YARRA INPUTS – TRACKING SOURCES OF FAECAL POLLUTION

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INTRODUCTION

The Yarra River has shaped Melbourne's development and growth, supporting industry and tourism, and is highly valued as an environmental and recreational asset.

Two million Melburnians live and work in the suburbs that drain into the Yarra River. Growing population, expanding urban development and intensification of agriculture activities in the catchment are all placing increasing stress on the river and directly impacting on its water quality.

The Yarra River is being used more and more for a range of water-based recreational activities, and the presence of bacterial contamination presents a potential public health risk to recreational users.

While many gains have been achieved over the past few decades, the Government's Yarra River Action Plan identifies more work that needs to be done to improve water quality further.

Identifying the types of faecal contamination and how and where it is entering the Yarra River is fundamental to ongoing improvements in recreational water quality. This information is necessary to allow the direction of management action and resource investment to areas where they will have the maximum benefit in reducing faecal contamination inputs.

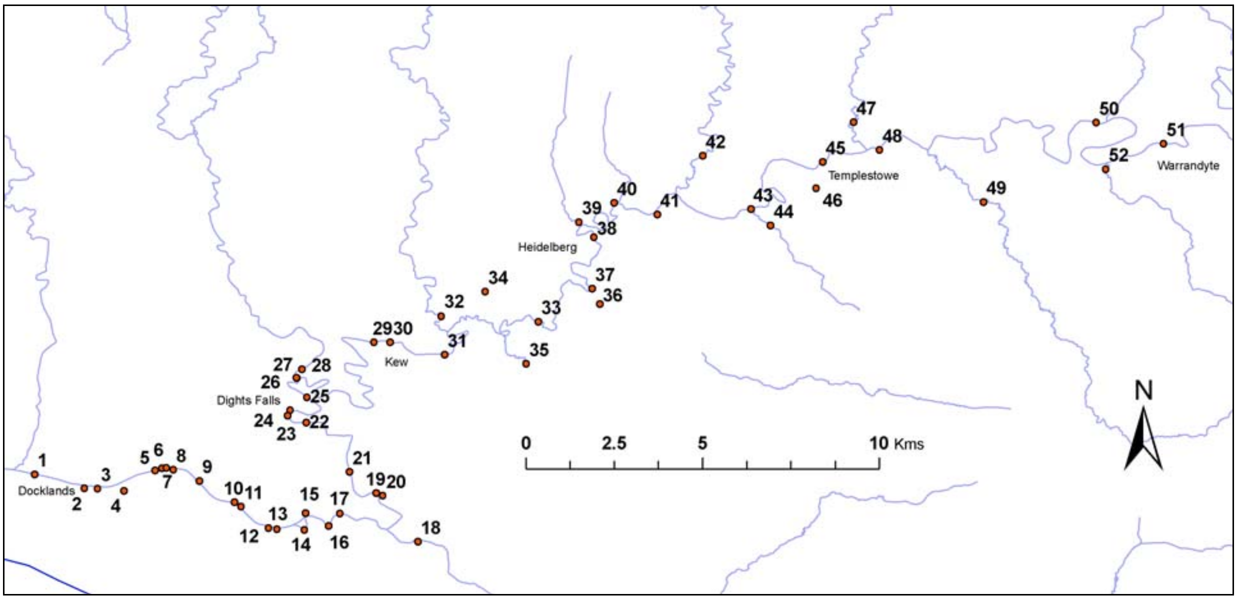

Figure 1: Yarra inputs – drains, tributaries and river sample sites

EPA Victoria and Melbourne Water are leading a three-year Yarra River Action Plan project to locate and remove key sources of faecal pollution entering the middle and lower reaches of the Yarra River.

This report provides a summary of the first-year screening investigation. This was undertaken to identify which of the many stormwater drains and tributaries entering the Yarra River:

- contribute significant levels of faecal contamination to the river
- require further detailed investigation to pinpoint the sources and direct works to remove these sources.

SOURCES OF CONTAMINATION

Melbourne's extensive drainage system carries stormwater from our streets and buildings through a series of gutters, pipes and drains and discharges it into rivers and creeks. The city's extensive sewerage system carries sewage through another series of pipes to sewage treatment plants.

In dry weather, potential sources of faecal contamination include sewer blockages, seepage of sewage from the system, and cross-connections between sewerage and stormwater pipes. Poorly operating septic tanks and animal inputs are also potential contributors.

In wet weather, the amount of contamination in the river may increase from a number of sources, including increased run-off from stormwater drains, surface run-off direct to the river and sewer emergency relief structures allowing temporary discharge of sewage to waterways during heavy storms.

IDENTIFYING THE SOURCES

Bacterial levels start to climb noticeably in the middle and lower reaches of the Yarra River and it is in these areas that water-based recreational activities become more frequent. The screening investigation was carried out to identify the most significant sources of faecal contamination in this stretch of the river.

Ten major metropolitan tributaries and 29 stormwater drains flow into the Yarra between Warrandyte and Docklands. Of these, there is a significantly higher density of stormwater drains in the lower reaches of the Yarra River downstream of Kew.

Samples were collected from these tributaries and drains, at or near the point of entry into the Yarra River, as well as at 13 locations in the river itself (Figure 1). Sampling occurred on six days during late 2005, in both wet and dry weather conditions.

E.coli indicator bacteria were measured at all sites, along with other water quality indicators such as nutrients. Flow rates entering the river were measured or estimated, to provide an indication of the relative contributions to the faecal load in the river from the various input tributaries and drains.

Where bacterial levels were found to be elevated, the faecal sterols method (developed by CSIRO) was also employed to assist in identifying whether human faecal contamination was present in the drains and tributaries. One faecal sterol in particular – coprostanol – is a biomarker of human contamination, constituting approximately 60% of the total sterols found in human faeces. Some of the Yarra River sites were also analysed for faecal sterols, regardless of their measured bacterial levels.

WHAT WE FOUND

The results (in the Appendix) showed that bacterial levels entering the river varied considerably, both between the sites and across the different sample dates at the same site. There are, however, some general comments that can be made.

In dry weather, many of the drains had much higher *E.coli* concentrations than the tributaries and the river itself. There was also much more variability between samples taken from individual drains. Because of the generally higher flows in the tributaries compared to the drains, the *E.coli* load for the tributaries was often relatively higher in dry weather. Despite this, the *E.coli* concentration in many of the tributaries was often similar to, or less than, the concentration in the river, so the effect of the tributary input was often only minor.

Rainfall run-off is known to contribute to elevated bacterial levels. In wet weather, both the drains and tributaries generally had much higher concentrations and loads of bacteria than in dry weather. Again, the drain samples showed the most variation between the sampling events. With higher flows on wet-weather sampling days, the tributaries made much greater relative contributions of faecal load than the drains. As would be expected, the wet-weather samples from the mainstream Yarra River sites had higher *E.coli* levels than the dry-weather samples.

Most drains recorded the faecal biomarker coprostanol at a level indicating the presence of human faecal contamination. Some drains showed very high proportions of human faecal matter compared to other sources of bacterial contamination on one or more sampling days.

The results clearly indicate a number of drains, such as Harper Street, Elizabeth Street and Kew, as significant sources of bacterial contamination. Others show little signs of contamination – for example, Banyule, Yarra Park and Federation Square drains. There are also a relatively large number of drains that show a great deal of variability in the *E.coli*, flow or human faecal biomarker results.

IDENTIFYING PRIORITY SOURCES

An assessment of the results from the screening investigation, and historical information where available, was undertaken to identify the tributaries and drains that are significant sources of faecal contamination to the Yarra River.

The assessment considered the results based on the premise that, if our stormwater and sewerage systems are performing well:

- in dry weather, there should be little bacterial contamination present in drains and tributaries, and evidence of human faecal contributions should not be found
- in wet weather, bacterial levels will increase from a range of sources, but evidence of human faecal contributions should only be found in storm events, when sewer emergency relief structures activate (allowing temporary discharge of sewage to waterways).

The determination of priorities was based on an analysis of the following factors:

- presence of high levels of *E.coli* on more than one occasion
- the load or volume of bacterial contamination contributed to the Yarra River
- the change in bacterial levels that this load would cause in the river itself
- biomarkers of human faecal contamination found in significant proportions relative to the total bacterial levels
- the significance of results in dry weather (when there should be little contamination) and wet-weather conditions
- for the tributaries where there was monitoring data available, the number of years of elevated *E.coli* levels.

From this process, 12 priority stormwater drains and three tributaries (listed below) have been identified. Further detailed follow-up investigations on each of these drains and creeks is required in order to identify where faecal contamination is being introduced into these systems.

- Harper Street Main Drain
- Elizabeth Street Main Drain
- Kew Main Drain
- Princes Bridge Drain
- Salt Creek Main Drain
- Hawthorn Main Drain
- Locksley Road Main Drain
- Porter Street Main Drain
- Bulleen North Main Drain
- Prahran Main Drain
- Fairfield Main Drain
- Glass Creek Main Drain
- Gardiners Creek
- Koonung Creek
- Darebin Creek.

PROGRESS OF PRIORITY INVESTIGATIONS

Intensive follow-up investigations are under way on a number of the priority drains that are easily accessible:

- Harper Street Main Drain
- Kew Main Drain
- Salt Creek Main Drain
- Hawthorn Main Drain
- Locksley Road Main Drain
- Bulleen North Main Drain
- Prahran Main Drain.

This involves walking through the larger stormwater drains, taking samples inside the drains and using closed circuit television for the smaller stormwater drains. Councils and water retailers are assisting with these investigations.

An investigation of the Elizabeth Street and Princes Bridge drains has also commenced. The lower sections of these drains are continuously flooded, cannot be safely entered, and require a different range of methods. A 'toolkit' of methods is being used for these drains, including investigating possible sources at the individual building and street level, and lifting manhole covers to collect samples.

Tributary investigations also require a different approach, as many smaller creeks and stormwater drains flow into Gardiners, Koonung and Darebin creeks. The program to investigate these is similar to that for the Yarra River, beginning with a screening phase to identify where major contributions of faecal contamination are entering the system. This will be followed by intensive investigation of identified significant creek and drain inputs.

Follow-up investigations of the remaining priority drains and tributaries will be undertaken over the next year.

Information will be published on the outcomes of each of the drain and tributary investigations once completed.

FURTHER TESTING OF NON-PRIORITY INPUTS

Further monitoring is being carried out over the next year on the drains that showed a great deal of variability in the *E.coli*, flow or human faecal biomarker results. This will provide a more substantial information base on which to assess whether any of these drains should be moved to the priority list. In addition, surveillance monitoring of the drains and tributaries that currently show little evidence of significant contamination is being conducted out to confirm their status or highlight any change in condition.

ACKNOWLEDGEMENTS

EPA wishes to thank the following organisations for their contributions to the screening phase investigation:

Melbourne Water

City West Water

South East Water

Yarra Valley Water

FURTHER INFORMATION

EPA Information Centre

40 City Road Southbank Victoria 3006

GPO Box 4395QQ Melbourne Victoria 3001

Telephone 03 9695 2700

Facsimile 03 9695 2710

www.epa.vic.gov.au

APPENDIX

Yarra inputs – screening phase drain results

			E. coli concentration (orgs/100 ml)						Relative load (% of Yarra River load at Kew)						Estimated change in Yarra River *E. coli* concentration (orgs/100 ml)						Human faecal biomarker (coprostanol/ 5a cholestanol ratio)					
Rank	**Site no.**	**Site Name**	24/08/05	25/08/05	31/08/05	8/11/05	29/11/05	30/11/05	24/08/05	25/08/05	31/08/05	8/11/05	29/11/05	30/11/05	24/08/05	25/08/05	31/08/05	8/11/05	29/11/05	30/11/05	24/08/05	25/08/05	31/08/05	8/11/05	29/11/05	30/11/05
			Dry	Dry	Wet	Wet	Dry	Dry	Dry	Dry	Wet	Wet	Dry	Dry	Dry	Dry	Wet	Wet	Dry	Dry	Dry	Dry	Wet	Wet	Dry	Dry
1	23	Harper Street Main Drain	120,000	160,000	73,000	16,000	240,000	170,000	3	5	0.3	1	50	34	19	19	6	45	42	50	9.6	5.5	6.9	4.2	4.6	8.1
2	5	Elizabeth Street Main Drain	140,000	92,000	17,000	17,000	46,000	14,000	13	10	0.2	1	359	40	93	23	4	12	289	55	5.2	3.2	nq	1.3	2.5	1.7
3	31	Kew Main Drain	>240,000	170,000	>240,000	52,000	2000	730	25	33	2	3	1	0.2	166	119	60	226	1	0	11.3	10.2	8.9		nq	<0.9
4	6	Princes Bridge Council Drain	61,000	2000	4600	31,000	20,000	160,000	1	0.4	0.1	1	2	18	9	1	0	17	1	26	5.7	0.5	1.9	1.0	1.8	1.0
5	39	Salt Creek Main Drain	24,000	2400	2900	9800	3700	6100	3	1	0.2	0.4	3	5	21	3	11	23	2	6	5.0	4.2	2.6	1.9	3.4	2.2
6	20	Hawthorn Main Drain	6100	1600	6500	24,000	1600	1400	1	0.4	1	5	3	1	4	0	13	180	2	1	1.4	1.5	1.8	3.1	1.8	2.3
7	34	Locksley Road Main Drain	120,000	14,000	14,000	7700	650	2000	2	0.4	0.2	3	0.1	0.1	14	2	10	204	0	0	8.7	7.2	5.4	0.9		2.1
8	46	Porter Street Main Drain	150	610	24,000	1300	6100	4100	0.0	0.1	1	0.0	3	1	0	0	29	0	3	1			2.5		3.1	3.2
9	41	Bulleen North Main Drain	35,000	6900	2000	8200	530	20,000	2	1	0.1	0.2	0.1	2	14	2	2	14	0	2	2.2	1.8		1.7		0.9
10	13	Prahran Main Drain	730	46,000	1300	35,000	52,000	31	0.1	6	0.0	5	27	0.0	0	12	−1	135	22	0	5.4	3.0	1.1	1.1	<0.5	
11	29	Fairfield Main Drain	2000	490	1700	87,000	39,000	290	0.1	0.0	0.0	1	11	0.0	0	0	0	52	10	0	4.0		2.3	2.8	3.9	
12	35	Glass Creek Main Drain	2000	310	2000	24,000	99	4100	0.2	0.0	0.1	12	0.0	18	1	0	4	861	0	24	1.6		1.0	2.2		nq
13	37	Bulleen Road Drain	870	2400	9200	13,000	730	1200	0.0	0.0	0.1	0.1	0.1	0.1	0	0	4	7	0	0	5.4		4.9	>6		3.3
14	22	Church Street Main Drain	1600	370	4100	12,000	2800	460	0.1	0.1	0.1	1	2	0.2	0	−1	1	45	2	0	2.3		nq	8.7	2.8	
15	14	Williams Road Diversion Drain	400	46	2000	82,000	1000	520	0.1	0.0	0.0	28	1	0.4	0	0	0	898	1	0			nq	1.3	<0.6	
16	9	Batman Avenue Drain (council)	2000	2000	920	12,000	17,000	820	0.1	0.1	0.0	0.1	6	0.2	0	0	0	0	5	0	<0.4	<0.4		1.0	<0.7	
17	24	Gipps Street Main Drain (council)	390	520	610	6900	1700	8200	0.0	0.0	0.0	0.2	0.1	0.5	0	0	0	7	0	1				<0.3	3.9	6.9
18	15	Richmond Quarry Main Drain	270	370	2600	1000	140	2400	0.0	0.0	0.0	0.0	0.0	0.1	0	0	0	−3	0	0		>4.8	<0.6	0.8		3.8
19	26	Alexander Parade Main Drain	34,000	1600	2000	39,000	260	150	2	0.2	0.1	1	0.4	0.1	12	0	−1	47	0	0	<0.8	nq	nq	<0.7		
20	16	Canberra Road Main Drain	290	1	1700	16,000	24,000	4600	0.0	0.0	0.0	0.3	4	1	0	0	0	6	3	1					0.9	<0.9
21	21	Palmer Street Main Drain	96	71	1400	20,000	93	820	0.0	0.0	0.0	2	0.0	0.1	0	0	0	77	0	0			0.9	1.0		
22	27	Alexander Parade Relief Drain	200	250	2000	17,000	24	15	0.0	0.0	0.0	0.2	0.0	0.0	0	0	0	6	0	0			nq	<1		
23	3	Ferrars Street Main Drain	980	440	2400	8700	22	34															1.2	0.7		
24	11	Yarra Park Main Drain	310	37	1200	4600	610	770	0.0	0.0	0.0	0.2	0.1	0.1	0	0	0	−7	0	0					<0.6	
25	4	Hanna Street Main Drain*	980	520	2400	230	2000	770													0.6		0.4		0.6	0.9
26	40	Banyule Main Drain (Banyule Ck)	770	280	980	1000	730	440	0.0	0.0	0.1	0.0	0.0	0.0	0	0	1	−4	0	0						
27	8	Federation Square Council Drain	10	1	140	460	690	310	0.0	0.0	0.0	0.0	0.1	0.0	0	0	0	0	0	0						
28	2	Johnson Street Main Drain	6	2	72	1	23	11																		

* Access to Hanna Street Main Drain limited to times of scheduled maintenance works. Sampling dates were: 2/09/05, 16/09/05, 30/09/05, 14/10/05, 27/10/05, 11/11/05

Site 10, Gosch's Paddock Main Drain, was not sampled because it was dry on all sampling occasions

Dry = dry weather sample run. Wet = wet weather sample run.

E.coli results with > indicates greater than the reporting limit of the method of analysis used.

Blank cells indicate no data - either flows could not be estimated at sites with tidal influence or *E.coli* levels were too low for faecal sterols analysis.

A negative number for estimated change in concentration means a reduction in *E. coli* in the Yarra River.

Faecal biomarker results with < or > are estimates due to sample method interferences. nq = Human proportion not quantified.

Raw sewage contains 1,000,000 to 10,000,000 *E.coli* organisms/100 ml. Raw sewage has a faecal biomarker ratio of 10 to 15. A faecal biomarker ratio > 5 indicates very high human contribution to total bacterial concentration.

Yarra inputs – screening phase tributary results

			E.coli concentration (orgs/100 ml)						Relative load (% of Yarra River load at Kew)						Estimated change in Yarra River *E.coli* (concentration orgs/100 ml)						Human faecal biomarker (coprostanol/5a cholestanol ratio)					
Rank	**Site no.**	**Site name**	24/08/05	25/08/05	31/08/05	8/11/05	29/11/05	30/11/05	24/08/05	25/08/05	31/08/05	8/11/05	29/11/05	30/11/05	24/08/05	25/08/05	31/08/05	8/11/05	29/11/05	30/11/05	24/08/05	25/08/05	31/08/05	8/11/05	29/11/05	30/11/05
0			Dry	Dry	Wet	Wet	Dry	Dry	Dry	Dry	Wet	Wet	Dry	Dry	Dry	Dry	Wet	Wet	Dry	Dry	Dry	Dry	Wet	Wet	Dry	Dry
1	18	Gardiners Creek	980	190	52,000	11,000	260	690	3	1	481	18	5	11	9	−2	9108	546	2	10	>2.1	>3.3	1.3	nq		
2	36	Koonung Creek	1000	410	3100	17,000	2400	550	1	0.4	2	9	11	2	3	1	71	620	8	2	>2.2			1.2	0.9	
3	32	Darebin Creek	980	150	4100	5800	2200	3100	2	0.4	24	11	15	13	9	−1	409	519	11	17				<0.5	2.3	2.8
4	47	Diamond Creek	980	550	1700	6500	270	1200	2	2	1	1	2	5	12	3	4	63	1	6				<0.4		nq
5	44	Ruffey Creek	580	210	3300	1400	1100	770	0.2	0.1	1	1	29	13	1	0	41	−11	19	12				0.8	1.3	
6	50	Stony Creek	170	390	1700	5500	730	>24,000	0.0	0.0	0.1	0.0	0.0	0.2	0	0	1	2	0	0				1.3	1.8	6.5
7	52	Andersons Creek	180	170	3100	5500	980	1600	0.1	0.1	1	0.3	5	5	0	0	21	28	3	6				1.3		nq
8	49	Mullum Mullum Creek	730	550	3300	8200	150	150	1	1	3	2	1	1	4	2	80	187	−1	0				<0.4		
9	42	Plenty River	280	240	1600	8700	610	690	0.4	1	1	3	7	4	0	1	33	173	3	4				<0.5		
10	28	Merri Creek	250	110	2500	3100	280	220	1	1	16	7	8	4	−12	−6	−46	−81	5	2			1.0	<0.6		

Dry = dry weather sample run. Wet = wet weather sample run.

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Raw sewage has a faecal biomarker ratio of 10 to 15.

A faecal biomarker ratio > 5 indicates very high human contribution to total bacterial concentration.

Water quality monitoring results 2000–05 for tributaries sampled in the Yarra inputs screening phase

	Gardiners Ck	Merri Ck	Darebin Ck	Koonung Ck	Plenty R	Ruffey Ck	Diamond Ck	Mullum Mullum Ck	Andersons Ck
2000	1041	287	1006	3091	1187	2209	858	1201	1743
2001	1216	337	497	2148	932	1571	839	888	830
2002	1216	201	378	2168	467	2122	425	548	673
2003	1984	500	832	2040	539	933	437	406	604
2004	1623	651	1063	1048	696	636	566	809	637
2005	913	404	1006	1341	746	500	704	888	588

Source: Melbourne Water