

# **Snow Surveying Field Sampling Protocols**

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*Prepared by:*

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**Document Status:** This document will be periodically updated as new field protocols are developed or in some cases, the procedures may be updated with new information and science. Each individual protocol includes the date of release to allow updated versions to be identified in the future.

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## 1.0 INTRODUCTION

This document contains field protocols and methods for the measurement of snow depth and water content in Alberta. These protocols are important to ensure that samples are collected consistently and the data obtained are accurate and scientifically sound. This information is critical for the accurate prediction of runoff potential, flood forecasting and water supply, and to assist in the operation of reservoirs and hydroelectric facilities.

The following procedures and instructions by the Government of Alberta staff provide default processes for all snow surveys conducted within the Province of Alberta. In general, the method is the preferred means of obtaining an integrated and representative sample which serves as an indicator for a much larger geographical area. Consistency in both sampling location and methodology is critical to ensure integrity of a database which in some cases exceeds forty years of record. Errors in measurement affect not only the current year's record, but also statistical analysis of the data for many years to come. Any changes in the nature of the sites such as removal of tree cover, changes in land use, deviation in sampling location, or disturbance of the snow pack should be noted in detail.

This document is the first standard set of protocols to be used by all Government of Alberta staff when measuring snow depth and water equivalent, and it outlines the procedures used by the Government of Alberta. The protocols in this document are considered to be best practices for snow survey measurements in Alberta. However, this is a living document, and as new technologies and techniques are developed, they will be evaluated and may be included in future versions of these protocols. Each protocol consists of a brief description of purpose, general background on the sampling technique, the type of sampling equipment required, and a step-by-step procedure to collect and report the sample results.

It should be noted that the sampling manual focuses on field sampling procedures and it does not cover the sampling design of field programs. Selection of new or alternate sampling locations should be done in consultation with experienced staff and the scientific professionals involved in interpreting, analyzing, and reporting on the data. Proper interpretation of special circumstances or sampling requirements is a skill that can only be developed with experience.

No official formal standard operating procedure (SOP) for the measurements of snow depth and water equivalent has been written by the Government of Alberta. Most knowledge has been passed on through demonstration, collaboration, and mentorship. Guidance was gained from the U.S. Department of Agriculture Soil Conservation Service Handbook No. 169 (April 1959), Environment and Climate Change Canada's Manual of Standards Snow Surveying Procedures (April 1973), and the draft 3<sup>rd</sup> edition dated January 2004. Additional information can be found at United States Department of Agriculture Natural Resources Conservation Service website (<https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/water/snowsurvey/>).

## 2.0 SNOW SURVEYING PROTOCOLS

### 2.1 Standard Ten-Point Snow Survey – General Instruction

#### Purpose

To obtain accurate and consistent measurement of snow depth and water equivalent at any sampling location in Alberta.

#### General

Many sites have designated sampling points, where the points are marked and numbered. Other locations in open fields have distance between sample points measured simply by pacing. Proper maintenance and trimming (brushing and grass trimming in fall season before the snowfall) of snow courses is critical to achieving accurate results. It is also recommended that prior to each sampling season, each scale be calibrated using either a water-weight calibration or specific weights. Tube sections should be coated using a Teflon-based wax prior to each sampling trip.

Criteria for completion of snow surveys is generally within  $\pm 5$  days from the first of the month, though a few exceptions do exist.

For calculations, use Banker's rounding or "rounding to the evens": i.e.  $20.5 = 20$ ,  $19.5 = 20$ .

#### Equipment

- Standard Federal Metric snow sampler with drive handle of an appropriate length for the snowpack being sampled. At minimum, two sections should be used plus the driver's handle.
- Snow scale and hanger appropriate for the snow pack being sampled (standard scales are graduated in 2 cm increments, where scales designed for use in heavy mountain snow packs have greater range and are graduated in 5 cm increments).
- Spanner wrenches for separating sections of tubing.
- Snow knife for removing stuck/packed snow from inside tubing.
- Brush or other means of removing sticky snow from inside tube.
- Notepad, notes (waterproof if required), pencil and calculator.
- Snowshoes or skis.
- PPE/survival gear appropriate to the terrain and conditions expected to encounter.

#### Procedures

- Ensure the tube is cooled to ambient air temperature to avoid snow sticking to it. It is not advisable to carry the tube inside the cab of the vehicle.
- After assembling sampling equipment, obtain and record the "Wt. Tube Only Before Sampling" (see Appendix A), or the tare weight of the tube. This should be repeated at the midpoint of the course. In ideal sampling conditions, confirmation at the end may be sufficient. In poor or difficult conditions, it may be necessary to confirm the tare weight at every sampling point.
- Hold the sampler perpendicular to the snowpack, and drive down with sufficient force to penetrate to the ground below, if possible. In compact or deep snow packs, augering down or making multiple downward thrusts may be necessary.
- Twist the sample tube a half or one turn to loosen the snow from the ground below, or to secure a plug of moss or earth in the tube.
- Read the depth of snow to the nearest cm from the scale on the side of the tube and record. If a large plug is removed from the tube in the next step, it may be necessary to subtract that amount from the

total depth.

- Gently extract the tube from the snowpack and check for a plug in the bottom. Be sure to hold the tube horizontally so that no snow is lost from either the top or bottom during this process. If a plug is present, use the snow removal tool to remove it. When sampling deep snow packs, it is preferable to have a second person assist with that task.
- After the plug is removed, or if no plug is present, place the tube on the scale cradle again taking care to keep it horizontal and balanced on the cradle. This is often the most difficult part of the task for inexperienced staff. As well, if no plug is present, ensure the full core was obtained by looking for flecks of dirt or light debris on the bottom of the snow and making sure a large void does not exist at the bottom of the tube.
- Obtain the weight of the tube and the core to the nearest cm, and record on the note (see Appendix A).
- Proceed to the next sample point and repeat the process. Ensure all snow from the previous sample point has been removed from the tube. It may be necessary to use the snow knife to loosen packed snow by inserting it through the slots in the side, or the sampler can be turned upside down and tapped against a boot, snowshoe, or tree.
- If there are two or more staff present, results should be calculated after each point and any outliers re-sampled. The guideline for re-sampling is when the density of an individual point falls outside a range of 5 % between the maximum and minimum on the course. In some cases, this result may be valid due to variation in sun exposure, drifting, or other variables, but nonetheless needs to be confirmed. Document any points re-sampled by indicating the number of retries beside the point number on the note (i.e. “3x” beside Point #7).
- Regardless of the number of staff present the results should be calculated at the very least upon completion of the course, and any outliers re-sampled prior to leaving. Also be sure to record start and end times for the measurement, as well as any other pertinent information such as weather conditions and variations or influences in the course condition and snow pack.

## 2.2 Bulk Snow Samples

### Purpose

To allow the measurement of average snow depth and water equivalent in locations where the snowpack is not of sufficient weight to determine water content of each individual sampling point.

### General

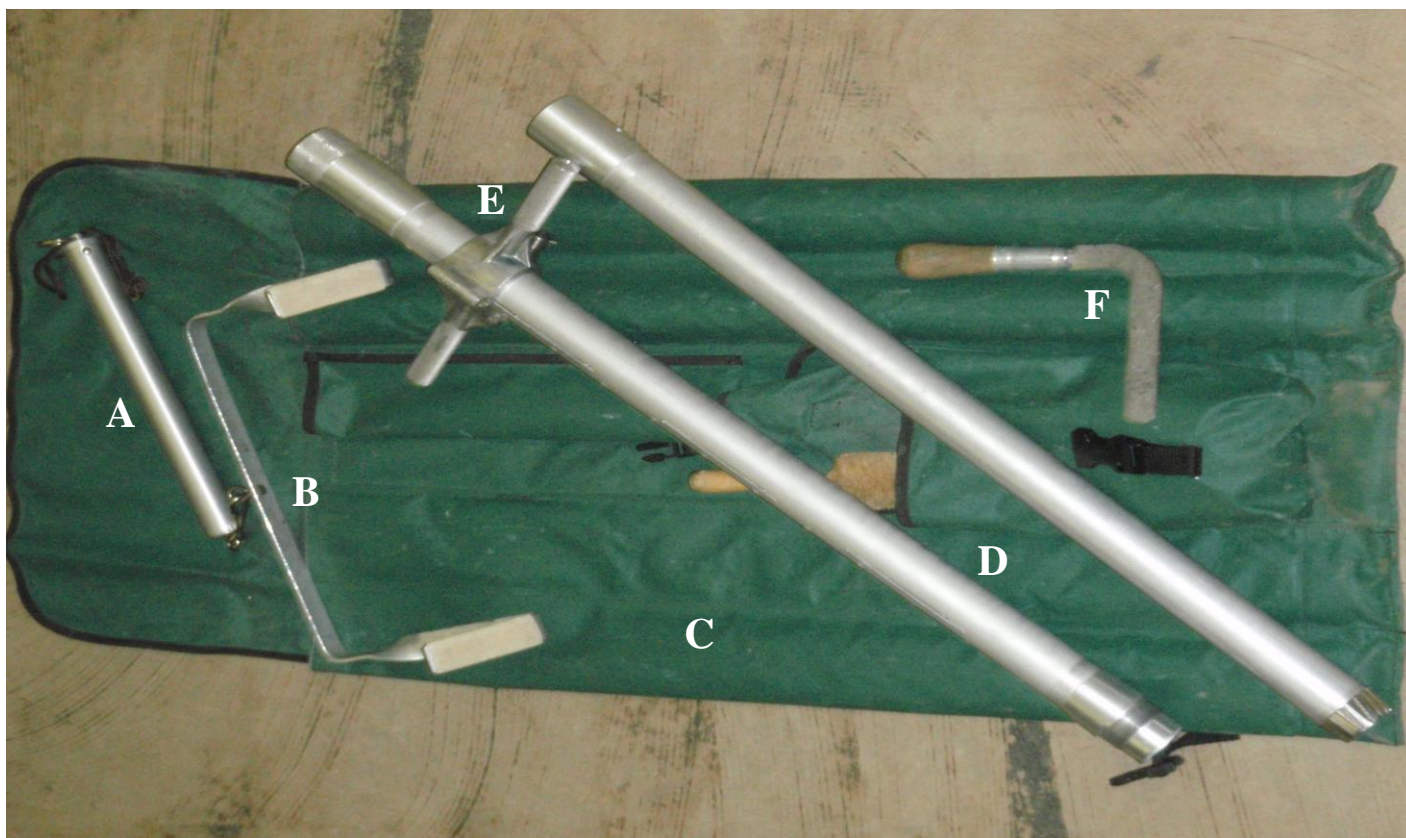
Though many jurisdictions focus their snow survey efforts in the mountain environment where the snow packs are generally much greater, in Alberta there is desire to obtain data from across the plains as well. Often the snow pack is either too light or has melted to the point where sufficient mass of snow does not exist to weigh each point individually. Over the years, there has been varying approaches on this, but general consensus is that when more than two of the ten individual samples weigh less than five cm of water equivalent, bulk sampling should be employed. As well, if snow exists on any of the points on a course, that course should be sampled.

Bulk sampling can also be employed in other circumstances such as extreme winds where it may be impossible to get accurate weights of individual samples on the course, allowing the bulk sample to be weighed in the protection of the truck or bush.

### Equipment

In addition to the equipment listed above:

- Cooler, pail, or rugged bag to collect individual cores.



**Figure 1.** Federal Metric Snow Sampling Kit: (A) Scale (B) Cradle (C) Carry Bag (D) Snow Tube (Two Sections) (E) Drive Handle (F) Snow Removal Tool.

### Procedures

- When using this method, it is permissible to use as little as a single section of snow tube without the handle, as the tare weight is provided by the collection container (provided it is not a plastic bag or very light pail, in which case the two sections of tube will need to be weighed along with it) (Figure 1).
- Weigh and record tare weight to the nearest cm on the scale. As only the individual depths and a final full weight will be recorded, write “Bulk Sample” across the body of the note (see Appendix A). Record the full and tare weights in the final sample point row.
- Collect the samples the same way as per Procedures in Section 2.1, but this time empty the core into the collection vessel. Remove any foreign objects or debris.
- Collect a core for every point that has snow, and be sure to record the individual depths. Record zero for points devoid of snow.

After all cores have been collected, first ensure there is no snow stuck to the bottom of the cooler, and all dirt and foreign objects have been removed. Weigh the sample and record it as the final “Weight Tube and Core”. Subtract the tare weight, and divide by ten to get the average water equivalent.

Regardless of sampling methodology, results should be entered in Water Information Systems by KISTERS (WISKI) or reported to Flow Forecasting on the day of the sampling, or at minimum the next morning.



### 3.0 SNOW SCALE ACCURACY CHECK

#### Purpose

To ensure the accuracy of the weighing device (manual scale) used to determine water equivalent.

#### General

Over time and through the rigors of field conditions, the scales used to determine water equivalency can become inaccurate. Regardless, it is a good quality control procedure to, at minimum, do an annual verification of the values each scale yields. Methods vary, some utilize weights, but the preferred method uses an equivalent volume of water to generate an expected result.

#### Equipment

- Snow scale and cradle
- Cooler or other suitable vessel to hang from scale
- Graduated cylinder
- Water

#### Procedure

- Hang the scale from a rod or other anchor securely fastened at a height well off the ground and clear of any obstacles or obstructions.
- Suspend the cooler or other vessel from the scale, and add water until a tare weight of 20 is reached.
- Add increments of 446 mL of water, which should equate to an increase of 40 cm on the scale. Record the results. Continue this process until a reading of 300 cm is reached on the scale.
- An additional check is to fill the vessel until an equivalent reading of 100 cm is reached on the scale, and then add 1000 mL of water. The result should be a reading of 190.
- A variation of  $\pm 3$  cm (1 % of full scale) is deemed to be acceptable. Any scale showing variation greater than that should be removed from service.

### 4.0 ACKNOWLEDGEMENTS

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### 5.0 REFERENCES

- Environment and Climate Change Canada (2004). *Manual of Standards Snow Surveying Procedures – Draft 3<sup>rd</sup> Edition.*
- United States Department of Agriculture (1959). *Snow Survey Sampling Guide, Agriculture Handbook No. 169.*

# APPENDIX A Example Notes



## SNOW SURVEYS

Snow Course No. 05CC801  
 Name Example  
 Sampler AA, BB Date Mar. 29, 2013  
 Start 11:50 End 12:10 (MST)

Station No.	Snow Depth	Weight Tube and Core	Wt. Tube Only Before Sampling	Water Equivalent	Density
1 (2)	71	130	110	20	.28
2	64	126		16	.25
3	78	131		21	.27
4	76	129		19	.25
5	83	132		22	.27
6	73	130	110	20	.27
7	86	133		23	.27
8	86	132		22	.26
9	83	130	110	20	.24
10	62	128	111	17	.27
Total	762 cm			200 cm	
Average	76 cm			200 mm	.26

IG rdg. \_\_\_\_\_ Enc. Rdg. \_\_\_\_\_ at \_\_\_\_\_ MST: <sup>Depth on</sup> Piliow \_\_\_\_\_ cm

Remarks -ground damp at Pt. #1  
-10cm fresh snow

Weather: Temp -2 °C Sky P/C Wind calm From \_\_\_\_\_

Checked by: \_\_\_\_\_



## SNOW SURVEYS

Snow Course No. 05DE801  
 Name Example  
 Sampler CC, DD Date Mar. 31, 2013  
 Start 14:00 End 14:15 (MST)

Station No.	Snow Depth	Weight Tube and Core	Wt. Tube Only Before Sampling	Water Equivalent	Density
1	8				
2	6				
3	6				
4	12				
5	5				
6	0				
7	4				
8	10				
9	7				
10	5	76	64		
Total	63 cm			12 cm	
Average	6 cm			12 mm	0.20

IG rdg. \_\_\_\_\_ Enc. Rdg. \_\_\_\_\_ at \_\_\_\_\_ MST: <sup>Depth on</sup> Piliow \_\_\_\_\_ cm

Remarks -light snow cover, bare patches

Weather: Temp -1 °C Sky sunny Wind lt From W

Checked by: \_\_\_\_\_