

6 FLOOD DAMAGES ASSESSMENT

Flood damage assessment is an important component of any floodplain management framework. This type of analysis enables the floodplain manager to gain an understanding of the magnitude of assets under threat from flooding. The method adopted for the study is ANUFLOOD, which is described in more detail in the following sections. The damages assessment has been undertaken for properties identified by the CoGG as being “at risk” of flooding.

6.1 Methodology

The basic procedure for calculating the monetary flood damages is provided below.

- Identify the areas inundated and the depth of inundation for the range of design flood events (1%, 5% and 20% AEP) modelled using the TUFLOW hydraulic model.
- Determine the damages due to a particular flood event using the assumed floor levels of properties that are flood-affected.
- Calculate the depth of above floor flooding within each property for each AEP event.
- Prepare stage-damage relationships for residential and commercial properties. These relationships will account for such factors as the relative degree of flood preparedness of the community.
- Produce total flood damages for the range of flood events for both residential and commercial/industrial properties.
- Sum damages for all properties for each AEP event and present the results in a probability-damage graph.
- Assume indirect damages are 30% of direct damages as recommended in the RAM (Rapid Appraisal Method) report (NRE, 2000).
- Determine the average annual damages (AAD).

6.1.1 Stage-Damage Curves

ANUFLOOD residential stage-damage curves were used for this flood damage assessment. These curves were sourced from NRE (2000). The non-residential stage-damage curves, also ANUFLOOD curves, were sourced from a journal paper by Smith (1994) “Flood Damage Estimation – A review of urban stage-damage curves and loss functions”. The curves have all been indexed to the 1st Quarter 2010 units using appropriate CPI factors sourced from Bureau of Statistics.

ANUFLOOD has 15 non-residential stage-damage curves. For each building size (small, medium and large), there are 5 curves representing 5 value classes. Because the existing building floor level information did not include data on the type, size or condition of each of the buildings considered, the size and condition of each residential building was assumed to be medium and average respectively.

The RAM report suggests that the ANUFLOOD curves underestimate flood damages. To address this issue, increases of 60% have been applied to both the residential and non-residential curves, as recommended in the RAM.

Ratios to convert Potential damages to Actual damages were used as per the recommendations from the RAM. That is, for an inexperienced community with less than 2 hours warning time, a factor (ratio) of 0.9 is used to reduce the potential damages to actual damages. Flood damages were calculated for the 1%, 5% and 20% AEP design flood events.

6.1.2 Damages Outside Buildings

Damages to equipment outside the building are not included in the standard stage-damage curves used. Such damages may include damage to fences, driveways, lower level laundries and outdoor equipment. To account for this, an estimate of “ground equipment damages” was made as a function of ground level inundation. That is, assume a sliding scale from \$0 to \$1000 with \$1000 being the maximum. The full \$1000 damage is experienced once the flood level has reached the floor level of the building. The sliding scale works on the difference between the ground level and the floor level (eg a ground level of 1m, floor level of 2m, flood level of 1.5m receives ground equipment damages of \$500).

Other damages, such as the loss of plants, lawn and landscaping, are difficult to quantify and are therefore considered in the non-economic assessment.

6.1.3 Damages Calculations

The peak 1%, 5% and 20% AEP depth of flooding was determined at each property for which floor levels were available and the associated flood damages extracted from the stage-damage relationships. Total damages for each flood event were determined by summing the predicted damages for each individual dwelling. The AAD was then calculated.

The AAD is the average damage in dollars per year that would occur in a designated area from flooding over a long period of time. In many years there may be no flood damage, in some years there will be minor damage (caused by small, relatively frequent floods) and, in a few years, there will be major flood damage (caused by large, rare flood events). Estimation of the AAD provides a basis for comparing the effectiveness of different management measures (i.e. the reduction in the AAD). The AAD is the area under the probability-damage graph. Ideally the probable maximum flood damages are included in the AAD analysis, and it is also necessary to assume a flood AEP in which no damages occur. As no flood larger than the 1% AEP event was modelled, the probability-damages graph was extrapolated, and it was assumed that no damages would occur in the 50% AEP event.

6.2 Existing Conditions Flood Damages

The total existing conditions damages for each design flood event are presented in Table 6-1. They are also illustrated in Figure 6-1. The existing conditions AAD for the Kosciusko Avenue MD study area, as presented in Table 6-1, is \$40,000.

Table 6-1 Existing Conditions Damages Summary

Event		Existing Case			
(Years ARI)	AEP	House Damages	Indirect Damages	Total Damages	Incremental Average Annual Damages
PMF ⁺	0.0%			\$ 397,000	
100	1%	\$ 268,000	\$ 80,000	\$ 348,000	\$ 4,000
20	5%	\$ 117,000	\$ 35,000	\$ 152,000	\$ 10,000
5	20%	\$ 51,000	\$ 15,000	\$ 67,000	\$ 16,000
2	50%	\$ -	\$ -	\$ -	\$ 10,000
Average Annual Damage					\$ 40,000

* Note – PMF damages are an extrapolation of the 1% AEP data, ie, they were not calculated using PMF flood levels

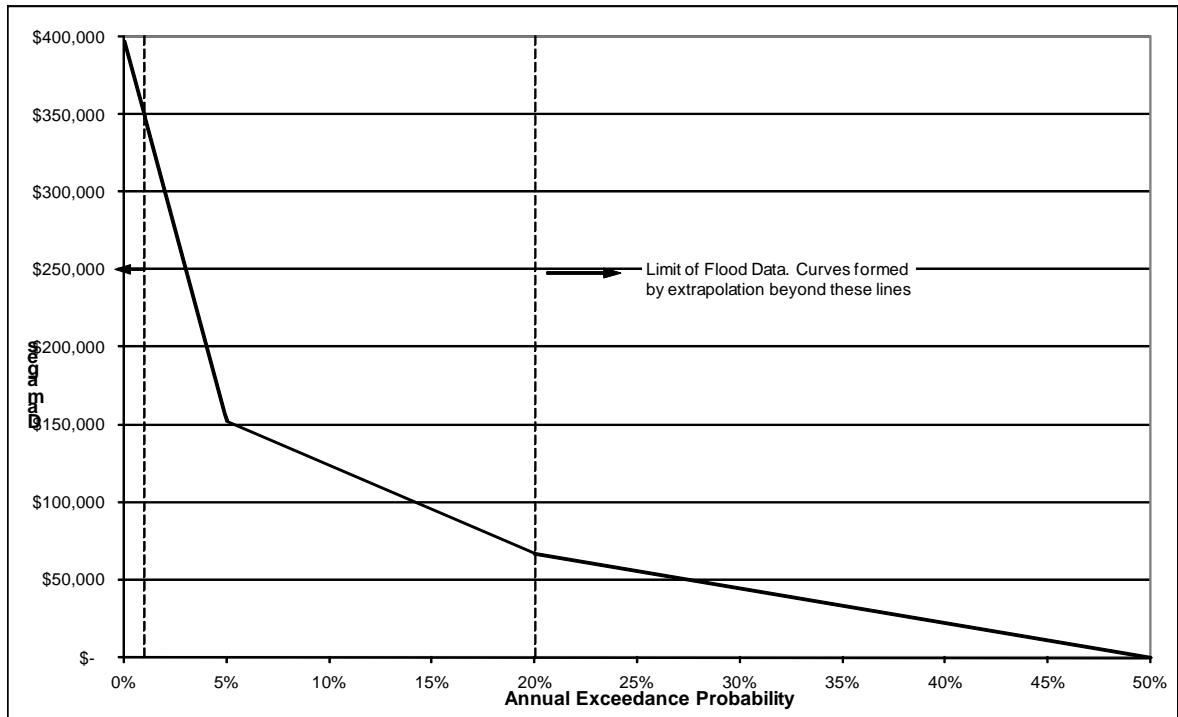


Figure 6-1 Existing Conditions Damages Probability Curve

7 MITIGATION SCHEMES ASSESSMENT

This section outlines and investigates Schemes designed to reduce existing flood damages: a scheme is a combination of several mitigation options. This section provides details on the formulation and evaluation of each of the Schemes and considers the benefit/cost of the proposed works (tangible benefits) along with various other economic and non-economic factors to assist in recommending a preferred strategy.

The assessment followed four key stages:

1. identification of focus areas;
2. mitigation option screening;
3. preliminary assessment of options; and
4. detailed assessment of Schemes.

7.1 Focus Areas

Through the modelling of the existing conditions in the Kosciusko Avenue MD catchment, widespread flooding was observed throughout the study area. Despite the number of properties exposed to flooding, relatively few houses had above floor flooding. However, the majority of houses that would be subject to above floor flooding are concentrated at the intersection of Plantation Road and Hendy Street, and along Kosciusko Avenue. Consequently, reducing the flood levels in the Plantation Road retarding basin and managing overland flow from the HRIE retarding basin formed the focus of the mitigation schemes. The HRIE retarding basin would have provided an ideal mitigation option by modifying the design, if possible, to alleviate the overland flooding along Hendy Street. However, at the time of this assessment the HRIE retarding basin construction project was too far advanced to incorporate any potential findings of the study.

7.2 Mitigation Option Screening

A wide range of mitigation options were considered as part of the “first pass” assessment. Options such as localised bund walls and pipe system upgrades were considered to alleviate a number of the flooding issues in the areas of concern. Large-scale levees, floodwalls and floodplain modification were not considered appropriate for the current study area. Table 7-1 sets out the broad categories of options considered and whether any detailed investigation was undertaken. The decision on which options were to be considered was undertaken in consultation with the CoGG.

The options that were selected for consideration are described in more detail in the following sections.

Table 7-1 Mitigation Option Element Screening

Element Type		Strategy Elements	Comment	Assessed
Urban	Structural Measures	Pipe system upgrade	Considered	✓
		Pumps	Not appropriate	x
		Soakage Pits	Not appropriate	x
		Retarding Basin	Considered	✓
		Diversions	Not appropriate	x
		Floodways	Not appropriate	x
		Open Drain	Considered	✓
		Channel Improvement	Considered	x
		Bund Walls	Considered	✓
		Lot scale infiltration	Not appropriate	x
		Lot scale detention	Not appropriate	x
	Individual Property Floodproofing	Possible, however very expensive	x	
	Non Structural Measures	Planning Scheme Amendments	Considered	x
Voluntary House Purchase		Considered	x	
Voluntary House Raising		Not feasible	x	
Rural	Structural Measures	Levees	Not applicable	x
		Floodwalls	Not applicable	x
		Floodways	Not applicable	x
		Floodplain Modification	Not applicable	x
		Channel Improvement	Not applicable	x
		Individual Property Floodproofing	Not applicable	x
		Flood Storage	Not applicable	x
		Diversions	Not applicable	x
	Non Structural Measures	Flood Warning Systems	Not applicable	x
		Land Use Planning	Not applicable	x
		Floodplain Education Programs	Not applicable	x
		Purchase and Relocation	Not applicable	x
		Information and Data Collection	Not applicable	x
Planning Scheme Amendments	Not applicable	x		
Regulation and Enforcement	Not applicable	x		

7.3 Detailed Assessment

7.3.1 Non-Structural Options

The non-structural options considered for the economic assessment were voluntary house raising, voluntary house purchase and amendments to the planning scheme. Voluntary house raising was not considered further because it has limited application in this catchment, where many of the flood affected buildings cannot be economically raised. This is due in part to many vulnerable houses being of slab-on-ground construction. Voluntary house purchase was not considered viable because of the cost of the buy back and re-construction.

7.3.2 Structural Options

The CoGG required that at least three mitigation schemes be assessed, with one of the schemes being “do nothing”. The four schemes that were assessed for the Kosciusko Avenue MD catchment are summarised in Table 7-2 and in Figure 7-1, Figure 7-2 and Figure 7-3. Hydraulic and economic assessments were undertaken for each scheme.

Table 7-2 Kosciusko Ave Catchment Mitigation Scheme Details

Scheme Number	Details
One	Augmentation of the Plantation Road retarding basin to maximise storage volume within Council land.
Two	Scheme two includes the Plantation Road retarding basin augmentation in conjunction with a new outlet connected to new twin 1350 mm RCP. The twin 1350 mm RCP will run from the retarding basin to the existing open channel at Princes Highway.
Three	<p>Scheme three includes the proposed scheme one and two works but with the outlet pipes increase from twin 1350 mm RCP to twin 1800 mm RCP. The existing basin outlet pipes are disconnected from the basin under this scheme. The disconnection aims to allow more available capacity in the existing pipe network to alleviate flooding down Kosciusko Avenue.</p> <p>New grated entry pits at the intersection of Plantation Road and Hendy Street connected to the existing pipe network.</p> <p>A new twin 1200 mm RCP with grated inlets running along Sharland Drive from Fairbairn Drive to the Plantation Road retarding basin.</p> <p>A 1050 mm RCP with a grated entry pit on Hendy Street, south of the Plantation Road and Hendy Street intersection.</p> <p>A newly constructed open channel running on the western side of Streeton Close from the Nigella Avenue retarding basin to the Plantation Road retarding basin. This component also includes removing any kerb and channel and re-grading along the western side of Streeton Close to encourage overland flow into the open channel.</p> <p>Disconnect the existing 1050 mm RCP along Streeton Close from the pipe network and reconnected into the proposed open channel.</p> <p>Disconnect the existing 750 mm RCP crossing Streeton Close, north of the roundabout, from the pipe network and reconnected into the proposed open channel.</p> <p>Connection of the Nigella retarding basin outlet pipe to the open channel.</p> <p>A new bund wall will be constructed along the southern boundary of the Geelong Bypass reserve, east and west of Cubbin Court. A second bund is proposed running along the eastern side of Streeton Close from the northern end of the small reserve to the Sharland Drive roundabout.</p>
Four	Do Nothing

7.3.2.1 Pipe Works

The proposed pipe works are have been summarised below for the respective schemes. No pipe works have been proposed for scheme one.

Scheme Two Pipe Works

Scheme two proposed pipe works include a new twin 1350 mm RCP along a similar alignment to the existing 1950 mm RCP from the retarding basin to the open channel. The proposed outlets are not connected to any side entry or grated entry pits to maximise the hydraulic performance of the proposed pipe.

Scheme Three Pipe Works

Scheme three pipe works include the proposed twin 1800 mm RCP from the Plantation Road retarding basin. In addition, the existing retarding basin outlets are disconnected in this scheme. The disconnection aims to provide more capacity in the existing pipe network to alleviate flooding down Kosciusko Avenue.

New twin 1200 mm RCP with grated inlet pits are proposed along Sharland Drive from Fairbairn Drive to the Plantation Road retarding basin. These pipes aim to capture overland flow from the north, crossing Sharland Drive and discharge into the Plantation Road retarding basin.

A new 1050 mm RCP with a grated inlet pit is proposed on Hendy Street, south of the Plantation Road and Hendy Street roundabout. A localised low point results in overland flow ponding at this location. The pipe and grated pit have been sized to capture and remove as much of the ponded water as possible given site constraints.

Disconnect the existing 1050 mm RCP along Streeton Close and discharge into the proposed open channel. This configuration directs pipe flows into the Plantation Road retarding basin as opposed to it continuing to flow along the pipe network, thus providing more capacity in the downstream pipe network for capturing overland flows. This approach also reduces surcharging of the network, keeping flood water underground. For the same reason, the existing 750 mm RCP crossing Streeton Close is also disconnected from the pipe network and discharged into the proposed open channel.

7.3.2.2 Retarding Basin Works

Existing Plantation Road Retarding Basin (Corner of Plantation Road and Hendy Street)

The augmentation of the Plantation Road retarding basin has been proposed for all schemes. The augmentation was modelled to the extent of Council's property to maximise storage volume. The level of the sporting fields was lowered as much as possible while ensuring free draining playing surfaces. The current grade and minor table drains of the existing sports fields have been maintained to ensure adequate drainage in minor rainfall events. The slope of the cut embankments were set at 1 in 5 to ensure they could be safely maintained.

7.3.2.3 Flood Bund Works

Geelong Bypass Bund – Scheme Three

A bund will be constructed on the southern boundary of the Geelong bypass reserve, along the boundary of the reserve on the east and west of Cubbin Close. The bunds assist in directing water down Cubbin Court and Streeton Close towards the retarding basins, as opposed to flowing through adjacent properties. The bund mitigates flooding from all events up to and including the 1% AEP flood event and will be set approximately 0.4 metres above the existing ground level.

Streeton Close Bund - Scheme Three

A bund will be constructed along the rear boundaries of properties backing on to Streeton Close from the north end of the small reserve to the Sharland Drive roundabout. This bund will divert floodwater flowing south along Streeton Close into the Nigella Avenue retarding basin as well as the proposed open channel (Section 7.3.2.4). On average, this flood bund will be set approximately 0.2 metres above the existing ground level.

7.3.2.4 Open Channel Works

An open channel is proposed for Scheme Three. The channel is proposed for the western side of Streeton Close, from the Nigella Avenue retarding basin to the Plantation Road retarding basin. This component also includes removing the kerb and channel and re-grading along the western side of Streeton Close, from Nigella Avenue to the Sharland Drive roundabout, to encourage overland flow into the open channel. A reserve of approximately 30m from the Streeton Close road boundary will be required for the open channel. The Scheme requires that Council purchase the land from the current School site.

7.3.3 Hydraulic Assessment

The 1%, 5% and 20% AEP design floods were assessed using the same eleven storm duration events as used for the existing case. A peak flood height envelope was then developed for each flood event for each scheme. The change in peak flood height for each scheme was calculated by subtracting the existing case peak flood heights from the scheme peak flood heights at each TUFLOW grid. The change in peak flood height was then colour contoured and mapped. The modelling and mapping was not done for the “Do Nothing” schemes as there were no changes from the existing conditions.

Peak flood height surfaces were used to calculate the number of properties flooded and depth of above floor flooding, which was then used in the flood damages assessment for each scheme.

The mapping pertaining to each scheme in the hydraulic assessment illustrates no change in flood level within a ± 0.03 m tolerance as a cream colour, reductions in flood level are shaded with greens and increases in flood level are shaded with browns/reds. A pink colour indicates a region where flooding currently occurs but would no longer occur if the scheme was implemented, and a blue colour indicates a region where flooding currently does not occur but would if the scheme was implemented.

7.3.3.1 Scheme One

The change in peak flood height and the properties with above floor flooding, for Scheme One of the Kosciusko Avenue MD catchment, are mapped in Figure 7-6 to Figure 7-8 for the three flood events assessed.

Modelling of the Plantation Road retarding basin augmentation has provided additional storage to reduce peak flows from the basin. The additional storage was not sufficient to prevent the basin from overtopping in the 1% AEP event. The mitigation works have a positive impact on flood extents and flood levels along Kosciusko Avenue compared to existing conditions.

Table 7-3 Reduction in Flooded Properties – Scheme One

AEP	No. Flooded Grounds*		Reduction	No. Flooded Floors*		Reduction
	Existing	Scheme One		Existing	Scheme One	
1%	144	144	0	23	17	6
5%	135	107	28	10	8	2
20%	81	73	8	4	4	0

* Results based on properties surveyed by CoGG.

7.3.3.2 Scheme Two

The change in peak flood height and the properties with above floor flooding, for Scheme Two of the Kosciusko Ave catchments, are mapped in Figure 7-9 to Figure 7-11 for the three flood events assessed.

The modelling of this scheme indicated that the proposed pipes further decrease flood levels along Kosciusko Ave in comparison to Scheme One. The basin no longer overtops in the 1% AEP event as a result of the proposed outlets providing additional capacity allowing the existing 1950 mm RCP to capture more overland flow thus reducing flood levels.

Overall, Scheme Two reduces flooding along Kosciusko Ave, however a significant proportion of overland flooding arrives from the north along Streeton CIs and Fairbairn Drv. This scheme has a greater impact on the 1% AEP above floor flooding reducing the number of flood affected properties from 17 in Scheme One to 9 in Scheme Two.

Table 7-4 Reduction in Flooded Properties – Scheme Two

AEP	No. Flooded Grounds*		Reduction	No. Flooded Floors*		Reduction
	Existing	Scheme Two		Existing	Scheme Two	
1%	144	132	12	23	9	14
5%	135	105	30	10	7	3
20%	81	73	8	4	4	0

* Results based on properties surveyed by CoGG.

7.3.3.3 Scheme Three

The change in peak flood height and the properties with above floor flooding, for Scheme Three of the Kosciusko Avenue catchment, are mapped in Figure 7-12 to Figure 7-14 for the three flood events assessed.

The proposed Plantation Road retarding basin works and outlet perform similarly to Scheme One and Two. The proposed bund works along the Geelong Bypass reserve boundary directs flood water south along Streeton Close via Cubbin Court.

The proposed new channel and regrading of the road verge, in addition to the bund works along Streeton Close, divert overland flows arriving from the north into the Plantation Road retarding basin. This results in Hendy Street (north of Plantation Road) being largely flood free under the proposed Scheme Three works.

The proposed twin 1200 mm RCP along Sharland Drive (from Fairbairn Drive to the Plantation Road retarding basin) intercepts overland flow arriving from the north on the east side of the Streeton Close bund. The proposed new pipes either eliminate or reduce flooding to a number of properties between Sharland Drive and Plantation Road therefore further reducing flood levels along Kosciusko Avenue.

The 1050 mm RCP and additional inlets at the intersection of Plantation Road and Hendy Street further reduce flood levels

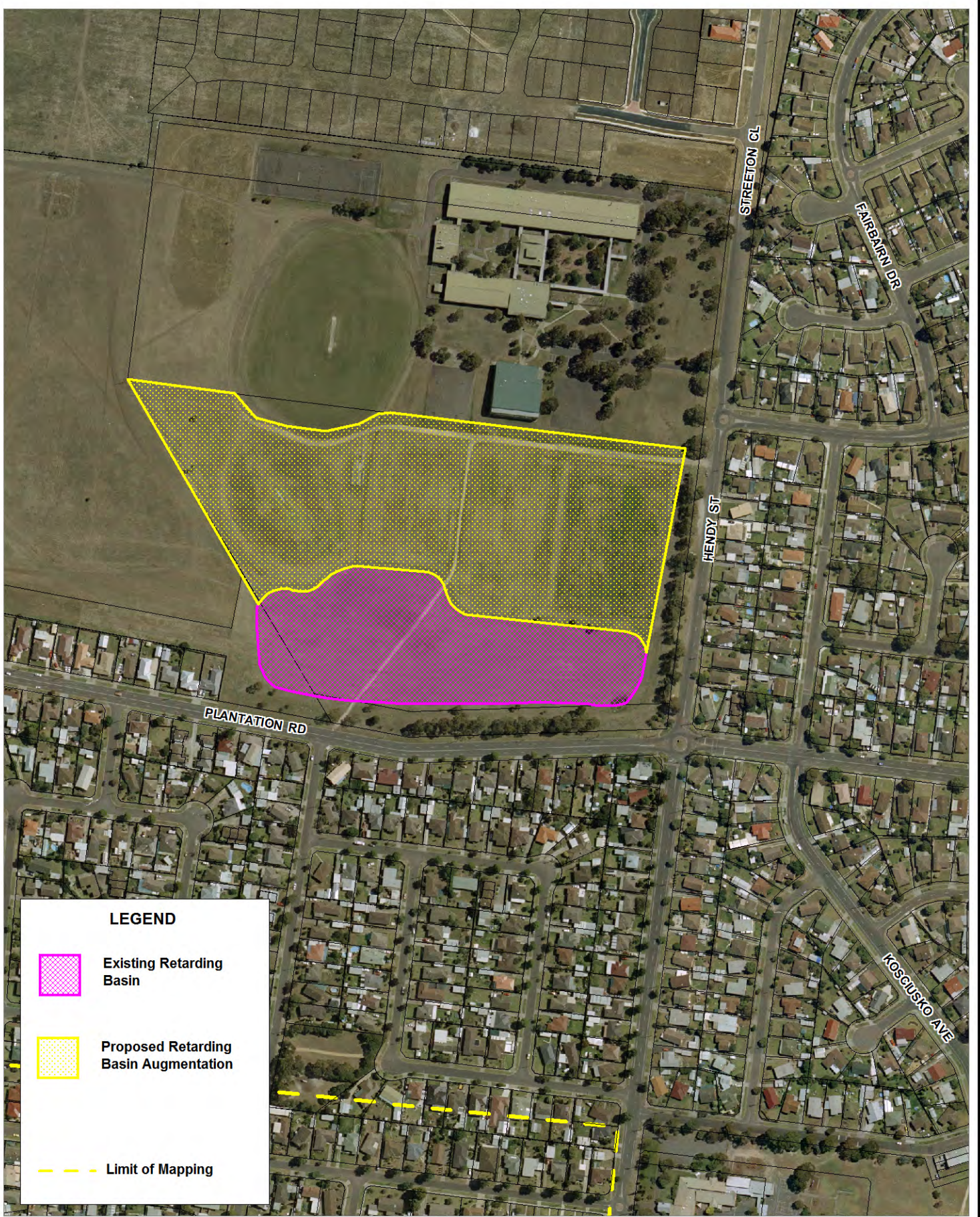
Overall, Scheme Three manages to either significantly reduce or eliminate flooding at all key locations and maximise the use of the Plantation Road retarding basin. The scheme has significantly reduced the number of flooded grounds in comparison to the previous two schemes. Areas that remain a concern include the intersection of Kosciusko Avenue and Plantation Road, Hendy Street (south of the Plantation Road intersection) and the southern end of Kosciusko Avenue. These areas experience significant ponding due to either the nature of the terrain or obstructions by road embankments, as is the case with the southern end of Kosciusko Avenue which is being obstructed by Princes Highway.

The number of properties experiencing above floor flooding have only marginally decreased in comparison to Scheme Two despite the significant number of flooded grounds reduced.

Table 7-5 Reduction in Flooded Properties – Scheme Three

AEP	No. Flooded Grounds*		Reduction	No. Flooded Floors*		Reduction
	Existing	Scheme Three		Existing	Scheme Three	
1%	144	108	36	23	8	15
5%	135	72	63	10	6	4
20%	81	45	36	4	4	0

* Results based on properties surveyed by CoGG.

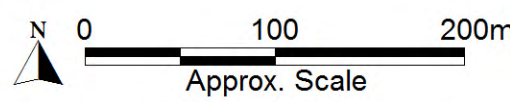


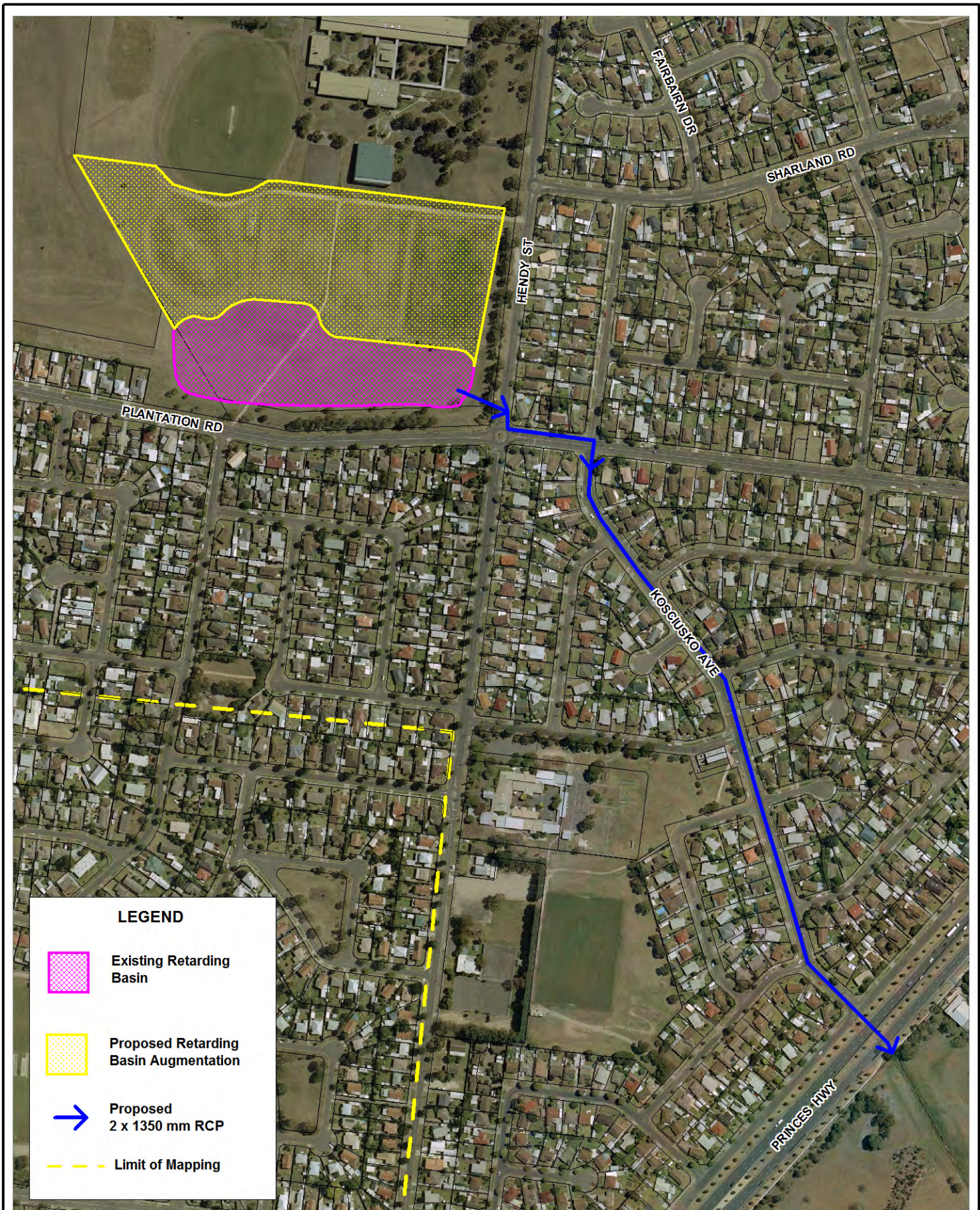
Title:
Scheme One
Proposed Mitigation Works

Figure:
7-1





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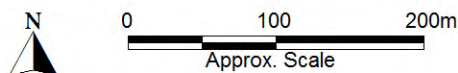
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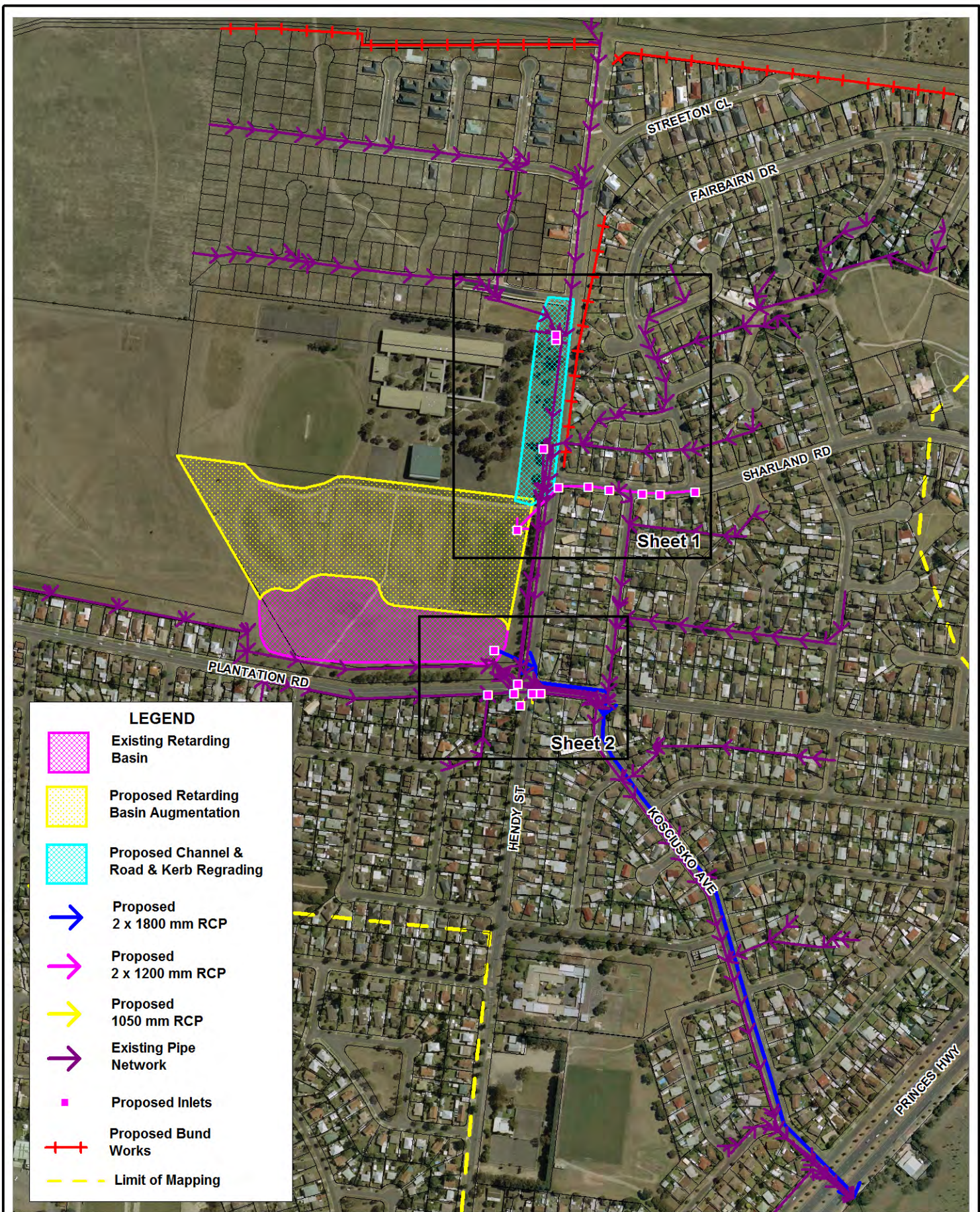
-  Existing Retarding Basin
-  Proposed Retarding Basin Augmentation
-  Proposed 2 x 1350 mm RCP
-  Limit of Mapping

Title:
Scheme Two
Proposed Mitigation Works

Figure: 7-2	Rev: A
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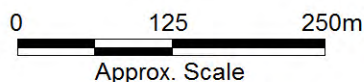


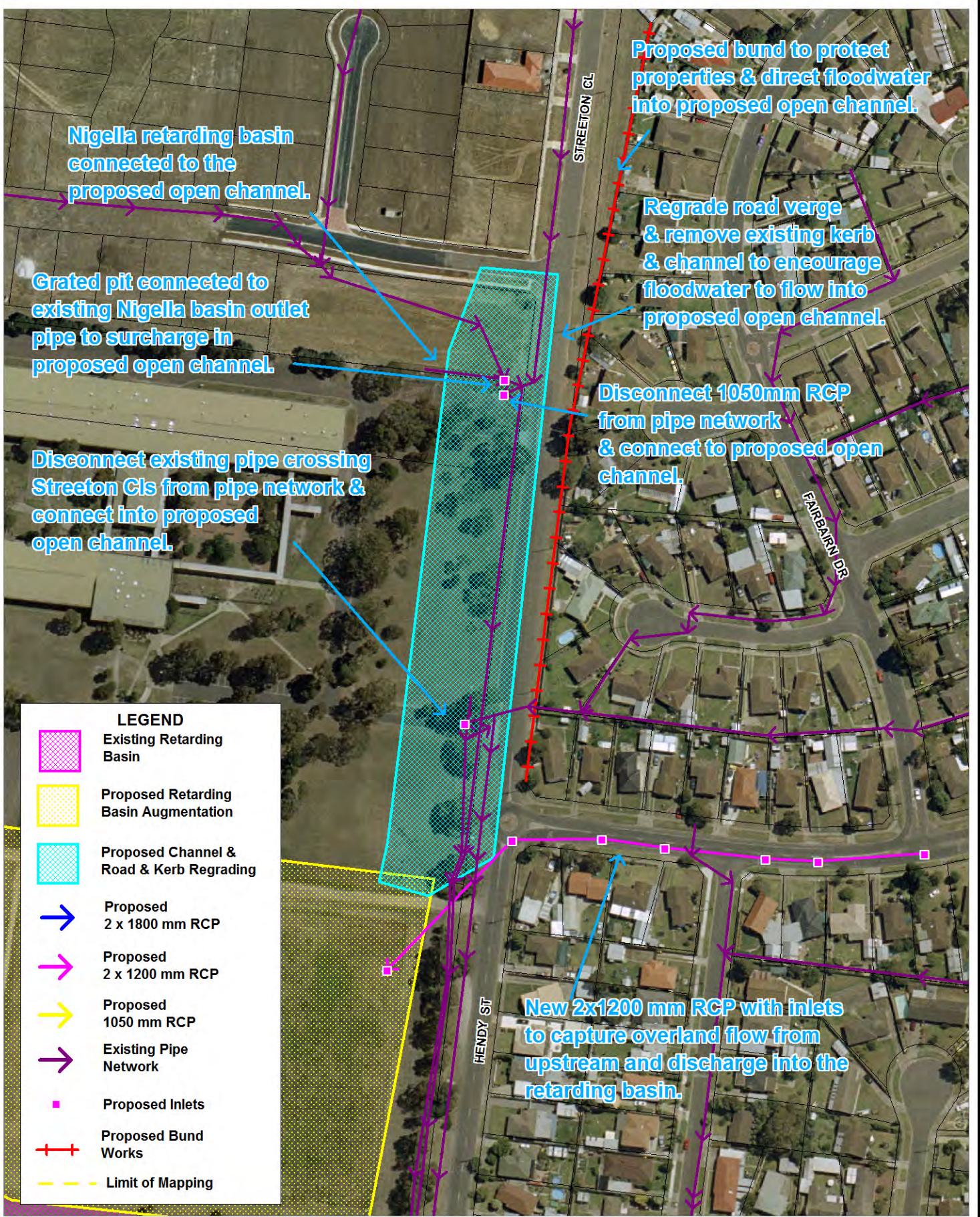
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**Scheme Three - Key Sheet
 Proposed Mitigation Works**

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7-3

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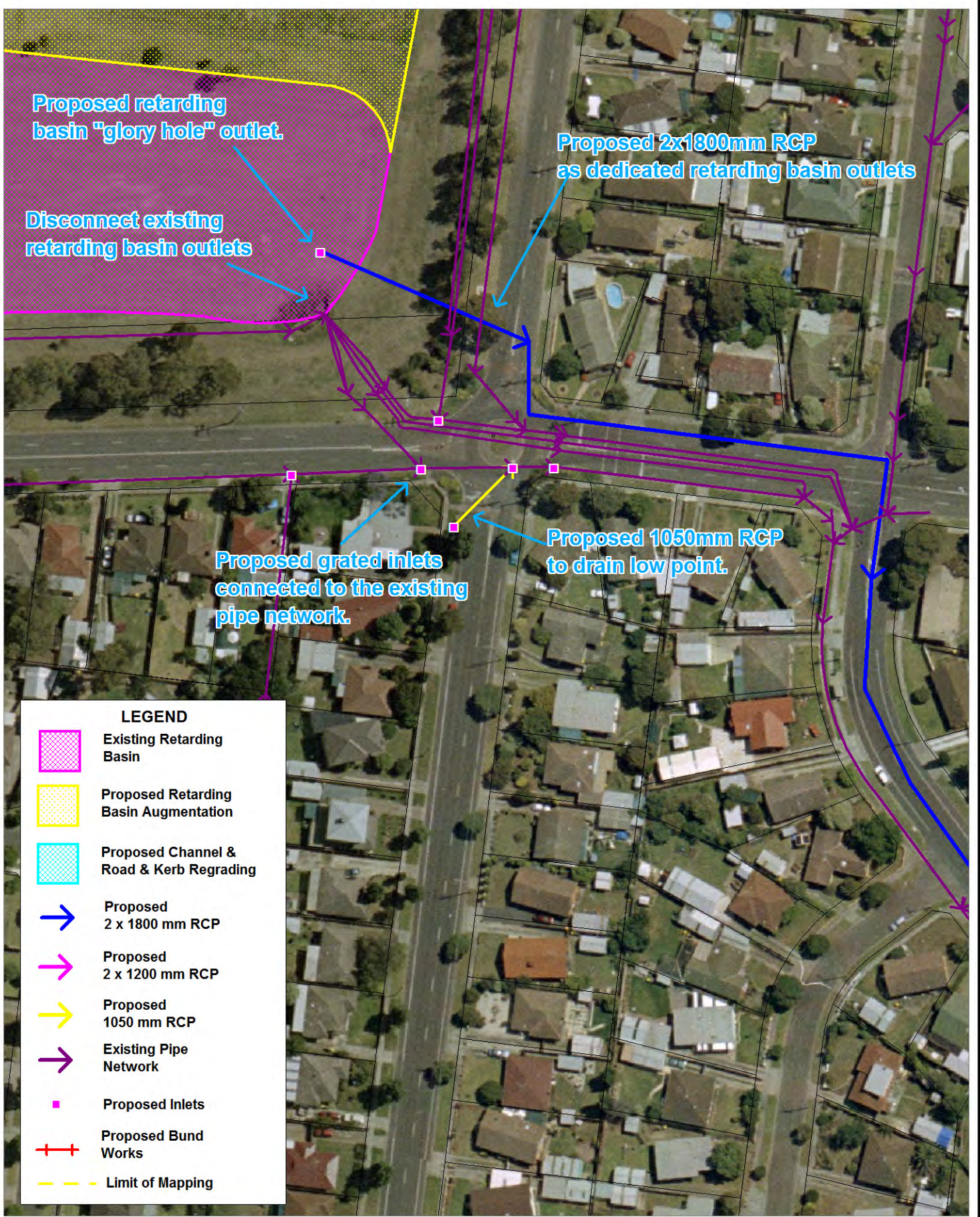




LEGEND

- Existing Retarding Basin
- Proposed Retarding Basin Augmentation
- Proposed Channel & Road & Kerb Regrading
- Proposed 2 x 1800 mm RCP
- Proposed 2 x 1200 mm RCP
- Proposed 1050 mm RCP
- Existing Pipe Network
- Proposed Inlets
- Proposed Bund Works
- Limit of Mapping

Title: Scheme Three Proposed Mitigation Works Sheet 1	Figure: 7-4	Rev: A
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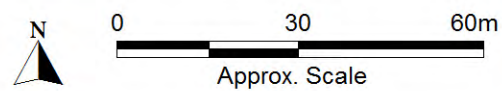


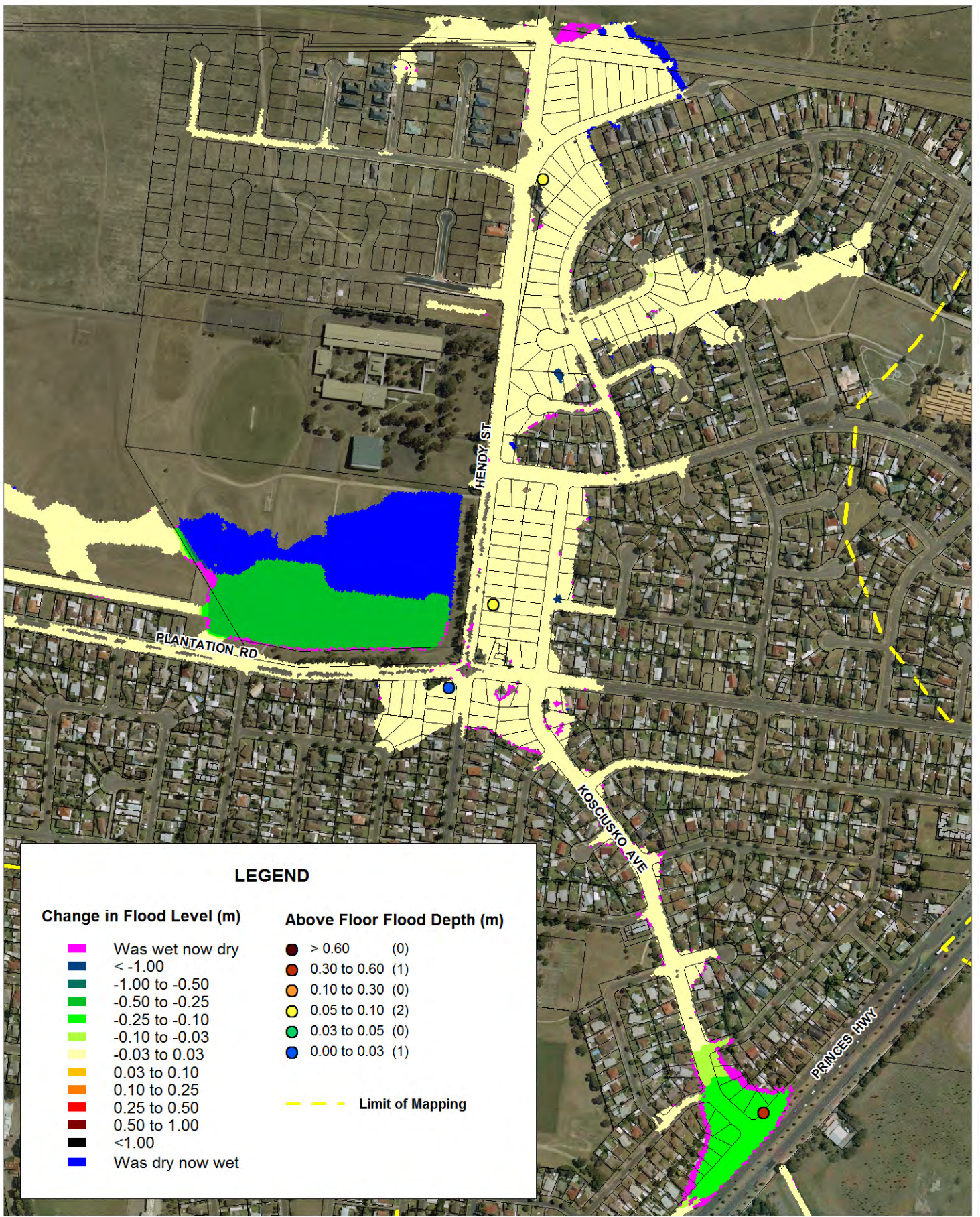
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Scheme Three Proposed Mitigation Works
Sheet 2

Figure:
7-5

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LEGEND

Change in Flood Level (m)

- Was wet now dry
- < -1.00
- -1.00 to -0.50
- -0.50 to -0.25
- -0.25 to -0.10
- -0.10 to -0.03
- -0.03 to 0.03
- 0.03 to 0.10
- 0.10 to 0.25
- 0.25 to 0.50
- 0.50 to 1.00
- <1.00
- Was dry now wet

Above Floor Flood Depth (m)

- > 0.60 (0)
- 0.30 to 0.60 (1)
- 0.10 to 0.30 (0)
- 0.05 to 0.10 (2)
- 0.03 to 0.05 (0)
- 0.00 to 0.03 (1)

 Limit of Mapping

Title:

**Scheme One
20% AEP Peak Flood Impact**

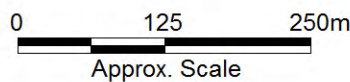
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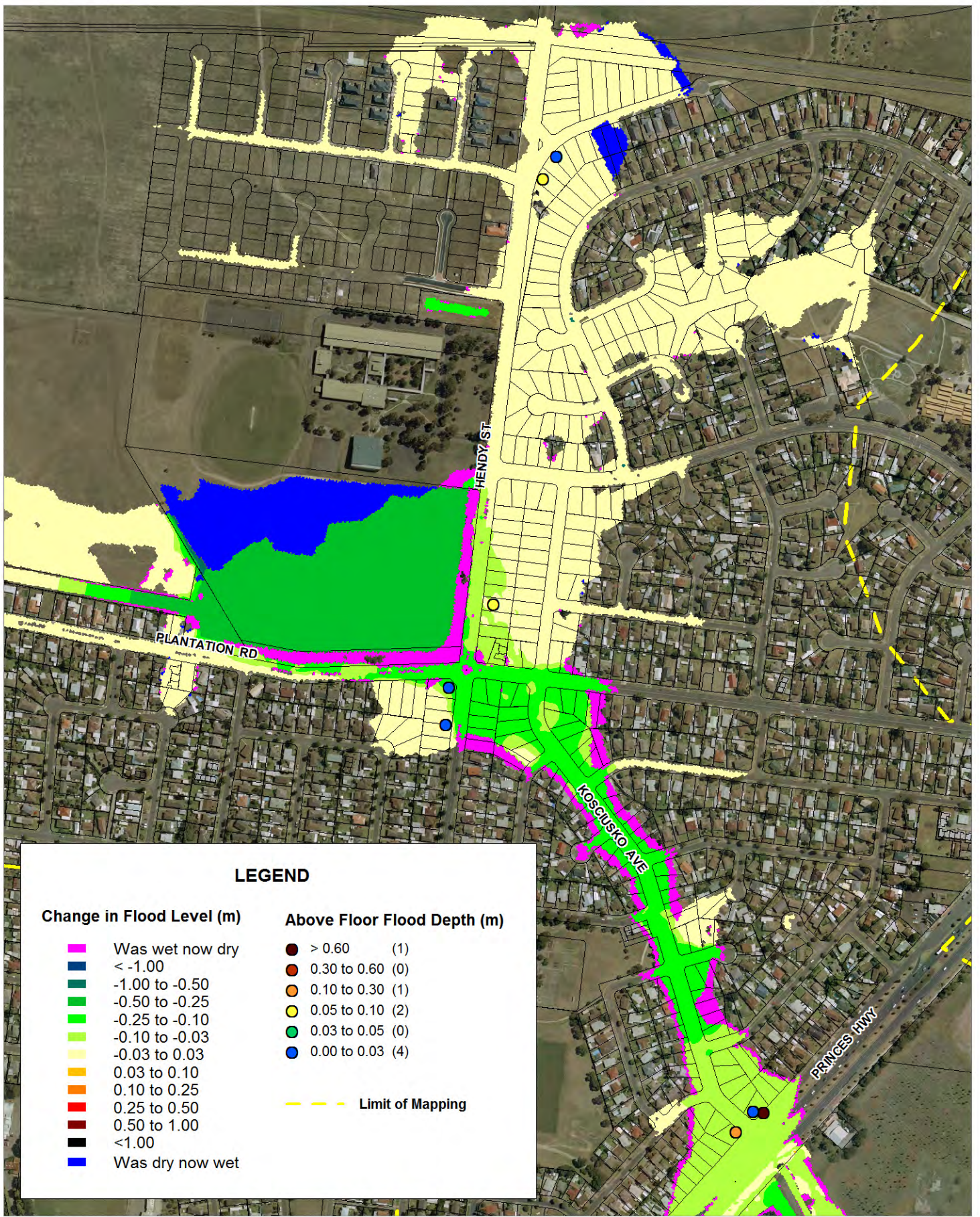
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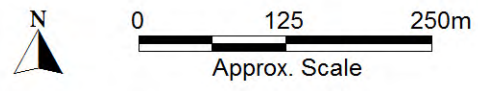


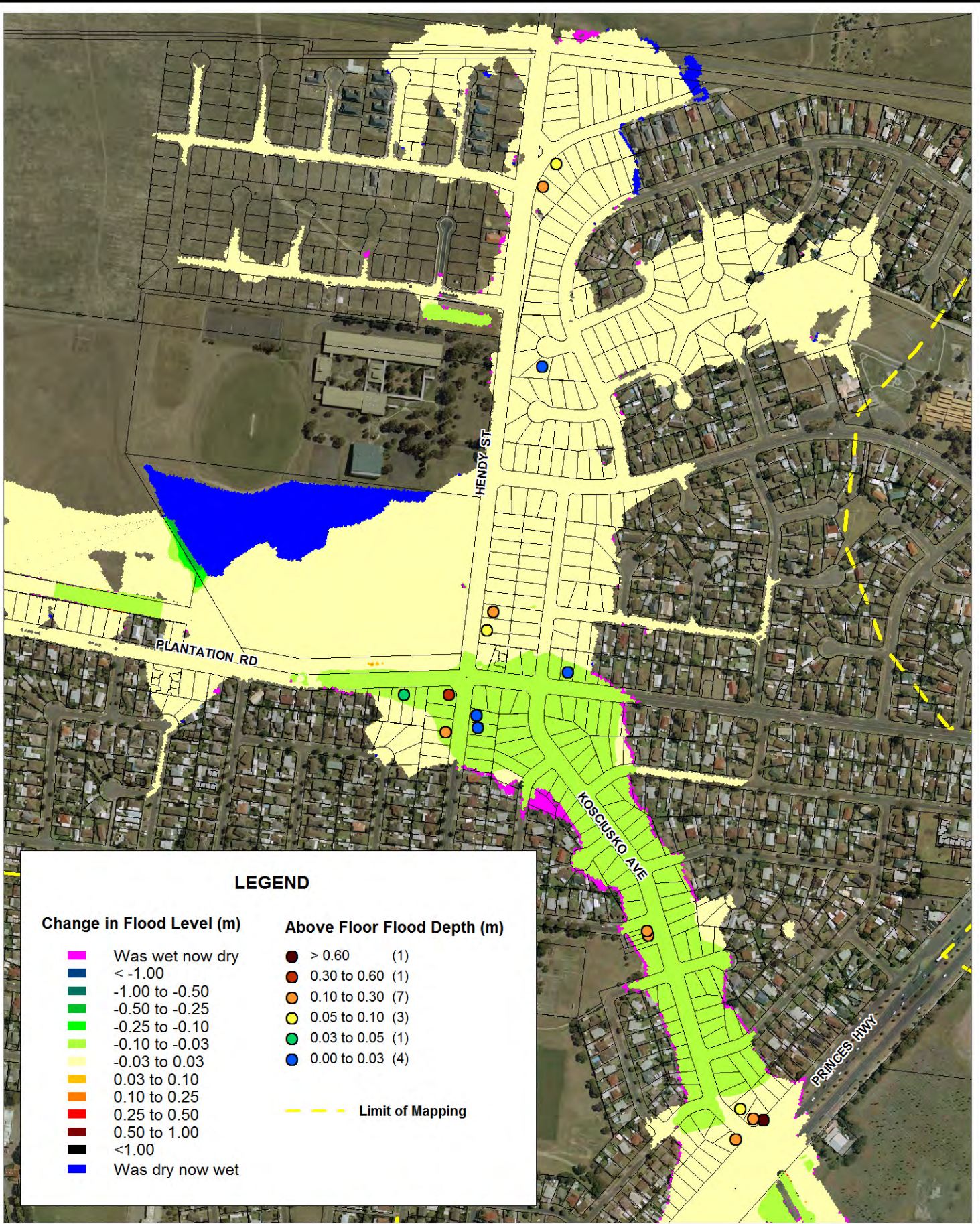
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Scheme One
5% AEP Peak Flood Impact

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7-7

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LEGEND

Change in Flood Level (m)

- Was wet now dry
- < -1.00
- -1.00 to -0.50
- -0.50 to -0.25
- -0.25 to -0.10
- -0.10 to -0.03
- -0.03 to 0.03
- 0.03 to 0.10
- 0.10 to 0.25
- 0.25 to 0.50
- 0.50 to 1.00
- <1.00
- Was dry now wet

Above Floor Flood Depth (m)

- > 0.60 (1)
- 0.30 to 0.60 (1)
- 0.10 to 0.30 (7)
- 0.05 to 0.10 (3)
- 0.03 to 0.05 (1)
- 0.00 to 0.03 (4)

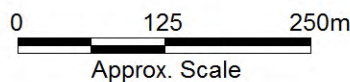
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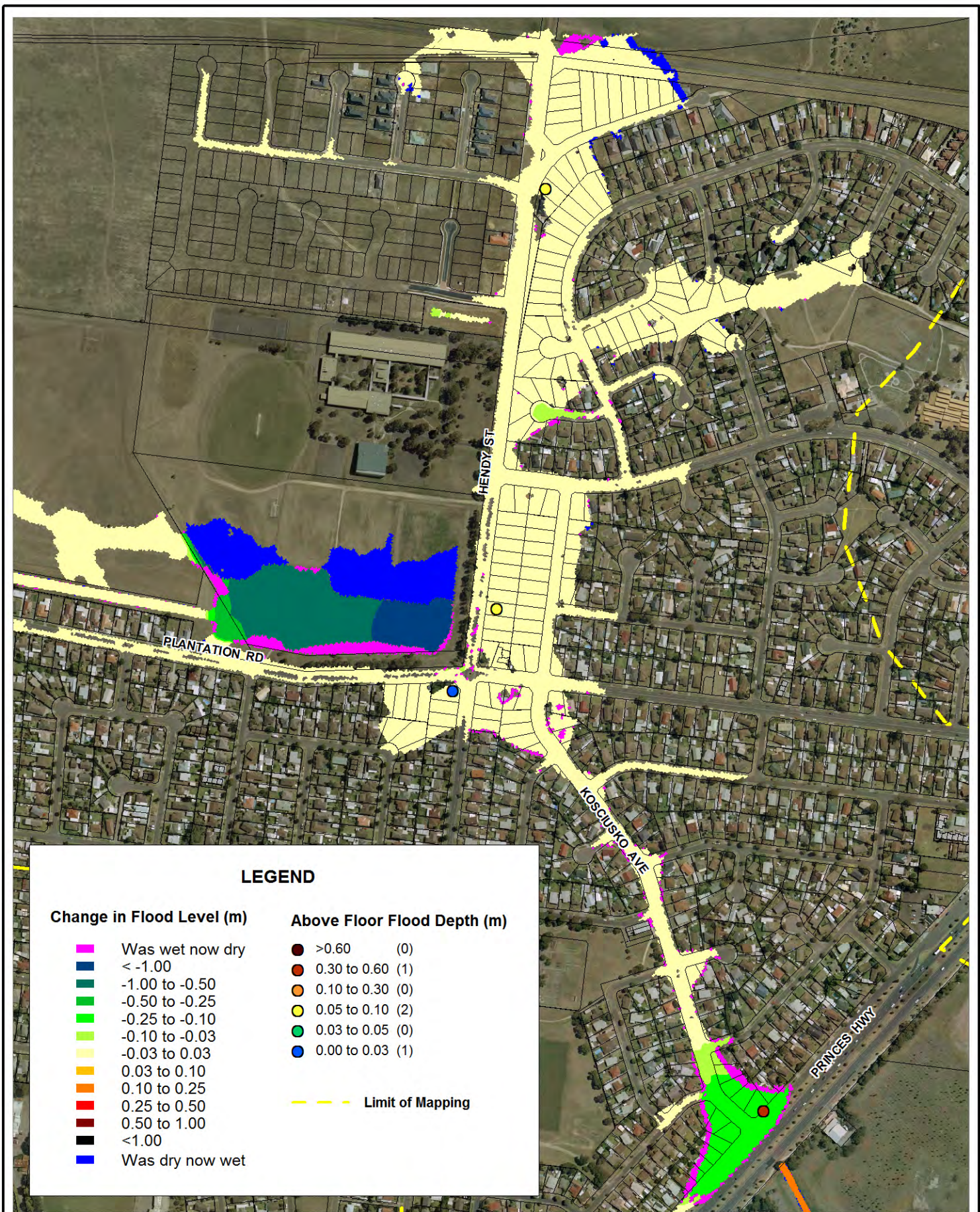
Title:
Scheme One
1% AEP Peak Flood Impact

Figure:
7-8

Rev:
B

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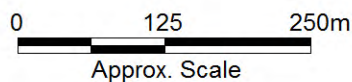


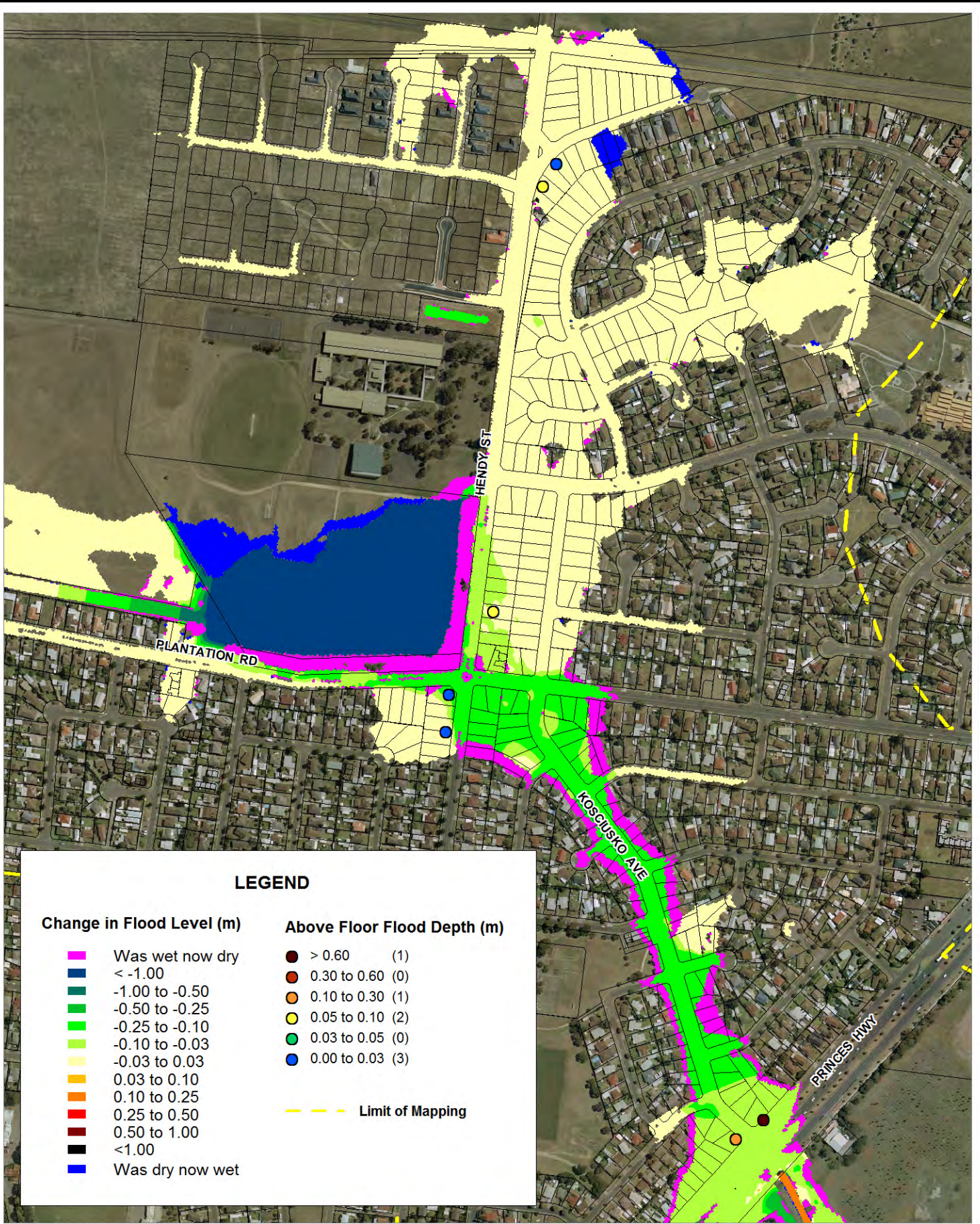
Title:
Scheme Two
20% AEP Peak Flood Impact

Figure:
7-9

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B

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LEGEND

Change in Flood Level (m)

- Was wet now dry
- < -1.00
- -1.00 to -0.50
- -0.50 to -0.25
- -0.25 to -0.10
- -0.10 to -0.03
- -0.03 to 0.03
- 0.03 to 0.10
- 0.10 to 0.25
- 0.25 to 0.50
- 0.50 to 1.00
- <1.00
- Was dry now wet

Above Floor Flood Depth (m)

- > 0.60 (1)
- 0.30 to 0.60 (0)
- 0.10 to 0.30 (1)
- 0.05 to 0.10 (2)
- 0.03 to 0.05 (0)
- 0.00 to 0.03 (3)

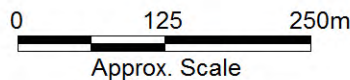
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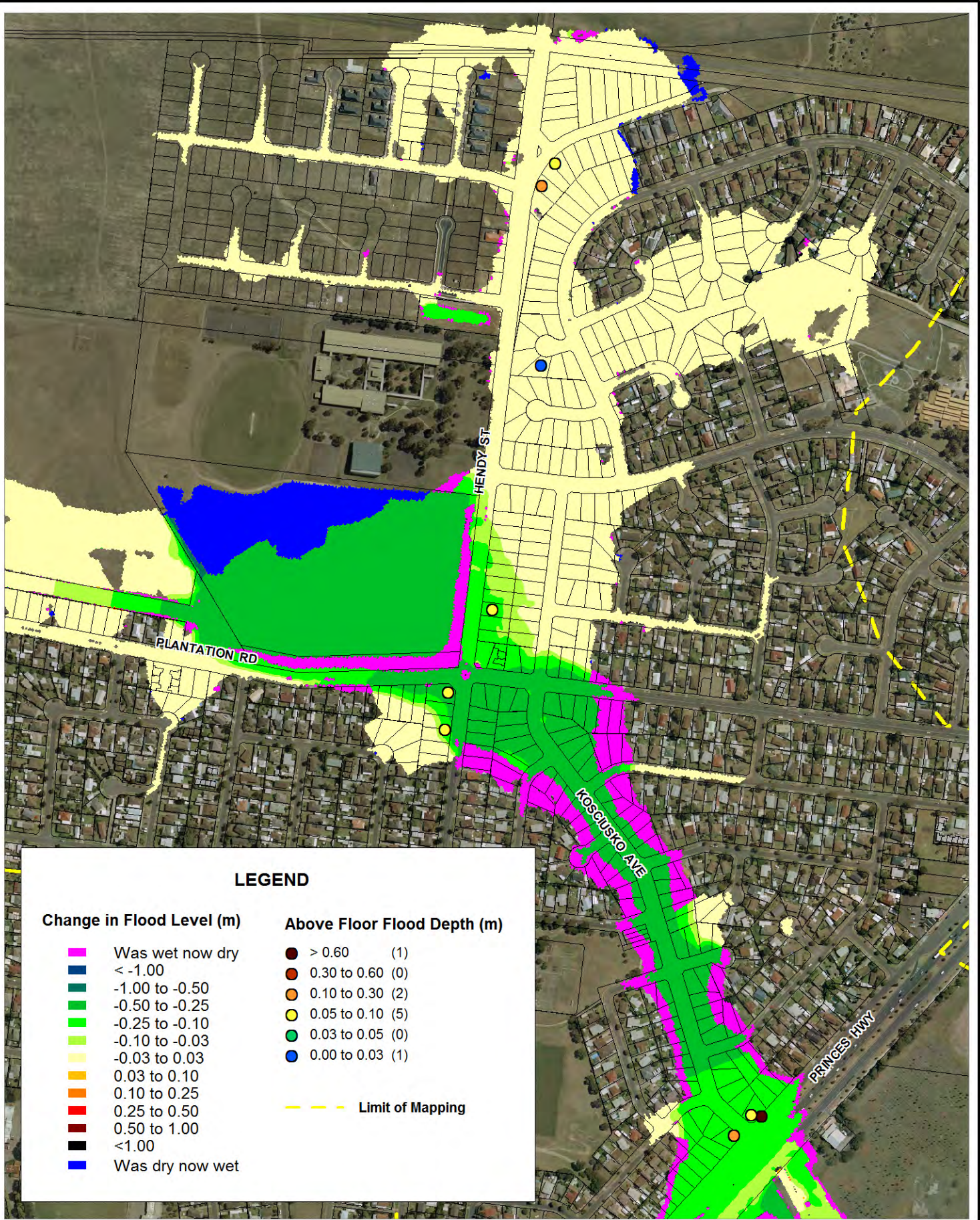
Title:
Scheme Two
5% AEP Peak Flood Impact

Figure:
7-10

Rev:
B

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LEGEND

Change in Flood Level (m)

- Was wet now dry
- < -1.00
- -1.00 to -0.50
- -0.50 to -0.25
- -0.25 to -0.10
- -0.10 to -0.03
- -0.03 to 0.03
- 0.03 to 0.10
- 0.10 to 0.25
- 0.25 to 0.50
- 0.50 to 1.00
- <1.00
- Was dry now wet

Above Floor Flood Depth (m)

- > 0.60 (1)
- 0.30 to 0.60 (0)
- 0.10 to 0.30 (2)
- 0.05 to 0.10 (5)
- 0.03 to 0.05 (0)
- 0.00 to 0.03 (1)

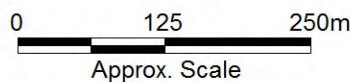
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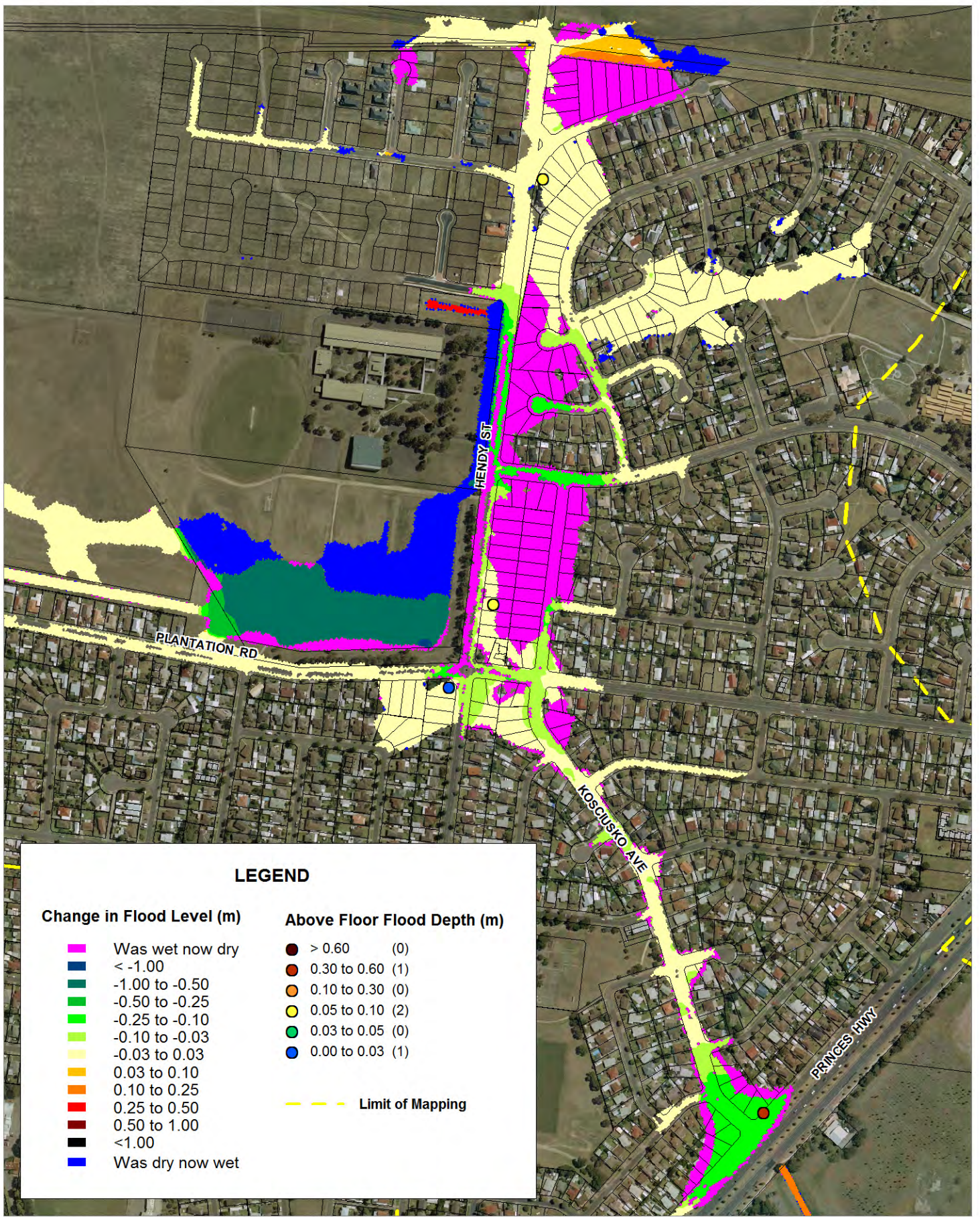
Title:
Scheme Two
1% AEP Peak Flood Impact

Figure:
7-11

Rev:
B

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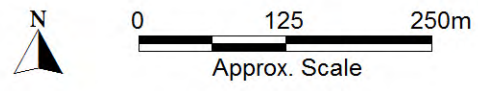


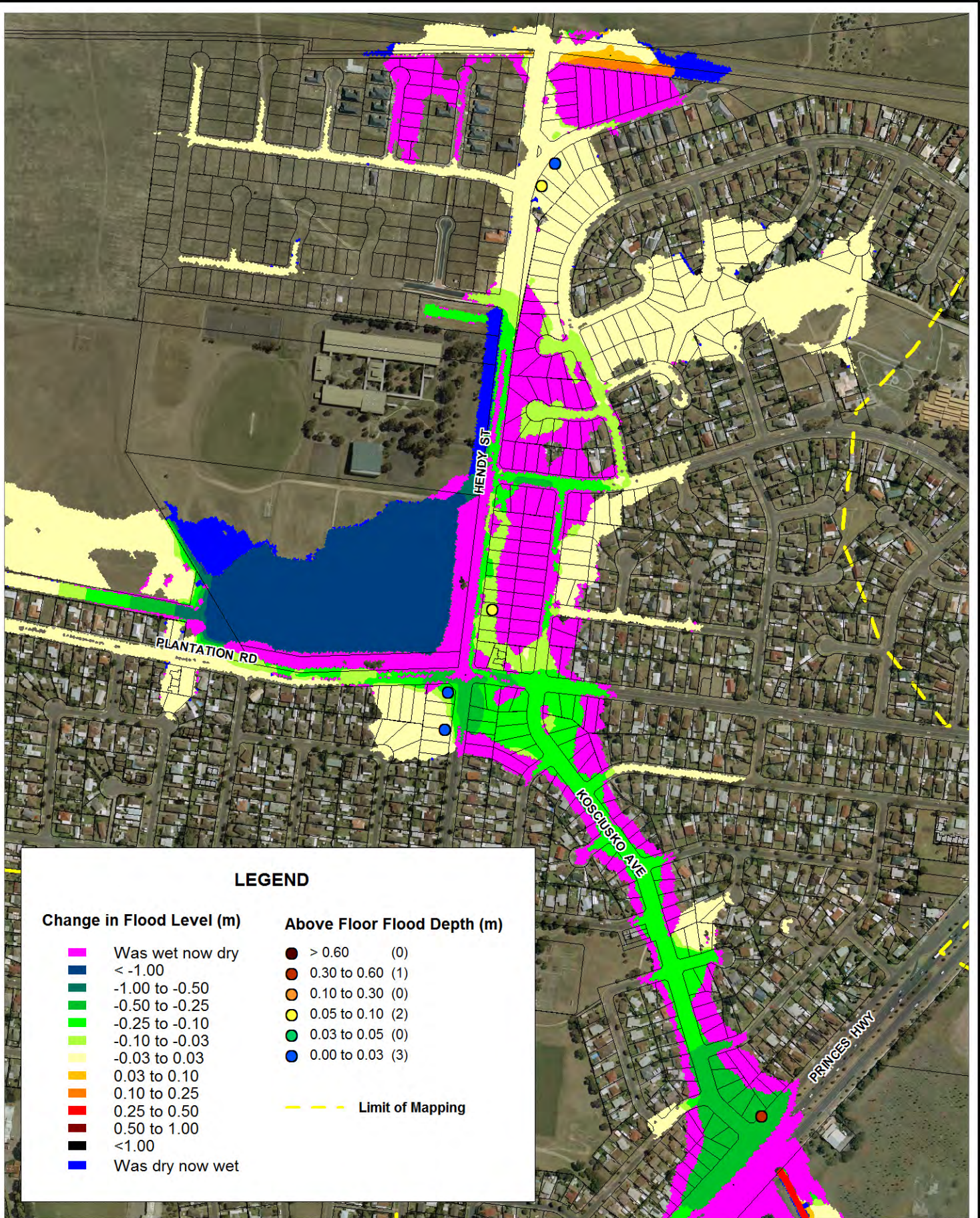
Title:
Scheme Three
20% AEP Peak Flood Impact

Figure:
7-12

Rev:
B

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LEGEND

Change in Flood Level (m)

- Was wet now dry
- < -1.00
- -1.00 to -0.50
- -0.50 to -0.25
- -0.25 to -0.10
- -0.10 to -0.03
- -0.03 to 0.03
- 0.03 to 0.10
- 0.10 to 0.25
- 0.25 to 0.50
- 0.50 to 1.00
- <1.00
- Was dry now wet

Above Floor Flood Depth (m)

- > 0.60 (0)
- 0.30 to 0.60 (1)
- 0.10 to 0.30 (0)
- 0.05 to 0.10 (2)
- 0.03 to 0.05 (0)
- 0.00 to 0.03 (3)

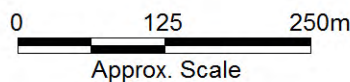
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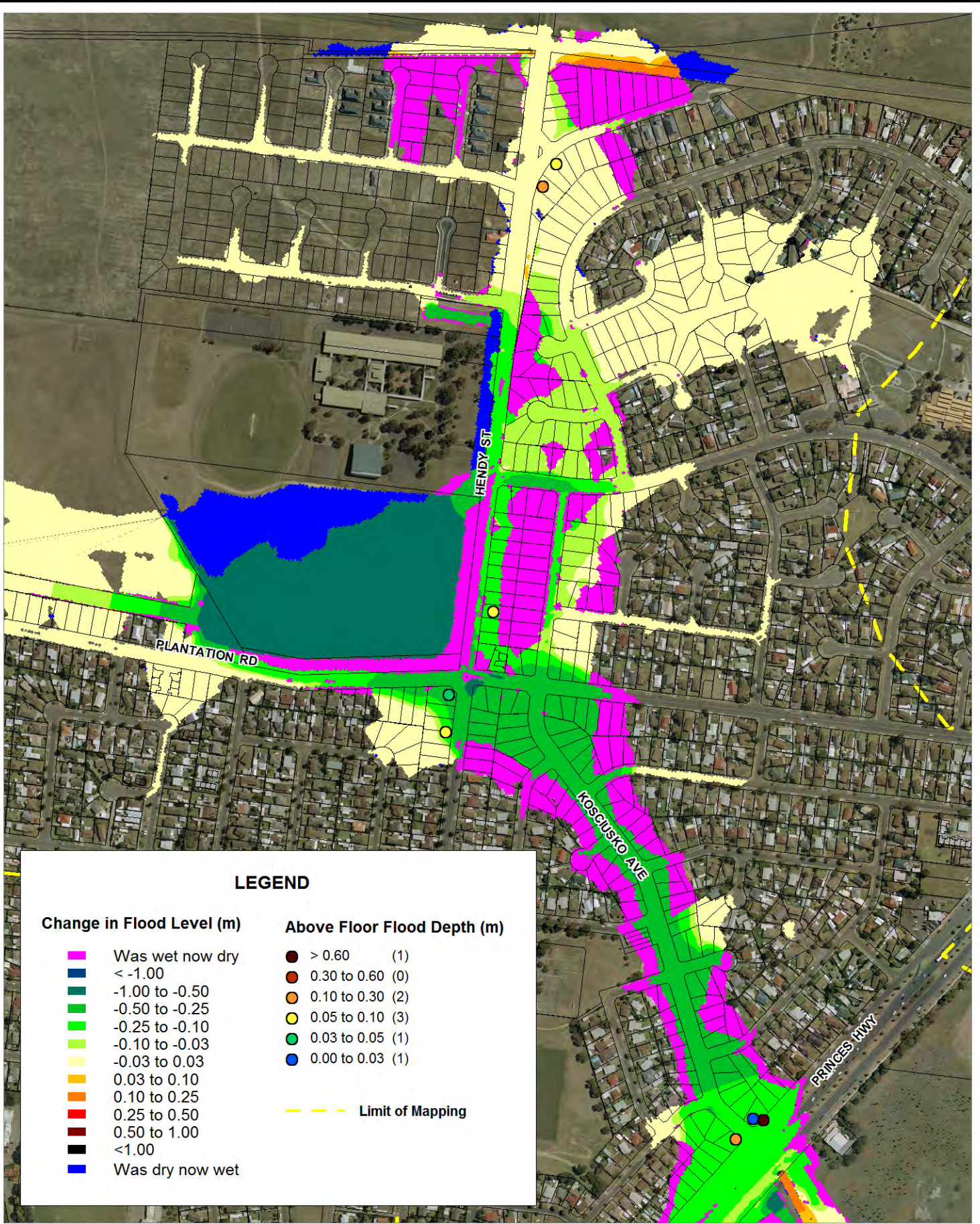
Title:
Scheme Three
5% AEP Peak Flood Impact

Figure:
7-13

Rev:
B

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LEGEND

Change in Flood Level (m)

- Was wet now dry
- < -1.00
- -1.00 to -0.50
- -0.50 to -0.25
- -0.25 to -0.10
- -0.10 to -0.03
- -0.03 to 0.03
- 0.03 to 0.10
- 0.10 to 0.25
- 0.25 to 0.50
- 0.50 to 1.00
- <1.00
- Was dry now wet

Above Floor Flood Depth (m)

- > 0.60 (1)
- 0.30 to 0.60 (0)
- 0.10 to 0.30 (2)
- 0.05 to 0.10 (3)
- 0.03 to 0.05 (1)
- 0.00 to 0.03 (1)

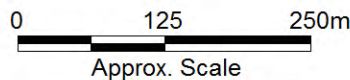
 Limit of Mapping

Title:
Scheme Three
1% AEP Peak Flood Impact

Figure:
7-14

Rev:
B

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8 MITIGATION OPTIONS ASSESSMENT

8.1 Economic Assessment

8.1.1 Basis of Assessment

In general, the benefits of the construction of flood management schemes are as follows:

- increased flood immunity of properties protected by the scheme;
- increased flood immunity of roads protected by the scheme and thus improved mobility of the community during flooding;
- decreased cost of flood damage to properties protected by the scheme;
- decreased potential for loss of life during a flood event within the area protected by the scheme; and
- decreased emotional, social and psychological trauma experienced by residents in times of flooding.

It is important to note that flood management schemes can have the effect of increasing flood levels in other areas, thereby resulting in increased flood damages to properties elsewhere.

Of the factors listed above, the change in flood damages is the only one that can be easily quantified in monetary terms. In Section 6, the flood damages for the existing study area were calculated. The reductions (or increases) in these damages have been calculated to quantify the monetary benefit of each scheme.

The overall financial viability of a scheme is initially assessed by calculating the monetary benefit-cost ratio (BCR). These ratios are used to evaluate the economic potential for the option to be undertaken. A monetary benefit-cost ratio of 1.0 indicates that the monetary benefits are equal to the monetary costs. A ratio greater than 1.0 indicates that the benefits are greater than the costs while a ratio less than 1.0 indicates that the costs are greater than the benefits. The change in infrastructure damage as a result of implementing the scheme is not included in the benefit-cost analysis.

In floodplain management, a BCR substantially less than 1.0 may still be considered viable because the economic analysis does not include the intangible benefits of a flood mitigation scheme.

In order to calculate the BCR, the annual financial benefit (the change in average annual damages) of a scheme is summed over the financial project life and converted to present value.

A financial project life of 30 years was chosen for this study. This does not imply that the projected structural life of the scheme is only 30 years. In fact, some measures should be effective in reducing the frequency of flooding for centuries to come.

It is not correct to simply multiply a long term average annual benefit by the financial project life of 30 years to derive a total worth of the benefits. To do so would ignore the important point that the benefits from this scheme (ie. reduced flood damages) will occur over time and in the future.

For example, a benefit of \$2.3 million to be gained in 10 years time is not worth \$2.3 million now but only \$1.2 million now. This is because \$1.2 million could be invested now and appreciate at say 7 % p.a. over and above inflation for 10 years. This would then be equivalent to \$2.3 million in 10 years time. This is called the Present Value of the benefit. It is a universally accepted economic theory and used in all major project economic analyses. The adopted rate of 7 % is called the discount rate and is the middle of the range 6 to 8 % typically considered for assessing public works.

As an example, Table 8-1 shows the present value of the annual benefit realised at different times over a 50 year period.

Table 8-1 Present Value of Annual Benefits

Year	Average Annual Benefit (\$ million)	Present Value (\$ million)
0	2.3	2.3
1	2.3	2.2
10	2.3	1.2
25	2.3	0.4
50	2.3	0.1

If the present value benefits for each year are totalled for the 50 years, the total present value (or total benefit) of the benefits is \$ 31.7 million. The calculation of the total benefit can be simplified through the use of a Present Value Factor. Rather than calculating the present value for each year and summing to calculate the total benefit, a Present Value Factor can be used when the average annual benefit is identical in each year. The Present Value Factor is calculated using equation (1). The Present Value Factor is multiplied by the average annual benefit to calculate the total benefit. The Present Value Factor is 13.8 for a 50 year period and a discount rate of 7%.

It is interesting to note that if a longer financial project life of say, 100 years was chosen then the total present value of the benefits is only \$1.1 million more at \$32.8 million. This is due to the fact that the present value of the benefits to be accrued in the second 50 year period is low because of the length of time until the benefits are realised.

$$\frac{\left[1 - \left(\frac{1}{(1+i)^n}\right)\right]}{i} \quad (1)$$

where
n is the number of years
i is the discount rate(%)

The procedure for calculating benefit-cost ratios is outlined below:

- calculate the average annual benefit associated with the option (i.e. the reduction in average annual damages) using the method described in Section 6;
- convert the average annual benefit to a total benefit by multiplying by the present value factor; and
- calculate the total cost of the option.

Calculate the monetary **benefit-cost** ratio:

$$\text{Benefit - Cost Ratio} = \frac{\text{Total Benefit}}{\text{Total Cost}}$$

It is important to recognise that the monetary benefit-cost ratios represent only one of the issues that must be considered in respect to the viability of an option. Other issues such as social and psychological impacts, although difficult to quantify, must be included in the complete assessment.

Benefit-cost ratios may be sensitive to variations and/or inaccuracies in the following:

- difficulties associated with upgrading pipes under existing roads;
- service conflicts;
- difficulties associated with trenching near buildings and power poles; and
- construction, maintenance and operation costs.

Data from Melbourne Water's Land Development Manual and Melbourne Water rate estimates for drainage works were used to estimate the total cost of each option. These rates are summarised in Appendix A. The rates for stormwater pipes and rising mains were factored by 1.5 for sections constructed alongside or under minor roads, and by a further 1.4 for 'jacking' under Princes Hwy. Stormwater pipes were costed on the basis of flush jointed construction with 100% fine crushed rock backfill. An allowance for engineering and contingencies of 15% and 20% respectively has been allowed for in the proposed works with an Administration allowance of 9% (applied to the cost estimate inclusive of the engineering allowance).

Maintenance costs were calculated based on recommendations made in the CoGG publication, Report on Asset Maintenance Benchmarking (GHD, 1997). Table Two of this report shows that CoGG are currently spending 0.4% of asset value on maintenance of drainage assets and recommends expenditure be increased to 2.4% of asset value. BMT WBM have adopted the recommended value of 2.4%.

8.1.2 Scheme One

The damages under Scheme One for each design flood event are summarised in Table 8-2 and illustrated in Figure 8-1. The Scheme One AAD, also presented in Table 8-2, is \$32,000, which is a reduction of \$8,000 from the existing conditions AAD of \$40,000. In calculating the AAD, the damages in the PMF were assumed to be the same as the existing case.

A summary of the capital costs for Scheme One is presented in Table 8-3 and the benefit cost analysis is summarised in Table 8-4. The BCR for Scheme One is 0.03. Based on the figures presented in Table 7-3 and Table 8-3, the capital cost of Scheme One per property floor saved from flooding during a 1% AEP flood event is \$370,000.

Table 8-2 Scheme One Damages Summary

Event		Scheme One			
(Years ARI)	AEP	House Damages	Indirect Damages	Total Damages	Incremental Average Annual Damages
PMF ⁺	0.0%			\$ 333,000	
100	1%	\$ 221,000	\$ 66,000	\$ 287,000	\$ 3,000
20	5%	\$ 78,000	\$ 23,000	\$ 102,000	\$ 8,000
5	20%	\$ 44,000	\$ 13,000	\$ 58,000	\$ 12,000
2	50%	\$ -	\$ -	\$ -	\$ 9,000
Average Annual Damage					\$ 32,000

* Note – PMF damages are an extrapolation of the 1% AEP data, ie, they were not calculated using PMF flood levels

Table 8-3 Scheme One Capital Cost Estimates

Item	Capital Cost
Retarding Basin Works	\$1,527,000
Contingencies (20%)	\$305,000
Engineering (15%)	\$229,000
Administration (9%)	\$158,000
Total	\$2,219,000

Table 8-4 Scheme One BCR Summary

Item	Existing	Scheme One
Damages (PA)	\$40,000	\$ 32,000
Benefit (PA)		\$ 8,000
Benefit (NPV)		\$ 99,000
Capital Cost		\$ 2,219,000
Maintenance (PA)		\$ 53,000
Maintenance (NPV)		\$ 658,000
Total Option Cost		\$ 2,878,000
BCR		0.03

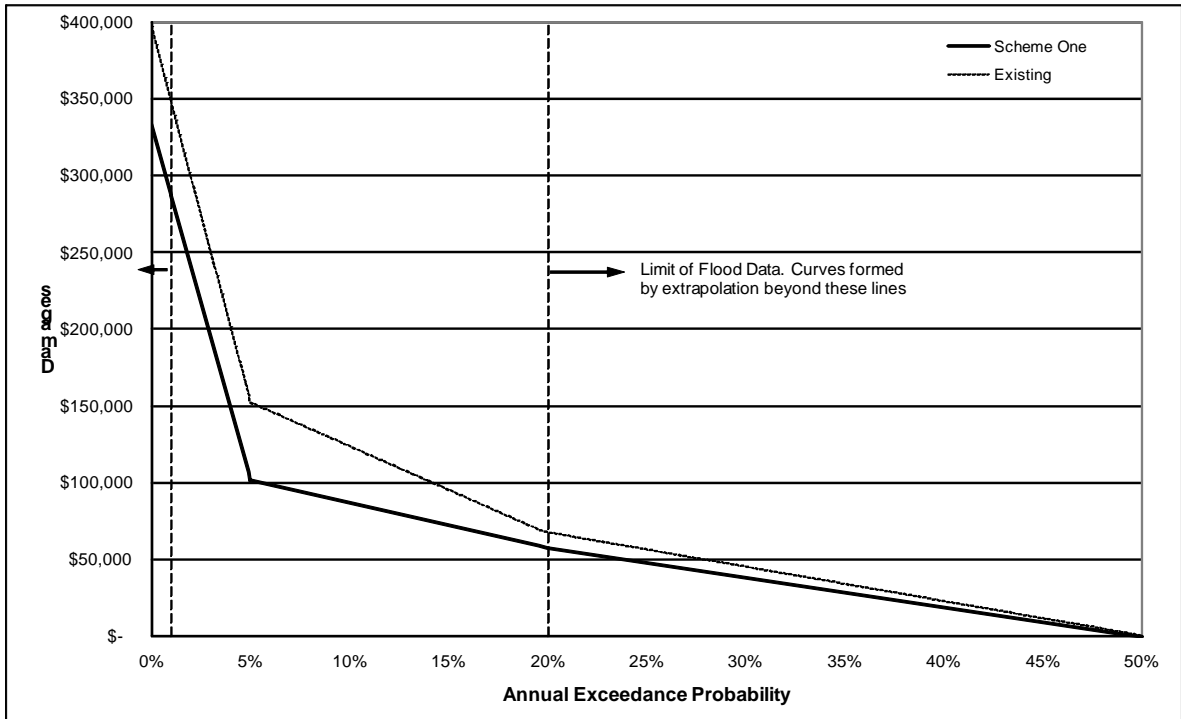


Figure 8-1 Scheme One Probability Damages Curve

8.1.3 Scheme Two

The damages under Scheme Two for each design flood event are summarised in Table 8-5 and illustrated in Figure 8-2. The Scheme Two AAD, also presented in Table 8-5, is \$26,000, which is a reduction of \$14,000 from the existing conditions AAD of \$40,000. In calculating the AAD, the damages in the PMF were assumed to be the same as for the existing case.

A summary of the capital costs for Scheme Two is presented in Table 8-6 and the benefit cost analysis is summarised in Table 8-7. The BCR for Scheme Two is 0.02. From the figures presented in Table 7-4 and Table 8-6, the capital cost of Scheme Two per property floor saved from flooding during a 1% AEP flood event is \$398,000.

Table 8-5 Scheme Two Damages Summary

Event		Scheme Two			
(Years ARI)	AEP	House Damages	Indirect Damages	Total Damages	Incremental Average Annual Damages
PMF ⁺	0.0%			\$ 162,000	
100	1%	\$ 115,000	\$ 34,000	\$ 149,000	\$ 2,000
20	5%	\$ 74,000	\$ 22,000	\$ 97,000	\$ 5,000
5	20%	\$ 42,000	\$ 13,000	\$ 54,000	\$ 11,000
2	50%	\$ -	\$ -	\$ -	\$ 8,000
Average Annual Damage					\$ 26,000

*Note – PMF damages are an extrapolation of the 1% AEP data, ie, they were not calculated using PMF flood levels

Table 8-6 Scheme Two Capital Costs

Item	Capital Cost
Retarding Basin Works	\$1,527,000
Kosciusko Ave Pipe Works	\$2,302,000
Contingencies (20%)	\$766,000
Engineering (15%)	\$574,000
Administration (9%)	\$396,000
Total	\$5,565,000

Table 8-7 Scheme Two BCR Summary

Item	Existing	Scheme 2
Damages (PA)	\$ 40,000	\$ 26,000
Benefit (PA)		\$ 14,000
Benefit (NPV)		\$ 174,000
Capital Cost		\$ 5,565,000
Maintenance (PA)		\$ 134,000
Maintenance (NPV)		\$ 1,663,000
Total Option Cost		\$ 7,228,000
BCR		0.02

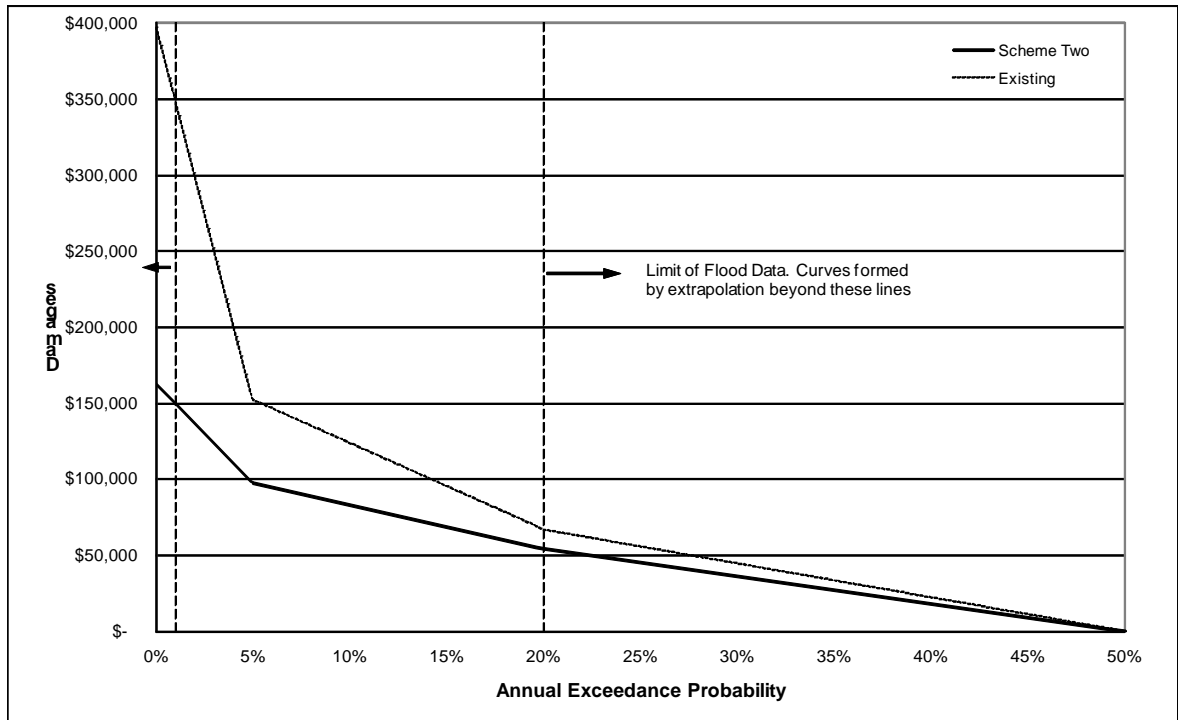


Figure 8-2 Scheme Two Probability Damages Curve

8.1.4 Scheme Three

The damages under Scheme Three for each design flood event are summarised in Table 8-8 and illustrated in Figure 8-3. The Scheme Three AAD, also presented in Table 8-8, is \$20,000, which is a reduction of \$20,000 from the existing conditions AAD of \$40,000. In calculating the AAD, the damages in the PMF were assumed to be the same as for the existing case.

A summary of the capital costs for Scheme Three is presented in Table 8-9 and the benefit cost analysis is summarised in Table 8-10. The BCR for Scheme Three is 0.02. From the figures presented in Table 7-5 and Table 8-9, the capital cost of Scheme Three per property floor saved from flooding during a 1% AEP flood event is \$706,000.

Table 8-8 Scheme Three Damages Summary

Event		Scheme Three			
(Years ARI)	AEP	House Damages	Indirect Damages	Total Damages	Incremental Average Annual Damages
PMF ⁺	0.0%			\$ 123,000	
100	1%	\$ 86,000	\$ 26,000	\$ 112,000	\$ 1,000
20	5%	\$ 52,000	\$ 16,000	\$ 68,000	\$ 4,000
5	20%	\$ 34,000	\$ 10,000	\$ 44,000	\$ 8,000
2	50%	\$ -	\$ -	\$ -	\$ 7,000
Average Annual Damage					\$ 20,000

*Note – PMF damages are an extrapolation of the 1% AEP data, ie, they were not calculated using PMF flood levels

Table 8-9 Scheme Three Capital Costs

Item	Capital Cost
Retarding Basin Works	\$1,527,000
Kosciusko Ave Pipe Works	\$3,807,000
Sharland Drv Pipe Works	\$425,000
Hendy St Pipe Works	\$12,000
Bund Works	\$7,000
Channel Works	\$1,439,000
Miscellaneous Structures (Grated inlet pits)	\$60,000
Contingencies (20%)	\$1,456,000
Engineering (15%)	\$1,092,000
Administration (9%)	\$753,000
Total	\$10,578,000

Table 8-10 Scheme Three BCR Summary

Item	Existing	Scheme 3
Damages (PA)	\$ 40,000	\$ 20,000
Benefit (PA)		\$ 20,000
Benefit (NPV)		\$ 248,000
Capital Cost		\$ 10,578,000
Maintenance (PA)		\$ 254,000
Maintenance (NPV)		\$ 3,152,000
Total Option Cost		\$ 13,754,000
BCR		0.02

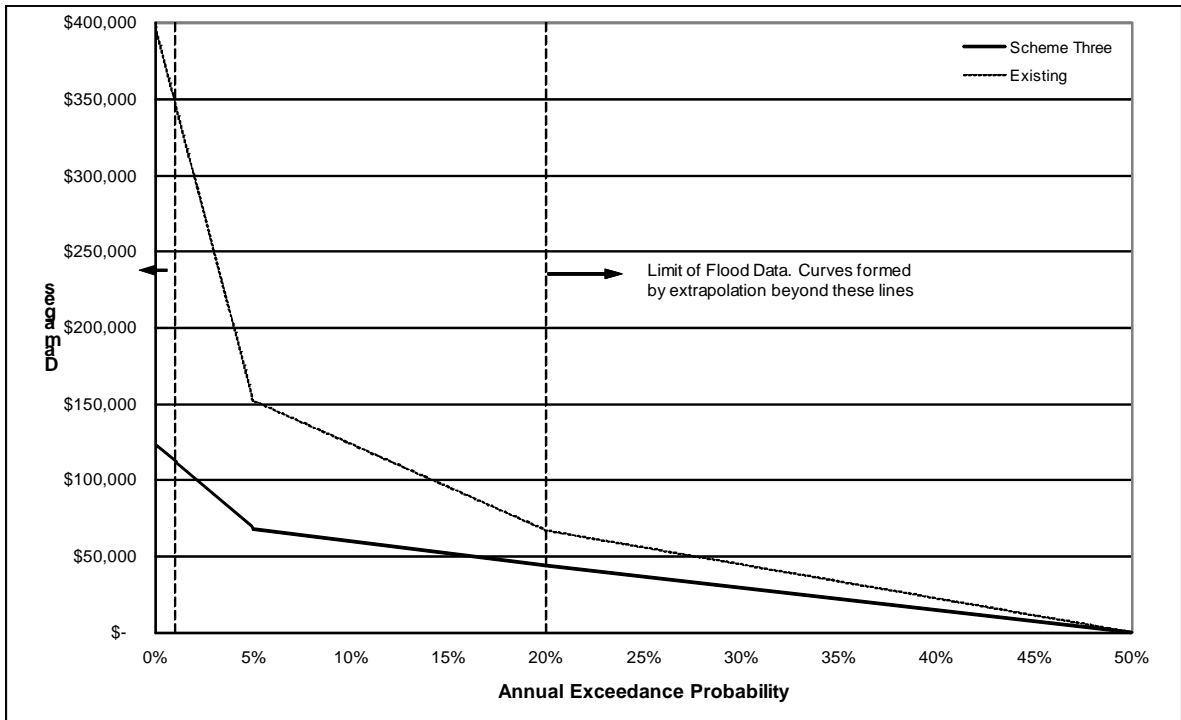


Figure 8-3 Scheme Three Probability Damages Curve

8.2 Environmental Assessment

Environmental impacts, associated with the construction and operation of each flood mitigation option, are discussed in this section. Table 8-11 presents details regarding the environmental implications for each scheme in the Kosciusko Avenue MD catchment. It is not anticipated that any of the schemes will have long-term environmental impacts.

Table 8-11 Environmental Implications

FLOOD MITIGATION SCHEMES				
ISSUE	Scheme One	Scheme Two	Scheme Three	Scheme Four “Do Nothing” (Existing Case)
Ecological impact.	No Change	No Change	No Change.	No Change.
Noise.	Minor impacts associated with the construction of retarding basin works.	Moderate impacts associated with the construction of retarding basin and pipe works.	Same as Scheme Two, but additional minor impacts associated with the construction of bund walls.	No Change.
Receiving Water Quality.	Insignificant impact. Augmentation of the retarding basin will lead to a greater risk of sediment entering the receiving waters during the construction and establishment phases of the Scheme. A thorough Construction Management Plan would be required for any works to minimise sediment entering the receiving water during construction of the proposed mitigation options.	Similar to Scheme One.	Same as Scheme Two.	No Change.
Air.	Minimal impact. Manage via construction management plan.	Minimal impact. Manage via construction management plan.	Minimal impact. Manage via construction management plan.	No Change.

8.3 Social Assessment

Table 8-12 outlines the social implications related to each flood mitigation scheme proposed for the Kosciusko Avenue MD catchment.

Table 8-12 Social Indicators

ISSUE	FLOOD MITIGATION SCHEMES			
	Scheme One	Scheme Two	Scheme Three	Scheme Four “Do Nothing” (Existing Case)
Recreation and Aesthetic.	High impact. Major impacts to the public sports fields during the construction of the Plantation Road retarding basin augmentation. The fields will be suitable for use during and after minor rainfall events but inaccessible during major events. Aesthetic values may be impacted during construction of the various components of the mitigation scheme.	Same as Scheme One.	Same as Scheme One. The proposed bunds need to be designed and landscaped to minimise visual impact.	No Change.
Cultural Heritage.	Manage via Cultural Heritage Management Plan.	Same as Scheme One.	Same as Scheme One.	No Change.
Public Safety.	Risk would be minimal during construction. Manage risk with appropriate construction phase management plans. Some potential risk from large drainage structures. Manage with best practice design. Potential risk with the sports fields forming part of the retarding basin. This issue can be managed through signage and education.	Same as Scheme One. Moderate risk due to potentially deep trenching along Kosciusko Avenue. Manage risk with appropriate construction phase management plans. Reduction in extent of unsafe flooding along Kosciusko Ave. Unsafe flooding generally contained within roads.	Same as Scheme One and Two. Potential risk with the proposed open channel when in flood. This risk can be managed through the installation of fencing/barriers.	No Change. Areas of unsafe flooding would remain.

8.4 Feasibility and Performance Indicators

Table 8-13 presents the feasibility and performance indicators for the Kosciusko Ave mitigation schemes.

Table 8-13 Feasibility and Performance Indicators

ISSUE	FLOOD MITIGATION SCHEMES			
	Scheme One	Scheme Two	Scheme Three	Scheme Four “Do Nothing” (Existing Case)
Maintenance costs.	Increases associated with augmented retarding basin.	Same as scheme One. Increases associated with new and upgraded pipe systems.	Same as scheme One. Increases associated with the new pipes, inlets, open channel and new bund walls.	No Change
Ease of Construction	Uncomplicated excavation, compaction and re-grading works.	Same as Scheme One. Difficulties associated with the laying of new pipes, in particularly under Princes Hwy whilst minimising disruption to traffic flow.	Same as Scheme Two	Not applicable.
Funding and feasibility.	High capital costs and a low BCR of 0.03 would make funding difficult. Capital cost of Scheme per property floor saved from flooding during a 1% AEP flood event is lowest at \$370,000.	High capital cost and a low BCR of 0.02 would make funding difficult. Capital cost of Scheme per property floor saved from flooding during a 1% AEP flood event is \$398,000.	High capital cost and a low BCR of 0.02 would make funding difficult. Capital cost of Scheme per property floor saved from flooding during a 1% AEP flood event is \$706,000.	Not applicable.
Public acceptability.	There would be minor issues related to this scheme as works are only proposed for the Plantation Road retarding basin and would only cause minimal direct disruption to the public.	There may be some issues during the construction of the proposed measures due to property access, construction dust and noise.	Same as Scheme Two	Issues relating to Council being seen to be doing nothing structurally about the problem.

9 PREFERRED MITIGATION SCHEME

9.1 Description of Preferred Scheme

Scheme Two is the preferred mitigation scheme for the Kosciusko Avenue MD catchment. Through consultation with the CoGG, the preferred scheme was selected as it focuses on the mitigation of overland flows and flood depths to reduce the flood hazard within the Kosciusko Avenue MD Catchment.

As documented in previous sections, and summarised below in Table 9-1, Scheme Two more than doubles the number of floors saved with a \$3.4M increase in capital cost. In comparison, Scheme Three requires an additional \$5M to save one additional floor in the 1 % AEP event. Hence, Scheme Two has significantly more flood benefit for the community, in terms of reducing flooded floors and flood hazard, whilst maintaining a feasible capital cost per floor saved.

Table 9-1 Comparison of Scheme One, Scheme Two and Scheme Three

Scheme	Capital Cost	BCR	Flooded Floors Saved in 1% AEP Flood Event*	Capital Cost per floor saved (1% AEP Flood Event)
One	\$2,219,000	0.03	6	\$370,000
Two	\$5,565,000	0.02	14	\$398,000
Three	\$10,578,000	0.02	15	\$706,000

* Results based on properties surveyed by CoGG.

Also considered in the selection of the preferred scheme were key indicators such as environmental, social and feasibility and performance. This analysis in regard to the preferred scheme, when compared to the other schemes, is summarised as follows:

- its potential environmental impact is minimal and similar to the other schemes;
- the social impacts arising from Scheme Two are very limited; and
- the feasibility and performance are comparable to the other schemes.

9.2 Structural Components

Scheme Two is schematised in Figure 7-2 and involves the following key elements:

- The augmentation of the Plantation Road retarding basin to the extent of Council's property to maximise storage volume with a 1 in 5 embankment slope for safety and maintenance purposes. The current grade and minor table drains of the existing sports fields are maintained to ensure adequate drainage in minor rainfall events.
- A new twin 1350 mm RCP along a similar alignment to the existing 1950 mm RCP from the retarding basin to the open channel. The proposed outlets are not connected to any side entry or grated entry pits to maximise the hydraulic performance of the proposed pipe.

Increased surveillance of critical drainage assets for blockages or obstructions is also recommended until such time as the works recommended above have been constructed.

Further reductions in the number of flood affected properties under Scheme Two may be achieved through localised works. It is recommended that the City investigate the feasibility of localised flood mitigation measures, such as lifting footpaths &/or underground drainage augmentation, in order to reduce the flood risk for properties at the intersection of Streeton Close & McCubbin Court.

9.3 Non-Structural Components

In addition to the structural works associated with Scheme Two, a number of additional recommendations are made in regard to the protection of individual buildings and property not provided with flood immunity by the preferred strategy. The following section summarises the additional components recommended for use in conjunction with Scheme Two.

A number of non-structural components are recommended for implementation in conjunction with the structural measures. These additional measures are summarised below.

- Further investigation into the feasibility of property-specific measures to manage risk from residual flooding (with Scheme Two in place). Potential measures include flood proofing of individual (or groups) of buildings/properties by landowners, and property buy-back with on-sell following modifications (where feasible) with conditions known to purchaser. This may be a feasible and economical alternative considering that house values are approximately \$200,000 to \$300,000 in the area, whereas the capital cost per floor saved in the 1% AEP event for Scheme Two is approximately \$398,000.
- Education and awareness program to inform landowners how to minimise the magnitude of damage during a flood event.
- Development controls via designation of areas as liable to flooding (in accordance with Building Regulations 2006) and use of flood zones/overlays within the Greater Geelong Planning Scheme.
- Recognition that further development within the catchment has the potential to increase flood risk to people and property. Assessment of rezoning proposals to include application of principle of zero adverse flood impact on adjacent, upstream and downstream areas. Assessment of development and subdivision applications (planning permit) to include application of best practice guidelines for development within or upstream of flood-prone areas.
- Best practice environmental management for stormwater runoff to be encouraged as part of development and subdivision applications in order to reduce runoff and improve water quality, where not a statutory requirement.

9.4 Flood Mapping of Preferred Scheme

Flood mapping has been undertaken for the preferred strategy for each flood event as follows:

- Flood Impacts - Figure 7-6 to Figure 7-8; and
- Flood Hazard Maps - Figure 9-1 to Figure 9-3.

The flood hazard maps (Figure 9-1 to Figure 9-3) show areas of increase flood hazard where floodwaters have ponded (Plantation Road RB and behind the Princess Highway road embankment). Appropriate signage may need to be provided in these areas to inform the public of the risk floodwaters pose to their safety.

Large scale A1 plans show detailed mapping of flood extent and flood impacted properties for each of the 1%, 5% and 20 % AEP events. These have been provided to CoGG as part of the data delivery in hard copy and digital GIS formats.

9.5 Funding of Preferred Scheme

Funding mechanisms available to Council for the upgrade of drainage infrastructure typically fall into one of two categories:

- **Private Benefit** for which a user-charge typically applies associated with a direct link between the infrastructure provided and the benefit received; and
- **Public Benefit** is related to infrastructure that provides a benefit to the wider community throughout the municipality.

Clearly, augmentation works undertaken within the Kosciusko Avenue MD catchment are for the direct benefit of those residents with an existing flooding problem or threat. There also exists an indirect benefit to those residents within the catchment associated with increased trafficability of roads subject to flooding, as well as public health and safety issues and other non-economic benefits. Benefit may also be deemed to apply to residents with properties that are not flood effected but discharge stormwater within the catchment. This principle of catchment wide benefit within drainage schemes has been successfully implemented under legislation previous to the Local Government Act 1989.

Special Rates and Charges are the typical mechanism for funding of drainage works under user charges. Section 163 of the Local Government Act 1989 sets out the provisions for the application of a special rate, charge or combination of these. The purpose of the rate or charge is to recoup costs associated with the provision of infrastructure. The charge is typically a one-off payment while a rate is generally an annual payment made over a number of years.

Recent decisions handed down at VCAT or AAT suggests a more confined application of special rates and charges particularly in relation to main drainage augmentation schemes. In essence the Ball decision (Appeal No 1993/37685) concluded:

- a special rate or charge can only be levied where a special benefit is received;
- the special benefit must be received by the land owners (rather than the property);
- in this context, a special benefit was recognised by the Tribunal as an increase in property values.

That is, according to the Tribunal, while every property in the catchment receives, to a greater or lesser degree, a benefit from the main drainage augmentation works, that benefit does not translate into an increase in property values and is therefore not a *special benefit*. Thus, according to the tribunal, funding via special rates and charges is not applicable.

Furthermore, the Tribunal ruled that where:

... properties are already drained to lawful points of discharge and the provision of additional capacity in the main drainage system, although obviously required to drain the entire catchment, will not provide a special benefit to them as owners of their land.

Appeal No 1993/37685 pg 7

This would indicate that the main drainage augmentation works within an area with made and kerbed streets is not considered by the Tribunal to provide a specific benefit to property owners in the catchment. Therefore the ruling would imply that in the case of the Kosciusko Avenue MD catchment area, funding via special rates and charges may be problematic due to potential legal uncertainty and social resistance.

It is recommended that Council seek independent legal advice to confirm the rationale of a test case involving a special rates and charges scheme.

9.6 Strategy for Implementation

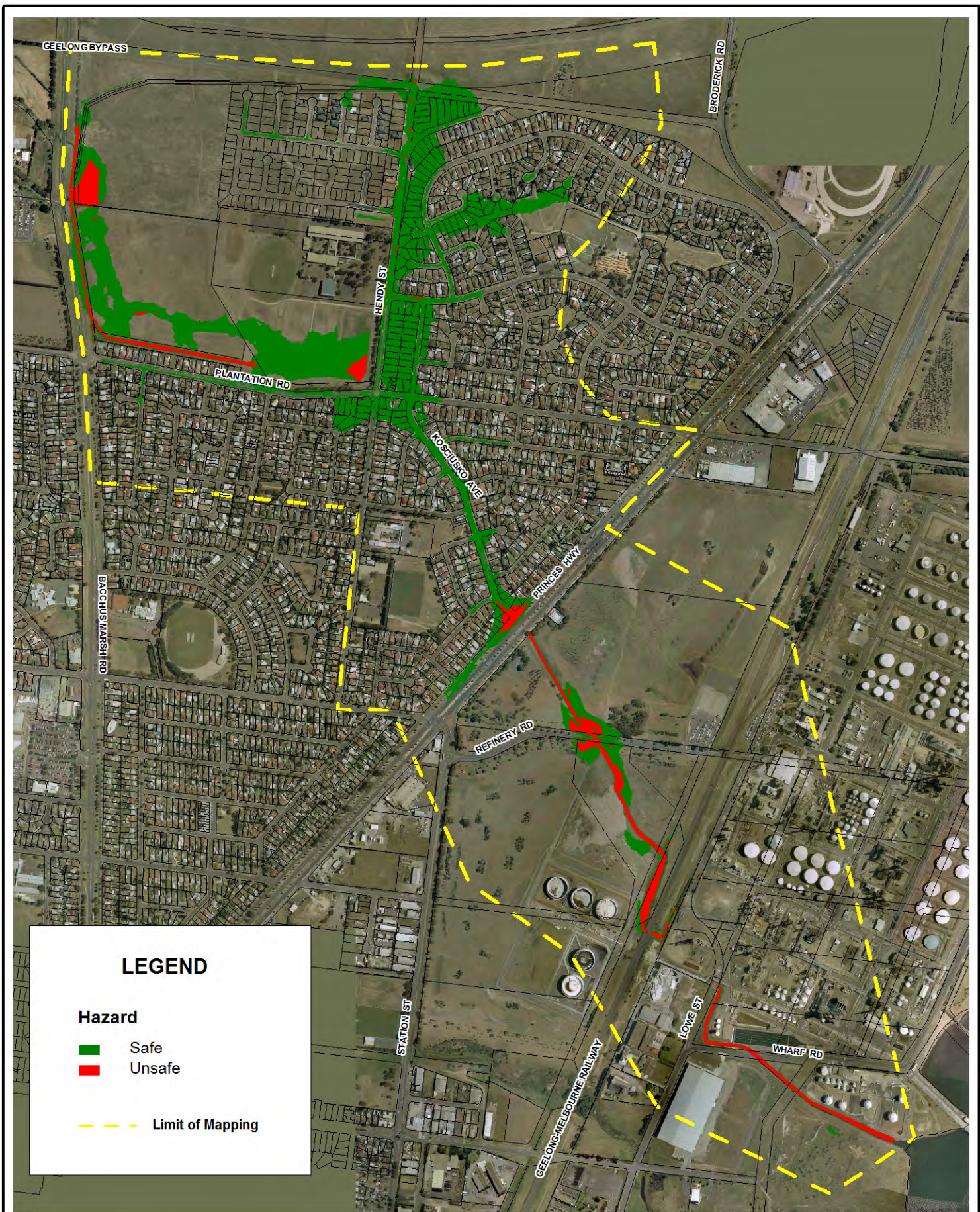
The capital cost for the catchment is approximately \$5.6M. Council currently allocates approximately \$2M per annum for major drainage works. Assuming that \$0.5M per annum could be allocated for this project, then the construction program could be staged over a period of 11 years. Allowing four years for the determination and arrangement of funding sources and the design of the drainage works, the period of implementation would be 15 years.

It is worth noting that the proposed pipe outlet from the Plantation Road RB is a separate system, not connected to the existing pipe drainage network. As a result, the staged construction would not yield any drainage/flood benefit until the final stage of the pipe outlet is connected to the RB. As an alternative funding and construction staging option, the basin and piped outfall could be constructed separately and the funds for each stage be invested until construction occurred. For the RB, this would occur in year 7, with the construction of the pipe outlet in Year 15.

The 15 year schedule allows for one year for the determination and arrangement of funding sources and two years for the design of the drainage works. The designation of flood levels and application of flood zones/overlays would occur in the first 2 years, individual flood proofing would commence in year 3 and an education and awareness program would be ongoing. An approximate schedule of implementation is shown in Table 9-2.

Table 9-2 Implementation Schedule

Item	Year 1	Year 2	Year 3	Year 4	Year 5 to 15
Determine Funding Source(s) and Prepare Business Case.	■				
Detailed Design of Scheme Two		■	■		
Staged Construction of Scheme Two				■	■
Designation and Dissemination of Flood Information.	■				
Planning Scheme Amendment (Flood Zones/Overlays).		■			
Individual Flood proofing.			■	■	■
Education and Awareness Program.	■	■	■	■	■



LEGEND

Hazard

- Safe
- Unsafe

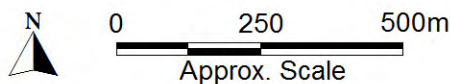
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Title:
Preferred Scheme
20% AEP Flood Hazard

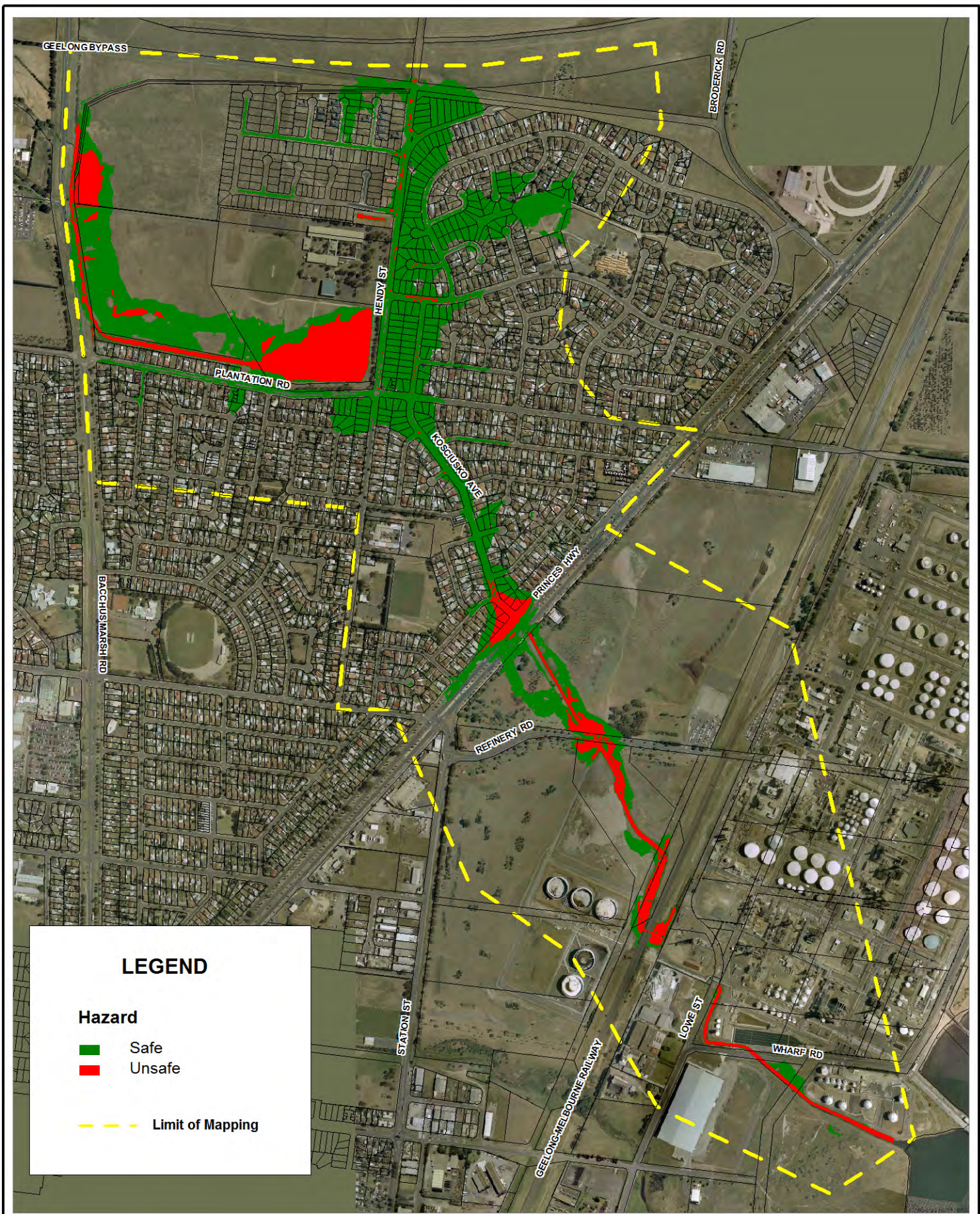
Figure:
9-1

Rev:
B

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LEGEND

Hazard

- Safe
- Unsafe

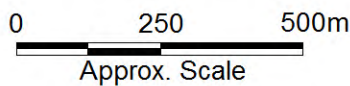
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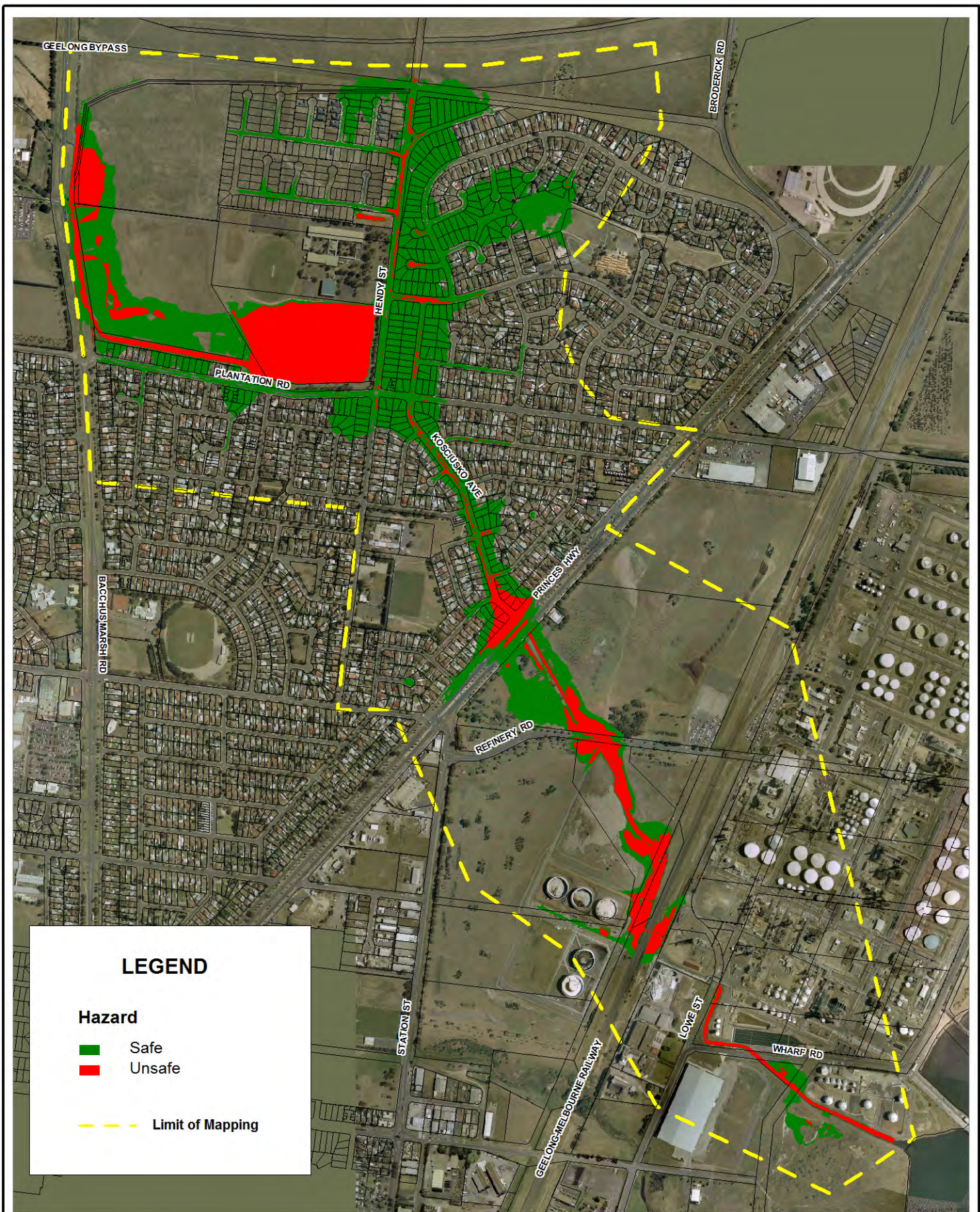
Title:
**Preferred Scheme
 5% AEP Flood Hazard**

Figure:
9-2

Rev:
B

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LEGEND

Hazard

- Safe
- Unsafe

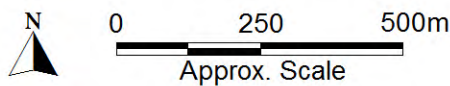
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Title:
**Preferred Scheme
 1% AEP Flood Hazard**

Figure:
9-3

Rev:
B

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10 PUBLIC CONSULTATION PROCESS

The Draft Report of the Kosciusko Ave MD Drainage/Flood Study and associated flood mapping were placed on public exhibition with an invitation for submissions. The general public was advised of the exhibition via public notices, and owners of properties affected by the 100 year ARI flood extent within the study area (approximately 401 properties) received individual letters with explanatory sheets.

A total of 12 submissions were received. A written submission was received from the owners of one property with the remaining eleven being verbal submissions or enquiries. Some of the submitters acknowledged that their properties or roads had experienced flooding in the past in a manner consistent with the Study's flood-mapping. The major issues of concern and the City's responses are listed in Appendix C.

11 REFERENCES

BMT WBM (2009). *Kosciusko Ave Main Drain Flood Study Interim Report - Hydrology*. Report prepared by BMT WBM for the City of Greater Geelong, BMT WBM Report No. R.M7299.003.00.DraftReport_MT_Review.doc, February 2009.

APPENDIX A: CONSTRUCTION RATES

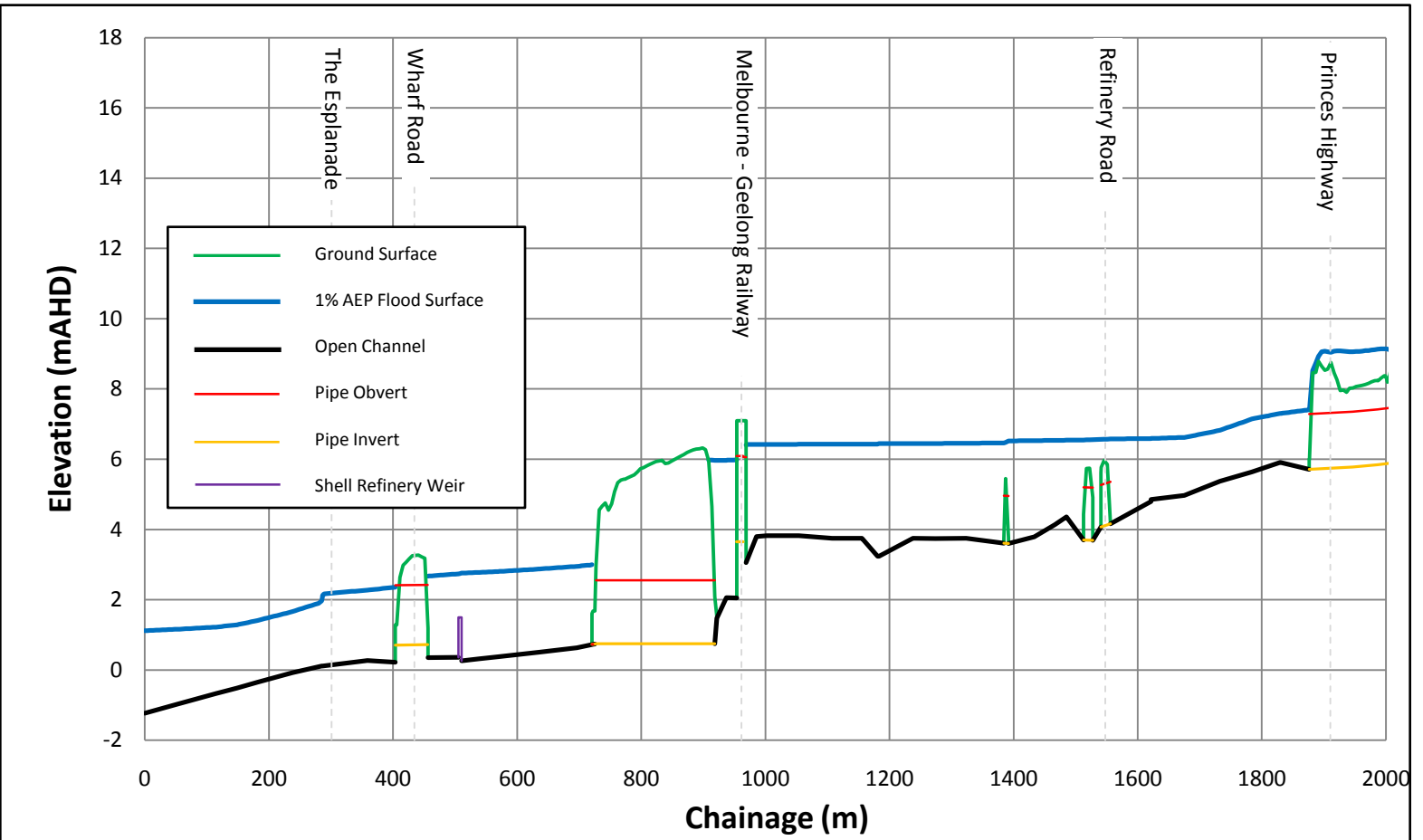
Table A-1 Melbourne Water Pipeline Rates (2010)

West Region Pipeline Rates (\$ per m)			
Nominal pipe diameter (mm)	Interlocking / Flush Jointed pipes	Adopted rates for pipes in road reserves	'Jacking' Rates
	100% FCR backfill	100% FCR backfill	
300	129	194	271
375	156	234	328
450	188	282	395
525	218	327	458
600	249	374	523
675	276	414	580
750	309	464	649
825	343	515	720
900	378	567	794
1050	460	690	966
1200	570	855	1197
1350	696	1044	1462
1500	841	1262	1766
1650	1,013	1520	2127
1800	1,244	1866	2612
1950	1,538	2307	3230
2100	1,901	2852	3992
2250	2,452	3678	5149
2400	3,061	4592	6428

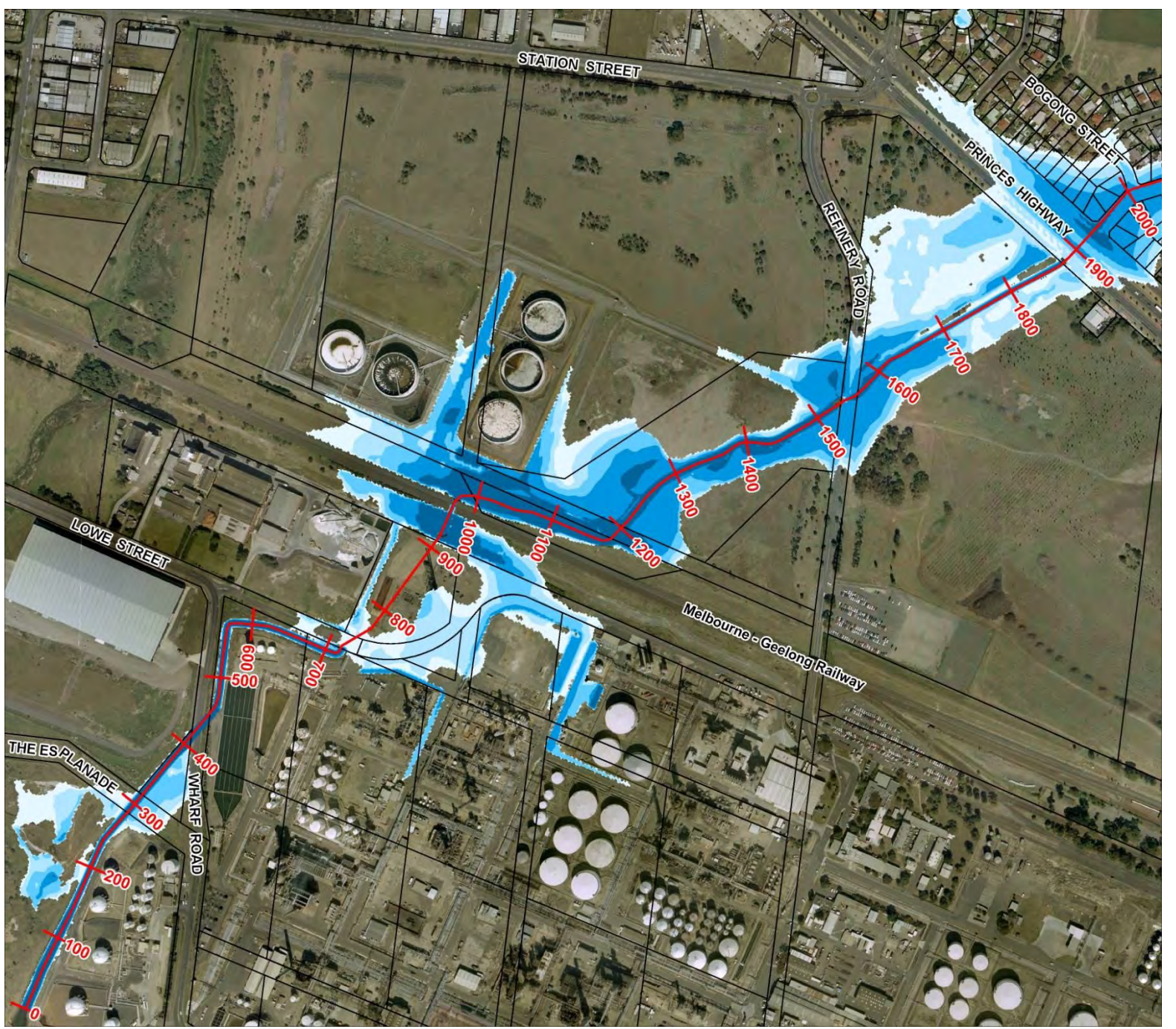
Table A-2 Melbourne Water Infrastructure Unit Rates

Infrastructure	Unit	Rate
Channel Works		
Excavation Rate	\$/m ³	12
Revegetation Rate	\$/m ²	10
Top Soiling Rate	\$/m ³	17
Traffic management (Kosciusko Avenue)	\$	20,000
Traffic management (Princes Highway)	\$	200,000
Land Acquisition (School Property)	\$/m ²	200
Structures		
RB Outlet structures	\$/unit	100,000
Grated Entry structures (high capacity)	\$/unit	3,500
Earthworks		
Excavation	\$/m ³	12
Disposal of surplus soil	\$/m ³	10
Construction and Compaction	\$/m ³	18
Topsoiling (100mm)	\$/m ³	17
Grassing	\$/m ²	1
Miscellaneous		
Relocation/protection of services (approximate estimate)	\$	200,000
Kerb and channel removal & Re-grading (approximate estimate)	\$	50,000
Concrete access crossings over proposed open channel	\$/unit	20,000

APPENDIX B: LONGITUDINAL PROFILE PLOTS



Chainage (m)	Ground Surface (m AHD)	Flood Surface (m AHD)
0	0.14	1.12
100	0.17	1.21
200	0.98	1.49
300	1.02	2.19
400	1.28	2.35
500	1.32	2.73
600	1.60	2.84
700	1.68	2.96
800	5.74	5.67
900	6.32	5.95
1000	3.82	6.42
1100	3.75	6.43
1200	3.75	6.45
1300	3.75	6.45
1400	3.75	6.62
1500	4.41	6.64
1600	4.70	6.59
1700	5.13	6.71
1800	5.64	7.20
1900	8.54	9.07
2000	8.34	9.14



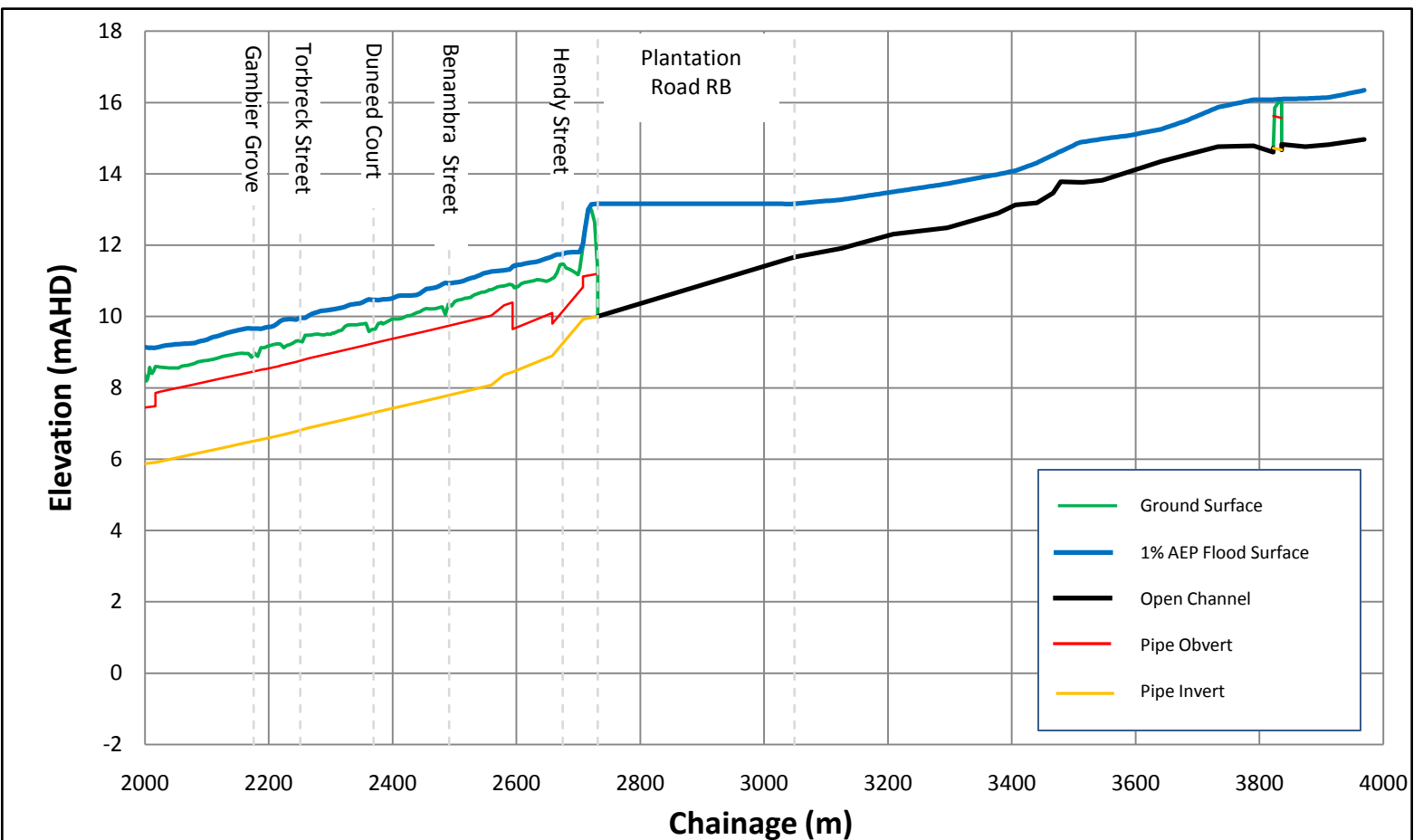
1% AEP Existing Conditions Flood Surface Longitudinal Profile
Bacchus marsh Road to Corio Bay (Part A)

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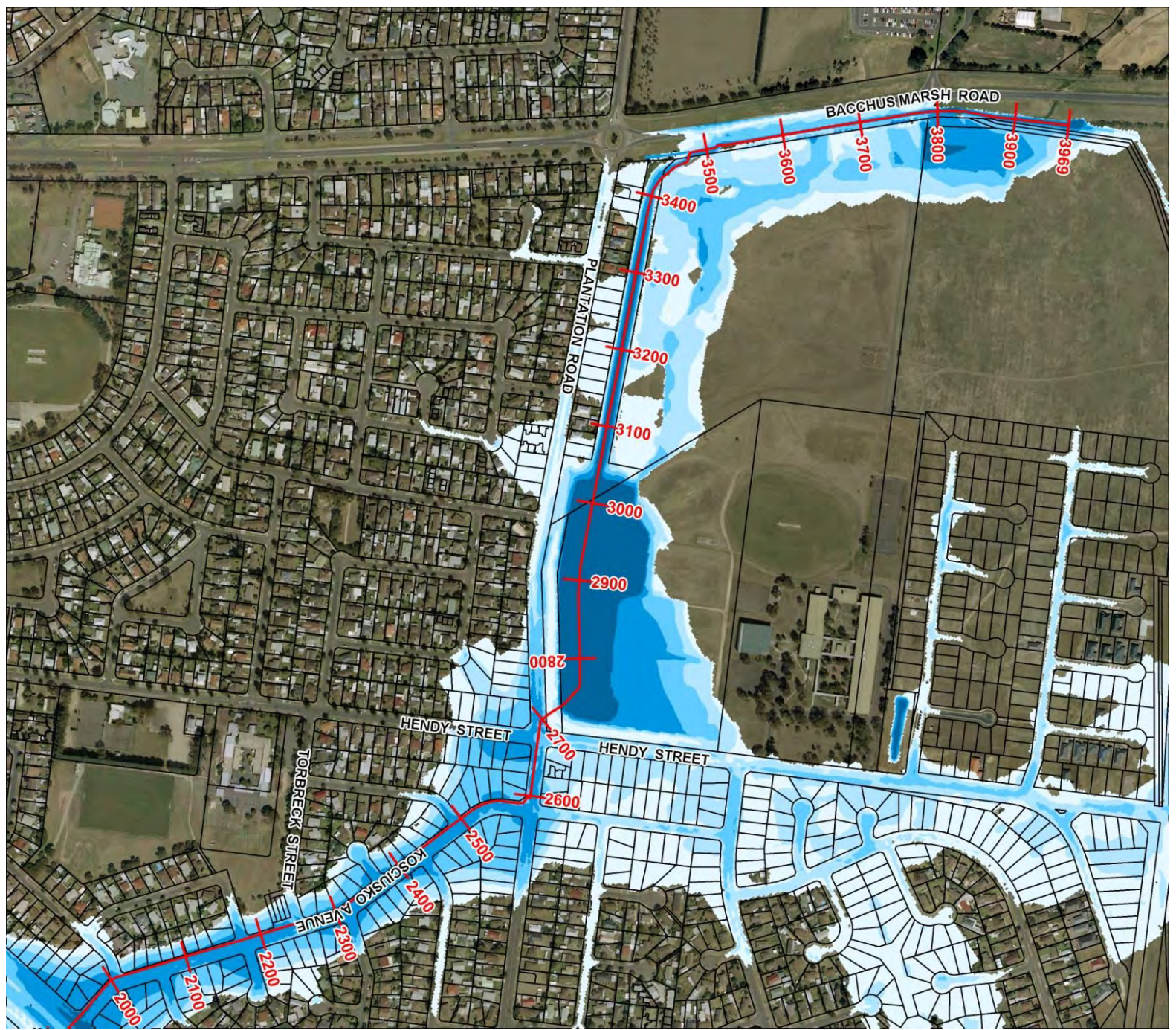


Figure: B-1
Rev: A





Ground Surface (m AHD)	8.34	8.77	9.17	9.50	9.94	10.42	10.81	11.17	10.83	11.12	11.34	11.84	12.30	12.63	13.11	13.96	14.58	14.85	15.39	15.84	15.53
Flood Surface (m AHD)	9.14	9.36	9.71	10.20	10.52	10.95	11.44	11.81	13.16	13.16	13.16	13.24	13.47	13.73	14.07	14.81	15.12	15.63	16.08	16.13	16.36
Chainage (m)	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800	3900	3969



1% AEP Existing Conditions Flood Surface Longitudinal Profile
Bacchus Marsh Road to Corio Bay (Part B)

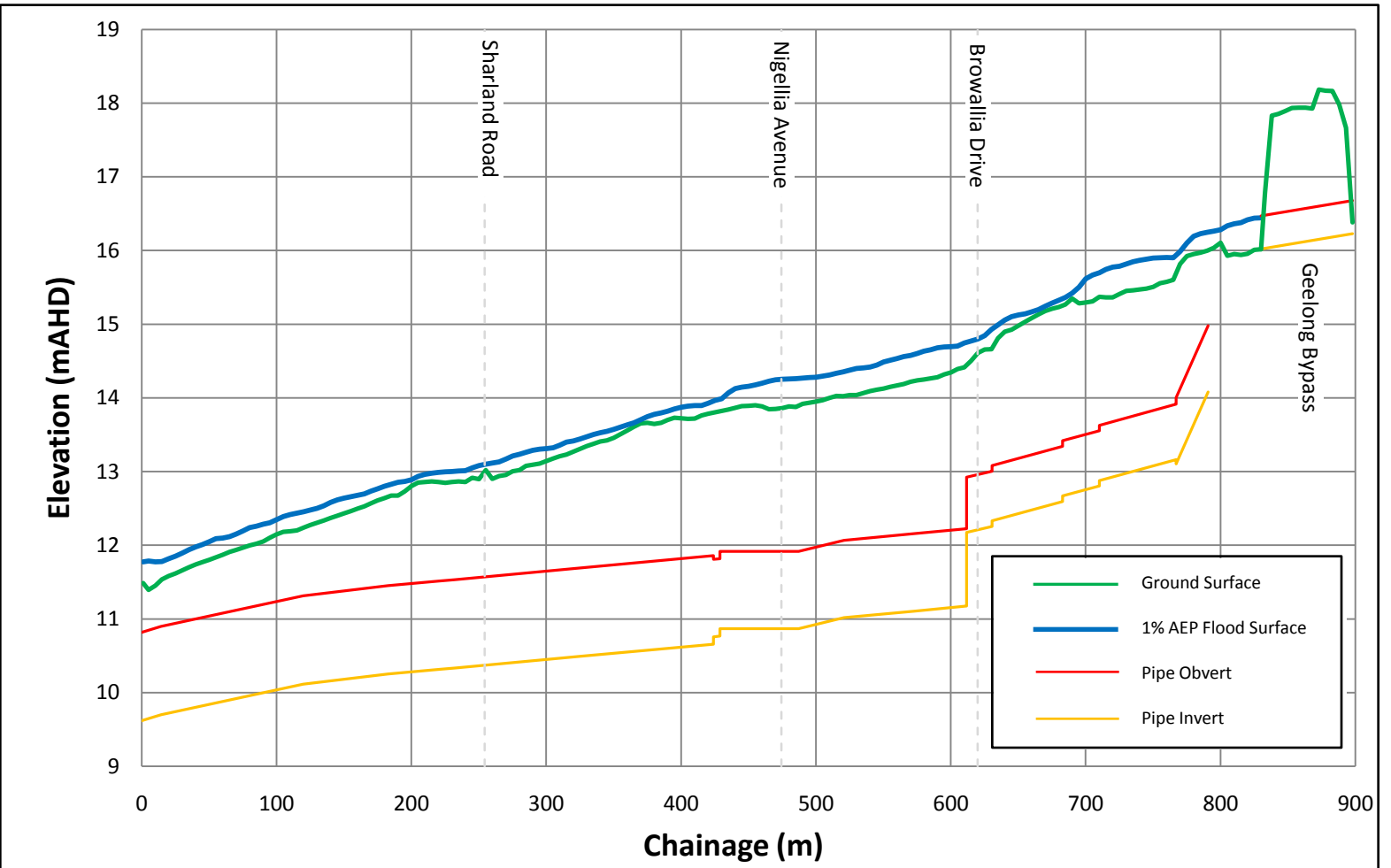
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 Rev: A

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Ground Surface (m AHD)	11.49	12.15	12.81	13.15	13.72	13.95	14.36	15.29	16.13	16.38
Flood Surface (m AHD)	11.77	12.37	12.90	13.32	13.88	14.29	14.69	15.65	16.31	-
Chainage (m)	0	100	200	300	400	500	600	700	800	897



1% AEP Existing Conditions Flood Surface Longitudinal Profile
Geelong Bypass to Kosciusko Avenue

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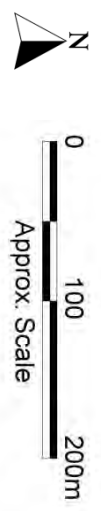


Figure: B-3
Rev: A



APPENDIX C: PUBLIC SUBMISSIONS AND RESPONSES

The major issues of concern raised by owners of affected properties are listed below with the relevant responses:

1. **I believe the construction of the Geelong Ring Road has increased the flooding within the area where I live.**

Response:

The Geelong Ring Road has been designed to maintain the drainage regime that existed along its length prior to its construction.

2. **How can my property be considered subject to flooding when it has never flooded?**

Response:

It cannot be assumed that flooding has not previously or will not occur at any given property, on the basis that there are no records of flooding or flooding to the extent identified by the mapping of the 1 in 100 year overland flows.

There is no evidence that the 1 in 100 year or 100 year Average Recurrence Interval (ARI) flood event for the Kosciusko Av Main Drain Catchment has occurred within living memory. When reliable rainfall figures have been available, proper analysis has indicated that actual storms were less than the critical event for 1 in 100 year flooding within the catchment.

3. **I pay my rates and expect to have a flood-free property in return.**

Response:

The flooding problem within the Kosciusko Av Main Drain Catchment is reflective of the long history of subdivision and development within the catchment, where in general, much lower town planning and infrastructure provision standards were applicable at that time. Community expectations were also lower at that time, with most dwellings constructed with elevated floors (i.e. minimal flood damage was likely).

Any proposal to now provide all private properties with immunity from the 1 in 100 year flood event would have an exorbitant cost and may also not be technically feasible given the significant constraints related to working within built-up areas.

Given all the circumstances, the preferred mitigation scheme (Scheme 2) is considered to be a reasonable and responsible approach to flood management within the Kosciusko Av Main Drain Catchment.

The City has an ongoing program of drainage/flood studies that identifies feasible flood mitigation measures to be prioritised within the City's ongoing capital works program. This process is consistent with best practice for flood management within Victoria and Australia.

4. **Are flood mitigation works proposed?**

Response:

The drainage/flood study included the identification and modelling of flood mitigation options, preparation of cost estimates, feasibility analysis, identification of preferred options and development of a strategy.

Scheme 2 was assessed to be the preferred mitigation scheme and this scheme shall be presented to Council for consideration within future budgets.

5. Will I be required to contribute to the cost of the proposed mitigation works?**Response:**

A definitive answer can not be provided at this point in time, but in recent years the Council has fully funded major drainage works. The final decision would need to be made by Council, based on advice from council officers.

The City's current policy on infrastructure funding allows for contributions from benefiting property owners towards the cost of providing "backlog" drainage infrastructure, which is the situation within the Kosciusko Av Main Drain Catchment. Special Charges schemes under the Local Government Act 1989, which are based on the principle of "special benefit", are normally used to levy these contributions.

The use of Special Charge schemes for easement drainage is well established, however there is some uncertainty regarding schemes for main drainage in areas where properties have "lawful points of discharge". The Final Report of the Study recommends the City seek independent legal advice on main drainage schemes.

6. Will the designation affect my house insurance?**Response:**

The Insurance Council of Australia has advised Melbourne Water that most home insurance policies, which provide coverage for storm damage, include cover for damages resulting from overland flows. Residents are advised to check with their insurance companies, but the nature of flooding, i.e. drainage-related rather than waterway, would need to be disclosed to the insurer.

7. Why was designation or a flood overlay not applicable to my property prior to purchase?**Response:**

The City's knowledge of actual flooding within the Kosciusko Av Main Drain Catchment has tended to be anecdotal in nature and therefore it was not suitable for designation of the 1 in 100 year flood extent, as required under State Government legislation. Reliable and credible flood data relating to the 1 in 100 year flood event is needed and this data can only be derived from a detailed flood study such as the Kosciusko Av Main Drain Catchment Drainage/Flood Study.

The proposed flood overlay on the Planning Scheme is a future planning scheme amendment, as recommended in the Study. The planning scheme amendment generally follows designation by Council under the Building Regulations 2006.

8. Is the information being gathered by Council going to affect property values or saleability?**Response:**

It is important to note that designation of an area as liable to flooding does not cause or change the likelihood of flooding, but recognises the existing condition of land.

The designation will not be described on title, but will be disclosed in Land Information Certificates issued under the Local Government Regulations, and for building permits under the Building Regulations.

The value of any property is determined by the complex interplay of many different factors such as demand/supply, location, streetscape and amenity, and it is difficult to assign what effect if any, the identification of land as liable to flooding may have on the value of a property. Devaluation of properties (identified as being liable to flooding) is considered unlikely once the nature of flooding is explained and taken into account.

9. **If the value of my property is adversely affected by the flood mapping information, is there compensation available?**

Response:

There is no reason for payment of compensation, as nothing has changed about the likelihood of a severe storm occurring or the path that overland flow will take. The City now has accurate information which, in many cases, may already be known by people who have lived at a property for many years.

There is also no case for compensation for subdivision of flood-prone land or construction of dwellings without elevated floors as subdivision and building permit applications were assessed in accordance with the planning scheme provisions and the building regulations, respectively, which were in place at that time.



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