

Stony Creek whole of system litter investigation & management prioritisation

Catchment Background Report

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1. Introduction

The Aquatic Environmental Stress Research Group (AQUEST) were engaged by Melbourne Water to conduct a strategic litter investigation across the entire Stony Creek catchment. The project aimed to identify the types and sources of litter in the catchment and identify and prioritise recommendations for the management of litter across the catchment.

1.1. Project drivers

In 2018, a Tottenham warehouse storing unregistered containers of toxic chemical waste caught fire. Firewater runoff containing chemical waste was washed into Stony Creek, decimating plant and animal life. Substantial remediation efforts were required to remove contaminated sediment and water from the catchment and make the area safe for users.

To address the lasting environmental damage caused by the warehouse fire, Melbourne Water partnered with the Environmental Protection Authority Victoria, Maribyrnong City Council and the local community to develop the Stony Creek Rehabilitation Plan 2019 – 2029. The Plan contains stakeholder-identified restoration goals for the Stony Creek catchment and the actions to be implemented to achieve these goals. Action WQ9 of the Plan is to improve litter management, specifically to 'Place litter traps in appropriate places throughout the Stony Creek catchment'. This project has been commissioned to improve litter management under Action WQ9 of the Rehabilitation Plan.

1.2. Scope of the study

This project investigates litter across the entire Stony Creek catchment. The project aimed to understand the litter problem in the catchment and identify how to effectively tackle it across different stakeholders.

The specific objectives of the project were to:

- Describe the current state of litter in the catchment, by:
 - Identifying the existing stormwater network assets
 - Identifying current litter management measures
 - Assessing how litter affects the catchment values, and
 - Locating litter hotspots.
- Characterise litter and determine its primary sources via litter counts and observations using methods developed under the Aquatic Pollution Prevention Partnership (A3P) (a research partnership between Melbourne Water and AQUEST @ RMIT): Project F5.1 *Understanding the impact of litter, including microplastics, on the social and ecological values of waterways and bays.*
- Create a high-level decision framework to prioritise risks and management options.

1.2.1. Definitions

Table 1 provides the definitions of terms used throughout this document.

Table 1 Definition of terms used in this report.

Term	Definition used in this project
Litter	"...any discarded, disposed of, or abandoned man-made objects and organic material that is present on land and in water. It consists of articles that have been made or used by people or businesses and subsequently deliberately discarded or accidentally lost. Examples include, but are not limited to, any waste glass, metal, plastic, paper, fabric, wood, trolleys, microplastics, cigarette butts, medical waste, household items, food, soil, sand, concrete or rocks, abandoned vehicles, abandoned vehicle parts, syringes, polystyrene, electronic wastes and garden remnants and clippings." (REF – MW litter project)
Litter management efforts	Any device, infrastructure or activity that seeks to: (1) prevent litter entering the catchment; (2) restricts the mobility of litter in the catchment; or (3) removes litter from the catchment. This includes, but is not limited to: <ul style="list-style-type: none"> • Programs designed to reduce littering behaviour • Installing and maintaining infrastructure that collects litter above and below ground • Physically removing litter.
Rehabilitation values	Refers to the natural, social and recreational values identified in the Stony Creek Rehabilitation Plan 2019 – 2029. Unlike the general definition of values, the Plan's rehabilitation values are linked to measurable improvement goals for the catchment.
Stormwater network assets	Pipes and channels which carry rainwater which has fallen on urban impervious surfaces, such as rooftops, roads, and pavements, and discharges it into Stony Creek.

2. Background

The Stony Creek catchment is one of ten sub-catchments in the Maribyrnong Catchment of Melbourne. The creek originates in St Albans and flows in a south-easterly direction through Sunshine, Tottenham, West Footscray, Kingsville and Yarraville before emptying into the Yarra River estuary at Spotswood, under the West Gate Bridge (Figure 1). At its confluence with the Yarra River, the creek forms a backwash and estuary.

The catchment has been extensively urbanised. Several areas were used as (now defunct) bluestone quarries, and significant portions of the catchment are now used for residential and industrial purposes. The Stony Creek estuary has been stabilised with silt and sand to limit erosion and prevent flooding of the nearby industrial areas (Melbourne Water, 2018, p.4). The creek itself has also been significantly altered over time, and now flows mostly in either a modified natural channel or a concrete-lined channel (Melbourne Water 2018). The creek has been diverted underground for most of its length through Sunshine, starting at Duke Street and emerging above ground at Matthew's Hill Reserve.

Stony Creek catchment has a long history of chemical and litter pollution. One of the largest pollution events, and perhaps the most publicised, occurred in 2018 with the Tottenham warehouse fire. This incident contaminated the catchment land and waters with chemical waste and decimated the plant and animal life. In contrast to chemical pollution, litter receives less media attention but is nevertheless a significant concern for users of the catchment.

Despite urbanisation and continued pollution problems, Stony Creek catchment is prized by the local community as a unique place to experience nature and connect with others. The community-driven, long-term vision for rehabilitation of the catchment seeks to address the ongoing litter problem (Action WQ9; Melbourne Water, 2019b).

This report details what we know about litter in the Stony Creek catchment, including litter sources, “hot spots”, current management and possible access points to enable management. We appreciate that there are knowledge gaps, we may not even be aware of and seek your input to make this comprehensive.

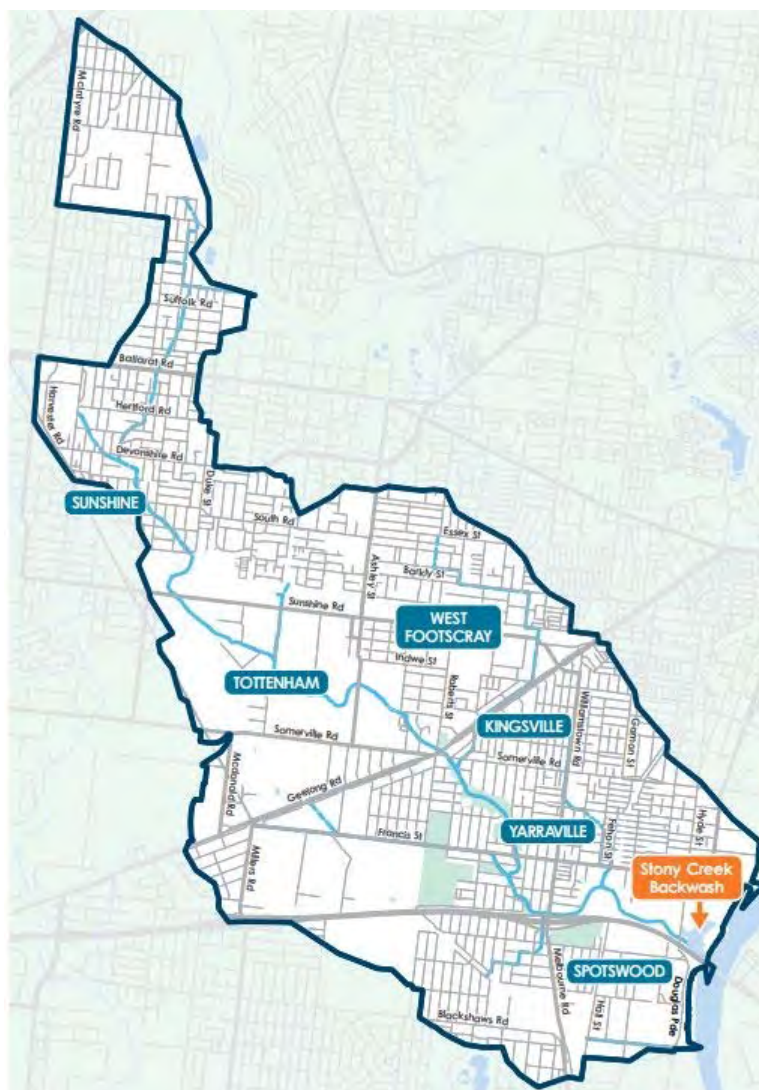


Figure 1 The Stony Creek catchment. The creek originates in the northern suburb of St. Albans and flows in a south-easterly direction through Sunshine, Tottenham, West Footscray, Kingsville and Yarraville. The creek forms a backwash and estuary where it empties into the Yarra River at Spotswood, under the West Gate Bridge. Source: Melbourne Water, 2019b.

2.1. Jurisdictional management

Stony Creek catchment, and the management infrastructure associated with it, falls within the jurisdiction of several governing bodies. The land within the catchment is managed by three local governments (Figure 2): Brimbank Council presides over the upper, northern section of the catchment; Maribyrnong Council, which holds the largest portion of the catchment, is located in the centre of the catchment; and Hobson’s Bay Council controls the lower south-east portion of catchment land.

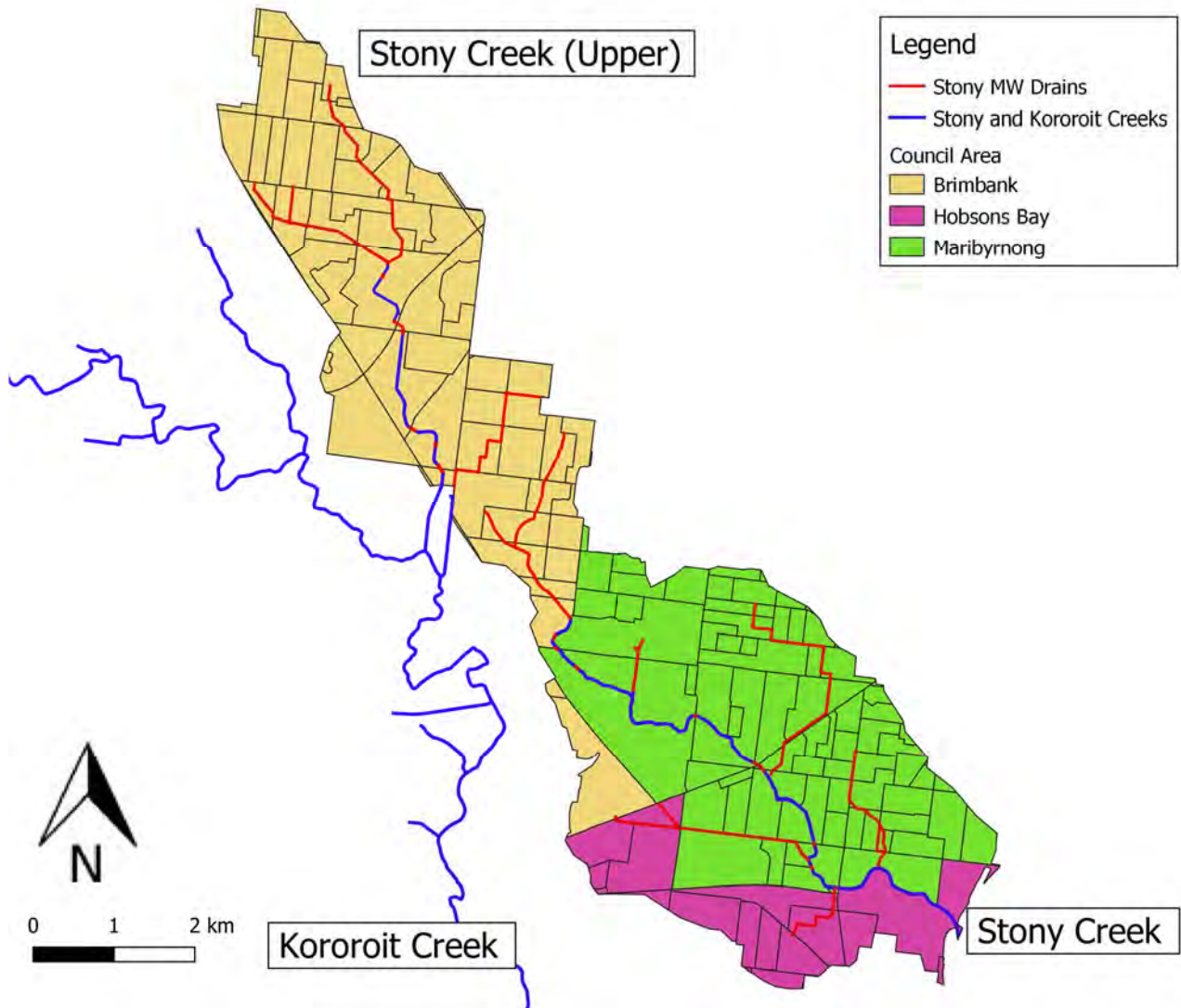


Figure 2 Stony Creek catchment falls within the jurisdictions of three local councils: Brimbank Council in the north (yellow), Maribyrnong Council on the centre (green) and Hobson’s Bay Council in the south-east (purple).

2.2. Stormwater network assets

Six main Melbourne Water drains run through the catchment, transporting stormwater from all three local councils into Stony Creek (Figure 2 and Figure 3). Feeding into these drains is a network of council-owned drains (Figure 3), of which there are 55 drain openings leading into Stony Creek.

Since managing litter may involve accessing the stormwater network, Appendix A: Recommended access points for main drains.

Table 2 lists the recommended access points for the Melbourne Water drains. These access points are mapped in Appendix A: Recommended access points for main drains.

Table 2 Recommended access points to the main Melbourne Water drains in the catchment.

Main drain #	Access point	Accessibility
1	Yarraville Golf Course, Yarraville	One manhole and drain outfall both accessible; located on private property.
2	Williamstown Rd, under the Westgate Freeway crossover, Yarraville	Two manholes and the drain outfall are currently inaccessible due to West Gate Tunnel Project construction.
3	St Leonard's Ave, Yarraville	Manhole is on private land and a fence currently blocks access; drain outfall is accessible.
4	Charlotte St, Yarraville	Manhole and drain both accessible.
5	Quarry Rd, Tottenham	The single manhole is inaccessible due to road and rail infrastructure; drain outfall is accessible from Quarry Rd.
6	Matthew's Hill Reserve, Sunshine	One manhole is accessible from Walter St; drain outfall is accessible from Matthew's Hill Reserve.

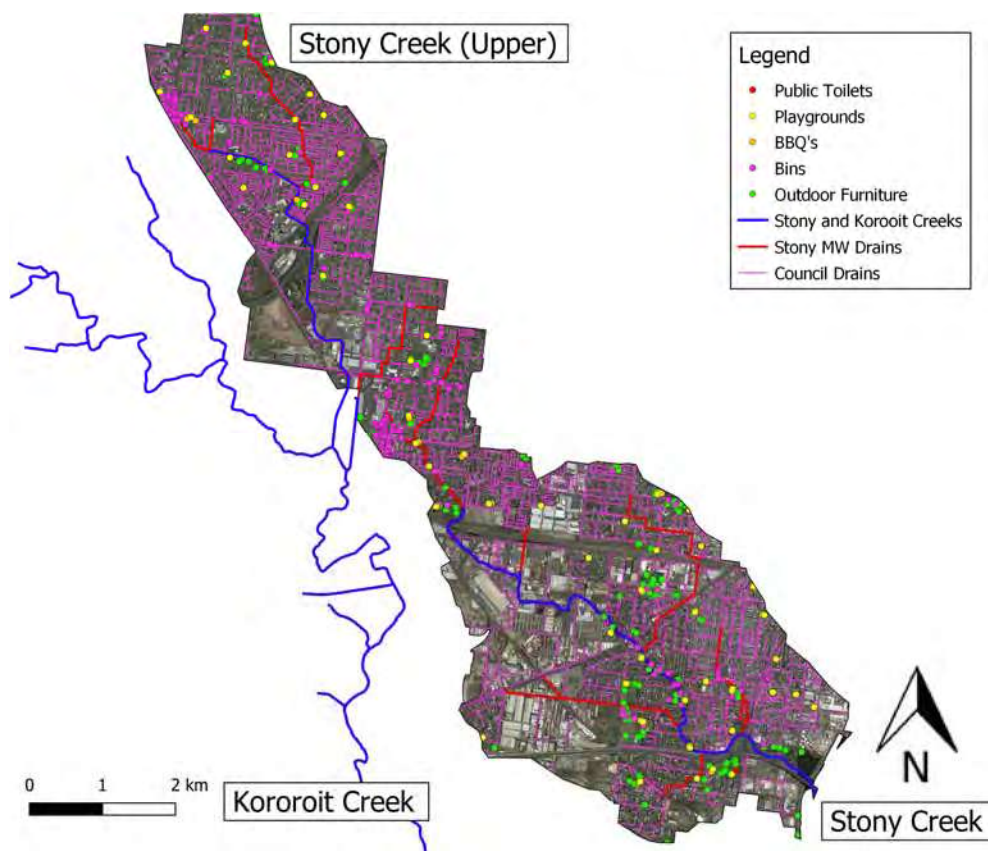


Figure 3 The stormwater drainage network and location of public amenities in the Stony Creek catchment. The drainage network consists of Melbourne Water drains (red) and council drains (pink).

2.3. Land uses in the catchment

The Stony Creek catchment is situated on approximately 25.6 km² of land. Although this land is used for several purposes (Table 3), it is primarily used for residential and industrial uses, and for roads. Together, these three categories account for 80.1% of catchment land use.

Table 3. Stony Creek catchment land use presented as area and percentage of total catchment land. Data source: Melbourne Water.

Land use category	Area (km ²)	Land use (%)
Residential	8.91	34.79
Industrial	6.77	26.43
Roads	4.84	18.89
Greenspace	1.53	5.99
Railway	1.17	4.57
Grassland	0.90	3.51
Commercial	0.68	2.67
Public Use	0.54	2.09
Water	0.15	0.58
Agricultural industry	0.11	0.44
Not classified	< 0.1	< 0.1
Quarry	< 0.1	< 0.1
Total	25.61	100

The largest portion of catchment land is used for residential dwellings (34.8%), which are in three clusters along the length of the catchment (Figure 4). The two largest clusters are in the northern beginnings of the catchment, around Sunshine, and at the north-eastern end of the catchment, around Kingsville and Yarraville. The third, smaller cluster of residences occurs midway along Stony Creek, at the north-eastern bounds of the catchment in West Footscray. Notably, significant building activity is occurring in the Maribyrnong section of the catchment, and this could be a potential litter source.

Industrial activities account for 26.4% of land use; this is almost as much as the amount of land used for residences. Industrial zones are located primarily in the middle of the catchment, around Tottenham. A smaller industrial area is located at the mouth of the catchment in Spotswood, around the Stony Creek backwash.

Residential and industrial land uses are a potential source of litter in the catchment. Additionally, paved roads, which account for almost 20% of the catchment area, efficiently transport litter from the catchment into stormwater drains.

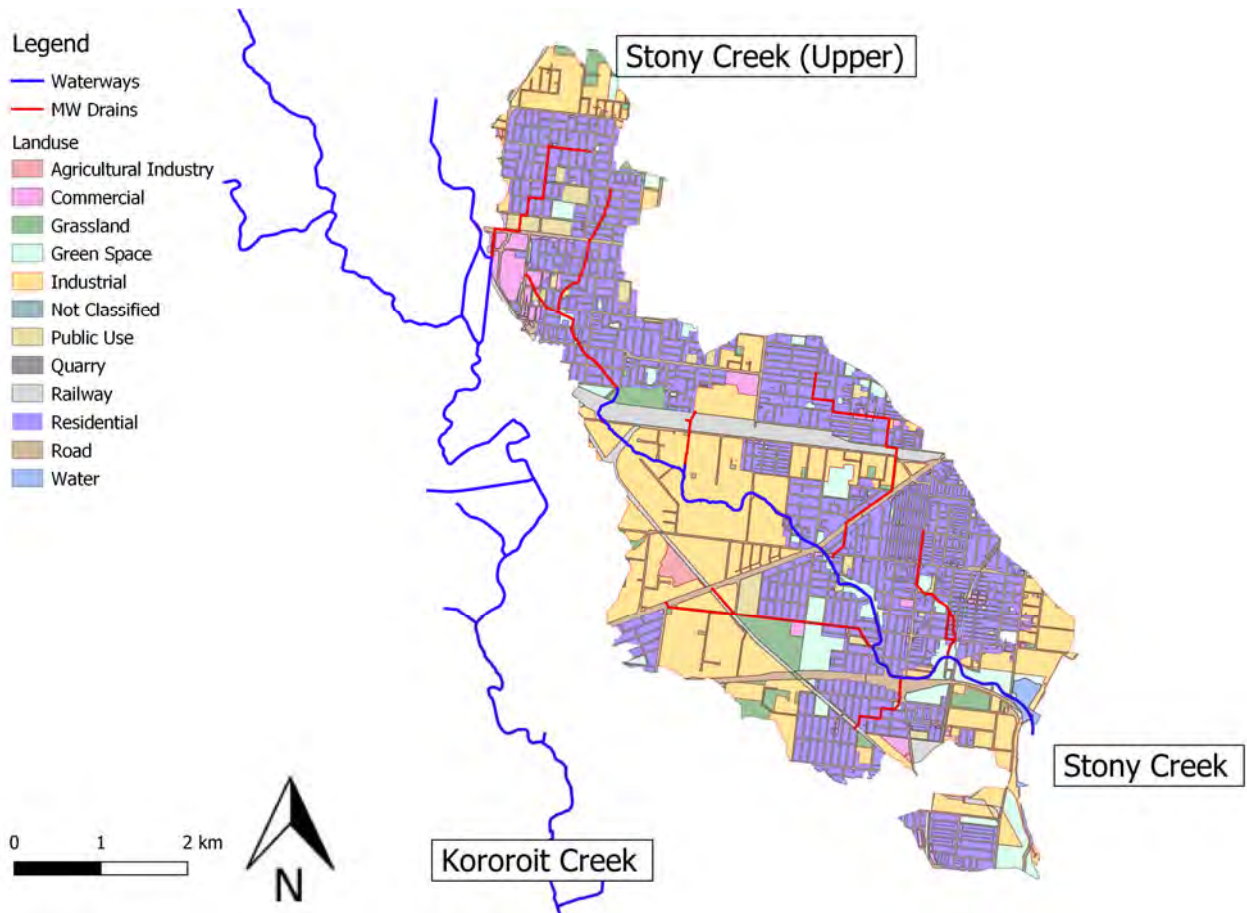


Figure 4. Land uses and stormwater assets in the Stony Creek catchment. Data source:
<https://data.gov.au/page/about-open-data>

Aside from percentage land use, the types and concentration of human activity can also indicate potential litter sources. For example, commercial activities account for less than 5% of the total Stony Creek catchment. However, depending on the nature of the commercial activities, this land use could contribute a disproportionate amount of litter to the catchment area. For example, takeaway food outlets could be the source of disposable plastic packaging – either from deliberate dumping by consumers or inadequate litter management facilities, such as bins.

Similarly, greenspaces, grasslands and public spaces account for a total of 11.6% of land use in the catchment. However, these lands concentrate human activities that is likely to generate litter. Figure 3 shows the location of public amenities, including litter bins, BBQ areas and outdoor seating. The map identifies several particularly dense clusters of amenities:

Table 4 Type and location of amenity clusters in the catchment.

Cluster	Amenities in cluster	Location	Jurisdiction	Nearby water infrastructure
1	Dense cluster; predominantly bins, with some toilets and outdoor furniture.	A large commercial hub in Sunshine, bordered by Anderson Road and the railway line. The area contains Sunshine Marketplace, Sunshine Plaza Shopping Centre, open-air carparks and street-side retail outlets.	Brimbank Council	Melbourne Water drains between Devonshire Road and Service Street.
2	Smattering of bins, outdoor furniture and play equipment.	Located along the banks of the creek in Cruikshank Park, between Somerville Road and Francis Street.	Maribyrnong Council	Stony Creek open channel.
3	Three clusters – one in each park – of bins, outdoor furniture and play equipment.	At Zacour Park, Beaton Reserve and Yarraville Skatepark/Oval, in Yarraville. These areas are located on adjacent blocks of land.	Maribyrnong Council	Melbourne Water drains down Williamstown Road, Anderson Street, and through Beaton Reserve.
4	Moderately sized cluster; predominantly outdoor furniture, several bins and play equipment	Around Angliss Reserve and Mclver Reserve, in Yarraville.	Maribyrnong Council	Melbourne Water drain under Francis Street.
5	Moderately sized cluster; predominantly outdoor furniture with some playgrounds.	At Donald McLean Reserve, Spotswood Oval and Westgate Golf Club, in Spotswood. These locations are on a single block of land.	Hobson's Bay Council	Melbourne Water drain under the West Gate Freeway, and Stony creek open channel to the north.

2.4. Existing litter management efforts

Numerous stakeholders were consulted (listed in Appendix B: Contacted stakeholders) to determine which litter management measures are currently in place in the Stony Creek catchment. The litter management efforts found can be categorised as: (1) educational programs, which aim to influence stakeholders' behaviour and reduce deliberate dumping and incidental littering; or (2) physical removal of litter. Where possible, data has been provided to indicate the scale of litter management efforts.

2.4.1. Educational programs

Educational programs aim to stop litter at its source by changing stakeholder behaviour and thereby reducing the number of deliberate or accidental acts of littering. Little evidence was found of educational programs in the Stony Creek catchment. There are anecdotes of an educational project,

run approximately 20 years ago, to encourage industrial stakeholders to prevent litter blowing out of bins.

Melbourne Water and Brimbank Council have jointly funded an educational mural which will be installed in central Sunshine in 2020 (T MacIntosh 2020, personal communication, 08 May). The mural targets members of the general community and encourages viewers to reflect on how litter affects the environment. Ultimately, the mural aims to reduce littering behaviour and therefore stem the flow of litter into surrounding waterways.

The only current educational program identified is the Victorian Wetland Care Education Program, which is run by Conservation Volunteers Australia and focuses on educating school-aged children about wetland conservation. The impacts of litter are included in this program, which was expanded in 2018 to include the Stony Creek backwash (Conservation Volunteers Australia, 2018).

2.4.2. Litter removal

Several governing bodies and volunteer organisations arrange for the physical removal of litter from the catchment. Compiling a complete list of litter removal activities, and the amount of litter removed through them, is difficult as most records are incomplete.

2.4.2.1. Litter removal by resource management organisations

Melbourne Water commissions litter removal in the channels that it owns. Whilst this has occurred at several sites on an as-needs basis, two sites – at Furlong Rd and in the concrete channel at Francis St – have been registered for frequent litter removal since at least 2017. These two sites routinely require around more than 10 labour hours per year to clean (Table 5).

Maribyrnong Council removes litter from catchment land under its jurisdiction on an as-needs basis. Park Rangers conduct routine inspections of the land and, when the litter builds up to a certain extent, arrange third-party removal of the litter. Sites for litter removal are also identified by catchment users, who frequently contact council to advise of accumulated litter. Cruikshank Park and Stony Creek Reserve require monthly litter removal efforts (**Table 5**). Maribyrnong Council partners with high school students to collect litter around Newell's Paddock Urban Nature Park in the Maribyrnong River catchment, but no equivalent program exists in the Stony Creek catchment. Individual volunteers and volunteer organisations also conduct litter removal activities. At Matthew's Hill Reserve, volunteers attended Melbourne Water's Stony Creek Litter Audit in 2019 and its Clean Up Australia Day litter removal in 2020.

2.4.2.2. Litter removal by community volunteers

Several volunteer community groups actively remove litter from several areas of Stony Creek. The Maidstone and West Footscray Residents Action/Activation Group (MAWFRAG) collect litter from Matthews Hill Reserve in Sunshine. MAWFRAG regularly collect litter from the creek banks at Matthews Hill and have recently teamed up with Melbourne Water's Water Watch program to sort and quantify the litter types they collect. However, MAWFRAG's immediate litter collection activities, and their capacity to contribute to litter collection in the future, face several restrictions (see Case study: Litter collection by MAWFRAG volunteers, below)

Case study: Litter collection by MAWFRAG volunteers

The Maidstone and West Footscray Residents Action/Activation Group (MAWFRAG) is a volunteer group that has been operating for four years. They conduct several environmental activities across a broad area. One of these activities is organising litter removal events at Matthews Hill Reserve in Sunshine.

Litter removal at Matthews Hill is restricted by several factors. Firstly, MAWFRAG cannot access the large amount of litter located inside the creek itself due to safety concerns. Whilst the group does collect litter along the creek bed, they cannot address the majority of litter at the site because it is located in the creek. Snake season is another restriction, with MAWFRAG suspending all litter activities when snakes are active at the site. Finally, MAWFRAG volunteers' have several other commitments, and this limits the amount of time they can donate to litter collection.

MAWFRAG organisers find it difficult to retain litter removal volunteers, and to recruit new ones. A MAWFRAG representative advised that it is hard to get the local community to care about litter in Stony Creek, which could stem from the fact that many residents – both new and long-term – are not aware that Stony Creek exists. This attitude could be changing, as COVID-19 restrictions in 2020 encouraged more people to seek out areas of naturalness in their neighbourhoods.

MAWFRAG members expressed a feeling of being “spread thin” between litter collection at Matthews Hill, activities they conduct in other suburbs, and other life commitments. They emphasised that relying on community volunteers to manage litter in Stony Creek is not a sustainable management solution.

Source: MAWFRAG representative 2020, personal communication, 22 May.

Further downstream, the Friends of Stony Creek remove litter at various sites throughout the catchment monthly, and recently cleared litter from Sara Grove as part of Clean Up Australia Day 2020 (Table 5). Friends of Cruikshank Park, another community volunteer group operating in the catchment, have contributed to the Clean Up Australia Day in the park, which have been running for 25 years (Clean Up Australia Day, 2020)

Many stakeholders are aware of the ‘Let’s Strain the Drain’ program, a collaboration between the Tangaroa Blue Foundation and several state and local government bodies which seeks to minimise the amount of litter entering Port Phillip Bay from waterways (Tangaroa Blue, 2018). The program has installed 120 stormwater drain traps in water bodies across Maribyrnong, but does not include Stony Creek. The litter collected in the drain traps is sorted and quantified every six weeks by volunteers, and data is lodged on the Australian Marine Debris Initiative (AMDI) Database (Tangaroa Blue, 2018; P. Hildebrand 2020, personal communication, 28 May).

Stakeholders also told us about the Love Our Streets program. This is an extensive network of volunteers collecting litter from their local areas on a monthly basis. The litter they collect is sorted and quantified, and the data stored on the LitterStopper database. Whilst there is a Love our Street group operating around the nearby Maribyrnong River, there is currently no group working in the Stony Creek catchment.

2.5. Litter hotspots in the catchment

The sites with repeated litter removal activities (listed in Table 5) indicate physically accessible litter hotspots within the catchment. To supplement this information, advice was sought from resource managers, community stakeholders and environmental researchers (listed in Appendix B: Contacted stakeholders) to confirm these areas as hotspots, and to identify other hotspots in the catchment. Significant hotspots are summarised in Table 6, and anecdotal stakeholder advice, where given, is presented in the short descriptions of sites, below.

Table 5 Frequency and location of physical litter clean-up efforts in Melbourne Water channels in the Stony Creek catchment.

Organisation	Location	Activity frequency	Measurement of waste collected
Melbourne Water	Furlong Rd to Anderson Rd, Sunshine North	Every 2 months	<ul style="list-style-type: none"> 16 labour hours per visit (estimated)
Melbourne Water	Concrete channel from Francis St to Thomas St, Yarraville	Every 4 months	<ul style="list-style-type: none"> 2017: 10 labour hours 2018: 9.5 labour hours 2019: 14 labour hours
Melbourne Water	Waratah St culvert	Once in 2017	No data
Melbourne Water	Thomas St to Hyde St	Once in 2017	<ul style="list-style-type: none"> 13 tyres 1.1 kg commercial/industrial waste
Melbourne Water	60 metres upstream of Sunshine Rd, Braybrook (below Matthew's Hill Reserve)	Once in 2017	No data
Melbourne Water	Paramount Rd to Geelong Rd	Once in 2020	No data
Melbourne Water & community volunteers	Matthew's Hill Reserve, Sunshine (the Stony Creek Litter Audit)	Monthly for 3 years	<ul style="list-style-type: none"> 231 bottles & cans collected in 3 months in 2019
Melbourne Water & community volunteers	Matthew's Hill Reserve, Sunshine (Clean Up Australia Day)	Once in 2020	No data
Maribyrnong council	Cruikshank Park	Every 2 weeks	No data
Maribyrnong council	Stony Creek Reserve	Every 3 weeks	No data

Friends of Stony Creek	Sara Grove, Tottenham (Clean Up Australia Day)	Yearly Clean Up Australia Day since 2019	<ul style="list-style-type: none"> 2019: 50 kg in 2 km^{2a}
Friends of Stony Creek	Stony Creek Reserve	Yearly Clean Up Australia Day until 2018	No data
Friends of Stony Creek	Various locations	Monthly	No data
Friends of Cruikshank Park	Cruikshank Park	Yearly Clean Up Australia Day	No data
Scab Duty	Stony Creek backwash	Weekly ^b	No data
Tangaroa Blue	Stony Creek Backwash	1 -2 times per year, since 2015	1 – 10 microplastics per cm ^c .

^a Data from <http://www.litterstopper.com/emaildata>

^b Sourced from Green (2014).

^c Data from H. Tate 2020, personal communication, 02 June.

Table 6 Significant litter hotspots in the Stony Creek catchment.

Litter hotspot location	Type of litter
Furlong Rd to Anderson Rd,	No data
Concrete channel from Francis St to Thomas St	No data
Thomas St to Hyde St, Yarraville	<ul style="list-style-type: none"> • Green waste/timber • Solid commercial/industrial waste • Tyres
Waratah St culvert	<ul style="list-style-type: none"> • Small litter items • Leaves, large branches
60 metres upstream of Sunshine Rd, Braybrook	<ul style="list-style-type: none"> • Small litter items • Leaves, large branches
Paramount Rd to Geelong Rd	No data
Stony Creek backwash, Yarraville	<ul style="list-style-type: none"> • Microplastics (1 – 5 mm) • Plastic bottles • Beverage cans • Spray cans • Fragments of plastic wrappers
Sara Grove, Tottenham	<ul style="list-style-type: none"> • Car parts • Car batteries • Small-medium sized litter items
Duke St/ Matthew’s Hill Reserve	<ul style="list-style-type: none"> • Industrial soft plastics (e.g. films) • Industrial foams • Parking tickets from Brimbank Council • Beverage cans and bottles • Food packaging • Shopping trolleys
VicTrack freight yard, Sunshine	<ul style="list-style-type: none"> • Spray cans • Car tyres • Construction materials • Dumped furniture

Sara Grove, Tottenham

The section of Stony Creek around Sara Grove, Tottenham, is surrounded by industrial land use. Stakeholders advised that lightweight litter, such as plastic, accumulates on the private land in this area. For example, litter can get trapped by weeds or wire perimeter fencing. From there, litter can be blown into the nearby Stony Creek.

Sara Grove is also a hotspot for illegal dumping of large items. Access to the creek is typically restricted by a padlocked fence owned by Melbourne Water. However, Maribyrnong park rangers advised that the lock is routinely cut with an angle grinder to facilitate vehicle access to the creek. Large industrial items, such as car parts and car batteries, are dumped at this site (M Forster 2020, personal communication, 07 April). Sara Grove has been the site of two Clean Up Australia Day efforts (Table 5), which indicates that significant amounts of small to medium sized litter items are also present.

Waratah St culvert

This site is characterised by small litter items and vegetation debris (Figure 5).



Figure 5: Small litter items and accumulated vegetation litter at Waratah St which was removed in 2017 by Melbourne Water. Source: Melbourne Water.

Sunshine commercial hub

The Sunshine commercial hub has a high density of retail outlets and contains many bins (Table 4). Additionally, the area has a large proportion of paved surfaces due to roads and car parks, which could facilitate litter being transport via wind into the Stony Creek catchment. Anecdotally, there is a strong perception amongst community members that this area generates a large amount of litter which finds its way into Stony Creek (T MacIntosh 2020, personal communication, 08 May; MAWFRAG representative 2020, personal communication, 22 May).

Duke St/Matthew's Hill Reserve

Duke street is surrounded by industrial activities. Lightweight litter, such as soft plastics and foams, escape from overfull industrial bins and are blown into Stony Creek. Litter from stormwater also accumulates in the creek at this location, before the creek enters the underground channel (M Forster 2020, personal communication, 07 April). Occasionally, dumped shopping trolleys are found at this site (MAWFRAG representative 2020, personal communication, 22 May).

Duke street ends at the streamside Matthew's Hill Reserve, the site of Melbourne Water-led litter audits which have occurred monthly for the past three years (Table 5) using Tangaroa Blue litter audit sheets (T MacIntosh, personal communication, 08 May). Matthew's Hill reserve has a high volume of recreational usage: the overhanging willows are a popular place for drinking, and the area is often strewn with beverage cans and bottles (M Forster 2020, personal communication, 07 April; T MacIntosh, personal communication, 08 May).

Other instances of deliberate littering that could contribute to litter at Matthews Hill are the bus stops in the area. These bus stops typically do not have litter bins associated with them, and community members have witnessed deliberate littering of food wrappers by patrons waiting for the bus to arrive (MAWFRAG representative 2020, personal communication, 22 May).

Community stakeholders noted that in addition to deliberate littering, incidental littering is a source of litter to the Mathews Hill hotspot (MAWFRAG representative 2020, personal communication, 22 May). One source of incidental litter are the dumpsters associated with retail outlets at the Central West Shopping Centre and the nearby cluster of shops on the corner of Duke St and South Rd. These dumpsters are regularly overfilled, and shop owners tend to leave the dumpster lids open. This enables crows to pull rubbish out of the dumpsters, and wind to blow soft plastics out of the dumpsters.

The school located at Ashley St, is another potential source of litter to Matthews Hill (MAWFRAG representative 2020, personal communication, 22 May). Schools are likely to generate large

amounts of lightweight plastics litter from food and beverages and will contain several outdoor litter bins that may not have adequate lids. The large paved surfaces associated with schools could facilitate wind transporting litter from the school to Stony Creek, particularly as Ashley Street runs directly to the creek.

Stony Creek backwash

Large amounts of litter accumulate in the Stony Creek backwash because it is entangled in the roots of the mangroves located there (S Stojkovic 2020, personal communication, 10 April). This litter includes beverage bottles and cans, and plastic wrappers (Kosic et al, unpublished data), and can be as dense as 1200 litter items per 100 m² (Smith et al, 2017).

There is significant public attention around microplastics, known as nurdles, in the Stony Creek backwash. Anecdotally, microplastics entered this area several years ago following a vehicle collision; nurdles remain prolific in the area, but it is unclear if they are left over from the accident, or the result of recent litter entering the catchment (M Forster 2020, personal communication, 07 April). Nurdle contamination is such a prominent feature of the Stony Creek backwash that the area is the focus of industry-led microplastic removal efforts (Operation Clean Sweep, 2020) and government-funded community research programs (Kowalczyk & Charko, 2017). Other litter removal in the backwash is conducted by the volunteer group Scab Duty (Green, 2014), and anecdotal evidence suggests that Parks Victoria are also active in this area, but no further information was obtainable.

Although the backwash is undoubtedly a litter hotspot, not all litter is likely to come from the Stony Creek catchment: some litter could be carried into the backwash from the adjoining Yarra River at high tides.

VicTrack freight yard

Community members identified the VicTrack freight yard as a hotspot for discarded and illegally dumped litter which could be swept into Stony Creek during storms. The litter here includes spray cans, wood and bricks from construction zones, and furniture Figure 6. The litter in this area accumulates at the northern embankment where the freight yard crosses Stony Creek, and east of the eastern train line to Newport (south of Sunshine Road).



Figure 6 Litter accumulation at the VicTrack freight yard includes spray cans, car tyres, and items of furniture.

2.6. Litter-related threats to rehabilitation values

The Stony Creek Rehabilitation Plan 2019 – 2029 identifies rehabilitation values for the creek, ranks these values' current status, and projects the trajectory for their improvement. The rehabilitation

values identified in the Rehabilitation Plan are the same as the values identified for the Stony Creek catchment in the plan for the broader, Maribyrnong catchment (Melbourne Water, 2018).

This section assesses how litter in the Stony Creek catchment could affect the improvement trajectory of these rehabilitation values. Only those values which can improve (Melbourne Water, 2019, p. 18) have been assessed for litter effects; values which the Rehabilitation Plan identified as unimprovable (frogs, macroinvertebrates, and platypus) were not considered in the analysis since litter would not affect the improvement trajectory of these values.

2.6.1. Natural values

The Rehabilitation Plan identified three natural values for improvement in the Stony Creek and the Stony Creek estuary: birds, fish and vegetation. Litter can affect all these values, by exacerbating the pressures already present and by creating new pressures (Table 7).

Birds

The rehabilitation value of 'birds' is not currently ranked because of a lack of data, but it is expected that bird life is currently low in the catchment because of climate change, disturbance and habitat loss, and introduced predators. The Rehabilitation Plan aims to improve bird life to a moderate level by 2029. Large litter items, such as car parts and pieces of wood, can hinder this progress by exacerbating disturbance and habitat loss: disturbance of the vegetation and sediment bed occurs when large litter is dumped in the creek, and continues as items travel through the creek with water flow. Efforts to remove large items from the catchment also disturb the environment, as the activity may necessitate trampling riparian vegetation to access the litter, and uprooting water plants and increasing turbidity as items are lifted out of the creek.

Litter can also directly reduce the health of individual birds. Small items, such as bottle caps and plastic fragments are consumed by birds, and this can damage internal digestive organs and limit the nutritional value the bird obtains from a meal. Birds can become entangled by flexible plastic litter, such as six-pack beverage rings and lengths of plastic film. This can significantly reduce the bird's movement, inhibiting the animal to find food and other resources.

Fish

'Fish' is a rehabilitation value that is currently ranked as low but is anticipated to improve if riparian habitat and water quality improve, and barriers to fish migration are removed. Litter contributes to all these factors, and therefore can impede the improvement of fish life. As described for 'Birds', large litter items can disturb riparian vegetation when these items are dumped, move through the environment and are removed. Clean-up activities that focus on removing small pieces of litter can also trample and degrade riparian habitat.

As identified for birds, fish can ingest litter items and become directly entangled by it. Many litter items have the potential to leach chemicals into the creek sediment and water column. Given the industries and activities occurring around the catchment, this threat could come from car batteries, which are classed as a hazardous waste (Sustainability Victoria, 2014), and construction materials which may contain chemicals and paints. Leached chemicals can degrade water quality in the creek, which can directly affect fish health. Indirectly, leached chemicals may affect the health of aquatic vegetation and invertebrates that provide shelter and food for fish populations.

Large litter items, and small items that accumulate over time, can form barriers in the creek that prevent fish migration. This is more likely to occur in areas where the water channel is narrow, or in areas where litter is caught and trapped by rocks and vegetation. Barriers formed by litter can affect fish populations by limiting the ability of fish to move to areas with adequate food, habitat and water quality.

Vegetation

‘Vegetation’ is a rehabilitation value identified for both the Stony Creek and the Stony Creek estuary. Vegetation values at both sites are currently low because of built-up land use: there is limited land available for vegetation to be replanted, or for existing vegetation to expand. Since litter cannot influence land use, this current pressure on vegetation will not be exacerbated by litter in the creek or estuary.

Litter can, however, act as a new pressure on the limited vegetation that is present at these sites. Litter that has a film or sheet-like form can become trapped in vegetation, acting as a blanket which limits plants’ access to atmosphere, sunlight, and pollinators. Long-term entanglement by such litter is likely to reduce the growth and reproduction of vegetation and, under extreme litter loads, could lead to plant death. Further, litter-related reductions in vegetation could create a feedback loop to birds and fish, as less vegetation may alter the amount of food, shelter or perches available for these animals.

2.6.2. Social and recreational values

The Rehabilitation Plan identified the following social and recreational rehabilitation values: amenity and community connection in Stony Creek, and recreation at both the creek and estuary (Table 7). The status of these three values are measured in part by user satisfaction, which can be influenced by litter. Using direct stakeholder quotes from the Rehabilitation Plan, an inference of what stakeholders envisaged when they spoke of amenity, community connection and recreation in the catchment can be made. Then one can determine how litter can affect the ability to achieve this envisaged future, and hence diminish user satisfaction. Since user satisfaction underpins the ability to improve all three values, these values are addressed collectively, in the section below.

Amenity, community connection, and recreation

Many community stakeholders expressed that the Stony Creek catchment provides an opportunity to connect with nature (Melbourne Water, 2019b, p. 3) and relax away from the noise and stress associated with urbanisation (Melbourne Water, 2019b, pg.1, 86). Users described the catchment as an oasis or haven away from urbanisation (Melbourne Water, 2019b, p.1), with one stakeholder identifying that the catchment provides an area that children can explore which “is so very needed in a time when we are becoming glued to technology” (Melbourne Water, 2019b, p.86). Litter diminishes users’ perceptions of naturalness because it acts as a constant reminder of urbanisation; users are unlikely to perceive the catchment as a “healthy and clean natural community asset” (Melbourne Water, 2019b, p.3) if litter is abundant.

Users described the catchment as an educational resource for children, saying it provides opportunities for children to be “on the land” and learn about the environment (Melbourne Water, 2019, p. 38, 86). This theme was so significant that stakeholders requested facilities to enable children’s nature-based play (Melbourne Water, 2019b, p.57). A striking example of the amenity that Stony Creek offers is demonstrated in the weekly outdoor programs run by Gowrie Clare Court Children’s Services, which is located next to Cruikshank Park (detailed in case study below). Litter can limit the ability of children to learn and play in the catchment because it can pose a health hazard (e.g. broken glass). Litter can also be perceived by adults and carers as a health hazard – even when the litter type does not actually pose a threat – and thereby reduce the number of children brought to the catchment area.

Adult users of the catchment envisaged the area enhancing the “physical, emotional and mental wellbeing of the community” (Melbourne Water, 2019b, p. 37). The Rehabilitation Plan determined that providing more facilities and activities to enhance users’ passive enjoyment of the catchment would improve the amenity, community connection and recreational values at both the creek and

estuary. However, if users do not perceive the areas as an attractive place to gather because of litter pollution, this will undermine the effectiveness of improving facilities.

Of note is that litter is a prominent concern for catchment users. Litter pollution was raised by several community members, independent of rehabilitation values, during the Rehabilitation Plan consultation period, indicating that users are acutely aware of litter in the catchment. This heightened sensitivity makes it likely that, if left untreated, litter will interfere with the improvement of social and recreational rehabilitation values.

Case study: Amenity and education in Stony Creek

Gowrie Clare Court Children's Services in Yarraville is a short walk from Cruikshank Park. The organisation uses the park to run 14 education programs for the children in their care, who range from 6 months to 5 years of age. These educational programs have been operating in Cruikshank park for approximately 5 years. Most programs are run weekly, with some running more regularly.

During the course of their outdoor programs, children and staff observe litter accumulating in Cruikshank Park. It is now common practice for them to take plastic bags on their outings, so that they can remove litter as they come across it. When litter accumulates to a significant extent, children and staff will undertake a dedicated litter-collection trip to remove the litter. The litter in Stony Creek has provided an opportunity to engage children in themes about the environment and environmental stewardship. For example, children have learned about "good materials and bad materials". Staff have noticed that, over time, children become champions of litter collection.

The young age of the children at Gowrie Clare Court means they are unable to express how litter pollution in Stony Creek affects them. As part of the Stony Creek Rehabilitation Plan, children and staff created an artwork to express how a healthy creek would look, and older children were able to articulate their desire to see more fish and bird life present at the creek. Gowrie Clare Court staff predicted that if there was less litter in the creek, it would create opportunities for them to engage children in other learning topics.

Source: S Amici-Limco, 2020, personal communication, 05 June.

2.6.3. Aboriginal cultural values

In addition to rehabilitation values, the Wurundjeri, Bunurong and Boon Wurrung peoples have cultural values associated with the catchment. Aboriginal and Torres Strait Islander peoples are the Traditional Owners and custodians of the land and water on which all Australians rely. The entire Stony Creek catchment is on land for which Registered Aboriginal Party status is undecided. Wurundjeri, Bunurong and Boon Wurrung peoples have expressed their connection to the land and its waters, and Melbourne Water has committed to engaging with all three groups during the implementation of the Rehabilitation Plan (Melbourne Water, 2019b, p.19). Cultural values lie outside of the rehabilitation values outlined in the Rehabilitation Plan; therefore, assessing how litter may affect cultural values associated with the catchment lies outside the scope of this project.

Table 7. How litter can affect the rehabilitation values for Stony Creek and Stony Creek estuary. Values, states, trajectories and reasons are taken from the Rehabilitation Plan.

	Value	Current state	Current trajectory	Future trajectory	Reasons for current state	How litter could affect the value
Stony Creek	Birds	NA	Low	Moderate	<ul style="list-style-type: none"> Climate change Disturbance Habitat degradation Introduced predators 	<ul style="list-style-type: none"> Small litter objects contribute to habitat degradation. Large litter, such as car parts and pieces of wood, disturb the creek environment when they enter and travel down the creek. Removing litter, particularly large items from the creek, will disturb the environment.
	Fish	Low	Moderate	Moderate	<ul style="list-style-type: none"> Lack of riparian habitat Poor water quality Barriers to migration, particularly in channels that are highly modified 	<ul style="list-style-type: none"> Some litter can leach chemicals that degrade water quality. Large litter items, or small items that have accumulated over time, may create an unsurpassable barrier to migration, particularly where the channel is narrow.
	Vegetation	Very low	Very low	Low	<ul style="list-style-type: none"> Land use change 	<ul style="list-style-type: none"> Litter can smother vegetation, reducing plants' access to atmosphere and sunlight. Litter effects on vegetation can create flow-on effects for birds and fish.
	Amenity	High	High	Very high	<ul style="list-style-type: none"> User satisfaction. Provision of facilities and activities that facilitate passive enjoyment. 	<ul style="list-style-type: none"> Litter decreases satisfaction because it visually detracts from naturalness Many stakeholders wanted an escape from urban life – litter prevents this
	Community connection	High	High	Very high	<ul style="list-style-type: none"> User satisfaction. Provision of facilities and activities that facilitate passive enjoyment. 	As above.
	Recreation	High	High	Very high	<ul style="list-style-type: none"> User satisfaction. Provision of facilities and activities that facilitate passive enjoyment. 	As above.
Stony Creek estuary	Vegetation	Low	Very low	Low	<ul style="list-style-type: none"> Climate change Surrounding areas are industrialized, leaving no space to increase vegetated areas. 	<ul style="list-style-type: none"> Litter can smother vegetation, reducing plants' access to atmosphere and sunlight.
	Amenity	Low	Low	Moderate	<ul style="list-style-type: none"> User satisfaction. Provision of facilities and activities that facilitate passive enjoyment. 	<ul style="list-style-type: none"> Litter decreases satisfaction because it visually detracts from naturalness <p>Many stakeholders wanted an escape from urban life – litter prevents this</p>
	Recreation	Moderate	Moderate	High	<ul style="list-style-type: none"> User satisfaction. Provision of facilities and activities that facilitate passive enjoyment. 	As above.

3. Proposed Targeted Monitoring Program

Targeted monitoring will be conducted to understand the state of the litter problem in Stony Creek and to prioritise management actions. The data collected from targeted monitoring will be used to determine:

- The sources of litter to Stony Creek
- Any hot spots for litter in Stony Creek
- The major types of litter occurring in Stony Creek
- Whether litter poses threats to values and services

Two types of targeted litter monitoring are proposed:

1. Monitoring litter from the stormwater system through drain surveys
2. Surveys of litter along the banks of Stony Creek

Further details of the monitoring plans and proposed sites are provided below.

3.1.1. Stormwater Drain Surveys

A spatial and temporal assessment of litter entering Stony Creek from the stormwater network is proposed. There are six larger stormwater outlets, managed by Melbourne Water, entering Stony Creek and over 55 council managed stormwater drain outlets. Sampling is proposed to focus on the 6 main drain outlets managed by Melbourne Water (Figure 7). Each drain would be sampled by AQUEST staff, on a weekly basis for a period of 5 weeks.

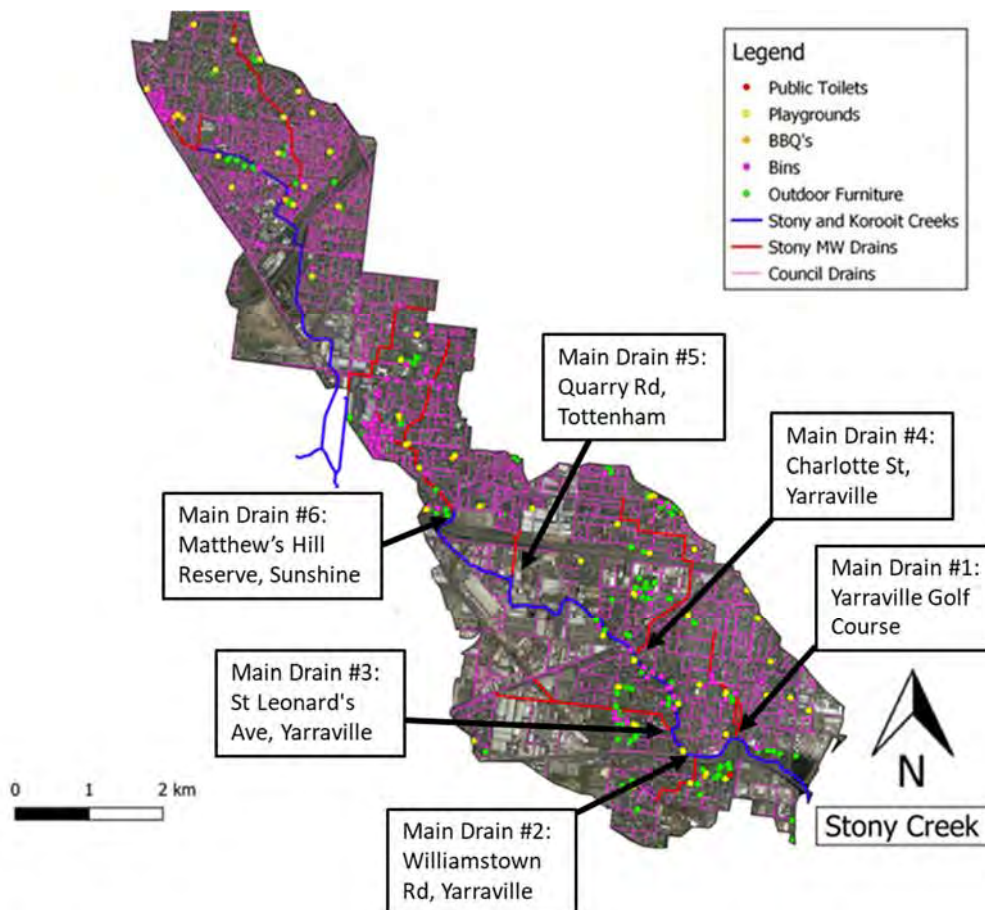


Figure 7: Proposed sites for targeted litter monitoring in stormwater drains.

3.1.2. Bank Surveys

Banks surveys would assess litter accumulation and types along the banks and instream of Stony Creek. A spatial and temporal sampling design is proposed, with 8 sites situated along the creek sampled on 5 occasions. Suggested sampling sites are shown in Figure 8 and Table 8.

Bank surveys are a great opportunity for the Stony Creek community to be involved in the Stony Creek whole of catchment litter investigation and management prioritization project. Community members could assist in completing surveys of litter along banks and instream, providing valuable data to complement drain surveys and inform management actions. Training would be provided by AQUEST Scientists and all required equipment provided. To find out more please contact Dr Jackie Myers at jackie.myers@rmit.edu.au or via phone on 9925 4841.

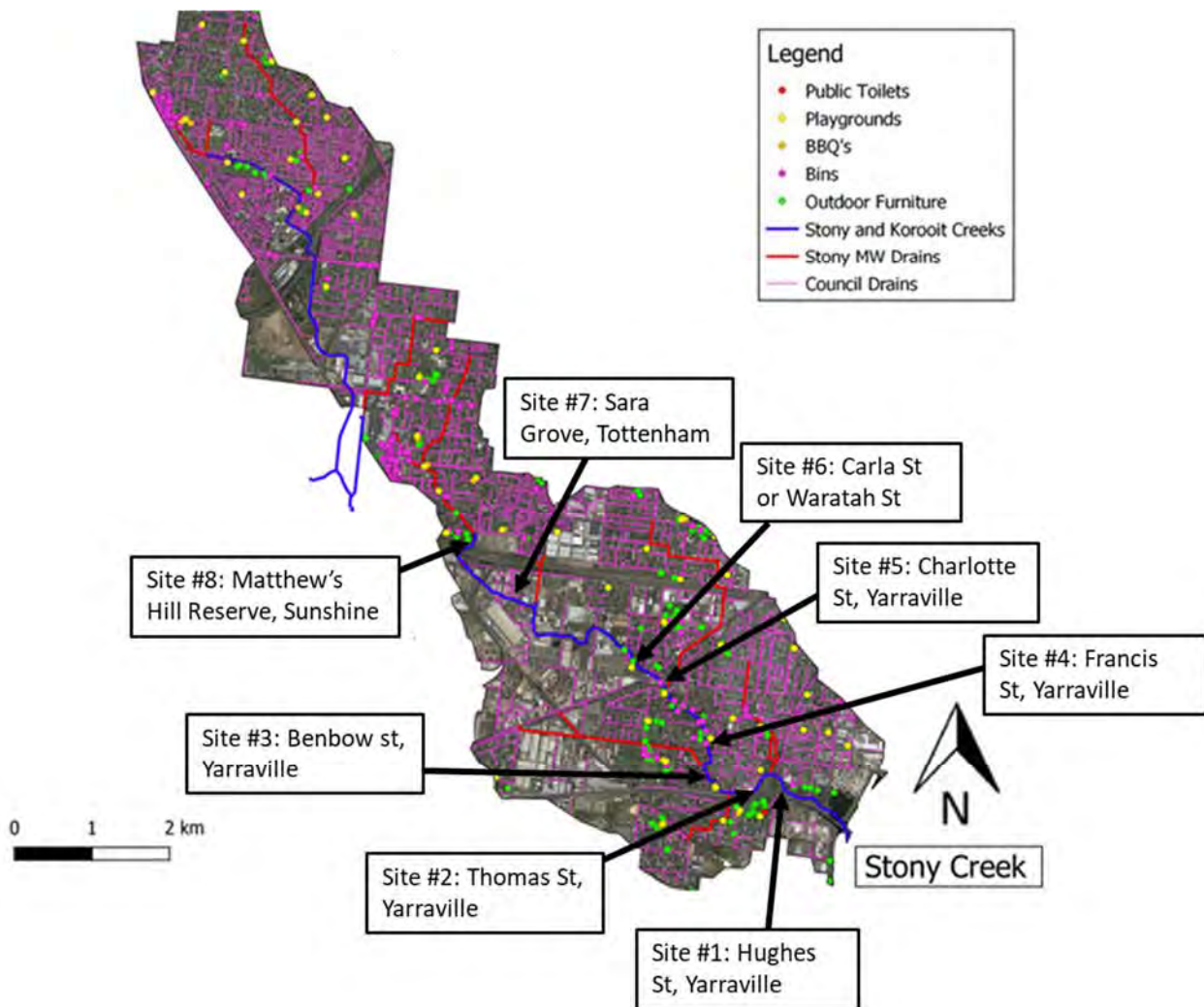


Figure 8: Proposed sampling sites for bank surveys

Table 8: Proposed site locations for bank surveys

Site Number	Location	Description
1	Hughes St Yarraville	Bottom of catchment, Stony Creek Reserve – needs to be above estuary. Site is below drain #1
2	Thomas Street Yarraville	Suggest upstream of Thomas St. Site is upstream of drain #1, downstream drain #2
3	Benbow Street Yarraville	Suggest downstream of street in concrete channel. Site is above drain #2, below drain #3
4	Francis St	Bottom of Cruikshank Park. Suggest just above Francis St before concrete channel. Site is above drain #3, below drain #4
5	Charlotte St	Top of Cruikshank Park suggest just upstream of Charlotte St, but below Somerville Rd. Site is above drain #4, below drain #5
6	Carla Street or Waratah Street	Suggest sample below council drain if Carla St. or above Waratah St bridge. Site will be above drain #4, below drain #5
7	Sara Grove	Site will be above drain #5, below drain #6
8	Matthews Hill Reserve	Top of catchment. Suggest site be above Sunshine rd. Site will be below drain #6.

4. References

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Appendix A: Recommended access points for main drains

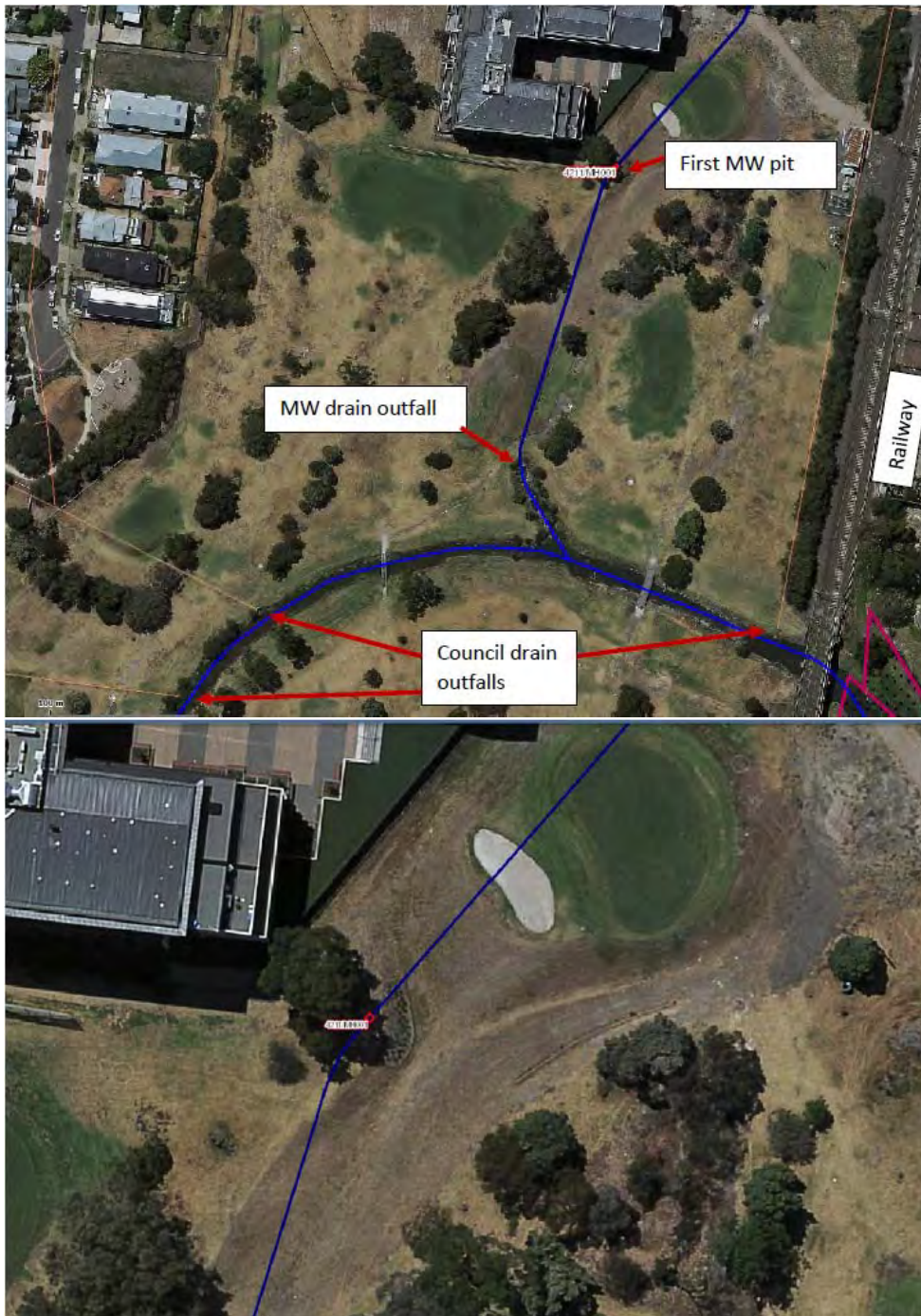


Figure 9: Location of Melbourne Water main drain at Yarraville Golf Course (top), and close-up of manhole location at Yarraville Golf Course (bottom).



Figure 10 Map of manholes and drain outfall on Williamstown Rd, beneath the Westgate Freeway overpass.



Figure 11 Map of manhole and drain outfall at St. Leonard's Ave.



Figure 12 Location of manholes and drain outfall at Charlotte St.

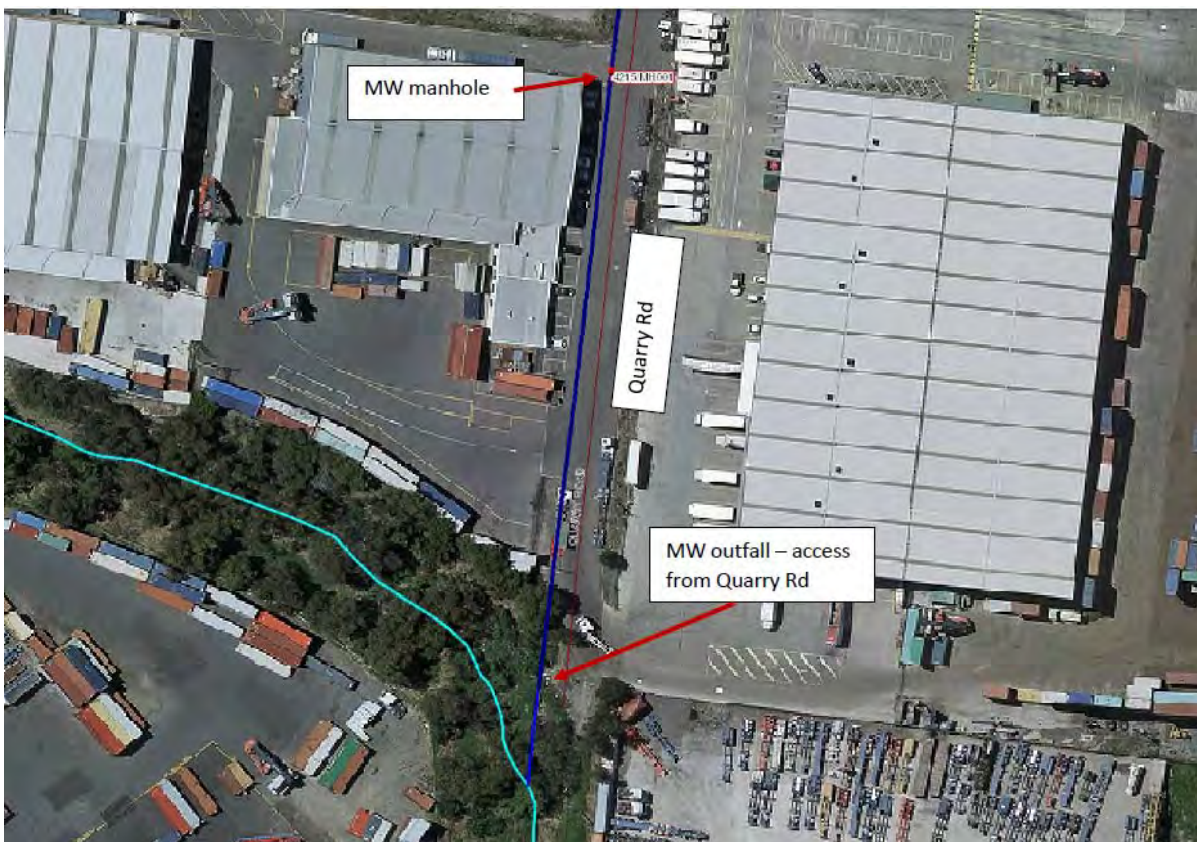


Figure 13 Location of manhole and drain outfall at Quarry St.



Figure 14 Location of manholes and drain outfall at Matthew's Hill Reserve. Manholes are located in Walter St.

Appendix B: Contacted stakeholders

The information presented in Section 2: Background was gathered through consultation with a variety of stakeholder groups. Resource management stakeholders were approached for information regarding current stormwater assets in place around the catchment and litter management data available, and community representatives were contacted to discuss the values for the catchment and how litter may affect those values. The organisations contacted are listed in Table 9.

Table 9. Stakeholder organisations contacted to determine background information on the litter resources and data collected from the Stony Creek catchment.

Organisation	Division
Maribyrnong City Council	Parks & Open Space
	Park Ranger
	Sustainability Officers
	Civil & Drainage
Melbourne Water	Stony Creek Rehabilitation Program
	Waterwatch Coordinators
	Waterways & Land Officer Regional Services
	Metropolitan waste & resource recovery group
EPA Victoria	Officers for the Protection of Local Environment
	Marine Water Sciences
	Applied Scientist
	Water Quality expert
	Chemical Storage Investigation
Friends of Stony Creek	Administration & management roles
Friends of Cruikshank Park	Member
Beach Patrol	General members
Love our Street	Member
Friends of Elster Creek	Member
Wurundjeri Woiwurrung Cultural Heritage Aboriginal Corporation	Water Unit
Bunurong Land Council	Land and Waters
Westgate Golf Club	Management role
RMIT University	Former postdoctoral researcher
Brimbank City Council	Asset & Property Services
	Conservation Coordinator
	Various other roles
Hobson's Bay City council	Reception desk
	Waste & Litter
	Conservation & Environment
Tangaroa Blue Foundation	Co-Ordinator

Maidstone and West Footscray Residents Action Group (MAWFRAG)	Administration
Gowrie Clare Court Early Learning Centre	Employees
Port Phillip Ecocentre	Project Manager
Sustainability Victoria	Victorian Litter Plan
Department of Environment, Land, Water and Planning	Marine Biodiversity Policy and Programs
Parks Victoria	Employee
Local community members	NA