The keys to restoring the Yarra River

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The topic I was given today is 'Septic and Stormwater inputs into the Yarra River'. It would be reasonable to expect that, with a topic like this that I'd spend most of my time talking about faecal contamination. Certainly, since the Age ran its stories about the state of the Yarra in 2005[1], faecal contamination has been a pre-occupation of many a politician and stream manager. And yes, I will talk about it today, but I'd like to start by saying that, while faecal contamination is obviously an important human health issue, our preoccupation with it could be a distraction from the Yarra's bigger problems.

I believe a bigger concern is the *ecological* health of the river. Faecal contamination is only one symptom of what is ailing the river: it is suffering from what has been termed 'the urban stream syndrome'[6], and it is suffered by rivers of cities all around the world. Ecologically sick rivers are the norm in cities, and at least in developed countries, the heart of the problem is old-fashioned, inappropriate stormwater drainage design.

Today I want to talk about why our stormwater drainage system is such a problem. I want to talk about how we can do stormwater drainage differently, to make the Yarra a healthy river again (and in the process, help solve Melbourne's water supply crisis). I'm not discounting the importance of faecal contamination – it's just that we could spend a lot of money chasing sources of poo in the river, and still have a sick river on our hands. I hope to show you that by tackling what is making the Yarra ecologically sick, we will also be tackling the faecal problem.

Following the interest generated by the Age coverage, the Yarra River Action Plan[2], while taking a broader view of river health, focused its efforts on solving the faecal problem. Priority projects were: $250m for replacement of almost 20,000 septic tanks in the urban fringe with a reticulated sewerage system, $300m for sewerage upgrades in Melbourne's north, and a modest $20m for stormwater management. Have they got these priorities right? It didn't seem right to me. My research group's work on Melbourne's streams had found that what was making our urban streams sick was stormwater: we looked at septic tanks, and they didn't seem to be much of an issue.

But we hadn't measured faecal contamination, so I wasn't absolutely sure. As a result, I chased up some *E. coli* measurements (the most common indicator of faecal contamination) that Melbourne Water had collected, and used the spatial data that we had been using, showing the locations of all septic tanks in the Shire of Yarra Ranges to see if there was a relationship between faecal contamination in streams and the number of septic tanks in their catchments. If septic tanks were playing a big part in faecal contamination you would expect a strong relationship between E. coli concentrations and the density of septic tanks in a catchment. This was not the case (Fig. 1).

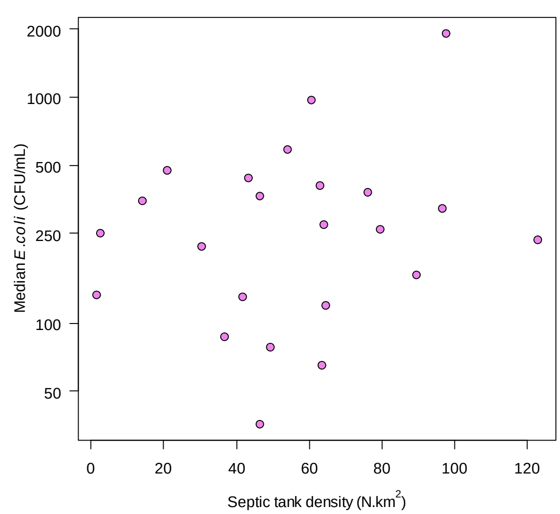

Fig. 1. *E. coli* concentration (median value, a good indicator of baseflow conditions) in streams of the Dandenong Ranges, plotted against catchment density of septic tanks, showing no relationship. (adapted from Walsh et al. 2006[8])

So can septics be that much of a problem? Well, of course, not all tanks are likely to be an equal problem and where the tank sits in the catchment can make a big difference. A tank on top of a hill, 100s of metres from the stream is much less likely to leak sewage into the stream than one that is situated just a few metres from the stream.

Once sewage gets into a stream, there are lots of physical and biological processes that dissipate its effect as it flows downstream. So, if we are measuring *E. coli* concentration at one point in the stream, a tank a few metres upstream is likely to be having a much larger influence on the reading we get than an equivalent tank a few kilometres upstream.

So, rather than just counting septic tanks to get a simple density, we might better explain variation in stream *E. coli* concentrations if we give each septic tank a score between 0 and 1, depending on how far across the land they are from the stream, and how far along the stream they are to our sampling point. We can then calculate a weighted density to see if that explains things better. And indeed it does.

The best model we found was one where we only counted those tanks within 60 m of a stream, and those tanks had diminishing scores downstream: 0.5 after 3.5 km, and near zero effect after 17 km (Fig. 2).

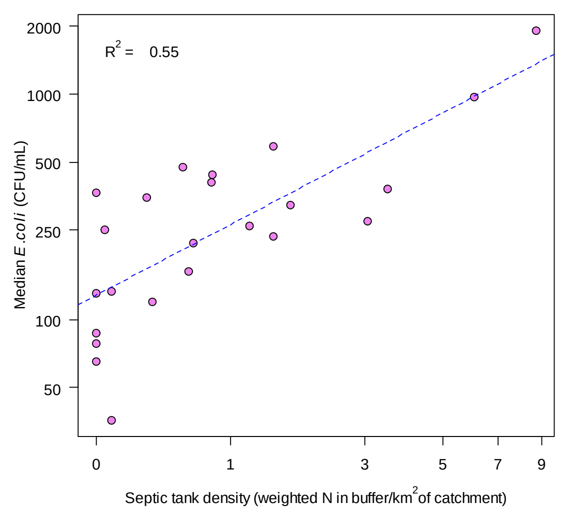

Fig. 2. *E. coli* concentration in streams of the Dandenong Ranges, plotted against weighted catchment density of septic tanks, showing no relationship. For all sites, each septic tank was given a score between 0 and 1. Tanks >60 m from the stream = 0, and tanks were given diminishingly small scores with distance along the stream (0.5 after 3.5 km, 0.05 after 17 km) (adapted from Walsh et al. 2006[8]).

So, we get the best relationship between faecal contamination in streams and septic tanks in the catchment if we don't count those tanks that are further than ~60 metres from the stream. Of the 15,700 tanks in the catchments of these sites in the Dandenong Ranges, only 600 tanks are within 60m of a stream. So, only 600 out of almost 16,000 tanks are likely to be contributing to faecal contamination in these streams. So across the wider Yarra catchment, we might be looking at 5 or (very conservatively) 10% of septic tanks as being potential problems to the Yarra or its tributaries.

And, of course, let's not forget that the worry about poo in the Yarra all began with high faecal readings down in the lower Yarra, below Dights Falls. The nearest septic tank to Dights Falls is in Templestowe, 25 km upstream. Now even though there may be some problem septics in Templestowe, the effect of faecal input will have diminished to almost nothing after 25 km of flow, so it is unlikely that a single septic tank will be contributing significantly to baseflow faecal contamination in the Yarra River below Dights Falls (not that I'm suggesting that we should only be worried about the lower river!).

So what is the major cause of faecal contamination in the lower Yarra? The sites we've looked at so far are all on the fringe of the Melbourne metropolitan area in the Dandenong Ranges (Fig. 3). *E. coli* levels in

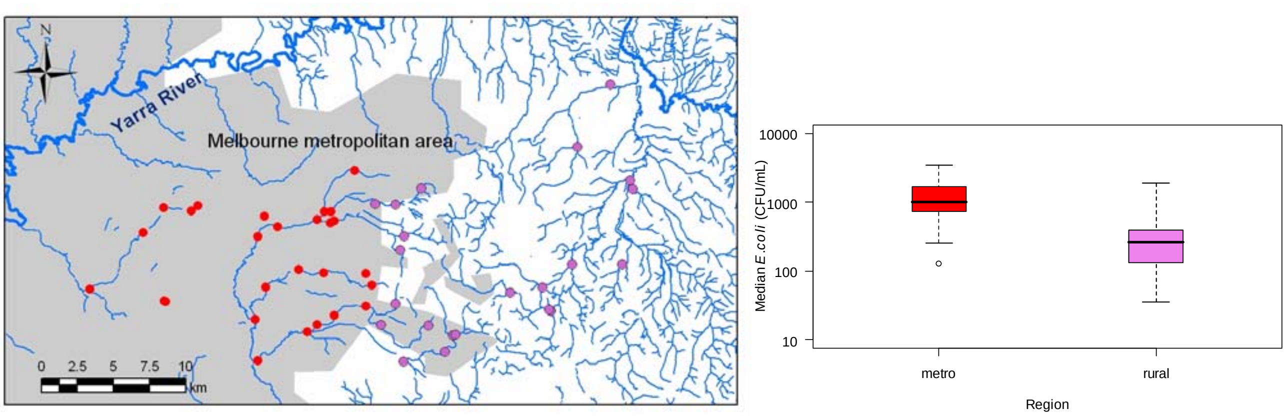

Fig. 3. Map of eastern Melbourne, with the metropolitan area shaded. Sites used in the septic tank-faecal contamination analyses of Figs. 1 and 2 are shown as purple dots, and the range of *E. coli* values for those sites is shown as the violet box plot. Metropolitan sites (red dots), with no septic tanks in the metropolitan parts of their catchments generally have much higher *E. coli* values (red dots). Adapted from Walsh et al. 2006[8])

these sites, where there are lots of septic tanks, are generally a lot lower than *E. coli* levels in metropolitan sites, where there are no septic tanks (boxplots in Fig. 3). So, where there are lots of septic tanks faecal contamination is not such a big problem, and the problems that do exist are caused by only a very small proportion of tanks. Where there are no septic tanks, faecal contamination is more of a problem. So, why are we spending a very large amount of money to replace 20,000 septic tanks to improve the river, if they are not a major cause of the problem? Perhaps a more important question is: *what **should** we be spending our money on?*

To answer this question, let's think about the relationship between the land and its streams in a non-urban landscape. Stormwater drainage networks greatly increase drainage density in catchments (Fig. 4). In the metropolitan area, the chance of a piece of land being directly connected to its stream is vastly greater than is the case in a natural catchment.

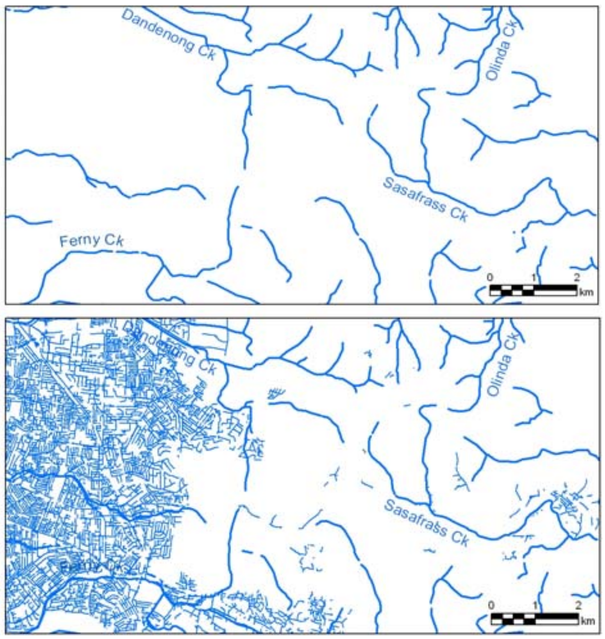

Fig. 4. Comparison of the natural drainage network of a part of the Dandenong Ranges (above), and the drainage network, when stormwater drains are included (below). A and B represent 2 random points, one in the rural area, and one in the metropolitan area.

Let's consider the sorts of things can happen in a landscape that might affect life in a stream:

- An animal could defecate;
- A septic tank could leak or overflow;
- A sewer pipe could leak.

And let's expand our thinking beyond faecal contamination, which is really just a symptom of a much bigger problem.

- Some oil could spill onto a road;
- Some herbicide/pesticide/fertilizer could be sprayed;
- A tree could drop its leaves;
- Someone could wash their car on the street

Of course, in any one day in a city of 4 million people, it is a virtual certainty that any of these things will happen more than once. If they were to happen at a place with a natural drainage density (say, point A in Fig. 4), the chances of any contaminants getting to the stream and any damage being done are very small. But if they were to happen at a place in the metropolitan area (say point B in Fig. 4), there is a very high probability of them finding their way to a stormwater drain and straight to the nearest stream. So, a septic tank or a dodgily plumbed toilet is a much bigger danger in an area where there is lots of stormwater drainage. The chance of them directly leaking to the stream is magnitudes larger than in a rural area.

The stormwater system is designed primarily to minimize flood risks in urban areas: normally it rains enough to create a flood risk perhaps once every year or two, but the stormwater system intercepts every drop from every storm, no matter how small, and sends it straight to the stream. It increases the frequency of disturbance to the stream from perhaps once or a few times a ***year***, when a big flood occurs, to once or a few times a ***week***, when it rains more than a mm or so. From a risk management perspective, if our aim is to have healthy urban rivers, this sort of stormwater drainage system is complete madness.

Given this madness, how could faecal levels in metropolitan streams be anything but elevated? And, of course, it is not just faecal levels. The frequent flushes of stormwater runoff and the cocktail of pollutants that it carries make the urban Yarra River and its tributaries ecologically sick, unable to support the diverse community of animals and plants that rural streams do, and much less able to perform ecological services for us, like the retention and transformation of pollutants from the land. Stormwater runoff saps the life out of streams and turns them into drains. This is the Yarra's biggest problem by far.

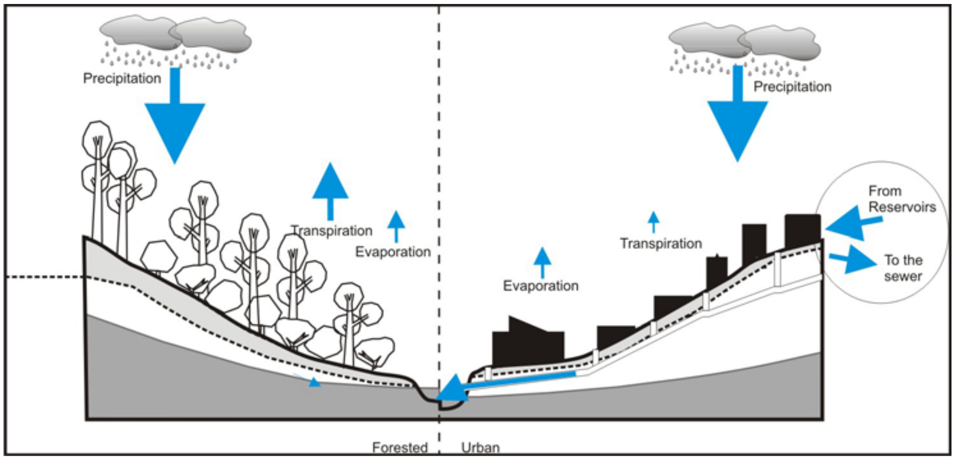

Fig. 5. Differences in the water cycle between a forested catchment and an urban catchment with conventional stormwater drainage. (adapted from Walsh et al. 2004[5])

So what can we do about it? Well we are already doing a fair bit right. Melbourne Water have been doing a good job for the last ten years encouraging councils to adopt new stormwater practices (often called water sensitive urban design), and now have a significant grants program to support things like biofiltration systems or raingardens on streets to intercept and filter runoff before it heads to the drains. The main driver for this new way of doing things has been the need to reduce nitrogen loads to protect the bay, but over the last ten years we have come to recognize that water sensitive urban design also has great potential to protect and restore urban rivers and streams. However, to really protect streams, we need to start doing water sensitive urban design differently:

Firstly we need to start designing stormwater treatment measures to reduce the frequency and volume of flow running into stormwater drains–as well as reducing nitrogen loads.

Flow objectives are really important because one of the biggest problems with stormwater is that there is way too much of it. All those roofs and roads produce masses more runoff than a non-urban piece of land: a typical suburb with 50% imperviousness produces as much as 5 times the volume of runoff than a similar bit of non-urban land. Let's see how that works with a picture of the water cycle (Fig. 5). In forested catchments, most of the water that hits the ground gets taken up by the trees and transpired back into the atmosphere. Only a small proportion of the water infiltrates into the ground to find its way to a stream (and water virtually never gets to the stream by flowing over the forest floor). In an urban catchment, with fewer trees, we lose much less water to the atmosphere by transpiration. Conventional stormwater drainage, takes every drop that falls on hard surfaces straight to the stream. If we are to have any hope of fixing up the Yarra, we need to be using this excess stormwater, and sending it to the sewer (which we can do using rainwater tanks that are plumbed into frequently used appliances like toilets and washing machines). This would also mean that we wouldn't have to take as much from the reservoirs.

If we do harvest all that excess water, then our stormwater treatment measures like rain gardens, swales and wetlands will be much more able to treat the water and release it slowly enough to restore a healthy baseflow to our streams. The modeling is done: we know we can collect enough, and we know it is virtually impossible to collect too much[3]. But the place we have to collect it is from is off the roofs of the catchment, *at the source* – there is no point in harvesting stormwater at Dights Falls: the damage is already done to the river and its tributaries by then. Fixing up the Yarra will require dispersed stormwater treatment measures, including rainwater tanks, across the catchment.

Surely this has to change the economics of rainwater tanks as an alternative water source. Not one study of rainwater tanks has considered their crucial role in river protection, and even without considering this, a recent report showed domestic rainwater tanks can be a significant addition to water supplies for Melbourne at a competitive cost (and this didn't even consider harvesting systems from more expansive commercial buildings)[4]. So if we are serious about fixing up the Yarra, dispersed rainwater harvesting should be included as one of the water planning scenarios being considered by the Victorian Government. At the moment it is not.

Finally I want to mention a couple of barriers that are preventing water sensitive urban design from being used as an effective river management tool in Melbourne. The first is a complex problem of ownership. We know that the highest priority action for fixing up the Yarra and its tributaries is to convert the streets of the suburbs to water sensitive urban design, but there are strong economic disincentives that discourage Melbourne Water from spending their large stream management budget up in the catchment. Although biofiltration systems built on council land might be the best way to protect or restore a stream, they have been difficult to get funded, because they would not be Melbourne Water assets.

A second barrier is a short-sighted desire for equity. One of Melbourne Water's aims for water sensitive urban design is to make it standard practice across Melbourne: a very admirable aim. But in doing this, they are spreading the meagre funds available for new stormwater management thinly across all the councils, supporting projects wherever the opportunity arises. Using this strategy alone almost certainly means that it will be many years before we start to see an improvement in the Yarra and its tributaries[7]. A better strategy would be, in addition to continue providing support to all councils across Melbourne, to target priority subcatchments so that we can see short-term improvements in some streams, and make sure that we have our methods as right as they can be. It might mean spending more money in a few priority areas, but it will mean a better outcome for all those who care about the Yarra and its tributaries.

So getting stormwater management right is going to be a challenge, there are barriers to overcome, but there are also some big opportunities that haven't been well recognized so far. If we manage to get stormwater right, we can help solve Melbourne's water supply problem. We are likely to start seeing better returns on our investments in other management practices like expanding the sewerage system, providing environmental flows, or riparian restoration. And we might yet see a clean, healthy Yarra flowing through the city in some of our lifetimes.

References

1. S. Cauchi, "Yarra a Cesspool, tests show: tests conducted for The Age reveal human source behind river pollution," *The Age*, 5 March 2005, pp. 1.
2. Department of Sustainability and Environment, "Yarra River Action Plan: Securing Water Quality for a Healthy Future" (Government of Victoria, 2006).
3. V. G. Mitchell, B. E. Hatt, A. Deletic *et al.*, "Integrated stormwater treatment and harvesting: technical guidance report" (Institute for Sustainable Water Resources, Monash University, 2006).
4. MJA, "The economics of rainwater tanks and alternative water supply options" (Marsden Jacob Associates, 2007). http://www.acfonline.org.au/uploads/res_rainwater_tanks.pdf
5. C. J. Walsh, A. W. Leonard, A. R. Ladson, T. D. Fletcher, *Urban Stormwater and the Ecology of Streams* (CRC for Freshwater Ecology and CRC for Catchment Hydrology, Canberra, ACT, 2004), pp. 44.
6. C. J. Walsh, A. H. Roy, J. W. Feminella *et al.*, The urban stream syndrome: current knowledge and the search for a cure *Journal of the North American Benthological Society* **24**, 706–723 (2005).
7. C. J. Walsh, T. D. Fletcher, *Water Sensitive Urban Design—can it really protect the environmental quality of receiving waters?* paper presented at the Proceedings of the 2nd Conference on Sustainable Water in the Urban Environment, Sippy Downs, Queensland 2006.
8. C. J. Walsh, J. Kunapo, M. Padgham, R. Coleman, "Urban stormwater drainage a stronger determinant of faecal contamination in Melbourne's streams than septic tank leakage" (Water Studies Centre, Monash University, 2006).

This is an illustrated transcript of a presentation by Chris Walsh at the Manningham Function Centre, Melbourne on 15th June 2007 as part of the seminar 'Water Quality in the Yarra River' organized by the Port Phillip and Westernport Catchment Management Authority and the Yarra Riverkeepers Association.