

Research Project C-06-09

Designing, Developing and Implementing a Living Snow Fence Program for New York State

Task 3-A1 & 3-A2

# **Protocol for Pre-Installation field Measurements for Prospective Living Snow Fence Sites in New York State**

August, 2013



State University of New York  
College of Environmental Science and Forestry



New York State  
Department of Transportation

Justin P. Heavey

Dr. Timothy Volk

Dr. Lawrence Abrahamson

State University of New York  
College of Environmental Science & Forestry

John Rowen  
New York State Department of Transportation

## **Background**

Site assessment and pre-installation measurements are important first steps in the establishment and long-term success of living snow fences. Once a prospective site has been selected for a living snow fence installation, site assessment and measurements inform the design and planting phases. The following protocol offers a general methodology for living snow fence site assessment and measurement that can be modified as needed by the design team based on the specifics of the site and design goals.

This paper specifies some measurements in English units and some in metric units. When metric units are specified, please calculate in metric units as metric units will be required in subsequent steps in subsequent equations.

## **Identify the Problem and Evaluate the Site**

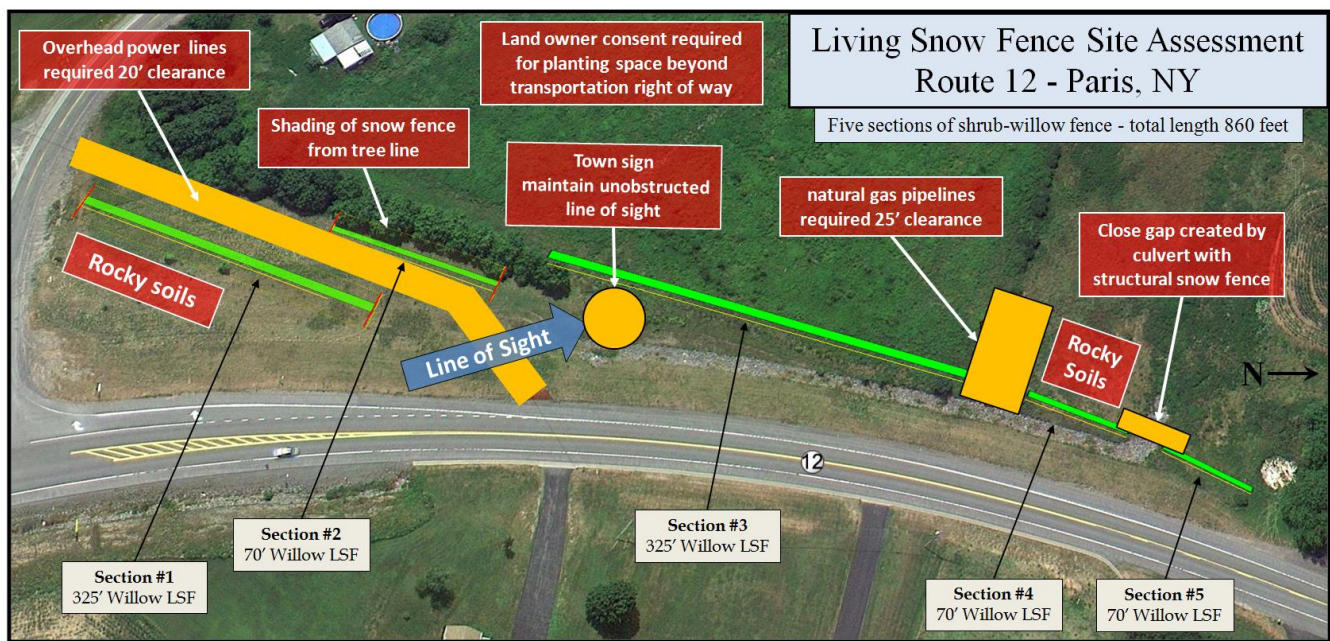
- ✓ Identify the problem by determining the source of blowing snow and potential solutions using living snow fences. Refer to Tabler (2003) chapter 4 for more specific information on blowing snow problem identification.
- ✓ Collect accounts of winter road conditions and drifting patterns. In collecting accounts, ensure that information is gathered from workers who plow or maintain a given highway segment. Such people are often the most familiar with the snow problem at a site. If possible, the living snow fence design team should observe winter road and drifting conditions firsthand.
- ✓ Thorough site assessment includes a combination of remote sensing using geographic information software (GIS) and site visits in the field. As site evaluation proceeds, numerous site visits are generally required before installation of the snow fence begins. Make at least one visit to the prospective site with as many stakeholders as possible (New York State Department of Transportation (DOT) staff, contractors, landowners, etc). Discuss any site-specific challenges and opportunities as a group while in the field with all stakeholders (Figure 1).
- ✓ A variety of challenges to continuous living snow fences can exist at a site and conditions vary widely from site to site. Challenges are anything that would impede or complicate the installation,

short, and long-term growth of the fence. Challenges can be above ground such as overhead utility lines, or below ground such as rocky soils. Examples of site challenges identified at a prospective living snow fence site in Paris, NY, are provided in Figure 2.



**Figure 1:** Discussion among stakeholders of potential site challenges and opportunities during a field investigation of a prospective living snow fence site in Hamburg, NY, in 2009

- ✓ Identify any potential permit requirements or regulatory agency concerns before proceeding to the next steps. For example, utility rights of way require certain clearance distances free of vegetation (including living snow fences) and environmentally sensitive areas, such as watersheds or wetlands, often restrict the use fertilizers and herbicides.
- ✓ During the initial site evaluation, consider the existing vegetation on site, topography, fences, buildings, open spaces and any other factors that would affect wind patterns or plant growth. Refer to Tabler (2003) chapter 4 for more specific information about landscape features that can be detrimental or beneficial to living snow fence function.



**Figure 2:** Challenges to snow fence installation (red boxes) identified during the site assessment phase of a prospective living snow fence installation in Paris, NY

## Examine Aerial Photos of the Snow Fence Site

Examining aerial photographs of a prospective living snow fence site and the surrounding land will assist in the site analysis and measurement by providing an overview of the site, and context of the landscape around the fence including fetch (**F**), the area *upwind* of the fence that contributes to the blowing snow problem. Examining aerial photographs before field visits can help determine the best parking and access route to the fence. Aerial photos provide a bird's-eye view of the site and can show things that may not be readily visible when on the ground, but may be important to the analysis of the snow fence and site. An example of an aerial photo of a living snow fence site is provided in Figure 3.

The Google Earth software program is a free, user-friendly GIS program that often has the most up to date aerial photos. Living snow fence sites can be easily viewed from multiple angles and resolutions in this software. Site locations can be “bookmarked” for easy identification and further analysis. Distances, such as the fetch distance (**F**), and elevations can also be quickly and easily measured in Google Earth and shapes can be marked on the landscape and printed as aerial maps that can assist in the next steps of site analysis. Examining aerial photos of living snow fences can frame the



snow fence in the context of the important site characteristics that contribute to the blowing snow problem.

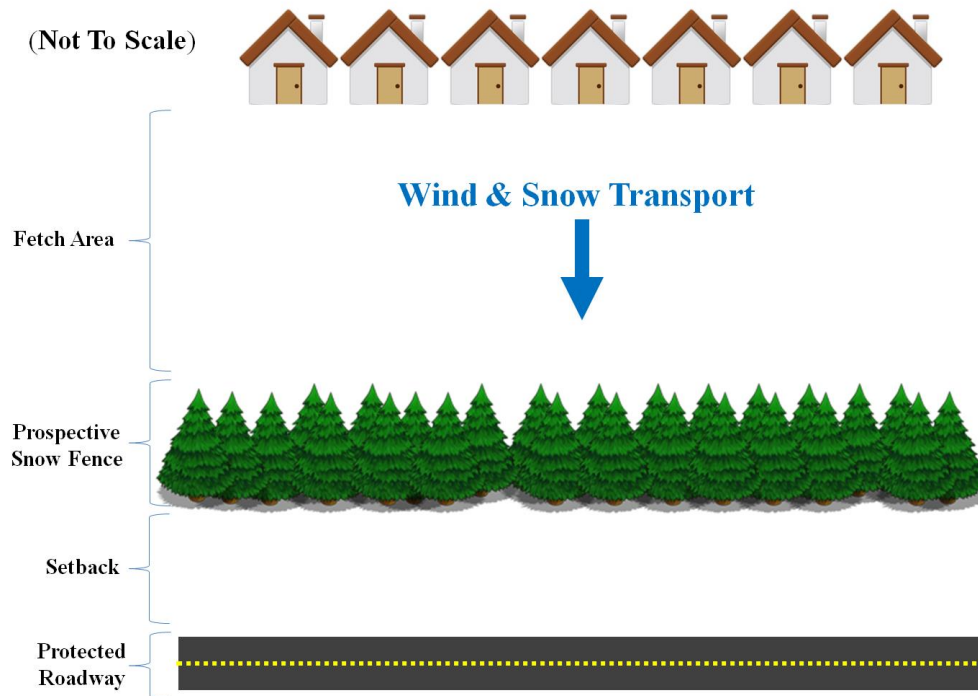
Another useful feature of Google Earth is that, for most locations, aerial photos from previous years can be easily accessed. This feature can provide valuable information on recent land use history. If possible, supplement historical aerial photos with information about land use history gathered from land owners, local residents or NYSDOT staff members who are familiar with the location.



**Figure 3:** Aerial photo of an existing living snow fence site from the Google Earth software program. The existing living snow fence is indicated by the tree icon for reference.

When examining aerial photos, consider the site in the context of the basic elements of living snow fence design. Figure 4 illustrates the basic elements of a snow fence site. At the top of this Figure is a row of houses that indicates an obstruction to the wind. Snow transport is assumed to start downwind of the houses. The *fetch area* is the open area upwind of the *protected roadway* where snow is lifted off the ground and transported by the wind toward the roadway. The *prospective snow fence* will disrupt the wind and cause snow deposition around the fence. *Setback* is the distance between the

fence and the **protected roadway**, required to prevent drifts from building on the roadway to be protected by the fence.



**Figure 4:** Diagram of living snow fence site showing the basic elements that influence site analysis, fence design and snow control

## Estimate or Measure Climate Variables

Estimating or measuring climate variables that influence snow transport is an important step in site analysis for living snow fences. The primary resource for estimating climate variables comes from Tabler (2000) "*Climatologic analysis for snow mitigation in New York State*". This report provides equations to model key variables for living snow fence design. The models in this report were developed using long-term climate data, weather station observations and other climate models. This resource provides the equations necessary to estimate the key variables of: snowfall over the drift accumulation season; the predominant direction of blowing snow; and the percentage of fallen snow relocated by the wind.

These models provide reasonably accurate estimates of climate conditions that are sufficient for the design of living snow fences in New York State in most situations. However, climate variables can be highly localized due to the effects of topography and other site conditions. In some cases, more precise data can be collected in the field using meteorological equipment, such as data logging weather stations, to measure wind speeds, wind direction, precipitation and other weather variables. In addition to the Tabler (2000), an example of how to conduct in-depth climatological analysis for living snow fences is available from Shulski and Seeley (2001).

In-depth climatological studies require large amounts of time and resources; the returns on investment in terms of highly critical data will likely be negligible in most situations. Climate studies in the field are therefore not recommended for most individual living snow fence sites. The methods of Tabler (2000) should be followed instead.

### **Measure Fetch Distance**

Fetch distance (**F**) is an important variable in the analysis of living snow fences. Fetch distance is used in the model of snow transport to determine the quantity of blowing snow at a site in an average year.

- ✓ Using GIS software or field surveying equipment, measure and record the fetch distance in metric units.
- ✓ Starting at the estimated point where the fence will be installed or the edge of the roadway to be protected, measure at a perpendicular angle to the roadway, to the first obstruction upwind that is assumed to disrupt wind patterns and cause snow deposition. Obstructions could include houses, forests or groups of trees. If the predominant winter wind angle is known from climatologic analysis, measure from the fence to the first obstruction at that angle.
- ✓ Take four individual measurements of fetch distance at equidistant spacing across the length of the prospective area where the fence is to be installed
- ✓ Compute the average of the four measurements and round the final value to the nearest meter to calculate the fetch value of the fence.

### **Estimate The Quantity of Snow Transport at the Site**

The primary variable that must be estimated to evaluate a prospective living snow fence site is the average annual snow transport quantity. A summary of how to measure average annual snow transport from Tabler (2000) is provided here. Average annual snow transport quantity (**Q**) can be estimated using the following model:

$$Q = 1500(0.17)(S_{we,AS})(1-0.14^{F/3000})$$

Where:

**Q** is average annual snow transport quantity in units of t/m (metric tons per linear meter)

(0.17) is the assumed snow relocation coefficient (**C<sub>r</sub>**) of snowfall

(**S<sub>we,AS</sub>**) is the water equivalent of snowfall over the drift accumulation season in meters

**F** is the fetch distance in meters

Snow transport (**Q**) is measured in units of t/m, or metric tons (1,000 kg) of snow water equivalent per linear meter of fence (or roadway to be protected). The assumed **C<sub>r</sub>** value of 0.17 represents a statewide average provided and described by Tabler (2000) as the recommended value for designing snow fences in New York State when a more precise value is not known or measured for the site in question. Snowfall water equivalent over the drift accumulation season (**S<sub>we,AS</sub>**) in the equation above can be estimated using the following model from Tabler (2000):

$$S_{we,AS} = (-695.4 + 0.076 * \text{Elev} + 17.108 * \text{Lat})(0.10)$$

Where:

**S<sub>we,AS</sub>** is water equivalent of snowfall over the drift accumulation season in inches<sup>^</sup>

**Elev** is the elevation of the snow fence site in meters

**Lat** is the degrees north latitude of the snow fence site

(0.10) is the assumed water equivalent of snowfall in New York State (Tabler 2000)

*^The output of Equation 2 must be converted from inches into meters to be used in the snow transport (**Q**) model above*

Note that “snowfall over the drift accumulation season” is different from the total annual snowfall for a location, the former being delimited by snowfall that does not contribute to the sustained growth of the snowdrift around the fence (i.e., snow that falls and melts before the drift achieves



sustained growth or snow that falls after the drift has started to permanently melt in the spring). Elevation and latitude values can be measured at the linear center of each fence in Google Earth. The 0.10 value for the water equivalent of snowfall is assumed to be an accurate statewide assumption based on Tabler (2000). If a more precise value at each site is known, substitute it for 0.10 in Equation 2.

## Assessing and Measuring Soil Properties

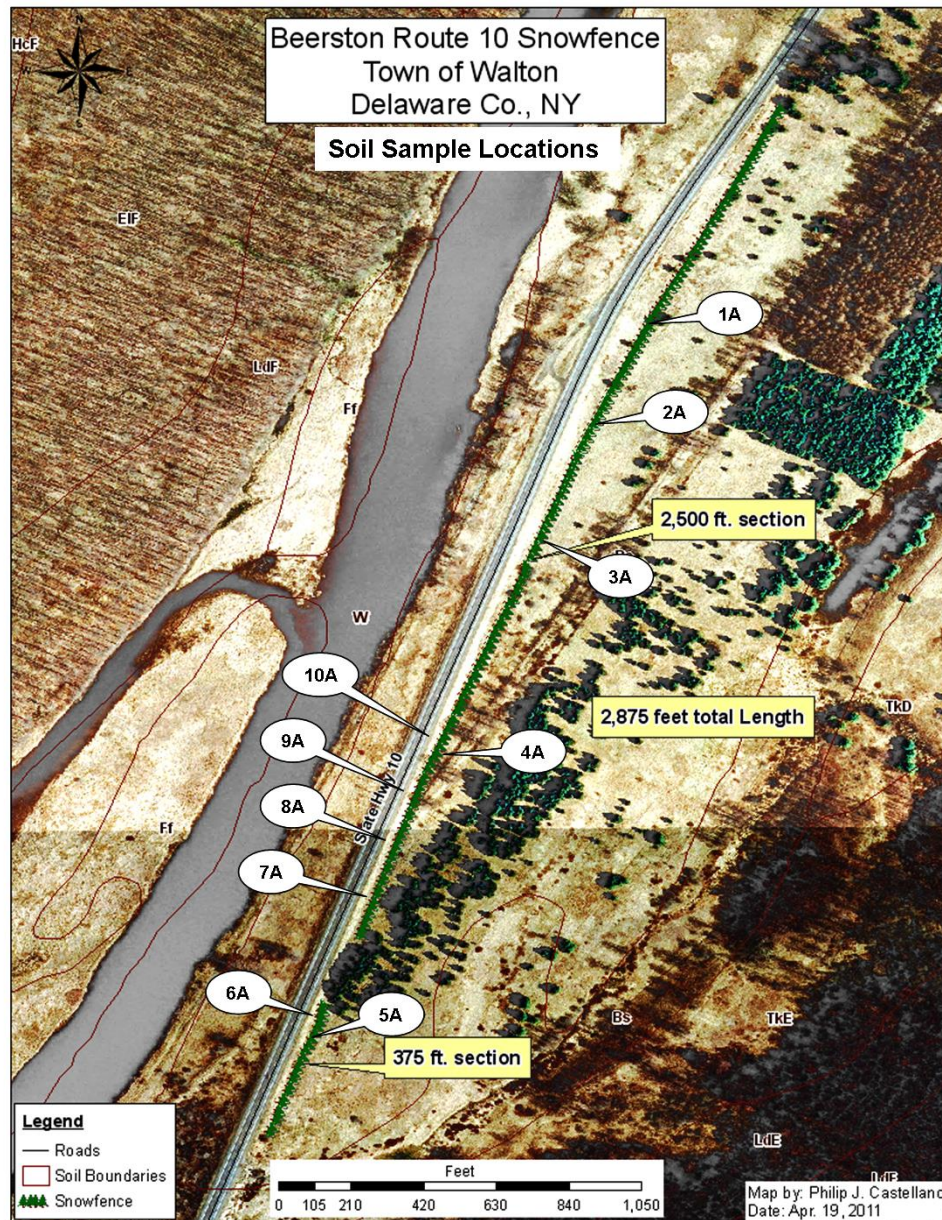
After the site has been preliminarily evaluated remotely and in the field, and the average annual snow transport has been estimated, undertake field samples and analysis of soils. **Soil quality is critical to a living snow fence surviving and growing.** A thorough soil evaluation during site assessment determines if soil quality can support a living snow fence. If soils are determined to be of poor quality, substantial efforts to improve the soils may be required. The critical factors in assessing soil quality are: soil depth, drainage, fertility, percentage of rocks by volume, and soil texture.

- ✓ Begin the soil assessment by evaluating the existing vegetation on the site, to get a rough indication of soil conditions. If the site supports lush woody vegetation or agricultural crops, the soil quality is likely sufficient for a living snow fence. If existing vegetation is sparse or primarily herbaceous (non-woody), this may indicate poor or degraded soils. Soils in or near the right of way may be degraded from previous construction activities. Note the presence of wetland indicator species, such as sensitive fern or cattails on the site, as this may indicate saturated soils and the presence of wetlands that may hinder living snow fence growth and require special permits. Agricultural soils previously used for crops are generally fertile and otherwise sufficient for planting with little modifications. Right of way soils can be heavily degraded or contain high levels of fill. These soils may require high levels of modification to support healthy living snow fences and planting should be approached cautiously.
- ✓ Consult the Natural Resource Conservation Service (NRCS) soil survey maps ([websoilsurvey.nrcs.usda.gov](http://websoilsurvey.nrcs.usda.gov)) for site-specific information on soil depth, drainage class, fertility and texture. Loams and sandy loams are preferred soils for most species. Soils with high clay content may impede drainage. The best sites for a living snow fence should have an NRCS soil drainage classification of “well drained” to “moderately well drained”. “Poorly drained” and

“somewhat poorly drained” soils will cause stunted growth or mortality in most species and will require more precise plant selection or substantial site modifications to improve drainage.

- ✓ Take soil samples at several locations across the area where the living snow fence will be planted (Figure 5) and have the soil tested by a university lab or environmental engineering firm for: pH, percentage of organic matter, soluble salts, available nitrogen, phosphorus, potassium, calcium, and magnesium. Follow the soil sampling procedures specified by the lab that will do the analysis. For woody plants, sampling the top 6 to 10 inches of soil is the most critical. Evaluate the chemical properties of the soil and consider the need for soil amendments in the design, species selection, site preparation, and installation phases.
- ✓ Dig a soil pit on the prospective installation location at several points across the site to expose the soil profile to a depth of 24 inches. Examine the soil profile in each pit to supplement and confirm NRCS data. Observe and evaluate the soil layers, textures, depths and the percentage of rocks in each layer.
  - If rocks, debris or large roots make up more than 50 percent of the soil volume, the site is likely unsuitable for a snow fence installation without substantial site modifications.
  - Determine the depth to root restricting layer (bedrock, clay, water table, etc.) and make sure there is sufficient depth for proper root development. Depth to restricting layer should be at least 18 inches.
  - Confirm the NRCS soil drainage classification at each soil pit across the site as indicated by the presence of soil mottling. Mottling is indicated by distinctive orange and grey soil particles, both occurring at the same depth in the soil profile. This indicates the depth to a seasonal water table and probable root restricting layer. High-quality sites with adequate drainage will show no signs of mottling at depths of 24 inches or greater. If mottling is observed at depths of 12 inches or less, the site may be too wet and unsuitable for planting. Some tree and shrub species tolerate wet conditions; only a limited number of species suitable for living snow fences thrive and grow rapidly in saturated soils.

- ✓ Consult your local environmental specialist, extension agent, or NRCS staff if you have questions about any of the steps in the soil assessment process.



**Figure 5:** Soil map showing NRCS soil classification boundaries, the approximate location of a prospective living snow fence and soil sample locations and identification tags for soil samples taken at the site to evaluate soil quality and determine the appropriate modifications

## Conclusion

The protocols in this document offer a simple methodology for site analysis and measurement of most prospective living snow fence sites to obtain the necessary information for the next steps of living snow fence design, site preparation and installation.

Each living snow fence site and each planting are unique and should be considered and analyzed individually. The protocols can be adjusted as the design team deems appropriate.

If the protocols are followed, the essential data for evaluating a prospective living snow fence site is gathered: identifying the blowing snow problem; examining aerial photos; assessing site challenges and potential solutions; measuring the fetch distance; estimating snow transport; and sampling soil conditions.

## References

- Shulski M and Seeley (2001) Climatological characterization of snowfall and snow drift in Minnesota: for the design of living snow fences. Mn/DOT Agreement No.74708. University of Minnesota, Minneapolis, MN [http://www.climate.umn.edu/snow\\_fence/intro.html](http://www.climate.umn.edu/snow_fence/intro.html)
- Tabler, R.D. 2000. *Climatological analysis for snow mitigation in New York State*. Tabler and Associates. Niwot, CO.
- Tabler, R.D. 2003. *Controlling blowing and drifting snow with snow fences and road design*. Tabler and Associates. Niwot, CO.