Banyule
CITY COUNCIL

WATERWATCH
Melbourne

Banyule City Council Bush Crew

Waterwatch Water Quality Data Report

A report on the water quality of
The Darebin Creek, at the Lillimur Avenue Drain
entrance, Heidelberg West.
From July 2007 to
July 2010

This report:

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The Banyule Bush Crew for collecting the data
Julia Vanderoord for training and assisting the bush crew during sampling.

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Executive Summary

Waterwatch data is collected by local community volunteers who are interested in waterway health. The information collected will improve the community's understanding of local river and creek ecology, and is particularly useful in helping to identify sources of pollution entering waterways. This information can then be passed onto the EPA

(Environment Protection Authority) to support prosecutions. It also helps Waterwatch groups to identify local actions to improve the health of local rivers and creeks.

As part of the North East Melbourne Waterwatch Program, The Banyule Council Bushlands team have monitored the Darebin creek over the past three years, commencing in July 2007. Data collected up until July 2010 is discussed in this report. The sampling program was initiated in order to determine if any pollutants were entering Darebin Creek via the Lillimur Ave Stormwater Drain from the industrial estate at Heidelberg West.

As can be seen in the table below, Electrical Conductivity (indicates Salinity), the nutrients ,Phosphate and Ammonium, Dissolved Oxygen and our biological sampling (of aquatic macro-invertebrates) all indicate outside rating guidelines (SEPP).

Conclusions for effects of Lillimur Drain on Darebin Creek from July 2007 – July 2010			
Parameters	**Upstream**	**At Drain**	**Downstream**
Electrical Conductivity	Unacceptable	Acceptable	Unacceptable
pH	Acceptable	Acceptable	Acceptable
Turbidity	Acceptable	Acceptable	Acceptable
Reactive Phosphorus	Unacceptable	Unacceptable	Unacceptable
Dissolved Oxygen	Unacceptable	Unacceptable	Unacceptable
Ammonium	Unacceptable	Unacceptable	Acceptable
Macro invertebrates	Unacceptable	Unacceptable	Acceptable

Table 1: Conclusions for effects of Lillimur Drain on Darebin Creek- see comments for this table on page 28

These water quality monitoring results have enabled recommendations for future river health directions for water managers of the Darebin Creek catchment. These are summarised in the table below, and discussed further in the recommendation section of this report.

Site	WQ issues	Recommended Actions
YDA420	• High nutrients • High EC • Low Dissolved Oxygen • Low macroinvertebrates	• Consider monitoring at a site further upstream, including another drain upstream to determine entry point of nutrients • Stormwater infrastructure improvements needed • Continue to monitor all the parameters • Commission consultant to test for Total Phosphate (TP) to get a more accurate indication of phosphate levels to SEPP. Consider monitoring Total Nitrogen and E.Coli. (there have been sewage leaks detected in 2011)
YDA421	• High nutrients • High EC • Low Dissolved Oxygen • Low macroinvertebrates	• Consider monitoring at a site further upstream, including another drain upstream to determine entry point of nutrients. Nutrient source investigation • Stormwater infrastructure improvements needed • Get a regular member of the community to keep observational records of this drain (ie colour changes, notice inputs) • Continue to monitor all the parameters • Discontinue macroinvertebrate sampling • Commission consultant to test for Total Phosphate (TP) to get a more accurate indication of phosphate levels to SEPP. Consider monitoring Total Nitrogen and E.Coli. (there have been sewage leaks detected in 2011)
YDA422	• High phosphate • High EC • Low Dissolved Oxygen	• Stormwater infrastructure improvements needed • Continue to monitor all the parameters • Commission consultant to test for Total Phosphate (TP) to get a more accurate indication of phosphate levels to SEPP. Consider monitoring Total Nitrogen and E.Coli. (there have been sewage leaks detected in 2011)

Table 2: Summarised water quality issues and recommended actions identified from this report.

1.Overview

1.1 Aim of the sampling program

- To assess the results of the monitoring program that was conducted monthly by the Banyule City Council Bush Crew, headed by Damien Karney, at the Lillimur Ave stormwater drain entrance into the Darebin Creek and at an upstream location and a downstream location.
- The hypothesis was that this drain is adding a significant level of pollution to the creek. If this claim can be legitimated with evidence it will allow relevant government organisations such as the EPA, Council and Melbourne Water to initiate changes in the area
- To explore whether education projects conducted by the EPA, Waterwatch and Council have been effective in reducing pollution incidences and improving overall Water Quality in this section of the creek and in the Lillimur Ave drain. These projects are described further in the 2009/10 Banyule City Council Waterwatch annual report.

1.2 Monitoring Plans

Monitoring for the existence of chemicals, hydrocarbons and other pollutants was done using parameters available to Waterwatch monitors (refer to section 2: Water Quality Parameters). The Banyule Council Bush Crew continues to monitor these sites monthly.

A monitoring plan gives direction, motivation and helps clarify to Waterwatch monitors how to collect data. It also provides directions to interpret data and ensures time and resources are used efficiently.

The Healthy Waterways Waterwatch Melbourne program regards the condition of water in rivers as an important indicator of environment health. The aim is to ensure that natural waterways are ecologically healthy. Waterwatch enables community groups and schools to become actively involved in the monitoring and management of waterways.

Monitoring was conducted monthly. Aquatic macro-invertebrate samples were taken seasonally (twice a year). Monitoring of the site was started in July 2007 and is currently ongoing. For the purposes of this report data was reported up until July 2010.

1.3 Monitoring Sites

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Site Code	Site Location	Northing	Easting
YDA420	Approximately 100 metres north (upstream) of the Lillimur Drain	5822331	327326
YDA421	located at the mouth of Lillimur Drain outlet	5822282	327325
YDA422	approximately 100 metres south (downstream) Lillimur Drain	5822289	327227

Table 3: Monitoring site locations

The monitoring was done at the Darebin Creek Grasslands Main Drain, which is located at the rear of the Heidelberg West industrial estate near Lillimur Avenue
Samples are taken at these three sites to show a comparison in water quality.

Figure 1: Map of West Heidelberg area showing collection site on Darebin creek. *Melways Ref. 19 E9*

Figure 2: Aerial map of site showing location of 3 sites sampled source: Banyule City Council, 2007

1.4 Data management and use

Hard copy data was (and is currently) forwarded to Waterwatch North East Melbourne Co-ordinator Julia Vanderoord for validation and entry into the Waterwatch database. It is also available to the *Friends of Darebin Creek*, the *Darebin Creek Management Committee* and to the general public as requested. This data is recorded on Waterwatch data sheets and kept on file at Banyule City Council. (Banyule City Council host the North East Melbourne Waterwatch program)

The data is used to inform the local community about the condition of the catchment through the publication of water quality results in community newsletters, through Councils annual Waterwatch reports and through the distribution of Waterwatch water quality reports such as this one.

This data represents the baseline data state before any major works have been undertaken at the site.

Quality of data

The data is at the standard required by the Waterwatch Victoria Data Confidence Manual July 2000 and it can be relied upon for management decisions concerning the Darebin Creek and consequently, flows entering into the Yarra River.

Data Users

Banyule City Council
Darebin City Council
Darebin Creek Management Committee
Friends of Darebin Creek
Melbourne Water
Waterwatch
EPA
General public
Local community

1.5 Background information on Darebin Creek and Lillimur Avenue Drain

Figure 3: Darebin Creek near Dougherty's Rd, West Heidelberg

Darebin Creek is a major tributary of the Yarra River within Melbourne's northern suburbs. The catchment covers an area of 129 square kilometres and includes two tributaries - Findon Creek and Henderson's Creek.

Where it flows through urban areas, including Heidelberg West, the creek has been heavily modified for use as a stormwater drainage line. Sections have been deepened and straightened and snags removed. While its headwaters in rural Victoria (Woodend) only flow intermittently, downstream of Epping the creek flows permanently, as a result of the many stormwater outlets meeting it. As a result, flow is faster and heavier than it would have been prior to European settlement.

This influx of stormwater brings with it health concerns for the creek. As John McGuckin (2002) notes, "Low oxygen concentrations and elevated nutrient inflows from drains, particularly during storm events, are responsible for pollutants being washed into Darebin Creek." Another issue is litter carried into the creek by wind and stormwater, introducing pollutants into the water as well as presenting hazards for wildlife.

McGuckin's report states that "water quality conditions in Darebin Creek are considered to be acceptable to aquatic biota and much better than in the past 20-30 years. From Bundoora to Alphington fair water quality conditions exist with most water quality parameters generally within the SEPP objectives for waters of the Yarra Catchment. However, Melbourne Water's *Melbourne's Rivers and Creeks 2004* rate the urban sections of Darebin Creek as follows:

Water quality	moderate
Aquatic life	poor
Bed/bank stability	moderate
Vegetation	very poor
Flow	poor

Table 3: Water quality from *Melbourne's Rivers and Creeks 2004*

The Lillimur drain is a stormwater outlet for the West Heidelberg industrial estate located on the east side of the creek. The land directly adjacent to the creek on both sides has been preserved as a recreational reserve. The west bank is dominated by lawn grasses and small numbers of indigenous trees, while the east bank is remnant grassland, heavily invaded by grassy weeds including several *Nassella* species. Stream bank vegetation is dominated by common reed (*Phragmites australis)*, with some invasion by weeds such as creeping buttercup (*Ranunculus repens)*. The creek itself has been deepened to create a trapezoidal earthen channel, although natural bends appear to have been left in place.

According to Melbourne Waters Environmental Review 2000/01, there is reason to believe that heavy metals are present in the lower Darebin creek. In the research done by Melbourne Water it has been shown that the lower Darebin Creek has elevated levels of heavy metals and other toxicants in stream sediments. The heavy metals found include cadmium, copper, lead, mercury, zinc and nickel. Other common toxicants include hydrocarbons and pesticides.

The visible signs of this have been observed by the Banyule Bushcrew. They have observed water emerging from the Lillimur drain with alterations of colour and/or oiliness or foam on the water.

Figure 4: **Visible pollution at Lillimur drain outlet – D.Karney 2009**

Figure 5: Signs of pollution near Lillimur drain outlet – D.Karney 2010

2. Water Quality Monitoring and use of SEPP guidelines

The aim of the monitoring is to put together a picture of current water quality of our catchments in the time frame monitored. To determine the current health, the water quality data can be compared with the relevant State Environment Protection Policy (SEPP) Guidelines, which are presented fully in Appendix 2. Over an annual to longer term period, we can draw conclusions as to the current health of our local waterways. The part of the guidelines that refers to the Yarra Catchment Urban waterways (Schedule F7), which includes the Darebin Creek, specifies water quality objectives using an upper limit or lower limit value for each parameter, which is derived from long term monitoring of selected reference sites. All graphs in this report have an indicator line added to show if the data has "exceeded" SEPP (ie results indicating an exception to the long term average).

There are different reference sites for different types of waterways, which reflect the fact that the quality of waterways varies naturally depending on environmental factors such as catchment land use and geology, and thus there are different segments which cover parts of the Yarra Catchment. The upper reaches of catchments protected from urban development naturally have much better water quality than urban waterways for example, and the SEPP objectives reflect this. References sites were selected for their exceptional health compared against other sites in the same segment. Thus SEPP gives us an idea of how our waterways are compared to what they could be.

For each parameter a results table is given which state the relevant SEPP objective for Darebin Creek. Darebin Creek at the location of this monitoring program is classified as an *Urban Waterways Segment of SEPP* Schedule F7 - WATERS OF THE YARRA CATCHMENT (see Victoria Government Gazette, June) 1999 in 7. References)
The results table gives a breakdown for each year of the monitoring in terms of the percentage of time that the results either exceeded the specified maximum limit or failed to reach the specified minimum limit. It then gives an overall conclusion as to if the parameter being measured is acceptably within limits or unacceptably out of limits.
Shown below for an example is the table for the Electrical Conductivity parameter.

Electrical Conductivity over the period July 2007 – July 2010			
SEPP Objective < 1000mg/l	YDA420	YDA421	YDA422
% time over SEPP 07/08 year	18%	9%	27%
% time over SEPP 08/09 year	50%	0%	50%
% time over SEPP 09/10year	24%	0%	15%
Overall % time over SEPP	29%	3%	28%
SEPP Conclusion	Unacceptable	Acceptable	Unacceptable

Waterwatch Victoria has developed a more descriptive, general set of guidelines, which allow groups to judge whether their sites are excellent, good, fair, poor or degraded with respect to each parameter for the actual day sampled. These categories are derived from Waterwatch Water Quality Guidelines, which give a general ideal of ecological health for waterways Victoria wide. These guidelines are shown on Table 4.

Table 4 : Waterwatch Water Quality Guidelines

	EXCELLENT	GOOD	FAIR	POOR	DEGRADED
CONDUCTIVITY (µS/cm)	<100	100 - 250	250 - 500	500 - 750	>750
TURBIDITY (NTU)	<15	15 – 17.5	17.5 - 20	20 - 30	>30
DISSOLVED OXYGEN (%)	> 80%	80 – 60%	60 – 50%	50 – 40%	<40%
pH	6 - 7	5.5 – 6 or 7 - 8	8 – 8.5	5 – 5.5 or 8.5 - 9	<5 or >9
PHOSPHATE (mg/L)	< 0.008	<0.02	<0.04	<0.08	>0.08
AMMONIUM*					

* No exact rating guideline available at the time of printing. Anything over zero is considered degraded.

2.1 Monitoring Methods and Equipment used

The methods and equipment used are as per the Waterwatch Victoria Data Confidence Manual (2000), Waterwatch Melbourne Training Booklet (2009) and as advised by the Local and Regional Waterwatch Coordinators.

Parameters tested	Equipment type used for sampling
Electrical Conductivity (EC)	ECTestr low
pH	pHTestr 2
Turbidity	Tube
Reactive Phosphorus	Visocolor Phosphate Test Kit
Ammonium	Visocolor Ammonium Test Kit
Dissolved Oxygen	Visocolor Dissolved Oxygen Test Kit
Temperature	Thermometer
Aquatic macro-invertebrates	Westlab 250 mm mesh net

Table 5: Parameters and measuring equipment used for monitoring water quality

2.2 Water Quality Parameters – Brief Description

(Further descriptions on the physical chemical parameters are located in Appendix 1.)

The following table is a list of the most commonly used physical and chemical parameters for measuring water quality. The table explains what each parameter is an indicator of, the potential impact of changes of the parameter, and the possible cause of those impacts.

Parameter	Indicator	Potential Impact	Possible Cause
Turbidity	Water cloudiness – indicating presence of suspended or colloidal matter	Reduces light penetration and limits photosynthesis. May affect other parameters e.g. Dissolved oxygen.	• Catchment erosion • Inappropriate land use coupled with inadequate stream side vegetation
Temperature	Temperature fluctuations	Flora and fauna have particular temperature tolerances. May affect other parameters e.g. Dissolved oxygen.	• Seasonal fluctuations • Industrial waste • Stormwater + Sewage effluent
Electrical Conductivity	Salinity	Important determinant of fauna and flora distribution.	• Clearing of trees • Irrigation • Natural catchment soil composition
Phosphorus	Nutrients Algal growth	Promotion of excessive plant growth leading to: • Toxic algal blooms, making water unsafe for human and animal consumption. • Alteration of the macro invertebrate community	• Fertilisers • Treated sewage • Plant debris
Ammonia	Nutrients	High levels can be toxic to many aquatic organisms	• Animal + some industrial wastes • Sewage Effluent
Dissolved Oxygen	Oxygen in the water	Low levels can impact on aquatic organisms	• Low flow • Increased temperature
pH	Acidity/alkalinity	May alter toxicity of other pollutants e.g. Acidity increases metal toxicity.	• Alkalinity ammonia (natural) • Acid rain

Table 6: Summary of Water Quality Parameters

Macro invertebrates (Water Bugs)

Macro invertebrates are animals that don't have a backbone and are visible to the naked eye. They are very useful in telling us how healthy or unhealthy a waterway is. Some water bugs are very sensitive to pollution, so will not be found in a polluted waterway. Checking to see which water bugs are in the waterway and which are not can tell us how healthy the waterway is. Sites with good quality water have many different kinds of water bugs.

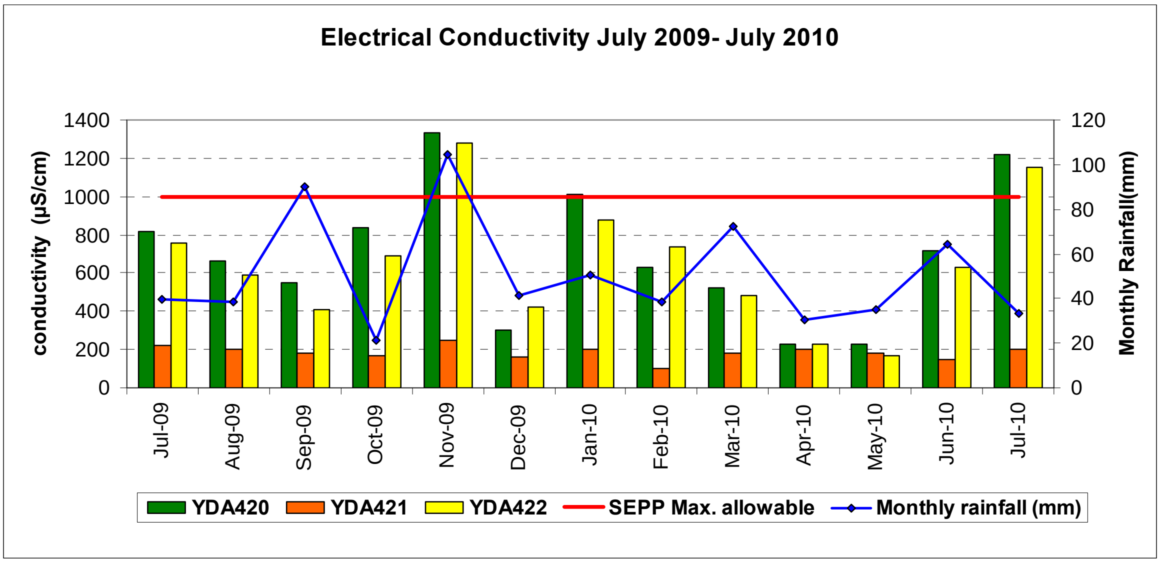
There are many different types of water bugs. To survive, each type has specific environmental requirements. Changes in water quality can lower the numbers of some water bugs and increase numbers of bugs which are more tolerant to changed conditions or pollution. Bugs that can survive polluted conditions usually increase in number because there is less competition and predation from other macro invertebrates. Waterwatch uses a modified method of analysing macroinvertebrates that is adapted from EPA's SIGNAL method. As stated by Chessman (2003) Community groups such as those in the national Waterwatch program often cannot take identification to family level. Typically, these groups identify to the taxonomic levels of order, class and phylum, depending on the type of macro-invertebrate.

Further information on the value of macroinvertebrate sampling is available in Appendix 3.

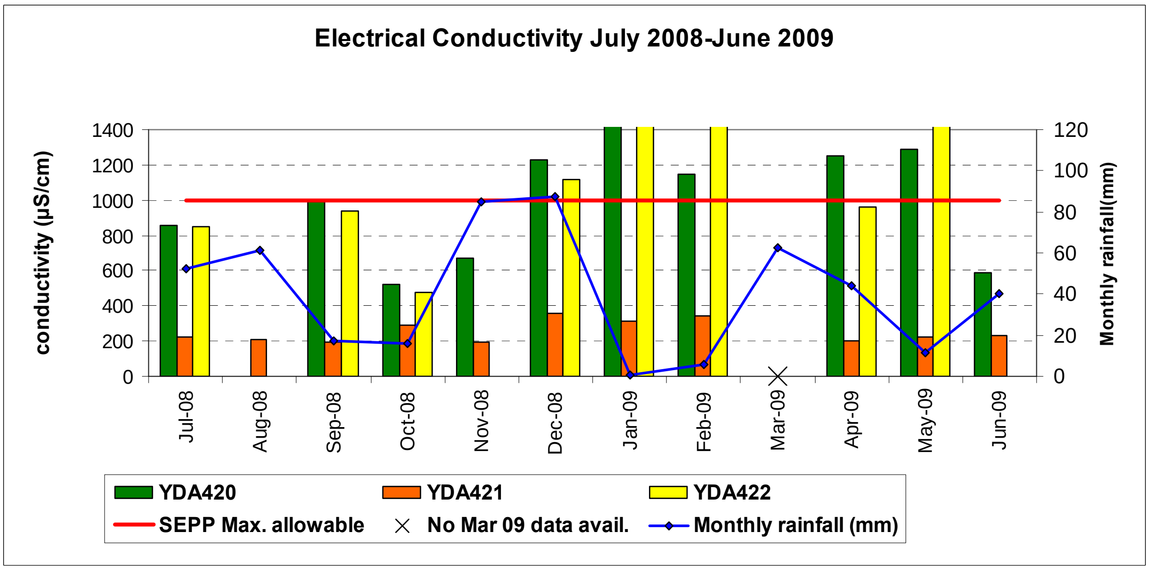
3. Results and Interpretation of Data

(State Environment Protection Policy (SEPP) Guidelines, are presented fully in Appendix 2.)

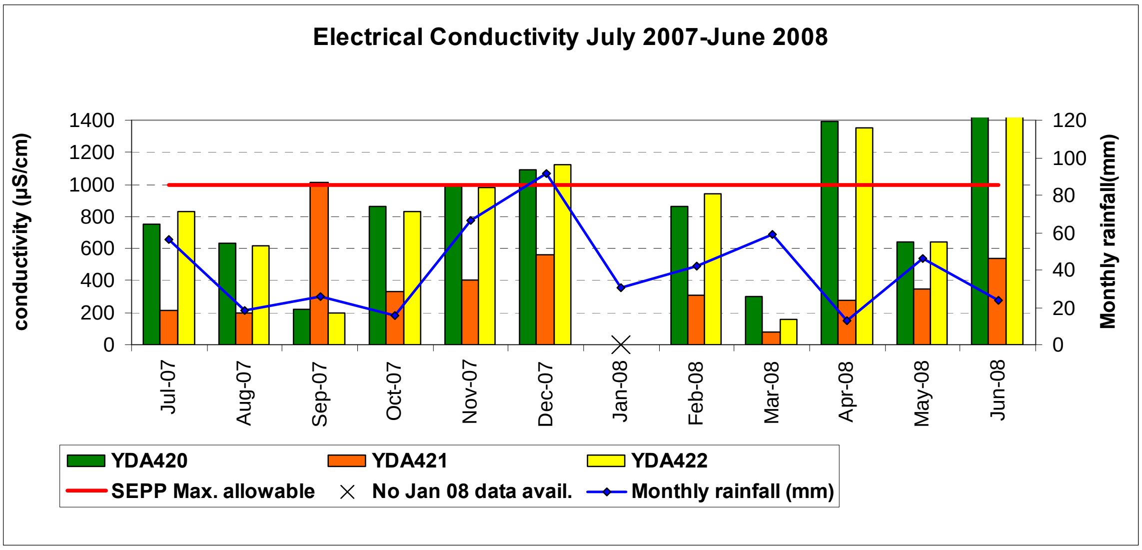
3.1 Electrical Conductivity Results



Graph 1: Electrical Conductivity results and average monthly rainfall July 2009 to July 2010



Graph 2: Electrical Conductivity results and average monthly rainfall July 2008 to June 2009



Graph 3: Electrical Conductivity results and average monthly rainfall July 2007 to June 2008

3.2 Electrical Conductivity Interpretation

Over the three years of monitoring the Electrical conductivity (EC) was consistently lower at the drain outlet than in the Darebin Creek (upstream or downstream locations). In the most recent year (2009/10) the EC at the drain was consistently 200µS/cm or less. In November 2009, January 2010 and July 2010 the EC was elevated to levels in excess of the SEPP max allowable but these values were recorded at the upstream and downstream locations rather than at the drain outlet itself.

The Darebin Creek does experience high salinity readings historically. As stated by McGuckin (2002) in his study of the Darebin Creek, he found that EC within the Urban Waterways Segment did not consistently meet SEPP guidelines. A maximum conductivity (3200 µS/cm) was recorded at McKimmies Road, Bundoora (close to the Waterwatch site in Bundoora) on 15 January and 11 March 2002. Saline groundwater intrusion is suspected to be responsible for elevated conductivities at this site and also for conductivities exceeding 2000 µS/cm at downstream sites on 11 March 2002. McGuckin (2002) also found from historical conductivity data for the Darebin Creek catchment at Settlement Road, Bundoora, that localised saline intrusion is expected to be the cause of the elevated conductivities in the Bundoora area. Further downstream in Ivanhoe high conductivity is suspected to have originated from stormwater drain inflows.

The period from December 2008 to May 2009 was a period with EC levels consistently elevated over the allowable limit at the upstream and downstream locations but again the level at the drain outlet was very low in comparison. Overall, this shows that the drain itself is not consistently adding EC to the creek, many times it is actually adding higher quality water to the creek (at the times sampled). High EC flows in this time period is probably due to an increased proportion of groundwater (which is naturally high in EC) contributing to stream flow, due to lower rainfall at the time.

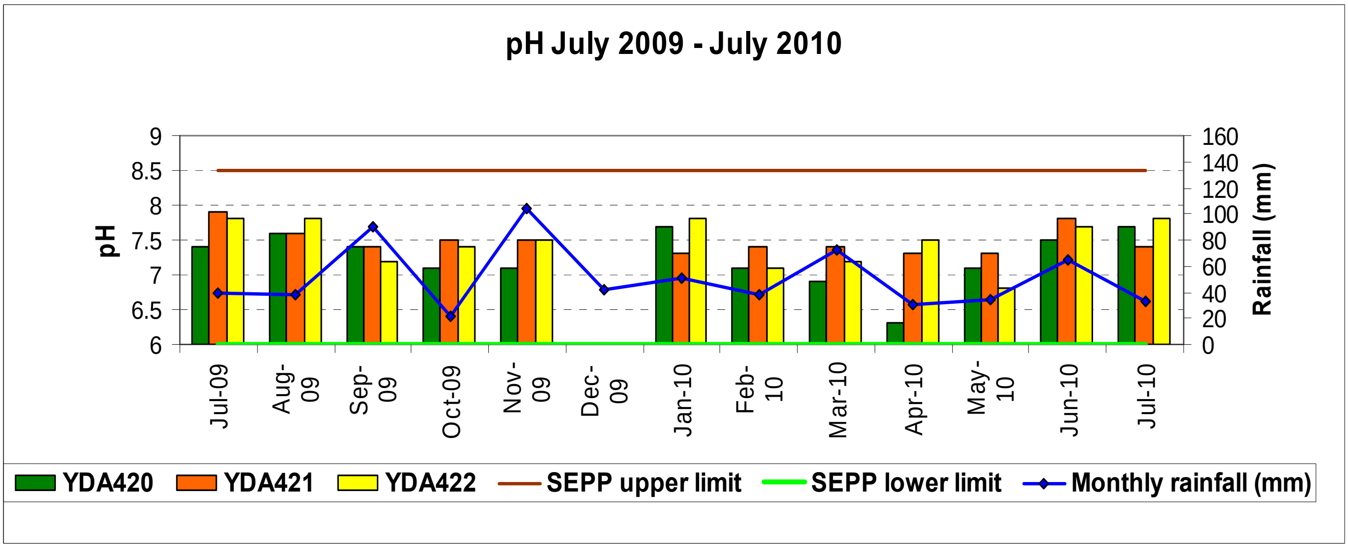
In the first year of monitoring the EC levels reached the SEPP limit for upstream and downstream locations in November 2007 and exceeded the limits in December 2007, and April and June of 2008. The highest level at the drain in this year occurred in September 2007 (1010µS/cm). At no other time was there a level above 560µS/cm in the three years of monitoring. This is unrepresentative of the typical condition. It could point towards a pollution event, but of what type is unclear because for this sampling session, pH, turbidity, and ammonium were all below the SEPP limit. Phosphate was above but not alarmingly so. It is possible to be an error with testing, or a flush of salty water being dumped from a property. (a swimming pool backwash discharge for example.)

In general in the first year of sampling there was a higher level of EC at the drain outlet than in subsequent years with levels from 300 - 560µS/cm from October 2007 to June 2008. This could be due to the below average rainfall experienced in this catchment during that time period.

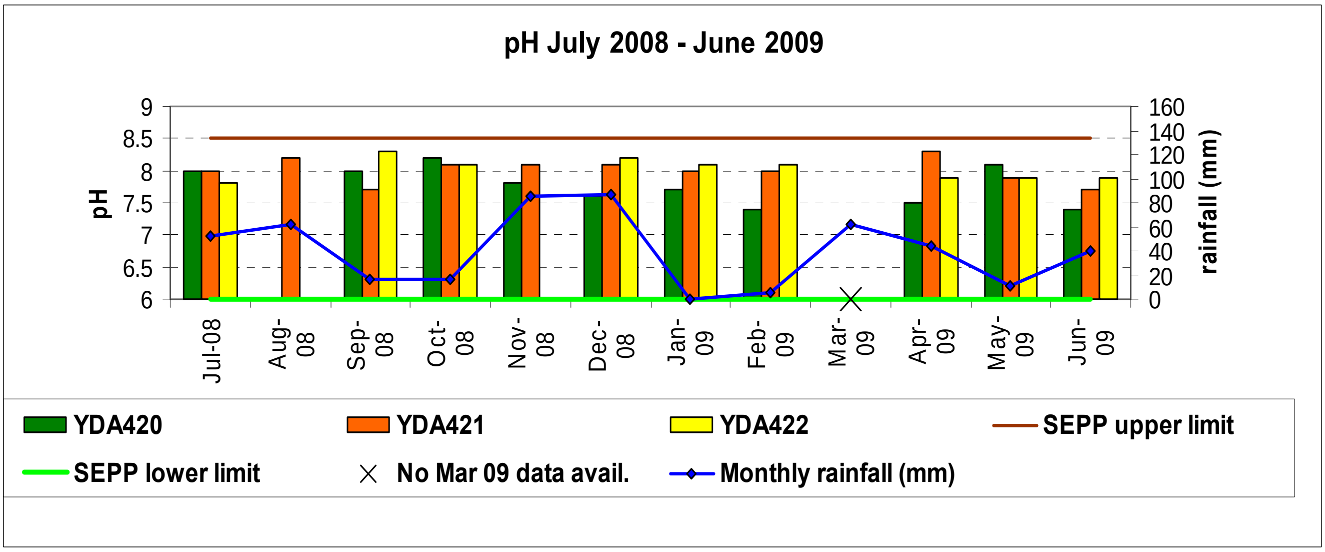
<table>
<tr><th colspan="4">Electrical Conductivity over the period
July 2007 – July 2010</th></tr>
<tr><td>SEPP Objective < 1000mg/l</td><td>YDA420</td><td>YDA421</td><td>YDA422</td></tr>
<tr><td>% time over limit 07/08 year</td><td>18%</td><td>9%</td><td>27%</td></tr>
<tr><td>% time over limit 08/09 year</td><td>50%</td><td>0%</td><td>50%</td></tr>
<tr><td>% time over limit 09/10year</td><td>24%</td><td>0%</td><td>15%</td></tr>
<tr><td>Overall % time over limit</td><td>29%</td><td>3%</td><td>28%</td></tr>
<tr><td>SEPP Conclusion</td><td>Unacceptable</td><td>Acceptable</td><td>Unacceptable</td></tr>
</table>

Table 7: Electrical Conductivity comparisons to SEPP guidelines

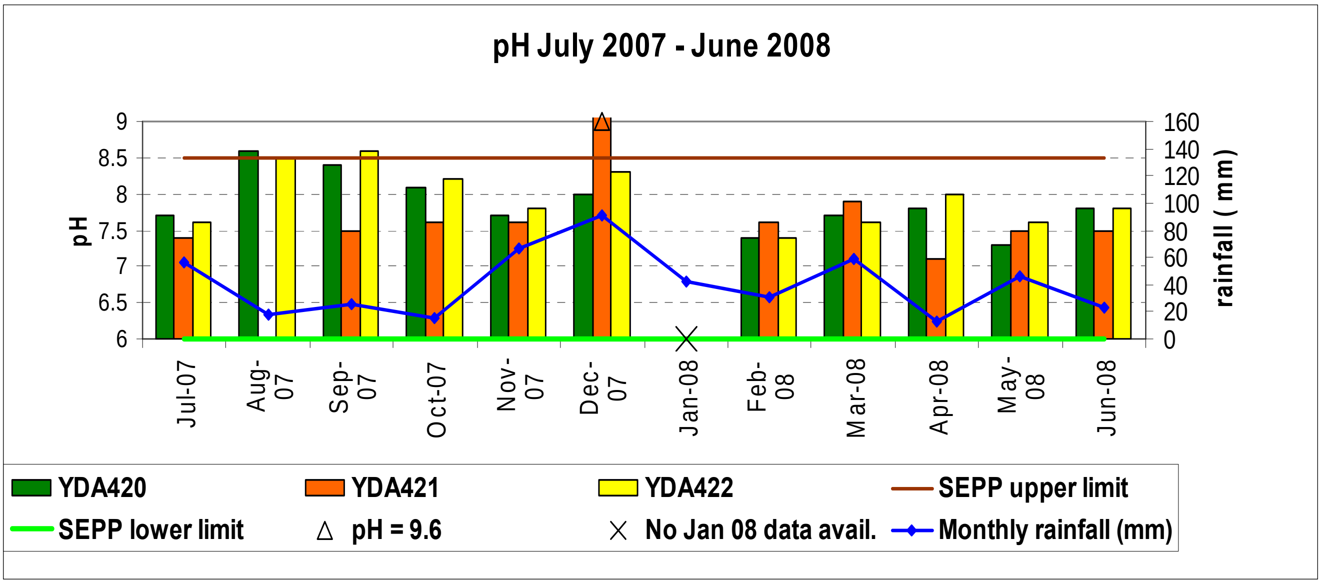
3.3. pH Results



Graph 4: pH and monthly rainfall July 2007 to July 2010



Graph 5: pH and monthly rainfall July 2008 to June 2009



Graph 6: pH and monthly rainfall July 2007 to June 2008

3.4 pH Interpretation

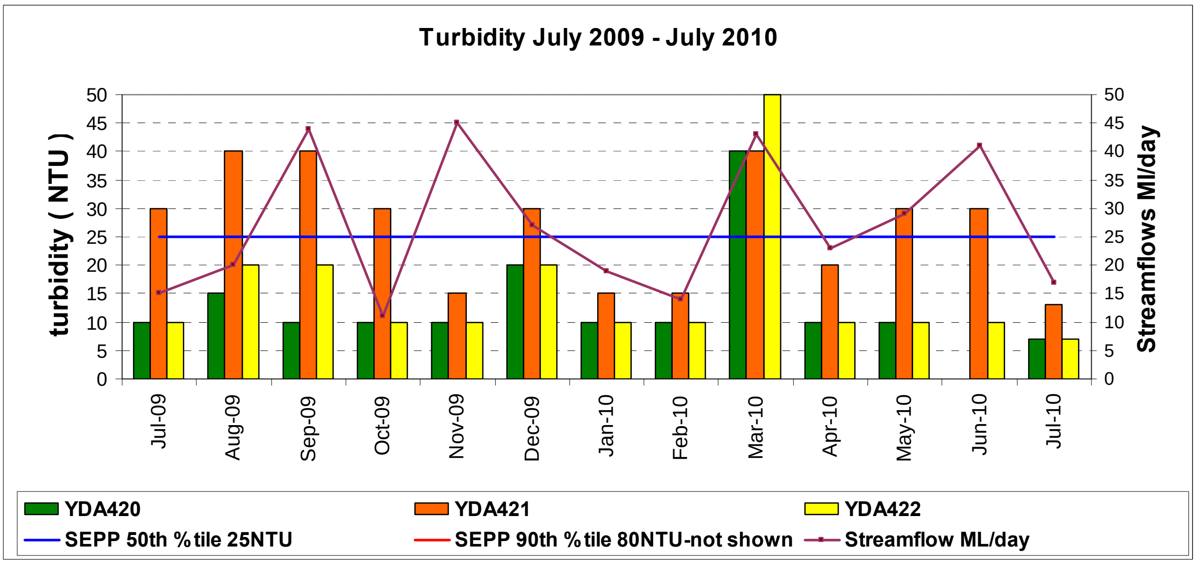
At no time in the sampling was the pH below the SEPP lower limit of 6 at any of the three sites.
In the first year of sampling the SEPP upper limit of 8.5 was exceeded twice at the creek upstream, once downstream and significantly at the drain in December 2007. Within the creek the high pH can be attributed to lower flows and rainfall in the first six months of 2007. This environment can encourage plant and algae growth within the stream bed. Plant life uses an increased amount of carbon dioxide for photosynthesis, increasing the pH of the stream (Tiller & Newall, 2009).
Within the drain itself, the high pH of Dec 2007 can be contributed to high stormwater flows. Dec 2007 had the highest rainfall in 6 months, thus stormwater flows coming into the creek via the drain would have increased and this would have increase pH levels- the high EC in the same month is further evidence for this. (high EC typically increases pH levels)

For the period 2008-2010 pH levels stayed well below SEPP levels.

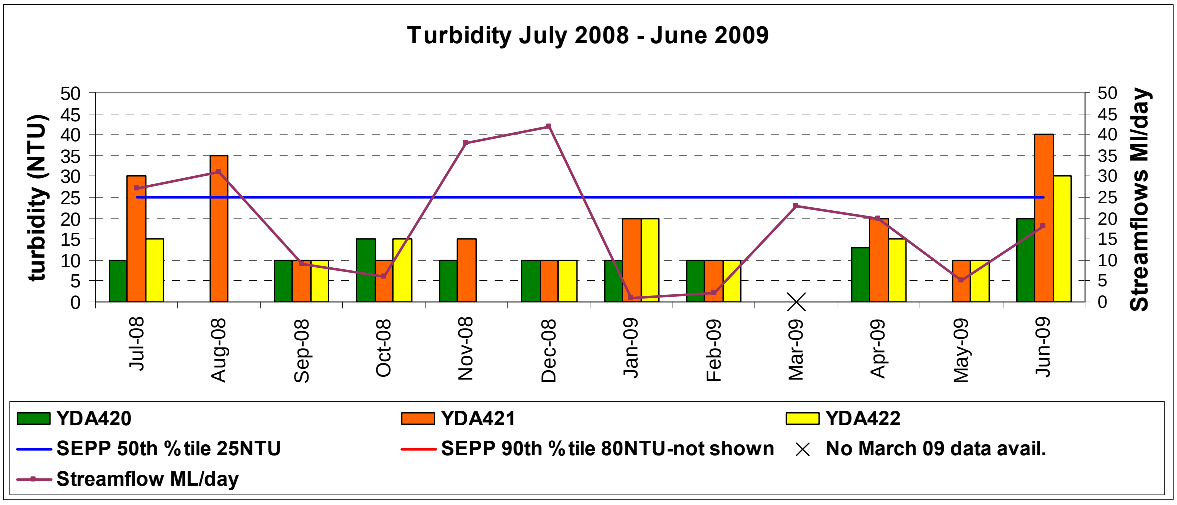
pH over the period July 2007 – July 2010			
SEPP Objective 6.0 – 8.5	YDA420	YDA421	YDA422
% time over limit 07/08 year	9%	10%	18%
% time over limit 08/09 year	0%	0%	0%
% time over limit 09/10 year	0%	0%	0%
Overall % time over limit	3%	3%	6%
SEPP Conclusion	Acceptable	Acceptable	Acceptable

Table 8 : pH comparison to SEPP guidelines

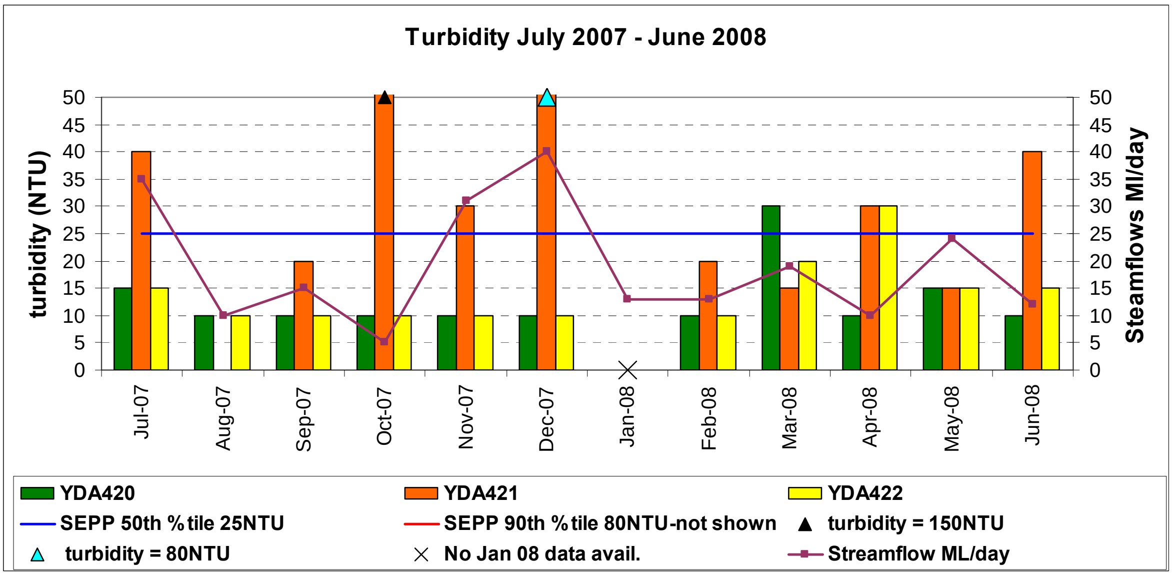
3.5 Turbidity Results



Graph 7: Turbidity results July 2009 to July 2010



Graph 8: Turbidity results July 2008 to June 2009



Graph 9: Turbidity results July 2007 to June 2008

3.6 Turbidity Interpretation

From the graphs and results tables it is clear that the waters in the drain generally have a higher turbidity than the creek but it is also clear that the turbidity in the creek downstream of the drain is not significantly impacted by the drain as the turbidity levels have fallen almost to the upstream levels.

While the turbidity levels are usually higher at the drain outlet, during the period September 2008 until May 2009, drain outlet turbidity levels fell to levels consistent with the upstream and downstream creek locations. Rainfall had increased from November 2008, so from November 2008 to May 2009 the drain would have been flushed out regularly of organic matter which could account for the lower turbidity readings. (ie there being no organic matter in the gutters to be washed into the drain). In this time period stream flows rose and fell significantly, and turbidity was almost the same at all 3 sites (in the months of Sept 08, Dec 08 and Feb 09.).This points to mixing. The creek water may have come up to a level that is mixing with incoming drain water where the sample is being taken. In fact reports had been coming in from the Bushcrew samplers that at times the drain water is moving slowly and at times moving backwards when connecting with the creek water. This then will not be the true turbidity reading of the drain and care must be taken to ensure that there is no mixing when collecting a sample.

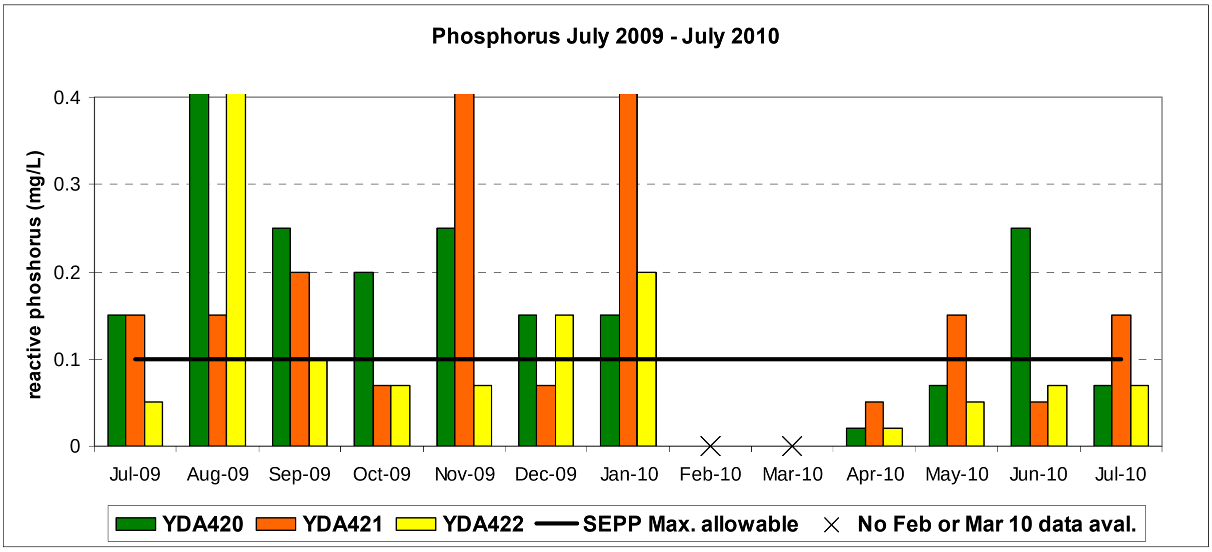
In 2009/10 the turbidity results most of the time correspond with the stream flows. When the drain turbidity levels exceeded SEPP, at the times there were high stream flows in the creek and high rainfall. In 2009/10, as in 2007/08 the drain was consistently higher than the creek, suggesting stormwater pollution.

Turbidity over the period July 2007 – July 2010			
SEPP Objectives 50th Percentile <25 90th Percentile <80	YDA420	YDA421	YDA422
50th percentile.	10	25	10
90th percentile.	19	40	20
SEPP Conclusion	Acceptable	Just Acceptable	Acceptable

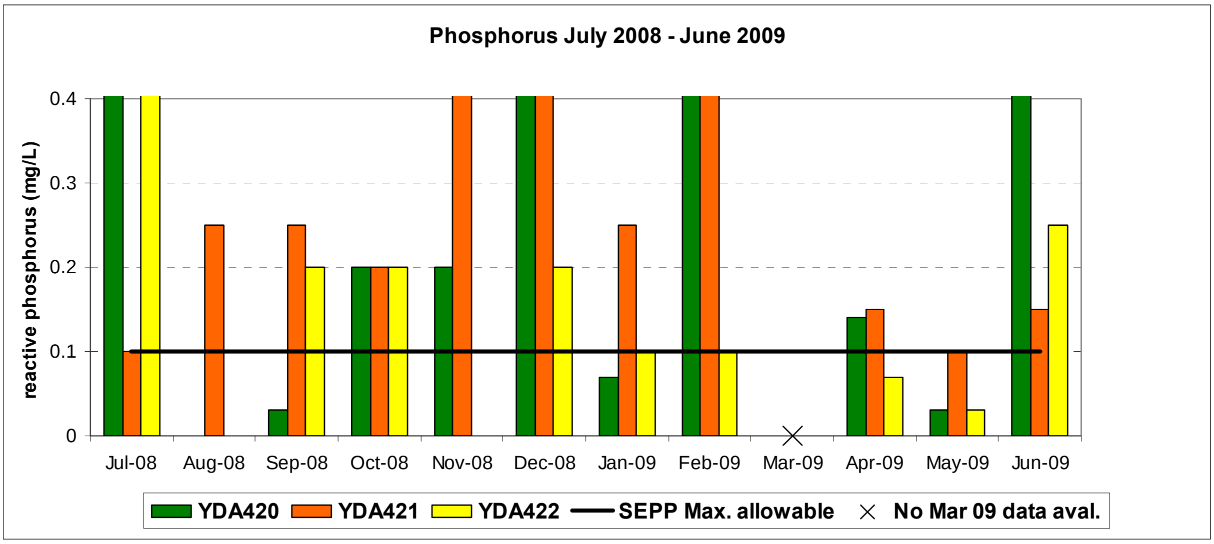
Table 9 : Turbidity comparison to SEPP guidelines*

***Turbidity is the only parameter in SEPP, Schedule F7 (waters of the Yarra Catchment) that uses percentiles to interpret results. Table 9 is in a different format to the results tables given for the other parameters as it isn't appropriate to indicate % of time over or under a limit when percentiles are being used. 50th percentile is the value below which 50 percent of the observations may be found. Similarly the 90th percentile is the value below which 90 percent of the results fall. For a full explanation of percentiles see glossary pg.29**

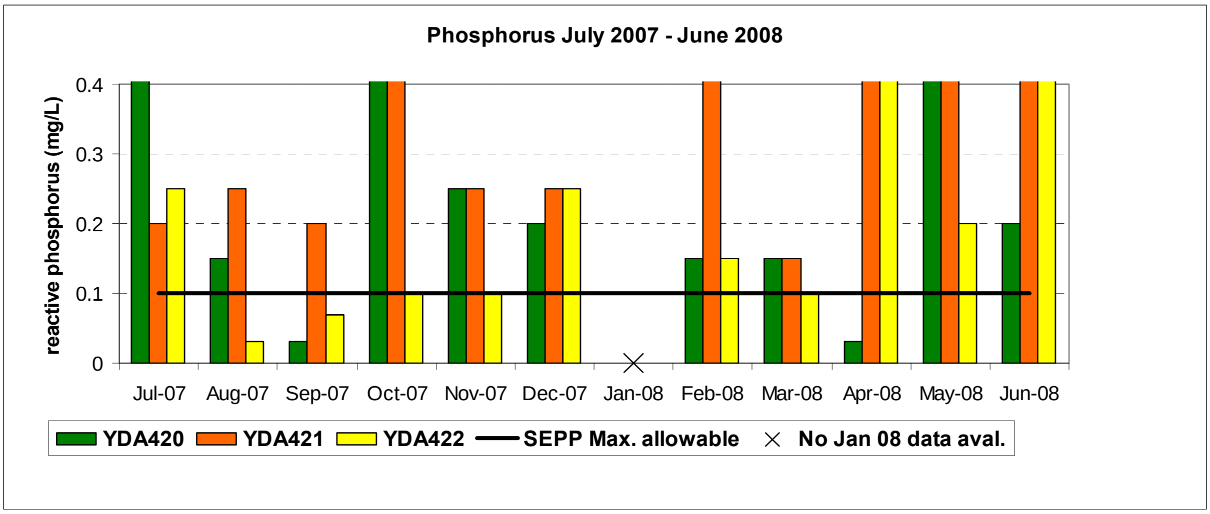
3.7 Reactive Phosphorus Results



Graph 10: **Reactive phosphorus from July 2009 to July 2010**



Graph 11: **Reactive phosphorus from July 2008 to June 2009**



Graph 12: Reactive phosphorus from July 2007 to June 2008

3.8 Reactive Phosphorus Interpretation

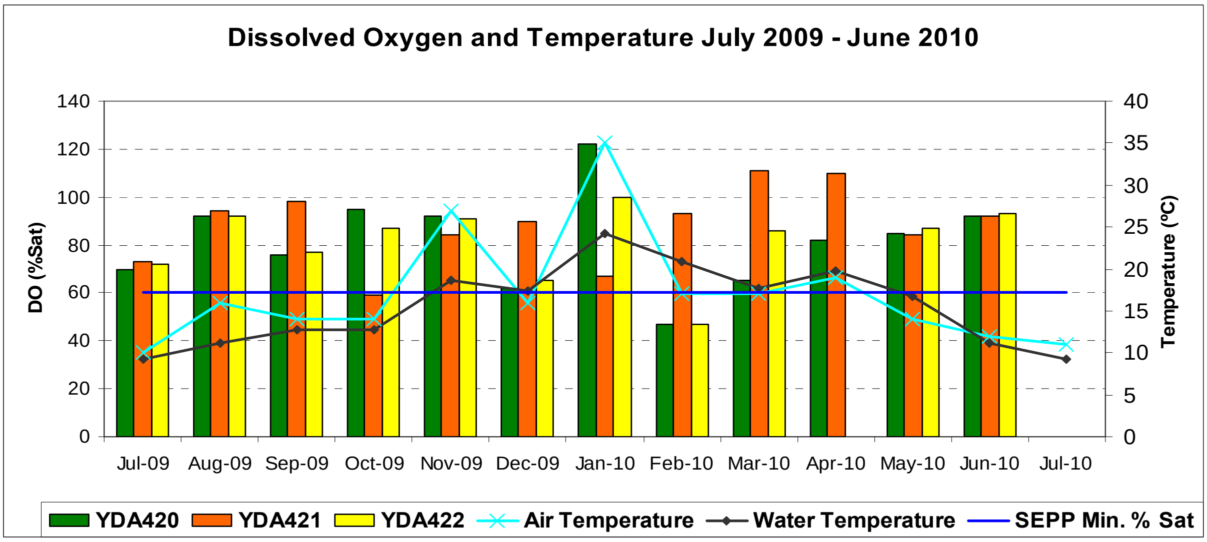
Reactive phosphorous is definitely a problem in this part of the catchment, at all 3 sites, with the drain exceeding SEPP slightly more frequently than the creek itself. At times the high phosphate levels correspond with high rainfalls, suggesting the phosphate is coming in via the stormwater system, in organic matter. At other times there is no clear correspondence with stream flow and rainfall, suggesting further human derived interference. This could include detergents entering the system (from washing of cars at the car workshops in the Industrial Estate for example) or a sewage leak from sewage pipes that run underground alongside the creek. A targeted education program was conducted in the Industrial estate in 2008 and 2009 that aimed to reduce pollution incidences into the creek from businesses. Car washing (suds going into stormwater drains) was noted at the time as a frequent activity (Vanderoord, 2009, pers comm.).After the education program in a follow up, it was noted that less car washing was observed. This would correspond with the decrease in phosphate readings, especially from the drain. The higher and consistent rainfall events and resultant flows in 2009/10 could also account for the lower phosphate results in 2009/10, meaning organic matter had already been flushed out of gutters, thus less volume coming into the drain and creek at this point.

Reactive Phosphorus over the period July 2007 – July 2010			
SEPP* Objective <0.1mg/l	YDA420	YDA421	YDA422
% time over limit 07/08 year	81%	100%	55%
% time over limit 08/09 year	70%	82%	55%
% time over limit 09/10 year	72%	64%	27%
Overall % time over limit	75%	81%	45%
SEPP Conclusion	Unacceptable	Unacceptable	Unacceptable

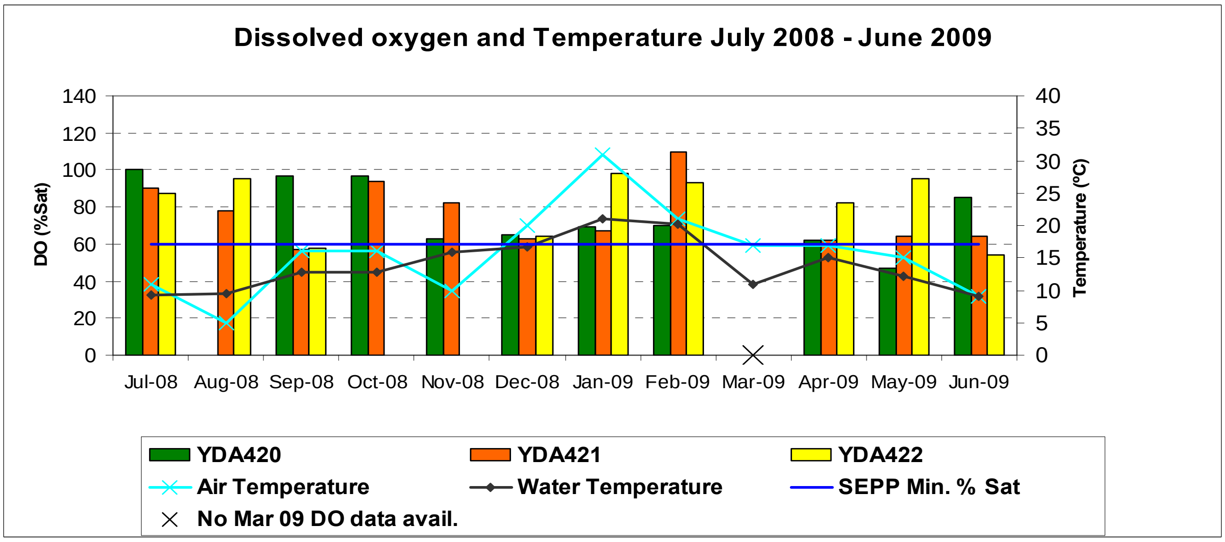
Table 10: Reactive Phosphorus comparison to Total Phosphorus SEPP Guidelines

*SEPP guidelines cannot strictly be used when analysing reactive phosphorus data as the guidelines only consider total phosphorus. It is put in as a rough guide (reactive phosphorous is 30-65% of TP)

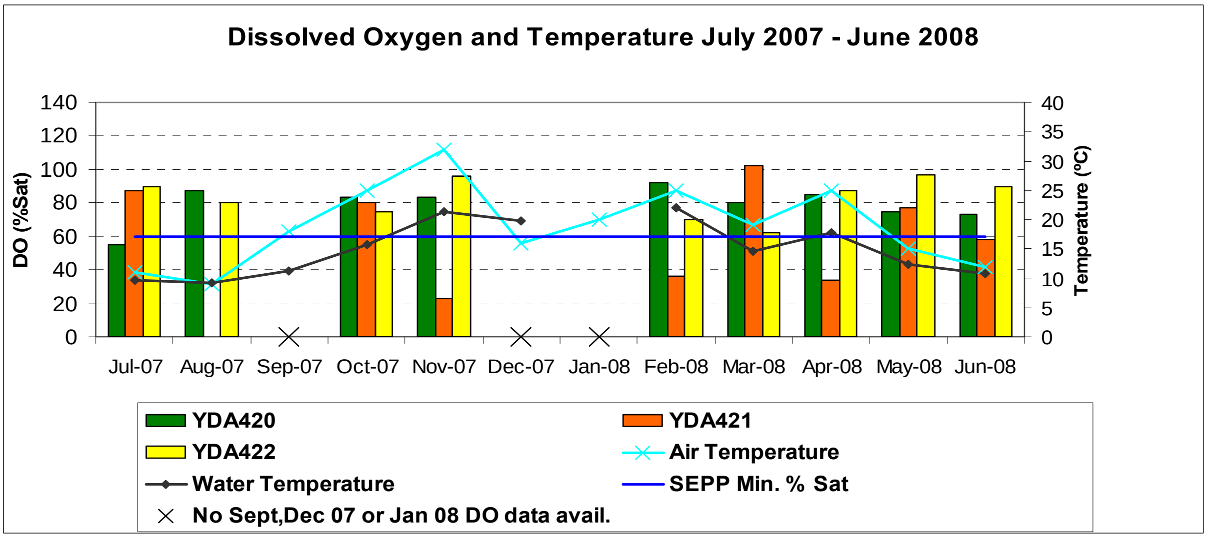
3.9 Dissolved Oxygen Results



Graph 13: Dissolved oxygen and air temperature July 2009 to July 2010



Graph 14: Dissolved oxygen and air temperature July 2008 to June 2009



Graph 15: Dissolved oxygen contrasted with air and water temperatures July 2007 to June 2008

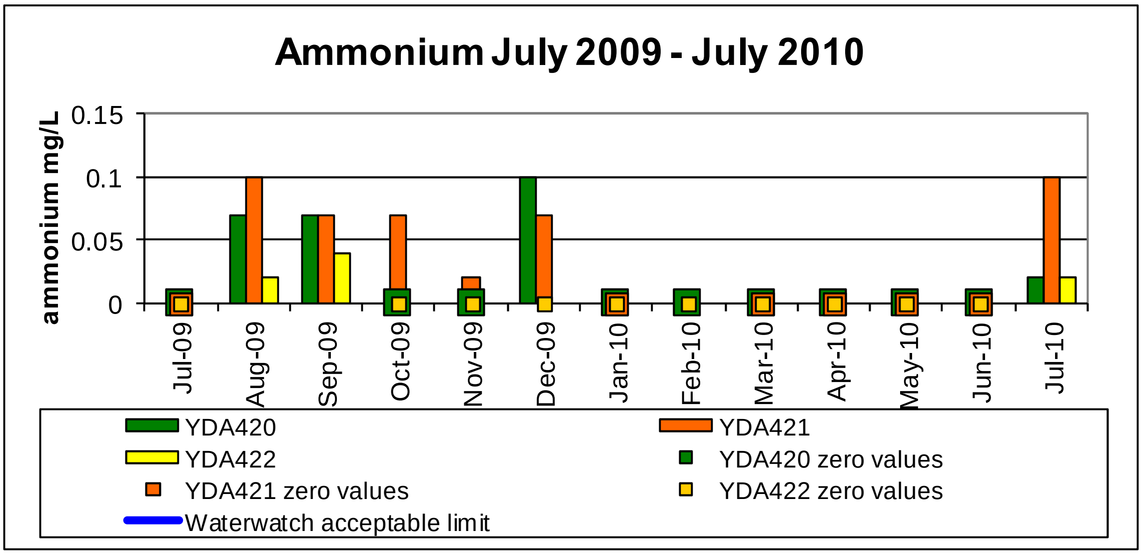
3.10 Dissolved Oxygen Interpretation

Lack of enough Dissolved Oxygen is definitely a problem at times in this part of the catchment, at all 3 sites, with the drain not reaching the SEPP minimum slightly more frequently than the creek itself. In the drain the most probable cause for low D.O readings are waste material, such as organic matter (leaves, soil) industrial discharges, oils and detergents. As these inputs are broken down, they consume oxygen, thus reducing D.O levels in the drain. If the water is reduced to a slow flow or trickle, the water will not be flowing as quickly, thus less oxygen can dissolve into the water from the air. Low D.O readings can also be attributed to high temperatures. Many of the low D.O readings were in the summer periods when air and water temperature were over 18 degrees. The higher temperatures equal less D.O that water can hold. Higher flows and rainfall period were experienced in 2009/10 compared with 2007/08 which does correspond with the lower D.O results. Better D.O readings were experienced in 2009/10, which is probably due to the increase of rainfall, but it also could be the reduction of pollution inputs in the creek via the drain. The D.O should continue to be monitored.

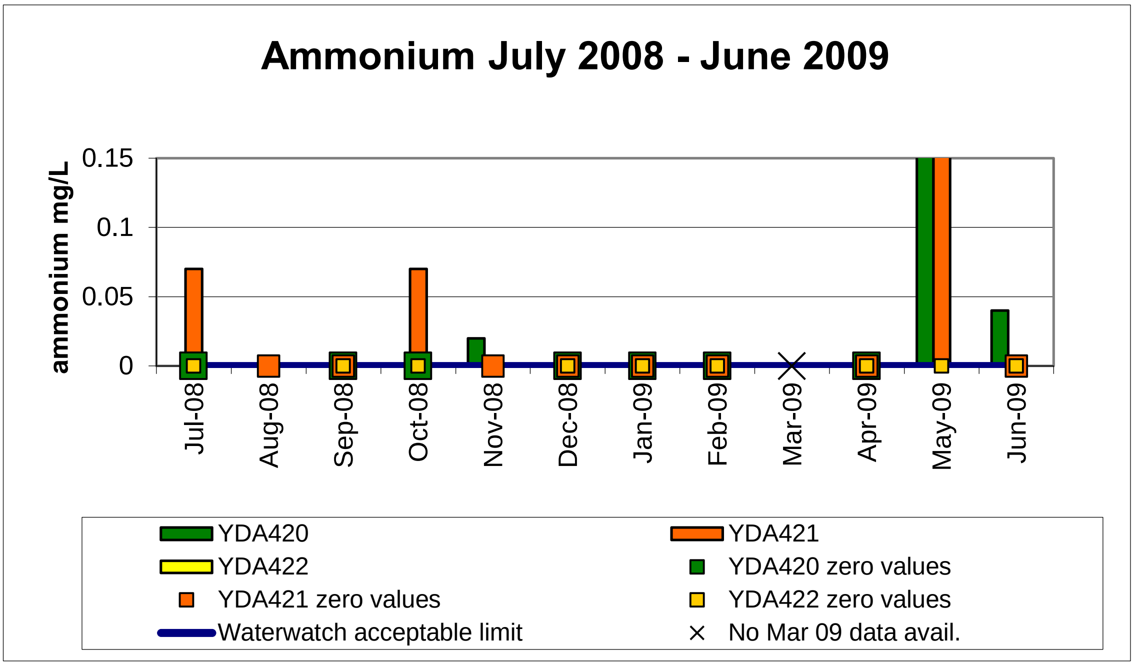
Dissolved Oxygen over the period July 2007 – June 2010			
SEPP Objective >60% saturation	YDA420	YDA421	YDA422
07/08	11%	50%	0%
08/09	10%	9%	22%
09/10	8%	8%	9%
% time less than minimum limit	10%	19%	10%
SEPP Conclusion	Unacceptable	Unacceptable	Unacceptable

Table 11: Dissolved oxygen levels compared to SEPP guidelines

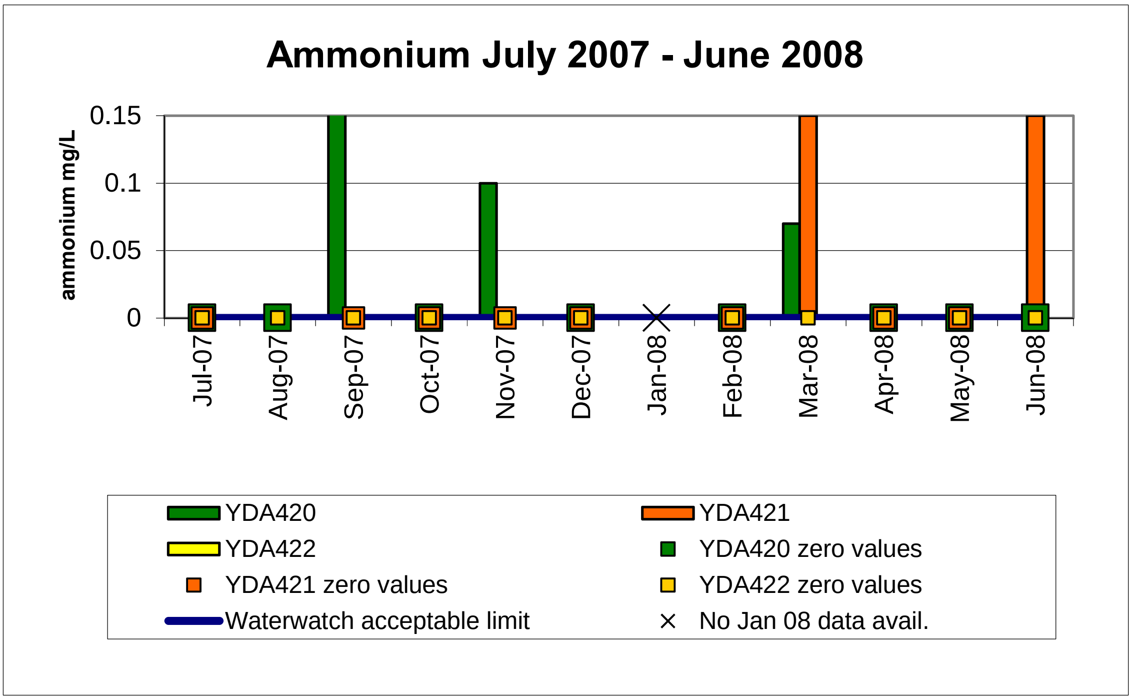
3.11 Ammonium Results



Graph 16: Ammonium results July 2009 to July 2010



Graph 17: **Ammonium results July 2008 to June 2009**



Graph 18: **Ammonium results July 2007 to June 2008**

3.12 Ammonium Interpretation

Ammonium results have been very interesting for this time period. Whist upstream results have gone above zero eight times and the drain eleven times in the time period, the downstream creek site has only gone above zero three times in the same time period. We have used Waterwatch guidelines as there is no SEPP[1] value for ammonium so anything above zero is considered degraded as per the table on page 11 of this report.

A possible explanation for this is mixing. If the drain sample water has been mixing with the upstream site, this could account for the similar high readings in some months (for example in August, September and December 2009).

In some months the creek's upstream site has had high ammonium readings (not the drain and downstream) such as in the months of September and November 2007 and June 2009 for example. This indicates that the drain is not contributing to these high readings and so it must be coming into the creek from a site (or drain) upstream. Drains further upstream should be tested for ammonium to determine the source.

As stated by Coleman (1998) from McGuckin (2002), very high nutrient levels (particularly ammonia) and *E.Coli* from the Bell St main drain are indicative of sewage contamination – with several emergency relief structures adjacent to the drain [at Bell St], this contamination is most probably from sewer overflows during wet weather. Although the Bell St main drain is downstream of this site, there may be other emergency relief structures further upstream that could account for the high ammonium levels if contamination occurs.

The drain outlets high ammonium readings in May, October and December 2009 can be attributed to low oxygen availability. Other high ammonium readings are indicative of organic wastes (animal waste such as dog droppings, sewage leaks from pipes, leaves) or a chemical spill. Ammonium should continue to be monitored as even low concentrations consistent over time can cause problems for fish and other aquatic life. If combined with oxygen ammonium can convert to nitrate and nitrite which can be toxic in waterways.

Ammonium Results over the period July 2007 – July 2010			
Ammonium should not be detectable	YDA420	YDA421	YDA422
% of time ammonium detected 07/08 year	27%	20%	0%
% of time ammonium detected 08/09 year	30%	27%	0%
% of time ammonium detected 09/10 year	31%	50%	23%
Overall % of time ammonium detected	29%	33%	9%
Conclusion	Unacceptable	Unacceptable	Acceptable

Table 12 : Ammonium levels using Waterwatch guidelines

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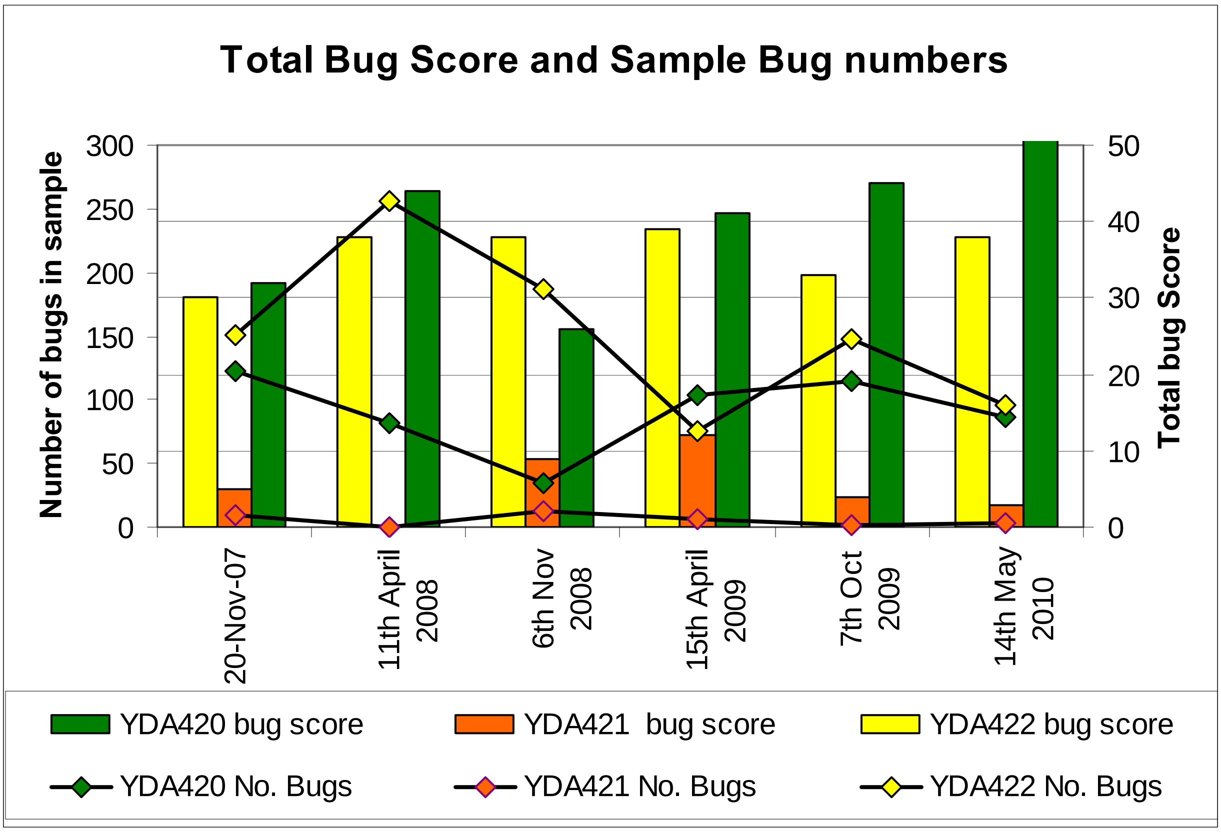
[1] SEPP, Schedule F7, gives an upper allowable limit for Total Nitrogen (TN) of 0.1mg/l. According to the Victorian Waterwatch *Data Interpretation Manual*, if the concentration of Ammonium (NH_3/NH_4^+) was approaching the TN objective, this would be a strong indication of excessive nitrogen concentrations as well as organic wastes and/or low oxygen conditions.

3.13 Aquatic Macro-invertebrates Results



Graph 19: **Macro invertebrates' total numbers and bug score**

3.14 Aquatic Macro-invertebrates Interpretation

If comparing the macro-invertebrate data with the physical chemical data, there are few surprises. The drain site (YDA421) consistently gives a poor result, whilst upstream and downstream have various results, the downstream site yielding better results than upstream. This may be because the downstream site has a better habitat mix to sample from, rather than a water quality reason. Bug sampling should be continued at sites YDA420 and YDA422 in order to have consistent data to compare and draw conclusion with the physical chemical data.

For Macro-invertebrate Data tables see Appendix 3

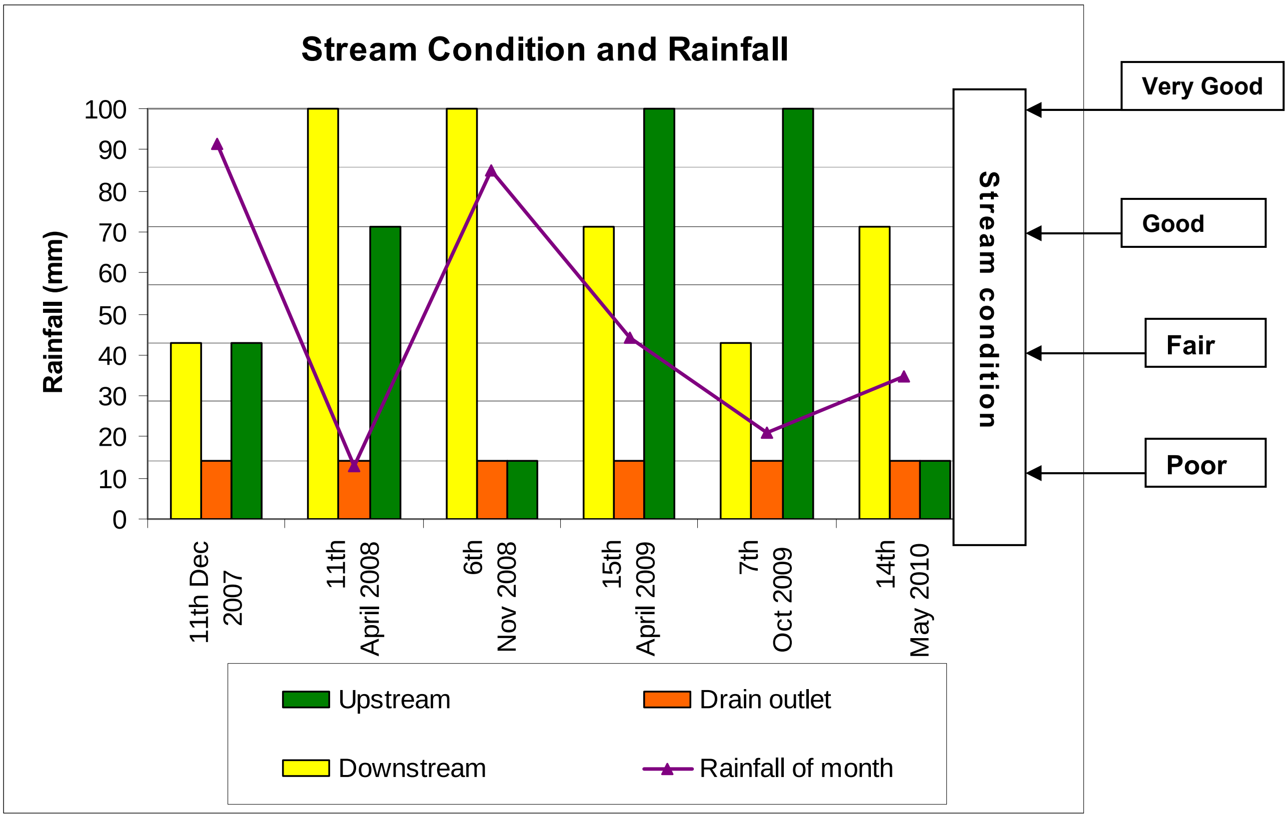
Figure 6 : Upstream sampling site – YDA 420

Figure 7: Lillimur Drain sampling site – YDA 421

Figure 8: Downstream sampling site – YDA 422

Creek Location	Nov/Dec 2007	April 2008	Nov 2008	April 2009	Oct 2009	May 2010
YDA420	Poor	Good	Poor	Good	Good	Poor
YDA421	Poor	Poor	Poor	Poor	Poor	Poor
YDA422	Fair	Good	Good	Good	Fair	Good

Table 13: Resulting Stream Conditions from Macro-invertebrate monitoring



Graph 20: **Macro-invertebrate determined Stream Condition**

4. Conclusions

Conclusions for effects of Lillimur Drain on Darebin Creek over the three years from July 2007 – July 2010			
Parameters	**Upstream YDA420**	**At Drain YDA421**	**Downstream YDA422**
Electrical Conductivity	Unacceptable	Acceptable	Unacceptable
pH	Acceptable	Acceptable	Acceptable
Turbidity	Acceptable	Acceptable	Acceptable
Reactive Phosphorus	Unacceptable	Unacceptable	Unacceptable
Dissolved Oxygen	Unacceptable	Unacceptable	Unacceptable
Ammonium	Unacceptable	Unacceptable	Acceptable
Macro invertebrates	Unacceptable	Unacceptable	Acceptable

Table 14 : Conclusions for effects of Lillimur Drain on Darebin Creek (Copy of Table 1)*

***These results are a compilation of individual results tables for each parameter. Generally they are based on SEPP guidelines. The exceptions are Ammonium which is not specified in SEPP (see explanation pg. 24) and Macroinvertebrates which are judged on Waterwatch guidelines. For a full explanation of SEPP and Waterwatch guidelines see pg.11 and appendix 2.**

5. Recommendations

These water quality monitoring results have enabled recommendations for future river health directions for water managers of the Darebin Creek catchment. These are summarised in the table below, and discussed further in the recommendation section below.

Site	WQ issues	Recommended Actions
YDA420	• High nutrients • High EC • Low Dissolved Oxygen • Low macroinvertebrates	• Consider monitoring at a site further upstream, including another drain upstream to determine entry point of nutrients • Stormwater infrastructure improvements needed • Continue to monitor all the parameters • Commission consultant to test for Total Phosphate (TP) to get a more accurate indication of phosphate levels to SEPP. Consider monitoring Total Nitrogen and E.Coli. (there have been sewage leaks detected in 2011)
YDA421	• High nutrients • High EC • Low Dissolved Oxygen • Low macroinvertebrates	• Consider monitoring at a site further upstream, including another drain upstream to determine entry point of nutrients. Nutrient source investigation • Stormwater infrastructure improvements needed • Get a regular member of the community to keep observational records of this drain (ie colour changes, notice inputs) • Continue to monitor all the parameters • Discontinue macroinvertebrate sampling • Commission consultant to test for Total Phosphate (TP) to get a more accurate indication of phosphate levels to SEPP. Consider monitoring Total Nitrogen and E.Coli. (there have been sewage leaks detected in 2011)
YDA422	• High phosphate • High EC • Low Dissolved Oxygen	• Stormwater infrastructure improvements needed • Continue to monitor all the parameters • Commission consultant to test for Total Phosphate (TP) to get a more accurate indication of phosphate levels to SEPP. Consider monitoring Total Nitrogen and E.Coli. (there have been sewage leaks detected in 2011)

Table 15: Summarised water quality issues and recommended actions identified from this report (copy of Table 2)

These results show conclusively that further investigation of point source pollution needs to be conducted. Waterwatch does not test all the potential pollutants to waterways, and in fact has a limited ability to undertake higher level testing of parameters such as heavy metals, hydrocarbons and pathogens that may be entering Lillimur drain from the Industrial Estate. Water managers of this catchment such as the EPA (enforcement of polluters) and Melbourne Water (water quality researchers and improvement works) would have completed such testing and these results should be communicated between Council, Waterwatch and the community, in order to determine what are the main pollutants specifically entering the creek at this point. There are opportunities for stormwater infrastructure improvement and community education. Liaison between the various waterway and drainage network managers is advised (namely Banyule City Council, Melbourne Water, EPA and the Darebin Creek Management Committee) in order to share available water quality data and ascertain responses to the above recommendations.

As part of the community education program, community members should be encouraged to become “drain spotters”. A Melbourne Water initiated program, drain spotters monitor local drains and report any significant water quality issues to the EPA for follow up. The Lillimur drain is an ideal drain to collect further frequent observational data in order to determine the main sources of pollution, which can hopefully be traced to their source.

All sites are recommended to continue testing all parameters monthly for at least another 24 months. The exception to this is macroinvertebrate sampling for YDA421 (Drain outlet). Unless infrastructure works are completed to improve the drain inputs and the surrounding habitat of where the drain flows, there is little point in sampling the drain water for macro-invertebrates, as the results will not change.

Samplers must ensure that there is no mixing of drain water with the creek sample to ensure each sample is collected with confidence. If the drain water appears to be mixing on the day sample is collected, do not collect the sample and make a note of this.

Since phosphate levels have continued to be high for all sites, a consultant should be employed to collect Total Phosphorous (in order to compare directly with SEPP) and E.Coli (Escherichia coli) results to determine if there is a biological health issue at these sites. This is because Waterwatch phosphate results don’t measure TP, they measure Reactive Phosphate. TP, Total Nitrogen (not essential) and E.Coli should be tested monthly for at least 12 months.

For many nutrient sample results, the upstream readings are higher or the same than the drain or downstream. This indicates that the drain is not the only supplier of nutrients to this section of Darebin Creek (as long as mixing has been eliminated). Drains that empty into Darebin Creek further upstream should be investigated and a further monitoring program initiated there, in order to determine where the nutrients are. Sites should be downstream of Plenty Road, as at the time of the writing of this report, the Darebin Bush Crew are monitoring upstream of Plenty Road.

6. Glossary

Data: data collected by local community monitors refers to test results

Data users: persons or organisations that need the data interpreted to them and may use the data to determine management decisions.

Drain spotters: Waterwatch volunteers who keep an eye on the stormwater drains as part of their data collection role.

Percentiles: are summary statistics that identify the value of a variable (change from the norm) within a data set, below which a certain percent (%) of observations fall.

50th percentile: is the median (middle value, not average) value of data below which 50 percent of the observations may be found. (In this report turbidity data is shown as a percentile)

75th percentile: is the value of data below which 75 percent of the observations may be found.

90th percentile: is value of data below which 90 percent of the observations may be found.

Nutrient : Substance such as nitrogen and phosphorus in various forms. Excess concentrations of *nutrients* can be harmful in rivers and creeks.

SEPP: State of the Environment Protection Policy are guidelines and environmental objectives to determine the water quality condition of waterways monitored within Victoria. If water quality results fall significantly outside these ranges a number of times in 12 months, a pollution report is logged with the EPA.

Stormwater drain: takes the rainwater that falls on roofs, streets and paved areas to the closest water way. Stormwater drains can run in the open and can also run underground. Unlike sewage, stormwater is not treated in anyway before entering waterways. (With the exception of Gross Pollutant Traps –GTPs –in some locations)

Figure 9: Lillimur Stormwater Drain

Stormwater pollution : Can include among other substances, heavy metals, pesticides and detergents

Stream Condition: Biological survey results are assigned a Stream Condition Code using the Victorian Waterwatch Macro invertebrate Assessment Technique. Streams can be assigned a ranking of: Poor, Moderate, Good or Very good; depending on the variety and abundance of macro invertebrates found.

Reactive phosphorus : Any form of P that reacts with reagents in a colorimetric test without prior filtering, or digestion (acid and heating). Total reactive phosphorus includes ortho-phosphates, as well as other easily hydrolysable organic and inorganic forms of P. This is the form that Waterwatch tests for.

Total Phosphorus: Sum of organic and inorganic forms of phosphorus in unfiltered water samples. Sample is hydrolysed with acid and digested (heated) which breaks down strong chemical bonds and allows all phosphorus in the sample to be measured colorimetrically.

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7. Appendices

Appendix 1 – Definitions of Water Quality Monitoring Parameters

Water quality monitoring involves teaching participants how to test a range of different physical and chemical properties within their local creek, river or wetland. Participants are taught how to test up to seven primary water quality parameters, including:

- Turbidity
- Temperature
- Electrical Conductivity
- pH
- Phosphorus
- Ammonium
- Dissolved Oxygen

i) Temperature

What is temperature?
Temperature is an important factor in water quality. Temperature affects the metabolic rate of aquatic plants and animals which have evolved to live at specific temperatures. If the temperature changes too rapidly the organisms do not function as effectively and become more vulnerable to toxic waste and diseases. Where a temperature change of more than 2 °C occurs in a 24 hours period most aquatic organisms can experience stress, and with extreme temperature change, many organisms will die.

How is it measured?
Water temperature is measured in degrees Celsius (°C). The aim of measuring water temperature is important to support interpretation of other physical- chemical results (WW data confidential manual, July 2000, page 6).

Why do we measure temperature?
There are many factors affecting water temperature including air temperature, exposure to sunlight and shade, turbidity of water, groundwater inflowing to the water body, discharge of warmed water from industries and power plants, warm or cold water from dams, vegetation and type, depth and flow of water body (WW data confidential manual, July 2000, page 6).

Temperature also impacts on the amount of oxygen that can be dissolved in water, and this in turn can have an effect on plant and algal growth due to decreases in photosynthesis (WW national technical manual – Module 4, July 2002, page 6). Warmer water has the capacity to hold less oxygen. A decrease in available oxygen can be a problem for many aquatic organisms that consume oxygen to live, as their metabolic rate and demand for oxygen increases in higher temperature. Photosynthesis and bacteria decomposition processes happen quicker in warmer waters resulting in a build-up of nutrients and algal blooms (WW data confidential manual, July 2000, page 6). Temperature can also affect salinity and turbidity as these particles are more soluble in warmer water.

As temperature has a direct correlation with Dissolved Oxygen the temperature results are interpreted in the Dissolved Oxygen section.

ii) Electrical Conductivity

What is electrical conductivity?
Electrical conductivity (EC) is generally used to measure the salinity of water as it is the salts in water that conduct electricity. Salinity is the concentration of dissolved salts in water. The types of salts causing the salinity are sodium, magnesium, calcium, potassium, chlorides, sulphates and carbonates.

How is it measured?

The unit of measurement used by Waterwatch for electrical conductivity is microSiemens per centimetre (µS/cm) Waterwatch program measures EC using EC meters, by inserting the EC probe into the water sample.

Why do we measure EC?
Electrical conductivity is affected by many factors such as: geology and soils, surface run-off, groundwater inflows, temperature, evaporation, dilution and flow (dilution factors). During high stream flows EC values are generally low, and during low stream flows EC is generally high (WW national technical manual – Module 4). Contamination discharge into stormwater can change the water's electrical conductivity. EC can be naturally elevated due to proximity of groundwater, tidal influences or poor management techniques such as tree clearing.

iii) pH

What is pH?
The pH of water is a measure of its acidity or alkalinity. Water contains both H^+ and OH^- ions and the pH is a measure of the Hydrogen ion (H^+) concentration. Pure distilled water has an equal number of H^+ and OH^- ions.

How is it measured?
pH is measured on a scale from 0-14, 7 being neutral, 0 the most acidic and 14 the most alkaline. There is a 10 fold difference with an increase or decrease of each pH unit. For example a pH of 9 is 10 times more alkaline than a pH of 8.

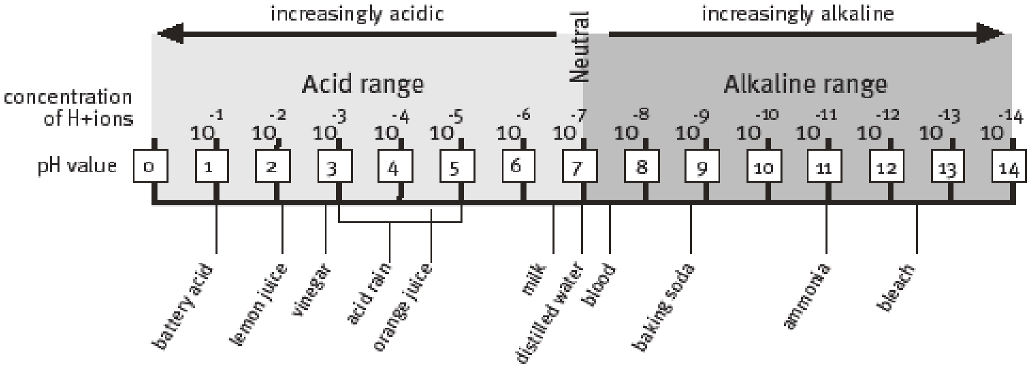

Figure 7: pH scale with some examples of what additives could cause a change in pH in a river system.

Why do we measure pH?
All animals and plants are adapted to specific pH ranges, generally between 6.5 and 8.0. If the pH of a waterway or water body is outside the normal range it can cause stress or even death of organisms (WW – Modules 4, page 26).

A wide variety of factors may have an effect on the pH of water such as: source of the water, rainfall, time of day, water temperature, amount of algal or plant growth in the water, geology and soils, discharges of industrial wastes, salinity and photosynthesis (WW – Modules 4, page 26). The pH of a water body varies during daytime as the balance between photosynthesis and respiration changes with the light intensity and temperature.

In-flowing water affects the pH of the water body as well. Rainfall is naturally slightly acidic because of carbon dioxide dissolved in it whereas water running off limestone areas has a relatively high pH making a stream slightly more alkaline. (WW – Modules 4, page 26).

iv)Turbidity

Turbidity is the measure of the clarity of water as a result of suspended solids. High turbidity reduces the transmission of light, or the more suspended materials in water the greater is the water's turbidity and the lower its clarity. As erosion occurs within a catchment, tiny particles of clay, silt or small organic particles (sediment) are washed into waterways. Industrial wastes, litter, algae and sewage can also contribute particles (Water Quality Monitoring Manual, 1996). Soil particles also contain nutrients, in particular phosphorous. Both organic and inorganic phosphate can be dissolved in the water or suspended (attached to particles in the water column). (Johnson, 2004)

Turbidity affects the distance light can penetrate into the water. Turbidity is often used as an indicator of the total amount of material suspended in the water. Turbidity can indicate the presence of sediment that has run off from construction sites, agricultural practices, logging forested areas or industrial discharge (Waterwatch National Technical Manual – Module 4, page 19).

There is less food and oxygen available to aquatic life in highly turbid waterways thus the photosynthetic ability of green plants in water is limited. This is due to the restricted penetration of light into water. Some species of plants can photosynthesise in low light or control their position in the water, they have the ability to grow in highly turbid water. This is a limited number of species, many of them introduced. If just these aquatic plants are surviving in a highly turbid waterway the biodiversity of that waterway is reduced. In highly turbid waterways the fine particles settle in the spaces in between rocks, where many macro-invertebrates live, breed and hide from strong flows and predators (Waterwatch National Technical Manual – Module 4, page 19). This can also reduced the biodiversity of aquatic animal life in a waterway.

Turbidity can be expressed by a range of units, including the preferred Nephelometric Turbidity Units (NTU). Turbidity meters measures the intensity of a light beam when it has been scattered by particles in the water.

v) Phosphorus

What is phosphorus?
Phosphorus is a mineral nutrient and essential element for all forms of life. Phosphorus is found naturally in both surface water and groundwater at low concentrations. It is naturally derived from the weathering of rocks and the decomposition of organic material, but it can also enter water bodies in runoff or discharges – soil and fertiliser particles can carry phosphorus, and sewage is also rich in phosphorus. High concentration of phosphorus in water bodies is often the result of human activities (Water quality monitoring manual, March 2004).

How is it measured?
Total Phosphorus is a measure of all forms of phosphorus; phosphorus naturally bound up in particles (e.g. soil) and dissolved phosphorus. Dissolved phosphorus is commonly known as reactive phosphorus and is in the form that is readily available for uptake by plants and animals. Waterwatch methods only measures reactive phosphorus as testing for total phosphorus would require a laboratory process.

Why do we measure phosphorus?
High levels of phosphorus concentrations in water result in problems such as algal blooms, excessive growth of aquatic weeds and loss of species diversity. Phosphorus concentration varies considerably under natural conditions, depending on factors such as local geology, soil types and seasonal conditions.

vi) Dissolved oxygen

What is dissolved oxygen?
Oxygen is essential for almost all forms of life. Aquatic animals, plants and most bacteria need oxygen for respiration (getting energy from food) as well as for some chemical reactions. Dissolved oxygen (DO) is the amount of oxygen dissolved in water which is available for aquatic life. Oxygen is produced and consumed in streams. Streams gain oxygen from the atmosphere and from plants as a result of photosynthesis. Oxygen enters the water and mixes with a water body. Agitated waters therefore contain more oxygen as the mixing process dissolves more oxygen than still water (water quality monitoring manual, 1996).

How is it measured?
Oxygen concentrations are expressed as milligrams per litre (mg/L) or as percentage saturation (%sat).

Why do we measure dissolved oxygen?
Oxygen is consumed by bacteria to break down organic matter during decomposition and respiration process. The population of bacteria in a stream can indicate the amount of organic matter and therefore the level of oxygen being used. As a result the health of the aquatic system depends on the concentration of dissolved oxygen (water quality monitoring manual, 1996). Stormwater runoff from farmland or urban streets, and failing septic systems often contain organic materials that are decomposed by micro-organisms.

Measurement of DO is a useful factor of water quality because it indicates the behaviour of a water body and the existence of pollutants. The concentration of DO is highly dependent on temperature, salinity, biological activities and rate of transfer from the atmosphere.

Increases in conductivity (salinity) reduce the maximum dissolved oxygen concentrations in water. Low DO levels are expected in muddy lowland rivers, where there is more organic matter than upland streams thus available Oxygen is used more readily by bacteria. DO is also lower after storms have washed organic materials into a water body. DO concentrations are higher during the day than overnight as oxygen is released by aquatic plants as a by-product of photosynthesis during daylight hours (WW national technical manual – module 4).

Low DO occurs due to no agitation at the water's surface in ponds and wetlands, as well as the presence of concentrated organic matter within ponds. Oxygen is used for the decomposition process of organic matter and is not being replenished as there is little agitation.

The temperature of the water has a direct influence on the amount of oxygen that can be dissolved in the water. Cooler water can hold a lot of oxygen whereas warmer water holds much less. This may result in dissolved oxygen varying at different depths.

Appendix 2 - Water Quality Environmental Objectives (SEPP)

This report uses the EPA (Environment Protection Authority) State of Environment Protection Policy (SEPP) - Waters of Victoria (WoV) Schedule F7, (Waters of the Yarra Catchment)
For our purposes (monitoring of the Lower Darebin creek) the Urban Waterways segment, with the tributaries of the Yarra River objectives are consulted.
These relevant sections of these guidelines are set out below:

Indicators	**Segment- Urban Waterways**
pH	6.0 – 8.5 max. variation 0.5
Electrical Conductivity	1000mg/l max. variation 20%
Dissolved Oxygen	Min. 6.0 mg/l Min saturation 60%
Turbidity	Max. Annual 50th percentile 25NTU Max. Annual 90th percentile 80NTU
Total Phosphorus[2]	Max. 0.1 mg/l
Total Nitrogen[3]	Max. 1.0mg/l

Table 16 : SEPP Guidelines for Urban Waterways, Schedule F7, tributaries of the Yarra River

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[2] SEPP guidelines are not used when analysing reactive phosphorus data as the guidelines only consider total phosphorus. It is put in as a rough guide (Reactive Phosphorous is 30-65% of TP, so roughly 50%- double reactive phosphate to compare)

[3] Ammonium is tested by our Waterwatch monitors not total nitrogen so this value is a guide only.

Appendix 3 - Macro invertebrates - Background information

What are macro invertebrates?

Aquatic macro-invertebrates (such as snails, mites, bugs, beetles, dragonflies, freshwater crayfish and worms) are very useful indicators in biological monitoring. They are animals without a backbone, visible to the naked eye and are commonly found in rivers and streams (WW – Module 3).

Why macro invertebrates' are monitored

The biological characteristics involve monitoring Macro-invertebrates to indicate the health of the river. Environmental changes on the river ecosystem, such as effects of pollution and surrounding land, have a major impact on aquatic animals. The presence or absence of specific species provides information about water quality. Generally sites with good quality water have a high level of species diversity (WW – Module 3).

They are a diverse group of animals and live in different habitats suitable to their living conditions. In order to survive, macro-invertebrates need specific ranges of environmental conditions such as nutrients, right temperature, enough oxygen levels, pH and salinity. Changes in water quality can therefore affect macro-invertebrates by decreasing the numbers of different types of macro-invertebrates and increasing those species which are more tolerant. The tolerant macro-invertebrates species or those can survive under polluted conditions usually increase in number because of the absence of other species, which normally compete with them for food (WW – Module 3).

Very sensitive animals	are only likely to be found in streams with good water quality
Sensitive animals	are usually only found in streams with good or medium water quality
Medium tolerant animals	can be found in streams with good or medium water quality but are less likely to be found in those of poor quality
Tolerant animals	can be found across a range of water quality in streams, but can live in poor quality water
Very tolerant animals	can be found in water of poor to good quality, but are usually the most abundant group in streams with poor water quality

Table 17: Sensitivity levels of macro invertebrates

Assessing the number of invertebrate families (biodiversity) found in streams represents the health of streams. The decrease in the average number of families in streams reflects the increasing impact of habitat degradation and polluted runoff from agriculture and urban environment (WW – Module 3).

Biological survey results are assigned a Stream Condition Code using the Victorian Waterwatch Macro invertebrate Assessment Technique. Streams can be assigned a ranking of: Poor, Moderate, Good or Very good; depending on the variety and abundance of macro invertebrates found during the survey.

Macro invertebrates are identified to an Order/Class/Phylum level, each being assigned a "Bug Score". Bug scores range from 1-8, with the orders of macro invertebrates most sensitive to pollution being assigned scores close to or equal to 8, and those tolerant to pollution; scores close to 1. The total abundance of all macro invertebrates found is then converted to an "abundance category" (see diagram below). These two values are then plotted on the Stream Condition Chart (see below), giving the stream condition.

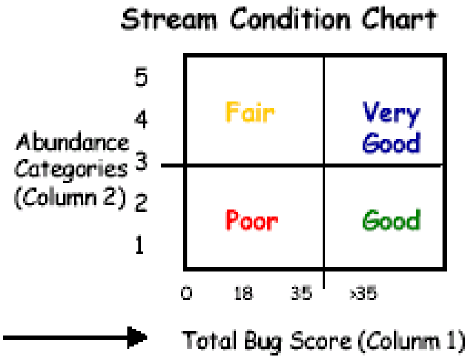


Table 18: Stream condition chart

Overall Abundance Categories

Nos. of animals	Category
0-30	1
31-100	2
101-200	3
201-500	4
>500	5

Table 19 : Abundance categories

Appendix 4 - Macro invertebrates – Data tables

Table 19: Macro invertebrate results May 2010, Oct 2009 and April 2009

Sampling Location		**YDA420**	**YDA421**	**YDA422**	**YDA420**	**YDA421**	**YDA422**	**YDA420**	**YDA421**	**YDA422**
Date of sampling		14th May 2010	14th May 2010	14th May 2010	7th Oct 2009	7th Oct 2009	7th Oct 2009	15th April 2009	15th April 2009	15th April 2009
Sample type		edge	edge	edge	edge	edge	edge	edge	edge	edge
	Bug Score									
Caddis-fly larvae	**7**	53	0	39	6	0	2	7	0	3
Mayfly larvae	**7**	0	0	2	0	0	0	0	0	0
Water mites	**7**	0	0	0	2	0	0	4	1	0
Dragonfly larvae	**6**	1	0	1	2	0	0	1	0	1
Damselfly larvae	**6**	14	0	22	14	0	26	36	0	36
Freshwater yabby	**5**	0	0	0	0	0	1	0	0	0
Freshwater shrimp	**5**	8	0	0	74	0	45	37	0	9
True Bugs	**4**	4	0	7	0	1	1	5	1	3
Snail	**3**	0	0	2	2	0	19	7	0	13
Leeches	**3**	0	0	0	0	0	0	0	0	0
Flatworms	**3**	1	0	0	2	0	0	0	0	0
Aquatic Beetles	**3**	0	0	0	0	0	0	0	0	1
Non-biting midges	**3**	5	0	4	10	0	0	6	0	8
Aquatic Caterpillar	**2**	0	0	19	1	0	0	0	0-	0
Mosquitoes	**2**	0	2	0	1	0	0	0	0	2
Biting-midges	**2**	0	0	0	0	0	52	0	0	0
Fly larvae	**2**	0	0	0	0	0	0	0	0	0
Segmented worms	**1**	0	1	0	1	0	1	0	5	0
Total no. of bugs		86	3	96	115	1	147	103	7	76
Abundance category		2	1	2	3	1	3	3	1	2
Total Bug score		31	3	38	45	4	33	41	12	39
Resulting Stream condition		Poor	Poor	Good	Good	Poor	Fair	Good	Poor	Good

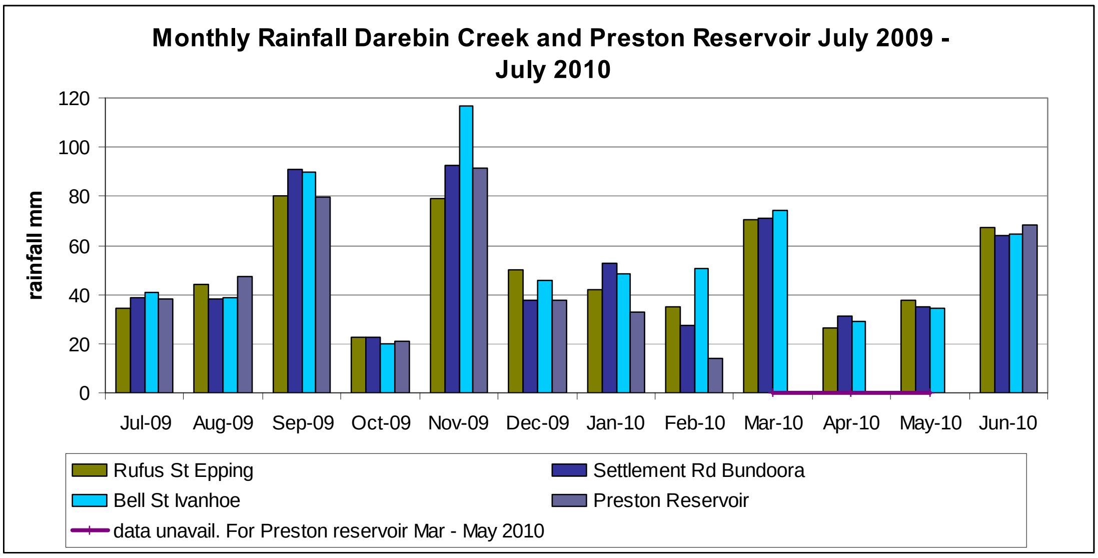
Table 20 : Macro invertebrate results Nov 2008, April 2008 and Nov/Dec 2007

Sampling Location		**YDA420**	**YDA421**	**YDA422**	**YDA420**	**YDA421**	**YDA422**	**YDA420**	**YDA421**	**YDA422**
Date of sampling		6th Nov 2008	6th Nov 2008	6th Nov 2008	11th April 2008	11th April 2008	11th April 2008	20-Nov-2007	11th Dec 2007	11th Dec 2007
Sample type		edge	edge	edge	edge	edge	edge	edge	edge	edge
	Bug Score									
Caddis-fly larvae	**7**	4	0	25	15	0	7	2	0	2
Mayfly larvae	**7**	0	0	0	1	0	2	0	0	0
Water mites	**7**	0	0	0	2	0	0	0	0	0
Dragonfly larvae	**6**	0	0	1	2	0	4	3	0	1
Damselfly larvae	**6**	9	0	15	35	0	15	2	0	2
Freshwater yabby	**5**	0	0	0	0	0	0	0	0	0
Freshwater shrimp	**5**	3	0	0	20	0	0	4	0	2
True Bugs	**4**	0	0	1	1	0	1	100	1	0
Snail	**3**	0	1	114	0	0	221	0	0	30
Leeches	**3**	0	0	0	0	0	1	0	0	0
Flatworms	**3**	4	0	2	0	0	0	0	0	0
Aquatic Beetles	**3**	0	0	0	0	0	0	0	0	0
Non-biting midges	**3**	0	1	1	0	0	0	0	0	0
Aquatic Caterpillar	**2**	1	0	1	0	0	0	0	0	0
Mosquitoes	**2**	0	0	2	5	0	5	10	0	110
Biting-midges	**2**	11	2	25	0	0	0	2	0	0
Fly larvae	**2**	0	1	0	0	0	0	0	0	0
Segmented worms	**1**	2	8	0	0	0	0	0	9	4
Total no. of bugs		34	13	187	81	0	256	123	10	151
Abundance category		1	1	3	2	1	4	3	1	3
Total Bug score		26	9	38	44	0	38	32	5	30
Resulting Stream condition		Poor	Poor	V Good	Good	Poor	V Good	Poor	Poor	Fair

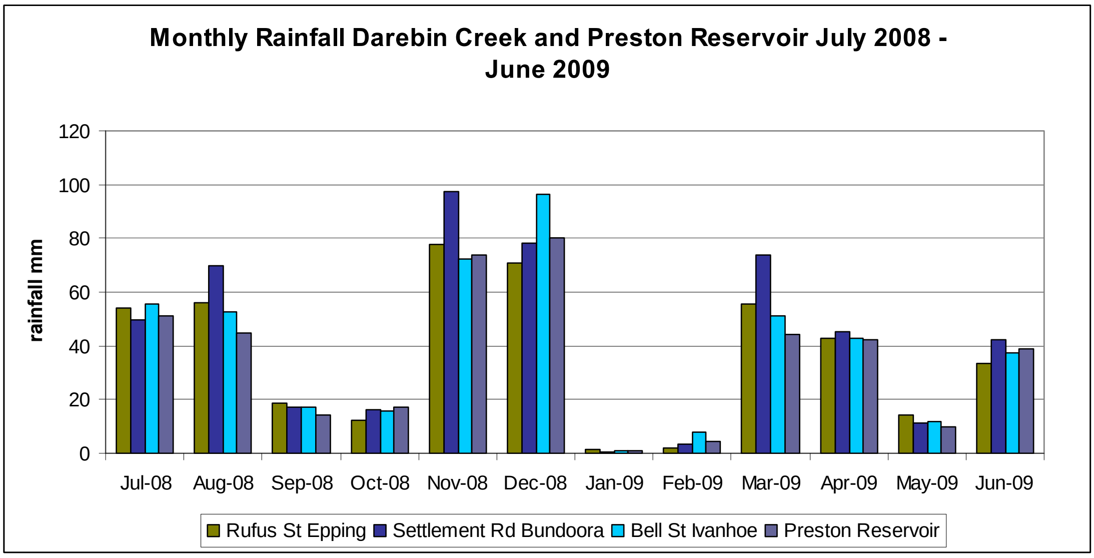
Appendix 5 - Melbourne Water data – Rainfall

Rainfall data source: http://www.melbournewater.com.au/

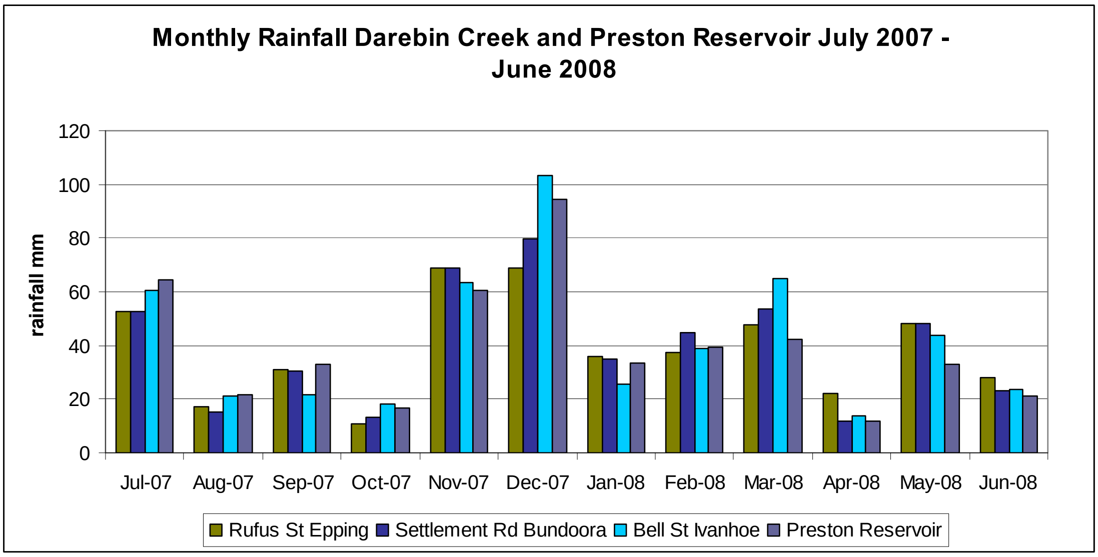
Whilst all due skill and attention has been taken in collecting, validating and providing the attached data, Melbourne Water Corporation shall not be liable in any way for loss of any kind including damages, costs, interest, loss of profits or special loss or damage, arising from any error, inaccuracy, incompleteness or other defect in this information.



Graph 21: Average monthly rainfall July 2009 to July 2010(data from Melbourne Water)



Graph 22: Average monthly rainfall July 2008 to June 2009(data from Melbourne Water)

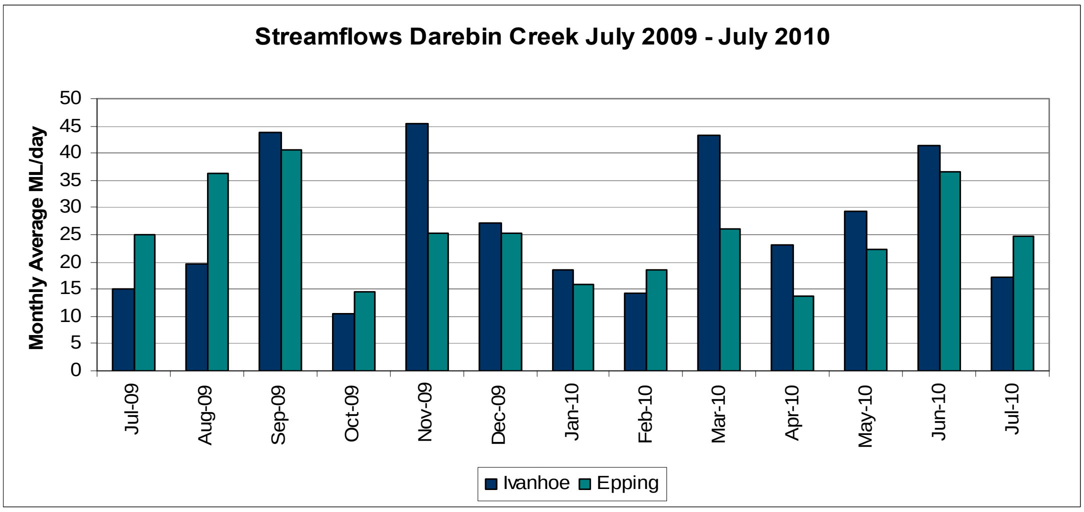


Graph 23: Average monthly rainfall July 2007 to June 2008(data from Melbourne Water)

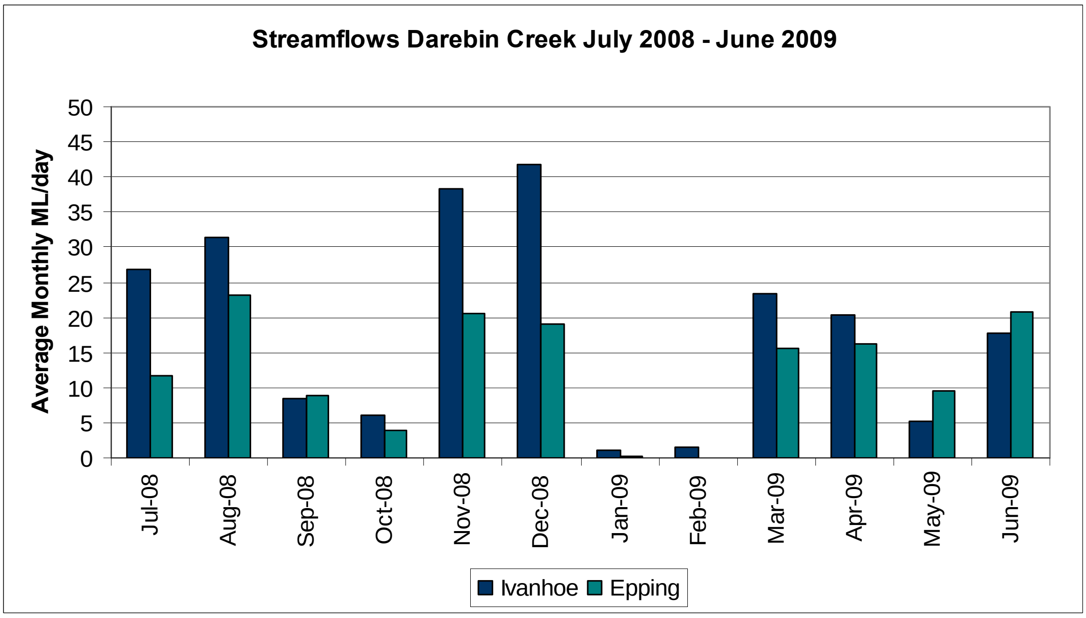
Appendix 6 - Melbourne Water data – Streamflows

Stream flow data source:
http://www.melbournewater.com.au/content/rivers_and_creeks/rainfall_and_river_level_data/

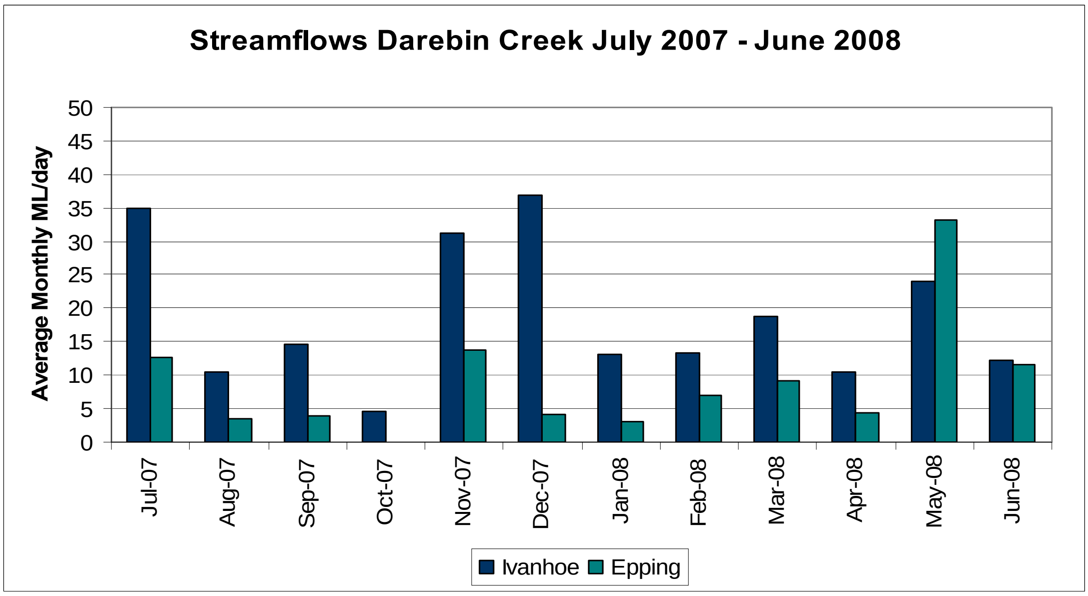
In utilising this information the recipient acknowledges that Melbourne Water Corporation makes no representations as to the accuracy or completeness of this information and the recipient ought to carry out its own investigations if appropriate.



Graph 24: Streamflow July 2009 to July 2010(data from Melbourne Water)



Graph 25: Streamflow July 2008 to June 2009(data from Melbourne Water)



Graph 26: Streamflow July 2007 to June 2008(data from Melbourne Water)