Rehabilitation of Stony Creek: Valuation of the benefits of rehabilitation

Concretised Stretch of Stony Creek

Semi-natural upstream stretch of Stony Creek with landscaped banks

Gilmore Retarding Basin

Possible conversion of Gilmour Retarding Basin into natural wetland or high quality open space with local vegetation

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Table of Contents

List of Figures

List of Tables

Executive Summary

Background and Research Objectives

The case study for this research is a 1.23 km stretch of Stony creek in the Sunshine North precinct of Brimbank City Council located in the western plains of the Melbourne region. This stretch of the creek was concretised in the 1980s as an engineering solution to prevent flooding in the area. It is unsightly, barren, concentrates pollutants in stormwater and retains heat in the area. In this context, City West Water (CWW) proposes rehabilitation of this particular stretch of Stony Creek to its natural state and create passive recreation amenity for residents in the Gilmore retarding basin (approx. 4 ha area adjacent to this stretch) at an estimated project cost of $6 to 10 M. This project aims to integrate water and vegetation into the surrounding landscape, deliver cooling benefits for the precinct and improve community connectivity, health and well-being.

The aim of this research is to assess the social returns from investment in Stony Creek rehabilitation that will help City West Water build a business case to secure funding for the project implementation. The objectives of the study are to:

1. Identify the key socio-economic factors of residents within the catchment of the project area to understand the project impact on them.
2. Evaluate the adequacy of green space and the existence of heat stress within the project catchment.
3. Quantify the social returns that can be achieved through the project.

Research Design

An initial workshop with CWW identified the key values that they want to achieve through the project. Geographical Information Systems maps were used to delineate the case study area and the statistical areas that are within 500 m and 1 km radius of the project area. Then socio-economic data was collected from ABS (2011) to build a profile of the area and catchment analysis data was sourced from the council to estimate quality and access to green spaces in the area. Next, the social benefits likely to accrue to the community once the project is completed were calculated using value projections and benefit transfer techniques from previous studies.

Findings

1. Statistical data (ABS 2011) shows that residents within 1km radius of the project area have high levels of - physical inactivity (44.2%); type 2 diabetes (4%); cholesterol (5.7%); over weight (32% Males, 21% female); obesity (16.7% Males, 17.8% female); self-rated poor health status (19.7%); unemployment (12.38%) and low income households (29%), vulnerable population to heat waves (5% in age group of 0-4 yr and 18% are 65yr and above). Research shows that high quality green spaces have a positive impact on all these factors directly and indirectly (Zhou & Rana. 2012).

2. A catchment analysis (EDAW and Sykes 2008) using a 500 metres radius, which considers physical barriers such as major roads and waterways, conducted to measure the adequacy in the provision of open spaces in the Brimbank City Council shows that the project area is one of the most poorly serviced areas in the municipality in terms of quality open spaces.

3. The projections of the cultural (recreational benefits, avoided health costs and increased property values) and regulating (reduction in heat island effect and carbon sequestration) ecosystem services were quantified, generating sufficient financial returns to account for annual maintenance costs and sufficient public and private returns to justify the capital costs. Estimates of the value of carbon sequestered and local thermal comfort benefits were made from secondary data and literature.

Summary of the benefits quantified from Stony Creek rehabilitation

Nature of the benefits	**Assumption**	**Value**
Economic value to community*	value per visit = $2.50* 13% increase in residents visiting green spaces	the marginal annual increase in value generated varies from $37,960 to $189,800**
Economic value to community*	Value per visit = $2.50 37% residents visit the project park more than once a week	the marginal annual increase in value generated varies from $107,936 to $431,746***
Avoided health costs	10% increase in physically active residents	within 500m = $ 43,711 per year within 1km = $75,049 per year
Increased property value	At 1% and 8% increase over current median house price within 500 m radius of project park	$2.3M at 1% increase in value $18.2M at 8% increase in value
Impact on Heat Island Effect	4000 trees planted and storm water retained in retarding basin	The project area with tree plantations and a rehabilitated creek with no concrete lining will increase thermal comfort for visitors especially on hot summer days
carbon sequestration benefits	4000 trees planted	Carbon sequestered per year is 22.1 t which is 81 t of carbon dioxide equivalents

*This could be an active or passive value derived by a person (above 18 years) by visiting the park including - recreation, socialising, walking, jogging, watching nature/being in nature, relaxing / de-stressing.

**The Net Present Value (NPV) of the marginal increase in value due to the project (assuming annual maintenance costs of $10,000, project life of 50 years and Social Discount Rate of 3.5%) ranges from $0.65M to $4.2 M.

***The Net Present Value (NPV) of the marginal increase in value due to the project (assuming annual maintenance costs of $10,000, project life of 50 years and Social Discount Rate of 3.5%) ranges from $2.2 M to $9.8 M.

Conclusions

The results of this analysis suggest that under a set of assumptions, rehabilitating / revegetating this stretch of Stony Creek should be implemented. There is a strong need for high quality green space in the project locality and the marginal benefits of the project exceed the annual maintenance costs of the project area. While the project creates sufficient potential for the capital costs of $6-10 M to be recovered through health benefits from increased physical activity and private benefits from increase in property values, a number of socio-economic and market factors may influence these returns. A post project evaluation together with a longitudinal study will help understand how the different values change over the years. Also, while the benefits from different values should be calculated, they may not necessarily be added up due to the risk of double counting values. Therefore, the key values which the project intends to achieve for its stakeholders may be considered to assess the economic viability of the project.

Background

In 2014, City West Water's head office will move from its current St Albans Road site to Footscray. City West Water (CWW) is currently preparing the St Albans Road site for sale. The site is 13 hectares in size and has a 700 metre long frontage to Stony Creek, which is lined by concrete and largely free of vegetation. Melbourne Water (MW) is working with CWW regarding the future of Stony Creek stretch adjoining the CWW office site, as it relates to the sale. The frontage adjoins the Gilmour Road flood retarding basin downstream owned by MW, which includes an extension of the concrete-lined channel of Stony Creek.

Melbourne Water has explored the feasibility of converting a stretch of the current concrete-lined channel of Stony Creek (approximately 1.23 km in length) to a more natural waterway including walking paths, trees and vegetation. As part of this feasibility study, consideration has been given to any impact on flood levels that would affect the Gilmour Road retarding basin, which is expected to be converted to a more natural wetland as part of the project. This project is a first for Melbourne Water where there is enough space for a concrete channel to be naturalised and still meet its drainage function. The sale of the CWW property has provided the catalyst to explore how the rehabilitation of Stony Creek and adjoining retarding basin could align with the Greening the West principles of contributing to a healthier urban habitat.

Greening the West is an initiative that aims to deliver positive health and social outcomes and enhanced liveability for communities in the Western suburbs of Melbourne (Greening the West. 2013). An immediate focus of Greening the West is to educate both stakeholders and the public on the social returns from investments in urban green infrastructure which will then pave the way for the investments required to reach the targets set out by the initiative and ensure that any measures taken are appropriate to the challenges posed by the natural environment of the West.

The current study is undertaken by the author who is based at the Victoria Institute of Strategic Economic Studies (VISES), Victoria University. The research is funded by the Commonwealth Collaborative Research Network and CSIRO, with in-kind support from Greening the West (2013). The CRN research scoping workshop was conducted by CSES with CWW on 21 Sept 2012. The main objectives of the workshop were:

- to present the research interests / ideas of CRN team to City West Water;
- understand the work/research of CWW;
- identify the key values that CWW would like to achieve through Greening the West projects
- identify areas of research of common interest; and
- identify areas of collaboration and data sharing.

Following the workshop, the Stony Creek rehabilitation project was selected as a case study for further research. In collaboration with CWW, it was decided to quantify the potential health and other benefits of rehabilitating Stony Creek, including the removal of concrete lining the creek. This report presents a detailed socio-economic profile of the community that will be directly affected or will benefit from the project and quantifies the various benefits from the project.

Research Aim and Objectives

Dollar values are increasingly being attributed to the environmental benefits provided by rivers, creeks and green spaces in urban areas. While some researchers argue that such practices may lead to commodification of environmental assets, and their eventual degradation, others argue that in a market-driven economy, it is essential to quantify the benefits from green spaces to build business cases to preserve and invest in them. In the current study, the aim of the research is to assess the social returns from investment in Stony Creek rehabilitation that will help City West Water to build a business case to secure funding for the project implementation. The objectives of the study are to:

- Identify the key socio-economic factors of residents within the catchment of the project area to understand the project impact on them.
- Evaluate the adequacy of green space and the existence of heat stress within the project catchment.
- Quantify the social returns that can be achieved through the project.

Methodology

An understanding of the values that the stakeholders cherish and aim to achieve is a prerequisite to the design of improved natural resource management (MacDonald 2013). A series of benefits and values associated with rehabilitation of the creek area were initially identified in collaboration with CWW officials through a scoping workshop. This was further guided by an extensive literature review of similar projects in Australia and other countries. A consultation forum with 27 participants from general community, friends groups, local government and businesses in the area helped to further confirm the key values to community from green spaces as identified by CWW and previous studies.

Initially, the case study area was established through discussion with CWW and then Geographical Information Systems (GIS) maps were used to identify the statistical areas that are within 500 m and 1 km radius of the project area (see Figure 1). Research shows that the percentage of green space inside a one kilometre radius had a significant relation to perceived general health of people (Maas et al 2006) and a positive impact on property values in the area (Mahmoudi et al 2013).

Data was collected from Australian Bureau of Statistics (2011)1 to build a socio-economic profile of the population within one kilometre radius of the project area, who are most likely to be influenced by the project. The data collected includes – population, number of households, age groups, education level, religion, access to internet, main mode of transportation used, number of cars owned per household, number couples with children, number of single parents with children, number of residents not fluent in English, number of residents born overseas, percentage of unemployment, percentage disabled, health statistics related percentage of people suffering from type two diabetes, percentage of residents who visit a green space at least once per week, percentage of residents classified as physically inactive, number and area of green spaces with public access and its quality.

[1] Compiled and presented in atlas.id by id, the population experts.

Next, the adequacy in the provision of open spaces, i.e., open green spaces and playgrounds, in the project area was measured using a catchment analysis of 500 metres radius. Brimbank City council aims to provide access to a green space and playground within 500 m radius of any given house in the council area.

Then the social returns from the investments were calculated in terms of – potential increase in property values that are within 500 m of the project area, savings from the avoided health costs of physical inactivity considering an increase on physical activity levels due to the project, general value derived from visit to the rehabilitated creek and the existence value of the high quality creek area for the community to enjoy and recreate. Approximate estimates of carbon sequestration value and impact on the local temperatures were made from secondary data and literature review.

Results

The Socio-economic profile of the residents who will be most influenced by this project; Catchment analysis of the project area to determine the adequacy of green spaces and; Social returns from the project investment to the community are presented in detail in this section.

Socio-economic profile of the case study area

It is important to understand the demography of the residents and their social and cultural characteristics, as they will be the ones most influenced by this project and are likely to be its main users. The concretised stretch of Stony Creek proposed for rehabilitation is 1.23 km in length. The Gilmore retarding basin adjoining this stretch (the triangular piece of land flanked by the creek on one side, and Gilmour road on the other side) is approximately 4 ha in area (see Figure 1). Within 500 meters (referred to as zone 1 in the report) of this space lies statistical divisions coded (SA1) 2133716, 2133718 and 2133724. The statistical divisions coded (SA1) 2133717, 2133719 and 2133720 are within 1 km of the project area (referred to as zone 2 in the report). For convenience, each of the statistical areas has been given a name based on the main street or landmark of the area.

Figure 1: Case study area

Source: ABS. 2011

Population influenced by the project

Within 1 km catchment of the project area, 2837 residents live in 973 households (see Table 1). Approximately 20% of the population are under 18 years old, 5% are under 5 and 18% of population are over 65. Research shows that the young (0-4 years) and old (60+ years) people are most vulnerable to heat waves (Bi et al 2011). The Western suburbs of Melbourne receive less rainfall and are warmer than the other regions of Melbourne (ABS 2012). According to a survey by Herald Sun news (2010) Sunshine ranks as the fifth driest suburb of Melbourne region with annual rainfall of 378 mm and temperatures can reach as high as 46o C in the months of January and February. Statistical data shows that 23% of the population in the project catchment area is vulnerable to heat extremes.

Table 1: Area and population in the case study area

[1]Sa1 Code	Name	Area (Ha)	[2]HH	[3]Pop	Density	Median age	under 18yr %	0-4yr %	65yr & over %
2133716	Camper	19	144	388	21	44	18.8	4	19
2133717	Lloyd	16	173	457	29	38	21	5.7	17
2133718	Furlong	24	161	604	25	46	18	4.8	22
2133719	Euroa	9	108	325	36	33	26	5.6	15
2133720	Ford	13	154	415	33	41	18	4	22
2133724	Heron	20	233	648	32	36	23	7	14
2133725	Creek	42	0	0	0	0	0	0	0
	Total	142	973	2837					

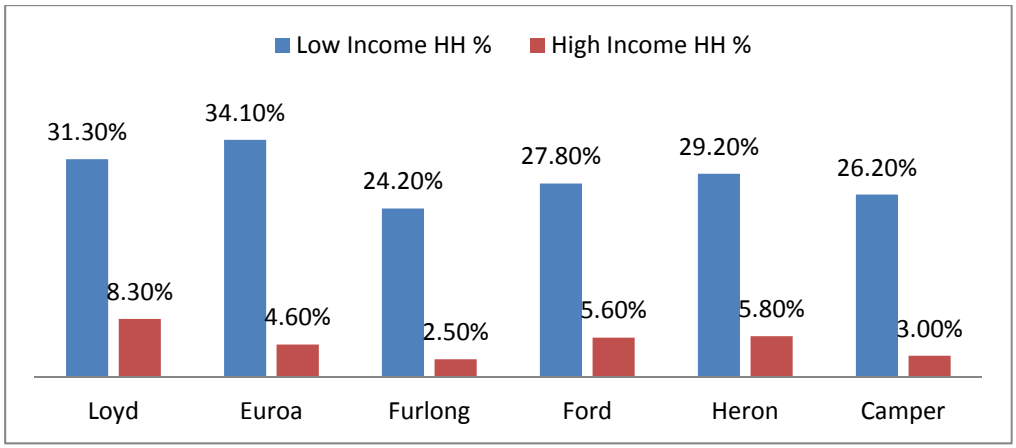
Notes: [1]Statistical area (Sa 1); [2]Households (HH); [3]Population.

Source: Atlas.id 2011.

Income levels

About 29% of households in the project area (279 within 1 km radius) are low income households(less than $600 per week) and 5% belong to high income (more than $2500 per week; see Figure 2). It is interesting to see that 12 out of 46 high income households are in Lloyd region which is along the creek. Most households belong to medium income levels – 1804 in zone 1 and 4199 in zone 2. Research shows that residents from low income households are most benefited by green spaces as they have very few options for recreation and do not travel too far for recreation (Maas et al 2006).

Figure 2: Household income levels

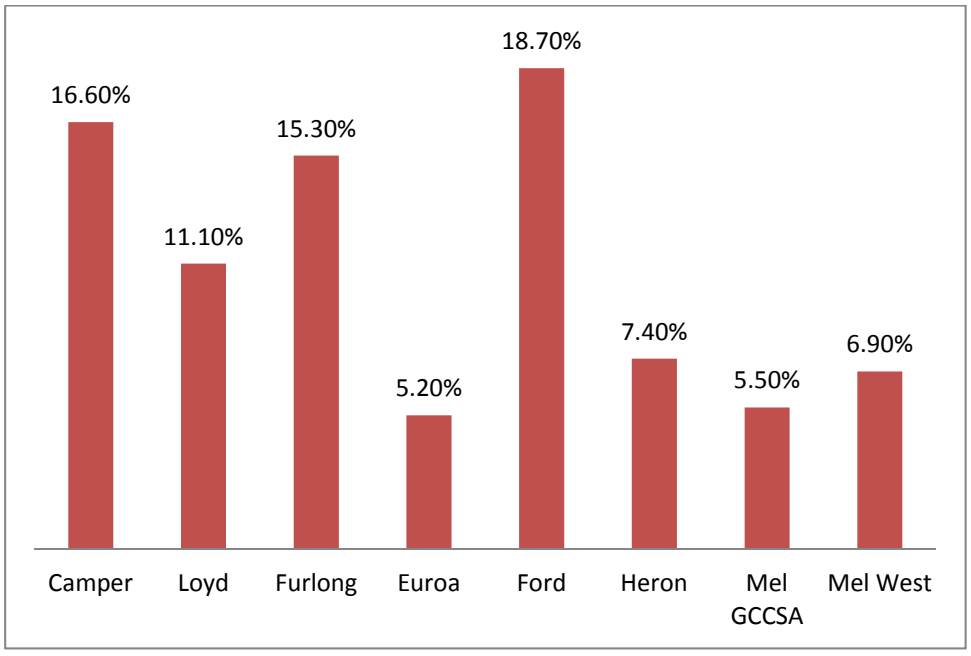


Source: Atlas.id 2011.

Unemployment and Education levels

The project area has a high average unemployment rate of 12.38 % compared to the western region Melbourne west region (6.9%) or Melbourne GCCSA region (5.5%; see Figure 3). This partly explains the low income status of the households in the area. Also, the other reasons for unemployment could be lack of English language skills, poor internet/broadband connectivity and education.

Figure 3: Percentage of unemployed people in the project area (2011)



Source: Atlas.id 2011.

An average 61% of the population in this project location has no qualification, 12% are trade qualified and 9% are university qualified (see Table 2). The low education levels may explain the high unemployment rates.

Table 2: Percentage of population educated to different levels

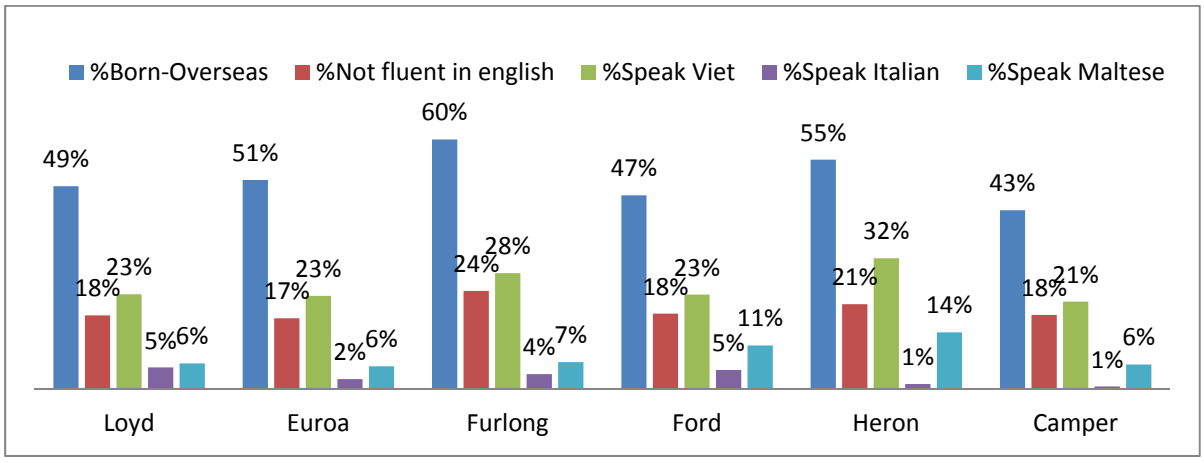
Location name	No Qualification	Trade Qual	University Qual	Attending TAFE	Attending University	< Year 11
Camper	60%	16%	7%	2%	3%	51%
Lloyd	62%	10%	11%	2%	4%	51%
Furlong	56%	8%	10%	4%	5%	43%
Euroa	61%	12%	8%	3%	3%	54%
Ford	64%	13%	6%	4%	4%	49%
Heron	60%	12%	10%	2%	3%	51%
Average	61%	12%	9%	3%	4%	50%

Source: Atlas.id 2011

Percentage born overseas and not fluent in English

Of the total population in the project area, 51% were born overseas; 48.2% were born in non-English speaking countries; 24% speak Vietnamese at home and; 19% are not fluent in English (see Figure 4). Lack of fluent English can decrease job prospects and social connectivity. According to Loughnan et al (2008) ethnicity or households where the primary language spoken at home was not English, also increased the heat stress vulnerability of the people.

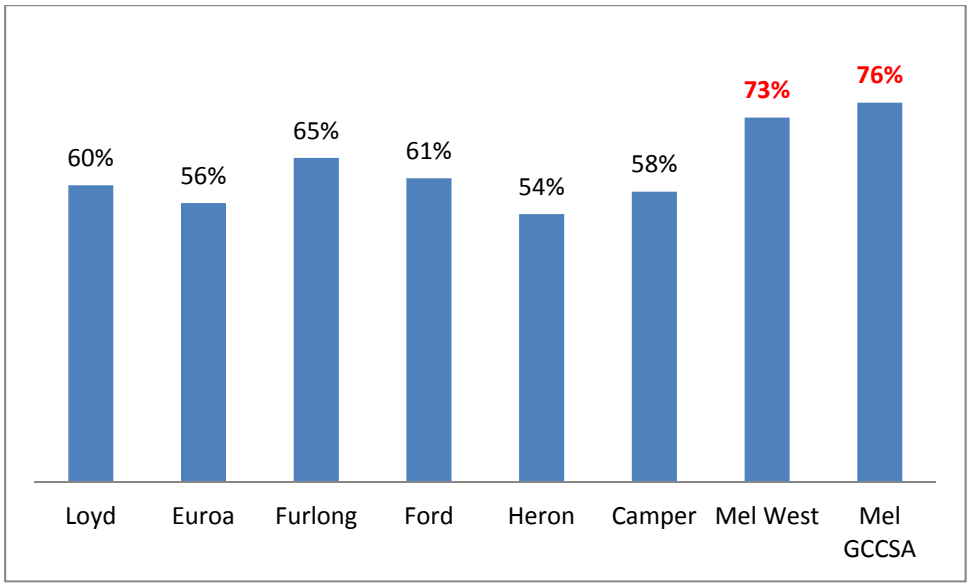
Figure 4: Diversity



Source: Atlas.id 2011.

Only 59% of the households in the project area are connected to broadband compared to the Melbourne average of 76% (see Figure 5).

Figure 5: Percentage of households with broadband connectivity

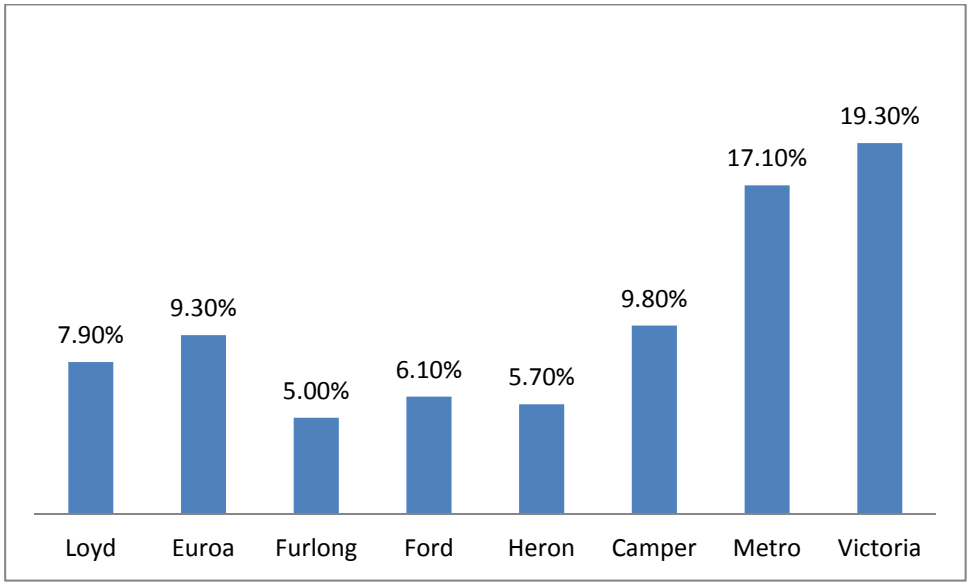


Source: Atlas.id 2011

Volunteerism

A metropolitan Melbourne investigation discussion paper (2010) on public land issues suggested that the protection and management of public land currently relies too heavily on the use of volunteers. Brimbank has low levels of volunteerism (10.1%) and citizen engagement, and the lowest percentage of persons who feel safe on the streets during the day and at night. In the project area only 5.5% of the population are regular volunteers (see Figure 6).

Figure 6: Percentage of volunteerism in the project area



Source: Atlas.id 2011.

Children, disability and religion

Of the total population in the project area, 9% of the population required disability assistance (see Table 3). This is an important statistic to be considered for the design of the project park to ensure easy access for disabled. About 50% of the households in the project area (35% of the households occupied by couples with children and 16% households occupied by lone parents with children) is occupied by families with children and therefore, the project park should be children friendly place for its maximum utilisation. Religion has an implication for the social cohesiveness, social capital and value systems of the people (Cheong et al 2007). Statistics show that majority population of the project area are Christians (56%).

Table 3: Percentage population with children, disabilities and religious affiliations in the case study area

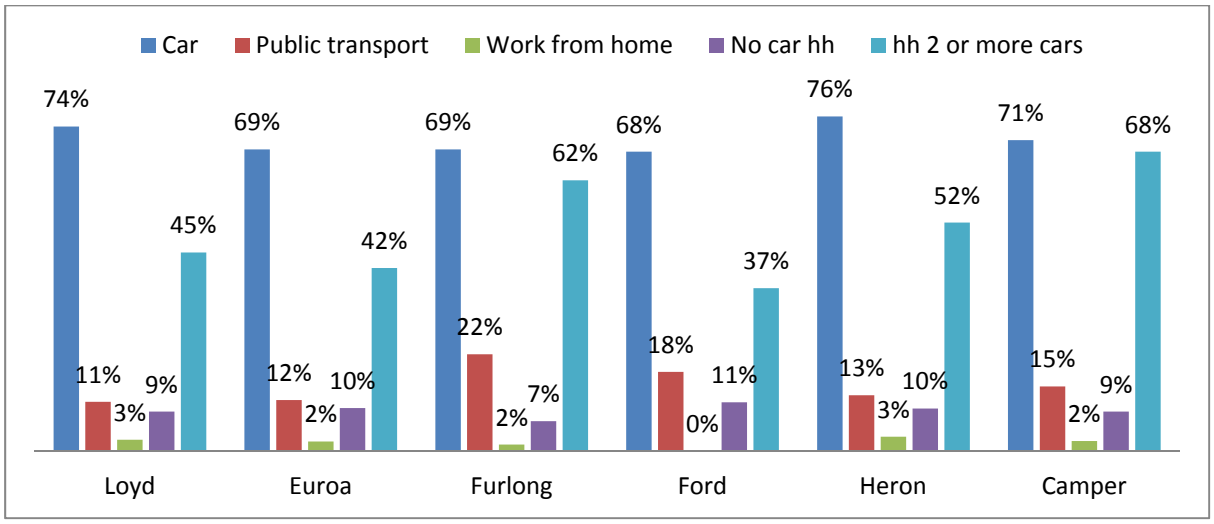
	Percentage Households			**Percentage population**			
Name	Couples with children	Lone parent with children	Lone person	Disability assistance required	No religion	Christians	Non-Christians
Camper	30	19	11	8	16	59	16
Lloyd	31	14	12	3	12	60	23
Furlong	50	11	8	19	14	51	31
Euroa	32	23	7	8	19	56	20
Ford	37	11	10	6	10	58	27
Heron	27	17	13	8	16	51	21
Average	35%	16%	10%	9%	15%	56%	23%

Source: Atlas.id 2011

Transport

A very high percentage (70%) of the local population travel by car in the project area compared to the Melbourne region average of 60.6% and Melbourne West average of 63%, further indicating low incidental activity levels (see Figure 7).

Figure 7: Transport used by people in the project area (2011)

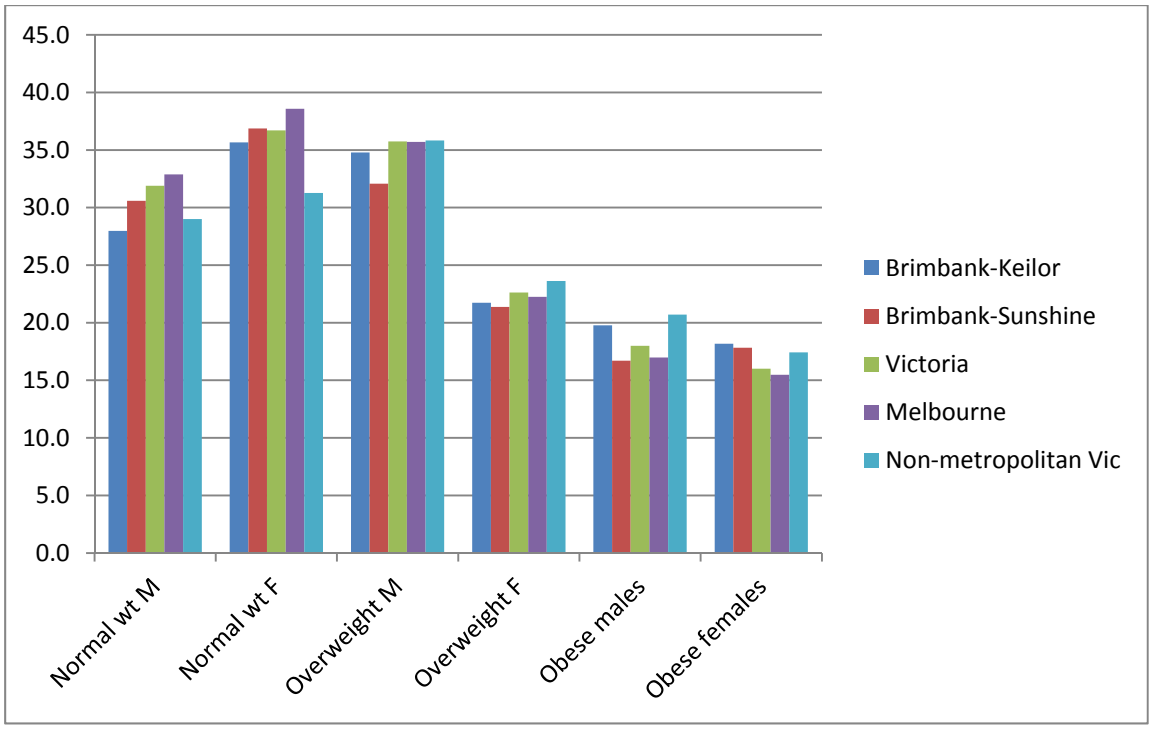


Source: Atlas.id 2011

Health profile

Statistical data (ABS, 2011) shows that the people within the Sunshine precinct where the project area is located, have high levels of physical inactivity (44.2%); high levels of type 2 diabetes (4%), high cholesterol (5.7%), over weight (32% Males, 21% female) and obese (16.7% Males, 17.8% female); high percentage of people with self-rated poor health status (19.7%) (see Figure 8 & 9).

Figure 8: Percentage of people over-weight and obese

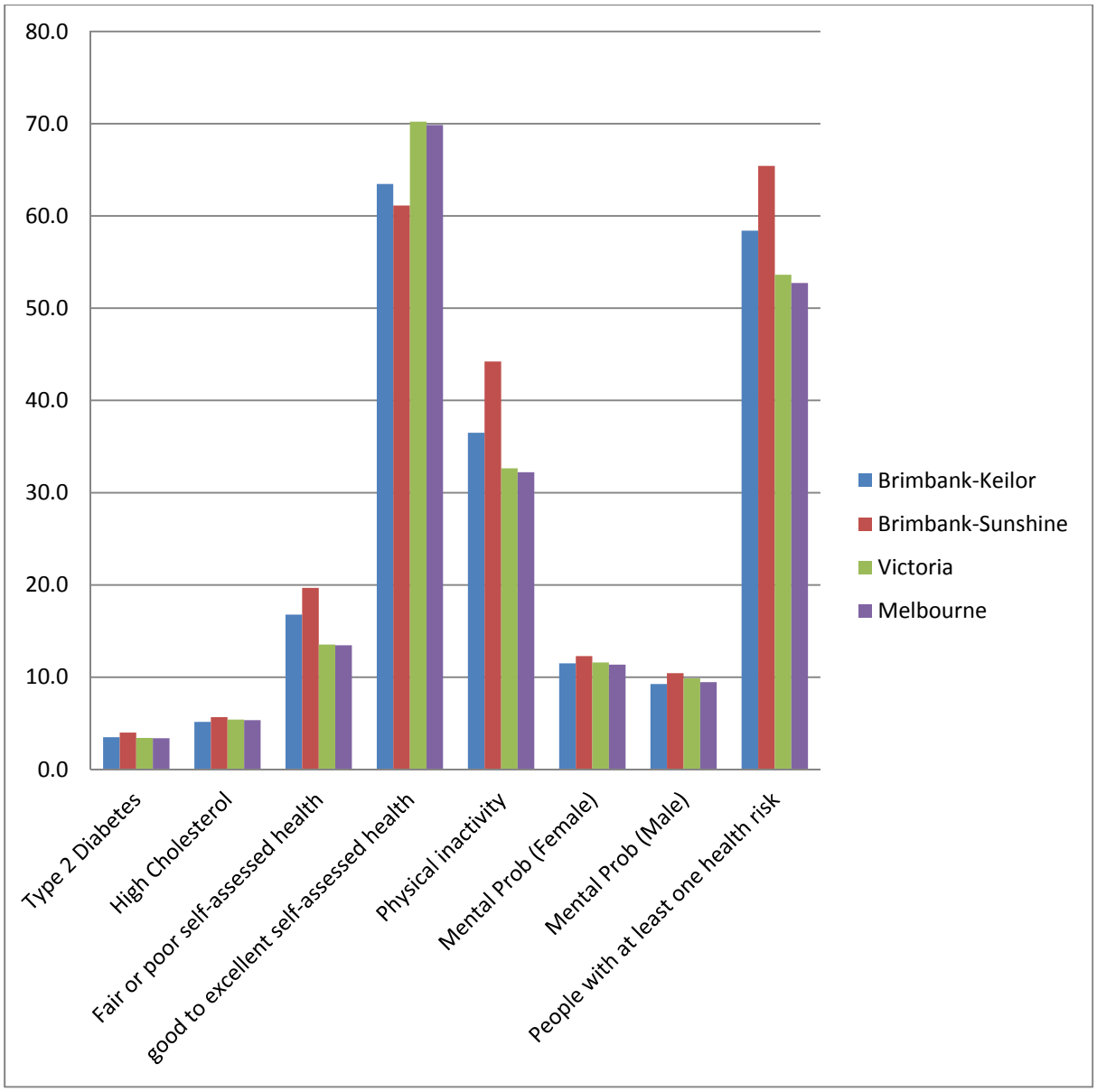


Rate per 100

	Normal wt M	Normal wt F	Overweight M	Overweight F	Obese males	Obese females
Brimbank-Keilor	28.0	35.7	34.8	21.7	19.8	18.2
Brimbank-Sunshine	30.6	36.9	32.1	21.4	16.7	17.8
Victoria	31.9	36.7	35.7	22.6	18.0	16.0
Melbourne	*32.9*	*38.6*	*35.7*	*22.2*	*17.0*	*15.5*
Non-metropolitan Vic	*29.0*	*31.3*	*35.8*	*23.6*	*20.7*	*17.4*

Source: Atlas.id 2011.

Figure 9: Percentage of people with health problems



			Self-assessed health			Mental Problems		
	Type 2 Diabetes	High Cholesterol	Fair or poor	good, very good or excellent	Physical inactivity	Female	Male	Health risk*
Brimbank-Keilor	3.5	5.2	16.8	63.5	36.5	11.5	9.3	58.4
Brimbank-Sunshine	4.0	5.7	19.7	61.1	44.2	12.3	10.4	65.4

Victoria	3.4	5.4	13.5	70.2	32.6	11.6	9.9	53.6
Melbourne	3.4	5.3	13.5	69.9	32.2	11.4	9.5	52.7

*People with at least one health risk-smoking, alcohol, physical inactivity, obesity

Source: Atlas.id 2011.

Access to quality green space

There is only one urban green space in the project area: Lloyd Reserve. Lloyd Reserve has been recently upgraded by the Brimbank City Council and is actively being used by Sunshine cricket club and Albion soccer club. Tester and Baker (2009) showed through their study that any park playfield renovations, with and without family and youth involvement initiative, appear to increase visitation and overall physical activity. However, a research by Floyd et al (2008) showed that such spaces are mostly used by a small group of physically active people, although enjoyed by a larger group as spectators (passive/sedentary recreation). A catchment analysis by EDAW and Sykes Humphreys for Brimbank City Council (Brimbank open space and playground policy and plan 2008) using a 500 metres radius, which considers physical barriers such as major roads and waterways, was conducted to measure the adequacy in the provision of open spaces in the Brimbank City Council. According to this analysis, the project area falls within one catchment area for open spaces (see Figure 10) and zero playground catchment (see Figure 11). According to the report, Sunshine North, east and west of McIntyre Road were found to be the most poorly serviced areas in the municipality in terms of quality open spaces (Brimbank open space and playground policy and plan 2008, p 31). Also, the community forum held by CSES, Victoria University in collaboration with Brimbank City Council (15 November 2013) showed that the space was inadequate and does not fulfil the green space needs of the people in the area.

Figure 10: 500 m catchment analysis of open spaces

Source: E DAW / SY K E S H UMP H R E YS C O N S U LT I N G. 2008. Brimbank open space and playground policy and plan. P32

Figure 11: 500 m catchment analysis of playgrounds

Source: E DAW / SY K E S H UMP H R E YS C O N S U LT I N G. 2008. Brimbank open space and playground policy and plan. P33

Heat Stress in the project area

The western suburbs of Melbourne have higher average temperatures compared to other parts of Melbourne region. Heat stress is known to have significant adverse health impacts especially for the elderly, very young and people with chronic illnesses. Loughnan et al (2008) developed a vulnerability index for the Melbourne region (see Figure 12) for heat stress. They identified five variables that influence variations in heat-related vulnerability:

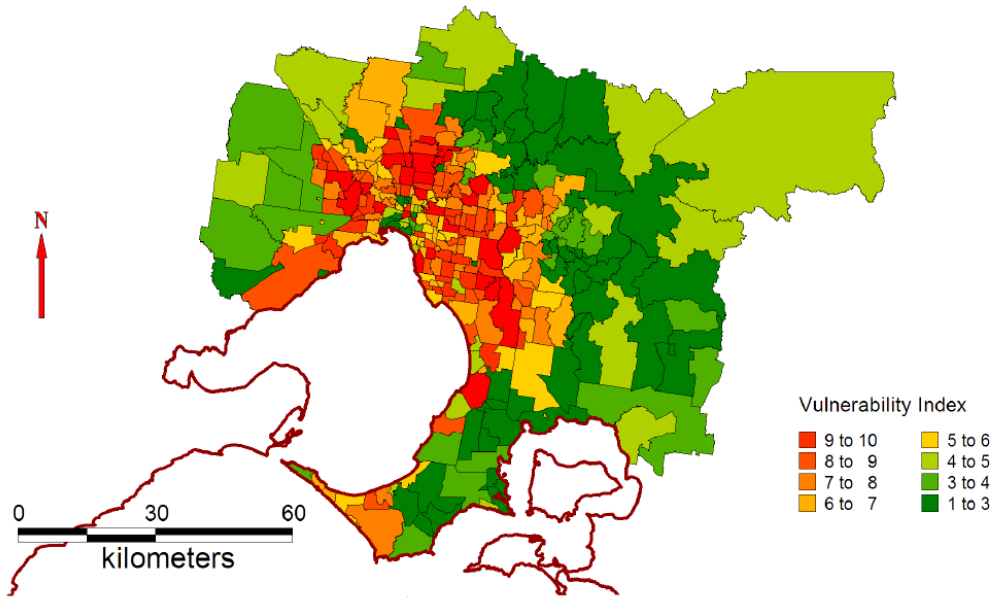
aged care facilities per postal area,

- households where the primary language spoken at home is not English,
- elderly people living alone,
- people living in single dwellings, and
- areas with a high proportion of elderly and very young citizens.

The index showed high vulnerability for Brimbank area. Heat-related mortality and morbidity are amongst the primary health concerns that are expected to increase as a function of climate change (Johnson and Wilson 2009). The public health outcomes of heat-waves depend on the level of exposure (timing, frequency, intensity and duration of the heat-wave), the extent of the event, and

the demographic profile of the exposed population, population sensitivity and the prevention measures in place (WHO 2009). The high quality green space that will be created as a result of the project can potentially reduce temperature in the immediate area, creating positive health benefits.

Figure 12: Statistical districts of Melbourne showing the weighted vulnerability index for each Australian postal areas



Source: Loughnan et al., 2008

Social returns on investment

The project establishment is expected to cost $6 to $10 million, and its maintenance cost is expected to be approximately $10,000 per annum.

Economic value to the community

Literature shows that the value from a visit to green space varies between $2.50 to $12.70 per visit depending on the type of space (AMION 2008; Saz-Salazar & Rausell-Köster 2008). According to VicHealth Indicators Survey (2011), 37.6% of people in the Sunshine area visit a green space weekly or more often compared to the Victorian average of 50.7%. With the implementation of the case study project, there are a range of possibilities in visitation/activity levels ranging from no change in visitation through to four-fold increase in visitation and activity levels. Literature suggests (City of Brimbank 2012; Tester and Baker 2009) that there will be an increase in visitation. For the purposes of analysis, some assumptions will need to be made. The first possibility is that the residents who have been visiting a park at least once a week before the project was implemented may start visiting the new park more frequently i.e., twice, thrice, four or five times a week. The second possibility is that the people who were previously not visiting a park may feel motivated to visit the park due to

its proximity/ aesthetics / utility etc at least once, twice, thrice, four times or more frequently. Considering these two possibilities and assuming residents derive a minimum value of $2.50 per visit in the project area, the minimum value taken from the literature (Northwest Regional Development Agency 2008; AMION 2008), the marginal increase in value created by the project and its NPV has been calculated using four different Social Discount Rates2 (SDR) and the project life period of 50 years with annual maintenance cost of $10,000.

Possibility one: Table 4 presents NPV of marginal increase in value due to Stony Creek Rehabilitation, assuming that the 37% of people (current Sunshine average of percentage of people visiting a green space once a week) within one kilometre radius were visiting only once a week prior to project and are now visiting more frequently – two visits per week; three visits per week; four times a week and five times a week. Four different Social Discount Rates of 3.5%, 5%, 6% and 7% are used assuming a project life of 50 years and the NPV of the marginal increase in value is presented in Table 5. Results show that the NPV of the marginal increase in value varies from $2.2 M to $9.8 M at a 3.5% discount rate. Considering that the project implementation costs varies approximately between $6 M to $10 M, the project has the potential to recover its capital costs if 37% of the residents within 1 km radius of project area above the age of 18 years visit the new project park at least four to five times a week. The economic value to the community from visiting the park easily exceeds the annual maintenance costs of the park.

Table 4: Marginal increase in value if residents visit park more frequently

		NPV @ 3.5% SDR
No. of people above 18 years age within 1 Km radius	2244	
No. of people above 18 years age who visit park at least once a week (37%)	830	
Annual value derived from visiting the park once a week ($2.5 per visit * 830 * 52 weeks)	$107936	
Annual value derived from visiting the park		
If they start visiting twice a week	$215873	
Marginal increase for twice a week	$107936	$2,279,614
If they start visiting thrice a week	$323809	
Marginal increase for thrice a week	$215873	$4,792,016
If they start visiting four times a week	$431746	

[2] According to Harrison (2010), SDR represents the social rate of time preference, the consumers' rate of time preference (the consumption rate of interest), the risk free rate, or the government's cost of funds. The Victorian Competition and Efficiency Commission (2007) recommend 3.5 per cent, endorsed by the Victorian Department of Treasury and Finance (2007). The South Australian Treasury (2007) uses the long-term government bond rate as a risk free rate, which it estimates to be 5 per cent real. Infrastructure Australia recommends cost-benefit studies submitted to it should use 'real risk free' discount rates of 4, 7 and 10 per cent (Infrastructure Australia 2008); The Commonwealth Department of Health and Aging Council recommends evaluating environmental health policies with a discount rate of 5 per cent, with sensitivity tests ranging from 3 to 7 per cent (Department of Health and Ageing and enHealth Council 2003).

Marginal increase for four times a week	$323809	$7,304,395
If they start visiting five times a week	$539682	
Marginal increase for five times a week	$431,746	$9,816,775

All numbers rounded to zero decimals

Table 5: NPV of marginal increase in value due to Stony Creek Rehabilitation if the residents visit the park more than once a week at various Social Discount Rates (SDR).

SDR	**3.5%**	**5%**	**6%**	**7%**
No. of visits per week				
Two visits per week	$2,279k	$1,779k	$1,538k	$1,348k
Three visits per week	$4,792k	$3,740k	$3,234k	$2,834
Four visits per week	$7,304k	$5,701k	$4,929k	$4,320k
Five visits per week	$9,817k	$7,662k	$6,624k	$5,806k

Possibility two: Table 6 presents the marginal increase in value if residents who previously did not visit the park start visiting the project park once implemented, assuming the average number of people visiting a green space will increase from the current 37% (which is the current Sunshine average) to at least 50% (which is the current Victorian average). Table 7 presents the NPV for various levels of park visitation at four different SDRs. Results show that the NPV varies from $0.65 M to $4.2 M at SDR of 3.5%, which covers less than 50% of the investment costs, but can easily recover the annual maintenance costs.

Table 6: Marginal increase in value if residents who previously did not visit the park start visiting the project park

No. of residents above 18 yr age within 1 Km radius		**2244**
No. of people above 18 yr age who visit park at least once a week (Sunshine average: 37%)		830
No. of people above 18 yr age who may start visiting park at least once a week once project implemented (Victorian average: 50%)		1122
Marginal increase in no. of residents visiting park (from 37% to 50%)		292
No. of visits per week	**Marginal annual value derived**	**NPV @ SDR 3.5%**

once a week	$37960	$650,813
twice a week	$75920	$1,534,391
thrice a week	$113880	$2,417,970
four times a week	$151840	$3,301,548
five times a week	$189800	$4,185,126

Table 7: NPV of marginal increase in value if residents who previously did not visit the park start visiting the project park at various SDRs.

SDR	3.5%	5%	6%	7%
No. of visits per week				
Once	$650k	$508k	$439k	$385k
Twice	$1,534k	$1,197k	$1,035k	$907k
Thrice	$2,418k	$1,887k	$1,631k	$1,430k
Four times	$3,301k	$2,577k	$2,228k	$1,952k
Five times	$4,185k	$3,268k	$2,824k	$2,475k

A survey by the Brimbank City Council (2013) showed that the percentage of people visiting recently upgraded council parks at least once a week has increased to 64%, which is a dramatic increase of 26.4%. It was found that majority of people (64%) who visited these parks were adults who took their children to play in the park and the others mainly used it for relaxation, socialising, walk the dog and as an access area to get to other places. Therefore, it is concluded that the marginal increase of 13% in visitation to the park is a conservative and reasonable estimate for preliminary valuation of benefits.

Avoided health cost benefits through increased physical activity levels

The National Physical Activity Survey reports recommend the accrual of at least 150 minutes (two and a half hours) moderate-intensity physical activity over at least five sessions in the week, which it calls as sufficient physical activity for good health (see Table 8) (Australian Government Department of Health). Low levels of physical activity are a major risk factor for ill health and mortality from all causes. People who do not do sufficient physical activity have a greater risk of cardiovascular disease, colon and breast cancers, Type 2 diabetes and osteoporosis. Being physically active improves mental and musculoskeletal health and reduces other risk factors such as overweight, high blood pressure and high blood cholesterol.

Table 8: Physical Activity Recommendations

Age	Minimum physical activity recommended	Comments
Toddlers (1 to 3 years) & Pre-schoolers (3 to 5 years)	3 hr per day	This can be built up throughout the day with a variety of activities
12-18 yr	60 min per day	This can be built up throughout the day with a variety of activities.
Adults	30 min per day	This can be built up throughout the day by combining a few shorter sessions of activity of around 10 to 15 minutes each.
Older adults (65 yr and above)	30 min per day	Moderate intensity physical activity on most, preferably all, days

Source: Australian Government Department of Health. Physical Activity Guidelines

Table 9: Avoided costs of physical inactivity

Statistical Area Code	Name of the area	Pop (2011 Census)	Pop Inactive @ 44.2%	Cost of inactivity @ $756.66 per capita (pc)	over 18	Pop Inactive over 18 @ 44.2%	If 10% become active, no. of people that could benefit from the project	Annual Cost of inactivity @ $756.66 pc that can be avoided if at least 10% pop over 18 becomes active	If 15% become active, no. of people that could benefit from the project	Annual Cost of inactivity @ $756.66 pc that can be avoided if at least 15% pop over 18 becomes active	12% of pop becomes active, no. of people in each area	If 12% of pop over 18 becomes active, avoided physical inactivity costs
2133716	Lloyd	388	171.496	129764.2	318	141	14	10635	21	15953	17	12762
2133717	Euroa	457	201.994	152840.8	361	160	16	12073	24	18110	19	14488
2133718	Furlong	604	266.968	202004	499	221	22	16689	33	25033	26	20026
2133719	Ford	325	143.65	108694.2	238	105	11	7960	16	11940	13	9552
2133720	Heron	415	183.43	138794.1	338	149	15	11304	22	16956	18	13565
2133724	Camper	648	286.416	216719.5	490	217	22	16388	32	24582	26	19665
Total		2837	1253.954	948816.8	2244	992	99	75049	149	112574	119	90059
500m							58	43,712	87	65,568	69	52,454
1km							99	75,049	149	112,574	119	90,059

According to the Social Health Atlas of Australia (2011), in Sunshine area, 65.4% of people suffer from at least one health risk - smoking, alcohol, physical inactivity, obesity and 44.2% of population of Brimbank-Sunshine (above 18 years of age) area are classified as physically inactive compared to Melbourne average of 32.2%. It is estimated that the average cost of physical inactivity in Australia is $756.66 per physically inactive person per year (Dedman 2011). If there is at least 10% increase in number of residents (previously inactive) who become physically active as a result of the project, the avoided health cost benefits within 500m will be $ 43,711 per year and within 1km will be $75,049 per year (see Table 9). These benefits outweigh the maintenance costs of the park approximately $10,000 per year.

Increased property value

Houses close to parks average 1 to 8% higher price than similar properties further away (Mahmoudi et al 2013; Rusche 2011; Stringer 2007). The net increase in property value in the 500 m radius of the project area will range from $2.27M (at 1% increase in value over current median house price of the area) to $18.15M (at 8% increase in value) (see Table 10). While these are private benefits, part of this money goes to the council through increased property rates (Capital Improved Value[3] x 0.002566) which amounts to $5825 to $46573 per year at 2012-13 rates or as capital gains tax which amounts to $1.13M to $9.07M.

Table 10: Number of houses within 500 m of the park and percentage increase in property value

		Percentage increase in property value @			
		1%	2%	3%	4%
House	541	2,147,770	4,295,540	6,443,310	8,591,080
Units	39	120,900	241,800	362,700	483,600
Total	580*	2,268,670	4,537,340	6,806,010	9,074,680
		Percentage increase in property value			
		5%	6%	7%	8%
House	541	10,738,850	12,886,620	15,034,390	17,182,160
Units	39	604,500	725,400	846,300	96,7200
Total	580*	11,343,350	13,612,020	15,880,690	18,149,360

Notes: *Only properties within 500m of Project Park have been considered for these calculations

Impact on the urban heat island effect

The concretised stretch of the creek in the case study area is designed to rapidly move stormwater away from the area to minimize flood risk by creating an extensive impervious surface cover. This

[3] The total market value of the land plus buildings and other improvements.

can exacerbate heating and drying, and promote the development of unfavourable urban climate. This combination of excessive heating driven by urban development, low water availability and future climate change impacts could compromise human health and amenity for the community in the area. The average number of days per year of maximum temperatures exceeding 35°C in Melbourne's west has increased from 8 to 12 since 1997, equalling the amount projected to occur in 2030 (Jones et al., 2013), and may continue to rise with climate change.

Coutts et al (2013) draws on existing literature to demonstrate the potential of Water Sensitive Urban Design (WSUD) to help improve outdoor human thermal comfort in urban areas and support Climate Sensitive Urban Design (CSUD) objectives within the Australian context. They suggest that by retaining water in the urban landscape through stormwater harvesting and reuse, one can lower temperatures and improve human thermal comfort, and when integrated with vegetation (especially trees) have potential to meet CSUD objectives. However, the intensity of cooling and improvements to human thermal comfort and extent of its benefits, depends on a multitude of factors including local environmental conditions, the design and placement of the systems, and the nature of the surrounding urban landscape. Coutts et al (2013) suggest the efficient design of green spaces, and landscaping in targeted high heat exposure areas like Sunshine can help promote infiltration and evapotranspiration increasing the thermal comfort in the area. Further, a study by Nowak & Heisler 2010 in Baltimore, USA, showed that a large urban park filled with trees can be up to 13°F (7°C) cooler than the surrounding area at night (Nowak & Heisler 2010). A recent research by Jenerette et al (2011) in Phoenix, Arizona State of USA found that the vegetation provided nearly a 25 oC surface cooling compared to bare soil on low-humidity summer days and estimated that 2.7 mm/d of water may be used in supplying cooling ecosystem services in the Phoenix region on a summer day. Approximately 4000 trees that are expected to be planted in the project area, have the potential to create thermal comfort for its visitors especially during hot summer days and energy savings for residents in the vicinity.

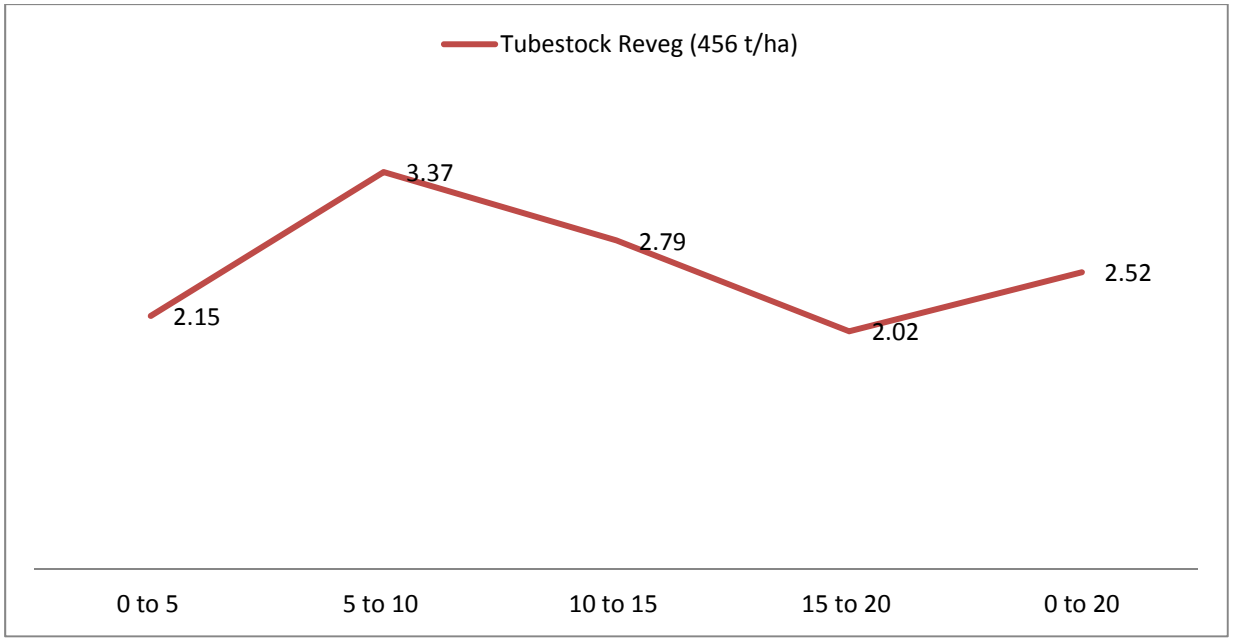
Nicholls et al. (2008) examined heat and mortality relationships in Melbourne for those over 65 years from 1979 to 2001. They found that when daily minimum temperatures exceeded 30°C average daily mortality for those over 65 increased by 15–17% (Nicholls et al., 2008). In the study area, 18.4% (522) of the population is aged 65 years and above. Western region of Melbourne is naturally warmer and the degraded urban natural vegetation combined with drought, water restrictions and xeric gardens, may further exacerbate urban warming and energy demands (Larson et al., 2009). In addition to predicted increases in average temperatures for Australian cities, the average number of days per year of maximum temperatures exceeding 35°C is expected to rise as a consequence of climate change (CSIRO 2007). While, it is difficult to estimate the cooling benefits of the project at this stage, previous research clearly indicates positive impact on the area and community. Further, Jenerette et al (2011) caution that increased vegetation should be managed through informed environmental policies as they have economic, water, and social equity implications.

Carbon storage

Trees and vegetation in parks can help reduce carbon dioxide (a dominant greenhouse gas) by directly removing and storing carbon dioxide and indirectly by reducing air temperature and building energy use in and near parks . According to a study by England et al (2006) on rates of

carbon sequestration in environmental plantings in north-central Victoria in the medium to low rainfall areas, carbon sequestered per ha of green space per year planted with trees (England et al 2006) is 2.52 t/ha/annum with a standard deviation of 1.06, assuming there are 456 trees per ha in the age range of 5-20 years, grown from tubestock revegetation (see Figure 14). Only the above ground biomass has been considered for this study. Considering this statistic and provided 4000 trees are planted, the annual carbon sequestered in the project park, will be approximately 22.10 t. One tonne of carbon is 3.67 t of 'carbon dioxide equivalent' (CO2-e). Therefore, the carbon dioxide equivalents stored by the project park area is 81 t. Predicting carbon prices for 60 or more years into the future is guesswork. Prices per NGAC (i.e. per tonne CO2-e) have fluctuated, from $8–10 in 2004, to $14 in 2006, to around $5 in 2009. According to Hope (2006), the mean value of the Social Cost of Carbon4 is $43 per tonne under both a business-as-usual scenario, and under a scenario aimed at stabilizing CO2 concentrations at 550 ppm. Estimates of annual returns from carbon-trading from a small environmental planting of 4 ha in Central-NSW varied greatly, from profit to loss (Johnson and Coburn 2010). In a latest study by Aaron et al (2013), while estimating the value of urban forest in Toronto, Canada, carbon sequestered and stored is valued at US$110.10 per tonne ($30 per tonne of CO2 equivalent). Bramley (2008) recommended this value in 2009 as an effective centerpiece in a federal Climate Change Action Plan.

Figure 13: Average rates of above ground biomass (t C / ha / yr)



Source: England et al 2006

Biodiversity and flood prevention benefits

The water in the creek, trees and other vegetation in the area is expected to help in increase of bird population in the area and also support native grasses and other flora, fauna and microscopic life. Melbourne Water studies predict reduced flood risk for the surrounding residential properties once the rehabilitation project is completed. The project will also serve to minimise public risk by slowing the water velocity in the vegetated creek.

[4] The social cost of carbon (SCC) is the value of the climate change impacts from 1 tonne of carbon emitted today as CO2, aggregated over time and discounted back to the present day.

Conclusion and Discussion

Using a cost-benefit approach, results of this analysis suggest that under a set of assumptions, rehabilitating / revegetating the Stony Creek stretch should be implemented. There is a strong need for high quality green space in the project locality and the marginal benefits of the project exceed the annual maintenance costs of the project area. While the project creates sufficient potential for the capital costs of $6-10 M to be recovered through health benefits from increased physical activity and private benefits from increase in property values, a number of socio-economic and market factors may influence these returns. A number of strategies can be used to improve the value of the rehabilitation benefits of Stony Creek including: retaining as much land along the creek as possible and purchase undeveloped private land along the creek; increasing the connectivity of the space to rest of the landscape by removing the fences around the park, laying walking tracks and bike trails; establishing ecological corridors to facilitate the movement of wildlife; permitting a coffee café in the park; and for particulate matter reduction year-round and for optimum physical comfort of visitors, Nowak & Heisler (2010) recommend that the park design should include a variety of land cover—areas of dense trees, scattered trees, and lawn. A post valuation of the project, once implemented and a longitudinal study will help understand how the different values change over the years. Also, while the benefits from different values should be calculated, they may not necessarily be added up due to the risk of double counting values. Therefore, only the key values which are most valued by the stakeholders should be considered to assess the economic viability of the project.

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