

## **Application of Snow Core and Automated Remote Data Collection to Monitor SWE in NYC's Water Supply Watershed**

JAMES H. PORTER, Ph.D.<sup>1</sup> AND GLENN D. HORTON<sup>1</sup>

### **ABSTRACT:**

The New York City Water Supply has been monitoring the snow pack in its 1972+ sq. mi. reservoir watershed for multiple decades. These manual snow surveys could only be conducted biweekly due to the amount of labor involved, but the regular accumulation-melt cycles common in New York require more frequent data for maximum usefulness. New York City (NYC) has thus begun investigating remote monitoring sensors to establish near real time SWE data for winter reservoir management. Due to health and safety concerns, the typical anti-freeze filled snow pillows were quickly eliminated from use. Testing of two types of solid state weighing instruments is presently being conducted with mixed results.

Recent side by side testing of the CRREL/NRCS Model SWE 001 Snow Water Equivalent Sensor against the SnoScale SS48 designed by EarthFlight Systems of Barrington, NH has offered the opportunity to compare accuracy, cost, and ease of maintenance. The complexity of this year's eastern winter has also allowed the instruments to be tested in a variety of environments which has resulted in suggested modifications to support the rapid changes that occur in the NYC watershed during winter.

**Keywords:** remote monitoring, snow pillow, NYC watershed

### **INTRODUCTION**

Snowpack based storage management has been a part of NYC's watershed management for many years. It is a type of spill mitigation that has been in place since the 1930's including the collection of snow core data by NYC Department of Environmental Protection (DEP) staff. This program is partially based on the concept that a percentage of the water equivalent in the snow pack on the watershed above a reservoir will eventually flow into the reservoir and can be counted as storage. It continues today.

While NYC has been collecting snow data for nearly 80 years, it is only recently that they have entertained using remote sensing instruments to measure snow water equivalent (SWE). Below is a recent time scale of activities the DEP has taken part in to start remote data acquisition of SWE content within its water supply.

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<sup>1</sup> New York City Department of Environmental Protection, P.O. Box 358, Grahamsville, NY 12740

## HISTORY

In 2006, three snow pillows were purchased to be installed at three different watershed locations within NYC's drinking watershed. These units were stainless steel; liquid filled snow pillows that were still in the installation phase when environmental concerns to the drinking watershed forced the removal of the units after two were installed.

In 2007, A Flexible Flow Management Program (FFMP) for the New York City Delaware Basin Reservoirs was agreed upon September 27, 2007 by the parties of a 1954 Supreme Court Decree, which includes the states of New York, Pennsylvania, New Jersey, Delaware and the City of New York. It provides a comprehensive framework for addressing multiple flow management objectives, including water supply, drought mitigation, spill mitigation, protection of the tail waters fishery, a diverse array of habitat needs in the main stem Delaware River, the Delaware Estuary and Delaware Bay, recreational uses and salinity repulsion.

As part of the FFMP, NYC has agreed to include half of the average SWE values in the surrounding watersheds as storage in determining release amounts. Higher storage levels call for higher releases, providing greater spill mitigation, while lower storage levels provide lower releases to protect water supply.

Also in 2007, a "solid state" unit using load cells and a weighing plate instead of a liquid filled bladder was located in Alaska. This unit was designed by Dr. Jerome B. Johnson and being tested by CRREL. The Delaware River Basin Commission (DRBC) received a grant to buy two automatic snowpack monitors for installation in DEP Delaware basin watershed (Figure 1).



Figure 1. Installation of CRREL/NRCS Model SWE 001 Snow Water Equivalent Sensor, January 2007

In 2008, DEP installed the solid state units; the first in the Neversink watershed and the second in the Pepacton watershed. Initial testing showed a variety of concerns of which some were easily identified and fixed while others needed further study to resolve.

Early in 2009, a third and different designed instrument, called SnoScale (Figure 2), was installed outside the Delaware River Basin area to be tested. Data was compared to the other two instruments already in place although late purchase and winter installation did not provide a full season of data. One CRREL unit was modified with a "sub-frame" to eliminate independent frost heaving of load cells (Figure 3). At the same time a SnoScale was introduced to that site along with a Pluvio weighing bucket and SR50 Snow Depth Sensor to compare data for future purchases (Figure 4).

The purchase of five more SnoScale units occurred late in 2009 and sites prepped for a late fall/early winter installation. Four units were located in a small USGS gauged watershed to assist NWS with developing an early flood warning model. Those four units were installed the last week of December.



Figure 2. Installation of SnoScale SS48, January 2009



Figure 3. Installation of CRREL unit with modified sub-frame, January 2009



Figure 4. Introduction of SnoScale to Neversink test site along with Pluvio weighing bucket and SR50 Snow Depth Sensor, September 2009

In 2010, a January thaw allowed for all SnoScales to start at “0” SWE in most watersheds. The development of ice freezing to the instrument due to two major rain/snow events in early January made it necessary to modify the SnoScales to attempt to eliminate the daily temperature effects to the ice on the weighing plate (Figure 5). CRREL units were too big to apply similar modifications. Multiple variations in modifications were applied to ascertain which changes best fit the units to accept various types of ice and snowpack.

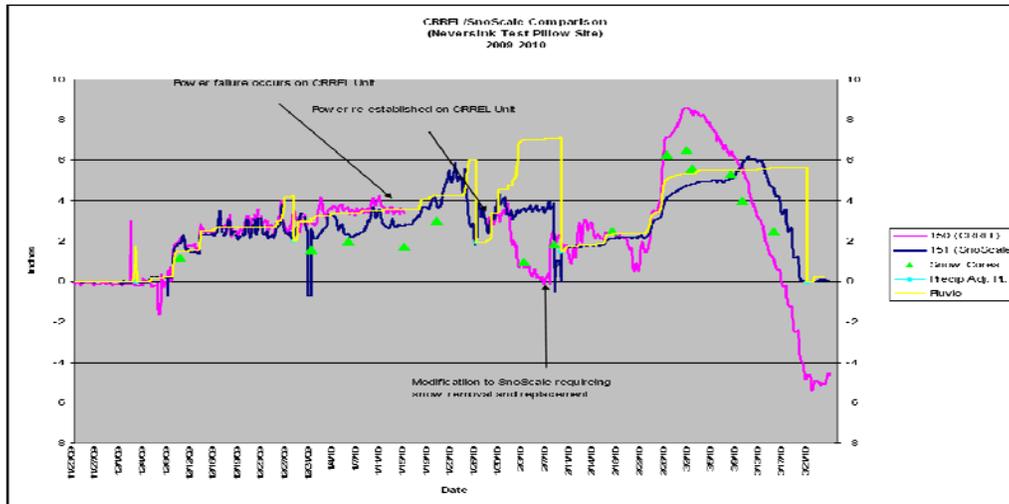


Figure 5. CRREL/SnoScale Comparison (Neversink Test Pillow Site), 2009-2010

## CONCLUSION

In the future, automatic monitors will be used to supplement manual snow surveys (Figure 6) working towards easier, quicker and more accurate snowpack data collection. The DEP is committed to developing a network of SWE sensors to assist in maintaining the regulations put forth by the FFMP, better model winter dynamics on NYC’s reservoirs and provide, through automation and instrumentation, access to near real-time SWE data for a variety of departments and agencies.

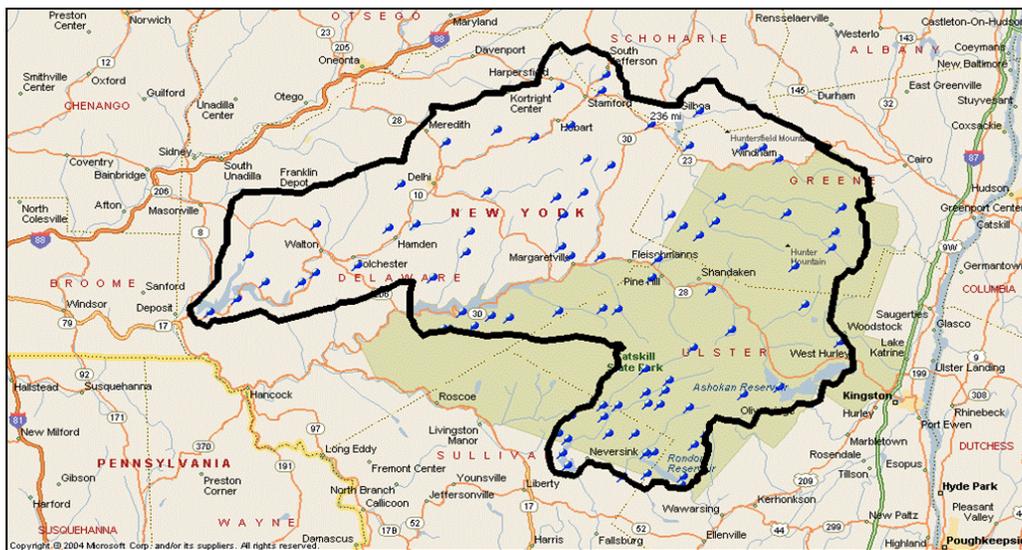


Figure 6. Map of NYC manual snow survey sites within West of Hudson watershed.

## **REFERENCE**

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