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Ecological Survey of Donald (Boar) Creek to meet Conditions 21 to 24 of Consent WAR 970080 that permit the discharge of contaminants to water from the Featherston Wastewater Treatment Plant

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CM Featherston WWTP 970080/21-24, 04.2010

1.0 Executive Summary

The wastewater treatment plant at Featherston comprises two oxidation ponds that discharge treated wastewater into Donald (Boar) Creek.

This discharge is authorised by Consent WAR 970080, Conditions 21, 22, 23 and 24 of which, prescribe the detail of an ecological survey that was required to determine the effect of the discharge on the aquatic ecosystem of Donald Creek.

The purpose of this report is to meet the requirements of Conditions 21 to 24 of Consent WAR 970080. It provides:

- details of an inspection of the streambed below the point of discharge (for a distance extending 100 m downstream of the discharge) for the presence of any nuisance heterotrophic or periphyton growths,
- a periphyton survey upstream and downstream of the oxidation pond discharge that was consistent with the current Stream Periphyton Monitoring Manual (Biggs & Kilroy 2000), and
- a macroinvertebrate survey upstream and downstream of the oxidation pond discharge that was consistent with Protocols C3 and P3 from the Ministry for the Environment's report on current protocols for sampling macroinvertebrates in wadeable streams (Stark et at. 2001).

The overall physical habitat quality at the prescribed sampling sites upstream and downstream of the discharge of treated wastewater to Donald Creek was not directly comparable in terms of flow and shading in particular.

The oxidation pond discharge to Donald Creek was associated with a conspicuous change in water clarity due to high chlorophyll concentration in the oxidation ponds and increased embeddedness of the gravel substrate in Donald Creek due to suspended solids discharged from the oxidation ponds.

There was a low cover (c. 5%) of heterotrophic growths (sewage fungus complex) in the 100 m reach of Donald Creek downstream of the discharge from the Featherston Oxidation Ponds.

Periphyton cover and biomass was significantly higher 100 m downstream of the discharge from the Featherston Oxidation Ponds relative to the control site 100 m upstream of the oxidation pond discharge. However, neither the cover nor the biomass of periphyton at the downstream sampling site exceeded "nuisance growth" criteria proposed by Biggs and Kilroy (2000) for aesthetics / recreation and trout habitat and angling.

Submerged and emergent macrophytes were present at the upstream but not the downstream sampling site.

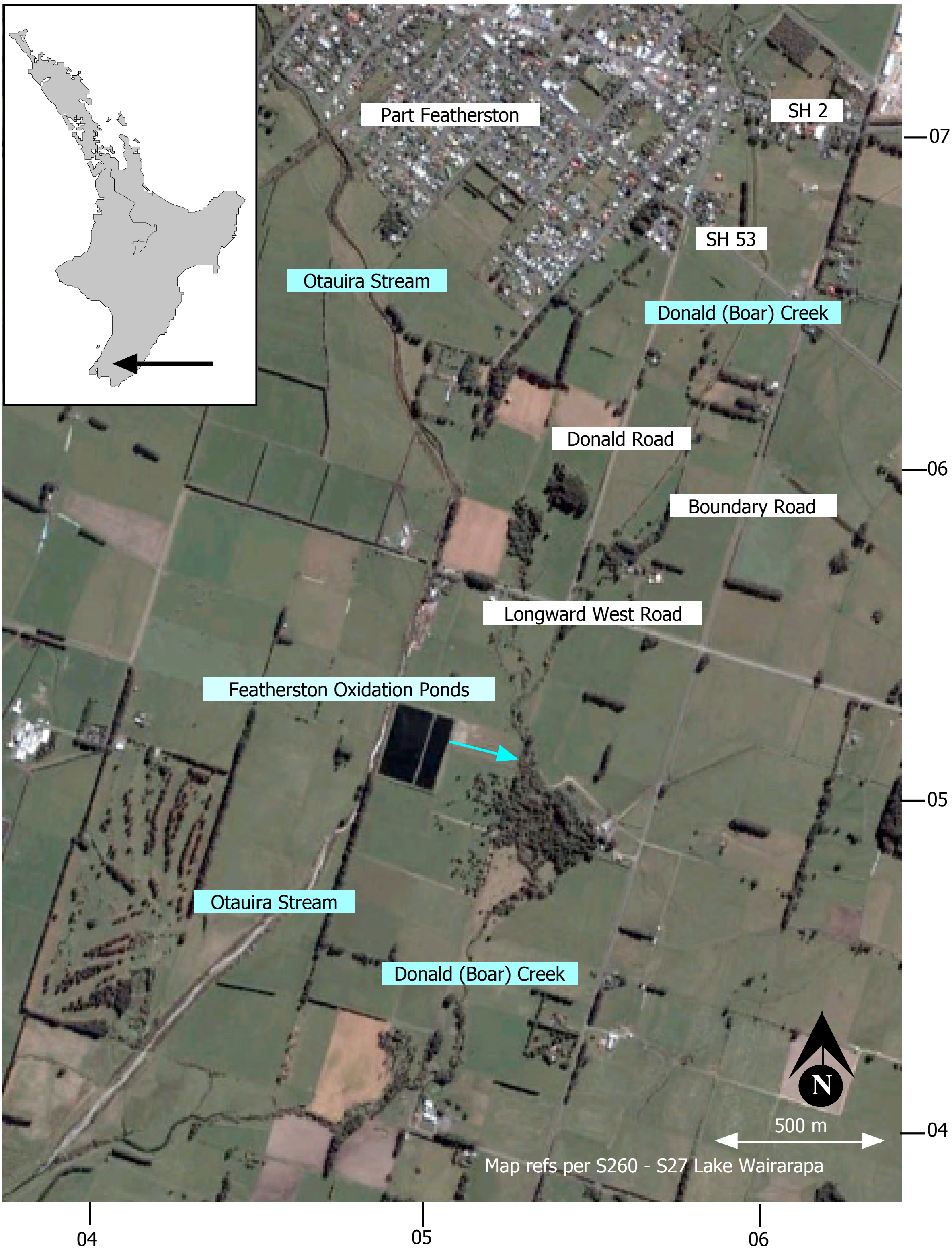
All of the metrics used to assess macroinvertebrate community structure indicated significantly compromised water quality 100 m downstream of the discharge from the Featherston Oxidation Ponds relative to a control site 100 m upstream of the oxidation pond discharge.

Any subsequent / repeat survey of Donald Creek to determine the effect of the discharge from the Featherston Oxidation Ponds should include two additional sampling sites. These should be in an unshaded reach of riffles upstream and downstream of the currently prescribed sampling sites

2.0 Introduction and Background

Wastewater from Featherston[1] was treated in two oxidation ponds that were two km south of the town centre and that were accessed from Longford West Road (see Figures 1 and 2).

Figure 1: Locality of Featherston Oxidation ponds, Donald Creek and Otauira Stream (Aerial photograph courtesy of Google Earth).



[1] The population of Featherston was 2,340 in the 2006 Census.

Figure 2: Discharge of Featherston Oxidation Ponds to Donald (Boar) Creek.

Treated effluent from these two oxidation ponds discharged into Donald (Boar) Creek on the eastern boundary of the oxidation ponds. Some 1.5 km south west of the oxidation ponds, Donald Creek discharged into the Otauira Stream (see Figure 1). The Otauira Stream discharged into Lake Wairarapa a further 2 km south west of its confluence with Donald Creek.

There was an area of land that appeared to have been previously developed as a surface flow wetland between the oxidation ponds and Donald Creek, but as of April 2010, effluent was being short-circuited directly to Donald Creek via a drain (see Plate A and Figure 2).

To the north of the discharge from the oxidation ponds and 350 m south of the discharge from the oxidation ponds, Donald Creek flowed through open farmland. However, for 350 m downstream of the discharge from the oxidation ponds, Donald Creek flowed through a dense willow swamp (see Figures 1 and 2 and Plate H).

The discharge of treated wastewater to Donald Creek is authorised by Consent (Discharge Permit) No. WAR 970080.

Conditions 21, 22, 23 and 24 of Consent WAR 970080 (see Appendix A) prescribed the detail of an ecological survey that was required to determine the effect of the discharge on the aquatic ecosystem of Donald Creek.

The purpose of this report is to meet the requirements of Conditions 21 to 24 of Consent WAR 970080. It provides:

- details of an inspection of the streambed below the point of discharge (for a distance extending 100 m downstream of the discharge) for the presence of any nuisance heterotrophic or periphyton growths,
- a periphyton survey upstream and downstream of the oxidation pond discharge that was consistent with the current Stream Periphyton Monitoring Manual (Biggs & Kilroy 2000), and
- a macroinvertebrate survey upstream and downstream of the oxidation pond discharge that was consistent with Protocols C3 and P3 from the Ministry for the Environment's report on current protocols for sampling macroinvertebrates in wadeable streams (Stark et at. 2001)

3.0 Methods and Approach

3.1 Instream Habitat Quality

Stream habitat, as affected by instream and topographical features, is a major determinant of aquatic community potential. Both the quality and quantity of available habitat affect the structure and composition of resident macroinvertebrate communities.

The effects of habitat differences can be minimised by sampling similar habitats at all sites being compared. However, when sites are not physically comparable (for example, a native forest head water stream site as opposed to a downstream site in an agricultural catchment), habitat characterisation is particularly important for the proper interpretation of biosurvey results. In this instance, the eleven habitat characteristics recommended by Edgar et. al., (1994) were used assessed to score habitat quality (see Appendix B).

3.2 Inspection for Heterotrophic growths

Instream growths of heterotrophic organisms (bacteria and/or fungi) occur in response to high inputs of readily degradable dissolved organic compounds (i.e., low molecular weight organic compounds such as short-chain organic acids, sugars and alcohols) that may be associated with discharges of inadequately treated effluent from milk factories and domestic wastewater treatment plants for example. These growths, commonly referred to as "sewage fungus", are unacceptable in recreational waters (Ministry for the Environment 1992).

Larger stones, bedrock, woody debris and macrophytes offer stable attachment sites for sewage fungus and summer temperatures in New Zealand streams are conducive to the rapid growth of sewage fungus.

Sewage fungus is normally identifiable in the field as a white to light grey mat with the appearance of "cotton wool". However, it is advisable to return samples to the laboratory for microscopic examination as sewage fungus can be mistaken for growths of stalked diatoms such as Gomphonema and *Didymosphenia*. The most common associate of sewage fungus is generally the filamentous bacterium *Sphaerotilus natans*.

An inspection of the streambed below the point of discharge (for a distance extending 100 m downstream of the discharge) was made for the presence of any nuisance heterotrophic or periphyton growths (as required by Condition 21 of Consent WAR 970080 – see Appendix A). Selected samples were returned to the laboratory for microscopic examination.

3.3 Description of Periphyton Communities

Periphyton was described upstream and downstream of the Featherston oxidation pond discharge to Donald Creek as required by Conditions 21 and 22 of Consent WAR 970080 (see Appendix A).

The periphyton survey included:

- An assessment of the percentage cover of both filamentous algae and algal mats (to nearest 5%) at ~~10~~ 5* points across each of four transects encompassing both riffle and run habitat and extending across the width of the creek at each sampling site;

  * Note: although RAM-1 quadrat method for assessing periphyton cover (Biggs & Kilroy 2000) recommended assessing cover at 10 points across each of four transects, in this instance the creek was only 1 – 2 m wide and this would involve an overlap of area assessed with a 15 to

20 cm quadrat. Hence, in common with RAM-2 point method for % cover (Biggs & Kilroy 2000), cover was assessed at 5 points across each of four transects encompassing both riffle and run habitat and extending across the width of the creek at each sampling site.

- Collection of a composite periphyton sample from riffle and run habitat (a composite of scraping from 10 rocks. 5 from a riffle and 5 from a run) across each sampling site using method QM-1a from the Stream Periphyton Monitoring Manual (Biggs & Kilroy 2000); and
- Analysis of periphyton samples for community composition and abundance using the Biggs & Kilroy (2000) relative abundance method and ash free dry weight.

3.4 Description of Aquatic Macrophytes

Aquatic macrophytes were a feature of the upstream sampling site but were not present under the canopy of a dense willow wetland at the downstream sampling site.

Therefore the cover of submerged macrophytes was described using the methodology recommended by Collier et al. (2007).

This involved the assessment of cover for submerged and emergent macrophytes across the same 4 transects at which periphyton cover was assessed at the upstream and downstream sampling sites.

3.5 Macroinvertebrate Community Structure

Macroinvertebrate Community Structure was described upstream and downstream of the Featherston oxidation pond discharge to Donald Creek as required by Conditions 21 and 23 of Consent WAR 970080 (see Appendix A).

The macroinvertebrate survey followed Protocols C3 and P3 from the Ministry for the Environment's report on protocols for sampling macroinvertebrates in wadeable streams (Stark et at. 2001).

The macroinvertebrate survey included:

- Collection of 5 replicate 0.1 m^2 Surber samples at random within a 20 m section of riffle habitat at each sampling site;
- Full count of the macroinvertebrate taxa within each replicate sample to the taxonomic resolution level specified for use of the Macroinvertebrate Community Index (MCI); and
- Enumeration of the results as average Taxa Richness, average Macroinvertebrate Community Index (MCI), average Quantitative Macroinvertebrate Community Index (QMCI), Percent Ephemeroptera, Plecoptera Trichoptera taxa (% EPT taxa) and Percent Ephemeroptera, Plecoptera Trichoptera Individuals (%EPT Individuals).

4.0 Results and Discussion

4.1 Instream Habitat Quality

An assessment of physical habitat conditions upstream and downstream of the oxidation pond discharge is tabulated in Appendix B and summarised in Figures 3 and 4.

Whilst total habitat scores were similar at both the upstream and downstream sampling sites (see Figure 3), there were marked differences in contributing habitat scores that resulted in variable habitat quality for macroinvertebrates upstream and downstream of the oxidation pond discharge (see Figure 4).

The downstream site was under the canopy of a willow wetland where riparian zone conditions were improved relative to the upstream site.

Conversely, channel structure, substrate / cover, and embeddedness were better at the upstream site because the oxidation pond discharge was associated with a significant input of silt, chlorophyll and nutrients to the stream (see Figure 4).

Interestingly, submerged and emergent macrophytes were not present under the willow canopy at the downstream site but there was an increased bed cover of periphyton at this site relative to the upstream control (see Appendix B and Figure 4).

Figure 3: *Total Physical Habitat Scores for Sampling Sites Upstream (U.S.) and Downstream (D.S.) of the Featherston Oxidation Ponds to Donald Creek, April 2010.*

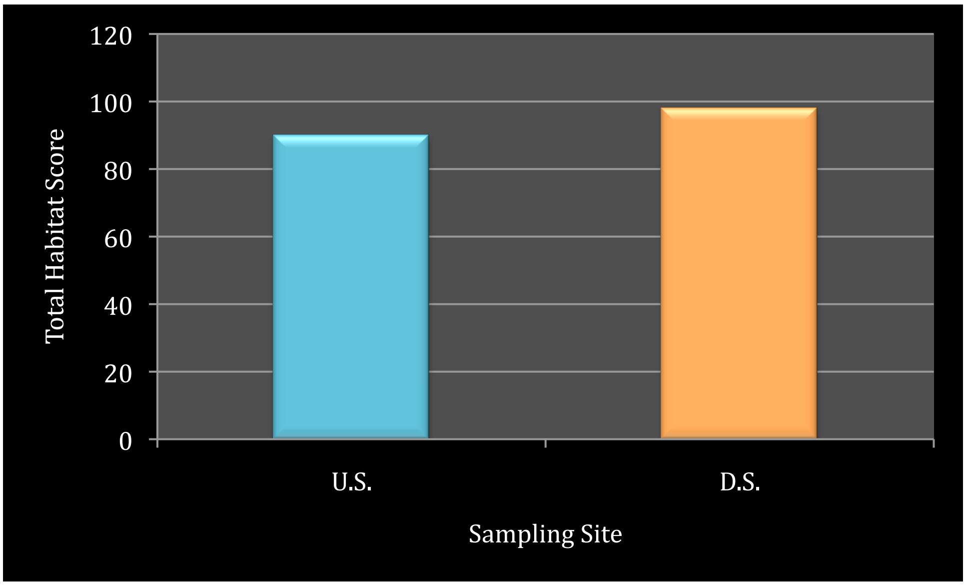
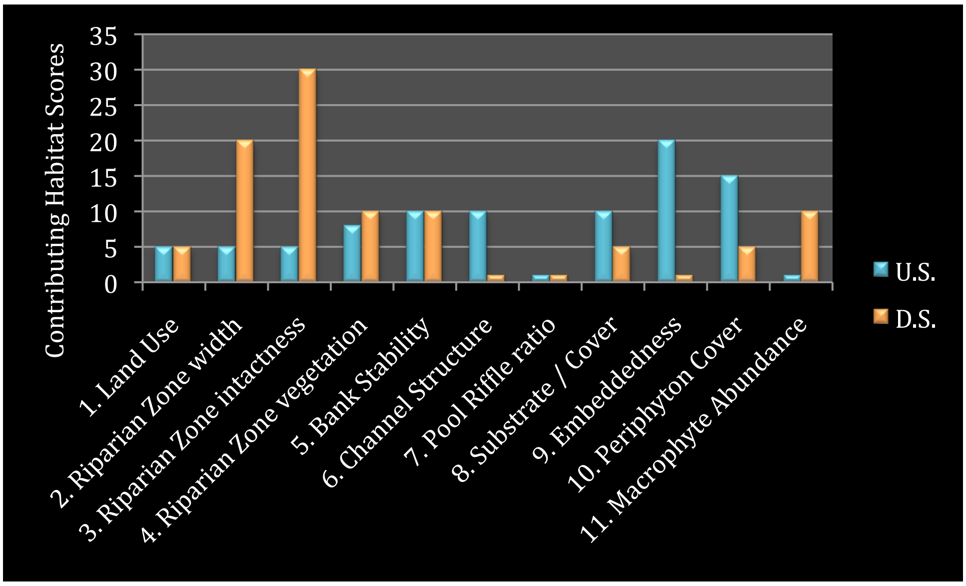


Figure 4: *Individual Physical Habitat Scores for the eleven metrics scored in Appendix B (after Edgar et. al., 1994) at Sampling Sites Upstream (U.S.) and Downstream (D.S.) of the Featherston Oxidation Ponds to Donald Creek, April 2010.*



At the time of this survey (13.04.2010) flow from the Featherston oxidation ponds were similar to flow at the upstream sampling site in Donald Creek and there were therefore, substantially higher flows at the downstream sampling site relative to the upstream site.

4.2 Inspection for Heterotrophic growths

Visually obvious growths of sewage fungus was present on c. 5% of stable submerged substrate (gravel, wood and submerged willow roots) throughout the 100 m reach of Donald Creek downstream of the oxidation pond discharge.

The filamentous bacterium *Sphaerotilus natans* (a principle component of sewage fungus) was present in 50 % of the samples that were dissected microscopically to assess the floristic composition of periphyton at the downstream sampling site (see Section 4.3 and Appendix C1).

4.3 Description of Periphyton Communities

The floristic composition of 5 periphyton samples from Transect 1 (riffle habitat) and 5 periphyton samples from Transect 3 (run habitat) both upstream and downstream of the oxidation pond discharge are tabulated in Appendix C1.

The mesotrophic taxa *Fragilaria vaucheriae*, *Gomphonema spp*. and *Phormidium spp*. co-dominated a low cover of periphyton upstream of the oxidation pond discharge in Donald Creek as of April 2010 (see Appendix C1). The eutrophic taxa *Stigeoclonium tenue* dominated periphyton at the downstream sampling site (see Appendix C1).

Periphyton cover scores and biomass (Ash Free Dry matter per m^2) are tabulated in Appendix C2 and summarised in Figures 5 and 6.

Figure 5: *Average Periphyton Scores at Sampling Sites Upstream (U.S.) and Downstream (D.S.) of the Featherston Oxidation Ponds to Donald Creek, April 2010 (error bars = ± SE of estimate where n = 5).*

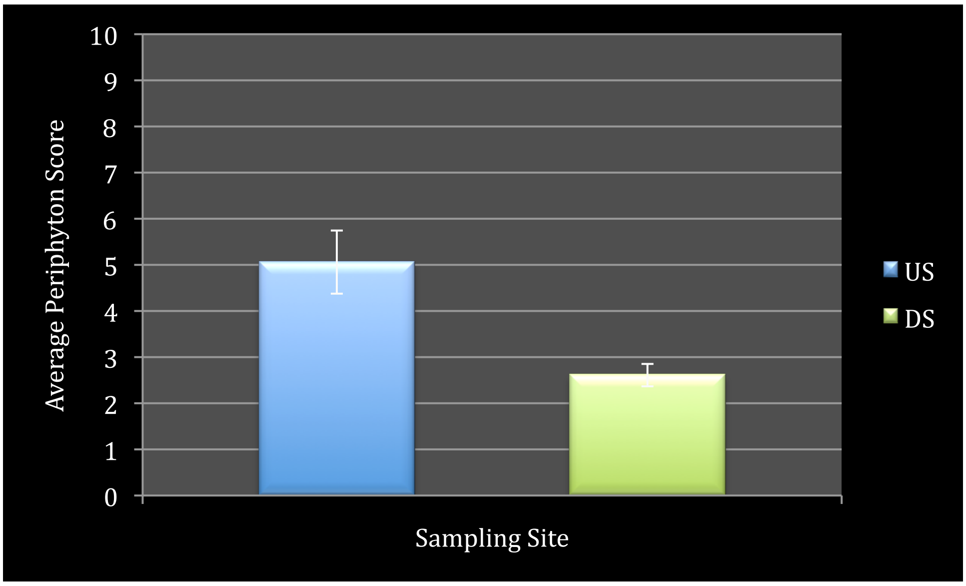
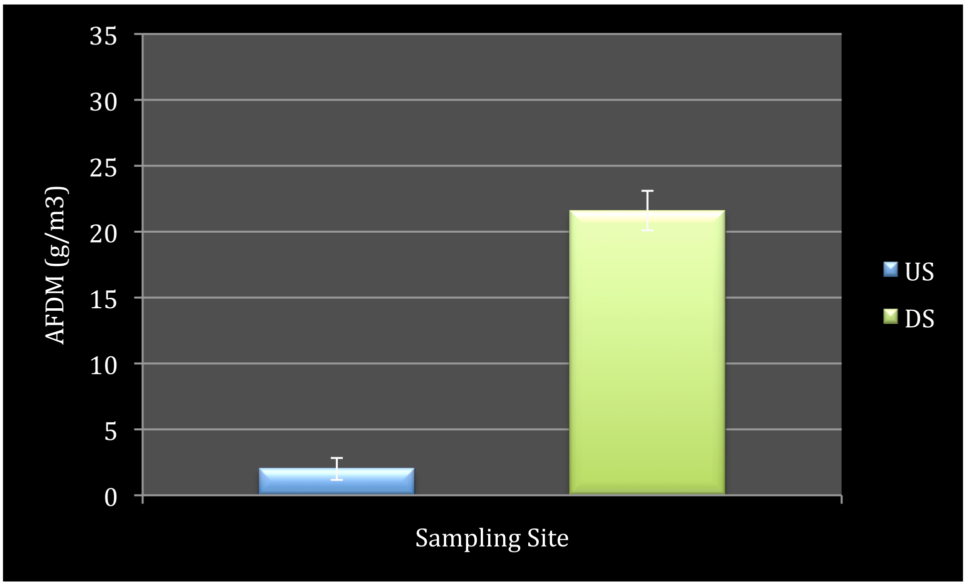


Figure 6: *Average Periphyton Biomass at Sampling Sites Upstream (U.S.) and Downstream (D.S.) of the Featherston Oxidation Ponds to Donald Creek, April 2010 (error bars = ± SE of estimate where n = 5).*



There was a statistically significant reduction in periphyton scores between the upstream and downstream sampling sites in Donald Creek[2].

Table 1 provides an interpretation of periphyton scores (after Biggs and Kilroy, 2000) and on this basis; Figure 5 represents a change from slight to moderate levels of nutrient enrichment.

Table 1: Interpretation of Periphyton scores (after Biggs and Kilroy, 2000).

Score: 0 to 1.9 There are mainly long filamentous green algae at the site indicating that there is moderate to high enrichment from phosphorus and/or nitrogen. Such enrichment could be from enriched seepage, a discharge from a treatment pond or could occur naturally in streams that have a high proportion of mudstone/siltstone or recent volcanic rocks (central North Island) in their catchments.
Score: 2 to 3.9 These communities suggest a moderate level of enrichment from phosphorus and/or nitrogen. Such enrichment could be from enriched seepage, a discharge from a treatment pond or could occur naturally in streams that have a high proportion of mudstone/siltstone or recent volcanic rocks (central North Island) in their catchments.
Score: 4 to 5.9 These communities suggest slight enrichment from phosphorus and/or nitrogen. Such enrichment could be from enriched seepage, a discharge from a treatment pond or could occur naturally in streams that have a high proportion of mudstone/siltstone, recent volcanic rocks (central North Island), limestone or marble in their catchments. Clean stones can result from recent abrasion by flood flows or intense grazing by invertebrates/insects that live in the gravels.
Score: 6 to 7.9 These communities are generally composed of species that are able to grow under moderate to low nutrient conditions. These communities also usually grow back first after a flood has removed previous growths, but may be out-grown by filamentous algae if nutrient levels are sufficiently high.
Score: 8 to 10 These communities usually signify low concentrations of nutrients and/or intensive grazing by invertebrates/insects that live among the gravels.

Periphyton cover was highest downstream of the oxidation pond discharge but was less (15% for long filaments and 24% overall) than the "nuisance value of 30% cover of filaments > 2cm long as proposed by Biggs and Kilroy 2000 for aesthetics / recreation and trout habitat and angling.

There was also a significant difference in the biomass of periphyton upstream and downstream of the oxidation pond discharge to Donald Creek[3] (see Figure 6). Again however, the higher downstream biomass of 21.6 $g.m^{-3}$ was less than the 35 $g.m^{-3}$ AFDM as proposed by Biggs and Kilroy (2000) for aesthetics / recreation and trout habitat and angling.

Overall, it appeared highly likely, that light limitation (because of the willow canopy at the downstream sampling site) masked the full potential effects of nutrient enrichment on periphyton growth at the downstream site.

4.4 Description of Aquatic Macrophytes

Survey sheets for aquatic macrophytes are attached in Appendix C3. The upstream sampling site prescribed in condition 21 of Consent WAR 970080 (see Appendix A) was relatively unshaded (see Plates D to G). The downstream sampling site prescribed in condition 21 of Consent WAR 970080 (see Appendix A) was shaded by a canopy of willow trees.

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[2] Paired Two Sample T-Test: CV (5%) is 2.3646 (7 dof). T-criterion value 3.6476 ∴ mean estimate significantly different.

[3] Paired Two Sample T-Test: CV (5%) is 2.2622 (9 dof). T-criterion value 10.7641 ∴ mean estimate significantly different.

There was a 15% cover of aquatic macrophytes at the upstream site (dominated by the submerged macrophyte *Elodea canadensis* and the sprawling emergent *Apium nodiflorum*) but there were no aquatic macrophytes at the downstream site.

4.5 Macroinvertebrate Community Structure

Metrics of macroinvertebrate community structure upstream and downstream of the discharge from the Featherston oxidation ponds are tabulated in Appendix D and summarised in Figures 7 to 13.

Statistical differences in these metrics of macroinvertebrate community structure upstream and downstream of the discharge from the Featherston oxidation ponds are tabulated in Table 2.

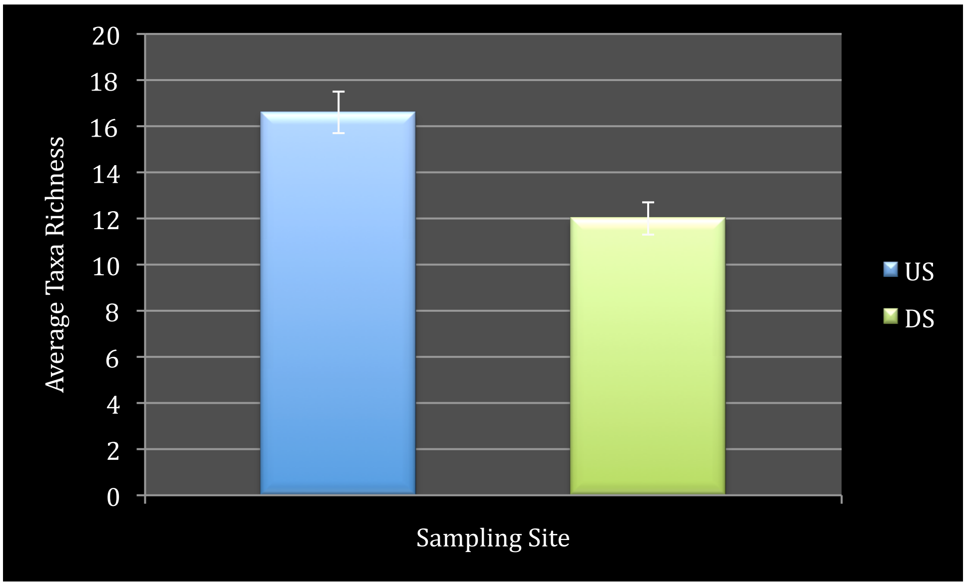
Table 2: T-Criterion Values from Paired Two sample T-Test for average metrics of community structure upstream and downstream of the Featherston Oxidation Ponds where Critical Value (5%) is 2.776 with 4 degrees of freedom.

Taxa Richness	6.782 (>2.776 ∴ Significant difference in means)
Macroinvertebrate Density	22.771 (>2.776 ∴ Significant difference in means)
MCI	7.982 (>2.776 ∴ Significant difference in means)
QMCI	10.361 (>2.776 ∴ Significant difference in means)
EPT Index	11.500 (>2.776 ∴ Significant difference in means)
%EPT Taxa	12.575 (>2.776 ∴ Significant difference in means)
%PT Individuals	28.492 (>2.776 ∴ Significant difference in means)

Average taxa richness for invertebrates (see Appendix D and Figure 7) reflects the "health" of instream communities and generally increases with increasing water quality, habitat diversity and / or habitat suitability.

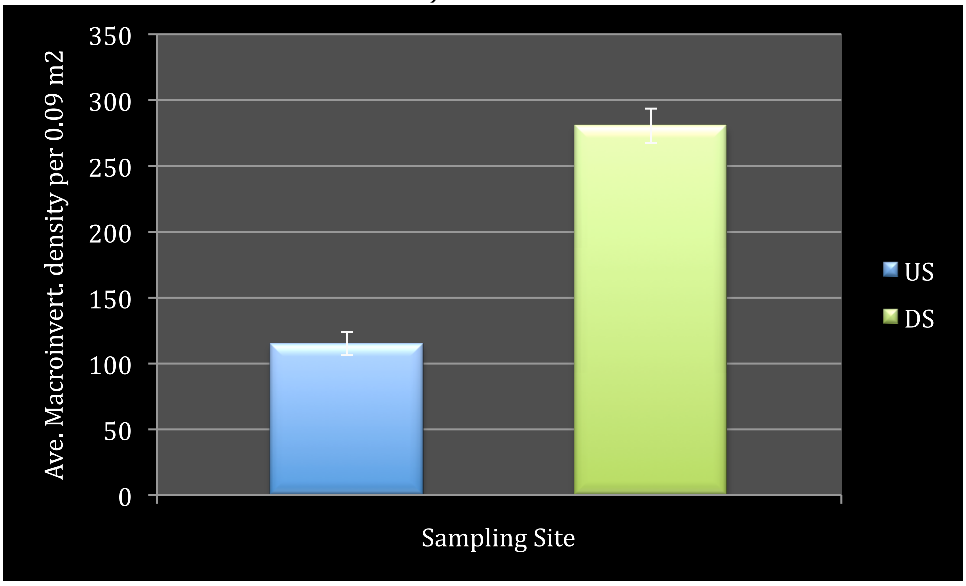
Average taxa richness upstream of the oxidation pond discharge (16.6 v 12) was significantly higher than at the downstream sampling site (see Figure 7 and Table 2).

Figure 7: Average Taxa Richness at Sampling Sites Upstream (U.S.) and Downstream (D.S.) of the Featherston Oxidation Ponds discharge to Donald Creek, April 2010 (error bars = ± SE of estimate where n = 5).



The average density of macroinvertebrates (see Figure 8) sampled with a 0.3 m x 0.3 m Surber Sampler upstream of the oxidation pond discharge (115 v 281) was significantly lower than at the downstream sampling site (see Figure 8 and Table 2).

Figure 8: Average density of macroinvertebrates per 0.09 m^{-2} Upstream (U.S.) and Downstream (D.S.) of the Featherston Oxidation Ponds discharge to Donald Creek, April 2010 (error bars = ± SE of estimate where n = 5).



The dominant macroinvertebrate taxon upstream of the oxidation pond discharge was the hydrobiid snail *Potamopyrgus antipodarum* (see Appendix D). Elmid larvae were the numerically dominant downstream of the oxidation pond discharge. The relatively high density of planktonic Daphnia included in the Surber Samples (see Appendix D) was clearly sourced from the oxidation pond discharge rather than Donald Creek.

The calculated Macroinvertebrate Community Index (MCI see Appendix B and Figure 9) and Quantitative Macroinvertebrate Community Index (QMCI see Appendix B and Figure 10) rely on prior allocation of scores (tolerance values range from 0 to 10) to freshwater macroinvertebrates based upon their pollution tolerances (see Appendix D). Taxa that are characteristic of pristine conditions score more highly than taxa that may be found in "polluted" conditions.

The MCI and QMCI have been developed as a means of detecting organic pollution in communities inhabiting rock or gravel riffles.

Figure 9: Average Macroinvertebrate Community Index (MCI) Upstream (U.S.) and Downstream (D.S.) of the Featherston Oxidation Ponds discharge to Donald Creek, April 2010 (error bars = ± SE of estimate where n = 5).

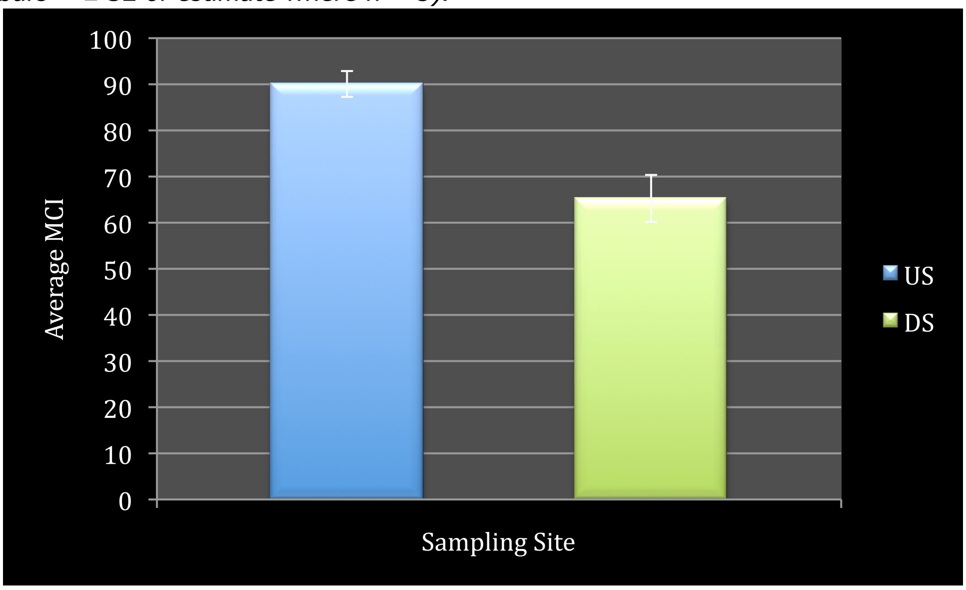
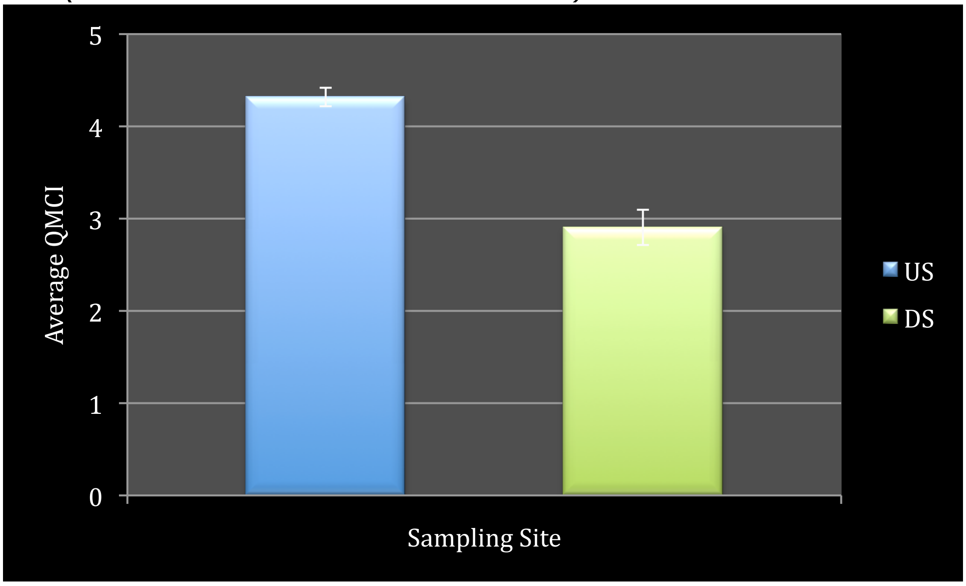


Figure 10: Average Quantitative Macroinvertebrate Community Index (QMCI) Upstream (U.S.) and Downstream (D.S.) of the Featherston Oxidation Ponds discharge to Donald Creek, April 2010 (error bars = ± SE of estimate where n = 5).

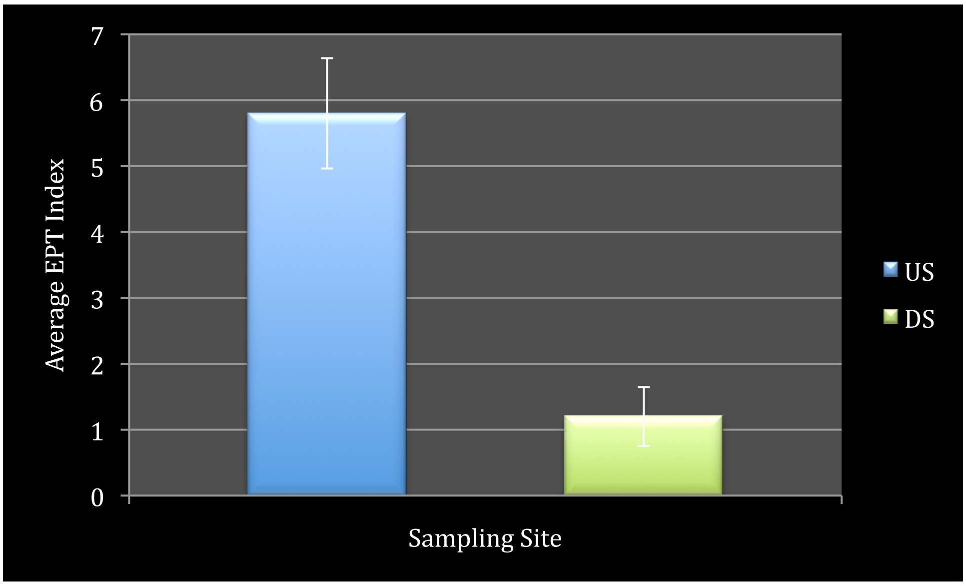


Both the average MCI and the average QMCI was significantly lower downstream of the Featherston oxidation pond discharge relative to the sampling site upstream of the Featherston oxidation pond discharge (see Figures 9 and 10, and Table 2).

An MCI value of 80 to 100 and a QMCI value of 4 to 5 at the upstream sampling site indicated probable moderate pollution (Stark, 1998). An MCI value of less than 80 and a QMCI value of less than 4 at the downstream sampling site indicated probable sever pollution (Stark, 1998).

The EPT (Ephemeroptera, Plecoptera Trichoptera) Index (see Figure 11) is the total number of distinct taxa within the orders Ephemeroptera, Plecoptera, and Trichoptera that are present at a sampling site and generally increases with increasing water quality. This value summarises taxa richness within the insect orders that are generally considered to be pollution sensitive.

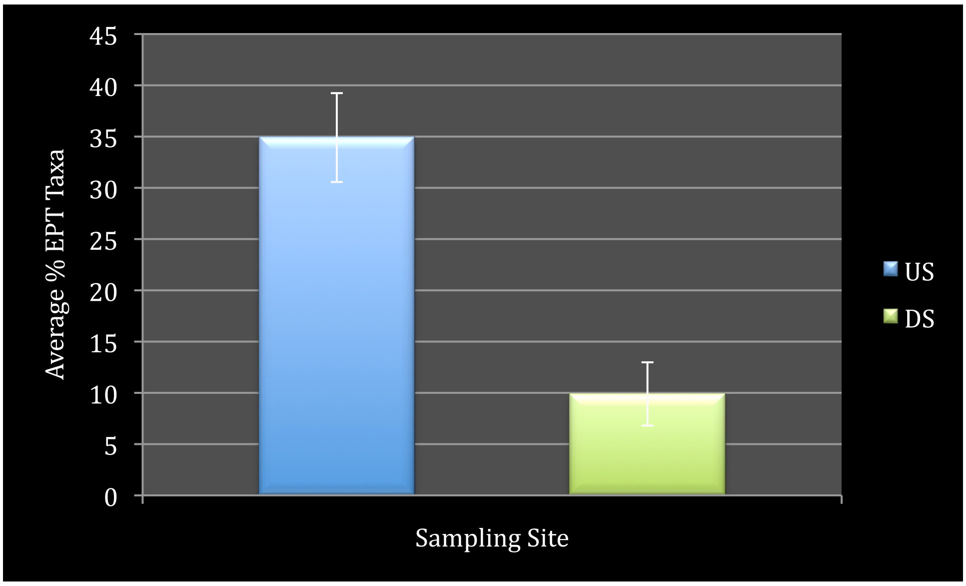
Figure 11: Average Ephemeroptera, Plecoptera, Trichoptera (EPT) Index Upstream (U.S.) and Downstream (D.S.) of the Featherston Oxidation Ponds discharge to Donald Creek, April 2010 (error bars = ± SE of estimate where n = 5).



As of April 2010, there was a significantly reduced EPT Index downstream of the oxidation pond discharge relative to the upstream control site (see Figure 11 and Table 2).

The average percent EPT Taxa is generally highest in unimpaired, pristine sites little affected by eutrophication or nutrient enrichment. It was significantly higher upstream of the Featherston oxidation pond discharge to Donald Creek relative to the downstream treated sampling site (see Figure 12 and Table 2).

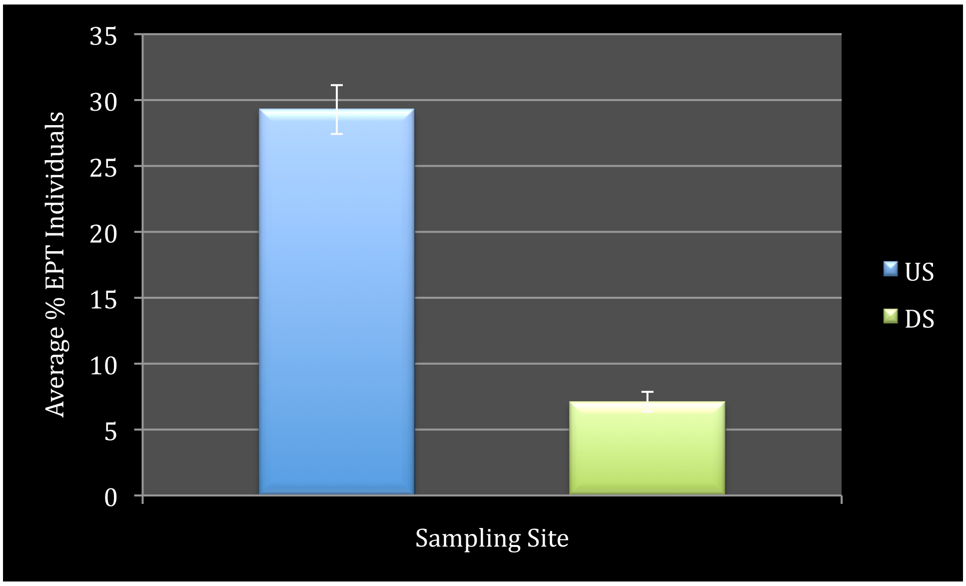
Figure 12: Average Percent Ephemeroptera, Plecoptera, Trichoptera Taxa (%EPT Taxa) Upstream (U.S.) and Downstream (D.S.) of the Featherston Oxidation Ponds discharge to Donald Creek, April 2010 (error bars = ± SE of estimate where n = 5).



"Very Good" instream habitat for aquatic macroinvertebrates is associated with greater than 60% EPT Taxa: "Poor" instream habitat is associated with less than 10% EPT Taxa and "Moderate" instream habitat is associated with 10 to 60% EPT Taxa (Milne and Perrie, 2006). On this basis, the upstream sampling site was of moderate quality and the downstream site was on the borderline between poor and moderate quality (see Figure 12).

The average percent of EPT individuals was significantly higher upstream of the oxidation pond discharge relative to the downstream treated sampling site (see Figure 13 and Table 2).

Figure 13: Average Percent Ephemeroptera, Plecoptera, Trichoptera Individuals (%EPT Individuals) Upstream (U.S.) and Downstream (D.S.) of the Featherston Oxidation Ponds discharge to Donald Creek, April 2010 (error bars = ± SE of estimate where n = 5).



5.0 Findings and Conclusions

The overall physical habitat quality at the prescribed sampling sites upstream and downstream of the discharge of treated wastewater to Donald Creek was not directly comparable in terms of flow and shading in particular. In the absence of the discharge from the Featherston Oxidation Ponds, higher habitat quality, reduced periphyton cover and biomass, and improved metrics of macroinvertebrate community structure would have been expected at the downstream sampling site.

The oxidation pond discharge to Donald Creek was associated with a conspicuous change in water clarity due to high chlorophyll concentration in the oxidation ponds and increased embeddedness of the gravel substrate in Donald Creek due to suspended solids discharged from the oxidation ponds.

There was a low cover (c. 5%) of heterotrophic growths (sewage fungus complex) in the 100 m reach of Donald Creek downstream of the discharge from the Featherston Oxidation Ponds.

Periphyton cover and biomass was significantly higher 100 m downstream of the discharge from the Featherston Oxidation Ponds relative to the control site 100 m upstream of the oxidation pond discharge. However, neither the cover nor the biomass of periphyton at the downstream sampling site exceeded "nuisance growth" criteria proposed by Biggs and Kilroy (2000) for aesthetics / recreation and trout habitat and angling. This may have been due to light limitation of instream plant growth due to a canopy of willow trees shading the downstream sampling site.

Submerged and emergent macrophytes were present at the upstream but not the downstream sampling site. This appeared to be associated with a canopy of willow trees shading the downstream sampling site.

All of the metrics used to assess macroinvertebrate community structure indicated significantly compromised water quality 100 m downstream of the discharge from the Featherston Oxidation Ponds relative to a control site 100 m upstream of the oxidation pond discharge. These metrics included:

- Taxa Richness,
- Macroinvertebrate Community Index,
- Quantitative Macroinvertebrate Community Index,
- Ephemeroptera, Plecoptera, Trichoptera Index
- Percent Ephemeroptera, Plecoptera, Trichoptera Taxa
- Percent Ephemeroptera, Plecoptera, Trichoptera Individuals

It is recommended any subsequent / repeat survey of Donald Creek to determine the effect of the discharge from the Featherston Oxidation Ponds should include two additional sampling sites. These should be in an unshaded reach of riffles upstream and downstream of the currently prescribed sampling sites to assess the potential effects of nutrient discharges from the Featherston Oxidation Ponds.

Colour Plates (Cover Plate *Apium nodiflorum* [water celery] upstream of WWTP discharge).

Plate A: There is the area available for a surface flow wetland between the Featherston Oxidation Ponds and Donald Creek (some evidence it has formerly been used for this purpose).

Plate B: Warning signage at the discharge from the Featherston Oxidation Ponds to Donald Creek.

Plate C: Highly coloured (green) discharge from the Featherston Oxidation Ponds to Donald Creek.

Plate D: Relatively un-shaded, hard-bottomed, section of Donald Creek upstream of Featherston oxidation ponds.

Plate E: *Apium nodiflorum* and a low cover of periphyton on gravel at upstream sampling site.

Plate F: Willow roots in the 1 – 2 m wide, gravel-lined channel of Donald Creek upstream of the Featherston oxidation pond discharge.

Plate G: Plume of highly coloured effluent on the right bank of Donald Creek immediately downstream of the Featherston Oxidation Pond Discharge.

Plate H: Donald Creek entering dense willow cover downstream of the Featherston oxidation pond discharge (also see Figure 2).

5.0 References

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Appendix A:

Consent No. WAR 970080
Category:

Discharge permit - water [2625]
Discharge permit -land [23139]
Discharge permit - air [20869]

Pursuant to sections 104, 104B, 105, 107 and 108, and subject to all the relevant provisions of the Resource Management Act 1991 and any regulations made thereunder, a consent in respect of a natural resource is hereby granted to:

Name	South Wairarapa District Council
Address	PO Box 6. Martinborough
Duration of consent	Effective: 25 August 2009 Expires: 25 August 2012
Purpose for which right is granted	To discharge contaminants to water, land, and air associated with the operation of the Featherston wastewater treatment plant
Location	Longwood West Road, Featherston, at or about map reference NZMS 260: S27: 2705187.6005162
Legal description of land	Part Section 258 Featherston Suburban, Part Section 330 Featherston Suburban, I Part Section 331 Featherston Suburban
Conditions	1 – 37 as attached

For and on behalf of WELLINGTON REGIONAL COUNCIL

Manger, Environmental Regulation
Date: 24/9/09

Relevant Conditions

21. Once in either 2010 or 2011, during the period 31 January to 30 April inclusive and following at least a two week period without a significant flood event, an appropriately experienced and qualified freshwater ecologist shall carry out a quantitative ecological survey of the Donalds Creek upstream and downstream of the point of discharge for the purpose of determining the effect of the discharge on the aquatic ecosystem of the creek. The survey shall comprise as a minimum:

    A. An inspection of the streambed below the point of discharge (for a distance extending 100 m downstream of the discharge) for the presence of any nuisance heterotrophic or periphyton growths; and

    B. One upstream and one downstream periphyton and macroinvertebrate sampling site in the general locations outlined below (and agreed with Wellington Regional Council prior to sampling) that, where possible, share similar habitat features in terms of substrate, flow, depth and width:

        (i) Immediately upstream of the discharge, at or about Map Reference NZMS 260 S27 :053.051; and

        (ii) Approximately 100 m downstream of the discharge, at or about Map Reference NZMS 260 S27:053-050.

22. The periphyton survey shall include:

- An assessment of the percentage cover of both filamentous algae and algal mats (to nearest 5%) at 10 points across each of four transects encompassing both riffle and run habitat and extending across the width of the creek at each sampling site;

- Collection of a composite periphyton sample from riffle and run habitat (a composite of scraping from 10 rocks. 5 from a riffle and 5 from a run) across each sampling site using method QM-1a from the Stream Periphyton Monitoring Manual (Biggs & Kilroy 2000); and
- Analysis of periphyton samples for community composition and abundance using the Biggs & Kilroy (2000) relative abundance method, ash free dry weight and chlorophyll a.

23. The macroinvertebrate survey shall follow Protocols C3 and P3 from the Ministry for the Environment's report on protocols for sampling macroinvertebrates in wadeable streams (Stark et at. 2001). This shall involve:

- Collection of 5 replicate 0.1 m^2 Surber samples at random within a 20 m section of riffle habitat at each sampling site;
- Full count of the macroinvertebrate taxa within each replicate sample to the taxonomic resolution level specified for use of the Macroinvertebrate Community Index (MCI); and
- Enumeration of the results as taxa richness, MCI, QMCI, %EPT taxa and %EPT Individuals.

24. The results of the ecological survey shall be reported in writing to Manager Environmental Regulation, Wellington Regional Council by 1 June of the year in which the survey was undertaken.

Appendix B: Stream Habitat Assessment (average condition 50 m upstream and downstream).

Stream / River Name: Donald (Boar) Creek (see Figures 1 and 2 for locality of sampling sites)

Date: 13.04.2010 Evaluators Name: BTC

	score	U.S. WWTP Discharge	D.S. WWTP Discharge
Q1. Land use pattern beyond the immediate riparian zone			
Undisturbed native forest	40		
Disturbed native forest	30		
Undisturbed exotic forest	30		
Disturbed exotic forest	20		
Mixture of shrub and pasture	10		
Intensive pastoral farming	5	5	5
Horticultural / Urban	1		
Q2. Width of riparian zone from stream edge to field/forest			
Riparian zone > 30 m wide	30		
Riparian zone varying from 5-30 m	20		20
Riparian zone 1 - 5 m	5	5	
Riparian zone absent	1		
Q3 Completeness of riparian zone			
Riparian zone intact without breaks in vegetation	30		30
Breaks occurring at intervals of > 50 m	20		
Breaks frequent with some gullies and scars	5	5	
Deeply scarred with gullies all along its length	1		
Q4 Stream-side cover			
Dominant vegetation is shrub	20		
Dominant vegetation is of tree form	10	8	10
Dominant vegetation is grass	5		
Over 50% of the stream bank has no vegetation	1		
Q5 Bank stability			
Bank stable. No evidence of erosion or bank failure. Side slopes generally < 30%	20		
Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank.	10	10	10
Moderately unstable. Moderate frequency and size of erosional areas. Side slopes up to 60% on some banks.	5		
Unstable. Many eroded areas. Side slopes > 60% common. "Raw areas" frequent along straight sections and banks.	1		

Appendix B: Stream Habitat Assessment (average condition 50 m upstream and downstream).

	score		
Q6. Channel structure.			
Little or no enlargement of islands or point bars, and/or no channelisation.	20		
Some new increase in bar formation, mostly from coarse gravel; and/or some channelisation present	10	10	
Moderate deposition of new gravel, coarse sand on old & new bars; pools part filled with silt; and/or embankments both sides.	5		
Heavy deposits of fine material, increased bar development; most pools filled with sediment; . and/or extensive channelisation	1		1
Q7 Pool/riffle; Run/bend ratio (av. distance between riffles OR bends divided by the average stream width.			
Ratio of 5-7. Variety of habitat. Deep riffles & pools	20		
7-15. Adequate depth in pools and riffles. Bends provide habitat.	10		
15-20. Occasional riffle or bend. Bottom contours provide some habitat.	5		
> 25. Essentially a straight stream. Generally all flat water or shallow riffles. Poor habitat.	1	1	1
Q8. Bottom substrate/available cover.			
Greater than 50% rubble, gravel, submerged logs, undercut banks or other stable habitat	20		
30-50% rubble, gravel or other stable habitat. Adequate habitat.	10	10	
10-30% rubble, gravel or other stable habitat. Habitat availability less than desirable.	5		5
Less than 10% rubble, gravel or other stable habitat. Lack of habitat is obvious.	1		
Q9 Embeddedness.			
Gravel, cobble, and boulder particles are between 0 and 25% surrounded by fine sediment.	20	20	
Gravel, cobble, and boulder particles are between 25 and 50% surrounded by fine sediment.	10		
Gravel, cobble, and boulder particles are between 50 and 75% surrounded by fine sediment.	5		
Gravel, cobble, and boulder particles are between 75 and 100% surrounded by fine sediment.	1		1
Q10. Periphyton Cover.			
Periphyton not visible on hand held stones	25		
Visible on bed covering few surfaces, < 20% cover	15	15	
Visible on bed covering many surfaces, 20-50% cover	10		
Visible on bed covering most surfaces, 50-80% cover	5		5
Visible as complete cover of bed, 80-100% cover	1		
Q11 Macrophyte Abundance			
Macrophytes absent	20		
Submerged and/or Emergent macrophytes present	10		10
Submerged macrophytes abundant	5		
Emergent macrophytes abundant	1	1	
Site Score		90	98

Appendix C1: Periphyton Database - Relative Abundance of Taxa.

Relative Abundance of Algal Taxa in Periphton Samples collected from Transect A upstream
and Transect A downstream of the discharge of the Featherston Oxidation Ponds

Date: 13 April, 2010

Laboratory dissection and ID by BTC.

d	dominant
cd	co-dominant
p	present as sub-dominant

	Upstream										Downstream									
	Transect 1					Transect 3					Transect 1					Transect 3				
	Stone / Sample Number										Stone Sample Number									
	1	2	3	4	5	11	12	13	14	16	1	2	3	4	5	11	12	13	14	15
Assorted Diatoms	p				p	p			p	p	p	p	p	p	p	p	p	p	p	p
Chroodactyton sp.	p				p	p			p	p					p					
Cladophora glomerata											p	p	p	p	p	p	p	p	p	p
Cladophora sp.	p				p	p			p	p										
Cocconeis placentula	p				p	p			p	p			p			p			p	
Cymbella kappii					p	p			p											
Encyonema sp										p								p		
Epithemia sorex,						p			p			p	p							
Fragilaria vaucheriae	cd				cd	cd			cd	cd							p			
Gomphonema spp.	cd				cd	cd			cd	cd								p		
Melosira varians											p	p	p	p	p	p	p	p	p	p
Microspora sp.	p				p	p			p	p						p				
Mougeotia sp.	p									p						p				
Navicula spp.	p				p	p			p				p			p	p			
Nitzchia spp.	p				p	p			p	p							p			
Nostoc sp.					p															
Oedogonium spp.	p				p	p			p	p			p						p	p
Oscillatoria spp.					p	p			p	p	p		p	p	p	p	p	p	p	p
Phormidium spp.	cd				cd	cd			cd	cd										
Rhizoclonium sp.											p	p	p	p	p	p	p	p	p	p
*Sphaerotilus natans**											p				p	p			p	p
Spirogyra sp.	p				p	p			p	p										
Stigeoclonium tenue											d	d	d	d	d	d	d	d	d	d
Synedra ulna	p				p	p			p	p	p		p							
Tabellaria flocculosa	p									p	p	p		p	p		p	p	p	p
Tribonema sp.					p							p	p			p			p	p
Ulothrix zonata						p			p				p							
Vaucheria sp	p									p	p				p					

* *a member of the "sewage gungus complex" that it technically a heterotrophic bacterium* rather than an autotrophic component of the periphyton community.

Appendix C2: Periphyton Cover and Biomass Database (after Biggs and Kilroy, 2000).

Site: Upstream of Featherston WWTP Discharge to Donald Creek

Date: 13.04.2010

Periphyton Cover on Individual Stones / Samples

			Stone / Sample Number:																			
			Riffle										Run									
		Periphyton Score	Transect 1					Transect 2					Transect 3					Transect 4				
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Thin mat/film:	green	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
(under 0.5 mm thick)	light brown	10	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	black/dark brown	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium mat:	green	5	5	0	0	0	5	5	0	0	0	5	0	0	0	0	0	5	0	0	0	0
(0.5-3 mm thick)	light brown	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	black/dark brown	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thick mat:	green/ light brown	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(over 3 mm thick)	black/dark brown	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filaments, short	green	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(under 2 cm long)	brown/reddish	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Filaments, long	green	1	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
(over 2 cm long)	brown/reddish	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(a) Total % Periphyton on stone surface			5	0	0	0	10	5	0	0	0	5	5	0	0	5	5	5	0	0	0	0
(b) List of: percentage cover x score for that type of periphyton			25				50 25	25				25	5			25	35	25				
(c) Sum of all multiplied % scores			25	0	0	0	75	25	0	0	0	25	5	0	0	25	35	25	0	0	0	0
(d) Average score per stone/sample [(c) / (a)]			5.0	0.0	0.0	0.0	7.5	5.0	0.0	0.0	0.0	5.0	1.0	0.0	0.0	5.0	7.0	5.0	0.0	0.0	0.0	0.0
(e) Total of all average scores in line (d)			41																			
(f) Total average periphyton score [d/sample#]			5.06 SE 0.6842																			

		Stone / Sample Number:									
		Transect 1					Transect 3				
		1	2	3	4	5	11	12	13	14	15
Ash Free Dry Mass (AFDM)	(g.m^2)	6	0	0	0	7	2	0	0	2	3
Average AFDM	(g.m^2)	2.0 SE 0.8300									

Appendix C2: Periphyton Cover and Biomass Database (after Biggs and Kilroy, 2000).

Site: Downstream of Featherston WWTP Discharge to Donald Creek

Date: 13.04.2010

Periphyton Cover on Individual Stones

			Stone / Sample Number:																			
			Riffle										Run									
		Periphyton	Transect 1					Transect 2					Transect 3					Transect 4				
		Score	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Thin mat/film:	green	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(under 0.5 mm thick)	light brown	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	black/dark brown	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium mat:	green	5	10	5	0	0	5	15	0	0	5	5	5	5	0	5	5	10	10	5	0	5
(0.5-3 mm thick)	light brown	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	black/dark brown	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thick mat:	green/ light brown	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(over 3 mm thick)	black/dark brown	7	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0
Filaments, short	green	5	0	15	20	15	0	0	0	0	0	0	0	10	0	5	0	0	0	0	0	0
(under 2 cm long)	brown/reddish	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filaments, long	green	1	15	5	10	10	25	10	30	25	20	15	10	10	15	15	10	20	10	0	30	15
(over 2 cm long)	brown/reddish	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(a) Total % Periphyton on stone surface			25	25	30	25	30	25	30	25	25	20	15	25	25	25	15	30	20	5	30	20
(b) List of:			50	25	100	75	25	75	30	25	25	25	25	25	70	25	25	50	50	25	30	25
percentage cover x score			15	75	10	10	25	10			20	15	10	50	15	25	10	20	10			15
for that type of periphyton				5										10		15						
(c) Sum of all multiplied % scores			65	105	110	85	50	85	30	25	45	40	35	85	85	65	35	70	60	25	30	40
(d) Average score per stone/sample [(c) / (a)]			2.6	4.2	3.7	3.4	1.7	3.4	1.0	1.0	1.8	2.0	2.3	3.4	3.4	2.6	2.3	2.3	3.0	5.0	1.0	2.0
(e) Total of all average scores in line (d)			52																			
(f) Total average periphyton score [d/sample#]			2.61 SE 0.2423																			

		Stone / Sample Number:									
		Transect 1					Transect 3				
		1	2	3	4	5	11	12	13	14	15
Ash Free Dry Mass	$(g.m^2)$	28	22	23	28	26	14	21	18	19	17
Average AFDM	$(g.m^2)$	21.6 SE 1.4996									

Appendix C3: Stream Survey Sheet 4: Macrophyte Cover and Scores.

Client / Job Code: SWDC Featherston WWTP.							Date: 13 April 2010			Assessed by: BTC	
Reach Upstream of Oxidation Pond Discharge to Donald Creek											
				Vegetation Cover (% Wetted Area of Channel)							
					Submerged Plants					Emergent Plants	
Transect	Wetted Width (m)	Channel Width (m)	Overall Cover	Total Cover	Surface reaching sub-total	Surface reaching Taxa	Sub-Surface sub-total	Sub-Surface Taxa		Total Cover	Taxa
1	1.7	2.6	10	5	0		5	Ec (5%)		5	An (5%)
2	1.4	2.0	25	10	5	Ec (5%)	5	Ec (3%) Nh (2%)		15	An (10%) Rc (3%) Gr (2%)
3	1.0	2.0	15	0	0		0			15	An (15%)
4	1.8	2.4	10	5	0		5	Ec (5%)		5	An (5%)
5	1.5	2.2	15	5	0		5	Ec (3%) Nh (2%)		10	Gr (5%) An (5%)
Totals			75	25	5		20			50	

Site A Macrophyte Total Cover (%) 15
Site A Macrophyte Channel Clogginess (%) 13
Site A Macrophyte Native Cover (%) 0.8

Ec = Elodea canadensis
Nh = Nitella hookeri
An = Apium nodiflorum
Rc = Rubus fruticosa
Gr = Assorted grasses

Client / Job Code:							Date: 13 April 2010			Assessed by: BTC	
Reach Downstream of Oxidation Pond Discharge to Donald Creek											
				Vegetation Cover (% Wetted Area of Channel)							
					Submerged Plants					Emergent Plants	
Transect	Wetted Width (m)	Channel Width (m)	Overall Cover	Total Cover	Surface reaching sub-total	Surface reaching Taxa	Sub-Surface sub-total	Sub-Surface Taxa		Total Cover	Taxa
1	2.3	3.1	100% willow canopy	0						0	
2	2.5	3.0	100% willow canopy	0						0	
3	2.6	3.4	100% willow canopy	0						0	
4	2.4	3.1	100% willow canopy	0						0	
5	2.6	3.2	100% willow canopy	0						0	
Totals			5	0	0		0			0	

Site C Macrophyte Total Cover (%) 100% tree cover
Site C Macrophyte Channel Clogginess (%) 0
Site C Macrophyte Native Cover (%) 0

Appendix D: Laboratory Analysis of Macroinvertebrate Samples.

Client / Job Code: Featherston WWTP	Date: 13.04.10

Stream Type			hard-bottomed					hard-bottomed				
	HB*	SB**	U.S.					D.S.				
TAXA	*MCI*	*MCI*	#1	#2	#3	#4	#5	#1	#2	#3	#4	#5
ANNELIDA (laboratory counts)												
Oligochaeta	*1*	*3.8*	3	7	5	5	4	31	20	24	28	21
Hirudinea	*3*	*1.2*	2	1	2	1	2	2	5	4	6	4
MOLLUSCA (laboratory counts)												
Physa sp.	*3*	*0.1*	0	0	1	0	0	12	14	19	17	14
Potamopyrgus antipodarum	*4*	*2.1*	29	42	33	27	37	5	5	8	7	8
CRUSTACEA (laboratory counts)												
Amphipoda	*5*	*5.5*	9	6	8	12	7	0	0	0	3	0
Daphnia sp.			0	0	0	0	0	52	45	51	47	43
Paranephrops planifrons	*5*	*8.4*	0	1	0	1	0	0	0	0	0	2
INSECT LARVAE (counts)												
EPHEMEROPTERA (mayflies)												
Deleatidium	*8*	*5.6*	17	12	16	11	17	0	0	1	0	0
Mauiulus luma	*5*	*4.1*	5	6	7	5	3	0	0	0	0	0
Zephlebia sp.	*7*	*8.8*	0	0	0	1	0	0	0	0	0	0
PLECOPTERA (stone flies)												
TRICHOPTERA (caddisflies)												
Aoteapsyche colonica	*4*	*6.0*	4	7	11	8	8	16	20	19	23	21
Costachorema sp.	*7*	*7.2*	0	0	0	1	0	0	0	0	0	0
Hudsonema amabilis	*6*	*6.5*	0	1	0	0	0	0	0	0	0	0
Hydrobiosis parumbripennis	*5*	*6.7*	0	0	1	0	0	0	0	0	0	0
Pycnocentrodes sp.	*5*	*3.8*	3	4	3	4	5	0	0	0	0	0
Triplectides obseleta	*5*	*5.7*	1	2	3	2	1	0	0	0	0	0
HEMIPTERA (water bugs)												
Microvelia macgregori	*5*	*4.6*	1	0	0	0	0	0	0	0	0	0
COLEOPTERA (beetles)												
Elmidae	*6*	*7.2*	8	6	12	7	5	59	80	68	74	71
MEGALOPTERA (dobsonflies)												
Archichauloides diversus	*7*	*7.3*	2	1	1	2	2	0	0	0	0	0
DIPTERA (two winged flies)												
Aphrophila neozelandica	*5*	*5.6*	0	0	0	0	1	0	0	0	0	0
Austrosiumulium austrolense	*3*	*3.9*	0	0	0	0	0	37	25	27	35	42
Chironomidae												
Chironomus	*1*	*3.4*	12	13	17	16	11	44	34	37	41	32
Orthocladiinae	*2*	*3.2*	7	4	7	3	5	2	0	0	0	0
Tanypodinae	*5*		5	2	3	3	2	0	0	2	0	0
Culex pervigilans	*3*		0	0	0	0	0	12	16	22	19	17
Limonia nigrescens	*6*	*6.3*	0	1	0	0	0	0	0	0	0	0
Muscidae	*3*	*1.6*	0	1	0	0	0	1	3	3	1	2
Paralimnophila skusei	*6*	*7.4*	1	0	0	0	0	0	0	0	0	0
Zelandoptipula sp	*6*	*3.6*	0	0	0	0	1	0	0	0	0	0

* Stark et. al. (2001)

** Stark and Maxted (2007)

SUMMARY STATS: MACROINVERTEBRATES

	U.S.							D.S.						
	#1	#2	#3	#4	#5	ave.	S.D.	#1	#2	#3	#4	#5	ave.	S.D.
Taxa Richness	16	18	16	17	16	16.6	0.89	12	11	13	12	12	12	0.71
# inverts	109	117	130	109	111	115	8.9	273	267	285	301	277	281	13.1
MCI	90	90	86.3	94.1	90	90.1	2.78	60	62	73.3	65.5	65.5	65.2	5.09
QMCI	4.5	4.15	4.25	4.25	4.43	4.32	0.14	2.6	3.08	2.88	2.93	3.04	2.91	0.19
EPT Index	5	6	6	7	5	5.8	0.84	1	1	2	1	1	1.2	0.45
%EPT Taxa	31.3	33.3	37.5	41.2	31.3	34.9	4.34	8.33	9.09	15.4	8.33	8.33	9.9	3.09
%PT Individuals	27.5	27.4	31.5	29.4	30.6	29.3	1.85	5.86	7.49	7.02	7.64	7.58	7.12	0.74