Cardinia Shire Council and South East Water

Pakenham East Growth Area Extension
Whole of Water Cycle Assessment

February 2015

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Executive summary

Pakenham East is a precinct located on the eastern edge of the South East growth corridor adjacent to the existing Pakenham Township and was part of the 2012 logical inclusions extension to Metropolitan Melbourne's Urban Growth Boundary. The precinct is approximately 635 hectares, with a developable area of approximately 440 ha providing land for approximately 6500 residential lots. A Precinct Struture Plan (PSP) is currently being developed by Council.

Council, South East Water and Melbourne Water all have an interest in the development of this area, due to the need to provide various water cycle services to support the development, and to minimise the impact on the environment. GHD were engaged to develop a Whole of Water Cycle management (WOWCM) plan for the precinct. This report summarises the development of the WOWCM plan.

The project was undertaken using the following broad methodology:

- Understand and document the key water assets, issues, opportunities and risks in the area.
- Develop and then assess a list of options to manage the water cycle. This step involved a number of workshops with a wide range of stakeholders.
- Consider the shortlisted options in more detail.

A key element of the approach was the inclusion of a range of stakeholders that formed a 'steering group' on the project. As well as Cardinia Shire Council, South East Water and GHD, the organisations on the steering group were Melbourne Water, OLV, and the MPA. The project included a number of workshops and meetings with the steering group where all key issues were discussed.

A wide range of options were initially considered to form a long-list and then multi-criteria analysis was undertaken on each of the option. A summary of the results from that analysis is presented in Table 1.

Guided by that analysis, a short list of options were identified for more detailed assessment as presented in Table 2. The shortlisted options are described further below:

- Option 1 **Traditional approach** - Conventional supply of water (from the Melbourne network) and disposal of sewage (to ETP), and a conventional drainage solution (with retarding basins and wetlands to meet BPEM).
- Option 2 **Pakenham WWTP recycled water -** Dual pipe supply (from the existing Pakenham wastewater recycling plant), and otherwise as for option 1.
- Option 3 **Bald Hill stormwater harvesting with recycled water -** Dual pipe supply (from a combination of recycled wastewater from the Pakenham facility and harvested stormwater), and an unconventional stormwater diversion to reduce retarding basin and wetland size. This option relies on altering the use of the existing Bald Hill basin, which is a SEW asset currently used to balance supply of Class C recycled water to irrigators.
- Option 4 **Lot scale roof water harvesting** – Rainwater tanks on each lot with no further recycled water supply, and no dual pipe. Otherwise the same as Option 1.
- Option 5 **Regional roof water harvesting -** Down pipes from rooftops connected into a separate drainage system and conveyed to a new storage downstream, where it is treated to potable standard and used to supply water to the precinct. This option may lead to a reduction in the retarding basin and wetland sizes.

Further analysis of these options included examination by the steering group, further concept development and a Cost Benefit Analysis. Table 3 presents a summary of the water balance analysis for each option. The sensitivity of the options in the Cost Benefit Analysis was investigated by varying some of the input parameters. A summary of the results from this sensitivity investigation is presented in Table 4. These further analyses were presented to the steering group who concluded that Options 2 and 3 were both attractive. Schematics presenting Options 2 and 3 are presented in Figures 1 and 2 respectively.

Option 3, which includes the harvesting of stormwater in the existing Class C basin at Bald Hill, has a number of attractive factors, as it could reduce land take in the development, and/or reduce downstream water quality impacts. However, it includes a number of uncertainties related to reuse of an existing asset. Further work is recommended to reduce the level of uncertainty around this option.

The work demonstrated the potential value of WOWCM investigations, as it identified this option, where an asset owned by one party could possibly be used differently to provide wider benefits.

Table 1 WoWCM Options – Qualitative assessment summary

Option Number	Water Supply	Description	Support liveable and sustainable communities;			Protect the environmental health of urban waterways and bays;			Protect public health; and	Deliver affordable essential water services.	Provide secure water supplies efficiently.						
			Effect on Local Flooding	Effect on Amenity in the PSP	Landtake within Development	Water Quality to Waterways	Maintain or manage flows and flow regime outside precinct	Maintain or manage flows and flow regime within the precinct	Meet regulatory requirements	Effects on Central System Potable Water Use	Effects on local Potable Water Supply Infrastructure	Effects on Waste Water Infrastructure	Effects on Stormwater Infrastructure	Additional Class A Infrastructure Needed	Landtake outside Development	Flexibility to manage change	Total
1	A	Traditional approach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	B1	ETP recycled water	0	1	0	0	0	0	0	2	2	1	0	-1	0	1	6
3	B2	Pakenham WWTP recycled water	0	1	0	0	0	0	0	2	2	1	0	-1	0	1	6
4	B3	Bald Hill LTP recycled water schematic	0	1	0	0	0	0	0	2	2	1	0	-1	-1	1	5
5	C1	Bald Hill stormwater harvesting	0	1	-1	1	1	0	0	1	1	0	-1	-1	-1	0	1
6	C2	Bald Hill stormwater harvesting with recycled water	0	1	-1	1	1	0	0	2	2	1	-1	-1	-1	1	5
7	D1	Bunyip Main Race potable water	0	1	0	0	0	0	0	2	0	0	0	0	-1	0	2
8	D2	Bunyip Main Race recycled water schematic	0	1	0	0	0	0	0	1	1	0	0	-1	-1	0	0
9	E1	Lot scale roof water harvesting	1	1	-1	1	1	1	0	2	1	0	2	0	0	0	9
10	E2	Regional roof water harvesting	2	1	0	1	1	1	0	1	1	0	1	0	-1	0	8

Table 2 Shortlisted Options

Servicing strategy	Long list of options		Short listed options		Comments
Traditional approach	A1	Traditional approach	1	Traditional approach	
Recycled water	B1	ETP recycled water	2	Pakenham WWTP recycled water	The decision on which recycled water option should be shortlisted would need to include consideration of the wider region beyond East Pakenham. The Pakenham WWTP was therefore selected for the short list based on discussions and agreement with SE Water.
	B2	Pakenham WWTP recycled water			
	B3	Bald Hill LTP recycled water			
Stormwater harvesting	C1	Bald Hill stormwater harvesting	3	Bald Hill stormwater harvesting with recycled water	It is unlikely that stormwater harvesting on its own would be able to provide sufficient resilience to meet demand in lower rainfall periods. The combined stormwater and recycled water option has therefore been selected for the short list. It will also be apparent with analysis of this option whether stormwater harvesting on its own would be a better option.
	C2	Bald Hill stormwater harvesting with recycled water			
Bunyip Main Race	D1	Bunyip Main Race potable water			The Bunyip Main Race was decommissioned in 1993 and since then parts of it have been filled in and the land sold. It is understood that the Bunyip Main Race is not capable of supplying water to the Pakenham East PSP.
	D2	Bunyip Main Race recycled water			
Roof water harvesting	E1	Lot scale roof water harvesting	4	Lot scale roof water harvesting	It is not clear at this stage which one of these two roof water harvesting options would be the best option to short list. The analysis required for both options is similar and if undertaken together we could manage within our budget for the project. Therefore both options have been selected for the short list.
	E2	Regional roof water harvesting	5	Regional roof water harvesting	

Table 3 Water balance results

Option	Potable water supply (ML/yr)	Alternative water supply (ML/y)	Wastewater (ML/y)	Stormwater conveyed downstream (ML/yr)
Traditional approach	1359	0	907	1748
Pakenham WWTP recycled water	802	907	0	1748
Bald Hill stormwater harvesting with recycled water	802	913	1009	733
Lot scale roof water harvesting	758	599	907	1149
Regional roof water harvesting	600	778[1]	1009	991

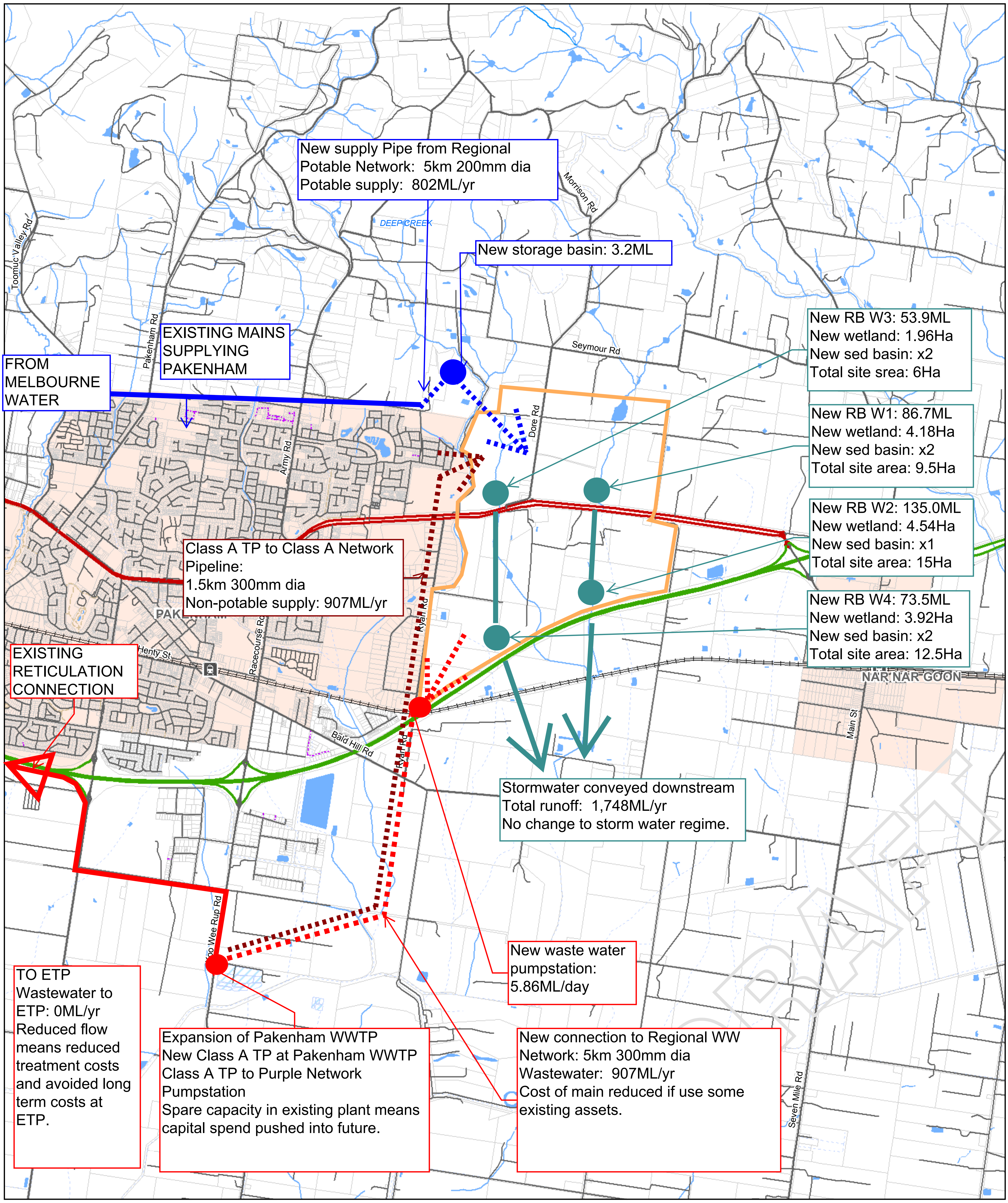
Notes:

1 Potable water

Table 4 Summary of Sensitivity Analysis Results

SCENARIO	Option 1 Traditional approach		Option 1 Pakenham WWTP recycled water		Option 3 Bald Hill stormwater harvesting with recycled water		Option 4 Lot scale roof water harvesting		Option 5 Regional roof water harvesting	
	NPV	BC	NPV	BC	NPV	BC	NPV	BC	NPV	BC
Scenario 0 - Base Case	157		159	0.92	174	0.46	164	0.69	184	0.39
Scenario 1.1 - Water Cost Low	149		154	0.78	169	0.34	160	0.52	181	0.29
Scenario 1.2 - Water Cost Min	132		145	0.48	159	0.12	150	0.17	173	0.10
Scenario 1.3 - Water Cost High	191		178	1.52	194	0.91	183	1.38	199	0.78
Scenario 1.4 - Water Cost Max	207		188	1.82	204	1.14	192	1.73	207	0.98
Scenario 2.1 - Wastewater Cost Low	151		156	0.78	168	0.46	158	0.69	178	0.39
Scenario 2.2 - Wastewater Cost Min	148		155	0.70	165	0.46	155	0.69	175	0.39
Scenario 2.3 - Wastewater Cost High	170		164	1.22	186	0.46	177	0.69	197	0.39
Scenario 2.4 - Wastewater Cost Max	182		170	1.52	199	0.46	189	0.69	209	0.39
Scenario 3.1 - Land Cost Low	154		156	0.92	171	0.46	161	0.69	183	0.39
Scenario 3.2 - Land Cost High	162		164	0.92	179	0.46	169	0.69	187	0.39
Scenario 3.3 - Land Cost Max	166		168	0.92	183	0.46	173	0.69	189	0.39
Scenario 4.1 - Nitrogen Cost Low	157		159	0.91	174	0.46	164	0.69	184	0.39
Scenario 4.2 - Nitrogen Cost High	160		160	0.98	177	0.46	167	0.69	187	0.39
Scenario 4.3 - Nitrogen Cost Max	167		164	1.14	184	0.47	174	0.69	194	0.39
Scenario 5.1 - Raintanks Cost Low	157		159	0.92	174	0.46	158	0.96	184	0.39
Scenario 5.2 - Raintanks Cost High	157		159	0.92	174	0.46	176	0.44	184	0.39
Scenario 5.3 - Raintanks Annual Maintenance Low	157		159	0.92	174	0.46	164	0.72	184	0.39
Scenario 5.4 - Raintanks Annual Maintenance High	157		159	0.92	174	0.46	170	0.55	184	0.39
Scenario 6.1 - Discount Rate 1.5%	210		205	1.18	226	0.60	210	1.02	237	0.52
Scenario 6.2 - Discount Rate 3%	175		175	1.01	192	0.51	180	0.81	202	0.44
Scenario 6.3 - Discount Rate 7%	122		127	0.73	138	0.35	133	0.45	147	0.29
Scenario 6.4 - Discount Rate 10%	101		107	0.60	116	0.27	114	0.32	123	0.23
Scenario 6.4 - Discount Rate 10%	179		180	0.92	174	1.12	186	0.69	201	0.43

SCENARIO	Option 1 Traditional approach		Option 1 Pakenham WWTP recycled water		Option 3 Bald Hill stormwater harvesting with recycled water		Option 4 Lot scale roof water harvesting		Option 5 Regional roof water harvesting	
	NPV	BC	NPV	BC	NPV	BC	NPV	BC	NPV	BC
Scenario 7.2 - SEPP F8 Applies PLUS Land Max Cost	194		196	0.92	183	1.12	201	0.69	212	0.43
Scenario 8.1 Dual Pipe Cost High	157		168	0.68	183	0.36	164	0.69	184	0.39
Scenario 8.1 Dual Pipe Cost High	157		174	0.57	189	0.31	164	0.69	184	0.39



Rail station
Township point
Freeway
Highway
Arterial
Collector
Proposed
Tracks
River
Stream
Drain/Channel/Other
Pondage
Lake
Rail
STRUCTURE_TYPE
Railway
Parcel
Township boundary
RECYCLED WATER
STORMWATER
POTABLE WATER
WASTEWATER

Paper Size A3
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Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Option 2 - Pakenham WWTP recycled water

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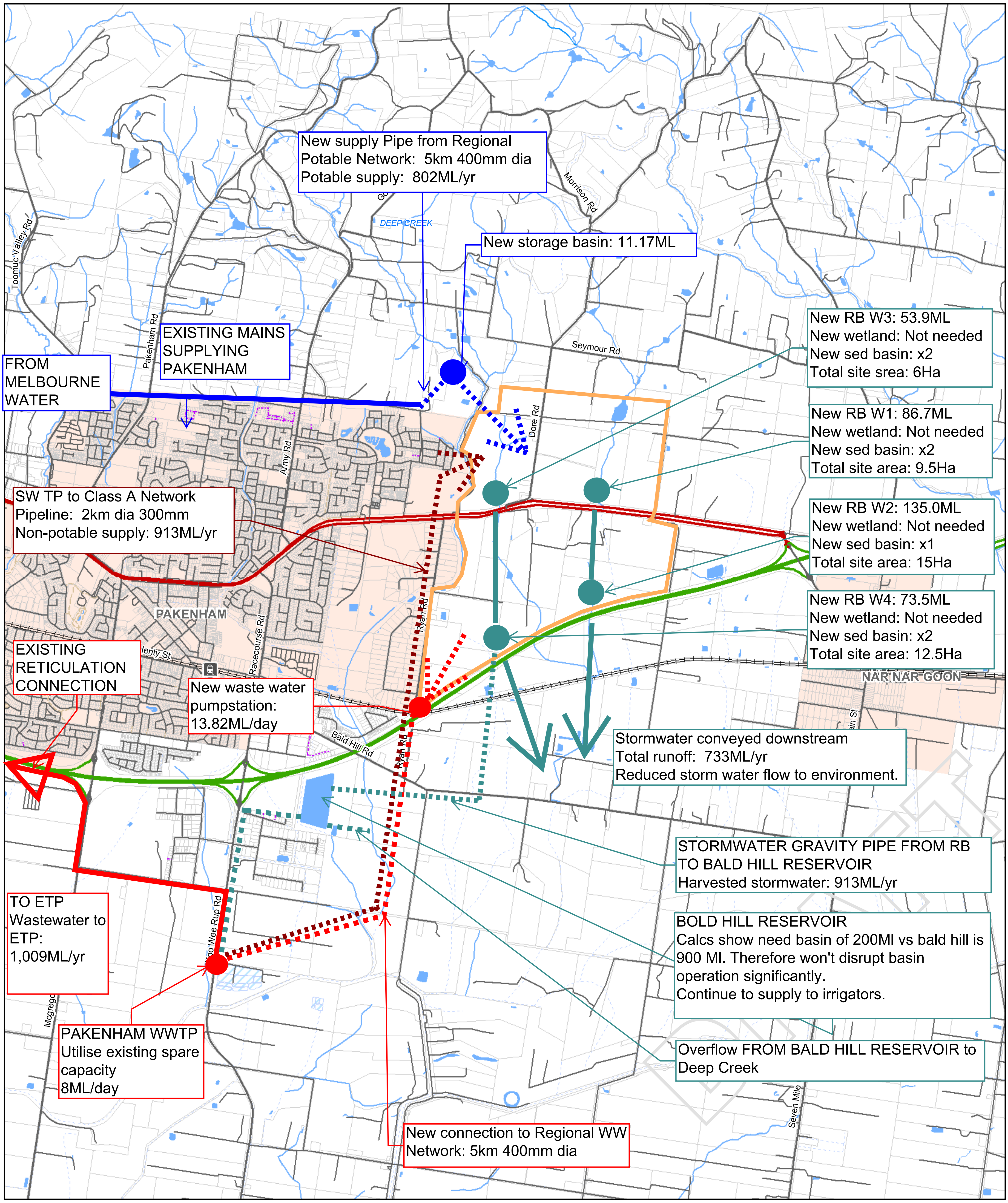
Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:cillingworth



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Paper Size A3
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Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Option 3 - Bald Hill stormwater harvesting and recycled water

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1. Introduction

1.1 Background

GHD was engaged by Cardinia Shire Council and South East Water to prepare a Whole of Water Cycle Management (WoWCM) and Servicing Plan for the Pakenham East growth area extension.

This whole of water cycle assessment provides the project stakeholders with a detailed understanding of the costs and benefits of a range of short listed options and enable selection of a strategy that delivers smart and economically efficient water services, protects the environment and existing beneficial uses and enhances the liveability of Pakenham East and surrounding communities. This evaluation will be aligned with the Office of Living Victoria's (OLV) recently released *IWCM Project Assessment Guidelines*.

1.2 Purpose of this report

The purpose of this report is to provide the technical basis for the development of Whole of Water Cycle Management options for the Pakenham East Growth Area Extension. The Whole of Water Cycle Management Plan will:

- Map existing and planned water infrastructure, including natural water assets and document service standards;
- Develop a water balance model that considers supply of alternative water sources and new development demand requirements;
- Define the Business as Usual (BAU) Scenario;
- Specify Alternative Options;
- Analysis and modelling of Options;
- Conduct Net Benefit Assessment for each option, and determine the net benefit compared to the BAU case;
- Defining the extent of developable land; and
- Consider WoWCM opportunities beyond the precinct boundaries such as the proposed rail stabling yard, which is likely to require a source of alternative water supply.

1.3 Location

The Pakenham East precinct is located on the eastern edge of the South East growth corridor adjacent to the existing Pakenham Township as shown on the metropolitan and regional context plan in Appendix A. The precinct was part of the 2012 logical inclusions extension to Metropolitan Melbourne's Urban Growth Boundary, and is now the easternmost extent of the UGB.

The surrounding area is characterised by existing urban development to the west, and rural pastureland to the north, south and east. The rural town of Nar Nar Goon is located approximately 4 kilometres south east of the precinct.

1.4 Development context

The Pakenham East precinct is approximately 635 hectares, with a developable area of approximately 440 ha. The precinct is located at the foothills of the Dandenong Ranges where the ranges meet low lying alluvial plains and is bounded by Deep Creek to the west, land zoned Green Wedge to the north and east, and the Princes Freeway to the south.

The majority of the precinct is currently zoned Farming, apart from a small number of parcels zoned Low Density, which are bounded by Deep Creek and Ryan Road to the west of the Precinct, and Category 1 Road Zone covering the Princes Highway.

The precinct has a Land Subject to Inundation overlay, Floodway overlay, Vegetation Protection Overlay (Schedule 1) and the Environmental Significance Overlay (Schedule 1). The Flood Overlay and Land Subject to Inundation account for the Deep Creek bounding the Precinct to the west and Hancock's Gully which traverses the site north to south. The Environmental Significance Overlay protects the environmental and landscape values in the northern hills area. All of the overlays are historical in nature and their purpose will be reviewed as part of any planning scheme amendment.

Some of the key elements of the precinct include:

- A ridgeline and the prominent peak of Mt Ararat bound the Precinct to the east and form a logical break between the proposed urban environment and the rural area to the east;
- Gas transmission pipelines traverse the site from east to west and north to south;
- High voltage transmission easement traverses the site east to west along the northern boundary;
- Prominent ridgeline through the centre of the Precinct;
- Numerous large scattered trees in the western portion of the site and along the Princes Highway road reserve; and
- There is some existing rural residential housing stock.

A plan showing the main existing features on the precinct is presented in Appendix B.

1.5 Recent studies

Recent studies that are relevant to this WoWCM assessment include:

- A Drainage Scheme investigation undertaken on behalf of Cardinia Shire Council by Stormy Water Solutions. We understand a review of this is being undertaken to incorporate SEPP F8 storm water quality requirements;
- A Development Environmental Values Risk Assessment of the Pakenham East Growth Area Extension has been undertaken on behalf of Cardinia Shire Council by SKM; and
- An ecological investigation detailing existing fauna and flora on the precinct.

1.6 Collaborative Approach

This project was jointly managed by Cardinia Shire Council and South East Water, and a key element of the approach was the inclusion of a range of stakeholders that formed a 'steering group' on the project. As well as Cardinia Shire Council, South East Water and GHD, the organisations on the steering group were Melbourne Water, OLV, and the MPA.

The project included a number of workshops and meetings with the steering group where all key issues were discussed.

The work was done in a number of stages, and each of these was presented to the steering group for consideration. This final report compiles and refines these presentations.

2. Objectives

Setting targets and goals is an important mechanism to encourage progression and accountability to commitments. The project steering group considered and agreed to the following as the basis for this project. The five broad objectives presented below in Table 5 are consistent with OLV's WoWCM key outcomes.

Table 5 Objectives & Sub-Objectives

Objective	Sub-Objective
Support liveable and sustainable communities	Effect on Local Flooding
	Effect on Amenity in the PSP
	Land take within Development
Protect the environmental health of urban waterways and bays	Water Quality to Waterways
	Maintain or manage flows and flow regime within & outside precinct
Protect public health	Meet regulatory requirements
Deliver affordable essential water services	Effects on Central System Potable Water Use
Provide secure water supplies efficiently	Effects on local Potable Water Supply Infrastructure
	Effects on Waste Water Infrastructure
	Effects on Stormwater Infrastructure
	Additional Alternative Water Infrastructure Needed
	Land take outside Development
	Flexibility to manage change

3. Underlying assumptions and their respective importance

3.1 Objectives of Whole of Water Cycle Management

Whole of water cycle management is a recognition that all parts of the water cycle are intrinsically connected. It is the recognition that water plays an important role in sustaining communities and the environment. Water provides services to urban developments: water for use inside houses, water to transport wastes away for treatment, and water used outside for irrigation to improve landscape and amenity. Water also falls on the developments, and runs across them. This water contributes to irrigation, and can also cause flooding or impacts on downstream receiving waters.

A whole of water cycle approach considers the following objectives:

- Enhanced flood protection, amenity and water security, which underpin a sustainable community;
- Health of receiving waters is protected or enhanced;
- Efficient and affordable water supplies are provided;
- Existing water infrastructure is optimised; and
- Climate resilient water supplies are provided to urban environments to ensure green spaces are maintained, enhancing community health and well-being.

3.2 Conceptual process

GHD's experience in developing WOWCM thinking has led to the following conceptual process:

1. Understand the quantity of water required to deliver the services needed. This water can be provided both intrinsically [through rain onto land], and through designed outcomes such as water supply, stormwater harvesting, wastewater recycling and the like.
2. Understand the required management of surface water runoff [in terms of both flow and quality].
3. Determine the driving requirement for landscape modification and land take [often this is the need to manage the 1:100 year flood].
4. Develop alternative options which maintain this fundamental landscape amenity, but alter other aspects while maintaining the same provision of water services, and meeting the downstream surface water management requirements.

3.3 Variables held constant

For the Pakenham East precinct, the following variables have been assumed to be constant between all options:

1. The demand for water inside houses. [This could vary with different devices with different efficiencies, but this is assumed to be constant for the purpose of comparing options to supply this demand.]
2. The demand for water outside for watering. This is assumed to be the shortfall requirement in dry times: i.e. the amount of water required to maintain green infrastructure during drought. Note: a key issue for consideration is the acceptable frequency of restrictions. For the purposes of the work on this project, it has been assumed that restrictions are not acceptable across the rainfall record used for assessment. In practical terms this means no restrictions would have occurred during the recent drought. This is a key contribution to liveability from the water cycle, as it means green infrastructure, and open space remain functional and available to benefit the community.

3.4 Key conclusions reached prior to detailed analysis

Review of the above variables lead to the following conclusions:

1. Liveability will be relatively similar for all options, except to the extent that the options themselves make a difference to the landscape. Why? Because all options are designed to supply the same amount of water with the same reliability.
2. Options which rely on rainwater or stormwater will require some form of backup or top up to allow them to continue to meet the demand for water in dry periods. [Or, will require very large storages to provide inter-year storage: similar to the main dams in the catchments. This is assumed to be impractical in a suburban environment.]
3. Some land within the retarding basins is encumbered by the LSIO (Land Subject to Innundation Overlay). The wetland designs as part of the proposed drainage strategy are partly located within this area, and therefore reductions in the need for the end of development wetland due to works upstream will not necessarily release all the area as unencumbered land for community or other use.
4. Lot scale rainwater tanks are unlikely to make a difference to the magnitude of 1 in 100 year ARI flood events (i.e. these tanks are likely to overtop regardless of whether the levels within these tanks are actively managed by smart technology). It is anticipated that rainwater tanks that are actively managed are likely to provide a benefit in terms of a reduction in the frequency of nuisance flooding experienced within the catchment. This project will give credit to the benefit associated with less frequent nuisance flooding rather than estimate the cost of a potential downsize in trunk drainage infrastructure.

4. Flooding, drainage and stormwater quality

4.1 Drainage strategy

A drainage strategy for the Pakenham East PSP was completed as a separate piece of work with Cardinia Shire Council prior to the preparation of this WoWCM and servicing plan.

Council and Melbourne Water have generally accepted this drainage strategy and agreed that it should form the basis of the drainage strategy for this WoWCM plan. No changes were therefore made to the general drainage strategy as part of this WoWCM, other than potential adjustments to the size of individual elements as a benefit of adopting a particular WoWCM option. It is understood that the strategy will be adjusted and a final version will be approved once this WoWCM plan is completed.

The design objectives and requirements for the drainage strategy covered the following:

- Integration of landscape values and ecological objectives.
- Internal drainage design and staging.
- Water quality requirements.
- Flood storage requirements.
- Flood protection requirements.
- Ecological objectives.

The current best practice requirements were adopted for treatment of stormwater prior to discharge from the PSP area. Therefore the strategy achieves at least 80% retention of Total Suspended Solids (TSS), 45% retention of Total Phosphorus (TP) and 45% retention of Total Nitrogen (TN).

Other water quality treatment targets were considered, including State Environment Protection Policy (SEPP) Schedule F8, and alternative arrangements were developed consistent with the tighter SEPP targets.

In line with current Koo Wee Rup Flood Protection District (KWRFPD) flood protection guidelines, the flood retarding basin objectives are to ensure:

- The peak 100 Year flow from the future development does not exceed the predevelopment flow rate at all outfall points from the PSP;
- The peak 24 hour 100 Year flow from the future development does not exceed the predevelopment flow rate for a storm of this duration at all PSP outfall points, and
- The retarding basins can store at least the difference between the expected post development and predevelopment 24 hour 100 Year flow volume to ensure no increased flood effect within the KWRFPD during a 24 hour 100 Year ARI flood event in the region.

A number of options for the drainage strategy were considered as part of the previous work. Option 1 was selected as the preferred strategy and has been adopted for this WoWCM and servicing plan.

The drainage strategy is summarised on the plan presented in Appendix C and generally consists of the following elements:

- Indicative frog pond locations (requirements to be confirmed following Environmental Protection and Biodiversity Conservation Act National Environmental Significance referral).
- Vegetated channels.
- Retarding basin/wetland.
- Sediment ponds.
- Diversion (Diversion of small rural catchment to Deep Creek at northern PSP boundary).

The main details for each of the retarding basins and wetlands proposed for the drainage strategy are presented in Table 6.

Table 6 Retarding Basin and Wetland Details

Wetland / Retarding basin	Wetland area at NWL (m2)	RB volume at 100-yr WL (m3)	NWL (mAHD)	100-yr ARI peak WL (mAHD)	100-yr ARI peak outflow (m3)	RB Area (ha)
W1 (North east)	41,800	86,700	39.0	40.70	14.2	9.5
W2 (South east)	45,400	135,000	28.2	30.50	15.0	15.0
W3 (North west)	19,600	53,900	40.3	42.20	2.1	6.0
W4 (South west)	39,150	73,500	28.5	29.95	4.8	12.5

4.2 SEPP F8 requirements

As part of the work that was undertaken to prepare the drainage strategy the EPA has advised, given previous investigations in Westernport, that state Environment Protection Policy (SEPP) Schedule F8 could be interpreted as requiring water quality treatment targets as presented in Table 7 in regard to TSS, TP and TN prior to stormwater discharge to Westernport Bay. The requirements for wetlands within the four retarding basins were therefore investigated to meet the more stringent State Environment Protection Policy (SEPP) Schedule F8 water quality treatment targets.

Table 7 SEPP F8 Water quality treatment targets

	TSS	TP	TN
SEPP F8 Target	93%	66%	63%

The increase in wetland size and the total area required for both the RB and wetland at each of the four sites is presented in Table 8 compared with best practice.

This shows that in the SEPP F8 case, the RB area is smaller than the required wetland area , so the wetlands start to drive additional land take. These areas are used in the sensitivity undertaken in the CBA analysis.

Table 8 Comparison of BPEM and SEPP F8

Wetland / Retarding basin	Current best practice		SEPP F8			
	Wetland area at NWL (m2)	RB incl wetland area (ha)	Wetland area at NWL (m2)	Increase in wetland area (%)	RB incl wetland area (ha)	Increase in RB incl wetland area (%)
W1 (North east)	41,800	9.5	41,800	0%	9.5	0%
W2 (South east)	45,400	15.0	130,000	186%	20.7	38%
W3 (North west)	19,600	6.0	38,000	94%	7.8	30%
W4 (South west)	39,150	12.5	90,000	130%	17.3	38%
Total areas	145,950	43	299,800	105%	55	29%

4.3 Water Sensitive Urban Design

It is understood that Cardinia Shire Council does not have a specific policy on managing stormwater assets, but when other factors such as topography, flood management and existing infrastructure, support larger end of line stormwater treatment systems, Council has a preference for this type of infrastructure as opposed to distributed WSUD assets. This approach is attractive to Council:

- As it centralises WSUD maintenance activities to a smaller number of assets relative to a distributed approach, which Council considers is a less expensive to maintain.
- Council has more experience with maintaining end of line systems, such as wetlands, and is therefore more comfortable with an end of line approach.

The implications of the above considerations are:

- Options which don't substantially reduce the magnitude of the 1:100 year flood extent (i.e. lot scale rainwater tanks) don't reduce land take; and
- The selection of many water sensitive urban design and water reuse initiatives are not beneficial from a land take perspective as encumbered space for stormwater quality is encompassed into the retarding basin.

Hence, any distributed WSUD approach is constrained by the floodplain management considerations and the options have been developed on that basis.

In theory, an end of line approach incorporating wetlands could be partly or largely replaced by alternative WSUD such as bio retention systems, swales and other WSUD innovations, distributed throughout the development. These could be designed and distributed to achieve a downstream outcome equivalent to that of the wetlands. Examples of typical wetlands and bio retention systems are provided in Figure 3 and Figure 4 respectively.

[Note: these discussions leave out rain-tanks, as they are assessed as part of the supply options for the precinct. That other assessment does consider the beneficial effects of rain tanks and stormwater harvesting on the downstream waterways.]

In Melbourne, wetlands typically require an area of 2.5% of the contributing catchment impervious area (based on an extended detention depth of 500 mm). In contrast, biorentention systems typically require an area of 1.6-2% of the contributing catchment impervious area (based on an extended detention depth of 100-300 mm).

Source: WSUD Engineering Procedures: Stormwater

Figure 3 Example Wetland Applications

Figure 4 Example Bio retention Applications

4.4 Summary of key considerations

These considerations have been assessed for Pakenham East, and are considered in the points set out as follows:

1. The northern area of the PSP has steep terrain (refer to Figure 5), which presents a challenge for distributed WSUD approaches such as bio retention systems without significant additional land take to achieve the same outcome. This is because the systems rely on detention time and slow moving water, and this is not typical in steep terrain.

2. The key waterway in the vicinity of the Pakenham East PSP is the Deep Creek, which borders the PSP for much of its length. The drainage strategy proposes that runoff from the development does not enter the creek until the downstream portion of the PSP (i.e. post wetland and retarding basin capture within the south west corner of the site). In effect any distributed WSUD measures within the PSP will not provide any immediate benefit to Deep Creek in the reaches adjacent to the precinct, as the stormwater from the PSP is not conveyed along this section of the Deep Creek.

3. In the southern area of the PSP, the terrain is flatter and potentially more suitable for the local lot and street scale approaches. However, additional land would be required both within the lots, and in the street scape. Due to the areas of land within the PSP which are not available for development for a range of reasons, such additional land take would need to be offset. As mentioned earlier, the use of such approaches could reduce the area of wetland needed in the current design. However, these wetlands are located within the retarding basins, and therefore any such land which is released would still be encumbered and has limited value to the community and to Council.

4. Street utilities also pose a constraint on any streetscape WSUD approach. In time these standards may need to be re-visited to explore how WSUD and in particular street trees are best incorporated into the streetscape to provide the recognised benefits, however such standards are not yet in place.

On balance, the current approach of end of development surface water management appears appropriate, provided it does meet the regulatory requirements for water quality and flow management, as the use of WSUD would be problematic in steeper areas, and would increase land take with no unencumbered offset in the flatter areas.

Figure 5 Pakenham East PSP Terrain Characteristics

Application of Bio retention Systems in Areas of Steep Terrain

The application of Bio retention systems can be undertaken in areas of steep terrain; however these systems generally require more land through terracing to achieve the desired level of detention and treatment. As a consequence these systems are more expensive to construct and maintain.

Examples of terraced bio retention systems are provided below.



4.5 Rainfall and runoff

This section provides some initial discussion about how water yield and demand is linked to variability in the climate, and that reducing the sensitivity to climatic influences incurs additional costs.

Rainwater contributes approximately half of stormwater runoff. The highest demands for non-potable water occur in a dry year for irrigation. The runoff in a dry year, is about half of that in a wet year, and two-thirds that of an average year. This difference is similar to the total non-potable demand.

Different means of capturing runoff have different yields. Limitations on yield vary from water available (for roofs) to the adopted capacity of treatment (for precinct stormwater harvesting).

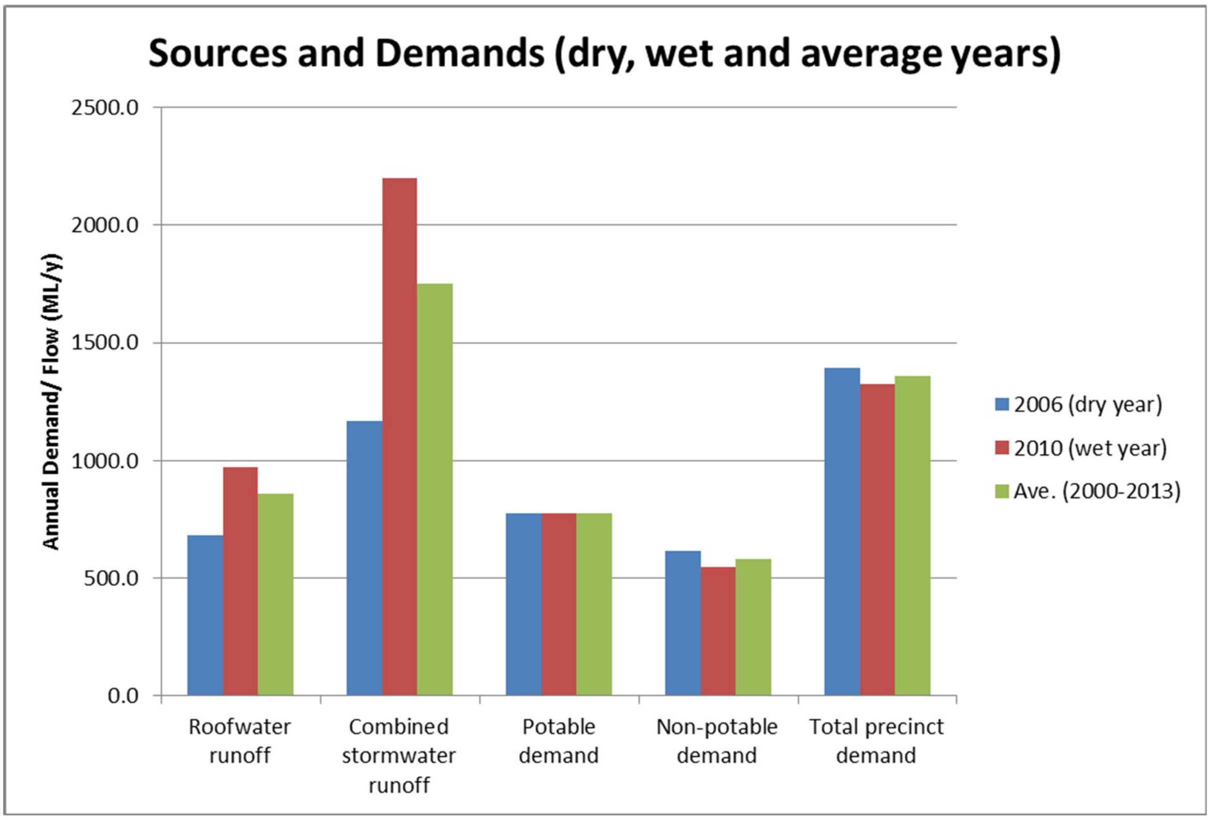


Figure 6 Stormwater Sources and Water Demand

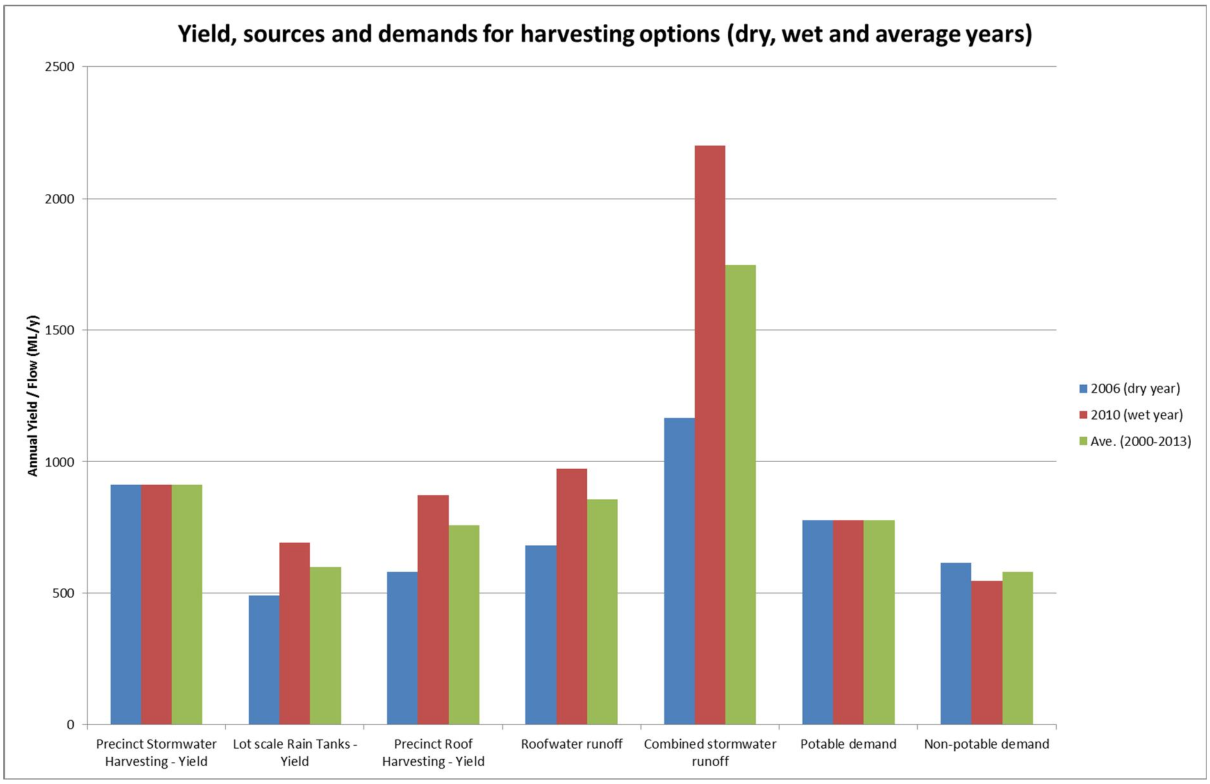


Figure 7 Stormwater Yield from Different Sources and Demand

The sizing of rainwater tanks will affect their reliability and yield as shown in the figure below.

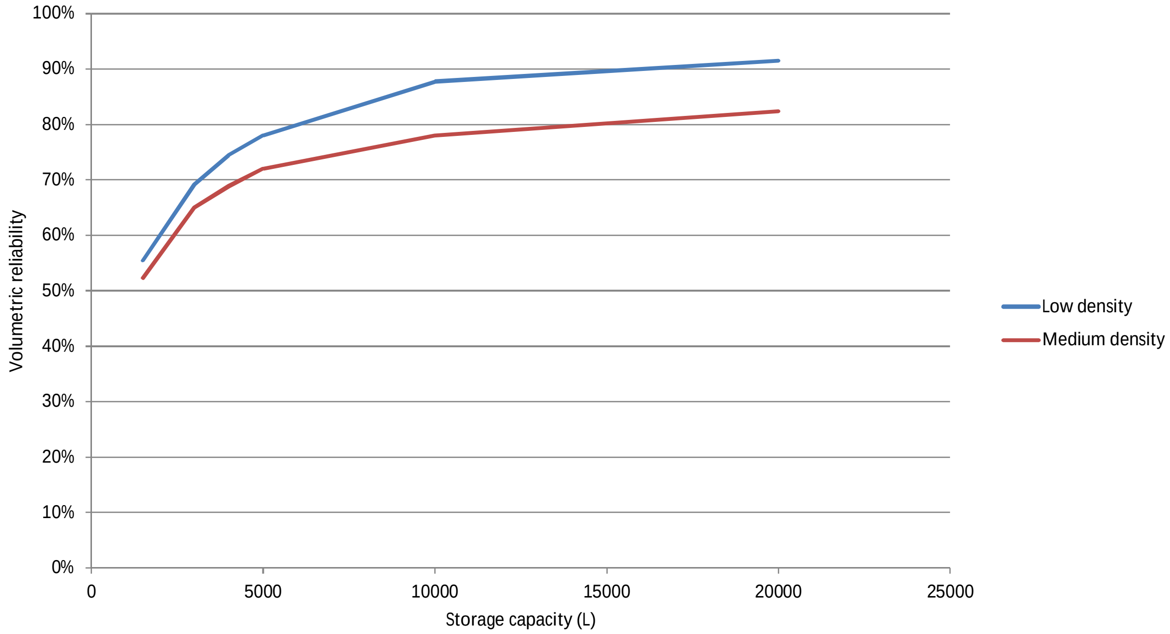


Figure 8 Rainwater Tank Capacity vs Reliability

This analysis led to the conclusion that rain tanks of 5 kL are a reasonable choice for houses.

The ability to capture storm events has a cost implication. The figures below show the rainfall intensity for a 1 in 100 year storm over a nine hour period. The rainfall intensity is then related to the cost of a harvesting network. These costs have been developed using GHD's Roof Water Harvesting Toolkit and from experience working with Wannon Water on the Warrnambool Roof Harvesting Network.

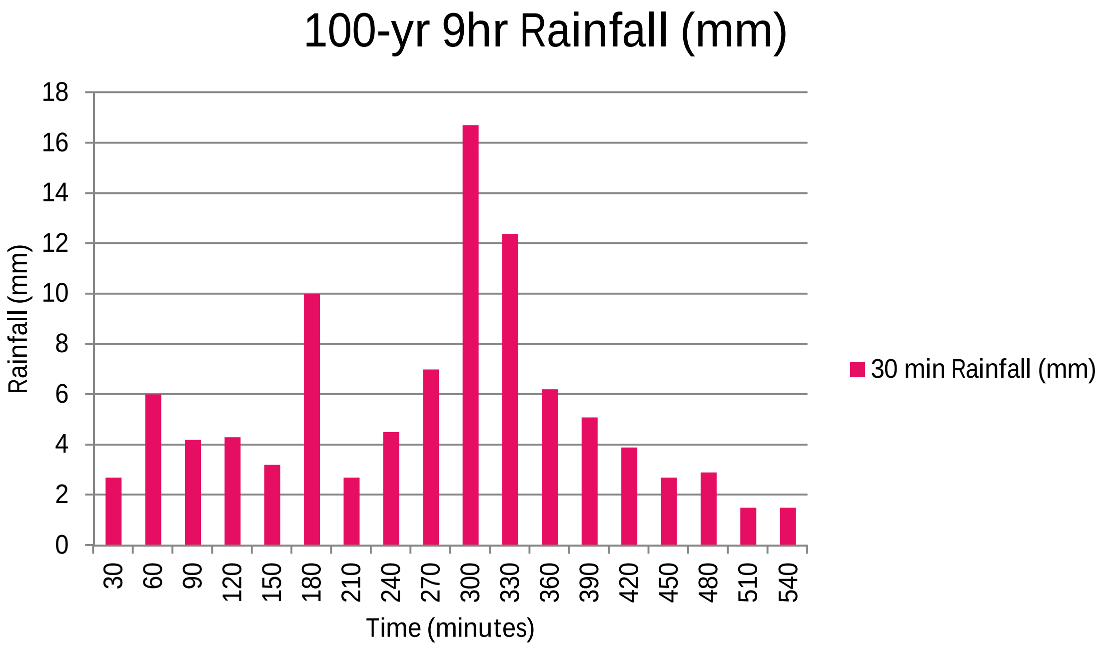


Figure 9 Rainfall Intensity During a Storm Event

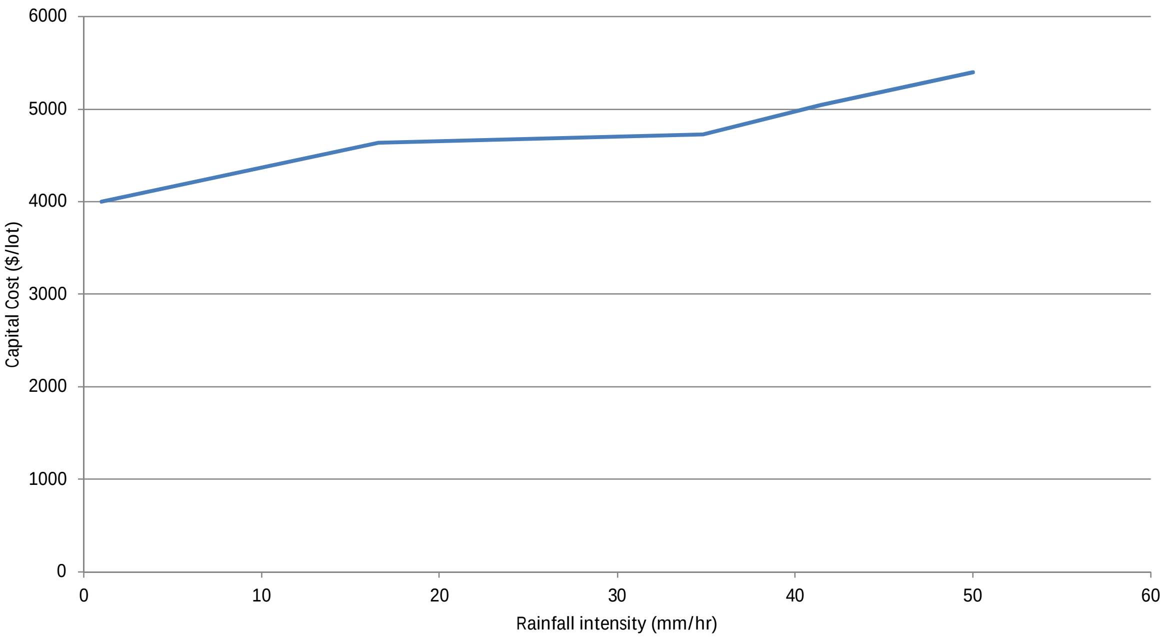


Figure 10 Roof water harvesting collection system capital costs with increasing rainfall intensity

5. Sizing of supply systems for the non-potable dual pipe options

This section provides some commentary on how a non-potable supply via a dual pipe arrangement is sized, and the implications on sizing (and hence cost) of reducing reliance on potable back up.

The analysis of the water supply over the time period selected for the project allowed analysis of the plant sizing to meet the non-potable demand.

The following graphs illustrate the time series for the total demand, the non-potable demand and the stormwater flows from the development area.

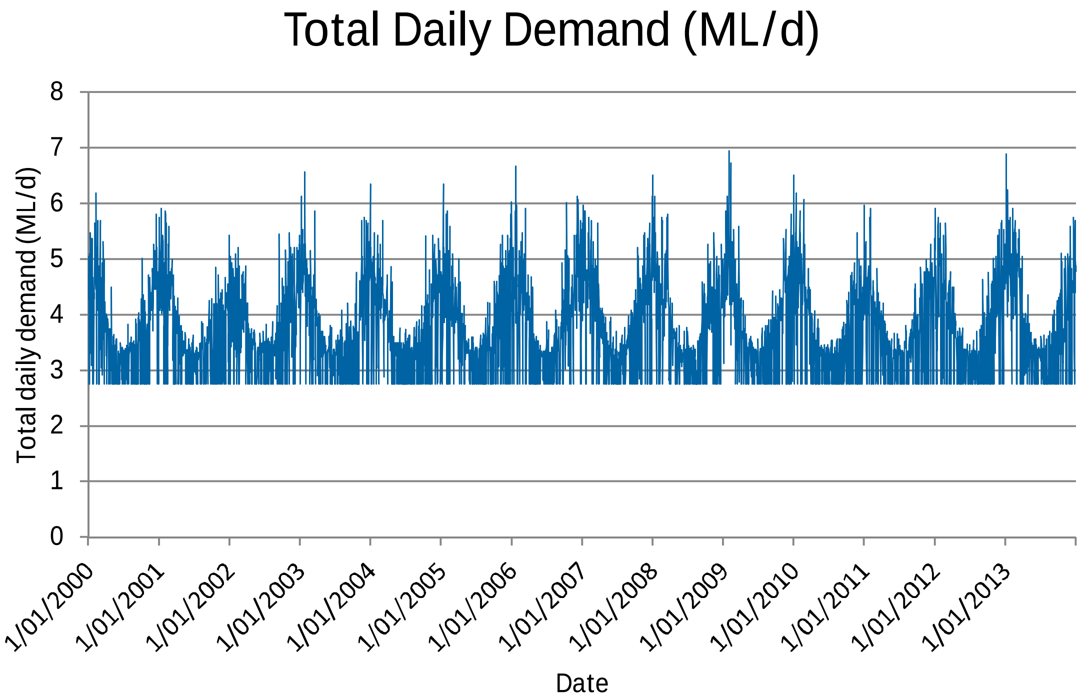


Figure 11 Example Time Series of Total Demand (Daily Demand)

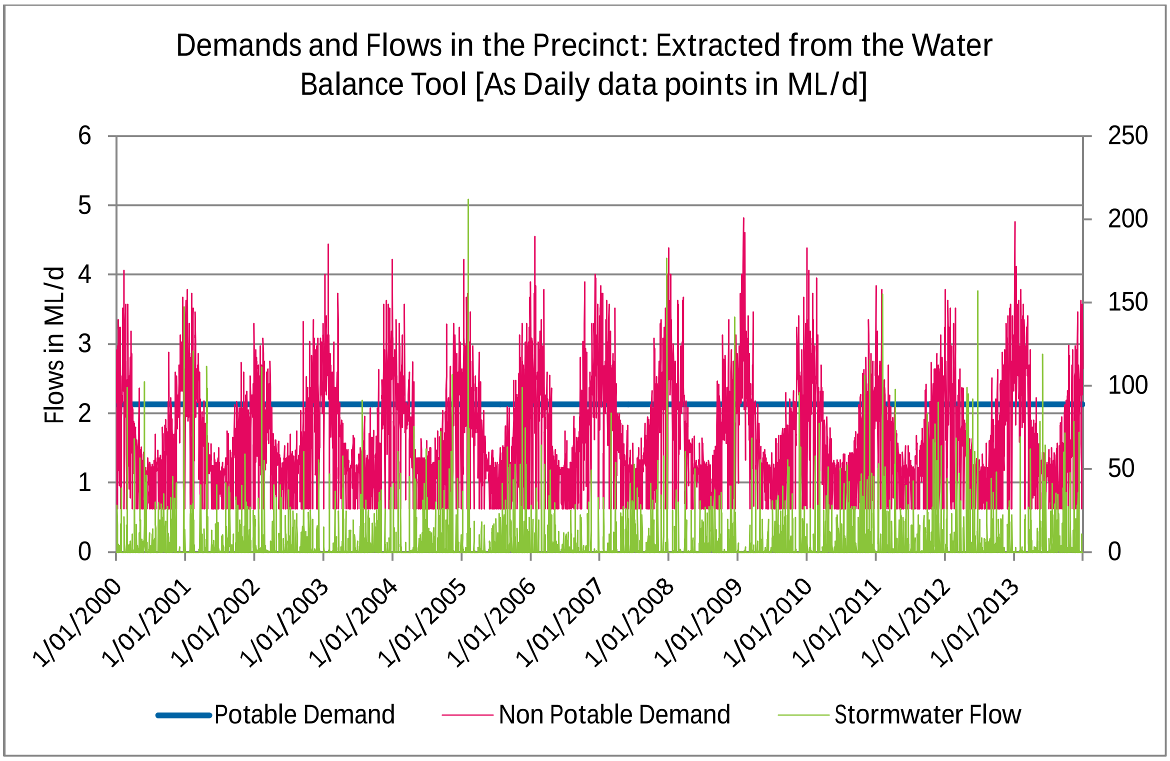


Figure 12 Example Time Series of Potable & Non Potable Demands with Stormwater Flow

These graphs show the seasonal variation in demand, with higher demands in the drier months. They also show the variation in the demands due to year by year variation.

The demands are derived by the water balance tool which takes rainfall into account: drier periods have higher demand and vice versa. There is a base demand which is static and this is associated with in-house demands, which have been assumed constant for this analysis.

Note that this graph reflects a thought experiment: what would the demands be for a fully developed precinct, if the rainfall record from 2000 to 2013 was to be replicated at that time?

The data sets underlying these graphs were then analysed to determine a reasonable sizing for the non-potable supply system. As the size of this supply system increases, the percentage of the annual non-potable demand that can be captured increases, and the amount of potable backup required decreases.

The following graph represents a summary of many runs done to analyse the effect of different plant sizing. The percentage results have been derived from sums or averages over the full 12 year time period.

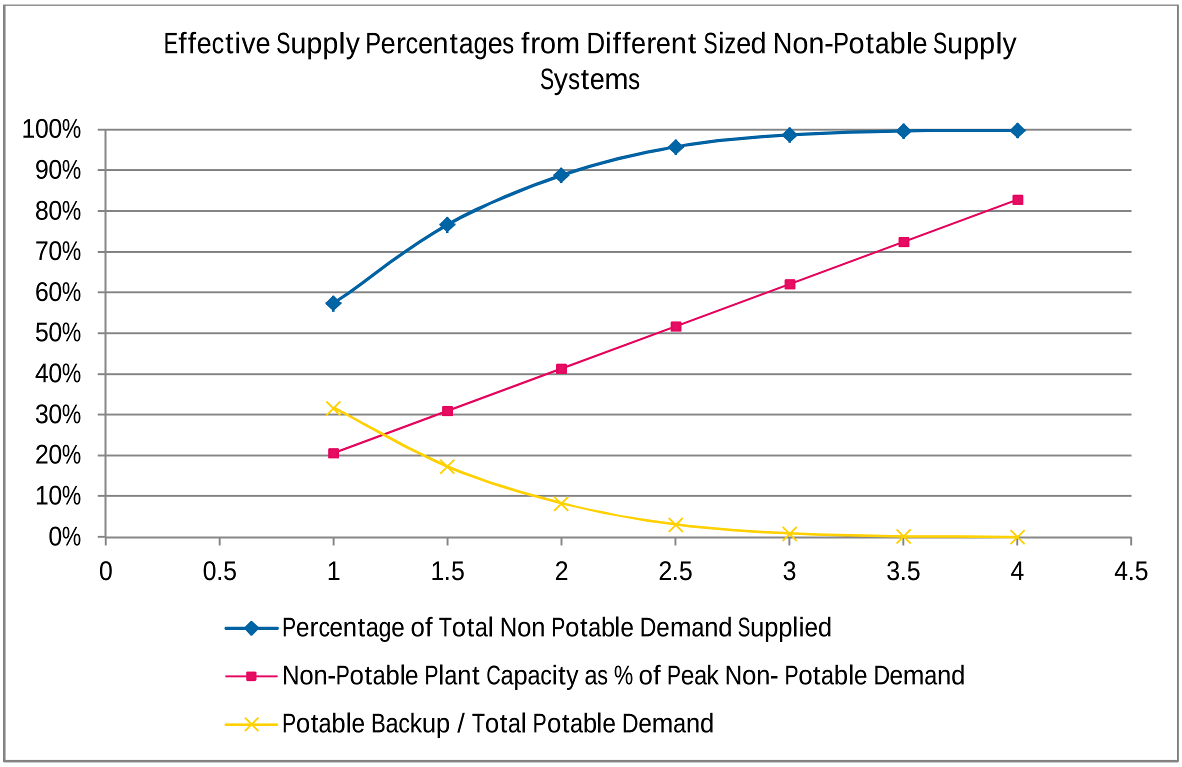


Figure 13 Plant Capacity and Ability to Meet Demand

This graph shows that as the plant/supply system approaches 2.5 ML per day, the gains in ‘yield’ become marginal.

6. Initial screening of Whole of Water Cycle Options

GHD facilitated two workshops with the project stakeholders to develop a range of WoWCM options for short listing. A total of ten options were developed based on five broad servicing strategies as shown in Table 9 below.

Table 9 Long list of options

Servicing strategy	Long list options	
Traditional approach	A	
Recycled water	B1	ETP recycled water
	B2	Pakenham WWTP recycled water
	B3	Bald Hill LTP recycled water
Stormwater harvesting	C1	Bald Hill stormwater harvesting
	C2	Bald Hill stormwater harvesting with recycled water
Bunyip Main Race	D1	Bunyip Main Race potable water
	D2	Bunyip Main Race recycled water
Roof water harvesting	E1	Lot scale roof water harvesting
	E2	Regional roof water harvesting

This section presents a description of each of the 10 options together with a qualitative assessment against the WoWCM objectives. The qualitative assessment was based on an approach that compared each long list option with the base case (traditional approach) adopting the following simple scoring system:

Table 10 Qualitative assessment scoring descriptions

Score	Description
-1	Not as good as the traditional approach
0	No change compared with the traditional approach
1	Better than traditional approach
2	Significantly better than the traditional approach

A consolidated summary of the qualitative assessment is presented within Table 16.

The adopted approach for shortlisting the options was based around a process of identifying the preferred option for each of the servicing strategies. This approach maintained a broad selection of options through to detailed analysis. The results from the qualitative assessment were used to inform the shortlisting approach. The results of this shortlisting approach are presented in Table 17. Schematics for the shortlisted options are presented in Appendix D.

6.1 Option A: Traditional approach

Description

- Potable water supplied from wider Melbourne system.
- Waste water sent to Pakenham WWTP and then onto ETP.
- Stormwater managed through conventional retarding basins and wetlands as outlined in the DSS (Development Services Scheme) drainage strategy.

Infrastructure

- Potable mains and sewers connected to every house. [May be pressure on other sewers.]
- Retarding basins and wetlands as proposed through the DSS drainage strategy. Outfall drainage (point of discharge) provided to every property larger than 0.4 ha. Infrastructure to meet requirements of the DSS drainage strategy.

Implementation Risks

- Standard risks that would be associated with a traditional approach. The approach and costs are understood.

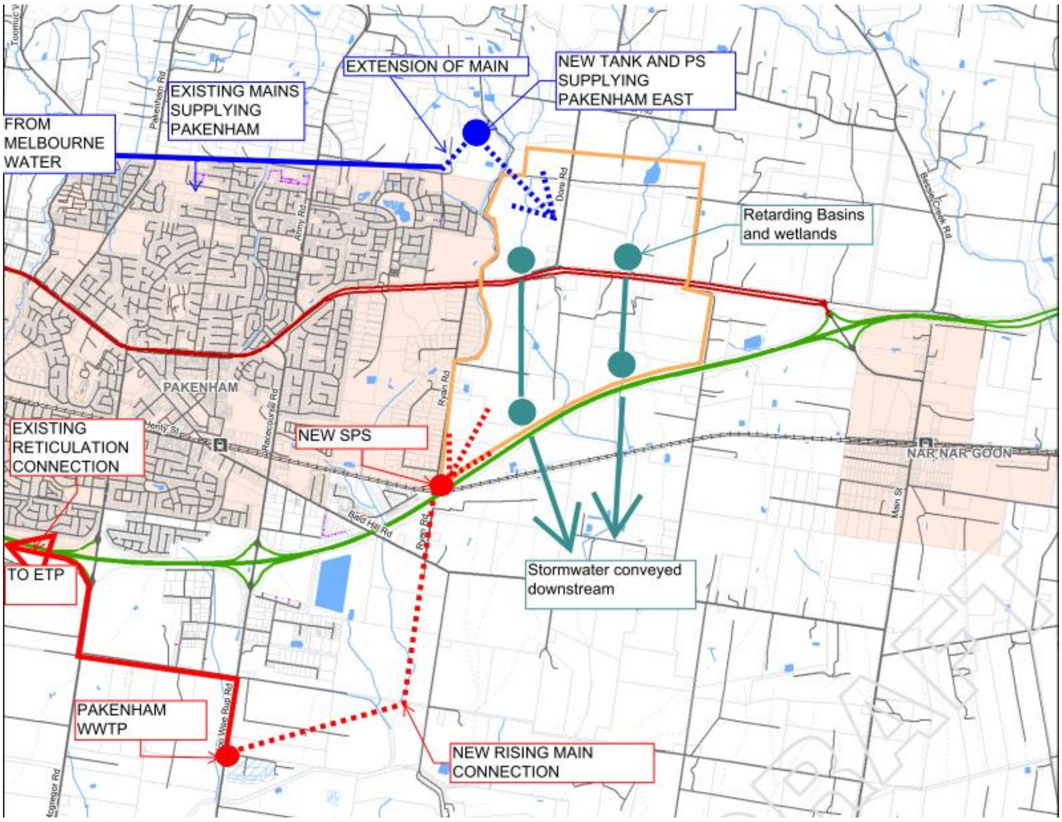


Figure 14 Option A - Traditional approach schematic

Table 11 Option A – Traditional approach assessment

Criteria		Comment	Score
Support liveable and sustainable communities;	**Effect on Local Flooding**	Attenuation of 100-yr ARI peak flood flows back to existing conditions through a number of retarding basins. See drainage strategy prepared by Stormy Water Solutions.	0
	Effect on Amenity in the PSP	Irrigation of open spaces is managed through water restrictions effecting useability of sports ovals, health of trees etc.	0
	Land take within Development	Land take required for drainage infrastructure (retarding basins and wetlands) in addition to that required for flow conveyance.	0
Protect the environmental health of urban waterways and bays;	**Water Quality to Waterways**	Meets the regulatory requirements through the wetlands proposed as part of the drainage strategy.	0
	Maintain or manage flows and flow regime outside precinct	Meets the regulatory requirements for peak flood flows through the retarding basins proposed as part of the drainage strategy. No management of flow regime, other than peak flood flows (meet requirements of Clause 56.07 of the VPP's).	0
	Maintain or manage flows and flow regime within the precinct.	Meets the regulatory requirements for peak flood flows through the retarding basins proposed as part of the drainage strategy. No management of flow regime, other than peak flood flows (meet requirements of Clause 56.07 of the VPP's)	0
Protect public health;	**Meet regulatory requirements**	Meets regulatory requirements.	0
Deliver affordable essential water services.	**Effects on Central System Potable Water Use**	All water is supplied by the central potable water system.	0
Provide secure water supplies efficiently.	**Effects on local Potable Water Supply Infrastructure**	Local potable water supply infrastructure is required to supply all water.	0
	Effects on Waste Water Infrastructure	Local waste water infrastructure required to receive all waste water and connect to Pakenham WWTP.	0
	Effects on Stormwater Infrastructure	Stormwater pipes, retarding basins and wetlands as proposed by the DSS drainage strategy.	0
	Additional Class A Infrastructure Needed	None required.	0
	Land take outside Development	No land take outside of the development.	0
	Flexibility to manage change	Additional water can be sourced from the wider network, and wastewater discharged to ETP up to the capacity of those systems – there are no new water sources from this option.	0
TOTAL			0

6.2 Option B: Third Pipe from Wastewater

Description

- Potable water supplied from wider Melbourne system.
- B1 - Waste water sent to Pakenham WWTP and then onto ETP and recycled Class A water supplied from ETP.
- B2 - Waste water sent to Pakenham WWTP and then excess onto ETP. Recycled Class A water supplied from Pakenham WWTP using existing class A infrastructure at Pakenham understood to be currently not used (available capacity 4ML/day, upgradeable to 8ML/day).
- B3 - Waste water sent to Pakenham WWTP and then excess onto ETP. Recycled Class C water supplied from Pakenham WWTP to Bald Hill reservoir. A new treatment plant at Bald Hill supplies Class A recycled water to the PSP.
- Stormwater managed through conventional retarding basins and wetlands as outlined in the DSS drainage strategy.

Infrastructure

- Potable mains [opportunity for reduction in size] and sewers connected to every house. [May be pressure or other sewers.]
- Third pipe to every house.
- B1: Mains connecting from ETP network to this precinct's third pipe network.
- B2: New mains from Pakenham WWTP. New Class A plant at Pakenham WWTP.
- B3: Mains from new Class A to be built at Bald Hill.
- Stormwater managed at end of precinct in wetland and RB in accordance with the DSS drainage strategy.

Implementation Risks

- B1 and B2: Low risk as know approach and costs.
- B3: Some risk as treatment of bald hill Class C is not typical approach, and need to manage allocations to irrigators.

Other Considerations

- Level of redundancy and reliability in the third pipe network.

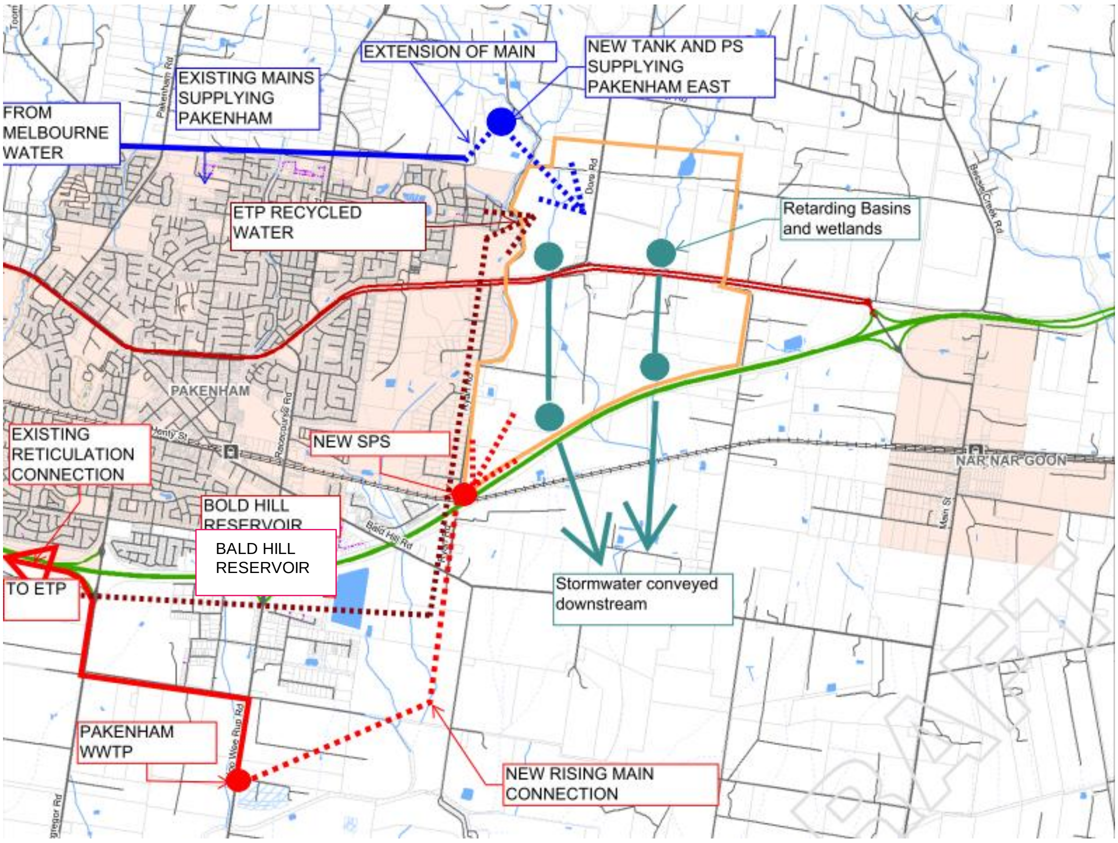


Figure 15 Option B1 - ETP recycled water schematic

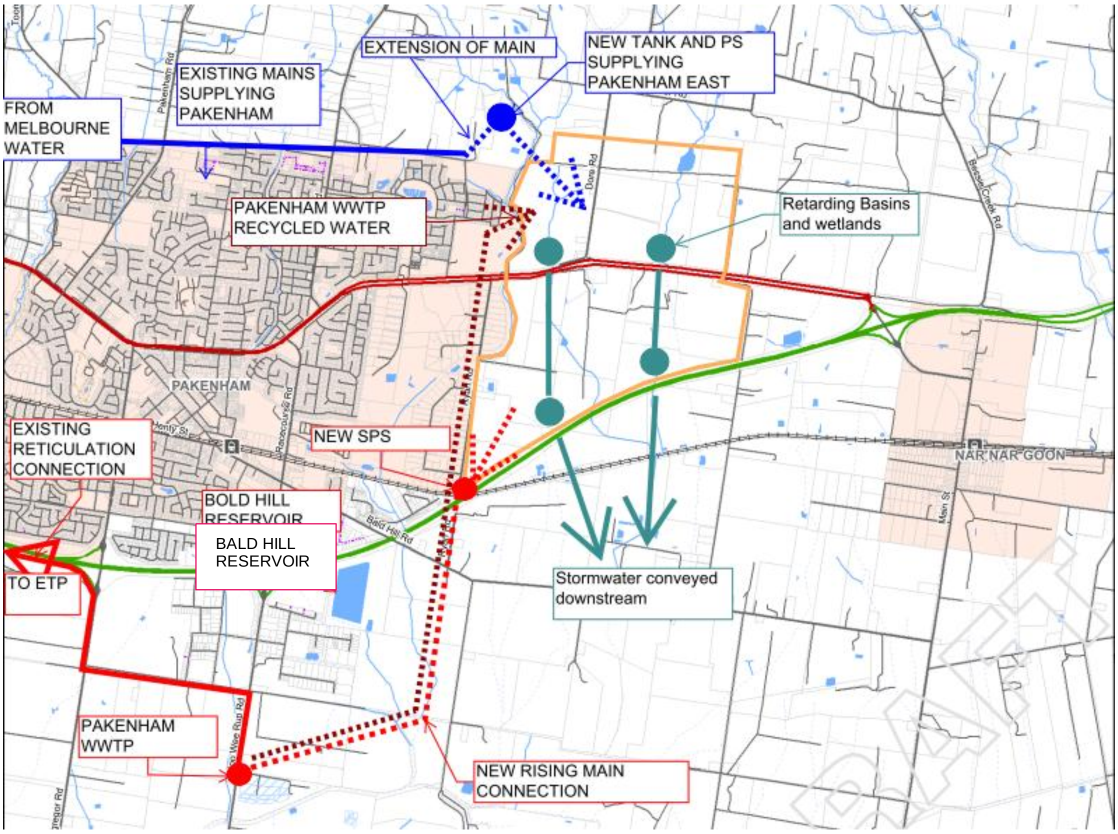


Figure 16 Option B2 - Pakenham WWTP recycled water schematic

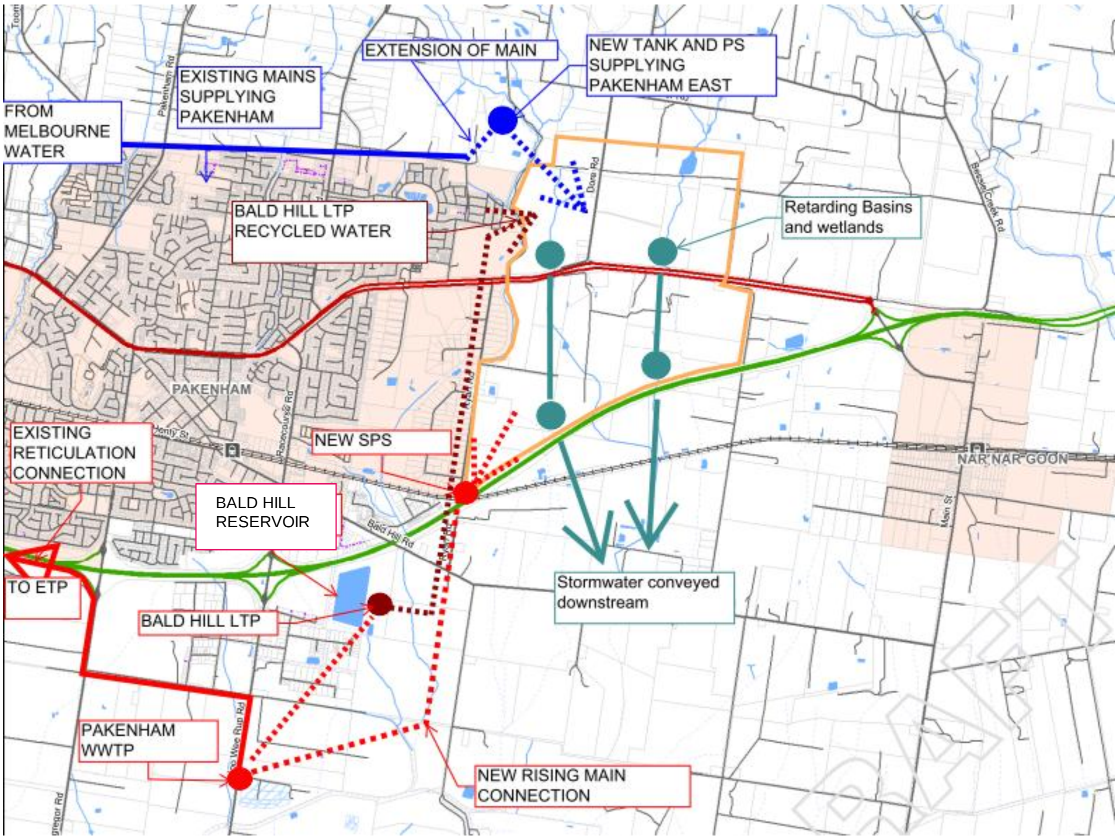


Figure 17 Option B3 - Bald Hill LTP recycled water schematic

Table 12 Option B – Recycled water assessment

Criteria		Comment	Score B1	Score B2	Score B3
Support liveable and sustainable communities;	**Effect on Local Flooding**	No change from base case.	0	0	0
	Effect on Amenity in the PSP	There will be no water restrictions. All irrigation demand will be met. Dry conditions do not restrict the use of sports ovals or significantly affect the health of trees etc.	1	1	1
	Land take within Development	No change from base case.	0	0	0
Protect the environmental health of urban waterways and bays;	**Water Quality to Waterways**	No change from base case.	0	0	0
	Maintain or manage flows and flow regime outside precinct	No change from base case.	0	0	0
	Maintain or manage flows and flow regime within the precinct.	No change from base case.	0	0	0
Protect public health; and	**Meet regulatory requirements**	Additional resilience to provide in low water availability times.	0	0	0
Deliver affordable essential water services.	**Effects on Central System Potable Water Use**	Reduced due to a reliable Class A supply.	2	2	2
Provide secure water supplies efficiently.	**Effects on local Potable Water Supply Infrastructure**	Reduction in mains size due to a reliable Class A supply.	2	2	2
	Effects on Waste Water Infrastructure	Less total waste water to ETP.	1	1	1
	Effects on Stormwater Infrastructure	No change from base case.	0	0	0
	Additional Class A Infrastructure Needed	Third pipe to all houses.	-1	-1	-1
	Land take outside Development	Plant at Bald Hill for B3.	0	0	-1
	Flexibility to manage change	B2 and B3 provide new local Class A sources.	0	1	1
TOTAL			5	6	5

6.3 Option C: Third Pipe from Stormwater

Description

- Potable water supplied from wider Melbourne system.
- Waste water sent to Pakenham WWTP and then onto ETP.
- C1 - Stormwater managed through conventional retarding basins and wetlands as outlined in the stormwater management plan. Stormwater harvested from proposed retarding basins and conveyed to Bald Hill reservoir where it is stored. Treated to Class A standard using the Class A infrastructure at Pakenham WWTP understood to be currently not used (available capacity 4 ML/day, upgradeable to 8 ML/day) and existing pipe connections between Pakenham WWTP and Bald Hill before being supplied to households through a third pipe.
- C2 - Stormwater managed through conventional retarding basins and wetlands as outlined in the DSS drainage strategy, although their sizes may be reduced as a result of the stormwater harvesting. Stormwater harvested from proposed retarding basins and conveyed to Bald Hill reservoir where it is stored. Treated to Class A standard using the Class A infrastructure at Pakenham WWTP understood to be currently not used (available capacity 4 ML/day, upgradeable to 8 ML/day) and existing pipe connections between Pakenham WWTP and Bald Hill before being supplied to households through a third pipe. Recycled Class C water supplied from Pakenham WWTP to Bald Hill reservoir would be used when there was insufficient stormwater available.

Infrastructure

- Potable mains [opportunity for reduction in size] and sewers connected to every house. [May be pressure or other sewers.]
- Third pipe to every house.
- C1: New enlarged retarding basins. Pipes, pumps and treatment plant.
- C2: New transfer pipe to Bald Hill and main back to precinct.
- Stormwater managed at end of precinct in wetland and RB in accordance with DSS drainage strategy.

Implementation Risks

- C1: Known approach but uncertainty of yield from stormwater.
- C2: New idea with new risk due to the unknowns, such as treatment of a variable mix of stormwater and wastewater, allocations to irrigators etc.

Other Considerations

- Level of redundancy and reliability in the third pipe network?
- Degree of credit for removing stormwater [and its associated pollutant load] from downstream waterways.
- The addition of stormwater mixed with wastewater would assist with managing salt levels within the recycled water.

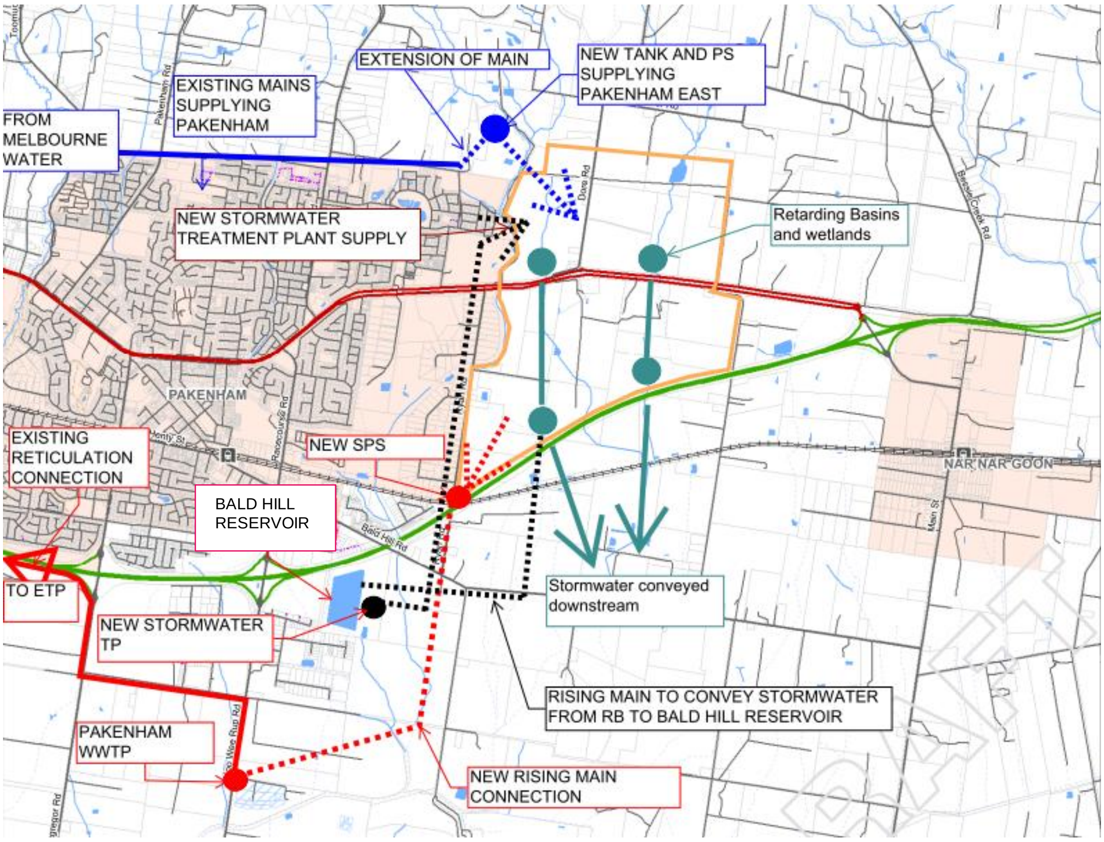


Figure 18 Option C1 - Bald Hill stormwater harvesting schematic

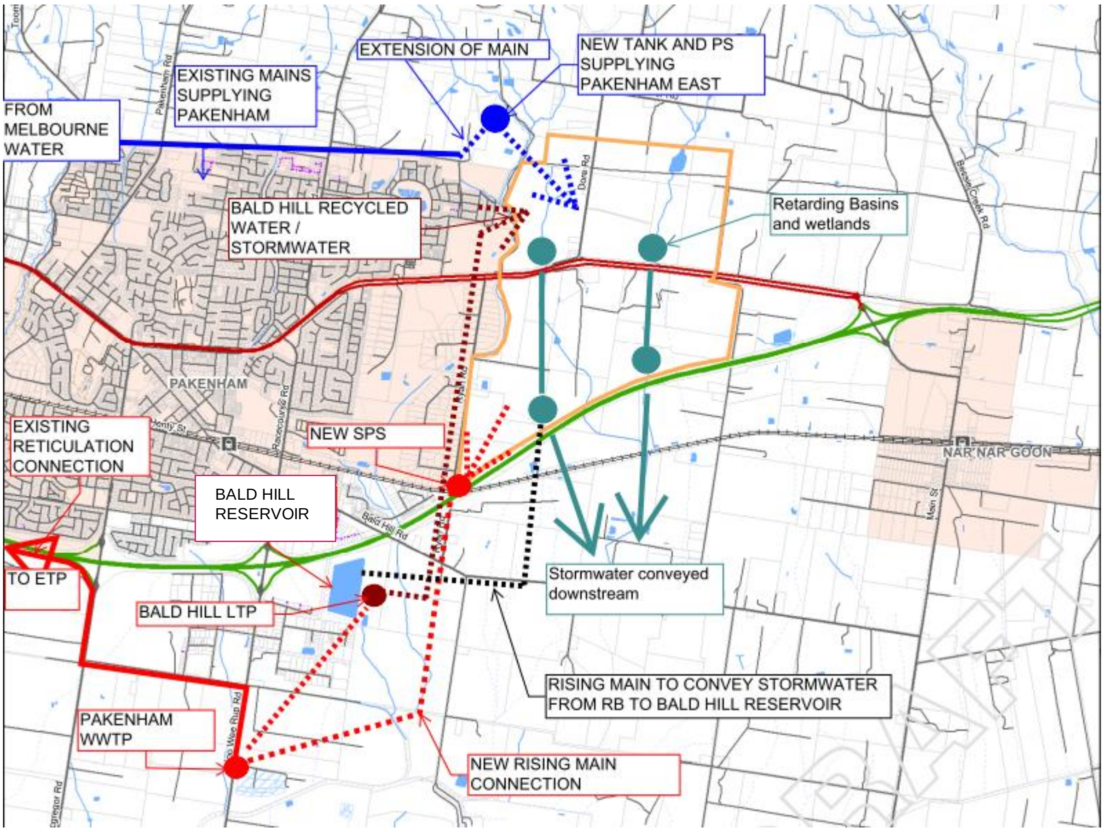


Figure 19 Option C2 - Bald Hill stormwater harvesting with recycled water schematic

Table 13 Option C – Stormwater harvesting assessment

Criteria		Comment	Score C1	Score C2
Support liveable and sustainable communities;	**Effect on Local Flooding**	As for base case. The storage basins will be located on the main drainage paths. The main drainage paths will be sized to convey the peak flood flows. There will be no change in the effect on local flooding.	0	0
	Effect on Amenity in the PSP	There will be no water restrictions. All irrigation demand will be met. Dry conditions do not restrict the use of sports ovals or significantly affect the health of trees etc.	1	1
	Land take within Development	Additional land take required to accommodate additional storage basin for stormwater harvesting.	-1	-1
Protect the environmental health of urban waterways and bays;	**Water Quality to Waterways**	Harvesting stormwater would prevent stormwater and the pollutants carried by it from being conveyed to the receiving waterways downstream.	1	1
	Maintain or manage flows and flow regime outside precinct	The increase in the volume of stormwater runoff draining downstream due to development would be reduced due to stormwater harvesting.	1	1
	Maintain or manage flows and flow regime within the precinct.	No change from base case.	0	0
Protect public health; and	**Meet regulatory requirements**	As for base case.	0	0
Deliver affordable essential water services.	**Effects on Central System Potable Water Use**	Reduced due to Class A supply. Option C2 is backed up by recycled wastewater.	1	2
Provide secure water supplies efficiently.	**Effects on local Potable Water Supply Infrastructure**	Reduction in mains size due to Class A supply.	1	2
	Effects on Waste Water Infrastructure	No change from base case for Option C1. Less total waste water to ETP for Option C2.	0	1
	Effects on Stormwater Infrastructure	Based on achieving the same treatment targets as for the base case, the required size of the wetlands would be reduced due to the removal of stormwater (and the pollutants contained within it) through harvesting. Additional storage will be required at the RBs to harvest the stormwater.	-1	-1
	Additional Class A Infrastructure Needed	Third pipe to all houses.	-1	-1
	Land take outside Development	Plant at Bald Hill	-1	-1
	Flexibility to manage change	New water sources in the area.	0	1
TOTAL			1	5

6.4 Option D: Bunyip Main Race

Description

- Potable water supplied from wider Melbourne system.
- Waste water sent to Pakenham WWTP and then onto ETP.
- Stormwater managed through conventional retarding basins and wetlands as outlined in the stormwater management plan.
- E1 - Water from old race to existing basin to the north and treated at a new treatment plant to potable standard.
- E2 - Water from old race to existing basin to the north and treated at a new treatment plant to class A standard and supplied through a third pipe to the precinct.

Infrastructure

- Race and local reservoir refurbished. New local WTP and tanks and pumps.
- Potable mains and sewers connected to every house. [May be pressure or other sewers.]
- Stormwater managed at end of precinct in wetland and RB in accordance with DSS drainage strategy.

Implementation Risks

- Significant due to unknown condition of the assets.
- Other issues with allocations and possible downstream users.

Other Considerations

Treatment requirements need to be developed. Likely to require Tarago level at least, plus additional protection due to unprotected catchment.

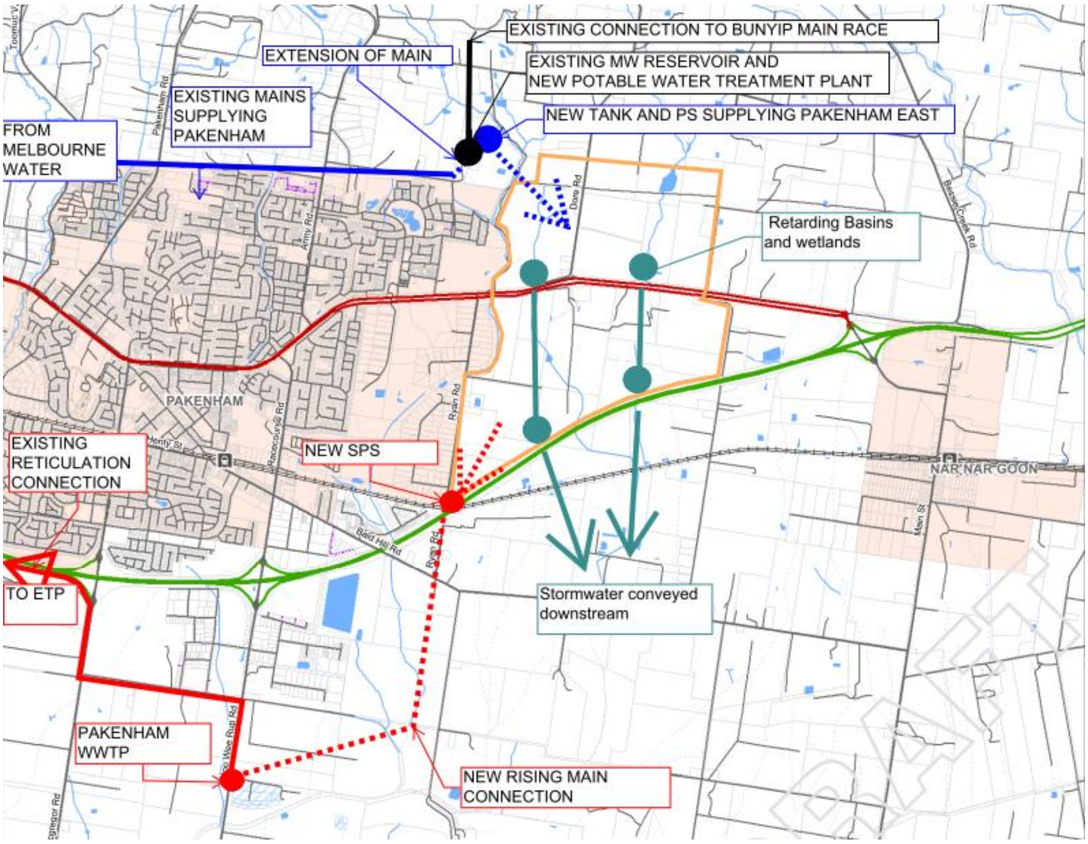


Figure 20 Option D1 - Bunyip Main Race potable water schematic

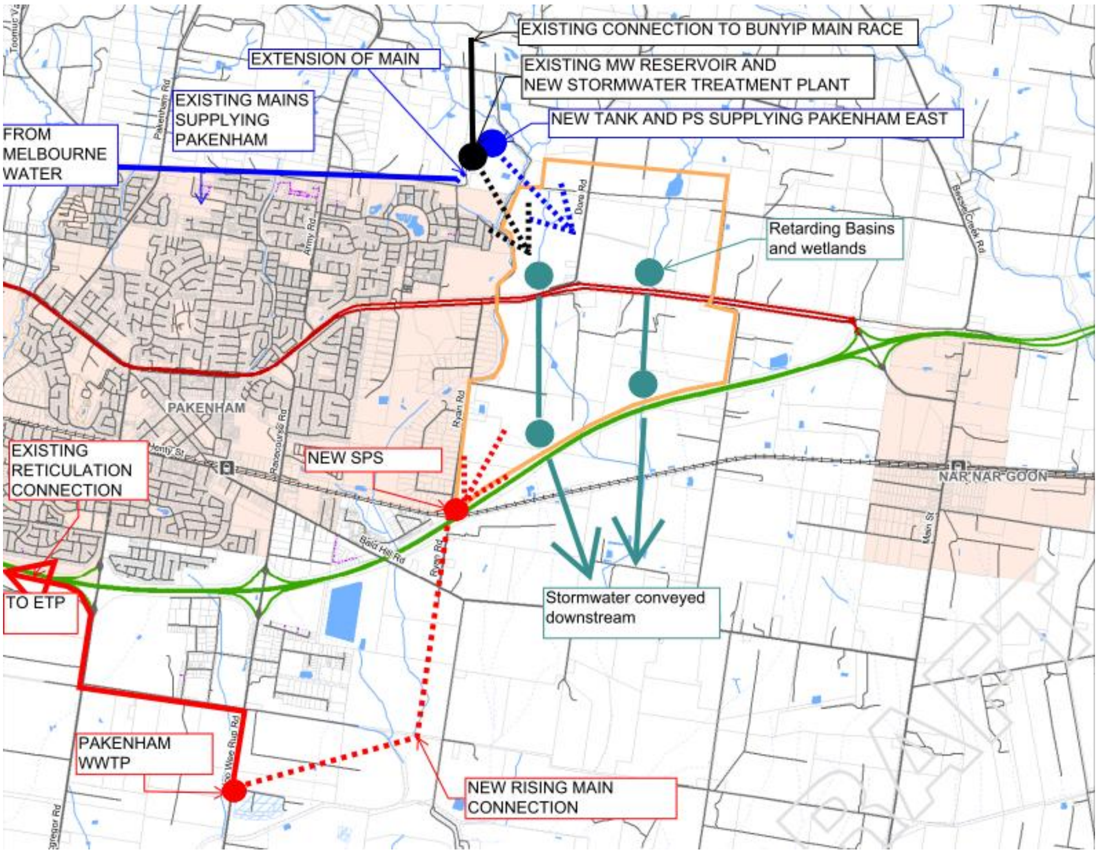


Figure 21 Option D2 - Bunyip Main Race recycled water schematic

Table 14 Option D – Bunyip Main Race assessment

Criteria		Comment	Score D1	Score D2
Support liveable and sustainable communities;	**Effect on Local Flooding**	No change from base case.	0	0
	Effect on Amenity in the PSP	There will be no water restrictions. All irrigation demand will be met. Dry conditions do not restrict the use of sports ovals or significantly affect the health of trees etc.	1	1
	Land take within Development	No change from base case.	0	0
Protect the environmental health of urban waterways and bays;	**Water Quality to Waterways**	No change from base case.	0	0
	Maintain or manage flows and flow regime outside precinct	No change from base case.	0	0
	Maintain or manage flows and flow regime within the precinct.	No change from base case.	0	0
Protect public health; and	**Meet regulatory requirements**	No change from base case.	0	0
Deliver affordable essential water services.	**Effects on Central System Potable Water Use**	Reduced due to supply from Bunyip main race. Potable water would be supplied for Option E1.	2	1
Provide secure water supplies efficiently.	**Effects on local Potable Water Supply Infrastructure**	No change from base case.	0	1
	Effects on Waste Water Infrastructure	No change from base case.	0	0
	Effects on Stormwater Infrastructure	No change from base case.	0	0
	Additional Class A Infrastructure Needed	No change from base case for Option E1. Third pipe required to all houses for Option E2.	0	-1
	Land take outside Development	Existing basin to north of PSP.	-1	-1
	Flexibility to manage change	Some due to new source locally.	0	0
TOTAL			2	1

6.5 Option E: Roof Water Harvesting

Description

- Potable water supplied from wider Melbourne system.
- Waste water sent to Pakenham WWTP and then onto ETP.
- Stormwater managed through conventional retarding basins and wetlands as outlined in the stormwater management plan.
- E1 - Rainwater tanks on each lot.
- E2 - Down pipes from rooftops connected into a separate drainage system and conveyed to a new storage downstream, where it is treated to potable standard and used to supply water to the precinct.

Infrastructure

- E1 - Rain tanks at every house.
- E2 - Duplicate drainage system with new storage, and then new WTP.
- Potable mains and sewers connected to every house. [May be pressure or other sewers.]
- Stormwater managed at end of precinct in wetland and RB in accordance with DSS drainage strategy.

Implementation Risks

- E1 - Minimal as known approach and known costs.
- E2 - Significant due to unknowns.

Other Considerations

- E1 - ‘Smart’ tank approaches may offer additional advantages.
- Local area has relatively high rainfall [compared for example to the west of Melbourne].
- E2 - Treatment requirements need to be developed.
- E2 - Space in streets for additional drainage may not be available.
- E2 - Need to identify site for substantial storage.

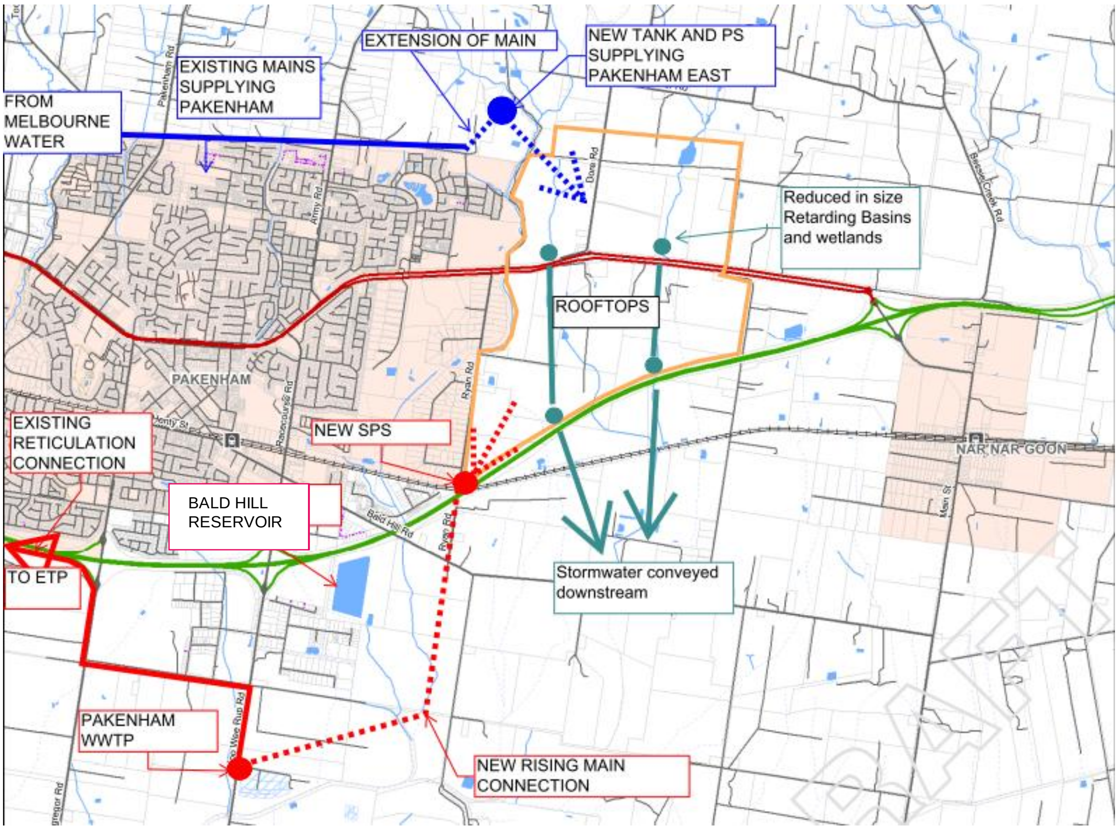


Figure 22 Option E1 - Lot scale roof water harvesting Schematic

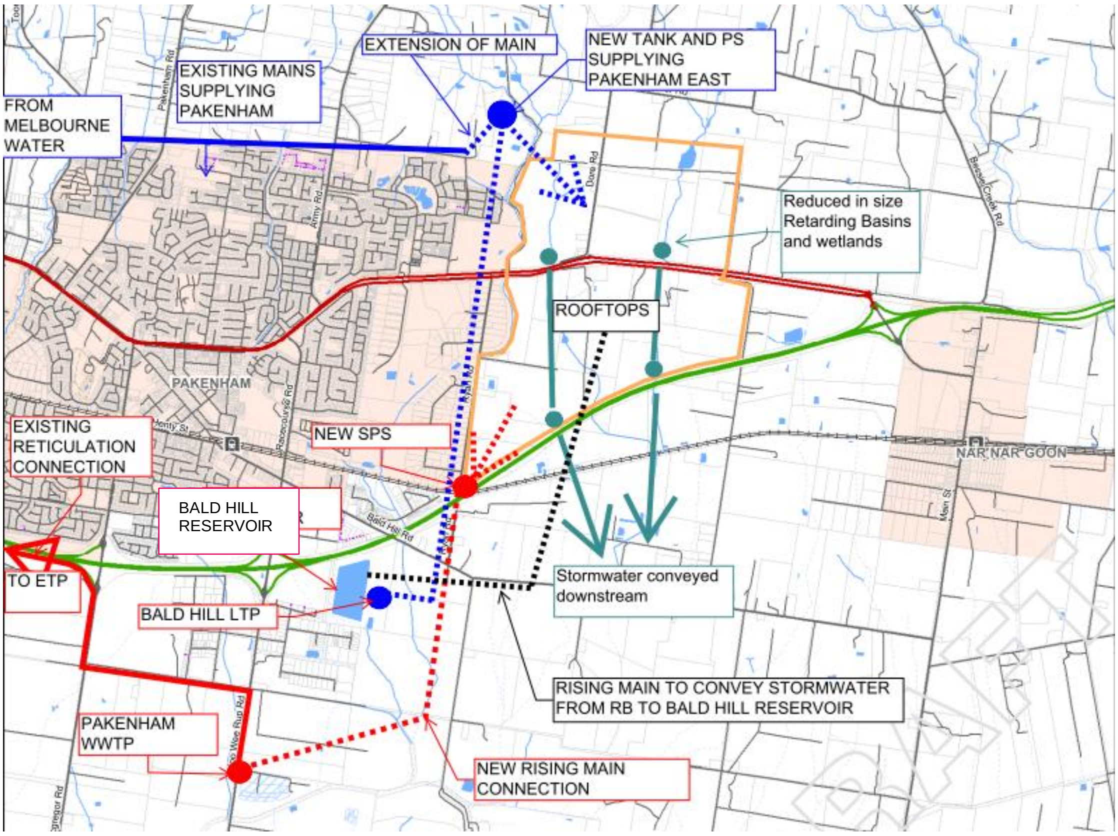


Figure 23 Option E2 - Regional roof water harvesting schematic

Table 15 Option E – Roof water harvesting assessment

Criteria		Comment	Score E1	Score E2
Support liveable and sustainable communities;	**Effect on Local Flooding**	If drains remain the same size [considered likely] then frequency of local flooding reduced to some extent.	1	2
	Effect on Amenity in the PSP	There will be no water restrictions. All irrigation demand will be met. Dry conditions do not restrict the use of sports ovals or significantly affect the health of trees etc.	1	1
	Land take within Development	Additional land take at houses for E1. As for base case for E2.	-1	0
Protect the environmental health of urban waterways and bays;	**Water Quality to Waterways**	Harvesting roof water would prevent roof water and the pollutants carried by it from being conveyed to the receiving waterways downstream.	1	1
	Maintain or manage flows and flow regime outside precinct	The increase in the volume of stormwater runoff draining downstream due to development would be reduced due to roof water harvesting.	1	1
	Maintain or manage flows and flow regime within the precinct.	The increase in the volume of stormwater runoff draining through the site due to development would be reduced due to roof water harvesting.	1	1
Protect public health; and	**Meet regulatory requirements**	As for base case.	0	0
Deliver affordable essential water services.	**Effects on Central System Potable Water Use**	Reduced due to rain water supply. E2 more reliable than lot scale roof water harvesting due to larger scale.	1	2
Provide secure water supplies efficiently.	**Effects on local Potable Water Supply Infrastructure**	Reduction in mains size due to roof water supply.	1	1
	Effects on Waste Water Infrastructure	No change from base case.	0	0
	Effects on Stormwater Infrastructure	Based on achieving the same treatment targets as for the base case, the required size of the wetlands would be reduced due to the removal of roof water (and the pollutants contained within it). It is expected that size of the RBs would be significantly reduced for E2.	1	2
	Additional Class A Infrastructure Needed	No change from base case.	0	0
	Land take outside Development	Existing basin to north of PSP.	0	-1
	Flexibility to manage change	No change from base case.	0	0
TOTAL			7	10

Table 16 WoWCM Options – Qualitative assessment summary

Option Number	Water Supply	Description	Support liveable and sustainable communities;			Protect the environmental health of urban waterways and bays;			Protect public health; and	Deliver affordable essential water services.	Provide secure water supplies efficiently.						
			Effect on Local Flooding	Effect on Amenity in the PSP	Landtake within Development	Water Quality to Waterways	Maintain or manage flows and flow regime outside precinct	Maintain or manage flows and flow regime within the precinct	Meet regulatory requirements	Effects on Central System Potable Water Use	Effects on local Potable Water Supply Infrastructure	Effects on Waste Water Infrastructure	Effects on Stormwater Infrastructure	Additional Class A Infrastructure Needed	Landtake outside Development	Flexibility to manage change	Total
1	A	Traditional approach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	B1	ETP recycled water	0	1	0	0	0	0	0	2	2	1	0	-1	0	1	6
3	B2	Pakenham WWTP recycled water	0	1	0	0	0	0	0	2	2	1	0	-1	0	1	6
4	B3	Bald Hill LTP recycled water schematic	0	1	0	0	0	0	0	2	2	1	0	-1	-1	1	5
5	C1	Bald Hill stormwater harvesting	0	1	-1	1	1	0	0	1	1	0	-1	-1	-1	0	1
6	C2	Bald Hill stormwater harvesting with recycled water	0	1	-1	1	1	0	0	2	2	1	-1	-1	-1	1	5
7	D1	Bunyip Main Race potable water	0	1	0	0	0	0	0	2	0	0	0	0	-1	0	2
8	D2	Bunyip Main Race recycled water schematic	0	1	0	0	0	0	0	1	1	0	0	-1	-1	0	0
9	E1	Lot scale roof water harvesting	1	1	-1	1	1	1	0	2	1	0	2	0	0	0	9
10	E2	Regional roof water harvesting	2	1	0	1	1	1	0	1	1	0	1	0	-1	0	8

Table 17 Shortlisted Options

Servicing strategy	Long list of options		Short listed options		Comments
Traditional approach	A1	Traditional approach	1	Traditional approach	
Recycled water	B1	ETP recycled water	2	Pakenham WWTP recycled water	The decision on which recycled water option should be shortlisted would need to include consideration of the wider region beyond East Pakenham. The Pakenham WWTP was therefore selected for the short list based on discussions and agreement with SE Water.
	B2	Pakenham WWTP recycled water			
	B3	Bald Hill LTP recycled water			
Stormwater harvesting	C1	Bald Hill stormwater harvesting	3	Bald Hill stormwater harvesting with recycled water	It is unlikely that stormwater harvesting on its own would be able to provide sufficient resilience to meet demand in lower rainfall periods. The combined stormwater and recycled water option has therefore been selected for the short list. It will also be apparent with analysis of this option whether stormwater harvesting on its own would be a better option.
	C2	Bald Hill stormwater harvesting with recycled water			
Bunyip Main Race	D1	Bunyip Main Race potable water			The Bunyip Main Race was decommissioned in 1993 and since then parts of it have been filled in and the land sold. It is understood that the Bunyip Main Race is not capable of supplying water to the Pakenham East PSP.
	D2	Bunyip Main Race recycled water			
Roof water harvesting	E1	Lot scale roof water harvesting	4	Lot scale roof water harvesting	It is not clear at this stage which one of these two roof water harvesting options would be the best option to short list. The analysis required for both options is similar and if undertaken together we could manage within our budget for the project. Therefore both options have been selected for the short list.
	E2	Regional roof water harvesting	5	Regional roof water harvesting	

7. Water balance

7.1 Land use assumptions

A summary of the key catchment assumptions for the water balance analysis are presented in Table 18.

Table 18 Key Catchment Assumptions

Catchment Summary	Area (ha)	Proportion (%)	Comments
Total Precinct Area	635.4		
Total Roof Area	176.2	28%	
Total other impervious area	82.4	13%	
Total pervious area	376.8	59%	
Total irrigated area	213.0	34%	
Total pervious area (ex. encumbered POS)	231.1	47%	
Ave. fraction impervious (ex. encumbered POS)	258.7	53%	

7.2 Demand assumptions

All the residential and non-residential demand assumptions are presented in Table 19.

Table 19 Consolidated Summary of Key Demand Assumptions

	Units	Residential - Low Density	Residential - Medium Density	Commercial - retail	Fire station	Active POS	Passive POS	Education - Primary school	Education - Secondary school	Transport	Encumbered open space	Rail stabling yard
Lots												
Proportion of total lots/allocated area	%	80%	20%	-	-	50%	50%	-	-	5%	Remainder	
Total development area	m2	3,224,115	806,029	97,000	3000	150,000	150,000	70,000	80,000	317,703	1456,220	
Lot size	m2	667	500	600	3000	-	-	35,000	80,000	-	-	
Number of lots	no.	4,836	1,612	162	1	1	1	2	1	1	1	
Demands												
Potable	L/d	305	305	778	3,888	-	-	7,477	17,090	-	-	TBC
Non-Potable	L/d	66	66	778	3888	-	-	17,446	39,877	-	-	TBC
Irrigation	kL/y	38	38	-	-	4ML/ha	1.5 ML/ha	4,200	9,600	0	0	TBC
Roof												
Roof area	m2	267	200	540	2700	-	-	14000	32,000	-	-	TBC
First Flush	mm	0.5	0.5	0.5	0.5	-	-	0.5	0.5	-	-	TBC
Wetting Loss	mm	1.5	1.5	1.5	1.5	-	-	1.5	1.5	-	-	TBC
Runoff Catchment												
Impervious area	m2	80	60	60	240	-	-	10500	24,000	285,933	0	

Table 20 Annual average demand summary

Demand Summary	Potable (ML/y)	Non-Potable (ML/y)	Irrigation (ML/y)
Residential Demand - Low Density	538	117	183
Residential - Medium Density	180	39	61
Active POS	-	-	60
Passive POS	-	-	23
Education - Primary	5	13	12
Education - Secondary	6	15	12
Commercial	46	41	-
Fire station	1	1	-
Total	778	230	351

Table 21 Wastewater Treatment & Class A Loss Assumptions

Metric	Wastewater (ML/y)	Class A (ML/y)
Loss	10%	5%

7.3 Water balance output

A schematic showing the water balance configuration for a typical scenario is presented within Figure 24.

A summary of the water balance results for each option is presented Table 23.

Table 22 Water balance results

Option	Potable water supply (ML/yr)	Alternative water supply (ML/y)	Wastewater (ML/y)	Stormwater conveyed downstream (ML/yr)
Traditional approach	1359	0	907	1748
Pakenham WWTP recycled water	802	907	0	1748
Bald Hill stormwater harvesting with recycled water	802	913	1009	733
Lot scale roof water harvesting	758	599	907	1149
Regional roof water harvesting	600	778[1]	1009	991
Notes: 1 Potable water				

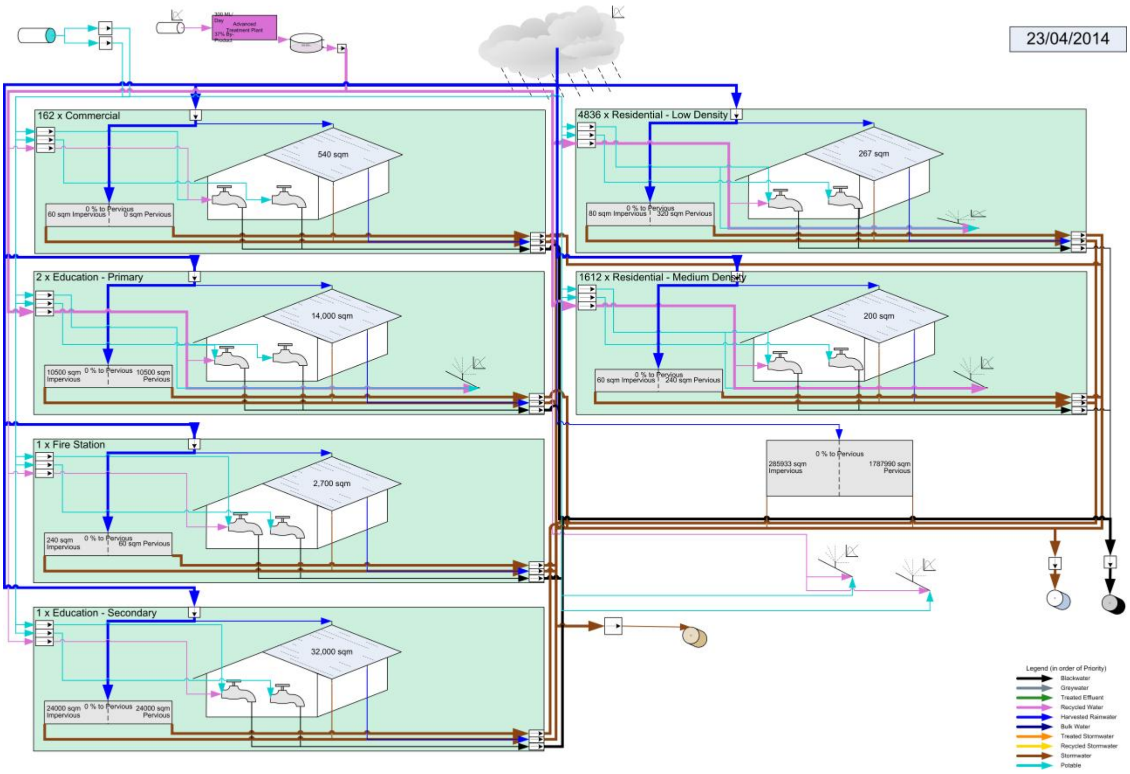


Figure 24 IWM Toolkit Water Balance Scenario

9. Effects of the WoWCM options on the proposed drainage strategy

9.1 Summary

The main elements of the drainage strategy are the four retarding basins and the wetlands located within those basins. A summary of the effect that each option has on these main elements is presented in Table 23.

Table 23 Summary of the Effect of the Options on the Drainage Strategy RBs and Wetlands

Option	Description	Effect on RBs	Effect on wetlands
1	Traditional approach	None	None
2	Pakenham WWTP recycled water	None	None
3	Bald Hill stormwater harvesting and recycled water	Potentially significant reduction in size subject to the size of the stormwater pipe connection to Bald Hill.	Potentially significant reduction in size subject to the size of the stormwater pipe connection to Bald Hill.
4	Lot scale roof water harvesting	Minor reduction in size.	Minor reduction in size.
5	Regional roof water harvesting	Significant reduction in size.	Minor reduction in size.

9.2 Effects of the options on the drainage strategy RBs

9.2.1 Option 3 - Bald Hill stormwater harvesting and recycled water

The diameter of the stormwater pipe connections from the southern retarding basins to Bald Hill, the volume of storage required at Bald Hill and the required retarding basin sizes are all related.

Analysis was undertaken to investigate the relationship between each of these elements for this option. The analysis was undertaken for the 100-yr ARI event (9hr duration), which is the required standard for the retarding basins. This analysis showed that by harvesting 2.7 ML (the adopted daily limit of the treatment plant) during the 100-yr ARI event, would result in a negligible effect on the required RB storage volume (RB4 reduced from 73.5 ML to 72 ML). A stormwater pipe connection from RB4 to Bald Hill with a diameter of 450 mm was shown to be required to convey the 2.7 ML over the period of this storm event.

This result shows that harvesting stormwater for the sole purpose of supplying alternative water to the East Pakenham PSP would have negligible effect on the size of the required RBs within the precinct. The storage volume of Bald Hill reservoir is 900 ML and the total storage volume of the retarding basins proposed for the drainage strategy is 349 ML. Bald Hill reservoir is therefore potentially large enough to provide the retardation function of the four proposed retarding basins. The economic viability of this depends largely on the cost of piping the unattenuated 100-yr ARI flood flows to Bald Hill and whether this is less than the savings in the cost of the retarding basins (and wetlands – see Section 4.4), including in particular land costs.

It is not clear what the land costs will ultimately be. Figure 25 shows for the RB4 site, the RB construction cost against pipeline construction cost for the full range of scenarios from that required to convey what is only required for alternative water supply (2.7 ML/day) to that which would convey all flow to Bald Hill. Based on this analysis it was established that a land value of less than approximately $700,000/ha did not make it economically viable to pipe flood flows to Bald Hill to reduce the size of the RBs. The relationship presented in Figure 25 shows the relative costs with a land value of $700,000/ha. Based on this particular land value, Figure 25 shows that the total construction cost is somewhat invariant to diversion rate. So for higher land values, the concept of increasing the pipe size and reducing RB size will start to be attractive.

This is subject to many other factors, which would need to be investigated and confirmed, such as how Bald Hill reservoir would be satisfactorily managed to provide the retardation function.

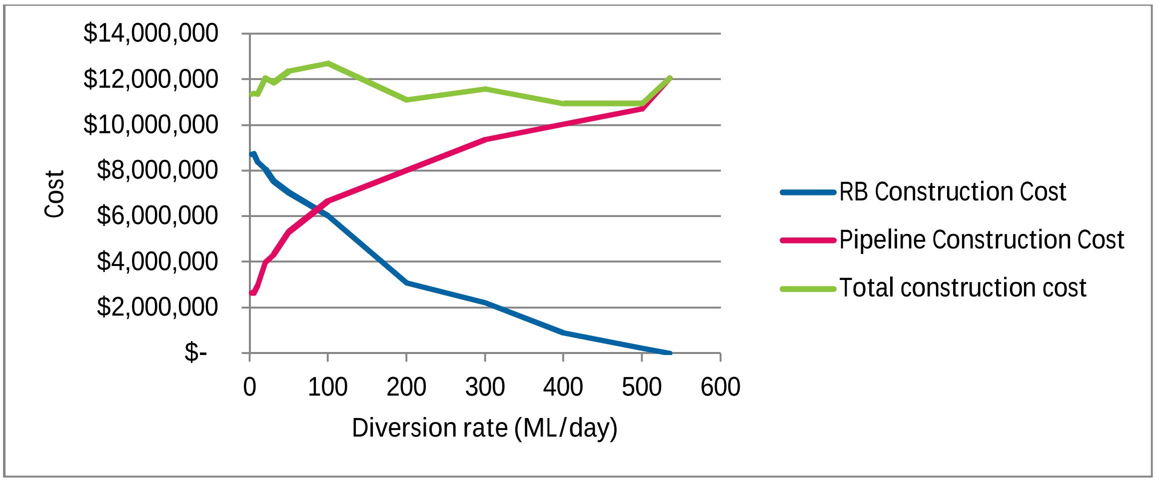


Figure 25 RB construction costs vs pipeline construction costs for Option 3

If stormwater is harvested to the extent that there is a significant reduction in the size of the RBs, then Bald Hill is effectively acting as an RB. Bald Hill will hold Class C treated wastewater, which cannot be allowed to spill to waterways. A spillway would therefore need to be included on the pipe connection before entering Bald Hill. This would ideally be undertaken at the RB sites so that flood flows are not diverted out of catchments.

9.2.2 Option 4 - Rainwater tanks

Rainwater tanks at the adopted size of 5 kL on each residential lot (low and medium density) would provide a total storage volume of 32ML within the precinct. The total storage volume provided by the four proposed retarding basins within the precinct would be 349ML. Based on their relative sizes (rainwater tanks represent just under 10% of the total volume provided by the retarding basins), it is clear that rainwater tanks would have no significant effect on attenuating peak flood flows in a 100-yr ARI event and therefore no material effect on RB sizing.

It is acknowledged that rainwater tanks may have a more significant effect on lower ARI events, but this would not affect the size of the retarding basins, which need to be sized for the 100-yr ARI event.

9.2.3 Option 5 - Regional Roof Water harvesting

This option removes the roofs from the effective total impervious area, and therefore can have an effect on the RB sizing. However, it would need to convey this water to a new storage at a high rate, and fully conveying the 1:100 year flood would need higher capacity interconnecting pipe systems than currently estimated.

So there is an opportunity to reduce RB sizes based on this option, but further detailed modelling would be needed before any confidence could be assigned to the actual reduction.

Based on a simplistic analysis which assumed no constraint from the distributed dual roof drainage, the following result was derived: RB size reduced from 73,500 down to 23,000. This is significant but limited in reality by the size of the capture basin. The current sizing is not based on achieving this reduction, and land would need to be acquired somewhere to achieve this. No significant effect on Wetland size (See Table 24).

Note that the system is based on Warrnambool roofwater harvesting scheme, which has been developed as the basis for a tool for the industry to use for analysis.

9.3 Effect of the options on the drainage strategy wetlands

The pollutant reduction contribution from each option is presented in Table 18.

The stormwater harvesting option has been estimated to harvest 58% of the total stormwater runoff from the precinct on average each year. Based on this estimate, it has been interpreted that the stormwater harvesting option removes 58% of each of the target pollutants.

Roof water will generally be less polluted than the stormwater that discharges from the precinct. This has been considered with the pollutant reduction contributions for the roof water harvesting options presented in Table 24 through adopting pollutant loads based on Fletcher 12 values.

The water quality treatment targets for best practice (adopted for the drainage strategy) and SEPP F8 are presented in Table 25 and Table 7 respectively. It can be observed that the stormwater harvesting option would achieve the best practice targets with the removal of stormwater solely through harvesting. This would therefore remove the need for wetlands as part of this option.

The roof water harvesting options have less of an effect on removing pollutants, particularly with TSS, and therefore these options would still require some further treatment measures to reach the best practice targets.

Table 24 Pollutant reduction contribution from harvesting

Option	TSS	TP	TN
Bald Hill stormwater harvesting and recycled water	58%	58%	58%
Lot scale rain tanks	4%	13%	26%
Precinct Roof Harvesting	6%	18%	37%

Table 25 BPEMG Water quality treatment targets

	TSS	TP	TN
BPEMG Target	80%	45%	45%

10. Pollutant loads and energy use

10.1 Pollutant loads from wastewater and stormwater

The pollutant loads present in the wastewater and the stormwater are characterised below.

1. These loads are characterised as the total 'raw' loads and as the loads post treatment.
2. The 'raw' loads are a somewhat arbitrary concept, as the waste water and the stormwater must be treated before going to the environment. In the case of wastewater, the final environmental destination is Bass Strait, some distance away and with different pollutant requirements.

10.1.1 Stormwater pollutant load reductions

The following table illustrates the concentrations adopted in the analysis. These have been developed from land use breakdown and the Fletcher 12 concentrations. The MUSIC defaults are presented for comparison.

Table 26 Assumed Pollutant Concentrations

	Assumed Pollutant Concentrations (mg/l)		
	TSS	TP	TN
Roads	269.8	0.5	2.2
Roofs	20	0.13	2
Other Impervious	140	0.25	2
Pervious	89.9	0.16	1.45
MUSIC defaults (typ.)	158.5	0.35	2.63
Weighted Average	**75.49**	**0.18**	**1.87**

Using these assumed concentrations, the following reductions were estimated for the different options.

Table 27 Estimated Pollutant Reductions

Option		Change		
		TSS	TP	TN
1	Traditional approach	-	-	-
2	Class A from WW	-	-	-
3	Stormwater from Basins	58%	58%	58%
4	Rain tanks*	9%	24%	37%
5	Precinct Roof Harvesting	13%	35%	52%

This table illustrates the difficulty with considering pollutant loads based on Nitrogen as a surrogate measure. The different options have different relative removals as they draw from different sources.

The following graph shows the nitrogen loads pre and post treatment from both stormwater and wastewater, for the different options.

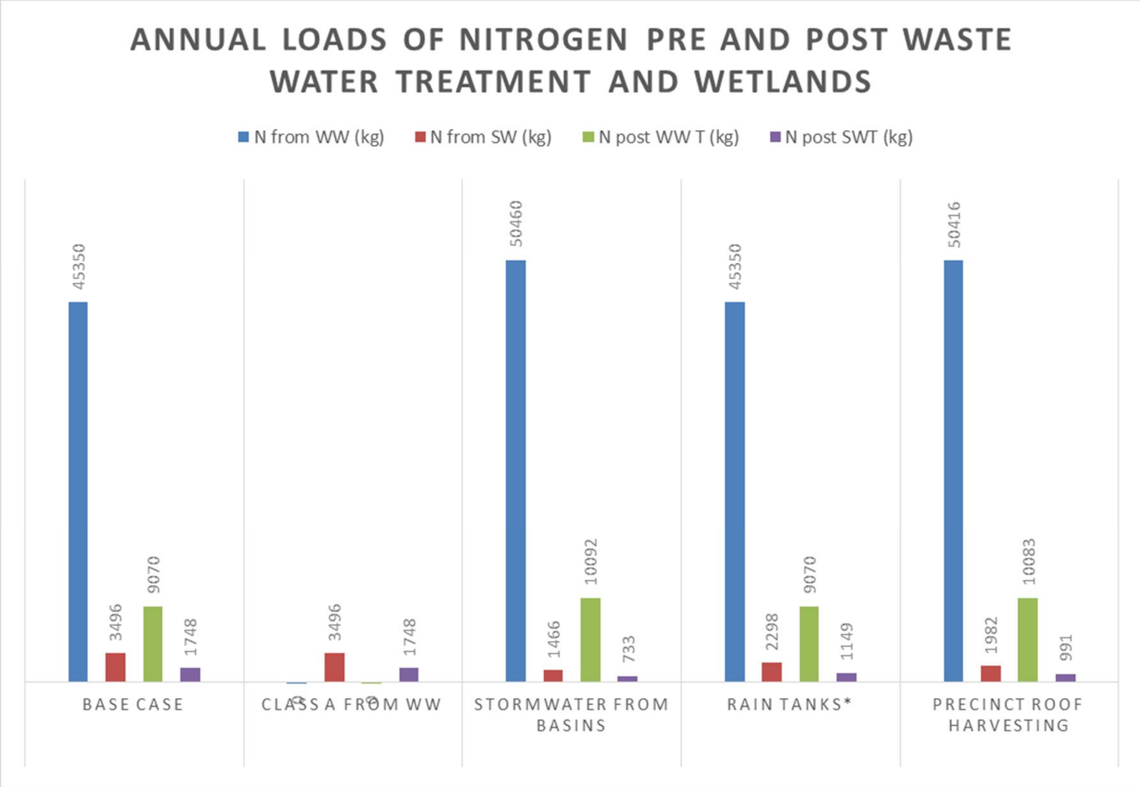


Figure 26 Nitrogen Loads Pre and Post Wastewater Treatment and Wetlands

The following observations can be made:

1. The raw waste water has significantly more nutrients than the stormwater, even though the flows of waste water are less.
2. After treatment, the nutrient loads in the waste water remain higher. If the waste water was being discharged locally, this might suggest that the Class A option had higher environmental value, as it would remove a greater load from the waterways. However, this flow is being sent to ETP and then to Bass Straight, so this is not such a clear point.
3. The stormwater harvesting option achieves the lowest loads to the local water way, noting that this level of removal is not required by BPEM.

10.1.2 The wetlands offset value

Melbourne Water has a technique for estimating the cost of providing waterway protection in cases where the developer cannot easily provide a wetland.

In this technique, the amount of nitrogen [in kg/yr.] that would have been removed to meet BPEM if a wetland was put in place is estimated, and then multiplied by the offset value [currently set at around $6000 per kg/yr.]. This value has been determined to be a reasonable estimate for the cost of a wetland which Melbourne Water will now need to build somewhere downstream to protect the water way. The value was determined by looking at the costs of some recently developed wetlands and dividing by the amount of nitrogen removed per year.

If the developer believes they can put in appropriate wetlands for less than this value, then they will do so, alternatively they can choose to pay the offset value.

While this offset value appears to be an externality for nitrogen, there are some points to consider before it is used on this basis.

1. It is a value for kg per year, not kg, so it cannot be used in a CBA for ongoing year after year cost estimation.
2. It is based on providing the value that a wetland provides, including removal of other contaminants such as TSS, TP etc. etc. The nitrogen removal is used as a simplifying measure, and if an alternative option only removed nitrogen and not these other parameters, using this value would overstate the value of that option.
3. It is based on the treatment required to meet BPEM, not to fully remove the contaminants. So it is not clear it can be extrapolated to be the value for removal of contaminants below the level required by BPEM.
4. It is not calibrated to waste water and waste water treatment. In fact, if this value is used for waste water treatment, it would assign very high capital values to waste water treatment plants, as they remove nitrogen at orders of magnitude higher rates than wetlands.

Due to these concerns, this study has adopted the approach of estimating the impact by considering the expansion or reduction in the sizes of wetlands in response to the different options, rather than assigning a value to the contaminants.

Note that the value given by the offset to the removals in this project is higher than the cost estimates for the existing wetland, which supports the decision to construct wetlands rather than pay for the offset.

10.2 Energy use

The energy cost of each option is included in the benefit cost analysis; however a standalone consideration has been made also. Energy (electricity) use for whole of water cycle occurs almost exclusively in pumping and treatment of water. This analysis has focussed on these two components only. Energy use associated with wastewater treatment at ETP and for potable supply from the wider Melbourne network has not been considered in this analysis, rather it has focussed on what is occurring at a precinct level.

Energy use has been estimated for pumping using the daily volume, and making an estimate of the head required, both as static lift and pipe friction. Treatment energy use (which may include re-lift pumping within a treatment process) has been estimated using typical specific energy requirements (kWh/kL) for different types of treatment.

The results are shown in the figure below. Option 2 has the lowest overall pumping requirements owing to the fact that wastewater is being treated locally, avoiding the need for pumping associated with transfer to ETP. This option does however have the largest treatment energy use, owing to both wastewater treatment (to Class C) and Class A treatment is required.

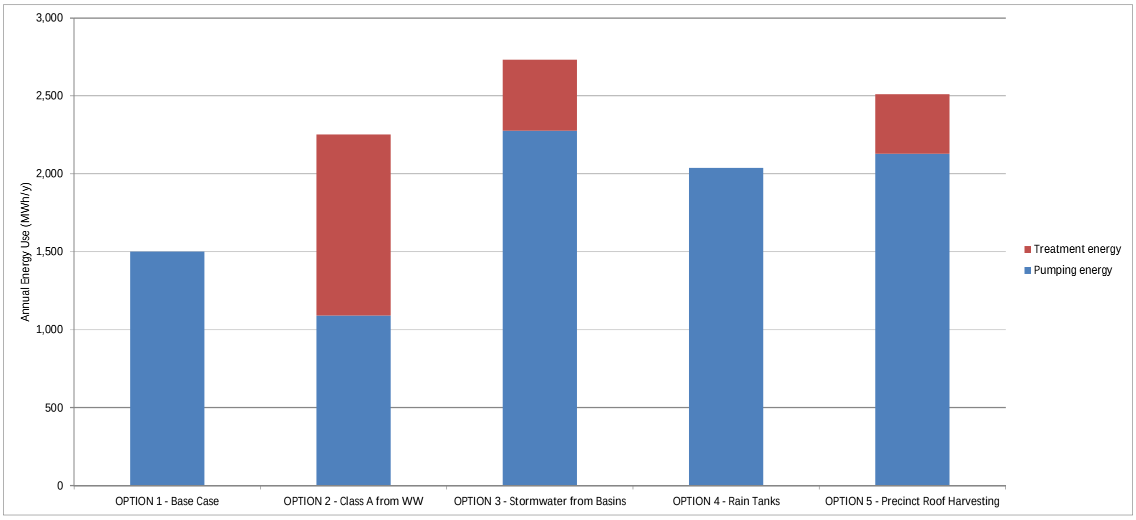


Figure 27 Comparison of Energy Use of Options

Options 3 and 5 both involve pumping of wastewater to ETP in addition to pumping of stormwater roof water for reuse within the precinct, hence the higher pumping energy requirements. Option 4 includes energy at a household level for pumping water from rain tanks to use around the house.

11. Cost benefit analysis of short listed options

11.1 Cost estimate methodology

Cost estimates have been developed for each of the short listed options. The costs involve both capital and annual costs, which form the basis of the net present value (NPV) and cost benefit analysis.

Capital Cost Assumptions:

- Reticulation:
  - Reticulation costs (i.e. potable water, sewerage, drainage, dual pipe or a dedicated roof harvesting network) have been developed from the number of houses within the precinct and applying a per house cost for the reticulation type.
  - The reticulation rates have been developed from a GIS based analysis that examined the reticulation in a similar suburb and estimated the cost based on typical engineering rates, breaking the final cost down to a per house basis.
- Pipelines:
  - Preliminary sizing of connecting pipelines has been based on the required flow rate and velocity to obtain a pipe diameter.
  - Pipe lengths are based on a GIS analysis of likely connection points both within and outside the precinct, following likely corridors along existing easements and roadways.
  - Costs have been calculated based on per metre pipe rates for the given pipe size over the identified length.
- Treatment Plants:
  - Cost curves for treatment plans have been applied using the design flows (e.g. peak day) from the water balance to estimate the required overall plant cost.
- Pump stations:
  - Pump station requirements have been estimated using typical pipe friction loss values (m/m values) over the relevant pipeline lengths and an adopted static lift for the particular application and location.
  - Once the pump station size (as measured in flow capacity and kW) is understood, cost curves are applied to determine capital costs.
- Tanks, Storages and basins:
  - Tanks and storages are sized based on meeting the design requirements (e.g. one peak day of storage) and the application of cost curves.
  - Retarding basin costs are estimated from basin volume and earthwork rates from Melbourne Water's Developer Services Scheme cost database.
  - Wetland areas are estimated based on areas within retarding basins and reference costs from other projects.
- Other Capital Costs:
  - Allowances for other capital costs have been included, including a value for land take/release. These values are determined based on input from stakeholder.

Annual Cost Assumptions:

- Mains water:
  - A unit cost ($/ML) is applied to water consumption based on the water balance to determine the annual cost of supply from the wider Melbourne potable water network. This price includes allowance for all elements of the water price, including wider network infrastructure upgrades and refurbishments.
- Wastewater to ETP:
  - Similar to mains water, a unit cost ($/ML) is applied to all wastewater treated at ETP.
- Other Treatment:
  - Where water or wastewater is treated locally (e.g. wastewater at Pakenham WWTP) a unit cost is developed based on an overhead cost for plant operation (covering maintenance, staffing etc.) and a unit cost for water treated (covering power, chemicals etc.).
- Pumping costs:
  - Pump sizes estimated for the purpose of capital costs are also used to estimate energy costs associated with operation of the pumps.
- Rainwater tank costs:
  - Annual costs have been developed on a per house basis to cover typical annual expenses related to pump operation and maintenance with a rainwater tank system.
- Contaminant Loads:
  - The cost associated with contaminants from the precinct entering the environment, either in wastewater or stormwater, is accounted for by placing an annual cost per unit on the contaminant (e.g. $/kg N).

11.2 Net present value

The NPV of each option has been developed to allow comparison of the whole of life costs for each project.

The NPV analysis has been considered over a 40 year horizon, with different capital deployment and annualised cost ramp up scenarios adopted.

A basis discount rate of 5.3% has been adopted. This value is tested in the sensitivity analysis.

11.3 Cost benefit analysis

A cost benefit analysis provides a simple unit-less measurement of the relative costs and benefits of a project. In the application for East Pakenham all short listed options have been compared to the base option (traditional servicing strategy).

Net present values for capital and annual costs are grouped together, and a comparison between the options are made by subtracting one from the other.

Table 28 Summary of Benefits and Costs

Benefits	Costs
Reduced cost of potable water	New pipelines and pump stations
Reduced cost to dispose of waste water at ETP	New treatment plants
Reduced cost of stormwater disposal to environment	Additional reticulation
Reduced cost of treated wastewater to the environment	Additional storage
	Additional treatment and pumping costs

The benefit cost ratio is found by dividing the net value (benefits minus costs expressed as NPV) of the option being considered by that of the traditional option. A ratio of 1.0 shows the option being considered is equivalent to the base option. Less than 1.0, the costs outweigh the benefits, and vice versa.

11.4 Sensitivity analysis

The sensitivity of the options was investigated by varying some of the input parameters over ranges that are outlined below.

Table 29 Summary of Sensitivity Ranges

Parameter to Vary	Lower Bound	Upper Bound
Additional [net additional] cost of adding dual pipe	$2 000 /house	$5 000 /house
Long Run Marginal Cost of Potable Water Supply from the Central System	$500 /ML	$2 000/ ML
Long Run Marginal Cost of Waste Water Treatment in the Central System [ETP]	$250 /ML	$3 000/ML
Value of Land which is made available [i.e. reduction/increase in land take from water infrastructure].	$250 000 /Ha	$700 000 /Ha
'Cost' or value of nitrogen avoided entering the environment.	$300 /kg	$6 000 /kg
Rain tank Installation Cost [for a 5 kL tank]	$2 000	$5 000
Rain tank Average Annual maintenance cost [not including pumping energy costs]	$20 /house	$100 /house
Discount Rate	1.5 %	10 %
SEPP 8 Applies	No	Yes

The results of the analysis are summarised in the table below.

Full outputs of the analysis can be found in Appendix G .

Table 30 Summary of Sensitivity Analysis Results

SCENARIO	Option 1 Traditional approach		Option 1 Pakenham WWTP recycled water		Option 3 Bald Hill stormwater harvesting with recycled water		Option 4 Lot scale roof water harvesting		Option 5 Regional roof water harvesting	
	NPV	BC	NPV	BC	NPV	BC	NPV	BC	NPV	BC
Scenario 0 - Base Case	157		159	0.92	174	0.46	164	0.69	184	0.39
Scenario 1.1 - Water Cost Low	149		154	0.78	169	0.34	160	0.52	181	0.29
Scenario 1.2 - Water Cost Min	132		145	0.48	159	0.12	150	0.17	173	0.10
Scenario 1.3 - Water Cost High	191		178	1.52	194	0.91	183	1.38	199	0.78
Scenario 1.4 - Water Cost Max	207		188	1.82	204	1.14	192	1.73	207	0.98
Scenario 2.1 - Wastewater Cost Low	151		156	0.78	168	0.46	158	0.69	178	0.39
Scenario 2.2 - Wastewater Cost Min	148		155	0.70	165	0.46	155	0.69	175	0.39
Scenario 2.3 - Wastewater Cost High	170		164	1.22	186	0.46	177	0.69	197	0.39
Scenario 2.4 - Wastewater Cost Max	182		170	1.52	199	0.46	189	0.69	209	0.39
Scenario 3.1 - Land Cost Low	154		156	0.92	171	0.46	161	0.69	183	0.39
Scenario 3.2 - Land Cost High	162		164	0.92	179	0.46	169	0.69	187	0.39
Scenario 3.3 - Land Cost Max	166		168	0.92	183	0.46	173	0.69	189	0.39
Scenario 4.1 - Nitrogen Cost Low	157		159	0.91	174	0.46	164	0.69	184	0.39
Scenario 4.2 - Nitrogen Cost High	160		160	0.98	177	0.46	167	0.69	187	0.39
Scenario 4.3 - Nitrogen Cost Max	167		164	1.14	184	0.47	174	0.69	194	0.39
Scenario 5.1 - Raintanks Cost Low	157		159	0.92	174	0.46	158	0.96	184	0.39
Scenario 5.2 - Raintanks Cost High	157		159	0.92	174	0.46	176	0.44	184	0.39
Scenario 5.3 - Raintanks Annual Maintenance Low	157		159	0.92	174	0.46	164	0.72	184	0.39
Scenario 5.4 - Raintanks Annual Maintenance High	157		159	0.92	174	0.46	170	0.55	184	0.39
Scenario 6.1 - Discount Rate 1.5%	210		205	1.18	226	0.60	210	1.02	237	0.52
Scenario 6.2 - Discount Rate 3%	175		175	1.01	192	0.51	180	0.81	202	0.44
Scenario 6.3 - Discount Rate 7%	122		127	0.73	138	0.35	133	0.45	147	0.29
Scenario 6.4 - Discount Rate 10%	101		107	0.60	116	0.27	114	0.32	123	0.23
Scenario 6.4 - Discount Rate 10%	179		180	0.92	174	1.12	186	0.69	201	0.43

SCENARIO	Option 1 Traditional approach		Option 1 Pakenham WWTP recycled water		Option 3 Bald Hill stormwater harvesting with recycled water		Option 4 Lot scale roof water harvesting		Option 5 Regional roof water harvesting	
	NPV	BC	NPV	BC	NPV	BC	NPV	BC	NPV	BC
Scenario 7.2 - SEPP F8 Applies PLUS Land Max Cost	194		196	0.92	183	1.12	201	0.69	212	0.43
Scenario 8.1 Dual Pipe Cost High	157		168	0.68	183	0.36	164	0.69	184	0.39
Scenario 8.1 Dual Pipe Cost High	157		174	0.57	189	0.31	164	0.69	184	0.39

Notes for Interpretation of These Results:

1. This table should not be used or read in isolation from the remainder of the report.
2. The CBA analysis is not fully comprehensive, as some externalities are not currently assigned a value. So a decision on what option to adopt should not be made based on this CBA alone, but should also consider other issues covered elsewhere in this report.
3. The CBA analysis does not address risk. Some options may have different likelihoods and consequences for failure. A separate risk assessment is provided to summarise some key considerations.
4. Refer Elsewhere in the Report for full descriptions of the options.
5. Refer to the full sheet for each analysis in the Appendices to understand the details behind the cost and benefit analysis.
6. The NPVs shown are in $ millions.
7. ‘BC’ is benefit cost ratio.
8. Benefit Cost Ratios above 1 are green, and below green move progressively from yellow to red as they become smaller.
9. One way of considering the information in this table is to think about which scenario makes a particular option more attractive. For example, ‘wastewater cost max’ reflects the upper end of the range for the long run marginal cost of wastewater treatment and disposal at ETP. This provides a high BC for option 2: Class A reuse, which is as expected.

11.5 Cost benefit analysis discussion

The methods and assumptions underlying the Cost Benefit Analysis (CBA) and related sensitivity analysis are set out in the previous Sections, and the output sheets for the analysis are provided in Appendix G.

The following sections discuss different outcomes from this analysis, and the potential implications for decisions about which option to adopt for the precinct.

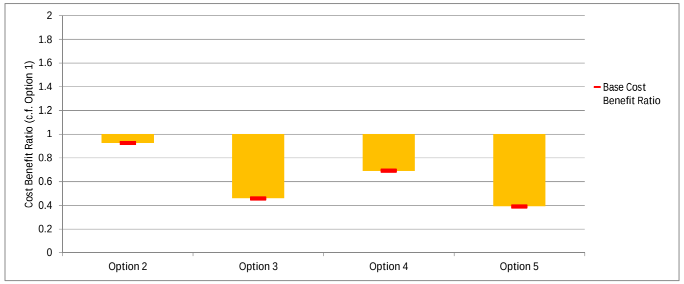
EAST PAKENHAM - SENSITIVITY ANALYSIS

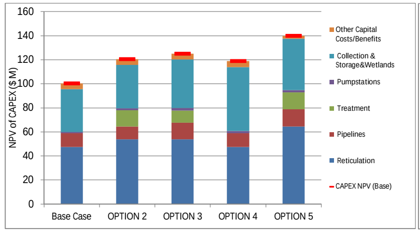
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

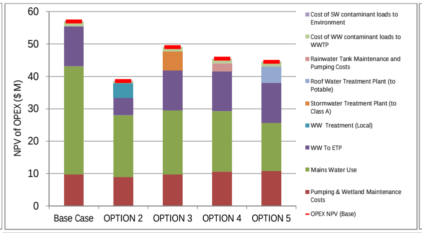
Comments on Sensitivity Test Scenario:

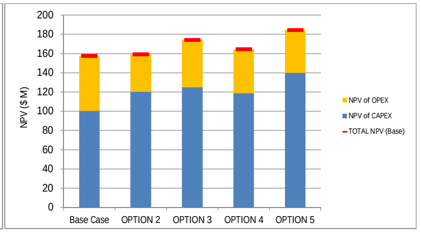
Scenario 0 - Base Case

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 157 M	$ 159 M	$ 174 M	$ 164 M	$ 184 M
%change	0%	0%	0%	0%	0%
BC Ratio *(c.f. 1)*		0.92	0.46	0.69	0.39



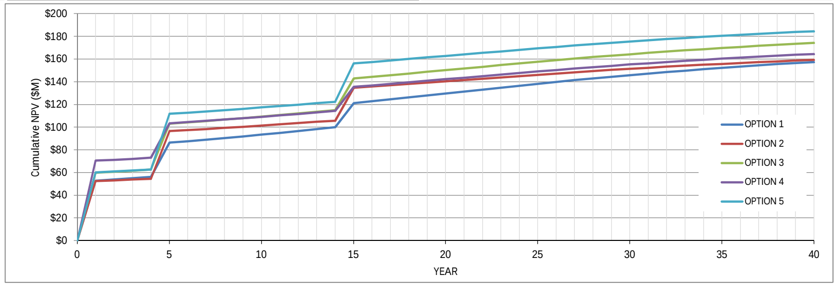


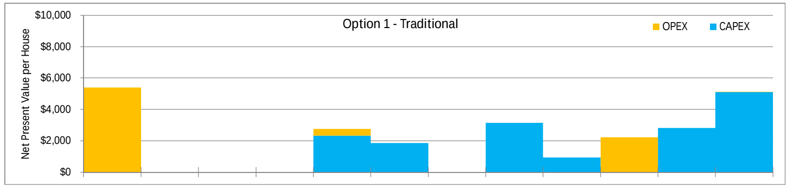


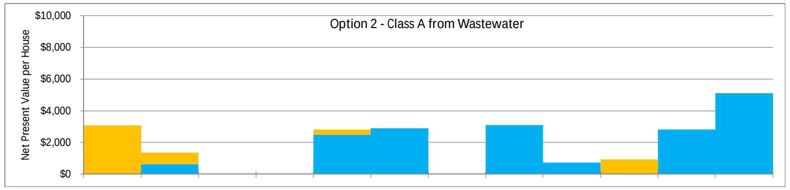


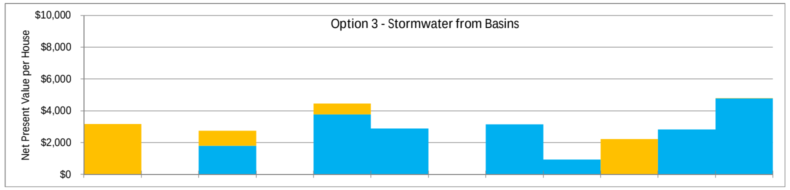
Short-listed Options

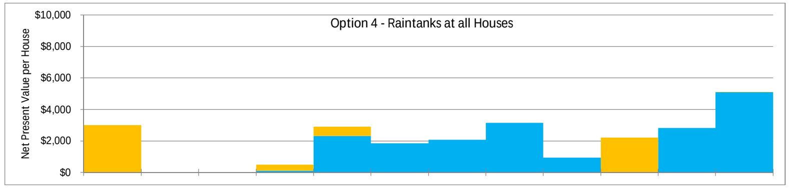
Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting

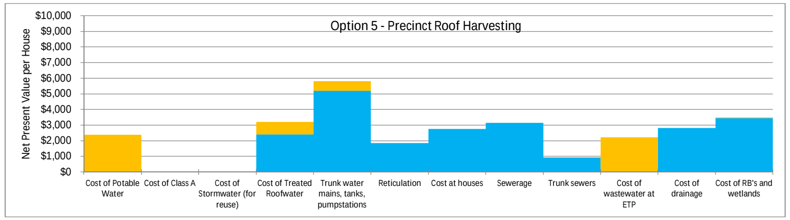












11.5.1 Long run marginal cost of potable water supply

One of the key inputs to the analysis is the cost of potable water supply. Options which have more local water recycling or other alternative water supplies use less potable water. This leads to an ongoing saving related to the following factors:

1. The cost of providing water with current water supply infrastructure: this is likely to increase as demand in the city increases and there is a call to use some of the capacity of the Wonthaggi desalination plant, as the operational cost of this water is higher than the cost of water from the dams.
2. The cost to construct new water supply infrastructure at some future date: if demand increases to some level, there will be a need to supply new water to the city from either another desalination plant, another dam or some other source. Using alternative water sources delays the need for such investment.
3. The supply of potable water to areas requires the construction of transfer infrastructure, and the current infrastructure will have to be upgraded at some point to accommodate increasing demand. Using alternative water sources delays the need for such investment.

OLV and the water industry is preparing avoided cost estimates for all these kinds of works to determine the Long Run Marginal Cost of providing additional water.

Given that an agreed LRMC is not available, this report adopted a sensitivity approach, where the effect of different LRMC numbers on the analysis was explored. Analysis over the range used shows that it is only when the LRMC is near the top of the ranges investigated that the alternative water supply options appear attractive.

This highlights the need for a robust and agreed LRMC for potable water supply.

Note that in this location, there are a range of large transfer mains, and therefore the LRMC will be largely related to additional central supply. This contrasts with the West of Melbourne, where there will be a higher LRMC to allow for additional transfer mains.

11.5.2 Long run marginal cost of waste water treatment and disposal

The final fate of the waste water generated in this precinct [if not recycled in some way] is to be treated at ETP and then sent to Bass Strait via the SE outfall at Boag's Rocks on the Mornington Peninsula.

Just as discussed above for the potable water supply, there are cost implications of increasing the loads sent to ETP.

1. The costs of treatment may increase as the plant is upgraded to accommodate additional loads.
2. There will be a need to invest in additional capacity at ETP to accommodate growth. Options which recycle waste water locally will delay the need for such investment.
3. At some future point, the capacity of the SE Outfall and the licence requirements for discharge may reach a limit, leading to a need for even more significant investment. Options which recycle waste water locally will delay the need for such investment.

OLV and the water industry is preparing avoided cost estimates for all these kinds of works to determine the Long Run Marginal Cost of treating additional wastewater in the central plants. Given that an agreed LRMC is not available, this report adopted a sensitivity approach, where the effect of different LRMC numbers on the analysis was explored.

Analysis over the range used shows that it is only when the LRMC is near the top of the ranges investigated that the recycled water options become attractive versus other options.

This highlights the need for a robust and agreed LRMC for waste water.

11.5.3 Land take and land value

All options include land take within the precinct for retarding basins and wetlands [although this land take does vary somewhat for the different options].

Some key points arise from the analysis:

1. If BPEM is adopted as the standard for the waterway discharges, then the wetland areas all lie within the retarding basin areas. So, even though the stormwater harvesting options do reduce the wetland area, they do not affect the area of encumbered land. The analysis includes the cost savings for wetland construction planting and maintenance, but no change in land take in the precinct.
2. If SEPP F8 is adopted [as an example of a more stringent standard for water way protection], then the wetland areas exceed the retarding basin areas. Based on work undertaken by others, this increase is about 12 additional hectares. This leads to a land take 'saving' for the options including stormwater harvesting, given this option reduces the nutrient loads by an amount equivalent to the requirements for SEPP F8.
3. Given the SEPP F8 requirements, and if a higher end land value is assumed, the stormwater harvesting option becomes favoured.

Note that there are complications to consider here. Although there could be an alteration in land take, it is not clear how this land value is translated into investment in the stormwater harvesting scheme. If land take for stormwater treatment and retardation is reduced, this logically results in an increase in Net Developable Area. The existing funding mechanism for drainage management of catchments above 60ha is through Development Services Schemes administered by MW. How this funding mechanism relates to funding stormwater harvesting infrastructure is to still to be confirmed.

11.5.4 The cost of rain tanks

The installation of rain tanks has been analysed with a range of costs per house in the sensitivity testing. This shows that if the costs are at the bottom end of the range, then rain tanks become attractive in the CBA. At the upper end of costs, this is not true.

This variation raises the issue of installation costs of tanks, including the positive or negative effect they may have on the house 'value'.

The following issues are of interest.

1. The 'star rating' system gives credit to either dual pipe connection, or rain tanks, so there is no simple difference on that basis.
2. Some homeowners may welcome rain tanks as part of their personal views on independence and sustainability.
3. Some sites, particularly if of small area, or on a steep incline, may not be suitable for the use of rain-tanks, or at least not at the costs estimated here.
4. The analysis includes consideration of the maintenance and other costs via the sensitivity analysis. This comparison shows the significance of these input costs if they are at the higher end of the estimation range.

11.5.5 Discount rate

The analysis examined the impact of different discount rates. Because the savings in potable water use are a significant fraction of the NPV, and these are an ongoing annual cost, which rises in time in the analysis until the development is finished, lower discount rates emphasise the savings in options which save more potable water over time.

As all of the options other than the base one have this characteristic, the sensitivity doesn't show much change between options 2, 3, 4 and 5. However, it does highlight the significance of the discount rate to the overall decision as to whether any option is more attractive than the base case.

11.5.6 Nitrogen cost

Nitrogen 'cost' has been used as a proxy for an externality related to the possible environmental impact related to the contaminants present in either stormwater or waste water.

The analysis has been done on the basis that full treatment of waste water and BPEM treatment of stormwater has already occurred. So it is a way of examining the residual impact and its related 'cost'.

The comparison shows that there is not a significant difference in the NPVs for the different 'costs' for nitrogen.

11.5.7 Further comparisons

It can be seen that many other combinations are possible. What happens if you have high land cost and a low discount rate?

The sensitivity testing has been limited to these scenarios to avoid creating too many different points for consideration.

However, other NPV results can be determined if necessary, or in many cases derived through interpolation between the existing results.

11.5.8 Observations from the results

1. There is only a small difference between the NPVs for Option 1 and 2, and therefore there are a number of cases where Option 2 becomes favoured. It seems reasonable to conclude that a choice between these two options could be made on grounds other than the cost benefit analysis. The main case where Option 2 is not favoured is where the LRMC of potable water is low, again highlighting the importance of this number.
2. Option 3 becomes attractive from a CBA viewpoint where water costs are high [as for all the options], but also in the case where SEPP F8 applies and the land cost is high. This highlights the need to understand the downstream waterway requirements, as stormwater harvesting benefits are emphasised when the receiving waterway has higher values. It also demonstrates that land take can have a material impact on the CBA for the full water cycle, at least at the upper end of land values analysed.

3. Option 4 becomes attractive at the lower end of rain tank costs. This lower end estimate is below that usually adopted. The view of some stakeholders was that the costs may in some cases be higher than the upper end analysed, due to the small block sizes and steep terrain for some houses. So careful consideration would be needed before this option was considered the most attractive.
4. There appear to be almost no circumstances analysed where Option 5 is preferred compared to other options based on the CBA. However, this Option has the unique property that it could be combined with Option 2 to provide a near 'water neutral' outcome.

11.6 Distributional analysis

A preliminary analysis has been completed to consider how the overall cost for each option is divided between the following stakeholders:

- Melbourne Water (responsible for bulk water, bulk wastewater and drainage).
- South East Water (water and wastewater service retailer, including recycled water).
- Council (responsible for local drainage and public spaces).
- The developer (builds much of the infrastructure that is subsequently transferred to other stakeholders).
- Households (residents of the precinct).

The analysis has considered a simple split of the overall net present values for the options using the matrix for CAPEX shown in Table 31 and for OPEX shown in

Table 32.

The analytical tool underlying this has been developed so that the weightings in this table can be easily modified to change how the costs are divided. It is recognised in this analysis that some assets are transferred (for example the reticulation) and that costs will be passed on through billing mechanisms to other parties and ultimately the households. This analysis does not include these transfers in any detail.

Table 31 CAPEX Cost Distribution Matrix

	MW	SEW	Council	Developer	Household
Cost of Potable Water	1				
Cost of Class A		1			
Cost of Stormwater (for reuse)		0.4		0.6	
Cost of Treated Roof water		0.6		0.3	0.1
Trunk water mains, tanks, pump stations		1			
Reticulation				1	
Cost at houses					1
Sewerage				1	
Trunk sewers		1			
Cost of wastewater at ETP	1				
Cost of drainage				1	
Cost of RB's and wetlands				1	

Table 32 OPEX Cost Distribution Matrix

	MW	SEW	Council	Developer	Household
Cost of Potable Water	0.5	0.5			
Cost of Class A		1			
Cost of Stormwater (for reuse)		0.8	0.2		
Cost of Treated Roof water		0.8	0.2		
Trunk water mains, tanks, pump stations		1			
Reticulation		1			
Cost at houses					1
Sewerage		1			
Trunk sewers		1			
Cost of wastewater at ETP	0.9	0.1			
Cost of drainage			1		
Cost of RB's and wetlands	0.2		0.8		

The cost of elements has been shared between parties where there is either some shared responsibility (e.g. for potable water Melbourne Water provide the bulk water and trunk mains, while SEW provide the supply mains and act as the retailer) or assets are delivered by one entity for another (e.g. the reticulation is built by the developer, who in turn transfers ownership to SEW).

The distribution in the above matrices provides overall costs (as net present values in $M) for each of the above described stakeholders in Table 33, Table 34 and Table 35 for CAPEX, OPEX and the total of CAPEX and OPEX respectively.

Table 33 CAPEX costs by Stakeholder (based on Distribution Matrix)

	MW	SEW	Council	Developer	Household
Option 1	$0.0	$19.9	$0.0	$74.6	$0.0
Option 2	$0.0	$16.5	$0.0	$80.1	$0.0
Option 3	$0.0	$18.7	$0.0	$81.6	$0.0
Option 4	$0.0	$20.3	$0.0	$74.7	$11.5
Option 5	$0.0	$45.4	$0.0	$68.6	$16.6

Table 34 OPEX costs by Stakeholder (based on Distribution Matrix)

	MW	SEW	Council	Developer	Household
Option 1	$9.3	$5.7	$0.1	$0.0	$0.0
Option 2	$4.2	$8.3	$0.1	$0.0	$0.0
Option 3	$8.0	$9.5	$1.0	$0.0	$0.0
Option 4	$7.9	$6.6	$0.5	$0.0	$0.0
Option 5	$7.5	$8.0	$0.9	$0.0	$0.0

Table 35 CAPEX and OPEX Costs by Stakeholder (based on Distribution Matrix)

	MW	SEW	Council	Developer	Household
Option 1	$9.3	$25.6	$0.1	$74.6	$0.0
Option 2	$4.2	$24.9	$0.1	$80.1	$0.0
Option 3	$8.0	$28.2	$1.0	$81.6	$0.0
Option 4	$7.9	$26.8	$0.5	$74.7	$11.5
Option 5	$7.5	$53.5	$0.9	$68.6	$16.6

12. Policy considerations

The table below, which outlines policy considerations, was created based on the discussions and work from the workshop held on 13 August 2014.

Table 36 Policy Considerations

Policy or Consideration	'Traditional': no dual pipe, no mandatory rain tanks, no stormwater harvesting.	Dual Pipe Supplied from Treated Wastewater	Dual Pipe Supplied from Treated Stormwater [captured in the large existing Bald Hill Basin]	Mandatory Rain Tanks at every House	Roof Water Harvesting then Treatment to Potable
Melbourne's Water Future [OLV]	Counter to the policy of reducing reliance on potable water, and increasing use of alternative sources.	Meets policy.	Meets policy.	May be a policy issue, as there are considerations about 'mandating' rain tanks.	New idea and no fundamental objection. However, some elements need further consideration. May not meet policy as it creates potable water, not 'fit for purpose water'.
Council	Counter to views on sustainable development.	Thought to be the new 'base case'.	No objection.	Concerns about practicality given small blocks and steeper terrain.	New idea and no fundamental objection. However, some elements need further consideration.
MPA	Counter to views on sustainable development.	Thought to be the new 'base case'.	No objection.	Concerns about relying on the house owner as part of a wider system.	New idea and no fundamental objection. However, some elements need further consideration.
SEW	Expected to be counter to views of board to use alternative sources: provided the price difference is not excessive.	Expected to be aligned with the views of the board to use alternative sources: provided the price difference is not excessive.	No objection, but role and responsibility for managing Bald Hill need further consideration.	No fundamental objection.	Will be considerations related to water quality risk. New idea and therefore more information and consideration needed.
MWC	No objection provided drainage assets meet MWC standards and requirements.	No objection provided meets mandated requirements.	Not clear at this time whether transferring flood risk management [in part] to Bald Hill would meet policy. Not clear at this time if removing water from annual flow allows wetland area reduction.	No fundamental objection.	Will be considerations related to water quality risk. The idea that this option might have an influence on flood storage and RB size needs more investigation before a conclusion can be drawn. New idea and therefore more information and consideration needed.

Policy or Consideration	‘Traditional’: no dual pipe, no mandatory rain tanks, no stormwater harvesting.	Dual Pipe Supplied from Treated Wastewater	Dual Pipe Supplied from Treated Stormwater [captured in the large existing Bald Hill Basin]	Mandatory Rain Tanks at every House	Roof Water Harvesting then Treatment to Potable
Discussion	A key issue here was the question of future restrictions: would potable water be restricted in future droughts?		Flood/RB offset idea transfers risk to an actively managed storage, and this is new and therefore uncertain.		DOH could be consulted on how to evaluate water quality risk. Flood/RB offset idea transfers risk to an actively managed storage, and this is new and therefore uncertain.
Summary	May be against policy and therefore not acceptable.	Acceptable	Acceptable, but some benefits need more investigation [wetland and RB reduction].	May be against policy to have mandatory tanks.	Needs more investigation to understand policy position.

13. Risks and issues management register

This is not a comprehensive risk assessment, but is intended to capture some key considerations. It does highlight the potentially self-evident point that ‘new’ ideas have more risks, particularly until/if more thinking is done.

Table 37 Risks and Implementation

	Base Case [Traditional]	Class A from Pakenham WWTP	Stormwater Harvesting from Bald Hill	Rain Tanks at All Houses	Roof Harvesting to Potable
Definition	This is the well understood approach, with inherent risks as for any engineering project. No notable risks related to definition of this option.	This approach has now been adopted at many locations, and could almost be considered to be Business As Usual. There are some questions on the following points: • What reliability and redundancy should be provided? • Should it provide 100% or slightly less of the demand, particularly at peak? • Should it be sized to also service laundries? • How will the salinity build-up be managed?	Further work is required to define this option, as the use of the existing Bald Hill basin has implications for the current supply to irrigators, amongst other factors. Some other considerations: • Managing levels to avoid overflows with stormwater coming in. • Treatment of blended storm and waste water. • Who is the manager? [Given the stormwater component as well as the wastewater.] • Benefits might be increased by harvesting more than the demand, but then a ‘use’ must be identified?	No notable risks related to definition of this option, other than the need to ensure the majority of houses install a tank.	This option needs considerable work to define, as it is a new concept not yet implemented in Melbourne, and only in a few other locations outside Melbourne.
Design	There are well established design standards.	There are well established design standards.	New thinking is required, on both the treatment of this variable blend, and on the management of the storage when it has new multiple functions.	There are established design approaches.	Design standards are not established.

	Base Case [Traditional]	Class A from Pakenham WWTP	Stormwater Harvesting from Bald Hill	Rain Tanks at All Houses	Roof Harvesting to Potable
Construction	There are a number of contractors who are very familiar with this approach. Developers will have no concerns from a technical perspective.	There are a number of contractors who are very familiar with this approach. Developers will have no concerns from a technical perspective.	The individual elements of the scheme are not likely to be new, so implementation once the scheme is designed should be relatively straightforward.	Construction would occur as part of house construction.	The individual elements of the scheme are not likely to be new, so implementation once the scheme is designed should be relatively straightforward. The need to manage cross connection risk between roof drainage and stormwater drainage would be new requirement.
Regulation	Regulation is largely based on this option.	Provided a 'typical' approach is used, this option is encompassed by the regulations.	A range of issues may arise: • The source water may not fit the typical basis for Class A and therefore additional verification may be required. • Management of storm and flooding is different and concerns may arise. • Using harvesting of a portion of the stormwater flow instead of wetlands as a basis for compliance with the SEPP or BPEM is not typical.	Regulation is generally in place for this option, with the exception of determining whether the rain water can be used to supply laundry and hot water systems.	A range of issues may arise: • The use of roof water when treated to provide potable water is a new concept which would need considerable work with regulators. • Any reduction in retarding basin size as a result of harvesting peak flows is new and would need considerable work with regulators.

	Base Case [Traditional]	Class A from Pakenham WWTP	Stormwater Harvesting from Bald Hill	Rain Tanks at All Houses	Roof Harvesting to Potable
Staging	This option can be staged to match growth, as it connects to the wider system.	There is a need for upfront investment to have the water available, although putting potable water into the network in early stages is possible. Note that existing capacity in the recycled water systems in the area is available, and this delays the need for some investments.	This option can be staged much as for the Class A option, by initialling supplying the dual pipe with Class A or potable water while the stormwater harvesting is developed.	This option is naturally staged as it occurs as the houses are built.	While the dual drainage can be staged as the development occurs, no benefit can be gained until the capture basin and treatment plant are constructed. Given these are elements which are likely to be most cost effective if constructed at full capacity at the start, there is less opportunity to stage them. Note also that if the dual drainage is put in place, it only has a function if the concept is agreed, and cannot be used for another function, which means the other risks need to be addressed to avoid investment which is not then utilised.
Funding	Funding mechanisms are generally built on this option, so are well understood.	Funding mechanisms are generally built on this option, so are well understood.	There are some challenges related to funding here, due to the multiple functions of the system. How much of the value is for water use offset, and how much for protecting downstream waterways?	Notionally this option is funded by the homebuilder/owner. However, if mandated for the purpose of aiding the water supply balance there may be a need to consider some alternative funding arrangements.	There are some challenges related to funding here, due to the multiple functions of the system. How much of the value is for water use offset, and how much for protecting downstream waterways?

	Base Case [Traditional]	Class A from Pakenham WWTP	Stormwater Harvesting from Bald Hill	Rain Tanks at All Houses	Roof Harvesting to Potable
Operation	Operation of this option is simple, and well understood.	Operation of this system is more complex, but nevertheless is well understood.	There are operational complexities for the storage, as it will have to manage providing supply for the irrigators, together with being available with some empty volume to allow stormwater capture. There are operational complexities for the treatment plant as it will be treating a variable mix of stormwater and Class C as its source water.	Some form of monitoring, either physical or via intelligent networks is likely to be needed to ensure the tanks are being utilised as expected, or the water balance benefits may not be realised. This monitoring of the private householder's activity is not typical.	Operation will require significant input for some time to provide confidence that the water is meeting the standards for drinking water.
Community	The community would understand this option, but may have reservations. They may not see it as current 'best practice'.	The community are familiar with this option, and generally are expected to be supportive. Note that a key question from the community may be the pricing and restrictions on this supply compared to potable.	The community may need to have this option explained to them, but for the most part should experience it as no different to normal Class A dual pipe. The irrigators may have concerns regarding this option, although it should not affect the volumes they receive. It will alter the water quality somewhat. However, it seems reasonable to assume that stormwater will be no more problematic for them as a source than Class C waste water. Discussion is needed.	Well understood and generally supported by the community, although not by all, and if mandated, may meet resistance.	Unusual option, so not clear how the community would view it. Some stakeholders mentioned that there may be some concerns about water being taken from 'their' roofs and then 'sold back' to them.
New Policy Direction	This approach may not meet the new policy directions for water management.	This approach meets some elements of the new policy directions, but does not fully address the idea of using stormwater beneficially.	This option seems aligned with policy drivers.	This option seems aligned with policy drivers, other than mandating tanks.	Not clear how this fits in with policy, particularly given it does not provide 'fit for purpose' water for non-potable demands.

14. Conclusions & next steps

This project examined options to manage the water cycle around the new PSP for Pakenham East. Several workshops were held with stakeholders during the project, and the conclusions set out below were generally agreed by the stakeholders in these workshops.

These conclusions represent a simplified summary of sometimes complex analysis, and should be read in conjunction with the details of the report.

The purpose of this WoWCM assessment was to provide the necessary information to enable the stakeholders to choose a preferred option. The following conclusions therefore do not provide a recommendation on the preferred option, but instead highlight the relevant information from the work presented in this report that is important in the decision making process.

14.1 Roof water harvesting for potable does not appear favoured

Sensitivity testing of the Cost Benefit Analysis [CBA] showed that for four of the five options considered, there are particular combinations of factors which make each of those four options the most attractive. However, that does not appear to be true for the option to harvest roof stormwater to then be treated to produce potable water. [Option 5]

This option requires a second parallel stormwater drainage network, which has a ‘per house’ cost greater than that estimated for the additional pipe (Class A), and needs a new capture storage to be constructed, along with a new water treatment plant. So it has the highest capital cost of any of the options.

It does have some unique features, which are worth noting:

- It allows the ‘use’ of potable demand, which is about half of the demand, and which otherwise cannot be substituted with an alternative source. So, if used in combination with another option, it could allow the precinct to be nearly ‘water neutral’.
- The other stormwater harvesting option [Option 3] only captures about half of the excess stormwater generated. So, if there was a need to minimise the flow of stormwater downstream, using these two options together would allow more reduction in stormwater flows.
- It provides a way to move a significant fraction of the storm peak flows into a centrally managed ‘rain tank’, which might be more attractive than the concept of managing storm flows in a large number of household tanks.

However, the circumstances in this precinct do not appear to make these drivers significant enough for this option to become favoured, and this is reflected in the CBA.

14.2 Option 1: ‘Traditional’ is favoured when the LRMC of potable water is Low

Option 1 is the ‘base case’ for comparison using the CBA. It is favoured in the CBA when the LRMC of the potable water supply is low. This is not surprising, and reflects the outcomes when the current regulatory requirements are applied, given the significant past investment in the centralised water system, which has significant excess capacity to allow for both growth and to provide for peaks and emergencies.

The CBA illustrates the points at which the LRMC becomes high enough for alternative options to become favoured. This point varies depending on the alternative under examination, as some other factors can introduce additional cost to the base case and most of the alternatives, while having less effect on one of the alternatives, thus favouring that alternative. The following points summarise some of the cases for this.

Note that the LRMC for treatment and disposal of waste water to ETP is also a significant cost, and therefore this number can also be influential in the analysis.

14.2.1 Option 2: 'Class A from Pakenham WWTP', is often attractive

Option 2 has only a small difference from Option 1 for the base assumptions on inputs into the CBA, and becomes more attractive [i.e. has a CBA above 1] when either the LRMC of potable water or wastewater is raised in the sensitivity analysis.

Note that there are particular local features which make this option of a lower cost than for some other green field development in this region: the proximity and existence of existing mains and treatment processes at Pakenham WWTP, and the fact that those assets are not currently fully utilised because they have been sized to account for future growth which has not yet occurred, although it is understood that Class A from Pakenham WWTP was originally planned to service Officer and not East Pakenham.

14.2.2 Option 3: 'Combined Stormwater and Class A from Bald Hill', is attractive when downstream waterway health is emphasised

This option shares many of the features of Option 2, but has higher costs as it has some additional infrastructure, notably the stormwater connection to Bald Hill.

In addition, it has a reduced benefit compared to Option 2, as more waste water needs to be sent to ETP, with a consequent increase in long term operating cost.

However, there are potential circumstances in which all other options have a higher cost, when the management of stormwater is emphasised. These are reflected in the CBA, and there are two examples:

- If the water quality requirements are set to meet SEPP F8 [rather than BPEM], then the current wetland design will need to be increased in size. Expanding the wetland will have construction cost impacts, and also land take impacts. Taking both of these into account with a higher land cost estimate make this the favoured option.
- If the new BPEM applies, and includes a downstream flow reduction requirement, then this option is attractive [this change would also make Options 4 and 5 more attractive in relative terms].

NOTE: Compared to other precincts and circumstances which GHD has investigated, this precinct does appear to have a relatively unique opportunity to pursue and consider stormwater harvesting [Option 3], due to the potential ability to utilise some of the capacity in the large [900 ML] Bald Hill basin.

14.3 Options 2 and 3 can be seen as Interchangeable in the early stages of the PSP

Because these two options both supply alternative water through a third pipe system, there are minimal difference between them in the precinct itself. The key differences in infrastructure occur outside the precinct, and it would be possible initially to supply the third pipe from other sources while further investigation occurs into the best source, or the need to apply different standards in relation to the downstream waterways.

This offers the opportunity to provide more certainty in relation to the PSP while remaining flexible on the source for alternative water to allow some risks and issues to be further investigated.

14.4 Option 5: Rain tanks is only attractive for a low cost for tanks

This option includes crediting of some water quality and flooding benefits in the CBA. However, the option is only attractive compared to Options 2 and 3 if the tank cost per house is set at the lower end of the sensitivity analysis.

The stakeholders provided some feedback on the additional issues which may occur with mandating tanks at all houses in this precinct, and this may provide additional reasons to not pursue this option.

So, this option does not appear particularly favoured based on this analysis.

14.5 Preliminary Conclusion

Based on the CBA and the points set out above, Options 2 and 3 appear favoured. However, the steering group need to consider this as there are non-costed elements which may weigh more in discussions.

This preliminary conclusion in essence means that dual pipe would be adopted, but the source is either Class A alone, or a combination of Class A and harvested stormwater.

14.6 Next steps

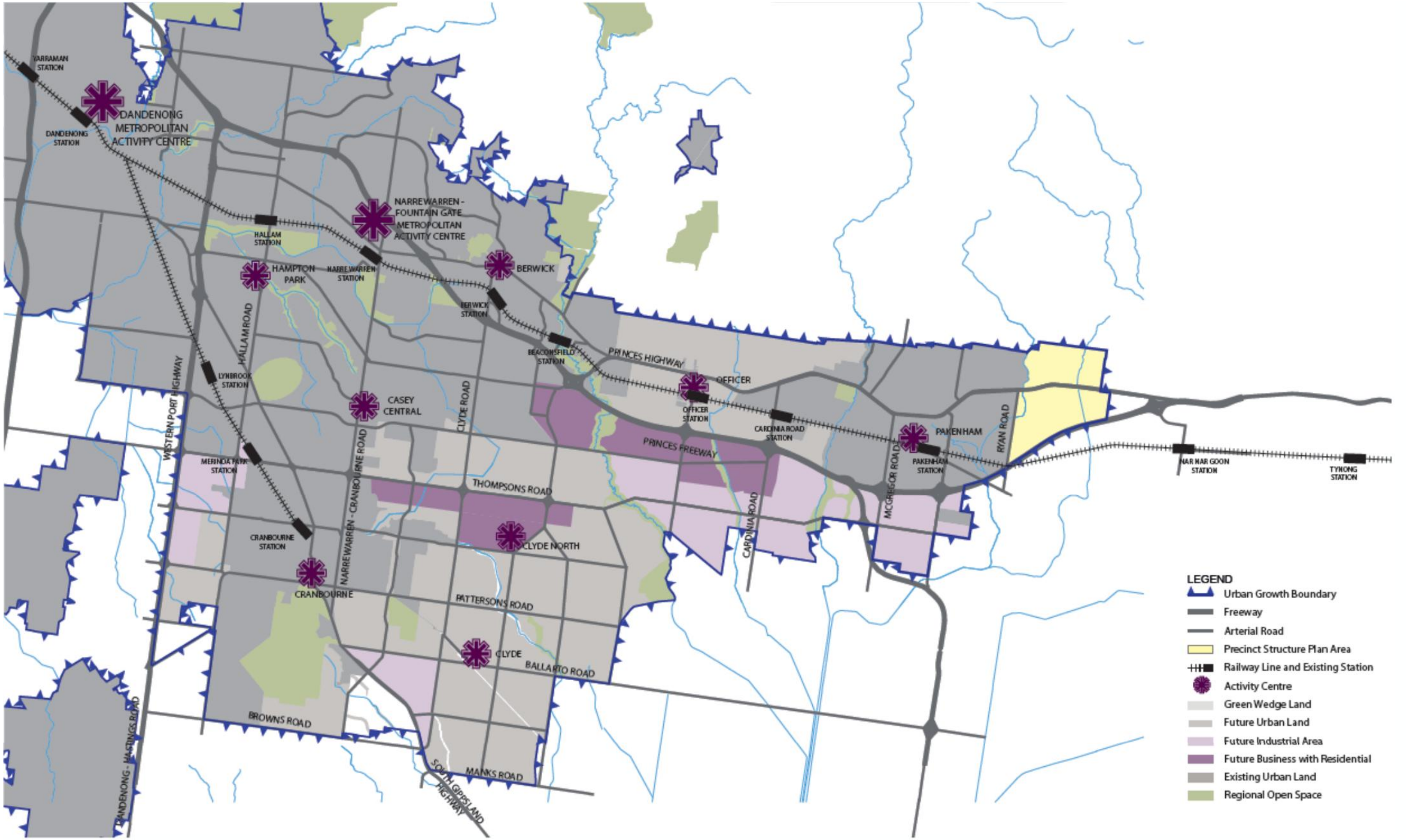
Based on the conclusions presented above, the following next steps are recommended:

- The stakeholders should meet to discuss the content of this report and agree on a preferred option (or options) to take forward for further more detailed assessment.
- Undertake more detailed assessment on the preferred option (or options) to improve understanding of the option and provide more certainty on the risks and costs involved.

  In particular, the Bald Hill harvesting option appears to have a number of attractive features, including the opportunity to reduce RB and wetland areas. However, altering the use of this basin has implications for SEW operations. In addition, the concept of diverting floodwater to an operating waste water storage basin clearly has risks which need consideration. Therefore further work is needed before this innovative option can be either adopted or discarded.

Appendices

Appendix A – Metropolitan and regional context plan



Metropolitan and Regional Context Plan

Pakenham East Precinct Structure Plan - Background Report

smec urban
Part of the SMEC Group

CARDINIA

Scale: 1:100,000 @ A3
0 1000 2000 3000m

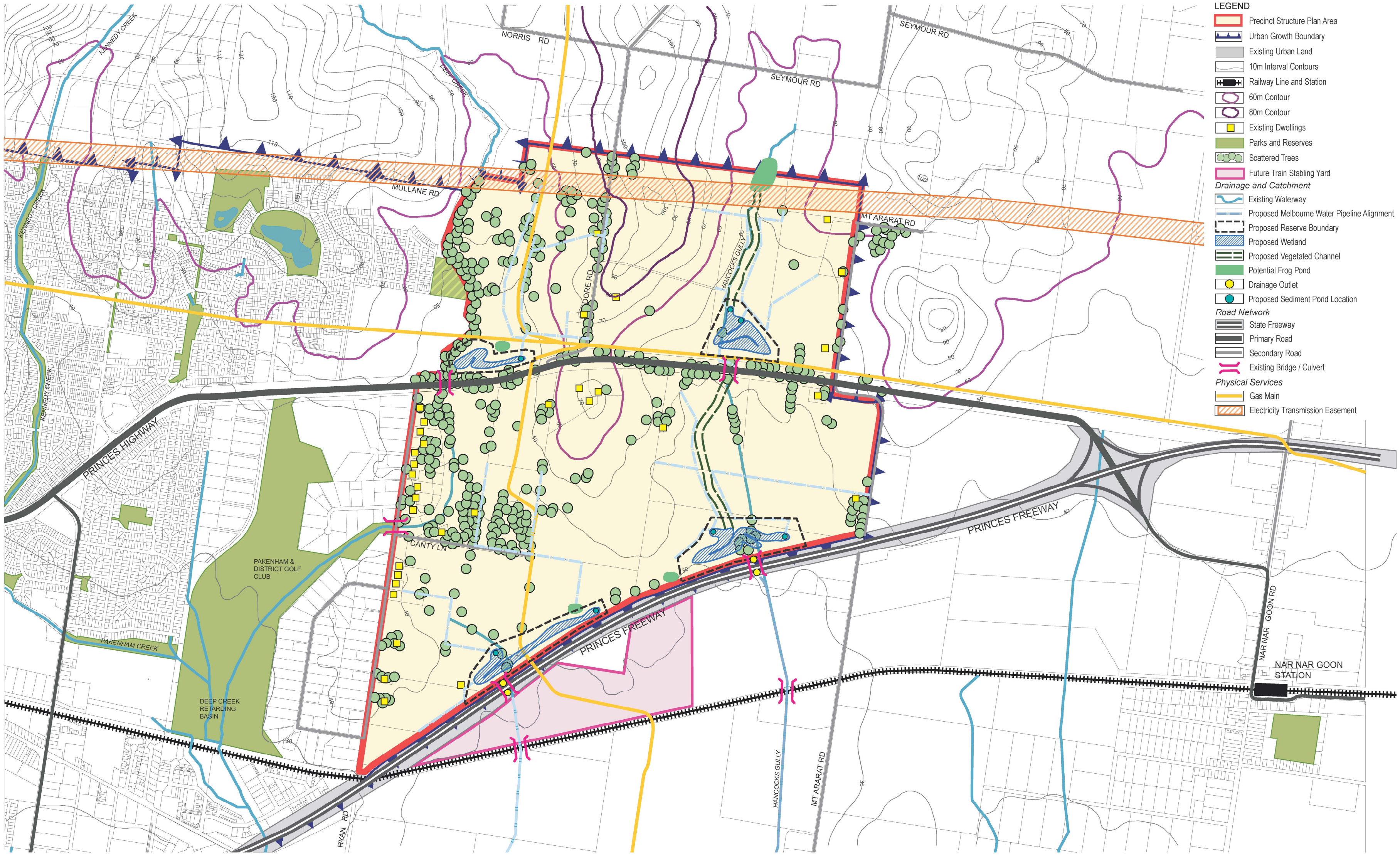
ref.: 3410808U
date: 08 November 2013
rev.: 3
drawn: LS
checked: CD

please note:
This plan is based on preliminary information only and may be subject to change as a result of formal Council/Authority advice, detailed site investigations and confirmation by survey

planning & urban design
melbourne - tel 9869 0800

abn 47 065 475 149
trading as smec urban

Appendix B – Precinct features



Precinct Features Plan - 10m Contour Lines

Pakenham East PSP

smec urban
Part of the SMEC Group

DRAFT

Scale: 1:10,000 @ A1
1:20,000 @ A3
0 200 400m

ref.: 3410808U
date: 18 February 2014
rev.: A
drawn: FS
checked: CD

please note:
This plan is based on preliminary information only and may be subject to change as a result of formal Council/Authority advice, detailed site investigations and confirmation by survey

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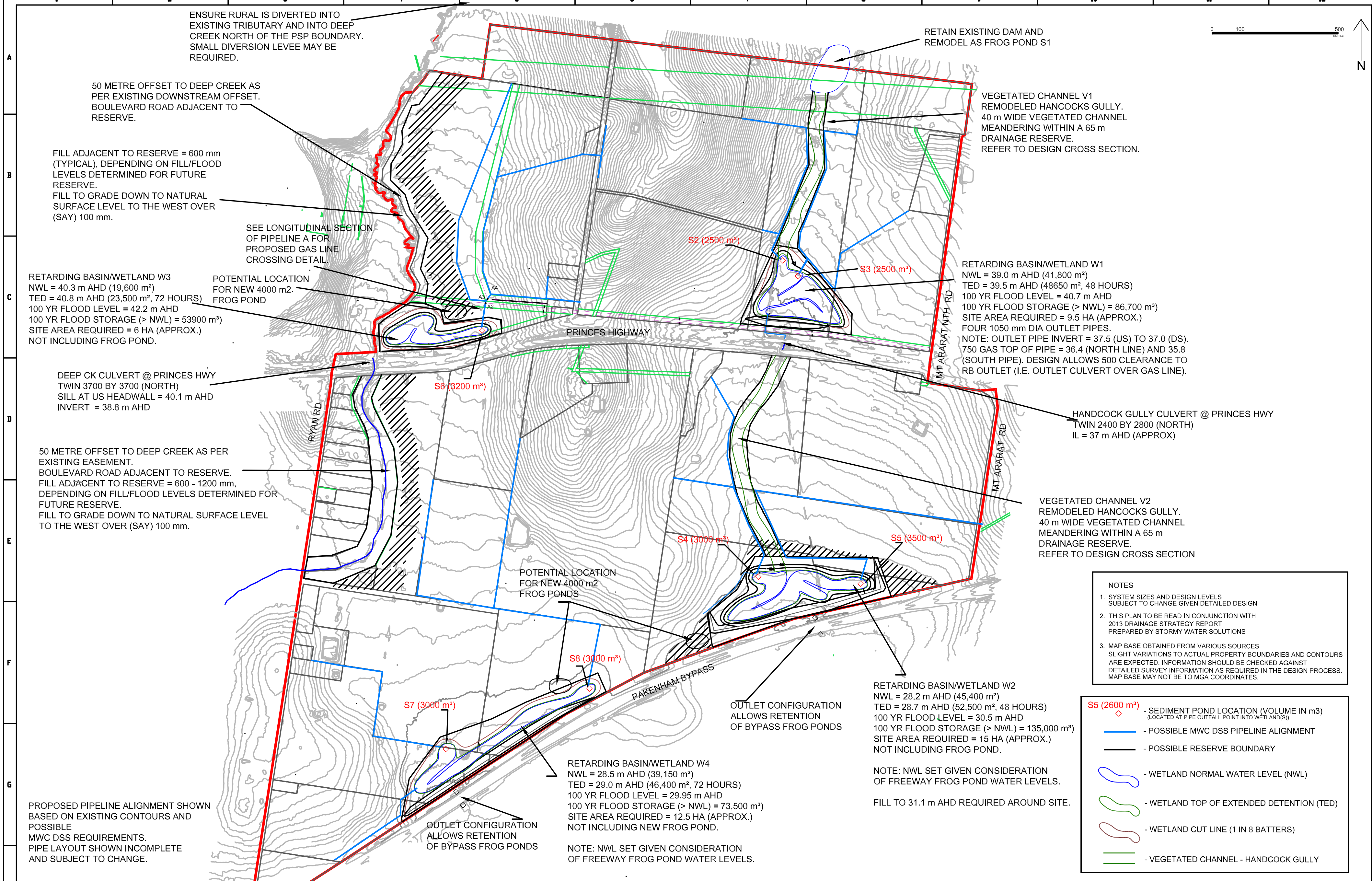
Appendix C – Drainage strategy



NOTES

1. SYSTEM SIZES AND DESIGN LEVELS SUBJECT TO CHANGE GIVEN DETAILED DESIGN
2. THIS PLAN TO BE READ IN CONJUNCTION WITH 2013 DRAINAGE STRATEGY REPORT PREPARED BY STORMY WATER SOLUTIONS
3. MAP BASE OBTAINED FROM VARIOUS SOURCES SLIGHT VARIATIONS TO ACTUAL PROPERTY BOUNDARIES AND CONTOURS ARE EXPECTED. INFORMATION SHOULD BE CHECKED AGAINST DETAILED SURVEY INFORMATION AS REQUIRED IN THE DESIGN PROCESS. MAP BASE MAY NOT BE TO MGA COORDINATES.

S5 (2600 m³) - SEDIMENT POND LOCATION (VOLUME IN m3) (LOCATED AT PIPE OUTFALL POINT INTO WETLAND(S))
- POSSIBLE MWC DSS PIPELINE ALIGNMENT
- POSSIBLE RESERVE BOUNDARY
- WETLAND NORMAL WATER LEVEL (NWL)
- WETLAND TOP OF EXTENDED DETENTION (TED)
- WETLAND CUT LINE (1 IN 8 BATTERS)
- VEGETATED CHANNEL - HANDCOCK GULLY

ISSUED FOR COMMENT	27 FEBRUARY 2013
UPDATED	25 MARCH 2013
REVISION	DATE

Stormy Water Solutions

DESIGNED	SWS	PLAN REF.	#
CHECKED	Valerie Mag	MELWAY REF No.	#
AUTHORISED BY		MELB WATER REF No.	#

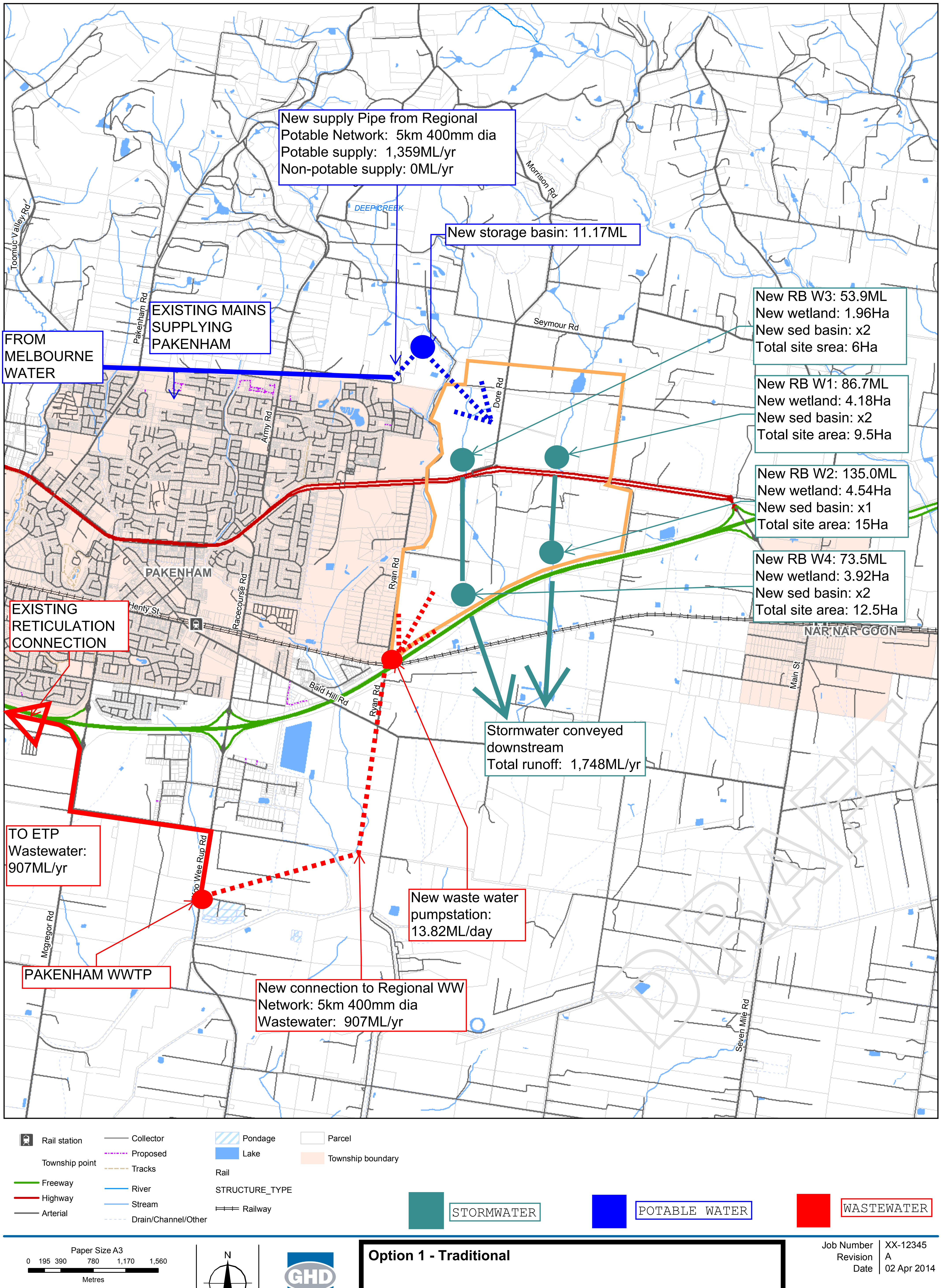
stormywater@optusnet.com.au
(03) 9511 5911
ABN 95 656 703 998

PAKENHAM EAST PRECINCT DRAINAGE STRATEGY

OPTION 1

SCALE: AS SHOWN
SHEET 1 OF 4
DRAWING No. 1304/1

Appendix D – Shortlisted option schematics

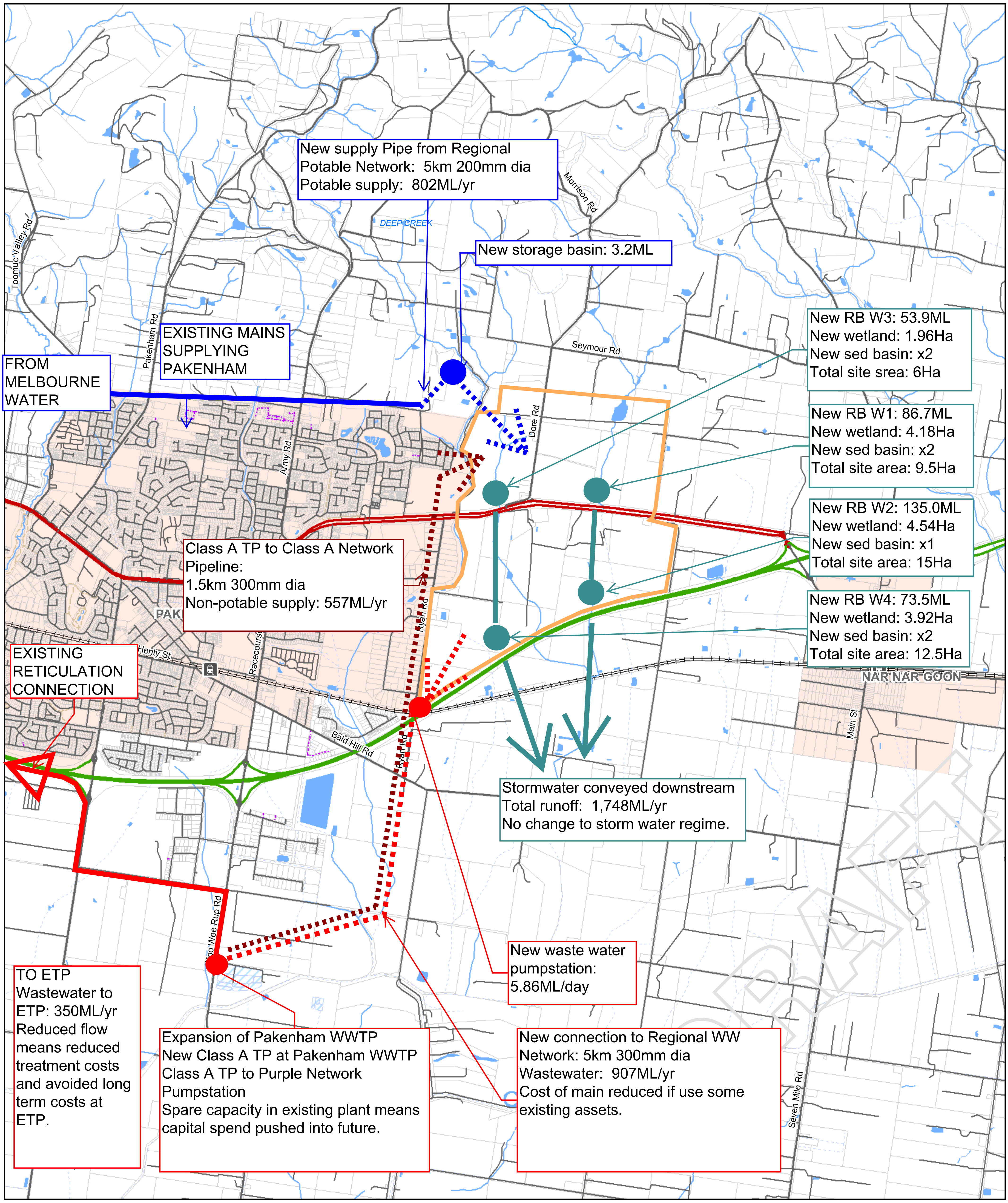


Option 1 - Traditional

Job Number	XX-12345
Revision	A
Date	02 Apr 2014

Figure 1

Hazelwood Drive (cnr Lignite Court) Morwell VIC 3840 Australia T 61 3 5136 5800 F 61 3 5136 5888 E mwlmail@ghd.com W www.ghd.com



Rail station
Township point
Freeway
Highway
Arterial
Collector
Proposed
Tracks
River
Stream
Drain/Channel/Other
Pondage
Lake
Rail
STRUCTURE_TYPE
Railway
Parcel
Township boundary

RECYCLED WATER
STORMWATER
POTABLE WATER
WASTEWATER

Paper Size A3
0 195 390 780 1,170 1,560
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

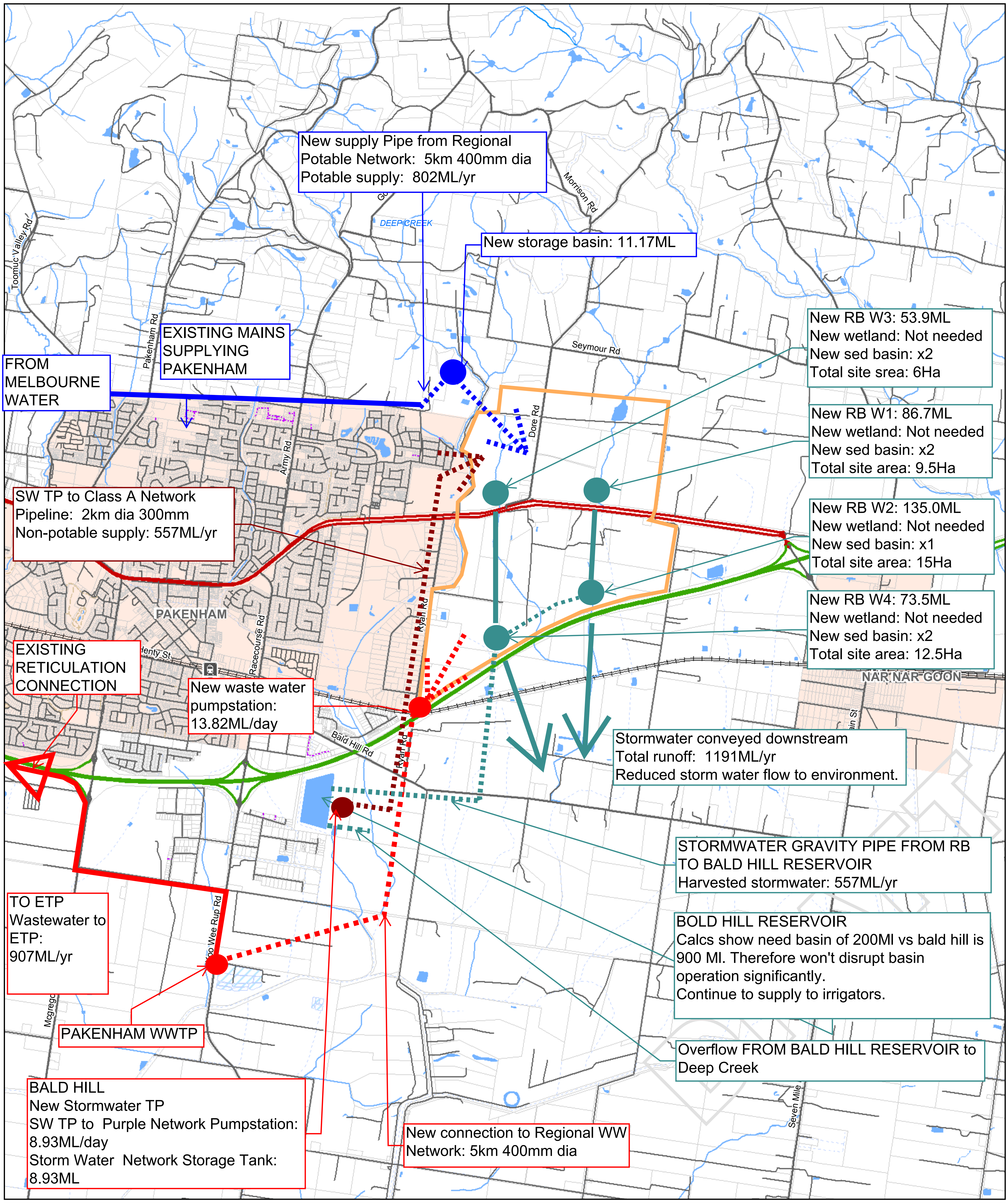
GHD

Option 2 - Pakenham WWTP recycled water

Job Number XX-12345
Revision A
Date 02 Apr 2014

Figure 1

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:cillingworth



Rail station
Township point
Freeway
Highway
Arterial
Collector
Proposed
Tracks
River
Stream
Drain/Channel/Other
Pondage
Lake
Rail
STRUCTURE_TYPE
Railway
Parcel
Township boundary

RECYCLED WATER

STORMWATER

POTABLE WATER

WASTEWATER

Paper Size A3

0 195 390 780 1,170 1,560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Option 3 - Bald Hill stormwater harvesting and recycled water

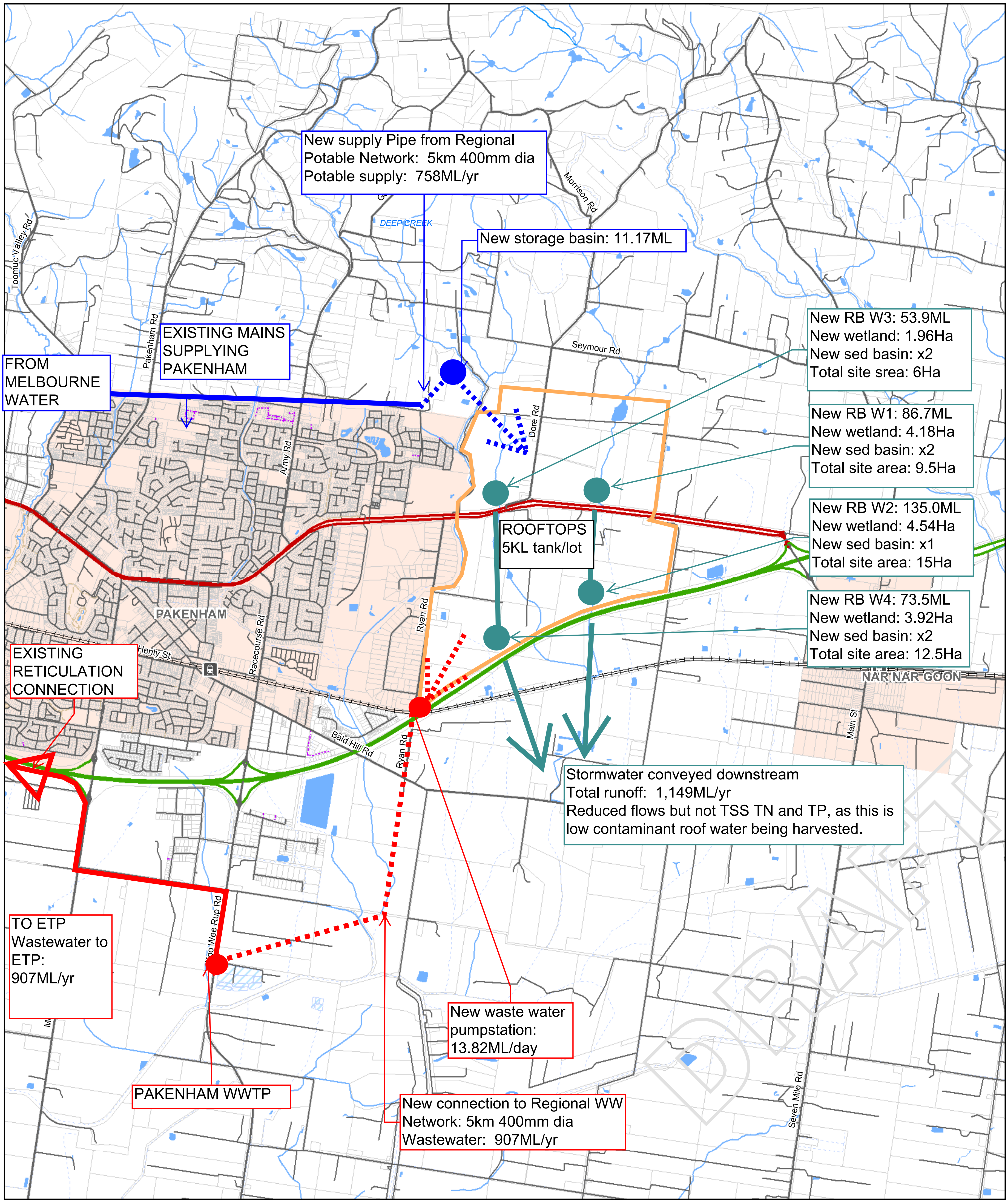
Job Number XX-12345
Revision A
Date 02 Apr 2014

Figure 1

G:\31\31322\GIS\Maps\Working\31322_005_WiderArea_A3P.mxd

Hazelwood Drive (cnr Lignite Court) Morwell VIC 3840 Australia **T** 61 3 5136 5800 **F** 61 3 5136 5888 **E** mwlmail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:cillingworth



Rail station
Township point
Freeway
Highway
Arterial
Collector
Proposed
Tracks
River
Stream
Drain/Channel/Other
Pondage
Lake
Rail
STRUCTURE_TYPE
Railway
Parcel
Township boundary

HARVESTED ROOFWATER
STORMWATER
POTABLE WATER
WASTEWATER

Paper Size A3
0 195 390 780 1,170 1,560
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Option 4 - Lot scale roof water harvesting

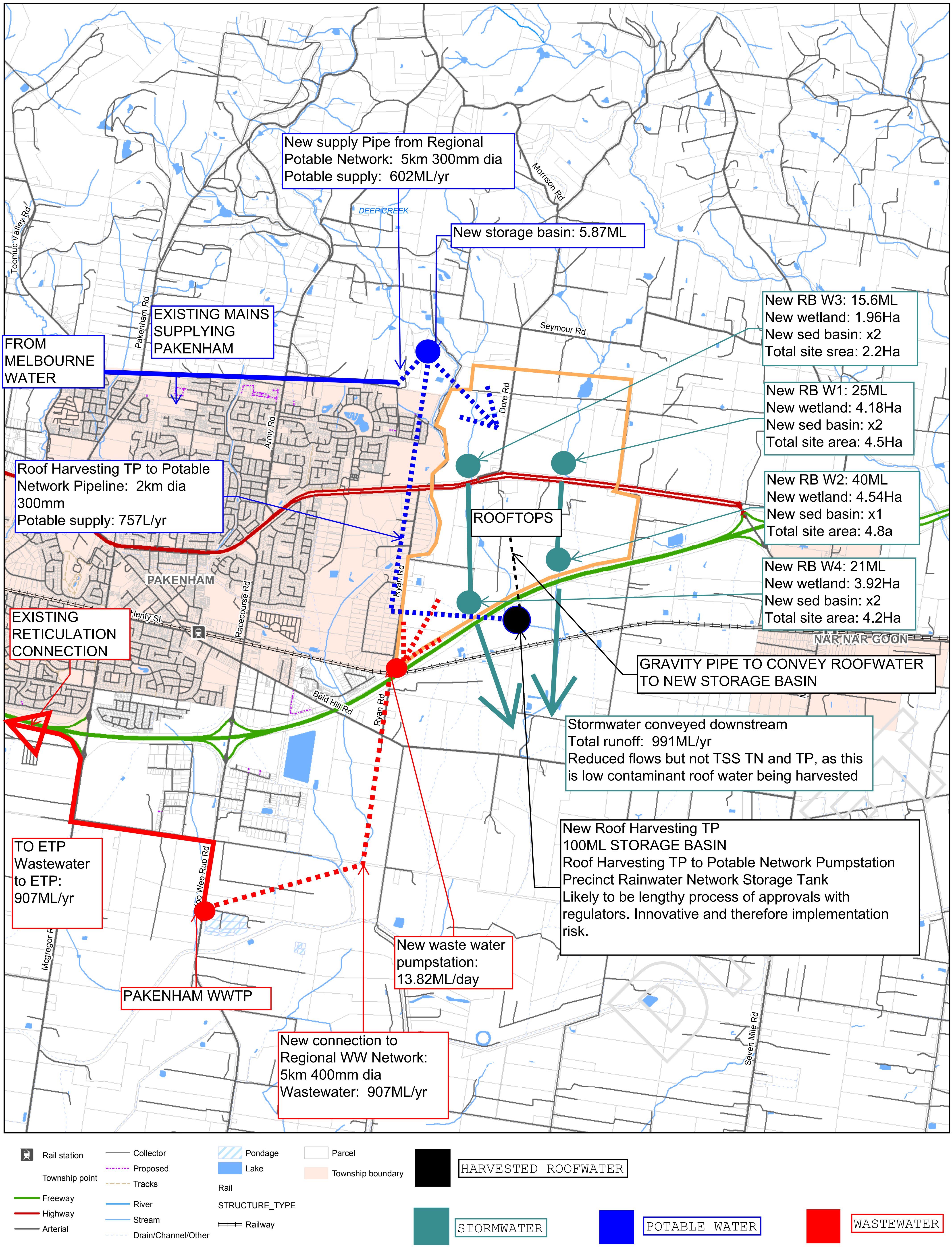
Job Number	XX-12345
Revision	A
Date	02 Apr 2014

Figure 1

G:\31\31322\GIS\Maps\Working\31322_005_WiderArea_A3P.mxd

Hazelwood Drive (cnr Lignite Court) Morwell VIC 3840 Australia T 61 3 5136 5800 F 61 3 5136 5888 E mwlmail@ghd.com W www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:cillingworth



Paper Size A3

0 195 390 780 1,170 1,560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Option 5 - Regional roof water harvesting

Job Number XX-12345
Revision A
Date 02 Apr 2014

Figure 1

G:\31\31322\GIS\Maps\Working\31322_005_WiderArea_A3P.mxd

Hazelwood Drive (cnr Lignite Court) Morwell VIC 3840 Australia T 61 3 5136 5800 F 61 3 5136 5888 E mwlmail@ghd.com W www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:cillingworth

Appendix E – Water and sewerage cost development for a housing development

This memorandum outlines the results of, and method used to, estimate the per lot cost of providing sewer and potable water infrastructure within a new housing development. The scope excludes the infrastructure required outside of the development (e.g. trunk mains and treatment).

Infrastructure Requirements

To determine the water infrastructure requirements for a housing development an existing development in the South East Water (SEW) region was analysed (Attachment 1). The development consists of 5090 lots serviced by a typical potable water and gravity sewer system. The SEW GIS system was utilised to determine the pipeline lengths and corresponding diameters for the water and sewer assets.

The output of this analysis is provided below:

Table E1 Total Sewer and Potable Water Pipework in Development

Sewer Network			Potable Water Network		
Diameter (mm)	Length (m)	Length (%)	Diameter (mm)	Length (m)	Length (%)
100	4,178	5.6%	20	350	3.2%
150	58,856	78.8%	32	614	0.5%
225	8,054	10.8%	40	1,687	0.8%
300	3,152	4.2%	50	2,153	2.3%
375	431	0.6%	63	4,212	2.9%
			80	98	5.7%
			100	32,304	0.1%
			125	163	43.5%
			150	15,258	0.2%
			180	102	20.5%
			225	1,519	0.1%
			250	227	2.0%
			300	7,779	0.3%

Potable water pipework above a diameter 300 mm was excluded from the cost analysis. Pipework above 300 mm diameter was assumed to be associated with the broader water network and therefore not a direct cost to the development.

Pipework Cost

Unit rate costs were developed from the following sources:

- Rawlinson's Construction Handbook 2013
- Tender prices
- Material supply budget prices

Potable Water

The rate for potable water pipework considered the following:

- Trenching
- Pipe supply and laying
- Bedding
- Backfill
- Pipe fitting supply and installation
- Valve supply and installation

The following assumptions were made in development of the rate:

- Pipe cover of 0.75 m to top of trench
- Trenches in light soil
- Two fittings required per 100 meters of pipeline (e.g. bends)
- One valve required per 200 meters of pipeline
- The rates adopted are provided in Table 2.

Sewer

The rate for sewer pipework considered the following:

- Trenching
- Pipe supply and laying
- Bedding
- Backfill
- Manhole and Inspection shafts

The following assumptions were made in development of the rate:

- Average pipe cover of 2.0 m to top of trench
- Trenches in light soil
- Four manholes/inspection shafts required per 100 m of sewer
- The rates adopted are provided in Table E2.

Adopted Rates

Table E2 Adopted Rates for Sewer and Potable Water Pipework

Sewer Pipework		Potable Water Pipework	
Diameter (mm)	Rate ($ / m)	Diameter (mm)	Rate ($ / m)
100	233	20	32
150	306	32	51
225	414	40	63
300	523	50	79
375	632	63	100
		80	126
		100	158
		125	198

Sewer Pipework		Potable Water Pipework	
Diameter (mm)	Rate ($ / m)	Diameter (mm)	Rate ($ / m)
		150	237
		180	284
		225	356
		250	395
		300	474

The adopted rates exclude contingencies amounts and design, and approvals. The rates are greenfield development in good soil conditions and exclude reinstatement of roads, footpaths etc. Further detail of the rate makeup is provided in Attachment 2.

Results

By applying the unit rates outlined in Section 3 and the pipework quantities outlined in Section 2 the total costs of water infrastructure, and cost per lot for water infrastructure were obtained. The result are provided in Table E3.

Table E3 Potable Water and Sewer Infrastructure Costs with the Development

Item	Total Cost ($ million)	Number of lots	Cost per lot
Potable water supply network	$13.85	5090	$2,721
Sewerage network	$24.21	5090	$4,756

A breakdown of the costs is provided in Attachment 3.

Attachment 1:

Housing Development GIS Screen Shot

Attachment 2:

Rates

PRESSURE PIPE			
	Pipe Cost		
	Form:	a*x	
	x =	Diameter (mm)	
	a =	Constant	1.30
	Fittings Cost		
	Form:	(b*x)*(c/100)	
	x =	Diameter (mm)	
	b =	Constant	9
	c =	Fittings per 100 m pipe	2
	Valve Cost		
	Form:	(d*x)*(e/100)	
	x =	Diameter (mm)	
	d =	Constant	20
	e =	Valves per 100 m pipe	0.5
	Pressure Pipeline Total Cost		
	Form:	a*x + (b*x)*(c/100) + (d*x)*(e/100)	
		x	**$ / m**
		20	32
		32	51
		40	63
		50	79
		63	100
		80	126
		100	158
		125	198
		150	237
		180	284
		225	356
		250	395
		300	474
		355	561
		375	593
		450	711
		600	948
		900	1422

SEWER PIPE

Pipe Cost

Form:	a*x	
x =	Diameter (mm)	
a =	Constant	1.45

Manhole/Inspection Shaft Cost

Form:	(d)*(e/100)	
d =	Constant	2200
e =	Manhole per 100 m pipe	4

Pressure Pipeline Total Cost

Form: a*x + (b*x)*(c/100) + (d)*(e/100)

x	$ / m
100	233
150	306
225	414
300	523
375	632

Attachment 3:

Cost Breakdown by Diameter

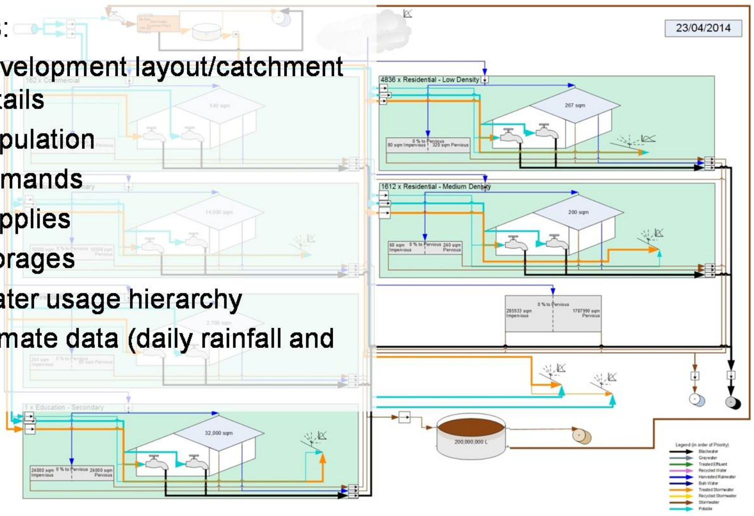
File	PIPE_SIZE	Length_m	Rate ($/m)	Total cost ($M)
V_SW_PIPE_LN	100	4177.6454	233	$ 0.97
V_SW_PIPE_LN	150	58855.616	306	$ 17.98
V_SW_PIPE_LN	225	8053.6819	414	$ 3.34
V_SW_PIPE_LN	300	3151.656	523	$ 1.65
V_SW_PIPE_LN	375	430.84346	632	$ 0.27
			Total cost:	$ 24.21

File	PIPE_SIZE	Length_m	Rate ($/m)	Total cost ($M)
V_WA_PIPE_LN	0	2,377.22	0	$ -
V_WA_PIPE_LN	20	350.03	32	$ 0.01
V_WA_PIPE_LN	32	613.56	51	$ 0.03
V_WA_PIPE_LN	40	1,686.61	63	$ 0.11
V_WA_PIPE_LN	50	2,153.05	79	$ 0.17
V_WA_PIPE_LN	63	4,212.00	100	$ 0.42
V_WA_PIPE_LN	80	97.57	126	$ 0.01
V_WA_PIPE_LN	100	32,303.52	158	$ 5.10
V_WA_PIPE_LN	125	162.60	198	$ 0.03
V_WA_PIPE_LN	150	15,258.43	237	$ 3.62
V_WA_PIPE_LN	180	101.68	284	$ 0.03
V_WA_PIPE_LN	225	1,519.22	356	$ 0.54
V_WA_PIPE_LN	250	226.75	395	$ 0.09
V_WA_PIPE_LN	300	7,778.90	474	$ 3.69
V_WA_PIPE_LN	355	343.99	561	
V_WA_PIPE_LN	375	572.93	593	
V_WA_PIPE_LN	450	1,471.57	711	
V_WA_PIPE_LN	600	2,404.58	948	
V_WA_PIPE_LN	900	690.53	1422	
			Total cost:	$ 13.85

Appendix F – Summary of GHD's Integrated Water Management Toolkit and Water Balance

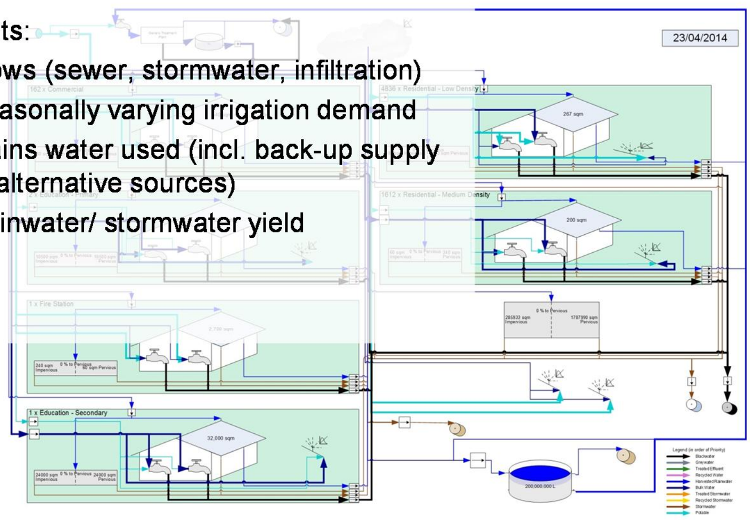
GHD's Integrated Water Management Toolkit

- Inputs:
  - Development layout/catchment details
  - Population
  - Demands
  - Supplies
  - Storages
  - Water usage hierarchy
  - Climate data (daily rainfall and Et)

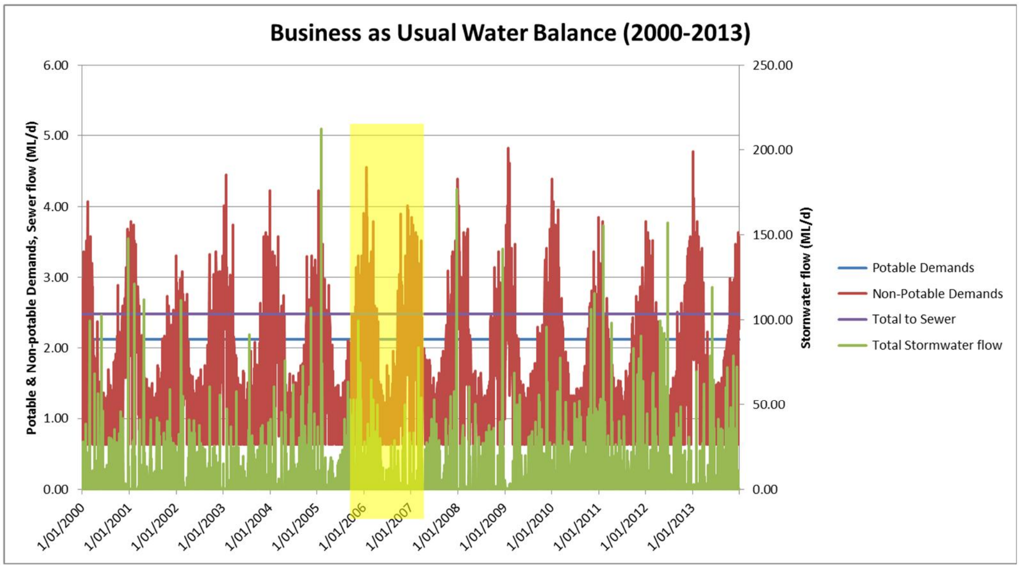


GHD's Integrated Water Management Toolkit, cont.

- Outputs:
  - Flows (sewer, stormwater, infiltration)
  - Seasonally varying irrigation demand
  - Mains water used (incl. back-up supply to alternative sources)
  - Rainwater/ stormwater yield



Business as Usual Water Balance (2000-2013)



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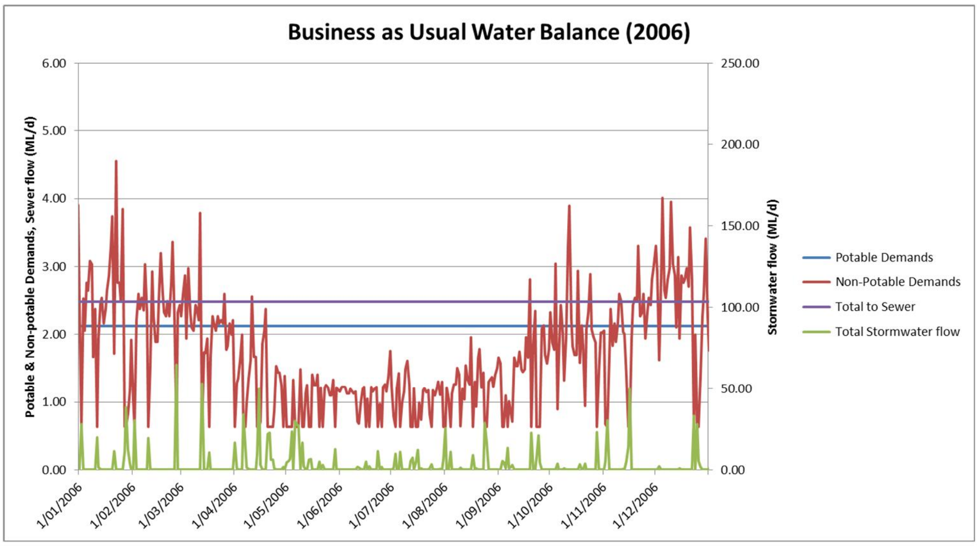
Business as Usual Water Balance (2006)



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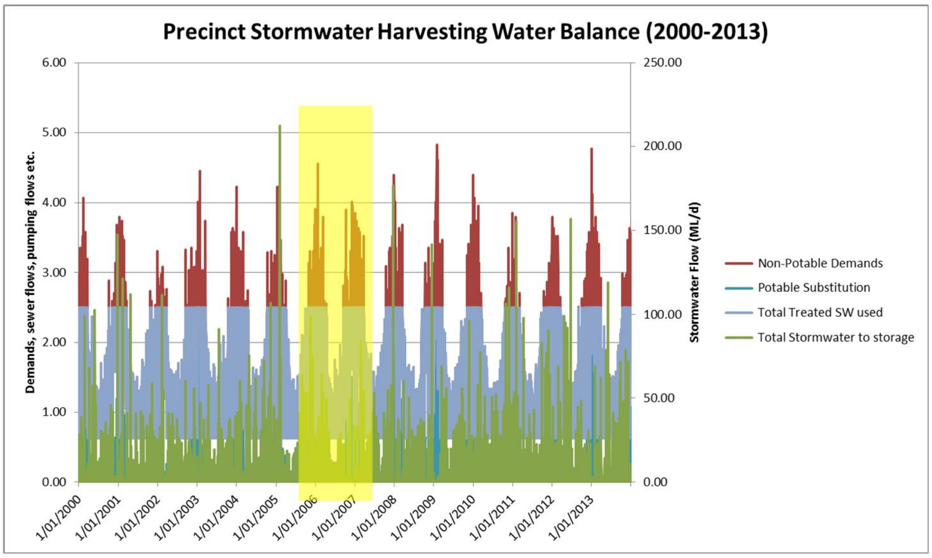
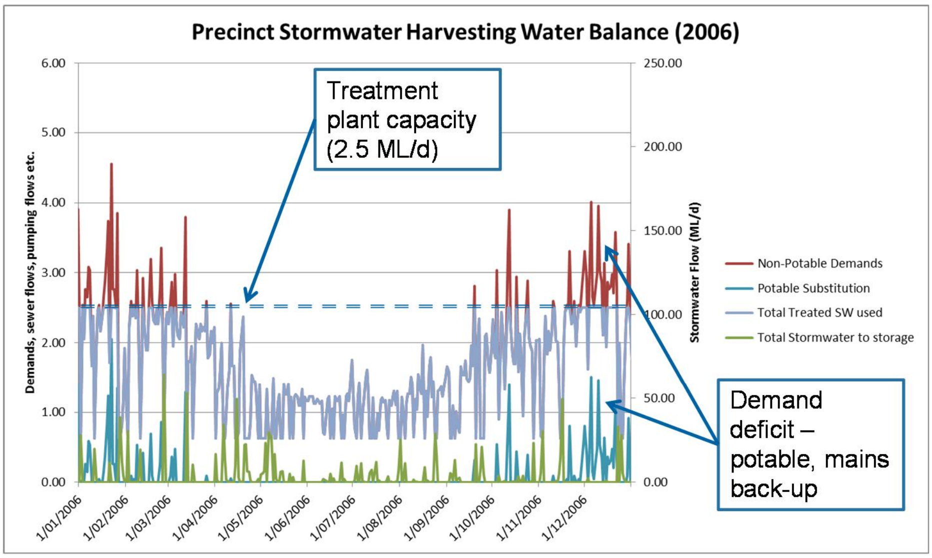
Precinct Stormwater Harvesting Water Balance (2000-2013)



Pakenham East Growth Area Extension,
WoWCM Servicing Plan – Steering Group
Workshop 2

Precinct Stormwater Harvesting Water Balance (2006)



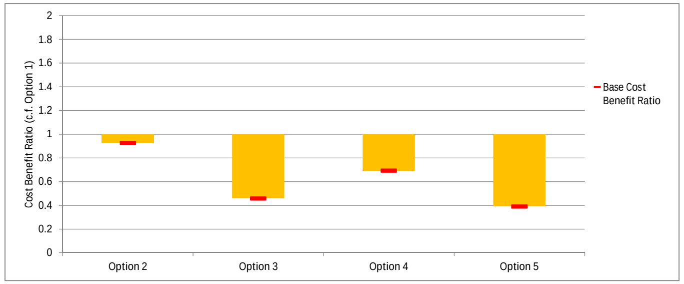
Pakenham East Growth Area Extension,
WoWCM Servicing Plan – Steering Group
Workshop 2

Appendix G – Sensitivity analysis results

EAST PAKENHAM - SENSITIVITY ANALYSIS

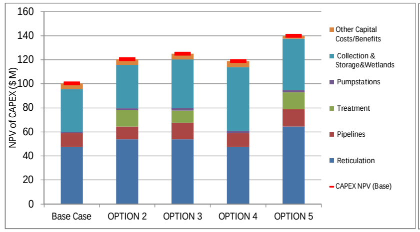
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

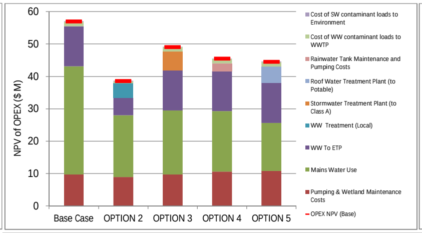
	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 157 M	$ 159 M	$ 174 M	$ 164 M	$ 184 M
%change	0%	0%	0%	0%	0%
BC Ratio *(c.f. 1)*		0.92	0.46	0.69	0.39

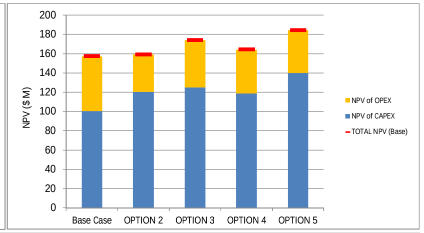


Comments on Sensitivity Test Scenario:

Scenario 0 - Base Case

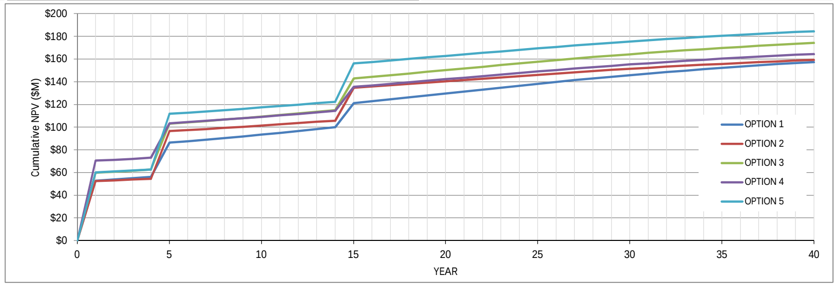


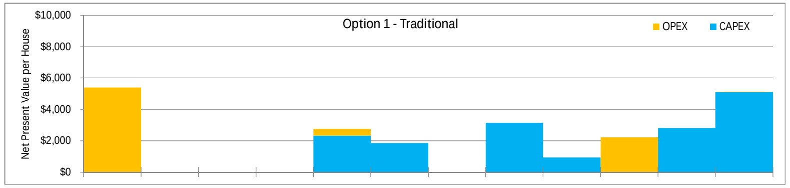


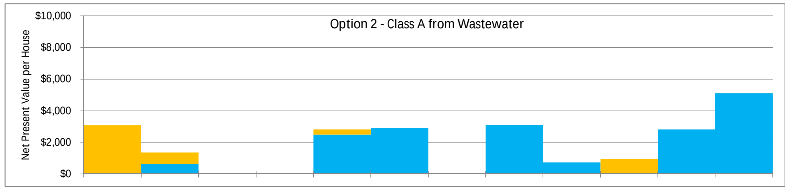


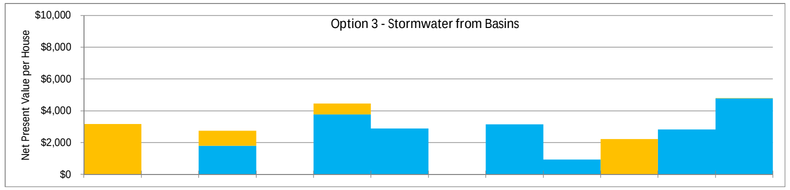
Short-listed Options

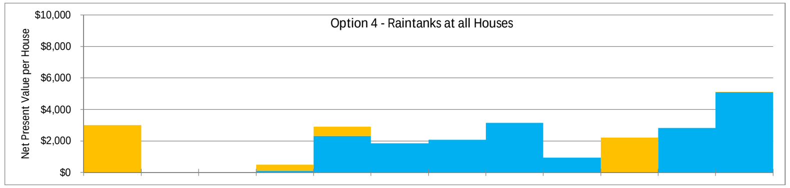
Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting

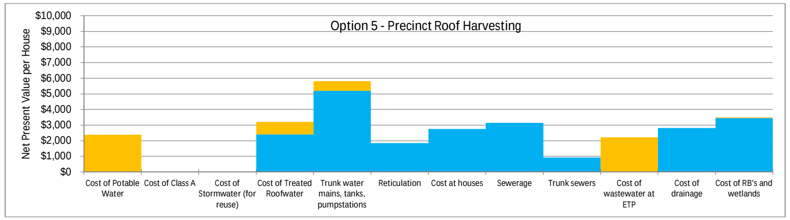












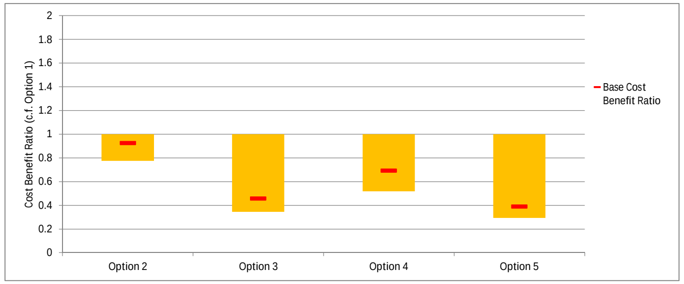
EAST PAKENHAM - SENSITIVITY ANALYSIS

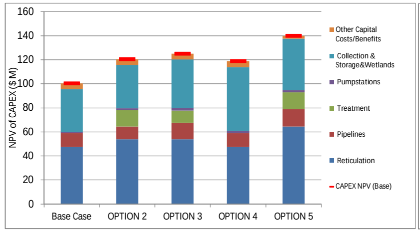
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 1 500 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

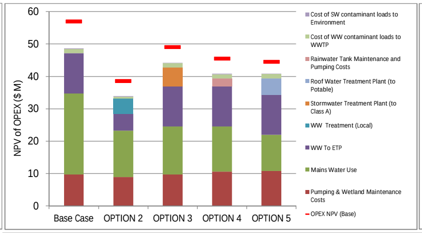
Comments on Sensitivity Test Scenario:

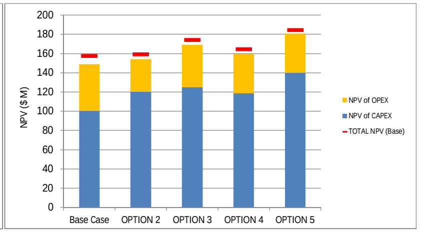
Scenario 1.1 - Water Low Cost

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 4. M	$ 2.8 M	$ 3.6 M	$ 3.3 M	$ 3.3 M
%change	-17%	-14%	-11%	-11%	-9%
NPV	$ 149 M	$ 154 M	$ 169 M	$ 160 M	$ 181 M
%change	-6%	-3%	-3%	-3%	-2%
BC Ratio *(c.f. 1)*		0.78	0.34	0.52	0.29



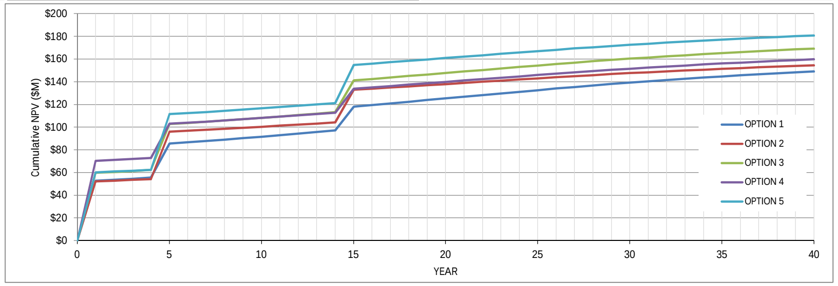


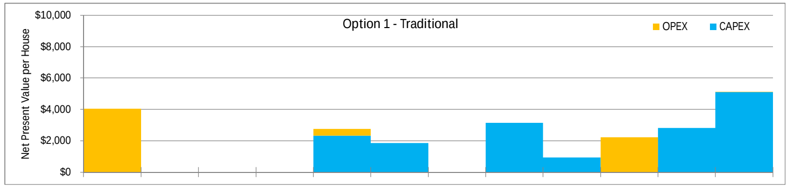


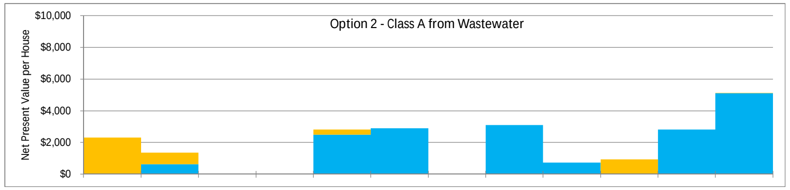


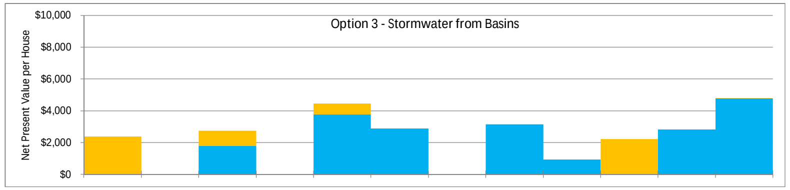
Short-listed Options

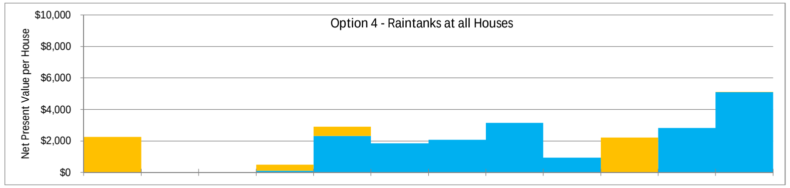
Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting

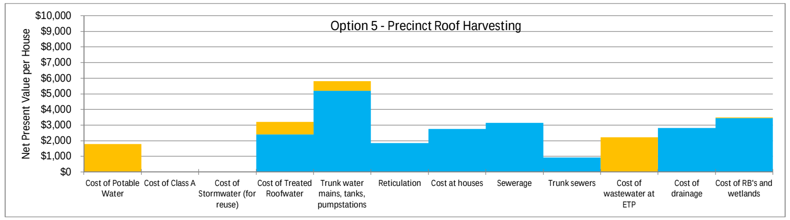












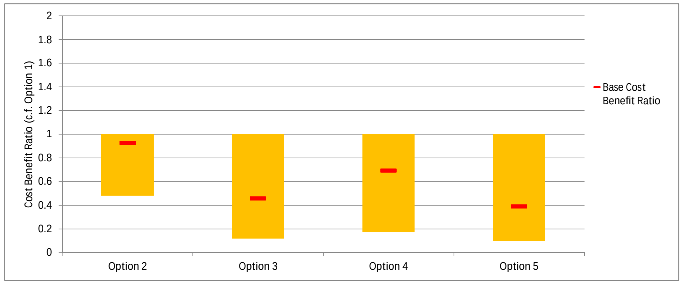
EAST PAKENHAM - SENSITIVITY ANALYSIS

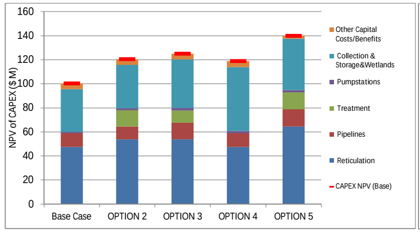
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 500 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

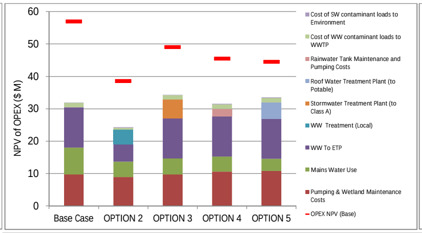
Comments on Sensitivity Test Scenario:

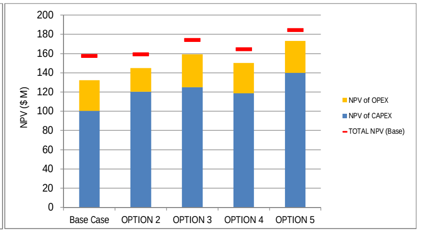
Scenario 1.2 - Water Min Cost

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 2.6 M	$ 2. M	$ 2.8 M	$ 2.6 M	$ 2.7 M
%change	-78%	-59%	-43%	-44%	-33%
NPV	$ 132 M	$ 145 M	$ 159 M	$ 150 M	$ 173 M
%change	-19%	-10%	-9%	-9%	-6%
BC Ratio *(c.f. 1)*		0.48	0.12	0.17	0.10









Short-listed Options

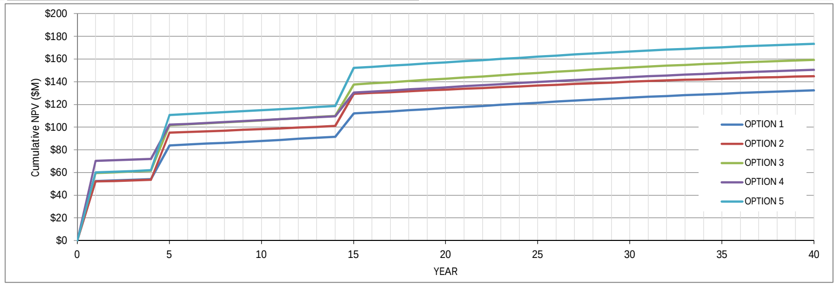
Option 1 - Base Case (Traditional)

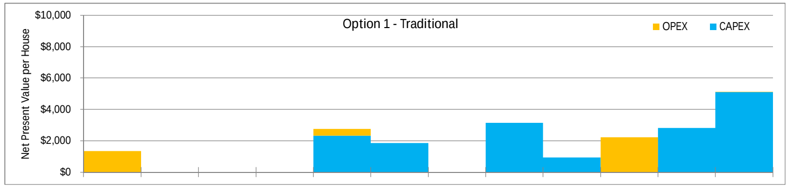
Option 2 - Class A from wastewater

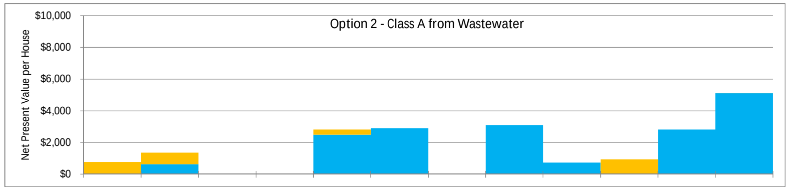
Option 3 - Stormwater from basins

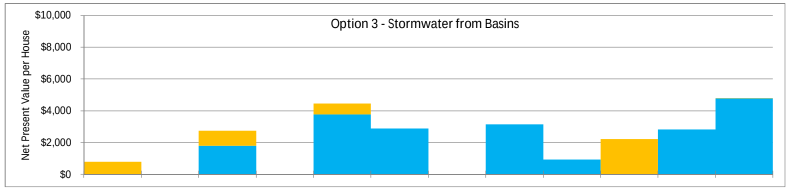
Option 4 - Rain tanks at all houses

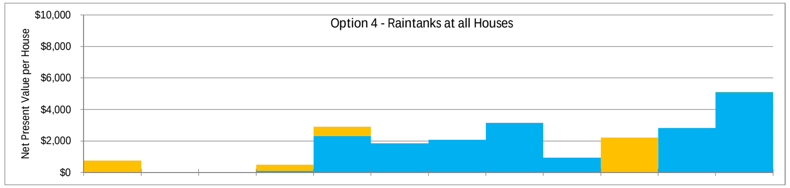
Option 5 - Precinct roof harvesting

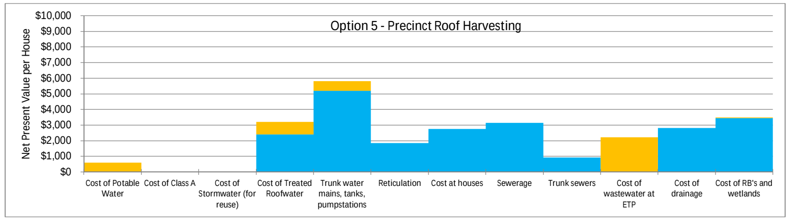












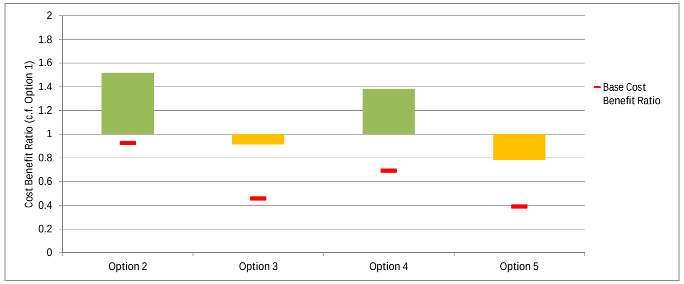
EAST PAKENHAM - SENSITIVITY ANALYSIS

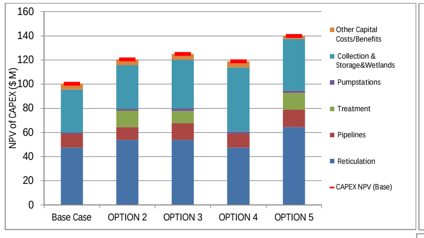
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 4 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

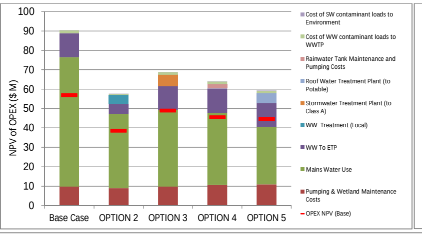
Comments on Sensitivity Test Scenario:

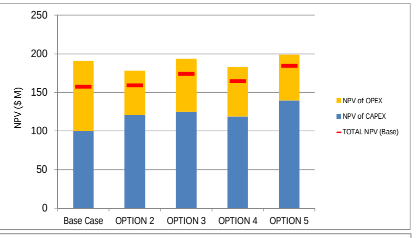
Scenario 1.3 - Water Cost High

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 7.4 M	$ 4.7 M	$ 5.6 M	$ 5.2 M	$ 4.8 M
%change	37%	33%	29%	29%	25%
NPV	$ 191 M	$ 178 M	$ 194 M	$ 183 M	$ 199 M
%change	18%	11%	10%	10%	7%
BC Ratio *(c.f. 1)*		1.52	0.91	1.38	0.78









Short-listed Options

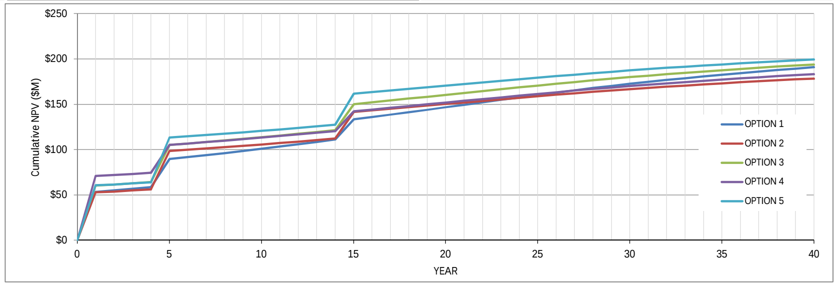
Option 1 - Base Case (Traditional)

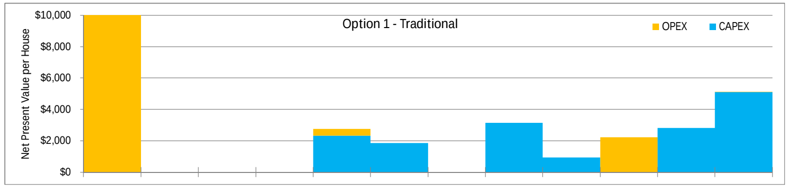
Option 2 - Class A from wastewater

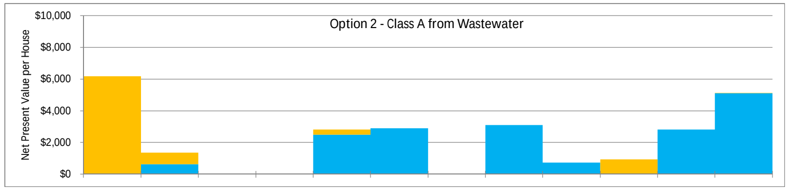
Option 3 - Stormwater from basins

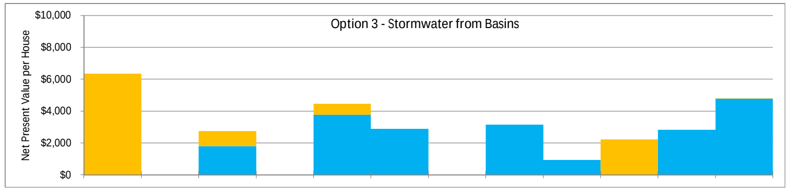
Option 4 - Rain tanks at all houses

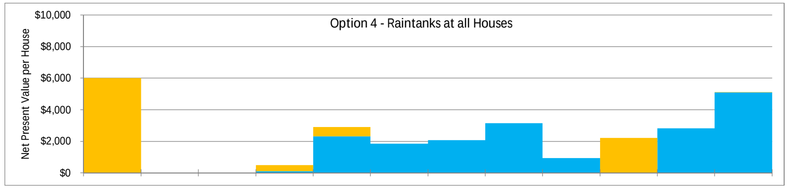
Option 5 - Precinct roof harvesting

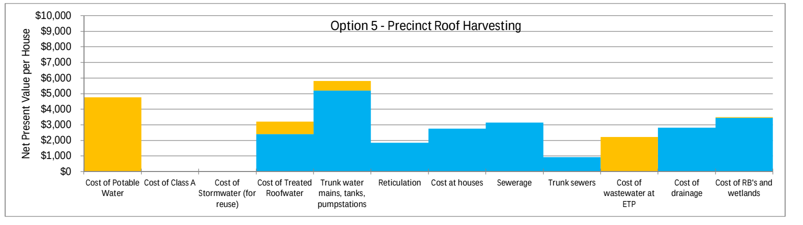












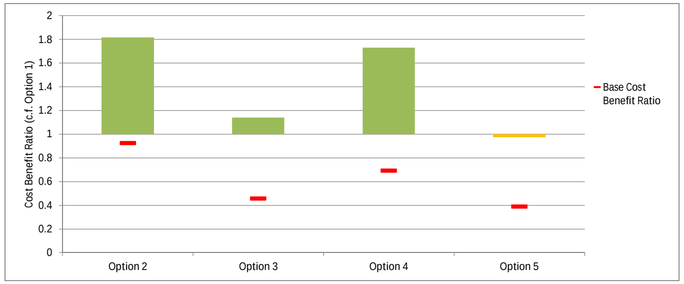
EAST PAKENHAM - SENSITIVITY ANALYSIS

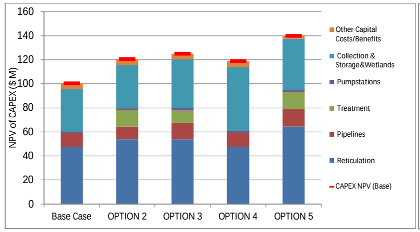
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 5 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

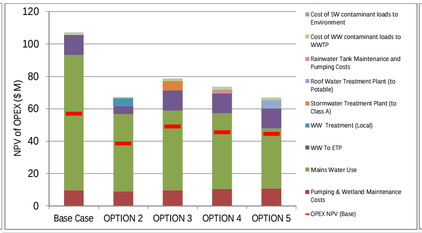
Comments on Sensitivity Test Scenario:

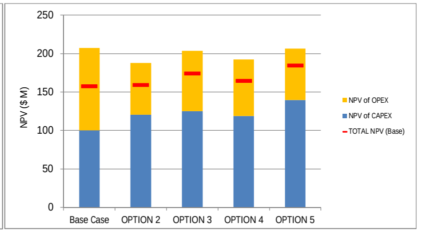
Scenario 1.4 - Water Cost Max

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 8.7 M	$ 5.5 M	$ 6.4 M	$ 6. M	$ 5.4 M
%change	47%	43%	38%	38%	33%
NPV	$ 207 M	$ 188 M	$ 204 M	$ 192 M	$ 207 M
%change	24%	15%	15%	15%	11%
BC Ratio *(c.f. 1)*		1.82	1.14	1.73	0.98









Short-listed Options

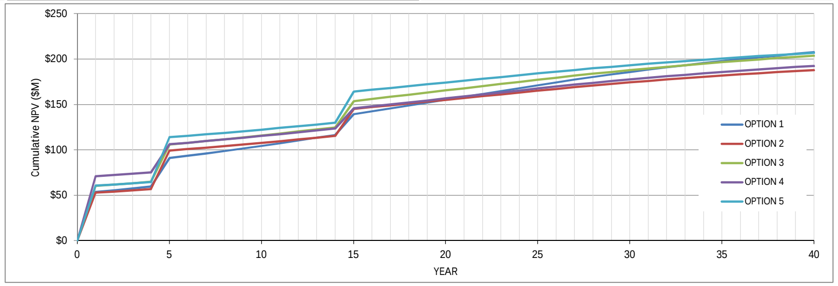
Option 1 - Base Case (Traditional)

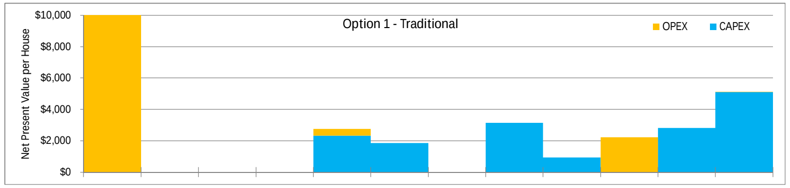
Option 2 - Class A from wastewater

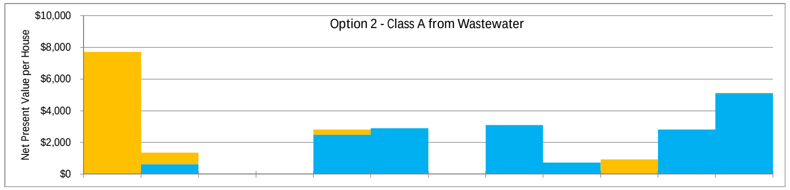
Option 3 - Stormwater from basins

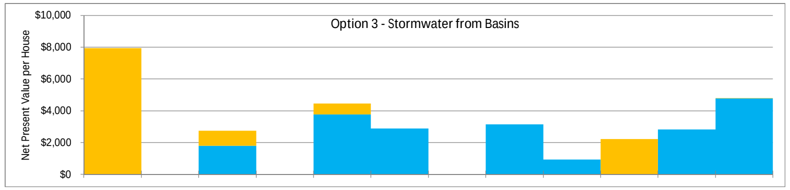
Option 4 - Rain tanks at all houses

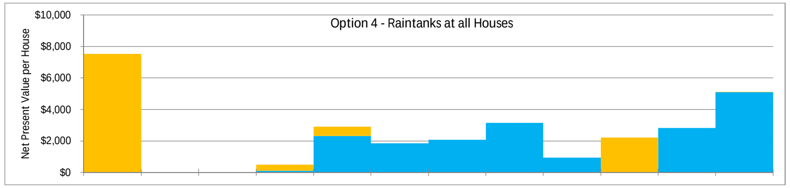
Option 5 - Precinct roof harvesting

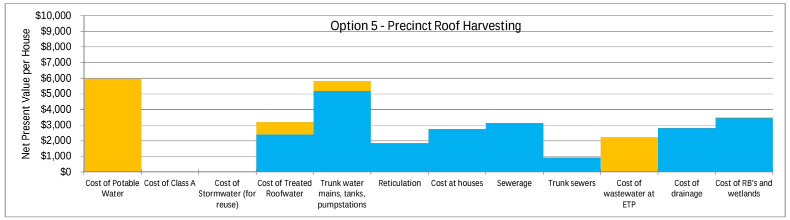












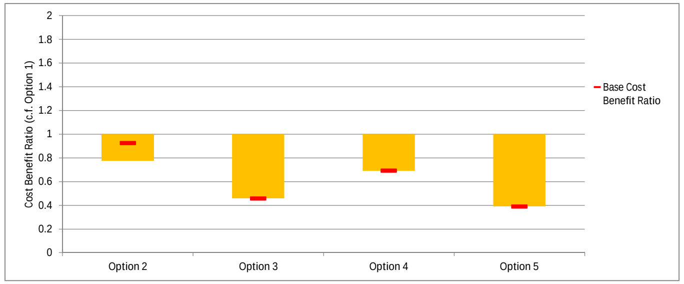
EAST PAKENHAM - SENSITIVITY ANALYSIS

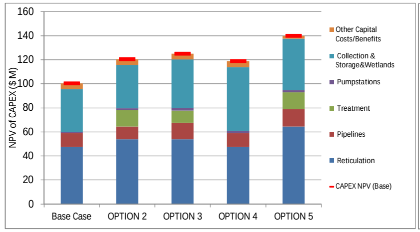
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 500 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

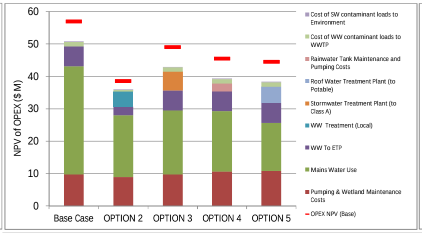
	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 4.1 M	$ 2.9 M	$ 3.5 M	$ 3.2 M	$ 3.1 M
%change	-12%	-7%	-14%	-16%	-16%
NPV	$ 151 M	$ 156 M	$ 168 M	$ 158 M	$ 178 M
%change	-4%	-2%	-4%	-4%	-3%
BC Ratio *(c.f. 1)*		0.78	0.46	0.69	0.39

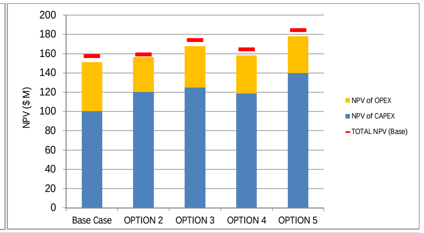
<u>Comments on Sensitivity Test Scenario:</u>

Scenario 2.1 - Wastewater Cost Low









<u>Short-listed Options</u>

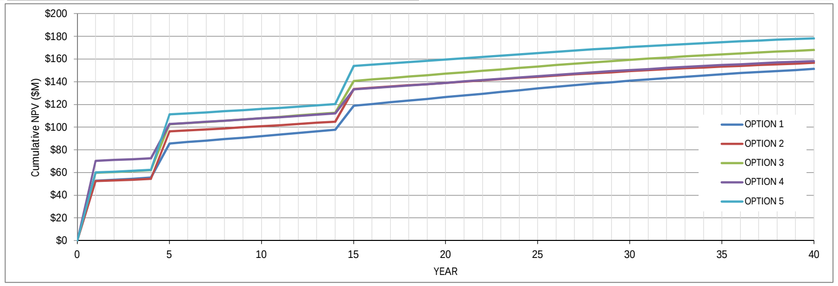
Option 1 - Base Case (Traditional)

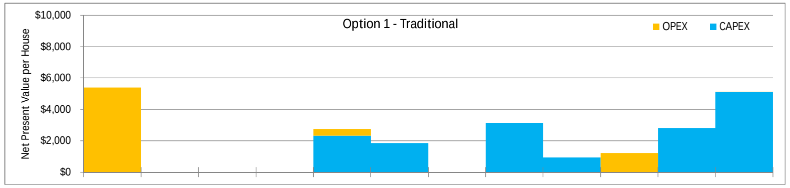
Option 2 - Class A from wastewater

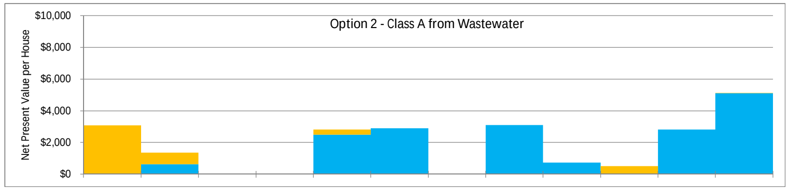
Option 3 - Stormwater from basins

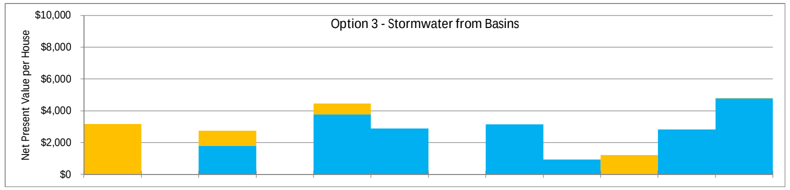
Option 4 - Rain tanks at all houses

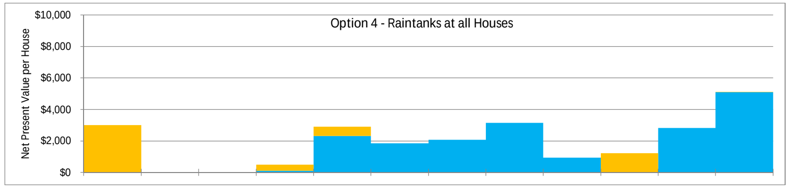
Option 5 - Precinct roof harvesting

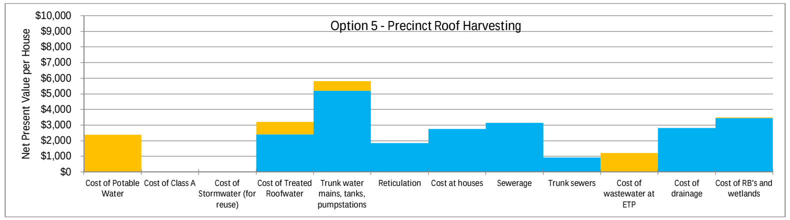












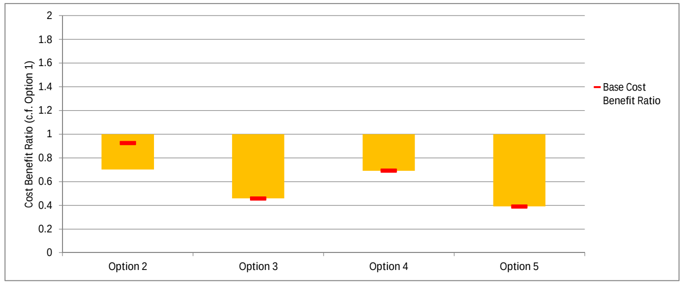
EAST PAKENHAM - SENSITIVITY ANALYSIS

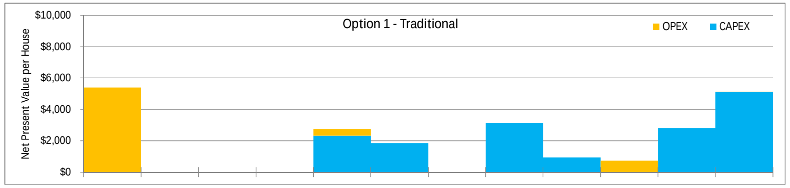
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 250 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

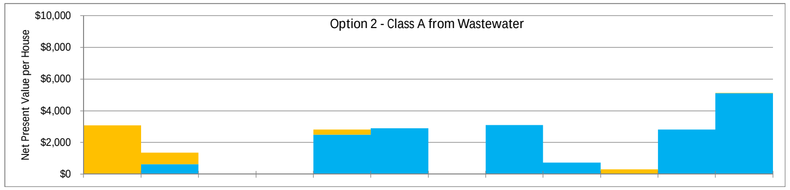
Comments on Sensitivity Test Scenario:

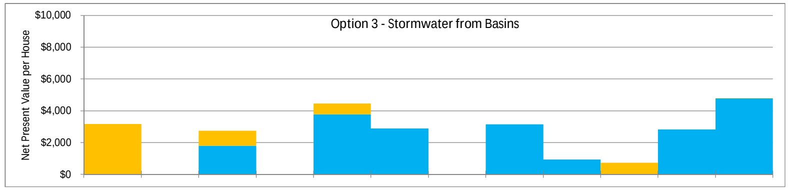
Scenario 2.2 - Wastewater Cost Min

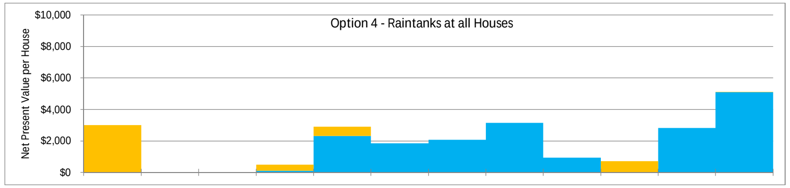
	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 3.9 M	$ 2.8 M	$ 3.2 M	$ 2.9 M	$ 2.9 M
%change	-19%	-11%	-23%	-26%	-26%
NPV	$ 148 M	$ 155 M	$ 165 M	$ 155 M	$ 175 M
%change	-6%	-3%	-6%	-6%	-5%
BC Ratio *(c.f. 1)*		0.70	0.46	0.69	0.39

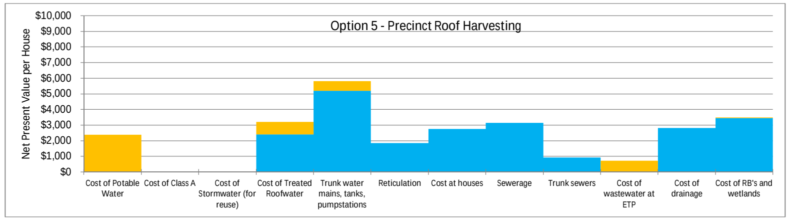


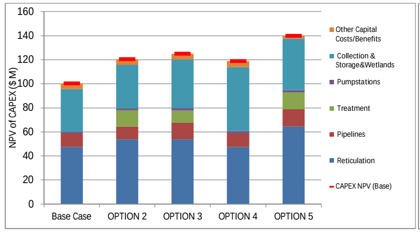


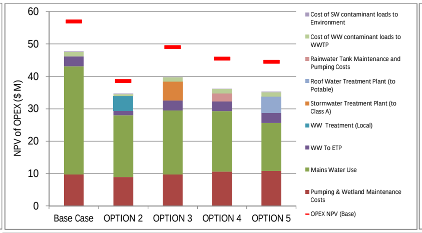


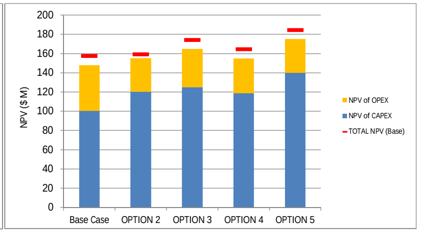






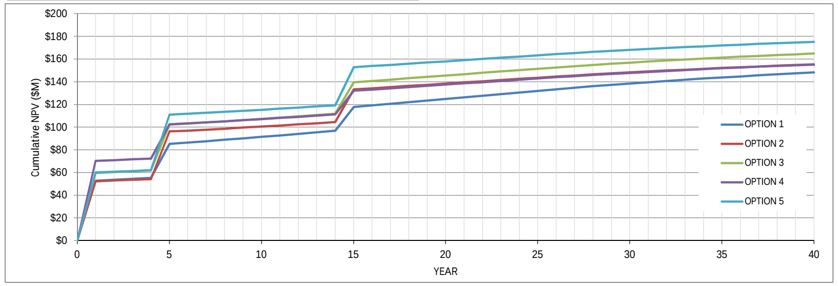






Short-listed Options

Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting



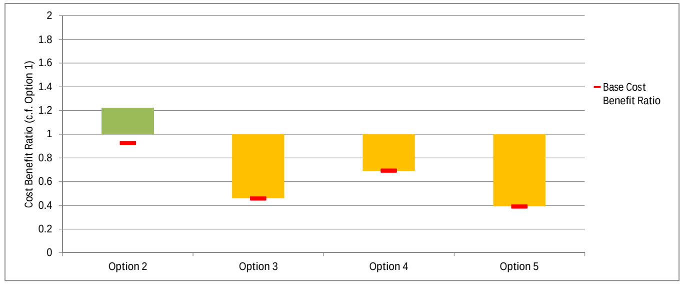
EAST PAKENHAM - SENSITIVITY ANALYSIS

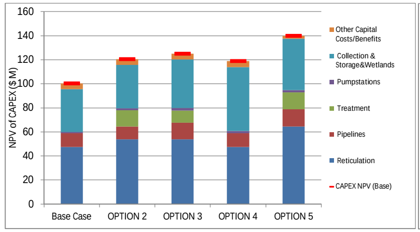
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 2 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

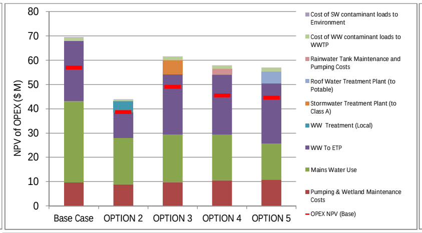
	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 5.6 M	$ 3.6 M	$ 5. M	$ 4.7 M	$ 4.6 M
%change	18%	12%	20%	21%	22%
NPV	$ 170 M	$ 164 M	$ 186 M	$ 177 M	$ 197 M
%change	7%	3%	7%	7%	6%
BC Ratio *(c.f. 1)*		1.22	0.46	0.69	0.39

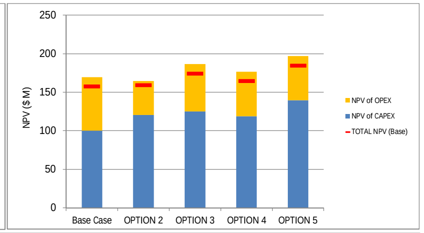
Comments on Sensitivity Test Scenario:

Scenario 2.3 - Wastewater Cost High









Short-listed Options

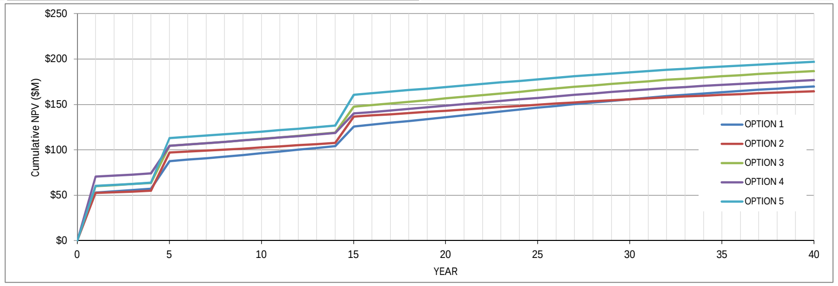
Option 1 - Base Case (Traditional)

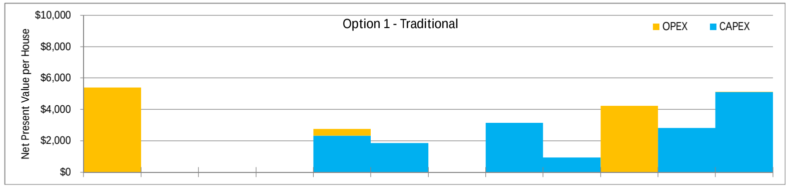
Option 2 - Class A from wastewater

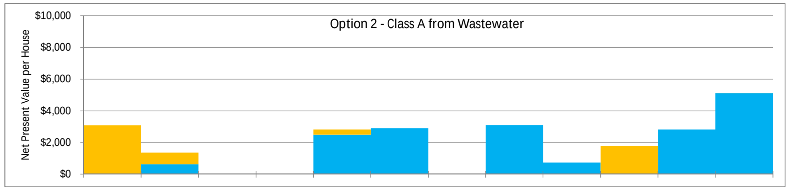
Option 3 - Stormwater from basins

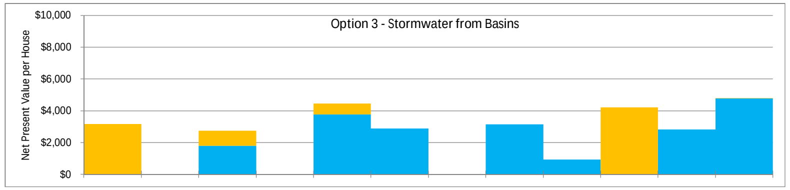
Option 4 - Rain tanks at all houses

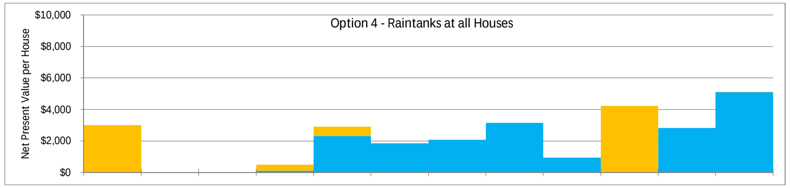
Option 5 - Precinct roof harvesting

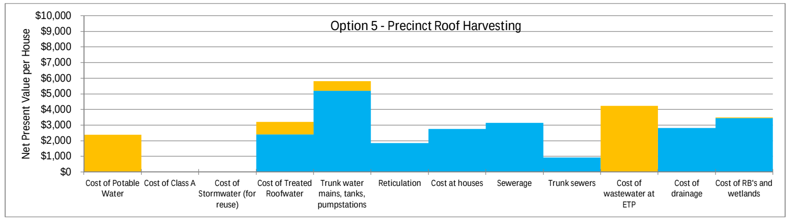








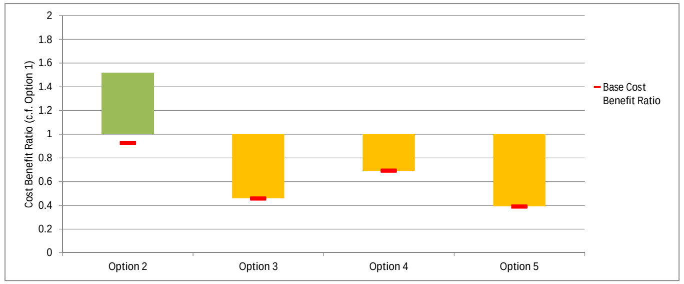




EAST PAKENHAM - SENSITIVITY ANALYSIS

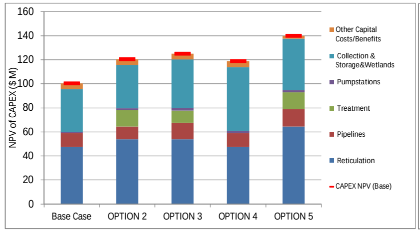
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 3 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

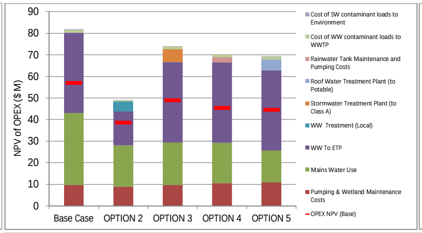
	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 6.7 M	$ 4. M	$ 6. M	$ 5.7 M	$ 5.6 M
%change	30%	21%	34%	35%	36%
NPV	$ 182 M	$ 170 M	$ 199 M	$ 189 M	$ 209 M
%change	14%	6%	12%	13%	12%
BC Ratio *(c.f. 1)*		1.52	0.46	0.69	0.39

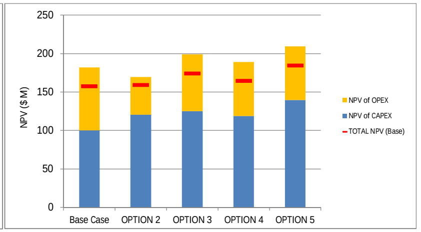


<u>Comments on Sensitivity Test Scenario:</u>

Scenario 2.4 - Wastewater Cost Max

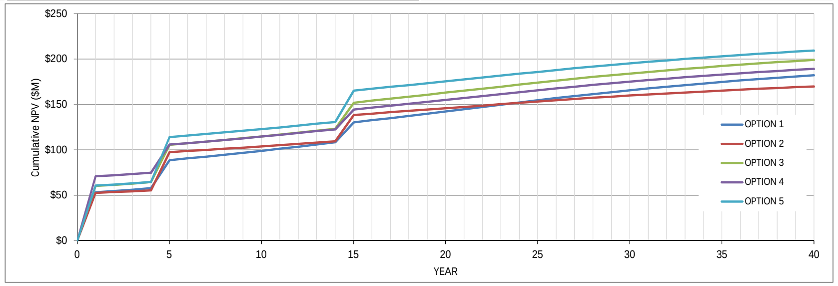


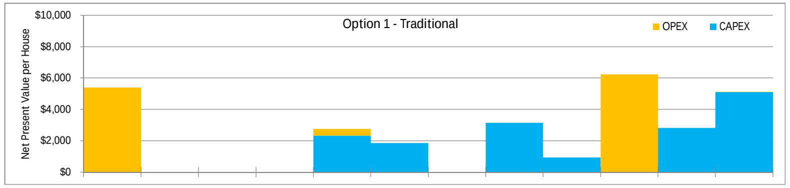


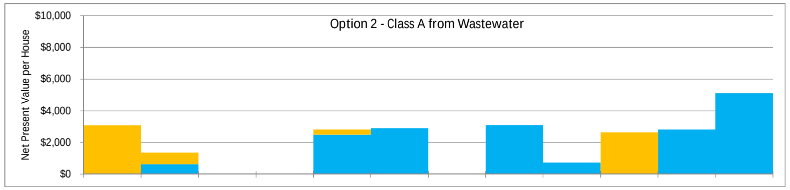


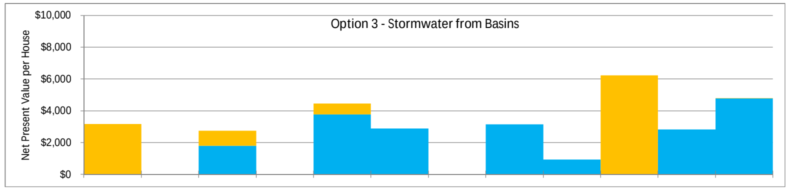
<u>Short-listed Options</u>

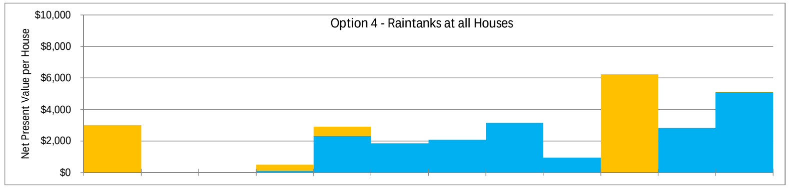
Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting

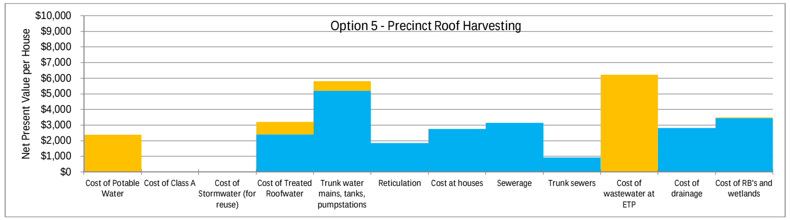








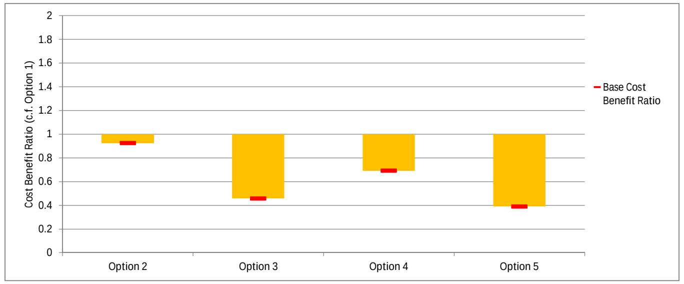




EAST PAKENHAM - SENSITIVITY ANALYSIS

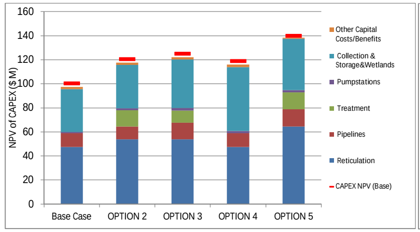
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 100 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

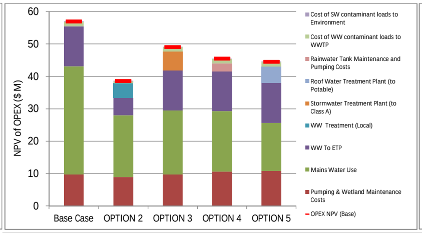
	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 122 M	$ 151 M	$ 155 M	$ 141 M	$ 178 M
%change	-2%	-2%	-2%	-2%	-1%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 154 M	$ 156 M	$ 171 M	$ 161 M	$ 183 M
%change	-2%	-2%	-2%	-2%	-1%
BC Ratio *(c.f. 1)*		0.92	0.46	0.69	0.39

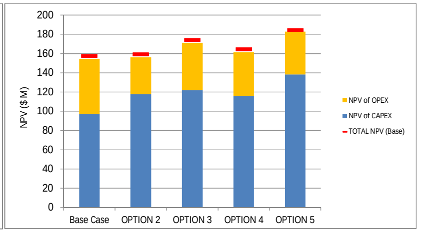


Comments on Sensitivity Test Scenario:

Scenario 3.1 - Land Cost Low

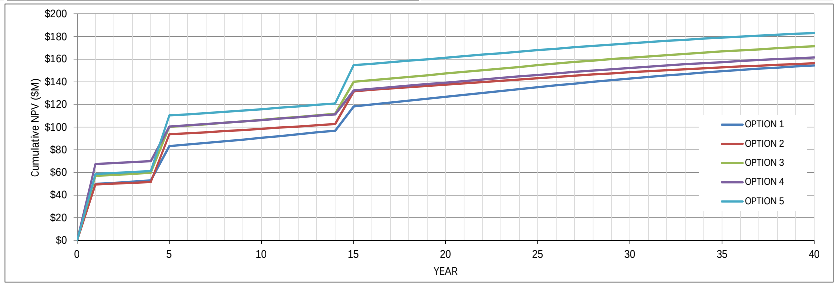


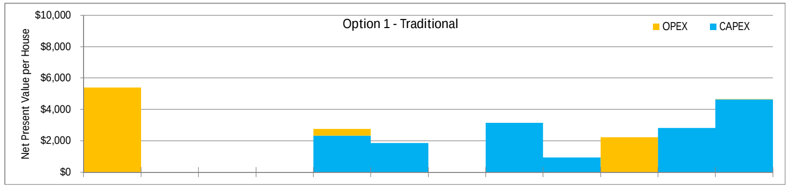


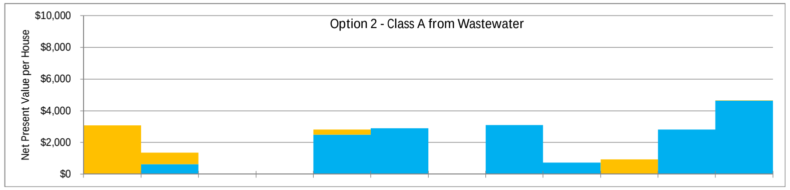


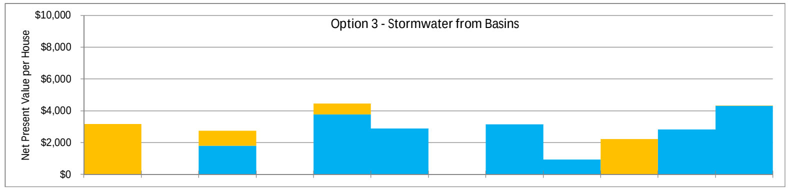
Short-listed Options

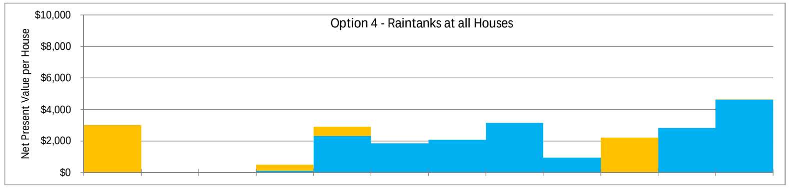
Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting

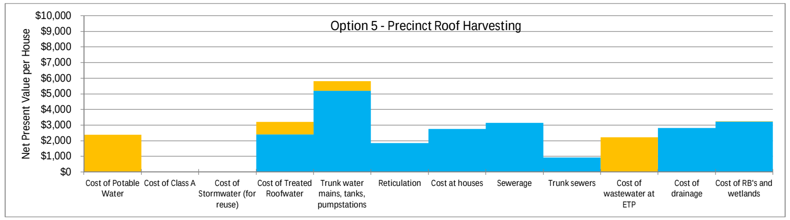












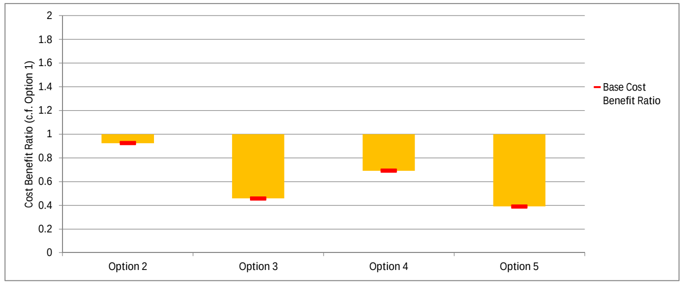
EAST PAKENHAM - SENSITIVITY ANALYSIS

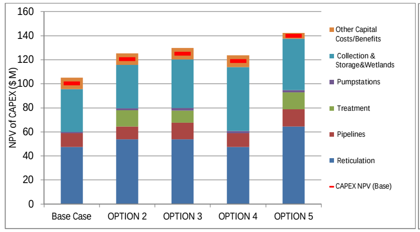
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 500 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

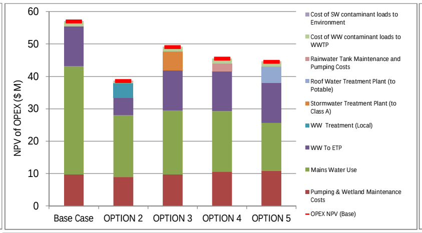
Comments on Sensitivity Test Scenario:

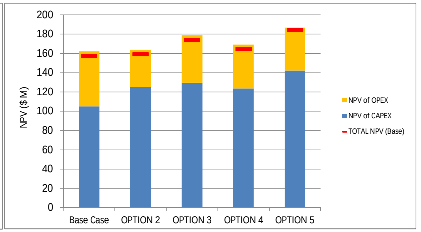
Scenario 3.2 - Land Cost High

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 130 M	$ 159 M	$ 163 M	$ 149 M	$ 182 M
%change	4%	3%	3%	3%	2%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 162 M	$ 164 M	$ 179 M	$ 169 M	$ 187 M
%change	3%	3%	3%	3%	1%
BC Ratio *(c.f. 1)*		0.92	0.46	0.69	0.39









Short-listed Options

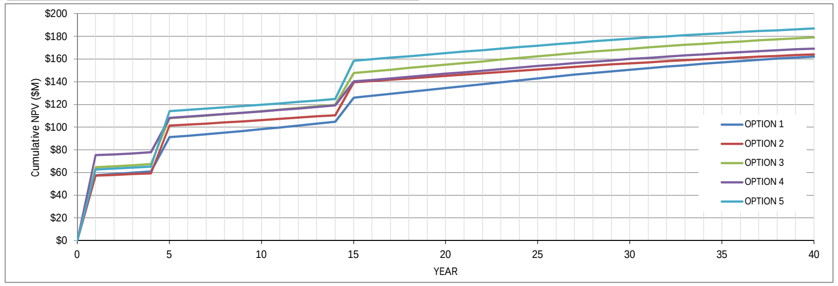
Option 1 - Base Case (Traditional)

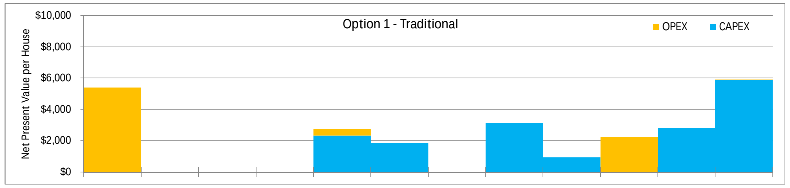
Option 2 - Class A from wastewater

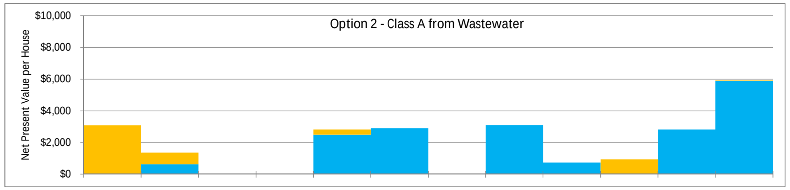
Option 3 - Stormwater from basins

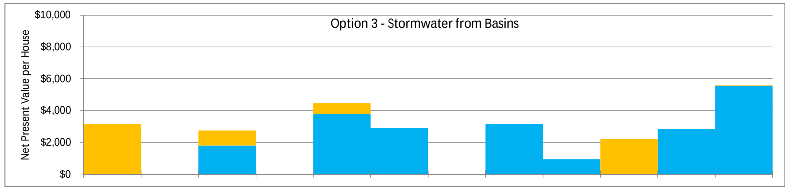
Option 4 - Rain tanks at all houses

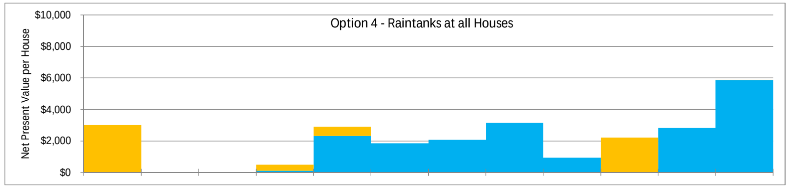
Option 5 - Precinct roof harvesting

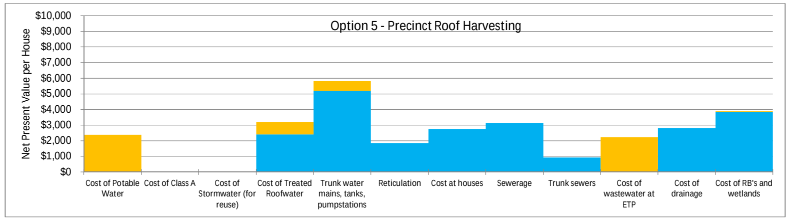












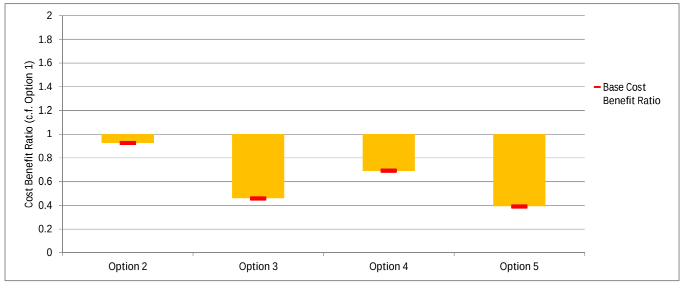
EAST PAKENHAM - SENSITIVITY ANALYSIS

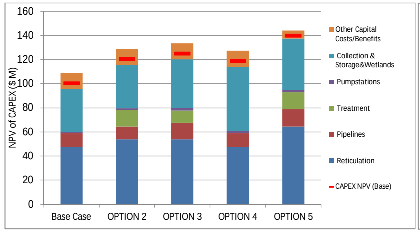
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 700 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

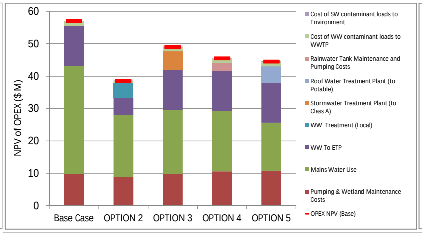
Comments on Sensitivity Test Scenario:

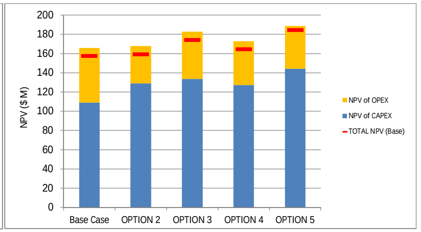
Scenario 3.3 - Land Cost Max

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 134 M	$ 163 M	$ 167 M	$ 153 M	$ 184 M
%change	7%	6%	5%	6%	3%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 166 M	$ 168 M	$ 183 M	$ 173 M	$ 189 M
%change	5%	5%	5%	5%	2%
BC Ratio *(c.f. 1)*		0.92	0.46	0.69	0.39



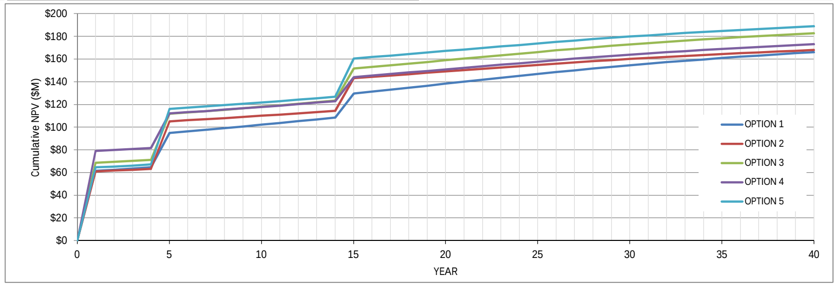


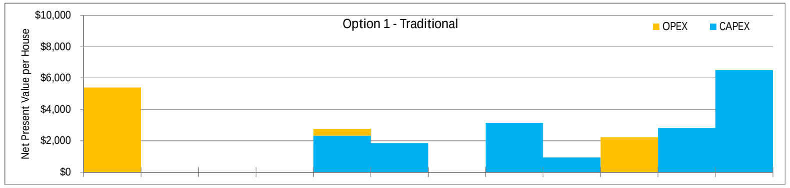


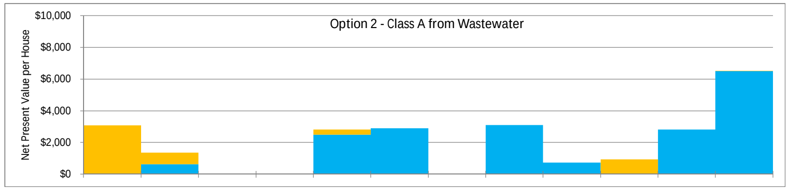


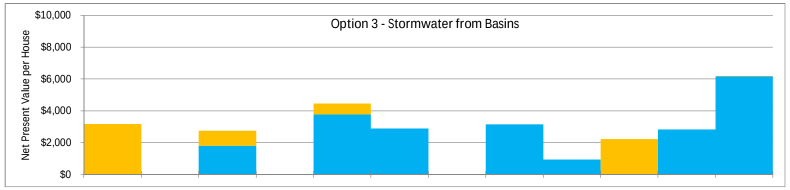
Short-listed Options

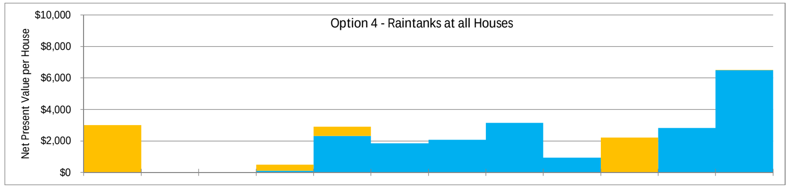
Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting

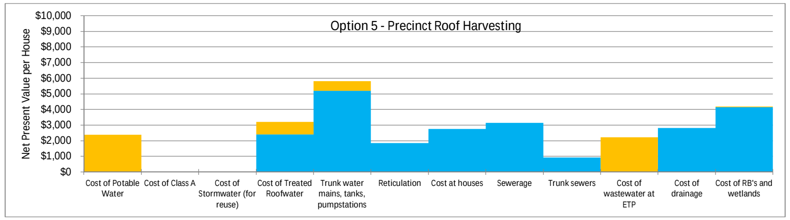












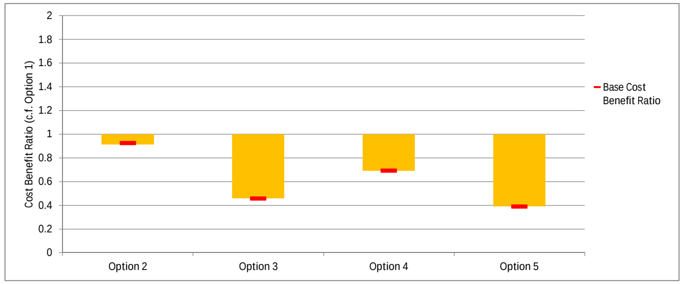
EAST PAKENHAM - SENSITIVITY ANALYSIS

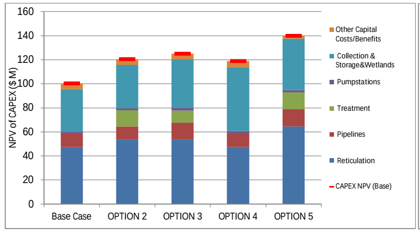
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 300 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

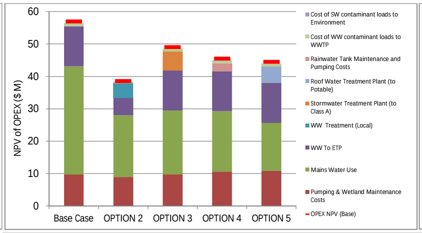
Comments on Sensitivity Test Scenario:

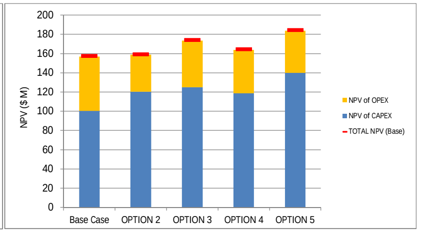
Scenario 4.1 - Nitrogen Cost Low

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	-1%	-1%	-1%	-1%	-1%
NPV	$ 157 M	$ 159 M	$ 174 M	$ 164 M	$ 184 M
%change	0%	0%	0%	0%	0%
BC Ratio *(c.f. 1)*		0.91	0.46	0.69	0.39









Short-listed Options

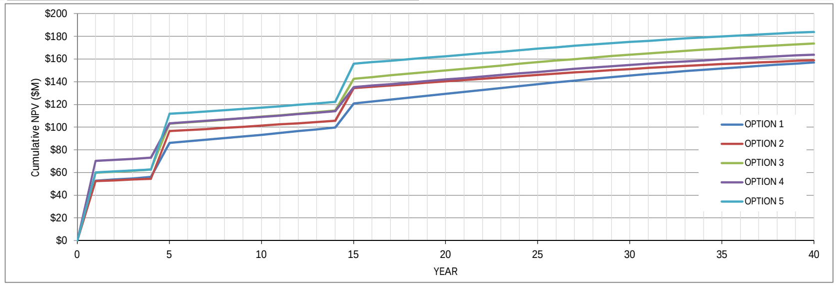
Option 1 - Base Case (Traditional)

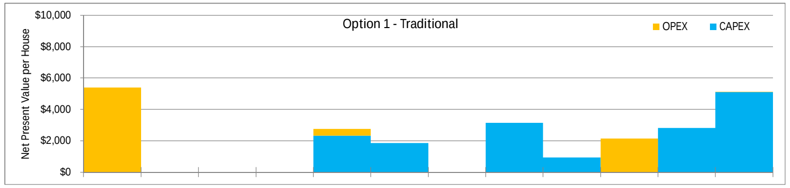
Option 2 - Class A from wastewater

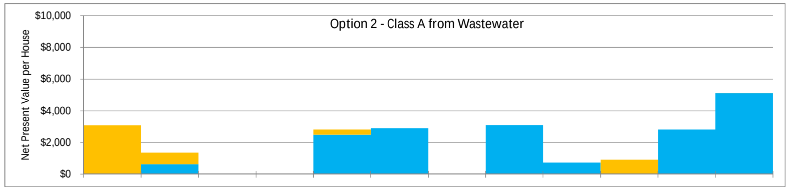
Option 3 - Stormwater from basins

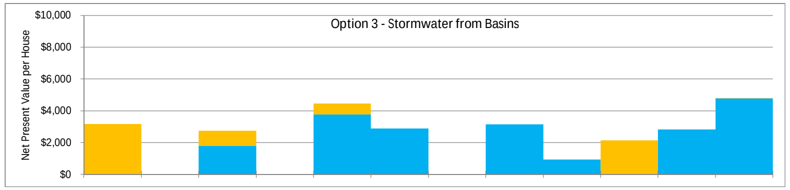
Option 4 - Rain tanks at all houses

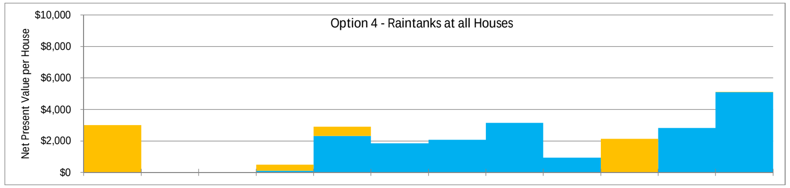
Option 5 - Precinct roof harvesting

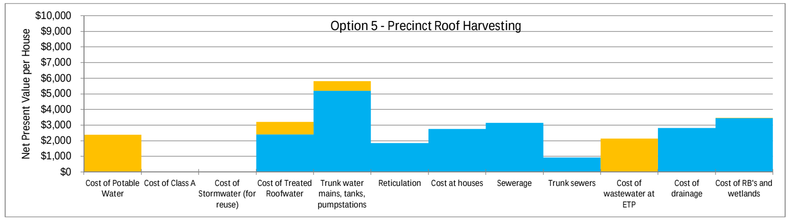












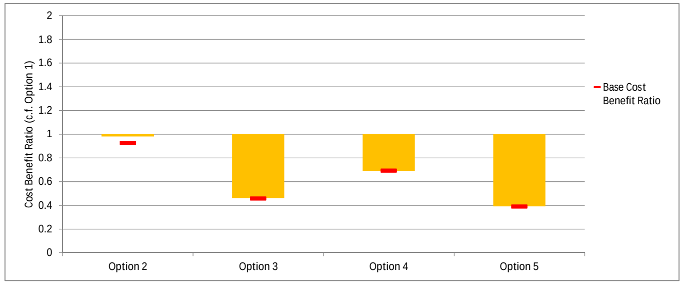
EAST PAKENHAM - SENSITIVITY ANALYSIS

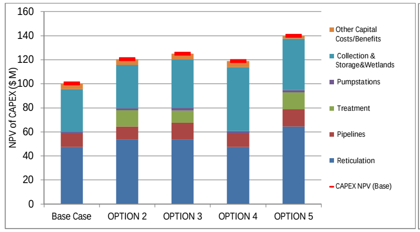
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 2000 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

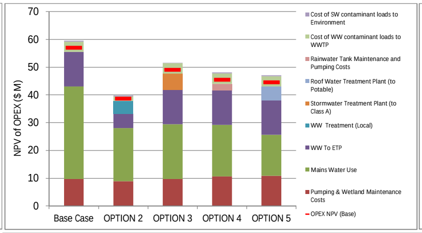
	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 4.8 M	$ 3.2 M	$ 4.2 M	$ 3.9 M	$ 3.8 M
%change	4%	3%	5%	5%	5%
NPV	$ 160 M	$ 160 M	$ 177 M	$ 167 M	$ 187 M
%change	2%	1%	1%	2%	1%
BC Ratio *(c.f. 1)*		0.98	0.46	0.69	0.39

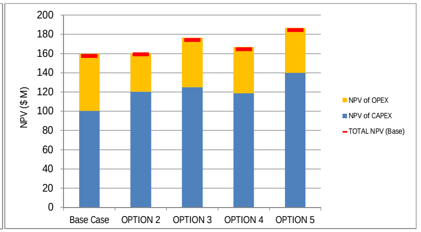
Comments on Sensitivity Test Scenario:

Scenario 4.2 - Nitrogen Cost High



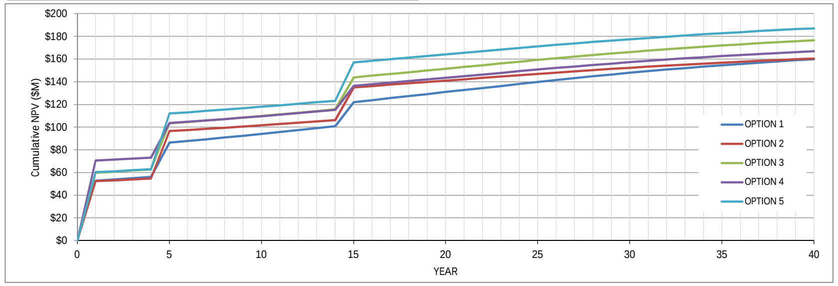


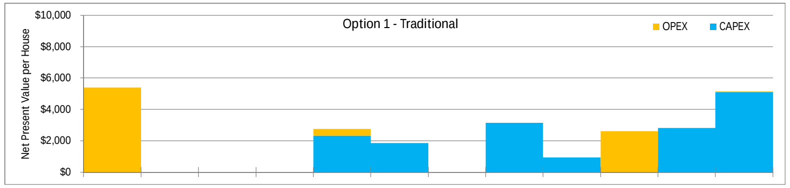


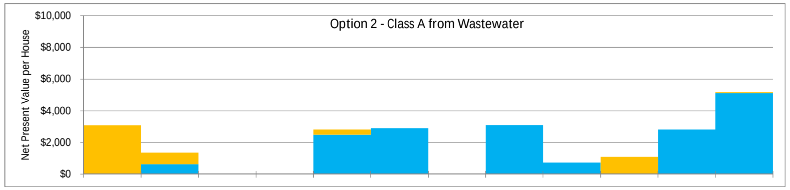


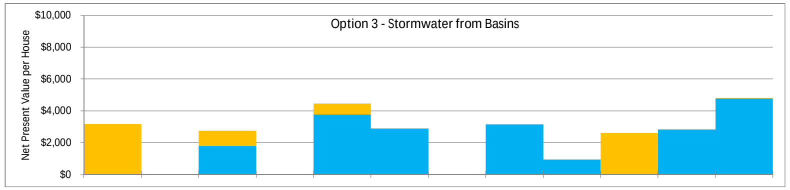
Short-listed Options

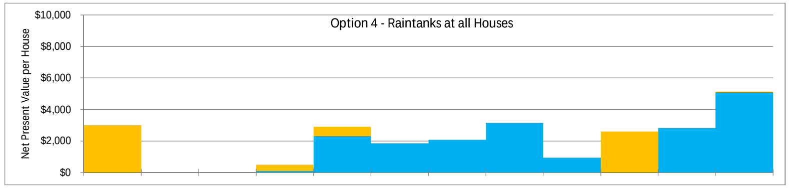
Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting

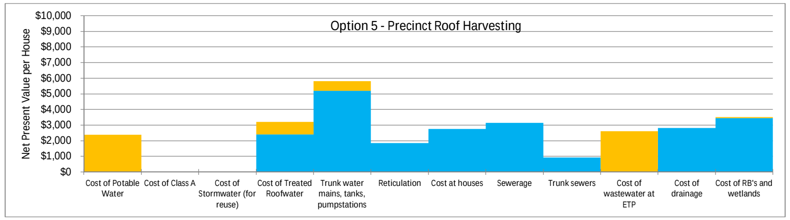












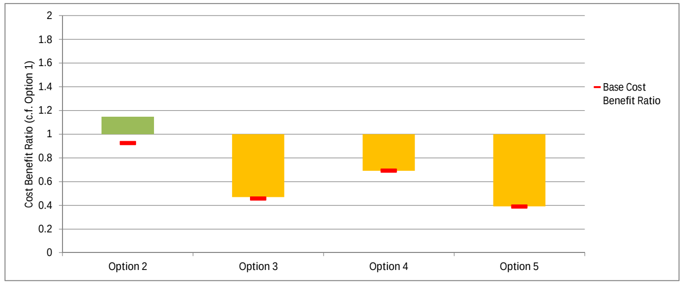
EAST PAKENHAM - SENSITIVITY ANALYSIS

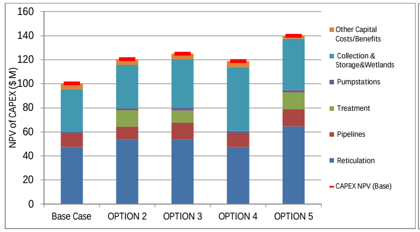
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 6000 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

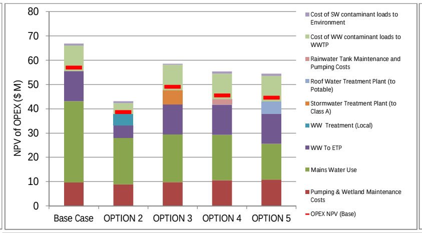
	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 5.4 M	$ 3.5 M	$ 4.8 M	$ 4.5 M	$ 4.4 M
%change	15%	10%	16%	18%	18%
NPV	$ 167 M	$ 164 M	$ 184 M	$ 174 M	$ 194 M
%change	6%	3%	5%	6%	5%
BC Ratio *(c.f. 1)*		1.14	0.47	0.69	0.39

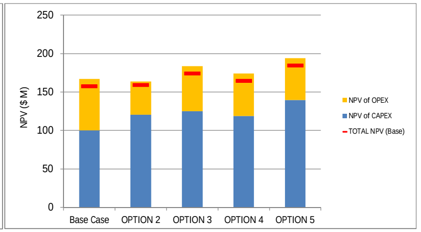
<u>Comments on Sensitivity Test Scenario:</u>

Scenario 4.3 - Nitrogen Cost Max









<u>Short-listed Options</u>

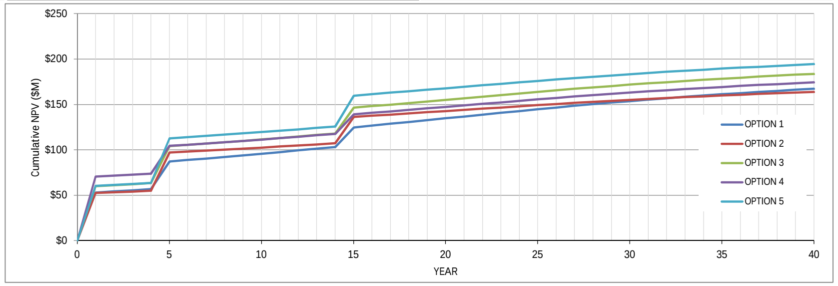
Option 1 - Base Case (Traditional)

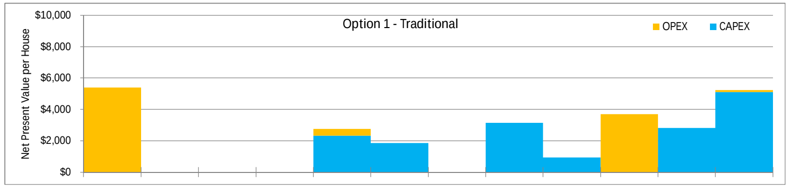
Option 2 - Class A from wastewater

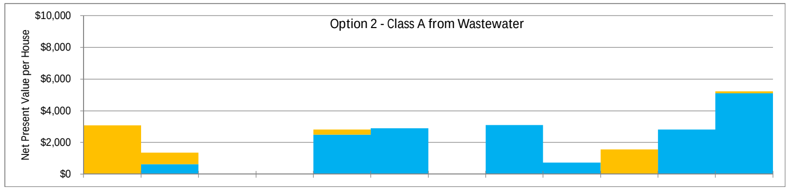
Option 3 - Stormwater from basins

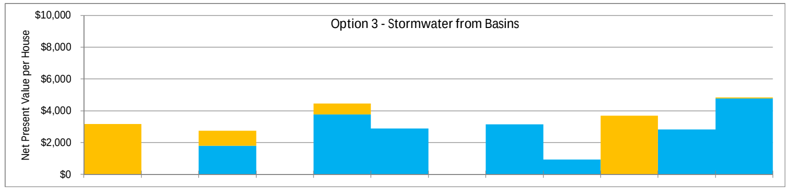
Option 4 - Rain tanks at all houses

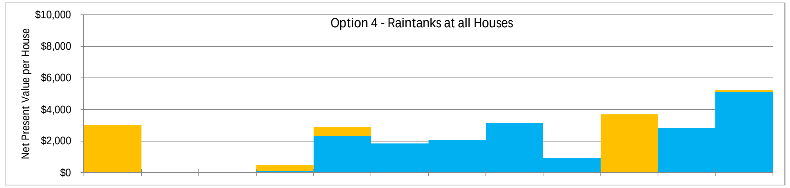
Option 5 - Precinct roof harvesting

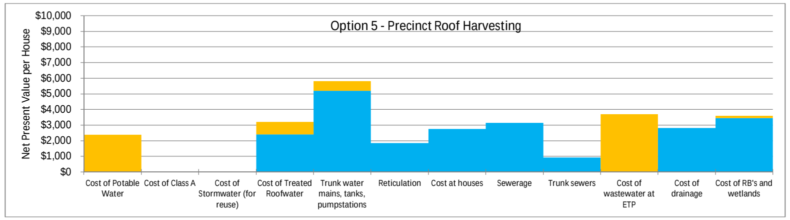












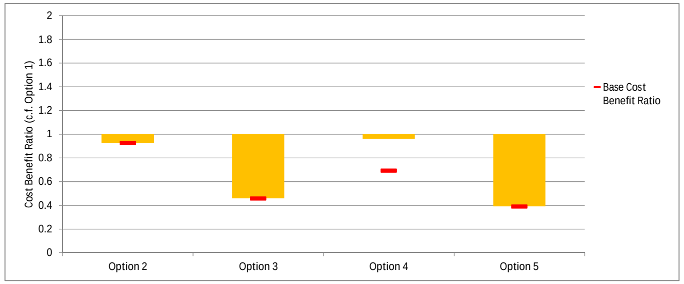
EAST PAKENHAM - SENSITIVITY ANALYSIS

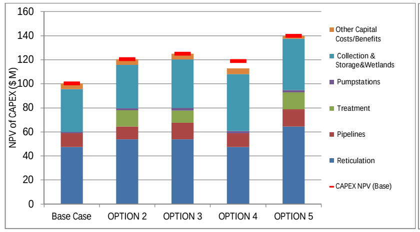
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 2 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

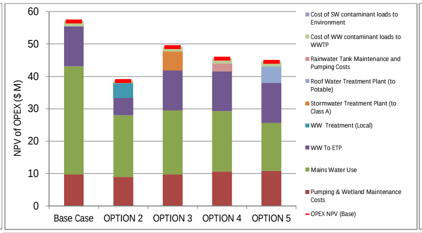
Comments on Sensitivity Test Scenario:

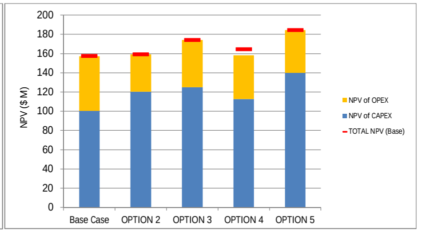
Scenario 5.1 - Raintanks Cost Low

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 138 M	$ 179 M
%change	0%	0%	0%	-4%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 157 M	$ 159 M	$ 174 M	$ 158 M	$ 184 M
%change	0%	0%	0%	-4%	0%
BC Ratio *(c.f. 1)*		0.92	0.46	0.96	0.39



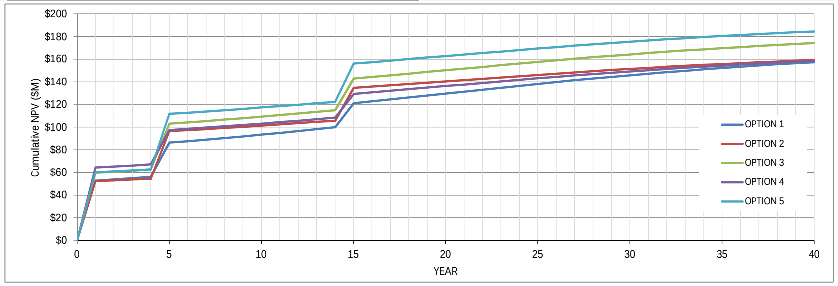


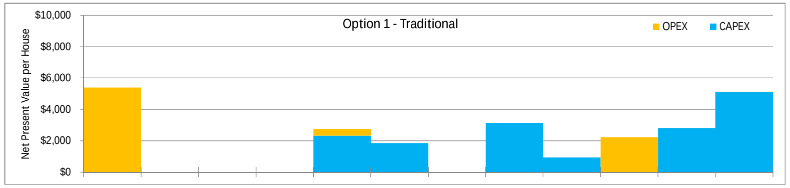


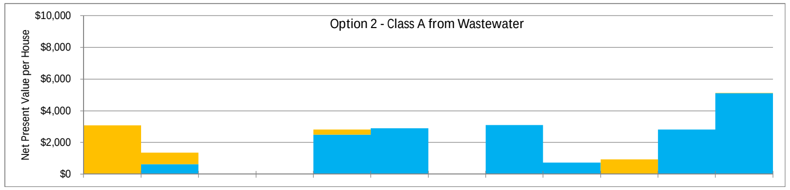


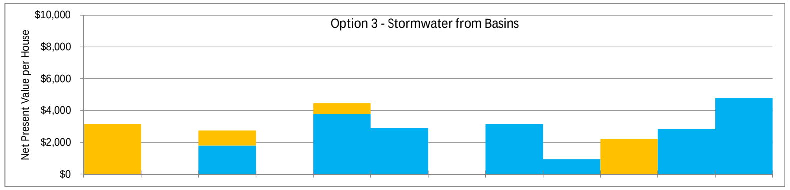
Short-listed Options

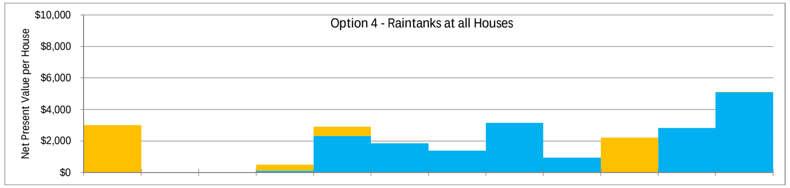
Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting

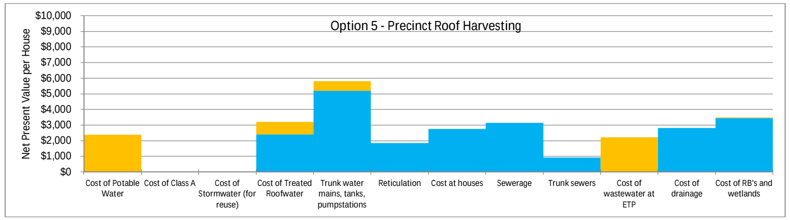












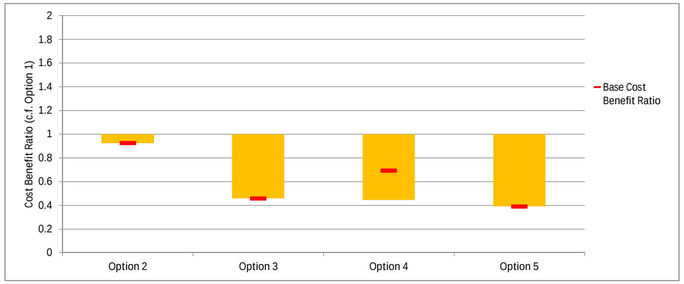
EAST PAKENHAM - SENSITIVITY ANALYSIS

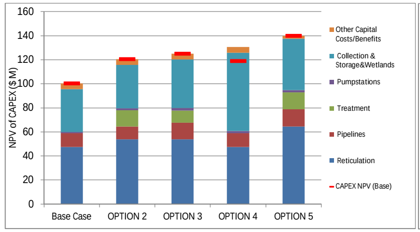
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 5 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

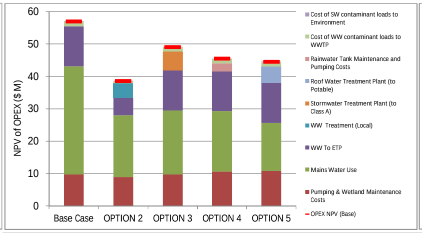
Comments on Sensitivity Test Scenario:

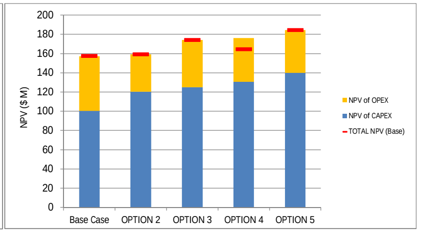
Scenario 5.2 - Raintanks Cost High

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 157 M	$ 179 M
%change	0%	0%	0%	8%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 157 M	$ 159 M	$ 174 M	$ 176 M	$ 184 M
%change	0%	0%	0%	7%	0%
BC Ratio *(c.f. 1)*		0.92	0.46	0.44	0.39









Short-listed Options

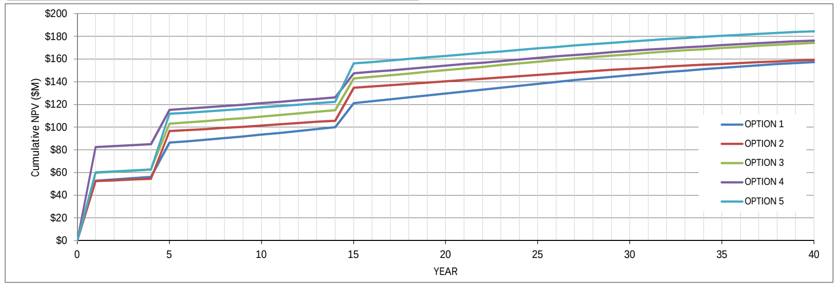
Option 1 - Base Case (Traditional)

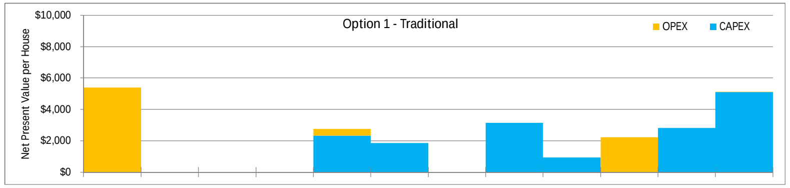
Option 2 - Class A from wastewater

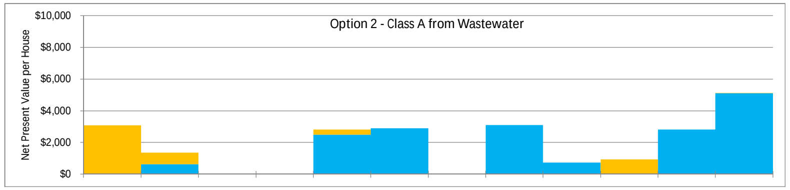
Option 3 - Stormwater from basins

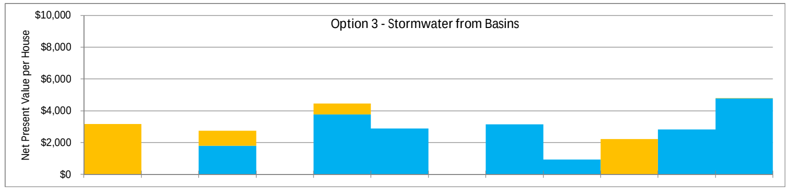
Option 4 - Rain tanks at all houses

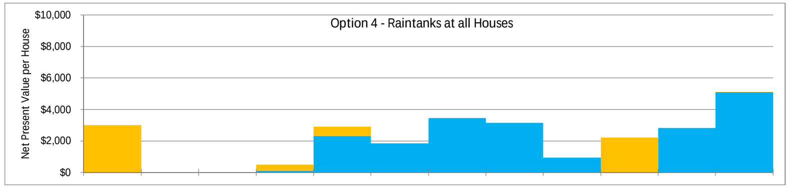
Option 5 - Precinct roof harvesting

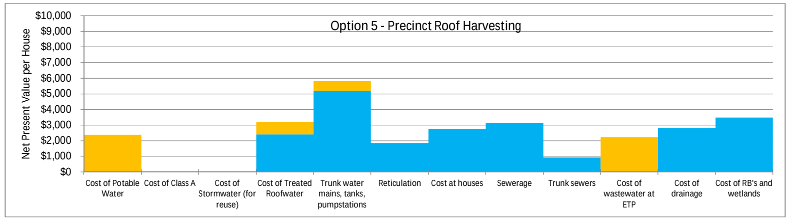










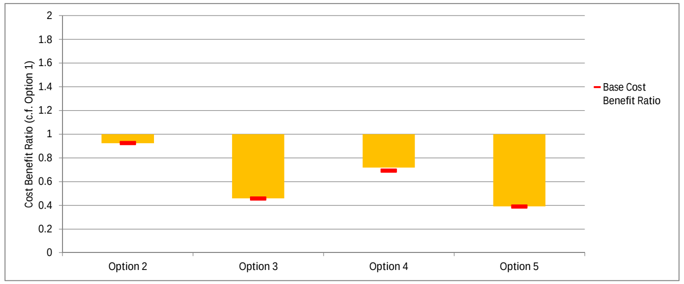


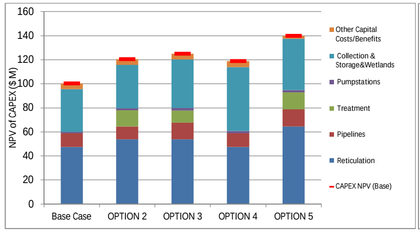
EAST PAKENHAM - SENSITIVITY ANALYSIS

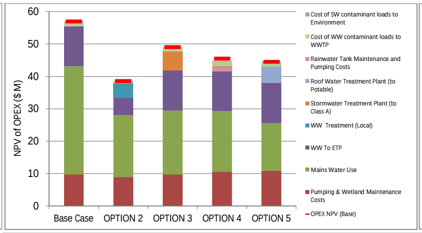
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

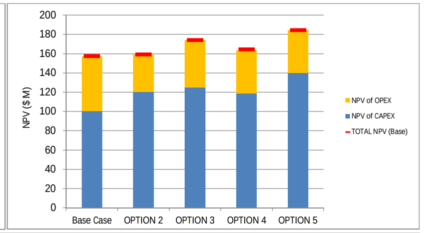
Comments on Sensitivity Test Scenario:		
Scenario 5.3 - Raintanks Annual Maintenance Low	$ 30 / house	$ 20 / house

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.6 M	$ 3.6 M
%change	0%	0%	0%	-2%	0%
NPV	$ 157 M	$ 159 M	$ 174 M	$ 164 M	$ 184 M
%change	0%	0%	0%	0%	0%
BC Ratio *(c.f. 1)*		0.92	0.46	0.72	0.39









Short-listed Options

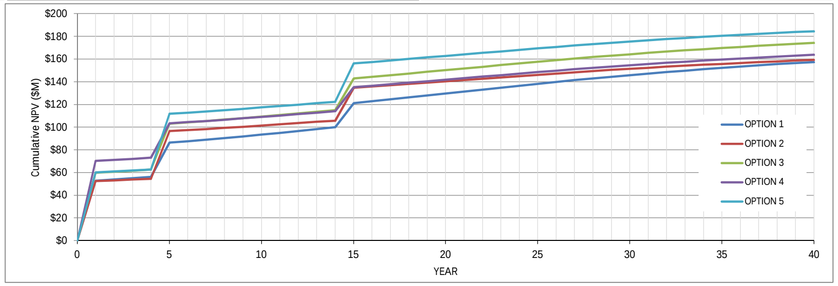
Option 1 - Base Case (Traditional)

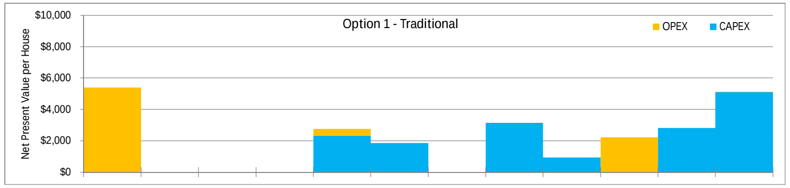
Option 2 - Class A from wastewater

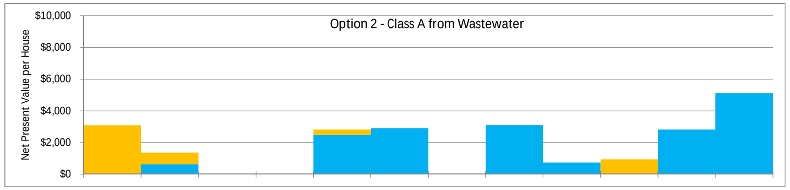
Option 3 - Stormwater from basins

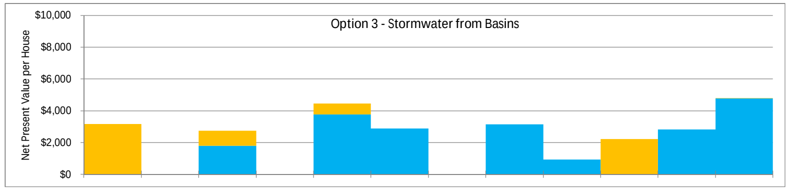
Option 4 - Rain tanks at all houses

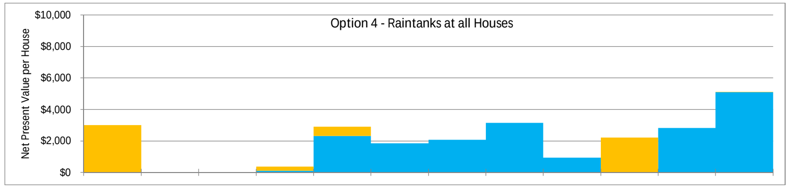
Option 5 - Precinct roof harvesting

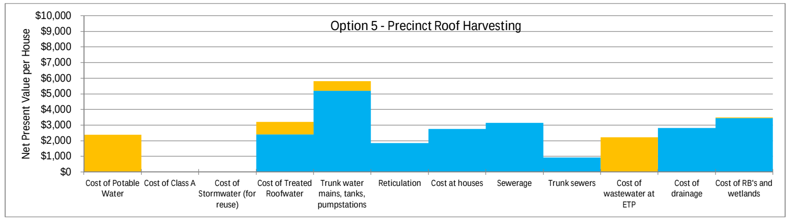








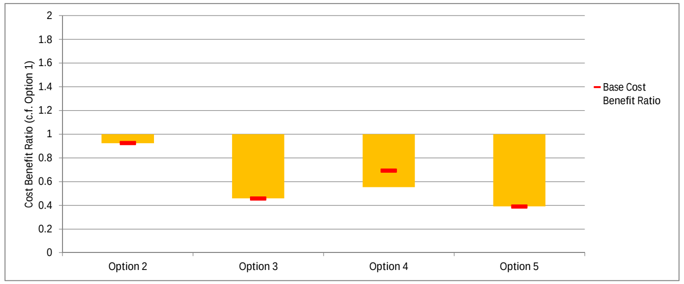




EAST PAKENHAM - SENSITIVITY ANALYSIS

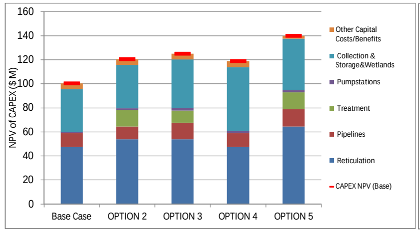
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

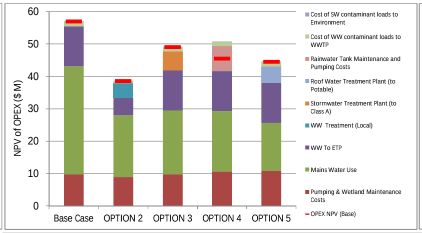
	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 4.1 M	$ 3.6 M
%change	0%	0%	0%	10%	0%
NPV	$ 157 M	$ 159 M	$ 174 M	$ 170 M	$ 184 M
%change	0%	0%	0%	3%	0%
BC Ratio *(c.f. 1)*		0.92	0.46	0.55	0.39

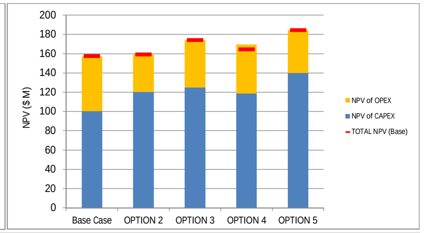


Comments on Sensitivity Test Scenario:

Scenario 5.4 - Raintanks Annual Maintenance High $ 30 / house $ 100 / house

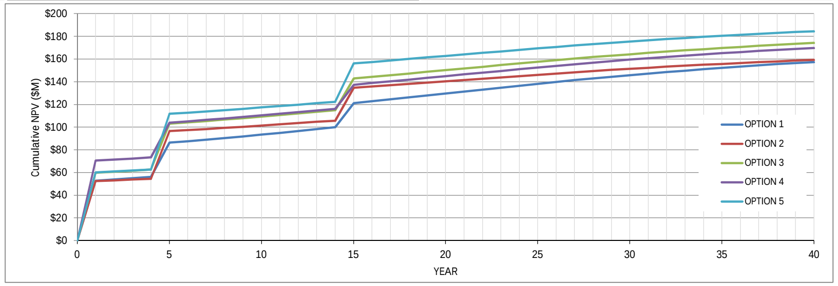


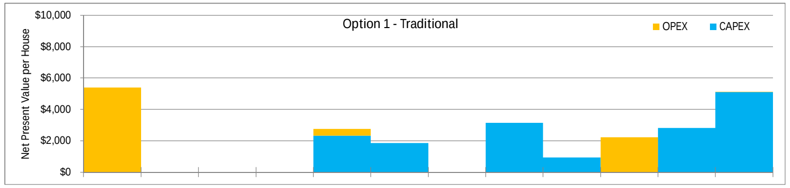


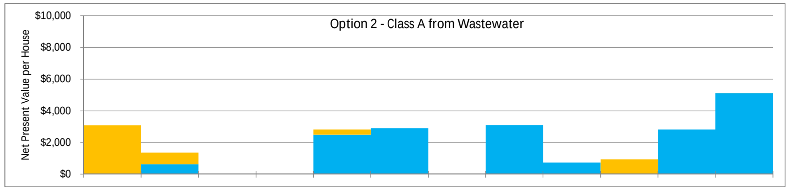


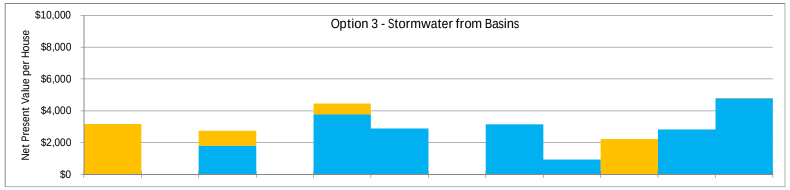
Short-listed Options

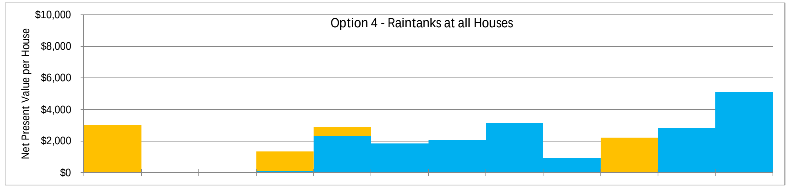
Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting

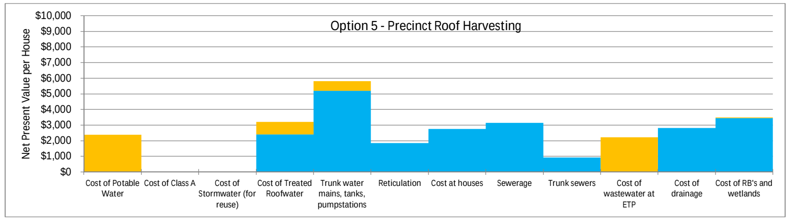












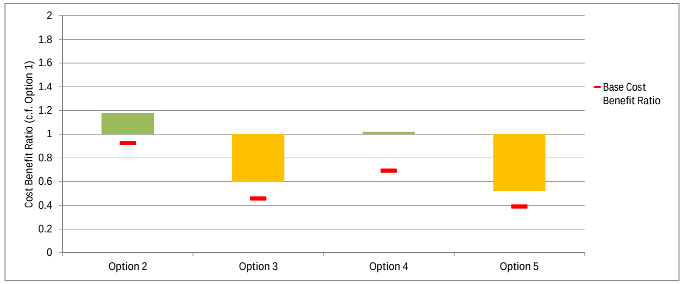
EAST PAKENHAM - SENSITIVITY ANALYSIS

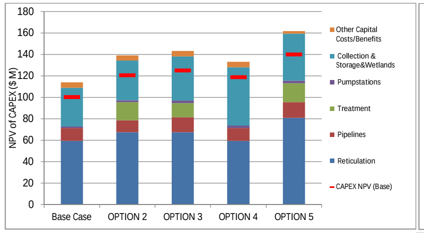
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	1.5%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

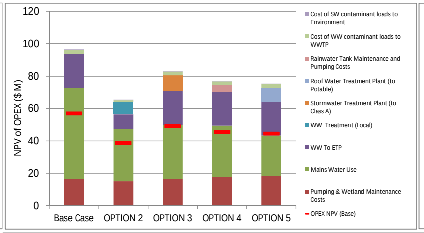
Comments on Sensitivity Test Scenario:

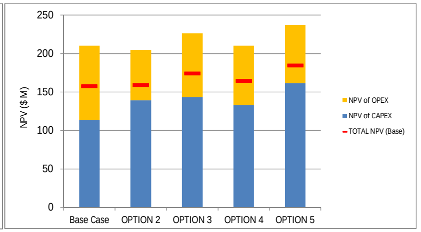
Scenario 6.1 - Discount Rate 1.5%

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 210 M	$ 205 M	$ 226 M	$ 210 M	$ 237 M
%change	25%	22%	23%	22%	22%
BC Ratio *(c.f. 1)*		1.18	0.60	1.02	0.52



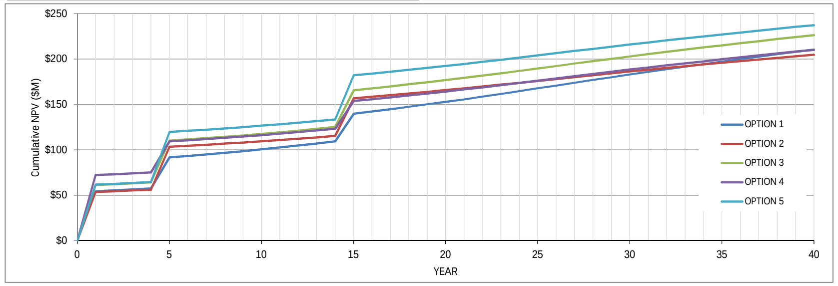


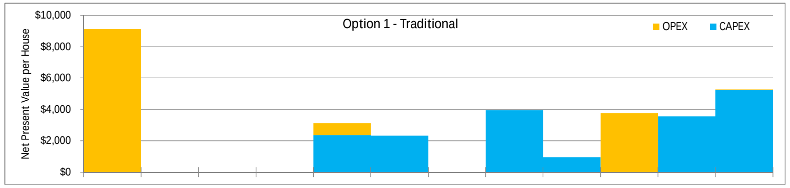


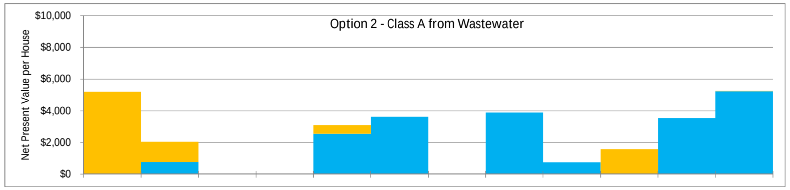


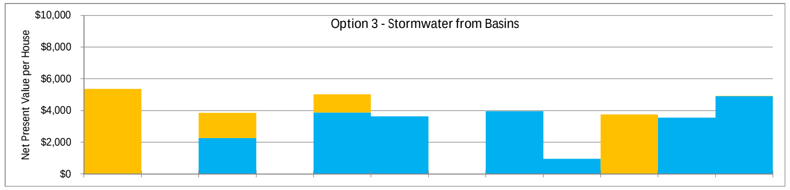
Short-listed Options

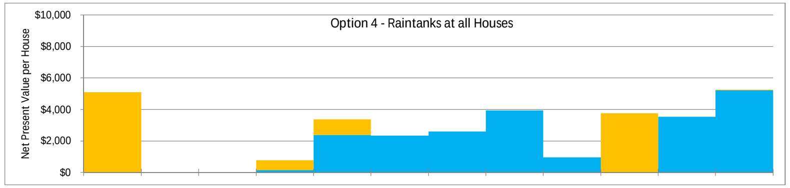
Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting

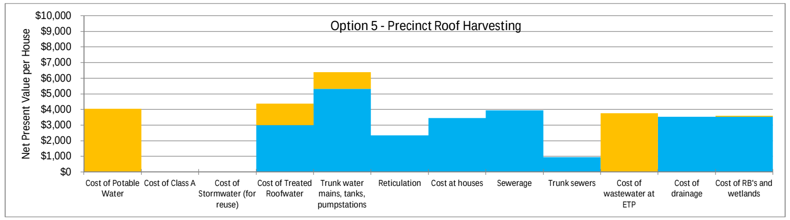












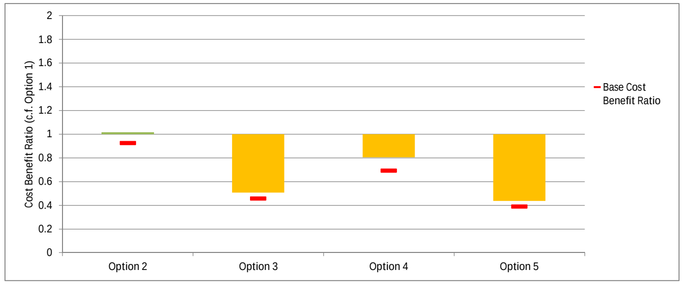
EAST PAKENHAM - SENSITIVITY ANALYSIS

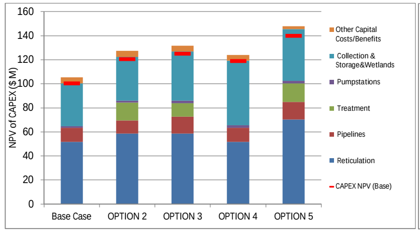
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	3.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

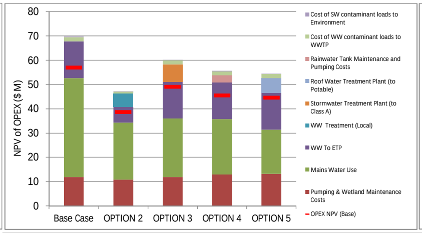
Comments on Sensitivity Test Scenario:

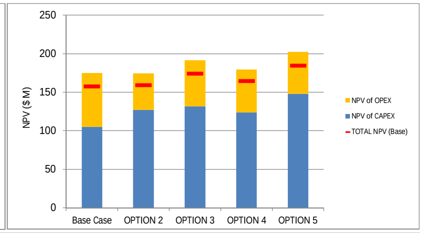
Scenario 6.2 - Discount Rate 3%

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 175 M	$ 175 M	$ 192 M	$ 180 M	$ 202 M
%change	10%	9%	9%	9%	9%
BC Ratio *(c.f. 1)*		1.01	0.51	0.81	0.44









Short-listed Options

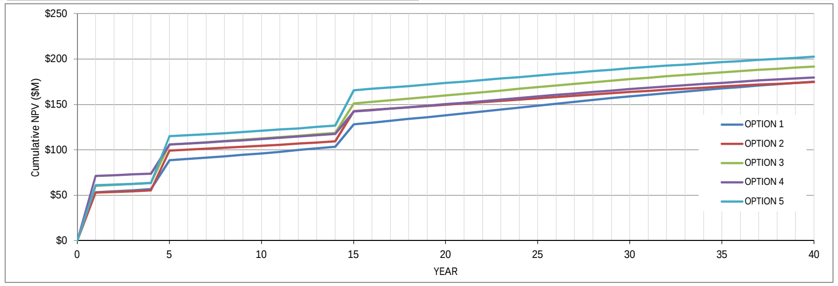
Option 1 - Base Case (Traditional)

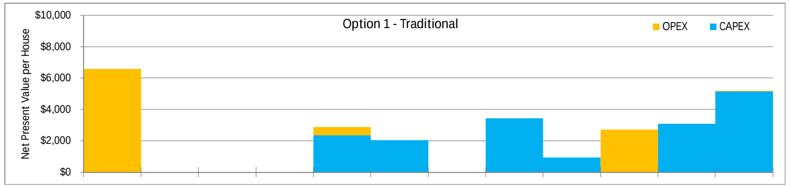
Option 2 - Class A from wastewater

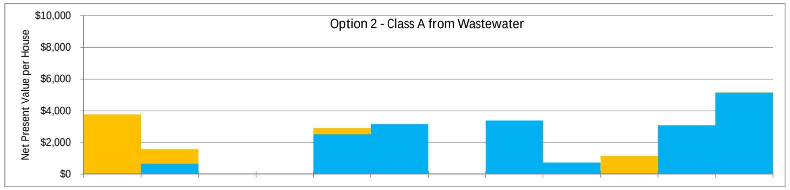
Option 3 - Stormwater from basins

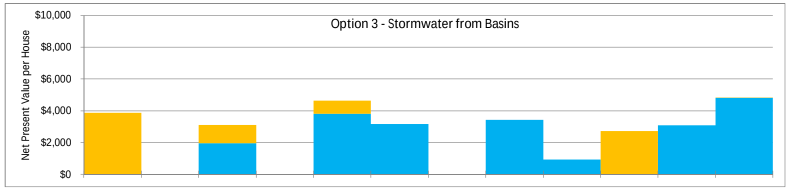
Option 4 - Rain tanks at all houses

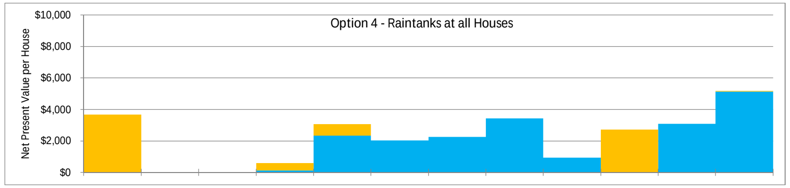
Option 5 - Precinct roof harvesting

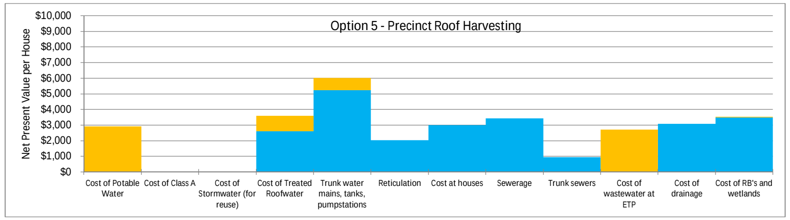












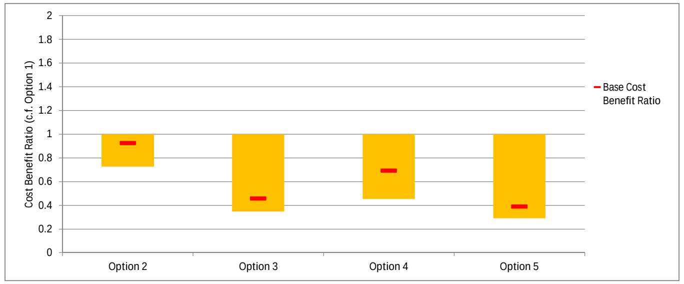
EAST PAKENHAM - SENSITIVITY ANALYSIS

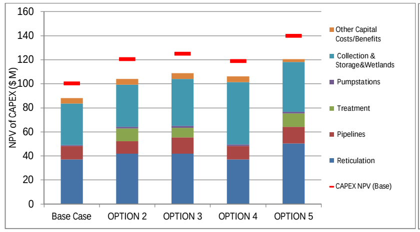
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	7.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

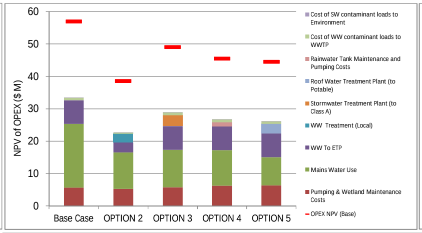
Comments on Sensitivity Test Scenario:

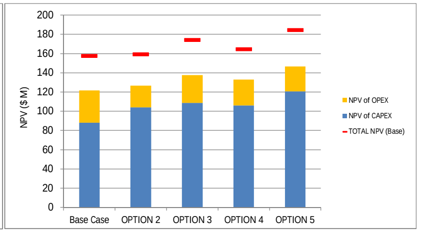
Scenario 6.3 - Discount Rate 7%

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 122 M	$ 127 M	$ 138 M	$ 133 M	$ 147 M
%change	-29%	-26%	-26%	-24%	-26%
BC Ratio *(c.f. 1)*		0.73	0.35	0.45	0.29









Short-listed Options

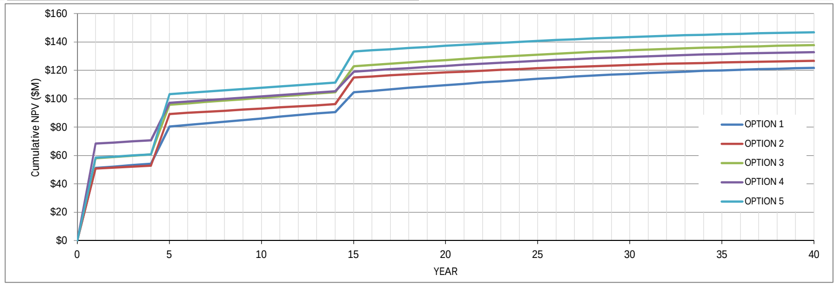
Option 1 - Base Case (Traditional)

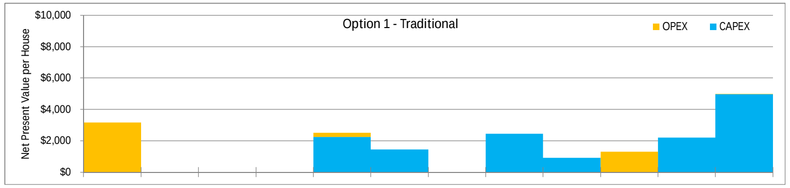
Option 2 - Class A from wastewater

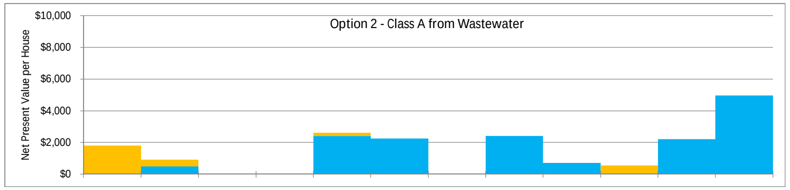
Option 3 - Stormwater from basins

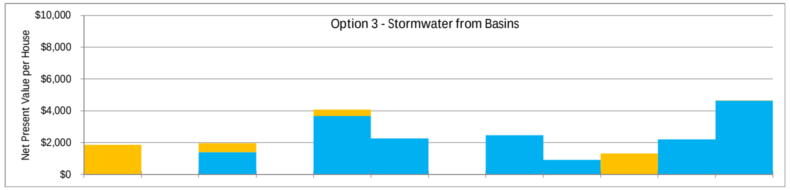
Option 4 - Rain tanks at all houses

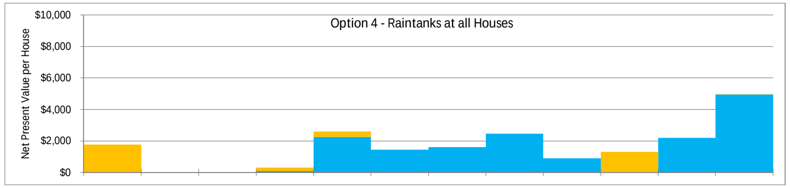
Option 5 - Precinct roof harvesting

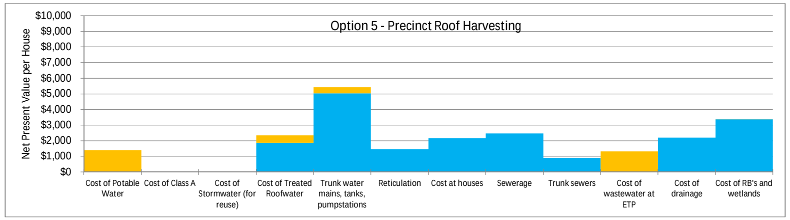












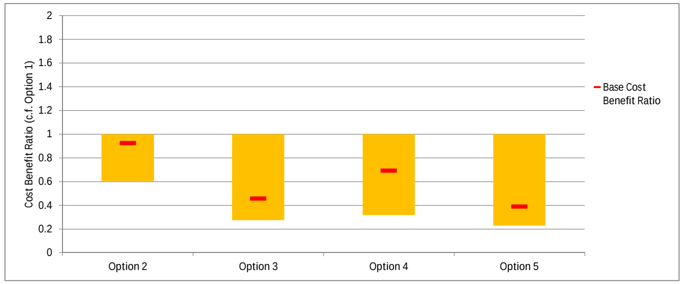
EAST PAKENHAM - SENSITIVITY ANALYSIS

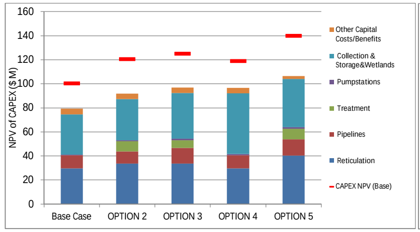
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	10.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

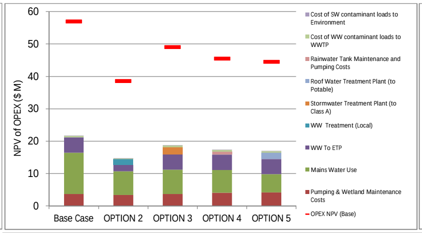
Comments on Sensitivity Test Scenario:

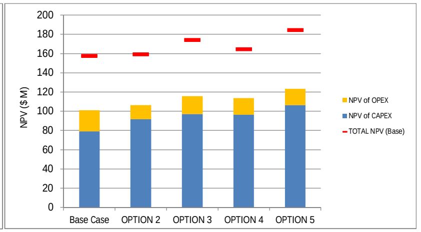
Scenario 6.4 - Discount Rate 10%

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 101 M	$ 107 M	$ 116 M	$ 114 M	$ 123 M
%change	-56%	-49%	-51%	-44%	-49%
BC Ratio *(c.f. 1)*		0.60	0.27	0.32	0.23









Short-listed Options

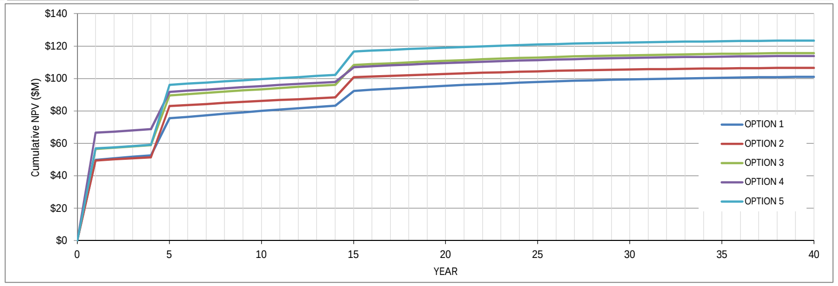
Option 1 - Base Case (Traditional)

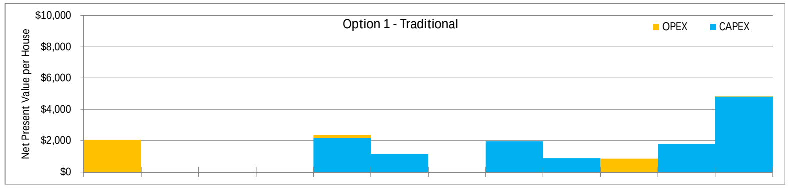
Option 2 - Class A from wastewater

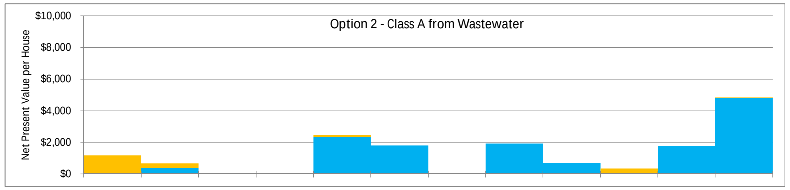
Option 3 - Stormwater from basins

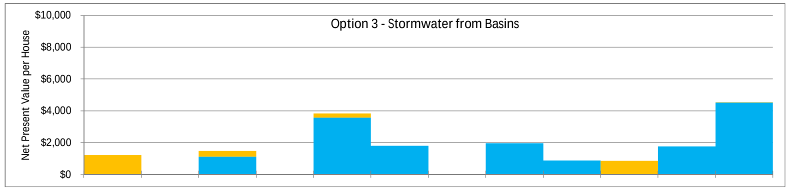
Option 4 - Rain tanks at all houses

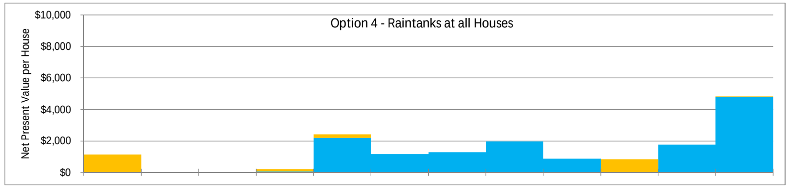
Option 5 - Precinct roof harvesting

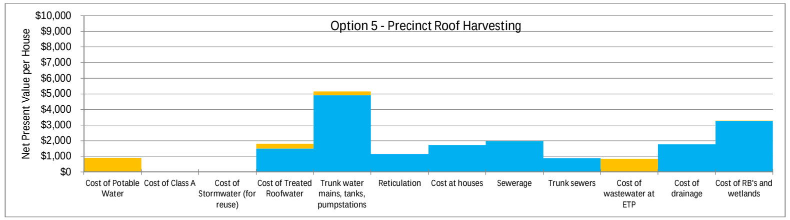












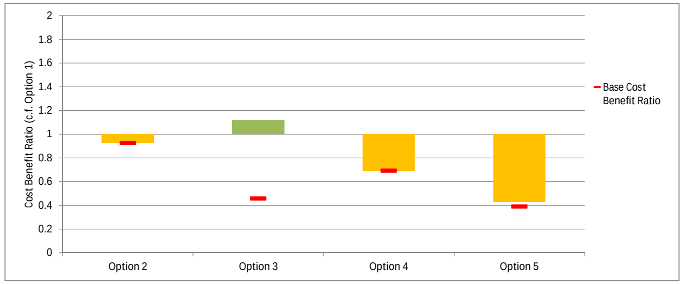
EAST PAKENHAM - SENSITIVITY ANALYSIS

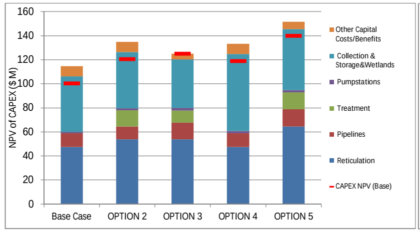
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	200%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	YES
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

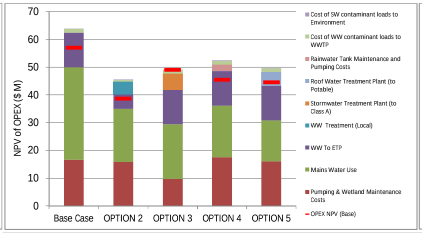
	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 140 M	$ 169 M	$ 158 M	$ 159 M	$ 191 M
%change	11%	9%	0%	9%	6%
OPEX	$ 5.2 M	$ 3.7 M	$ 4. M	$ 4.3 M	$ 4.1 M
%change	11%	15%	0%	13%	10%
NPV	$ 179 M	$ 180 M	$ 174 M	$ 186 M	$ 201 M
%change	12%	12%	0%	11%	8%
BC Ratio *(c.f. 1)*		0.92	1.12	0.69	0.43

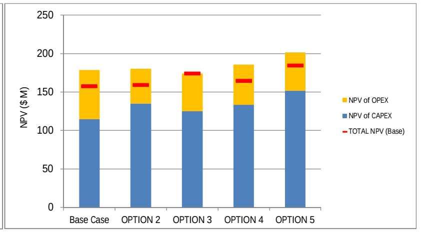
<u>Comments on Sensitivity Test Scenario:</u>

Scenario 6.4 - Discount Rate 10%









<u>Short-listed Options</u>

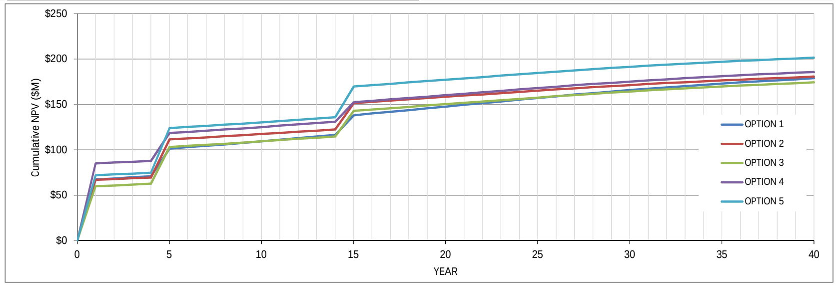
Option 1 - Base Case (Traditional)

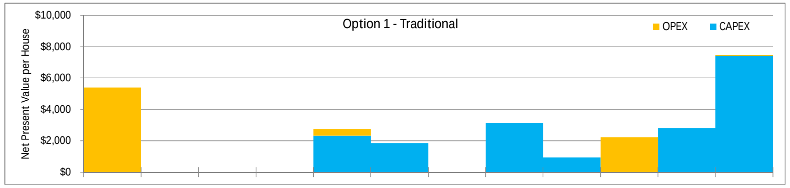
Option 2 - Class A from wastewater

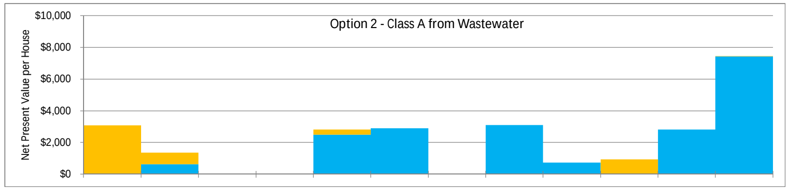
Option 3 - Stormwater from basins

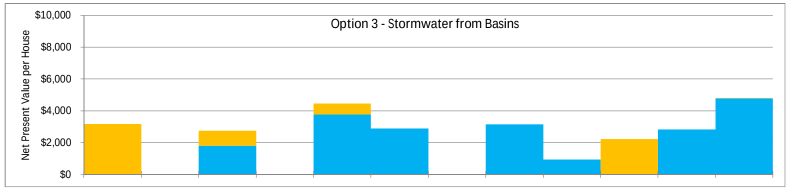
Option 4 - Rain tanks at all houses

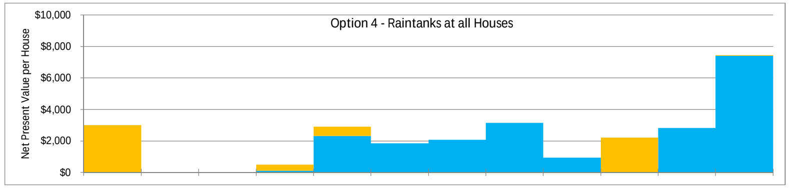
Option 5 - Precinct roof harvesting

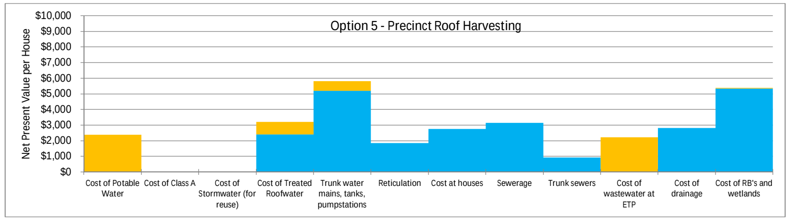












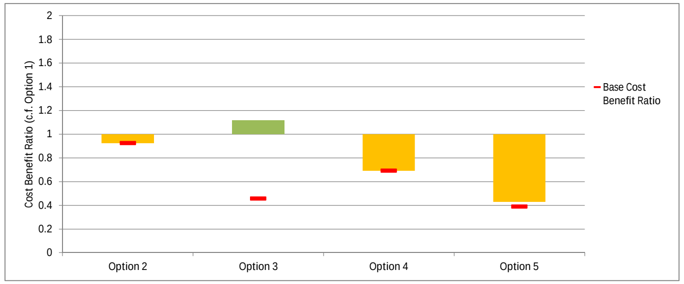
EAST PAKENHAM - SENSITIVITY ANALYSIS

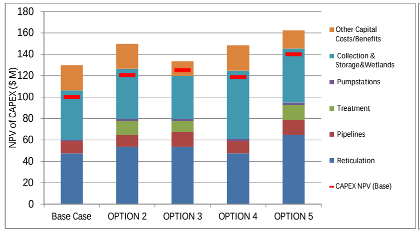
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	200%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 700 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	YES
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

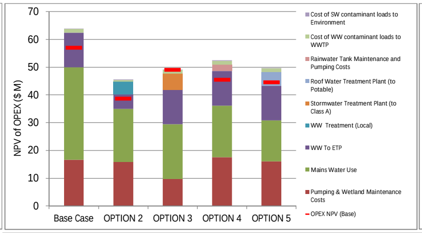
Comments on Sensitivity Test Scenario:

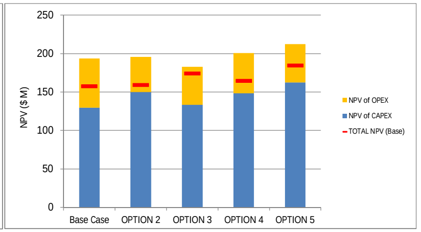
Scenario 7.2 - SEPP F8 Applies PLUS Land Max Cost

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 156 M	$ 185 M	$ 167 M	$ 175 M	$ 203 M
%change	20%	17%	5%	18%	12%
OPEX	$ 5.2 M	$ 3.7 M	$ 4. M	$ 4.3 M	$ 4.1 M
%change	11%	15%	0%	13%	10%
NPV	$ 194 M	$ 196 M	$ 183 M	$ 201 M	$ 212 M
%change	19%	19%	5%	18%	13%
BC Ratio *(c.f. 1)*		0.92	1.12	0.69	0.43



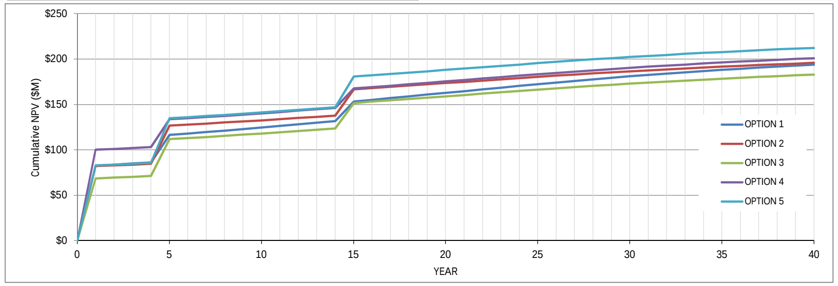


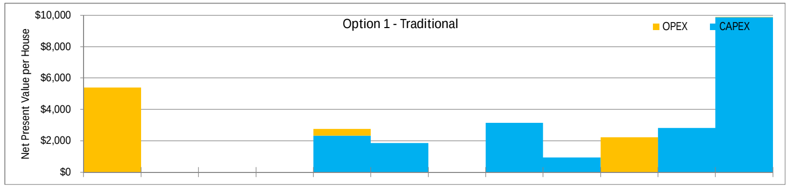


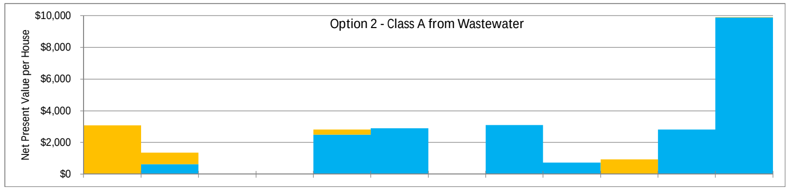


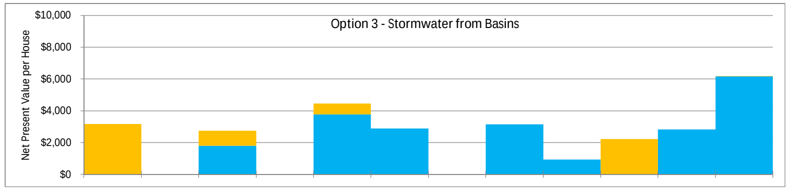
Short-listed Options

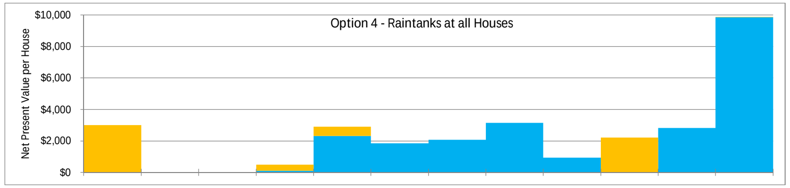
Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting

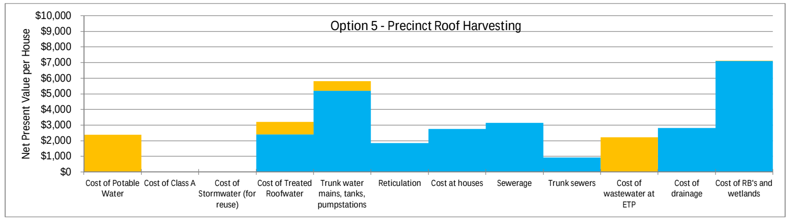








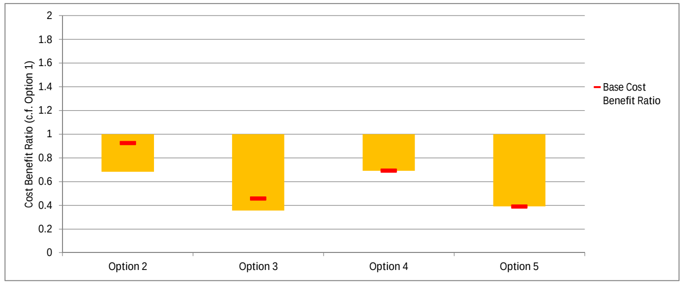




EAST PAKENHAM - SENSITIVITY ANALYSIS

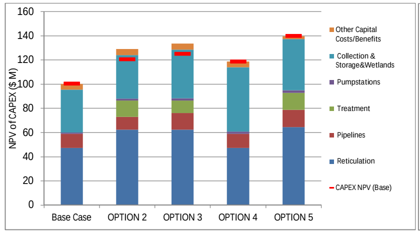
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 3 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

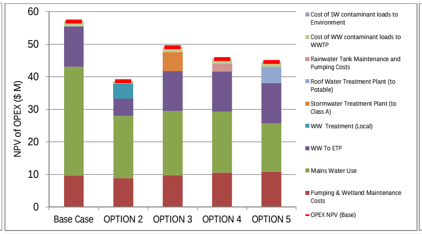
	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 167 M	$ 170 M	$ 144 M	$ 179 M
%change	0%	8%	7%	0%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 157 M	$ 168 M	$ 183 M	$ 164 M	$ 184 M
%change	0%	5%	5%	0%	0%
BC Ratio *(c.f. 1)*		0.68	0.36	0.69	0.39

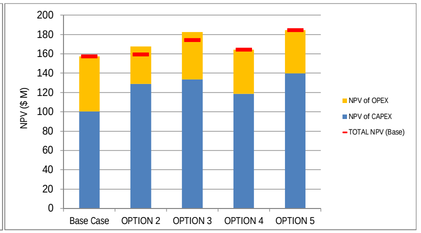


Comments on Sensitivity Test Scenario:

Scenario 8.1 Dual Pipe Cost High

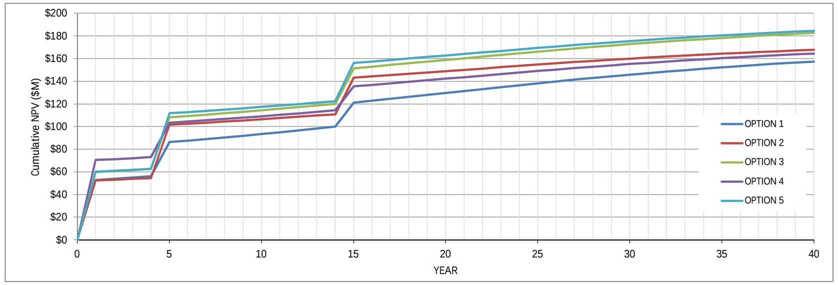


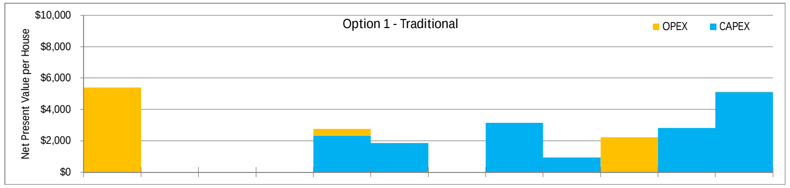


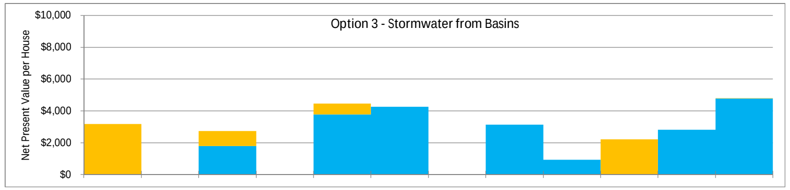


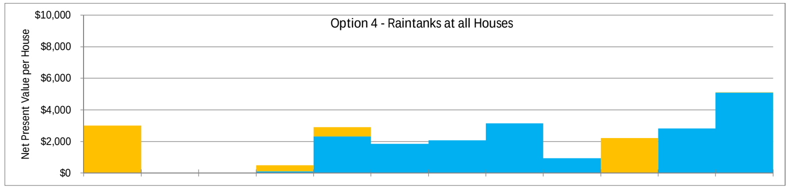
Short-listed Options

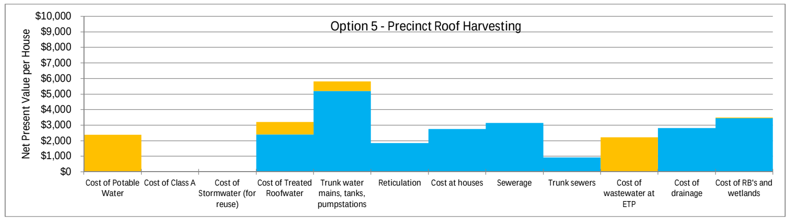
Option 1 - Base Case (Traditional)
Option 2 - Class A from wastewater
Option 3 - Stormwater from basins
Option 4 - Rain tanks at all houses
Option 5 - Precinct roof harvesting







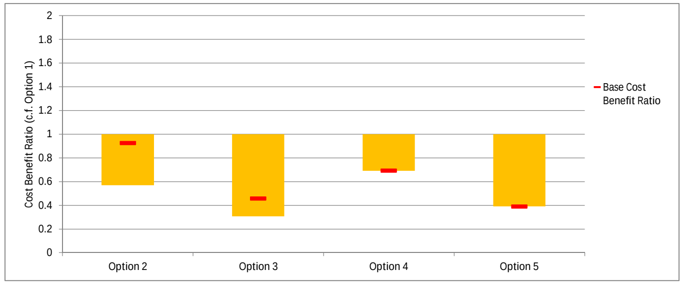




EAST PAKENHAM - SENSITIVITY ANALYSIS

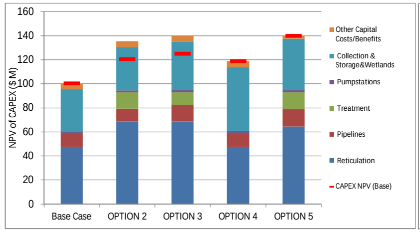
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 5 000 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

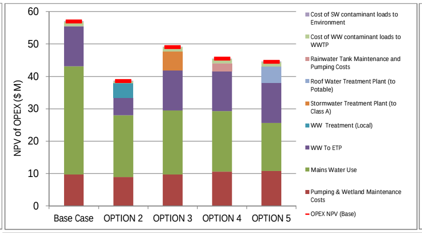
	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 176 M	$ 179 M	$ 144 M	$ 179 M
%change	0%	13%	12%	0%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 157 M	$ 174 M	$ 189 M	$ 164 M	$ 184 M
%change	0%	9%	8%	0%	0%
BC Ratio *(c.f. 1)*		0.57	0.31	0.69	0.39

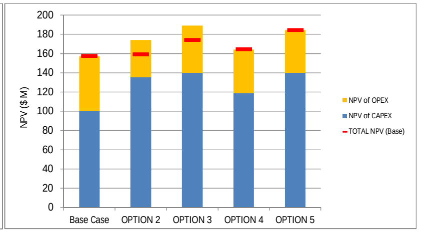


Comments on Sensitivity Test Scenario:

Scenario 8.2 Dual Pipe Cost Max







Short-listed Options

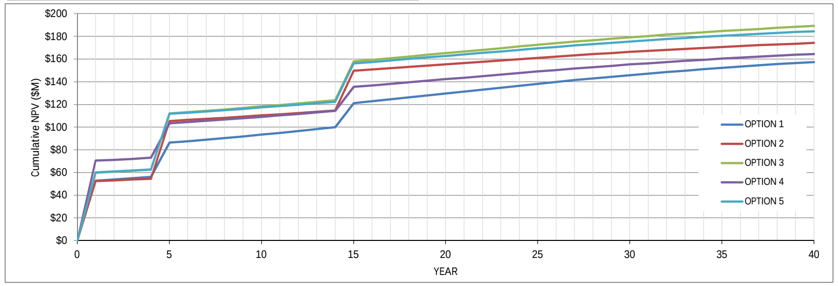
Option 1 - Base Case (Traditional)

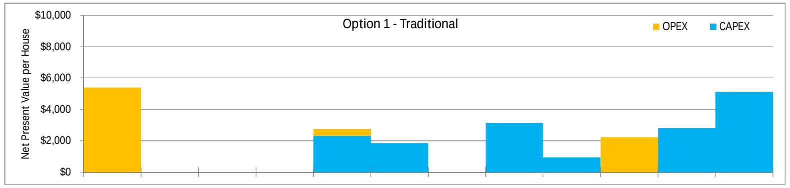
Option 2 - Class A from wastewater

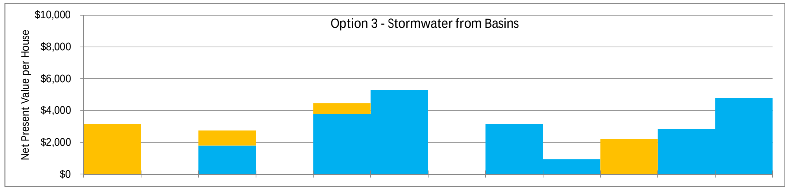
Option 3 - Stormwater from basins

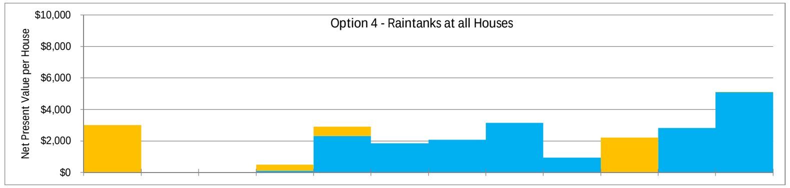
Option 4 - Rain tanks at all houses

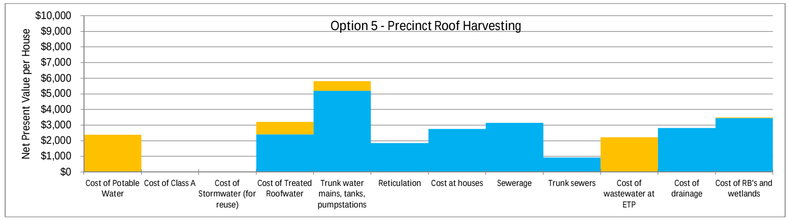
Option 5 - Precinct roof harvesting











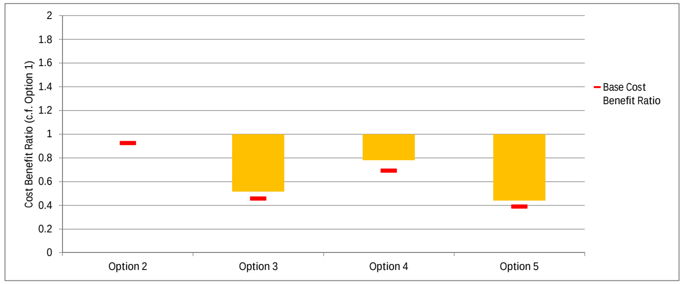
EAST PAKENHAM - SENSITIVITY ANALYSIS

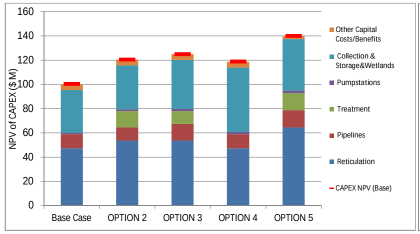
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 253 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

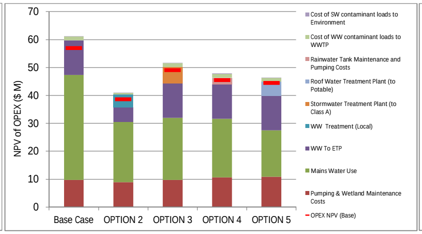
Comments on Sensitivity Test Scenario:

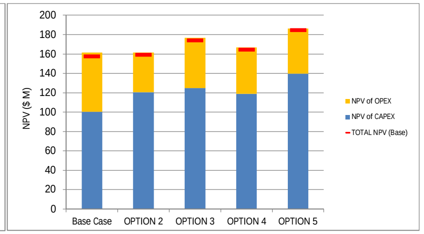
OPTION 2 BC Ratio = 1 (by varying cost of potable water only)

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 144 M	$ 179 M
%change	0%	0%	0%	0%	0%
OPEX	$ 5. M	$ 3.3 M	$ 4.2 M	$ 3.9 M	$ 3.8 M
%change	7%	6%	5%	5%	4%
NPV	$ 162 M	$ 162 M	$ 177 M	$ 167 M	$ 186 M
%change	3%	1%	1%	1%	1%
BC Ratio *(c.f. 1)*		1.00	0.52	0.78	0.44









Short-listed Options

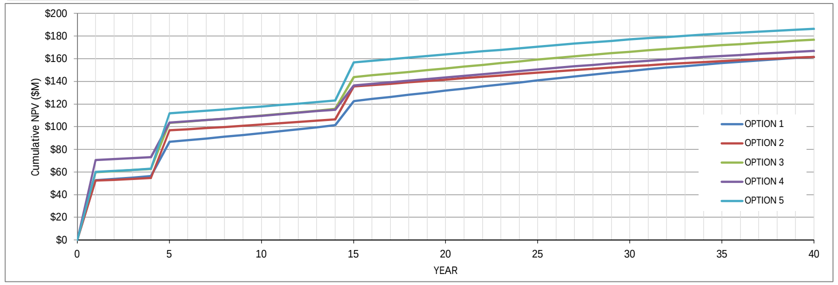
Option 1 - Base Case (Traditional)

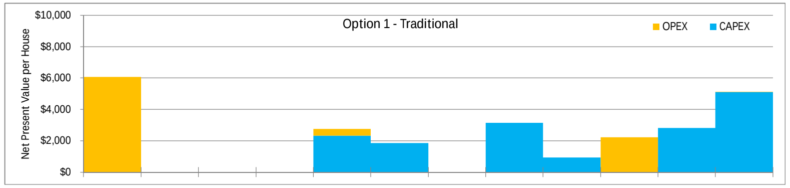
Option 2 - Class A from wastewater

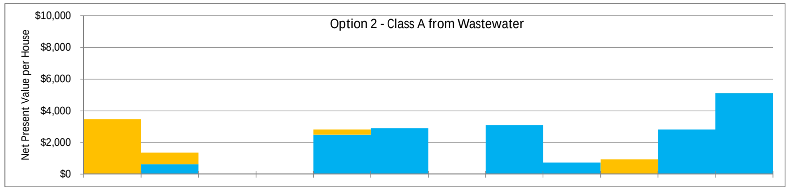
Option 3 - Stormwater from basins

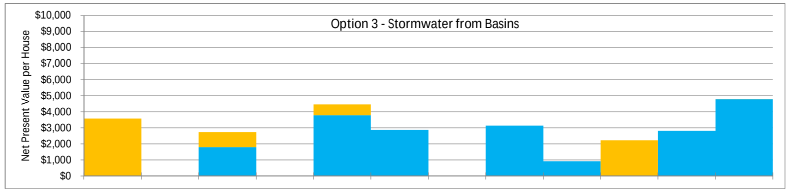
Option 4 - Rain tanks at all houses

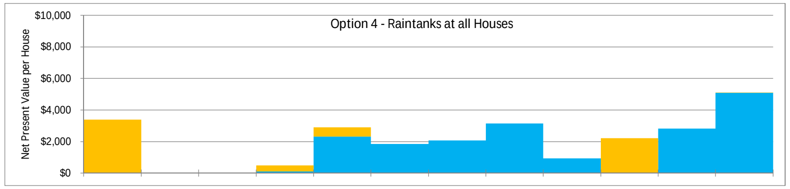
Option 5 - Precinct roof harvesting

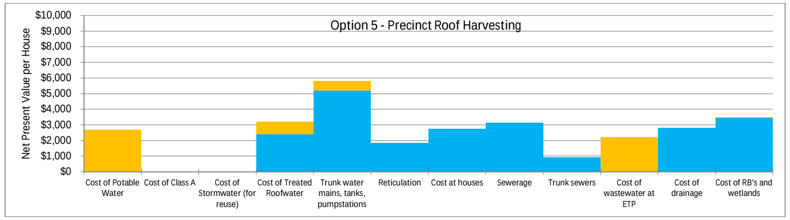












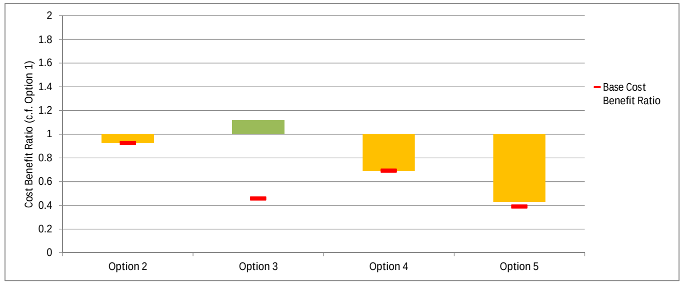
EAST PAKENHAM - SENSITIVITY ANALYSIS

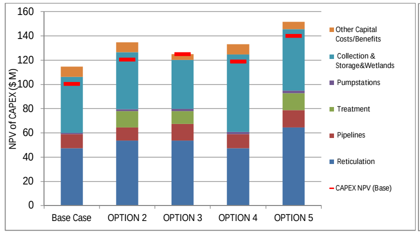
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	200%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 3 000 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	YES
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

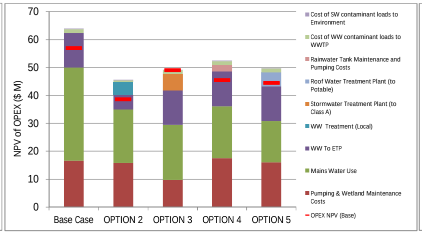
Comments on Sensitivity Test Scenario:

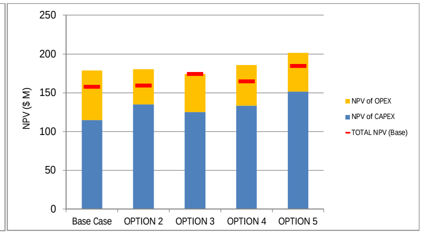
OPTION 3 BC Ratio > 1 (implementing SEPP F8)

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 140 M	$ 169 M	$ 158 M	$ 159 M	$ 191 M
%change	11%	9%	0%	9%	6%
OPEX	$ 5.2 M	$ 3.7 M	$ 4. M	$ 4.3 M	$ 4.1 M
%change	11%	15%	0%	13%	10%
NPV	$ 179 M	$ 180 M	$ 174 M	$ 186 M	$ 201 M
%change	12%	12%	0%	11%	8%
BC Ratio *(c.f. 1)*		0.92	1.12	0.69	0.43









Short-listed Options

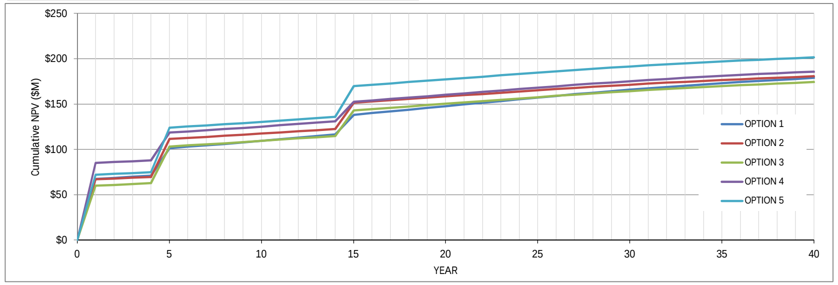
Option 1 - Base Case (Traditional)

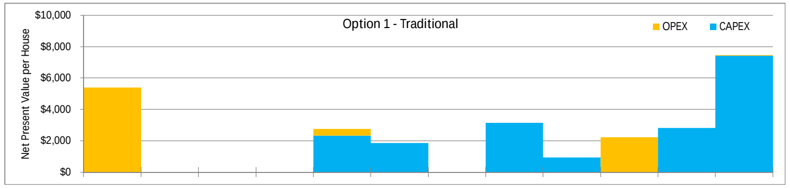
Option 2 - Class A from wastewater

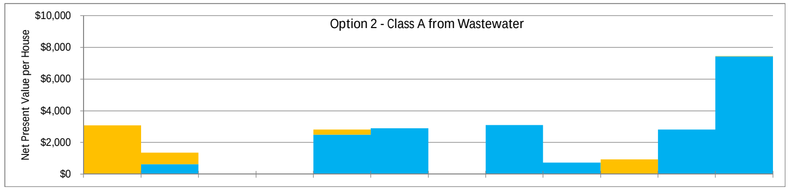
Option 3 - Stormwater from basins

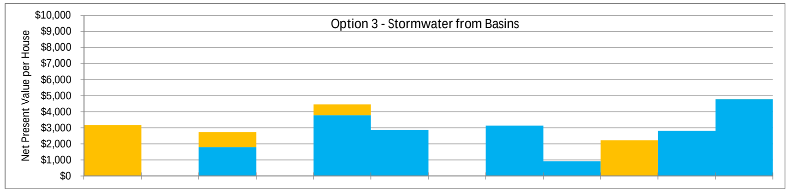
Option 4 - Rain tanks at all houses

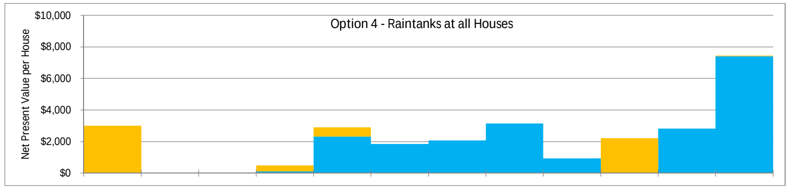
Option 5 - Precinct roof harvesting

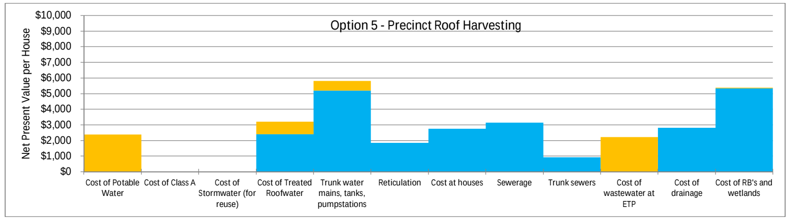












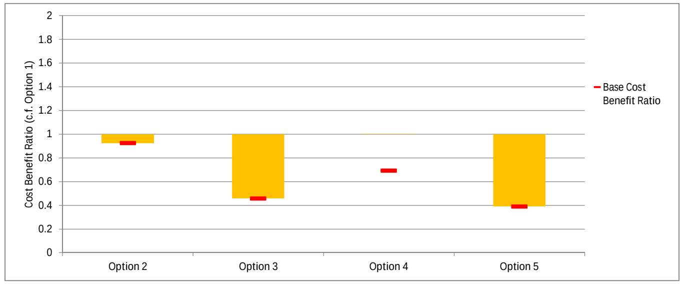
EAST PAKENHAM - SENSITIVITY ANALYSIS

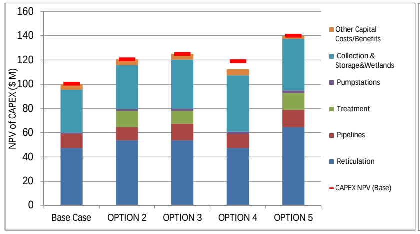
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 2 000 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	100%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 4 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 250 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 1 500 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 1 899 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

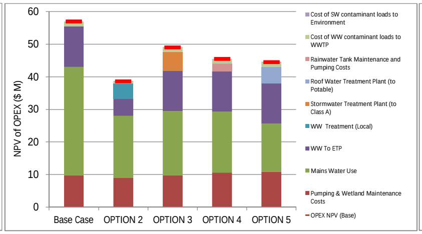
Comments on Sensitivity Test Scenario:

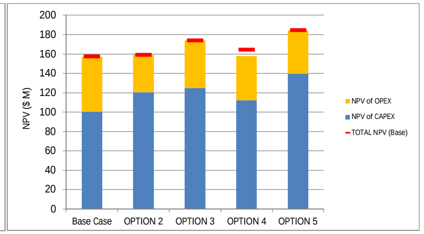
OPTION 4 BC Ratio = 1 (changing raintank cost)

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 125 M	$ 154 M	$ 158 M	$ 138 M	$ 179 M
%change	0%	0%	0%	-4%	0%
OPEX	$ 4.6 M	$ 3.1 M	$ 4. M	$ 3.7 M	$ 3.6 M
%change	0%	0%	0%	0%	0%
NPV	$ 157 M	$ 159 M	$ 174 M	$ 158 M	$ 184 M
%change	0%	0%	0%	-4%	0%
BC Ratio *(c.f. 1)*		0.92	0.46	1.00	0.39









Short-listed Options

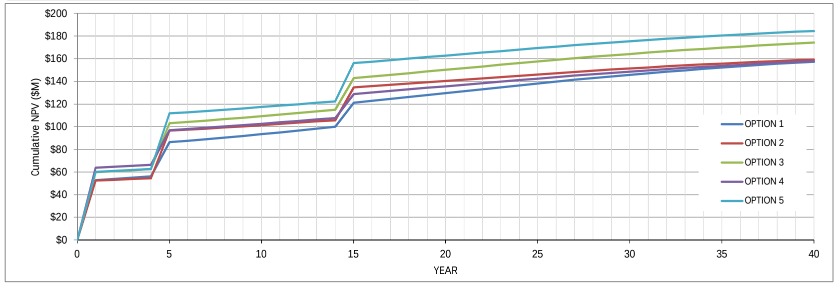
Option 1 - Base Case (Traditional)

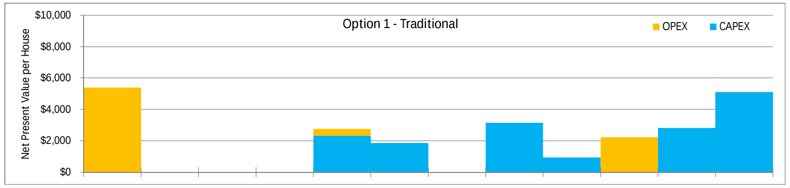
Option 2 - Class A from wastewater

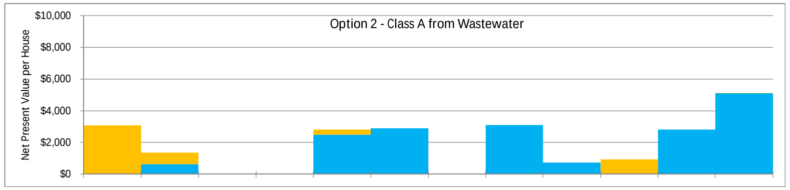
Option 3 - Stormwater from basins

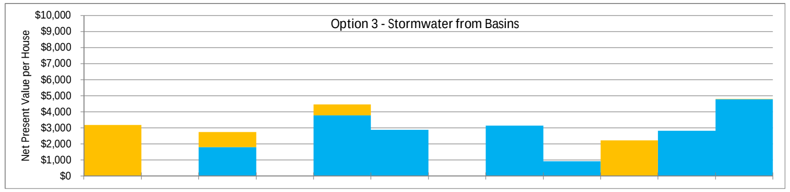
Option 4 - Rain tanks at all houses

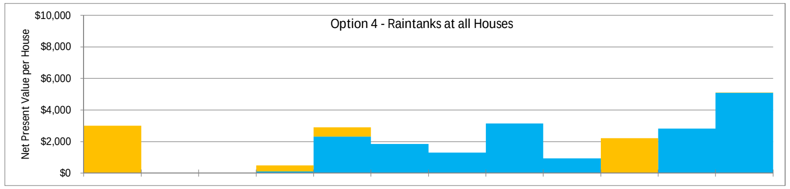
Option 5 - Precinct roof harvesting

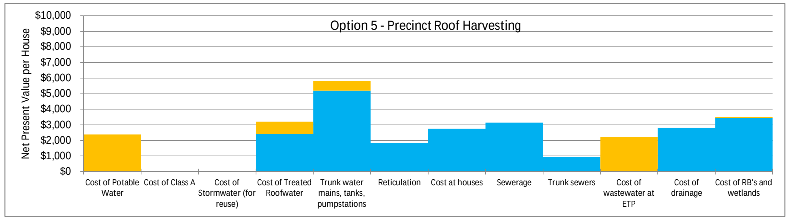












EAST PAKENHAM - SENSITIVITY ANALYSIS

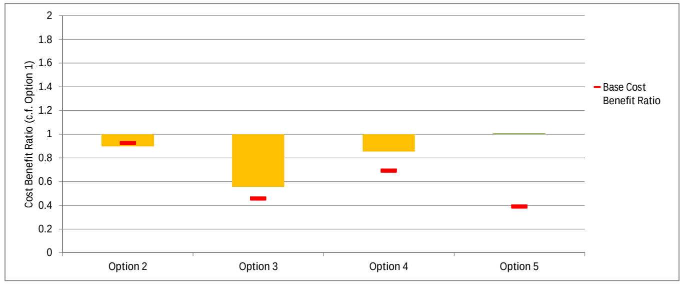
ELEMENT	BASE VALUE	TEST VALUE
Cost of supply of potable water	$ 2 000 /ML	$ 3 500 /ML
Cost of wastewater to ETP	$ 1 000 /ML	$ 1 000 /ML
Cost of potable supply infrastructure	100%	100%
Cost of wastewater infrastructure to ETP	100%	100%
Cost of treatment plants	100%	85%
Wetlands Size	100%	100%
Retarding Basin Size	100%	100%
Cost of Roof Harvesting Network	$ 4 000 /h	$ 1 000 /h
Land take/release cost (RB's/wetlands)	$ 250 k /ha	$ 700 k /ha
Cost of dual pipe (per house)	$ 1 500 /h	$ 5 000 /h
Cost of rainwater tanks (per house)	$ 3 000 /h	$ 4 500 /h
Timing of new Class A treatment at Pakenham WWTP	years 5, 15	years 5, 15
Opportunity to use MW storage to north of development	No	No
SEPP F8 Applies?	No	No
Discount rate	4%	4.0%
Externality cost of N (WW)	$ 600 /kg	$ 600 /kg
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

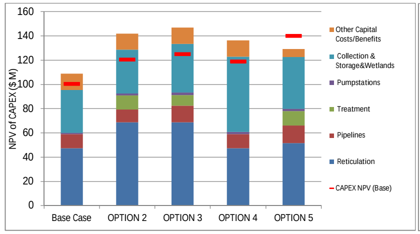
Comments on Sensitivity Test Scenario:

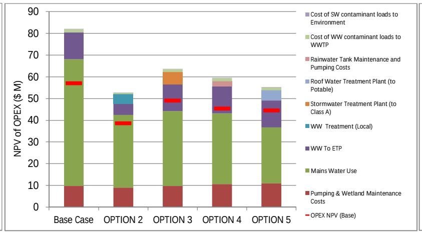
OPTION 5 BC Ratio = 1 - Requires multiple elements to be changed.

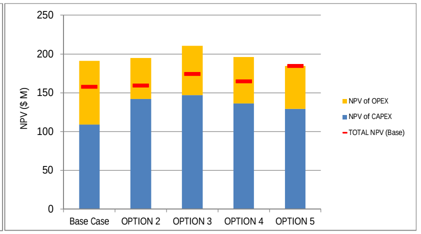
Elements changed highlighted above - for Option 5 to have the best outcome, dual pipe and rain tank costs needed to be changed, these only have a negative impact on Options 1 and 3 respectively, no impact on Option 5.

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 134 M	$ 182 M	$ 186 M	$ 163 M	$ 162 M
%change	7%	15%	15%	12%	-10%
OPEX	$ 6.7 M	$ 4.3 M	$ 5.2 M	$ 4.8 M	$ 4.5 M
%change	31%	27%	23%	23%	19%
NPV	$ 191 M	$ 195 M	$ 211 M	$ 196 M	$ 185 M
%change	18%	18%	17%	16%	0%
BC Ratio *(c.f. 1)*		0.90	0.56	0.85	1.01









Short-listed Options

Option 1 - Base Case (Traditional)

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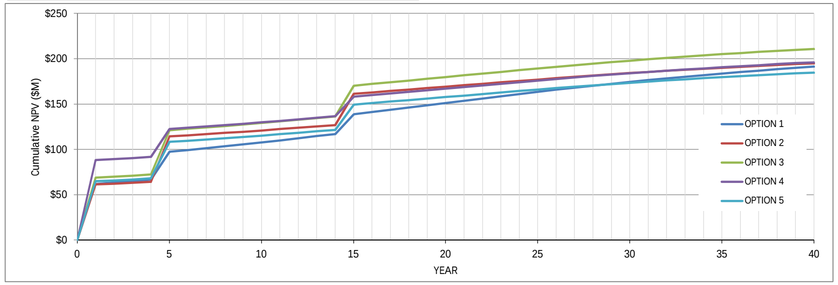
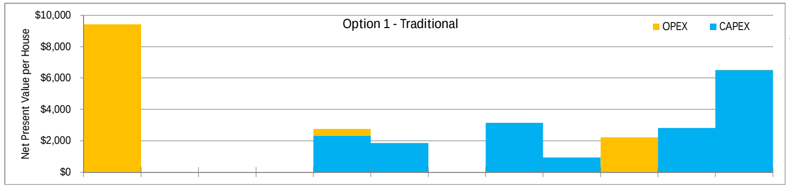
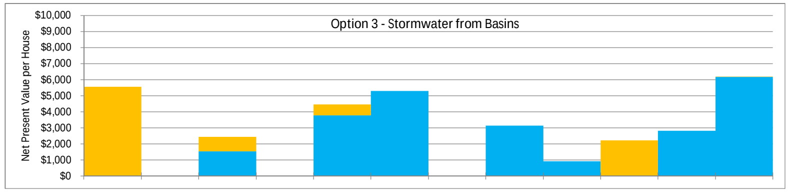
Option 3 - Stormwater from basins

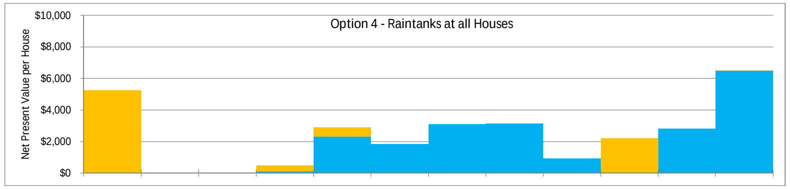
Option 4 - Rain tanks at all houses

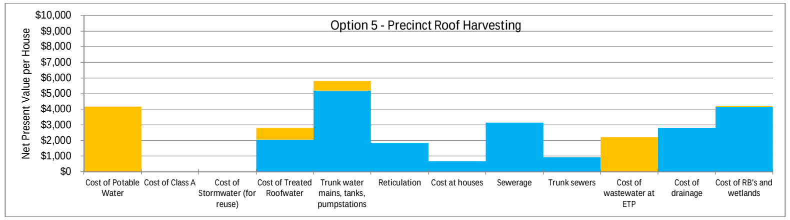
Option 5 - Precinct roof harvesting











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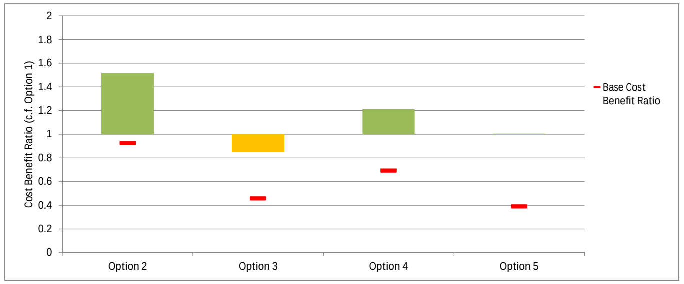
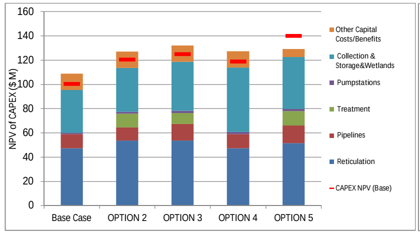
Externality cost of P (WW)	$ 10 /kg	$ 10 /kg

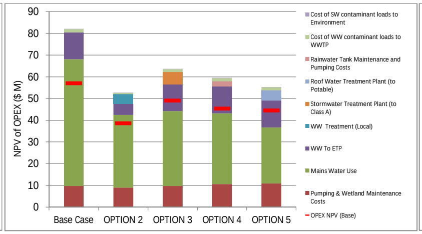
Comments on Sensitivity Test Scenario:
OPTION 5 BC Ratio = 1 - Requires multiple elements to be changed.

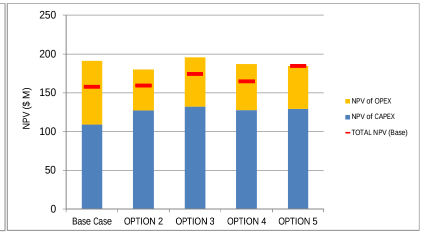
Elements changed highlighted above - in this scenario Option 5 has a BC ratio of 1 but is not the best option, with both Options 2 and 4 offering greater benefits relative to costs.

	Option 1	Option 2	Option 3	Option 4	Option 5
CAPEX	$ 134 M	$ 160 M	$ 164 M	$ 153 M	$ 162 M
%change	7%	4%	4%	6%	-10%
OPEX	$ 6.7 M	$ 4.3 M	$ 5.2 M	$ 4.8 M	$ 4.5 M
%change	31%	27%	23%	23%	19%
NPV	$ 191 M	$ 180 M	$ 196 M	$ 187 M	$ 185 M
%change	18%	12%	11%	12%	0%
BC Ratio *(c.f. 1)*		1.52	0.85	1.21	1.01









Short-listed Options
Option 1 - Base Case (Traditional)
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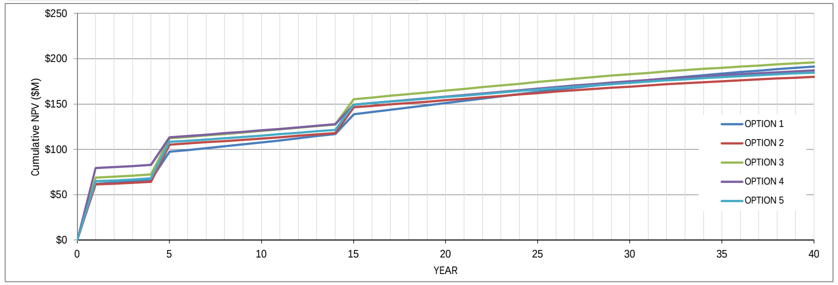
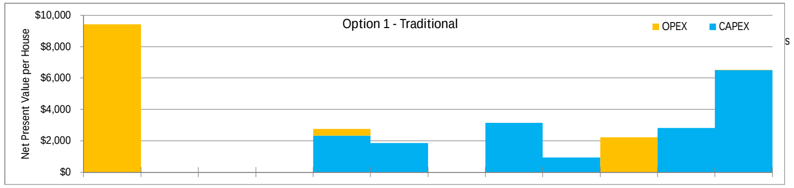
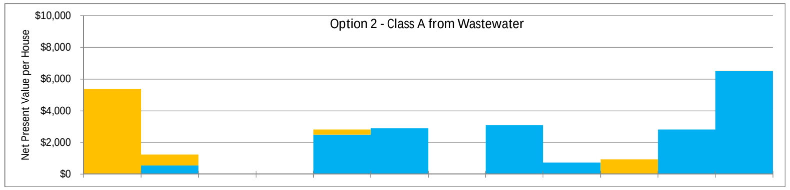
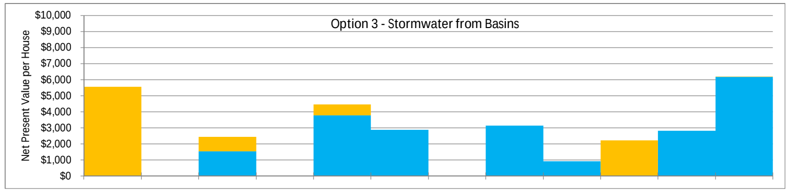
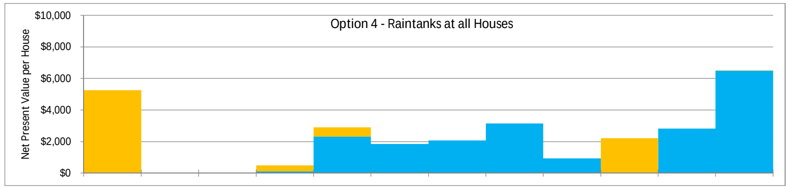
Option 5 - Precinct roof harvesting

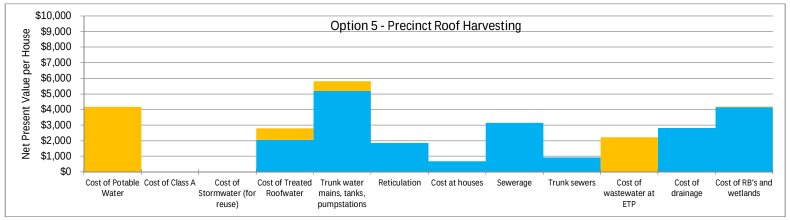












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