Environmental Monitoring Strategy: Year One Auckland Central Streams Results

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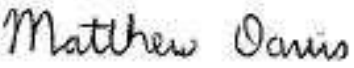
 Name: Judy-Ann Ansen Position: Stormwater Technical Services Manager Organisation: Auckland Council Date: 25 June 2012	 Name: Matthew Davis Position: Development and Technical Services Manager Organisation: Auckland Council Date: 25 June 2012

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Environmental Monitoring Strategy: Year One Auckland Central Streams Results

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Contents

Glossary

ACC	Auckland City Council
ARC	Auckland Regional Council
CI	Central Inteceptor
CSO	Combined Sewer Overflow
EFM	Electric Fishing Machine
SEV	Stream Ecological Valuation
TLB	True Left Bank
TRB	True Right Bank
WMP	Watercourse Management Plan

1.0 Executive Summary

Auckland Council is statutorily responsible for the maintenance of the Auckland Central's public watercourses which prior to the formation of the new Council was managed by Metrowater on behalf of Auckland City Council. Metrowater and Auckland City Council were involved in a joint network resource consent project to obtain Auckland Regional Council (ARC) consent to authorise the operation of Auckland's drainage network.

As part of the network consent applications Metrowater developed a Receiving Environment Monitoring Strategy. Since transition in November 2010, Morphum Environmental has been engaged by the Council to continue this project with a modified scope that considers Watercare's Central Interceptor Project. This project has the potential to affect the streams that are within the project zone of influence. The study streams include Meola Creek, Motions Creek, Oakley Creek, Edgars Creek and Cox's Creek. These waterways have been selected for year one of a longer term monitoring programme.

Twelve sites were selected from the targeted streams to carry out ecological monitoring. The Stream Ecological Valuation (SEVs) method was the selected method for assessment chosen after discussion and agreement with Auckland Council. This method includes fish survey and macroinvertebrate sampling and scoring at each site. The surveys were conducted between April and June 2011.

The average SEV score for all sites surveyed was 0.551 which reflects what can be considered to represent moderate ecological function. Oak_EMS_05 (Oakley Creek) was the highest scoring site with an SEV score of 0.680 and Oak_EMS_03 the lowest with an SEV score of 0.330. Oak_EMS_06 (Oakley Creek) had the highest biodiversity score reflecting the high habitat heterogeneity below the Oakley Creek Waterfall. Torrentfish (*Cheimarrichthys fosteri*), redfin bullies (*Gobiomorphus huttoni*) and inanga (*Galaxias maculatus*) were amongst the fish species found at this site. Oak_EMS_03 (Oakley Creek) had the lowest biodiversity score, as a result of being concrete lined with reduced habitat quality. Scores for each site are included in Summary Table of all SEV Scores below.

Summary Table of all SEV Scores

Site Name	Hydraulic	Biogeochemical	Habitat Provision	Biodiversity	SEV Score
Edg_EMS_01	0.45	0.65	0.35	0.41	0.503
Cox_EMS_01	0.42	0.72	0.56	0.28	0.513
Mot_EMS_01	0.55	0.64	0.56	0.30	0.525
Mot_EMS_02	0.68	0.59	0.70	0.51	0.606
Meo_EMS_01	0.67	0.65	0.58	0.36	0.574
Meo_EMS_02	0.55	0.70	0.54	0.49	0.591
Meo_EMS_03	0.65	0.63	0.69	0.49	0.608
Meo_EMS_04	0.69	0.66	0.72	0.54	0.645
Oak_EMS_02	0.35	0.55	0.43	0.26	0.416
Oak_EMS_03	0.32	0.51	0.34	0.08	0.330
Oak_EMS_05	0.73	0.74	0.77	0.49	0.680
Oak_EMS_06	0.49	0.68	0.75	0.61	0.624

Due to budgetary constraints and timing issues the sampling methods and scope was affected. In particular this relates to macroinvertebrate and fish sampling that should be conducted in summer months rather than autumn. It should be noted that scores may have been affected; however the results are considered to be representative and indicative of the waterways surveyed.

2.0 Introduction

Auckland Council is statutorily responsible for the maintenance of the Auckland Central's public watercourses which, prior to formation of the new Council, was managed by Metrowater on behalf of Auckland City Council (ACC). Metrowater and Auckland City Council were involved in a joint network resource consent project to obtain Auckland Regional Council (ARC) consent to authorise the operation of ACC's drainage network.

As part of the network consent applications Metrowater developed a Receiving Environment Monitoring Strategy. Since transition in November 2010, Morphum Environmental Ltd has been engaged by the Council to continue this project with a modified scope that considers Watercare's Central Interceptor Project, which has the potential to affect the streams that are within the project zone of influence.

Twelve sites have been selected from the targeted streams to carry out ecological monitoring. The Stream Ecological Valuation (SEV) method was the selected method for assessment and includes fish and macroinvertebrate surveying.

Desktop study:

A review of available reports and information relating to the subject streams was carried out to assist in the selection of sites for monitoring within Auckland Central. These include:

- Suren (2001) Review and summary of the state of the aquatic ecology of streams receiving stormwater from Auckland City;
- Allibone (2001) Stream classification and in-stream objectives for Auckland's urban streams;
- Sides and Bennett (1998) Mid-Waitemata Harbour catchment freshwater ecological survey; and,
- Relevant ARC technical publications and reports.

Previous studies of ACC's streams have indicated that ecological values are reduced, consistent with the impacts of urbanisation. The severity of these impacts varies across the urban area and in some streams ecological values can be relatively high.

Ecological conditions within streams change as a result of various pressures and ecology and biota can be indicators of the effects of urbanisation. Monitoring of specific ecological indicators will provide important information on the state of the city's freshwater stream environments and their response to temporal and local changes including the influence of management actions and restoration initiatives.

2.1 Report Layout

The monitoring undertaken between April and June 2011 is the first year of what is anticipated to be an ongoing monitoring programme to be implemented and expanded across the isthmus.

As such the collected data from this phase of the project has the potential to form part of a larger data set and additionally can be considered in terms of the ongoing Regional monitoring now being conducted by Auckland Council (but formerly by the Auckland Regional Council (ARC)).

For each of the 12 sites the following information is provided:

1. Catchment context and site description,
2. Macroinvertebrate indices (MCI, EPT, Taxa Richness),
3. Fish species identified and index of biotic integrity (IBI),
4. SEV Scores and key points of interest.

2.2 Monitoring 2012

The streams listed below are not included in the initial stage of the environmental monitoring strategy due to prioritisation being placed on those streams associated with the Central Interceptor Project and under guidance from Auckland Council. The next phase of the monitoring strategy, intended to be carried out in summer 2012 includes the following streams:

- Orakei Stream,
- Purewa Stream,
- Southdown Stream,
- Omaru Creek,
- Whau Creek,
- Churchill Creek,
- Meadowbank Stream,
- Newmarket Stream.

These streams and associated sites were identified in the Receiving Environment Monitoring Strategy: Stream Ecology Site Scoping report (MEL, 2009b).

3.0 Site Selection

3.1 Target Streams

Target streams were predefined in Section 5.3.1 of the Auckland Waterways: Receiving Environment Monitoring Strategy – Streams and Estuarine Environments (2008) report. Streams were selected following consideration of the following factors (Hill Young Cooper, 2008):

- Sites with contributing catchments comprising different land uses (i.e commercial/industrial and residential);
- Large and small streams;
- Sites with contributing catchments undergoing change; and
- Control sites where change is expected to be minimal (to the extent possible within Auckland City).

This stage of monitoring and associated reporting outputs relates to the streams within the Central Interceptor zone of influence only.

3.2 Site Selection

Site selection is an important component of any monitoring strategy as the sites must be representative of the stream as a whole, in addition to representing the ecological state of waterways across the city. In order to assess the suitability of sites for ongoing monitoring, Morphum Environmental Ltd developed a selection criteria matrix (MEL, 2009b). This provided robust reasoning for each stream and site selection (refer Table 2).

Historical studies and recent information gathered during Watercourse Management Plan and Stream Walk assessments has been considered. Sites have been discussed with Auckland Council and sites selected have been the product of collaboration to ensure multiple objectives are met.

Rationale for site selection includes:

- Availability of historical information (e.g. State of the Environment [SOE] information);
- Location relative to the stream (e.g. below a confluence);
- Proximity to existing ongoing Regional monitoring sites;
- Proximity to growth nodes;
- Proximity to areas of infrastructural change (e.g. roading, network upgrades);
- Proximity to areas where change is expected (including Restoration Opportunities as identified in WMP); and
- Location of Wai Care groups.

3.2.1 Site Selection Criteria

Included in Table 1 is a summary showing the previous or existing survey sites for each of the target streams. Based on the number of previous sites and their locations, an assessment was undertaken to determine the monitoring sites to be included in the EMS. A total of 12 EMS sites have been assessed.

Table 1: Site Selection Criteria for Monitoring Sites on Year One Streams.

Catchment	Stream	Sites	Comments
Cox's Catchment	Edgars Creek	Edg_EMS_01	Moved to upstream of mangroves
	Cox's Creek	Cox_EMS_01	Upper Kelmarna arm, bedrock substrate
Oakley Catchment	Oakley Creek	Oak_EMS_02	Immediately upstream of May Road within bank-lined section
		Oak_EMS_05	Lower Powell Street, upstream of the waterfall, cobbly bottom
		Oak_EMS_06	Downstream of the waterfall, cobbly bottom, different habitat than SOE site
		Oak_EMS_03	Moved closer to Richardson Road, in line with Allibone (2001) site.
Meola Catchment	Meola Creek	Meo_EMS_01	Downstream of Lyons Ave overflow within Roy Clements Treeway
		Meo_EMS_02	Rawalpindi Reserve
		Meo_EMS_03	Upstream of ARC flow monitoring weir
		Meo_EMS_04	Downstream of water quality treatment device (litter trap)
Motions Catchment	Motions Creek	Mot_EMS_01	Upstream of the zoo
		Mot_EMS_02	Downstream of Old Mill Road, where *Fissidens* moss is located

Once the number of sites per stream was decided the location of each site was considered, based on the position of previous site locations and the representativeness of the site in terms of upstream catchment land use. Table 2 identifies the rationale behind site selection. Maps showing the locations of the EMS sites are included in Appendix A

Table 2: Site Selection Information

Stream	Site Names	Location	X Coordinate	Y Coordinate	Reason	Additional Notes
Motions Creek	Mot_EMS_01	Below culvert exiting Western Springs Lake	1753682.99300153	5918768.01822685	Native fish fauna identified during MEL stream walk including eels and inanga.	Worthwhile doing 2 sites to ensure ongoing monitoring of influence of zoo effluent on stream ecology. Potential changes to the volume of water entering the stream as a result of changes being made to the drainage network at Eden Park for Rugby World Cup. Network separation project may also reduce the volume of wastewater entering the stream.
	Mot_EMS_02	Below Old Mill Rd	1753260.60196936	5919169.60970061	Existing Wai Care data indicates stream is of moderate to good quality for an urban catchment. Fauna found include woody cased caddisflies, damselflies, inanga, bullies. Close to water quality and flow monitoring site.	
Oakley Creek	Oak_EMS_02	Immediately above May Rd	1754912.73111896	5914270.63016331	Location of previous habitat assessment. Modified banks and poor riparian cover. Channel deeper and wider here than in reaches immediately downstream through Walmsley and Underwood Reserves.	Need for ongoing monitoring given state of growth and motorway extension. Sites selected based on previous studies and changes expected from SH20 Waterview Extension. Reference has also been made to the Oakley Creek WMP document. Likely changes to the state of the creek in the future as a result of reduced wastewater overflows, motorway and land use developments, and growth in the upper catchment.
	Oak_EMS_03	Lower Walmsley Park	1754069.18413698	5915035.78058563	Highly modified section of stream and upstream catchment. Remedial works recommended as part of Oakley Creek WMP.	
	Oak_EMS_05	Bottom of Powell Street, Avondale	1751994.51836184	5915842.61814242	Located downstream of cascades. Potential for restoration identified. Area likely to be less impacted by SH20 Waterview Extension. Site representative of upstream catchment.	
	Oak_EMS_06	Under bridge below Oakley Creek Waterfall	1751779.28969845	5916944.13319536	The Oakley Creek Waterfall currently forms a barrier to fish passage for many species. ARC has one macroinvertebrate monitoring site at the bottom of the creek. This represents soft bottom stream types. Sampling below the footbridge downstream of the waterfall provides a different habitat type for macroinvertebrate monitoring. The WMP stream survey identified several fish species in proximity of this site including eels, koi carp, inanga, unidentified galaxiids and bullies.	
Meola Creek	Meo_EMS_01	Below overflow at RCT	1754048.73879719	5916655.41643821	Extensive restoration work has been carried out in Roy Clements Treeway. The creek at this location is generally open with some bank/channel modification. An existing overflow, and proposed changes to the volume of storm and wastewater entering the stream makes this an important site to monitor long term. Eels have been seen in the area frequently. Mt Albert Grammar and STEPS are involved in Wai Care monitoring in the area.	Wai Care data available for downstream sections. Restoration work in RCT and proposed changes to the overflow/Mt Eden project likely to affect the creek so should be monitored. Major restoration project underway in lower area (Lower Meola Restoration Project). Major capital works planned including combined network separation, Central Interceptor and network upgrades for Eden Park as part of the Rugby World Cup upgrades. Likely to change volume and velocity of water entering stream.
	Meo_EMS_02	Rawalpindi Reserve	1752850.73915606	5917687.14958503	Site is located between a section of lined channel (downstream) and gabion lined banks (upstream). Relatively natural channel with some native vegetation. Eels have been seen upstream of this site. Representative section of the creek between moderately modified reaches. Previous habitat monitoring immediately upstream.	
	Meo_EMS_03	Above ARC monitoring weir	1753194.37712716	5918535.24524408	The rare aquatic moss, *Fissidens berteroi*, is located in proximity of the weir. The substrate in this section of the creek consists of cobbles and small boulders. Water velocity is relatively high and the site provides a good mix of in-stream habitats. Riparian cover in the area is good although primarily exotic. Restoration opportunities have been identified for this area in the Meola Creek WMP. Previous habitat and ecology sites immediately upstream. Water flow monitoring and previous habitat assessment downstream.	
	Meo_EMS_04	Below Pasadena Intermediate	1753035.86749277	5918788.04078167	This area of the creek has extensive macrophyte coverage which provides habitat for many aquatic fauna. Pasadena Intermediate conducts on-going monitoring in this section of the creek as part of the Wai Care programme. Restoration opportunities identified in the Meola Creek WMP are focussed in this area and will provide interesting information over time as restoration projects are implemented. Water quality site in proximity.	
Coxs Creek	Cox_EMS_01	Kelmarna Ave Arm	1754472.58218901	5920319.0376057	The Kelmarna arm of Coxs Creek receives combined sewer overflows frequently. The creek is predominantly bedrock in the upper reaches with deposition an issue in the lower reaches, requiring sediment removal.	Coxs Catchment has been the subject of major capital works including extensive network upgrades over recent years. In order to improve water quality and reduce odours, the low gradient stream mouth has been regularly cleaned out to improve hydraulics to enable 'self-flushing'.
Edgars Creek	Edg_EMS_01	Downstream of Warnock Ave	1753905.34576347	5919791.07242479	The Edg_EMS_01 site is located at the most downstream point of Edgars Creek. It is characterised by low gradient resulting in deposition and is bordered by residential properties. Downstream of the site the stream is piped under Coxs Bay Reserve. The site is immediately upstream of the tidal influence.	Edgars Creek is impacted by combined sewer overflows and stormwater. The stream flows through both Francis and Wellpark Reserves before reaching the subject SEV sites. Wai Care data from the reaches within these reserves indicates a healthy population of banded kokopu inhabit the stream and community plantings have been undertaken along these banks. Major stormwater capital works are planned in the upper catchment.

4.0 Methodology

This ecological monitoring programme has been designed as a two-staged approach with sampling initially conducted at two yearly intervals for six years. This data will provide a baseline upon which to reference future data. Following the collection of 'baseline data', sampling will be carried out at five yearly intervals. Sampling will be carried out during summer months between December and March.

Data from the Wai Care programme and ARC regional monitoring sites may be used to supplement the data collected through the EMS process to provide additional information for alternative sites.

4.1 Habitat Assessment

Habitat was assessed using the Suren (2001) habitat assessment with reference made to the Stream Habitat Assessment Protocols (Harding et al. 2009).

4.2 Fish

Increasingly it is recognised that urban streams provide valuable habitat for fish and other aquatic organisms (Vermonden et al, 2009; Paul and Meyer, 2001). Fish will be included in the ongoing ecological monitoring strategy and will be assessed for average fish condition, fish abundance, and length frequency distribution.

Due to time constraints and agreed budget limitations, electric fishing was the method chosen for monitoring at all sites. No other method of fish surveying has been included as part of this study. It is recognised that electric fishing is not suitable for all habitat types and therefore may limit the diversity of species identified.

Particular species of fish have been targeted as indicators of different tolerances and habitat preferences. These are:

- shortfin eel (*Anguilla australis*);
- longfin eel (*Anguilla dieffenbachii*);
- banded kokopu (*Galaxias fasciatus*);
- common bully (*Gobiomorphus cotidianus*), and
- inanga (*Galaxias maculatus*).

Reasons for these species being selected are included in Table 3 below.

Table 3: Key freshwater fish species for monitoring in Auckland City streams

Fish species	Preferences and ecological commentary (Hill Young Cooper, 2008)	Size Descriptors (Environment Waikato Regional Council, 2010)	Best practice method for assessment (Environment Waikato Regional Council, 2010)
Shortfin eel	Highly tolerant of poor water quality (e.g., tolerates low dissolved oxygen and high temperatures, high nutrient etc.), able to utilise streams with a variety of in-stream cover, reasonable to strong upstream migrant. Absence of this species indicates either a significant migration barrier or very poor in-stream conditions.	Tiny - ≤100 mm Small – 101-300 mm Medium – 301-500 mm Large – ≥ 501 mm	EFM tends to detect higher numbers than spotlighting (particularly smaller eels).
Longfin eel	Tolerant of poor water quality but less temperature tolerant than the shortfin eel. Very strong upstream migrant, long lived species with large individuals indicating good long-term in-stream conditions. Prefers good riparian shade.	Tiny - ≤100 mm Small – 101-300 mm Medium – 301-500 mm Large – ≥ 501 mm	EFM tends to detect higher numbers than spotlighting
Banded kokopu	Tolerant of poor water quality (low dissolved oxygen and moderate temperatures), requires good in-stream cover. Large individuals indicate good in-stream conditions in the previous five to ten years, a good to strong upstream migrant. Prefers good riparian shading.	Tiny - ≤50 mm Small – 51-100 mm Medium – 101-200 mm Large – ≥ 201 mm	Spotlighting tends to yield higher numbers than EFM
Common bully	Tolerant of low flows but requires average to good water quality, weak migrant. Requires some in-stream cover but does not require riparian shading. Short life span and populations may respond rapidly to good in-stream conditions	Tiny - ≤20 mm Small – 21-40 mm Medium – 41-60 mm Large – ≥ 61 mm	EFM tends to detect higher numbers than spotlighting (however is somewhat site dependent as where few riffles are present, results are similar)
Inanga	Tolerant of poor water quality and prefers low flows, weak migrant. Located close to the sea, and spawn on vegetated banks within tidal interface. Generally widespread and are often seen shoaling during the day.	Tiny - ≤40 mm Small – 41-60 mm Medium – 61-80 mm Large – ≥ 81 mm	Not known.

4.3 Macroinvertebrates

Macroinvertebrates are a useful indicator of changes in water quality and have been used extensively to monitor the impacts of land use change both internationally and in New Zealand (Boothroyd and Stark, 2000).

Stark et al. (2001) created the Protocols for Macroinvertebrate Sampling in Wadeable Streams which details methods by which to carry out macroinvertebrate sampling. Semi-quantitative methods, Protocol C1 for soft bottom streams and Protocol C2 for hard bottom streams, are recommended for monitoring the city's urban streams. These protocols are comparable over time and between sites.

For each sampling round, one composite benthic macroinvertebrate sample was collected from each site using a kick-net (500 µm mesh) following the semi-quantitative macroinvertebrate sample protocol C1, outlined in Stark et al. (2001).

Samples were preserved in 70% ethanol in the field and processed according to a variation on the methods described by Stark et al. (2001). For more information refer to Appendix F.

Samples were processed and sorted in the laboratory, identified to genus or species level where possible and/or appropriate using a binocular microscope.

Macroinvertebrates were scored using the Macroinvertebrate Community Index (MCI) and EPT (Ephemeroptera, Plecoptera and Trichoptera) methods for pollution sensitivity as per Stark and Maxted (2007).

- **Taxonomic Richness –** a measure of the number of different macroinvertebrate taxa present in each sample.
- **EPT taxa richness**– a measure of the relative abundance of Ephemeroptera, Plecoptera and Trichoptera taxa (excluding Hydroptilidae), the major pollution sensitive taxonomic groups within invertebrate communities, providing insight into water and habitat quality conditions.
- **% EPT**– a measure of the dominance of Ephemeroptera, Plecoptera and Trichoptera taxa (excluding Hydroptilidae).
- **Macroinvertebrate Community Index (MCI)** – The MCI method developed by Stark et al. (2001) is a macroinvertebrate presence/absence based measurement which describes the 'health of the stream' based on individual taxa scores between 1 and 10 (tolerant or sensitive to organic enrichment respectively).

Table 4: MCI score descriptions (Stark & Maxted, 2007).

Stark & Maxted (2004, 2007) quality class	Stark (1998) descriptions	MCI
Excellent	Clean water	>120
Good	Doubtful quality or possible mild pollution	100-119
Fair	Probable moderate pollution	80-99
Poor	Probable severe pollution	<80

4.4 Stream Ecological Valuation

The Stream Ecological Valuation (SEV) method (Rowe et al., 2006) assesses the performance of stream ecological functions at a reach scale Table 5.

Table 5: Summary of ecological functions assessed in the SEV method.

Hydraulic function: Processes associated with water storage, movement and transport.	• Natural flow regime • Connectivity to flood plain • Connectivity for species migration • Connectivity to groundwater
Biogeochemical function: Relates to the processing of minerals, particulates and water chemistry.	• Water temperature control • Dissolved oxygen levels • Organic matter inputs • In-stream particle retention • Decontamination of pollutants • Flood-plain particle retention
Habitat provision functions: The types, amount and quality of habitats that the stream reach provides.	• Fish spawning habitat • Habitat for aquatic fauna
Native biodiversity function: The occurrences of diverse populations of flora and fauna that would normally be associated with the stream reach.	• Fish fauna • Invertebrate fauna • Aquatic biodiversity • Riparian vegetation

The SEV method incorporates a broad range of physical and biological parameters including assessments of fish and macroinvertebrate communities. The method is designed as a spot assessment of ecological value and can be used as a comparable monitoring tool. The SEV method is being carried out at all sites.

5.0 Results

The results obtained during the sampling undertaken in May 2011 are included in the following sections. The following tables summarise the scores. Fish IBI score (Table 6), macroinvertebrate indices (Table 7) and SEV scores (Table 8) for all sites are included to provide context across sites.

Table 6 includes the IBI score based on inclusion of all species recorded at that site from electric fishing, NIWA Freshwater Fish Database and observations made by Morphum Environmental Ltd during Streamwalks. A list of macroinvertebrate species identified at each site is included in Appendix C: Macroinvertebrate Results.

Table 6: Fish IBI results.

Index of Biological Integrity - Auckland Region : Fish Centre for Freshwater Ecosystem Modelling and Management, Massey University				
	Electric fishing undertaken in May 2011		**Based on electric fishing AND other observations/NZFFD**	
Site	**IBI score**	**Rating**	**IBI score**	**Rating**
Mot_EMS_01	30	Fair	26	Poor
Mot_EMS_02	38	Good	48	Very Good
Cox_EMS_01	14	Very Poor	14	Very Poor
Meo_EMS_01	32	Fair	32	Fair
Meo_EMS_02	24	Poor	52	Excellent
Meo_EMS_03	38	Good	52	Excellent
Meo_EMS_04	0	Not Electric Fished	44	Very Good
Oak_EMS_02	34	Fair	30	Fair
Oak_EMS_03	0	Not Electric Fished	0	No Natives
Oak_EMS_05	32	Fair	32	Fair
Oak_EMS_06	52	Excellent	58	Excellent
Edg_EMS_01	0	Not Electric Fished	46	Very Good

Table 7: Macroinvertebrate results obtained from all sites during EMS study.

Site	**Macroinvertebrate Indices**			
	Taxa Richness	**Taxa Abundance**	**EPT**	**MCI**
Mot_EMS_01	11	1413	0	56
Mot_EMS_02	20	5249	0	67
Cox_EMS_01	15	1930	0	59
Meo_EMS_01 (SB)	15	1771	0	55
Meo_EMS_02	19	3430	0	59
Meo_EMS_03	15	8893	0	64
Meo_EMS_04	17	2663	1	75
Oak_EMS_02	15	1451	0	65
Oak_EMS_03	13	6704	0	65
Oak_EMS_05	16	1371	0	70
Oak_EMS_06	18	4185	0	66
Edg_EMS_01 (SB)	19	3430	0	69

Table 8: Stream ecological valuation scores for all functions at all sites surveyed.

Function	Edg_EMS_01	Cox_EMS_01	Mot_EMS_01	Mot_EMS_02	Meo_EMS_01	Meo_EMS_02	Meo_EMS_03	Meo_EMS_04	Oak_EMS_02	Oak_EMS_03	Oak_EMS_05	Oak_EMS_06
Natural flow regime	0.07	0.08	0.12	0.18	0.07	0.08	0.08	0.08	0.07	0.11	0.16	0.16
Connectivity to flood-plain	1	0.5	0.55	0.7	1	0.6	0.7	0.85	0.05	0.05	0.85	0.85
Connectivity for migration	0.06	0.18	1	1	1	1	1	1	1	1	1	0.02
Connectivity to groundwater	0.68	0.91	0.54	0.83	0.62	0.54	0.82	0.83	0.3	0.1	0.92	0.93
Hydraulic function mean score	**0.45**	**0.42**	**0.55**	**0.68**	**0.67**	**0.55**	**0.65**	**0.69**	**0.35**	**0.32**	**0.73**	**0.49**
Water temperature control	0.67	0.71	0.55	0.56	0.64	0.73	0.73	0.57	0.65	0.46	0.74	0.61
Dissolved oxygen maintained	0.15	0.82	1.00	0.51	0.23	1.00	0.48	0.75	1	1	1	1
Organic matter input	0.5	0.74	0.13	0.2	0.34	0.32	0.51	0.24	0.3	0.12	0.42	0.15
Instream particle retention	0.69	0.58	0.65	0.7	0.75	0.58	0.45	0.65	0.31	0.39	0.58	0.52
Decontamination of pollutants	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Flood-plain particle retention	0.9	0.46	0.53	0.6	0.92	0.58	0.64	0.78	0.07	0.07	0.71	0.79
Biogeochemical function mean score	**0.65**	**0.72**	**0.64**	**0.59**	**0.65**	**0.7**	**0.63**	**0.66**	**0.55**	**0.51**	**0.74**	**0.68**
Fish spawning habitat	0.46	0.53	0.63	0.88	0.88	0.56	0.88	0.88	0.5	0.63	0.88	0.88
Habitat for aquatic fauna	0.25	0.59	0.5	0.52	0.29	0.52	0.5	0.56	0.36	0.17	0.66	0.63
Habitat provision function mean score	**0.35**	**0.56**	**0.56**	**0.7**	**0.58**	**0.54**	**0.69**	**0.72**	**0.43**	**0.4**	**0.77**	**0.75**
Fish fauna intact	0.77	0.23	0.43	0.8	0.53	0.87	0.87	0.73	0.5	0	0.53	0.97
Invertebrate fauna intact	0	0	0.19	0.19	0.09	0.19	0.19	0.33	0.09	0.19	0.19	0.19
Aquatic biodiversity intact	0.53	0.2	0.32	0.7	0.35	0.6	0.54	0.57	0.42	0.09	0.45	0.7
Riparian vegetation intact	0.33	0.68	0.27	0.35	0.48	0.3	0.37	0.52	0.03	0.03	0.8	0.6
Biodiversity function mean score	**0.41**	**0.28**	**0.3**	**0.51**	**0.36**	**0.49**	**0.49**	**0.54**	**0.26**	**0.08**	**0.49**	**0.61**
SEV Score	**0.503**	**0.513**	**0.525**	**0.606**	**0.574**	**0.591**	**0.608**	**0.645**	**0.416**	**0.338**	**0.68**	**0.624**

5.1 Motions Creek

The following summary information regarding Motions Creek has been obtained from the Motions Creek Watercourse Management Plan (Morphum Environmental Ltd, 2010a).

Motions Creek is an urban waterway which flows through the suburbs of Kingsland and Point Chevalier, extending as far as Symonds St. The catchment is highly modified, with an average catchment imperviousness of 52%. The upper reaches are extensively modified with the upper catchment being predominantly piped. Motions Creek is mostly fed by surface flow, stormwater and wastewater discharges.

The open section of the creek starts in Western Springs Reserve and flows through the Auckland City Zoo, Seddon Fields and Jaggers Bush before entering the inner harbour adjacent to Meola Reef. The lower reaches are in a relatively natural state and public access pathways are located through Jaggers Bush on the TRB.

As per the Proposed Auckland Regional Plan: Air, Land and Water (PARP: ALW) Motions Creek falls into two main stream types with the main channel being permanent and some tributaries intermittent.

The primary function of Motions Creek is for drainage as defined by the Auckland City Urban Stream Classification devised by NIWA (Webster et al., 2005). This is because the stream is highly modified and the catchment has a high level of imperviousness.

5.1.1 Mot_EMS_01

Site Summary

Mot_EMS_01 is the uppermost site within the Motions Creek catchment, and is located within Western Springs Park, above the Auckland Zoo boundary Figure 1.

The site is characterised by rock-lined banks and cobbly stream bed. Riparian vegetation along the banks is varied with mown grass the dominate type in the upper part of the SEV reach. Steep banks in the lower part of the reach are weedy and lack stability.

While undertaking the SEV, prior to electric fishing, approximately 20 eels were spotted from the banks in the lower part of the reach, where the channel is less modified Figure 2.

Figure 1: Mot_EMS_01 site, looking upstream towards section of bank modification.

Figure 2: More than 20 eels near the edge of a deep pool just upstream of the zoo boundary in Motions Creek.

Habitat Summary

The habitat at this site is considered to be of low to moderate value, with poor riparian vegetation and some bank and channel modification evident.

Macroinvertebrates

Macroinvertebrate taxa and indices are included in Table 9. No EPT taxa were found in the sample taken at Mot_EMS_01. Typically macroinvertebrate sampling is undertaken during summer months. As the samples taken in this monitoring programme were taken later the score may have been influenced by increased flows and seasonal differences. The MCI score of 56 is indicative of poor water quality (Table 4).

Table 9: Macroinvertebrate taxa and indices recorded from Mot_EMS_01 (where R = 1-4, C = 5-19, A = 20-99, VA = 100-499 and VVA = 500+)

Site Name (Date)	Mot-EMS-01 (13/04/2011)
Taxa	**Abundance**
Oxyethira	**R**
Paraoxyethira	**R**
Xanthocnemis	**R**
Chironomus	**R**
Orthocladiinae	**VVA**
Collembola	**R**
Ostracoda	**C**
Physa	**R**
Oligochaeta	**A**
Hirudinea	**A**
Platyhelminthes	**R**
Taxa Abundance	1413
Taxa Richness	11
EPT (excl. Hydroptilidae)	0
MCI	56

Fish

Electric fishing revealed shortfin (*Anguilla australis*) and longfin (*Anguilla dieffenbachii*) eels. The size range of the eels was between <100 mm up to 500 mm. Several unidentified eels were observed including several less than 50 mm and a possible Australian shortfin eel (*Anguilla reinhardtii*) which got away before an accurate identification could be made. The abundance and size range of all fish is included in Table 10.

Table10: Fish species and abundance data recorded at Mot_EMS_01.

Site Name	Mot_EMS_01	Date	19/05/2011
Common Name	**Scientific Name**	**Size Range**	**Frequency**
Longfin Eel	*Anguilla dieffenbachii*	<100-150	3
		200-300	3
		250-300	1
Shortfin Eel	*Anguilla australis*	100-150	22
		200-250	13
		400-450	1
		500	1
		300-400	4
Unidentified Eel	*Anguilla* sp.	400-450	1
		100-150	8
		<50	8

The efficacy of electric fishing was limited in this site due to water depth and access. As such it is expected that the full complement of species was not captured.

The NIWA Freshwater Fish Database records additional species to those captured via electric fishing. Koi carp (*Cyprinus carpio*) and gambusia (*Gambusia affinis*) have been recorded at the site before. These species were included in the IBI and SEV calculator.

The IBI score of the Mot_EMS_01 site is 30 indicative of Fair biotic integrity. However, when results from previous studies are included the score is lowered to 26 (Poor biotic integrity) due to the presence of two exotic species.

Refer Freshwater Fish Database Form Appendix B: Freshwater Fish Database Forms

Stream Ecological Valuation

The Mot_EMS_01 site has an overall SEV value of 0.525 indicating moderate ecological stream values. Table 11 details the breakdown of this score.

Table 11: SEV function scores for Mot_EMS_01

Site Name	Mot_EMS_01
Stream Name	Motions Creek
Hydraulic	
Natural Flow Regime	0.12
Connectivity to flood-plain	0.55
Connectivity for migration	1.00
Connectivity to groundwater	0.54
Mean score	**0.55**
Biogeochemical	
Water temperature control	0.55
Dissolved oxygen maintained	1.00
Organic matter input	0.13
In-stream particle retention	0.65
Determination of pollutants	1.00
Flood-plain particle retention	0.53
Mean score	**0.64**
Habitat Provision	
Fish spawning habitat	0.63
Habitat for aquatic fauna	0.50
Mean score	**0.56**
Biodiversity	
Fish fauna intact	0.43
Invertebrate fauna intact	0.19
Aquatic biodiversity intact	0.32
Riparian vegetation intact	0.27
Mean score	**0.30**
SEV Value	**0.525**

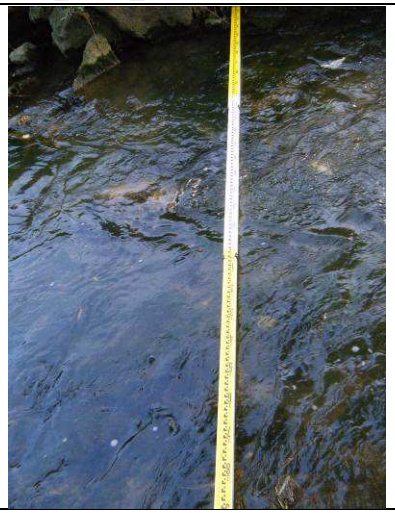
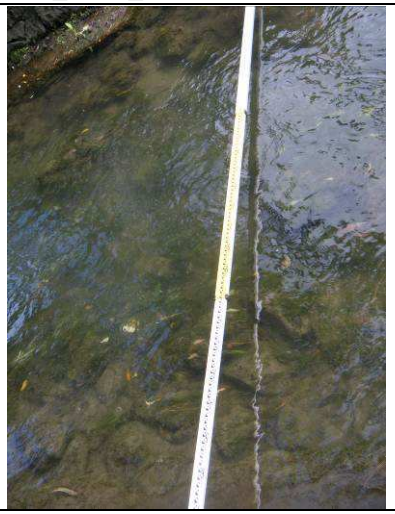
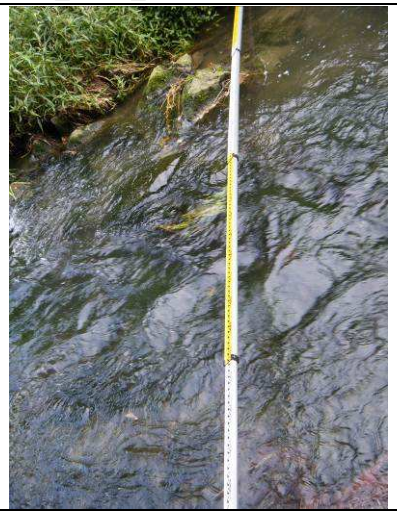
The hydraulic function score is 0.55 reflecting good connectivity for migrations but poor natural flow regimes as a result of bank lining. This bank lining has also negatively influenced the ability of the stream to connect to groundwater and floodplains. Upstream catchment imperviousness is high with little to no flood control as Western Springs Lake provides little attenuation as it is essentially offline.

The biogeochemical function score is 0.64 which is moderate, with poor riparian cover influencing the score reducing its water temperature control and organic matter input functions. Mown banks have also reduced the capacity of the floodplain to retain particles. Improving riparian cover in this reach could increase the score for this function.

Habitat provision is considered to be moderate, with sufficient boulders and pools to provide suitable habitat for fish fauna. Bank lining has again impacted this score by reducing the abundance and quality of undercut banks and bank heterogeneity.

As for most of the sites, a poor macroinvertebrate fauna has lowered the biodiversity function score. The fish fauna intact measure is also relatively low given its proximity to the coastline and as there are no downstream barriers to fish passage. As for the biogeochemical function, the poor riparian cover along the reach has also influenced the biodiversity score.

SEV Transect Photographs

Mot_EMS_01 T1	Mot_EMS_01 T2	Mot_EMS_01 T3	Mot_EMS_01 T4	Mot_EMS_01 T5
				
Mot_EMS_01 T6	Mot_EMS_01 T7	Mot_EMS_01 T8	Mot_EMS_01 T9	Mot_EMS_01 T10
				

5.1.2 Mot_EMS_02

Site Summary

Mot_EMS_02 is located near Seddon Fields below Old Mill Road. The site is downstream of the zoo inputs and upstream of the tidal influence of the Motions Creek stream mouth.

This section of Motions Creek is affected by stormwater and wastewater flows in addition to the treated water coming from the Zoo. The rare aquatic moss *Fissidens beteroi* is located within this reach (Bodmin, 2009).

A visit to the site approximately one month after the SEV was carried out revealed that several large willows on the true left bank had been cut down. This is likely to have an impact on the SEV score as they had been providing a significant amount of shade to the wider sections of channel. This should be considered in future comparative SEV's.

Figure 3: Mot_EMS_02 SEV reach looking upstream.

Figure 4: Large willows on TRB were removed after the SEV was carried out. These were providing shade to a wide section of the creek.

Habitat Summary

The habitat at this site is considered to be of moderate value, with some riparian vegetation and relatively natural banks evident. Macrophytes provide habitat for aquatic fauna and are not considered to be choking the stream.

Macroinvertebrates

Macroinvertebrate taxa and indices are included in Table 12. No EPT taxa were found in the sample taken at Mot_EMS_02. Typically macroinvertebrate sampling is undertaken during summer months. As the samples taken in this monitoring programme were taken later the score may have been influenced by increased flows and seasonal differences. The MCI score of 67 is indicative of poor water quality (Table 4); however is one of the highest scores obtained from the urban streams surveyed.

Table 12: Macroinvertebrate taxa and indices recorded from Mot_EMS_02 (where R = 1-4, C = 5-19, A = 20-99, VA = 100-499 and VVA = 500+)

Site Name (Date)	Mot-EMS-02 (13/04/2011)
Taxa Count	**Abundance**
Oxyethira	**VA**
Paraoxyethira	**R**
Sigara	**R**
Chironomus	**R**
Muscidae	**C**
Orthocladiinae	**VVA**
Tanytarsini	**A**
Collembola	**R**
Acarina	**R**
Copepoda	**R**
Cladocera	**C**
Ostracoda	**R**
Paratya	**C**
Lymnaea	**R**
Physa	**C**
Potamopyrgus	**VA**
Oligochaeta	**VVA**
Hirudinea	**A**
Nemertea	**R**
Hydra	**R**
Chironomidae indet	**112P**
Taxa Abundance	5249
Taxa Richness	20
EPT (excl. Hydroptilidae)	0
MCI	67

Table 13: Fish species and abundance data recorded at Mot_EMS_02.

Site Name	Mot_EMS_02	**Date**	10/05/2011
Common Name	**Scientific Name**	**Size Range**	**Frequency**
Inanga	*Galaxias maculatus*	80	1
Longfin Eel	*Anguilla dieffenbachii*	500	1
		<100-150	5
		200-300	11
Shortfin Eel	*Anguilla australis*	200	12
		200	2 (infected)
		<100	1
		>600	2
		100-150	14
		250-350	21
		400-450	6
Unidentified Eel	*Anguilla* sp.	100-350	31
		550-600	1

Fish

Electric fishing revealed shortfin (*Anguilla australis*) and longfin (*Anguilla dieffenbachii*) eels. The size range of the eels was typically between <100 mm up to 450 mm. A longfin eel reaching 500 mm and two shortfins measuring >600 mm were identified. Several unidentified eels were observed including one >550 mm and 31 between 100 and 350 mm long. Two of the shortfin eels showed signs of infection around open wounds. One healthy, male inanga (*Galaxias maculatus*) measuring 80 mm was also observed at this site. The abundance and size range of all fish is included in

Table 13.

Inanga spawning takes place over autumn months and as such more inanga are likely to inhabit this site, but were most likely downstream spawning at the time of sampling.

No additional species are recorded in the NIWA Freshwater Fish Database records however unidentified bullies (*Gobiomorphus* sp.) have been recorded at the site during Wai Care monitoring. These species were included in the IBI and SEV calculator.

Mot_EMS_02 has an IBI score of 38, indicating Good biotic integrity. When the *Gobiomorphus* sp. recorded at the site is included in the calculation, the score increases to 48 indicative of Very Good biotic integrity.

Refer Freshwater Fish Database Form Appendix B: Freshwater Fish Database Forms.

Stream Ecological Valuation

The Mot_EMS_02 site has an overall SEV value of 0.606 indicating moderate ecological stream values. Table 14 details the breakdown of this score.

The hydraulic function score is 0.68 reflecting excellent connectivity but poor natural flow regimes due to sediment deposition throughout the reach. Upstream catchment imperviousness is high with limited flow control as Western Springs Lake has a small surface catchment and is not designed for attenuation.

The biogeochemical function score is 0.59 which is moderate. This is a result of relatively low riparian cover, which is partly due to the width of the channel. The low cover has reduced the score for water temperature control and organic matter input functions. Deposition of sediment through the upper reach has negatively influenced the score for dissolved oxygen Macrophytes are abundant in the upper section of the reach, also influencing sediment deposition. Improving riparian cover, particularly in the upper reach could increase the score for this function.

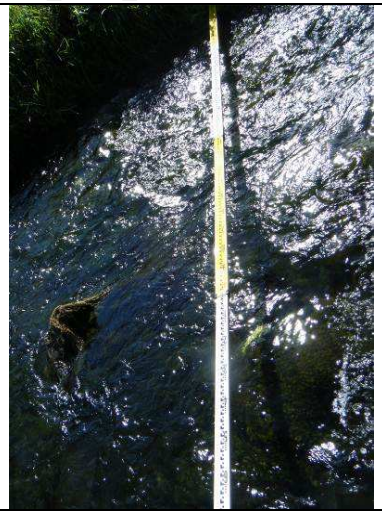
Habitat provision is considered to be good (0.70), with sufficient boulders, geomorphic unit heterogeneity and macrophytes to provide suitable habitat for fish fauna. Fish spawning habitat is well provided for with hard substrates in stream and good topography and vegetation on banks.

As for most of the sites, a poor macroinvertebrate fauna has bought the biodiversity function score down (0.51). The fish fauna intact measure is high given its proximity to the coastline and variety of habitat types. As for the biogeochemical function, the moderate riparian cover along the reach has also influenced the biodiversity score.

Table14: SEV function scores for Mot_EMS_02

Site Name	Mot_EMS_02
Stream Name	Motions Creek
Hydraulic	
Natural Flow Regime	0.18
Connectivity to flood-plain	0.70
Connectivity for migration	1.00
Connectivity to groundwater	0.83
Mean score	**0.68**
Biogeochemical	
Water temperature control	0.56
Dissolved oxygen maintained	0.51
Organic matter input	0.20
In-stream particle retention	0.70
Determination of pollutants	1.00
Flood-plain particle retention	0.60
Mean score	**0.59**
Habitat Provision	
Fish spawning habitat	0.88
Habitat for aquatic fauna	0.52
Mean score	**0.70**
Biodiversity	
Fish fauna intact	0.80
Invertebrate fauna intact	0.19
Aquatic biodiversity intact	0.70
Riparian vegetation intact	0.35
Mean score	**0.51**
SEV Value	**0.606**

SEV Transect Photographs

Mot_EMS_02 T1	Mot_EMS_02 T2	Mot_EMS_02 T3	Mot_EMS_02 T4	Mot_EMS_02 T5
				
Mot_EMS_02 T6	**Mot_EMS_02 T7**	**Mot_EMS_02 T8**	**Mot_EMS_02 T9**	**Mot_EMS_02 T10**
				

5.2 Oakley Creek

The following summary information regarding Oakley Creek has been obtained from the Oakley Creek Watercourse Management Plan (Morphum Environmental Ltd, 2010b).

Oakley Creek is an urban stream which flows from Mt Roskill South through to Waterview in the western suburbs of Auckland City and suffers from pollution inputs from stormwater runoff and wastewater overflows. The creek discharges to the Motu Manawa (Pollen Island) Marine Reserve in the Waitemata Harbour.

Oakley Creek flows through a largely urban watershed that is highly modified, with an average catchment imperviousness of 48%. The upper reaches are highly modified and the headwaters are fed predominantly by surface flow, stormwater and wastewater discharges. The high level of catchment imperviousness is reflected in the modified nature of the watercourse. The middle to lower reaches of Oakley Creek are less modified and have a large area of open space which acts as a buffer between the creek and surrounding houses. Approximately 57% of the creek is buffered by more than 27 council parks and reserves. The lower reaches are in a relatively unmodified natural state with public access pathways a common feature. A 6 m high waterfall in the lower reaches is a significant natural feature and marks a change in fish fauna populations as it is a barrier to most fish species.

The Western Ring Route motorway extension, joining the Auckland Airport and the Northwestern Motorway, has had significant impacts on the upper reaches of the creek. This has resulted in the loss of open sections of channel. The ongoing motorway construction works has and will continue to put further pressure on stream health. Connectivity between reaches in the upper sections has been lost as a consequence of piping. At least three sections of the creek are separated by long lengths of piping.

A very dedicated community group, the Friends of Oakley Creek, led by Wendy John, have ensured restoration and enhancement of the lower reaches occurs with over 34,000 plants.

5.2.1 Oak_EMS_02

Site Summary

Oak_EMS_02 is located upstream of May Road, and has been subject to previous habitat assessments. It was chosen in late 2010 to be added to the Regional SOE monitoring programme however was not included in the 2011 sampling round.

The banks are steep and are generally lined with rocks (Figure 5). The upper section of the reach surveyed appears to be lined with natural volcanic rock (Figure 6).

The majority of the reach is dominated by boulders with the lower section of the reach being concrete lined. The reach is bordered by residential properties and is designed to convey flood flows efficiently to limit flooding.

Figure 5. Oak_EMS_02 looking upstream. Steep and bank lined with rocks.

Figure 6. Upstream section of the reach. Bouldery with bank lined with volcanic rock.

Habitat Summary

The habitat at this site is considered to be of low to moderate value, with poor riparian vegetation and significant bank and channel modification evident. In-stream heterogeneity is adequate, with algae covering hard surfaces, however there is little macrophyte coverage.

Macroinvertebrates

Macroinvertebrate taxa and indices are included in Table 15. No EPT taxa were found in the sample taken at Oak_EMS_02. Typically macroinvertebrate sampling is undertaken during summer months. As the samples taken in this monitoring programme were taken later the score may have been influenced by increased flows and seasonal differences. The MCI score of 65 is indicative of poor water quality Table 4; however is one of the highest scores obtained from the urban streams surveyed.

Table 15: Macroinvertebrate taxa and indices recorded from Oak_EMS_02 (where R = 1-4, C = 5-19, A = 20-99, VA = 100-499 and VVA = 500+)

Site Name (Date)	Oak-EMS-02 (13/04/2011)
Taxa Count	**Abundance**
Oxyethira	**VA**
Xanthocnemis	**R**
Austrosimulium	**A**
Muscidae	**R**
Orthocladiinae	**VA**
Polypedilum	**R**
Collembola	**VA**
Amphipoda	**VA**
Gyraulus	**VA**
Physa	**A**
Potamopyrgus	**C**
Oligochaeta	**C**
Hirudinea	**R**
Platyhelminthes	**R**
Nemertea	**R**
Taxa Abundance	1451
Taxa Richness	15
EPT (excluding *Oxyethira* and *Paroxyethira*)	0
MCI	65

Fish

Electric fishing revealed shortfin (*Anguilla australis*) and longfin (*Anguilla dieffenbachii*) eels. One gambusia (*Gambusia affinis*) was also found during electric fishing. The size range of the eels was between <100 mm up to 500 mm. Three unidentified eels were observed 150 – 200 mm. The abundance and size range of all fish is included in Table 16.

Table 16: Fish species and abundance data recorded at Oak_EMS_02.

Site Name	Oak_EMS_02	**Date**	20/05/2011
Common Name	**Scientific Name**	**Size Range**	**Frequency**
Gambusia	*Gambusia affinis*		1
Longfin Eel	*Anguilla dieffenbachii*	250-300	3
		550	2
Shortfin Eel	*Anguilla australis*	>600	1
		100-150	1
		400-450	1
		300-400	4
		200-350	1
Unidentified Eel	*Anguilla* sp.	150-200	3

The NIWA Freshwater Fish Database records additional species to those captured via electric fishing. Koi carp (*Cyprinus carpio*) and gambusia (*Gambusia affinis*) have been recorded at the site before. These species were included in the IBI and SEV calculator.

Oak_EMS_02 has an IBI score of 34 indicating Fair biotic integrity. When including the data from the NIWA Freshwater Fish Database the IBI decreases to 30 (Fair biotic integrity), due to a record of the exotic goldfish (*Carassius auratus*).

Refer Freshwater Fish Database Form Appendix B: Freshwater Fish Database Forms.

Stream Ecological Valuation

The Oak_EMS_02 site has an overall SEV value of 0.416 indicating poor ecological stream values. Table 17 details the breakdown of this score.

Table 17: SEV function scores for Oak_EMS_02.

Site Name	Oak_EMS_02
Stream Name	Oakley Creek
Hydraulic	
Natural Flow Regime	0.07
Connectivity to flood-plain	0.05
Connectivity for migration	1.00
Connectivity to groundwater	0.30
Mean score	**0.35**
Biogeochemical	
Water temperature control	0.65
Dissolved oxygen maintained	1.00
Organic matter input	0.30
In-stream particle retention	0.31
Determination of pollutants	1.00
Flood-plain particle retention	0.07
Mean score	**0.55**
Habitat Provision	
Fish spawning habitat	0.50
Habitat for aquatic fauna	0.36
Mean score	**0.43**
Biodiversity	
Fish fauna intact	0.50
Invertebrate fauna intact	0.09
Aquatic biodiversity intact	0.42
Riparian vegetation intact	0.03
Mean score	**0.26**
SEV Value	**0.416**

The hydraulic function score is 0.35 reflecting poor natural flow regime and connectivity to floodplain and groundwater. This is due to extensive bank lining and some channel lining. The site is in the upper catchment; however catchment imperviousness is high with little flood control.

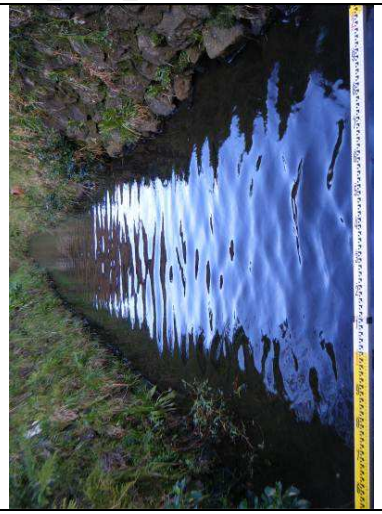
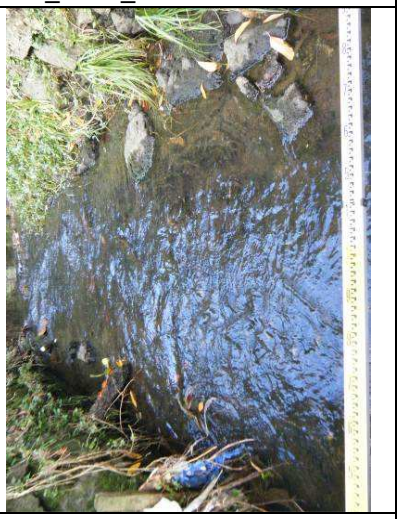
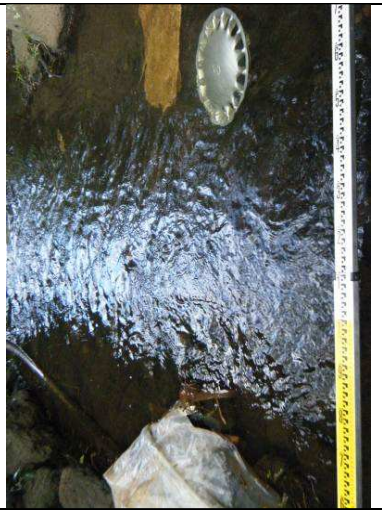
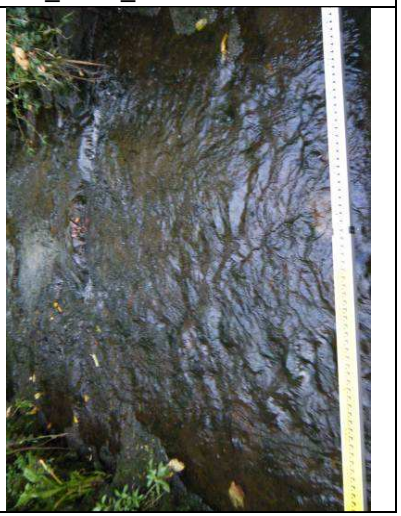
The biogeochemical function score is 0.55 which is moderate. Steep banks provide the majority of shade to the site; therefore the low riparian cover reduces the organic matter inputs. Dissolved oxygen is maintained well, likely a result of no deposition zones as it is in the upper catchment.

Due to steep banks, mown grass at the top and in-frequent flooding, floodplain particle retention score very low.

Habitat provision is considered to be poor (0.43), with habitat limited to boulders and cobbles, and bank-lining reduces the occurrence of undercut banks. Fish spawning habitat is poorly provided for with hard substrates in stream the only available spawning habitat.

As for most of the sites, a poor macroinvertebrate fauna has bought the biodiversity function score down (0.26). The fish fauna intact measure is moderate, made up of eels only, however is near the top of the catchment and a long way inland. In addition, the Oakley Creek Waterfall in the lower catchment is likely to have influenced the species complement in the upper catchment. The poor riparian vegetation has also negatively influenced this function score.

SEV Transect Photographs

Oak_EMS_02 T1	Oak_EMS_02 T2	Oak_EMS_02 T3	Oak_EMS_02 T4	Oak_EMS_02 T5
				
Oak_EMS_02 T6	Oak_EMS_02 T7	Oak_EMS_02 T8	Oak_EMS_02 T9	Oak_EMS_02 T10
				

5.2.2 Oak_EMS_03

Site Summary

Oak_EMS_03 is located in a highly modified section of Oakley Creek flowing through Walmsley Reserve (Figure 7). The channel is completely concrete lined and little to no riparian vegetation (Figure 8). The true right bank is bordered by residential properties to the stream edge, and the true left bank is bordered by a mown reserve.

This section of Oakley Creek is upstream of Alan Wood and Hendon Reserves, where the State Highway 20 Motorway will pass through.

Figure 7. Oak_EMS_03 looking upstream.

Figure 8. Looking downstream. Concrete lined channel.

Habitat Summary

The habitat at this site is considered to be of poor value, with complete concrete lining and bank modification resulting in poor heterogeneity. Riparian cover is very low, with only the high steep banks providing shade.

Macroinvertebrates

Macroinvertebrate taxa and indices are included in Table 18. No EPT taxa were found in the sample taken at Oak_EMS_02. Typically macroinvertebrate sampling is undertaken during summer months. As the samples taken in this monitoring programme were taken later the score may have been influenced by increased flows and seasonal differences. The MCI score of 65 is indicative of poor water quality (Table 4).

Table 18: Macroinvertebrate taxa and indices recorded from Oak_EMS_03 (where R = 1-4, C = 5-19, A = 20-99, VA = 100-499 and VVA = 500+)

Site Name (Date)	Oak-EMS-03 (13/04/2011)
Taxa Count	**Abundance**
Oxyethira	**VVA**
Paraoxyethira	**C**
Sigara	**R**
Orthocladiinae	**C**
Collembola	**R**
Amphipoda	**R**
Gyraulus	**C**
Physa	**C**
Potamopyrgus	**VVA**
Oligochaeta	**C**
Hirudinea	**C**
Platyhelminthes	**R**
Nemertea	**C**
Taxa Abundance	6704
Taxa Richness	13
EPT (excluding *Oxyethira* and *Paroxyethira*)	0
MCI	65

Fish

Electric fishing was not carried out at this site due to water depth being insufficient to safely undertake fishing. One gambusia (*Gambusia affinis*) was identified from the macroinvertebrate sample.

No other species are recorded from this site.

Oak_EMS_03 has IBI of 0 as no native fish are present.

No Freshwater Fish Database Form is included for this site.

Stream Ecological Valuation

The Oak_EMS_03 site has an overall SEV value of 0.330 indicating poor ecological stream values. Table 19 details the breakdown of this score.

The hydraulic function score is 0.32 reflecting poor natural flow regime and connectivity to floodplain and groundwater. This is due to extensive bank and channel lining. The site is in the upper catchment; however catchment imperviousness is high with little flood control.

The biogeochemical function score is 0.51 which is moderate. Steep banks provide the majority of shade to the site; therefore the low riparian cover reduces the organic matter inputs. Due to steep banks, mown grass at the top and infrequent flooding, floodplain particle retention scores very low.

Habitat provision is considered to be poor (0.34), with habitat limited to debris that has built up on the concrete channel lining. Fish spawning habitat is limited to hard substrates. Concrete in the stream is the only available spawning habitat.

The biodiversity function scores very low (0.08) at this site. Only gambusia (*Gambusia affinis*) were present at this site and macroinvertebrates and riparian cover scored very poorly. The poor complement of species at this site is likely due to concrete lining limiting habitat availability. The Oakley Creek Waterfall in the lower catchment is likely to have also influenced the species present in the upper catchment.

Table 19: SEV function scores for Oak_EMS_03

Site Name	Oak_EMS_03
Stream Name	Oakley Creek
Hydraulic	
Natural Flow Regime	0.11
Connectivity to flood-plain	0.05
Connectivity for migration	1.00
Connectivity to groundwater	0.10
Mean score	**0.32**
Biogeochemical	
Water temperature control	0.46
Dissolved oxygen maintained	1.00
Organic matter input	0.12
In-stream particle retention	0.39
Determination of pollutants	1.00
Flood-plain particle retention	0.07
Mean score	**0.51**
Habitat Provision	
Fish spawning habitat	0.50
Habitat for aquatic fauna	0.17
Mean score	**0.34**
Biodiversity	
Fish fauna intact	0.00
Invertebrate fauna intact	0.19
Aquatic biodiversity intact	0.09
Riparian vegetation intact	0.03
Mean score	**0.08**
SEV Value	**0.330**

SEV Transect Photographs

Oak_EMS_03 T1	Oak_EMS_03 T2	Oak_EMS_03 T3	Oak_EMS_03 T4	Oak_EMS_03 T5
				
Oak_EMS_03 T6	**Oak_EMS_03 T7**	**Oak_EMS_03 T8**	**Oak_EMS_03 T9**	**Oak_EMS_03 T10**
				

5.2.3 Oak_EMS_05

Site Summary

Oak_EMS_05 is located at the bottom of Powell Street, Avondale (Figure 9). Channel heterogeneity is good through this section of Oakley Creek, with pools, cascades and runs present.

Upstream of the surveyed reach is fast flowing and characterised predominantly by cascades. A large pipe enters the stream on the true right bank Figure 10.

The survey site is typically well shaded by large canopy trees. Floodplain vegetation is limited to low-growing exotic grass. Woolly nightshade (*Solanum mauritianum*) is prevalent on both banks, with both juvenile and mature plants present.

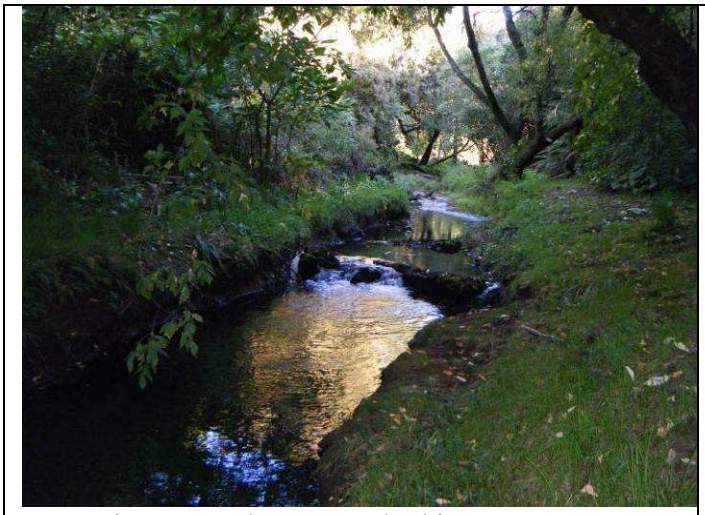


Figure 9: Oak_EMS_05 looking upstream.

Figure 10: Engineered asset on true right bank of Oakley Creek within Oak_EMS_05.

Habitat Summary

The habitat at this site is considered to be of moderate value, with good riparian vegetation and generally natural banks. In-stream heterogeneity is good with both pools and riffles, and macrophytes and bank undercut providing habitat for aquatic fauna.

Macroinvertebrates

Macroinvertebrate taxa and indices are included in Table 20. No EPT taxa were found in the sample taken at Oak_EMS_05. Typically macroinvertebrate sampling is undertaken during summer months. As the samples taken in this monitoring programme were taken later, the score may have been influenced by increased flows and seasonal differences. The MCI score of 70 is indicative of poor water quality (Table 4); however is one of the highest scores obtained from the urban streams surveyed.

Table 20: Macroinvertebrate taxa and indices recorded from Oak_EMS_05 (where R = 1-4, C = 5-19, A = 20-99, VA = 100-499 and VVA = 500+)

Site Name (Date)	Oak-EMS-05 (12/04/2011)
Taxa Count	**Abundance**
Oxyethira	**A**
Paraoxyethira	**C**
Xanthocnemis	**A**
Austrosimulium	**VA**
Harrisius	**R**
Orthocladiinae	**C**
Collembola	**R**
Amphipoda	**VA**
Copepoda	**R**
Ferrissia	**R**
Gyraulus	**VA**
Physa	**A**
Potamopyrgus	**VA**
Oligochaeta	**C**
Hirudinea	**C**
Nematomorpha	**C**
Taxa Abundance	1371
Taxa Richness	16
EPT (excluding *Oxyethira* and *Paroxyethira*)	0
MCI	70

Fish

Electric fishing revealed six shortfin (*Anguilla australis*) and 18 longfin (*Anguilla dieffenbachii*) eels. Nine of the longfin eels were <150 mm in length, the rest were between 200-350 mm. The shortfin eels observed were between 100-400 mm. Eight unidentified eels were observed within the size range 50-250 mm. One gambusia (*Gambusia affinis*) was also found during electric fishing. The abundance and size range of all fish is included in Table 21.

Table 21: Fish species and abundance data recorded at Oak_EMS_05.

Site Name	Oak_EMS_05	**Date**	20/05/2011
Common Name	**Scientific Name**	**Size Range**	**Frequency**
Gambusia	*Gambusia affinis*		1
Longfin Eel	*Anguilla dieffenbachii*	<100-150	9
		200-300	1
		250-300	3
		300-350	5
Shortfin Eel	*Anguilla australis*	100-150	1
		150-250	4
		300-400	1
Unidentified Eel	*Anguilla* sp.	50-100	4
		150-250	4

The NIWA Freshwater Fish Database records no additional species to those captured via electric fishing.

The IBI score of Oak_EMS_05 is 32 indicating Fair biotic integrity.

The efficacy of electric fishing was limited in this site due to water depth and access. As such it is possible that the full complement of species was not captured. This site is also upstream of the Oakley Creek Waterfall which is a barrier to most species.

Refer Freshwater Fish Database Form Appendix B: Freshwater Fish Database Forms.

Stream Ecological Valuation

The Oak_EMS_05 site has an overall SEV value of 0.680 indicating good ecological stream values and one of the highest scoring sites of those surveyed. Table 22 details the breakdown of this score.

Table 22: SEV function scores for Oak_EMS_05.

Site Name	Oak_EMS_05
Stream Name	Oakley Creek
Hydraulic	
Natural Flow Regime	0.16
Connectivity to flood-plain	0.85
Connectivity for migration	1.00
Connectivity to groundwater	0.92
Mean score	**0.73**
Biogeochemical	
Water temperature control	0.74
Dissolved oxygen maintained	1.00
Organic matter input	0.42
In-stream particle retention	0.58
Determination of pollutants	1.00
Flood-plain particle retention	0.71
Mean score	**0.74**
Habitat Provision	
Fish spawning habitat	0.88
Habitat for aquatic fauna	0.66
Mean score	**0.77**
Biodiversity	
Fish fauna intact	0.53
Invertebrate fauna intact	0.19
Aquatic biodiversity intact	0.45
Riparian vegetation intact	0.80
Mean score	**0.49**
SEV Value	**0.680**

The hydraulic function score is 0.73 reflecting excellent connectivity but reduced natural flow regime due to high catchment imperviousness. Connectivity to floodplain and groundwater is good, and there are no barriers to migration within the reach. There is a significant barrier to fish passage downstream of this site, which will influence the diversity of fish species found.

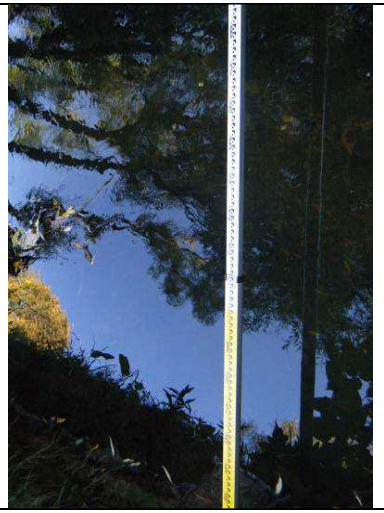
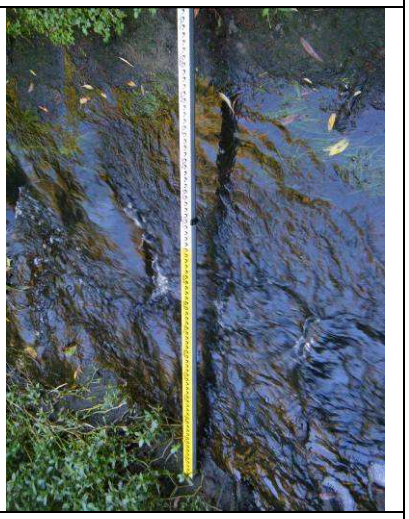
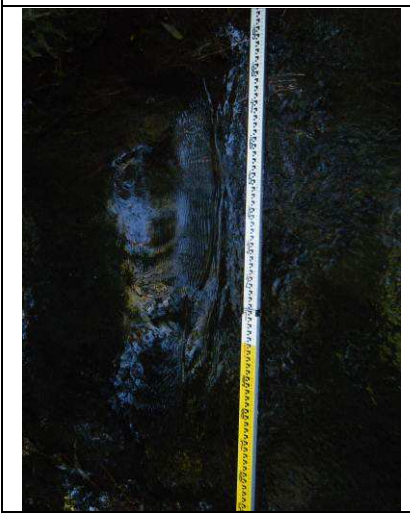
The biogeochemical function score is 0.74 which is good. Riparian cover is good however, the stream banks could benefit from species better suited for particle retention. Dissolved oxygen is well maintained as flow is consistent and there are limited deposition zones.

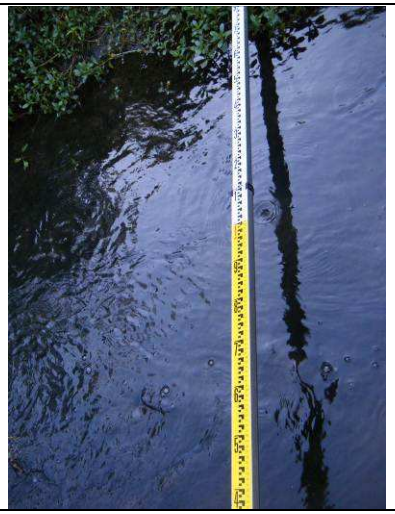
Habitat provision is considered to be good (0.77), with a variety of pools, runs and riffles and macrophytes, boulders and undercut banks available to fauna. Provision of fish spawning habitat is excellent, with hard substrates in stream and good floodplains available.

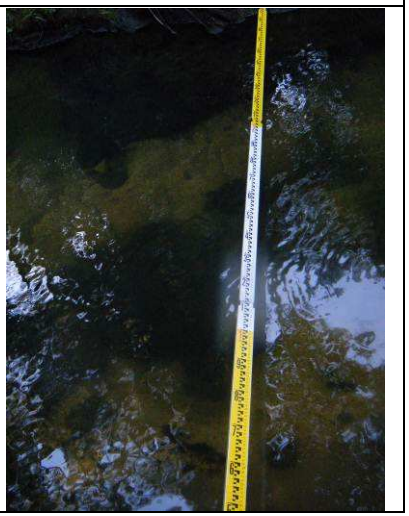
The biodiversity function scores moderately (0.49) at this site. Fish fauna is likely to be influenced by a significant barrier to passage downstream of the reach, however the presence of shortfin and longfin eels scored moderately. Riparian vegetation is relatively intact, but is predominantly exotic species. Macroinvertebrate fauna is limited at this site, most likely due to water quality issues rather than habitat availability.

SEV Transect Photographs







5.2.4 Oak_EMS_06

Site Summary

Oak_EMS_06 is the most downstream site within the Oakley Creek catchment. The site is located under the footbridge linking the Unitec Campus and the Unitec student accommodations. This site is located downstream of the Oakley Creek waterfall (Figure 11). The waterfall is a barrier to climbing and swimming fish species, due to its perched nature. As such this has formed a biodiversity hotspot for fish, as they unable to navigate the upstream barrier.

This section of Oakley Creek has been the subject of extensive restoration efforts by local community group, the Friends of Oakley Creek. The group undertakes revegetation plantings, weed control, litter clean-ups and pest monitoring.

Figure 11: Oak_EMS_06 SEV site looking upstream towards the Oakley Creek Waterfall.

Figure 12: Gravid female torrentfish (*Cheimarrichthys forsteri*) caught from cascades within Oak_EMS_06.

Habitat Summary

The habitat at this site is considered to be of moderate value, with good riparian vegetation and relatively natural banks. Pools, riffles and runs are present, with a waterfall in the upper end of the reach providing oxygenation processes. Substrate heterogeneity and macrophytes provide habitat, without choking the channel.

Macroinvertebrates

Macroinvertebrate taxa and indices are included in Table 23. No EPT taxa were found in the sample taken at Oak_EMS_06. Typically macroinvertebrate sampling is undertaken during summer months. As the samples taken in this monitoring programme were taken later the score may have been influenced by increased flows and seasonal differences. The MCI score of 66 is indicative of poor water quality (Table 4).

A regional ecological monitoring site (Oakley LTB) is located in the soft-bottom section of the stream downstream of the Oak_EMS_06 survey reach. The latest ecological results available for this site are those from February 2010 and the site scored an MCI score of 75.7. The difference in

scores from the Oak_EMS_06 site and the regional monitoring sites could be a function of the different habitats (soft-bottom versus hard-bottom) or the time of year the samples were taken, with the regional site sampling carried out in February, and Oak_EMS_06 in April.

Table 23: Macroinvertebrate taxa and indices recorded from Oak_EMS_06 (where R = 1-4, C = 5-19, A = 20-99, VA = 100-499 and VVA = 500+)

Site Name (Date	Oak-EMS-06 (13/04/2011)
Taxa Count	**Abundance**
Oxyethira	**C**
Paraoxyethira	**R**
Xanthocnemis	**R**
Austrosimulium	**C**
Orthocladiinae	**A**
Tabanidae	**R**
Collembola	**C**
Amphipoda	**A**
Copepoda	**R**
Ferrissia	**R**
Gyraulus	**R**
Lymnaea	**R**
Physa	**R**
Potamopyrgus	**VVA**
Oligochaeta	**C**
Hirudinea	**C**
Platyhelminthes	**R**
Nemertea	**R**
Taxa Abundance	4185
Taxa Richness	18
EPT (excluding *Oxyethira* and *Paroxyethira*)	0
MCI	66

Fish

Oak_EMS_06 had the highest diversity of any of the sites surveyed. Electric fishing revealed inanga (Galaxias maculatus), shortfin eels (*Anguilla australis*) and longfin eels (*Anguilla dieffenbachii*). In addition, 14 male and 14 female redfin bullies (*Gobiomorphus huttoni*) ranging from 30-55 mm and a gravid (carrying eggs) 120 mm female torrentfish (*Cheimarrichthys forsteri*) (Figure 12) were identified. The abundance and size range of all fish is included in Table 24.

The NIWA Freshwater Fish Database records additional species to those captured via electric fishing. These have been caught below the waterfall and are common bully (*Gobiomorphus cotidianus*) and common smelt (*Retropinna retropinna*). These were included in the IBI and SEV calculators for inclusion in this report.

The IBI based on the electric fishing only was 52 indicating Excellent biotic integrity. Based on the inclusion of NIWA Freshwater Fish Database records as well, the score increases to 58, still indicative of excellent biotic integrity

The efficacy of electric fishing was limited in parts of this survey reach due to water depth. As such it is possible that the full complement of species was not captured. This site is downstream of the Oakley Creek Waterfall, making it an end-point for fish that cannot navigate the barrier.

Refer Freshwater Fish Database Form Appendix B: Freshwater Fish Database Forms.

Table 24: Fish species and abundance data recorded at Oak_EMS_06.

Site Name	Oak_EMS_06	**Date**	20/05/2011
Common Name	**Scientific Name**	**Size Range**	**Frequency**
Inanga	*Galaxias maculatus*	50-80	1
Longfin Eel	*Anguilla dieffenbachii*	250-300	3
Redfin Bully (f)	*Gobiomorphus huttoni*	50-55	5
		30-40	9
Redfin Bully (m)	*Gobiomorphus huttoni*	40-45	7
		50	7
Shortfin Eel	*Anguilla australis*	200	1
		<100	8
		250-350	7
		150-250	2
Torrentfish	*Cheimarrichthys forsteri*	120	1
Unidentified Eel	*Anguilla* sp.	250-300	2
		50-100	2

Stream Ecological Valuation

The Oak_EMS_06 site has an overall SEV value of 0.624 indicating good ecological stream values and one of the highest scoring sites of those surveyed. Table 25 details the breakdown of this score.

The hydraulic function score is 0.49 reflecting excellent connectivity to groundwater (0.93) and floodplain (0.85) but reduced natural flow regime (0.16) due to high catchment imperviousness. A significant barrier to migration within this reach has severely impacted this score (0.02). The barrier is a natural, 6 m high waterfall which is perched and therefore restricts access to all species excluding anguilliforms. The reach is at the lower end of the catchment and therefore this barrier restricts access to a large area of potential habitat.

The biogeochemical function score is 0.68 which is good. Riparian cover is moderate, mostly a function of wide channels in parts and public reserve areas which are not planted. Organic matter input is low due to little overhanging deciduous vegetation. Dissolved oxygen is well maintained as flow is consistent and there are limited deposition zones.

Habitat provision is considered to be good (0.75), with a variety of pools, runs and riffles and macrophytes, boulders and undercut banks available to fauna. Provision of fish spawning habitat is excellent, with hard substrates in stream and good floodplains available.

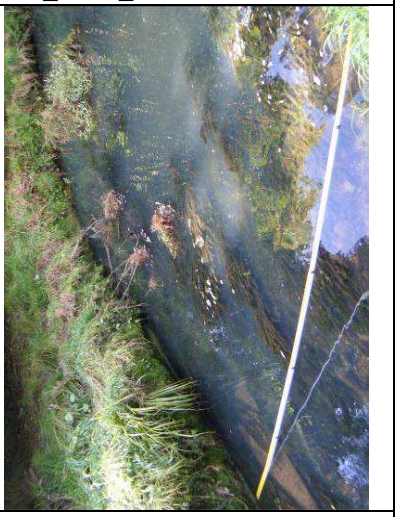
The biodiversity function scores well (0.61) at this site, particularly compared to the others surveyed. As the majority of the site was downstream of the waterfall barrier, fish fauna is well represented. A high diversity of fish species (0.97) and moderate riparian vegetation (0.60)

positively influenced the score. Macroinvertebrate fauna scored low (0.19), likely due to water quality rather than habitat availability.

Table 25: SEV function scores for Oak_EMS_06.

Site Name	Oak_EMS_06
Stream Name	Oakley Creek
Hydraulic	
Natural Flow Regime	0.16
Connectivity to flood-plain	0.85
Connectivity for migration	0.02
Connectivity to groundwater	0.93
Mean score	**0.49**
Biogeochemical	
Water temperature control	0.61
Dissolved oxygen maintained	1.00
Organic matter input	0.15
In-stream particle retention	0.52
Determination of pollutants	1.00
Flood-plain particle retention	0.79
Mean score	**0.68**
Habitat Provision	
Fish spawning habitat	0.88
Habitat for aquatic fauna	0.63
Mean score	**0.75**
Biodiversity	
Fish fauna intact	0.97
Invertebrate fauna intact	0.19
Aquatic biodiversity intact	0.70
Riparian vegetation intact	0.60
Mean score	**0.61**
SEV Value	**0.624**

SEV Transect Photographs

Oak_EMS_06 T1	Oak_EMS_06 T2	Oak_EMS_06 T3	Oak_EMS_06 T4	Oak_EMS_06 T5
				
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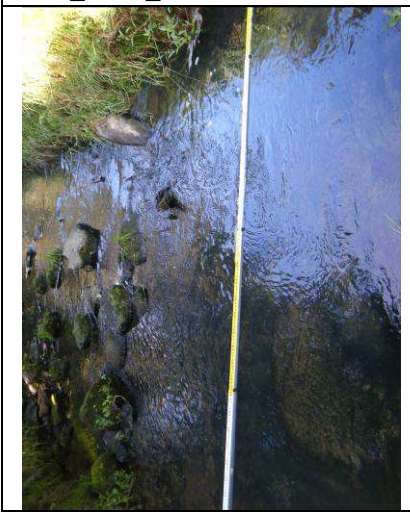
				

5.3 Meola Creek

The following summary information regarding Meola Creek has been obtained from the Meola Creek Watercourse Management Plan (Morphum Environmental Ltd, 2009a).

Meola Creek is an urban stream which flows from Mt Albert through to Point Chevalier, in the western suburbs of Auckland Central. Meola Creek flows through a highly modified urban watershed with approximately 64% catchment imperviousness. The high level of catchment imperviousness is reflected in the modified nature of the watercourse, particularly in the channelised, concrete lined and piped sections. Additionally, flow from the local groundwater aquifer contributes to baseflow via springs throughout the length of the watercourse.

In its upper reaches Meola Creek is highly modified and has been piped and walled in many locations to improve stormwater conveyance and minimise erosion. The degree of naturalness increases as the watercourse gets closer to the sea.

Some of the key values and characteristics of Meola Creek, making it unique and of interest include:

- The middle to lower reaches have high water clarity that can be attributed to the aquifer-fed spring flow through these areas;
- The stream mouth borders Meola Reef, park and reserve areas. It has a broad tidal area with a transitional interface from marine, brackish to freshwater ecologies;
- At the upper extent of the spring tide margin, included in the stream mouth, is a large area of potential inanga spawning habitat that is characterised by wide floodplain areas and sedges/grasses;
- A rare species of moss, Fissidens berteroi, is found in this area along Motions Road and would benefit significantly from surrounding habitat restoration and protection;
- A spring-fed wetland has recently been restored in the upper reaches of Roy Clements Treeway which is an important source of clean water to the creek; and
- Community interest in the waterway is high. In the reaches above Alberton Avenue, adjacent to Mt Albert Grammar School, the St Lukes Environmental Protection Society (STEPS) played an important part in the recently constructed Roy Clements Boardwalk project streamside planting programme.

Wai Care has recently implemented the Lower Meola Restoration Project in the lower catchment involving several community groups and schools.

5.3.1 Meo_EMS_01

Site Summary

Meo_EMS_01 is the most upstream site within the Meola Creek catchment (Figure 13). The site is located downstream of the Lyons Ave combined sewer overflow within Roy Clements Treeway. The banks are lined (Figure 14) in the upper section of the SEV reach, below the Lyons Ave comb9ined sewer overflow (CSO).

Frequent flooding within the Treeway led to a raised boardwalk being built by Council to reduce public contact with floodwaters containing wastewater and pollutants. Local community group St Lukes Environmental Protection Society (STEPS) worked with Council to undertake planting of the floodplain with native species to aid in pollutant removal and particle retention.

This site has been the subject of an SEV previously in January 2010 and scored an overall SEV score of 0.51. This was made up of the following scores; hydraulic (0.67), biogeochemical (0.57), habitat provision (0.52) and biodiversity (0.26).

Based on the SEV value (0.57) obtained in the recent survey in May 2011 the site has improved in ecological function since January 2010. This is likely to be due to the growth of the vegetation along the riparian margin and electric fishing revealing more fish species than previously.

Another factor that is likely to have influenced the change in score is the season in which the SEV was carried out. January 2010 was very dry and little rain had fallen in the time leading up to the SEV. Therefore the groundwater inputs from the aquifer were limited, compared to May 2011 when the aquifer had more water in it, therefore increasing baseflow in the stream. It is expected that this has influenced the score as well.

Figure 13: Meo_EMS_01 looking upstream, with the floodplain planting on the true right bank.

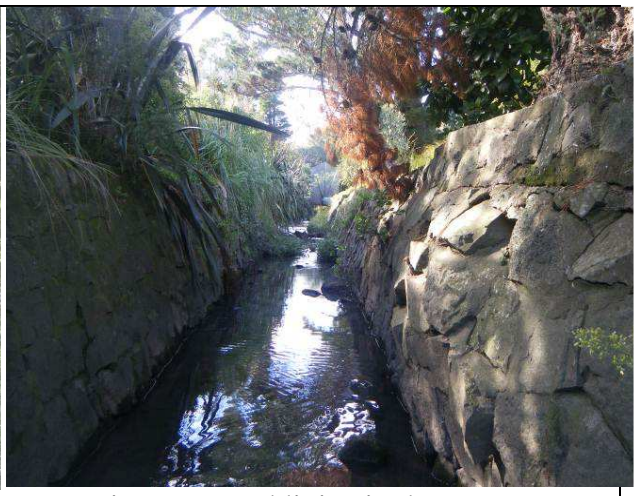


Figure 14: Banklining in the upper Meo_EMS_01 SEV survey reach.

Habitat Summary

The habitat at this site is considered to be of low value, with bank and channel modification evident in parts. Riparian vegetation is improving following community planting, however is restricted to low growing grass species rather than those that provide shade. Fine sediments deposition and macrophytes instream reduce habitat heterogeneity.

Macroinvertebrates

Macroinvertebrate taxa and indices are included in Table 26. No EPT taxa were found in the sample taken at Meo_EMS_01. Typically macroinvertebrate sampling is undertaken during summer months. As the samples taken in this monitoring programme were taken later the score may have been influenced by increased flows and seasonal differences. The MCI score of 55 is indicative of poor water quality (Table 4).

Table 26: Macroinvertebrate taxa and indices recorded from Meo_EMS_01 (where R = 1-4, C = 5-19, A = 20-99, VA = 100-499 and VVA = 500+)

Site Name (Date	Meo_EMS_01 (12/04/2011)
Taxa Count	**Abundance**
Oxyethira	**C**
Chironomus	**A**
Orthocladiinae	**VVA**
Polypedilum	**A**
Collembola	**VA**
Acarina	**R**
Cladocera	**R**
Ostracoda	**R**
Lymnaea	**R**
Physa	**R**
Potamopyrgus	**VA**
Oligochaeta	**A**
Hirudinea	**A**
Platyhelminthes	**C**
Nematoda	**R**
Taxa Abundance	1771
Taxa Richness	15
EPT (excluding *Oxyethira* and *Paroxyethira*)	0
MCI-sb	55

Fish

Electric fishing revealed shortfin eels (*Anguilla australis*) and longfin eels (*Anguilla dieffenbachii*). Only four longfin eels were identified ranging in size from 250-350 mm. One shortfin eel and one unidentified eel were approximately 600 mm long, while most other shortfin eels ranged between 200 and 450 mm. The abundance and size range of all fish is included in **Error! Not a valid bookmark self-reference.**7.

The NIWA Freshwater Fish Database records no additional species to those captured via electric fishing. The IBI score for Meo_EMS_01 was 32 indicating Fair biotic integrity.

The efficacy of electric fishing was limited in parts of this survey reach due to extensive macrophyte cover. As such individuals became tangled in the weed restricting capacity for capture and identification. It is possible that the full complement of species was not captured.

Refer Freshwater Fish Database Form Appendix B: Freshwater Fish Database Forms.

Table 27: Fish species and abundance data recorded at Meo_EMS_01.

Site Name	Meo_EMS_01	**Date**	20/05/2011
Common Name	**Scientific Name**	**Size Range**	**Frequency**
Longfin Eel	*Anguilla dieffenbachii*	250-300	2
		300-350	2
Shortfin Eel	*Anguilla australis*	>600	1
		100-150	1
		250-350	7
		400-450	1
		200-350	4
Unidentified Eel	*Anguilla* sp.	550-600	1
		50-100	1
		150-250	2
		300-350	9
		200-250	5
		400-450	2

Stream Ecological Valuation

The Meo_EMS_01 site has an overall SEV value of 0.574 indicating moderate ecological stream values. Table 28 details the breakdown of this score.

Table 28: SEV function score for Meo_EMS_01.

Site Name	Meo_EMS_01
Stream Name	Meola Creek
Hydraulic	
Natural Flow Regime	0.07
Connectivity to flood-plain	1.00
Connectivity for migration	1.00
Connectivity to groundwater	0.62
Mean score	**0.67**
Biogeochemical	
Water temperature control	0.64
Dissolved oxygen maintained	0.23
Organic matter input	0.34
In-stream particle retention	0.75
Determination of pollutants	1.00
Flood-plain particle retention	0.92
Mean score	**0.65**
Habitat Provision	
Fish spawning habitat	0.88
Habitat for aquatic fauna	0.29
Mean score	**0.58**
Biodiversity	
Fish fauna intact	0.53
Invertebrate fauna intact	0.09
Aquatic biodiversity intact	0.35
Riparian vegetation intact	0.48
Mean score	**0.36**
SEV Value	**0.574**

The hydraulic function score is 0.67 reflecting excellent connectivity for migration (1.00) and floodplain (1.00) but reduced natural flow regime (0.07) due to high catchment imperviousness. The reach is bank lined for a significant portion and due to its location in the catchment experiences flooding frequently.

The biogeochemical function score is 0.65 which is good. The riparian margin along the reach has been the subject of riparian planting by local community. These plants are typically floodplain species and are low growing providing little shade and organic input. Dissolved oxygen maintained scored poorly in this reach due to extensive deposition zones and poor quality water inputs from combined sewer overflows. Good in stream particle retention and determination of pollutants brought this score up.

Habitat provision is considered to be moderate (0.58) despite a relatively poor availability of habitat in stream (0.29). Provision of fish spawning habitat is excellent (0.88), with hard substrates in stream and good floodplains available.

The biodiversity function scores poorly (0.36) at this site. Fish fauna is moderate (0.53) which is largely due to the distance inland, rather than species diversity. Macroinvertebrate fauna was low (0.09) with riparian vegetation intactness scoring 0.48 and bringing the score up a little. Water quality issues within this reach are compounded by sediment deposition and poor dissolved oxygen, affecting the macroinvertebrate fauna present within the reach.

SEV Transect Photographs

Meo_EMS_01 T1	Meo_EMS_01 T2	Meo_EMS_01 T3	Meo_EMS_01 T4	Meo_EMS_01 T5
				
Meo_EMS_01 T6	Meo_EMS_01 T7	Meo_EMS_01 T8	Meo_EMS_01 T9	Meo_EMS_01 T10
				

5.3.2 Meo_EMS_02

Site Summary

Meo_EMS_02 is located adjacent to Rawalpindi Reserve, Mt Albert. Habitat monitoring has been undertaken previously in proximity to this site.

This reach of Meola Creek is bank lined with gabion baskets in the upper section and has a partially concrete lined channel. The reach's lower section is natural and rock lined on the banks. The true right bank is covered by extensive exotic vegetation for a width of approximately 10 metres, until it reaches the border of the Chamberlain Park Golf Course. The true left bank has some exotic vegetation directly on the riparian margin which is surrounded by extensive mown grass in the reserve.

Upstream of the SEV reach the creek is bordered by residential properties, with varying amounts of riparian vegetation present. Downstream the creek passes through the Chamberlain Park Golf Course where the channel becomes wide and shallow.

During the course of other work in the creek in the months preceding the EMS work, large shoals of inanga were observed in the reach immediately downstream of the SEV (Figure 16). In addition, inanga have been recorded upstream of the SEV reach.

Figure 15: Meo_EMS_02 site, looking upstream.

Figure 16: A large shoal of inanga in the reach immediately downstream of the SEV.

Habitat Summary

The habitat at this site is considered to be of moderate value, with some riparian vegetation present. Gabion baskets line the banks and provide similar habitat to bank undercuts. In-stream heterogeneity is adequate, with algae covering hard surfaces and little macrophyte coverage.

Macroinvertebrates

Macroinvertebrate taxa and indices are included in Table 29. No EPT taxa were found in the sample taken at Meo_EMS_02. Typically macroinvertebrate sampling is undertaken during summer months. As the samples taken in this monitoring programme were taken later the score may have been influenced by increased flows and seasonal differences. The MCI score of 59 is

indicative of poor water quality (Table 4); however is one of the highest scores obtained from the urban streams surveyed.

Table 29: Macroinvertebrate taxa and indices recorded from Meo_EMS_02

(where R = 1-4, C = 5-19, A = 20-99, VA = 100-499 and VVA = 500+)

Site Name (Date	Meo_EMS_02 (12/04/2011)
Taxa Count	**Abundance**
Oxyethira	**VA**
Xanthocnemis	**C**
Austrosimulium	**VA**
Chironomus	**C**
Muscidae	**R**
Orthocladiinae	**VVA**
Polypedilum	**VA**
Tanytarsini	**A**
Collembola	**R**
Amphipoda	**VVA**
Ostracoda	**R**
Gyraulus	**C**
Lymnaea	**R**
Physa	**R**
Potamopyrgus	**VA**
Oligochaeta	**A**
Hirudinea	**C**
Platyhelminthes	**R**
Nemertea	**R**
Taxa Abundance	3430
Taxa Richness	19
EPT (excluding *Oxyethira* and *Paroxyethira*)	0
MCI	59

Fish

Electric fishing at Meo_EMS_02 revealed shortfin eels (*Anguilla australis*), unidentified eels (*Anguilla* sp.) and one common bully (*Gobiomorphus cotidianus*). The abundance and size range of all fish is included in Table 30.

The NIWA Freshwater Fish Database records additional species to those captured via electric fishing. Inanga (*Galaxias maculatus*), longfin eels (*Anguilla dieffenbachii*) and banded kokopu (*Galaxias fasciatus*) have also been recorded at this site.

The IBI score for Meo_EMS_02 was 24 indicating Poor biotic integrity. However, based on the inclusion of the species recorded elsewhere the score increases to 52, indicative of Excellent biotic integrity.

The efficacy of electric fishing was limited in parts of this survey reach due to extensive macrophyte cover. As such individuals became tangled in the weed restricting capacity for capture and identification. It is possible that the full complement of species was not captured.

Refer Freshwater Fish Database Form Appendix B: Freshwater Fish Database Forms.

Table 30: Fish species and abundance data recorded at Mot_EMS_01.

Site Name	Meo_EMS_02	Date	10/05/2011
Common Name	**Scientific Name**	**Size Range**	**Frequency**
Common Bully	*Gobiomorphus cotidianus*	50	1
Shortfin Eel	*Anguilla australis*	100-150	5
		200-350	18
		500	1
		650	1
Unidentified Eel	*Anguilla* sp.	50-100	2
		150-250	15
		300-350	5

Stream Ecological Valuation

The Meo_EMS_02 site has an overall SEV value of 0.591 indicating moderate ecological stream values. Table 31 details the breakdown of this score.

The hydraulic function score is 0.55 reflecting excellent connectivity for migration (1.00) but reduced natural flow regime (0.06) due to high catchment imperviousness. The reach is bank lined with gabion baskets for a significant portion.

The biogeochemical function score is 0.705 which is good. The riparian margin along the reach is mostly limited to the TRB with a public reserve on the TLB. Dissolved oxygen maintained and determination of pollutants scored well in this reach. Organic matter input is the limiting function in this section due to poor deciduous canopy cover directly over the stream.

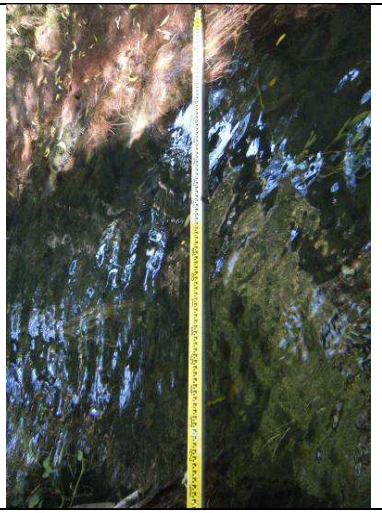
Habitat provision is considered to be moderate (0.54) with both spawning habitat and habitat instream scoring moderately. The presence of boulders and pools within the stream is likely to have influenced this score. Gabion baskets along the banks also provided some habitat, where despite poor undercut banks, eels were seen swimming in and out between the rocks of the gabions.

The biodiversity function scores moderately (0.49) at this site. Fish fauna is excellent (0.87) with several species recorded at this site overtime. As at other sites, macroinvertebrate fauna was low (0.19) a likely results of water quality issues within this reach rather than habitat availability.

Table 31: SEV function scores for Meo_EMS_02.

Site Name	Meo_EMS_02
Stream Name	Meola Creek
Hydraulic	
Natural Flow Regime	0.08
Connectivity to flood-plain	0.60
Connectivity for migration	1.00
Connectivity to groundwater	0.54
Mean score	**0.55**
Biogeochemical	
Water temperature control	0.73
Dissolved oxygen maintained	1.00
Organic matter input	0.32
In-stream particle retention	0.58
Determination of pollutants	1.00
Flood-plain particle retention	0.58
Mean score	**0.70**
Habitat Provision	
Fish spawning habitat	0.56
Habitat for aquatic fauna	0.52
Mean score	**0.54**
Biodiversity	
Fish fauna intact	0.87
Invertebrate fauna intact	0.19
Aquatic biodiversity intact	0.60
Riparian vegetation intact	0.30
Mean score	**0.49**
SEV Value	**0.591**

SEV Transect Photographs

Meo_EMS_02 T1	Meo_EMS_02 T2	Meo_EMS_02 T3	Meo_EMS_02 T4	Meo_EMS_02 T5
				
Meo_EMS_02 T6	**Meo_EMS_02 T7**	**Meo_EMS_02 T8**	**Meo_EMS_02 T9**	**Meo_EMS_02 T10**
				

5.3.3 Meo_EMS_03

Site Summary

Meo_EMS_03 is located in the section of creek flowing parallel to Motions Road, Point Chevalier (Figure 17). The site is situated immediately above the ARC flow monitoring weir and provides habitat to the rare native moss, *Fissidens berteroi* (Bodmin, 2009).

Both banks are covered by some native and extensive exotic vegetation, to a width of greater than 10 metres through the majority of the reach, with environmental weeds such as crack willow (*Salix fragilis*), tobacco weed (*Solanum mauritianum*) and tradescantia abundant.

The channel substrate is bouldery, with abundant macrophytes present (eelgrass, *Vallisneria spiralis*) (Figure 18) and some fine sediment loading. Groundwater springs influence the lower reaches of Meola Creek.

This section of Meola Creek forms part of the Lower Meola Restoration Project taking place in the area (Morphum Environmental Ltd, 2011). Revegetation and weed control are the key activities that will be carried out in the area, however clean-ups and pest monitoring may take place in future.

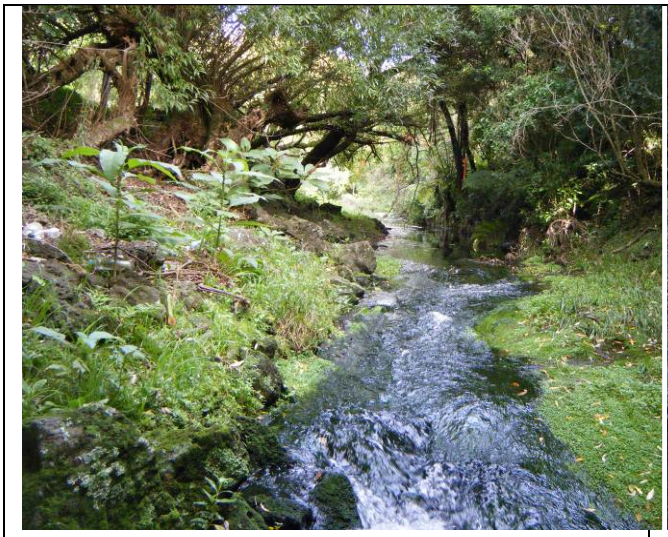


Figure 17: Meo_EMS_03 site, looking upstream.

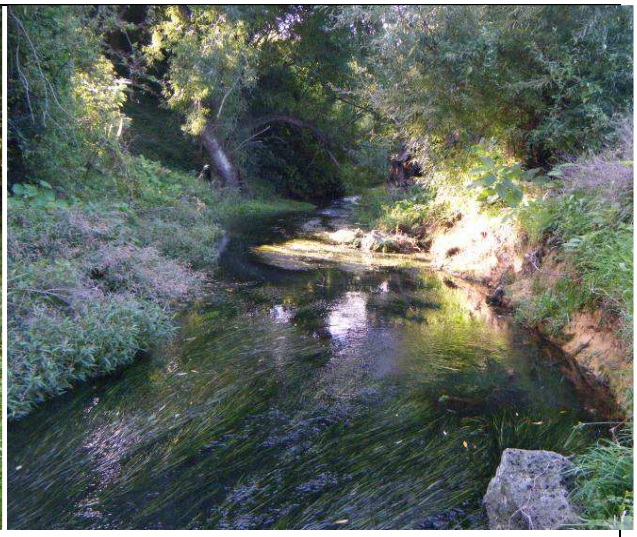


Figure 18: Looking downstream, showing extensive macrophyte biomass (Eelgrass).

Habitat Summary

The habitat at this site is considered to be of good value, with riparian vegetation providing shade throughout the reach. Runs, riffles and pools are present and coupled with macrophytes provide suitable habitat for aquatic fauna.

Macroinvertebrates

Macroinvertebrate taxa and indices are included in Table 32. No EPT taxa were found in the sample taken at Meo_EMS_03. Typically macroinvertebrate sampling is undertaken during summer months. As the samples taken in this monitoring programme were taken later the score may have been influenced by increased flows and seasonal differences. The MCI score of 64 is

indicative of poor water quality (Table 4) and is one of the highest scores obtained of the sites surveyed.

Table 32: Macroinvertebrate taxa and indices recorded from Mot_EMS_01 (where R = 1-4, C = 5-19, A = 20-99, VA = 100-499 and VVA = 500+)

Site Name (Date	Meo_EMS_03 (08/04/2011)
Taxa Count	**Abundance**
Oxyethira	**VA**
Xanthocnemis	**VA**
Austrosimulium	**VA**
Orthocladiinae	**VA**
Polypedilum	**R**
Collembola	**R**
Amphipoda	**VVA**
Paratya	**R**
Ferrissia	**R**
Gyraulus	**C**
Physa	**C**
Potamopyrgus	**VVA**
Oligochaeta	**R**
Hirudinea	**VA**
Platyhelminthes	**R**
Taxa Abundance	8893
Taxa Richness	15
EPT (excluding *Oxyethira* and *Paroxyethira*)	0
MCI	64

Fish

Electric fishing at Meo_EMS_03 revealed shortfin eels (*Anguilla australis*), longfin eels (*Anguilla dieffenbachii*) unidentified eels (*Anguilla* sp.) and three inanga (*Galaxias maculatus*). The size range of longfin and unidentified eels was 250 – 300mm, shortfin eels ranged from 150 – 350mm. The abundance and size range of all fish is included in Table 33.

The efficacy of electric fishing was limited in this site due to water depth and access. As such it is expected that the full complement of species was not captured.

The NIWA Freshwater Fish Database records additional species to those captured via electric fishing. Banded kokopu (*Galaxias fasciatus*) and Common bully (*Gobiomorphus cotidianus*) have also been recorded at this site. These species were included in the IBI and SEV calculator.

The IBI score for Meo_EMS_03 was 38 indicating Good biotic integrity. However, based on the inclusion of the species recorded elsewhere the score increases to 52, indicative of Excellent biotic integrity.

Refer Freshwater Fish Database Form Appendix B: Freshwater Fish Database Forms.

Table 33: Fish species and abundance data recorded at Meo_EMS_03.

Site Name	Meo_EMS_03	Date	10/05/2011
Common Name	**Scientific Name**	**Size Range**	**Frequency**
Inanga	*Galaxias maculatus*	50-80	1 (male)
		80-120	1
Longfin Eel	*Anguilla dieffenbachii*	<100-150	5
		250-300	3
		200-350	2
Shortfin Eel	*Anguilla australis*	250-350	2
		150-250	7
		300-400	1
Unidentified Eel	*Anguilla* sp.	550-600	1
		150-200	10
		250-300	15

Stream Ecological Valuation

The Meo_EMS_03 site has an overall SEV value of 0.608 indicating moderate ecological stream values.

Table 34 details the breakdown of this score.

Table 34: SEV function scores for Meo_EMS_03.

Site Name	Meo_EMS_03
Stream Name	Meola Creek
Hydraulic	
Natural Flow Regime	0.08
Connectivity to flood-plain	0.70
Connectivity for migration	1.00
Connectivity to groundwater	0.82
Mean score	**0.65**
Biogeochemical	
Water temperature control	0.73
Dissolved oxygen maintained	0.48
Organic matter input	0.51
In-stream particle retention	0.45
Determination of pollutants	1.00
Flood-plain particle retention	0.64
Mean score	**0.63**
Habitat Provision	
Fish spawning habitat	0.88
Habitat for aquatic fauna	0.50
Mean score	**0.69**
Biodiversity	
Fish fauna intact	0.87
Invertebrate fauna intact	0.19
Aquatic biodiversity intact	0.54
Riparian vegetation intact	0.37
Mean score	**0.49**
SEV Value	**0.608**

The hydraulic function score is 0.65 reflecting excellent connectivity for migration (1.00) and connectivity to groundwater (0.82) but reduced natural flow regime (0.08) due to high catchment imperviousness.

The biogeochemical function score is 0.63 which is good. The riparian margin is typically good, but sections have no canopy cover which has influenced the water temperature control score (0.73). Dissolved oxygen maintained is reduced due to abundant macrophytes causing sediment deposition. Various substrate sizes are present which means that determination of pollutants scores well in this reach.

Habitat provision is considered to be good (0.69) with both spawning habitat scoring well (0.88). The instream habitat function score is reduced by abundant macrophytes, however benefits from a wide range of geomorphic units present (pools, riffles, runs).

The biodiversity function scores moderately (0.49) at this site. Fish fauna is excellent (0.87) with several species recorded at this site overtime. As at other sites, macroinvertebrate fauna was low (0.19) a likely results of water quality issues within this reach rather than habitat availability. Sections of poor riparian cover in an otherwise good reach have influenced this score (0.37).

SEV Transect Photographs

Meo_EMS_03 T1	Meo_EMS_03 T2	Meo_EMS_03 T3	Meo_EMS_03 T4	Meo_EMS_03 T5
				
Meo_EMS_03 T6	Meo_EMS_03 T7	Meo_EMS_03 T8	Meo_EMS_03 T9	Meo_EMS_03 T10
				

5.3.4 Meo_EMS_04

Site Summary

Meo_EMS_04 is the most downstream site within the Meola Creek catchment (Figure 19). This site is located downstream of Pasadena Intermediate, adjacent to the Te Mahurehure Marae, private residences and MOTAT property boundaries.

The channel is wide and deep in parts, with saline influence downstream of the reach surveyed. The lower section of the reach is characterised by anaerobic silt in most places, with woody debris and some concrete lining present. Moving up the reach the substrate becomes bouldery with rapids and pools present.

Midway through the reach, two flat sections jut out into the creek. These were identified as Restoration Opportunities in the WMP, due to their potential for inanga (*Galaxias maculatus*) spawning (Figure 20).

While undertaking the SEV, two unidentified bullies (*Gobiomorphus* sp.) and two unidentified eels (*Anguilla* sp.) were seen in the lower part of the reach.

This section of Meola Creek is part of the Lower Meola Restoration Project (Morphum Environmental Ltd, 2011). Revegetation and weed control are the key activities that will be carried out in the area. Inanga spawning monitoring, clean-ups and pest monitoring are other activities that may take place in the future.

Figure 19: Meo_EMS_04 site, looking upstream.

Figure 20: Potential inanga spawning site.

Habitat Summary

The habitat at this site is considered to be of moderate value, with wide channels limiting the capacity for shading from riparian margins. The site is located immediately above the tidal influence and as such is considered a depositional zone. Fine sediment in the lower section of the reach reduces substrate heterogeneity. In the upper reach, instream heterogeneity is adequate, with algae covering hard surfaces and little macrophyte coverage.

Macroinvertebrates

Macroinvertebrate taxa and indices are included inTable 35. One EPT taxa was found in the sample taken at Meo_EMS_04; this was two *Triplectides* caddisflies. Typically macroinvertebrate

sampling is undertaken during summer months. As the samples taken in this monitoring programme were taken later the score may have been influenced by increased flows and seasonal differences. The MCI score of 75 is indicative of poor water quality (Table 4); however is the highest score obtained from the urban streams surveyed.

Table 35: Macroinvertebrate taxa and indices recorded from Meo_EMS_04 (where R = 1-4, C = 5-19, A = 20-99, VA = 100-499 and VVA = 500+)

Site Name (Date)	Meo_EMS_04 (01/06/2011)
Taxa Count	**Abundance**
Oxyethira	**A**
Paraoxyethira	**R**
Triplectides	**R**
Xanthocnemis	**R**
Orthocladiinae	**VA**
Polypedilum	**VA**
Tanypodinae	**R**
Tanytarsini	**R**
Collembola	**R**
Acarina	**C**
Amphipoda	**VA**
Isopoda	**C**
Ostracoda	**R**
Paratya	**R**
Potamopyrgus	**VVA**
Oligochaeta	**VA**
Platyhelminthes	**C**
Taxa Abundance	2663
Taxa Richness	17
EPT (excluding *Oxyethira* and *Paroxyethira*)	1
MCI	75

Fish

Electric fishing was not undertaken at this site due to its proximity to the tidal influence, sediment deposition and safety. While carrying out the SEV fish were observed and recorded. These were an unidentified bully (*Gobiomorphus* sp.) (Figure 21) and an unidentified eel (*Anguilla* sp.) (Figure 22).

The IBI score used in the SEV calculator is based on the NIWA Freshwater Fish Database information. The database records yellow eye mullet (Aldrichetta forsteri), shortfin eel (*Anguilla australis*), longfin eel (*Anguilla dieffenbachii*), torrentfish (*Cheimarrichthys forsteri*), inanga (*Galaxias maculatus*) and common bully (*Gobiomorphus cotidianus*). The IBI score for Meo_EMS_04 was 44 indicating Very Good biotic integrity. No Freshwater Fish Database Form is included for this site.

Figure 21: Unidentified bully (*Gobiomorphus sp.*).

Figure 22: Unidentified eel (*Anguilla sp.*) observed.

Stream Ecological Valuation

The Meo_EMS_04 site has an overall SEV value of 0.645 indicating good ecological stream values and one of the highest scoring sites of the ones surveyed. Table 36 details the breakdown of this score.

Table 36: SEV function scores for Meo_EMS_04.

Site Name	Meo_EMS_04
Stream Name	Meola Creek
Hydraulic	
Natural Flow Regime	0.08
Connectivity to flood-plain	0.85
Connectivity for migration	1.00
Connectivity to groundwater	0.83
Mean score	**0.69**
Biogeochemical	
Water temperature control	0.57
Dissolved oxygen maintained	0.75
Organic matter input	0.24
In-stream particle retention	0.65
Determination of pollutants	1.00
Flood-plain particle retention	0.78
Mean score	**0.66**
Habitat Provision	
Fish spawning habitat	0.88
Habitat for aquatic fauna	0.56
Mean score	**0.72**
Biodiversity	
Fish fauna intact	0.73
Invertebrate fauna intact	0.33
Aquatic biodiversity intact	0.57
Riparian vegetation intact	0.52
Mean score	**0.54**
SEV Value	**0.645**

The hydraulic function score is 0.69 reflecting excellent connectivity but reduced natural flow regime (0.08) due to high catchment imperviousness.

The biogeochemical function score is 0.66 which is good. Extensive floodplain area of the TRB has reduced the extent of the riparian margin which has influenced the water temperature control score (0.57) and organic matter input (0.24). The dissolved oxygen maintained function is good however some deposition in the lower part of the reach reduced the score (0.75).

Habitat provision is considered to be good (0.72) with spawning habitat scoring well (0.88). The large area of floodplain provides spawning habitat for inanga (*Galaxias maculatus*) and cobbles in stream are suitable for bullies (*Gobiomorphus* sp.) spawning. In stream habitat is better in the upper half of the reach however fish were observed in the lower part while undertaking surveying.

The biodiversity function scores moderately (0.54) at this site. Fish fauna is good (0.73) with records limited only to what has been recorded in the freshwater fish database and species observed during fieldwork. Macroinvertebrate fauna was low (0.33), however scored better than most other sites. This may be due to dilution of pollutants by groundwater inputs which are prevalent in this section of the creek.

SEV Transect Photographs

Meo_EMS_04 T1	Meo_EMS_04 T2	Meo_EMS_04 T3	Meo_EMS_04 T4	Meo_EMS_04 T5
				
Meo_EMS_04 T6	**Meo_EMS_04 T7**	**Meo_EMS_04 T8**	**Meo_EMS_04 T9**	**Meo_EMS_04 T10**
				

5.4 Cox's Creek

Cox's Creek is a tidal channel that flows through Cox's Bay Reserve before entering Waitemata Harbour. The creek is fed by a number of stormwater outlets that drain the Grey Lynn catchment, and from time to time it also receives sewer network overflows.

Cox's Creek has been significantly modified during the last 100 years, including the formation of a causeway (West End Road), land reclamation (Cox's Bay Reserve) and channel alignment changes with a history of dredging and bunding.

Poor water quality and odour have long been a problem at Cox's Creek. Studies have been undertaken to assess the causes of the pollution issues and the most effective management options for the creek. Recent physical works (including sediment removal) have been undertaken in the lower catchment, downstream of the study site, to improve amenity and water quality.

5.4.1 Cox_EMS_01

Site Summary

Cox_EMS_01 site is located on the Kelmarna arm of Cox's Creek, upstream of Bayfield Park and Cox's Bay Reserve and downstream of a piped section of creek (Figure 23). The site is adjacent to private properties with some riparian vegetation on the true right bank, and a walkway and native vegetation canopy on the true left bank.

The lower section of the reach is characterised by a narrow channel cut into bedrock, with some deep pools and fine sediment present. In the upper section the channel widens and anaerobic sediment is present. Sewage fungus was observed at the upper extent of the reach at the main outfall to the stream.

While undertaking the SEV, prior to electric fishing, an unidentified eel (*Anguilla* sp.) was observed in the upper part of the reach.

Figure 23: Cox_EMS_01 site, looking upstream.

Figure 24: Perched culvert at upper extent of the reach surveyed.

Habitat Summary

The habitat at this site is considered to be of moderate value, with good riparian vegetation and natural bedrock banks evident. In-stream heterogeneity is adequate, with pools, runs and chutes present at varying depths. Algae covers the majority of the bedrock surfaces, except in the upper reaches where sediment deposition has occurred.

Macroinvertebrates

Macroinvertebrate taxa and indices are included in Table 37. No EPT taxa were found in the sample taken at Cox_EMS_01. Typically macroinvertebrate sampling is undertaken during summer months. As the samples taken in this monitoring programme were taken later the score may have been influenced by increased flows and seasonal differences. The MCI score of 59 is indicative of poor water quality Table 4 and was the lowest score of all sites surveyed.

Table 37: Macroinvertebrate taxa and indices recorded from Mot_EMS_01 (where R = 1-4, C = 5-19, A = 20-99, VA = 100-499 and VVA = 500+)

Site Name (Date)	Cox_EMS_01 (08/04/2011)
Taxa Count	**Abundance**
Chironomus	**VA**
Orthocladiinae	**A**
Polypedilum	**VVA**
Psychodidae	**A**
Tanytarsini	**VA**
Collembola	**C**
Ostracoda	**R**
Paratya	**R**
Ferrissia	**A**
Gyraulus	**R**
Physa	**VA**
Potamopyrgus	**R**
Oligochaeta	**VA**
Platyhelminthes	**A**
Nemertea	**R**
Taxa Abundance	1930
Taxa Richness	15
EPT (excluding *Oxyethira* and *Paroxyethira*)	0
MCI	59

Fish

Electric fishing at Cox_EMS_01 revealed shortfin eels (*Anguilla australis*). Two were <100mm in size and three were between 150 – 250mm. The abundance and size range of all fish is included in Table 38.

Table 38: Fish species and abundance data recorded at Cox_EMS_01.

Site Name	Cox_EMS_01	Date	19/05/2011
Common Name	**Scientific Name**	**Size Range**	**Frequency**
Shortfin Eel	*Anguilla australis*	<100	2
		100-150	7
		150-250	3
		300-400	1
Unidentified Eel	*Anguilla* sp.	100-350	11

The efficacy of electric fishing may have been limited at this site due to water quality as anaerobic sediment reduced conductivity and visibility instream. As such the full complement of species may not have been captured.

The NIWA Freshwater Fish Database records no additional species to that captured via electric fishing.

The IBI score for Cox_EMS_01 was 14 indicating Very Poor biotic integrity a possible result of poor water quality.

Refer Freshwater Fish Database Form Appendix B: Freshwater Fish Database Forms.

Stream Ecological Valuation

The Cox_EMS_01 site has an overall SEV value of 0.513 indicating moderate ecological stream values. Table 39 details the breakdown of this score.

The hydraulic function score is quite low (0.42) reflecting excellent connectivity to groundwater but poor natural flow regime (0.08) due to high catchment imperviousness. The site is in the upper catchment with natural steep banks which reduces the frequency of flooding, impacting the connectivity to floodplain score. In addition, a small barrier (lip of a culvert) in stream is likely to affect some swimming species at low flows and has reduced the hydraulic score.

Table 39: SEV function scores for Cox_EMS_01.

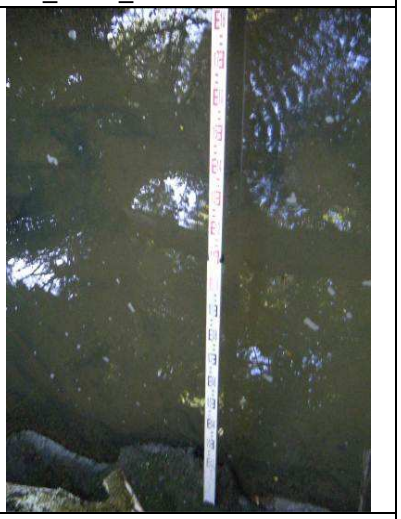
Site Name	Cox_EMS_01
Stream Name	Cox's Creek
Hydraulic	
Natural Flow Regime	0.08
Connectivity to flood-plain	0.50
Connectivity for migration	0.18
Connectivity to groundwater	0.91
Mean score	**0.42**
Biogeochemical	
Water temperature control	0.71
Dissolved oxygen maintained	0.82
Organic matter input	0.74
In-stream particle retention	0.58
Determination of pollutants	0.98
Flood-plain particle retention	0.46
Mean score	**0.72**
Habitat Provision	
Fish spawning habitat	0.53
Habitat for aquatic fauna	0.59
Mean score	**0.56**
Biodiversity	
Fish fauna intact	0.23
Invertebrate fauna intact	0.00
Aquatic biodiversity intact	0.20
Riparian vegetation intact	0.68
Mean score	**0.28**
SEV Value	**0.513**

The biogeochemical function score is 0.72 which is good. Naturally steep banks and good riparian cover have bought this score up, with in stream (0.58) and floodplain (0.46) particle retention scores slightly lower.

Habitat provision is considered to be moderate (0.56). Poor floodplain connectivity has reduced the score for spawning habitat. Instream habitat is varied including pools, riffles, chutes and root mats.

The biodiversity function scores poorly (0.28) at this site. Fish fauna is poor (0.23) which is possibly due to the presence of a barrier to migration downstream of the surveyed reach. Macroinvertebrate fauna was very poor (0.00), which is likely due to water quality issues rather than habitat availability. Immediately upstream of the surveyed reach is the discharge point of one of the oldest combined sewer overflows within central Auckland. Riparian vegetation (0.68) scores well in this section however, bringing the score up.

SEV Transect Photographs

Cox_EMS_01 T1	Cox_EMS_01 T2	Cox_EMS_01 T3	Cox_EMS_01 T4	Cox_EMS_01 T5
				
Cox_EMS_01 T6	Cox_EMS_01 T7	Cox_EMS_01 T8	Cox_EMS_01 T9	Cox_EMS_01 T10
				

5.5 Edgars Creek

Edgars Creek flows through Francis Reserve and Wellpark Reserve before going under Warnock Street and discharging to Cox's Bay via the lower end of Cox's Creek. The creek has been the subject of Wai Care monitoring by Westmere Primary School and has been revegetated in parts.

5.5.1 Edg_EMS_01

Site Summary

Edg_EMS_01 is in the downstream section of the Edgars Creek catchment, upstream of the tidal influence (Figure 25). This site is adjacent to residential properties on the true right and left banks and is upstream of Cox's Bay Park.

The SEV site is downstream of Wellpark and Francis Reserves, which has had some riparian restoration planting undertaken by the Grey Lynn 2030 community group and Westmere Primary School. Banded kokopu (*Galaxias fasciatus*) and unidentified eels (*Anguilla* sp.) have been observed in both reserves, prior to the SEV taking place. Both juvenile and adult banded kokopu have been observed, with seasonal reduction in fish numbers followed by juvenile numbers increasing indicating successful spawning.

The SEV site has some riparian cover but is largely open with both native and exotic vegetation present, including large oak trees and prolific tradescantia causing the riparian margin to be unstable. Some private property owners have landscaped to the edge of the riparian margin (Figure 25).

The channel is narrow and shallow throughout the reach, with abundant fine sediment present. In some parts of the reach the channel disappears under sediment and debris (Figure 26), it was not possible to assess the ecological value in these areas. Three transects were not assessed because the channel was not visible.

Figure 25: Edg_EMS_01 site, looking upstream. Private landscaping in part of the reach.

Figure 26: Channel not visible due to debris present.

Habitat Summary

The habitat at this site is considered to be of low value, with poor riparian vegetation and extensive sediment deposition evident. Slow-flowing or stagnant water is typical, likely a result of debris jams.

Macroinvertebrates

Macroinvertebrate taxa and indices are included in Table 40. No EPT taxa were found in the sample taken at Edg_EMS_01. Typically macroinvertebrate sampling is undertaken during summer months. As the samples taken in this monitoring programme were taken later the score may have been influenced by increased flows and seasonal differences. The MCI score of 69 is indicative of poor water quality (Table 4); however is one of the highest scores obtained from the urban streams surveyed.

Table 40: Macroinvertebrate taxa and indices recorded from Mot_EMS_01 (where R = 1-4, C = 5-19, A = 20-99, VA = 100-499 and VVA = 500+)

Site Name (Date)	Edg_EMS_01 (08/04/2011)
Taxa Count	**Abundance**
Microvelia	**A**
Scirtidae	**A**
Chironomus	**A**
Culicidae	**VA**
Polypedilum	**VA**
Tanytarsini	**VA**
Collembola	**R**
Acarina	**R**
Copepoda	**R**
Isopoda	**R**
Ostracoda	**A**
Physa	**C**
Potamopyrgus	**C**
Sphaeriidae	**VA**
Oligochaeta	**VA**
Platyhelminthes	**VVA**
Nematoda	**R**
Nemertea	**R**
Taxa Abundance	3430
Taxa Richness	19
EPT (excluding *Oxyethira* and *Paroxyethira*)	0
MCI-sb	69

Fish

Electric fishing was not carried out at this site due to insufficient water depth and sediment, which, when stirred up increased conductivity, making visibility poor and electric fishing was not safe.

The IBI score used in the SEV calculator is based on the NIWA Freshwater Fish Database information. The database records shortfin eel (*Anguilla australis*), longfin eel (*Anguilla*

dieffenbachii) and banded kokopu (*Galaxias fasciatus*). The IBI score for Edg_EMS_01 was 46 indicating Very Good biotic integrity.

Refer Freshwater Fish Database Form Appendix B: Freshwater Fish Database Forms.

Stream Ecological Valuation

The Edg_EMS_01 site has an overall SEV value of 0.503 indicating moderate ecological stream values. Table 41 details the breakdown of this score.

Table 41: SEV function scores for Edg_EMS_01.

Site Name	Edg_EMS_01
Stream Name	Edgars Creek
Hydraulic	
Natural Flow Regime	0.07
Connectivity to flood-plain	1.00
Connectivity for migration	0.06
Connectivity to groundwater	0.68
Mean score	**0.45**
Biogeochemical	
Water temperature control	0.67
Dissolved oxygen maintained	0.15
Organic matter input	0.50
In-stream particle retention	0.69
Determination of pollutants	1.00
Flood-plain particle retention	0.90
Mean score	**0.65**
Habitat Provision	
Fish spawning habitat	0.46
Habitat for aquatic fauna	0.25
Mean score	**0.35**
Biodiversity	
Fish fauna intact	0.77
Invertebrate fauna intact	0.00
Aquatic biodiversity intact	0.53
Riparian vegetation intact	0.33
Mean score	**0.41**
SEV Value	**0.503**

The hydraulic function score is quite low (0.45) reflecting good connectivity to groundwater but poor natural flow regime (0.07) due to high catchment imperviousness. The site is in the lower catchment with natural steep banks which increases the frequency of flooding, impacting the connectivity to floodplain score (1.00). A barrier (partially buried pipe) in stream is likely to affect swimming species and has reduced the hydraulic score.

The biogeochemical function score is 0.65 which is good. Determination of pollutants and floodplain particle retention both score well. Extensive sediment deposition with a score of 0.15 has reduced the overall score for this site. The channel is narrow and in parts completely covered by fallen vegetation and debris, so scores well for water temperature control (0.67).

Habitat provision is considered to be poor (0.35). Some fish spawning habitat is provided in the form of floodplains, however in stream substrate exhibits poor heterogeneity. There is very little variety with only shallow pools and relatively stagnant water present.

The biodiversity function scores poorly (0.41) at this site. Fish fauna is based on observations from the freshwater fish database and Wai Care monitoring and scores relatively well (0.77). Macroinvertebrate fauna was very poor (0.00), which is likely due to a combination of water quality issues and poor habitat.

SEV Transect Photographs

Edg_EMS_01 T1	Edg_EMS_01 T2	Edg_EMS_01 T3	Edg_EMS_01 T4	Edg_EMS_01 T5
				
Edg_EMS_01 T6	Edg_EMS_01 T7			
				

6.0 Conclusion

The environmental monitoring strategy carried out in autumn 2011 shows that the urban streams surveyed are of moderate quality. Sites located in the lower catchment tend to have a higher SEV score than those in the upper catchment, which may be a result of decreasing water quality (Meola Creek) or increasing modification (Oakley Creek).

Several native fish species are present with the highest diversity concentrated in the lower reaches of the larger waterways. The Oakley Creek waterfall is considered a significant barrier to fish passage and limits biodiversity in the upper catchment, although the highest diversity of fish species was recorded below the waterfall.

Macroinvertebrate indices indicate that water quality is poor across all sites. This may be due to the timing of the sampling which was undertaken in the cooler months of autumn. However, given the level of upstream catchment development, the low scores are most likely attributed to poor water quality associated with stormwater pollutants and wastewater inputs. Where groundwater inputs are evident (e.g. Lower Meola Creek) the MCI values improve marginally, as they are likely to be diluting potential pollution and providing more stable diurnal conditions.

The data obtained in this initial stage of monitoring provides a sound basis for on-going monitoring; however some improvements to the monitoring methodology are included below.

6.1 Recommendations

Electric fishing was the only method used in the study (as defined by the scope). Due to high in-stream conductivity, areas of deep water, excessive bed sediment, cooler temperatures and weed growth, the efficacy of the electric fishing machine may be reduced. In addition, some species exhibit less sensitivity to the machine so may not react to the electricity when fishing.

- It is recommended that additional fish monitoring methods could be used in any future monitoring including spotlighting and trapping.

The timing of the survey may have an impact on both the fish and macroinvertebrate populations, particularly as some fish species are known to spawn in autumn, and may not have been in their 'normal' habitat.

- It is recommended that surveying should be undertaken in line with the regional monitoring programme over summer months to improve comparability across sites and streams. This must also be considered in relation to the timing of samples undertaken in this round of monitoring.

7.0 References

Allibone, R.; Horrox, J.; Parkyn, S. (2001). *Stream Classification and in-stream objectives for Auckland's urban streams*. Report prepared by NIWA for Auckland Regional Council.

Bodmin, K. (2009) *Management of the rare moss Fissidens beteroi at Motions Creek, Auckland*. Prepared by NIWA for Tonkin and Taylor (NIWA Client report HAM2009-015).

Boffa Miskell Ltd (2010). *Western Ring Route – Waterview Connection. G. 6 Assessment of Freshwater Ecological Effects*. Prepared by Boffa Miskell Ltd for NZ Transport Agency. Document Reference: No. 20.1.11.3-R-N-1007-A. August 2010

Boothroyd, I. and Stark, J. (2000). *Chapter 14. Use of invertebrates in monitoring* in New Zealand Stream Invertebrates: Ecology and Implications for Management (eds) Collier, K. and Winterbourn, M. New Zealand Limnological Society.

Environment Waikato Regional Council (2010). *Regional Guidelines for Ecological Assessments of Freshwater Environments. Standardised Fish Monitoring for Wadeable Streams*. Prepared by Bruno David and Mark Hamer for Environment Waikato Regional Council, Hamilton. Doc # 1576121

Golder Kingett Mitchell Ltd (2007). *Strategy for monitoring the effects of Auckland City/Metrowater network discharges*. Unpublished draft report prepared for Auckland City and Metrowater, March 2007.

Harding, J., Clapcott, J., Quinn, J., Hayes, J., Joy, M., Storey, R., Greig, H., Hay, J., James, T., Beech, M., Ozane, R., Meredith, A., and Boothroyd, I. (2009). *Stream Habitat Assessment Protocols for wadeable rivers and streams of New Zealand*. University of Canterbury, Christchurch.

Hickey, M. A. and Closs, G. P. (2006). Evaluating the potential of night spotlighting as a method for assessing species composition and brown trout abundance: a comparison with electrofishing in small streams. Journal of Fish Biology 69: 1513-1523.

Hill Young Cooper (2008). Auckland Waterways: Receiving Environment Monitoring Strategy – Streams and Estuarine Environments. Unpublished final draft prepared for Metrowater, September 2008.

McCullough, C. D. and Hicks, B. J. (2002). Estimating the abundance of banded kokopu (Galaxias fasctiatus Gray) in small streams by nocturnal counts under spotlight illumination. New Zealand Natural Sciences 27: 1-14.

McDowall, R. M. (2000). *The Reed Field Guide to New Zealand Freshwater Fishes*. Reed Publishing (NZ) Ltd, Auckland.

Morphum Environmental Ltd (2009a). *Meola Creek Watercourse Management Plan*. Prepared by Morphum Environmental Ltd for Metrowater/Auckland City Council. November 2009. MW034

Morphum Environmental Ltd (2009b). *Receiving Environment Monitoring Strategy: Stream Ecology site Scoping*. Prepared by Morphum Environmental Ltd for Metrowater/Auckland City Council. December 2009. MW048.

Morphum Environmental Ltd (2010a). *Motions Creek Watercourse Management Plan*. Prepared by Morphum Environmental Ltd for Metrowater/Auckland City Council. October 2010. MW104

Morphum Environmental Ltd (2010b). *Oakley Creek Watercourse Management Plan*. Prepared by Morphum Environmental Ltd for Metrowater/Auckland City Council. October 2010. MW070

Morphum Environmental Ltd (2010c). Roy Clements Treeway, Meola Creek Stream Ecological Valuation. Prepared by Morphum Environmental Ltd for Metrowater/Auckland City Council. February 2010. MW114.

Morphum Environmental Ltd (2010). Integrated Stormwater and Wastewater programme within the Central Interceptor Zone of Influence: Receiving Environment Monitoring. Meola Catchment Pilot Environmental Monitoring Study. Prepared for Auckland Council. November 2010. ACC080.

Morphum Environmental Ltd, 2011. *Lower Meola Restoration Project Implementation Plan*. Prepared by Morphum Environmental Ltd for Wai Care May 2011.

Paul, M. and Meyer, J. (2001). Streams in the urban landscape. *Annual Review of Ecology, Evolution, and Systematics* 32:333-65.

Rowe, D., Collier, K., Hatton, C., Joy, M., Maxted, J., Moore, S., Neale, M., Parkyn, S., Phillips, N., and Quinn, J. (2006). Stream Ecological Valuation (SEV): a method for scoring the ecological performance of Auckland streams and for quantifying environmental compensation (2nd Ed.). Prepared for Auckland Regional Council (ARC TP302).

Stark, J., Boothroyd, I, Harding, J., Maxted, J. and Scarsbrook, M. (2001). Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

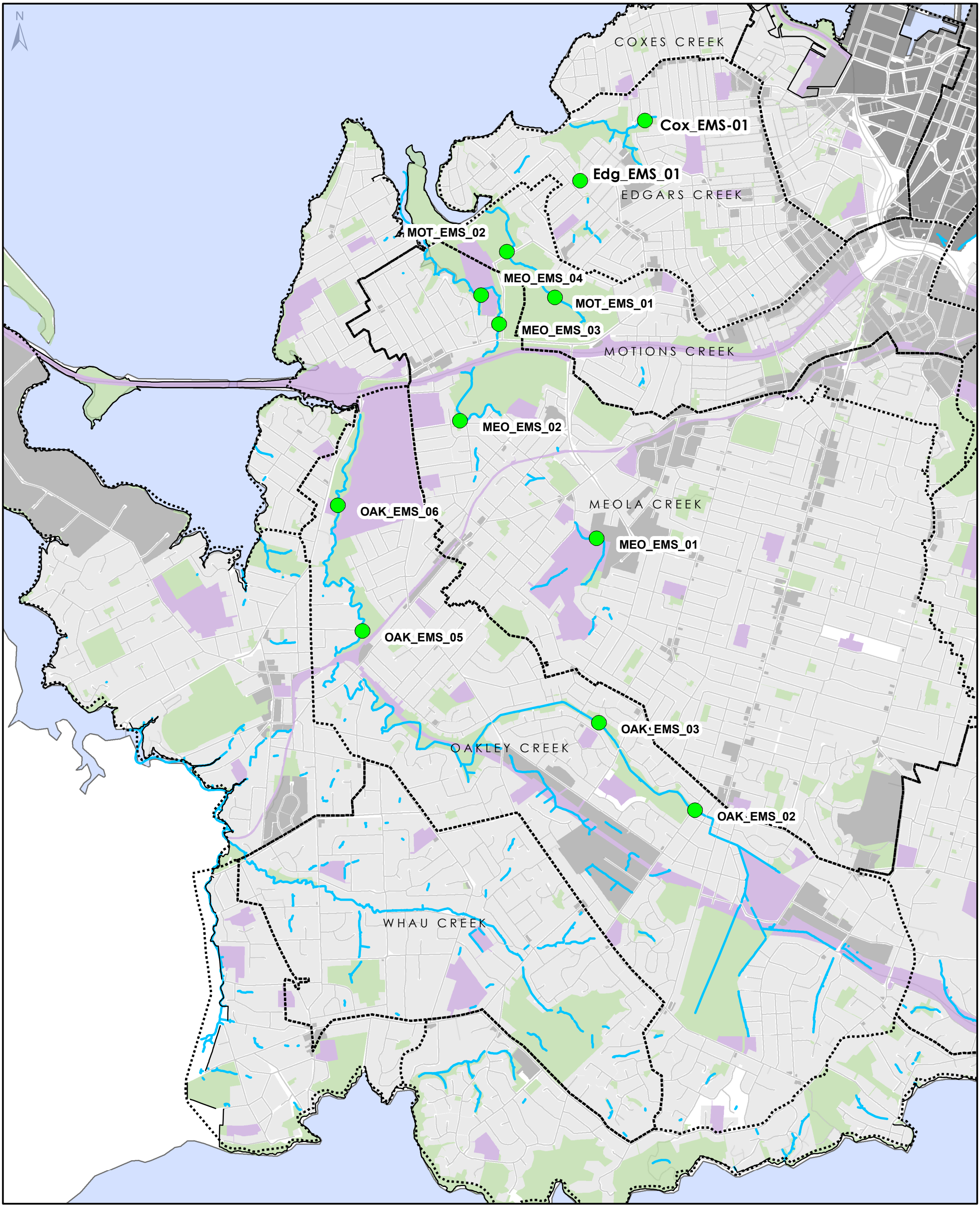
Stark, J. and Maxted, J. (2007). A User Guide for the Macroinvertebrate Community Index. Prepared for the Ministry for the Environment. Cawthron Report No. 1166.

Suren, A. (2001). Review and summary of the state of the aquatic ecology of streams receiving stormwater from Auckland City. NIWA Client Report No. CHC01/09 prepared for Auckland City and Metrowater, February 2001.

Vermonden, K., Leuven, R., van der Velde, G., van Katwijk, M., Roelofs, J. and Hendriks, J., (2009). Urban drainage systems: an undervalued habitat for aquatic macroinvertebrates. *Biological Conservation* 142:1105-1115.

Appendix A:
Site Overview Map

Environmental Monitoring Strategy Sites: CI Zone of Influence



Landuse

- Residential
- Business
- CBD
- Openspace
- Special Purpose

- EMS Site
- Drainage Management Area
- Watercourse

Auckland Council

MORPHUM ENVIRONMENTAL LTD

Project : EMS - CI Sites	
Project No : ACC027	
Client : Auckland Council	
Scale : 1 to 30,000 @A3	
Sheet 1 of 1	Version : 2
Date : 04/07/11	Drawn by : AP
Map Number: 1	Approved by : DY

Appendix B:
Freshwater Fish Database Forms

NZ FRESHWATER FISH DATABASE FORM	PLEASE RETURN TO:	FRESHWATER FISH DATABASE NIWA PO BOX 11-115, HAMILTON	Cox_EMS_01
Date: 19-05-2011	Catchment system Cox's Bay		Catchment Number 081.040
Time: 0900	Sampling locality Cox's Creek – Kelmarna Arm		
Observer: JC	Access notes Access via walkway at Kelmarna Avenue, Grey Lynn		Altitude (m) 8.0
Organisation: Morphum	NZMS260 map R11	Coordinates x 1754472.58218901 y 5920319.0376057	Inland distance (km) 0.124
Fishing Method: EFM	Area fished (m^2) or Number of nets used	Number of electric fishing passes 1	Tidal no

HABITAT DATA

Water	Colour Brown			Clarity milky		Temp.	pH
	Average width (m) 1.3	Average depth (m) 0.1		Maximum depth (m) 0.6		Conductivity (ms/m)	
Habitat type (%)	Still 40	Backwater	Pool 10	Run 45	Riffle 5	Rapid	Cascade
Substrate type (%)	Mud 20	Sand	Fine gravel	Coarse gravel	Cobble	Boulder	Bedrock 80
Fish cover (yes/no)	Weed Algae N	Instream Debris Y	Undercut Banks	Bank Vegetation N			
Catchment vegetation (%)	Native Forest	Exotic Forest 10	Farming	Urban Area 90	Scrub	Swamp land	Other
Riparian vegetation (%)	Native Forest 50	Exotic Forest 45	Grass Tussock 5	Exposed bed	Scrub Willow	Raupo Flax	Other

Type of stream

Water level normal	Downstream blockage unknown	Pollution high
Large invertebrate fauna	Koura unknown	
	Paratya shrimp Common	Freshwater mussels nil
Small benthic invertebrate fauna low/moderate/high/unknown	Predominant species mayflies/caddis/snails/combination/other	Permanent water yes

Purpose of work

FISH DATA

Species and life stage	Abundance*	Length data	Habitat/comments
Anguilla australis	1	30 cm	
Anguilla australis	3	20-25 cm	
Anguilla australis	7	10-15 cm	
Unidentified eel	7	10-15 cm	
Unidentfied eel	4	20-25 cm	
Anguilla australis	2	< 100	

Comments
All healthy, couple with minor talk redness (potential infection starting)

*Use numbers observed or abundant/common/occasional/rare

NZ FRESHWATER FISH DATABASE FORM	PLEASE RETURN TO:	FRESHWATER FISH DATABASE NIWA PO BOX 11-115, HAMILTON	Meo_EMS_02
Date: 10-05-2011	Catchment system: Meola Creek		Catchment number 081.020
Time: 1515	Sampling locality Meola Creek Rawailpindi Reserve		
Observer	Access notes Access site upstream of Chamberlain Park Golf Course to the boundary of private properties		Altitude (m) 10.5
Organisation	NZMS260 map R11	Coordinates x 1752850.73915606 y 5917687.14958503	Inland distance (km) 3.298
Fishing Method: EFM	Area fished (m^2) or Number of nets used: Stop net/dip net	Number of electric fishing passes 1	Tidal: No

HABITAT DATA

Water	Colour green:			Clarity: milky		Temp. 17.4°C	pH: 7.25
	Average width (m) 3.4	Average depth (m) 0.2		Maximum depth (m) 0.9		Conductivity (ms/m): 227(ms/cm)	
Habitat type (%)	Still 40	Backwater	Pool 10	Run 50	Riffle	Rapid	Cascade
Substrate type (%)	Mud 20	Sand 20	Fine Gravel 20	Coarse gravel	Cobble 40	Boulder	Bedrock
Fish cover (yes/no)	Weed Algae	Instream Debris Y	Undercut Banks Y	Bank Vegetation Y			
Catchment vegetation (%)	Native forest	Exotic forest	Farming	Urban Area 100	Scrub	Swamp land	Other
Riparian vegetation (%)	Native forest	Exotic Forest 15	Grass Tussock 20	Exposed bed	Scrub Willow 65	Raupo Flax	Other

Type : stream

Water level: normal	Downstream blockage no	Pollution: high
Large invertebrate fauna	Koura unknown	
	Paratya shrimp abundant/common/occasional/rare/nil/unknown	Freshwater mussels unknown
Small benthic invertebrate fauna low/moderate/high/unknown	Predominant species mayflies/caddis/snails/combination/other	Permanent water yes
Purpose of work		

FISH DATA

Species and life stage	Abundance*	Length data	Habitat/comments
Anguilla Unknown	2	5-10 cm	
Shortfin	18	20-35 cm	
Shortfin	2	15 cm	
Anguilla Unknown	15	15-25 cm	
Anguilla Unknown	5	30-25 cm	
Shortfin	5	10-15 cm	
Shortfin	1	50 cm	
Common Bully	1	5 cm	
Shortfin	1	65 cm	

Comments

*Use numbers observed or abundant/common/occasional/rare

NZ FRESHWATER FISH DATABASE FORM	PLEASE RETURN TO:	FRESHWATER FISH DATABASE NIWA PO BOX 11-115, HAMILTON	Meo_EMS_03
Date 10-05-2011	Catchment system Meola Creek		Catchment Number 081.020
Time 1334	Sampling locality Meola Creek Motions Road		
Observer JC	Access notes Site parallel to Pasadena Intermediate and Motions Road		Altitude (m) 4.5
Organisation Morphum	NZMS260 map	Coordinates x 1753194.37712716 Y 5918535.24524408	Inland distance (km) 2.3
Fishing Method: EFM	Area fished (m^2) or Number of nets used:	Number of electric fishing passes: 1	Tidal: No

HABITAT DATA

Water	Colour : green			Clarity: clear		Temp. 17.2°	pH 7.02
	Average width (m): 4.5	Average depth (m): 0.5		Maximum depth (m)		Conductivity (ms/cm) 233	
Habitat type (%)	Still	Backwater	Pool 10	Run 80	Riffle 10	Rapid	Cascade
Substrate type (%)	Mud 25	Sand	Fine gravel	Coarse Gravel 20	Cobble 50	Boulder 5	Bedrock
Fish cover (yes/no)	Weed Algae Y	Instream Debris Y	Undercut Banks Y	Bank vegetation			
Catchment vegetation (%)	Native forest	Exotic forest	Farming	Urban Area 100	Scrub	Swamp land	Other
Riparian vegetation (%)	Native forest	Exotic Forest 70	Grass Tussock 5	Exposed bed	Scrub Willow 20	Raupo Flax 5	Other

Type : stream

Water level normal	Downstream blockage no	Pollution nil/low/moderate/high
Large invertebrate fauna	Koura unknown	
	Paratya shrimp abundant/common/occasional/rare/nil/unknown	Freshwater mussels unknown
Small benthic invertebrate fauna low/moderate/high/unknown	Predominant species mayflies/caddis/snails/combination/other	Permanent water yes

Purpose of work

FISH DATA

Species and life stage	Abundance*	Length data	Habitat/comments
Galaxias maculatus	1	5-8 cm	1 (m)
Galaxias maculatus	1	8-12 cm	
Unidentifed Anguilla	10	15-20 cm	1 x 60+
Unidentifed Anguilla	15	25-30 cm	
Anguilla australis	2	20-30 cm	
Anguilla australis	7	15-25 cm	
Anguilla dieffenbachii	3	25-30 cm	
Anguilla australis	5	10-15 cm	
Anguilla australis	1	30-40 cm	
Anguilla dieffenbachii	1	30-35 cm	
Anguilla dieffenbachii	1	20-25 cm	

Comments
Vallisneria spiralis throughout. A lot of reach was too deep to fish.

*Use numbers observed or abundant/common/occasional/rare

NZ FRESHWATER FISH DATABASE FORM	PLEASE RETURN TO:	FRESHWATER FISH DATABASE NIWA PO BOX 11-115, HAMILTON	Meo_EMS_04
Date: 20-05-2011	Catchment system: Meola Creek		Catchment Number 080.020
Time: 1430	Sampling locality Meola Creek Roy Clements Treeway		
Observer: JC	Access notes Access from Alberton Ave footbridge		Altitude (m) 25
Organisation: Morphum	NZMS260 map	Coordinates x 1754048.73879719 Y 5916655.41643821	Inland distance (km) 5.5
Fishing Method: EFM	Area fished (m^2) or Number of nets used	Number of electric fishing passes	Tidal no

HABITAT DATA

Water	Colour: brown			Clarity milky		Temp. 16.8	pH: 7.2
	Average width (m) 2.4	Average depth (m) 0.17		Maximum depth (m) 0.6		Conductivity (ms/m): 229 (ms/cm)	
Habitat type (%)	Still	Backwater	Pool	Run	Riffle	Rapid	Cascade
Substrate type (%)	Mud 60	Sand 10	Fine gravel	Coarse Gravel 10	Cobble 20	Boulder	Bedrock
Fish cover (yes/no)	Weed Algae Y	Instream Debris Y	Undercut Banks Y	Bank Vegetation N			
Catchment vegetation (%)	Native forest	Exotic forest	Farming	Urban Area 100	Scrub	Swamp land	Other
Riparian vegetation (%)	Native forest	Exotic Forest 10	Grass Tussock 35	Exposed bed	Scrub Willow 5	Raupo Flax 50	Other

Type of : stream

Water level normal	Downstream blockage no	Pollution high
Large invertebrate fauna	Koura unknown	
	Paratya shrimp abundant/common/occasional/rare/nil/unknown	Freshwater mussels unknown
Small benthic invertebrate fauna low/moderate/high/unknown	Predominant species mayflies/caddis/snails/combination/other	Permanent water yes

Purpose of work

FISH DATA

Species and life stage	Abundance*	Length data	Habitat/comments
Anguilla Unknown	9	30-35 cm	
Longfin	2	30-35 cm	
Longfin	2	25 cm	
Anguilla Unknown	6	20-25 cm	1 x 60 cm
Anguilla Unknown	2	15 cm	
Anguilla Unknown	2	40-45 cm	
Shortfin	7	25 – 30 cm	
Shortfin	2	15/45 cm	
Shortfin	4	20-35 cm	
Unknown	1	<100 cm	
Shortfin	1	600 cm	

Comments
Egeria densa prolific in lower reach, therefore lots of unidentified eels. Lots of sanitary items in-stream. Sewage/anaerobic odour.

*Use numbers observed or abundant/common/occasional/rare

NZ FRESHWATER FISH DATABASE FORM	PLEASE RETURN TO:	FRESHWATER FISH DATABASE NIWA PO BOX 11-115, HAMILTON	Mot_EMS_01
Date: 19-05-2011	Catchment system: Motions Creek		Catchment Number 080.030
Time: 1200	Sampling locality: Motions Creek Western Springs Reserve		
Observer: JC	Access notes Site located immediately upstream of the Auckland Zoo boundary within Western Springs Reserve		Altitude (m) 7.5
Organisation: Morphum	NZMS260 map R11	Coordinates x 1753682.99300153 Y 5918768.01822685	Inland distance (km) 1.3
Fishing Method: EFM	Area fished (m^2) or Number of nets used	Number of electric fishing passes	Tidal no

HABITAT DATA

Water	Colour green			Clarity milky		Temp.	pH
	Average width (m) 3.5	Average depth (m) 0.2		Maximum depth (m) 1.4		Conductivity (ms/m)	
Habitat type (%)	Still	Backwater	Pool 5	Run 90	Riffle 5	Rapid	Cascade
Substrate type (%)	Mud 10	Sand	Fine gravel	Coarse gravel	Cobble 90	Boulder	Bedrock
Fish cover (yes/no)	Weed Algae Y	Instream Debris Y	Undercut Banks Y	Bank Vegetation N			
Catchment vegetation (%)	Native forest	Exotic forest	Farming	Urban Area 100	Scrub	Swamp land	Other
Riparian vegetation (%)	Native forest	Exotic Forest 10	Grass Tussock 90	Exposed bed	Scrub Willow	Raupo Flax	Other

Type of stream

Water level normal	Downstream blockage no	Pollution moderate
Large invertebrate fauna	Koura unknown	
	Paratya shrimp abundant/common/occasional/rare/nil/unknown	Freshwater mussels unknown
Small benthic invertebrate fauna low/moderate/high/unknown	Predominant species mayflies/caddis/snails/combination/other	Permanent water yes
Purpose of work Ecological Monitoring		

FISH DATA

Species and life stage	Abundance*	Length data	Habitat/comments
Unidentified eel	1	45 cm	possible Australian longfin – yellow
Shortfin eel	13	20-25 cm	
Shortfin eel	18	10-15 cm	
Shortfin eel	2	45 cm (1), 50 cm (1)	
Shortfin eel	4	30 cm	
Longfin eel	1	< 10 cm	
Longfin eel	2	10-15 cm	
Longfin eel	3	20 cm	
Unidentified eel	8	<5 cm	
Unidentified eel	8	10-15 cm	

Comments
Depth of pools likely to have limited efficiency of electric fishing machine

*Use numbers observed or abundant/common/occasional/rare

NZ FRESHWATER FISH DATABASE FORM	PLEASE RETURN TO:	FRESHWATER FISH DATABASE NIWA PO BOX 11-115, HAMILTON	Mot_EMS_02
Date 10-05-2011	Catchment system Motions Creek		Catchment Number 080.030
Time: 1055	Sampling locality: Motions Creek Old Mill Road		
Observer JC	Access notes Downstream of the zoo on Old Mill Road, upstream of tidal influence		Altitude (m) 4
Organisation Morphum	NZMS260 map R11	Coordinates x 1753260.60196936 Y 5919169.60970061	Inland distance (km) 0.615
Fishing Method EFM	Area fished (m^2) or Number of nets used: 1 stop net, 1 Dip net; 8x100m	Number of electric fishing passes: 1	Tidal: no

HABITAT DATA 173 minutes fished

Water	Colour: green			Clarity: milky		Temp. 16.8°C	pH 6.88
	Average width (m) 5.4	Average depth (m) 0.21		Maximum depth (m) 1.0		Conductivity (ms/m) 242 (ms/cm)	
Habitat type (%)	Still 5	Backwater	Pool	Run 50	Riffle20	Rapid 20	Cascade 5
Substrate type (%)	Mud	Sand 10	Fine gravel	Coarse Gravel 10	Cobble 25	Boulder 45	Bedrock 10
Fish cover (yes/no)	Weed Algae Y	Instream Debris Y	Undercut Banks Y	Bank Vegetation Y			
Catchment vegetation (%)	Native forest	Exotic forest	Farming	Urban Area 100	Scrub	Swamp land	Other
Riparian vegetation (%)	Native forest	Exotic Forest 20	Grass Tussock 40	Exposed bed	Scrub Willow 20	Raupo Flax 20	Other

Type of stream

Water level normal	Downstream blockage no	Pollution high
Large invertebrate fauna	Koura unknown	
	Paratya shrimp occasional	Freshwater mussels unknown
Small benthic invertebrate fauna low/moderate/high/unknown	Predominant species mayflies/caddis/snails/combination/other	Permanent water yes

Purpose of work

FISH DATA

Species and life stage	Abundance*	Length data	Habitat/comments
Shortfin Eel	14	10-15 cm	Rapid; Large rocks
Unknown Anguilla	1	55-60 cm	Underbanks protected by Willow roots
Shortfin Eel	6	40-45 cm	
Shortfin Eel	12	20 cm	
Shortfin Eel	21	25-35cm	
Unknown Anguilla	31	10-35 cm	
Shortfin Eel	1	<10 cm	
Longfin	1	50 cm	
Longfin	11	20-30 cm	
Longfin	5	=< 10-15 cm	
Shortin	2	>= 60 cm	
Shortfin	2	20 cm	Bacterial infection/ raw skin, big & fat

Comments
One Inanga

*Use numbers observed or abundant/common/occasional/rare

NZ FRESHWATER FISH DATABASE FORM	PLEASE RETURN TO:	FRESHWATER FISH DATABASE NIWA PO BOX 11-115, HAMILTON	Oak_EMS_02
Date: 20-05-2011	Catchment system: Oakley Creek		Catchment Number 080.010
Time: 1330	Sampling locality Oakley Creek Memorial Ave		
Observer: JC	Access notes Access via May Road, section of creek through Memorial Ave bank lined section		Altitude (m) 49
Organisation: Morphum	NZMS260 map R11	Coordinates x 1754912.73111896 Y 5914270.63016331	Inland distance (km) 8.4
Fishing Method: EFM	Area fished (m^2) or Number of nets used	Number of electric fishing passes 1	Tidal yes/no/unknown

HABITAT DATA

Water	Colour green		Clarity dirty			Temp.: 16.2°C	pH: 7.1
	Average width (m) 2.3	Average depth (m) 0.1	Maximum depth (m) 0.8			Conductivity (ms/m): 285 (ms/cm)	
Habitat type (%)	Still	Backwater	Pool	Run 100	Riffle	Rapid	Cascade
Substrate type (%)	Mud 20	Sand	Fine gravel	Coarse Gravel 20	Cobble 60	Boulder	Bedrock
Fish cover (yes/no)	Weed Algae Y	Instream Debris Y	Undercut Banks N	Bank Vegetation N			
Catchment vegetation (%)	Native forest	Exotic forest	Farming	Urban Area 100	Scrub	Swamp land	Other
Riparian vegetation (%)	Native Forest	Exotic Forest 5	Grass Tussock 95	Exposed bed	Scrub Willow	Raupo Flax	Other

Type of : stream

Water level normal	Downstream blockage no	Pollution moderate
Large invertebrate fauna	Koura unknown	
	Paratya shrimp abundant/common/occasional/rare/nil/unknown	Freshwater mussels unknown
Small benthic invertebrate fauna low/moderate/high/unknown	Predominant species mayflies/caddis/snails/combination/other	Permanent water yes

Purpose of work Ecological Monitoring

FISH DATA

Species and life stage	Abundance*	Length data	Habitat/comments
Anguilla australis	1	45 cm	
Anguilla australis	4	30-35 cm	
Anguilla australis	1	60 cm	
Anguilla australis	1	15 cm	
Anguilla australis	2	20 cm	
Gambusia	1		
Anguilla dieffenbachii	3	30 cm (2), 25 cm (1)	
Anguilla dieffenbachii	2	55 cm	
Anguilla sp.	2	Unknown	
Anguilla sp.	1	20 cm	

Comments

*Use numbers observed or abundant/common/occasional/rare

NZ FRESHWATER FISH DATABASE FORM	PLEASE RETURN TO:	FRESHWATER FISH DATABASE NIWA PO BOX 11-115, HAMILTON	Oak_EMS_05
Date: 20-05-2011	Catchment system: Oakley Creek		Catchment Number 080.010
Time: 1200	Sampling locality: Oakley Creek Powell Street		
Observer: JC	Access notes Access via property at bottom end of Powell Street, Avondale		Altitude (m) 23
Organisation: Morphum	NZMS260 map R11	Coordinates x 1751994.51836184 Y 5915842.61814242	Inland distance (km) 2.7
Fishing Method: EMF	Area fished (m^2) or Number of nets used	Number of electric fishing passes	Tidal yes/no/unknown

HABITAT DATA

Water	Colour: green			Clarity: clear		Temp.: 14.5°C	pH:: 7.2
	Average width (m) 2.3	Average depth (m) 0.25		Maximum depth (m) 2		Conductivity (ms/m): 295 (ms/cm)	
Habitat type (%)	Still	Backwater	Pool 5	Run 95	Riffle	Rapid	Cascade
Substrate type (%)	Mud 40	Sand	Fine gravel	Coarse gravel	Cobble 60	Boulder	Bedrock
Fish cover (yes/no)	Weed Algae Y	Instream Debris Y	Undercut Banks Y	Bank Vegetation N			
Catchment vegetation (%)	Native forest	Exotic forest	Farming	Urban Area 100	Scrub	Swamp land	Other
Riparian vegetation (%)	Native Forest 20	Exotic Forest 40	Grass Tussock 20	Exposed bed	Scrub Willow	Raupo Flax 20	Other

Type of : stream

Water level: normal	Downstream blockage: No (yes for waterfall barrier)	Pollution: moderate
Large invertebrate fauna	Koura unknown	
	Paratya shrimp rare	Freshwater mussels unknown
Small benthic invertebrate fauna low/moderate/high/unknown	Predominant species mayflies/caddis/snails/combination/other	Permanent water yes

Purpose of work

FISH DATA

Species and life stage	Abundance*	Length data	Habitat/comments
Gambusia	1		
Anguilla australis	4	20 cm (3), 25 cm (1)	
Anguilla australis	1	30 cm	
Anguilla australis	1	15 cm	
Anguilla sp.	4	<10 cm (3), <50 cm (1)	
Anguilla sp.	4	25 cm (3), 15 cm (1)	
Anguilla dieffenbachii	9	15 cm	
Anguilla dieffenbachii	4	20 cm (1), 25 cm (3)	
Anguilla dieffenbachii	5	35 cm (2), 30 cm (3)	

Comments
Water depth restricted of along entire length; only & fished.

*Use numbers observed or abundant/common/occasional/rare

NZ FRESHWATER FISH DATABASE FORM	PLEASE RETURN TO:	FRESHWATER FISH DATABASE NIWA PO BOX 11-115, HAMILTON	Oak_OMS_06
Date 20-5-11	Catchment system Oakley Creek		Catchment Number 080.010
Time 0900	Sampling locality Oakley Creek Waterfall		
Observer JC	Access notes Downstream of Oakley Creek waterfall, access via Unitec		Altitude (m) 6
Organisation Morphum	NZMS260 map R11	Coordinates x 1751779.28969845 Y 5916944.13319536	Inland distance (km) 0.951
Fishing Method EFM	Area fished (m^2) or Number of nets used	Number of electric fishing passes 1	Tidal no

HABITAT DATA

Water	Colour Green			Clarity clear		Temp. 13.9°C	pH 7.38
	Average width (m) 3.4	Average depth (m) 0.27		Maximum depth (m) 2		Conductivity (ms/cm) 291	
Habitat type (%)	Still	Backwater	Pool 20	Run 60	Riffle 20	Rapid	Cascade
Substrate type (%)	Mud	Sand 20	Fine Gravel 20	Coarse Gravel 20	Cobble 20	Boulder 15	Bedrock 5
Fish cover (yes/no)	Weed Algae Y	Instream Debris Y	Undercut Banks Y	Bank Vegetation			
Catchment vegetation (%)	Native forest	Exotic forest	Farming	Urban Area 100	Scrub	Swamp land	Other
Riparian vegetation (%)	Native Forest 20	Exotic Forest 10	Grass Tussock 50	Exposed bed	Scrub Willow	Raupo Flax 20	Other

Type of : stream

Water level: high	Downstream blockage: yes	Pollution: high
Large invertebrate fauna	Koura unknown	
	Paratya shrimp Rare	Freshwater mussels unknown
Small benthic invertebrate fauna low/moderate/high/unknown	Predominant species mayflies/caddis/snails/combination/other	Permanent water yes

Purpose of work Ecological Monitoring

FISH DATA

Species and life stage	Abundance*	Length data	Habitat/comments
Torrent	1	12 cm	Rock cascade
Shortfin	7	30/35 cm	Just before bridge
Redfin (male)	7	4.5/4.0 cm	Beautiful colouration
Redfin (female)	5	5.5/5.0 cm	One gravid female
Longfin	3	30/25 cm	
Refin (female)	0	3.0/4.0/3.5 cm	Cascade just under bridge
Redfin (male)	7	5 cm	
Angullia (Unknown)	2	25 cm	
Shortfin	8	10/6/ >5 cm	
Angullia (Unknown)	2	10 cm	Above bridge
Inagna	1	5 cm	

Comments

*Use numbers observed or abundant/common/occasional/rare

Appendix C:
Macroinvertebrate Results

ACC027	Edg-EMS-01	Edg-EMS-01	Cox-EMS-01	Cox-EMS-01	Meo-EMS- 01	Meo-EMS- 01	Meo-EMS- 02	Meo-EMS- 02	Meo-EMS- 03	Meo-EMS- 03	Meo-EMS- 04	Meo-EMS- 04	Oak-EMS-02	Oak-EMS-02	Oak-EMS-03	Oak-EMS-03	Oak-EMS-05	Oak-EMS-05	Oak-EMS-06	Oak-EMS-06	Mot-EMS-01	Mot-EMS-01	Mot-EMS-02	Mot-EMS-02
EMS:CI ZI	SB	SB	HB	HB	SB	SB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB
	8/04/2011	8/04/2011	8/04/2011	8/04/2011	12/04/2011	12/04/2011	12/04/2011	12/04/2011	8/04/2011	8/04/2011	01/06/2011	01/06/2011	23/05/2011	23/05/2011	13/04/2011	13/04/2011	12/04/2011	12/04/2011	13/04/2011	13/04/2011	13/04/2011	13/04/2011	13/04/2011	13/04/2011
Taxa																								
Ephemeroptera																								
Acanthophlebia																								
Ameletopsis																								
Arachnocolus																								
Atalophlebiodes																								
Austroclima																								
Coloburiscus																								
Deleatidium																								
Ichthybotus																								
Isothraulus																								
Mauiulus																								
Neozephlebia																								
Nesameletus																								
Oniscigaster																								
Rallidens																								
Siphlaenigma																								
Zephlebia																								
Plecoptera																								
Acroperla																								
Austroperla																								
Cristaperla																								
Halticoperla																								
Megaleptoperla																								
Nesoperla																								
Spaniocerca																								
Spaniocercoides																								
Stenoperla																								
Taraperla																								
Zealandobius																								
Zealandoperla																								
Notonemouridae indet																								
Trichoptera																								
Alloecentrella																								
Aoteapsyche																								
Beraeoptera																								
Confluens																								
Costachorema																								
Edpercivalia																								
Ecnomidae																								
Helicopsyche																								
Hudsonema																								
Hydrobiosella																								
Hydrobiosis																								
Hydrochorema																								
Kokiria																								
Neurochorema																								
Oecetis																								
Oeconesidae																								
Olinga																								
Orthopsyche																								
Oxyethira					11	C	416	VA	176	VA	20	A	280	VA	2624	VVA	42	A	13	C	1	R	416	VA
Paraoxyethira											1	R			6	C	6	C	1	R	1	R	1	R
Philorheithrus																								
Plectrocnemia																								
Polyplectropus																								
Psilochorema																								
Pycnocentrella																								
Pycnocentria																								
Pycnocentrodes																								
Rakiura																								
Tiphobiosis																								
Triplectides											2	R												
Triplectidina																								
Zelolessica																								
Megaloptera																								
Archichauliodes																								
Odonata																								
Aeshna																								
Antipodochlora																								
Austrolestes																								
Hemicordulia																								
Procordulia																								
Xanthocnemis							5	C	128	VA	4	R	1	R			29	A	3	R	1	R		
Hemiptera																								
Anisops																								
Diaprepocris																								
Microvelia	48	A																						
Sigara															1	R							1	R
Coleoptera																								
Antiporus																								
Berosus																								
Dytiscidae																								
Elmidae																								
Homeodytes																								
Hydraenidae																								
Hydrophilidae																								
Liodessus																								
Ptilodactylidae																								
Rhantus																								
Scirtidae	32	A																						

ACCO27	Edg-EMS-01	Edg-EMS-01	Cox-EMS-01	Cox-EMS-01	Meo-EMS- 01	Meo-EMS- 01	Meo-EMS- 02	Meo-EMS- 02	Meo-EMS- 03	Meo-EMS- 03	Meo-EMS- 04	Meo-EMS- 04	Oak-EMS-02	Oak-EMS-02	Oak-EMS-03	Oak-EMS-03	Oak-EMS-05	Oak-EMS-05	Oak-EMS-06	Oak-EMS-06	Mot-EMS-01	Mot-EMS-01	Mot-EMS-02	Mot-EMS-02
EMS:CI ZI	SB	SB	HB	HB	SB	SB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB
	8/04/2011	8/04/2011	8/04/2011	8/04/2011	12/04/2011	12/04/2011	12/04/2011	12/04/2011	8/04/2011	8/04/2011	01/06/2011	01/06/2011	23/05/2011	23/05/2011	13/04/2011	13/04/2011	12/04/2011	12/04/2011	13/04/2011	13/04/2011	13/04/2011	13/04/2011	13/04/2011	13/04/2011
Staphylinidae																								
Neuroptera																								
Kempynus																								
Diptera																								
Aphrophila																								
Austrosimulium							208	VA	144	VA			68	A			336	VA	13	C				
Blephariceridae																								
Chironomidae																								
Calopsecta																								
Ceratopogonidae																								
Chironomus	32	A	124	VA	80	A	7	C													3	R	2	R
Corynoneura																								
Cryptochironomus																								
Culex																								
Culicidae	140	VA																						
Dolichopodidae																								
Empididae																								
Ephydridae																								
Eriopterini																								
Harrisius																	2	R						
Hexatomini																								
Limonia																								
Lobodiamesa																								
Maoridiamesa																								
Mischoderus																								
Molophilus																								
Muscidae							4	R					1	R									7	C
Nannochorista																								
Neocurupira																								
Neoscatella																								
Nothodixa																								
Orthocladiinae			20	A	1072	VVA	528	VVA	304	VA	288	VA	436	VA	12	C	9	C	65	A	1328	VVA	3120	VVA
Parochlus																								
Paradixa																								
Paralimnophila																								
Paucispinigera																								
Pelecorhynchidae																								
Peritheates																								
Podonominae																								
Polypedilum	304	VA	816	VVA	48	A	112	VA	1	R	240	VA	1	R										
Psychodidae			36	A																				
Sciomyzidae																								
Stratiomyidae																								
Syrphidae																								
Tabanidae																			1	R				
Tanypodinae											1	R												
Tanytarsini	104	VA	156	VA			80	A			1	R											80	A
Tanytarsus																								
Thaumaleidae																								
Zelandotipula																								
Lepidoptera																								
Hygraula																								
Collembola	1	R	5	C	224	VA	1	R	1	R	1	R	128	VA	3	R	3	R	6	C	2	R	3	R
Acarina	4	R			1	R					6	C											3	R
Crustacea																								
Amphipoda							1696	VVA	4000	VVA	368	VA	324	VA	1	R	336	VA	57	A				
Copepoda	2	R															1	R	1	R			2	R
Cladocera					4	R																	5	C
Isopoda	3	R									14	C												
Ostracoda	88	A	2	R	1	R	1	R			1	R									12	C	3	R
Paranephrops																								
Paratya			1	R					4	R	3	R											6	C
Tanaidacea																								
Mollusca																								
Ferrissia			44	A					1	R							1	R	2	R				
Gyraulus			4	R			8	C	8	C			152	VA	11	C	192	VA	3	R				
Hyridella																								
Latia																								
Lymnaea					1	R	1	R											1	R			1	R
Melanopsis																								
Physa	6	C	192	VA	1	R	1	R	7	C			44	A	10	C	45	A	1	R	3	R	12	C
Physastra																								
Potamopyrgus	10	C	1	R	144	VA	288	VA	4000	VVA	1456	VVA	6	C	4000	VVA	336	VA	4000	VVA			400	VA
Sphaeriidae	232	VA																						
Oligochaeta	256	VA	460	VA	96	A	56	A	4	R	240	VA	7	C	5	C	8	C	8	C	32	A	1104	VVA
Hirudinea					80	A	14	C	112	VA			1	R	15	C	13	C	6	C	28	A	80	A
Platyhelminthes	756	VVA	68	A	6	C	2	R	3	R	17	C	1	R	1	R			2	R	2	R		
Nematoda	4	R			2	R																		
Nematomorpha																	12	C						
Nemertea	1	R	1	R			2	R					1	R	10	C			2	R			1	R
Coelenterata																								
Hydra																							2	R
Taxa Count	18		15		15		19		15		17		15		13		16		18		11		20	
Abundance	2023		1930		1771		3430		8893		2663		1451		6704		1371		4185		1413		5249	
Chironomidae indet																					64P		112P	
Fish															1		1							

Notes
Numbers in green, subsampled and multiplied by sixteen
Numbers in red, subsampled and multiplied by four
4000 denotes >4000 based on a sixteenth subsample

Appendix D:
Macroinvertebrate Processing Methodology

Methods used by Kate Senner (taxonomist) for the processing of freshwater invertebrates to obtain the Macroinvertebrate Community Index (2011)

Method

The method used for processing invertebrate samples is based on Protocol P3- Full Count with Sub-sampling Option, described by Stark, Boothroyd, Harding, Maxted, Scarsbrook (2001). Some modifications have been applied to improve efficiency, accuracy and to reduce damage to the delicate invertebrate material.

On receipt of the samples from the courier, the jars are checked to establish they have not been damaged in transit, they have been preserved adequately and the labels on the outside of the jars are legible. The chain of custody sheet is then faxed to the sender to confirm the arrival of the samples and to detail their condition.

The jars are then collated so that the samples can be processed one site at a time and in the order in which they were collected from each site.

Each jar is then processed using the following procedure.

1. FOR SAMPLE VOLUMES < 500mls (usually Suber samples) A cleaned Endecott sieve, 500 microns, is placed over a receptacle (This is to ensure any material that may be inadvertently washed over the sieve during the washing process is captured and can be returned to the sample). The contents of the sample jar are gently washed from the jar into the sieve. The label is removed, examined and matched with the external labels on the jar and with the information on the chain of custody sheet.
2. A gentle stream of water is then passed over the sample. Large stones and plant material are lifted from the sample and washed under the flow of water until free of invertebrates. This large material is then discarded. The silt is washed through the sieve. (It has been found that hand washing the large material and removing it manually opposed to using a series of large meshed sieves reduces the amount of damage to the more delicate invertebrates)
3. The material is washed to one side of the sieve which is tilted slightly over a container of water so that the sample does not dry out. The material is then examined in approximately 25 ml lots using a stereo-microscope at 7x magnification. Thus the complete sample is examined under the microscope.
4. Approximately 25 ml of sample is placed into a rectangular Perspex dish approximately 160mm x 30mm x 20mm.

Fig 1

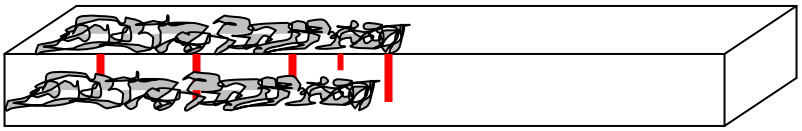
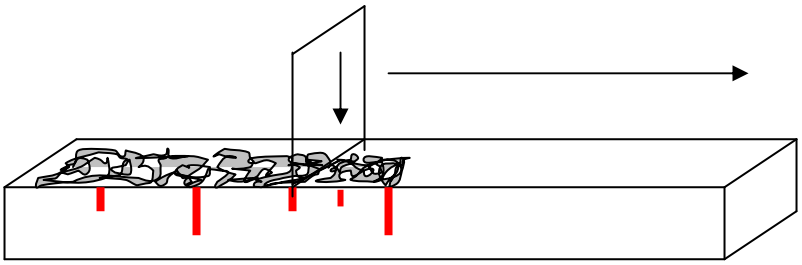
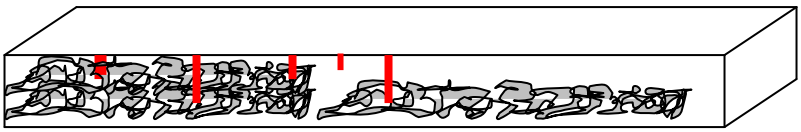


Fig 2



If it appears that the numbers of particular taxa are very high the material is compacted into half the dish as shown in Fig1. A plastic cutter is pushed down through the material at the eighth, quarter or half mark (in red) to separate it from the whole. This material is then distributed along the remaining length of the sorting dish. (*Fig 2 shows a quarter sub-sample)

Fig 3



5. All invertebrates are removed from A as shown in Fig 3. At this stage the taxa to be sub-sampled are established.

6. Only taxa not being sub-sampled are removed from **B.**

7. The invertebrates removed are preliminarily sorted to order, family or genus and placed into small white dishes. The process is repeated in approximately 25ml lots until the whole sample has been sorted.

8. The small dishes are now placed under the stereo-microscope (up to 40x magnification) and the invertebrates are identified to the level required for the allocation of their MCI values, Stark et al (2001) and counted. The results are entered on to the table supplied by the environmental consultant. Sub-sampled taxa are multiplied by 2, 4 or 8 depending on the fraction examined.

9. The specimens from each sample are placed in Samco 50mm soda glass vials containing 100% ethanol (Specially Denatured Alcohol) and labelled. The label notes the job number supplied by the environmental consultant, the date of collection and the site and sample identifier. The labels are written on waterproof, acid free paper using an alcohol resistant archival pen. Where several vials are used for a particular sample this is noted on the label, for example, 1 of 3, 2 of 3, 3 of 3 respectively. The lid of each vial is marked with a

reference number and then the vials are stored in their original cardboard box which is labelled with the job number and date of collection.

10. All washing and sorting equipment is thoroughly cleaned between samples.

11. FOR LARGE VOLUMES OF SAMPLE (>500ml) collected by sweep net. All of the material for a particular sample is placed into a clean bucket. Large pieces of material are washed clean and removed. The contents of the bucket are then thoroughly mixed with additional water to free up the silt. The sample is then poured into a 500 micron sieve, over a tray to ensure any material that may be inadvertently washed over the sieve can be collected and returned to the sample. The sample is washed further under a gentle flow of water to remove the remaining silt. The sample material is then evenly distributed in the sieve by the flow of water and then gently compacted and leveled so that a cruciform separator can be overlaid on the sample. A quarter is cut away and removed from the whole. From this quarter, 25ml lots are placed into the rectangular Perspex tray and ALL invertebrates are removed while being viewed under a stereo microscope using the equipment and methods described above. These invertebrates are then identified, counted and the numbers are then multiplied by four and the results entered (in red) on the result sheet. The remaining three quarters are then searched for rare taxa.

12. In large sweep net samples there are often numerous taxa in numbers in excess of 100 found in the quartered sample. When this is the case the quartered sample is itself sub-sampled by one quarter in the way described in Notes 4 – 7 and the numbers multiplied by sixteen and entered on the result sheet in blue.

13. Whatever sub-sampling technique is used the whole sample is searched under a stereo–microscope to locate the rare taxa and these are removed, identified and counted.

When removing invertebrates, especially in large sweep net samples, it soon becomes apparent when a particular taxon will exceed 2000 individuals. At this point they are no longer removed from the sample to save time. It is entered as 2000 on the result sheet but this will only represent the minimum number present. Certain Crustacea, Molluscs and Diptera are often present in numbers greater than 5000.

Identifications

Any specimens that look unusual or are difficult to identify are taken to Stephen Moore at Landcare Research for his opinion. The specimens are compared with reference material and/or are sent off to the appropriate expert for an identification / confirmation.

References

CHAPMAN, M.A.; LEWIS, M.H. 1976: An introduction to Freshwater Crustacea of New Zealand, Auckland.

COWLEY, D.R. 1978: Studies on the larvae of New Zealand Trichoptera. *N.Z. Journal of Zoology 5:* 639-750.

McFARLANE, A.G. 1951: Caddis fly larvae (Trichoptera) of the family Rhyacophilidae. *Records of the Canterbury Museum 5:* 267-89.

McFARLANE, A.G. 1990: A generic key to late instar larvae of the New Zealand Trichoptera (caddis flies). *Records of the Canterbury Museum 10:* 25-38

McLELLAN, I.D. 1991: Notonemouridae (Insecta: Plecoptera). *Fauna of New Zealand 22.*

McLELLAN, I.D. 1993: Antarctoperlinae (Insecta: Plecoptera). *Fauna of New Zealand 27.*

McLELLAN, I.D. 1998: A revision of *Acroperla* (Plecoptera: Zelandoperlinae) and removal of species to *Taraperla* new genus. *N.Z. Journal of Zoology 25:185-203.*

NEEDHAM, J.G.; NEEDHAM, P.R. 1962: A guide to the study of Fresh-Water Biology. *Holden-Day, inc., San Francisco.*

TOWNS, D.R.; PETERS, W.L. 1996: Leptophlebiidae (Insecta: Ephemeroptera). *Fauna of New Zealand 36.*

STARK, J.D.; BOOTHROYD, I.K.G.; HARDING, J.S.; MAXTED, J.R.; SCARSBROOK, M.R. 2001: Protocols for Sampling Macroinvertebrates in Wadeable Streams. *New Zealand Macroinvertebrate Working Group Report No1.*

USINGER, R.L. Editor, 1958: Aquatic Insects of California. *University of California Press.*

WINTERBOURN, M.J. 1973: A guide to freshwater Mollusca of New Zealand. *Tuatara 20:* 141-159.

WINTERBOURN, M.J.; GREGSON, K.L.D.; DOLPHIN, C.H.; Guide to the Aquatic Insects of New Zealand. *Bulletin of the Entomological Society of New Zealand 14.*