

**Management of Agricultural Landscapes with Wetlands and Riparian  
Zones: Economic and Greenhouse Gas Implications**

Funding provided by Ducks Unlimited Canada

and

Agriculture and Agri-Food Canada

under the

*Advancing Canadian Agriculture and Agri-Food (ACAAF) Program*

DUC-ACAAF Field Sampling Protocol Manual

May 10, 2006

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**Questions?** Contact: Tom Goddard, Alberta Agriculture

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(R. Bourbonniere 9 April 2006)

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DUC-ACAAF Observation Field Sheet

DUC-ACAAF Plant Identification Field Sheet

DUC-ACAAF GHG Sample Sheets

(Use Microsoft Excel File titled DUC-ACAAF Sample Sheet)

Blank Soils Observation Field Sheet

## The Project Team:

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Lindsay Kinseman  
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## Shipping Information:

### 1. Water Chemistry Analyses:

Ship samples as per protocol to appropriate ALS Laboratory in:

Winnipeg: Judy Dalmaijer, 745 Logan Avenue, Winnipeg, R3E 3L5  
Phone: (204) 945-5713

Saskatoon: Raechelle Kreese, 819-58th Street East, Saskatoon, S7K 6X5  
Phone: (306) 668-8370

Edmonton: Jessica Webber, 9936-67 Avenue, Edmonton, T6E 0P5  
Phone: (780) 413-5220

Calgary: Shanna Wienmeyer, Bay 7, 1313-44th Ave NE, Calgary, T2E 6L5  
Phone: (403) 291-9897

Waterloo: Theresa Stephenson, 60 Northland Rd, Unit 1, Waterloo, N2V 2B8  
(Hamilton is closer to Waterloo) Phone: (519) 886-6910

### 2. DOC & DIC Water Analyses:

Ship samples as per protocol to:

Dr. Rick Bourbonniere and Karen Edmondson  
Environment Canada / NWRI  
867 Lakeshore Road  
Burlington, ON  
L7R 4A6

Phone:  
Rick: (905) 336 - 4547  
Karen: (905) 336 – 6451

**Send E-mails to these three addresses indicated shipping date and include the tracking number in the message.**

**1. Rick.Bourbon@ec.gc.ca 2. rbourbon@uwo.ca 3. Karen.Edmondson@ec.gc.ca**

### 3. Greenhouse Gas Analyses:

Ship samples as per protocol to:

Greenhouse Gas Analysis Lab  
Department of Environmental Science  
Nova Scotia Agricultural College  
P.O. Box 550, 21 Cox Road  
Truro, NS B2N 5E3  
Phone: (902) 893-6250

**Send E-mail to this address indicating shipping date and include the tracking number in the message**

**davidlburton@mac.com**

#### 4. Soil Fertility Analyses:

Ship samples as per protocol to:

ALS Laboratory (formerly Enviro-Test Laboratories)  
#819-58<sup>th</sup> Street East  
Saskatoon, Saskatchewan  
S7K 6X5  
Phone: (306) 668-8370

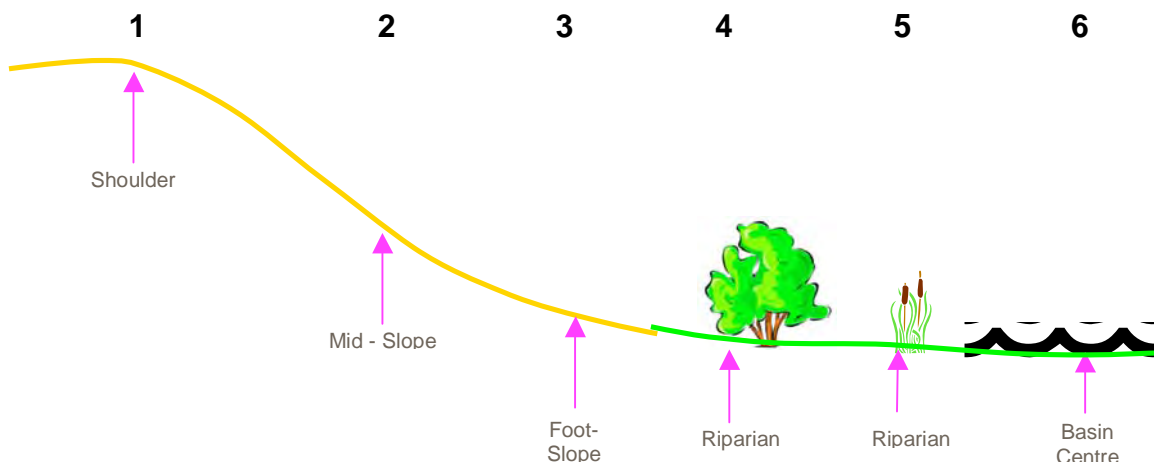
- Sample Analysis Quotation Number: **Q11685. Print off a copy of the Quote and submit it with your samples.**

## DUC-ACAAF Sampling Schedule: (Take digital photos at each visit)

1. All transects must be numbered from one to six with number 1 in the upland, and proceeding down slope to number 6 in the water (see graphic below)
2. Use your GPS unit to record the location of each transect point.
3. Greenhouse gas emissions of CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub> from the surfaces of soil and water are sampled four times per year
4. Soil fertility sampling (0-15 cm depth) twice per year (spring and fall) plus some deeper (15-30 cm depth) samples in the fall
5. Soil Quality Test Kit used to monitor other soil characteristics as desired
6. Water chemistry sampling and water DIC/DOC sampling three times per year
7. Riparian vegetation biomass sampling once per year
8. Crop yield sampling once per year
9. Crop residue sampling once per year
10. A basic weather station will be installed at each site to establish a continuous record of air temperature, soil temperature, soil moisture and precipitation. The data logger should be checked and down-loaded several times per year. This will be coordinated by the Node Leader.
11. Soil organic carbon and nitrogen content to one metre depth will be sampled once at the outset of the project. This will be coordinated by the Node Leader.

### Sampling Transect:

#### Transect Position:



## DUC-ACAAF Sampling Schedule: The Basics

Time	Sampling Period	Sampling
1	<b>Early Spring</b> (Post-Thaw)	<ul style="list-style-type: none"> <li>▪ Greenhouse Gas Sampling</li> <li>▪ Soil Fertility Sampling</li> <li>▪ Water Chemistry and DOC/DIC Sampling</li> </ul>
2	<b>Mid-Spring</b> (Post-Seeding)	<ul style="list-style-type: none"> <li>▪ Greenhouse Gas Sampling</li> <li>▪ Water Chemistry and DOC/DIC Sampling</li> </ul>
3	<b>Late-Summer</b> (Before Harvest)	<ul style="list-style-type: none"> <li>▪ Greenhouse Gas Sampling</li> <li>▪ Crop Yield Sampling*</li> <li>▪ Plant Identification**</li> <li>▪ Riparian Vegetation Biomass Sampling</li> <li>▪ *** See note below on Water Sampling</li> </ul>
4	<b>Mid-Fall</b> (After Harvest before Freeze-up)	<ul style="list-style-type: none"> <li>▪ Greenhouse Gas Sampling</li> <li>▪ Soil Fertility Sampling</li> <li>▪ Crop Residue Sampling</li> <li>▪ Water Chemistry and DOC/DIC Sampling***</li> </ul>

\* Use three methods for crop yield sampling: hand sampling, weigh wagons, and yield monitors.

\*\* Plant and weed identification in crop and riparian areas.

\*\*\* **If it is a dry year**, and it looks like your wetlands will be dry by the Time 4 Mid-Fall sampling time, then the third set of water samples should be collected earlier, at Time 3 Late Summer.

### Very Important:

Digital photographs should be taken at each site at each visit through the year.

Take pictures around each transect point (GHG collar), as well as wider view pictures of the wetland or stream, the riparian area and the transect through the crop.

These pictures can be used to help with vegetation identification and for accurately describing the sites.

Pictures of people performing activities in the field are always a welcome addition to any study and communication effort.

## 1.0 Water Chemistry Sampling Protocol

### 1.1 Overview

Water sampling will begin in the spring of 2006. All samples will be submitted to ALS Labs, (formerly Enviro-Test) please see Section 1.8 of this manual for shipping details. You need to call the ALS Lab in your region to arrange to have your coolers shipped out to you a few days ahead of when you intend to sample. Note: for two sites, you probably want two separate coolers, in case you sample on different days. When returning the samples back to ALS ensure your Provincial code is on the Chain of Custody (COC) form provided and use the Purolator account for shipping. Please ensure that the COC's are clearly labeled with the Provincial account number and identification that samples are for Ducks Unlimited Canada, so they know which analyses are to be done.

### 1.2 Sampling Schedule

Water samples are collected three times annually:

1. Time 1: Early Spring (immediately after thaw)
2. Time 2: Mid-Spring (Post-seeding)
3. Time 4: Mid-fall (After harvest before freeze-up) \*

\* **Note:** Sampling regime may have to be adjusted to the water conditions in your area. For example: Under drying conditions, you may have to take your third water sample earlier, at Time 3: Late-summer, before the water disappears.

Conduct sampling early in the week, from **Monday to Wednesday** to ensure prompt analysis. Sampling at the end of the week can result in samples sitting over the weekend in the cooler or at the lab, **at which time samples are no longer good!!**

### 1.3 Supplies Needed

Supplies for water chemistry sampling are provided by the commercial lab and will include:

1. Sample bottles (labeled in permanent ink, ie. Sharpie)
2. Chain of Custody Form and Provincial Account Number
3. Coolers and shipping labels from the appropriate lab
4. Frozen Ice pack

### 1.4 Labeling Protocol

All labels must clearly provide five pieces of information:

1. Province (Provincial abbreviation eg. Manitoba as MB)
2. Ducks Unlimited Canada (abbreviated DUC)
3. Full Site Name (eg. Clements W1)
4. Wetland or Transect Identification (3 wetlands on each site – W1,W2,W3)
5. Date (day/mon/year eg. 09/Oct/05)

## 1.5 Sampling Preparation

Prior to sampling contact the appropriate lab to request:

1. Coolers and sample bottles
2. Ice packs
3. Chain of custody forms.

**Note:** Ensure the lab sends the supplies out with enough time to enable ice packs to be frozen before your sampling is conducted.

Clearly label all bottles before sampling commences.

## 1.6 Sampling Procedure

Samples are collected from **each** of the wetlands at a site. (Three wetlands = 3 water samples collected. Sometimes the lab will request you to collect two or three bottles of water from each wetland for different analyses. In this case they will provide you with the appropriate number of bottles for each wetland.)

All samples are to be collected below the surface of the water.

Rinse all bottles three times with wetland site water before collecting the sample. Please ensure rinse water is discarded away from the sample area.

Technician holds the sample bottle in his/her hand and submerges the bottle under the water to a depth equal to the elbow. **Note:** Limit sunscreen, bug repellent, lotion and soap application before sampling as it may contaminate the sample.

In shallow areas ensure the water is deep enough to submerge the entire bottle without disturbing the sediment.

If sediment is disturbed while sampling relocate sampling to another undisturbed area of the wetland.

If the lab provides preservative chemicals, they are added to the full bottle of water just prior to capping the bottle.

Once the sample is collected, place it in the cooler with ice packs.

When sampling is completed, ship or bring samples to the lab. Samples should be delivered to the lab the same day as sampling or shipped as promptly as possible.

When samples are shipped or delivered to the lab, include the negotiated quote number (which will be provided) which identifies the analyses and price structure for the samples.

## 1.7 Sample Analysis:

Submit ALS Chain of Custody form provided with appropriate account number specifying analysis to be conducted.

## 1.8 Shipping:

Ship samples as per protocol to appropriate ALS Laboratory in:

Winnipeg: Judy Dalmaijer, 745 Logan Avenue, Winnipeg, R3E 3L5  
Phone: (204) 945-5713

Saskatoon: Raechelle Kreese, 819-58th Street East, Saskatoon, S7K 6X5  
Phone: (306) 668-8370

Edmonton: Jessica Webber, 9936-67 Avenue, Edmonton, T6E 0P5  
Phone: (780) 413-5220

Calgary: Shanna Wienmeyer, Bay 7, 1313-44th Ave NE, Calgary, T2E 6L5  
Phone: (403) 291-9897

Waterloo: Theresa Stephenson, 60 Northland Rd, Unit 1, Waterloo, N2V 2B8  
(Hamilton is closer to Waterloo) Phone: (519) 886-6910

Provincial ALS Lab Account Numbers:

Ontario/Nova Scotia: 13282

Manitoba: W1731

Alberta/Saskatchewan: 13282

A copy of the lab results should be sent to:

**Ainslie Macbeth**

Ducks Unlimited Canada

P.O. Box 1160

Stonewall, MB

R0C 2Z0

Phone: 204-467-3258

Email: a\_macbeth@ducks.ca

## 2.0 Sampling and Processing Water for DOC & DIC Analyses: (DOC is dissolved organic carbon; DIC is dissolved inorganic carbon)

REVISED 7 APRIL 2006 – R. BOURBONNIERE

### 2.1 Sampling Schedule

DOC & DIC samples are collected at the same time as the other water samples (see section 1.0) three times annually:

1. Time 1: Early Spring (immediately after thaw)
2. Time 2: Mid-Spring (Post-seeding)
3. Time 4: Mid-fall (After harvest before freeze-up) (or earlier if necessary)

### 2.2 Supplies Needed

A kit is supplied that contains:

- a. 40 mL glass vials for collecting raw samples from the pond or stream
- b. Cooler and ice pack
- c. Glass filtration unit for 2.5 cm filters
- d. Filter flasks (2)
- e. Hand vacuum pump
- f. Glass fiber filters (Macherey-Nagel GF5, 0.4  $\mu\text{m}$ , nominal pore size)
- g. Filtering forceps
- h. 25 mL serum bottles for shipping filtered samples
- i. septa, seals and a crimping tool

### 2.3 Labeling Protocol

All labels must clearly provide five pieces of information:

1. Province (Provincial abbreviation eg. Manitoba as MB)
2. Ducks Unlimited Canada (abbreviated DUC)
3. Full Site Name (eg. Clements W1)
4. Wetland or Transect Identification (3 wetlands on each site – W1,W2,W3)
5. Date (day/mon/year eg. 09/Oct/05).

### 2.4 Sampling Procedure

Follow the same sampling procedures outlined in Section 1.6 above and collect 40 mL sample of water from the wetland or stream in the glass vials.

Store sample in ice or 4-degree refrigerator for **no more than 24 hours before filtering**. Please note any deviation from this rule in the field book and on sample submission sheet.

### 2.5 Filtration Procedure

Use a 2.5 cm glass fiber Macherey-Nagel GF5 – 0.4  $\mu\text{m}$  filter.

The loose end of the hand pump tubing connects to the hard plastic connecting tube on the 100 mL filtering flasks

Pre-clean the filter by rinsing with 50 mL of distilled water. Pour the distilled water through the filter on the filter unit and allow it to collect in the filter flask you will use for the sample. Use the hand pump to pull the rinse water through the filter with a vacuum no greater than 50 centibars.

Discard the distilled water from the filter flask, shake the flask and allow it to drain for 10 minutes. **Do Not** use paper of any kind to wipe the inside of the flask dry. Rinsing serves as well to clean the flask of material remaining from the previous sample.

[Note: flasks can be alternated, one draining while the other is in use. Two filters can be pre-cleaned in advance in case some samples require more than one filter, but this is unlikely with only 40 mL of sample.]

Using a vacuum of no more than 50 centibars, pass the entire 40 mL of the water sample through the pre-rinsed filter into a drained filtering flask.

Rinse filter unit and flasks well with distilled water and air dry for storing between samplings. Wash glass sampling vials and caps with detergent, rinse well with tap water, followed by three rinses with distilled water, drain to dry, and cap between uses.

## 2.6 Sample Storage

Store the filtered samples in completely filled 25 mL serum bottles.

The bottles come pre-cleaned. Remove the protective Parafilm and fill the bottle completely with filtered sample so that there are no air bubbles.

Insert a gray butyl septum into the top in such a way that no air bubbles are introduced (bend the septum with your thumb and insert the septum beginning on one side of the opening). Excess water will spill over. It is a good idea to practice this with distilled water the first time.

Seal the bottle using an aluminum ring and the crimping tool. The tool may need adjusting on the first use. If crimped properly you should not be able to turn the aluminum around the bottle with normal finger pressure.

Label the sample, see 2.3. (If filtered more than 24 hours after sampling, please note on label.)

Store serum bottles in a 4-degree refrigerator or on ice.

**NOTE:** If using wet ice, then package the bottles in Ziploc bags, so the labels don't fall off.

*It is important that samples are filtered soon after collection, but once filtered they can be stored in the fridge. You may accumulate samples in fridge for 7-10 days before shipping. Please minimize the shipping period by following the instructions below to ensure samples are not warmed or heated.*

## 2.7 Sample Shipping

Wrap and pack bottles so that they do not break – include sufficient ice packs and packing to eliminate dead space.

Send samples to our lab at the Canada Centre for Inland Waters (CCIW - see below) in Burlington by overnight air courier in a cooler with ice pack(s).

“Priority Overnight” is sufficient as Purolator arrives by 10:30 every day at CCIW – no need to pay extra for 9 AM delivery. It is best to ship on Mon-Tue-Wed to better avoid a long layover. [*I.E.* a Thursday shipment that was delayed for 1 day would actually be delivered on Monday, likely sitting in a warm warehouse or truck all weekend.] Saturday delivery is not possible at CCIW.

### Ship to:

Dr. Rick Bourbonniere / Karen Edmondson      Phones: (905) 336-4547 / 6451  
Environment Canada / NWRI / CCIW  
867 Lakeshore Road  
Burlington, ON  
L7R 4A6

Send an E-mail to these three addresses when you have shipped them and include the tracking number in the message.

1. **Rick.Bourbon@ec.gc.ca**
2. **rbourbon@cogeco.ca**
3. **Karen.Edmondson@ec.gc.ca**

Please address any questions to either of us.

## 3.0 Soil Carbon Characterization of the Landscape.

### 3.1 Overview

This document describes a field procedure for sampling soils along a catenary sequence to determine variability in soil properties such as soil carbon and chemical properties as well as pedologic characteristics. Rationale is provided for the sampling techniques and examples of a core photograph.

### 3.2 Sampling Schedule

Soil carbon characterization will be conducted once at each site during the site preparation and sampling in mid-fall 2005. Characterizations not completed in 2005 will be done in spring 2006. **Node Leaders will coordinate this sampling.**

### 3.3 Supplies Needed

1. Core truck. This investigation procedure cannot be done using manual coring methods. You will require a large core barrel that is one meter or more in length. The diameter should be 87 mm in diameter (3.5") if possible. Use a smaller core barrel if conditions warrant (we have not needed to go with less than 50 mm (2") in diameter).
2. Core Board. This is to put the core on for sampling and photographs. Use a piece of plywood (e.g. 3/8", good one side) about 1.2 m long and 30 cm wide. Starting about 5 or 10 cm from one end, mark decimeter markings down one side with a large wedge, permanent marker. Fancy versions can be painted or have an arborite surface but be careful that any surface coating does not come off with scraping for samples. Also do not use a high gloss surface as it will flare in photos where a flash is used.
3. Bentonite. Prilled or chipped bentonite in bags to put down the vacant core holes. Long bladed carving knife (something longer and thinner than a field knife). Better for cutting core lengthwise and for cross cutting bulk density samples.
4. Lubricant for coring barrel (dry silicone spray, PAM-wipe excess off with a cloth, or WD40) **Note:** try not to use lubricants unless absolutely necessary as most contain carbon which skews the carbon analyses.
5. Plastic bags to put samples in.
6. Permanent Sharpie Marker for labeling bags.
7. Field Sheet. Record data on field sheet.
8. Digital camera. Photograph soil cores on core board.

### 3.4 Procedure

1. Select points on the catena to be sampled and flag them so as not to traffic and compact the surface at those locations.
2. Use as large a core as possible on the drill truck. Ensure truck is well secured on slopes.

3. Observe and make notes of the surface litter layer (direct seeded or forage fields). Remove previous year's litter and undecomposed material. Leave a decomposed mulch layer and/or a LFH layer. Remember if an organic layer exists to measure depths from the start of the mineral layer.
4. It is recommended that three cores be taken:
  - i. one for bulk density samples
  - ii. one for pictures and fertility samples
  - iii. and one to add to the bulk soil for fertility samples (to increase amount of soil in sample and decrease variability)
5. Take a core to 1 meter depth or more. Slide the core carefully out onto the core board. Align the top of the core with the top mark on the core board. Carefully cut down about 1 cm into the core lengthwise. Grab the core carefully from both sides and pull apart so the two halves lay beside one another. If this cannot be done easily, then cut a little deeper with the knife. We want the core to break apart so that the natural structure can be seen on the core face.
6. Take a digital photo of the open core on the core board. Ensure the camera is pointing vertically down, not at an angle. Try not to use a wide-angle setting of the lens, as this will also distort the image. Avoid direct sunlight if possible – it will accentuate the shadowing of the structure and may alter the true colours. On a sunny day the core board can be placed on the ground on the shady side of the core truck for pictures.
7. Describe the horizons of the core. Use a typical profile description field sheet providing as much information as possible. Ensure the date and time of day is recorded. The time can be used to sort out which digital picture is associated with which sampling site. We recommend you determine the geographic position of the sampling site with DGPS so that you can either go back to the exact spot or avoid the exact spot (for sampling nearby). With accurate positioning you can also draw reasonable cross sections of the positions on the landscape.
8. The core (now in two halves) can be cut across in sections for sampling. We recommend 0-5, 5-10, and 10 cm increments thereafter down to 1 meter. Horizon type and depths are recorded on the field sheet.
9. Bulk densities are critical for mass element determinations. Once a core is split lengthwise it is unsuitable for cross cutting for BD determinations. Thus, another, separate core should be taken from the site, carefully laid out on the core board and measured and cut. Do not measure with the rough markings on the core board, use a tape measure. Be careful in determining where the zero-surface measurement starts –account for mulch or LFH layers. Avoid any compression of the core when taking it. If the first core you take is a “good one” without stone scrapings or compression, then use it for bulk density samples and take the second core for profile descriptions and fertility sampling. If you encounter unavoidable compression at depth then stop and measure the depth of core barrel remaining above ground. Subtract that from the total core barrel length to determine the depth at which compaction occurs. You can be confident of BD measurements above that depth. If it is difficult to see the top of the core while coring to determine if compression is occurring, then try placing a stick/dowel/pin flag on the top of the core and sticking out the core barrel slot (be careful to remove and replace the marker as you core if the lengthwise slot is intermittent).
10. Place excess soil back in the core holes. Fill core holes with bentonite chips until level with the top of the B horizon. This will mitigate any leaks of wetlands or lateral flows between textural discontinuities.

11. Once back at the lab, the bulk density cores should be crumbled and homogenized (to speed the drying process), placed in metal tins with tight fitting covers, and wet weights should be taken. Soil should then be placed in a drying oven (minus the tight fitting covers) for a minimum of 24 hours at about 105°C. Once soil is dry it can be removed from the oven and reweighed. The difference between the wet weight & dry weight, minus the weight of the tin will give bulk density measurements.

### **3.5 Rationale for profile descriptions**

- If you want to determine how the soil properties relate to published soil series and/or variant name data then you better know what soil you have sampled.
- If you want to know how different your soil is from the published profile description (modal soil profile) then you had better measure the horizons and describe the profile.
- You may have an “inclusion” of a different soil than any described for the soil polygon that you are in accounting for variability. This also permits densification of the existing soil map information.
- Profile descriptions don’t cost anything more than some time in the field.
- Profile descriptions of characteristics such as secondary carbonates will tell you something of the changed hydrology of the site and may explain the unusual chemical data.
- Descriptions often provide the pedological story.

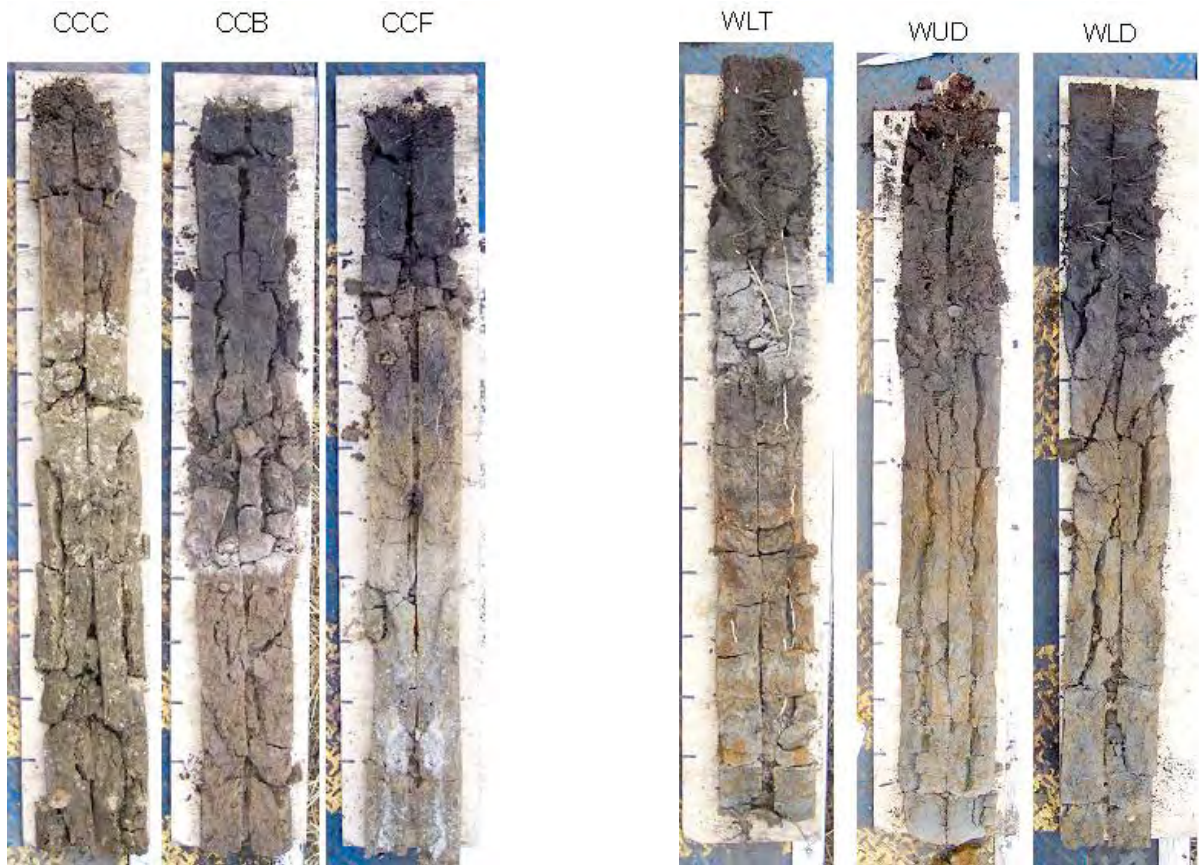
### **3.6 Rationale for depth increments**

- Many people still sample the 0-6 inch (0-15 cm) increments. The only remaining reason for that would be that they want to compare to historical data without interpolating values. The historical reason was that the moldboard ploughs turned the soil over to a 6 inch depth (mixing depth or “acre-furrow slice”). That is now a part of history. If we want to characterize soils and/or sample depths for pedology or environmental sampling, then other increments are much more appropriate.
- Pedologic convention describes soils to a one meter depth or the C horizon if that is deeper. For consistency sample to 100 cm or as deep as possible (to a depth of encountering a compression or impermeable layer).
- In many soil profiles it is possible to have two horizons occurring within a 15 cm increment. Narrower increments have more of a chance of separating them (however more than one horizon may occur no matter how small an increment is sampled).
- With the predominance of direct seeding systems the depth of any possible mixing is in the order of 5 to 8 cm, half that of the “six inch slice”. The state and dynamics of the soil system is quite different in this surface layer than the one below it, even if they both occur as A horizons (not unusual to have an Ap1, Ap2, Ah sequence).
- Relative to a 15 cm depth, using a 10 cm increment captures more the vertical variation in the soil profile (reflective of changing pedological processes) and is more convenient mathematically.

### **3.7 Core Photographs (See Figure 1)**

- A photo says a thousand words. A photo and a profile description can be used to determine a suitable soil name or taxadjunct after the sampling campaign.
- A digital photo can be manipulated/cropped to highlight profile features.
- A photo strengthens a report or argument.
- Photos can be cropped and placed side-by-side for a composite image.
- Be sure to include a scale in your photo.

**Figure 1:** Two groups of 3 core photos. Left grouping is taken from a cultivated crest, backslope and footslope. Right grouping is from a native wetland (toe, upper and lower depression – basin centre).



**Figure 2:** Sample of field sheet to record observations and descriptions. This example may be used to fill out the field sheet provided in Appendix 1: Field Sheets.

**Conservation & Development Branch**

Legal Loc. \_\_\_\_\_ Site WLD Project PCF-GMB

Lat/Lon \_\_\_\_\_ Map unit \_\_\_\_\_ 1250h. start Date Nov 6/02

Northing/East \_\_\_\_\_ Name Tony B. Tom.

Horiz	Depth	Color	Text	Mott.	Struct.	Consist	Roots	Pore/Film	React.	%CF
<u>OH</u>	<u>0-6</u>									
<u>AL</u>	<u>0-14</u>	<u>10YR 7/4</u>	<u>L</u>		<u>m m S AB</u>		<u>many</u>			
<u>Ahe</u>	<u>14-18</u>	<u>10YR 7/2</u>	<u>L</u>		<u>w c SAB</u>		<u>✓</u>			
<u>Bg<sub>1</sub></u>	<u>18-33</u>	<u>10YR 3/1</u>	<u>CL</u>		<u>slide from</u> <u>7.5YR 7/4</u>		<u>few</u>			
<u>Bg<sub>2</sub></u>	<u>33-50</u>	<u>2.5Y 3/2</u>	<u>CL</u>	<u>7.5YR 7/6</u>						
<u>Bg<sub>3</sub></u>	<u>50-60</u>	<u>2.5Y 7/2</u>	<u>CL</u>	<u>7.5YR 7/6</u>						
<u>Bg<sub>4</sub></u>	<u>60-88</u>	<u>2.5Y 7/2</u>	<u>CL</u>	<u>7.5YR 7/6</u>						
<u>Bg<sub>5</sub></u>	<u>88-115</u>	<u>5Y 5/1</u>	<u>CL</u>	<u>5/6</u>						
<u>1</u>										

Elev.	
Pos'h	
Curv.	
Asp.	
Drainage	

Slope %
Simp Cplx
0-0.5
0.5-2
2-5
6-9
10-15
16-30
31-45
46-70
70-100
>100

**Vegetation - weeds**

Core 2 of 10-8, 0m 8-0 Core 3 same as #2

**Notes**

BRUN	MB-EB-SB-DYB	0-E-GL-GLE
CHER	B-DB-BL-DG	0-R-CA-E-SZ-V-GL-GLR-GLC-GLE-GLSZ-GLV
GLE	HG-LG	0-FE-HU
LUV	GL-DBL	OG-DG-BR-PZ-SZ-FG-VG-G(G,DG,BR...)
ORG	F-M-H-FO	TY-FH-ME-HU-LM-CU-T-TF-TME-THU
REGO	R-HR	0-CU-GL-GLCU
SOLZ	SZ-SS-SO	B-DB-BL-DG-G-GLA-GLB-GLDB-GLBL-GLDG-GLG
VERT	V-HV	0-GL-GLC
Phase	Carb-Crylic-Lithic-Peaty-Saline-Stony-Thin-Turbic	

Stoniness	Erosion
0-none	Water-W
1-slight	Wind-D
2-mod	Pitted-P
3-sev	1-Slight
4-exceed	2-Mod
5-excessv	3-Severe

Mineral	1	2
Anthrop		
Colluv		
Eolian		
Fluv		
GlacFluv		
Lacust		
GlacLac		
Morainal		
Undiffer		
Residual		

Sfc Expr.	Modif.
Blanket	Avalanched
Delta	Bevelled
Fan	Deflated
Hummocky	Eroded
Level	Failed
Ridged	Glaciated
Rolling	Kettled
Terrace	Washed
Undulating	Gullied
Veneer	Rilled
Inclined	
Steep	

See Appendix 1: Field Sheets for a blank copy of this field sheet.

## 4.0 Soil Fertility Sampling

### 4.1 Overview

Soil fertility sampling will be conducted along each transect in both the cropped field and riparian zones twice annually. The correlation between GHG flux and soil nutrient fertility will be investigated by examining a standard suite of nutrients including available  $\text{NH}_4$  and  $\text{NO}_3$ , in the first 15 cm of the surface soil in spring and fall, and P, K, S, Ag pH, E.C. from a select number of samples in the first 30 cm of surface soil **in the fall only**. Analyses will be done by the ALS Laboratory in Saskatoon, Saskatchewan (see pg.9 for shipping address).

### 4.2 Sampling Schedule

1. Time 1: Early Spring (Immediately after thaw)
2. Time 4: Mid-Fall (After harvest before freeze-up)

### 4.3 Supplies Needed

- Small core sampler (eg. Oakfield or similar). Core sampler should be no larger than  $\frac{3}{4}$  inch in diameter. If conditions are too wet, clayey, etc for a tube sampler then use an auger design of sampler ( $\frac{3}{4}$ " Dutch auger).
- Pail to mix cores.
- Plastic bags.
- Permanent Sharpie Marker for labeling bags.

### 4.4 Sampling Procedure

1. Push aside surface residue on cropped fields. In hay or pasture fields plan on coring deeper than 15 cm, then cut the sod layer off the top of the core and collect the next 15 cm depth of the mineral soil.
2. Insert the sampler vertically to secure a 15 cm sample. Watch for compression. If compression is more than 10% (1.5 cm) then resample. If conditions prevent use of a tube sampler then use an auger sampler.
3. From around each of transect points #1-3 take 10 cores from the 0-15cm depth. Mix the 10 cores from one transect point together and put them into one properly labeled bag. **During the fall fertility sampling time, we will also take a sub-set of samples from the 15-30 cm depth at certain points.** So, at the following transect points, take both a 0-15 cm sample and a 15-30 cm sample: W1-1 (shoulder) and W1-3 (foot-slope), W2-1 (shoulder) and W2-3 (foot-slope), and W3-2 (mid-slope). At each of these points, take an additional 10 cores from the 15-30cm depth, mix them together and place in a separately labeled (15-30 cm) bag.

**Note:** W1-1 means Wetland 1, transect position 1, which is the shoulder position

**Note:** one 30cm long core can be collected and then divided into the proper 0-15cm & 15-30cm depths and bagged separately.

All samples, spring and fall are analyzed for available nitrogen. **The additional PKS (Phosphorus, Potassium, Sulfur) analysis will be done on the transect points where two samples (0-15 and 15-30 cm) are taken in the fall. These are the samples that must be checked off in the PKS column on the Soil Fertility Sample spreadsheet (highlighted in yellow).**

4. From around each of the riparian/wetland transect points #4-6 take 5-6 cores from the 0-15cm depth. Mix the 10 cores from one transect point together and put them into one properly labeled bag.
5. In the cropped portion of the transect under conventional till, collect cores from randomly spaced locations within about a 2-m radius of each GHG collar. The sampling should occur no closer than 1-m from the transect point (GHG collar) and may occur as far out as a 2 to 3-m radius, depending on the size of the zone you are trying to sample.
6. Under zero-till collect cores from exactly mid-row between the largest row spacing within a 2-m radius of each collar. Mid-row sampling under zero-till will ensure sampling avoids hitting a nitrogen band regardless of the band configuration.
7. In the riparian zone of each transect collect 5-6 cores from randomly spaced locations within a 1 to 3-m radius of each GHG collar. Plan on coring deeper than 15 cm, then cut the sod/vegetation layer off the top of the core and collect the next 15 cm depth of the mineral soil. The sampling should occur no closer than 1 m from the transect point (GHG collar) and may occur as far out as a 2 to 3-m radius, depending on the size of the zone you are trying to sample.
8. Keep samples cool and dark until transported back to the lab, where they should be air-dried as soon as possible.

***Air drying samples:***

- Place soil samples in a **room that has NO access to ANY animals, including cats and dogs**, as they may urinate in the soil and thus ruin the samples.
- Open the bags wide and roll or fold them down to the height of the soil sample inside, to allow for maximum airflow to the sample for drying. Break up any big chunks to facilitate drying. A fan can be used to circulate the air over the samples.
- Leave samples open until they are completely dry (any moisture means there are still microbes at work decomposing the soil, which is bad for analyses!)
- Re-seal bags and prepare them for shipment.

**9. Ship samples to lab for analysis once they are dry.**

- **Note: all** soil samples will be analyzed for available nitrate-N, and ammonia-N.
- **For the fall round of sampling only**, the following **10 samples** will also receive **PKS analysis**:
  - Wetland 1: transect points 1 & 3 (0-15 and 15-30 cm depth)
  - Wetland 2: transect points 1 & 3 (0-15 and 15-30 cm depth)
  - Wetland 3, transect point 2, (0-15 & 15-30 cm depth)
- Ship samples via our Purolator account **by ground** to the following address:  
ALS Laboratory (formerly Enviro-Test Laboratories)  
#819-58<sup>th</sup> Street East  
Saskatoon, Saskatchewan  
S7K 6X5  
Phone: (306) 668-8370
- Sample Analysis Quotation Number: **Q11685. Print off a copy of the Quote and submit it with your samples. Also print off a copy of the Excel Soil Fertility Sample spreadsheet (first page) and submit it with your samples.**
- When shipping samples be sure to pack the box **full! (ie. Fill extra space in the box with balled-up newspaper right to the top)** otherwise there is a chance the box of samples may break open during shipping, for example, if a heavy box is placed on top of a half full box of soil samples.

## 5.0 Plant Identification

### 5.1 Sampling Schedule:

Plant identification should be done once annually in late-summer (prior to harvest). At transect positions 1, 2 and 3, the crop plants and the dominant weed species should be identified. At positions 4, 5, and 6, the three main dominant species should be identified at a minimum. An attempt to identify a wider range of riparian species should be made. Digital photos taken throughout the year around each transect point (GHG collar) will aid in the description and identification of plant species in each zone.

### 5.2 Supplies Needed:

- Data sheet (see Appendix 1) and pencil
- Two meter sticks or a 100 cm by 100 cm quadrat sampler

### 5.3 Sampling Procedure:

1. Start near transect position 1 in the crop field and move down to position 6
2. Place meter sticks perpendicular to each other in an “L” shape to form a 1 x 1 meter quadrat
3. Estimate the percent cover of each species present within the quadrat and record on data sheet (Crop species and weeds at first three transect points, then at least the three most abundant species, and more if possible at the next three transect point in the riparian zone and wetland basin)
4. Measure depth of standing water at wetland basin centre if water is present.
5. Plant identification should be done before vegetation clips are taken (see next section).

## 6.0 Crop Yield and Riparian Vegetation Biomass Sampling

### 6.1 Sampling Schedule:

**Important!** For crop yield, keep in touch with the farmer cooperators near the end of summer so that you are aware of intended harvest dates. Get there before the swather or combine!! If the crop is a forage crop then be prepared to go earlier (early July?) for the first cut and again in late summer for the second cut. For riparian zone vegetation, we try to capture the “peak of green” productivity by sampling in late summer.

#### **Purpose:**

1. To try to follow nutrient cycling we need to measure primary productivity (all biomass production in a year). Thus we clip all vegetation biomass to ground level. We are also interested in the N and C content of that biomass so we need to keep a sub sample for nutrient analysis.
2. The farmer is interested in economic productivity so we need to measure crop yield separate from total biomass. Different yields by landform position may be informative to the farmer and agronomists.
3. Soil organic matter gets inputs from root biomass (which we can estimate if we know the above ground crop biomass) and surface residue/mulch. The surface residue is easy to measure.

### 6.2 Supplies Needed:

- Cotton sacks, provided by ACAAF (187 g/bag)
- Labels. Tear proof preferable
- Marking pen (permanent Sharpie)
- Zip or cable ties for the sacks
- Tape measure and/or meter stick
- Quarter square meter frame(s) (which is 50 cm by 50 cm square)
- Hand sickles work well for cutting. Smooth bladed ones for crops and serrated blades for stalked plants or forages. Sheep shears are also a favorite tool for forages.

(Keep Band-Aids on hand – then you won't need to use them!)

### 6.3 Sampling Procedure:

In all cases document the dimensions of your clip. For riparian vegetation, record the area you are clipping (i.e. 50 x 50 cm square). For annual crops, record the row spacing dimension and the number of rows you are clipping in a square meter frame (or the number of rows and length of the rows you are clipping).

Vegetation clips are taken near transect positions 1, 2 and 3 for crop yield, and at positions 4 and 5 for riparian vegetation biomass. If the wetland basin is dry at time of sampling, then you should also take a plant clip at transect position 6.

Take three separate clips around each transect point (GHG collar) and keep the samples in separate bags. Clipping should occur no closer than 1 m from the transect

point (GHG collar) and may occur within a 2-3 m radius of the transect point (depending on the size of the vegetation zone you are trying to sample).

Be sure all bags are labeled (a **duplicate label put inside the bag** as well as one on the outside zip tie is good insurance).

### **6.31 Solid seeded or narrow row grains and oilseeds:**

Use a square meter frame and clip the crop to ground level within the frame. Put the sample in a cotton or breathable bag for storage while drying and waiting for threshing. At threshing time determine the mass of straw in the sample as well as grain yield. Keep a sub sample of each for nitrogen analysis.

If the crop does not facilitate the use of a square meter frame (e.g. canola) then you may clip a length of several rows (e.g. 3 rows, 1m long) and bag that. You may prefer to sample length of rows instead of a square meter frame – just make sure the square area works out to the same.

### **6.32 Row crops:**

For row crops measure row spacing, length of row, and number of plants per foot or meter of row.

Corn – collect the cobs off of several plants. Collect the stover separately. Grain yield may be determined by following established protocols of counting kernels and rows on the cob.

Potatoes – dig several plants and collect all tubers for a mass measurement. Collect and dry the above ground plant as well.

### **6.33 Perennial forage and Vegetation in Riparian Zone and Wetland Basin:**

Use a quarter square meter frame (50 cm by 50 cm) and hand clip the vegetation to ground level or plant crowns. Be careful to collect only the current year forage and not residue from the previous year.

Domestic forage as a hay crop in the upland area may need to be harvested twice in a year (according to how the farmer harvests the hay). Domestic pasture should have exclosure cages and be harvested once per year.

Native or domestic species in the riparian zone or wetland basin should be harvested once per year in late summer at “peak of green”.

Remember to collect three replicate samples around each transect point.

### **6.34 Weeds**

If weed populations are very light then they can be clipped along with the annual crop harvest. If they are a heavy infestation then they should be clipped and bagged separately for biomass determinations. Remember to mark on the label which transect point the weeds were clipped from! If the crop is forages (or you are in the riparian area) then weeds are clipped along with and included in the plant yield.

## 6.4 Handling:

- Hang filled bags where rodents will not share in your celebration of a good yield.
- Hang the bags so that air can circulate around them and dry the sample.
- (Bags can be tied together in twos or threes and thrown over a railing or fence)
- At threshing time, for crop samples, determine the mass of straw in the sample as well as grain yield. Keep a sub sample of each for nitrogen analysis.
- Corn – collect the cobs off of several plants. Collect the stover separately. Grain yield may be determined by following established protocols of counting kernels and rows on the cob.
- Potatoes – dig several plants and collect all tubers for a mass measurement. Collect and dry the above ground plant as well.
- Vegetation samples from the riparian zone and wetland basin can be dried in a drying oven at 104°C until dried to a constant weight. (Use disposable aluminum pans from the grocery store for this).
- Record the dry weight of each vegetation sample collected. Keep a sub sample of each riparian and wetland vegetation sample for nitrogen analysis.
- These vegetation sub-samples will be sent to the appropriate commercial lab for nitrogen analysis (info later on this.)

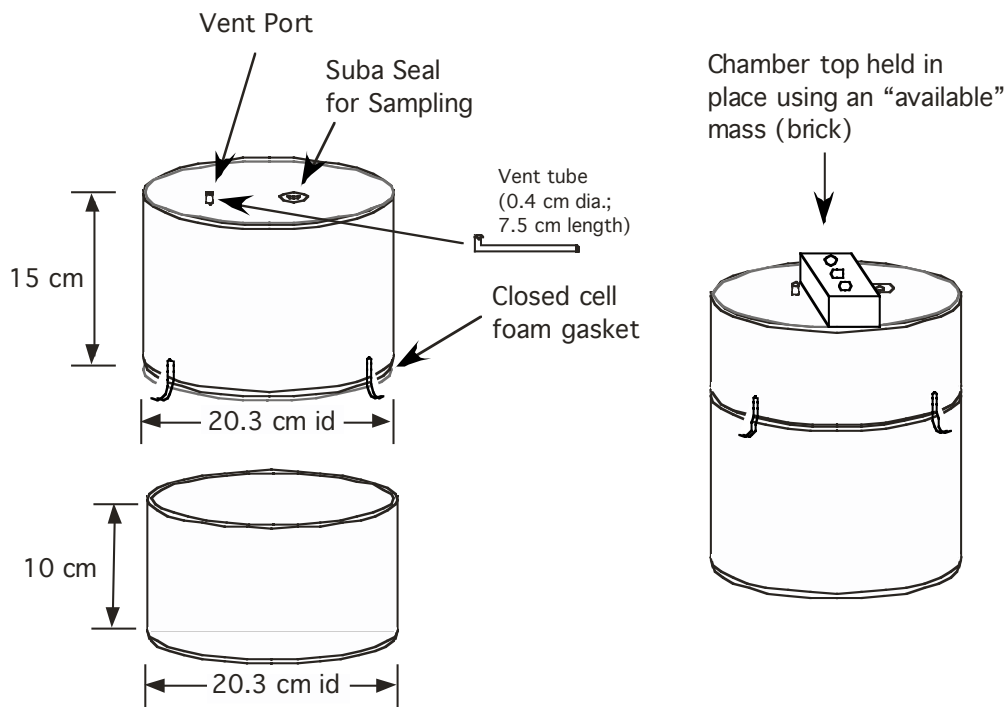
## 6.5 Residue:

If there is significant residue left over (ie. In direct seeding systems) then delineate a quarter square meter area between seed rows. Gently scrap up the residue (previous year's straw, chaff, stalks, etc) within that area and put into a bag (medium size Ziploc freezer bag works well), labeled with the transect position. Dry and measure the mass of residue.

## 7.0 Greenhouse Gas (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O) Flux Measurement

### 7.1 Equipment (Provided in GHG Sample Kit by David Burton)

- Chamber tops and collars
- Data sheet & pencil
- Soil temperature probe
- Air temperature and humidity gauge (Cole-Palmer)
- Hydrosense soil moisture gauge (Campbell Scientific)
- 12mL Exetainers – 4 for each transect point to be measured plus 6 for ambient atmosphere samples plus 3 spares for each transect. For this fall, a total of 87 exetainers are needed (6 x 4 x 3 + 9 + 6 = 87) (Next spring we will also add 5 exetainers for standard gases.)
- 20mL disposable syringes (one for each chamber (Becton-Dickinson))
- Luer-Lok tip
- Stop watch
- Freezer bag to store exetainers
- Tube of silicone
- Needles – one for each syringe plus spares (Becton-Dickinson)
  - 23 gauge
  - 1" length
  - turquoise hub colour



$$\text{Upper chamber volume} = \pi \cdot r^2 \cdot h = \pi(10.15)^2 \cdot 15$$

$$\text{volume(L)} = \frac{323.7(\text{cm}^2) \cdot 15(\text{cm})}{1000} = 4.856\text{L}$$

$$\text{Collar volume} = \pi \cdot r^2 \cdot h = \pi(10.15)^2 \cdot h$$

$$\text{volume(L)} = \frac{323.7(\text{cm}^2) \cdot h(\text{cm})}{1000}$$

$$\text{collar area} = \pi \cdot r^2 = \pi(10.15)^2 = 0.0315 \text{ m}^2$$

## 7.2 Procedure

### 7.21 *Preparation of Exetainers*

Exetainers will be evacuated by the analytical lab prior to shipping of exetainers.

Exetainers will be labelled by the analytical lab (with a consecutive number and the province). Please use only these labels. **Do not add labels or codes to the vials.** Exetainers codes should be recorded on the data sheet prior to sampling and this is where all other identifying information for your exetainers is recorded. See the GHG Sample Sheet at the end of this protocol manual.

### 7.22 *Insertion of collars*

Collars should be inserted as soon as possible after arriving on site.

Flux measurements should not be taken from collars until 1 hour after insertion of the collar.

The lower PVC collar is driven into place using a sledge hammer and a wooden block (to protect the edges of the collar from damage) until about 5 cm remains above the soil surface.

In cases where the soil is very dry or cemented, chamber insertion may require excavation of soil around the outside of collar to ease insertion. A sturdy serrated knife used to cut a ring around the chamber bottom is a fast and efficient method under these conditions.

### 7.23 *Initial Preparation prior to starting flux measurement*

The objective of this procedure is to use the rate of gas accumulation in the headspace as a measure of the emission of the gas from the soil surface. Therefore it is important that representative gas samples be collected at the time specified. **Careful planning and organization** will allow you to effectively move from chamber to chamber and collect samples on schedule.

**Prior to starting the flux measurement** it is useful to lay out the chamber tops, exetainers and syringes needed for each transect.

**You must also record the exetainer numbers** on the GHG Sample Sheet prior to starting the measurements. This can be done before you head out to the field as an effective time saving measure.

**Take care** to ensure that the correct exetainers are used for each sampling interval. To ensure that samples are analyzed sequentially on the gas chromatograph it is preferable to use sequential numbers for the sampling times for a chamber (e.g. use

NS 506, NS 507, NS 508, NS 509 for t=0, t=15, t=30 and t=45 minute samples respectively). (You will note that this is how the GHG Sample sheet is set up.)

### 7.3 Collection of Gas Samples (READ ALL THROUGH FIRST!)

- **Overview of process:** Place the chamber top on top of the collar and place a brick or stone on the top to ensure an adequate seal.
- Flush the syringe by "pumping it" twice in the ambient air before taking each sample.
- Start the stop watch. We generally sample at 90 second intervals (for beginners). So set your stop watch to beep every 90 seconds. (Sample chamber one as you start your stop watch. Move to chamber 2, put the chamber top on, and take the sample when the watch beeps at 90 seconds. Move to chamber 3, put the chamber top on, and take the sample when the watch beeps at 90 seconds. Continue to sample chambers 4, 5 and 6 every 90 seconds. Then return to the first chamber position, and wait until the next time step, which starts at 15 minutes. (you will have about 5-6 minutes break before you start the second round of sampling.) On the second round of sampling at 15 minutes, the chamber tops are already on the chambers, so you will have a little more time to take each sample of gas. However, keep to the 90 second interval between chambers for consistency throughout the sampling.
- **How to collect the gas sample:** Collect a headspace sample from the first chamber immediately after it is sealed.
  - Insert the needle into the septum
  - Draw 20 mL of headspace gas into the syringe, pause 1-2 seconds to allow the gas to flow into the syringe. Do not "pump" the syringe while it is inserted in the septum.
  - Remove the needle and inject the sample into the correctly numbered evacuated 12mL Exetainer. Keep the syringe plunger depressed until the needle is removed from the Exetainer.
- Take one ambient air sample (Just a 20 mL syringe full of the surrounding air) at about chamber height (10 cm height above the field surface) just after your Time 0 sampling and just after your time 45 minute sampling at each transect.
- At each prescribed collection interval (e.g., 15, 30, and 45 minutes) collect a headspace sample from each of the chambers using the procedure described above.
- Record the exact time of sampling if it deviates from the planned time.
- At the end of the sampling interval take 5 x 20mL of the standard gas and inject into correctly numbered exetainers. **This procedure will begin with the Spring 2006 sampling.**

## **7.4 Gas Sample Transportation and Storage**

The silicone is used to provide a more rapid sealing of the exetainer septa after sampling. The grey septa can take a few minutes to effectively re-seal. Consequently, silicone should be applied immediately after sampling is complete.

The samples should be placed back into their original shipping box (with the dividers) with a photo-copy of the corresponding data sheet, correctly filled out.

Samples should be transported back to the lab in a cooler to moderate temperature fluctuation and provide secure storage

## **7.5 Shipping**

The box containing the exetainers and a copy of the sample sheets should be placed in a sturdy cardboard box or small cooler and packaged with foam chips or other suitable packing materials. There is no need to keep the samples cool.

Items should be shipped via Purolator Courier to:

Greenhouse Gas Analysis Lab  
Department of Environmental Science  
Nova Scotia Agricultural College  
P.O. Box 550, 21 Cox Rd.  
Truro, Nova Scotia  
B2N 5E3

Phone: (902) 893-6250

Send an E-mail to this address indicating shipping date and include the tracking number in the message

davidlburton@mac.com

## **7.6 Measurement of Associated Soil Properties**

### **7.61 Volumetric Soil Moisture Content**

At each chamber location use the HydroSense soil moisture sensor to record the soil water content. This measurement can be made at anytime during the flux measurement. If the soil is very hard use the guide probe block provided to establish the holes and then insert the HydroSense unit. Record this data on the data sheet.

### **7.62 Air Temperature and Humidity**

At the base of each chamber use the air temperature/humidity sensor provided to measure the air temperature and humidity at approximately 10cm above the soil surface. Record this data on the data sheet.

### **7.63 Soil Temperature**

Using an electronic temperature probe insert to a depth of 5 cm, record the temperature at each chamber location on data sheet.

#### **7.64 Measure the Height of the Collar**

Using the collar height measuring device, record the height of each of the six metal bars protruding from the device once it has been fitted on top of the collar. Write all six heights on the data sheet in the appropriate box.

### **7.7 Emergency Evacuation of Exetainers in Field**

Sometimes, exetainers lose their vacuum, and you may not have brought along enough spares. If this happens, you can still hand-evacuate an exetainer in the field.

- 1) Place syringe plunger in the down/closed position
- 2) Insert syringe needle into the septa of the exetainer
- 3) Pull syringe plunger to the up/open position and hold up for 1-2 seconds allowing gas to flow into the syringe
- 4) Continue holding the plunger in the up/open position while pulling the needle out of the exetainer (there will be a substantial suction down of the plunger)
- 5) In the ambient air push the syringe plunger to the down/closed position, thus releasing the collected gas into the ambient air
- 6) Repeat steps 1-5 a second time

**NOTE:** the second evacuation is significantly more difficult as there is substantial suction of the plunger

### **7.8 Additional Notes & Suggestions for Sampling**

To facilitate easy location of collars, mark them with a brightly coloured flag or stake, or spray paint a rock in fluorescent orange and place it near collar.

To save time on large sites, two people can work simultaneously such that two transects are sampled at the same time. Alternatively one person can collect one time and the second (and/or third) can collect the next time(s). If this is to be done make sure the stop watches or other timing devices are synchronized.

## ADDENDUM - FOR FLOATING CHAMBERS

(R. Bourbonniere 9 April 2006)

### 7.0A Greenhouse Gas (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O) Flux Measurement

#### 7.1A - When to Use the Floating Chamber(s):

For the ACAA project the best comparisons are made at the six points along transects where collars are installed either permanently in the riparian zones or temporarily in the field. Floating chambers are to be used only when the water level in the wetland is high enough to be covering one or more installed collars. If there is water inside the collar, but it is not submerged, then use the usual GHG chambers and determine the air space in the collar down to the water level.

Floating chambers are designed to be used in calm water, gentle winds and only small ripples in the surface of the pond. They could also be used in slow moving streams. Any significant wave action or fast current will invalidate the results.

#### 7.2A - Where to Use the Floating Chamber(s):

The measurement of GHG flux made with the floating chamber is a measure of what is diffusing across the water-air interface. The actual site of deployment does not have to be exactly at the same location as the installed and submerged collar, but it should be as near as possible to that location WHERE A MINIMUM WATER DEPTH OF 25 CM IS AVAILABLE. As well one must be careful not to disturb the sediment or nearby wet soil at the deployment site, so it is important to work from a dock, boardwalk, or other means of protecting the sediment from disturbance – in deeper ponds a tethered inflatable boat has been used successfully.

#### 7.3A - Equipment (Provided by Rick Bourbonniere)

- Chamber affixed to square pontoon
- Chamber has vent tube and insulation installed
- Quick-connect fitting (bottom portion affixed already)
- Syringe and collecting system (two included)
  - Quick connect top portion
  - Tygon tubing (1.5 m length)
  - 4-way Luer stopcock
  - 30 mL syringe
  - M-M Luer connector (rotating)
- Spare quick-connect bottom fitting
- 25 GA, 5/8 inch needles
- Wooden shipping/carrying case
- You will need a length of light twine or fishing line
- Remainder of equipment is provided in the regular GHG kit (stopwatch, Exetainers, etc.)

Note: The carrying case handle is inside the Ziploc bag and is to be mounted on top using the 4 screws provided (already screwed into the top).

## 7.4 A - Deployment

The floating chamber must be deployed in such a way that does not disturb the sediment and remains floating evenly so that the bottom does not tip out allowing the accumulated GHGs in the chamber to escape. The chambers are designed so that 3 cm of the chamber is submerged.

Wind or current will carry the chamber away from the deployment area so it must be tethered in such a way that the wind or current does not push the chamber into grass, mud or shallow (< 25 cm deep) water. To do this it is best to tie a length of light twine to one corner of the pontoons and fix the loose end as close to the water level as possible so that the chamber is no more than 1 m from the dock or other standing point. If the dock is not an appropriate point to tie the loose end you may have to insert a stick firmly into the sediment “upstream” of the chamber. If you do this, then you should wait a few minutes for the disturbance to clear before deploying the chamber. Note the syringe tube is 1.5 m long but it is fixed to the top and if the chamber is anchored from the top it will tilt up in all but the calmest water (no wind).

## 7.5 A - Sampling the Floating Chamber

The floating chamber should be sampled in sequence with all other chambers in its transect. The Exetainers used should be those same ones that would have been used if a fixed collar was being sampled. Water temperature at a depth of 5-10 cm should be recorded, as well as air temperature and R.H. in the vicinity of the floating collar. Obviously the soil water content is NOT measured with the Hydrosense.

We use the tygon tube and the quick connect fitting to replace the septum and needle because pushing the needle through the septum would push down on the floating chamber would disturb the water under the chamber and affect the diffusion rate.

Preliminary operations (before starting GHG measurements on the transect):

- Connect one of the tygon tubes to the chamber by pushing together the top and bottom portion of the quick-connect until it snaps in place.
- Tether chamber from corner of float and tie as explained above – test the direction and distance that the wind or current takes the chamber – shorten to 1 m or less if necessary.
- Proper tethering will allow enough slack on the tygon tubing for syringe operations to proceed without tugging on the tube and tilting the chamber.
- Place a needle on the M-M connector that is connected to the 4-way stopcock

Step-by-step sampling procedure once transect measurements have begun – read though in advance to familiarize before the actual measurement begins:

1. The volume of the tubing and fittings total about 12 mL and this must be flushed three times to clear the tubing of the previous sample. This also will mix the chamber contents somewhat.
2. When its time to begin measurement at the floating site, carefully place the (pre-tethered) floating chamber in the water at its designated starting time.
3. Place the stopcock so that the “off” position points to the needle on the M-M connector.
4. Draw in 30 mL of chamber air with the syringe and blow it back into the chamber, being careful not to tug on the tubing and tilt the chamber.

5. Repeat step 4 two more times.
6. On the fourth draw stop at 25 mL.
7. Turn the stopcock so that the "off" position points to the tubing.
8. Have the Exetainer ready
9. Flush the M-M connector and needle with 5 mL of the syringe contents
10. Push the Exetainer onto the needle and watch that the plunger moves on its own, thus certifying that the Exetainer is a good one (is evacuated).
11. If is it good, then push the remainder of the 20 mL into the Exetainer and remove it as usual (holding the plunger so that the over-pressure in the Exetainer does not push the plunger back up the syringe).
12. Place the syringe and needle assembly where it will remain clean and dry AND so that it does not tug on the floating chamber.
  
13. Repeat steps 3-12 for the 15, 30, and 45 minute syringes.

Note: The floating chamber volume used for calculation is constant (total volume – volume of 3 cm depth) for all chambers at all sites.

## 8.0 Weather and Soil Environmental Monitoring

Please refer to the Hobo instruction manual supplied with the weather stations for set-up, use and maintenance instructions.

Check the weather station every time you visit a site. Critters are known for tripping, chewing, rubbing on all or parts of a weather station! Every time you are at the site, check that the funnel on the top of the tipping bucket is clear of debris (straw, dust, bird poop).

Contact DUC for copies of Hoboware or replacement sensors if any of them get chewed, damaged or fail for any reason.

The Hobo rain gauge is a tipping bucket design (model: S-RGA-M002). Ensure the bucket is level on the mast and check it periodically (annually). You will note the instructions for the field calibration (page 4 of 4) suggest an annual check of the calibration.

You will note the rain gauge is the only sensor in the array that is a "smart sensor" which is sensitive to a sampling interval as well as a logging interval. We suggest you set the Hoboware parameters for a one hour logging interval. Thus, every hour the temperature is measured and logged. The temperature sensors are not "smart" so they do not sample every minute and log the average of 60 minutes every hour. If the air temperature cools down in the last five minutes of the hour, then that is the temperature that is recorded (good enough for our monitoring of the growing season and annual weather, not good enough for micromet brain surgeons). The manual states the rain sensor is capable of 4000 tips per logging interval (40 inches of rainfall). We could envision an extreme event of a short, intense burst of rainfall that could rain 1 inch in 5 minutes. That would need 100 tips of the bucket in 300 seconds, a tip every 3 seconds. If you expect an occurrence of that intensity then set your sampling interval for 3 seconds. If you expect an intensity less than that then try a sampling interval for every 10 seconds.

If you need to replace the temperature sensor: Insert a screwdriver at a 45 degree angle so that the tip of the sensor will be about 7.5 cm below ground level (below depth of the start of the mineral soil).

If you need to replace the moisture sensor, insert a flat piece of steel such as a large carving knife at an angle so that the bottom of the sensor does not go below 15 cm and that the top is even with the top of the mineral soil.

## Appendix 1: Field Sheets

DUC-ACAAF Observation Field Sheet

DUC-ACAAF Plant Identification Field Sheet

DUC-ACAAF GHG Sample Sheets (Use Attached Microsoft Excel File)

Blank Soils Observation Field Sheet

# DUC-ACAAF Observation Field Sheet

Complete the following during every sampling session.

Date: \_\_\_\_\_ Name(s) of sampler(s): \_\_\_\_\_

Site: \_\_\_\_\_

Province: \_\_\_\_\_

Time Gas Sampling started: \_\_\_\_\_

ended: \_\_\_\_\_

## 1. Weather conditions

- a. Wind speed and direction (description)
- b. Sky conditions (i.e. cloudy, sunny etc.)
- c. Air temp, measured in the shade near ground level ( $^{\circ}\text{C}$ )
- d. Water temp in wetland (10cm depth)

## 2. Soil and crop conditions

- a. Soil appearance (i.e. wet, cracked, etc.)
- b. Soil temp at 2.5 cm below surface ( $^{\circ}\text{C}$ )
- c. Visible soil moisture (how much and how deep)
- d. Type of crop
- e. Stage of crop
- f. Row spacing

## 3. Other Tests

- a. Soil Moisture (Theta Probe or Hydrosense)

## 4. Other pertinent information

- a. Date of last significant precipitation, if known
- b. Is there standing water in the wetland? Depth \_\_\_\_\_ cm.
- c. Estimate of # of cow pies per square meter. Estimate parallel to chamber sites along transect.  

1	2	3	4	5	6
- d. Date of spring thaw, frost, or freeze up

## 5. Comments/Notes:

## DUC-ACAAF Plant Identification Field Sheet

Complete the following at Time 3: Late-Summer sampling.

Date: \_\_\_\_\_ Name(s) of sampler(s): \_\_\_\_\_

Site: \_\_\_\_\_

Province: \_\_\_\_\_

Transect Position	Species	% Cover Estimate
1		
2		
3		
4		
5		
6		

Other Notes:

