85	2.52	4.5hr
W4	0.30	0.38	0.43	0.44	0.46	0.36	0.47	0.41	0.35	0.37	0.27	0.47	4.5hr
Wout	3.42	4.81	5.50	5.82	6.23	5.68	6.41	5.93	5.55	5.82	4.45	6.41	4.5hr
N7_a	0.39	0.59	0.67	0.76	0.81	0.76	0.81	0.83	0.79	0.81	0.63	0.83	6hr
N7_b	0.89	0.91	1.02	1.17	1.26	1.24	1.28	1.44	1.73	1.64	1.48	1.73	9hr
W6_a	1.06	1.49	1.75	1.99	2.15	2.03	2.12	2.17	2.09	2.15	1.64	2.17	6hr
N6_b	1.27	1.78	2.07	2.33	2.52	2.37	2.52	2.52	2.41	2.49	1.90	2.52	4.5hr
N5_e	0.51	0.71	0.82	0.88	0.96	0.86	0.97	0.91	0.86	0.90	0.69	0.97	4.5hr
W5_a	0.48	0.63	0.71	0.72	0.75	0.60	0.79	0.69	0.61	0.64	0.47	0.79	4.5hr
W5_c	0.63	0.83	0.94	0.95	1.01	0.89	1.07	0.96	1.14	1.13	0.90	1.14	9hr
W5_b	0.85	1.12	1.29	1.32	1.38	1.18	1.48	1.28	1.16	1.23	0.92	1.48	4.5hr
W5_d	1.27	1.55	1.76	1.81	1.94	1.78	2.07	1.88	2.23	2.23	1.91	2.23	9hr

100 yr ARI

Storm Burst Duration

Subcatchment	0.5hr	0.75hr	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	18hr	Max	Critical
W1	1.63	2.01	2.17	2.15	2.20	1.77	2.16	1.85	1.58	1.68	1.26	2.20	2hr
W2	3.33	4.30	4.70	4.65	4.80	4.02	4.72	4.11	3.62	3.76	2.89	4.80	2hr
W3	2.37	3.01	3.30	3.44	3.60	3.17	3.50	3.14	2.86	2.96	2.32	3.60	2hr
W4	0.54	0.60	0.65	0.65	0.70	0.53	0.59	0.52	0.44	0.45	0.33	0.70	2hr
Wout	6.19	7.80	8.56	8.49	8.80	7.59	8.80	7.66	6.87	7.17	5.53	8.80	2hr
N7_a	0.74	0.98	1.09	1.14	1.20	1.08	1.16	1.07	0.98	1.02	0.79	1.20	2hr
N7_b	1.22	1.50	1.69	1.83	1.94	1.81	1.87	1.91	2.37	2.24	1.99	2.37	9hr
W6_a	1.94	2.53	2.81	2.95	3.12	2.80	2.97	2.79	2.58	2.64	2.08	3.12	2hr
N6_b	2.32	2.99	3.30	3.44	3.63	3.26	3.51	3.24	2.98	3.07	2.41	3.63	2hr
N5_e	0.92	1.18	1.29	1.30	1.36	1.18	1.35	1.18	1.06	1.11	0.86	1.36	2hr
W5_a	0.85	0.98	1.07	1.07	1.11	0.86	1.02	0.88	0.75	0.78	0.57	1.11	2hr
W5_c	1.08	1.32	1.43	1.42	1.44	1.20	1.44	1.26	1.53	1.52	1.20	1.53	9hr
W5_b	1.51	1.82	1.98	1.97	2.01	1.60	1.95	1.67	1.43	1.51	1.13	2.01	2hr
W5_d	2.05	2.52	2.77	2.73	2.76	2.43	2.85	2.52	2.99	2.97	2.63	2.99	9hr

PMF

Storm Burst Duration

Subcatchment	0.25hr	0.5hr	0.75hr	1hr	1.5hr	2hr	2.5hr	3hr	4hr	5hr	6hr	Max	Critical
W1	12.09	15.52	15.34	14.26	11.69	10.09	8.72	7.63	6.34	5.54	5.05	15.52	0.5hr
W2	24.62	33.97	34.76	32.36	26.97	23.26	20.34	17.81	14.74	12.86	11.70	34.76	0.75hr
W3	17.41	25.20	27.04	25.45	21.79	18.69	16.54	14.54	11.99	10.43	9.45	27.04	0.75hr
W4	3.88	4.38	4.19	3.87	3.11	2.62	2.27	2.00	1.67	1.47	1.35	4.38	0.5hr
Wout	45.26	63.03	65.51	61.33	51.77	44.51	39.13	34.28	28.31	24.68	22.42	65.51	0.75hr
N7_a	5.57	8.31	9.16	8.60	7.44	6.47	5.69	5.04	4.15	3.60	3.26	9.16	0.75hr
N7_b	8.69	12.95	15.31	15.34	14.25	13.97	13.80	13.53	13.17	12.57	11.85	15.34	1hr
W6_a	14.16	21.63	23.88	22.54	19.56	17.10	14.98	13.31	10.98	9.52	8.61	23.88	0.75hr
N6_b	17.00	25.35	27.75	26.12	22.64	19.70	17.32	15.35	12.66	10.99	9.94	27.75	0.75hr
N5_e	6.84	9.58	10.09	9.47	8.06	6.90	6.07	5.32	4.39	3.82	3.47	10.09	0.75hr
W5_a	6.28	7.45	7.22	6.71	5.42	4.60	3.97	3.49	2.91	2.55	2.33	7.45	0.5hr
W5_c	7.91	10.47	10.66	10.01	9.10	8.95	8.82	8.53	8.10	7.48	7.17	10.66	0.75hr
W5_b	11.09	14.09	13.88	12.91	10.51	9.05	7.82	6.85	5.69	4.99	4.53	14.09	0.5hr
W5_d	14.84	20.11	20.95	19.78	17.77	17.17	16.89	16.59	16.49	16.08	15.46	20.95	0.75hr

3 Flooding Assessment

The assessment of the impact or otherwise of development on the Ropes Creek floodplain was undertaken using a TUFLOW model of the upper Ropes Creek floodplain.

The model extent covers those portions of the subject site draining to Ropes Creek.

3.1 Existing Conditions

3.1.1 100 yr ARI

The locations at which 100yr ARI hydrographs from the **xprafts** model were input into the TUFLOW floodplain model are identified in **Figure 6**. The TUFLOW floodplain model was run for a range of storm durations up to 9 hours. It was found that the critical storm burst duration varied depending on location as identified in **Figure 7**.

The estimated 100 year ARI flood levels and extent, depths and velocities under benchmark Existing Conditions are plotted in **Figures 8, 9** and **10** respectively.

When initially considering pedestrian and vehicular stability, three velocity x depth criteria were identified as follows:

Velocity x Depth	Comment
≤ 0.4 m^2/s	This is typically adopted by Councils as a limit of stability for pedestrians
0.4 – 0.6 m^2/s	Unsafe for pedestrians but safe for vehicles if overland flood depths do not exceed around 0.3 m
> 0.6 m^2/s	This is typically adopted by Councils as a limit of stability for vehicles

As part of the current revision of Australian Rainfall & Runoff (ARR) a series of research projects have been undertaken to inform the updating of the current edition of ARR. This includes ARR Project 10 Appropriate Safety Criteria for Vehicles. Most recently in December 2013 a draft version of Book 9 Chapter 6 Safety Design Criteria has been released by Engineers Australia for industry review (Download from: http://www.arr.org.au/downloads-and-software/chapters/).

In the draft Chapter 6 Book 9 *stability criteria based on the best available information for stationary small passenger cars, large passenger cars and large 4WD vehicles in various flow situations are presented in Figure 9.6.6 and Table 9.6.2* This Table and Figure are reproduced below.

In the draft Chapter 6 Book 9 it is further advised that:

> *Shand et al (2011) concludes that the available datasets do not adequately account for the following factors and that more research is needed in these areas:*
> - *Friction coefficients for contemporary vehicle tyres in flood flows;*
> - *Buoyancy changes in modern cars;*
> - *The effect of vehicle orientation to flow direction (including vehicle movement);*
> - *Information for additional categories including small and large commercial vehicles and emergency service vehicles*

Table 9.6.2. Interim Flow Hazard Regimes for Vehicles (Shand et al, 2011)

Class of vehicle	Length (m)	Kerb Weight (kg)	Ground clearance (m)	Limiting still water depth[1]	Limiting high velocity flow depth[2]	Limiting velocity[3]	Equation of stability
Small passenger	< 4.3	< 1250	< 0.12	0.3	0.1	3.0	$DV \leq 0.3$
Large passenger	> 4.3	> 1250	> 0.12	0.4	0.15	3.0	$DV \leq 0.45$
Large 4WD	> 4.5	> 2000	> 0.22	0.5	0.2	3.0	$DV \leq 0.6$

[1]At velocity = 0 ms^{-1}; [2]At velocity = 3.0 ms^{-1}; [3]At low depth

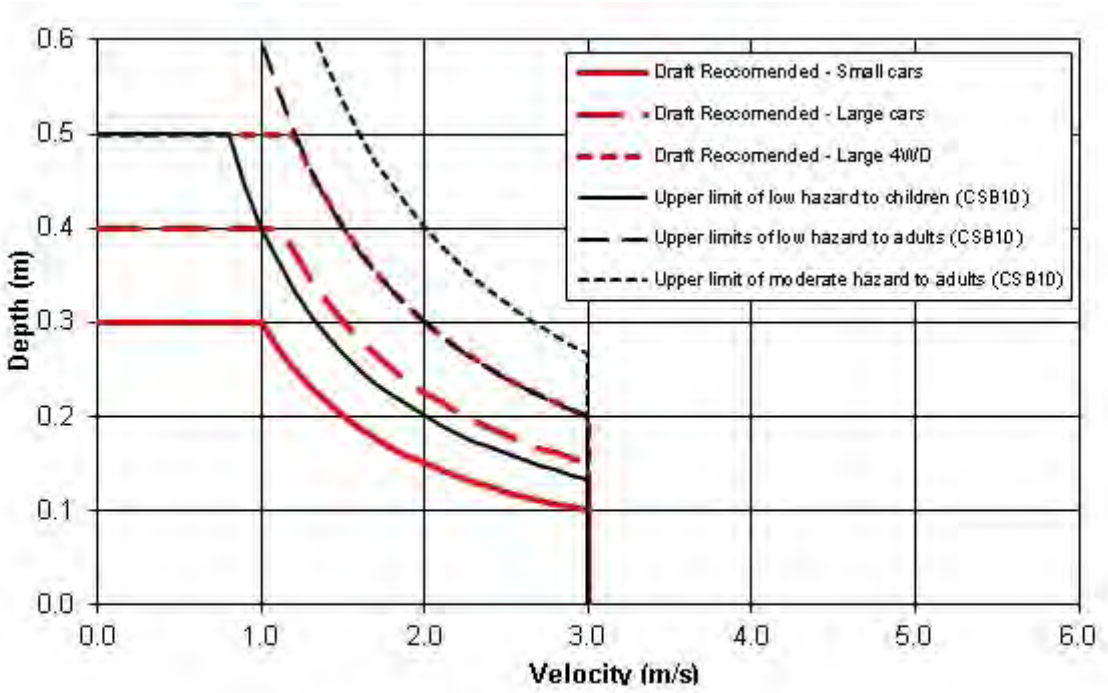
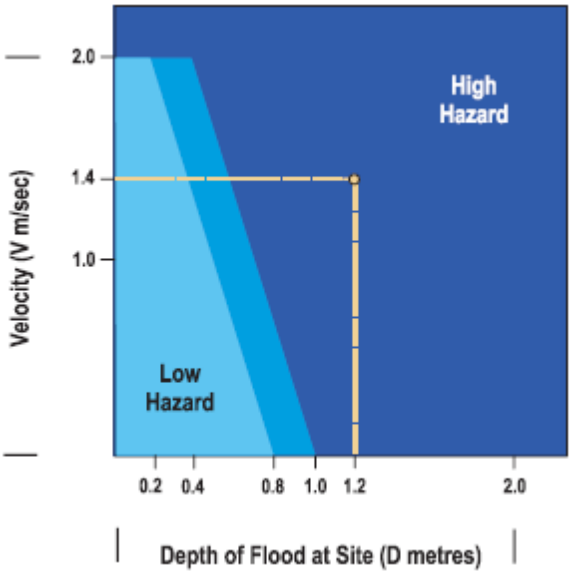


Figure 9.6.6. Interim Safety Criteria for Vehicles in Variable Flow Conditions (After Shand et al. 2011)

The estimated 100 year ARI velocity x depth under Existing Conditions is plotted in **Figure 10.**

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. 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.



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

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 100 year ARI provisional flood hazard under Existing Conditions is plotted in **Figure 12**.

3.1.2 PMF

The locations at which PMF hydrographs from the **xprafts** model were input into the TUFLOW floodplain model are identified in **Figure 13.** The TUFLOW floodplain model was run for a range of PMP storm durations up to 6 hours. It was found that the critical PMP storm duration varied depending on location as identified in **Figure 14**.

The estimated PMF flood levels and extent, depths and velocities under benchmark Existing Conditions are plotted in **Figures 15, 16** and **17** respectively.

The estimated PMF velocity x depth under Existing Conditions is plotted in **Figure 18.**

The estimated PMF provisional flood hazard under Existing Conditions is plotted in **Figure 19**.

3.2 Future Conditions

Prior to assessing flooding under future conditions the proposed development terrain was imported using a supplied TIN. The proposed development layout is given in **Figure 3**. Features of the proposed development include (refer **Figure 3**):

- Filling of the floodplain t0 create Lot 5A (refer **Figure 3**) immediately west to Ropes Creek;
- The diversion of runoff into a farm dam under Existing Conditions to an alternative discharge locations (compare reference location D in Figures 4 and 5);
- The construction of channels to convey basin outflows to current discharge locations eg. Locations B and C which are some distance from the basin outlet)

3.2.1 100 yr ARI

The model was the run to estimate 100 yr ARI flooding under Future Conditions based on the approach adopted by GHD previously when assessing Future Conditions (as discussed in **Appendix B**).

The locations at which 100yr ARI hydrographs from the **xprafts** model were input into the TUFLOW floodplain model are identified in **Figure 20**. The TUFLOW floodplain model was run for a range of storm durations up to 9 hours. It was found that the critical storm burst duration varied depending on location as identified in **Figure 21**.

The estimated 100 year ARI flood levels and extent, depths, velocities, velocity x depth and hazards under Future Conditions are plotted in **Figures 22, 23, 24, 25** and **26** respectively.

3.2.2 PMF

The model was the run to estimate PMF under Future Conditions based on the approach discussed in **Appendix B**.

The locations at which PMF hydrographs from the **xprafts** model were input into the TUFLOW floodplain model are identified in **Figure 31**. The TUFLOW floodplain model was run for a range of PMP storm durations up to 6 hours. It was found that the critical PMP storm duration varied depending on location as identified in **Figure 32**.

The estimated PMF flood levels and extent, depths and velocities under benchmark Future Conditions are plotted in **Figures 33, 34** and **35** respectively.

The estimated PMF velocity x depth under Future Conditions is plotted in **Figure 36.**

The estimated PMF provisional flood hazard under Future Conditions is plotted in **Figure 37**.

4 Flood Impact Assessment

The estimated impact of Future Conditions on 100 year ARI levels and velocities (in comparison to Existing Conditions) are plotted in **Figures 27** and **29** respectively. The estimated incremental impact of Oakdale West over and above the Oakdale South development on 100 year ARI level and velocities are plotted in **Figures 28** and **30** respectively.

The estimated impact of Future Conditions on PMF levels and velocities (in comparison to Existing Conditions) are plotted in **Figures 38** and **40** respectively. The estimated incremental impact of Oakdale West over and above the Oakdale South development on PMF levels and velocities are plotted in **Figures 39** and **41** respectively.

Table 1 Estimated 100 yr ARI Flood Levels at Reference Locations

	Existing Conditions			Future Conditions					
				Oakdale South	Oakdale West + South				
Location	100yr 2hr (m AHD)	100hr 9hr (m AHD)	Max WL (m AHD) (a)	Max WL (m AHD) (b)	100yr 2hr (m AHD)	100hr 9hr (m AHD)	Max WL (m AHD) (c)	Difference (cm) (c)-(a)	Difference (cm) (c)-(b)
R1	62.97	62.79	62.97	62.72	62.72	62.65	62.72	-25	0
R2	60.96	60.84	60.96	60.86	60.87	60.84	60.87	-10	1
R3	60.03	59.94	60.03	60.04	60.05	60.03	60.05	2	1
R4	58.86	58.81	58.86	58.91	58.92	58.90	58.92	5	1
R5	58.32	58.25	58.32	58.31	58.32	58.30	58.32	0	1
R6	57.48	57.43	57.48	57.43	57.44	57.44	57.44	-4	1
R7	56.64	56.65	56.65	56.66	56.66	56.67	56.67	2	1
R8	54.94	54.95	54.95	54.93	54.92	54.93	54.93	-2	1

Table 2 Estimated PMF Levels at Reference Locations

	Existing	Future Conditions			
		Oakdale South	Oakdale West + South		
Location	PMF (m AHD) (d)	PMF (m AHD) (e)	PMF (m AHD) (f)	Difference (cm) (f)-(d)	Difference (cm) (f)-(e)
R1	64.20	64.11	64.11	-9	0
R2	62.13	62.44	62.46	34	2
R3	60.97	61.15	61.16	19	1
R4	59.91	59.90	59.91	0	2
R5	59.41	59.68	59.70	29	2
R6	58.64	58.65	58.68	4	3
R7	57.60	57.68	57.70	10	3
R8	56.24	56.18	56.22	-3	4

The 100 yr ARI flood levels and PMF levels at 8 reference locations identified in **Figure 42** are summarised in **Tables 1** and **2** respectively.

It is noted from **Figures 27** and **28** that:

- within the Ropes Creek floodplain that there are zones of both minor reductions and minor increases in the 100 yr ARI flood levels;
- the minor changes in flood levels do not change the flood extents on any adjoining properties;
- a zone of significant local increases in 100 yr ARI flood levels occurs within the power line easement adjacent to the proposed development;
- these local impacts are attributed to the partial filling of an existing flood runner to create the development platform without any compensating earthworks to convey diverted flows; and
- these impacts primarily are associated with the Oakdale South development and the local impact of Oakdale West development is created by Lot 5A and is confined within the overall Oakdale precinct

It is noted from **Figures 29** and **30** that:

- within the Ropes Creek floodplain that there are some zones with local increases in the 100 yr ARI velocities which is associated with local earthworks and /or due to the walls of local retarding basins; and
- these changes are confined within the 100 yr ARI flood extent which is not significantly changed by proposed earthworks; and
- the local impact of Oakdale West development is created by Lot 5A and is confined within the overall Oakdale precinct.

As expected based on the severity of flooding, a number of flowpaths through the development would be activated by PMF flows discharged into the development along existing drainage lines.

The estimated PMF level differences under Future Conditions in comparison with Existing Conditions are plotted in **Figure 38**. It is noted from **Figure 38** that the PMF levels in the vicinity of the Warragamba Pipelines Corridor are largely unchanged or slightly reduce in level. It is noted that there are some local small increase in the PMF level adjacent to the corridor which appears associated with the earthworks undertaken immediately north of the subject site in Oakdale Central. It is noted from **Figure 39** that these impacts primarily are associated with the Oakdale South development and the local impact of Oakdale West development is created by Lot 5A and is confined within the overall Oakdale precinct.

The estimated PMF velocity differences under Future Conditions in comparison with Existing Conditions are plotted in **Figure 40**. It is noted from **Figure 39** that the PMF velocities in the vicinity of the Warragamba Pipelines Corridor are effectively unchanged. It is noted from **Figure 41** that the local impact of Oakdale West development is created by Lot 5A and is confined within the overall Oakdale precinct.

In 2015 Worley Parsons released the Updated South Creek Flood Study report which provides flood extents north of the Sydney Water pipeline corridor. The West North South Link (WNSL) Road which is included in the SSDA has been laid over a composite of the Worley Parsons flood extent in **Figure 43**.

It is concluded that the alignment of the West North South Link (WNSL) Road is expected is well away from the 1% AEP flood extent and the road will not impact on 1% AEP flood levels (on the basis that runoff will be managed by basins such that the peak flow is not increased. A review of the PMF extents disclosed that the alignment of the WNSL Road is well away from the PMF flood extent and the road alignment will not impact on PMF flood levels.

5 Conclusions

A flood impact assessment has been prepared to inform an SSD for the Oakdale West precinct which is being submitted to the Department of Planning. The following will be included in this application:

- Staged Subdivision of Oakdale West entire estate
- Staged Bulk Earthworks for Oakdale West
- Concept Master Plan / Development Controls for Oakdale West
- Stage 1 DA for Development Precinct 1 building and civil works

As part of the master planning for the precinct the existing flood modelling was reviewed, re-run and an assessment was undertaken of the impacts on flooding of the proposed earthworks and measures associated with the planned development of the Oakdale West Estate.

This flood impact assessment report should be read in conjunction with AT&L's Civil, Stormwater and Infrastructure Services Report.

It is concluded that the proposed development will have a minor impact on 100 yr ARI flooding on the Ropes Creek floodplain which will not adversely impact on any adjoining property subject to the target peak outflows at Locations A, B, C, D and E note exceeding the designated 2 yr ARI and 100 yr ARI peak flows (refer Section 2.2).

It is also concluded that the assessed impacts on 100 yr ARI and PMF flood levels and velocities are primarily associated with the Oakdale South development and the local impact of Oakdale West development is primarily created by Lot 5A and the incremental impacts are confined within the overall Oakdale precinct.

In 2015 Worley Parsons released the Updated South Creek Flood Study report which provides flood extents north of the Sydney Water pipeline corridor. The West North South Link (WNSL) Road which is included in the SSDA has been laid over a composite of the Worley Parsons flood extent in **Figure 43**.

It is concluded that the alignment of the West North South Link (WNSL) Road is expected is well away from the 1% AEP flood extent and the road will not impact on 1% AEP flood levels (on the basis that runoff will be managed by basins such that the peak flow is not increased. A review of the PMF extents disclosed that the alignment of the WNSL Road is well away from the PMF flood extent and the road alignment will not impact on PMF flood levels.

6 References

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

GHD (2013) “S75W Mod 5 Application, Oakdale Stage 1 Ropes Creek Flood Study”, *Addendum*, prepared for Goodman International Limited, July, 7 pp + Apps

Cardno (2015) “Flood Impact Assessment, Oakdale South Industrial Estate”, Final Report, prepared for Goodman Ltd, 16 September 2015, 9 pp + Apps

Oakdale West Estate

APPENDIX A
FIGURES

Cardno
Shaping the Future

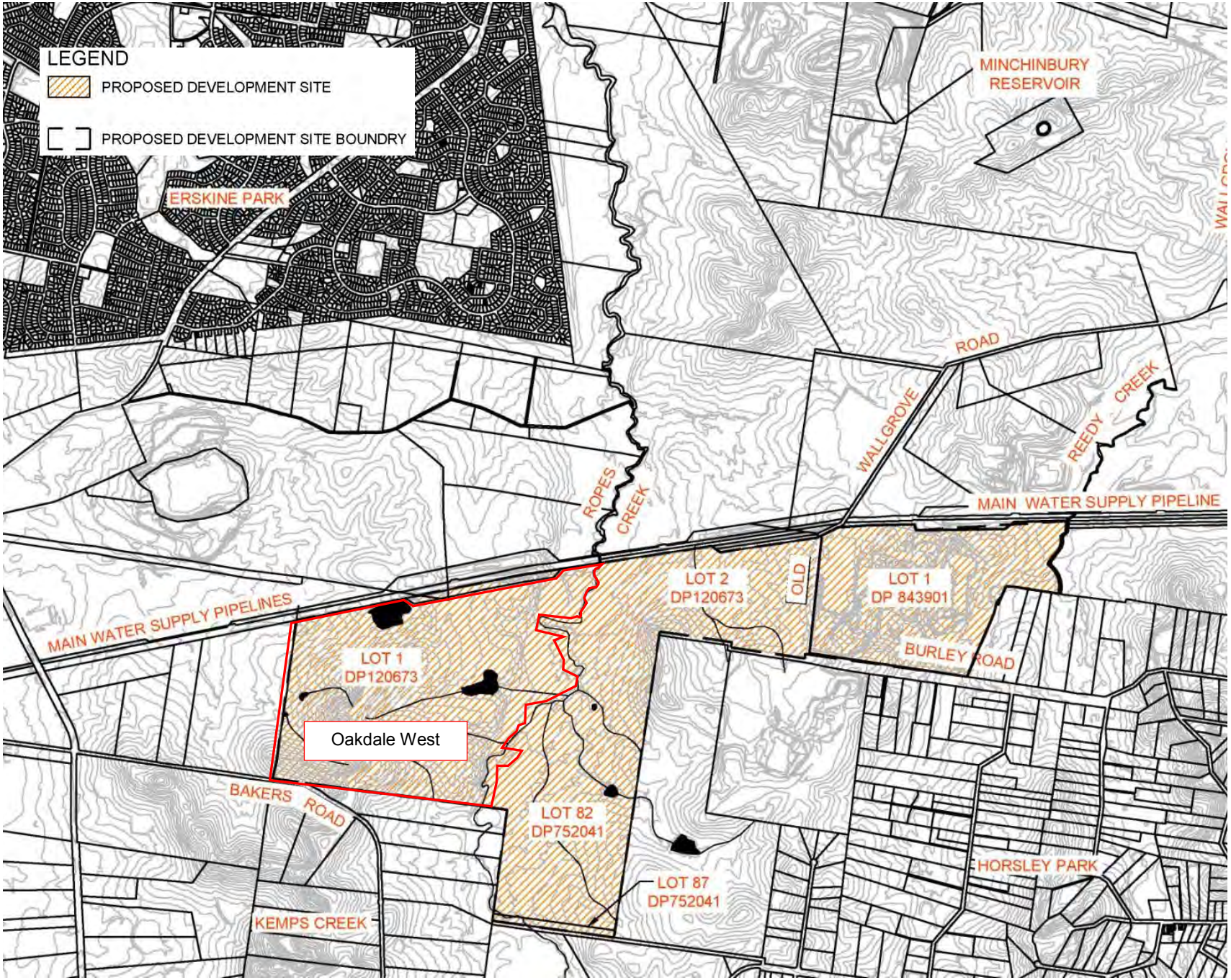


Figure 1 Location of Oakdale South Precinct (after Figure 1, GHD, 2008)

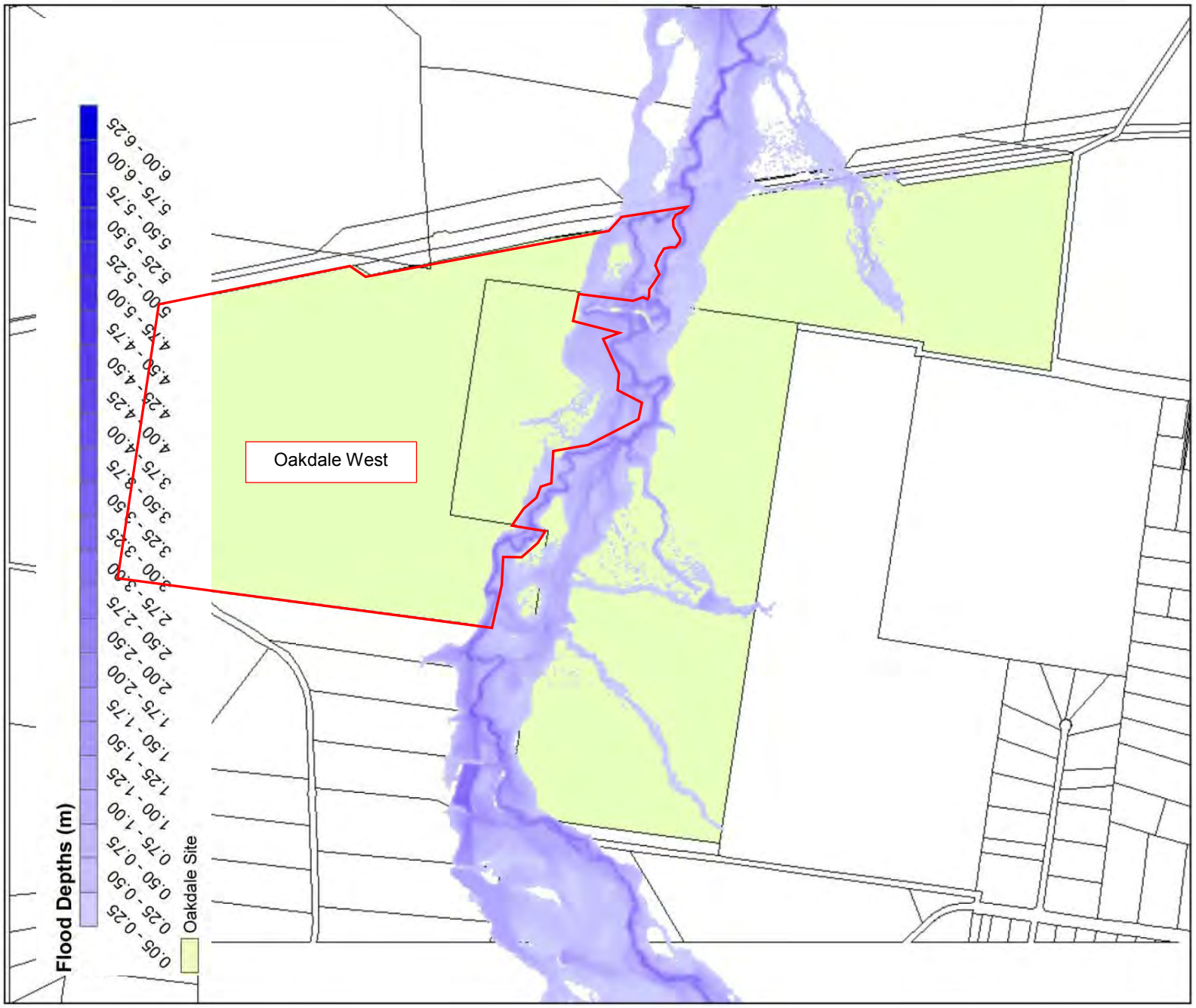


Figure 2 100 yr ARI Flood Map (Rev A, June 2007) (after GHD, 2008)

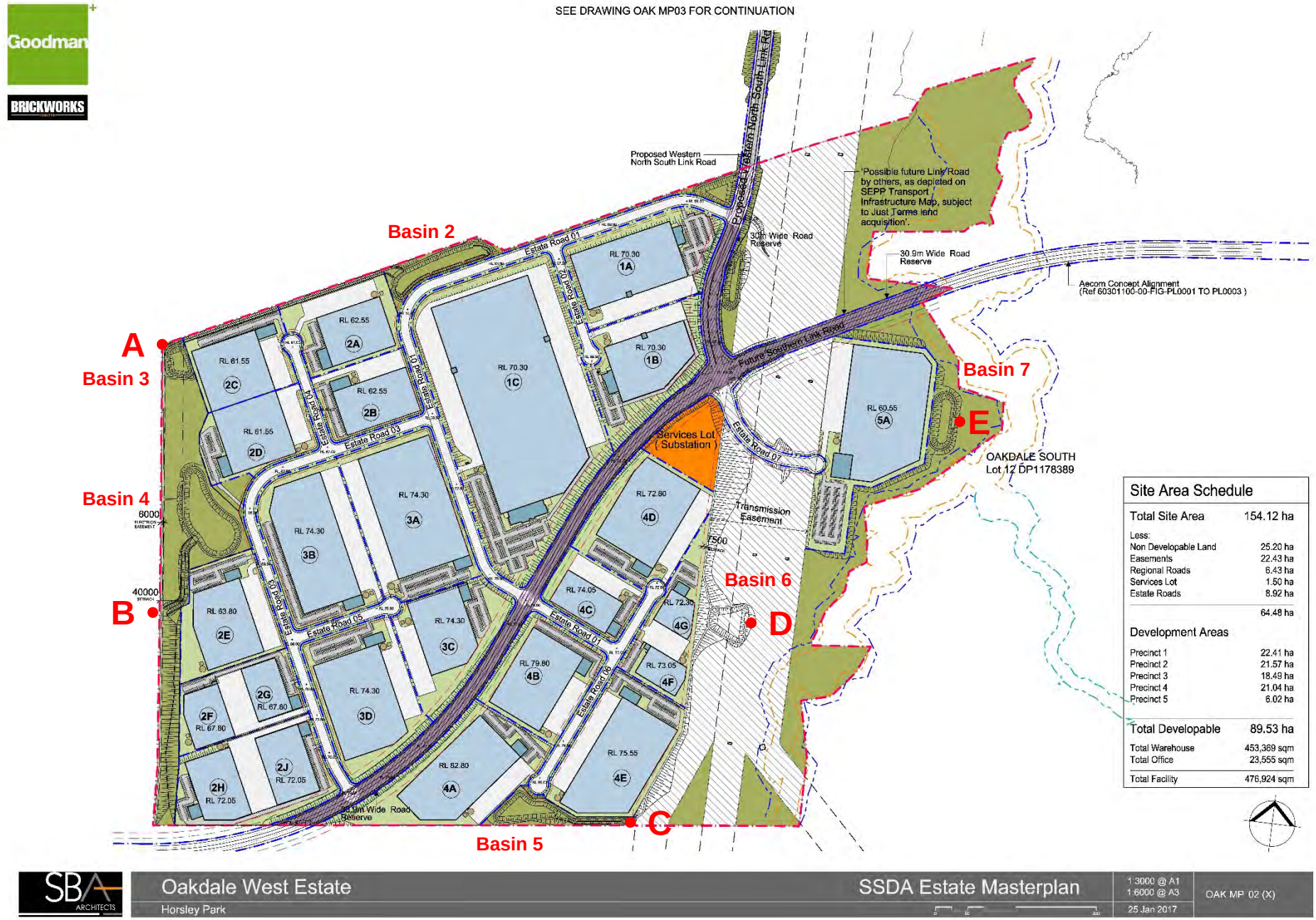


Figure 3 Concept Oakdale West Estate Masterplan

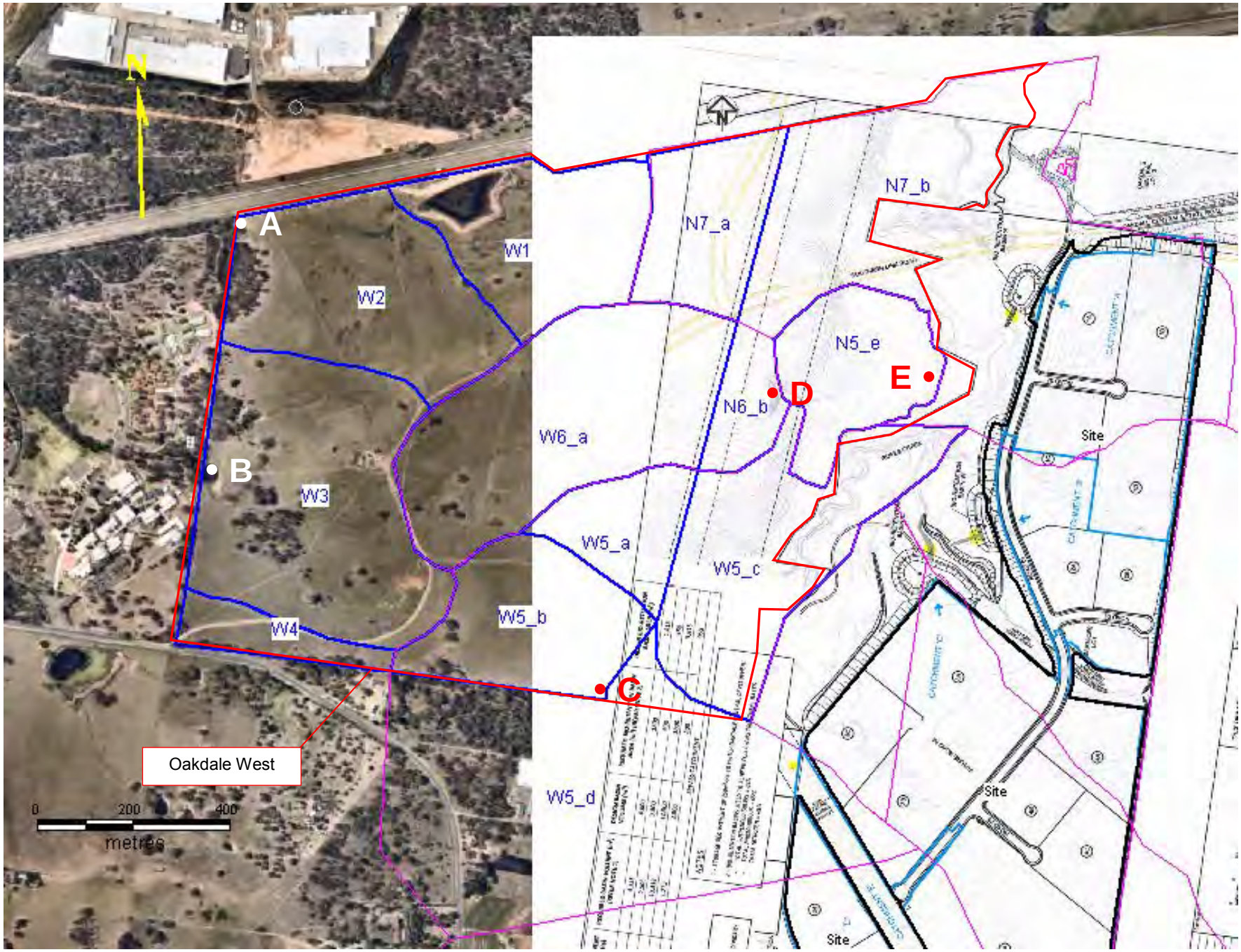


Figure 4 Subcatchment Boundaries in the vicinity of Oakdale South under Amended Existing Conditions

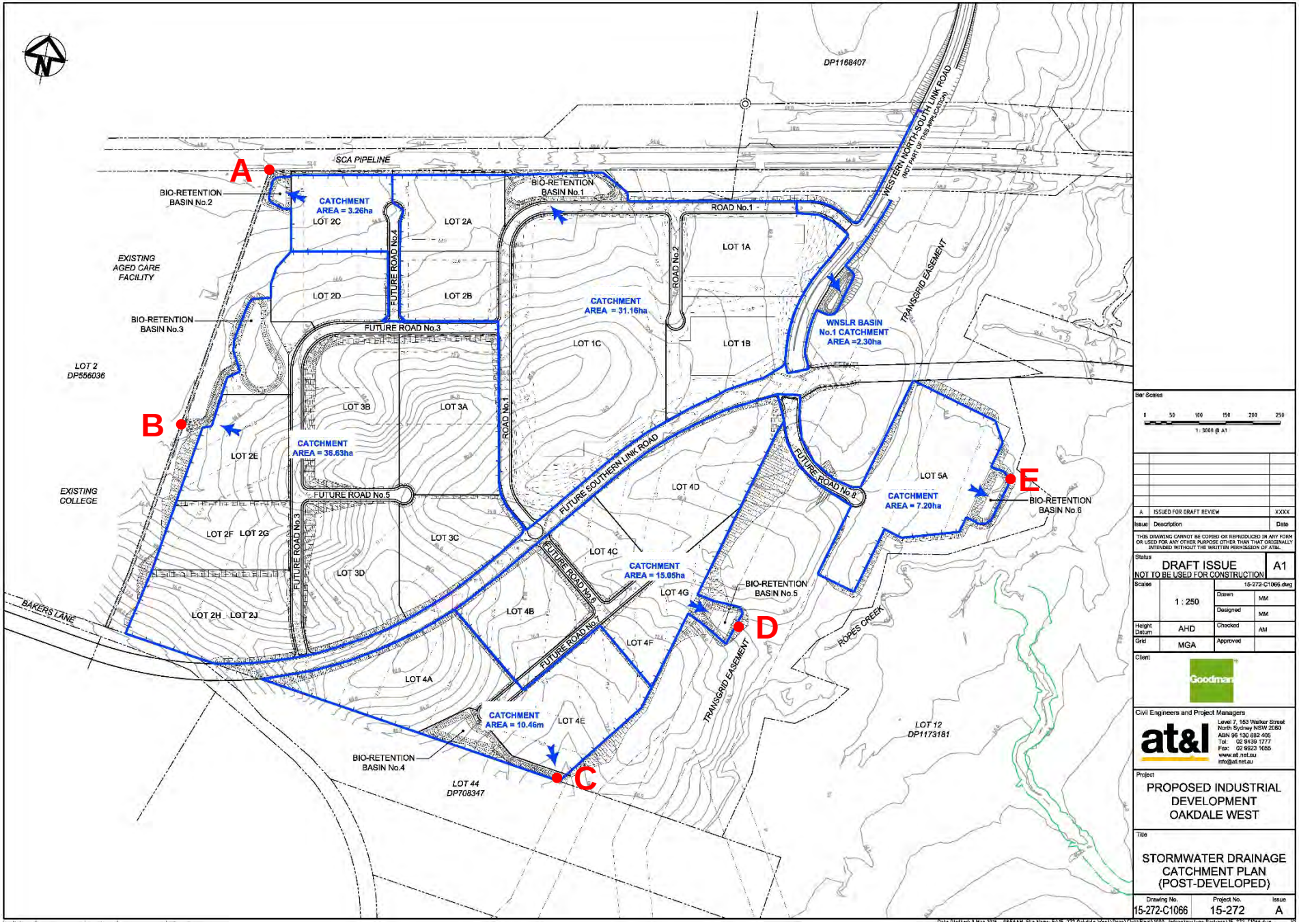


Figure 5 Subcatchment Boundaries under Future Conditions

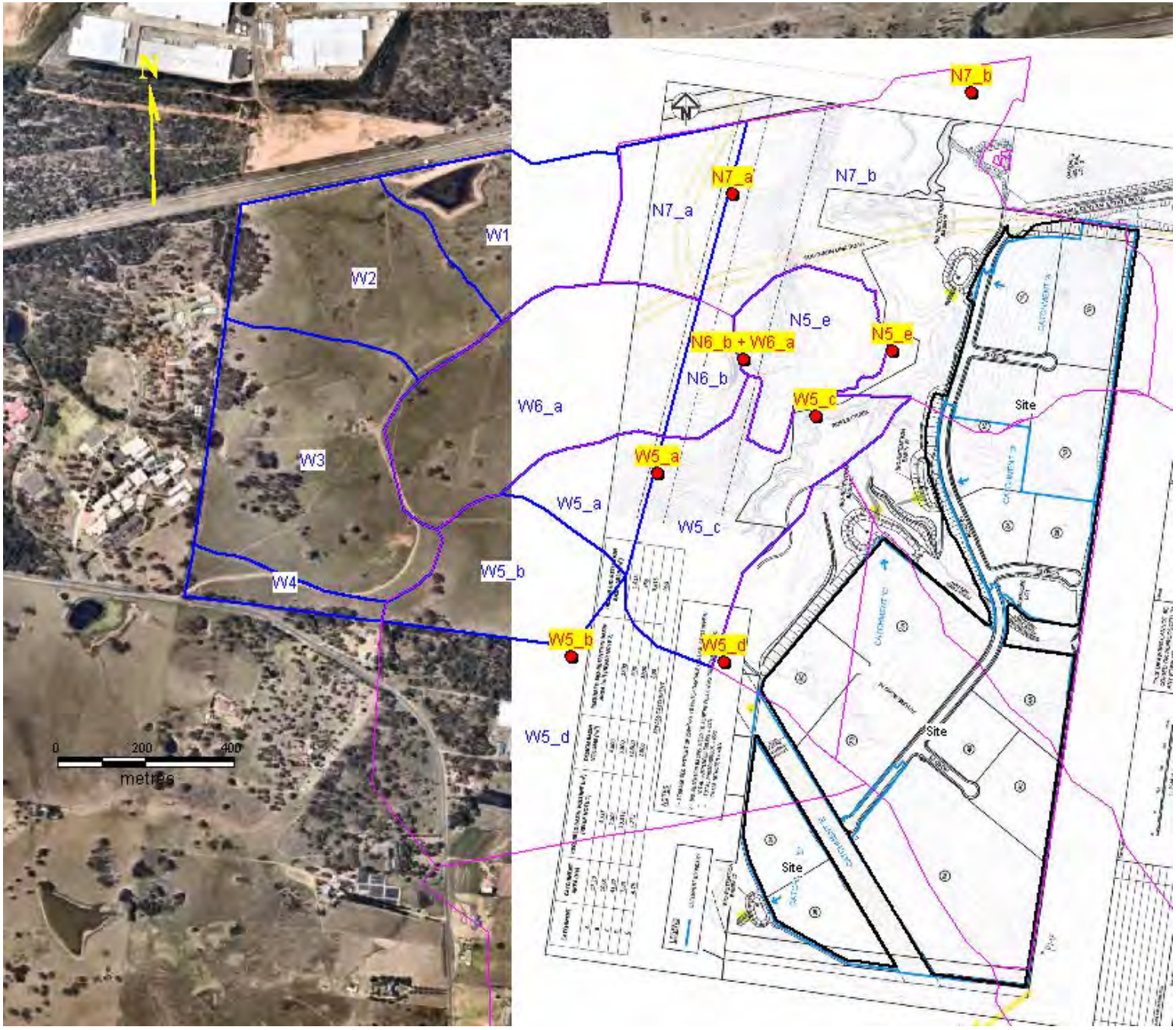


Figure 6 100 yr ARI Inflow Locations in TUFLOW Model – Amended Existing Conditions

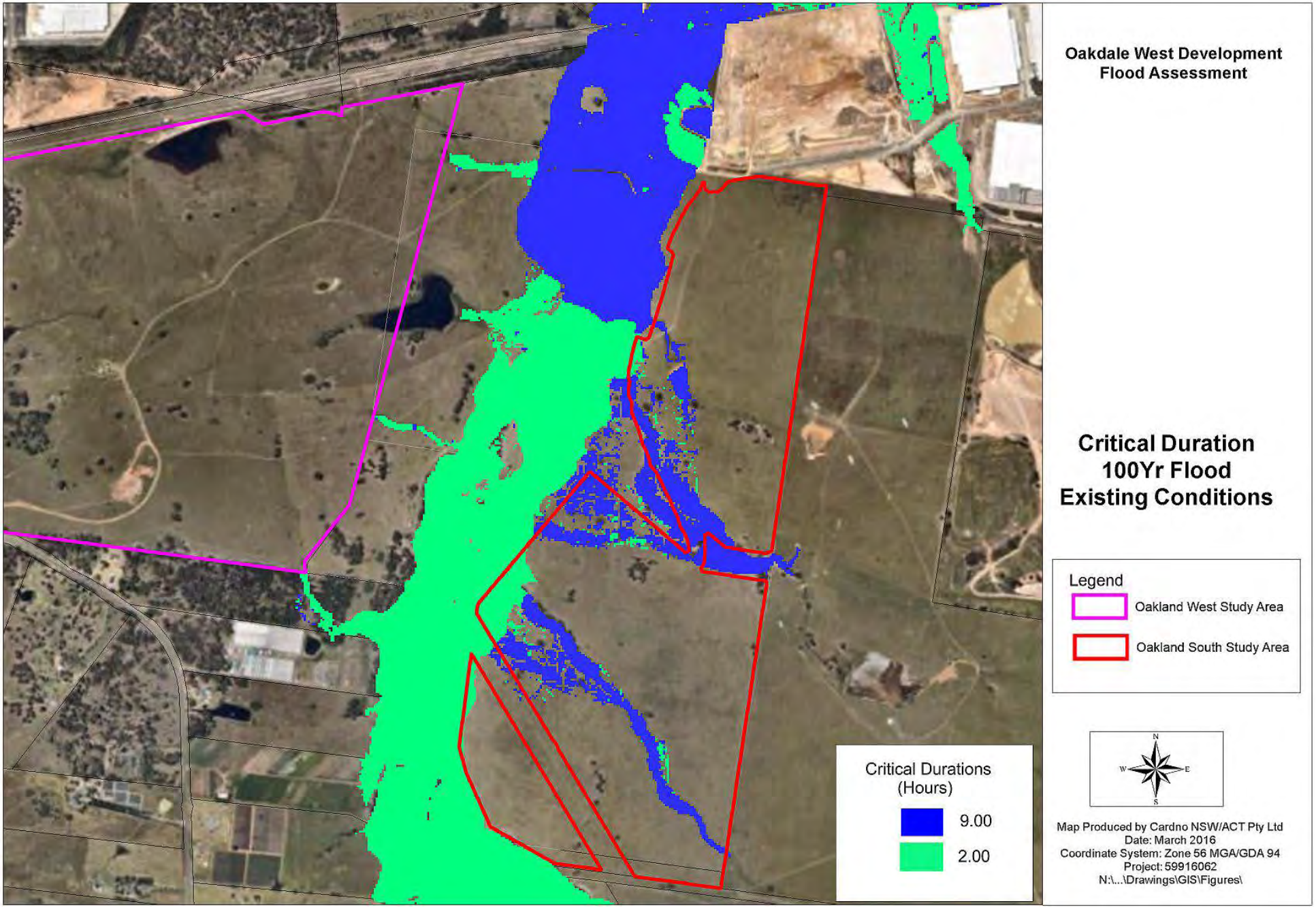


Figure 7 100 yr ARI Critical Storm Burst Durations - Existing Conditions

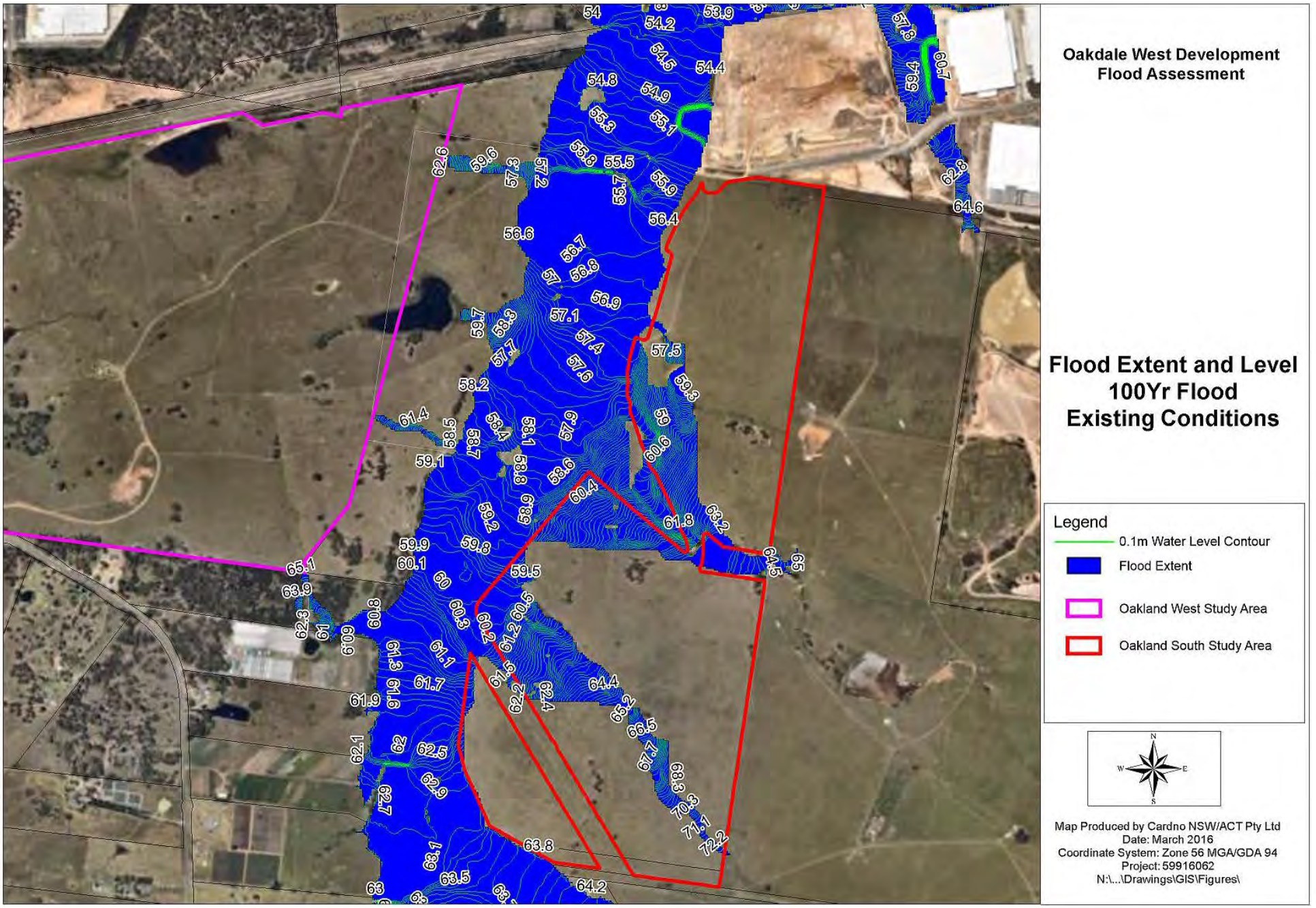


Figure 8 100 yr ARI Flood Extents and Flood Levels - Existing Conditions

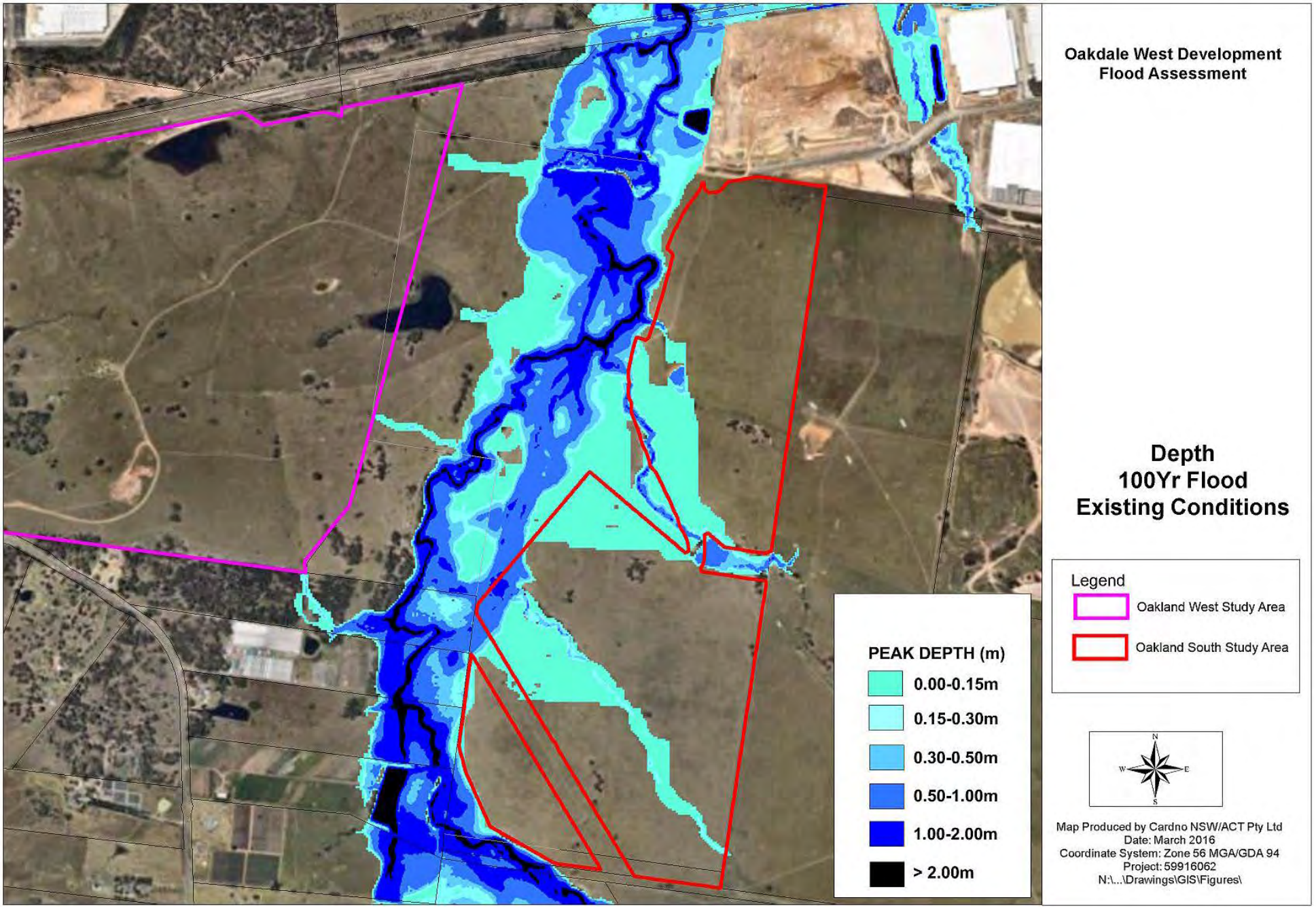


Figure 9 100 yr ARI Flood Depths - Existing Conditions

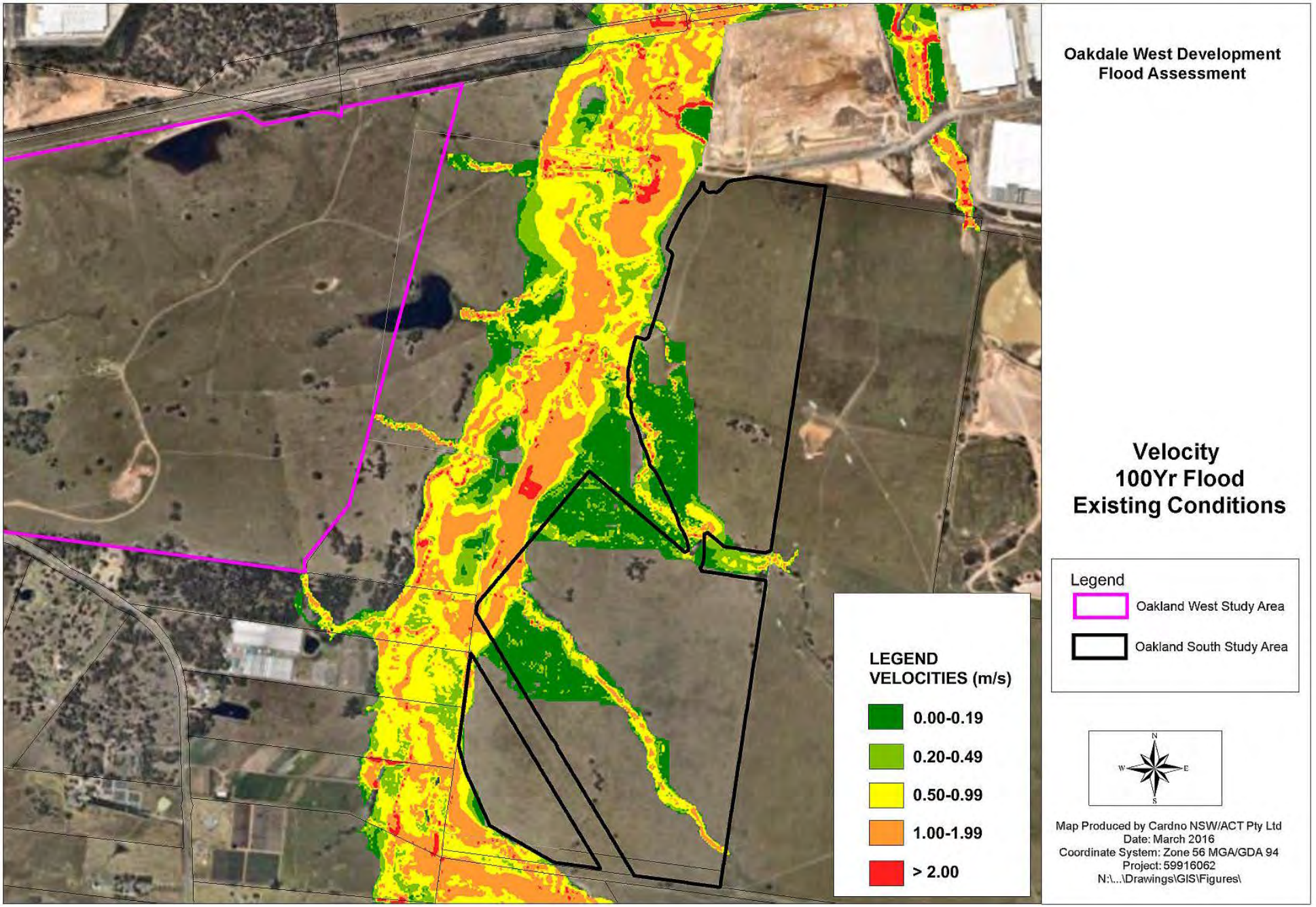


Figure 10 100 yr ARI Flood Velocities - Existing Conditions

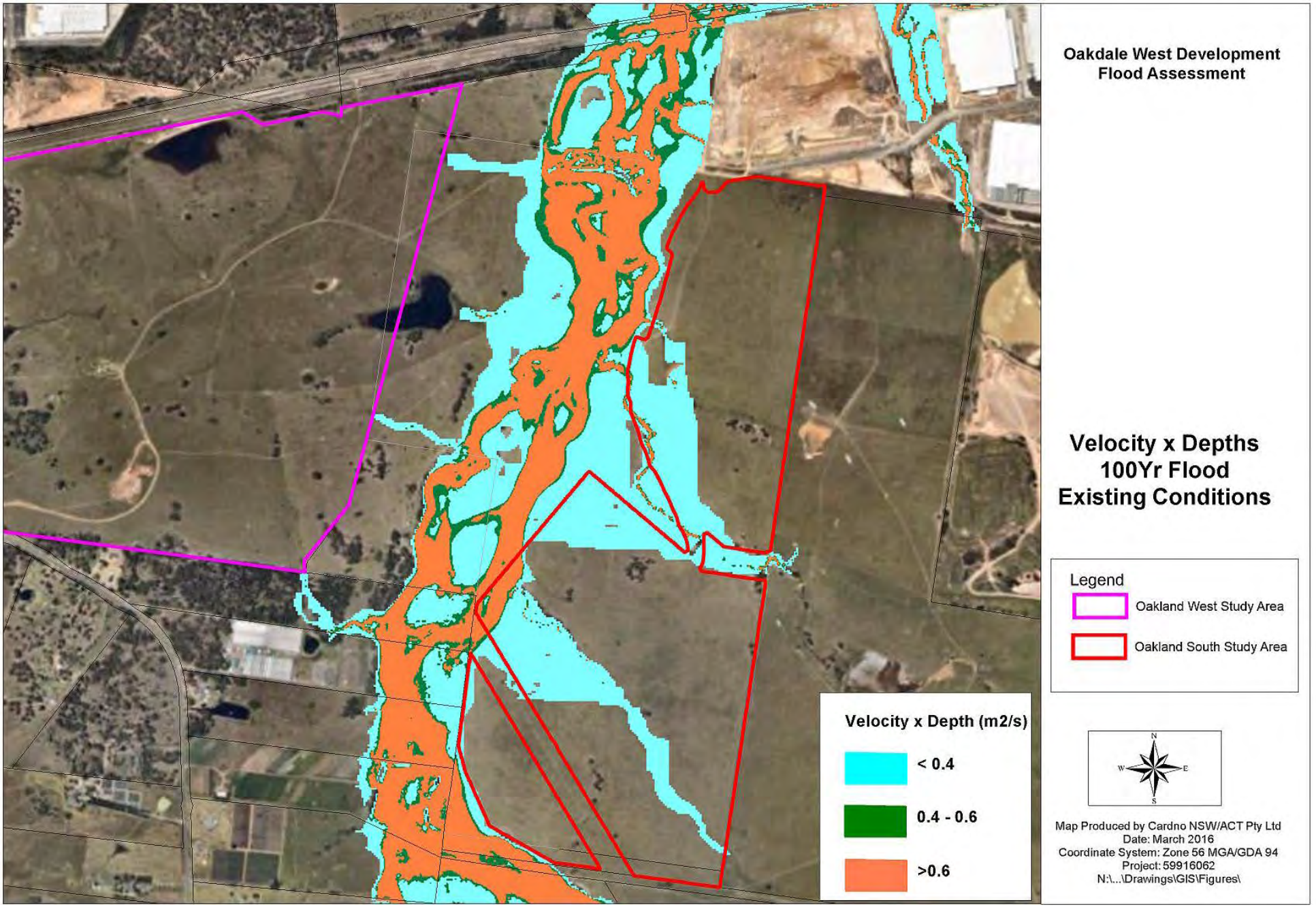


Figure 11 100 yr ARI Flood Velocity x Depth - Existing Conditions

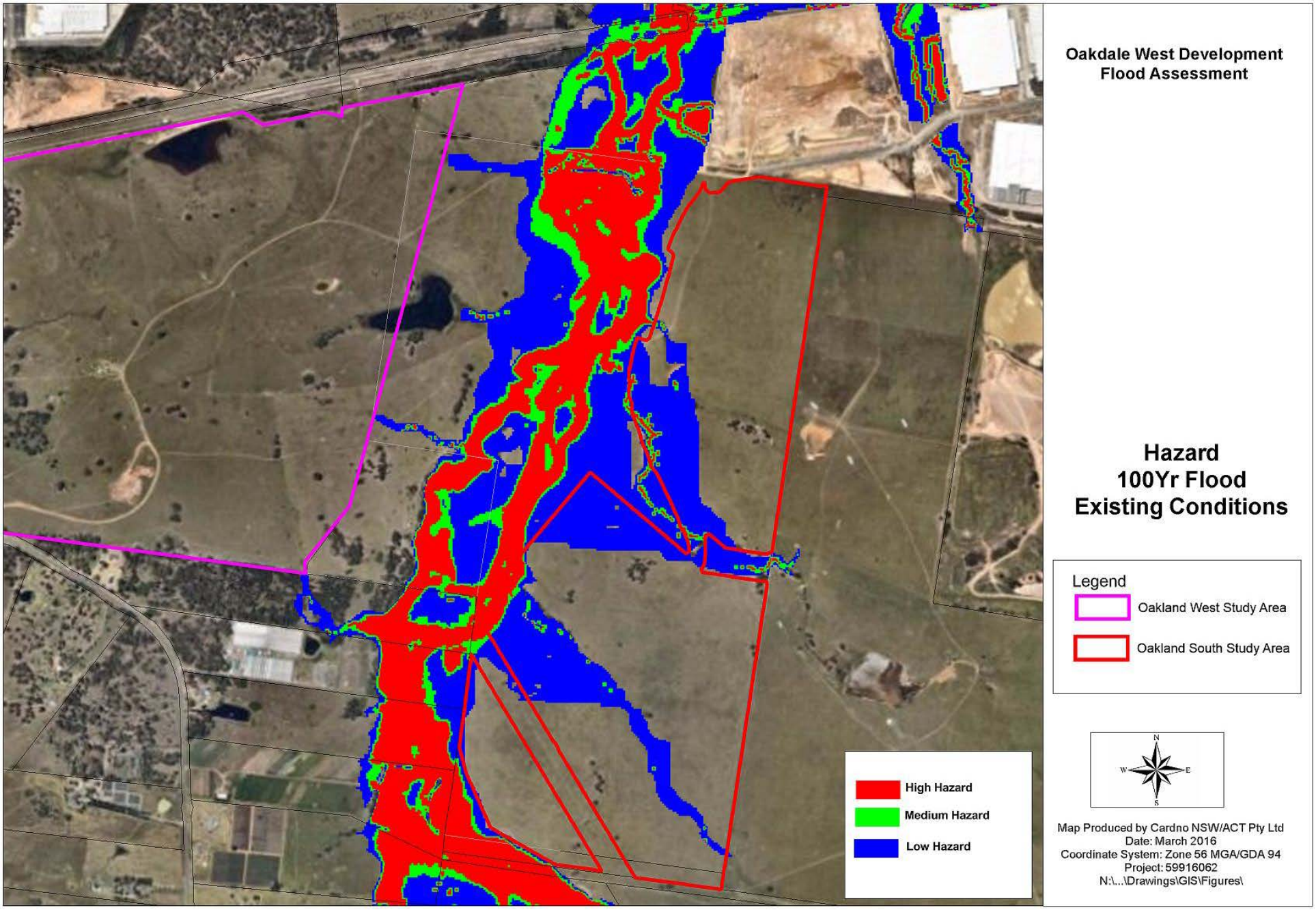


Figure 12 100 yr ARI Flood Hazards - Existing Conditions

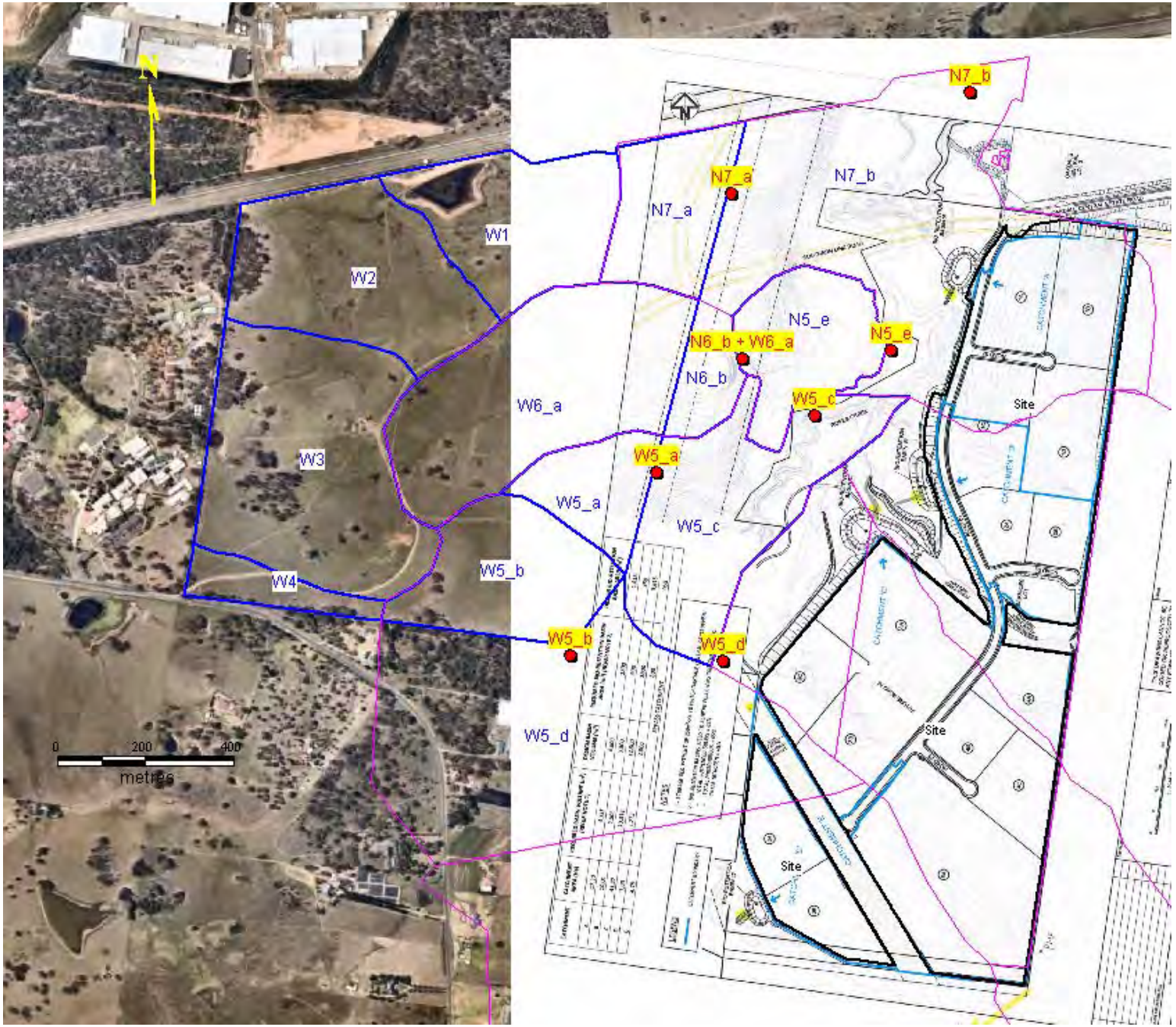


Figure 13 PMF Inflow Locations in TUFLOW Model – Amended Existing Conditions

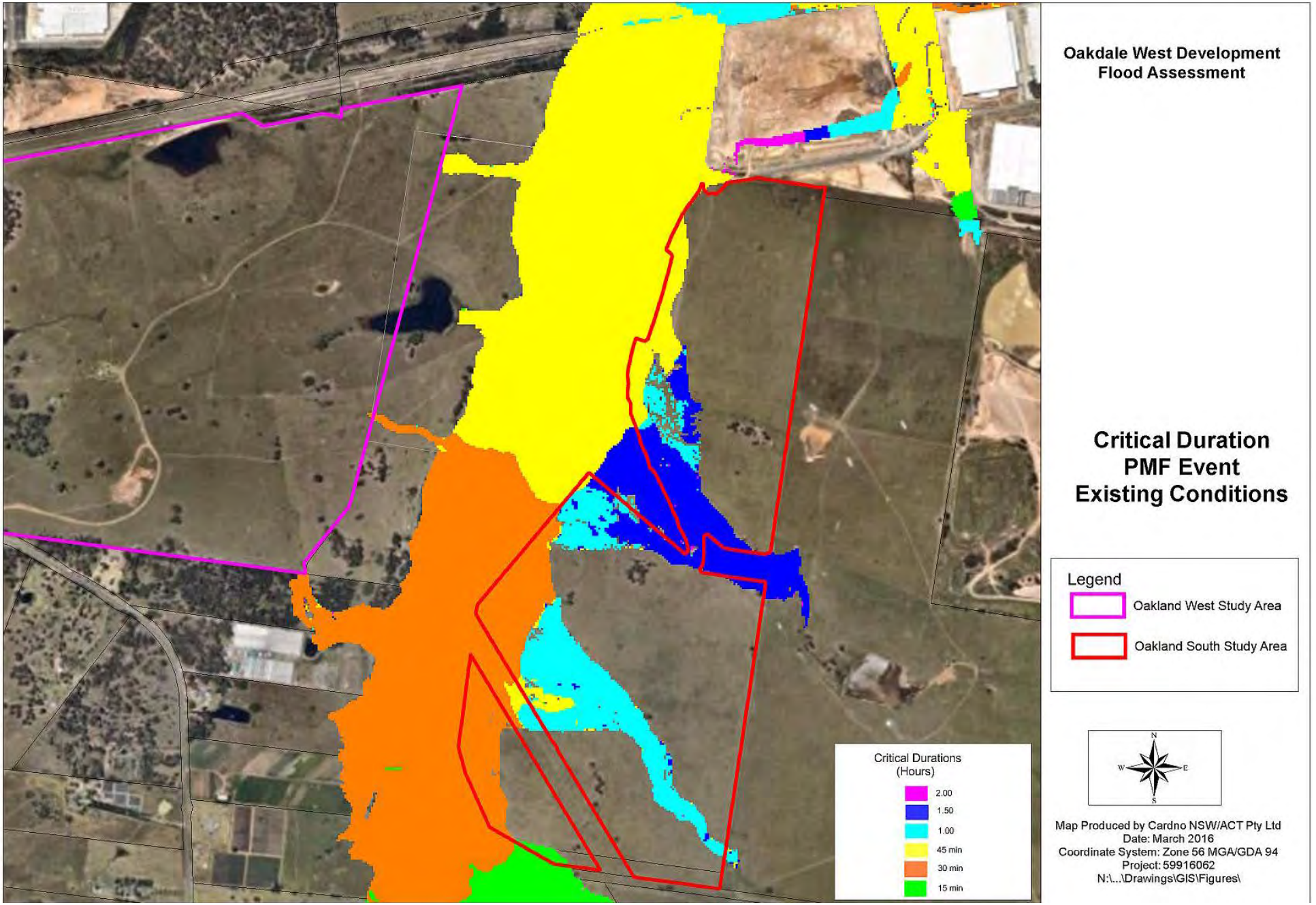


Figure 14 PMF Critical Storm Burst Durations - Existing Conditions

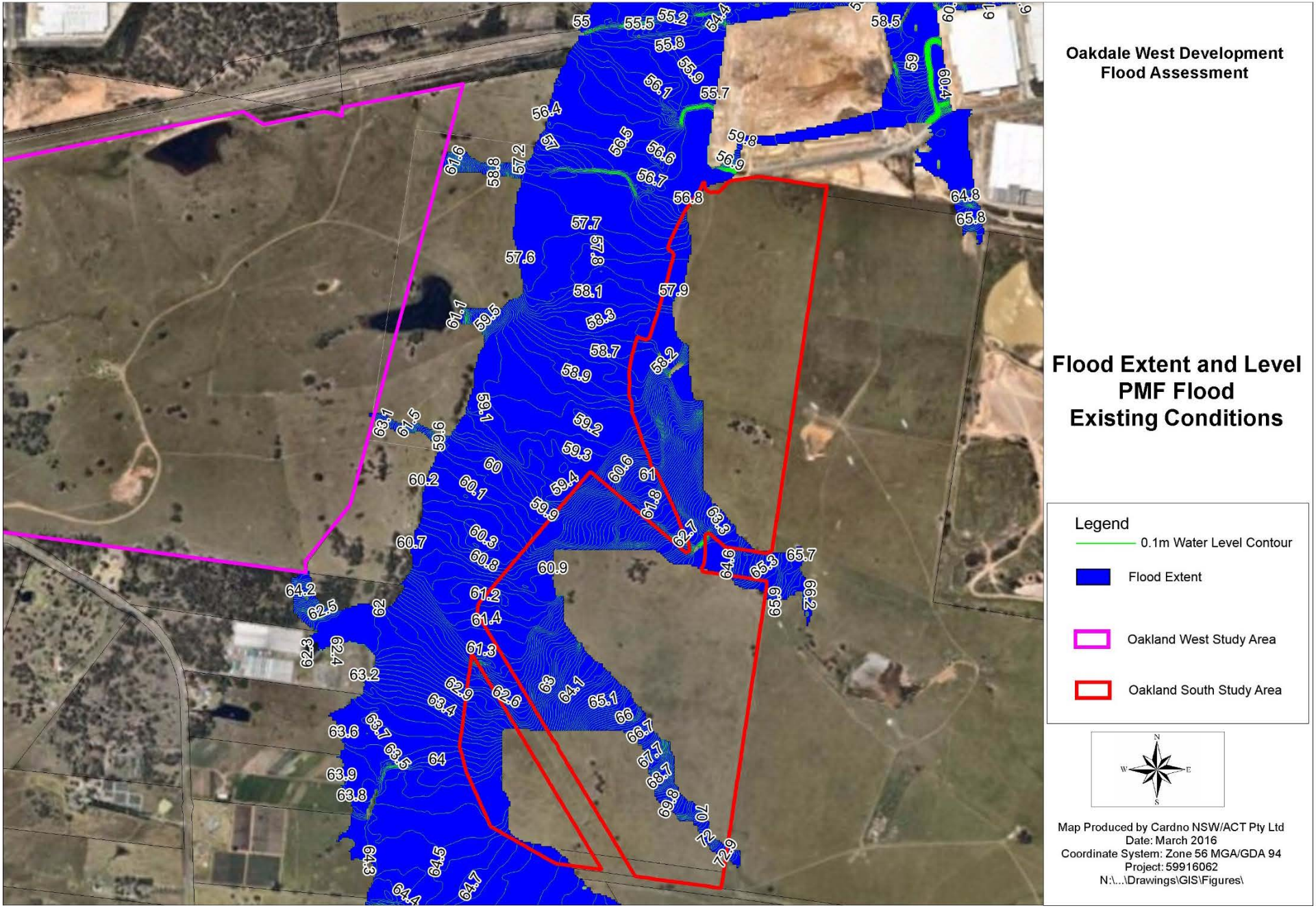


Figure 15 PMF Flood Extents and Flood Levels - Existing Conditions

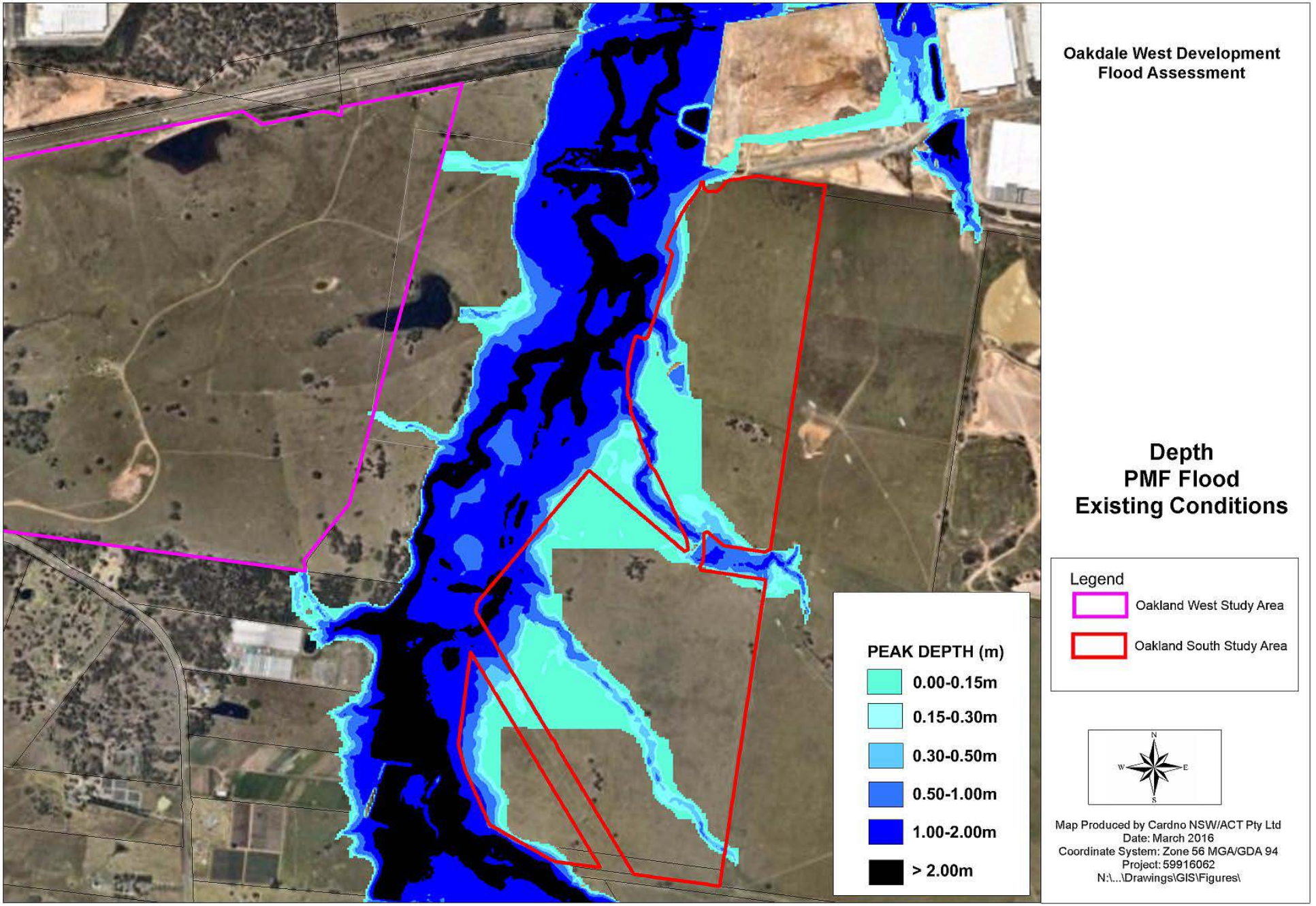


Figure 16 PMF Flood Depths - Existing Conditions

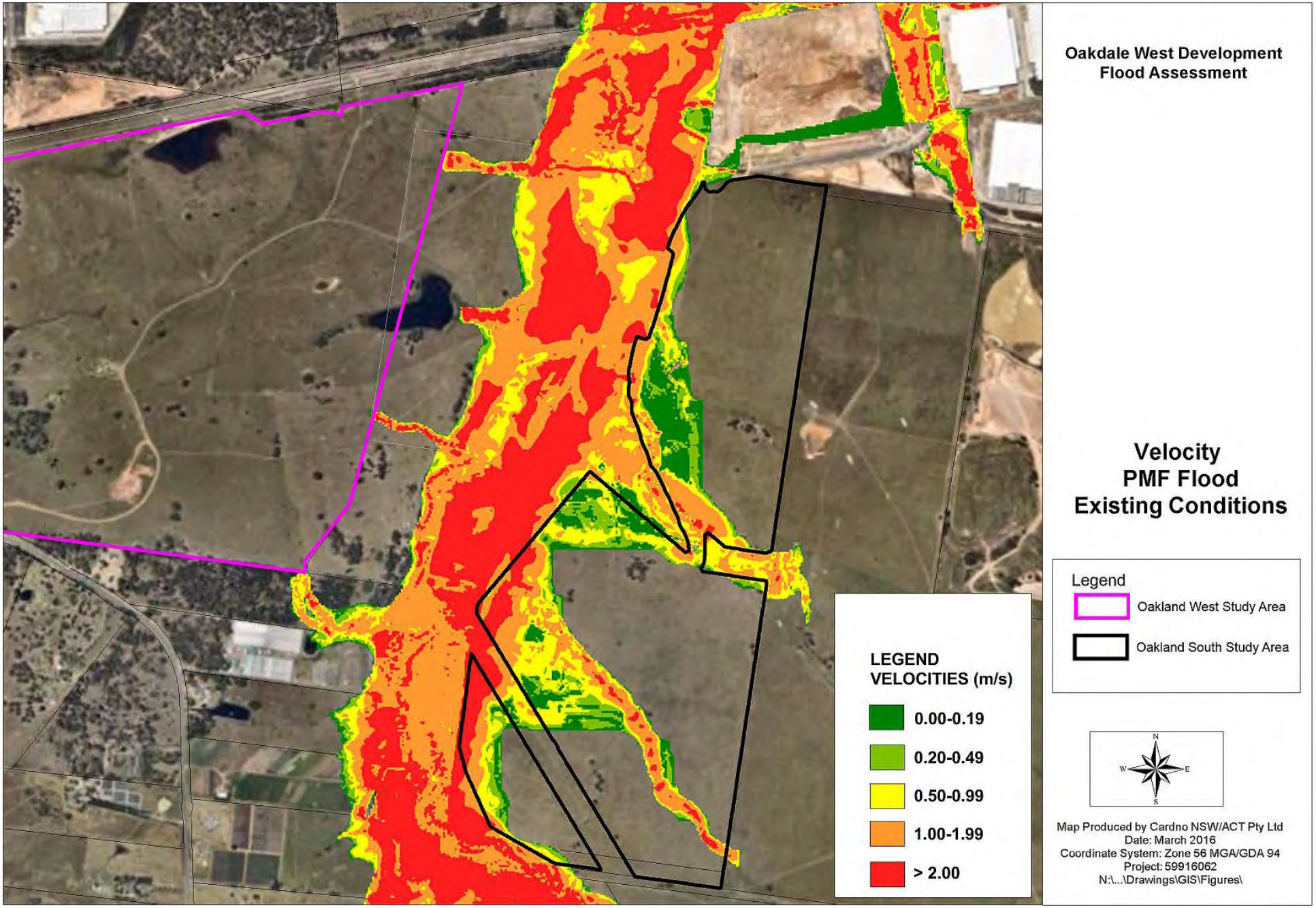


Figure 17 PMF Flood Velocities - Existing Conditions

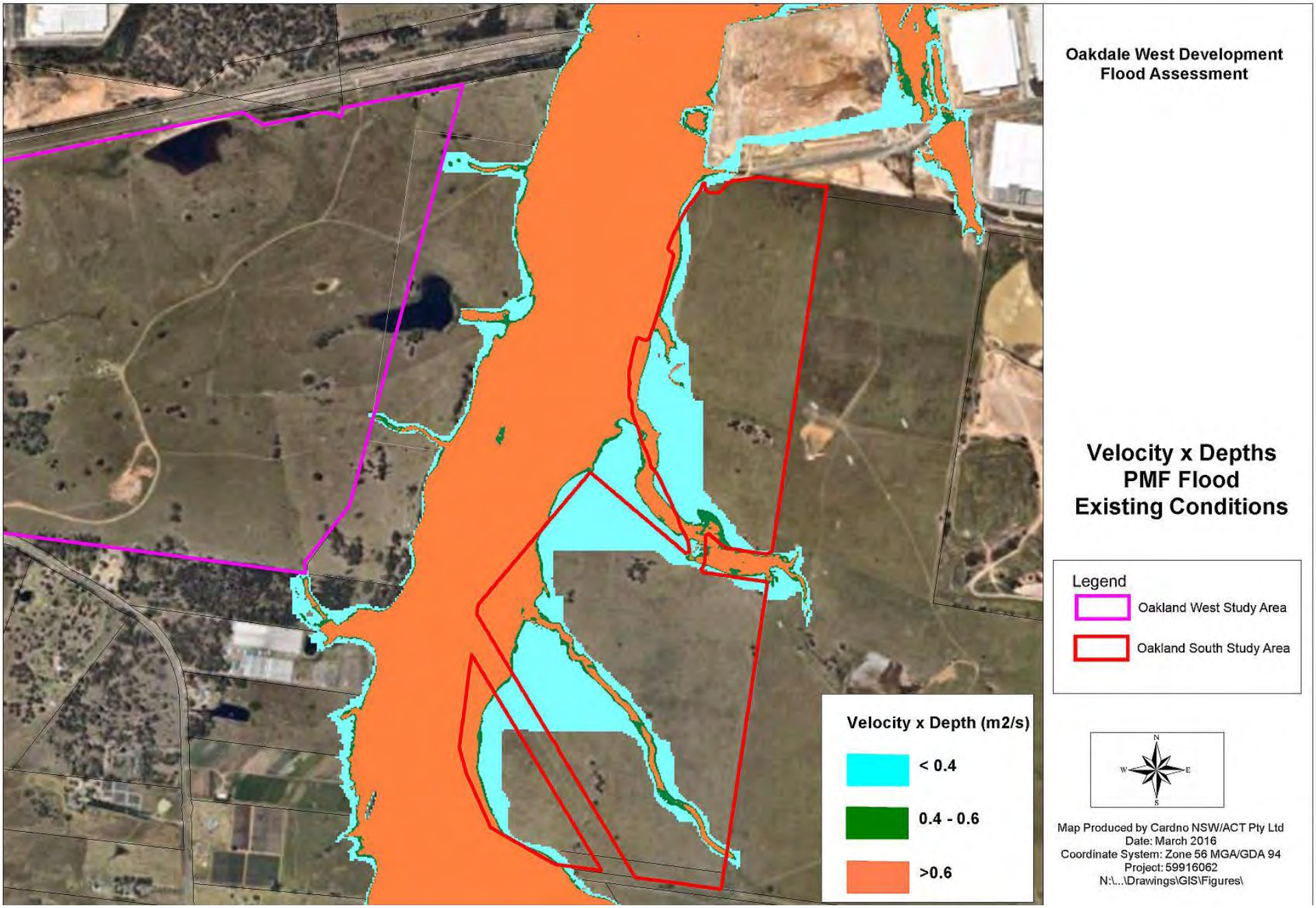


Figure 18 PMF Flood Velocity x Depth - Existing Conditions

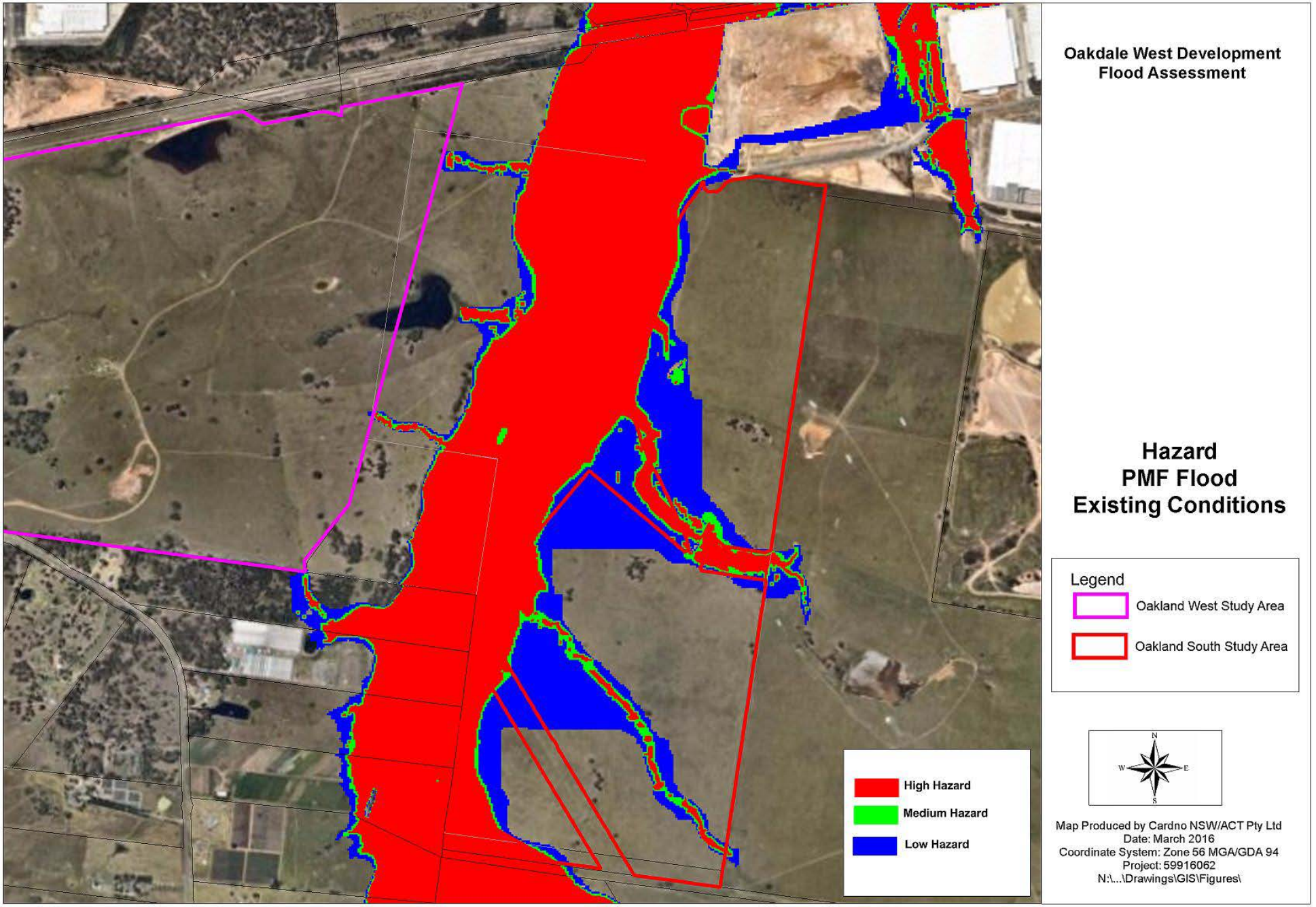


Figure 19 PMF Flood Hazards - Existing Conditions

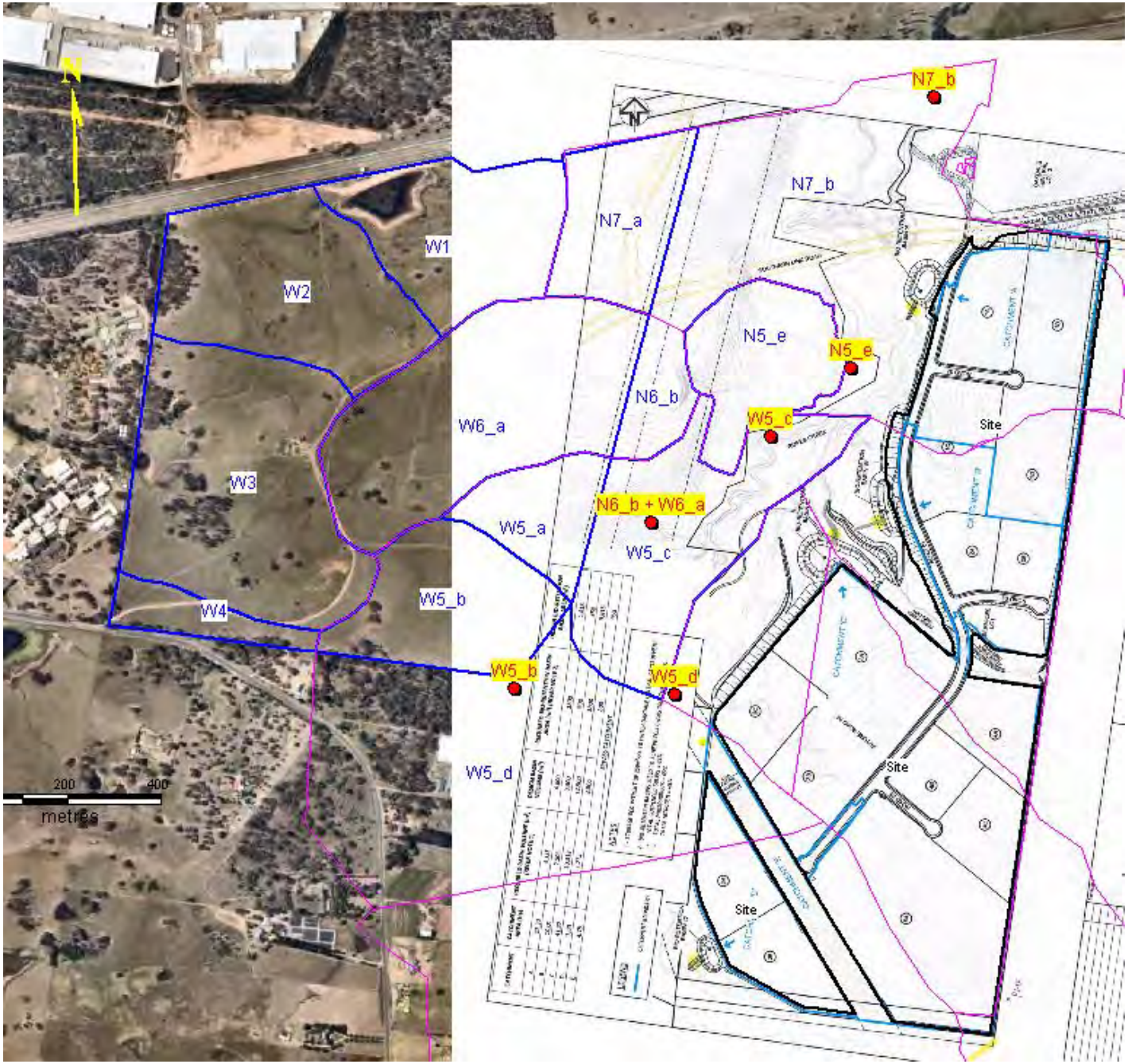


Figure 20 100 yr ARI Inflow Locations in TUFLOW Model - Future Conditions

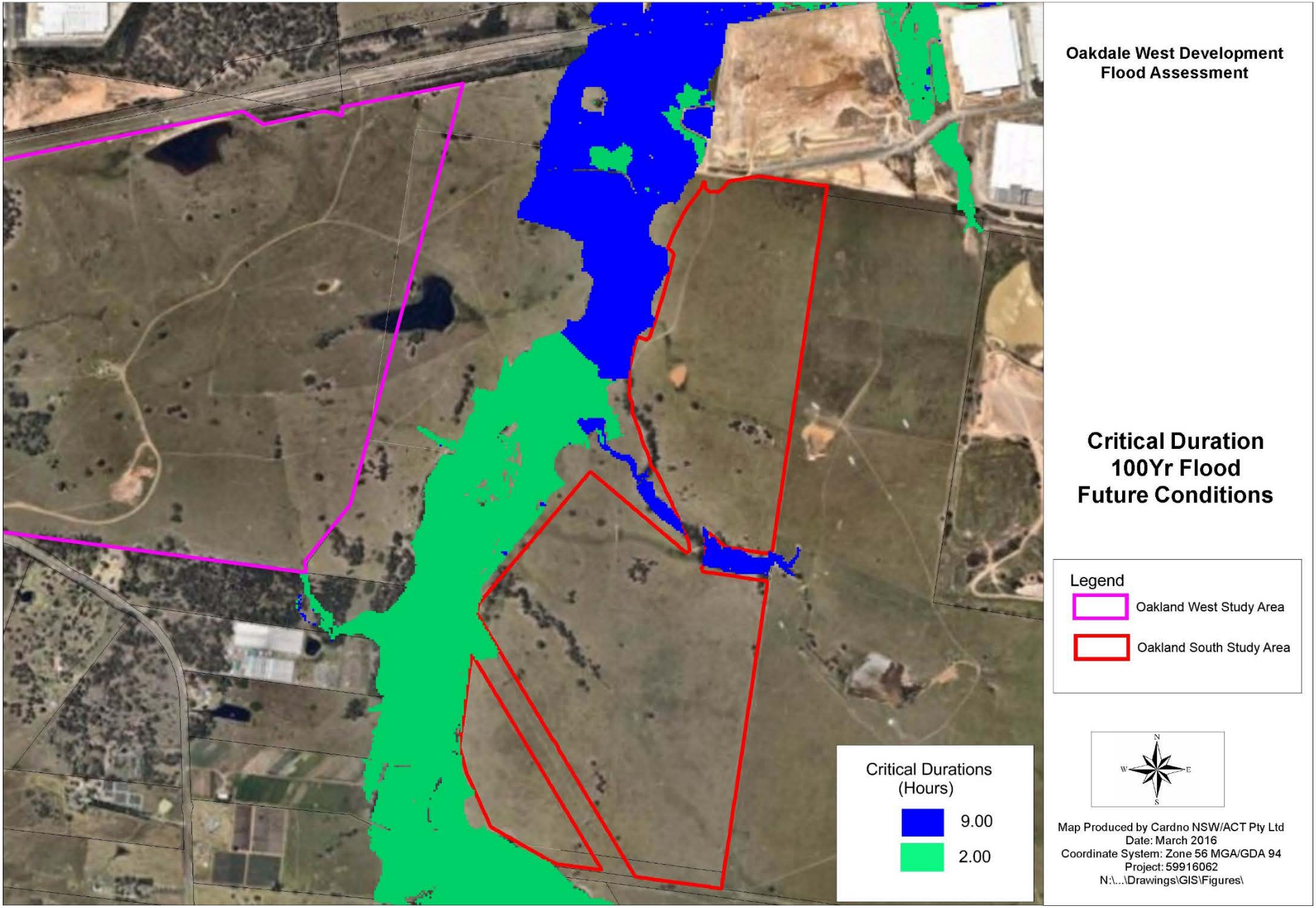


Figure 21 100 yr ARI Critical Storm Burst Durations - Future Conditions

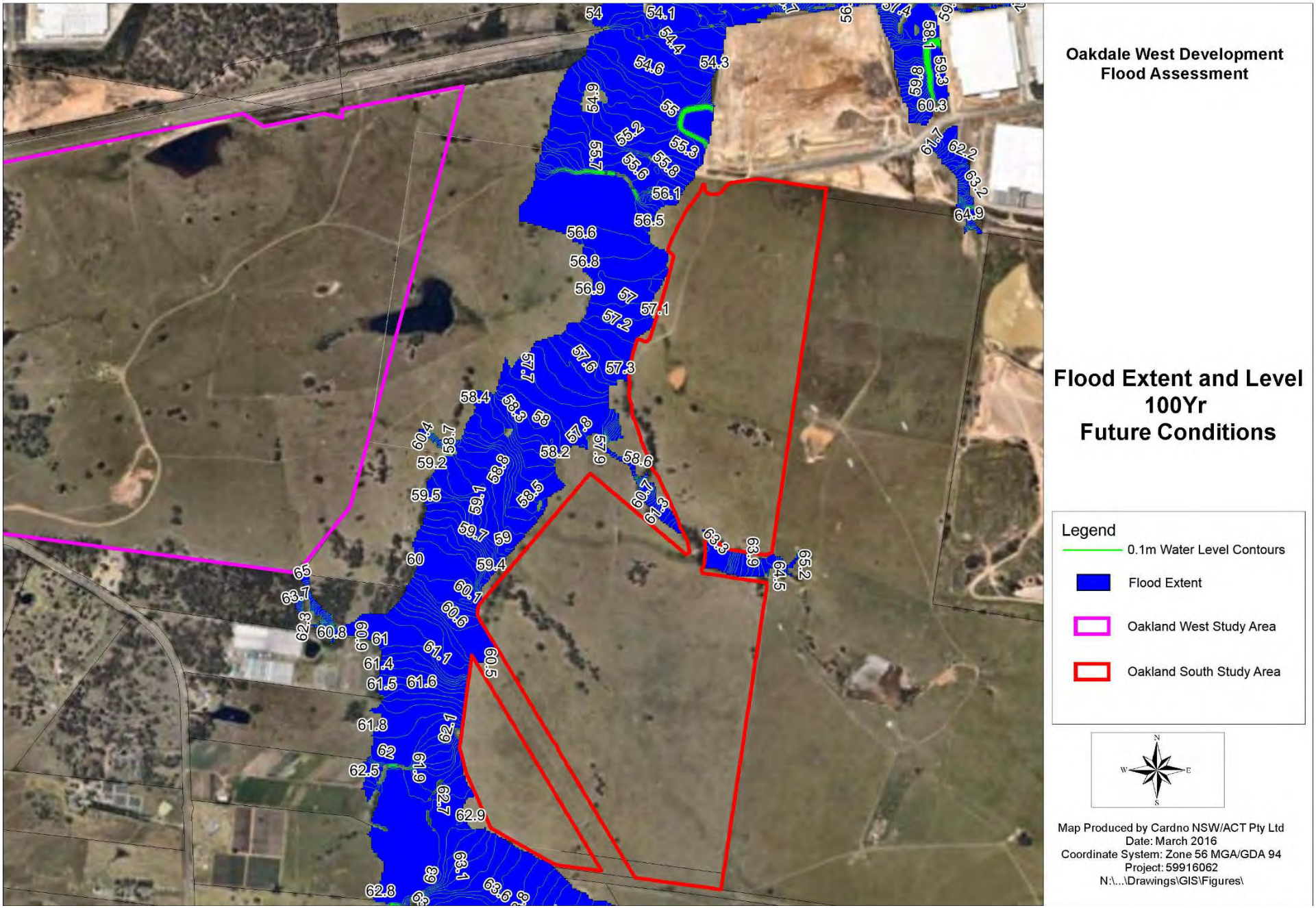


Figure 22 100 yr ARI Flood Extents and Flood Levels - Future Conditions

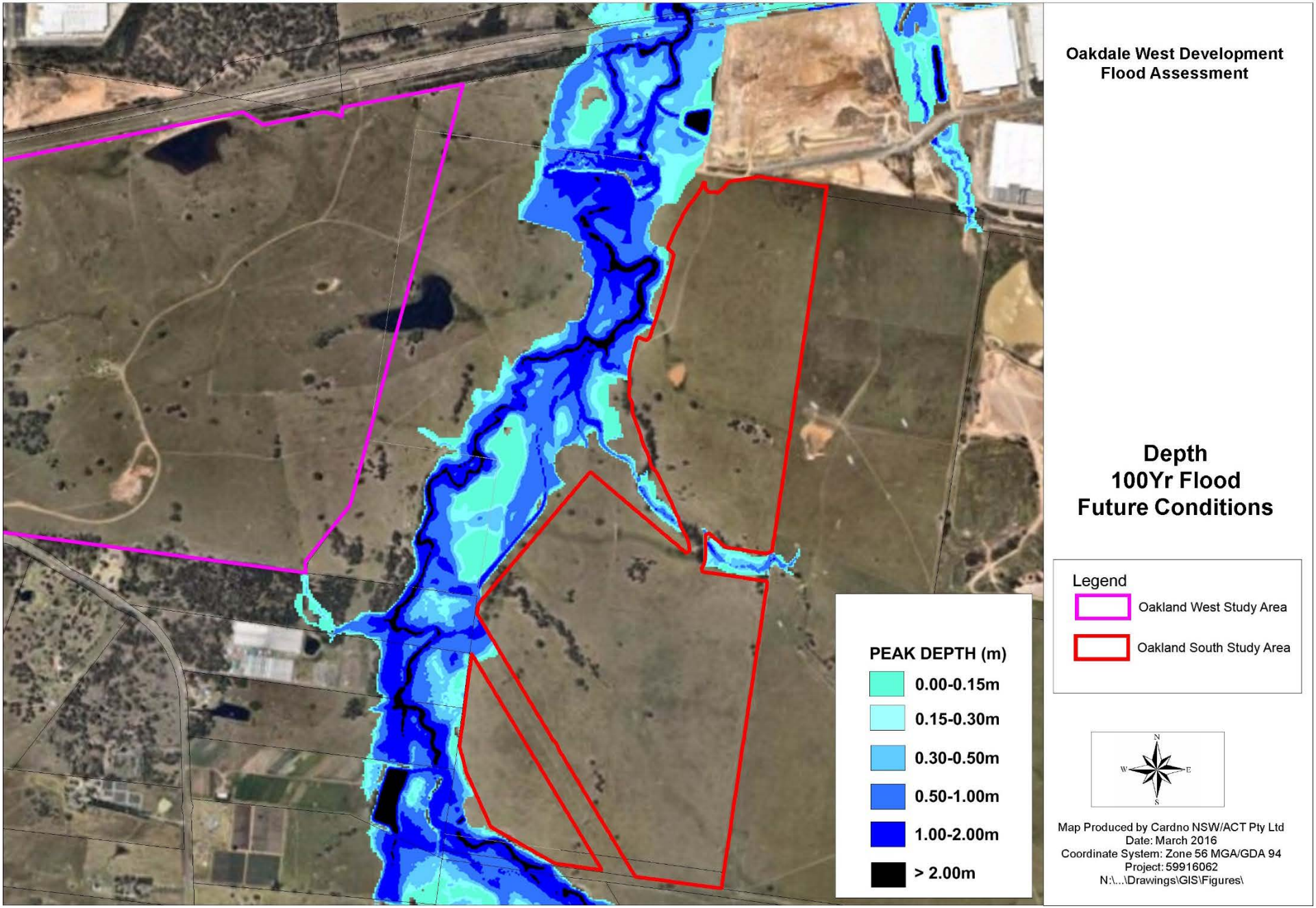


Figure 23 100 yr ARI Flood Depths - Future Conditions

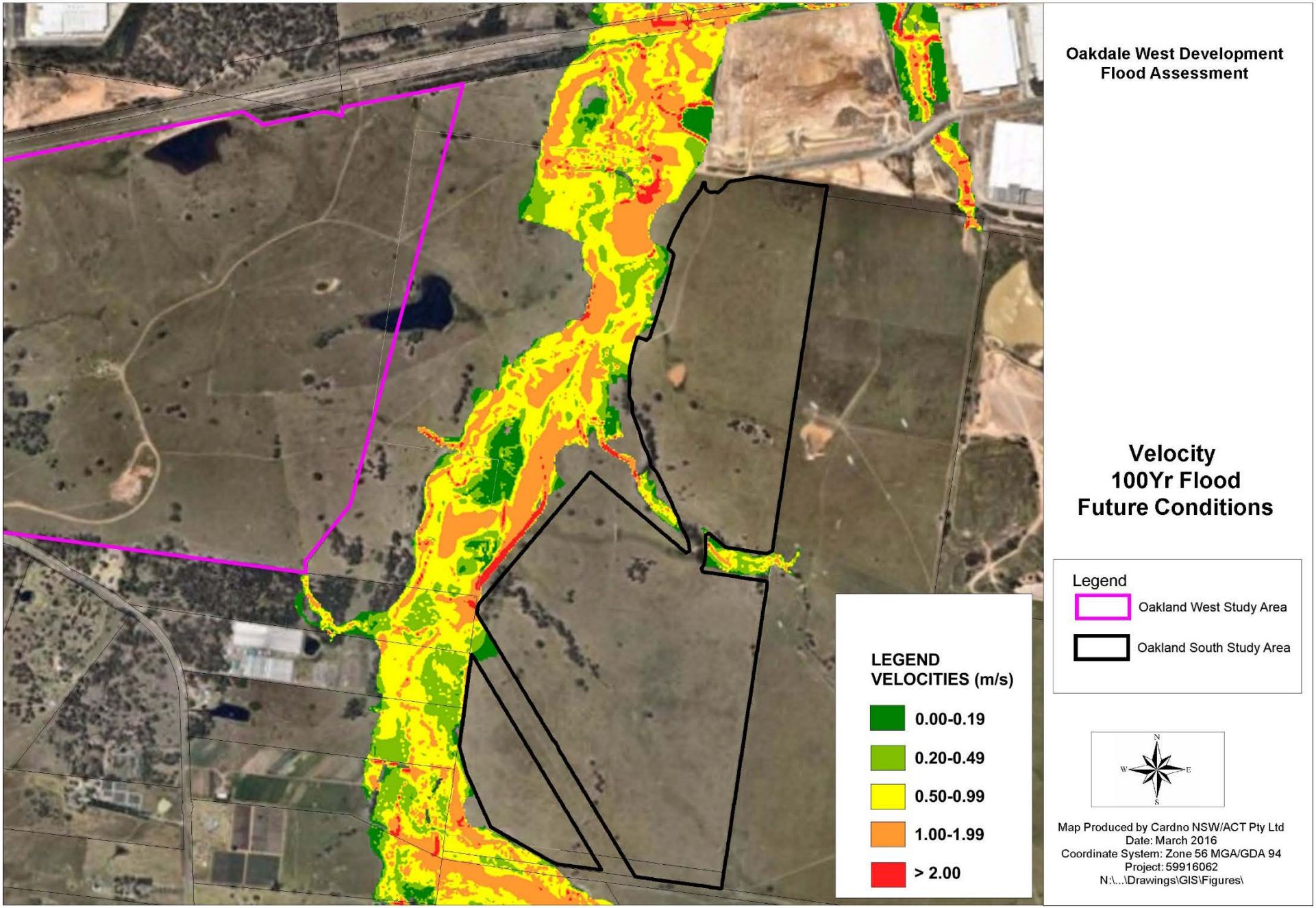


Figure 24 100 yr ARI Flood Velocities - Future Conditions

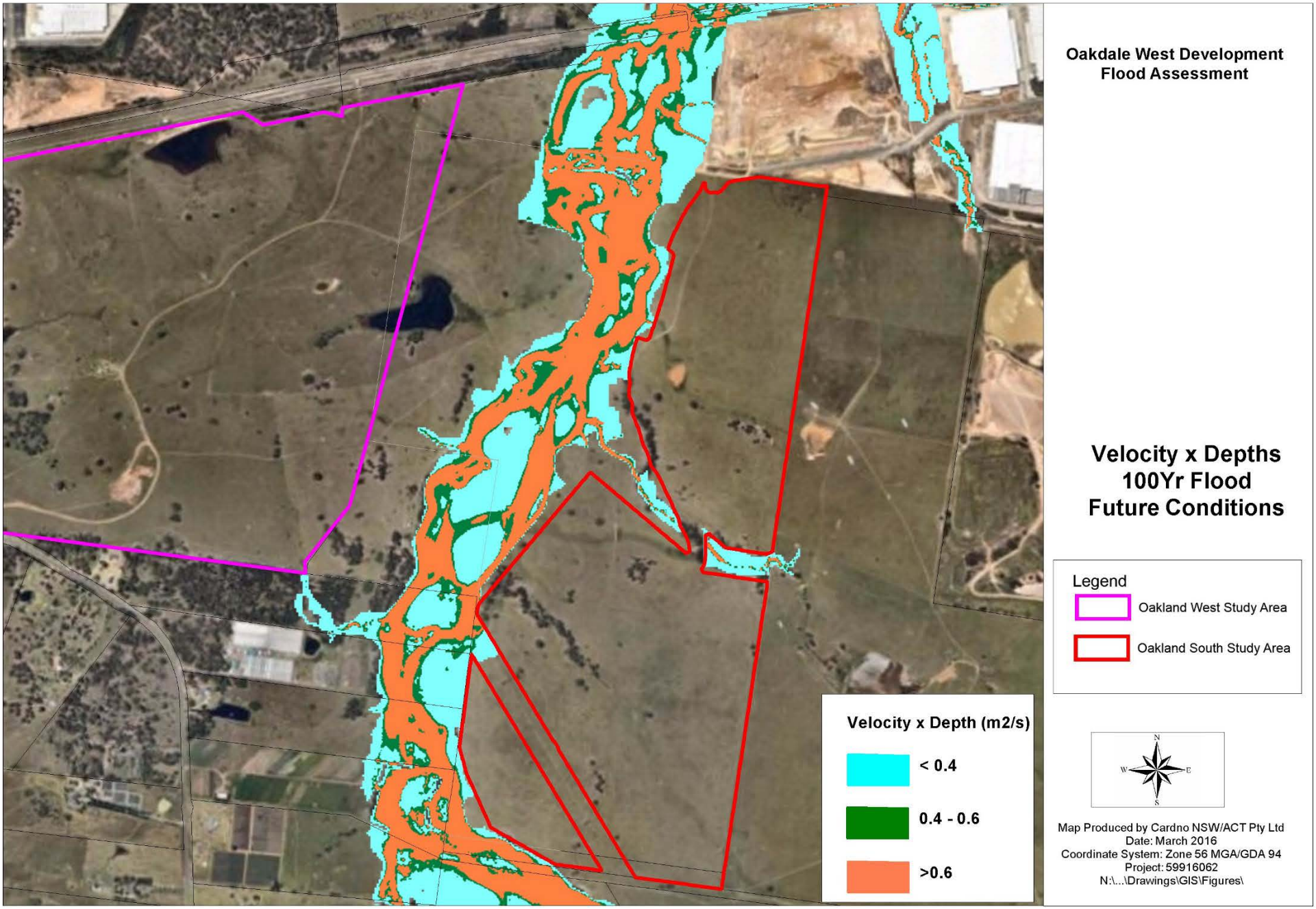


Figure 25 100 yr ARI Flood Velocity x Depth - Future Conditions

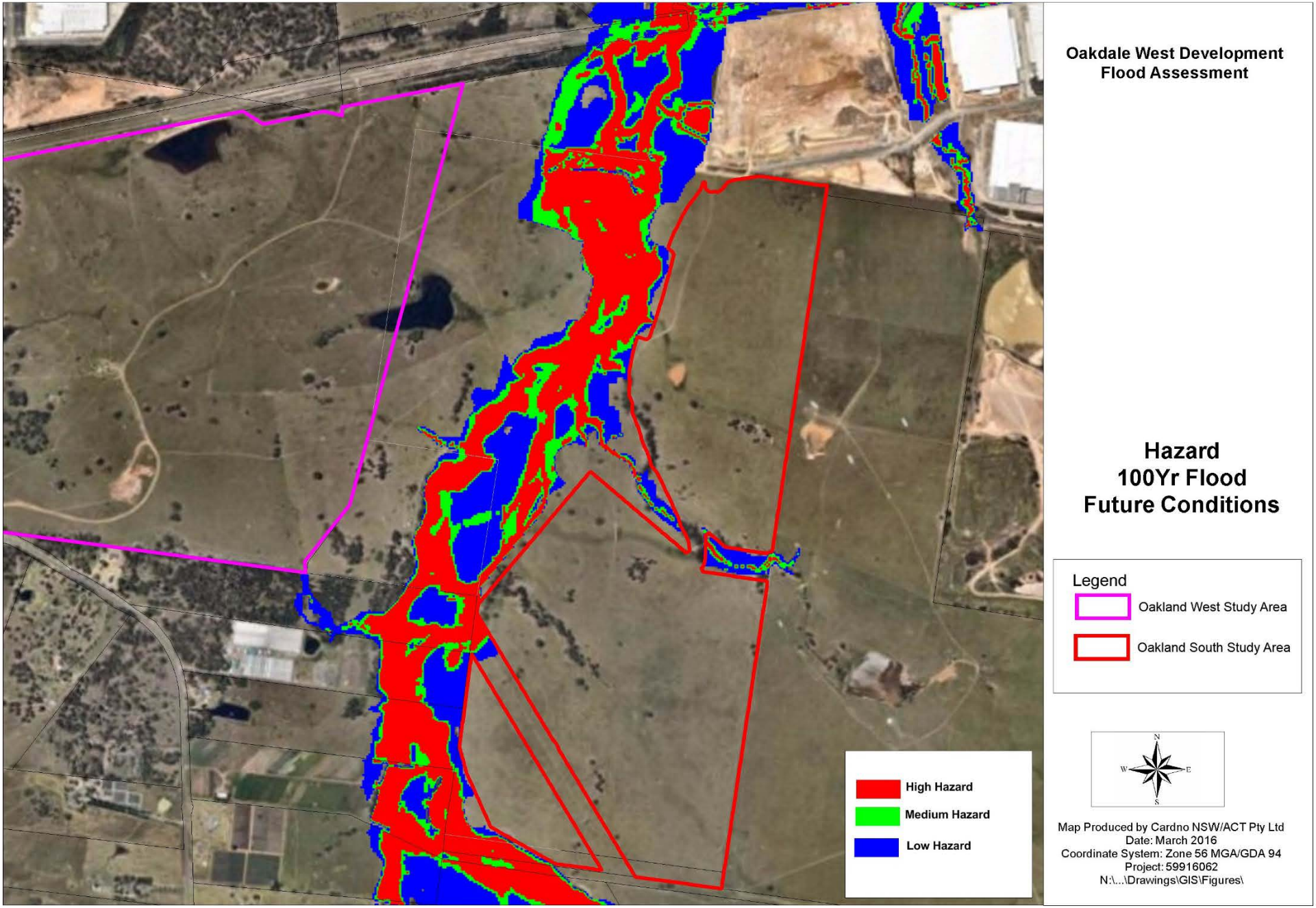


Figure 26 100 yr ARI Flood Hazards - Future Conditions

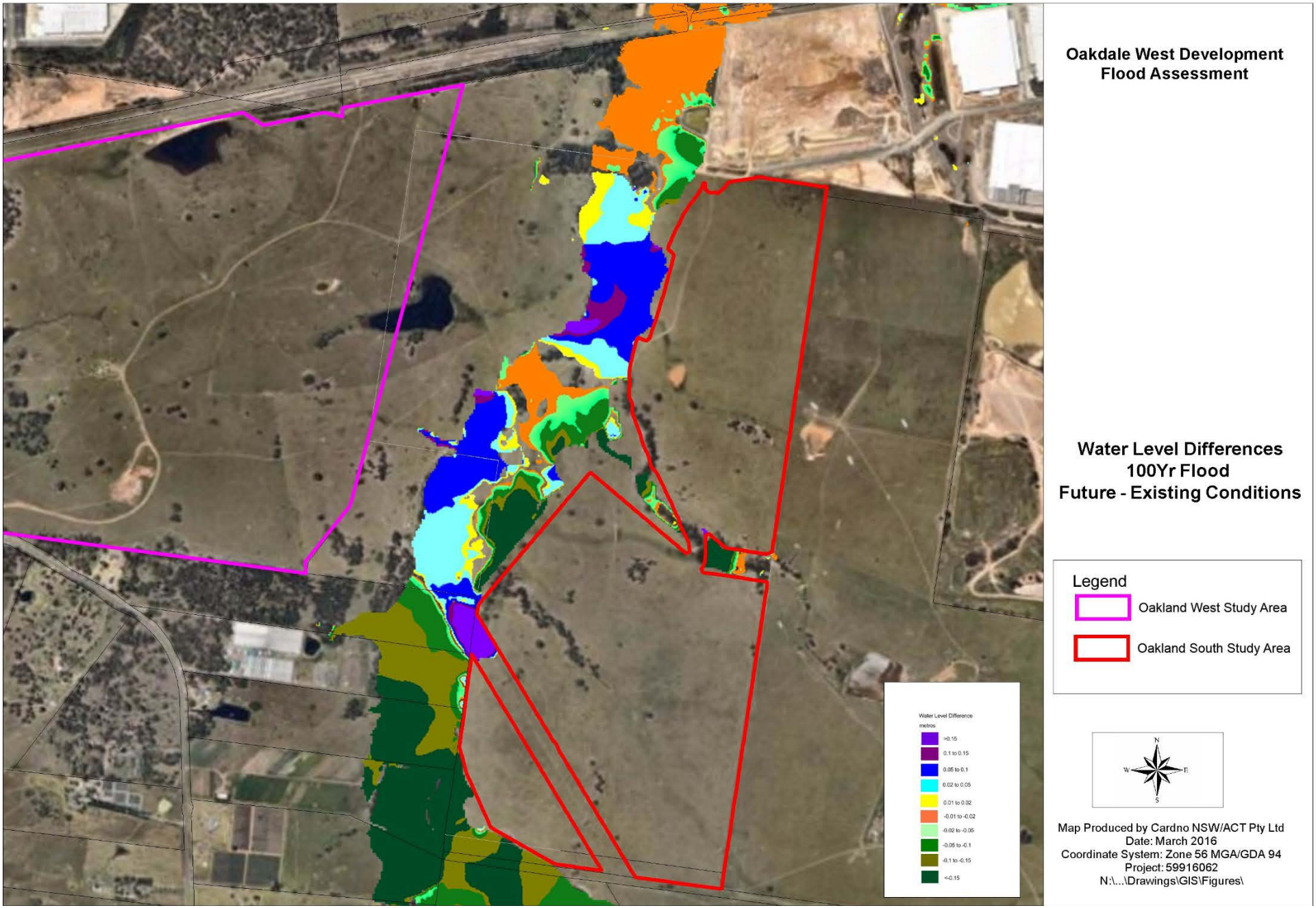


Figure 27 100 yr ARI Level Differences - (Future – Existing Conditions)

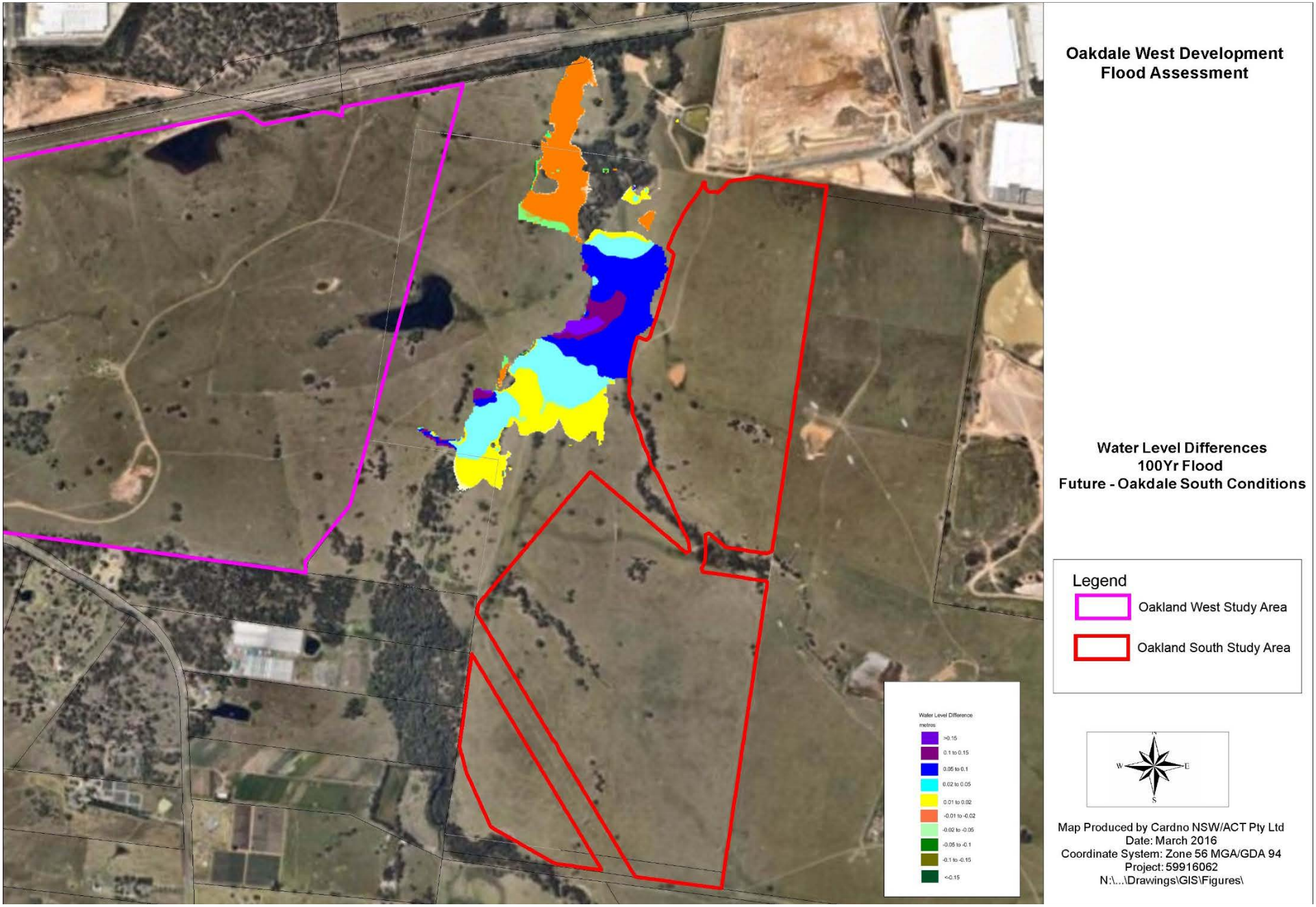


Figure 28 100 yr ARI Level Differences - (Future – Oakdale South Conditions)

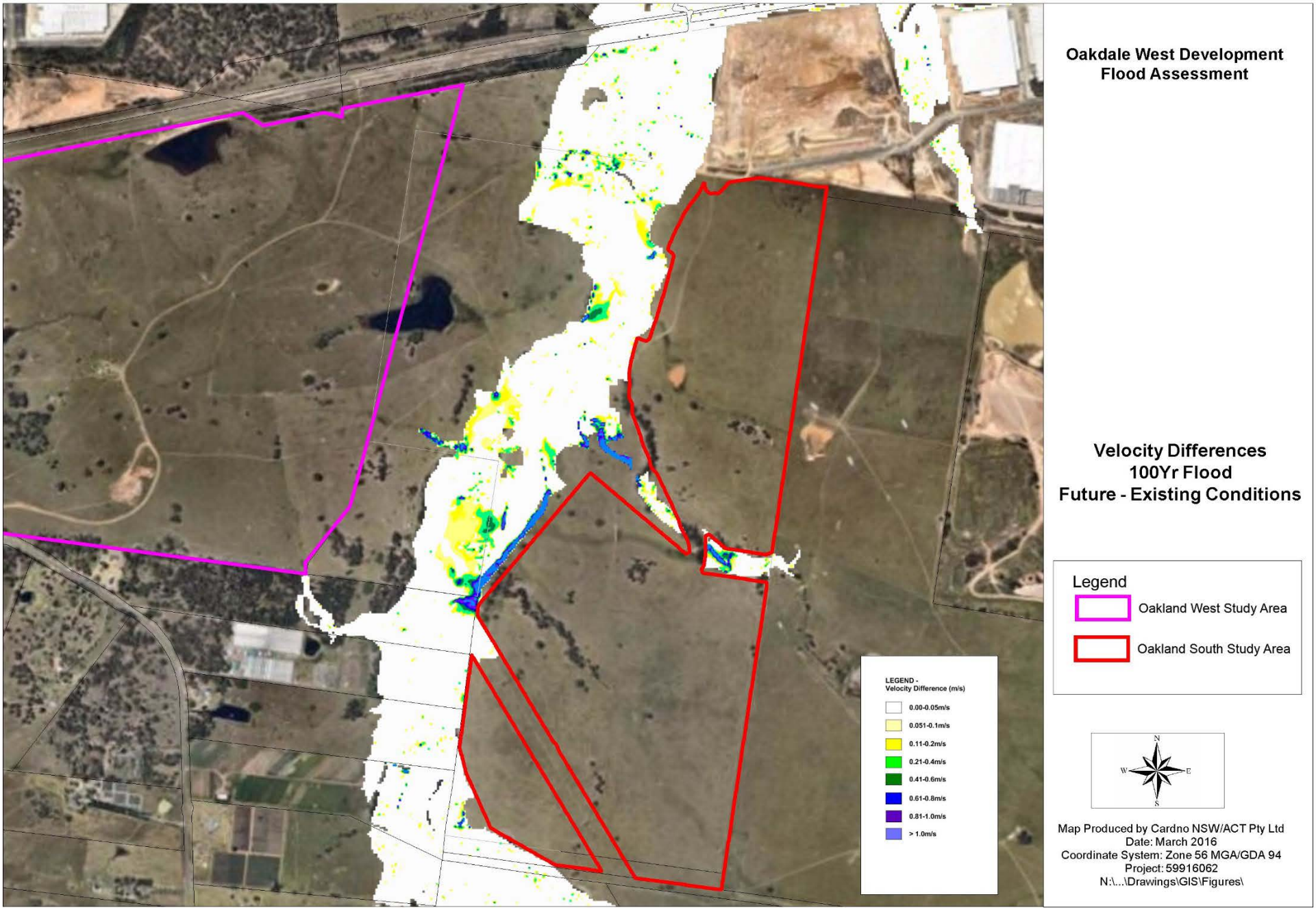


Figure 29 100 yr ARI Velocity Differences - (Future – Existing Conditions)

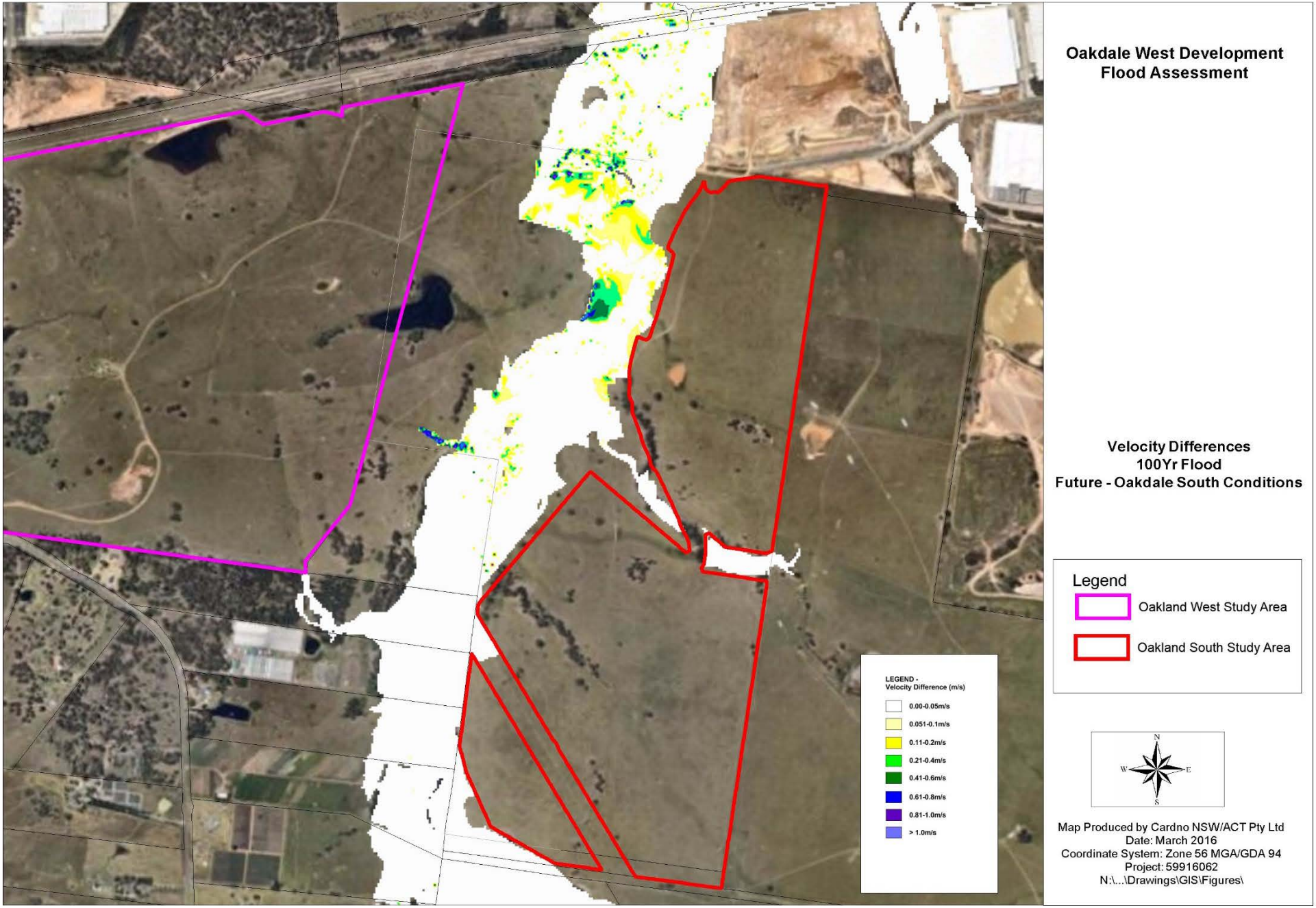


Figure 30 100 yr ARI Velocity Differences - (Future – Oakdale South Conditions)

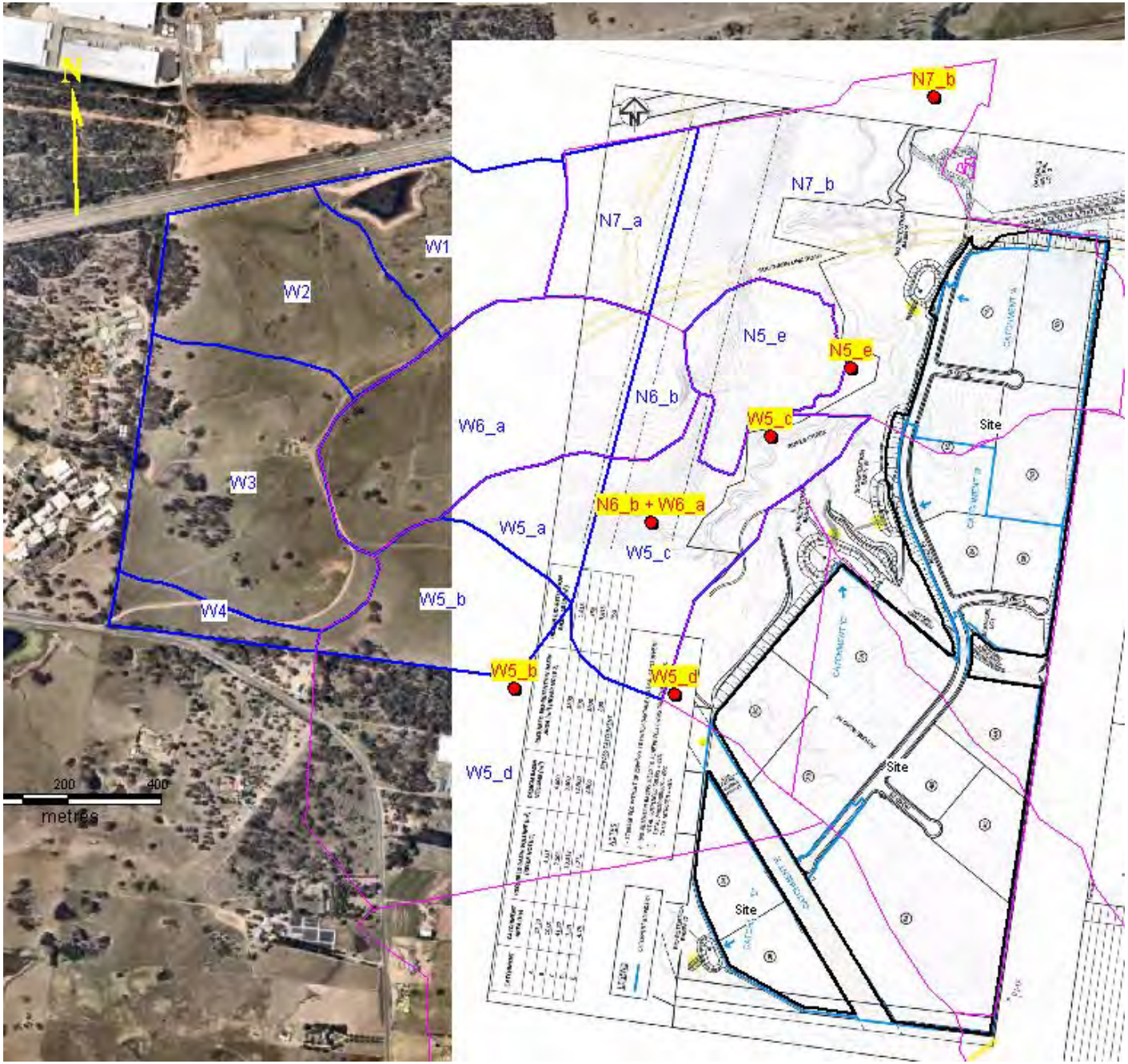


Figure 31 PMF Inflow Locations in TUFLOW Model - Future Conditions

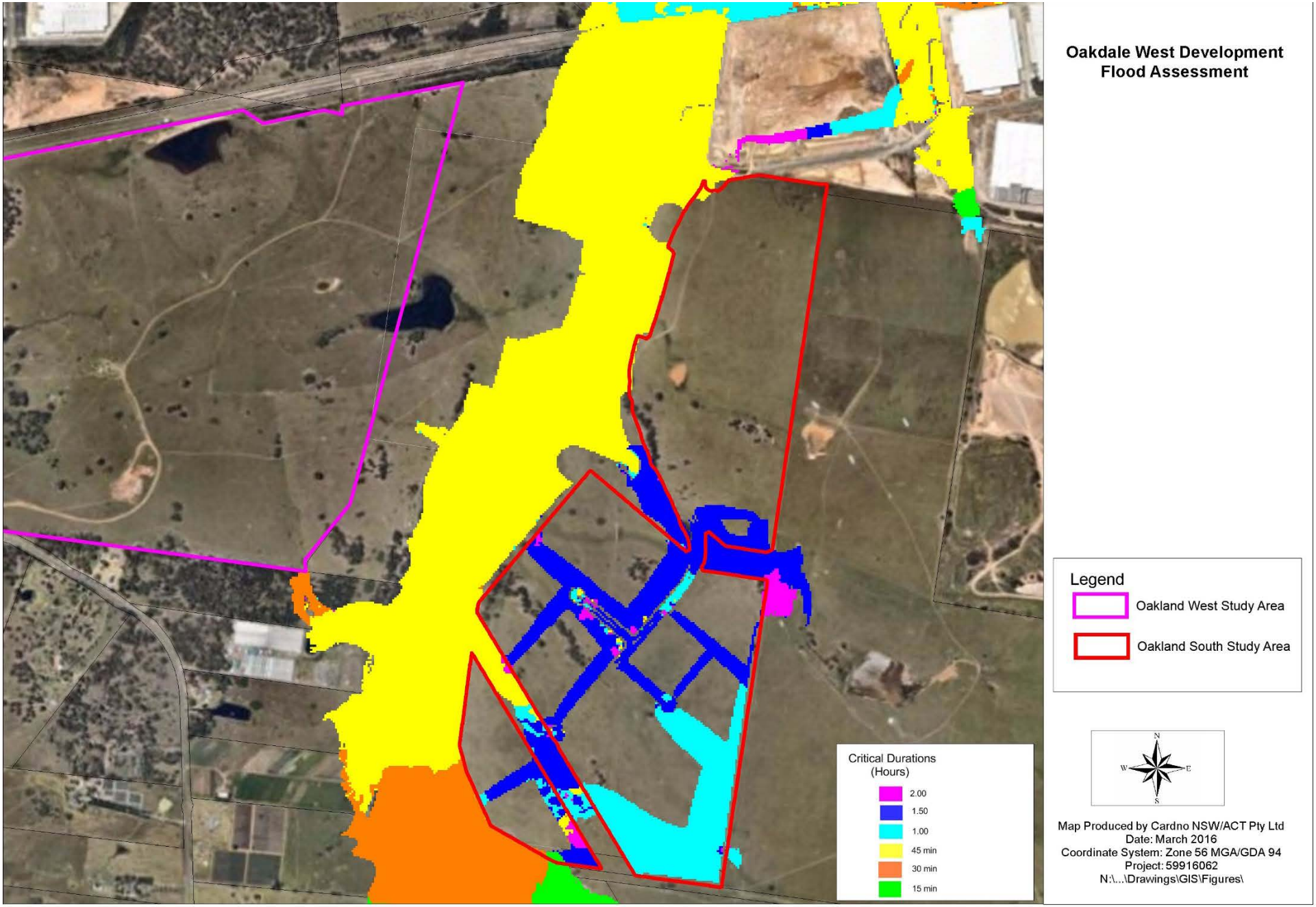


Figure 32 PMF Critical Storm Burst Durations - Future Conditions

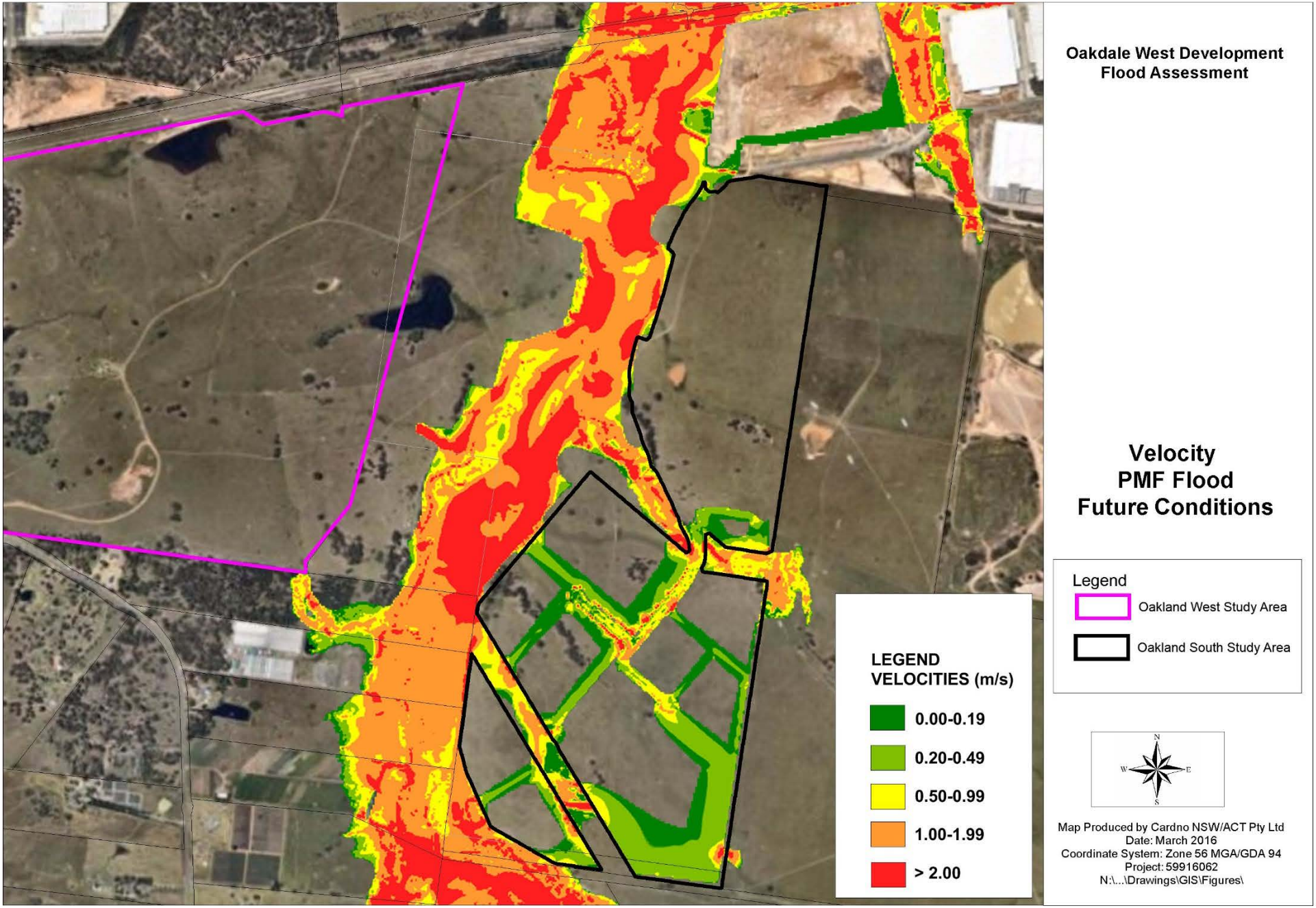


Figure 33 PMF Flood Extents and Flood Levels - Future Conditions

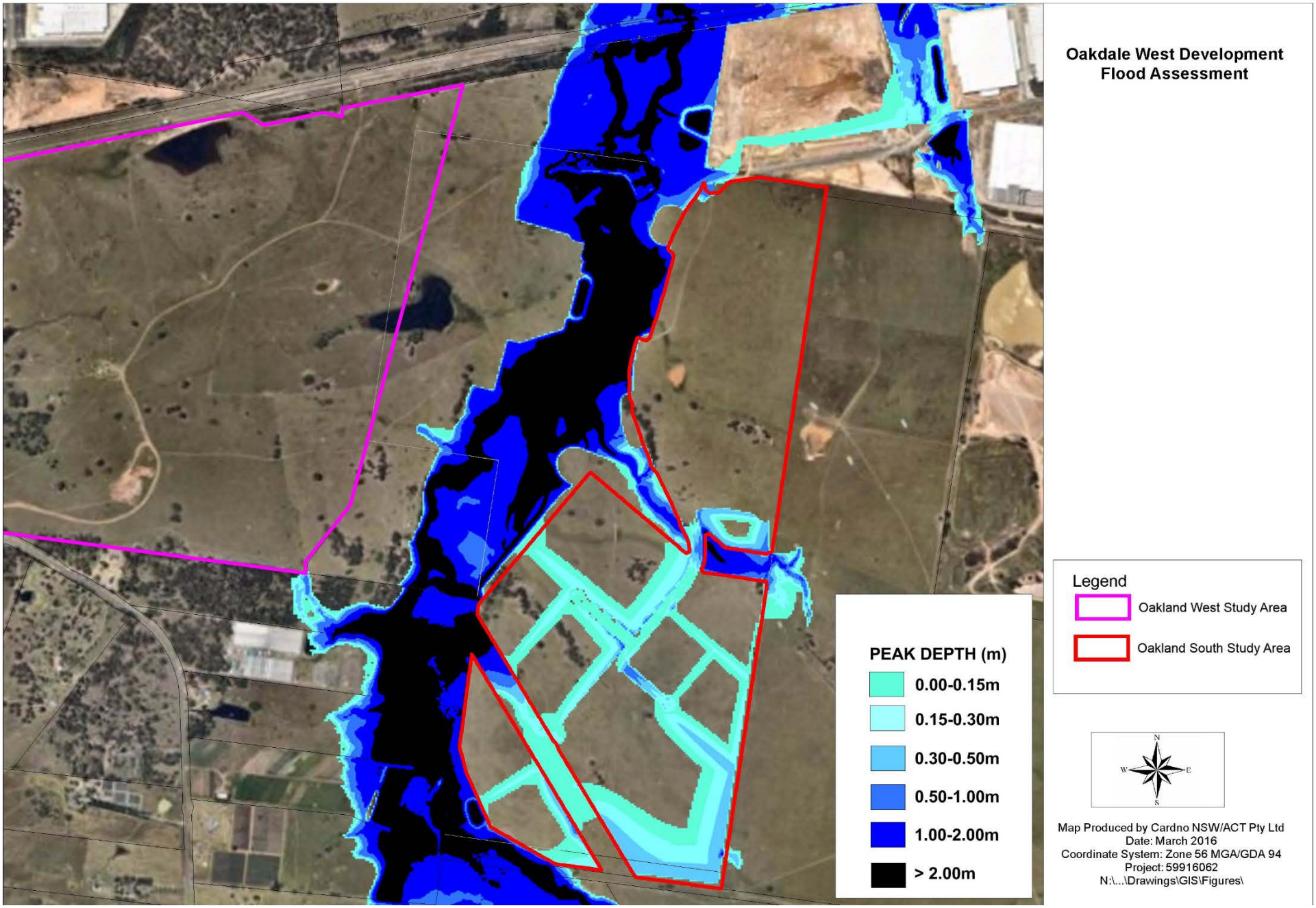


Figure 34 PMF Flood Depths - Future Conditions

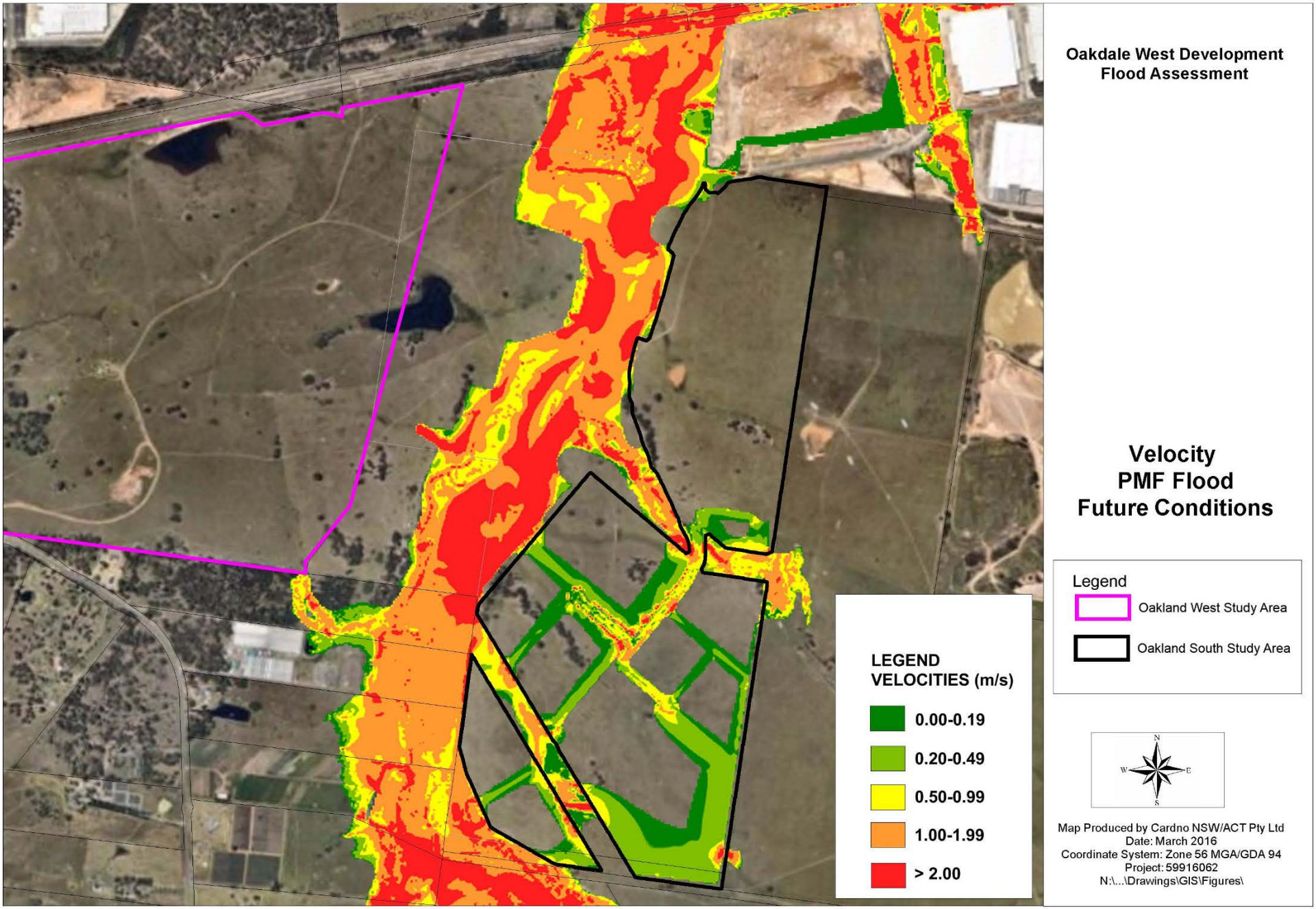


Figure 35 PMF Flood Velocities - Future Conditions

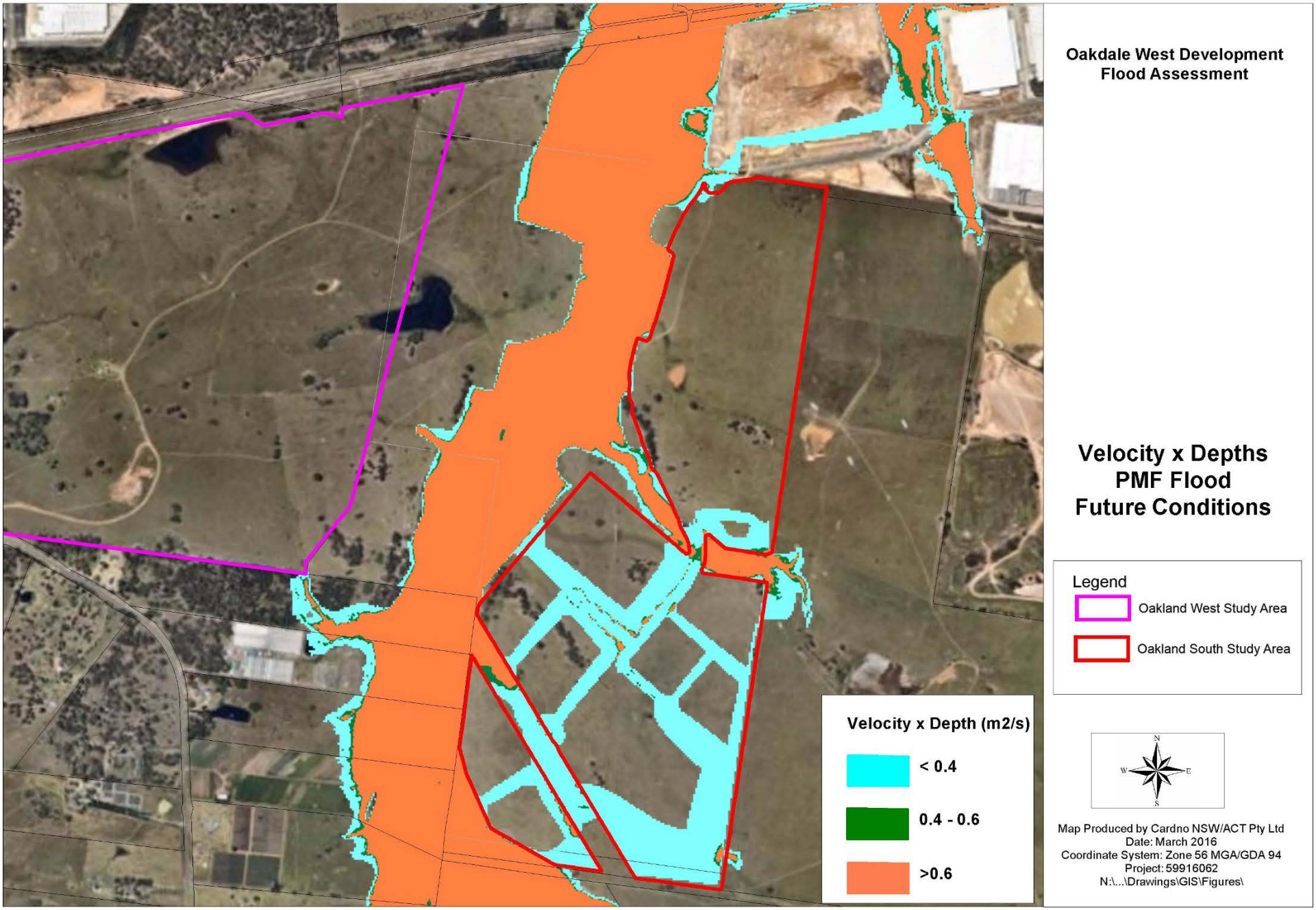


Figure 36 PMF Flood Velocity x Depth - Future Conditions

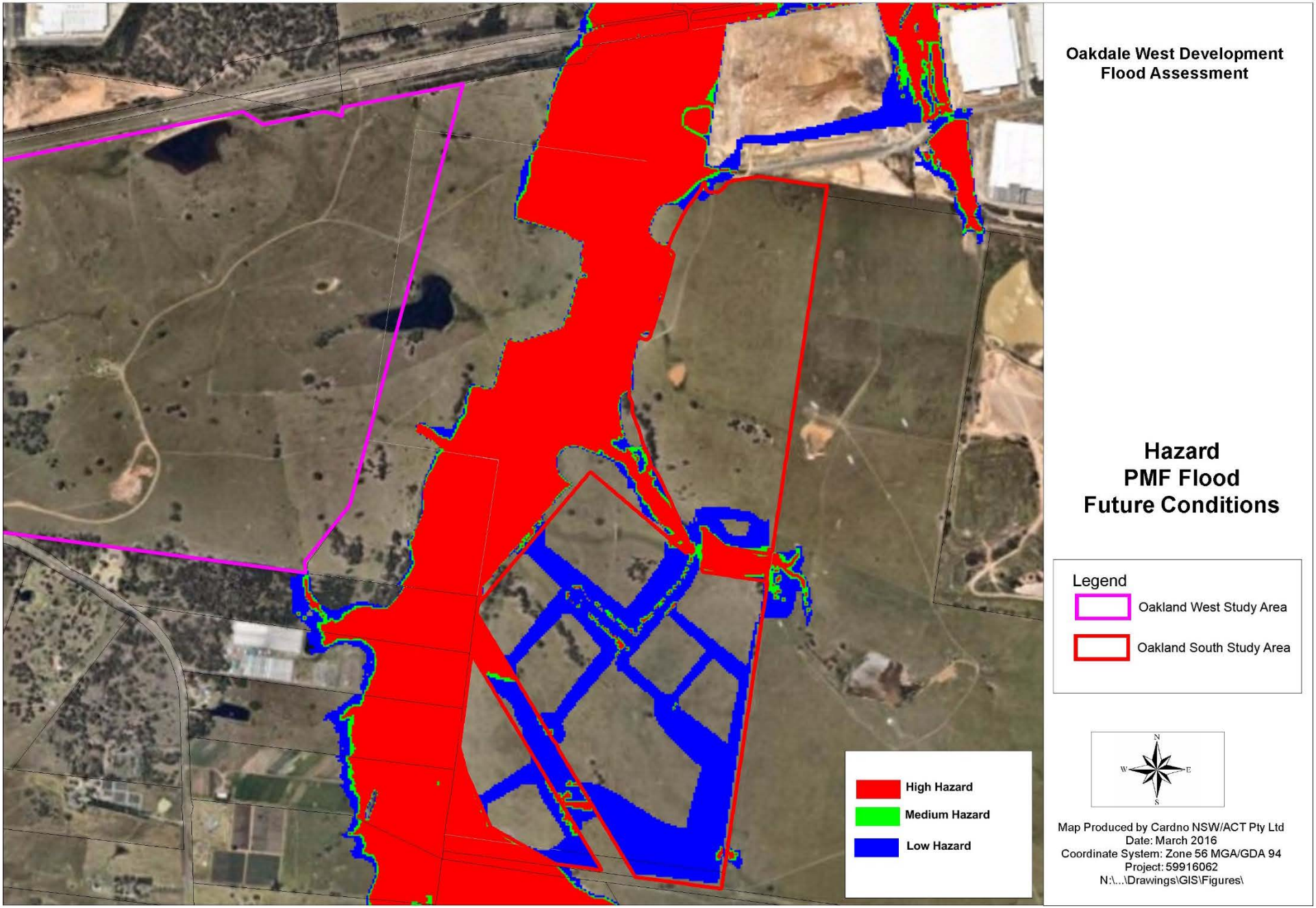


Figure 37 PMF Flood Hazards - Future Conditions

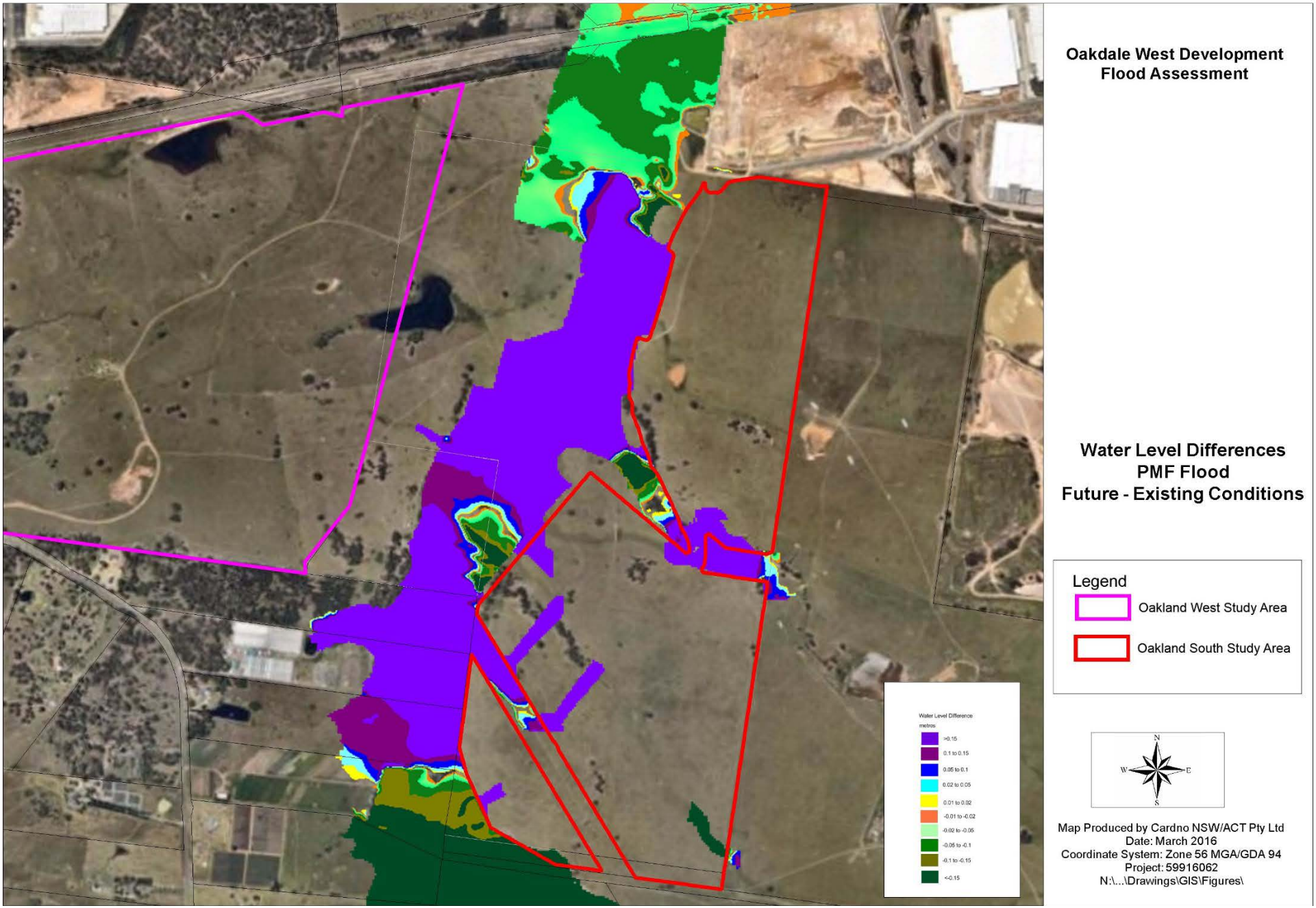


Figure 38 PMF Level Differences - (Future – Existing Conditions)

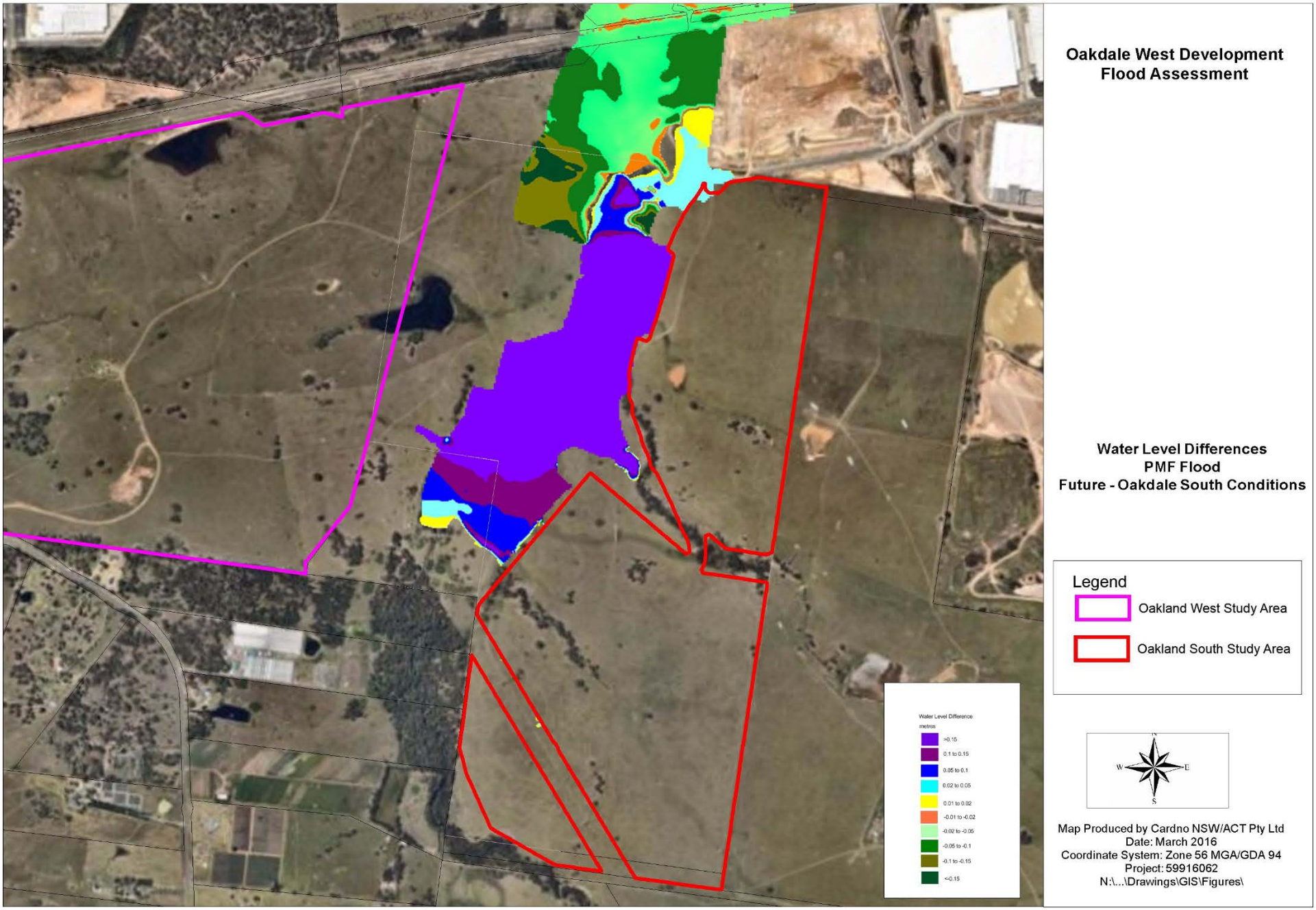


Figure 39 PMF Level Differences - (Future – Oakdale South Conditions)

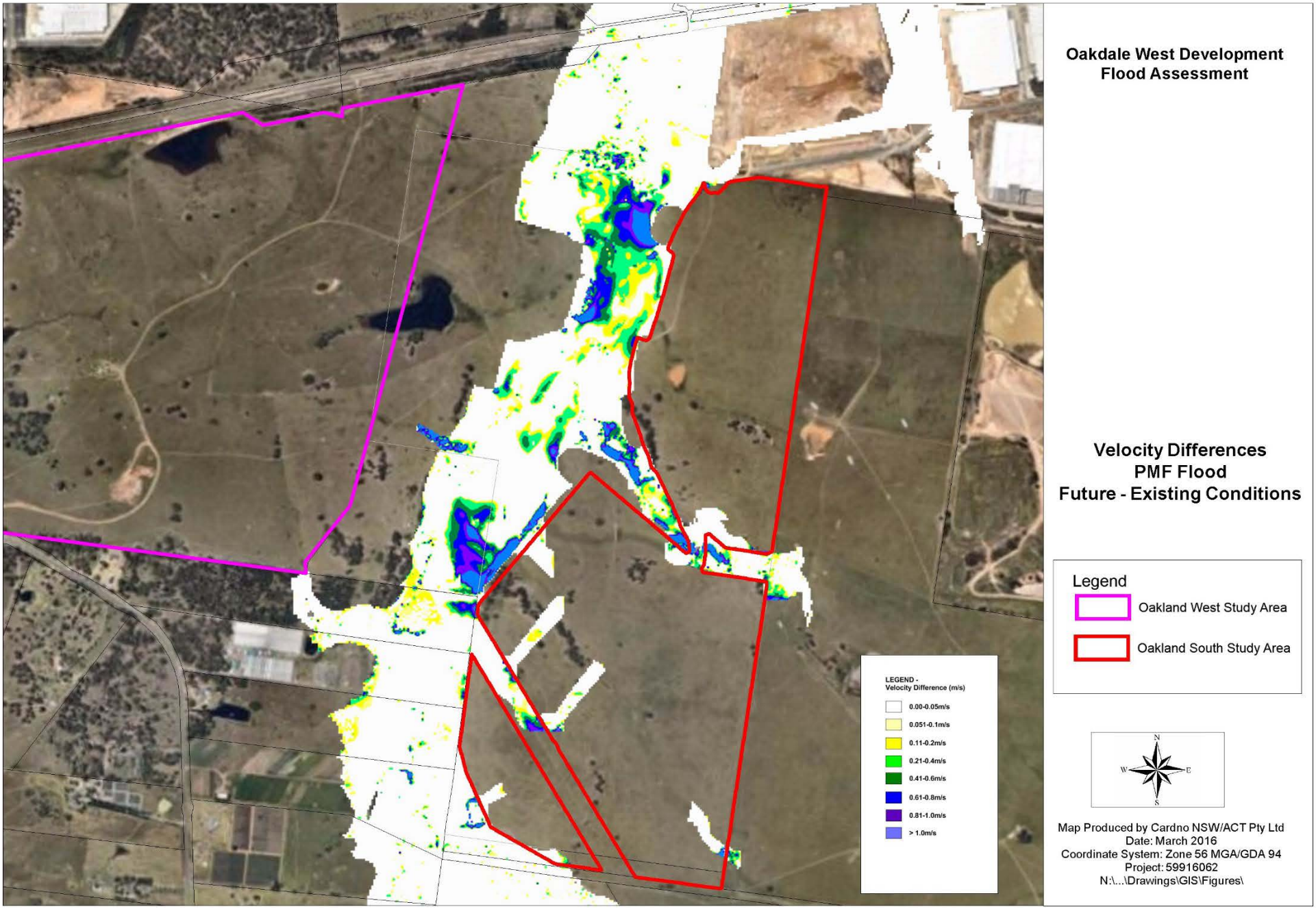


Figure 40 PMF Velocity Differences - (Future – Existing Conditions)

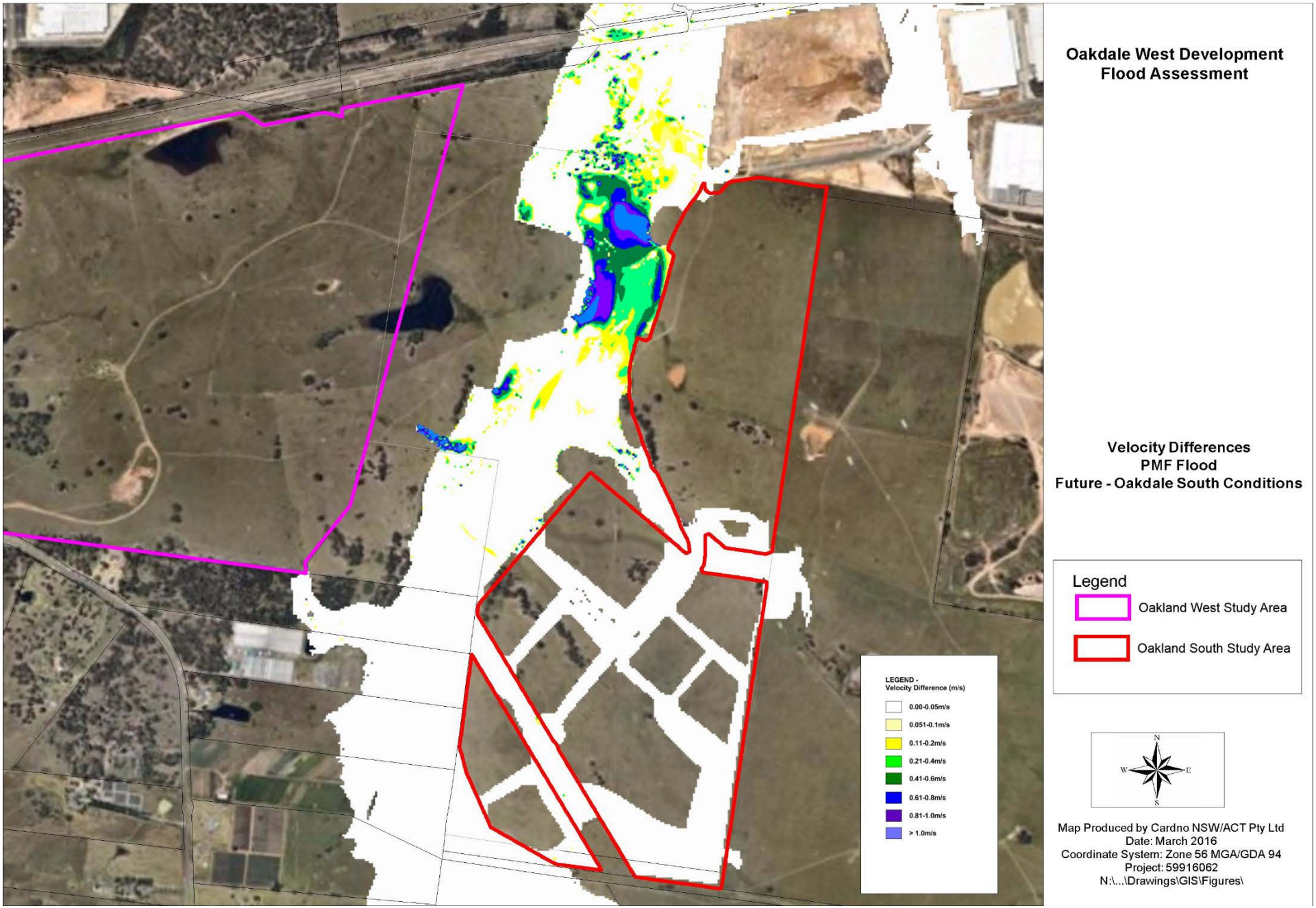


Figure 41 PMF Velocity Differences - (Future – Oakdale South Conditions)

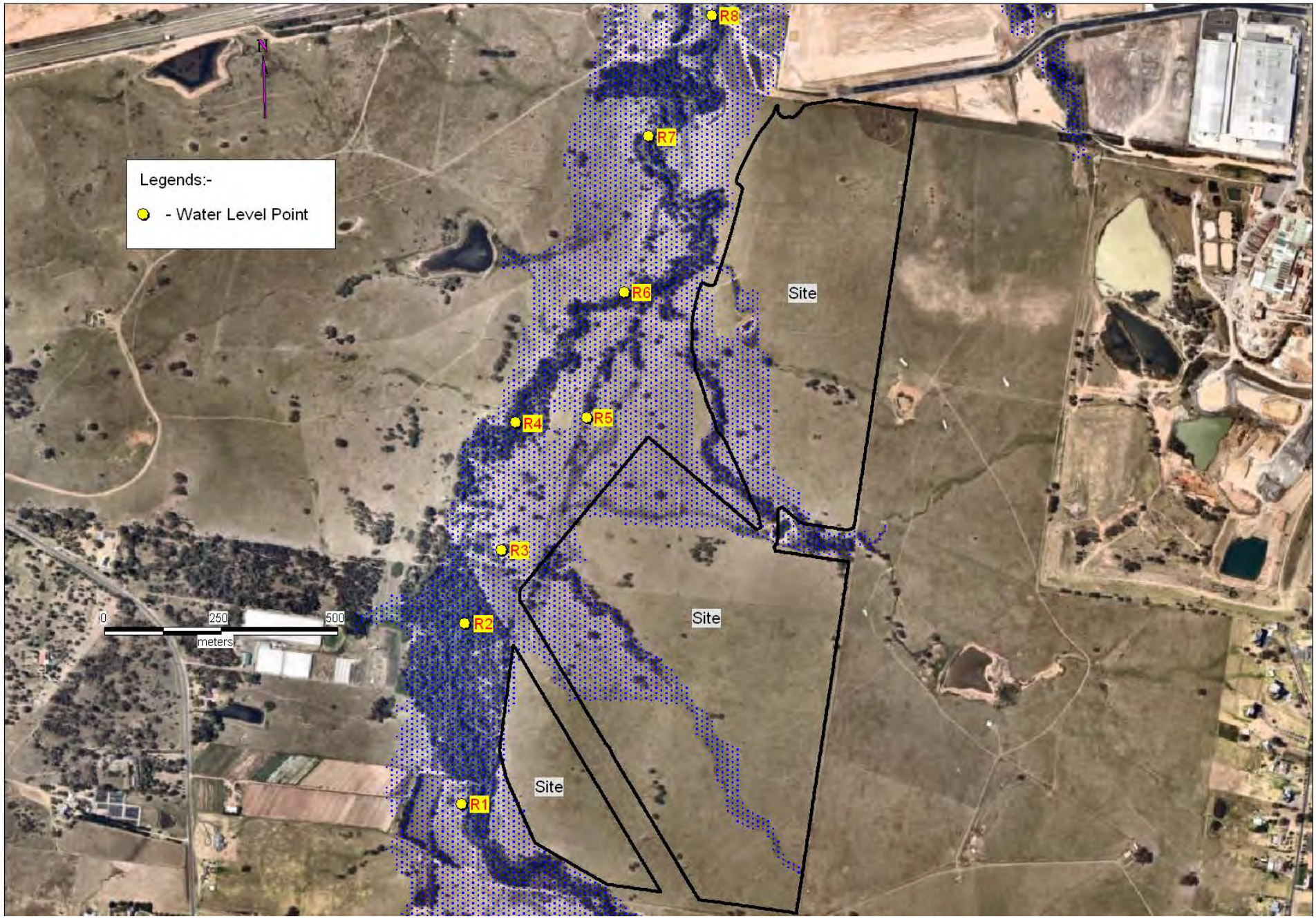


Figure 42 Reference Locations

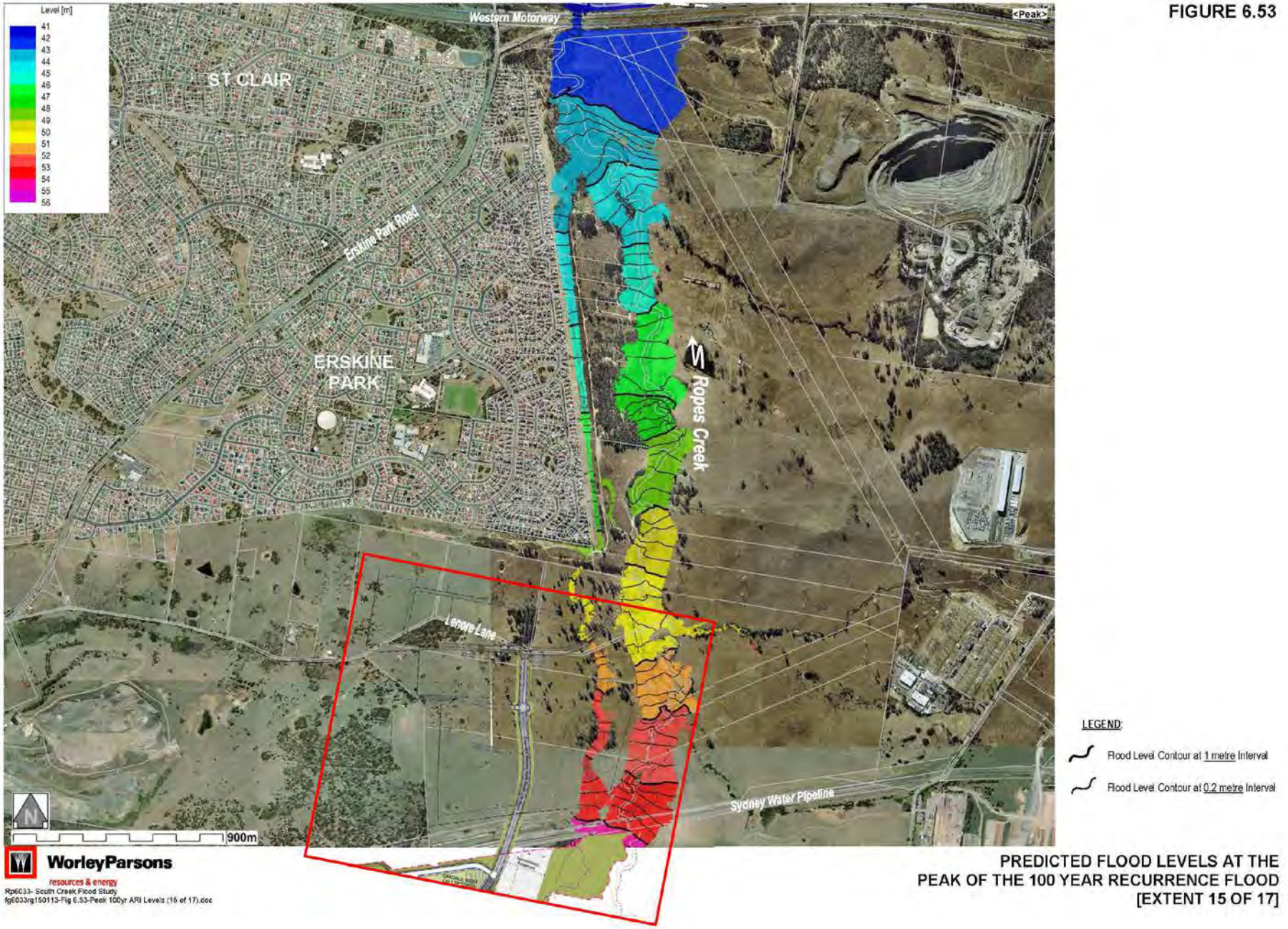


Figure 43 Overlay of WNSL Rd with 1% AEP Flood Extents from the 2015 Updated South Creek Flood Study prepared by Worley Parsons

Oakdale West Estate

APPENDIX B

ASSESSING THE IMPACT OF DEVELOPMENT CONTROLS ON DESIGN FLOWS

Cardno
Shaping the Future

B.1 Aim

For strategic planning purposes, the approach adopted by GHD when assessing Future Conditions was to assume that post-development flows would be the same as flows under Existing Conditions on the basis that retarding basins would be constructed to limit peak flows under post-development conditions to pre-development peak flows.

The accuracy of this approach was assessed by analysing a representative subcatchment in the upper Ropes Creek catchment (refer Subcatchment N5a in **Figure 4**).

B.2 Test Catchment Properties

The properties of the test catchment under Existing Conditions were:

Subcatchment area (ha)	27.81
Imperviousness	5%
Vector average slope	1.28%
Pervious area roughness	0.06
Impervious area roughness	0.025

The rainfall losses adopted by GHD were as follows:

Surface Type	Initial Loss (mm)	Continuing Loss (mm/h)
Pervious	15	2
Impervious	2.5	0

GHD adopted these losses for both 100 yr ARI and PMF assessments.

For the purposes of these assessments the same rainfall losses were adopted for the 100 yr ARI assessments. In the case of PMF assessments the following losses were adopted:

Surface Type	PMF Initial Loss (mm)	PMF Continuing Loss (mm/h)
Pervious	1	0
Impervious	1	0

The modelling approach was based on “split subcatchments”.

B.3 100 yr ARI Scenarios

Six 100 yr ARI scenarios were assessed as follows.

PreDevN5a Pre-development Conditions where the adopted imperviousness was 5%;

PDevN5a Post-development Conditions where the assumed the imperviousness is 80%;

PreDn5aAdj1 Pre-development Conditions where the pervious rainfall losses were area weighted losses under Post-development Conditions ie. initial loss = 5 mm and continuing loss = 0.4 mm/h;

PreDn5aAdj2 Pre-development Conditions where the adopted rainfall losses were area weighted losses under Post-development Conditions and the subcatchment was modelled as a lumped subcatchment with 0% imperviousness;

PDev+Bas Post-development Conditions with a basin with a volume required to contain 100 yr ARI runoff in the basin without overtopping. It was further assumed that the basin would be 1 m deep and that the rectangular slot outlet would be sized to give an outflow at 1 m depth which matches the target peak flow under Pre-development Conditions.

PDevN5aBX Post-development Conditions with the B values adjusted to approximate a basin that limits the peak outflow to the peak flow under Pre-development Conditions.

B.4 Results

The peak flows were assessed for each scenario for storm burst durations from 30 minutes to 9 hours. The estimated peak outflows are summarised in **Table B.1**.

Table B.1 Estimated Peak Flows (m^3/s)

Node	Storm Burst Duration (mins)									
	30	45	60	90	120	180	270	360	540	Max
PreDevN5a	1.09	1.40	1.66	2.06	2.25	2.28	2.22	2.35	2.52	2.52
PDevN5a	10.83	9.87	10.50	11.14	10.44	6.04	5.42	4.18	3.77	11.14
PreDn5aAdj1	1.52	1.92	2.25	2.56	2.71	2.65	2.57	2.74	2.66	2.74
PreDn5aAdj2	1.40	1.91	2.25	2.57	2.70	2.66	2.56	2.71	2.62	2.71
PDev+Bas	1.63	1.97	2.15	2.25	2.35	2.26	2.23	2.41	2.56	2.56
PDevN5aBX	1.42	1.89	2.22	2.43	2.54	2.42	2.29	2.45	2.28	2.54

Table B.2 Accuracy of Estimated Peak Flows (m^3/s)

Node	Storm Burst Duration (mins)									
	30	45	60	90	120	180	270	360	540	Max
PreDevN5a	*-33%*	*-29%*	*-23%*	*-9%*	*-4%*	*1.0%*	*-0.5%*	*-2.5%*	*-1.4%*	*-1.4%*
PDevN5a	*565%*	*401%*	*389%*	*395%*	*344%*	*167%*	*143%*	*74%*	*47%*	*335%*
PreDn5aAdj1	*-7%*	*-3%*	*4.9%*	*13.8%*	*15.3%*	*17%*	*15.2%*	*13.9%*	*3.8%*	*7.0%*
PreDn5aAdj2	*-14%*	*-3%*	*4.8%*	*14.3%*	*15.1%*	*18%*	*14.8%*	*12.8%*	*2.3%*	*6.0%*
PDevN5aBX	*-13%*	*-4%*	*3.4%*	*7.8%*	*8.2%*	*7.1%*	*2.9%*	*1.7%*	*-11%*	*-0.7%*

For assessment purposes the Post-Development Conditions with a basin were adopted as the benchmark when assessing the accuracy of any alternative approach. The differences between the estimated peak flows for each scenario against the benchmark peak flows are given in **Table B.2**.

It was found that the 9 hour storm burst is critical under Pre-development Conditions and the 90 minute storm burst is critical under Post-development Conditions. With a basin in place the critical storm burst duration is 9 hours.

Figure B.1 plots and compares hydrographs generated by the 2 hour and 9 hour storm bursts under the various scenarios.

It is concluded that in relation to 100 yr ARI flooding:

(i) Adopting Pre-Development Conditions as a surrogate for Post-Development Conditions with a basin would match the peak flow to within 2% in a 9 hour storm burst but would underestimate peak flows in shorter duration storm bursts less than 2 hours duration. It would also underestimate the overall volume of runoff;

(ii) Adopting Pre-Development Conditions and adjusting the rainfall loss rates improves the estimated volume of runoff and would also match the peak flow to within 4% in a 9 hour storm burst but would overestimate peak flows in shorter duration storm bursts around 2 hours duration by up to 15%;

(iii) The approach adopted to representing the catchment with areal weighted rainfall losses had little impact on the estimated peak flows;

(iv) Increasing the BX value as a surrogate for development with a basin could match the Pre-Development peak flow but in a 2 hour storm burst and would underestimate the peak flow in a 9 hour storm burst by around 11%.

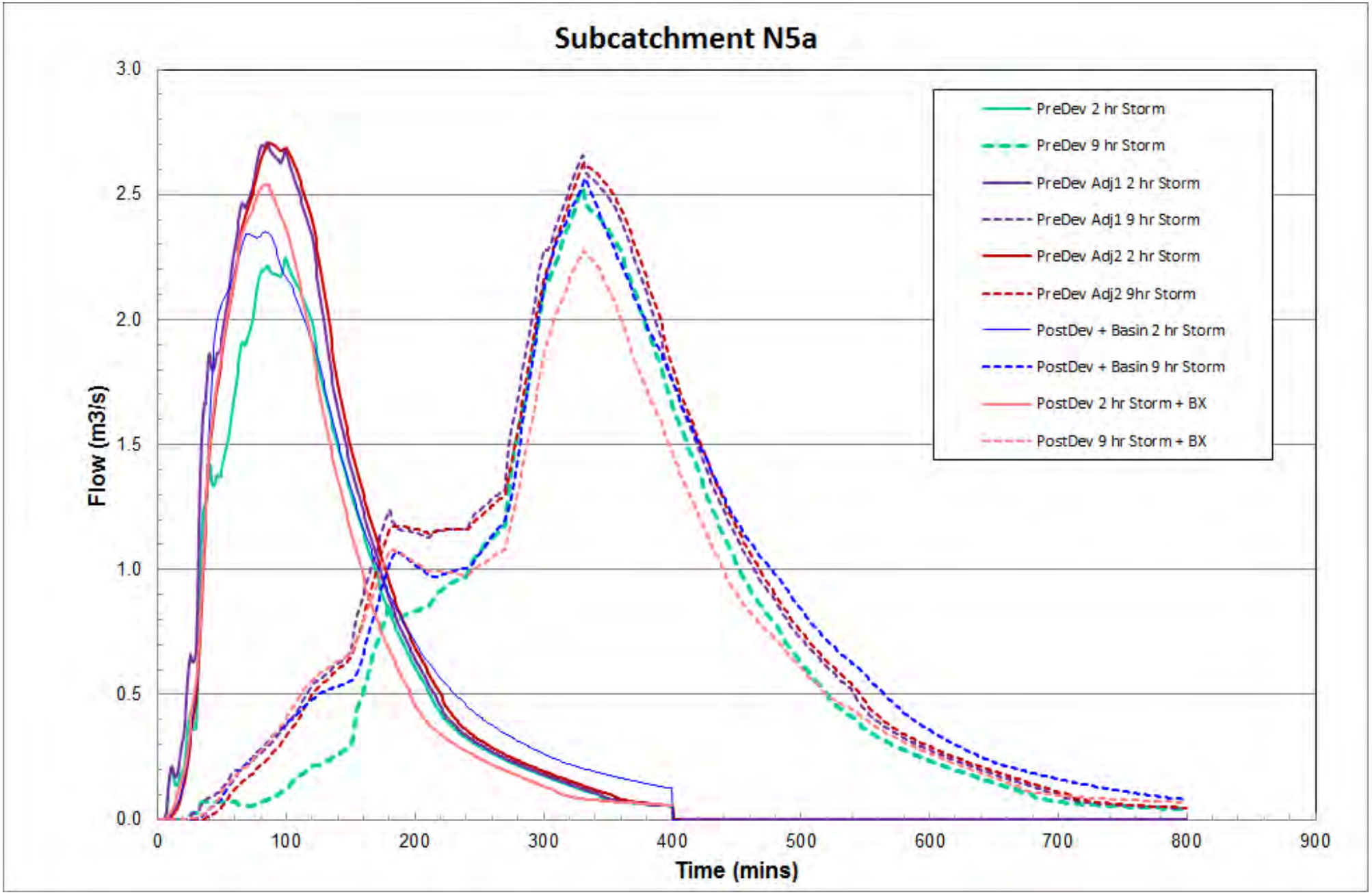


Figure B.1 Comparison of 1% AEP Outflow Hydrographs for Various Scenarios