Leichhardt Floodplain Risk Management Study and Plan

APPENDIX D

MITIGATION OPTION ASSESSMENTS SUB-CATCHMENT REPORTS - DRAFT

Cardno
Shaping the Future

Area 8 - White Bay Options Assessment

Leichhardt Flood Risk Management Study and Plan - DRAFT

NA49913094

Prepared for
Inner West Council

Cardno
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1 White Bay Catchment Description

The Whites Bay Catchment is approximately 120 hectares in size. The majority of the catchment is within Balmain. The two main flowpaths in this catchment discharge into Whites Bay. In both cases, properties have historically been constructed across the flowpaths resulting in significant obstruction to overland flows and associated ponding of water in streets and properties. In some cases, this obstruction to flow also results in an effective detention basin with a flood benefit to the properties downstream (as the obstruction from the properties slows and holds back the water, reducing the potential flooding downstream).

In the downstream portion of both of these flowpaths, flood levels are controlled by the culverts under Robert Street and the port at White Bay and the ability for flows to overtop the port area. In addition, a long section of the port is obstructed by a high level fence. The combination of these factors results in significant ponding of water in this location along Robert Street.

The location of the White Bay Catchment within the study area is shown in **Figure 1-1.**

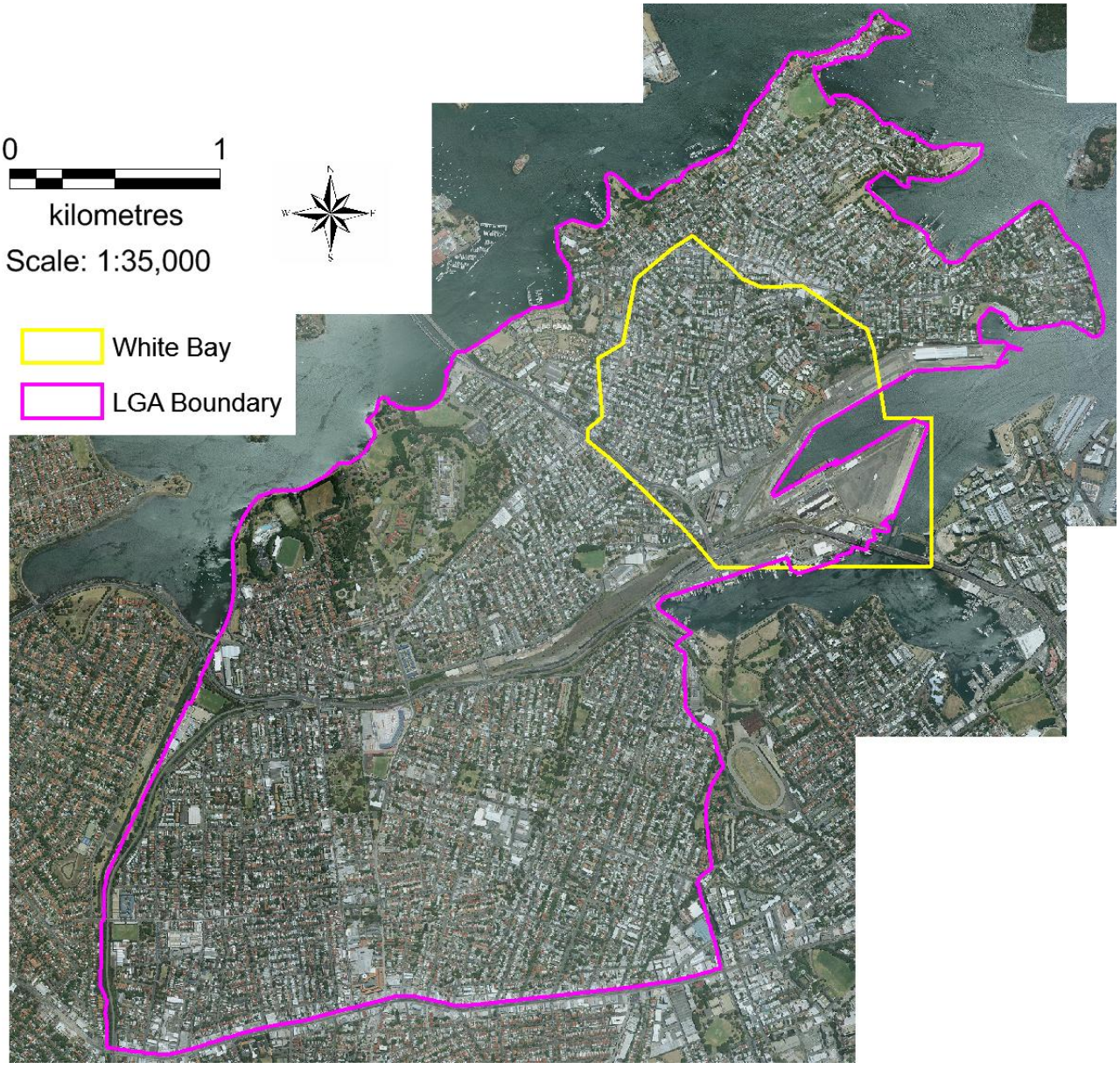

Figure 1-1 White Bay Catchment Location

2 Flood Mitigation Options Identification

2.1 Flood Modification Measures for White Bay

The existing flood behaviour within the Whites Bay is detailed in the Leichhardt Flood Study (Cardno 2014). Based on the flood model results, historical information and engineering judgement, possible flood modification measures (i.e. structural measures) for the study area were identified.

The various management options were identified taking into consideration the:

- flood behaviour and flow in the 20 year ARI event;
- grade of pipe (upstream and downstream); and
- preliminary availability and location of easements.

It should also be noted that Sydney Water and RMS may also play a major role in regards to fund allocation for the options recommended. Sydney Water's approach to flood-related improvement works on its assets is that Sydney Water will work with Councils to deliver the works (typically on a 50:50 cost-sharing basis) and provided Sydney Water has funding available within its Flood Risk Program. It is assumed that RMS will provide all the funding for the transverse pipe sections across State roads. Currently no allocation of RMS funding has been assigned for infrastructure travelling longitudinally along State Roads.

2.2 White Bay Flood Mitigation Options

Within the White Bay catchment six (6) sets of options were modelled, these are shown in **Table 2-1** and **Figure 2-1.** The 100yr, 20yr and 5yr ARI peak water level difference plots for each mitigation option are attached at the end of this appendix report.

Table 2-1 White Bay Mitigation Options

Option Description	Option Name	ID
Beattie Street Branch – Proposing a new pipe network or duplication of existing pipe network. Starting from Llewellyn St to the outlet at White Bay. The trunk drainage starts from Roseberry St at the start and Robert St to the end. Then travelling East, parallel to Robert St and eventually draining into White Bay.	Beattie Street Branch WB-FM1	WB-FM1
Wortley Street Branch – Proposing additional pipes to be incorporated into the existing pipe network. Additions at Creek St, Wortley St, Foy St, Hyam St, Roseberry Place and eventually crossing Robert St to drain into White bay.	Wortley Street Branch WB-FM2	WB-FM2
Reynolds Street/(Wortley Street) Proposed Basin – Proposed basin in Punch park, situated next to Reynolds St.	Reynolds Street Proposed Basin WB-FM3	WB-FM3
Montague Street Branch and additional pipes – Proposing additional pipes from Montague St that connect into the existing network.	Montague Street Branch WB-FM4	WB-FM4
Booth Street Proposed Basin – at Gladstone park (Balmain Public School) next to Booth St.	Booth Street Proposed Basin WB-FM5	WB-FM5
Elliot Street Basin	Elliot Street Basin WB-FM6	WB-FM6

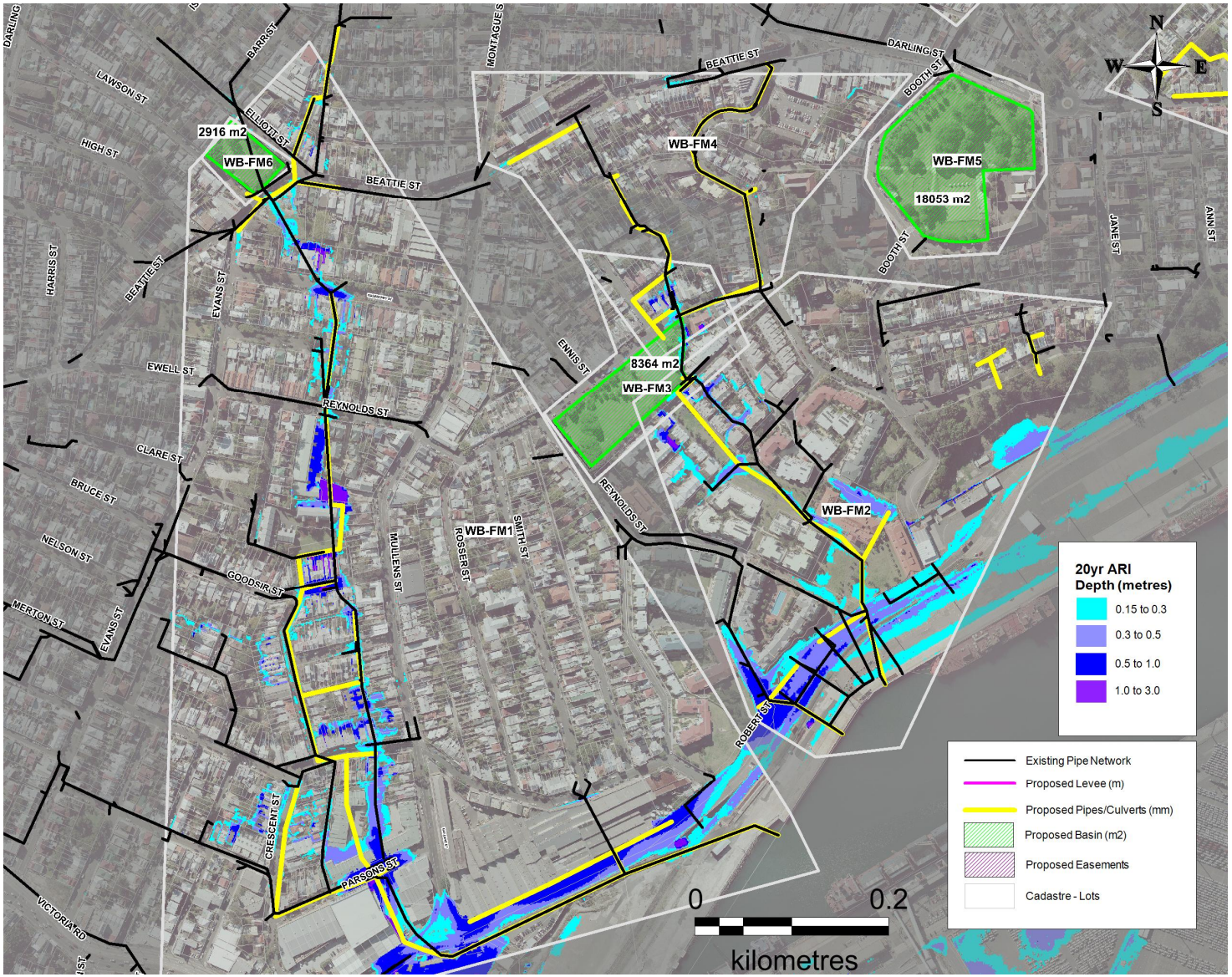

Figure 2-1 White Bay Mitigation Options Locations

2.2.1 Beattie Street Branch WB-FM1

The Beattie Street Branch proposes new pipes and duplication of the existing pipe network. WB-FM1 starts with a proposed 600mm diameter pipe north of the Beattie Street / Elliot Street intersection, with the proposed works culminating in a proposed 2.8m x 1.8m culvert draining to White Bay. The proposed branch which starts at Llewellyn Street includes proposed 600mm and 900mm diameter pipes, which join the existing Sydney Water 900mm diameter pipe in Evans Street. The main pipe branch of this option crosses Roseberry Street (1200mm diameter pipe), Reynolds Street (1500mm diameter pipe), Goodsir Street (1650mm diameter pipe), Perrett Street (1650mm diameter pipe), Mullens Street (1650mm diameter pipe), Mansfield Street (1650mm diameter pipe) and ending on Parsons Street (1650mm diameter pipe). Side branches (900mm, 1200mm, 1000mm diameter pipes) drain into the main branch at various locations between Beattie Street and Parson Street. On Parson Street the pipe drains onto a 2.8m x 1.8m box culvert located along Robert Street before eventually draining into White Bay.

Further additional drainage works are proposed from Hanover Street (450mm, 600mm and 900mm diameter pipes) to the existing main trunk drainage at Parsons Street.

Flooding is present under existing conditions in the area with depths reaching up to 2m as result of the 20 year ARI storm event.

Potential constraints for this measure include the buyback of two properties and costs due to construction, services and traffic management requirements on Robert Street.

Funding from Sydney Water (for the main trunk drainage) and RMS funding may be available for a majority of the cost. The RMS funding has been allocated towards the transverse pipe upgrade on Robert Street.

2.2.2 Wortley Street Branch WB-FM2

This option proposes additional pipes from Pashley Street to Roberts Street. The proposed drainage passes through Creek Street, Wortley Street, Foy Street, Hyam Street, Roseberry Place and eventually crossing Robert Street to drain into White Bay.

2.2.3 Reynolds Street Proposed Basin WB-FM3

WB-FM3 consists of a proposed basin with an area of 8,400 square meters. The basin is proposed in Punch Park, next to Reynolds Street. The basin is required to hold a volume of 2,300 cubic meters. The aim of the basin is to mitigate flood inundation around the area due to the 20 year ARI storm event. Depths under existing conditions can reach around 1.6m in the 20 year ARI storm event.

Potential constraints for this measure includes vegetation removal in Punch Park and changes to recreational use of Punch Park, depending on the configuration of the basin and if underground storage is adopted.

2.2.4 Palmer Street Branch WB-FM4

Additional 750mm pipes are proposed from Beattie Street, connecting at the downstream end to the existing pipe network at Wortley Street.

2.2.5 Booth Street Proposed Basin WB-FM5

The preliminary options modelling reviewed the potential for a basin located at Gladstone Park (Balmain Public School), near to Booth Street. However, preliminary results indicated that there were very little, if any reductions in flood levels as a result of the proposed basin. As such, this option has not been assessed further.

2.2.6 Elliot Street Basin WB-FM6

WB-FM6 is a detention basin that has been proposed to be located at Ann Cashman Reserve north-west of the Elliot Street/Beattie Street intersection. The basin has an area of 2916 square meters and is proposed to hold a volume of around 2500 cubic meters. The aim of the basin is to mitigate flood inundation around that specific block. Under existing conditions flood depths reach up to 1m due to the 20 year ARI storm event.

Potential constraints for this measure includes vegetation removal from the grounds and changes to recreational use of the grounds. The specific design of the basin configuration and / or the use of underground storage may mitigate some of these impacts.

3 Mitigation Option Modelling Outcomes

The Whites Bay flood mitigation options were assed for the 5, 10, 20, 50 and 100 Year ARI design flood events, along with the PMF event.

The outcomes of the modelling are shown in the 5, 20, and 100 Year ARI water level difference plots in **Appendix D**.

A summary of the impacts on flood behaviour for each option is provided below.

3.1 Beattie Street Branch WB-FM1

The proposed increase in drainage capacity of mitigation option WB-FM1 is shown to reduce overland flows for the majority of the Beattie Street flow path. The water level difference results show a decrease of 0.1m – 0.85m along the flow path in the 20 Year ARI event. The mitigation strategy particularly shows significant water level decreases on Beattie Street, Roseberry Street, Reynolds Street, Goodsir Street, Moore Street, Perrett Street, Pine Street, Mansfield Street, Parsons Street and Robert Street. Decreases in water levels up to 0.10m are also observed on Hanover Street, Murdoch Street, Collins Street and Crescent Street.

Modelling of this mitigation strategy indicates that many properties in this catchment would have a reduction in water levels in all events, with a number of properties no longer experiencing over floor flooding in both frequent and rare events.

3.2 Wortley Street Branch WB-FM2

Mitigation option WB-FM2 shows significant water level decreases along the Wortley Street Branch flowpath. The increase in drainage capacity at Roberts Street has significant reductions in flood levels (up to 0.70m in a 100 Year ARI event). Decreases in flood levels are also seen on Wortley Street, Foy Street, Hyam Street, Rosebery Place and Buchanan Street. The reductions in flood levels along the flowpath are in an order of 0.10m and 0.30m for all the modelled design flood events.

Over floor flooding is removed for up to 10 properties in most events assessed.

3.3 Reynolds Street Proposed Basin WB-FM3

The proposed detention basin option at Reynolds Street (WB-FM3) shows slight reductions in flood levels downstream of the basin. The reductions are in an order of 0.01m to 0.10m in a 5 Year ARI event.

3.4 Palmer Street Branch WB-FM4

Mitigation option WB-FM4 shows decreases in flood levels along the Palmer Street flowpath and the Little Street flowpath in all the modelled flood events. The reductions are in an order of 0.01m to 0.10m vicinity of the proposed option.

The option does not remove flooding entirely from the grounds of any properties, but may result in two properties no longer being affected by overfloor flooding in all events up to and including the 100 year ARI event.

3.5 Elliot Street Basin WB-FM6

The basin proposed at Elliot Street results in only minor decreases in flood levels and results in flood level increases of approximately 0.2m immediately downstream of the basin.

The minor flood level reductions are relatively widespread and so result in an overall flood damages reduction in the more frequent events, despite the increased damages locally to the basin. However, in the rarer events (50 Year ARI and greater) the increase in flood levels immediately downstream of the basin exceed the benefits further downstream and result in an overall increase in flood damages. Due to these increases in flood damages, this option has not been assessed with regards to its benefit costs ratio.

4 Economic Assessment of Flood Damages in the Whites Bay Catchment

4.1 Whites Bay Mitigation Options Damages Assessment

An assessment of damages for the existing condition in the White Bay Catchment is presented in the Floodplain Risk Management Study. The approach adopted for calculating the existing damages has been repeated for the modelling results from the mitigation options proposed for the White Bay catchment.

The economic flood damage results for each of the options and the existing scenarios are presented in **Table** 4-1 to **Table 4-5**. The reductions in properties affected by overground and overfloor flooding, total damages and AAD are provided. Negative values represent increases from the existing scenario.

The total reduction in damaged properties and the associated reduction in damage costs for each mitigation strategy is summarised in **Table 4-6**. This table represents a summary of differences between existing and Mitigation scenarios presented in **Table 4-1** to **Table 4-5.**

The flood damages assessment is a useful tool for comparing the merits of various options, it is not a precise flood risk analysis tool and the limitation associated with the assessment should be considered when interpreting the results.

The following information should be considered when interpreting the damages data:

- Negative property or dollar values represent increases from the existing scenario.
- Where an option results in a reduction in flood depths there may not be any reduction in the flood damages where:
    - The reduction in flood depths or extent occur in open space or roadways; or
    - The reduction in flood depths occurs on properties that were not impacted by over floor flooding (i.e. the flooding on the property grounds is shallower but still exists).
- The flood damages are calculated at a discrete location on each property. This location is where the floor level and ground level survey was obtained from. As such, if the flooding occurs at another location on the property other than the survey point, this property will not register any damages with regards to this damages assessment.
- Commercial and industrial damages are only incurred when over floor flooding exists.
- The reduction in the number of properties impacted as a result of an option may vary between different flood events due to the performance of the proposed work under the different flow behaviour of each flood event.

Table 4-1 WB_FM1 Flood Damage Assessment Summary

Event / Property type	Properties with Overfloor Flooding		Properties with Overground Flooding		Estimated Total Damage ($ June 2016)	
	Existing Case	*Mitigation Case*	*Existing Case*	*Mitigation Case*	*Existing Case*	*Mitigation Case*
PMF Event						
Residential	357	316	531	525	$ 22,742,301	$ 20,166,820
Commercial	2	2	7	7	$ 79,707	$ 79,733
Industrial	39	37	43	43	$ 9,367,993	$ 8,775,617
PMF Total	**398**	**355**	**581**	**575**	**$ 32,190,001**	**$ 29,022,170**
100yr ARI						
Residential	104	83	154	145	$ 5,595,125	$ 4,289,188
Commercial	0	0	0	0	$ -	$ -
Industrial	26	12	26	26	$ 5,076,109	$ 4,413,319
100yr ARI Total	**130**	**95**	**180**	**171**	**$ 10,671,235**	**$ 8,702,507**
50yr ARI						
Residential	96	80	150	142	$ 5,019,880	$ 4,095,138
Commercial	0	0	0	0	$ -	$ -
Industrial	24	9	26	26	$ 4,681,605	$ 4,077,309
50yr ARI Total	**120**	**89**	**176**	**168**	**$ 9,701,484**	**$ 8,172,447**
20yr ARI						
Residential	85	72	138	135	$ 4,396,833	$ 3,762,711
Commercial	0	0	0	0	$ -	$ -
Industrial	21	9	24	23	$ 4,429,241	$ 3,907,988
20yr ARI Total	**106**	**81**	**162**	**158**	**$ 8,826,073**	**$ 7,670,699**
10yr ARI						
Residential	77	65	123	121	$ 3,991,635	$ 3,241,294
Commercial	0	0	0	0	$ -	$ -
Industrial	18	9	23	10	$ 4,106,883	$ 2,085,534
10yr ARI Total	**95**	**74**	**146**	**131**	**$ 8,098,518**	**$ 5,326,828**
5yr ARI						
Residential	50	42	89	86	$ 2,826,076	$ 2,202,891
Commercial	0	0	0	0	$ -	$ -
Industrial	15	6	15	14	$ 2,650,756	$ 2,340,196
5yr ARI Total	**65**	**48**	**104**	**100**	**$ 5,476,832**	**$ 4,543,087**
Total Annual Average Damage					**$ 2,517,469**	**$ 2,010,523**

Table 4-2 WB_FM2 Flood Damage Assessment Summary

Event / Property type	Properties with Overfloor Flooding		Properties with Overground Flooding		Estimated Total Damage ($ June 2016)	
	Existing Case	*Mitigation Case*	*Existing Case*	*Mitigation Case*	*Existing Case*	*Mitigation Case*
PMF Event						
Residential	96	96	143	143	$ 10,160,824	$ 10,160,824
Commercial	1	1	3	3	$ 289,104	$ 289,104
Industrial	16	16	16	16	$ 7,461,065	$ 7,461,065
PMF Total	**113**	**113**	**162**	**162**	**$ 17,910,993**	**$ 17,910,993**
100yr ARI						
Residential	28	24	40	39	$ 2,233,888	$ 1,469,113
Commercial	0	0	0	0	$ -	$ -
Industrial	12	6	12	12	$ 3,244,299	$ 2,844,632
100yr ARI Total	**40**	**30**	**52**	**51**	**$ 5,478,187**	**$ 4,313,745**
50yr ARI						
Residential	26	22	40	39	$ 2,146,353	$ 1,397,231
Commercial	0	0	0	0	$ -	$ -
Industrial	11	4	12	12	$ 2,888,702	$ 2,505,333
50yr ARI Total	**37**	**26**	**52**	**51**	**$ 5,035,055**	**$ 3,902,564**
20yr ARI						
Residential	24	22	38	37	$ 1,920,098	$ 1,391,384
Commercial	0	0	0	0	$ -	$ -
Industrial	9	2	11	11	$ 2,470,792	$ 2,133,331
20yr ARI Total	**33**	**24**	**49**	**48**	**$ 4,390,890**	**$ 3,524,715**
10yr ARI						
Residential	21	19	34	33	$ 1,670,693	$ 1,144,833
Commercial	0	0	0	0	$ -	$ -
Industrial	9	2	10	9	$ 2,085,534	$ 1,797,925
10yr ARI Total	**30**	**21**	**44**	**42**	**$ 3,756,227**	**$ 2,942,758**
5yr ARI						
Residential	18	16	29	28	$ 1,445,713	$ 993,860
Commercial	0	0	0	0	$ -	$ -
Industrial	8	1	8	8	$ 272,794	$ 76,702
5yr ARI Total	**26**	**17**	**37**	**36**	**$ 1,718,507**	**$ 1,070,563**
Total Annual Average Damage					**$ 502,048**	**$ 500,033**

Table 4-3 WB_FM3 Flood Damage Assessment Summary

Event / Property type	Properties with Overfloor Flooding		Properties with Overground Flooding		Estimated Total Damage ($ June 2016)	
	Existing Case	*Mitigation Case*	*Existing Case*	*Mitigation Case*	*Existing Case*	*Mitigation Case*
PMF Event						
Residential	35	35	36	36	$ 5,395,415	$ 5,335,719
Commercial	1	1	1	1	$ 289,104	$ 289,131
Industrial	0	0	0	0	$ -	$ -
PMF Total	**36**	**36**	**37**	**37**	**$ 5,684,519**	**$ 5,624,849**
100yr ARI						
Residential	20	18	22	22	$ 1,464,784	$ 1,304,625
Commercial	0	0	0	0	$ -	$ -
Industrial	0	0	0	0	$ -	$ -
100yr ARI Total	**20**	**18**	**22**	**22**	**$ 1,464,784**	**$ 1,304,625**
50yr ARI						
Residential	19	17	21	21	$ 1,415,370	$ 1,249,483
Commercial	0	0	0	0	$ -	$ -
Industrial	0	0	0	0	$ -	$ -
50yr ARI Total	**19**	**17**	**21**	**21**	**$ 1,415,370**	**$ 1,249,483**
20yr ARI						
Residential	19	16	21	21	$ 1,261,857	$ 1,114,281
Commercial	0	0	0	0	$ -	$ -
Industrial	0	0	0	0	$ -	$ -
20yr ARI Total	**19**	**16**	**21**	**21**	**$ 1,261,857**	**$ 1,114,281**
10yr ARI						
Residential	16	14	19	19	$ 1,054,304	$ 899,479
Commercial	0	0	0	0	$ -	$ -
Industrial	0	0	0	0	$ -	$ -
10yr ARI Total	**16**	**14**	**19**	**19**	**$ 1,054,304**	**$ 899,479**
5yr ARI						
Residential	14	12	15	15	$ 882,709	$ 749,194
Commercial	0	0	0	0	$ -	$ -
Industrial	0	0	0	0	$ -	$ -
5yr ARI Total	**14**	**12**	**15**	**15**	**$ 882,709**	**$ 749,194**
Total Annual Average Damage					**$ 377,463**	**$ 328,028**

Table 4-4 WB_FM4 Flood Damage Assessment Summary

Event / Property type	Properties with Overfloor Flooding		Properties with Overground Flooding		Estimated Total Damage ($ June 2016)	
	Existing Case	*Mitigation Case*	*Existing Case*	*Mitigation Case*	*Existing Case*	*Mitigation Case*
PMF Event						
Residential	86	83	132	131	$ 6,177,358	$ 6,019,987
Commercial	1	1	4	4	$ 289,104	$ 288,353
Industrial	0	0	0	0	$ -	$ -
PMF Total	**87**	**84**	**136**	**135**	**$ 6,466,462**	**$ 6,308,340**
100yr ARI						
Residential	24	22	35	35	$ 1,569,261	$ 1,499,172
Commercial	0	0	0	0	$ -	$ -
Industrial	0	0	0	0	$ -	$ -
100yr ARI Total	**24**	**22**	**35**	**35**	**$ 1,569,261**	**$ 1,499,172**
50yr ARI						
Residential	23	22	35	35	$ 1,492,568	$ 1,435,410
Commercial	0	0	0	0	$ -	$ -
Industrial	0	0	0	0	$ -	$ -
50yr ARI Total	**23**	**22**	**36**	**36**	**$ 1,492,568**	**$ 1,435,410**
20yr ARI						
Residential	22	21	34	34	$ 1,423,753	$ 1,364,256
Commercial	0	0	0	0	$ -	$ -
Industrial	0	0	0	0	$ -	$ -
20yr ARI Total	**22**	**21**	**34**	**34**	**$ 1,423,753**	**$ 1,364,256**
10yr ARI						
Residential	20	19	30	30	$ 1,201,420	$ 1,147,428
Commercial	0	0	0	0	$ -	$ -
Industrial	0	0	0	0	$ -	$ -
10yr ARI Total	**20**	**19**	**30**	**30**	**$ 1,201,420**	**$ 1,147,428**
5yr ARI						
Residential	17	16	27	27	$ 1,021,235	$ 950,024
Commercial	0	0	0	0	$ -	$ -
Industrial	0	0	0	0	$ -	$ -
5yr ARI Total	**17**	**16**	**27**	**27**	**$ 1,021,235**	**$ 950,024**
Total Annual Average Damage					**$ 429,176**	**$ 405,870**

Table 4-5 WB_FM6 Flood Damage Assessment Summary

Event / Property type	Properties with Overfloor Flooding		Properties with Overground Flooding		Estimated Total Damage ($ June 2016)	
	Existing Case	*Mitigation Case*	*Existing Case*	*Mitigation Case*	*Existing Case*	*Mitigation Case*
PMF Event						
Residential	296	298	402	402	$ 17,585,743	$ 17,780,398
Commercial	0	0	0	0	$ -	$ -
Industrial	34	34	38	38	$ 3,347,421	$ 3,339,273
PMF Total	**330**	**332**	**440**	**440**	**$ 20,933,164**	**$ 21,119,672**
100yr ARI						
Residential	100	100	150	150	$ 4,983,405	$ 4,975,314
Commercial	0	0	0	0	$ -	$ -
Industrial	22	22	22	22	$ 2,439,372	$ 2,450,042
100yr ARI Total	**122**	**122**	**172**	**172**	**$ 7,422,777**	**$ 7,425,356**
50yr ARI						
Residential	92	93	146	146	$ 4,415,728	$ 4,436,709
Commercial	0	0	0	0	$ -	$ -
Industrial	20	19	22	22	$ 2,394,427	$ 2,385,119
50yr ARI Total	**112**	**112**	**168**	**168**	**$ 6,810,156**	**$ 6,821,827**
20yr ARI						
Residential	82	83	134	134	$ 3,839,152	$ 3,835,032
Commercial	0	0	0	0	$ -	$ -
Industrial	17	17	20	20	$ 2,323,403	$ 2,322,578
20yr ARI Total	**99**	**100**	**154**	**154**	**$ 6,162,555**	**$ 6,157,610**
10yr ARI						
Residential	74	74	119	119	$ 3,449,964	$ 3,445,416
Commercial	0	0	0	0	$ -	$ -
Industrial	14	14	19	19	$ 2,242,490	$ 2,239,377
10yr ARI Total	**88**	**88**	**138**	**138**	**$ 5,692,454**	**$ 5,684,793**
5yr ARI						
Residential	48	48	86	86	$ 2,348,242	$ 2,337,902
Commercial	0	0	0	0	$ -	$ -
Industrial	11	11	11	11	$ 983,743	$ 981,414
5yr ARI Total	**59**	**59**	**97**	**97**	**$ 3,331,985**	**$ 3,319,316**
Total Annual Average Damage					**$ 1,654,916**	**$ 1,652,801**

Table 4-6 Reduction in Damages Associated with Each Option

	Overfloor flooding properties reduction	Overground flooding properties reduction	Total Damage Reduction ($)	AAD Reduction ($)
WB-FM1				
PMF event	43	6	$3,167,831	$25,680
100yr ARI event	35	9	$1,968,728	$17,489
50yr ARI event	31	8	$1,529,038	$40,266
20yr ARI event	25	4	$1,155,375	$98,177
10yr ARI event	21	15	$2,771,690	$185,272
5yr ARI event	17	4	$ 933,745	$140,062
Total				**$506,945**
WB-FM2				
PMF event	0	0	$ -	$5,822
100yr ARI event	10	1	$1,164,442	$11,485
50yr ARI event	11	1	$1,132,491	$29,980
20yr ARI event	9	1	$ 866,175	$41,991
10yr ARI event	9	2	$ 813,469	$73,071
5yr ARI event	9	1	$ 647,944	$97,192
Total				**$259,540**
WB-FM3				
PMF event	0	0	$ 59,669	$1,099
100yr ARI event	2	0	$ 160,158	$1,630
50yr ARI event	2	0	$ 165,887	$4,702
20yr ARI event	3	0	$ 147,576	$7,560
10yr ARI event	2	0	$ 154,825	$14,417
5yr ARI event	2	0	$ 133,515	$20,027
Total				**$49,436**
WB-FM4				
PMF event	3	1	$ 158,122	$1,141
100yr ARI event	2	0	$ 70,088	$636
50yr ARI event	1	0	$ 57,158	$1,750
20yr ARI event	1	0	$ 59,497	$2,837
10yr ARI event	1	0	$ 53,992	$6,260
5yr ARI event	1	0	$ 71,211	$10,682
Total				**$23,306**
WB-FM6				
PMF event	-2	0	-$ 186,508	-$945
100yr ARI event	0	0	-$ 2,579	-$71
50yr ARI event	0	0	-$ 11,672	-$101
20yr ARI event	-1	0	$ 4,944	$315
10yr ARI event	0	0	$ 7,661	$1,016
5yr ARI event	0	0	$ 12,669	$1,900
Total				**$2,114**

[1] A modelling instability produced unreliable results for the PMF design event for FM2. The results available, would suggest the flow behaviour would not be impacted significantly in the PMF as a result of this option.

4.2 Benefit to Cost Ratio of Options

The economic evaluation of each modelled measure was assessed by considering the reduction in the amount of flood damages incurred for the design events and by then comparing this value with the cost of implementing the measure.

Table 4-7 summarises the results of the economic assessment of each of the flood management options. The indicator adopted to rank these measures on economic merit is the benefit-cost ratio (B/C), which is based on the net present worth (NPW) of the benefits (reduction in AAD) and the costs (capital and ongoing), adopting a 7% discount rate and an implementation period of 50 years.

The benefit-cost ratio provides an insight into how the damage savings from a measure, relate to its cost of construction and maintenance:

- Where the benefit-cost is greater than 1 the economic benefits are greater than the cost of implementing the measure;
- Where the benefit-cost is less than 1 but greater than 0, there is still an economic benefit from implementing the measure but the cost of implementing the measure is greater than the economic benefit;
- Where the benefit-cost is equal to zero, there is no economic benefit from implementing the measure; and
- Where the benefit-cost is less than zero, there is a negative economic impact of implementing the measure.

Table 4-7 Summary of Economic Assessment of Flood Management Options

Option ID	Option Description	NPW of Reduction in AAD	NPW of Cost of Implementation	B/C Ratio	Economic Ranking
WB-FM1	**Beattie Street Branch** – Proposing a new pipe network or duplication of existing pipe network. Starting from Llewellyn St to the outlet at White Bay. The trunk drainage starts from Roseberry St at the start and Robert St to the end. Then travelling East, parallel to Robert St and eventually draining into White Bay.	$5,310,000	$ 26,063,000	0.20	3
WB-FM2	**Wortley Street Branch** – Proposing additional pipes to be incorporated into the existing pipe network. Additions at Creek St, Wortley St, Foy St, Hyam St, Roseberry Place and eventually crossing Robert St to drain into White bay.	$3,582,000	$ 8,675,000	0.41	1
WB-FM3	**Reynolds Street (Wortley Street) Proposed Basin** – Proposed basin in Punch park, situated next to Reynolds St.	$682,000	$ 1,728,000	0.39	2
WB-FM4	**Montague Street Branch and additional pipes** – Proposing additional pipes from Montague St that connect into the existing network.	$322,000	$ 2,190,000	0.15	4
WB-FM5	**Booth Street Proposed Basin** – at Gladstone park (Balmain Public School) next to Booth St.	*Not Feasible*			
WB-FM6	**Elliot Street Basin**	*Not Feasible*			

White Bay Mitigation Option Figures

Figure WB_FM1_5yr_WlDiff
Figure WB_FM1_20yr_WlDiff
Figure WB_FM1_100yr_WlDiff
Figure WB_FM2_5yr_WlDiff
Figure WB_FM2_20yr_WlDiff
Figure WB_FM2_100yr_WlDiff
Figure WB_FM3_5yr_WlDiff
Figure WB_FM3_20yr_WlDiff
Figure WB_FM3_100yr_WlDiff
Figure WB_FM4_5yr_WlDiff
Figure WB_FM4_20yr_WlDiff
Figure WB_FM4_100yr_WlDiff
Figure WB_FM6_5yr_WlDiff
Figure WB_FM6_20yr_WlDiff
Figure WB_FM6_100yr_WlDiff

Peak Water Level Difference
metres

- >0.5
- 0.2 to 0.5
- 0.1 to 0.2
- 0.01 to 0.1
- -0.01 to -0.1
- -0.1 to -0.2
- -0.2 to -0.5
- <-0.5

Existing Pipe Network

Proposed Pipe/Culvert Options

5yr Flood Extent

Cadastre - Lots

Properties no longer affected by over-floor flooding - 16

Properties no longer affected by garden flooding - 4

Properties with flood levels reduced by more than 15 cm - 34

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INNER WEST COUNCIL
LEICHHARDT FRMS&P
WB_FM1 5YR ARI WL DIFF
MITIGATION LESS EXISTING
FIG_A8_1

Date
10/2016

Size
A3

WB_FM1_5yr_WIDiff
Drawing Number

01
Revision

Peak Water Level Difference
metres

- >0.5
- 0.2 to 0.5
- 0.1 to 0.2
- 0.01 to 0.1
- -0.01 to -0.1
- -0.1 to -0.2
- -0.2 to -0.5
- <-0.5

Existing Pipe Network

Proposed Pipe/Culvert Options

20yr Flood Extent

Cadastre - Lots

Properties no longer affected by over-floor flooding - 26

Properties no longer affected by garden flooding - 4

Properties with flood levels reduced by more than 15 cm - 81

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WB_FM1 20YR ARI WL DIFF
MITIGATION LESS EXISTING
FIG_A8_2

Date
10/2016

Size
A3

WB_FM1_20yr_WIDiff
Drawing Number

01
Revision

Peak Water Level Difference
metres

- >0.5
- 0.2 to 0.5
- 0.1 to 0.2
- 0.01 to 0.1
- -0.01 to -0.1
- -0.1 to -0.2
- -0.2 to -0.5
- <-0.5

Existing Pipe Network

Proposed Pipe/Culvert Options

100yr Flood Extent

Cadastre - Lots

Properties no longer affected by over-floor flooding - 43

Properties no longer affected by garden flooding - 6

Properties with flood levels reduced by more than 15 cm - 112

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INNER WEST COUNCIL
LEICHHARDT FRMS&P
WB_FM1 100YR ARI WL DIFF
MITIGATION LESS EXISTING
FIG_A8_3

Date
10/2016

Size
A3

WB_FM1_100yr_WIDiff
Drawing Number

01
Revision

Peak Water Level Difference
metres

- >0.5
- 0.2 to 0.5
- 0.1 to 0.2
- 0.01 to 0.1
- -0.01 to -0.1
- -0.1 to -0.2
- -0.2 to -0.5
- <-0.5

BEATTIE ST
EVANS ST
EWELL ST
REYNOLDS ST
CLARE ST
BRUCE ST
NELSON ST
GOODSIR ST
MERTON ST
TIONAL ST
MULLENS ST
ROSSER ST
SMITH ST
ENNIS ST
REYNOLDS ST
BOOTH ST
JANE ST
ANN ST
STEPHEN ST
ROBERT ST
PARSONS ST
QUIRK ST

Properties no longer affected by over-floor flooding - 9

Properties no longer affected by garden flooding - 1

Properties with flood levels reduced by more than 15 cm - 9

- Existing Pipe Network
- Proposed Pipe/Culvert Options
- 5yr Flood Extent
- Cadastre - Lots

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WB_FM2 5YR ARI WL DIFF
MITIGATION LESS EXISTING
FIG_A8_4

Date
10/2016

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WB_FM2_5yr_WIDiff
Drawing Number

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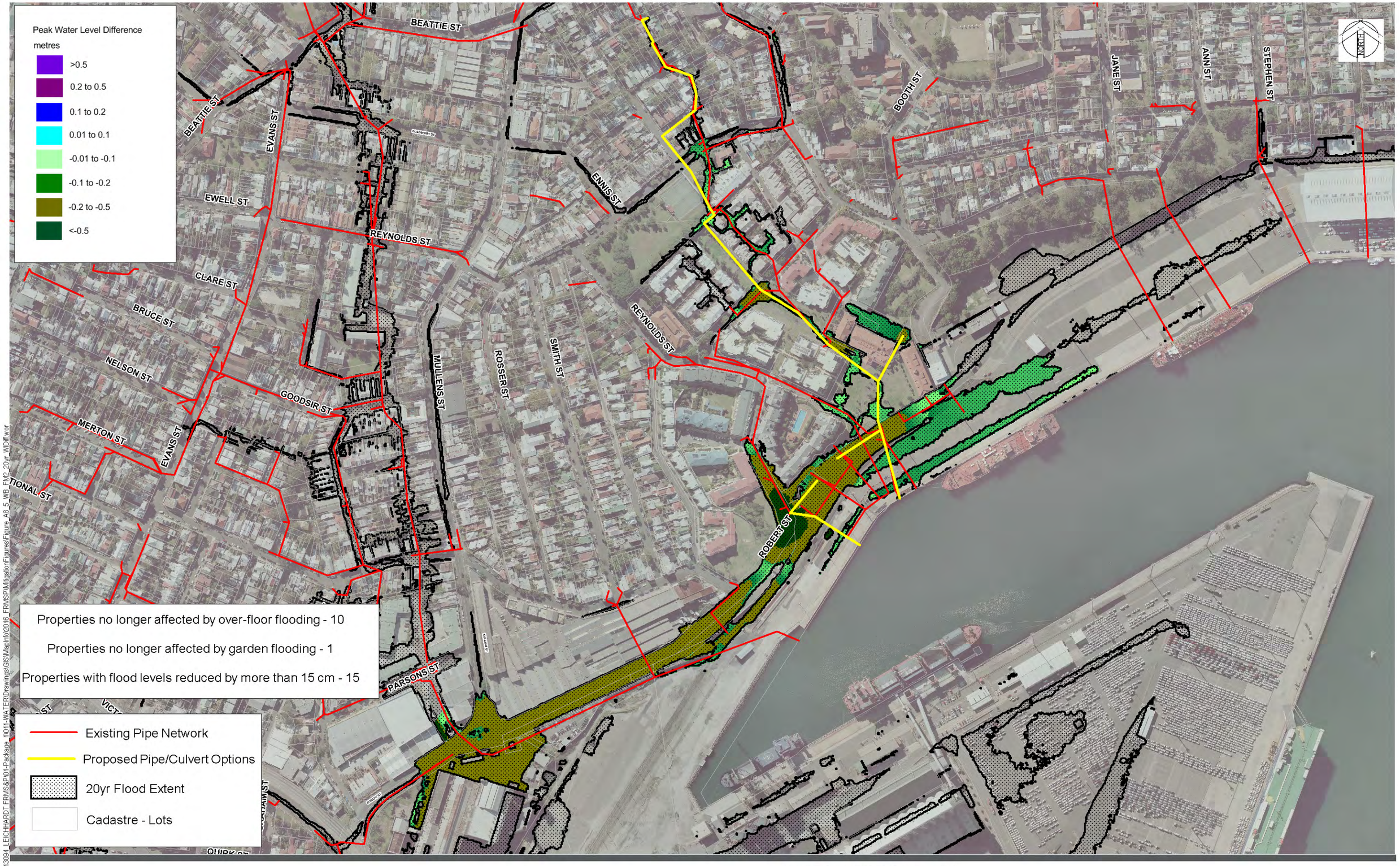
Revision



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MITIGATION LESS EXISTING
FIG_A8_5

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WB_FM2 100YR ARI WL DIFF
MITIGATION LESS EXISTING
FIG_A8_6

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WB_FM3 5YR ARI WL DIFF
MITIGATION LESS EXISTING
FIG_A8_7

Date
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Size
A3

WB_FM3_5yr_WIDiff
Drawing Number

01
Revision

Peak Water Level Difference
metres

- >0.5
- 0.2 to 0.5
- 0.1 to 0.2
- 0.01 to 0.1
- -0.01 to -0.1
- -0.1 to -0.2
- -0.2 to -0.5
- <-0.5

ENNIS ST

8364 m2

REYNOLDS ST

SM

NORTH

Properties no longer affected by over-floor flooding - 3

Properties no longer affected by garden flooding - 0

Properties with flood levels reduced by more than 15 cm - 11

- Existing Pipe Network
- Proposed Basin
- 20yr Flood Extent
- Cadastre - Lots

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LEICHHARDT FRMS&P
WB_FM3 20YR ARI WL DIFF MITIGATION LESS EXISTING
FIG_A8_8

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Size
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WB_FM3_20yr_WIDiff
Drawing Number

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Revision

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WB_FM3 100YR ARI WL DIFF
MITIGATION LESS EXISTING
FIG_A8_9

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WB_FM4 5YR ARI WL DIFF
MITIGATION LESS EXISTING
FIG_A8_10

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WB_FM4_5yr_WIDiff
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FIG_A8_11

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MITIGATION LESS EXISTING
FIG_A8_12

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WB_FM4_100yr_WIDiff
Drawing Number

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Revision

Peak Water Level Difference
metres

- >0.5
- 0.2 to 0.5
- 0.1 to 0.2
- 0.01 to 0.1
- -0.01 to -0.1
- -0.1 to -0.2
- -0.2 to -0.5
- <-0.5

ST

DARLING ST

BOOTH ST

18053 m2

BOOTH ST

JANE ST

ANN ST

NORTH

Properties no longer affected by over-floor flooding - 0

Properties no longer affected by garden flooding - 0

Properties with flood levels reduced by more than 15 cm - 0

- Existing Pipe Network
- Proposed Basin
- 5yr Flood Extent
- Cadastre - Lots

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WB_FM5 5YR ARI WL DIFF
MITIGATION LESS EXISTING
FIG_A8_13

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WB_FM5 20YR ARI WL DIFF
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FIG_A8_14

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FIG_A8_15

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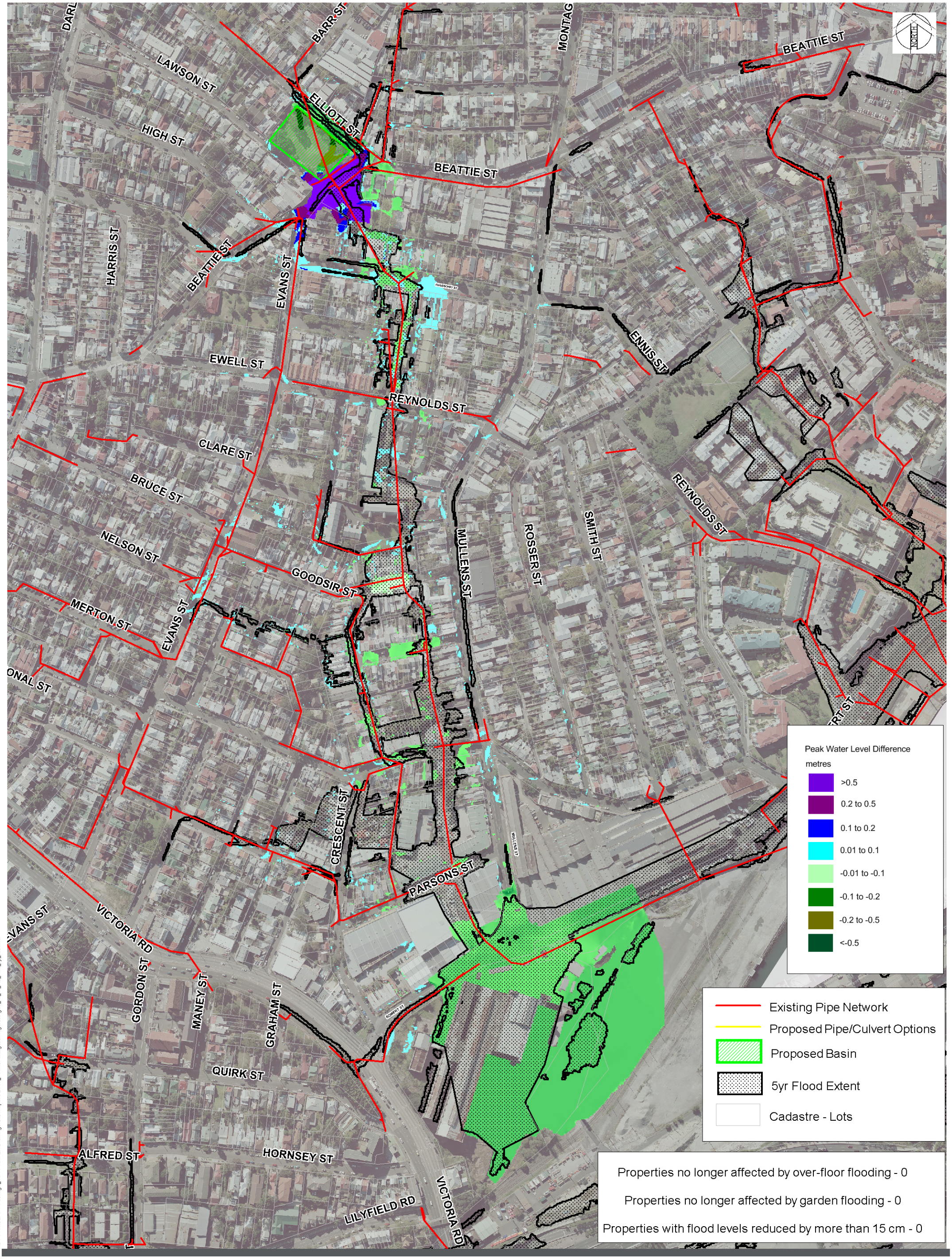

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MITIGATION LESS EXISTING
FIG_A8_16

Date
03/2017

Size
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WB_FM6_5yr_WIDiff
Drawing Number

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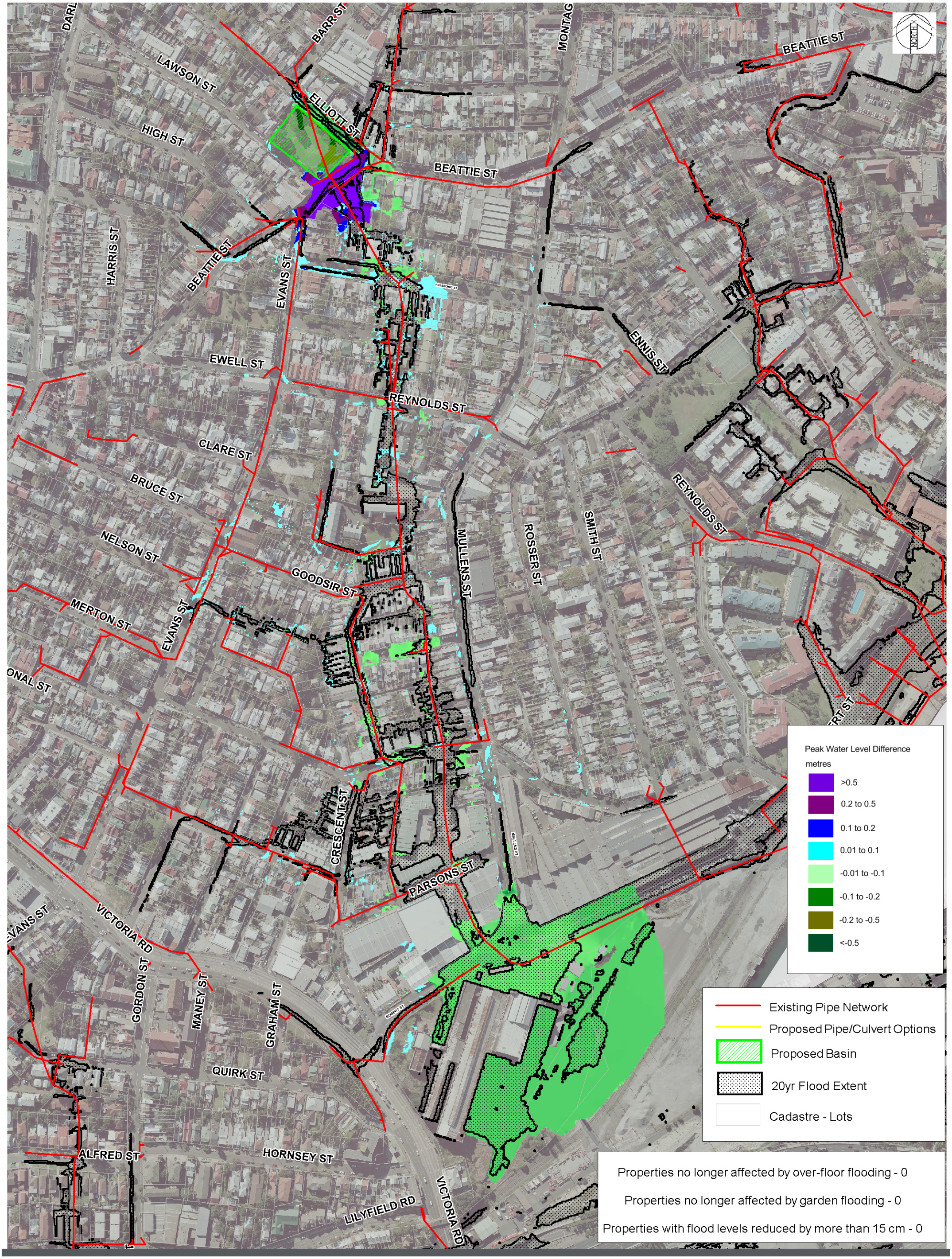
Revision



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WB_FM6 20YR ARI WL DIFF
MITIGATION LESS EXISTING
FIG_A8_17

Date
03/2017

Size
A3

WB_FM6_20yr_WIDiff
Drawing Number

03
Revision

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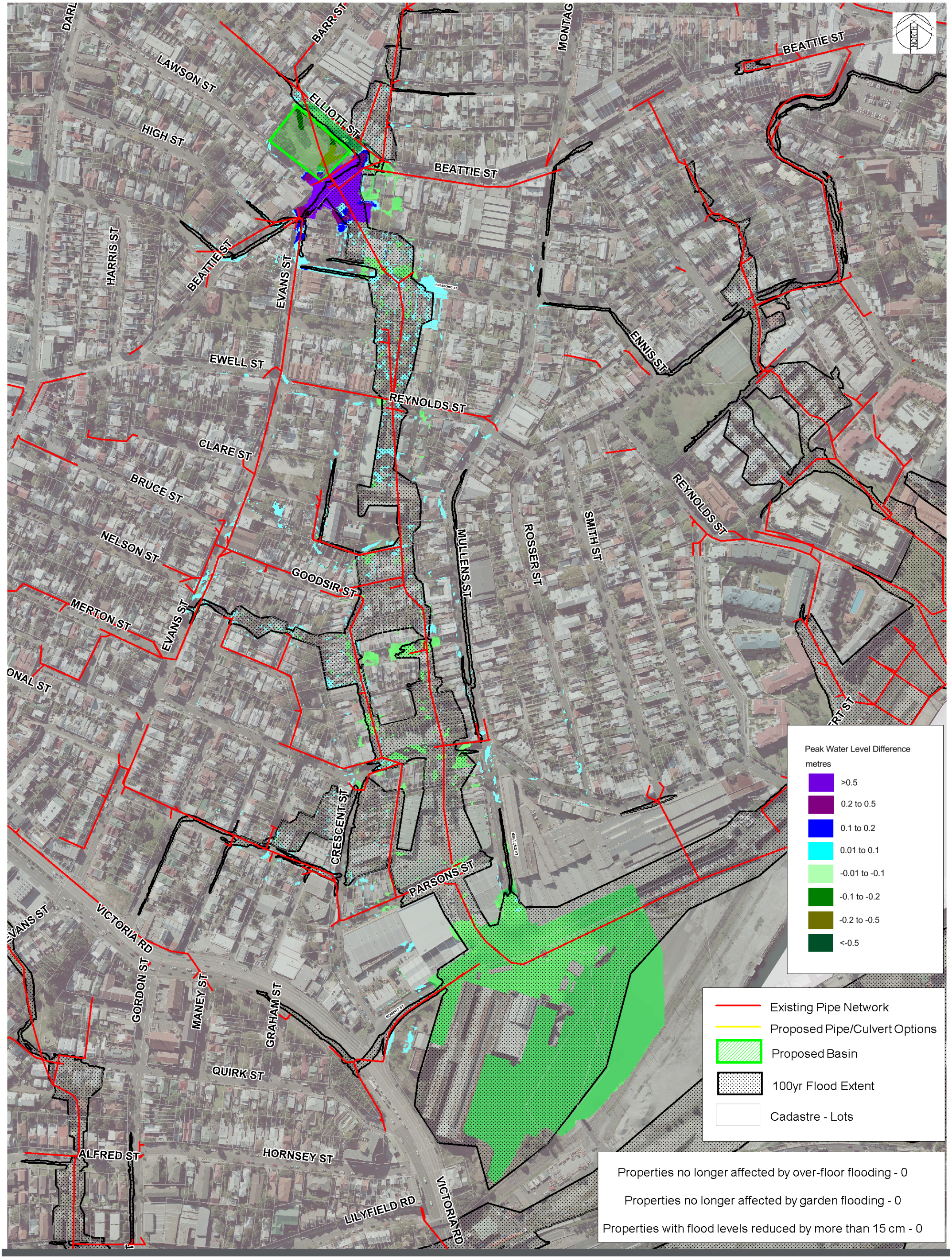

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FIG_A8_18

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Size
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WB_FM6_100yr_WlDiff
Drawing Number

03
Revision