Environment Waikato Technical Report TR2005/02

Regional Guidelines for Ecological Assessments of Freshwater Environments

Macroinvertebrate Sampling in Wadeable Streams

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1 Introduction

Environment Waikato is currently developing a series of guidelines to assist those involved in assessment and monitoring of freshwater ecosystems. The guidelines are intended to establish a regionally consistent set of approaches for sample collection, analysis and reporting, and to set a minimum level of effort that workers are welcome to exceed. We recognise that each study will have its own set of questions and requirements, and that variations to any guidelines or recommended methods may be necessary to address specific questions. These guidelines should not constrain the scope of work that is carried out but should be used to ensure that, where appropriate, the approaches applied are consistent with recommended methods and meet or exceed the minimum level of effort.

This guideline covers macroinvertebrate sampling of perennial wadeable streams. We define wadeable stream sites as those where more than half of the sampling reach can be safely accessed at summer low flow so that representative samples can be collected from benthic and/or other stable, productive habitats. These sites typically have mean depth of ≤1 m and occur on first- through to fourth-order streams, although some larger sites within this range may be non-wadeable. Sampling guidelines for non-wadeable streams are currently under development. In addition to guidance on macroinvertebrate sample collection and processing methods for wadeable streams, this guideline offers advice on approaches to study design and provides details of Environment Waikato's qualitative habitat assessment procedure which we recommend is used as part of the site characterisation process.

2 Study design

The design of any study will depend on the specific objectives being addressed, and these need to be clearly formulated. This section provides general comments on expectations relating to aspects of study design aimed at quantifying impacts and assessing potential environmental effects. Entire books have been written on this subject, and as an introduction to this literature and general concepts, readers are referred to pages 363-369 in Boothroyd & Stark (2000). The following comments relate to aspects of site selection, use of control or reference sites, sample replication, and sampling time.

Site selection – Careful consideration needs to be given to the location of sites to avoid, account for or minimise confounding factors (e.g., varying levels of shade, differences in gradient and substrate composition etc). Environment Waikato's Regional Ecological Monitoring of Streams (REMS) programme generally assesses conditions along 50 to 100-m long reaches, although variations around this length may occur depending on study objectives, the need to avoid major tributary inputs, access or size of the waterway. Sampling reaches should be reasonably homogenous in terms of general habitat, and away from the influence of road-crossings, tributary inputs, and other structures or non-target point source inputs. When identifying headwater perennial streams outside the typical summer low flow period, it is important to make a judgement on whether the site flows year-round to ensure the fauna is not influenced by temporary dewatering of the channel.

Control or reference sites – The inclusion of physically comparable sites that are un-impacted by the disturbance(s) under investigation is a key component in any sampling programme aimed at understanding environmental effects. In the context of monitoring, a "control" site refers to a location that is very similar (as close as can be obtained) to a disturbed site to isolate the effect of a particular disturbance, whereas a "reference" site denotes more general conditions that reflect undisturbed or minimally disturbed conditions in the area prior to human development (e.g., vegetation adjacent to reach unmodified and >95% upstream catchment in mature native vegetation).

Control or reference sites may be on the same stream but above the impact site where comparable reaches are available, or on nearby streams that are physically similar (e.g., size, gradient, substrate type etc) but un-impacted by the disturbance(s) under investigation. Where an impact is anticipated in the future, both control sites and "impact" sites can be sampled prior to the onset of effects to establish baseline comparability between sites. Sampling of control and "impact" sites before and after the onset of disturbance (BACI design) is viewed as one of the most robust sampling designs for assessing environmental effects.

Replication – Important questions to consider when assessing impacts are (i) how representative is the reach being sampled of general "impact" and "control" conditions, and (ii) how does the variability within sites compare to the variability among sites. These questions can be addressed using appropriate replication. This may involve the sampling of multiple distinct reaches above impact points; generally sampling of three reaches provides a reasonable picture of variability among sites. Where replicate sampling sites are not available, questions are often framed around the extent of a particular disturbance. In this situation data can be collected from a comparatively larger number of disturbance sites than would otherwise be gathered (e.g., along a mixing zone), so that stronger inferences may be drawn about the disturbance in relation to disturbance gradients.

Collection of replicate samples within sites is necessary to evaluate statistically significant differences among sites (e.g., when determining the magnitude of a particular impact). Generally, at least four replicate samples within a site are needed to assess this; pooling of replicate samples means that appropriate univariate statistical tests are generally not possible. Replication within sites may not be necessary where qualitative assessments of general reach conditions or wider scale patterns are being made, or where trends over very long timescales (e.g., >10 years) are being monitored regularly. However, it may be advantageous to quantify within site variability by analysing separate replicate samples at the start of such general assessments or extended monitoring programmes.

Replicate sampling is important where specific effects above and below a particular disturbance are being assessed over the short- to medium-terms.

Sampling times – The timing and frequency of sample collection will depend in part on the objectives and urgency of the study. For example, impacts such as sediment runoff may be greatest after winter rains, whereas temperature-associated impacts are likely to be greatest in late summer. Being clear about the objectives of the study will help define appropriate sampling times and frequencies. Sampling frequency may range from once a year in the same season where general patterns among several sites and/or changes over long timescales are of interest, to twice a year to assess the range of climatic extremes (winter vs. summer), to quarterly where seasonal variations are of interest, to monthly or more often where intensive assessment is required.

Where this fits in with study objectives, we recommend that any sampling programme include a date in January-March so that the results can be placed in the context of Environment Waikato's Regional Ecological Monitoring of Streams (REMS) programme which covers over 120 sites throughout the region.

Flood disturbance - The occurrence of recent major floods can compromise the validity of bioassessments, particularly where quantitative data are used, as the results tend to reflect the effects of flow disturbance rather than the stressor being investigated. Guidelines for post-flood standown periods for biological sampling are currently being reviewed. As an interim guideline, Environment Waikato is currently using a minimum standown period of 2 weeks following a large flood that causes extensive mobilisation of the streambed.

3 Habitats

The decision on which habitats to sample for invertebrates will partly depend on the aims of the study. If qualitative characterisation of general reach conditions is desired for a particular site, then sampling available stable habitats in proportion to their abundance may be appropriate. Where quantitative measurements of invertebrate abundance are required or multiple sites that vary in habitat availability are being compared, it may be appropriate to focus on a particular habitat type (e.g., stony riffles, wood, macrophytes).

Stark *et al.* (2001) describe approaches for quantitative and semi-quantitative sampling of invertebrates in hard-bottomed streams where stony substrates are sampled, and in soft-bottomed streams where macrophytes and wood are sampled. **The distinction between stream types in those protocols is based on whether reaches have surficial cover by sand/silt or pumice which is greater than or equal to 50% (soft-bottomed) or less than 50% (hard-bottomed) of bed area.**

Our experience in the Waikato indicates that a substantial proportion of sites may have surficial sand/silt cover exceeding 50% but still have reasonable amounts of large gravel habitat where invertebrate production may be relatively high. This observation leads us to recommend that qualitative or semi-quantitative assessments of invertebrate faunas focus on productive, flowing water habitats which have stable substrates (see Figure 1). This definition encompasses runs or riffles in shallow streams dominated by stony substrates. In our experience, bedrock does not support a diverse array of invertebrates so we focus our sampling on stony substrates in hard-bottomed streams. In "soft-bottomed" streams, wood in particular and also macrophytes in flowing water provide the most stable and productive habitats, along with large gravels where they are abundant in run habitats.

Where general reach conditions are being characterised in soft-bottomed streams, sampling effort should be allocated in proportion to stable habitat abundance in flowing water. This approach generally involves avoiding pools and fine or unstable (e.g., pumice gravels) substrates unless these habitats are specifically required to meet study objectives (e.g., as part of a stratified sampling approach). Note, however, that avoidance of pools and fine/unstable substrates will under-represent some invertebrate taxa that occur mostly in these habitats (e.g., freshwater mussels).

When sampling multiple habitats it is important to record and report the relative proportions of habitat types sampled (see Field Assessment Cover Form).

Environment Waikato's REMS habitat assessment protocol is provided in Appendix 1 of this report. This includes a cover form for recording general physicochemical features and sampling effort, along with habitat forms for soft-bottomed (<50% sand/silt/unstable substrates and dominated by runs and pools) or hard-bottomed (≥50% stony substrates and dominated by runs and riffles) streams. We have found that the resulting habitat scores correlate quite well with several invertebrate community metrics and we recommend that this assessment is carried out at all sampling sites, along with measurement of any other habitat characteristics considered important. Reporting of habitat scores will help us place habitat quality of the site being investigated in the broader context of other sites in the Waikato Region.

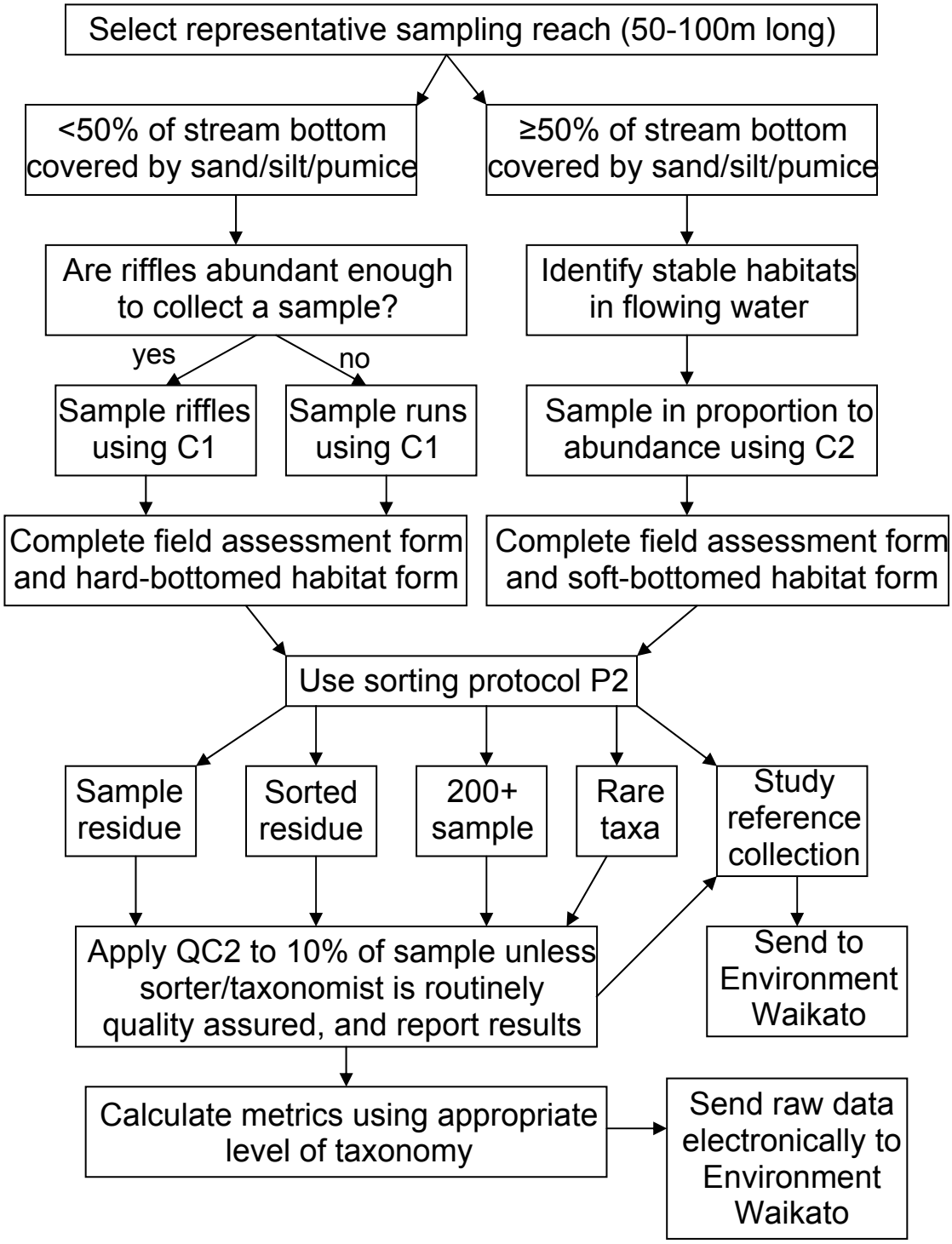


Figure 1: Flow chart describing the process for semi-quantitatively or qualitatively sampling wadeable streams, and processing samples.

4 Sample Collection

4.1 Quantitative sampling

For quantitative assessments of invertebrate abundance, we recommend that the Ministry for the Environment (MfE) protocols C3 (stony substrates) or C4 (macrophytes) are used as described by Stark *et al.* (2001) ***(available on***

http://www.smf.govt.nz/results/5103_protocols_manual.pdf). Note that these protocols require the use of 0.5 mm mesh nets; finer mesh nets can be used but samples should be thoroughly rinsed through a 0.5 mm mesh sieve to achieve consistency. We recognise that other quantitative invertebrate sampling methods exist and may be appropriate for certain studies.

4.2 Semi-quantitative or qualitative sampling (see Figure 1)

For semi-quantitative (where relative absolute abundances are to be compared) or qualitative (where percent abundance or presence/absence data are used) sampling of hard-bottomed streams we recommend MfE protocols C1 and C2 as outlined in Stark *et al.* (2001) and modified below (**see italics**). To maintain consistency with Environment Waikato's REMS protocol we prefer sampling in riffles when comparing among hard-bottomed sites (see below) where this does not compromise study objectives.

MfE Protocol C1 (additions or variations to MfE protocols indicated in italics**)**
Hard-bottomed Semi-quantitative/qualitative

Protocol:

1. Ensure the sampling net, sieve and bucket are clean *and no animals remain from previous samples.*
2. Select the appropriate habitat (e.g., riffles; we define riffles as areas of faster flow with broken water surface).
3. Sample beginning at the downstream end of the reach and proceed across and upstream.
4. Select an area of substrate (0.1-0.2m^2) to sample with a natural flow that will direct organisms into the net. Place the net on the streambed and step into the sampling area immediately upstream of the net, disturb the substrate under your feet by kicking to dislodge the upper layer of cobbles or gravel and to scrape the underlying bed. The area disturbed should extend no further than 0.5 metres upstream from the net. Remove the material from the net into the tray, bucket or sieve bucket if the net begins to get clogged.
5. Repeat Step 4 at several different locations within the reach and cover a variety of velocity regimes until a total area of 0.6-1.0m^2 of riffle habitat has been sampled. Transfer this material to a white tray or bucket approximately half full of water, or to a sieve bucket. Wash or pick all animals off the net. ***If this level of effort proves insufficient to obtain at least 200 animals, then the area sampled should be increased until sufficient animals are collected.***
6. Rinse and remove any unwanted large debris items (eg: large stones, sticks, leaves) that may not fit into the sample container or will absorb and diminish the effectiveness of the preservative.
7. Transfer the sample to the sample container via a 0.5mm sieve if a sieve bucket is not used. Inspect the sieve or sieve bucket and return any macroinvertebrates to the sample container.
8. Add preservative. Aim for a preservative concentration in the sample container of 70-80% (ie: allowing for the water already present). Be generous with preservative for samples containing plant material (leaves, sticks, macrophytes or moss) *and pumice substrates; to achieve the desired dilution, equal volumes of preservative and sample may be necessary.*
9. *Label the pottle with a permanent marker but also put a waterproof label with details marked in pencil inside the pottle.*
10. *Complete Field Assessment Cover Form and Habitat Assessment Field Data Sheet for Hard-bottomed Streams (see Appendix 1).*

Where stony riffles are not present or do not cover a large enough area, sampling of hard-bottomed streams may be carried out in stony runs (flowing water habitats intermediate between pools and riffles) (see Fig. 1). For soft-bottomed streams, we

recommend use of MfE protocol C2 with the inclusion of large gravel (32-64 mm across middle axis) where these are abundant (e.g., 20-50% of streambed area) in runs, as described below. Stable habitats should be sampled in proportion to their abundance, and the relative amount of effort used among habitat types should be reported (e.g., 20% stones, 50% wood, 10% banks, 20% macrophytes). **Pools, fine substrates and small pumice gravels should be avoided.**

MfE Protocol C2 (additions or variations indicated in italics**)**
Soft-bottomed. Semi-quantitative/qualitative

No one substrate type is suitable for macroinvertebrate collection from soft-bottomed streams. However, wood is particularly important and should be included in the sample whenever possible. The method for soft-bottomed streams outlined below recommends a single sample be collected from a fixed area of c. 3m^2 (10 replicates each of 0.3m^2) with different substrates (wood, gravels, macrophytes and bank margins) represented in proportion to their importance.

Protocol:

1. Ensure sampling net, sieve and bucket are clean and *no animals remain from previous samples.*
2. Sample a unit (0.3m^2) of wood, bank margins, *large gravels* or aquatic macrophytes using the following procedures. Avoid dragging the net along the bottom in mud or sand and avoid leaves and algae if possible.

Woody Debris: Select submerged and partially decayed woody debris (50-250mm diameter preferred). Place over the mouth of the bucket or sieve bucket. Pour water over the substrate while brushing the substrate gently by hand to remove organisms. Larger pieces may be sampled in situ by brushing the log while holding the net directly behind it. **A one metre section of woody debris is equivalent to a sample area of 0.3m^2.**

Bank Margins: Locate an area of bank with good structure and aggressively jab the net into the bank for *an appropriate distance (dependent on the width of the net mouth)* to dislodge organisms followed by 2-3 cleaning sweeps to collect organisms in the water column. ***A sample effort of 0.3m^2 is achieved by a 1 metre stretch for a net 0.3 m wide, or a 0.6 m stretch for a net 0.5 m wide.***

Macrophytes: Sweep the net through macrophyte beds *for an appropriate distance (dependent on the width of the net mouth and weed bed)* to dislodge invertebrates followed by 2-3 sweeps to collect organisms present in the water column. ***A sample effort of 0.3m^2 is achieved by a 1 metre stretch for a net and weed bed 0.3 m wide, or a 0.6 m stretch for a net and weed bed 0.5 m wide.***

Large gravels: Use a kicking movement to dislodge invertebrates among gavels > c.30 mm across. ***Two half-meter long kicks with a foot are roughly equivalent to 0.3 m^2 for a net 0.3 m wide, or two 0.3 m long kicks for a 0.5 m wide net.***

3. Repeat step 2 at 10 locations while moving progressively upstream. Remove sample material to a bucket or sieve bucket after each collection to avoid clogging the net. Select substrates to be sampled in proportion to their prevalence along a 50-100m reach of stream. Record the reach length and the proportion of the sample taken from each substrate type (eg: 50% wood, 25% banks, 25% macrophytes). After the 10th unit effort, wash or pick all animals off the net. The bucket or sieve bucket should now contain one entire sample comprising material dislodged from *the equivalent of* 3m^2 of substrate. ***If this level of effort proves insufficient to obtain at least 200 animals, then the area sampled should be increased until sufficient animals are collected.***

4. Fill the bucket with water and rinse and remove any unwanted large debris items (eg: sticks, leaves) that may not fit into the sample container or will absorb and diminish the effectiveness of the preservative.
5. Transfer the sample to the sample container via a 0.5mm sieve if a sieve bucket is not used. Two containers may be needed; each container should be no more than two-thirds full with sample material. Inspect the sieve or sieve bucket and return any macroinvertebrates to the sample container.

6. Add preservative. Aim for a preservative concentration in the sample container of 70-80% (ie: allowing for the water already present). Be generous with preservative for samples containing plant material (leaves, fine detritus, algae, moss, macrophytes) *and pumice substrates; to achieve the desired dilution equal volumes of preservative and sample may be necessary.*
7. *Label the pottle with permanent marker but also put a waterproof label with details marked in pencil inside the pottle.*
8. *Complete Field Assessment Cover Form and Habitat Assessment Field Data Sheet for Soft-bottomed Streams (see Appendix 1).*

As best practice to avoid inadvertent transfer of pest species (macrophyte fragments, fish eggs etc) when moving between streams or catchments, we recommend that nets are soaked in a concentrated saltwater solution (1 part salt to 14 parts water) for 2 hours or a bleach solution (>4% or >40 ml per litre). The bleach solution is fast acting and nets only need to be sprayed or dipped in this solution for it to be effective. However, the bleach solution will not remain effective for longer than a day.

5 Sample Processing and Quality Assurance

Stark *et al.* (2001) provide a range of options for sample processing. Where density data are required, entire samples (possibly with subsampling) need to be processed (see MfE protocol P3 with quality control protocol QC3).

Percent abundance data are suitable for calculation of most invertebrate metrics, and for this purpose we recommend the use of MfE protocol P2 (200 fixed count + scan for rare taxa) with quality control protocol QC2, as described below. A scan for rare taxa in combination with fixed-count assessments allows comparison of taxa lists generated by coded abundance and full count methods.

MfE Protocol P2 (additions or variations indicated in italics)

200 Individual Fixed Count with Scan for Rare Taxa

Protocol:

1. Thoroughly rinse sample in a clean 0.5mm sieve to remove preservative and fine sediment. Large organic material (whole leaves, twigs, algal or macrophyte mats, etc.) not removed in the field should be rinsed, visually inspected for organisms and discarded. Gently mix the sample by hand while rinsing, and continue until wash water runs clear and the sample is thoroughly homogenised (ie: break down lumps of algae etc.) A coarse sieve (eg: 4mm) can be helpful for removing larger pieces of unwanted organic material so long as all macroinvertebrates are picked out and placed into the 0.5mm sieve.
2. After washing, transfer contents of the sieve to a white sorting tray marked with grids approximately 6cm x 6cm (use black indelible marker). Visually check sieve before washing in prepartation for next sample. Using the wash bottle spread the sample evenly across the tray. There should be enough water to just cover all material. If the samples have been preserved in alcohold some organisms (particularly ostracods and early instart insects) may float on the surface. If this occurs add a drop of washing detergent and stir gently. *This may be better done when the sample is "dry" (i.e., directly from the sieve to ensure more even spread of heavier animals. If the sample is too large then you may wish to consider subsampling for the 200-count (although the whole sample should be assessed for rare taxa). One approach is to evenly spread the "dry" material across a tray and then remove material from randomly*

selected squares so that an appropriate subsample is obtained (e.g., one quarter, one sixteenth).

3. Use a random numbers table to select a starting grid square within the tray. Moving systematically across the square remove all organisms visible to the naked eye. Place captured organisms in a separate labelled vial counting each individual. When complete do a final check of the square's contents to ensure no animals have been missed.
4. Any organism that is lying over a line separating two grids is considered to be in the square containing its head. *If the head is on the line it should be included.* In those instances where it may not be possible to determine the location of the head (worms for instance), the organism is considered to be in the square containing most of its body.
5. After all visible organisms have been removed, transfer any remaining detritus to a container labelled as "sorted residue". Include location and date information. Add preservative. This provides material for sorting QA/QC procedures.
6. If a total of at least 200 organisms has been obtained, sample sorting ceases. However, if less than 200 organisms have been obtained, place another cookie cutter on a second randomly chosen square. Continue this process until at least 200 animals have been obtained.
7. Once a square has been started it should be finished even if the 200 individual total is exceeded. The total number of grid squares covered should be noted. Along with the total individual count.
8. Save the remaining unsorted sample debris residue in a separate container labelled "sample residue"; this container should include the original sample label. Add preservative.
9. The "sample residue" and vial containing the 200 individuals must be sorted by an experienced taxonomist. Pour the 200-individual sample into a Petri-dish or Bogorov tray and observe under a binocular microscope. Compile a taxa list and count the numbers of each taxon. *Taxonomic identification should be at least to the level indicated in Appendix 2 (based on Appendix B of Stark et al. 2001) (see below for guidance on what to do with "indeterminate" taxa).*
10. Return the 200 individuals to a labelled vial and add preservative. The sample will be used for taxonomic QA/QC purposes.
11. Identification should not include aerial adult insects, pupae, terrestrial invertebrates, empty snail shells, caddisfly cases or exuviae. Examination of pupae can, however, assist greatly with larval identifications.
12. Complete the taxa list by scanning the "sample residue" for rare taxa. This is carried out with the sample spread in white sorting trays. Any rare taxa obtained should be placed in a labelled vial with preservative. This is also an opportunity to remove larger or better-conditioned individuals of taxa already encountered to assist in identification.
13. The vial containing the 200 individuals, and the vial containing rare taxa should be taped together. Record the taxa found in the scan for rare taxa separately from the 200 fixed count data.
14. Return the "sample residue" to its container with the original labels.
15. On completion of sample processing there should be: (1) A labelled container holding the sample residue (already scanned for rare taxa); (2) A labelled container holding the sorted residue (required for QC procedures to assess sorting efficiency); (3) a labelled vial containing the 200+ individuals; and (4) a labelled vial containing the rare taxa (not included in the 200+ sample) removed from the sample residue.

What to do with indeterminate taxa?

In some instances, invertebrates will be too small or too damaged to confidently allocate them to one of the taxonomic groups indicated in Appendix 2. In this case they should be recorded at the appropriate level of taxonomy as "indeterminate" (e.g., Leptophlebiidae indet.). If there is a good case for placing indeterminate individuals in a lower taxonomic group based on other information (e.g., small Leptophlebiidae indet.

were allocated to *Deleatidium* because the sample was dominated by this genus and/or patterning was similar), then the number allocated and the basis for this decision needs to be reported. Such decisions should only be made by an experienced taxonomist or after consultation with one.

Chironomidae often pose a problem for inexperienced taxonomists and several levels of identification are provided in Appendix B of Stark *et al.* (2001). This has been simplified to some extent in Appendix 2 of this report. The minimum level of resolution for this group is sub-family for Orthocladiinae, Podonominae, and Tanypodinae, and lower for Diamesinae (*Maoridiamesa*, *Lobodiamesa* and Diamesinae indet. where larvae are not one of the preceding genera or are too small to identify), and Chironominae (Tanytarsini, *Paucispinigera*, *Cryptochironomus*, *Harrisius*, *Polypedilum*, *Chironomus*, and Chironominae indet.).

Oligochaeta need not resolved beyond Class but it is useful to report whether samples were dominated by Tubificidae, and whether the possibly introduced *Lumbriculus variegatus* was present.

MfE Protocol QC2 (additions or variations indicated in italics)

Quality Control for Fixed Count

Protocol:

1. Ten percent of the sorted samples *should* be re-examined by another sorter *unless the processing and identification is carried out by someone who is routinely quality assured*. *The samples selected for QC should represent the range of habitat types sampled*. The second sorter must be familiar with the sorting procedures and also familiar with the full range of macroinvertebrate taxa from running waters in New Zealand. They will also be provided with the results from the first sorter.
2. The fixed count protocol requires examination of the sample residue for additional rare taxa and the sorted residue for additional unrecorded individuals. A check on the taxonomic efficiency of both the 200+ subsample and the vial of rare taxa is also required.
3. *A reference collection of representatives of each taxon (including pupae retained but not counted) identified is also desirable for each study for additional QC purposes. The reference collection should be submitted to Environment Waikato in case future verification is required. Samples should be stored in 70% ethanol and labelled indicating site number/name, collection date, easting/northing, and collector.*
4. Taxonomic accuracy
   On average, the number of taxa that are identified as different taxa, in either the full 200+ individual vial, or the rare taxa vial, between the two taxonomists must be <10% of the total taxa recorded from the sample. For example, a sample with 31 taxa passes QC when no more than 3 taxa are identified differently between the two taxonomists. If the correct taxonomic identification of an organism is disputed, then a specimen should be checked by an agreed expert.
   Sorting accuracy 1 (missed taxa)
   If an average >10% new species are found in the sample residue then the scan for rare taxa is deemed to have failed and a further 10% of samples are to be rechecked. If the criterion is still not met than all samples *should* be re-processed.
5. Sorting accuracy 2 (missed individuals)
   If an average >10% more organisms are found in the sorted residue then a further 10% of samples are to be re-checked. If the criterion is still not met then all samples *should* be re-processed.
6. Trainee sorters should have at least 50% of samples re-checked for QC and can be considered competent sorters when <10% of checked samples are returning <10% new taxa, or <10% re-codes than the first sort.

7. After a sample has been completely sorted all sieves, trays and equipment should be thoroughly cleaned and picked free of organisms and debris before the next sample is begun.

A taxonomic list for identification purposes is provided in Appendix 2. An electronic spreadsheet in the correct format is available on request to Environment Waikato (email kevin.collier@ew.govt.nz or johlene.kelly@ew.govt.nz). ***It is imperative that any new species found are added to the bottom of the spreadsheet and not within the existing list. Environment Waikato's database is aligned with this identification sheet and any movement of data causes problems with data transfer***

Invertebrate metrics (see below) should be calculated only from data at this level of identification (Appendix 2) as variable taxonomic levels can influence metric values and hinder comparisons among studies. Organisations are expected to have their own systems in place for checking data entry (these systems should be described in the methods section of reports).

6 Reporting

Site descriptions should provide a map of the location and photos of sampling sites, along with the GPS easting and northing co-ordinates (transverse Mercator) of each site. Methods should clearly state the invertebrate collection method or MfE protocol used, including net mesh size, area or volume sampled if applicable, proportions of habitats sampled, sorting method, number counted or fraction subsampled, and QC methods adopted.

A range of invertebrate community metrics are available. We request that the following metrics should be among those reported (note that these should be calculated based only on the level of taxonomic resolution indicated in Appendix 2).

- Total taxa richness
- EPT (Ephemeroptera, Plecoptera, Trichoptera) richness (excluding *Oxyethira* and *Paroxyethira*)
- %EPT (excluding *Oxyethira* and *Paroxyethira*) (i.e., number of EPT / total number x 100)
- % dominant taxon (i.e., number of dominant taxon / total number x 100)
- Macroinvertebrate Community Index (where appropriate; see below)

When calculating MCI scores, use only the MCI tolerance scores indicated in Appendix 2***. Do not change scores or include additional scores for taxa not listed***. Where scores are not available, the taxon should be left out of MCI calculations.

It is important to note that the MCI was originally developed to indicate the tolerance of communities to organic pollution in stony streams. Caution needs to be exercised when interpreting this index for other types of disturbance and other habitat types.

Complete taxonomic lists for each site should be provided in appendices of reports and electronic copies submitted in the appropriate format to Environment Waikato's regional macroinvertebrate database (email kevin.collier@ew.govt.nz or johlene.kelly@ew.govt.nz).

Scores for each habitat field along with total scores at each site should also be included as an Appendix in the report.

7 References

Boothroyd, I.; Stark, J. 2000. Use of invertebrates in monitoring. In: (Collier, K.J.; Winterbourn, M.J. eds.) New Zealand stream invertebrates: ecology and implications for management. New Zealand Limnological Society, Christchurch. Pp. 344-373.

Stark, J.D.; Boothroyd, I.K.G.; Harding, J.S.; Maxted, J.R.; Scarsbrook, M.R. 2001. Protocols for sampling macroinvertebrates in wadeable streams. NZ Macroinvertebrate Working Group report no. 1. Ministry for the Environment, Wellington.

Appendix 1 Qualitative Habitat Assessment Procedure

At each site, two data sheets are completed – a Field Assessment Cover Form and a Habitat Assessment Field Data Sheet. Soft-bottomed and hard-bottomed sites are assessed using the same Field Assessment Cover Form but different Habitat Assessment Field Data Sheet.

The habitat assessment is a composite of landscape characteristics and biotic variables, which use different scales when evaluating the stream. Zeros are not used to avoid statistical averaging problems. The method is derived from the revised versions of the USEPA Rapid Bioassessment Protocol. These have been subsequently modified to reflect local stream conditions. When assessing stream habitat the observer selects a 100 metre or more length of stream then estimates the condition of each characteristic over the entire length. It may be necessary to walk beyond the length of the reach to ascertain how 'typical' it is of the immediate catchment. All characteristics are determined by direct observation. The procedure for scoring a site's habitat quality requires that all characteristics are evaluated and entered on a score sheet.

1.1 Field Assessment Cover Form

A Field Assessment Cover Form is to be filled out for every site. Here watershed and instream characteristics are generically described, along with important sampling information. The objective of these data is to detail the general nature of the stream and also to provide some context for the subsequent numerical scoring in the relevant Habitat Assessment Field Data Sheet. These forms should be completed after collecting the macroinvertebrate sample as the field operator will have a more complete feel for the reach conditions.

The Field Assessment Cover Form comments field should include any relevant comments on stream conditions that might help further explain the categorical classifications and/or numerical scoring, or provide evidence of change which may be reflected in the sample.

The types of habitat and percentages sampled are recorded in this form. Compaction refers to how easy it is to move the substrate and generally assessed using your foot. Bedrock or cobbles/boulders that are very hard to turn over will generally be considered "tightly packed or overlapping" whereas fine sediment or very loose gravels will be considered to have "no packing/loose assortment". Embededness reflects the degree to which sand/silt cover larger substrate particles; soft-bottomed streams will by default occur in one of the two bottom categories (i.e., ≥50% sand/silt). The index for algal cover is a qualitative assessment of stable substrates based on touch for none-slippery, or visual assessment for obvious (periphyton growths visible), abundant (filamentous growths evident), and excessive (>80% filamentous algae cover).

Note that if a site is rated as "highly turbid" then assessments of detritus and fine organic matter are probably not possible, but inorganic substrate composition should still be assessed based on touch if possible. Note that fine organic matter does not include iron floc.

1.2 Habitat Assessment Field Data Sheet

The Habitat Assessment Field Data Sheet which is selected (hard- or soft-bottomed) will reflect the type of sampling which has been undertaken according to protocols outlined in Section 4 of this document.

The following descriptions relate to the interpretation and ranking of each question within the Habitat Filed Data Sheets.

Question 1: Riparian Vegetative Zone Width (hard- and soft-bottomed)
Assesses the extent of natural vegetation from the edge of the stream bank out through the riparian zone. The vegetative zone serves as a buffer to pollutants entering a stream from runoff, controls erosion, and provides habitat and organic matter input into the stream. A relatively undisturbed riparian zone supports a robust stream system; narrow riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the stream bank. Residential developments, urban centers, and inappropriate farming practices are the common causes of anthropogenic degradation of the riparian zone.

Question 2: Vegetative Protection (hard- and soft-bottomed)
Evaluates the amount and type of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone. The root systems of plants growing on stream banks help hold soil in place, thereby reducing the amount of erosion that is likely to occur. This parameter supplies information on the ability of the bank to resist erosion as well as some additional information on the uptake of nutrients by the plants, the control of instream scouring, and stream shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or riprap. This parameter is made more effective by defining the type of natural vegetation (i.e., shrubs, trees, etc.). In areas of high grazing pressure from livestock or where residential and urban development activities disrupt the riparian zone, the growth of a natural plant community is impeded and can extend to the bank vegetative protection zone.

Question 3: Bank Stability (hard- and soft-bottomed)
Assesses whether the stream banks are eroded (or have the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks, and are therefore considered to be unstable. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of sediment movement and deposition, and suggest a scarcity of cover and organic input to streams.

Question 4: Frequency of Riffles or Bends (hard-bottomed) or Channel Sinuosity (soft-bottomed)
This provides a way to measure the sequence of riffles and thus the heterogeneity occurring in a hard-bottomed stream. Riffles are a source of high-quality habitat and diverse fauna, therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community. For areas where distinct riffles are uncommon (often in soft-bottomed streams), a run/bend ratio can be used as a measure of meandering or sinuosity. A high degree of sinuosity can provide diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding and provides refugia for benthic invertebrates and fish during storm events. To gain an appreciation of this parameter in some streams, a longer segment or reach than that designated for sampling may be incorporated into the evaluation. In some situations, this parameter may be rated from viewing accurate topographical maps or GIS.

Question 5: Channel alteration (hard- and soft-bottomed)

Is a measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened, or diverted into concrete channels, often for flood control or irrigation purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Channel alteration is present when artificial embankments, riprap, and other forms of artificial bank stabilisation or structures are present, when the stream is very straight for significant distances, when dams and bridges are present, and when other such changes have occurred. Scouring is often associated with channel alteration.

Question 6: Sediment Deposition (hard- and soft-bottomed)
Measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. Deposition occurs from large-scale movement of sediment. Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals, or result in the filling of runs and pools. Usually deposition is evident in areas that are obstructed by natural or manmade debris and areas where the stream flow decreases, such as bends. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms.

Question 7: Velocity/Depth Regimes (hard-bottomed) or Pool Variability (soft-bottomed)
Patterns of velocity and depth are included for hard-bottomed streams under this parameter as an important feature of habitat diversity. The most diverse hard-bottomed streams will have all four patterns present: (1) slow-deep, (2) slow-shallow, (3) fast-deep, and (4) fast-shallow. The general guidelines are 0.5 m depth to separate shallow from deep, and 0.3 m/sec to separate fast from slow. The occurrence of these four patterns relates to the stream's ability to provide and maintain a stable aquatic environment.

Pool variability rates the overall mixture of pool types generally found in soft-bottomed streams, according to size and depth. The four basic types of pools are large-shallow, large-deep, small-shallow, and small-deep. A stream with many pool types will support a wide variety of aquatic species. Rivers with low sinuosity (few bends) and monotonous pool characteristics do not have sufficient quantities and types of habitat to support a diverse aquatic community. General guidelines are any pool dimension (i.e., length, width, oblique) greater than half the cross-section of the stream for separating large from small, and 1 m depth separating shallow and deep.

Question 8: Abundance and Diversity of Habitat (hard- and soft-bottomed)
Includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. A wide variety and/or abundance of submerged structures in the stream provides macroinvertebrates and fish with a large number of niches, thus increasing habitat diversity. As variety and abundance of cover decreases, habitat structure becomes monotonous, diversity decreases, and the potential for recovery following disturbance decreases. Riffles and runs are critical for maintaining a variety and abundance of insects in most hard-bottomed streams and serving as spawning and feeding refugia for certain fish. The extent and quality of the riffle is an important factor in the support of a healthy biological condition in hard-bottomed streams with adequate channel gradients. Riffles and runs offer a diversity of habitat through variety of particle size, and, in many small hard-bottomed streams, will provide the most stable habitat. Snags and submerged logs are among the most productive habitat structure for macroinvertebrate colonisation and fish refugia in soft-bottomed streams.

Question 9: Periphyton Growth

Check for the presence or absence of periphyton growth on the stream/river bed. When wading, pick up a variety of stones and/or large rocks and observe if any algal growth is present. Algae may be in the form of an obvious slimly matt or filamentous growth (often green, sometimes brown or black) on the surface of the rock or as a non-visible thin algal film which still has the 'slippery-slime' feel. If the river is too deep to retrieve stones and visibility is poor then the 'feel' of the rocks on the feet of waders is often a good indication of algal growth. Generally, rivers/streams with a high % of substrate fines i.e. clays/silts have little to no periphyton growth, but because they are not considered to have stable substrates these sites score in the "marginal" range of scores.

Field Assessment Cover Form

Wadeable Hard-Bottomed and Soft-Bottomed Streams

STREAM NAME:		ASSESSOR:	
SITE NUMBER:	**SAMPLE NUMBER:**	**DATE:**	**TIME (NZST):**

GPS COORDINATES: **Downstream end of reach - Easting –** **Northing –**
Upstream end of reach - Easting – **Northing –**

CHANNEL AND RIPARIAN FEATURES

Canopy Cover:

❍ Open ❍ Partly shaded ❍ Significantly shaded

Fencing:

❍ None or ineffective
❍ One side or partial
❍ Complete both sides

Dominant Riparian Vegetation:

❍ Crops etc ❍ Retired vege.
❍ Pasture ❍ Native shrub
❍ Exotic trees ❍ Native trees

INSTREAM HYDRAULIC CONDITIONS

Estimated or measured reach average:

Stream width (active channel) _____ m
Stream width (water) _____ m
Stream depth _____ m
Surface velocity _____ m/sec

WATER QUALITY

Temperature: _____ °C Conductivity: _____ µS/cm @ 25°C
Dissolved Oxygen: _____ % _____ mg/L
Turbidity: ❍ Clear ❍ Slightly turbid ❍ Highly turbid ❍ Stained ❍ Other_____

STREAM-BOTTOM SUBSTRATA

Compaction (inorganic substrata)**:**
❍ assorted sizes tightly packed &/or overlapping
❍ moderately packed with some overlap
❍ mostly a loose assortment with little overlap
❍ no packing / loose assortment easily moved.

Embeddedness:
(% gravel-boulder particles covered by fine sediment)
❍<5% ❍5-25% ❍26-50% ❍51-75% ❍>75%

ORGANIC MATERIAL (% cover)
Large wood (>10 cm diameter):
❍<5% ❍5-25% ❍26-50% ❍51-75% ❍>75%
Coarse Detritus (small wood, sticks, leaves etc >1 mm):
❍<5% ❍5-25% ❍26-50% ❍51-75% ❍>75%
Fine (**<1 mm) Organic Deposits** (edges and backwaters):
❍<5% ❍5-25% ❍26-50% ❍51-75% ❍>75%

% surficial inorganic substratum size composition (should sum to 100%)

Substratum type	Dimension (middle axis)	Percentage
Bedrock	-	
Boulder	> 256mm	
Cobble	>64-256mm	
Gravel	>2-64mm	
Sand	>0.06-2mm	
Silt	0.004-0.06mm	
Clay	<0.004mm	

INSTREAM PLANT COVER (% of streambed area)
Filamentous Algae (>2mm long) & Mats (>3 mm thick):
❍<5% ❍5-25% ❍26-50% ❍51-75% ❍>75%
Macrophytes:
❍<5% ❍5-25% ❍26-50% ❍51-75% ❍>75%
Mosses/Liverworts:
❍<5% ❍5-25% ❍26-50% ❍51-75% ❍>75%

HABITAT TYPES SAMPLED (% of effort; each column should sum to 100%)

Stones: _____%
Wood: _____%
Macrophytes: _____%
Edges: _____%
Riffles: _____%
Runs: _____%

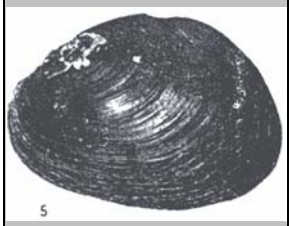
COMMENTS

NO. INVERTEBRATES RETURNED:

Koura: _____ Shrimps: _____
Crabs: _____ Mussels: _____
Others (specify) _____

Species of mussel (tick)

Hyridella



Shell smooth; up to 100mm long; variable shell shape

Cucumerunio

Nodules and ridges on upper part of shell; up to 90mm long

Wadeable Hard-Bottomed Streams

Qualitative Habitat Assessment Field Data Sheet

STREAM NAME:		**SITE NUMBER:**
SAMPLE NUMBER:	**ASSESSOR:**	**DATE:**

Habitat Parameter	**Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Riparian Vegetative Zone Width (score each bank; determine left or right side by facing downstream)	• Bankside vegetation buffer is >10m • Continuous and dense	• Bankside vegetation buffer is <10m • Mostly continuous	• Pathways present and/or stock access to stream • Mostly healed over	• Breaks frequent • Human activity obvious
Left bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB&RB_____				
2. Vegetative Protection (score each bank; determine left or right side by facing downstream	• Bank surfaces and immediate riparian zones covered by native vegetation • Trees, understorey shrubs, or non-woody plants present • Vegetative disruption minimal	• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry	• Bank surfaces covered by a mixture of grasses/shrubs, blackberry, willow and introduced trees • Vegetation disruption obvious • Bare soil/closely cropped vegetation common	• Bank surfaces covered by grasses and shrubs • Disruption of streambank vegetation very high • Grass heavily grazed • Significant stock damage to the bank
Left bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB&RB_____				
3. Bank Stability (score each bank; determine left of right side by facing downstream	• Banks stable • Erosion/bank failure absent or minimal • <5% of bank affected	• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded	• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods	• Unstable • Many eroded areas • 60-100% of bank has erosional scars
Left bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB&RB_____				
4. **Frequency of Riffles**	• Riffles relatively frequent • Distance between riffles divided by width of stream = 5-7 • Variety of habitat is key	• Occurrence of riffles infrequent • Distance between riffles divided by width of stream = 7-15	• Occassional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by width of stream = 15-25	• Generally flat water, shallow riffles • Poor habitat • Distance between riffles divided by width of stream = >25
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

SUBTOTAL : _____

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
5. Channel Alteration	• Changes to channel/dredging absent or minimal • Stream with normal pattern	• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present	• Channel changes/dredging extensive • Embankments or shoring structures present on both banks • 40 to 80% of reach channelised and disrupted	• Banks shored with gabion or cement • >80% of the stream reach channelised and disrupted. • Instream habitat altered or absent
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Deposition (out of channel and in channel)	• Little/no islands or point bars present • <20% of the bottom affected by sediment deposition	• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of the bottom affected • Slight deposition in pools	• Some deposition of new gravel, sand or fine sediment on old and new bars • 50-80% of the bottom affected • Sediment deposits at obstructions, constrictions, and bends	• Heavy deposits of fine material • Increased bar development • >80% of the bottom changing frequently • Pools almost absent due to sediment deposition
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Veloctity/Depth Regimes	• 4 velocity/depth regimes present • Slow/deep, Slow/shallow, Fast/shallow, Fast/deep	• 3 of 4 velocity/depth regimes present • If fast/shallow is missing then score lower	• 2 of 4 velocity/depth regimes present • If fast/shallow or slow/shallow are missing score low	• Dominated by 1 velocity/depth regime • Usually slow/deep
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Abundance and Diversity of Habitat	• >50% substrate favourable for invertebrate colonisation and wide variety of woody debris, riffles, root mats • Snags/ submerged logs/ undercut banks/ cobbles provides abundant fish cover • Must not be new or transient	• 30-50% substrate favourable for invertebrate colonisation • Snags/submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material	• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment	• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
10. Periphyton	• Periphyton not visible on hand held stones • Stable substrate • Surfaces rough to touch	• Periphyton not visible on stones • Stable substrate • Periphyton obvious to touch	• Periphyton visible • <20% cover of available substrate	• Periphyton obvious and prolific • >20% cover of available substrate
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Total Score ____	NB: Use only means of LB and RB values			

Wadeable Soft-Bottomed Streams

Qualitative Habitat Assessment Field Data Sheet

STREAM NAME:	**SITE NUMBER:**
SAMPLE NUMBER: **ASSESSOR:**	**DATE:**

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Riparian Vegetative Zone Width (score each bank; determine left or right side by facing downstream)	• Bankside vegetation buffer is >10m • Continuous and dense	• Bankside vegetation buffer is <10m • Mostly continuous	• Pathways present and/or stock access to stream • Mostly healed over	• Breaks frequent • Human activity obvious
Left bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB&RB_____				
2. Vegetative Protection (score each bank; determine left or right side by facing downstream)	• Bank surfaces and immediate riparian zones covered by native vegetation • Trees, understorey shrubs, or non-woody plants present • Vegetative disruption minimal	• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry	• Bank surfaces covered by a mixture of grasses/shrubs, blackberry, willow and introduced trees • Vegetation disruption obvious • Bare soil/closely cropped vegetation common	• Bank surfaces covered by grasses and shrubs • Disruption of streambank vegetation very high • Grass heavily grazed • Significant stock damage to the bank
Left bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB&RB_____				
3. Bank Stability (score each bank; determine left of right side by facing downstream	• Banks stable • Erosion/bank failure absent or minimal • <5% of bank affected	• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5-30% of bank eroded	• Moderately unstable • 30-60% of bank in reach has areas of erosion • High erosion potential during floods	• Unstable • Many eroded areas • 60-100% of bank has erosional scars
Left bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right bank	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB&RB_____				
4. **Channel sinuousity**	• Bends increase stream length 3-4 times longer than if it was in a straight line	• Bends increase the stream length 2-3 times longer than if it was in a straight line	• Bends increase the stream length 1-2 times longer than if it was in a straight line	• Channel straight
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

SUBTOTAL : _____

Soft bottomed continued

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
5. Channel Alteration	• Changes to channel/dredging absent or minimal • Stream with normal pattern	• Some changes to channel/dredging • Evidence of past channel/dredging • Recent channel/dredging not present	• Channel changes/dredging extensive • Embankments or shoring structures present on both banks • 40 to 80% of reach channelised and disrupted	• Banks shored with gabion or cement • >80% of the stream reach channelised and disrupted. • Instream habitat altered or absent
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Deposition	• Little/no islands or point bars present • <20% of the bottom affected by sediment deposition	• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of the bottom affected; • Slight deposition in pools	• Some deposition of new gravel, sand or fine sediment on old and new bars • 50-80% of the bottom affected • Sediment deposits at obstructions, constrictions, and bends	• Heavy deposits of fine material • Increased bar development • >80% of the bottom changing frequently • Pools almost absent due to sediment deposition
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Pool Variability	• Pools evenly mixed • Large/shallow, Large/deep, Small/shallow, Small/deep	• Majority of pools large/deep • Very few shallow pools	• Prevalence shallow pools	• Majority of pools small/shallow
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Abundance and Diversity of Habitat	• >50% substrate favourable for invertebrate colonisation and wide variety of woody debris, riffles, root mats • Snags/ submerged logs/ undercut banks/ cobbles provides abundant fish cover • Must not be new or transient	• 30-50% substrate favourable for invertebrate colonisation • Snags/submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material	• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved by foot • Woody debris rare or may be smothered by sediment	• <10% substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or limited to macrophytes
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Periphyton	• Periphyton not evident on hand held substrates (macrophytes, wood etc) or fine sediments	• Periphyton not visible on substrates but obvious to touch	• Periphyton visible • <20% cover of available substrates	• Periphyton obvious and prolific • >20% cover of available substrates
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Total Score ____	NB: Use only means of LB and RB values			

Appendix 2 Minimum level of taxonomic resolution required for calculation of macroinvertebrate metrics in streams and rivers.

Site:		Date:	
Easting:		Sampling protocol:	
Northing:		Net mesh size:	
NAME	No.	MCI tolerance score	Comments
EPHEMEROPTERA (Mayflies)		-	
Acanthophlebia		7	
Ameletopsis		10	
Arachnocolus		8	
Atalophlebioides		9	
Austroclima		9	
Austronella		-	
Coloburiscus		9	
Deleatidium		8	
Icthybotus		8	
Isothraulus		8	
Mauiulus		5	
Neozephlebia		7	
Nesamaletus		9	
Oniscigaster		10	
Rallidens		9	
Siphlaenigma		9	
Tepakia		-	
Zephlebia		7	
PLECOPTERA (Stoneflies)		-	
Acroperla		5	
Austroperla		9	
Cristoperla		8	
Halticoperla		8	
Megaleptoperla		9	
Notonemoura		-	
Spaniocera		8	
Spaniocercoides		8	
Stenoperla		10	
Zelandobius		5	
Zelandoperla		10	
TRICOPTERA (Caddisflies)		-	
Alloecentrella		9	
Aoteapsyche		4	
Beraeoptera		8	
Confluens		5	
Costachorema		7	
Economidae/*Zelandoptila*		8	
Edpercivalia		9	
Helicopsyche		10	
Hudsonema		6	

Hydrobiosella		9	
Hydrobiosis		5	
Hydrochorema		9	
Neurochorema		6	
Oecetis		-	
Oeconesidae		9	
Olinga		9	
Orthopsyche		9	
Oxyethira		2	
Paroxyethira		2	
Philorheithrus		8	
Plectrocnemia		8	
Polyplectropus		8	
Psilochorema		8	
Pycnocentrella		9	
Pycnocentria		7	
Pycnocentrodes		5	
Tiphobiosis		6	
Triplectides		5	
Triplectidina		5	
Zelolessica		10	
HEMIPTERA (Waterbugs)		-	
Anisops		5	
Diaprepocoris		5	
Hydrometra		-	
Mesoveliidae		-	
Microvelia		5	
Sigara		5	
COLEOPTERA (Beetles)		-	
Curclionidae		-	
Dytiscidae - *Antiporus*		5	
Dytiscidae - *Liodessus*		5	
Dytiscidae - *Rhantus*		5	
Dytiscidae - Other		5	
Elmidae		6	
Hydraenidae		8	
Hydrophilidae - *Berosus*		5	
Hydrophilidae - Other		5	
Ptilodactlidae		8	
Staphylinidae		5	
Scirtidae		8	
DIPTERA (Two-winged flies)		-	
Aphrophila		5	
Austrosimulium		3	
Ceratopogonidae		3	
Chironomidae - Chironominae - *Chironomus*		1	
Chironomidae - Chironominae - *Cryptochironomus*		3	
Chironomidae - Chironominae - *Harrisius*		6	
Chironomidae - Chironominae - *Paucispingera*		6	
Chironomidae - Chironominae - *Polypedilum*		3	
Chironomidae - Chironominae - Tanytarsini		3	
Chironomidae - Chironominae indeterminate		-	
Chironomidae - Diamesinae - *Lobodiamesa*		5	
Chironomidae - Diamesinae - *Maoridiamesa*		3	
Chironomidae - Diamesinae indeterminate		-	
Chironomidae - Orthocladiinae		2	

Chironomidae - Podonominae		8	
Chironomidae - Tanypodinae		5	
Chironomidae indeterminate		-	
Culex		3	
Empididae		3	
Ephydridae		4	
Eriopterini		9	
Hexatomini		5	
Limonia		6	
Molophilus		5	
Muscidae		3	
Neocurupira		7	
Neoscatella		7	
Nothodixa		5	
Paradixa		4	
Paralimnophila		6	
Pelecorhynchidae*		9	
Peritheates		7	
Psychodidae		1	
Sciomyzidae		3	
Stratiomyidae		5	
Syrphidae*		1	
Tabanidae		3	
Tanyderidae		4	
Thaumaleidae		9	
Zelandotipula		6	
ODONATA (Damselflies & dragonflies)		-	
Aeshna		5	
Antipodochlora		6	
Austrolestes		6	
Diplacodes		-	
Hemicordulia		5	
Ischnura		-	
Procordulia		6	
Xanthocnemis		5	
MEGALOPTERA (Dobsonfly)		-	
Archichauliodes		7	
NEUROPTERA (Lacewing)		-	
Kempynus		5	
LEPIDOPTERA (Moth)		-	
Hygraula		4	
MOLLUSCA (Snails, mussels and clams)		-	
Cucumerunio		-	
Ferrisia (Gundlachia)		3	
Glyptophysa (Physastra)		5	
Gyraulus		3	
Hyridella		3	
Latia		3	
*Lymnaea (Austropeplea/Pseudosuccinea)**		3	
Melanopsis		3	
*Physella (Physa)**		3	
Planorbidae		-	
Potamopyrgus		4	
Sphaerium		3	
CRUSTACEA		-	
Amarinus (*Helicarcinus*)		-	

Amphipoda		5	
Cladocera		5	
Copepoda		5	
Isopoda		5	
Mysidae		-	
Ostracoda		3	
Paranephrops		5	
Paratya		5	
Tanaidacea		4	
ARACHNIDA		-	
Acarina (Mites)		5	
OLIGOCHAETA (Worms)		1	
PLATYHELMINTHES (Flatworms)		3	
HIRUDINEA (Leeches)		3	
NEMERTEA (Proboscis worms)		3	
NEMATODA (Nematode worms)		3	
NEMATOMORPHA (Horse hair worms)		3	
BRYOZOA (Sponges)		-	
COELENTERATA (Hydroids)		3	
COLLEMBOLA (Springtails)		6	

* = probably an alien species

NOTES: