5. WORK PLAN

The following sections outline the work plan and methodology proposed by WorleyParsons. The scope of work will include:

- project communications;
- field planning;
- collection of baseline water quality samples at three sampling stations at each outfall location;
- collection of baseline sediment samples at four sampling stations at each outfall location;
- the collection of physical oceanographic data at each outfall location;
- data analysis and QA/QC evaluation; and,
- pre-discharge monitoring report preparation

Furthermore, WorleyParsons has provided a description of the proposed additional scope items to be completed at the discretion of the CRD.

5.1 Project Communications

Project Initiation Meeting

WorleyParsons will attend a project initiation meeting with the CRD at the commencement of the project. The purpose of the meeting will be to review the work plan and schedule for the project.

Bi-Weekly Progress report

WorleyParsons will prepare and submit bi-weekly progress reports to the CRD for the duration of the project. The reports will be either written, in person, by telephone or by e-mail (format determined at request of the CRD).

5.2 Field Planning

Detailed field planning will be conducted prior to each field sampling date. This field planning will minimize health and safety risks and the amount of time lost to poor weather or site conditions.

The health and safety plan will include:

- a hazardous task analysis;
- identification and implementation of hazard controls; and
- daily field safety meetings.

The field planning will also include:

- monitoring marine weather forecasts and tide predictions during the field program;

- duplicating and backing up all electronic files following each field day;
- ensuring appropriate back-up equipment is available in case of malfunction; and,
- preparation of field data sheets (on waterproof paper).

5.3 Water Quality

Baseline water quality monitoring will be conducted quarterly (spring, summer, fall and winter) over a 1.5 year period. A spring quarterly monitoring event was conducted by Golder Associates in May 2009. In year 1, baseline water quality samples will therefore be obtained only during the last two quarters (fall 2009, and winter 2009/2010), and for all four quarters of the Year 2 (2010/2011) sampling program.

Each quarterly sampling event will consist of 5 weekly sampling events within a 30 day period; a protocol consistent with microbiological sampling under the MSR.

Water quality sample collection will take place aboard the *Aluminator* provided by Arrawac Marine Services Ltd. The vessel specifications are provided in Table B. This vessel is ideally suited for the program as it is a durable and versatile work boat in all weather conditions and its smaller size provides economical value for the program.

Table B Sampling Vessel Specifications: "*Aluminator*"

Aluminator

The *Aluminator* is optimized for coastal surveys using state-of the-art navigation and data acquisition systems. Vessel safety equipment meets or exceeds CCG requirements. With a 1998 225hp Yamaha outboard, the *Aluminator* can cruise at 24 knots with a maximum speed of 30 knots. A unique feature for a vessel of this size is the heated, stand-up cabin (>6 ft headroom), an essential feature for all weather operating capability.

Length: 20 ft (23 ft LOA) **Beam:** 8 ft **Draft**: 22 in **Speed:** 24 knot cruise, 30 knot max

Standard Equipment:

225H.P. Yamaha Outboard
9.5 H.P. four stroke Yamaha kicker
Garmin GPS with NMEA output
Sitex depth sounder, NMEA output, 200kHz transducer
Sitex T-150, 18 n mi radar
Davit (s)

Operator:

Doug Hartley has a 350 ton Masters License and over 30 years of experience on the BC coast having skippered the University of Victoria's *RVJohn Strickland* (relief), Dobrocky Seatech's *Sea Lion,* the *Beatrice*, and the *Richardson Point*. Doug has conducted a wide-range of research cruises including wave-rider and current meter deployments, water sampling, hydrocasting, geophysical surveys, and ROV and underwater video surveys.

5.3.1 Vessel Positioning and Station Keeping

Positioning of the vessel on station will be the responsibility of the skippers. The key to good station keeping and successful deployment of sampling devices is to maintain zero wire angle and as low speed over ground as possible. These attributes are achieved by using the drift of the vessel (dictated by the wind and tidal current) rather than driving the vessel to the station (as you would a car). At the start of each station, the skipper will test the drift of the vessel to establish the drift track and rate of drift. Based on this knowledge, the vessel will be positioned up drift of the station prior to the deployment of samplers.

Station location will be determined by the equipment described below for the *Aluminator*:

Aluminator

A Trimble DGPS with a positioning accuracy to within about 0.5 m will feed directly into a laptop computer running digital charting software. Vessel position will be displayed on digital CHS charts in real-time. The screen display will be set to full zoom so the skipper can position the vessel in relation to the station as accurately ass possible. This information will also be used to fine tune the position and drift path the vessel. The GPS receiver will be mounted on the ship's davit, directly over the hydro wire entering the water to ensure the position of the sampler (not the boat) is measured as accurately as possible.

5.3.2 Water Sample Collection and Analysis

Baseline water samples will be collected at three stations in the vicinity of each of the two proposed outfalls. The coordinates of the sampling stations are provided in Table C.

Table C Water Quality Sampling Station Locations

Saanich East WWTP	Latitude	Longitude
Station 1	49°29.129' N	123° 16.601' W
Station 2	49°29.164' N	123° 16.187' W
Station 3	49°28.893' N	123° 16.113' W
West Shore WWTP		
Station 1	48°23.191' N	123° 28.274' W
Station 2	48°23.217' N	123° 27.826' W
Station 3	48°23.207' N	123° 27.215' W

Discrete water samples will be collected at three depths using a Van Dorn sampler. The samples will be collected at:

- 1 m below the water surface;
- mid-depth in the water column; and,
- 1 m above the seabed.

The near seabed samples will be obtained using the bottom touch method. This method provides consistency to collecting bottom-water samples from approximately 1 m above the ocean floor and minimizes the risk of sample contamination from the sediment plume. The bottom-touch method involves:

- setting a deadweight 1 m beneath the Van Dorn bottle;
- positioning the vessel to ensure it will be up drift of the sampling station;
- quickly lowering the bottle to about 10 m above the ocean floor depth estimated using the depth sounder
- slowly lowering the deadweight to the ocean floor until touch is detected (by noticing slack in the wire tension) just up drift of the sampling station;
- marking the depth on the wire and then pulling it in by about 2 m; and,
- allowing the vessel to drift for a few seconds to move away from the touchdown sediment disturbance and then re-lowering the bottle on station to the marked bottom depth and releasing the messenger to trip the Van Dorn and collect the sample.

Mid-depth samples will be collected using a graduated line at a mid-water (estimated using a depth sounder).

Water samples will be labelled, stored on ice in coolers, and taken to CANTEST in Victoria to be analysed for a suite of parameters as outlined in the RFP, including: conventionals, biological, nutrients, trace metals, and organics. Table E summarizes the total number of stations, depths and season each type of parameter are to be measured. Also included is the total number or samples to be analysed during each year of the program.

Table D General Water Quality Parameters

Location	Parameter Type	# Sampling Stations	Station ID	Depths Sampled	# Sampling Events Per Season	Year 1 Seasons[1]	Year 1: Total # Samples	Year 2 Seasons	Year 2: Total # Samples
Saanich East WWTP	Conventionals (Group 1), Biological, and, Nutrients	3	1 2 3	Surface Mid, Bottom	5	Spring[1] Fall Winter	135	Spring Summer Fall Winter	180
	Conventionals (Group 2)	3	1 2 3	Surface Mid, Bottom	1	Spring[1] Fall Winter	27	Spring Summer Fall Winter	36
	Trace Metals	1	2	Surface Mid, Bottom	5	Spring[1] Fall Winter	45	Spring Summer Fall Winter	60
	Organics (Group 1)	2	1 2	Bottom	2	Fall Winter	8	Summer Winter	8
	Organics (Group 2)	1	2	Bottom	1	Fall Winter	4	Summer Winter	4
WestShore WWTP	Conventionals (Group 1), Biological, and, Nutrients	3	1 2 3	Surface Mid, Bottom	5	Spring[1] Fall Winter	135	Spring Summer Fall Winter	180
	Conventionals (Group 2)	3	1 2 3	Surface Mid, Bottom	1	Spring[1] Fall Winter	27	Spring Summer Fall Winter	36
	Trace Metals	1	2	Surface Mid, Bottom	5	Spring[1] Fall Winter	45	Spring Summer Fall Winter	60
	Organics (Group 1)	2	1 2	Bottom	2	Fall Winter	8	Summer Winter	8
	Organics (Group 2)	1	2	Bottom	1	Fall Winter	4	Summer Winter	4

[1] Spring sampling has been previously completed by Golder Associates.

The individual analyses that will be included within each parameter type are outlined in Table F, with detailed analyte lists for each parameter included in Appendix 3.

Table E Specific Water Quality Parameters

Parameter Type	Parameter
Conventionals (Group 1)	pH Conductivity Total Suspended Solids Major Anions Hardness
Conventionals (Group 2)	Total Organic Carbon Dissolved Organic Carbon Total Kjeldahl Nitrogen Total Phosphate (as P) Orthophosphate
Microbiological	Enterococci Fecal Coliform s
Nutrients	Ammonia Nitrate and Nitrite (as N) Nitrate
Organics (Group 1)	Polycylis Aromatic Hydrocarbons (PAHs) Organochlorine Pesticides Chlorinated Phenolics Volatile Organic Compounds (VOCs, including BTEX) Phthalates Polybrominate Diphenyl Ethers (PBDEs)
Organics (Group 2)	Polychlorinated Biphenyls (PCBs) Nonyphenol and its ethoxolates

5.3.3 Water Column Profiling

Water quality profiles will be obtained at each sampling station during each sampling event. The water column profiles will be measured *in situ* using a Seabird Electronics Inc. SBE19 fitted with the necessary sensors to measure the following parameters:

- temperature;
- salinity;
- depth;
- pH;
- dissolved oxygen (DO); and,
- turbidity.

The instrument will be lowered to the seafloor and raised to the surface at a constant speed of approximately 0.1 to 0.4 m/s. This is well within the recommended profiling rate for the SBE19 (Sea-Bird Electronics, Inc. 2009). The instrument collects data at a rate of 4 Hz, therefore 10 to 40 data points will be collected for each metre of the water column. The range and accuracy reported by the manufacturer for the Seabird SBE19 is provided in Table G. The Seabird will provide more than sufficient accuracy for the purposes of this study.

Table F Range and Accuracy of the Seabird SBE19

	Seabird SBE19	
Sensor	**Range**	**Reported Accuracy**
Conductivity (Salinity)	0 - 90 mS/cm	± 0.005
Temperature	-5 to +35 ºC	± 0.005
pH	0 to 14 pH	±0.1
DO	120%	±2%
Turbidity	0-2,000 NTU	±1%

Vessel positioning will be accomplished as described in section 5.3.1. A weight can be added to the CTD, if necessary, to ensure accurate vertical profiles are measured at each site. If very fast currents are present, profiles can be taken at slack tide, when currents are at their lowest.

5.3.4 Field Quality Assurance and Quality Control Plan

The field QA/QC plan will include procedures to reduce the risk of contamination of the samples. Specific QA/QC procedures that will be incorporated into the QA/QC plan will include:

- sampling equipment will be rinsed at least three times with de-ionized or distilled water (supplied by CANTEST Ltd.) before each sampling event;
- duplicate and/or triplicate samples will be collected by means of splitting a single sample in the field;
- travel blanks supplied by CANTEST Ltd. will be analysed;
- all field samples and field data sheets will be clearly labelled using pencil or waterproof ink
- prevention of sample contamination by carefully handing bottles and lids to prevent their interior from contacting boat surfaces or receiving drips from vessel riggings or rain when open; and,
- filling coolers with ice contained in sealed bags to maintain sample temperature but prevent contamination through samples contacting ice melt water

The number of triplicate samples and field blanks to be analysed are outlined Table G.

Table G QA/QC Sample Frequency

Location	Parameter Type	# Sampling Stations to be Sampled in Triplicate per Season	# Seasonal Blanks	Year 1: Seasons	Year 2 Seasons
Saanich East WWTP & WestShore WWTP	Conventionals (Group 1) Biological Nutrients Conventionals (Group 2)	2 (one per outfall)	2	2	4
	Trace Metals	1	1	2	4
	Organics (Group 1)		1	2	2
	Organics (Group 2)		1	2	2

Furthermore, the field QA/QC plan will also include measures to ensure quality data is collected and prevent data loss, including:

- bench testing all field equipment to ensure proper function prior to each sampling date
- carefully calibrating instruments each day and recording the calibration results in the field notes
- use of waterproof and tear-proof paper and pens for field data sheets
- use of chain of custody records for laboratory correspondence
- backing up all electronic data (e.g. positional data from GPS or water quality data from electronic instruments), in duplicate, at the end of each field day and labelling all electronic files;
- keeping thorough notes, including photographs, GPS coordinates, tidal/weather conditions, and recording all potential confounding factors observed during all field days and at all sites.
- Saving station positions in the digital chart software as well as in field notes for redundancy

These QA/QC measures will ensure high-quality samples and data are collected and reported throughout this study.

5.4 Sediment Quality and Benthic Community

Sediment quality and benthic community samples will be collected in conjunction with the fall sampling event aboard *RV Richardson Point* (specifications in Table G). Samples will be collected from 13 sampling stations at each outfall location:

- one station at each proposed terminus location (Optional);
- four stations within the anticipated Initial Dilution Zone (IDZ) of each proposed outfall;
- four stations outside the anticipated IDZ along the axis of the dominant current direction at each proposed outfall; and,
- four stations at far field locations for each outfall.

Sediment station locations will be reviewed upon award of the contract to ensure they are aligned with the predominant current direction based on modelling data provided by the CRD. Sediment sampling stations should be in line with the predominant current direction and along similar depth contours

A total of seven sediment samples will be collected at each station. Four samples will be used to characterise benthic invertebrate communities and three will be used for sediment quality analysis. For sediment quality samples, WorleyParsons recommends a slightly modified sample collection process aimed at improving the accuracy of the sampling and conforming to the *Puget Sound Estuary Program: Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound* (PSEP,1997). Sediment quality samples will be collected from three Van Veen grab samples as proposed by the CRD, however the sediment-microbiology samples and sediment-chemistry samples to be analysed for acid volatile sulphides (AVS), simultaneously extractable metals (SEM) and moisture content will be obtained directly from the Van Veen before a composite sample is created. The sediment-chemistry composite samples, tested for sediment physical parameters, nutrients, metals, and organics (group 1 and group 2), will be collected as per the RFP. Detailed descriptions of sample collection and analyses are provided in Section 5.4.2.

5.4.1 Vessel Positioning and Station Keeping

Positioning of the vessel on station will be the responsibility of the skippers. The key to good station keeping and successful deployment of sampling devices is to maintain zero wire angle and as low speed over ground as possible. These attributes are achieved by using the drift of the vessel (dictated by the wind and tidal current) rather than driving the vessel to the station (as you would a car). At the start of each station, the skipper will test the drift of the vessel to establish the drift track and rate of drift. Based on this knowledge, the vessel will be positioned up drift of the station prior to the deployment of samplers.

Station location will be determined by the equipment described below for the *Richardson Point*.

RV Richardson Point

The vessel is equipped with a 12 Channel Differential Global Positioning System (DGPS) utilizing a Sperry gyroscope multiplexed into the ships computer. This computer runs an advanced vessel position and digital charting system that was custom developed to provide accurate position fixing and has been used successfully for the Macaulay and Clover Point outfall monitoring programs. An additional Trimble DGPS will be used for final positioning to increase positioning accuracy to within about 0.5 m. The Sperry gyroscope will provide information to accurately maintain the ship's heading on the digital charting software during the slow speed manoeuvres required to fine tune the position of the vessel. The DGPS receiver will be mounted on the ship's davit, directly over the hydro wire entering the water to ensure the position of the sampler (not the boat) is measured as accurately as possible.

Table H Sampling Vessel Specifications: "MV Richardson Point"

MV Richardson Point

Specifications

Certificates: Canadian Coast Guard CSI Home Trade II
Length: 20 m **Beam:** 5.5 m **Speed:** Maximum 12 Knots, Cruise 8 Knots, Minimum 2 Knots

Navigation Equipment:
2 Seamaster magnetic compasses
Sperry SR 130 Gyrocompass
2 Sperry Gyrocompass bridge repeaters
Cetrex Fluxgate compass
Raytheon DGPS
Garmin DGPS
Sitex GPS
Ross Loran C Koden 32 mi. Radar
Ratheon 96 mi. Radar (gyro stabilized)
Koden large screen colour chromascope

Winches & A-Frame:
Hydrographic winch (duplex drum hydrowire/cable)
2 - CTD winches
Hydraulic boom crane c/w cable and topping lift
Harrison and Robbins anchor winch
Hydraulic A-Frame (stern mounted)

Communications:
GMDSS and VHF Radios
SSB Radio

Life Saving Equipment:
EPIRB (emergency position indicating radio beacon) 406 MHz and 121.5 MHz (self deploying)
Automatic distress tone broadcast on SSB
1 - 16 man self-inflating life raft (A-Pac)
6 man Novurania RIB c/w 40 HP Outboard c/w lifeboat kit
10 Immersion suits
20 Standard adult life jackets
1 Level 2 First Aid kit

5.4.2 Benthic Sample Collection and Analysis

A 0.1 m^2 stainless steel Van Veen sediment grab sampler will be used to collect sediment samples. This Van Veen sampler has top screens and rubber flaps to reduce sediment disturbance during deployment and retrieval. Vessel positioning will be conducted as described in the bottom touch method (Section 5.3.2). The Van Veen sampler will be deployed to within about 5 m of the seabed when the vessel is up drift of the station. As the vessel approaches the station, the skipper will fine tune the position of the vessel with slight thrusts of power from the vessels engines. Once directly on station and with zero wire angle, the skipper will give the deckhand the signal release the cable on the winch until the grab touches down and triggers to close.

Upon retrieval, the excess water will be siphoned off from the Van Veen sampler using sterilized tubing. A separate piece of sterile tubing (soaked in bleach solution prior to field work and sealed in individual zip-loc bags) will be used for each grab so as not to introduce contamination or cross contaminate the samples.

Four near-field sampling stations (inside IDZ), 4 mid-field stations (outside IDZ), and 4 far-field sampling stations (background) will be located in the vicinity of each outfall and a total of seven successful grabs will be taken at each station (4 grabs will be used for benthic invertebrate taxonomic identification and three grabs will be used for chemical analysis). One additional station at the proposed outfall terminus (7 grabs/station) is presented as an optional component to this study. Therefore a total of 26 stations will be sampled (including options) for a total of 182 individual grabs collected. Station locations will be finalized at a later date in consultation with the CRD and their consultants.

Benthic Invertebrate Samples

Four of the seven Van Veen sediment grab samples collected at each of the 26 sampling stations will be submitted to Biologica for invertebrate taxonomic identification. Only three samples will be analysed initially, with the fourth kept as an archive (to be analysed based on the precision of the first 3 samples). These three samples will be processed separately as they will be used as replicate samples to give a measure of variance among benthic infauna samples. Acceptability criteria for the benthic invertebrate samples are as follows:

- The sediment appears undisturbed with no signs of wash-out.
- Sample volumes (>80% of grab) must be nearly equal (within approximately 10%, by visual inspection).
- Samples appear to be similar in colour, texture and smell.

All invertebrate samples will be washed on board the *Richardson Point* upon collection by four trained technicians provided by Biologica (seawater for washing will be filtered through 125 or 250 micron screen prior to use). For each successful Van Veen grab sample, the sample will be photographed, qualitative characteristics (sediment colour, texture, odour, debris and biological material) will be described on a field data sheet. Each sample will be placed in its own pre-labelled plastic container(s) that have been rinsed with seawater from the screening source and then preserved.

Biologica will follow the benthic invertebrate field sampling protocol outlined in the RFP (Appendix 1) with the exception of the following changes provided by Biologica:

- Biologica will use the Biologica benthic sample field screening system during field collection. This proven system was designed and built in 1998 to provide a sample washing arrangement which minimizes damage to the invertebrates under study. It employs a stacked series of portable stainless steel trays with mesh bottoms secured in an aluminum frame. The frame and tray system does include a self-contained battery-operated water pump, if required for washing the fine sediment from the sample.
- Samples will be washed in the order in which they were collected.
- Fragile organisms will be removed by the technicians as the samples are washed and will be placed in small vials to prevent damage.
- Samples will be prepared for shipping to the laboratory at the end of each sampling day. Samples will be transported to the laboratory by the outgoing field crew or by a Biologica technician. Sample delivery will not involve couriers to avoid loss of shipments.

Biologica will follow all quality control requirements listed in the RFP. Additional measures to ensure quality and consistency include:

- Biologica's senior biologist will be on board for the first day of sampling for quality control.
- A waterproof label, made up in advance, will be added to each benthic invertebrate sample as soon as it is brought on board ship. This label will remain with the sample through the washing and sorting procedures. The label will be retained with the debris.
- Only one benthic sample processing technician will handle (screen) each sample, except in the case where there are no other samples on deck.

Sediment-Microbiology Grab Samples

Three of the seven Van Veen sediment grab samples collected at each of the 26 sampling stations will be submitted to CANTEST for Sediment-Microbiology analysis.

Sediment microbiology samples will consist of three aliquots from the surface of each of these Van Veen samples. The three aliquots will be removed from the surface of each of the three undisturbed successfully-collected Van Veen sediment grab samples (a total of 90 sediment grab samples: 26 sites * 3 samples/site + 4 replicates* 3 samples/replicate). Each of these three aliquots will be removed using pre-sterilized stainless-steel ice-cream scoops. Aliquots will be removed from the Van Veen sediment grab samples by rotating the scoops into the sediment so as to maintain the surface of the sediment sample and cause as little disturbance as possible. Each aliquot will be approximately 36 mL in volume, therefore each microbiology sediment sample will be approximately 108 mL (36 mL/aliquot * 3 aliquots/sample) and will be combined in a wide-mouth sterile polyethylene container.

The sediment microbiology samples will be handled with care to avoid contamination and will be packed in light-proof insulated containers that are surrounded by, but not in contact with, freezer packs or ice. Chain-of-custody forms will be completed and packaged with the samples inside a sealed Zip-loc bag.

Sediment microbiology samples will be delivered to the laboratory on the same day as sampling takes place before 5:00 PM. If this is not possible, samples will be stored overnight in a sample refrigerator at 4°C in dark conditions and delivered between 8:00 and 9:00 AM the following morning. Since most field days are anticipated to extend from 6:00 AM to 6:00 PM, we will coordinate one of our office staff to hand deliver the samples to the laboratory so that there is no reliance on couriers and control and possession over the samples can be maintained. Sediment microbiology samples will be analysed for fecal coliforms.

Sediment-Chemistry Grab Samples

Three Van Veen sediment grab samples will be collected at each of the 26 sampling stations, and used for sediment-microbiology samples. After these microbiology samples are successfully taken from the Van Veen sediment grab, sediment-chemistry samples will be obtained from the grab. The subsamples will be obtained from the upper 2 cm of the sediment using a flat bottomed scoop shaped like a coal shovel. Each sediment-chemistry sample will be scooped from one of the successfully-collected Van Veen grabs into a pre-cleaned, 125 mL, wide mouth, glass jar with a Teflon-lined lid. Each of these jars will be filled to the brim with sediment (zero head space) to exclude as much air as possible. Thirty sediment-chemistry grab samples will be obtained from the 26 sampling stations (two stations will be sampled in triplicate using fresh casts of the Van Veen). Sediment-chemistry grab samples will be packaged in lightproof coolers containing freezer packs and sent to CANTEST under chain-of-custody within 24 hours of collection. Sediment-chemistry samples will be tested for acid volatile sulphides (AVS), simultaneously extractable metals (SEM) and moisture content (see Appendix 3 for details).

Sediment-Chemistry Composite Samples

Sediment-chemistry composite samples will be collected from each of the 26 sampling stations. Three Van Veen sediment grab samples will be collected at each of the 26 sampling stations and used for sediment-microbiology grab samples and sediment-chemistry grab samples. After both sediment-microbiology grab samples and sediment-chemistry grab samples have been successfully obtained, the remaining sediment from the three Van Veen casts at each site will be used for the sediment-chemistry composite samples. In addition two sampling stations (one per outfall location) will be sampled in triplicate using fresh casts of the Van Veen. The upper 2 cm of sediment from each of the three Van Veen casts at each site will be removed using a pre-cleaned stainless steel flat-bottomed scoop and placed in a pre-cleaned, round-bottom, stainless steel, bowl. These three, same-station, samples will be mixed thoroughly by stirring until the colour and texture of the sediment in the bowl are homogenous. This composite sample will be deposited into pre-cleaned, amber glass jars to be analysed for the parameters outlined in Table H. These amber jars will be filled to the brim to exclude as much air as possible.

Table I Sediment-Chemistry Composite Sample Parameters and Sampling Stations

Parameter Type	Parameters	Sampling Sites	Number of Stations (per Site)	Total # Sampling Stations / Outfall	Number of Replicate QA/ QC Samples	Total Number of Samples / Outfall (Includes Terminus)	Total Number of Samples (Includes Terminus)
Physical	Particle Size Total Organic Carbon Total Carbon	Terminus (Option 5.7.1)	1	12 (13)	2	14 (15)	28 (30)
		IDZ	4				
		Mid Field	4				
		Far Field	4				
Nutrients	Total Nitrogen Total Phosphorous	Terminus (Option 5.7.1)	1	12 (13)	2	14 (15)	28 (30)
		IDZ	4				
		Mid Field	4				
		Far Field	4				
Trace Metals	Total Trace Metal Suite	IDZ	4	12 (13)	2	14 (15)	28 (30)
		Mid Field	4				
		Far Field	4				
Organics (Group 1)	Plycyclic Aromatic Hydrocarbons (PAH's) Organochlorine Pesticides Chloronated Phenolics Volatile Organic Compounds (VOC's including BTEX) Phathalates Polybrominated Diphenyl Ethers (PBDEs)	Terminus (Option 5.7.1)	1	4 (5)	2	6 (7)	12 (14)
		IDZ	2				
		Far Field	2				
Organics (Group 2)	Polyclorinate Biphenyls (PCB's)	Terminus (Option 5.7.1)	1	2 (3)	2	4 (5)	8 (10)
		IDZ	1				
	Nonylphenol and it Ethoxylates	Far Field	1				

5.4.3 Field Quality Assurance and Quality Control Plan

The field QA/QC plan will include procedures to reduce the risk of contamination of the samples such as:

- decontamination of sediment sampling equipment and associated utensils by scrubbing with a brush and phosphate-free detergent solution to remove excess sample material;
- all equipment will then be thoroughly rinsed with clean water, using either a clean hose while on deck, or by repeatedly submersing the equipment overboard;
- sample-handling utensils will be rinsed a second time with analyte-free (de-ionized or distilled) water.
- clearly labelling all field samples and field data sheets; and

Furthermore, the field QA/QC plan will include measures to prevent data loss, including:

- use of water and tear proof paper for field data sheets;
- backing up all electronic data (e.g. positional data from GPS or water quality data from electronic instruments), in duplicate, at the end of each field day;
- thoroughly labelling all electronic files; and
- keeping thorough field notes, including photographs, during all field days.

These QA/QC measures will ensure the data are collected in a manner that is defensible under scientific scrutiny.

5.5 Oceanography

Site specific oceanographic data will be collected to characterize the physical oceanography of the receiving environment. The data will be used to calibrate hydrodynamic computer models of the receiving environment and discharge plume dynamics. The oceanographic studies will include:

- three dimensional current profiles; and,
- conductivity (salinity), temperature, and depth (CTD) profiles.

Currents

During the Year 1 field program WorleyParsons will deploy two Acoustic Doppler Current Profilers (ADCP) near each outfall.

A total of four Teledyne RD Instruments Workhorse ADCPs will be used. Either 300kHz models or 600kHz models can be used depending on the depth of the deployment site (for water depths less than 60 m, 600 KHz models will be used and for water depths over 60 m 300 kHz models will be used). The instruments are fitted with a pressure sensor, temperature and tilt sensor, and will be will be fitted with bottom mounted oceanographic moorings as shown in Photo A. The moorings will utilise a combination of a ground line and an acoustically released float line that will be used to retrieve the instruments, as shown in Figure B.

Photo A ADCP Mooring

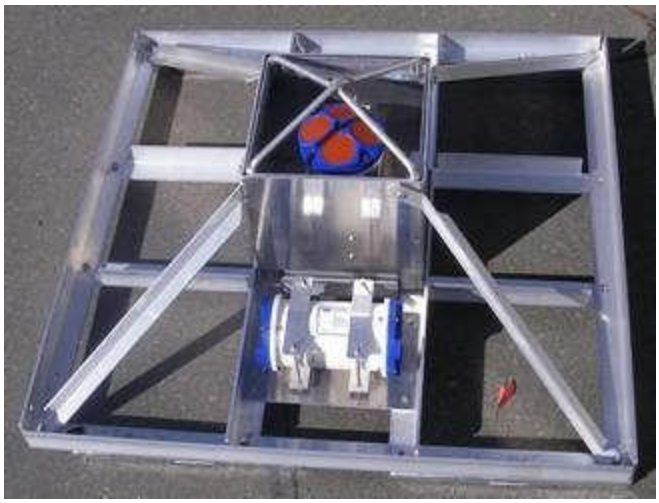
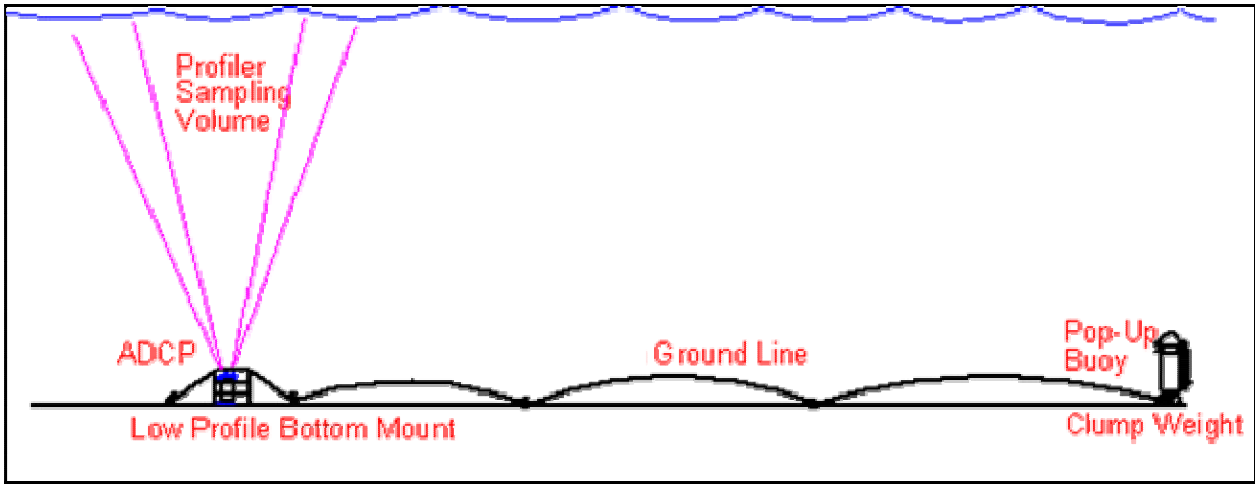


Figure B Ground Line and Float Configuration for ADCP Mooring



The ADCPs will be deployed for a period of approximately one month (30 days), which corresponds to the length of one entire lunar/tidal cycle. In addition to the scope proposed by the CRD, meteorological conditions from nearby Environment Canada weather stations will be obtained during the current meter installation, as weather events can cause abnormal current regimes, especially in the upper water column.

CTD Water Column Profiling

CTD data will be collected concurrently with the baseline water quality sampling to assess seasonal variation in salinity, temperature, and turbidity properties. Water column profiling is described in Section 5.3.3.

5.6 Data Analysis

5.6.1 Water and Sediment Quality

Analytical results of the water and sediment samples will undergo a comprehensive QA/QC evaluation and then (pending successful QA/QC evaluation) be compiled, summarized and compared to relevant guidelines.

QA/QC

The results from the baseline water quality data collection will undergo a QA/QC evaluation against the Data Quality Objectives established for the program in the *Guidance Manual for Assessment and Analysis on WMEP Data* (Golder, 2007). Data quality objectives have been established for the precision (reliability), bias (consistent deviation from a true value), and representatives of the data. The QA/QC evaluation will involve:

- Data screening for suspect values
    - Upon receipt of analytical results data will be screened to ensure that the reported values fall within the expected range.
    - Values with a substantial deviation from the expected values will be investigated or re-analysed using archived samples volume.
- Assessment of Laboratory Compliance
    - Analytical reports will be reviewed to ensure all requested analysis were completed; if method detection limits met or exceeded requirements, if QA/QC requirements were fulfilled, if QA/QC samples were within acceptable criteria, if formulae were correct.
- Assigning Data Qualifiers
    - Data will be assigned data qualifiers based on the flow chart outlined in Appendix A of Golder (2007). Based on this analysis data points will be assigned one of the following data qualifiers:
        - R: Data is Rejected
        - J: Analyte has been positively identified
        - J(-): Analyte has been positively identified but the reported concentration is believed to be *biased low.*
        - J(+):Analyte has been positively identified but the reported concentration is believed to be *biased high.*
        - U: Analyte was not detected above the sample detection limit.
        - UN: Analyte was not detected above the sample detection limit but significant quantitative uncertainty exists.
- Qualify Associate Data.

- If data is rejected, the source of the rejection will be reviewed. Qualifiers may be added to additional analytes, if the source of a rejection is viewed as a systematic problem that may affect an entire group of analytes.

- Re-Analyse Samples if Required.
  - Reject data will be re-analysed if it possible to do so within analytical holding times; if the missing information in necessary to achieve the goals of the program, it is expected that the re-analysis will produce higher-quality results, and can be conducted at realistic cost and expenditure of effort.

- Identifying Outliers
  - Values that either extremely large or small in relation to the rest of the data set will be identified and assessed based on options discussed in the guidance manual (Golder, 2007).

Data Analysis

Water and sediment quality data will be compiled, summarised and compared to applicable guidelines and criteria. The statistical method used for summarising each analyte will be assessed individually, and will be based on the regulatory guideline, data properties, and data quality. Assessments and statistical methods will be based on recommendations outlined in the *Guidance Manual for Assessment and Analysis on WMEP Data* (Golder, 2007).

Water quality data will be screened against the following guidelines and criteria:

- British Columbia - Ministry of Environment (Working Water Quality Guidelines)
- Canadian Council of the Ministers of Environment (CCME)
- Washington State – Ecology
- United States Environmental Protection Agency (USEPA)

Sediment quality data will be compared to the following guidelines and criteria:

- British Columbia - Ministry of Environment (Working)
- Canadian Council of the Ministers of Environment (CCME)
- BC Contaminated Sites Regulation
- Washington State – Ecology
- United States Environmental Protection Agency (USEPA)

Analytical results will also be summarised and provided to the CRD in the CRD Environmental Services Information System (ESIS) format.

5.6.2 Benthic Invertebrate Community

The presence or absence, abundance and biomass of each benthic invertebrate taxon in the community is the basic information to be obtained from the benthic invertebrate surveys. Additionally, organisms will be separated into adults, intermediates and recently settled juveniles, the latter of which do not clearly reflect long-term sediment effects (Burd, 2000). In the absence of direct biomass measurements, a biomass conversion for each species abundance value tends to de-emphasize the small, abundant forms and emphasize the large, rarer forms, which contribute considerably to the biomass of the community. Often, a comparison based on both raw-abundance and biomass-converted abundance will be illuminating in discerning community structural patterns.

Benthic invertebrate community data will be provided by Biologica and QA/QC and data analysis will be performed by Dr. Brenda Burd of Ecostat Research Ltd. Benthic invertebrate community structure will be described and discussed in the monitoring report.

QA/QC

QA/QC of benthic invertebrate samples is composed of a series of steps, in which data are verified. These steps include (provided by Dr. Brenda Burd):

- The benthic ecologist must be satisfied prior to data analysis that the reference collection is complete, and that verifications have been reviewed. If the compliance in taxonomic identifications is acceptable, and any discrepancies discussed and corrected, then analyses can continue on the data. Biologica Environmental Services will ensure that taxonomic verifications have been completed prior to data analysis.
- The sampling precision (variability between replicates) for each station will be examined using the method of Elliott (1977) to determine if adequate replicates have been collected to ensure a representative proportion of the overall assemblage has been sampled. If 3 replicates are inadequate for 20% precision (standard error/mean), the 4th replicate sample will be processed.
- A comparison of the species list with the existing ACCESS master database for the BC coast (Burd, in prep.) will be done, and taxonomic coding harmonized for easy comparison in future years. A stand-alone database has already been constructed by Ecostat Research Ltd. for CRD for the Macaulay Point outfall. The data for the new sites can be incorporated into this database if desired.
- Data will be checked for outliers, using a variety of data summary and output methods. Any unusual values will be checked against the original bench-sheets for laboratory enumeration. If necessary, unresolved errors will be checked by re-examination of original samples.
- We do not recommend the use of data transformations, except potentially for biomass-transformations of abundance data, which can be more readily interpreted ecologically, and will often have the same effect as geometric transformations (Burd et al., 1990). In particular, as these are baseline surveys, it is not expected that dominance by 1 or 2 small taxa will be high.

Data Analysis

Statistical analyses will be performed by Dr. Brenda Burd of Ecostat Research and will provide meaningful baseline data. Dr. Burd will address the following questions with related hypothesis, power and/or probability testing.

Question 1: Are the benthic infauna homogeneous throughout each sample area?

Question 2: Are the benthic infauna related to sediment conditions (organic content, substrate type, etc.)

Question 3: Are the benthic infauna similar between the different sampling areas?

Specific hypotheses to be tested related to these questions will be outlined in the project report (though generalized hypotheses to be tested and statistical analyses are provided by Dr. Burd as Appendix 4).

All analyses are based initially on the assumption that the background fauna in these areas are healthy and sustainable. This will be examined by comparing basic biological factors from the sample areas (various abundance, biomass and species richness measures) with background thresholds calculated from the larger BC coastal database (Burd et al., in revision), as well as background data from the Parry Bay region.

Furthermore, the data will be presented such that it may be used in the future to satisfy numerous objectives, including but not limited to:

- Hypothesis testing about the proposed discharges and their effects
- Testing for significant differences in abiotic and biotic factors between reference sites and sites near the proposed discharges
- Determination if any observed effect can be attributed to the proposed discharges
- Evaluation of the influences of confounding factors in the environment

5.7 CRD Proposed Additional Scope 1

The items associated with Additional Scope 1 are described below. These items will be executed in Year 1 and year 2.

5.7.1 Additional Outfall Station

An additional sediment sampling location will be located at the theoretical terminus location of each proposed outfall. Samples obtained from this station will be analysed for:

- sediment (Physical, Nutrient, Biological, Metals, AVS, SEM Organics (Group 1&2));
- benthic invertebrate tissue chemistry analysis; and,
- benthic invertebrate community structure.

The benthic invertebrate tissue chemistry analysis will focus on the concentrations of metals and organic substances found in invertebrate tissue.s Sample collection, and analytical procedures will be based on the protocols outlined in the *Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound.* (PSEP 1996*).*

This optional scope item includes the additional time and expenses for sample collection and handling and analysis along with the additional sample QA/QC evaluation.

5.7.2 Bioassay and Bioaccumulation

Sediment samples will be collected at three stations at each proposed outfall location (6 stations in total). The samples will be used for sediment bioassay and bioaccumulation tests. The tests will include:

- marine amphipod sediment toxicity test (*R. abonius or E. estuaries*);
- marine polychaete sediment toxicity test; and,
- marine polychaete sediment bioaccumulation test (*Nereis spp. or Neathes spp.*).

Sample collection, and analytical procedures will be based on the protocols outlined in the *Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound.* (PSEP, 1996*).*

5.8 CRD Proposed Additional Scope 2

The items associated with Additional Scope 2 are described below. These items would be executed in Year 1 and Year 2.

5.8.1 High Resolution Organics Group 1 and 2 Analysis

Sediment samples obtained during the field program (Section 5.4) will be analysed for organic parameters (Group 1 and Group 2) at high resolution (pg/g) (see Appendix 3). This task will not require additional field time.

5.8.2 Archive Samples

This proposed additional scope item includes storage and archiving of all samples that have been collected. The effort involved to carry out this task will involve long-term storage of the analytic samples for a period of one year after the generation of the final analytical report by the analytical laboratory.

5.8.3 Sediment Box Core Sampling

Sediment box core samples will be collected at three stations per outfall (total of six stations). The sediment samples will be analysed for:

- radio isotopes (Ra226, and Pb210); and,
- C:N ratio.

Core depths will also be archived for historic substance deposition.

This task will involve:

- Collection of 6 box core samples.
- Sample handling
- Analysis, and
- Sample archiving.

5.8.4 Water Column Sterols and Hormones Analysis

Water samples will be collected and analysed for sterols. The full list of Sterols and Hormones to be analysed are provided in Appendix 3. WorleyParsons proposes to sample sterols at the same number of stations and frequency as the proposed water sampling for Organics Group 2. This task would therefore involve the collection of one sample per outfall location, at one depth, once per season, with sampling occurring during two seasons each year. A QA/QC blank would also be analysed once per season for a total of 3 samples per season, and 6 samples each year.

5.8.5 Sediment Pharmaceuticals and Personal Care Products Analysis

Sediment samples will be collected from the sediment chemistry grab samples (Section 5.4.2) and analysed for pharmaceuticals and personal care products. The full lists of analytes are provided in Appendix 3. WorleyParsons proposes to analyse a total of 8 sediment samples per year (i.e. at the sample frequency as the Organic Group 2 analysis). One sample will be obtained for two sampling sites at each outfall location, with one sample per outfall location to be analysed in triplicate.

5.9 Reporting for the Pre-Discharge Monitoring Program

Year 1 Monitoring Report

The results from the first year of the pre-discharge monitoring program will be summarised in a formal report. The report will include:

- an executive summary;
- a statement of purpose;
- a description of the methodology and processes followed;
- a description of the analyses carried out,
- results
- conclusions; and,
- recommendations.

Based on the results of Year 1, recommendations will be made for Year 2 of the monitoring program, including a review of the scope of the study. The recommendations will be discussed and agreed upon by the CRD and MOE before changes are made to Year 2 of the program.

Year 2 Monitoring Report

The results from the second year of the pre-discharge monitoring program will be summarised in a formal report. The report will include:

- an executive summary;
- a statement of purpose;
- a description of the methodology or process followed;
- a description of the analysis carried out,
- results;
- conclusions; and,
- recommendations.

5.10 Stage 2 EIS Support Document (Pre-Discharge Monitoring Report)

A final report will be prepared, intended to support the marine component of the Stage 2 EIS. The scope of the report will be based on the relevant requirements of an expanded scope EIS for discharges to marine waters with maximum daily effluent flow greater than 10,000 m^3/d as outlined in the *Environmental Impact Study Guideline* (MELP 2000). The proposed scope of the pre-discharge monitoring report will include:

1. identification of applicable water quality guidelines at areas of concern;
2. the physical meteorological and physical oceanographic setting will be characterised as it relates to the discharge and dispersion of the effluent plume. This will include;
    a. accessing and summarising meteorological data available from Environment Canada;
    b. summary of current meter measurements; and,
    c. summary of CTD profiles measured (including temperature, salinity, turbidity, pH, and dissolved oxygen);
3. baseline water quality data collected during the pre-discharge monitoring program (Section 5.3) will be summarised and compared to applicable guidelines;
4. baseline sediment quality data collected during the pre-discharge monitoring program (Section 5.4) will be summarised compared to applicable guidelines;
5. baseline benthic invertebrate community structure data collected during the pre-discharge monitoring program (Section 5.6.2) will be summarized;
6. recommendations will be made for post-discharge effluent and environmental monitoring programs.

6. SCHEDULE

WorleyParsons has proposed the following tentative schedule for the pre discharge monitoring program.

Table J Tentative Schedule

Year	Task	Commencing	Notes
Year 1	Project Startup Meeting	Sept 7, 2009	
	Fall Water Quality Sampling	Sept 15, 2009	5 Weekly Sampling Events over a 30 Day Period
	Sediment Sampling	Oct 19, 2009	
	ADCP Deployment	Nov 2, 2009	ADCP will be deployed for a minimum of 30 days
	ADCP Retrieval	Nov 30, 2009	
	Winter Sampling	January 2010	5 Weekly Sampling Events over a 30 Day Period
	Year 1 Monitoring Report	April 2010	Two months after winter 2010 sampling
Year 2	Spring Sampling	April 2010	5 Weekly Sampling Events over a 30 Day Period
	Summer Sampling	July 2010	5 Weekly Sampling Events over a 30 Day Period
	Year 2 Sediment Sampling	September 2010	
	Fall Sampling	October 2010	5 Weekly Sampling Events over a 30 Day Period
	Winter Sampling	January 2010	5 Weekly Sampling Events over a 30 Day Period
	Year 2 Monitoring Report	March 2011	Two months after Year 2 sampling completion
	Pre Discharge Monitoring Report	April 2011	Three months after Year 2 sampling completion

7. DELIVERABLES

The following deliverables will be provided for this project:

- Attendance at an initial project meeting;
- Bi-weekly project status reports;
- Year 1 Monitoring Report (3 unbound copies)
- Year 2 Monitoring Report (3 unbound copies)
- Pre-Discharge Monitoring Report, including 1 unbound copy, 3 bound copies, electronic file version, pdf copy and an executive summary and selected text and graphics formatted for the CRD website.
- Spatially referenced data, GPS, GIS and excel according to the data format criteria specified by the CRD.