BENALLA AND DISTRICT ENVIRONMENT GROUP

WATER MONITORING REPORT 1996-2009

WATERWATCH
Goulburn/Broken Catchment

GOULBURN-MURRAY WATER
GOULBURN VALLEY WATER
GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY
GOULBURN MURRAY LANDCARE NETWORK

FRONT COVER : 2009 PHOTO COLLAGE OF SITES MONITORED IN HOLLAND CREEK

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Introduction

Waterwatch is a community water quality monitoring program that assists the community in monitoring their local waterway. The program aims to:

- increase community awareness and understanding of water quality issues;
- increase community involvement in water management decisions;
- generate useful data for community, and agency, use which complements Agency monitoring; and,
- assist in assessing the value of river restoration programs.

Monitoring networks across the Goulburn Broken Catchment have been formed to study water quality in their local areas. The networks are able to test a local stream for a range of parameters using equipment supplied by the Waterwatch Program. The parameters selected for testing in each area depend upon the water quality issues identified by the monitoring network. Monitors also record the date, time and rainfall to assist in the interpretation of the data.

Members of the Benalla and District Environment Group are concerned with the water quality in Holland Creek and Broken River around Benalla. They began a monitoring program in the area in 2005. The program includes sites on Holland Creek and the Broken River.

During 2009, the network monitored 8 sites on a monthly basis for six parameters. They were:

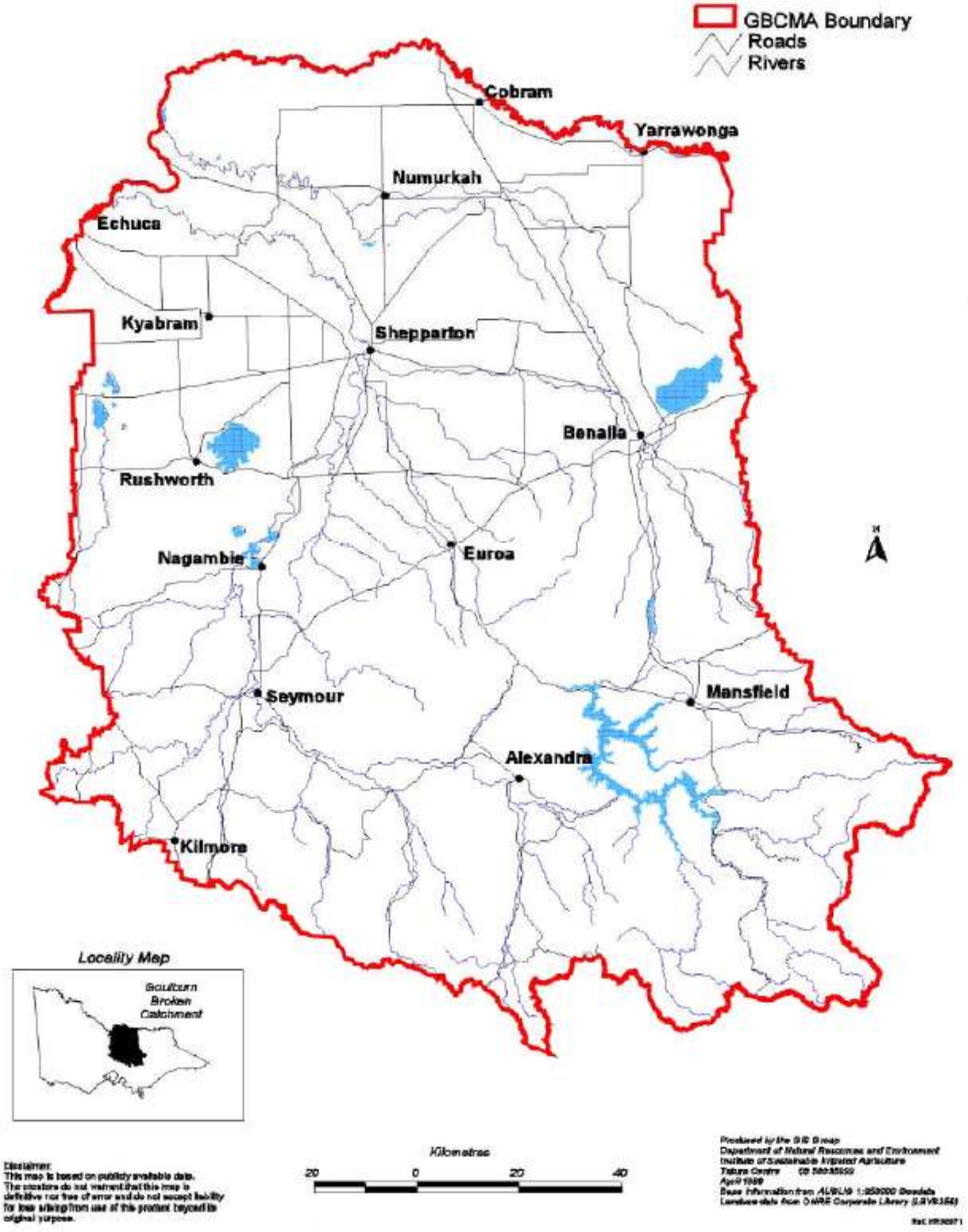
1. Electrical Conductivity (Salinity);
2. Turbidity;
3. pH;
4. Temperature;
5. *E.coli* at selected sites; and
6. Total Phosphorus at selected sites.

This report contains the following information:

1. Monitoring Plan
2. Information about water quality parameters
3. A tabular summary of data collected at sites monitored by the Benalla and District Environment Group
4. Graphical representation of parameters along the length of the waterway
5. Graphical representation of parameters over the period of the monitoring program
6. Comparisons of local water quality data with State Environment Protection Policy (SEPP) guidelines
7. Raw data for 2009

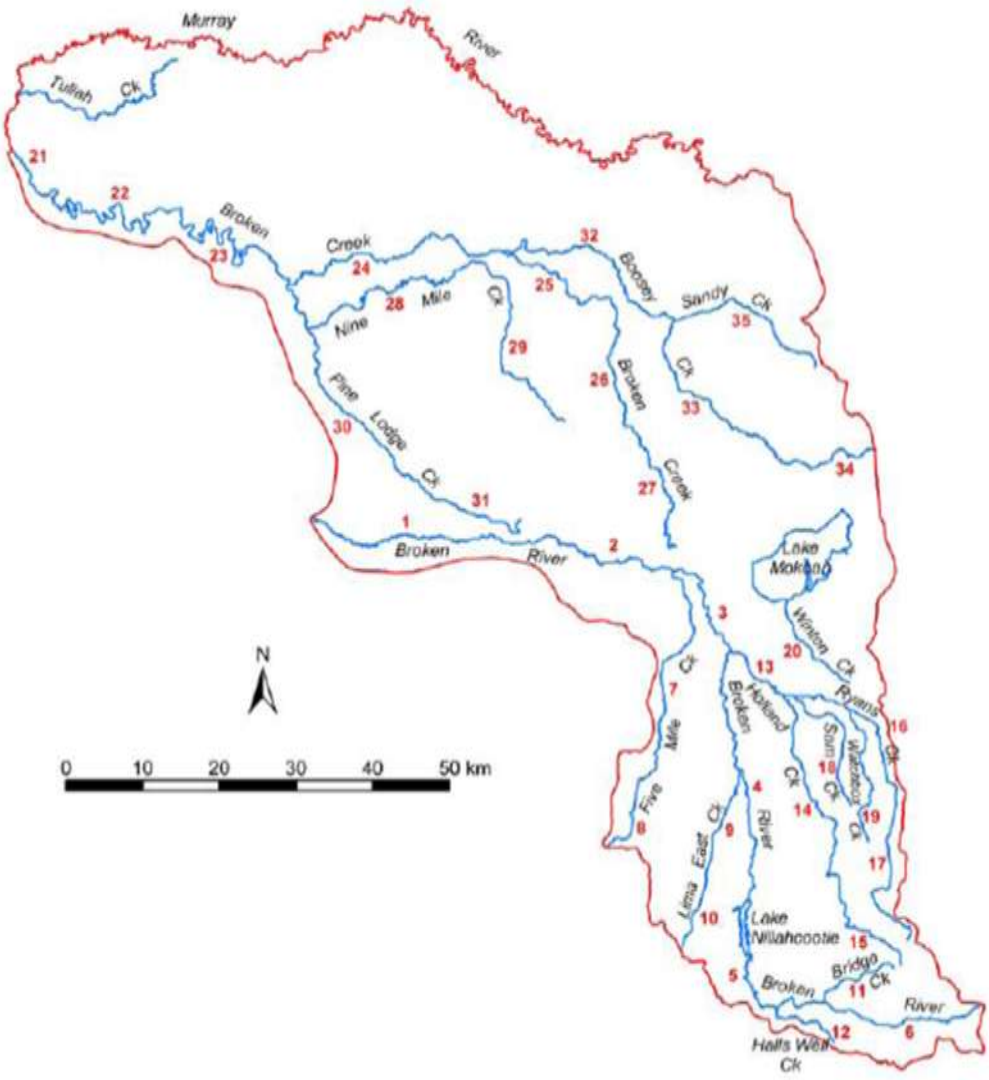
The report provides a summary of testing results since 1996 and should be used to stimulate discussion on the state of water quality in Broken River and Holland Creek and potential actions to improve water quality. There is the potential to use water quality data collected in the program to discover trends in water quality over time and to measure the effects of improvement works carried out in the sub-catchment.

Figure 1. Goulburn Broken Catchment



(GBCMA, 2005)

Figure 2. Broken River Basin
Red numbers show river reaches



GBCMA, 2005

Regional River Health Strategy

Rivers are divided into sections, known as "reaches", and each section or reach is given a number. Most sites monitored by Goulburn Broken Waterwatch are in reaches that are addressed in the Goulburn Broken Catchment Management Authority's (GBCMA) Regional River Health Strategy (RRHS). The reaches that are targeted in the RRHS are identified through the five yearly Index of Stream Condition (ISC) Assessment (GBCMA, 2005). Holland Creek and the Broken River both have reaches which fall under Program A in the RRHS. This Program addresses key issues in forty three reaches in the Goulburn Broken catchment which have been identified as High Priority Reaches. A High Priority Reach is one of high community value for environmental, social and economic values (GBCMA, 2005).

River	Reach	Description	High Values to be protected	Threats
Holland Creek HOL015 HOL020	13	START – Holland Creek at confluence with Ryans Creek, 550 m upstream of Emu Bridge Road crossing END - Holland Creek 700 m downstream of crossing at Samaria Road	Macquarie Perch.	Stock access; Water quality - turbidity, Dissolved oxygen and nutrients; Water Quality trend – pH; Barrier to fish migration; Channel modification; Flow deviation; Introduced flora; Degraded riparian vegetation.
Broken River BRO085	1	START – Broken River 1.2km upstream of Gowangardie Weir, (3.3 km downstream of Dookie-Violet Town Road) END - Broken River at end of Hassett St, Shepparton (2 km downstream of Goulburn Valley Highway)	Association with wetlands of National significance; Murray Cod; Silver Perch.	Stock access; Flow deviation; Water quality SIGNAL, turbidity, Dissolved oxygen and nutrients; Introduced flora and fauna; Channel modification; Bed instability; Loss of in-stream habitat.

River	Reach	Description	High Values to be protected	Threats
Broken River BRO048 BRO050 BRO055	3	START - Broken River 500 m downstream of Poison Creek confluence, 850 m downstream of Burns Lane off Samaria Road END – Broken River 150 m downstream of Casey Weir	Macquarie Perch; Murray Cod.	Stock access; Water quality SIGNAL, turbidity, Dissolved oxygen and nutrients; Water quality trend pH and turbidity; Barrier to fish migration; Flow deviation; Water temperature; Channel modification; Introduced flora.
Broken River BRO028 BRO030	4	START – Broken River at Nillahcootie Lake Road crossing, (North end of Lake Nillahcootie) END - Broken River 500 m downstream of Poison Creek confluence, 850 m downstream of Burns Lane off Samaria Road	Macquarie Perch; Murray Cod.	Stock access; Flow deviation; Barrier to fish migration; Water quality - turbidity, Dissolved oxygen and nutrients; Channel modification; Water quality trend - Electrical conductivity, pH and turbidity; Water temperature; Introduced flora; Degraded riparian vegetation.

Table 1 GBCMA (2005)

Monitoring Plan

Name of Project Activity Area: Benalla and District Environment Group

Monitoring Coordinators: David Hodgkins

Why are you monitoring ?

Waterwatch has an on-going objective to encourage the community to become involved in monitoring local waterways to learn more about water quality issues. The data that is collected through this monitoring program can be used to target on-ground works to improve water quality.

Who will use the data?

The data is primarily collected for the benefit of the community. The data is also available to other organisations and individuals that have an interest in catchment water quality. These include Federal and State Government agencies, Local Government, Catchment Management Authorities (CMAs), Natural Resource Management (NRM) bodies and managers, community groups and local farmers and landholders.

How will the data be used?

Waterwatch data is used by the community to understand issues regarding water quality in waterways. The data is then available to develop local action plans to improve water quality and to measure the effectiveness of these plans.

Goulburn Broken Waterwatch integrates our monitoring programs into the Goulburn Broken Catchment Management Authority's Regional River Health Strategy. The Goulburn Broken Catchment Management Authority can utilise the data to assess actions to improve river health against targets and objectives.

Who will be involved and where will you monitor?

MELINDA SHEPHERD

HOL015 – MAP 8024 E415753 N5947634	Holland Creek at Emu Bridge.
HOL020 – MAP8024 E409851 N5952766	Holland Creek at Sherwills Bridge Benalla.
BRO048 – MAP 8024 E409201 N5953257	Broken River at footbridge in Benalla.
BRO050 – MAP 8024 E408413 N5954577	Lake Benalla.
BRO055 – MAP 8024 E407362 N5955285	Broken River after Benalla at Pump station in Faithful St.

WATERWATCH COORDINATORS

BRO028 – MAP 8124 E413284 N5922359	Broken River after Nillahcootie at Williams Road
BRO030 – MAP 8024 E411684 N5932712	Broken River at Evans Bridge.
BRO085 – MAP 7925 E357117 N5968930	Broken River at Archer Street.

See map on page 11 also.

Which parameters will be monitored?

- Turbidity;
- Electrical Conductivity;
- Temperature;
- pH;
- *E.coli* (at selected sites);
- Total Phosphorus (at selected sites).

The sites monitored by Waterwatch coordinators are also tested for dissolved oxygen.

Data quality controls?

See Data Confidence Plan

What methods will you use?
When and how often will you monitor?

See Community Monitoring Manual for the methods and procedures used in the Waterwatch Program.

A statistical analysis of water quality data requires monthly monitoring as a minimum.

How will the data be managed and reported?

All water quality data is sent to the local Waterwatch Coordinator for quality assurance checking prior to being sent to the Data Management Coordinator for entry into the Regional Waterwatch Database.

Periodically, raw data reports and written reports are prepared by the Data Management Coordinator and distributed to the volunteer monitoring network, and agencies or groups who have requested the data.

Raw data is also loaded monthly onto the Goulburn Broken Waterwatch website (www.gbwaterwatch.org.au).

Map of Monitoring Sites

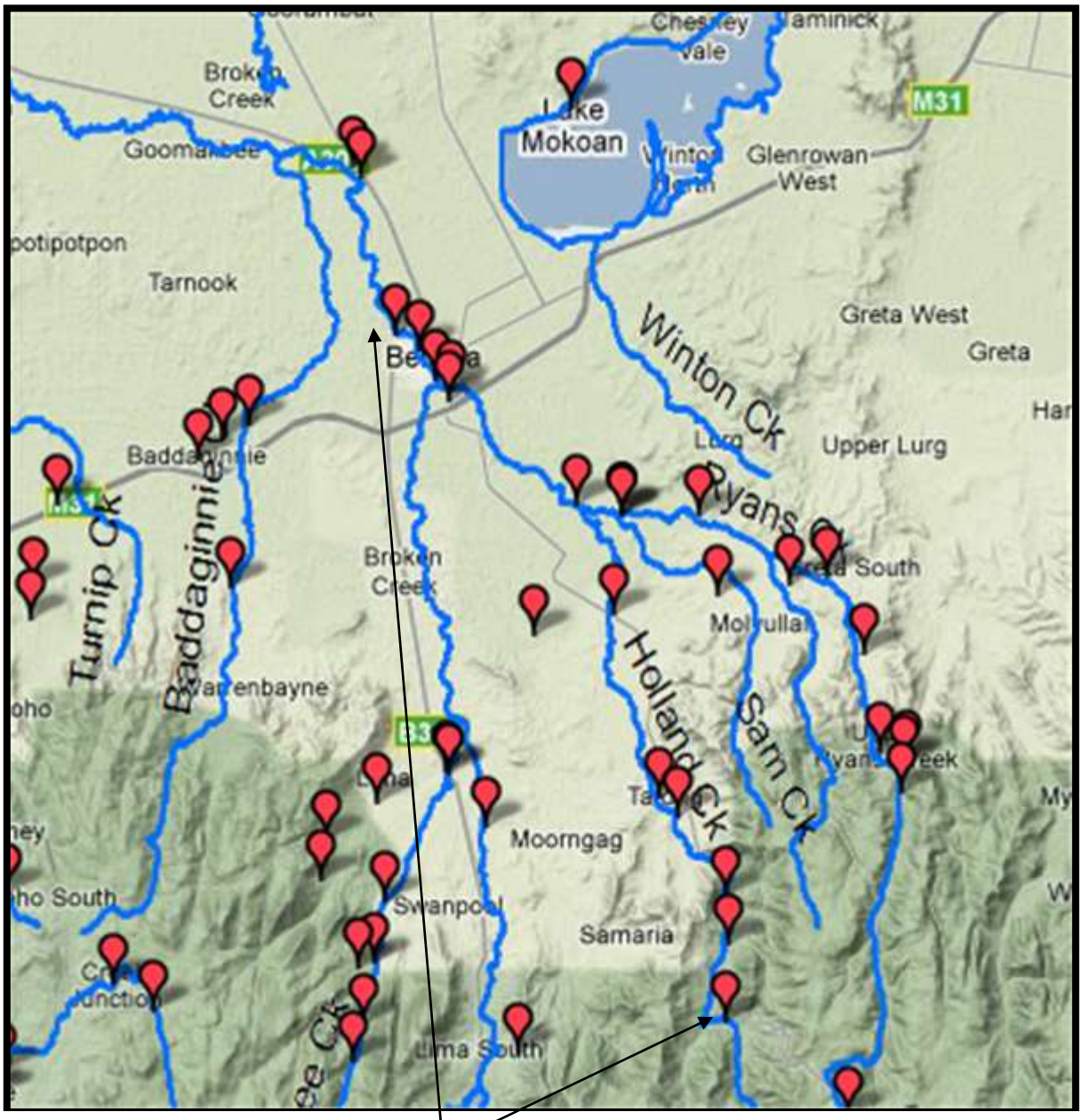


Figure 3: This map is taken from the Goulburn Broken Waterwatch Website, (www.gbwaterwatch.org.au) and shows the water quality monitoring sites in the Benalla and District Environment Group Region.

Turbidity

Turbidity is a measure of the clarity of water which is caused by suspended material in the water. As suspended material increases, the clarity decreases, and water appears cloudy or muddy.

As water becomes more turbid, the ability of light to pass through the water decreases. This can limit the growth of submerged plants. This affects the fish and invertebrate communities which feed on and live in the plants. The lack of light also makes it difficult for predatory fish and birds to hunt successfully (Tiller and Newall, 2009).

Turbid water loses its ability to support a large variety of aquatic organisms due to lower levels of oxygen. Where there is less light penetrating the water, there is less photosynthesis occurring, and therefore a lower level of oxygen in the water. The water also becomes warmer because the suspended material absorbs heat from the sun. This also decreases the amount of oxygen dissolved in water.

Turbidity can be caused by silt, clay, micro-organisms, plant material, sewage or industrial effluent discharges, algae and chemicals, however most of the sediment comes from erosion of the surrounding catchment or stream bank (Tiller and Newall, 2009). Soil weathering and erosion are a natural process, but human land use such as agriculture, forestry or housing development can result in significant quantities entering waterways.

Presence of riparian vegetation along the waterways can reduce the amount of suspended material entering waterways. It acts as a filter for rainfall runoff therefore reducing, or maintaining, the turbidity of the water.

Levels of turbidity will vary over time. Rain events inevitably cause an increase in turbidity in a waterway, as apart from transporting sediment into the waterways from the surrounding catchment, they also result in an increased flow, which may stir up the water body. Bushfires also have a detrimental effect on the turbidity levels in waterways due to the decimation of vegetation, riparian and other, resulting in exposure of soil, and lack of filtering the runoff to a waterway in the case of a rain event.

Turbidity for BDEG sites

Waterwatch have been testing for turbidity in the region since 1996. Benalla and District Environment Group began additional monitoring in 2005. The table and graphs below summarise the data collected.

Site code	Site Description	TURBIDTY MEDIANS (NTU)													
		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BRO028	**Broken River at Nillahcootie after Williams Rd**	11	7	12	43	34	27	-	30	21	18	-	40	43	35
HOL015	Holland Creek at Emu Bridge	-	-	-	-	-	-	-	-	-	20	-	10	24	11
HOL020	**Holland Creek at Sherwills Bridge, Benalla**	-	19	20	-	28	-	-	-	-	-	-	14	13	16
BRO030	Broken River at Evans Bridge	-	-	-	-	-	-	-	-	-	12	-	31	-	17
BRO048	**Broken River at footbridge in Benalla**	-	-	-	-	-	-	-	-	-	25	-	26	28	28
BRO050	Lake Benalla	-	20	22	-	-	-	-	-	-	29	20	20	15	20
BRO055	**Broken River after Benalla at pump station in Faithful St**	19	19	23	40	41	33	-	35	18	24	-	22	18	25
BRO085	Broken River at Archer St, Shepparton	38	36	50	50	48	42	57	78	77	56	44	92	91	76
Annual Rainfall Total (mm) BoM Killanoola Station (82109) until 2006, then BoM Benalla Airport Station (82170)		837	447	614	716	770	596	457	-	623	855	-	545	445	420

Ratings for Plains:
<15 NTU Excellent <17.5 NTU Good <20 NTU Fair <30 NTU Poor >30 NTU Degraded

Ratings for Valleys (BRO028 and HOL015):
<10 NTU Excellent <12.5 NTU Good <15 NTU Fair <22.5 NTU Poor >22.5 NTU Degraded

Table 2

- Turbidity at Broken River at Nillahcootie, after Williams Road, continues to be degraded.
- The turbidity median has improved at Holland Creek at Emu Bridge (HOL015) since 2008.
- A slight increase at HOL020 at Sherwills Bridge, but still within the "good" rating.
- Results at Lake Benalla (BRO050) and After Benalla at Faithful Street (BRO055) have also increased slightly since 2008, and are currently rated as "Poor".

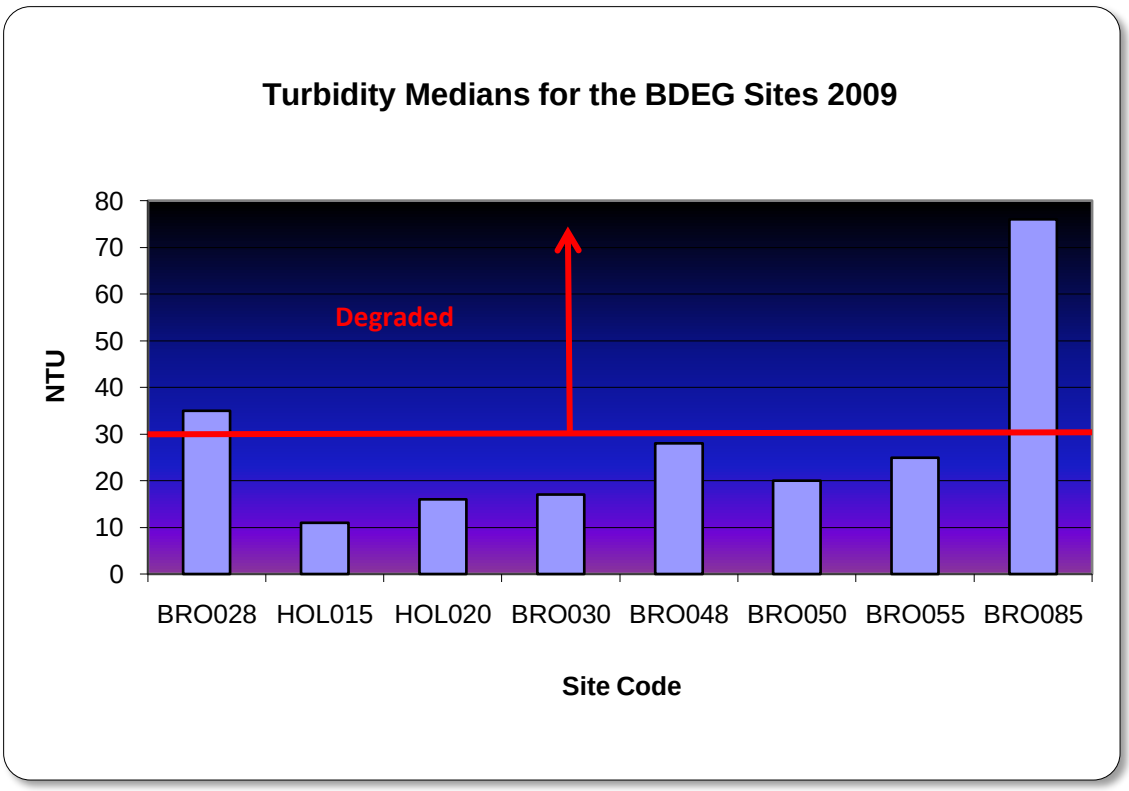


Figure 4

Figure 4 above shows annual turbidity medians for 2009 only.

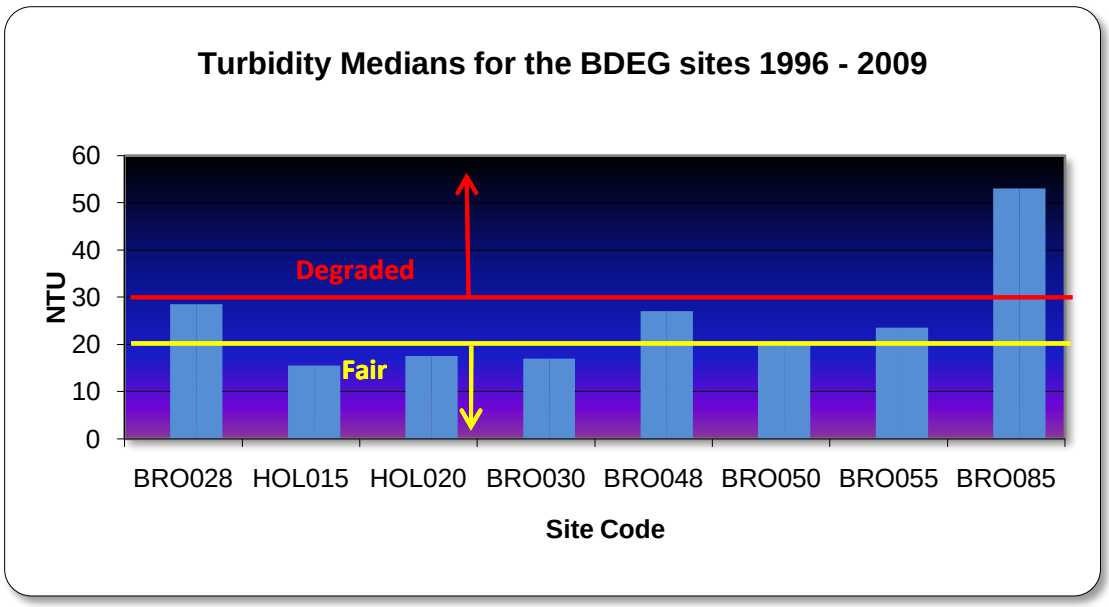


Figure 5

Figure 5 shows the long term median turbidity at each site over the fourteen year period that monitoring has been undertaken.

Electrical Conductivity (Salinity)

Electrical conductivity (EC) measures the flow of electricity in a solution (Tiller and Newall, 2009). As the amount of dissolved salts in the water increase, the conductivity increases. This relationship is used as a measure of salinity, and is recorded as micro Siemens per centimetre (µS/cm) (Tiller and Newall, 2009).

Salts are necessary for aquatic organisms to survive, but excessive amounts may be toxic to some. Different organisms have different tolerance levels to salt, but most freshwater aquatic organisms will not tolerate high levels. In general, EC levels less than 1500 µS/cm are considered to have little short term effect (Tiller and Newall, 2009). As salinity rises, the number of species decline.

Geology, urban and agricultural runoff, industrial and sewage runoff, proximity to the coast, and groundwater all affect salinity levels. Naturally salinity levels are higher in dry periods, as evaporation concentrates the salt levels. During these dry times, groundwater maybe the major contributor of water to waterways. Groundwater can have very high salt concentrations, and rising groundwater tables are known to have elevated salinity levels in many rivers in Victoria (Tiller and Newall, 2009). Once there is runoff again from rainfall, the salt concentrations will decrease.

Dryland salinity is caused when deep rooted trees are replaced with seasonal crops or grasses that do not pump the water into the atmosphere as efficiently. If trees are cleared higher up in a catchment, this can lead to dramatic rises in groundwater tables. Revegetation of recharge areas and buffer strips along local streams can help to reduce salinity.

The following summary can assist in interpretation of salt levels in surface waterways.

0-800 µS/cm

- Water from your tap at home would be within this range.
- This is good drinking water for people and suitable for all animals.
- When water of 300 µS/cm is used in irrigation through overhead sprinklers, plants that are sensitive to salt may develop leaf scorch.

800-2500 µS/cm

- People can drink water within this range but it would start to taste very salty.
- This water is still suitable for all animals.
- Peas, apricots and grapes can't be grown with water over 1,500 µS/cm.
- If this water is used for irrigation farming, special care must be taken with drainage and choosing plants that are tolerant to salt. For example, lucerne can be irrigated with water of 2,000 µS/cm and white clover with water of 1,000 µS/cm, provided they are grown on sandy soil with good drainage.

2,500-10,000 µS/cm

- Water in this range is not suitable for people and should only be drunk in an emergency.
- When water over 4,000 µS/cm is given to laying hens it causes their eggs to crack.
- Water over 6,000 µS/cm is unsuitable for pigs and poultry.
- Highly saline water may also contain a high level of magnesium which can be harmful to stock.
- This water is generally not used for irrigation farming except on some crops that have a very high tolerance to salt.
- Pears, apples and tomatoes could not be grown with water in this range.

Over 10,000 µS/cm

- Water over 10,000 µS/cm has an extremely high salinity.
- This water is unsuitable for people and for most animals.
- Only beef cattle and adult sheep can survive on water in this range.
- Irrigation farming is not possible with such highly saline water.
- In dryland areas only salt tolerant pastures will survive.
- At 50,000 µS/cm water has salinity similar to the sea.

Salinity for BDEG Sites

Waterwatch has been monitoring some of the sites in Table 3 for salinity since 1996. BDEG began monitoring additional sites in 2005. The table and graphs below summarise the data collected.

Site code	Site Description	Electrical Conductivity MEDIANS (µS/cm)													
		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BRO028	**Broken River at Nillahcootie after Williams Rd**	60	85	140	92	110	110	-	131	125	113	-	155	196	200
HOL015	Holland Creek at Emu Bridge	-	-	-	-	-	-	-	-	-	102	-	150	150	100
HOL020	**Holland Creek at Sherwills Bridge, Benalla**	-	160	120	-	190	-	-	-	-	-	-	145	151	140
BRO030	Broken River at Evans Bridge	-	-	-	-	-	-	-	-	-	131	-	162	202	281
BRO048	**Broken River at footbridge in Benalla**	-	-	-	-	-	-	-	-	-	124	-	160	170	180
BRO050	Lake Benalla	-	120	135	-	-	-	-	-	-	139	132	160	160	160
BRO055	**Broken River after Benalla at pump station in Faithful St**	110	130	135	110	120	140	-	164	124	136	-	160	164	160
BRO085	Broken River at Archer St, Shepparton	165	210	170	141	145	150	182	200	220	186	221	287	317	258
Annual Rainfall Total (mm) BoM Killanoola Station (82109) until 2006, then BoM Benalla Airport Station (82170)		837	447	614	716	770	596	457	-	623	855	-	545	445	420

Ratings for the Plains:
<100 EC Excellent, <250 EC Good, <500 EC Fair, <750 EC Poor, >750 EC Degraded

Ratings for the Valleys (BRO028 and HOL015) –
<80 EC Excellent, <240 EC Good, <400 EC Fair, <600 EC Poor, >600 EC Degraded

Table 3

- Electrical conductivity medians show most sites to be rated as "good" for 2009.
- Broken River at Evans Bridge (BRO030), and Broken River at Archer Street in Shepparton (BRO085)have slightly higher medians, but are still rated as "fair" in 2009.

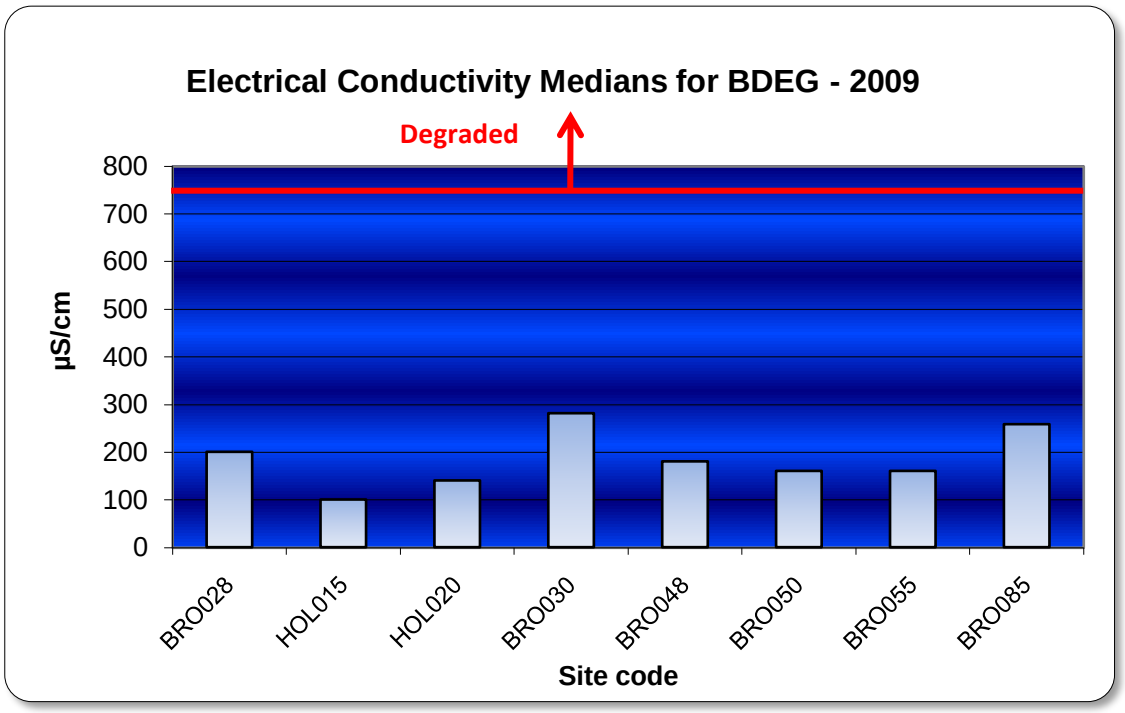


Figure 6

Figure 6 above shows electrical conductivity medians for 2009 only.

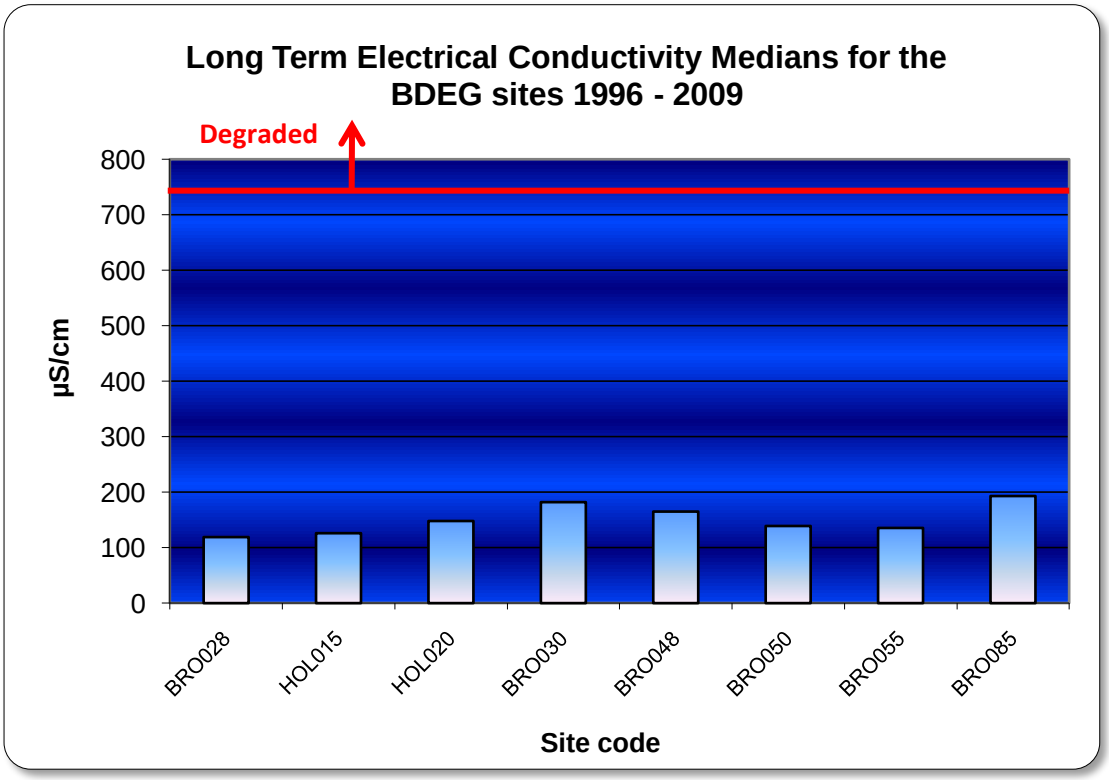


Figure 7

- Figure 7 shows the long term median salinity at each site for the period 1996 to 2008.
- In general, salinity levels can be expected to rise as a waterway moves through a catchment.
- Figure 7 shows a slightly elevated salinity in Holland Creek at Benalla (HOL020), which in turn increases the salinity in the Broken River at Evan's Bridge (BRO030).
- Levels remain fairly steady around Benalla, with this long term graph showing levels increase again by the time the Broken River reaches Shepparton.

pH

The pH of a stream is a measure of how acid or alkaline (basic) the water is on a scale from 0 to 14. It is a measure of the hydrogen ion (H^+) concentration. Water contains both H^+ and OH^- ions. Pure distilled water contains equal numbers of H and OH ions and is considered neutral (pH 7).

pH measurements between 7 and 0 indicate the solution is acidic and the solution contains more H ions than OH ions. Measurements from 7 to 14 indicate alkalinity and the water contains more OH ions than H ions. From pH 7 to pH 0, water becomes more acidic and from pH 7 to 14, water becomes increasingly alkaline. pH is a logarithmic scale so that for every one unit change (e.g. from 5 to 4), there is a ten-fold increase in acidity.

The pH of fresh waters usually lies in the range 6.5 to 8.2 although wide variations can occur because of catchment geology. The pH can also be affected by a range of factors including industrial runoff and sewage.

pH Changes in Water

Changes in pH outside the normal range of a water body will cause loss of the more sensitive species. Extremely high and low pH values will lead to the death of all aquatic life.

The most common cause of unnatural changes in pH occurs in catchments which have acid sulphate soils that have been exposed to the atmosphere by mining or urban development. During high rainfall events, these acids can be washed into streams causing sharp rises in pH values for short periods of time. Nutrient pollution can cause excessive growth of algae and other plants and lift the pH values to quite high levels at certain times of the day. These sometimes large variations in pH can reduce the number of species of aquatic organisms normally present in the water body.

pH in the Broken River

Some sites in the Broken River and its tributaries have been monitored by Waterwatch for pH since 1996. The table below summarises the data collected.

Site code	Site Description	MEDIAN pH													
		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BRO028	**Broken River at Nillahcootie after Williams Rd**	**6.5**	**6.9**	**7.2**	**7.1**	**7.2**	**7.9**	**-**	**7.4**	**7.7**	**-**	**-**	**7.4**	**7.5**	**7.4**
BRO030	Broken River at Evans Bridge	-	-	-	-	-	-	-	-	-	**7.3**	-	**7.4**	**7.7**	**7.2**
BRO050	Lake Benalla	-	**6.9**	**6.9**	**-**	-	-	-	-	-	**7.3**	**7.6**	**8.0**	**7.8**	**-**
BRO055	**Broken River after Benalla at pump station in Faithful St**	**-**	**7.0**	**6.9**	**6.6**	**7.1**	**7.3**	-	**7.0**	**-**	**7.4**	**-**	**7.8**	**7.6**	**-**
BRO085	Broken River at Archer St, Shepparton	**6.5**	**6.5**	**6.0**	**6.0**	**6.0**	**6.0**	**6.3**	**6.3**	**7.0**	**6.5**	**7.3**	**7.4**	**7.7**	**7.0**
Annual Rainfall Total (mm) BoM Killanoola Station (82109) until 2006, then BoM Benalla Airport Station (82170)		**837**	**447**	**614**	**716**	**770**	**596**	**457**	**-**	**623**	**855**	**-**	**545**	**445**	**420**

Table 4

Ratings for Valley and Plains:

6.0 - 7.5 Excellent 5.5 - 6 or <8.0 Good 8.0 - 8.5 Fair 5.0 - 5.5 or 8.5 - 9.0 Poor < 5.0 or > 9.0 Degraded

- All sites monitored for pH in 2009 fall within the "Excellent" rating.
- These results are useful baseline data and continue to contribute to an overall long term "picture" of pH in the catchment.

Phosphorus

Phosphorus is a nutrient that occurs naturally at low concentrations in water and it is essential for all forms of life. It comes from processes like the weathering of rocks (inorganic phosphorus) and from the decomposition of organic matter such as plant litter (organic phosphorus).

Other sources of phosphorus entering river systems include:

- Organic material from animals such as waste and decaying tissue
- Wastewater treatment plants
- Stormwater runoff
- Runoff or discharge from intensive agricultural or dairy industry
- Forest runoff

Phosphorus is one of the nutrients required by aquatic plants and animals, however it is often the one in shortest supply, therefore limiting plant growth. If phosphorus levels are high enough they can contribute to algal blooms and excessive growth of aquatic plants. This can result in smothering of aquatic habitat, and also cause severely high oxygen peaks and low oxygen troughs due to excess photosynthesis during the day, and respiration at night. These extreme highs and lows can be enough to severely stress or kill stream fauna (Tiller and Newall, 2009).

There can be seasonal variation in phosphorus levels. High flows generally result in higher phosphorus concentrations, as runoff carries sediment containing phosphorus into waterways. As for turbidity, bushfire and resultant devastation of riparian, and other, vegetation can result in extremely high levels of phosphorus. This is due to the massive sediment and ash inputs to the waterways after storm events.

Nutrients in waterways (particularly phosphorus) became an important parameter to monitor when deciding the quality of water in a waterway when the Water Quality Strategy was produced for the Goulburn Broken Catchment. Phosphorus is also a parameter included in the chemical sub-index as part of the Victorian Index of Stream Condition (ISC) rating system for measuring the condition of a waterway.

Total phosphorus is used rather than soluble (reactive) phosphorus, as it includes all forms of phosphorus present in a waterway rather than the soluble component. It will generally increase from headwaters to the lower part of a waterway.

Phosphorus in BDEG Region

Some of the sites in the BDEG region have been tested for phosphorus by Waterwatch since 1996. Since 2005, the BDEG has conducted additional monitoring. The table below summarises the data collected by Waterwatch and the BDEG.

Site Code	Site Description	TOTAL PHOSPHORUS MEDIANS (mg/L)													
		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BRO028	**Broken River at Nillahcootie after Williams Rd**	**0.05**	**0.03**	**0.05**	**0.09**	**0.07**	**0.06**	**0.06**	**0.06**	**0.03**	**0.03**	-	**0.05**	**0.03**	**0.045**
HOL015	Holland Ck at Emu Bridge	-	-	-	-	-	-	-	-	-	**0.05**	-	**0.02**	**0.02**	
HOL020	**Holland Ck at Sherwill's Bridge, Benalla**	-	-	**0.05**	-	**0.08**	-	-	-	-	-	-	**0.05**	**0.04**	
BRO030	Broken River at Evan's Bridge	-	-	-	-	-	-	-	-	-	**0.03**	-	**0.05**	-	-
BRO048	**Broken River at footbridge in Benalla**	-		-	-	-	-	-	-	-	**0.06**	-	**0.04**	**0.06**	**0.06**
BRO050	Lake Benalla	-	**0.05**	**0.08**	-	-	-	-	-	-	**0.06**	**0.03**	**0.04**	**0.03**	**0.06**
BRO055	**Broken River after Benalla at pump station in Faithful St**	**0.06**	**0.05**	**0.07**	**0.1**	**0.1**	**0.09**	**0.09**	**0.08**	-	**0.07**	-	**0.04**	**0.04**	**0.06**
BRO085	Broken River at Archer St, Shepparton	**0.16**	**0.15**	**0.17**	-	**0.14**	-	**0.18**	**0.19**	**0.14**	**0.09**	-	**0.12**	**0.12**	**0.07**
Annual Rainfall Total (mm) BoM Killanoola Station (82109) until 2006, then BoM Benalla Airport Station (82170)		**837**	**447**	**614**	**716**	**770**	**596**	**457**	-	**623**	**855**	-	**545**	**445**	**420**

Ratings for valleys and plains:
<0.01 mg/L Excellent, <0.025mg/L Good, <0.05mg/L Fair, <0.1mg/L Poor, >0.1mg/L Degraded

Table 5

- Phosphorus results are poor for 2009.
- There has been improvement at Broken River at Archer Street since 2008.

E.coli

Microbiological quality of a water-body is generally measured by testing for bacteria that are indicators of faecal pollution. Water intended for human consumption should contain none of these bacteria.

Indicator organisms are bacteria whose presence in water gives a simple and meaningful indication that faecal contamination has occurred. Such organisms are always present in high numbers in the faeces of humans (and other warm blooded animals and birds). Their presence in a water body indicates faecal contamination which may lead to potential health risks from disease causing pathogens, such as *Salmonella*, Hepatitis A, and *Giardia* (Tiller and Newall, 2009).

One of the major indicator organisms of faecal pollution is *Escherichia coli (E. coli).* When indicator bacteria are detected in water, their presence indicates that excrement from birds, animals or humans has recently polluted the water and that all types of pathogens (bacteria, viruses, protozoans and parasites) may also be present.

E. coli is a member of the coliform group of bacteria found naturally in the intestines of all warm-blooded animals. It is the predominant coliform in fresh faeces and so its presence in water is indicative of recent faecal contamination. The *E. coli* count does not differentiate between bacteria of bird, animal or human origin but, as animals and birds can act as carriers of human intestinal pathogens, the presence of *E. coli* should always be considered to have sanitary significance.

State Environment Protection Policy *E coli* Objectives for Waterways are shown in the table below.

Beneficial Use	Description	*E.coli* (orgs/100ml) Median of 5 samples at regular intervals within 30 days
Primary Contact	Swimming, bathing and other direct water-contact sports	≤150
Secondary Contact	Boating and fishing	≤1,000

Table 6

Some generalisations to help with interpretation:

- *E.coli* can fluctuate widely even to the extent of increases from "tens" to "hundreds" without necessarily indicating contamination from a pollution source;
- If this magnitude of increase occurred regularly between two sampling sites and a known possible source was implicated, then there is some evidence of contamination;
- Normally, *E.coli* levels will greatly increase after rainfall;
- Potential sources include sewage overflows, leaking sewerage systems, illegal sewerage connections to stormwater, septic tanks, and runoff from contaminated areas.

E.coli in the Benalla and District Environment Group Project Region in 2009

Site	22nd January 2009	24th February 2009	18th March 2009	20th May 2009	17th June 2009	20th August 2009	26th November 2009
BRO050 *Lake Benalla*	249	6	15	118	43	80	91

FAIL

Table 7

- Apart from the sample taken on the 22nd of January 2009, all results for Lake Benalla are within the SEPP guidelines for Primary contact.

State Environment Protection Policy (SEPP) Compliance

The State Environment Protection Policy (SEPP) Waters of Victoria (WoV) water quality objectives identify the 'ideal' result range for environmental data at a particular location in a waterway. If a site fails a SEPP objective for one parameter, it indicates a possible problem for the whole system, not just for the one parameter and not just for the one site). It is recommended that an ecological risk assessment (ERA) be undertaken to determine if there is a risk to the values (or "beneficial uses") associated with that stream.

Basically, any set of results that fails the objective is a red flag to look more closely at what's going on. This differs from aiming for a particular turbidity or total phosphorus result, as an ERA may determine that it is acceptable to exceed the SEPP objectives for some parameters depending on the use/value of the waterway.

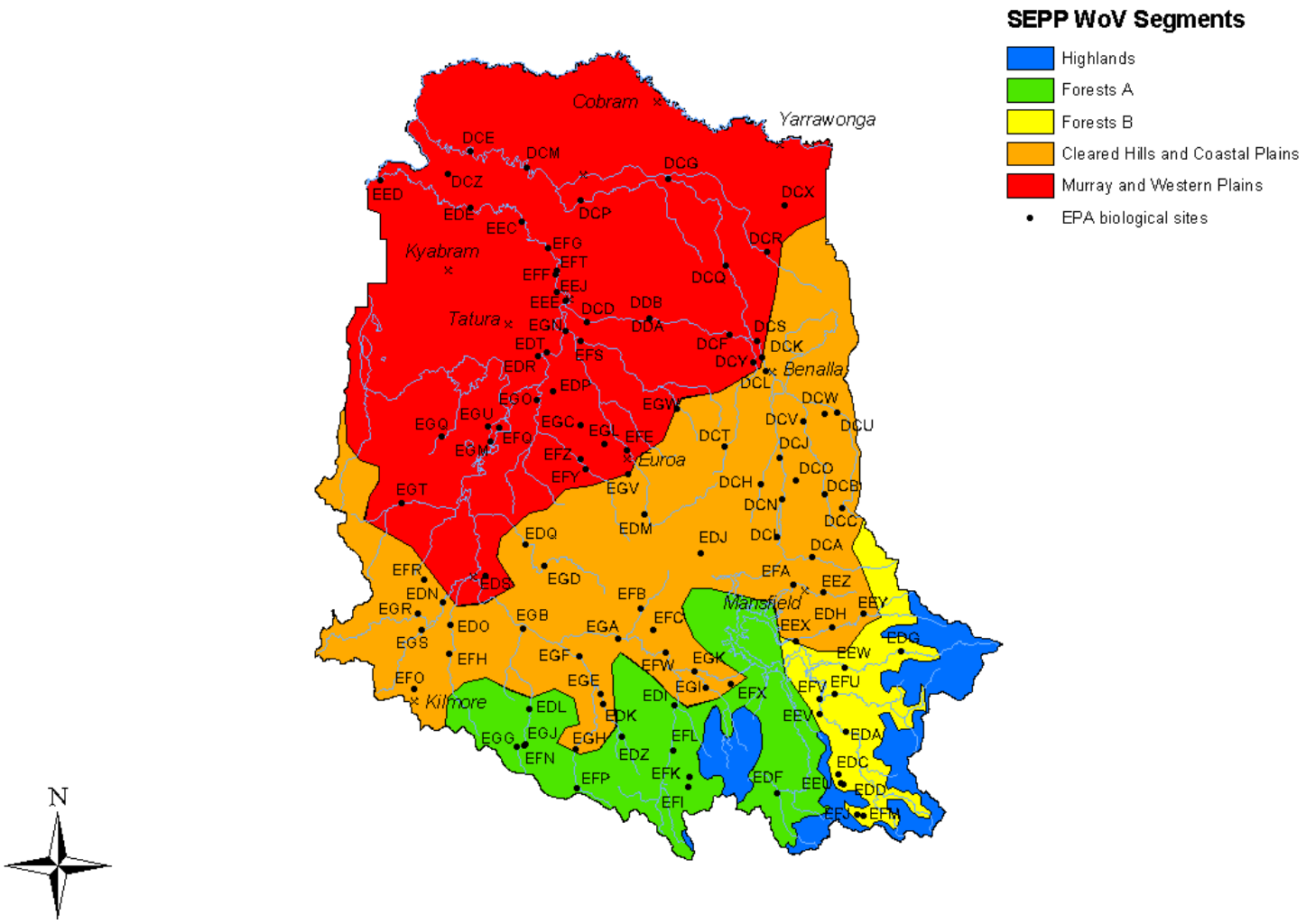


Figure 8: Goulburn Broken Catchment Management Authority - SEPP (WoV) segments (EPA,2003).

State Environmental Protection Policy (Waters of Victoria) Environmental Quality Objectives for Rivers and Streams – water quality

The State Environment Protection Policy (Waters of Victoria) segment and objectives applicable within the Goulburn Broken CMA region for the tests of relevance to the Benalla and District Environment Group are shown in Table 8. This table has been reproduced from the State Environment Protection Policy Waters of Victoria (Victorian Environment Protection Authority 2003).

SEGMENT	INDICATOR						
	Total phosphorus (ug/L)	Dissolved oxygen % saturation		Turbidity (NTU)	Electrical conductivity (uS/CM)	pH (pH units)	
	75th percentile	25th percentile	maximum	75th percentile	75th percentile	25th percentile	75th percentile
Cleared Hills and Coastal Plains							
• mid-reaches of Ovens, Goulburn and Broken catchments	≤25	≥85	110	≤10	≤500	≥6.4	≤7.7
Murray and Western Plains							
• lowlands of Kiewa, Ovens, Goulburn & Broken catchments	≤45	≥85	110	≤30	≤500	≥6.4	≤7.7

Table 8

Note: SEPP objectives are long term theoretical goals for water quality. It is not expected that waterways will comply at this stage

2009 results for Benalla and District Environment Group (Table 9) to be compared to SEPP objectives– water quality (Table 8)

SEGMENT	INDICATOR						
	Total phosphorus (ug/L)	Dissolved oxygen % saturation		Turbidity (NTU)	Electrical conductivity (uS/CM)	pH (pH units)	
	75th percentile	25th percentile	maximum	75th percentile	75th percentile	25th percentile	75th percentile
BRO028 Broken River at Nillahcootie after Williams Rd	50	93	105	47	229	7.2	7.7
HOL015 Holland Ck at Emu Bridge	100			16	130		
HOL020 Holland Ck at Sherwill's Bridge, Benalla	160			16	228	6.9	7.1
BRO030 Broken River at Evan's Bridge		96	116	36	305	7.0	7.4
BRO048 Broken River at footbridge in Benalla	90			30	210		
BRO050 Lake Benalla	70			21	215		
BRO055 Broken River after Benalla at pump station in Faithful St	70			37	208		
BRO085 Broken River at Archer St, Shepparton	110	81	100	100	286	6.9	7.1

Table 9

- When comparing with SEPP objectives, three quarters of the readings taken should fall below the 75th percentile.
- All seven sites monitored for total phosphorus continue to exceed their relevant SEPP objective.
- Broken River at Evans Bridge exceeds maximum Dissolved Oxygen saturation, and Broken River at Archer Street does not meet 25th percentile.
- Only three of the eight sites meet the SEPP objective for turbidity.
- Electrical conductivity and pH results are all within the SEPP guidelines, which is excellent considering that SEPP objectives are long term theoretical goals for water quality.
- It is not expected that waterways will comply with all objectives at this stage.

Summary for Benalla and District Environment Group

The Benalla and District Environment Group is encouraged to continue their monitoring program in 2010. Results for 2009 show that;

-
- The sub-catchment has elevated levels of turbidity at more than half the sites monitored when compared with the SEPP objective for a waterway in this part of the catchment;
- Electrical conductivity levels are good and all sites meet the SEPP objectives;
- pH results are good, and are well within the SEPP objectives;
- Total Phosphorus levels are poor and all sites monitored exceed the SEPP objective in 2009;
- *E.coli* levels are good and 85 % of samples taken at Lake Benalla fall below the SEPP guideline.

Similar sampling sites are recommended for 2010, and a continuation of the reduced sampling program for total phosphorus, to add to the baseline data set.

These results have so far been distributed to:

- Goulburn Broken Catchment Management Authority
- Waterwatch State Office
- Benalla Rural City Council

References

EPA (2003) Goulburn Broken Catchment Management Authority SEPP (WoV) Segments and environmental quality objectives. Environment Protection Authority, Macleod.

GBCMA (2005). *Regional River Health Strategy 2005-2015*. Goulburn Broken Catchment Management Authority, Shepparton.

GBCMA (2005). *Regional River Health Strategy 2005-2015*. *Status of the Riverine System – Regional Overview.* Goulburn Broken Catchment Management Authority, Shepparton.

Tiller, D. and Newall, P. (2009). *Interpreting River Health Data – Waterwatch Victoria.* Mulqueen Printers Pty Ltd.

Glossary

DO	Dissolved Oxygen – a measure of the concentration of oxygen in the water
EC	Electrical Conductivity – measures the flow of electricity in a solution in µS/cm
EPA	Environment Protection Authority
EPT	Ephemeroptera, Plecoptera and Trichoptera
GBCMA	Goulburn Broken Catchment Management Authority
ISC	Index of Stream Condition
Median	Numbers in a series are sorted into ascending order, and the middle number is the median
Mean	Average calculated by adding all data points and dividing by the number of data points
pH	Acidity or alkalinity of the water – 0 being acidic, 14 being alkaline
Photosynthesis	Process where plants produce oxygen during daylight hours
Respiration	Process where plants consume oxygen during non daylight hours
RRHS	Regional River Health Strategy
SEPP	State Environment Protection Policy
SIGNAL	Stream Invertebrate Grade Level
Turbidity	A measure of the clarity of water, measured in NTU

Appendix A

Benalla and District Environment Group

For Samples from 01 Jan 2009 to 31 Dec 2009

SiteNo: BRO028 Broken River after Nillahcootie at Williams Road.

Date:	Time:	Sample Type:	Temp ° C	TPhos mg/L P	EC µS/cm	Turb NTU	% O2 Sat %	Ecoli orgs/100 mL	pH pH Units	Flow ML/day	Rainfall mm	DO mg/L
		Parameters:										
20-Jan-09	1:15 PM	Grab	23.9	0.04	200	122	97		7.8	Mediu	0	7.8
18-Feb-09	5:15 PM	Grab	22.3	0.05	226	57	94		8.2	Mediu	0	8.1
18-Mar-09	1:00 PM	Grab	18.6	0.03	225	46	93		7.4	Mediu	0	8.6
16-Apr-09	11:50 AM	Grab	13.6	<0.02	231	47	99		7.4	Mediu	0	10.2
21-May-09	3:00 PM	Grab	14.4	0.05	236	47	99		7.6	low	0	10.5
17-Jun-09	11:40 AM	Grab	6.7	0.08	245	35	93		7.3	MedSlow	0	11.1
16-Jul-09	2:30 PM	Grab	9	0.05	170	17	95		7.1	medslow	5	10.9
28-Aug-09	4:15 PM	Grab	11.6		148	23	105		7.2	Mediu	0	11.0
18-Sep-09	9:40 AM	Grab	11.7	0.02	148	27	91		7.2	steady	15	9.9
30-Oct-09	1:00 PM	Grab	23.0		159	11	103		7.2	Mediu	0	9.0
29-Nov-09	2:10 PM	Grab	20.8		185	35	88		7.7	med	16.6	7.8

SiteNo: HOL015 Holland Creek at Emu Bridge Road

Date:	Time:	Sample Type:	Temp ° C	TPhos mg/L P	EC µS/cm	Turb NTU	% O2 Sat %	Ecoli orgs/100 mL	pH pH Units	Flow ML/day	Rainfall mm	DO mg/L
		Parameters:										
22-Jan-09	11:45 AM	Grab	24.5	0.12	310	11			7.1	0	0	
18-Feb-09	10:30 AM									dry	0	
24-Feb-09	4:10 PM									dry	0	
18-Mar-09	11:30 AM									dry	0	
17-Apr-09	11:45 AM									dry	0	
20-May-09	12:00 PM									0	0	
17-Jun-09	12:00 PM									dry		
16-Jul-09	2:00 PM	Grab	9.2	0.06	130	16						
20-Aug-09	2:40 PM	Grab	12.4	0.04	100	<10						
16-Sep-09	5:30 PM	Grab	13.3	0.05	90	<10					0	
26-Nov-09	2:10 PM	Grab	24	0.10	90	18			7.6	rising		
17-Dec-09	12:00 PM	Grab		0.09								

Waterwatch Victoria Application (WVA) - Site Report

SiteNo: HOL020 Holland Creek at Sherwill's Bridge Benalla

Date:	Time:	Sample Type:	Temp ° C	TPhos mg/L P	EC µS/cm	Turb NTU	% O2 Sat %	Ecoli orgs/100 mL	pH pH Units	Flow ML/day	Rainfall mm	DO mg/L
		Parameters:										
22-Jan-09	12:00 PM									0	0	
18-Feb-09	10:00 AM	Grab	20.6	0.18	48	16	38		6.9	stag		3.3
24-Feb-09	4:15 PM	Grab	24.3	0.16	220	17				stag	0	
18-Mar-09	10:30 AM	Grab	18	0.16	228	16	34		6.9	stag	0	2.9
18-Mar-09	2:15 PM	Grab	20.3	0.11	240	21			7.8	pools	0	
17-Apr-09	10:05 AM	Grab	13.2	0.04	237	10	44		6.7	stagna	0	4.4
20-May-09	12:00 PM									Dry	0	
17-Jun-09	12:00 PM									dry		
16-Jul-09	1:30 PM	Grab	9.1	0.06	120	11						
20-Aug-09	2:50 PM	Grab	11.2	0.04	140	<10						
16-Sep-09	5:35 PM	Grab	12.7	0.05	90	<10					0	
26-Nov-09	2:20 PM	Grab	22.4	0.08	110	16			7.1	rising		

SiteNo: BRO030 Broken River at Evans Bridge, Swanpool

Date:	Time:	Sample Type:	Temp ° C	TPhos mg/L P	EC µS/cm	Turb NTU	% O2 Sat %	Ecoli orgs/100 mL	pH pH Units	Flow ML/day	Rainfall mm	DO mg/L
		Parameters:										
20-Jan-09	1:05 PM	Grab	25.5	0.02	207	33	87		7.4	Low	0	7.2
16-Apr-09	11:30 AM	Grab	12.2		232	38	97		7.2	Low	0	10.4
17-Jun-09	12:15 PM	Grab	8.1		259	14	97		7.5	Low	0	11.2
16-Jul-09	4:15 PM	Grab	9.7	0.16	332	12	102		6.9	lowmed	5	11.6
28-Aug-09	3:40 PM	Grab	14.0		309	14	116		7.0	Mediu	0	12.3
18-Sep-09	9:10 AM	Grab	10.9		301	44	94	23	7.0	Mediu	15	10.0
30-Oct-09	12:20 PM	Grab	21.5		281	17	99		7.3	Low	0	8.6

Waterwatch Victoria Application (WVA) - Site Report

SiteNo: BRO048 Broken River at footbridge in Benalla

Date:	Time:	Sample Type:	Temp ° C	TPhos mg/L P	EC µS/cm	Turb NTU	% O2 Sat %	Ecoli orgs/100 mL	pH pH Units	Flow ML/day	Rainfall mm	DO mg/L
		Parameters:										
22-Jan-09	**11:15 AM**	Grab	25.5	0.05	220	14			7.9		0	
24-Feb-09	**5:00 PM**	Grab	22.3	0.07	210	28			7.9	Low	0	
18-Mar-09	**2:40 PM**	Grab	18.6	0.03	220	25			7.4	Low	0	
20-May-09	**11:20 AM**	Grab	12.2	<0.02	200	20				Low	0	
17-Jun-09	**12:00 PM**	Grab		0.05	144	39						
16-Jul-09	**4:45 PM**	Grab	9.6	0.09	130	38						
20-Aug-09	**3:10 PM**	Grab	12.0	0.10	180	29						
16-Sep-09	**8:00 AM**	Grab	10.9	0.05	160	28					0	
26-Nov-09	**8:45 AM**	Grab	21.7	0.06	160	30			7.7	rising		
17-Dec-09	**12:00 PM**	Grab		0.11								

SiteNo: BRO050 Lake Benalla

Date:	Time:	Sample Type:	Temp ° C	TPhos mg/L P	EC µS/cm	Turb NTU	% O2 Sat %	Ecoli orgs/100 mL	pH pH Units	Flow ML/day	Rainfall mm	DO mg/L
		Parameters:										
22-Jan-09	**1:00 PM**	Grab		0.06				249				
24-Feb-09	**4:40 PM**	Grab	25	0.03	230	10		6		Low	0	
18-Mar-09	**2:25 PM**	Grab	23	0.03	230	19		15	7.4		0	
20-May-09	**4:30 PM**	Grab	13.5	0.03	210	21		118		0	0	
17-Jun-09	**12:00 PM**	Grab		0.09	141	20		43				
16-Jul-09	**2:15 PM**	Grab	10.8	0.06	130	45						
20-Aug-09	**3:30 PM**	Grab	14.2	0.07	140	20		80				
16-Sep-09	**8:10 AM**	Grab	11.9	0.05	160	21					0	
26-Nov-09	**4:50 PM**	Grab	23.3	0.09	160	18		91	7.3	steady		
17-Dec-09	**12:00 PM**	Grab		0.03								

Waterwatch Victoria Application (WVA) - Site Report

SiteNo: BRO055 Broken River after Benalla at Pump station in Faithful St.

			Parameters:									
Date:	Time:	Sample Type:	Temp ° C	TPhos mg/L P	EC µS/cm	Turb NTU	% O2 Sat %	Ecoli orgs/100 mL	pH pH Units	Flow ML/day	Rainfall mm	DO mg/L
22-Jan-09	11:30 AM	Grab	24.8	0.04	200	10			7.6	Low	0	
24-Feb-09	4:40 PM	Grab	23.3	0.04	230	<10				Low	0	
18-Mar-09	3:00 PM	Grab	20.3	0.02	220	10			7.6	steady	0	
20-May-09	11:40 AM	Grab	12.2	0.03	210	40				Rising	0	
17-Jun-09	12:00 PM	Grab		0.07	141	55						
16-Jul-09	5:10 PM	Grab	9.4	0.12	130	68						
20-Aug-09	4:40 PM	Grab	13.0	0.08	150	29						
16-Sep-09	7:45 AM	Grab	11.3	0.06	160	24					0	
30-Oct-09	11:30 AM	Grab	23.0		159	25	69		7.2	Low	0	5.8
26-Nov-09	3:30 PM	Grab	24.4	0.07	150	22			7.3	rising		

SiteNo: BRO085 Broken River at Archer Street

			Parameters:									
Date:	Time:	Sample Type:	Temp ° C	TPhos mg/L P	EC µS/cm	Turb NTU	% O2 Sat %	Ecoli orgs/100 mL	pH pH Units	Flow ML/day	Rainfall mm	DO mg/L
21-Jan-09	8:15 AM	Grab	21.8	0.14	263	67	49		7.1	0	0	4.0
18-Feb-09	9:10 AM	Grab	23.0	0.12	846	104	82		7.5	Low	0	7.0
13-Mar-09	8:45 AM	Grab	20.3	0.08	315	98	77		7.1	Low	10	7.4
15-Apr-09	9:20 AM	Grab	15.5	0.03	276	50	90		7.1	Low	0	8.9
20-May-09	9:00 AM	Grab	10.8	0.03	253	44	88		6.7	low	0	9.7
17-Jun-09	9:15 AM	Grab	7.0	0.05	235	33	99		6.6	Low	0	11.9
20-Aug-09	7:10 AM	Grab	10.2		170	84	100		6.9	Mediu	0	11.3
28-Oct-09	8:30 AM	Grab	17.9		197	105	83		6.9	Mediu	0	8.1