Caseys Creek –

Baseline Water and Sediment Quality

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Introduction

Caseys Creek is one of a number of small spring-fed streams in the Blenheim area. Blenheim is located on the edge of a layer of silt and clay-rich material, the Dillons Point Formation, which was deposited as a result of a temporary extension of sea cover during a period of warmer climate approximately 8700 years ago [3]. Because water cannot penetrate the Dillons Point Formation, groundwater from the large Wairau River aquifer is forced to the surface forming spring-fed streams.

Caseys Creek is located in the northern part of Blenheim flowing in a west to east direction (Figure 1). The lower reaches run parallel to Old Renwick Road before the creek flows into the Ōpaoa River at Landsdown Park. Caseys Creek has a relatively small surface catchment, but receives water through emerging groundwater and several stormwater discharges from residential areas located along both sites of the waterway. Stormwater discharges are predominantly affecting the water quality of the lower reaches, while the upper reaches of Caseys Creek are more influenced by the surrounding agricultural and horticultural land use.

The stream has been significantly modified over the years. Most notably, the stream channel has been straightened for almost the entire length of the waterway.

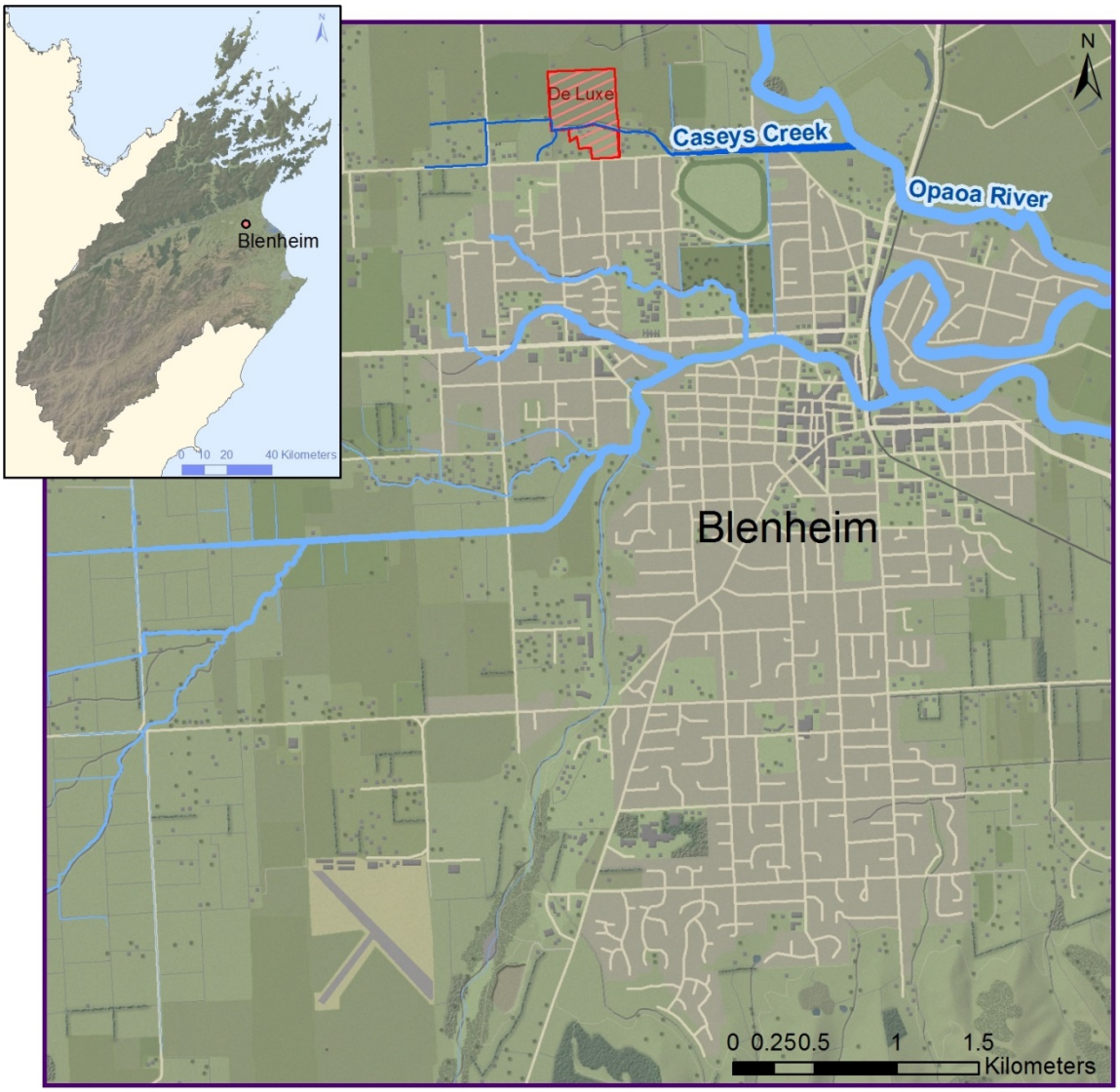

Figure 1: Location of Caseys Creek.

Hydrology

Despite its relatively short length, Caseys Creek is permanently flowing in the middle and lower reaches. This is due to significant groundwater inflow along these parts of the stream. Field observations indicate that the upper reaches only flow occasionally. This includes the parts of the stream located on the De Luxe property.

Gaugings of several sites on Caseys Creek were carried on 24 May 2010 during base flow conditions (Figure 2). The most upstream gauging site marks the location of a relatively large spring that discharges into a small pond (Figure 3). During dryer conditions this is usually the location at which the first surface flow appears. Downstream of this point the inflow of groundwater appears to be relatively constant until the stream reaches Waipuna Street Bridge at which point the flow increases at a slightly higher rate. Along the lowest reaches, the stream appears to be losing water before flowing into the Ōpaoa River. In May 2010 the flow increased from 5 L/s at the most upstream gauging site to 95 L/s at the Waipuna Street Bridge and then decreased to a flow of 80 L/s upstream of the Opaoa River.

Figure 2: Flow measurements on 24 May 2010 at several sites along Caseys Creek.

Figure 3: The first gauging site, which is also the location of the first significant surface flow of Caseys Creek.

Water Quality

Methodology

Between August 2016 and May 2017 several sites along Caseys Creek were sampled during eight sampling runs. The samples were chilled and dropped off at the Blenheim Hill Laboratories Office for analysis.

Samples were taken during base flow conditions and during rainfall events (Figure 4). Two of the rainfall sampling runs were carried out during light rainfall, within the first hours of rainfall. These were attempts to capture first flush events. Unfortunately, rain during the first of these runs was significantly lighter than was forecast. Nevertheless, stormwater was flowing into Caseys Creek during both sampling runs.

To further investigate the influence of rainfall on the water quality of Caseys Creek two sampling runs were carried out during heavy rainfall. These were the only sampling runs during which Caseys Creek was flowing upstream of the De Luxe property.

Caseys Creek was also sampled immediately below the De Luxe property (Figure 5). Apart from the two sampling runs during heavy rainfall, flow was only observed during two of the base flow sampling runs, but not during the light rainfall runs. On all other sampling occasions the creek was dry at this point. When flowing water was observed during dry weather, the flow was very small (less than 0.5 L/s). This meant that any impact by wildfowl or other animals would have been significant due to the lack of dilution and the greater chance of bed disturbance. Therefore, the results from these samples need to be treated with caution.

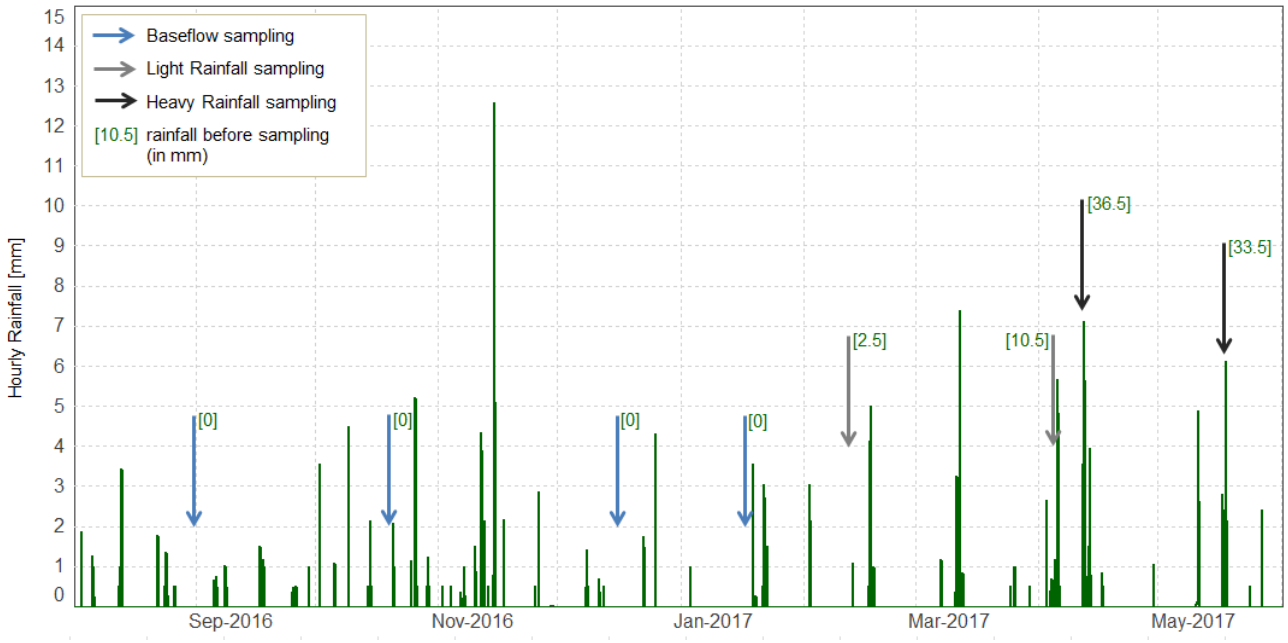

Figure 4: Caseys Creek sampling runs.

Figure 5: The sampling site downstream of the De Lux property – dry (left), during base flow and light rainfall (middle), and heavy rainfall (right).

The following sections describe the observed water quality for the individual parameters measured. To put the results into context, values are compared to those observed in Murphys Creek. Murphys Creek is similar to Caseys Creek. Both waterways are short, spring-fed streams that receive significant amounts of urban stormwater. Murphys Creek is located less than 15 kilometres south-west of Caseys Creek (Figure 6). The creek is monitored on a monthly basis as part of Council's State of the Environment program. For better comparison, only monitoring results for the period during which Caseys Creek was sampled are shown.

Because water quality of Caseys Creek is substantially influenced by groundwater inflows, monitoring results from Well P28w/3120 (short: Well 3120) are also shown. Again, only results from monitoring during the study period between August 2016 and May 2017 are used.

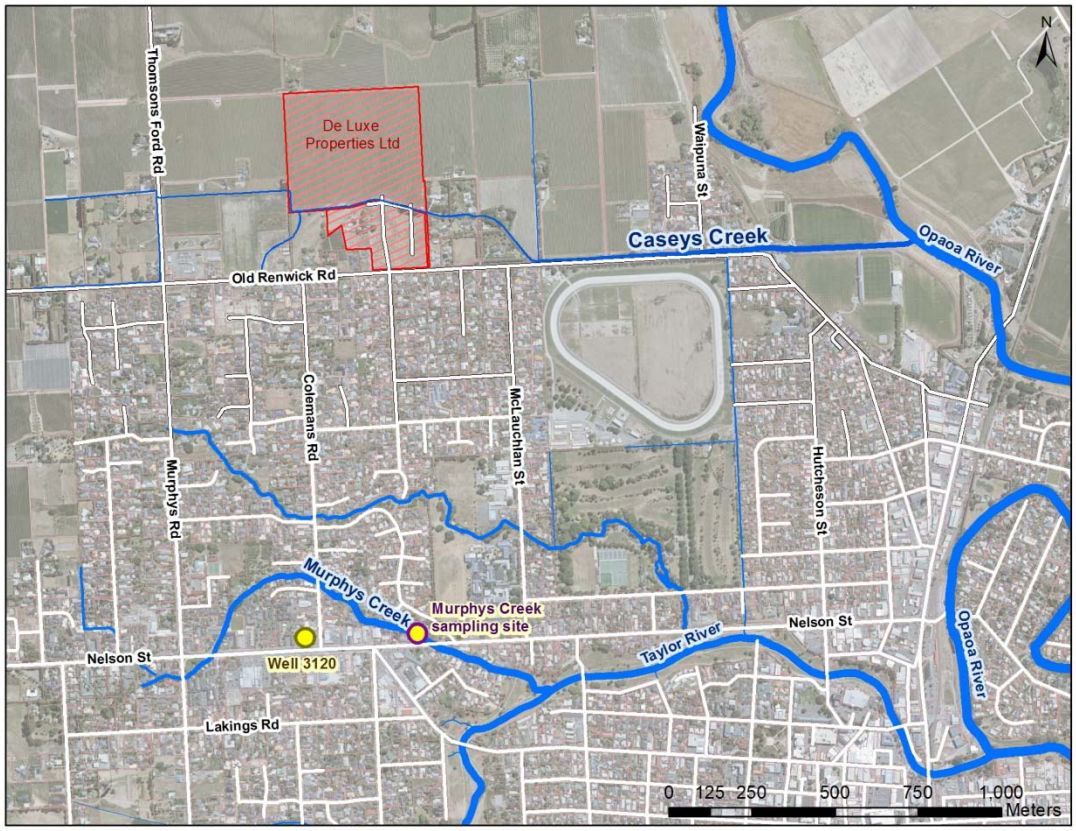

Figure 6: Caseys Creek, Murphys Creek and Well 3120.

Results

Nitrate-Nitrogen

High levels of Nitrate-Nitrogen have two effects on waterways. As the main form of dissolved nitrogen it is a major nutrient for algae and macrophytes. Excessive growth of these plants can result in habitat loss and changes to the dissolved oxygen dynamics, negatively effecting aquatic life. Council uses a guideline of 0.165 mg/L as an indication for excessive growth of algae (periphyton) mats [4]. This value is based on work by Biggs (2000) [2]

At higher concentrations Nitrate is directly toxic to aquatic animals. The toxicity guideline used here is based on the acute effects A-band limit of the National Policy Statement for Freshwater (NPS) [9]. This limit was also incorporated into Objective 15.1b of the proposed MEP.

The Guideline used for the assessment of Total Ammonical Nitrogen concentrations is also based on the maximal allowable limits in the NPS, which are based on its toxicity to aquatic life. Total Ammonical Nitrogen concentrations within the NPS A-Band are required under Objective 15.1c in the proposed MEP. Objectives 15.1b and 15.1c state that water quality needs to be maintained or enhanced so that Nitrate-Nitrogen and Ammonical Nitrogen concentration are within the A-band of the NPS.

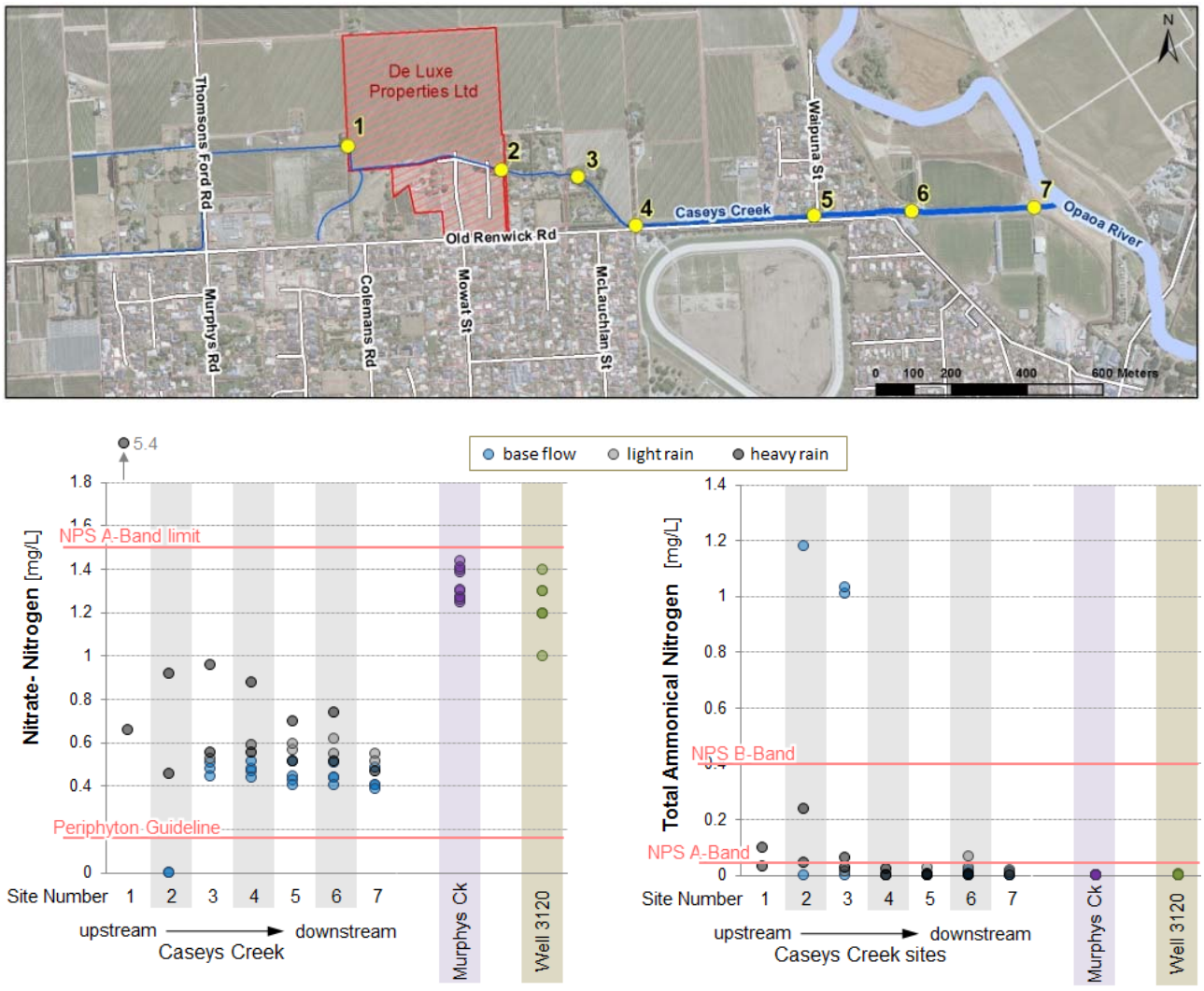

Figure 7: Top: Map of the sampling sites (with Site Numbers) on Caseys Creek. Bottom: Nitrate-Nitrogen and Total Ammonical Nitrogen concentrations measured in Caseys Creek, Murphys Creek and Well 3120. For Caseys Creek the different sampling conditions are distinguished by colour.

Nitrate-Nitrogen concentrations in Caseys Creek are generally above the Periphyton guideline, but below the A-Band limit of the NPS (Figure 7). During base flow conditions, concentrations are very similar at all sites, with a median value of 0.45 mg/L. The only exception is Site 2 (downstream of De Luxe). However, as mentioned, the flow was very low and the result is likely not representative of general water quality due to significant interaction with the stream bed.

Nitrate-Nitrogen concentrations in Caseys Creek are lower than those observed in Murphys Creek and Well 3120. It is likely that the groundwater emerging in Caseys Creek follows a slightly different flow path than that feeding into Murphys Creek and receives less nitrogen through leaching. The limited variation of the Nitrate concentrations in both streams, however, indicates that groundwater inflow is the main source of Nitrate during base flow conditions.

During rainfall events, Nitrate concentrations are higher than the base flow values. The difference is the result of inputs from overland flow and stormwater. The highest concentration was measured during heavy rainfall upstream of the De Luxe property. The water at this site is predominantly influenced by rural land uses upstream. Septic tanks are also a possible source, but microbial source tracking of the sample taken downstream of the De Luxe property during the same event showed that no human sewage was present.

Total Ammonical Nitrogen concentrations were below the NPS A-band limit in most samples. Exceptions during baseflow were samples taken at sites 2 and 3. It is unclear what caused the high Ammonical Nitrogen levels, but a possible origin is interactions with stream sediment at site 2 (see above). At site 3 the break-down of abundant organic material from the dense vegetation surrounding the pond combined with low flows could also cause high Ammonical Nitrogen concentrations. Other sources are animal or human faecal matter, but E. coli concentrations at Site 3 were consistently low during base flow conditions, making this an unlikely source for these samples.

Elevated Ammonical Nitrogen concentrations during rainfall events, however, are likely the result of faecal matter that is washed into the stream through surface runoff or sewage contamination of stormwater discharged into the creek. Nevertheless, dilution was sufficient enough to prevent exceedances of the NPS B-band.

In comparison, Ammonical Nitrogen concentrations in Murphys Creek are consistently close to the detection limit. This includes samples taken during rainfall events [5]. Concentrations are also very low in Well 3120.

Dissolved Reactive Phosphorus

Like nitrogen, phosphorus is a major plant nutrient. Dissolved Reactive Phosphorus (DRP) is the form of phosphorus easily absorbed by algae and other aquatic plants. Therefore, high levels of DRP result in excessive growth of algae (periphyton) and macrophytes. In this section DRP concentrations are compared to the periphyton guideline used for the state of the environment reporting by council [4]. There are no limits set for DRP in the NPS.

DRP concentrations are quite variable across sites on Caseys Creek. During base flow, the highest concentrations are measured in the upper reaches (Figure 8), with particularly high values at Site 2 downstream of De Luxe (see Footnote 1). In the lower reaches DRP values are close, but generally below the Periphyton Guideline, with the lowest values at Waipuna Street Bridge (Site 5). Values at this site are the closest to those observed in Murphys Creek and Well 3120. This means that during base flow inflowing groundwater is the main source of DRP in the lower reaches of Caseys Creek.

During rainfall, DRP concentrations are noticeably higher compared to base flow values. This is not surprising; unlike Nitrate, which enters waterways mainly through leaching, DRP is mostly bound to sediment and soil, which is washed into the stream through surface runoff.

DRP concentrations were particularly high in the upper reaches during heavy rainfall. These are predominantly influenced by rural land uses and receive surface runoff mainly from unsealed areas. The rapid decline in DRP concentrations downstream shows the influence of urban stormwater draining largely sealed surfaces containing less sediment.

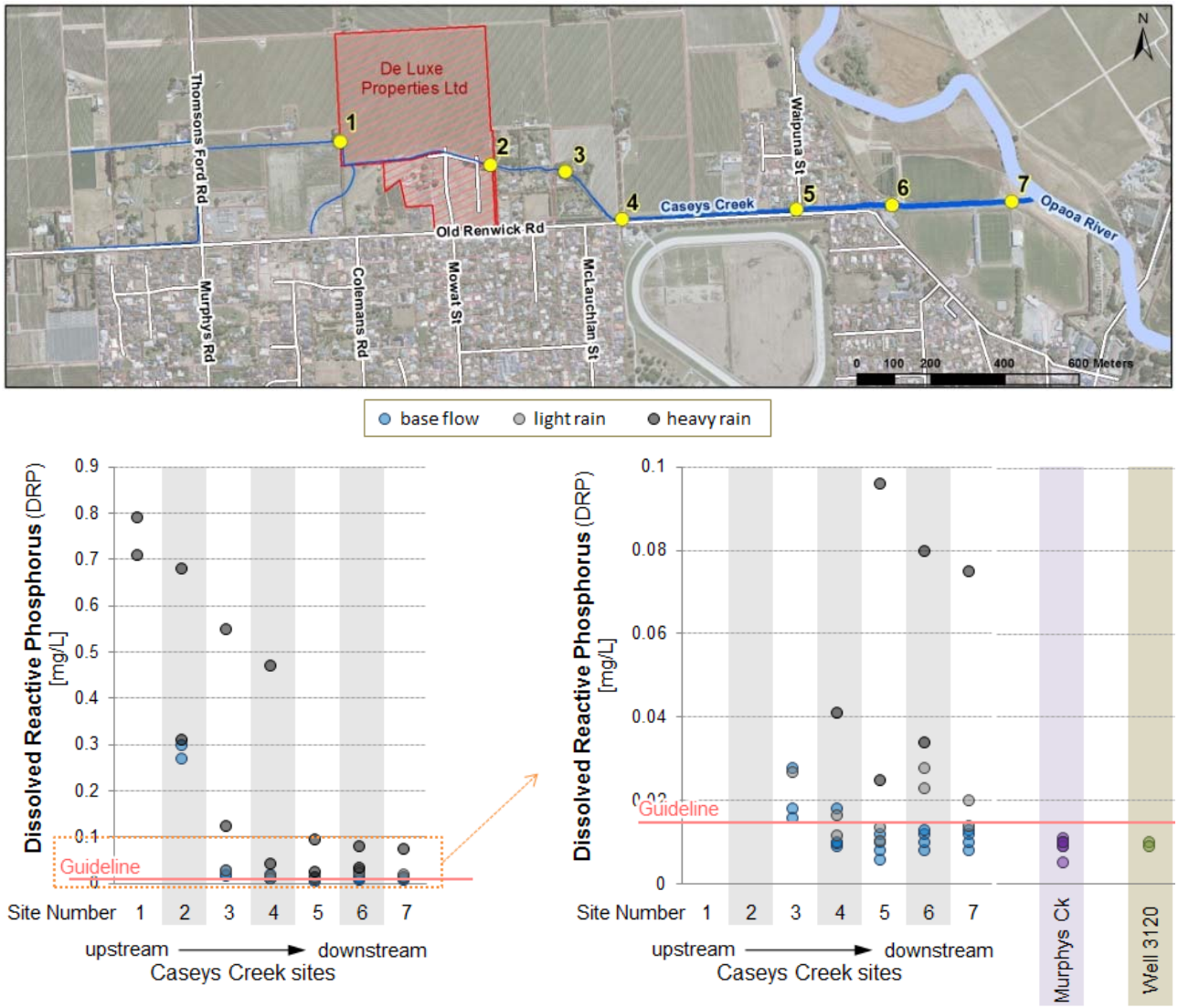

Figure 8: Top: Map of the sampling sites (with Site Numbers) on Caseys Creek. Bottom: Dissolved Reactive Phosphorus concentrations measured in Caseys Creek, Murphys Creek and Well 3120. For Caseys Creek the different sampling conditions are distinguished by colour.

Unlike Caseys Creek, Murphys Creek has no rural component in the surface catchment. In recent years DRP concentrations in Murphys Creek have very rarely exceeded the periphyton guideline including during rainfall. This further underlines that rural land uses are the main source of DRP in Caseys Creek during rainfall.

Turbidity and Total Suspended Solids

Due to the significant inflow of naturally clear groundwater, turbidity in Caseys Creek is generally quite low during base flow conditions. Turbidity is an indirect measure of water clarity and is therefore an indicator for the amount of small particles suspended in the water column. Measurements of Total Suspended Solid concentration is a more direct measure of suspended sediment. Unfortunately, the detection limit for Total Suspended Solids is quite high (3 mg/L), resulting in non-detection values for most of the samples. Therefore, Turbidity often provides a more complete picture. The guideline used here is the recreational and amenity trigger value of the ANZECC 2000 Guidelines [1]. However, suspended sediment does not only affect amenity values and visibility for aquatic animals, but also has the potential to settle on the stream bed, smothering aquatic habitat.

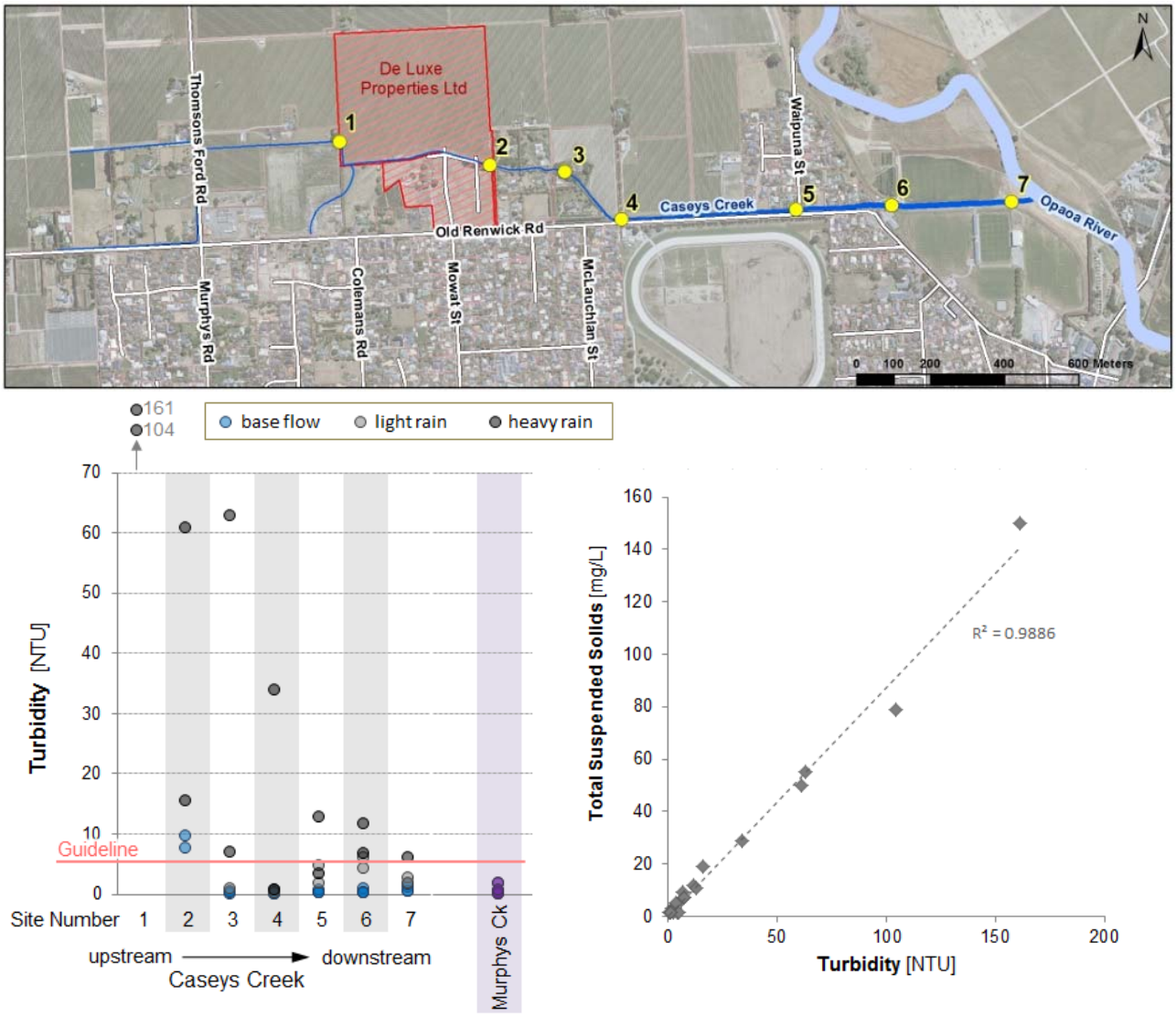

Figure 9: Top: Map of the sampling sites (with Site Numbers) on Caseys Creek. Bottom-Left: Turbidity measured in samples taken from Caseys Creek and Murphys Creek. For Caseys Creek the different sampling conditions are distinguished by colour. Bottom-Right: Correlation between Turbidity and Total Suspended Solids.

The pattern of Turbidity along Caseys Creek is very similar to that of DRP concentrations. Turbidity is generally higher in the upper reaches of Caseys Creek particularly during heavy rainfall (Figure 9). During base flow conditions the ANZECC Guideline is only exceeded at the site immediately downstream of De Luxe (Site 2). The reasons are similar to those mentioned in previous sections for this site.

During light rainfall, the water in Caseys Creek remains clear in the lower reaches. Only during heavy rainfall, do significant amounts of sediment enter the stream, causing higher Turbidity.

Turbidity in the samples taken from Caseys creek correlates very well with the Total Suspended Solid concentrations measured in the same samples. This indicates a limited number of sources are causing increases in Turbidity. The Total Suspended Solid concentrations measured during rainfall also correlate well with DRP concentrations[1] (Figure 10). This suggests that the sources of turbidity/sediment and DRP are identical and therefore were already discussed in the previous section.

[1] Not surprisingly, the correlation between Turbidity and DRP was also good.

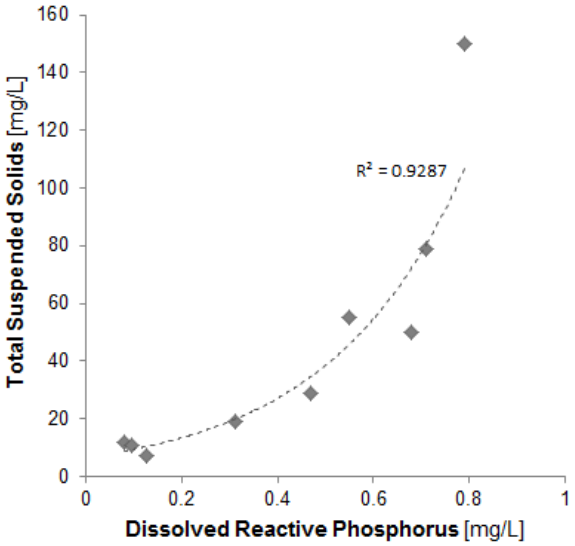

Figure 10: Correlations between DRP concentrations and Total Suspended Solid concentrations measured in Caseys Creek.

E. coli concentrations

E. coli concentrations are an indication of faecal contamination from warm-blooded animals or humans. Although swimming is unlikely to occur in Caseys Creek, the guideline for contact recreation of 550 E. coli units/100ml is used to compare measurement values against [6], because the limit proposed in the recent changes to the NPS is very similar with 540 E. coli units/100mL [8].

The majority of samples taken during base flow conditions had E. coli concentrations below the guideline level (Figure 11). The sites at which E. coli levels were exceeding the guideline were Site 2 and the two sites downstream of Waipuna Street, Site 6 and 7. For Site 2, the minimal dilution due to a very low flow and the presence of ducks[2] can easily explain the results. The reasons for the high E. coli concentrations at the other two sites are less obvious, but will be made clearer below.

During rainfall, nearly all samples had E. coli levels above the guideline, with particularly high levels during heavy rainfall. The highest E. coli concentrations was measured upstream of De Luxe with a rapid decline in E. coli concentration in a downstream direction.

To investigate the sources, some samples were sent to Cawthron for analysis of genetic markers and species-specific bacteriods (marked orange in the graph of Figure 11). All samples contained faecal matter from ruminant sources. Apart from Site 2, wildfowl and dogs were also sources of faecal contamination in all samples. Human bacteriods, an indicator for sewage contamination, were present only at the two most downstream sites (Sites 6 and 7).

The results clearly show that during heavy rainfall, significant faecal contamination from rural activities enters Caseys Creek upstream of the De Lux property. Ruminant markers were present at all sites, including during light rain at Site 6. This shows that rural land use activities effect water quality along the whole length of the creek.

At the lower reaches of Caseys Creek, faecal contamination is partly the result of sewage contamination, likely as a result of cross-contamination within the stormwater network.

Field observations revealed that ducks were present along the whole length of Caseys Creek during sampling and the results from genetic marker analysis show that they are an additional source of faecal contamination at all sites.

[2] Small numbers of ducks were present at all sampling sites

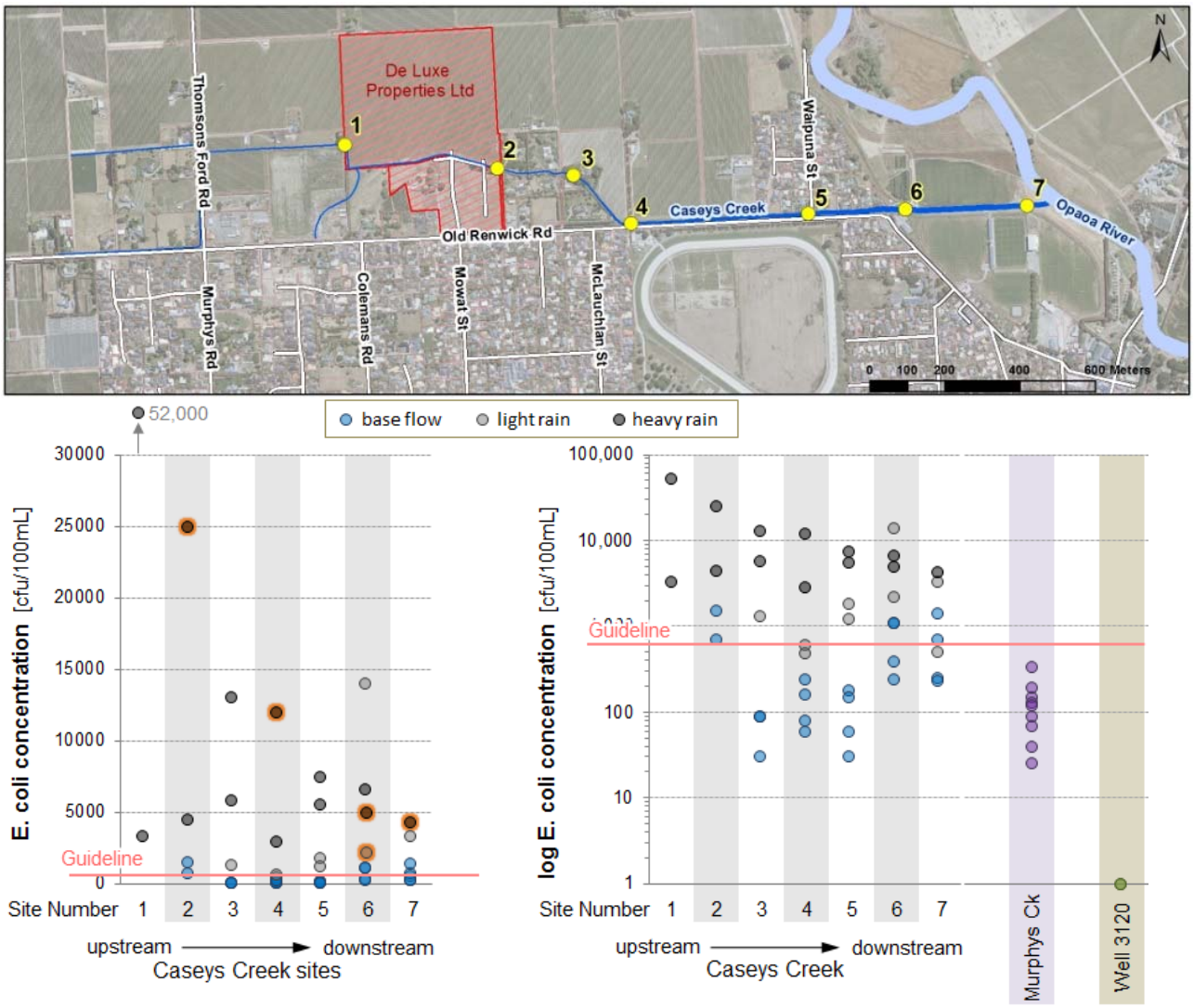

Figure 11: Top: Map of the sampling sites (with Site Numbers) on Caseys Creek. Bottom: E. coli concentrations measured in Caseys Creek, Murphys Creek and Well 3120 (The graph on the right shows the results on Log-scale). For Caseys Creek the different sampling conditions are distinguished by colour. Sample results marked orange indicate samples analysed for genetic markers.

E. coli concentrations in Murphys Creek are generally lower than those in Caseys Creek. They did not exceed the guideline level during the study period, which included rainfall events. Murphys Creek lacks the influences of rural land use activities. It also has a bigger flow resulting in greater dilution of faecal contamination, which is another reason for the generally lower E. coli concentrations.

E. coli levels in Well 3120 are unsurprisingly below detection limit, which excludes the inflowing groundwater as a source of faecal contamination.

Heavy Metals

Water in urban streams is often contaminated with heavy metals as a result of run-off from roof, roads and other sealed areas [7]. Copper and zinc are the metals most often detected in the water of urban waterways [eg; 8]. However, heavy metal can also be present as a result of agricultural land uses. Cadmium, for example, is an impurity in some fertilizers, while arsenic can be present as a result of historic activities, such as sheep dips or pesticide application and storage.

Concentrations of zinc, copper and cadmium were measured in all samples taken from Caseys Creek, while arsenic concentrations were measured during every rainfall run, but only one base flow run.

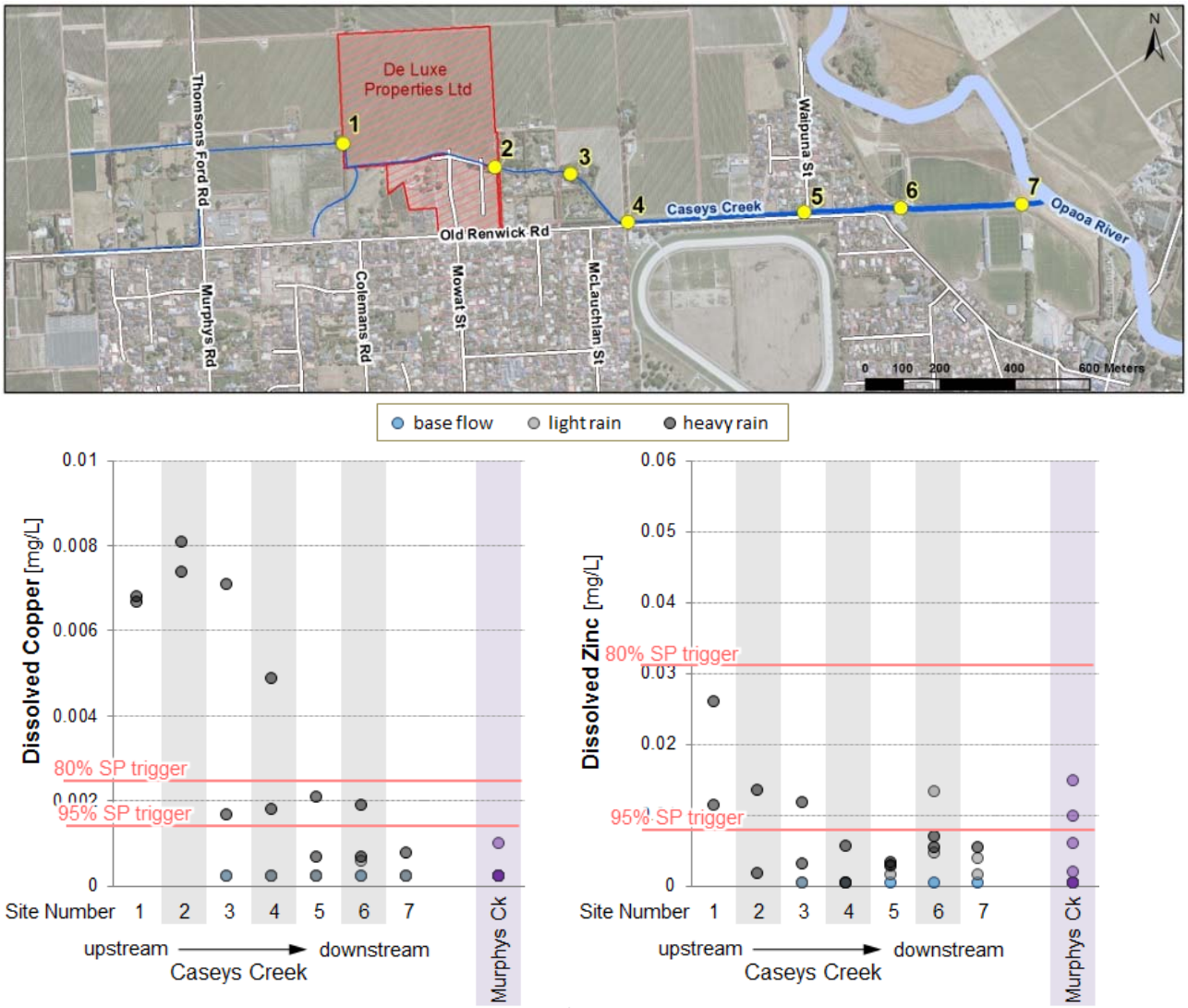

Figure 12: Top: Map of the sampling sites (with Site Numbers) on Caseys Creek. Bottom: Dissolved Copper and Zinc concentrations measured in samples taken from Caseys Creek and Murphys Creek. For Caseys Creek the different sampling conditions are distinguished by colour.

During base flow conditions and light rain, dissolved copper and zinc concentrations in Caseys Creek were below the ANZEEC 95% Species protection trigger at all sites. The only exception was one sample taken during light rain from Site 6.

Samples taken during heavy rain, however, had zinc concentrations above the 95% Species protection trigger at a number of sites. Copper concentrations exceeded the 95% Species protection trigger at almost all sites and even exceeded the more lenient 80% Species protection in the upper reaches. Concentrations were generally highest in the most upstream samples. This is surprising as these two metals are commonly associated with urban stormwater rather than rural run-off.

In comparison, dissolved copper concentrations in Murphys Creek are consistently below the ANZECC trigger levels, while dissolved zinc concentrations are similar to those observed in Caseys Creek.

Cadmium concentrations in Caseys Creek were almost always below the detection limit of 0.000053 mg/L. Only one sample, taken during heavy rainfall from Site 1 had detectable Cadmium slightly above the detection limit.

Arsenic levels were consistently below the detection limit during base flow and light rainfall. During heavy rainfall, however, arsenic was detected in all water samples, but only one sample taken from Site 6 had an

arsenic concentration (0.0195 mg/L) slightly above the 95% Species protection ANZECC 2000 trigger value of 0.013 mg/L (The more conservative trigger value for Arsenic (V) is used here as arsenic speciation was not done).

Stream Sediment Quality

Stream sediment was sampled at four sites on 14 December 2016 and two additional sites upstream and downstream of the proposed stormwater discharge location on 8 June 2017. At each site five subsamples of fine sediment (clay, silt and fine sand) to a depth of 3cm were combined into a composite sample and sent to Hill Laboratories for analysis.

Site Date	S1 14/12/2016	S2 14/12/2016	S3 8/06/2017	S4 8/06/2017	S5 14/12/2016	S6 14/12/2016	ISQG-Low	ISQG-High
Dry Matter (Env)	53	39	26	21	51	76		
Total Organic Carbon	4.7	6.5	9.7	7.9	4.2	0.28		
Heavy Metals								
Total Recoverable Arsenic	4.6	3.9	2.8	4.8	2.6	2.8	20	70
Total Recoverable Cadmium	0.15	0.24	0.141	0.161	0.127	0.042	1.5	10
Total Recoverable Chromium	24	22	17.7	21	19	18.6	80	370
Total Recoverable Copper	24	22	25	21	13.1	9.8	65	270
Total Recoverable Lead	21	23	17	23	37	10	50	220
Total Recoverable Mercury	0.073	0.06	0.07	0.072	0.054	0.045	0.15	1
Total Recoverable Nickel	**24**	**21**	**23**	**21**	**22**	**27**	21	52
Total Recoverable Zinc	131	114	89	68	91	48	200	410
PAHs								
Acenaphthene	< 0.05	< 0.06	< 0.04	< 0.05	< 0.05	< 0.03	10	
Acenaphthylene	< 0.05	< 0.06	< 0.04	< 0.05	0.09	< 0.03		
Anthracene	< 0.05	< 0.06	< 0.04	< 0.05	0.12	< 0.03	85	
Benzo[a]anthracene	< 0.05	< 0.06	0.04	< 0.05	0.63	< 0.03	261	
Benzo[a]pyrene (BAP)	< 0.05	< 0.06	0.06	< 0.05	0.85	< 0.03	430	
Benzo[b]fluoranthene + Benzo[j]fluoranthene	< 0.05	< 0.06	0.05	< 0.05	0.96	< 0.03		
Benzo[g,h,i]perylene	< 0.05	< 0.06	< 0.04	< 0.05	0.62	< 0.03		
Benzo[k]fluoranthene	< 0.05	< 0.06	< 0.04	< 0.05	0.44	< 0.03		
Chrysene	< 0.05	< 0.06	0.04	< 0.05	0.71	< 0.03	384	
Dibenzo[a,h]anthracene	< 0.05	< 0.06	< 0.04	< 0.05	0.11	< 0.03	63	
Fluoranthene	< 0.05	< 0.06	0.12	0.11	1.49	< 0.03	600	
Fluorene	< 0.05	< 0.06	0.05	< 0.05	< 0.05	< 0.03	19	
Indeno(1,2,3-c,d)pyrene	< 0.05	< 0.06	0.05	0.08	0.62	< 0.03		
Naphthalene	< 0.3	< 0.3	< 0.2	< 0.3	< 0.3	< 0.15	160	
Phenanthrene	< 0.05	< 0.06	0.09	0.05	0.56	< 0.03	240	
Pyrene	< 0.05	< 0.06	0.1	0.1	1.45	< 0.03	665	
Total PAH	< DL	< DL	0.6	0.34	8.65	< DL	4000	

Table 1: Analysis results of Stream Sediment sample taken from Caseys Creek.

Table 1 shows a summary of the analysis results. The results are assessed against the Interim Sediment Quality Guidelines (ISQG) in the ANZECC 2000 Guideline document [1]. Although these guidelines are not 'pass/fail' values, they do provide indicators for the potential onset of biological effects (ISQG-low) and for concentrations that can cause significant biological effects (ISQG-high).

In the sediment from Caseys Creek all heavy metals were found in concentrations above the detection limits. However, the only contaminant of concern was Nickel, which was found in concentrations at or slightly above the ISQG-Low guideline value at all sites. The highest Nickel concentration was detected in the most downstream sample, but considering the natural variability and the limited sample effort[3] the differences between the Nickel concentrations at the sites cannot be considered statistically significant.

None of the sites had consistently higher heavy metal concentrations. The samples from each site had the maximum measured concentration for a different heavy metal. The only notable exception was the sampling site upstream of De Luxe (Site S1), which had the highest concentrations for three of the heavy metals. This is consistent with the results of the water quality sampling, which showed that the highest Zinc concentrations were observed in the upper reaches of Caseys Creek (see previous section)

The stream sediment samples were also analysed for Polycyclic Aromatic Hydrocarbons (PAHs). The highest concentrations were generally observed at Site S5, but values were well below the ISQG-Low levels for the individual analytes and the guideline level for Total PAHs.

[3] Several composition samples per site would provide a more statistically robust result.

Result Summary

Sampling of several sites along Caseys Creek was carried out during base flow, light rainfall and heavy rainfall.

For almost all parameters monitored, significantly higher values are observed during heavy rainfall with the highest levels in the upper reaches of the Creek. This means that rural influences appear to have a greater impact on water quality than the discharges of stormwater in the lower reaches of the water way.

Nitrate Nitrogen concentrations in Caseys Creek are exclusively above the Periphyton Guideline, but are lower than those observed in Murphys Creek and except for one sample were below the A-band limit of the NPS. Murphys Creek is an urban, spring-fed stream with similar characteristics to Caseys Creek. Ammonical Nitrogen concentrations Caseys Creek are higher than those observed in Murphys Creek. Apart from one sample, the NPS A-band limit is exceeded in the upper reaches only.

Dissolved Reactive Phosphorus (DRP) concentrations in Caseys Creek were also often higher than in Murphys Creek, with a significant number of samples having DRP above the Periphyton Guideline. DPR concentrations correlate well with Total Suspended Solid concentrations. Therefore, during rainfall the source of elevated DRP concentrations is sediment that has been washed into the creek as surface run-off. The highest concentrations of DRP and Total Suspended Solids were again measured in the upper reaches of Caseys Creek.

During base flow conditions emerging groundwater is the main source of DRP.

E. coli concentrations were often higher than those observed in Murphys Creek. In the upper reaches, rural influences were identified as the source of significant faecal contamination which resulted in E. coli concentrations of up to 52,000 cfu/100mL. In the lower reaches, downstream of Waipuna Street, human sewage was an additional source. Wildfowl, in particular duck, were a source of faecal contamination along the whole length of the stream.

Of the heavy metals monitored, only copper and zinc exceeded the ANZECC trigger levels at almost all sites. This, however, was the case only during rainfall. At base flow, heavy metal concentrations were well below the trigger levels.

In general, water quality was worse in the upper reaches of Caseys Creek, particularly during heavy rainfall. Run-off from rural areas appears to have a greater impact on the water quality of Caseys Creek than urban discharges further downstream. The exception is the occurrence of sewage contamination downstream of Waipuna Street which presents a significant health risk to recreational users.

Overall, water quality in Caseys Creek is slightly more degraded than in Murphys Creek, which based on Council's recent State of the Environment reporting has 'fair' water quality, indicating acceptable, but nevertheless impacted water quality.

Analysis of stream sediment sampled at 6 sites along Caseys showed that Nickel was the only heavy metal exceeding ANZECC guideline values at a number of sites; however values were only slightly above the ISQG-Low level. Polycyclic Aromatic Hydrocarbons were below guideline levels at all sites.

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Appendix 1 - Sampling sites

Site	Site Number	Easting	Northing
Caseys Creek at Lansdowne Park	7	1679969	5405523
Caseys Creek at Pumping Station	6	1679645	5405513
Caseys Drain at Waipuna Street Bridge	5	1679386	5405502
Caseys Drain at Two Bridges	4/S3	1678914	5405476
Caseys Drain at Lockes	3	1678760	5405605
Caseys Creek downstream Deluxe	2/S2	1678558	5405623
Caseys Creek upstream Deluxe	1/S1	1678151	5405686
Caseys Creek Sediment - Site 01	S6	1679798	5405516
Caseys Creek Sediment - Site 02	S5	1679422	5405504
Caseys Drain downstream Two Bridges	S4	1678934	5405477

Appendix 2 – Laboratory Results

Presented here are excerpts of the result files showing the actual numeric results values only. The pdf files supplied by Hill Laboratories can be supplied on request.

Sample Type: Aqueous						
Sample Name:		20163576 Caseys Creek at Lansdowne Park 31-Aug-2016 2:25 pm	20163577 Caseys Creek at Pumping Station 31-Aug-2016 2:50 pm	20163578 Caseys Drain at Waipuna Street Bridge 31-Aug-2016 3:00 pm	20163579 Caseys Drain at Two Bridges 31-Aug-2016 3:20 pm	20163580 Caseys Creek at Deluxe 31-Aug-2016 3:35 pm
Lab Number:		1640463.1	1640463.2	1640463.3	1640463.4	1640463.5
Turbidity	NTU	1.73	0.26	0.30	0.38	7.7
pH	pH Units	7.4	7.2	7.2	7.1	7.2
Total Cadmium	g/m³	< 0.000053	< 0.000053	< 0.000053	< 0.000053	< 0.000053
Total Copper	g/m³	< 0.00053	< 0.00053	< 0.00053	< 0.00053	0.0040
Total Lead	g/m³	0.00018	< 0.00011	< 0.00011	< 0.00011	0.00051
Total Zinc	g/m³	0.0015	< 0.0011	< 0.0011	< 0.0011	0.0136
Total Ammoniacal-N	g/m³	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Nitrite-N	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	0.002
Nitrate-N	g/m³	0.39	0.41	0.41	0.44	< 0.002
Nitrate-N + Nitrite-N	g/m³	0.39	0.41	0.42	0.44	0.003
Dissolved Reactive Phosphorus	g/m³	0.010	0.010	0.008	0.010	0.27
Escherichia coli	cfu / 100mL	1,400	1,100	60 #1	240	700 #1

Analyst's Comments

The customer has indicated that the sampling time was recorded as NZ Standard Time (NZST). The sampling time has been reported as supplied in NZST. It should be noted any other times reported by Hill Laboratories will have been corrected for New Zealand Daylight Saving Time (NZDT), where applicable.

#1 Statistically estimated count based on the theoretical countable range for the stated method.

Sample Type: Aqueous						
Sample Name:		20163920 Caseys Creek at Lansdowne Park 04-Oct-2016 9:05 am	20163921 Caseys Creek at Pumping Station 04-Oct-2016 9:25 am	20163922 Caseys Drain at Waipuna street Bridge 04-Oct-2016 9:35 am	20163923 Caseys Drain at Two Bridges 04-Oct-2016 9:45 am	20163924 Caseys Drain at Lockes 04-Oct-2016 10:10 am
Lab Number:		1659029.1	1659029.2	1659029.3	1659029.4	1659029.5
Turbidity	NTU	1.22	1.03	0.36	0.84	0.52
pH	pH Units	7.4	7.4	7.3	7.3	7.2
Total Cadmium	g/m³	< 0.000053	< 0.000053	< 0.000053	< 0.000053	< 0.000053
Total Copper	g/m³	< 0.00053	< 0.00053	< 0.00053	< 0.00053	< 0.00053
Total Lead	g/m³	< 0.00011	< 0.00011	< 0.00011	< 0.00011	< 0.00011
Total Zinc	g/m³	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011
Total Ammoniacal-N	g/m³	< 0.010	< 0.010	< 0.010	< 0.010	0.011
Nitrite-N	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N	g/m³	0.41	0.44	0.43	0.48	0.45
Nitrate-N + Nitrite-N	g/m³	0.41	0.44	0.43	0.49	0.45
Dissolved Reactive Phosphorus	g/m³	0.008	0.008	0.006	0.009	0.016
Escherichia coli	cfu / 100mL	700 #1	1,100 #1	150 #1	160 #1	90 #1

Analyst's Comments

The customer has indicated that the sampling time was recorded as NZ Standard Time (NZST). The sampling time has been reported as supplied in NZST. It should be noted any other times reported by Hill Laboratories will have been corrected for New Zealand Daylight Saving Time (NZDT), where applicable.

#1 Statistically estimated count based on the theoretical countable range for the stated method.
Please interpret this result with caution as the sample was > 8 °C on receipt at the lab. The sample temperature is recommended by APHA to be less than 8 °C on receipt at the laboratory (but not frozen). However, it is acknowledged that samples that are transported quickly to the laboratory after sampling, may not have been cooled to this temperature.

Sample Type: Aqueous						
Sample Name:		20165106 Caseys Creek at Lansdowne Park 14-Dec-2016 9:30 am	20165107 Caseys Creek at Pumping Station 14-Dec-2016 10:15 am	20165108 Caseys Drain at Waipuna Street Bridge 14-Dec-2016 10:30 am	20165109 Caseys Drain at Two Bridges 14-Dec-2016 10:50 am	20165110 Caseys Drain and Lockes 14-Dec-2016 11:20 am
Lab Number:		1697052.1	1697052.2	1697052.3	1697052.4	1697052.5
Turbidity	NTU	0.61	0.34	0.41	0.22	0.20
pH	pH Units	7.0	7.2	6.9	6.7	6.8
Total Cadmium	g/m³	< 0.000053	< 0.000053	< 0.000053	< 0.000053	< 0.000053
Total Copper	g/m³	< 0.00053	< 0.00053	< 0.00053	< 0.00053	< 0.00053
Total Lead	g/m³	< 0.00011	< 0.00011	< 0.00011	< 0.00011	< 0.00011
Total Zinc	g/m³	0.0012	< 0.0011	< 0.0011	< 0.0011	< 0.0011
Total Ammoniacal-N	g/m³	0.013	0.012	< 0.010	< 0.010	< 0.010
Nitrite-N	g/m³	0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N	g/m³	0.41	0.44	0.45	0.47	0.48
Nitrate-N + Nitrite-N	g/m³	0.41	0.44	0.45	0.47	0.48
Dissolved Reactive Phosphorus	g/m³	0.013	0.012	0.012	0.018	0.018
Escherichia coli	cfu / 100mL	250 #1	390 #1	180 #1	80 #2	30 #3

Sample Name:		20165111 Caseys Drain at Deluxe 14-Dec-2016 11:05 am				
Lab Number:		1697052.6				
Turbidity	NTU	9.7	-	-	-	-
pH	pH Units	7.2	-	-	-	-
Total Cadmium	g/m³	< 0.000053	-	-	-	-
Total Copper	g/m³	0.0044	-	-	-	-
Total Lead	g/m³	0.00126	-	-	-	-
Total Zinc	g/m³	0.0064	-	-	-	-
Total Ammoniacal-N	g/m³	0.182	-	-	-	-
Nitrite-N	g/m³	0.007	-	-	-	-
Nitrate-N	g/m³	0.002	-	-	-	-
Nitrate-N + Nitrite-N	g/m³	0.009	-	-	-	-
Dissolved Reactive Phosphorus	g/m³	0.30	-	-	-	-
Escherichia coli	cfu / 100mL	1,500 #3	-	-	-	-

Analyst's Comments

The customer has indicated that the sampling time was recorded as NZ Standard Time (NZST). The sampling time has been reported as supplied in NZST. It should be noted any other times reported by Hill Laboratories will have been corrected for New Zealand Daylight Saving Time (NZDT), where applicable.

#1 Please interpret this result with caution as the sample was > 24 hours old at the time of testing in the lab.

#2 Statistically estimated count based on the theoretical countable range for the stated method. Please interpret this result with caution as the sample was > 24 hours old at the time of testing in the lab.

#3 Please interpret this result with caution as the sample was > 24 hours old at the time of testing in the lab.

Sample Type: Aqueous						
Sample Name:		20170356 Caseys Creek at Lansdowne Park 17-Jan-2017 9:50 am	20170357 Caseys Creek at Pumping Station 17-Jan-2017 10:10 am	20170358 Caseys Drain at Waipuna Street Bridge 17-Jan-2017 10:20 am	20170359 Caseys Drain at Two Bridges 17-Jan-2017 10:35 am	20170360 Caseys Drain at Lockes 17-Jan-2017 10:55 am
Lab Number:		1709261.1	1709261.2	1709261.3	1709261.4	1709261.5
Individual Tests						
Sum of Anions	meq/L	0.90	0.94	0.87	0.93	0.93
Sum of Cations	meq/L	0.89	0.90	0.88	0.90	0.95
% Difference in Ion Balance	%	0.35	1.71	0.52	2.1	1.42
Turbidity	NTU	0.55	0.45	0.92	0.17	0.48
pH	pH Units	7.4	7.3	7.2	7.0	7.0
Total Alkalinity	g/m³ as $CaCO_3$	34	35	33	36	35
Electrical Conductivity (EC)	mS/m	9.3	9.3	9.3	9.4	9.7
Total Suspended Solids	g/m³	< 3	< 3	< 3	< 3	< 3
Dissolved Arsenic	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total Arsenic	g/m³	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011
Total Cadmium	g/m³	< 0.000053	< 0.000053	< 0.000053	< 0.000053	< 0.000053
Dissolved Copper	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Total Copper	g/m³	< 0.00053	< 0.00053	< 0.00053	< 0.00053	< 0.00053
Total Nickel	g/m³	< 0.00053	< 0.00053	< 0.00053	< 0.00053	< 0.00053
Dissolved Zinc	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total Zinc	g/m³	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011
Chloride	g/m³	3.0	3.0	3.0	3.0	3.1
Total Inorganic Nitrogen	g/m³	0.51	0.53	0.53	0.52	0.55
Total Nitrogen	g/m³	0.35 #2	0.61	0.61	0.58	0.59
Total Ammoniacal-N	g/m³	0.015	0.020	0.007	< 0.005	0.036
Nitrite-N	g/m³	0.003	0.002	< 0.002	< 0.002	0.002
Nitrate-N	g/m³	0.49	0.51	0.52	0.52	0.51
Nitrate-N + Nitrite-N	g/m³	0.50 #2	0.51	0.52	0.52	0.51
Dissolved Reactive Phosphorus	g/m³	0.0120	0.0131	0.0100 #3	0.0098 #3	0.028
Total Phosphorus	g/m³	0.014	0.014	0.008 #3	0.008 #3	0.030
Reactive Silica	g/m³ as SiO_2	12.5	12.6	12.3	12.4	12.5
Sulphate	g/m³	4.8	5.1	4.8	4.8	4.6
Faecal Coliforms and E. coli profile						
Faecal Coliforms	cfu / 100mL	310	360	35	60 #1	110 #1
Escherichia coli	cfu / 100mL	230	240	30	60 #1	90 #1

Analyst's Comments

The customer has indicated that the sampling time was recorded as NZ Standard Time (NZST). The sampling time has been reported as supplied in NZST. It should be noted any other times reported by Hill Laboratories will have been corrected for New Zealand Daylight Saving Time (NZDT), where applicable.

#1 Statistically estimated count based on the theoretical countable range for the stated method.

#2 It has been noted that the result for Nitrate-N + Nitrite-N was greater than that for Total Nitrogen, but within the analytical variation of these methods.

#3 It has been noted that the result for Dissolved Reactive Phosphorus was greater than that for Total Phosphorus, but within the analytical variation of these methods.

Sample Type: Aqueous						
Sample Name:		20164443 Caseys Drain at Two Bridges 13-Feb-2017 8:50 am	20164442 Caseys Drain at Waipuna Street Bridge 13-Feb-2017 8:45 am	20164441 Caseys Creek at Pumping Station 13-Feb-2017 8:30 am	20164440 Caseys Creek at Lansdowne Park 13-Feb-2017 9:00 am	
Lab Number:		1722654.1	1722654.2	1722654.3	1722654.4	
Individual Tests						
Turbidity	NTU	0.85	1.89	6.3	2.8	-
pH	pH Units	6.9	7.1	7.1	7.2	-
Electrical Conductivity (EC)	mS/m	9.6	9.3	9.2	9.7	-
Total Suspended Solids	g/m³	< 3	3	9	3	-
Dissolved Arsenic	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	-
Total Arsenic	g/m³	< 0.0011	< 0.0011	< 0.0011	< 0.0011	-
Total Cadmium	g/m³	< 0.000053	< 0.000053	< 0.000053	< 0.000053	-
Dissolved Copper	g/m³	< 0.0005	< 0.0005	0.0006	< 0.0005	-
Total Copper	g/m³	< 0.00053	< 0.00053	0.00112	< 0.00053	-
Dissolved Zinc	g/m³	< 0.0010	0.0028	0.0133	0.0016	-
Total Zinc	g/m³	< 0.0011	0.0033	0.0192	0.0025	-
Total Inorganic Nitrogen	g/m³	0.60	0.61	0.69	0.58	-
Total Nitrogen	g/m³	0.70	0.77	0.97	0.78	-
Total Ammoniacal-N	g/m³	< 0.005	0.032	0.069	0.023	-
Nitrite-N	g/m³	0.002	0.002	0.006	0.005	-
Nitrate-N	g/m³	0.59	0.57	0.62	0.55	-
Nitrate-N + Nitrite-N	g/m³	0.59	0.58	0.62	0.56	-
Dissolved Reactive Phosphorus	g/m³	0.0117	0.0105	0.028	0.0139	-
Total Phosphorus	g/m³	0.018	0.011	0.043	0.021	-
Faecal Coliforms and E. coli profile						
Faecal Coliforms	cfu / 100mL	700 #1	2,600	14,000 #1	4,100	-
Escherichia coli	cfu / 100mL	600 #1	1,200	14,000 #1	3,300	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	-
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	-
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4	-
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	< 0.7	-

Analyst's Comments

The customer has indicated that the sampling time was recorded as NZ Standard Time (NZST). The sampling time has been reported as supplied in NZST. It should be noted any other times reported by Hill Laboratories will have been corrected for New Zealand Daylight Saving Time (NZDT), where applicable.

#1 Statistically estimated count based on the theoretical countable range for the stated method.

Sample Type: Aqueous						
Sample Name:		20171659 Caseys Creek at Lansdowne Park 05-Apr-2017 9:45 am	20171660 Caseys Creek at Pumping Station 05-Apr-2017 10:10 am	20171661 Caseys Drain at Waipuna Street Bridge 05-Apr-2017 10:30 am	20171662 Caseys Drain at Two Bridges 05-Apr-2017 10:45 am	20171663 Caseys Drain at Lockes 05-Apr-2017 10:55 am
Lab Number:		1753703.1	1753703.2	1753703.3	1753703.4	1753703.5
Individual Tests						
Turbidity	NTU	1.95	4.4	4.8	0.26	1.15
pH	pH Units	7.1	7.1	7.1	7.0	7.0
Electrical Conductivity (EC)	mS/m	9.0	8.9	9.3	9.9	9.6
Total Suspended Solids	g/m³	< 3	< 3	< 3	< 3	< 3
Dissolved Arsenic	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total Arsenic	g/m³	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011
Total Cadmium	g/m³	< 0.000053	< 0.000053	< 0.000053	< 0.000053	< 0.000053
Dissolved Copper	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Total Copper	g/m³	< 0.00053	0.00077	0.00062	< 0.00053	0.00083
Dissolved Zinc	g/m³	0.0040	0.0048	0.0016	< 0.0010	< 0.0010
Total Zinc	g/m³	0.0052	0.0085	0.0093	< 0.0011	0.0027
Total Inorganic Nitrogen	g/m³	0.53	0.58	0.61	0.59	0.55
Total Nitrogen	g/m³	0.58	0.64	0.64	0.59	0.59
Total Ammoniacal-N	g/m³	0.010	0.030	< 0.005	0.005	0.017
Nitrite-N	g/m³	0.003	< 0.002	< 0.002	< 0.002	0.002
Nitrate-N	g/m³	0.52	0.55	0.60	0.59	0.53
Nitrate-N + Nitrite-N	g/m³	0.52	0.55	0.60	0.59	0.54
Dissolved Reactive Phosphorus	g/m³	0.020	0.023	0.0138	0.0165	0.027
Total Phosphorus	g/m³	0.033	0.035	0.022	0.026	0.035
Faecal Coliforms and E. coli profile						
Faecal Coliforms	cfu / 100mL	1,200 #1	3,100	2,300	590	1,400 #1
Escherichia coli	cfu / 100mL	500 #1	2,200	1,800	480	1,300 #1
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7

Analyst's Comments

The customer has indicated that the sampling time was recorded as NZ Standard Time (NZST). The sampling time has been reported as supplied in NZST. It should be noted any other times reported by Hill Laboratories will have been corrected for New Zealand Daylight Saving Time (NZDT), where applicable.

It was observed that the containers for samples 1753703/1, 3 & 4 were not completely filled. Volatile loss may have occurred due to the headspace created in the container.

#1 Statistically estimated count based on the theoretical countable range for the stated method.

Sample Type: Aqueous						
Sample Name:		20172003 Caseys Creek at Lansdowne Park 12-Apr-2017 11:50 am	20172004 Caseys Creek at Pumping Station 12-Apr-2017 11:15 am	20172005 Caseys Drain at Waipuna Street Bridge 12-Apr-2017 11:00 am	20172006 Caseys Drain at Two Bridges 12-Apr-2017 11:25 am	20172007 Caseys Drain at Lockes 12-Apr-2017 10:35 am
Lab Number:		1757698.1	1757698.2	1757698.3	1757698.4	1757698.5
Individual Tests						
Turbidity	NTU	6.2	6.9	3.6	0.89	7.1
pH	pH Units	7.3	7.5	7.5	7.5	7.6
Electrical Conductivity (EC)	mS/m	7.7	8.0	8.0	9.7	9.3
Total Suspended Solids	g/m³	6	7	5	< 3	7
Dissolved Arsenic	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total Arsenic	g/m³	0.0011	< 0.0011	< 0.0011	< 0.0011	0.0013
Total Cadmium	g/m³	< 0.000053	< 0.000053	< 0.000053	< 0.000053	< 0.000053
Dissolved Copper	g/m³	0.0008	0.0007	0.0007	0.0018	0.0017
Total Copper	g/m³	0.00127	0.00120	0.00123	0.00075	0.0024
Dissolved Zinc	g/m³	0.0055	0.0070	0.0030	< 0.0010	0.0032
Total Zinc	g/m³	0.0086	0.0106	0.0047	< 0.0011	0.0065
Total Inorganic Nitrogen	g/m³	0.48	0.53	0.52	0.56	0.64
Total Nitrogen	g/m³	0.81	0.77	0.75	0.76	1.04
Total Ammoniacal-N	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	0.067
Nitrite-N	g/m³	0.003	0.003	0.002	0.002	0.006
Nitrate-N	g/m³	0.47	0.52	0.52	0.56	0.56
Nitrate-N + Nitrite-N	g/m³	0.47	0.53	0.52	0.56	0.57
Dissolved Reactive Phosphorus	g/m³	0.075	0.034	0.025	0.041	0.125
Total Phosphorus	g/m³	0.098	0.054	0.038	0.048	0.174
Faecal Coliforms and E. coli profile						
Faecal Coliforms	cfu / 100mL	6,000	11,000 #1	12,000 #1	3,100	8,600 #1
Escherichia coli	cfu / 100mL	4,300	6,600 #1	7,500 #1	2,900	5,800

Sample Name:		20172008 Caseys downstream Deluxe 12-Apr-2017 9:50 am	20172009 Caseys upstream Deluxe 12-Apr-2017 10:15 am			
Lab Number:		1757698.6	1757698.7			
Individual Tests						
Turbidity	NTU	15.7	161	-	-	-
pH	pH Units	7.2	7.3	-	-	-
Electrical Conductivity (EC)	mS/m	4.3	18.9	-	-	-
Total Suspended Solids	g/m³	19	150	-	-	-
Dissolved Arsenic	g/m³	0.022	0.0015	-	-	-
Total Arsenic	g/m³	0.0195	0.0030	-	-	-
Total Cadmium	g/m³	< 0.000053	< 0.000053	-	-	-
Dissolved Copper	g/m³	0.0081	0.0068	-	-	-
Total Copper	g/m³	0.0094	0.0129	-	-	-
Dissolved Zinc	g/m³	0.0018	0.0114	-	-	-
Total Zinc	g/m³	0.0061	0.044	-	-	-
Total Inorganic Nitrogen	g/m³	0.70	5.4	-	-	-
Total Nitrogen	g/m³	1.72	8.3	-	-	-
Total Ammoniacal-N	g/m³	0.24	0.100	-	-	-
Nitrite-N	g/m³	0.011	0.028	-	-	-
Nitrate-N	g/m³	0.46	5.3	-	-	-
Nitrate-N + Nitrite-N	g/m³	0.47	5.3	-	-	-
Dissolved Reactive Phosphorus	g/m³	0.31	0.79	-	-	-
Total Phosphorus	g/m³	0.38	1.25	-	-	-
Faecal Coliforms and E. coli profile						
Faecal Coliforms	cfu / 100mL	5,500	3,500	-	-	-
Escherichia coli	cfu / 100mL	4,500	3,300	-	-	-

Analyst's Comments

The customer has indicated that the sampling time was recorded as NZ Standard Time (NZST). The sampling time has been reported as supplied in NZST. It should be noted any other times reported by Hill Laboratories will have been corrected for New Zealand Daylight Saving Time (NZDT), where applicable.

#1 Statistically estimated count based on the theoretical countable range for the stated method.

Sample Type: Aqueous						
Sample Name:		20172605 Caseys Creek at Pumping Station 18-May-2017 10:50 am	20172606 Caseys Drain at Waipuna Street Bridge 18-May-2017 10:30 am	20172607 Caseys Drain at Two Bridges 18-May-2017 10:15 am	20172608 Caseys Drain at Lockes 18-May-2017 10:00 am	20172609 Caseys Creek at downstream Deluxe 18-May-2017 9:00 am
Lab Number:		1777765.1	1777765.2	1777765.3	1777765.4	1777765.5
Individual Tests						
Turbidity	NTU	11.7	12.9	34	63	61
pH	pH Units	7.2	7.1	7.0	6.9	7.1
Electrical Conductivity (EC)	mS/m	10.8	11.0	11.5	10.1	9.4
Total Suspended Solids	g/m³	12	11	29	55	50
Dissolved Arsenic	g/m³	0.0011	0.0011	0.0029	0.0036	0.0033
Total Arsenic	g/m³	0.0012	0.0013	0.0034	0.0044	0.0041
Total Cadmium	g/m³	< 0.000053	< 0.000053	< 0.000053	< 0.000053	< 0.000053
Dissolved Copper	g/m³	0.0019	0.0021	0.0049	0.0071	0.0074
Total Copper	g/m³	0.0031	0.0028	0.0071	0.0100	0.0103
Dissolved Zinc	g/m³	0.0055	0.0033	0.0057	0.0119	0.0135
Total Zinc	g/m³	0.0096	0.0062	0.0123	0.029	0.032
Total Inorganic Nitrogen	g/m³	0.75	0.71	0.92	1.01	0.98
Total Nitrogen	g/m³	1.24	1.22	2.2	2.6	2.8
Total Ammoniacal-N	g/m³	0.007	0.009	0.024	0.028	0.048
Nitrite-N	g/m³	0.004	0.005	0.012	0.020	0.017
Nitrate-N	g/m³	0.74	0.70	0.88	0.96	0.92
Nitrate-N + Nitrite-N	g/m³	0.75	0.70	0.89	0.98	0.94
Dissolved Reactive Phosphorus	g/m³	0.080	0.096	0.47	0.55	0.68
Total Phosphorus	g/m³	0.130	0.168	0.63	0.98	1.23
Faecal Coliforms and E. coli profile						
Faecal Coliforms	cfu / 100mL	10,000 #1	11,000 #1	12,000 #1	26,000 #1	25,000 #1
Escherichia coli	cfu / 100mL	5,000 #1	5,500 #1	12,000 #1	13,000 #1	25,000 #1

Sample Name:		20172610 Caseys Creek at upstream Deluxe 18-May-2017 9:30 am
Lab Number:		1777765.6
Individual Tests		
Turbidity	NTU	104
pH	pH Units	7.0
Electrical Conductivity (EC)	mS/m	9.6
Total Suspended Solids	g/m³	79
Dissolved Arsenic	g/m³	0.0038
Total Arsenic	g/m³	0.0048
Total Cadmium	g/m³	0.000055
Dissolved Copper	g/m³	0.0067
Total Copper	g/m³	0.0113
Dissolved Zinc	g/m³	0.026
Total Zinc	g/m³	0.052
Total Inorganic Nitrogen	g/m³	0.71
Total Nitrogen	g/m³	2.0
Total Ammoniacal-N	g/m³	0.033
Nitrite-N	g/m³	0.015
Nitrate-N	g/m³	0.66
Nitrate-N + Nitrite-N	g/m³	0.67
Dissolved Reactive Phosphorus	g/m³	0.71
Total Phosphorus	g/m³	1.20
Faecal Coliforms and E. coli profile		
Faecal Coliforms	cfu / 100mL	52,000
Escherichia coli	cfu / 100mL	52,000

Analyst's Comments

The customer has indicated that the sampling time was recorded as NZ Standard Time (NZST). The sampling time has been reported as supplied in NZST. It should be noted any other times reported by Hill Laboratories will have been corrected for New Zealand Daylight Saving Time (NZDT), where applicable.

#1 Statistically estimated count based on the theoretical countable range for the stated method.

Sample Type: Sediment						
Sample Name:		20165194 Caseys Creek Sediment - Site 01 14-Dec-2016 9:00 am	20165195 Caseys Creek Sediment - Site 02 14-Dec-2016 10:15 am	20165196 Caseys Creek Downstream Deluxe 14-Dec-2016 11:05 am	20165197 Caseys Creek Upstream Deluxe 14-Dec-2016 12:20 pm	
Lab Number:		1699680.1	1699680.2	1699680.3	1699680.4	
Individual Tests						
Dry Matter	g/100g as rcvd	76	51	39	53	-
Total Organic Carbon*	g/100g dry wt	0.28	4.2	6.5	4.7	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	2.8	2.6	3.9	4.6	-
Total Recoverable Cadmium	mg/kg dry wt	0.042	0.127	0.24	0.150	-
Total Recoverable Chromium	mg/kg dry wt	18.6	19.0	22	24	-
Total Recoverable Copper	mg/kg dry wt	9.8	13.1	22	24	-
Total Recoverable Lead	mg/kg dry wt	10.0	37	23	21	-
Total Recoverable Mercury	mg/kg dry wt	0.045	0.054	0.060	0.073	-
Total Recoverable Nickel	mg/kg dry wt	27	22	21	24	-
Total Recoverable Zinc	mg/kg dry wt	48	91	114	131	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.03	< 0.05	< 0.06	< 0.05	-
Acenaphthylene	mg/kg dry wt	< 0.03	0.09	< 0.06	< 0.05	-
Anthracene	mg/kg dry wt	< 0.03	0.12	< 0.06	< 0.05	-
Benzo[a]anthracene	mg/kg dry wt	< 0.03	0.63	< 0.06	< 0.05	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.03	0.85	< 0.06	< 0.05	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.03	0.96	< 0.06	< 0.05	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.03	0.62	< 0.06	< 0.05	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.03	0.44	< 0.06	< 0.05	-
Chrysene	mg/kg dry wt	< 0.03	0.71	< 0.06	< 0.05	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.03	0.11	< 0.06	< 0.05	-
Fluoranthene	mg/kg dry wt	< 0.03	1.49	< 0.06	< 0.05	-
Fluorene	mg/kg dry wt	< 0.03	< 0.05	< 0.06	< 0.05	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.03	0.62	< 0.06	< 0.05	-
Naphthalene	mg/kg dry wt	< 0.15	< 0.3	< 0.3	< 0.3	-
Phenanthrene	mg/kg dry wt	< 0.03	0.56	< 0.06	< 0.05	-
Pyrene	mg/kg dry wt	< 0.03	1.45	< 0.06	< 0.05	-

Sample Type: Sediment						
Sample Name:		20172802 Caseys Creek at two bridges 08-Jun-2017 12:15 pm	20172803 Caseys Creek downstream two bridges 08-Jun-2017 12:00 pm			
Lab Number:		1789127.1	1789127.2			
Individual Tests						
Dry Matter	g/100g as rcvd	26	21	-	-	-
Total Organic Carbon*	g/100g dry wt	9.7	7.9	-	-	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	2.8	4.8	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.141	0.161	-	-	-
Total Recoverable Chromium	mg/kg dry wt	17.7	21	-	-	-
Total Recoverable Copper	mg/kg dry wt	25	21	-	-	-
Total Recoverable Lead	mg/kg dry wt	17.0	23	-	-	-
Total Recoverable Mercury	mg/kg dry wt	0.070	0.072	-	-	-
Total Recoverable Nickel	mg/kg dry wt	23	21	-	-	-
Total Recoverable Zinc	mg/kg dry wt	89	68	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
1-Methylnaphthalene	mg/kg dry wt	< 0.04	< 0.05	-	-	-
2-Methylnaphthalene	mg/kg dry wt	< 0.04	< 0.05	-	-	-
Perylene*	mg/kg dry wt	0.05	< 0.05	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.04	< 0.05	-	-	-
Acenaphthene	mg/kg dry wt	< 0.04	< 0.05	-	-	-
Anthracene	mg/kg dry wt	< 0.04	< 0.05	-	-	-
Benzo[a]anthracene	mg/kg dry wt	0.04	< 0.05	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.06	< 0.05	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.05	< 0.05	-	-	-
Benzo[e]pyrene	mg/kg dry wt	< 0.04	< 0.05	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.04	< 0.05	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.04	< 0.05	-	-	-
Chrysene	mg/kg dry wt	0.04	< 0.05	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.04	< 0.05	-	-	-
Fluoranthene	mg/kg dry wt	0.12	0.11	-	-	-
Fluorene	mg/kg dry wt	0.05	< 0.05	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.05	0.08	-	-	-
Naphthalene	mg/kg dry wt	< 0.2	< 0.3	-	-	-
Phenanthrene	mg/kg dry wt	0.09	0.05	-	-	-
Pyrene	mg/kg dry wt	0.10	0.10	-	-	-