Smart Irrigation Technology
Northern Water has many examples of “smart” irrigation technology onsite. Smart controllers are irrigation clocks that automatically adjust irrigation run times in response to environmental changes.

Every irrigation zone is capable of being managed with a smart controller. Climate-based smart controllers as well as soil-moisture based smart controllers are used throughout the Conservation Gardens at Northern Water. Additionally, Northern Water has a new smart controller demonstration project geared to the residential user.

Northern Water’s Smart Controller Demonstration Project
Northern Water is comparing 10 different smart controllers. All are residential grade and available on the market. Four controllers are soil-moisture based; the other six are Evapotranspiration (or weather-based) controllers. Each controller manages irrigations in two plots—a tall fescue plot and a Kentucky bluegrass plot. Controller irrigations are compared by checking the gallons of irrigation water applied and the turf water status in each plot with independent measurements.

Table 1. Northern Water Smart Controller Comparison

<table>
<thead>
<tr>
<th>Soil Moisture-based Controllers</th>
<th>Weather-based Controllers</th>
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<tr>
<td>MorpH2O AguaMiser</td>
<td>ECO 100 Sprinkler Optimizer</td>
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<td>BaseLine WaterTec S100*</td>
<td>AquaConserve ET-6*</td>
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<td>Rainbird SMRT-Y</td>
<td>Rainbird ESP-SMT*</td>
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<td>Acclima SC6*</td>
<td>Weathermatic SmartLine SL800*</td>
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<td>Toro WeatherTRAK ETplus*</td>
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<td>Hunter Pro-C Solar-Sync*</td>
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*SWAT (Smart Water Application Technologies) tested

What is smart irrigation technology?
Smart Irrigation Technology encompasses any irrigation technology that helps apply water to the landscape efficiently with quantified, documented water savings. Smart irrigation controllers have been in the forefront of the new smart irrigation technology. A smart controller uses environmental information such as weather or soil moisture to adjust the landscape irrigation schedule for the changing environmental conditions.

Smart controllers were developed to improve irrigation efficiency and landscape water conservation by automatically adjusting for seasonal or short-term weather conditions.

How do smart controllers help conserve water?
Smart controllers use site-specific information to adjust landscape irrigations. Smart controllers use either soil moisture or weather data to make these adjustments, changing either the amount of time to run the irrigation system or the frequency of irrigation. These changes reflect seasonal and short-term weather conditions and help prevent unnecessary irrigations.

A rain shut-off device added to the system can override the controller and shut the controller down after a significant rain event, resulting in even more water savings.
Residential sprinkler controllers are typically set for highest summer irrigation application rates and are commonly not adjusted for seasonal changes or changing weekly or daily weather conditions. Water is over applied in spring and fall when landscape water demand is lower. Properly installed and programmed smart controllers can help conserve water in residential landscapes.

**What types of smart controllers are there?**

Climate-based smart controllers use weather information to adjust the controller settings, usually with on-site instrumentation that can include air temperature, humidity, wind, solar and/or rain sensors. These weather instruments must be properly located to collect this information.

Generally, climate-based controllers use this site-specific weather information to derive evapotranspiration (ET) values for the landscape. Evapotranspiration is the combination of evaporation and plant transpiration. Other smart controllers collect weather or ET data from existing sources and disseminate it via a communication technology such as wireless, phone, Internet or other means. Usually there are means to further tailor or adjust the ET information to the specific site. Still other climate-based controllers use historic ET data from the local area to modify the controller irrigation settings.

Soil-moisture based controllers have a soil moisture sensor that is installed in the turf and connected directly to the controller. Soil moisture sensors monitor the changes in soil moisture as the turf extracts water or as irrigation or rainfall replenish the soil water. Knowledge of soil water holding properties is very helpful in setting up, understanding, and effectively “training” these systems. Soil moisture sensors must be carefully installed in a representative area of the turf. Excessive sod disturbance and root damage will result in non-representative soil moisture readings. Close contact with the sensor is required, so air gaps from installation must be eliminated. However, soil compaction during installation will adversely affect water entry and distribution into the soil. Proper installation is critical.

**Climate-Based Controllers**

Climate-based controllers require several inputs from the user. Two inputs common to any irrigation system are application rate and system efficiency. The type of sprinkler heads and nozzles installed on the system affects the application rate and efficiency, so these parameters must be known for effective irrigations using smart controllers. Irrigation system efficiencies are determined by conducting a system audit, though there are standard values used for different types of systems that can be substituted for a specific-system value. Lower efficiencies result in more water applied to compensate for the losses inherent in an inefficient system.

It is very important to install on-site weather instruments in the right place. Rain gauges and rain shut offs should be mounted in an open area away from roofs, overhangs, buildings, and overhead vegetation. Likewise, temperature sensors should be located away from buildings or other structures that can heat up in the sun and affect the temperature at the sensor. It is much easier to install wireless sensors in the correct locations than wired sensors.

Other necessary inputs for climate-based smart controllers include landscape information such as soil type, plant types in the landscape, slopes, and shady or sunny conditions. These factors all affect the water use of the plants or turf in the landscape.

The smart controller uses this information to calculate the actual turf or landscape ET from the reference ET value obtained from the onsite weather sensors, historical sources, or from ET data disseminated via remote communications. The parameters entered into the controller adjust the actual turf or landscape ET to the specific site.

Knowing the soil type is critical to the success of a smart controller. Find out how to determine your soil type. Each soil type has a different soil water holding capacity. Sands hold the least amount of water, while clay soils hold the most. However, clay soils have low soil water infiltration rates, meaning that water takes a long time to penetrate into the root
zone and be stored rather than just runoff the soil surface. That has implications for rate of irrigation application and how a controller is programmed to cycle/soak irrigations.

Various plant types require different amounts of water relative to a reference evapotranspiration value calculated from weather data. This parameter is known as the crop coefficient, and varies seasonally with cooler and warmer weather, as well as by plant species or type. Turf typically needs the most water, while many Xeriscape landscapes require 50 to 75% or less of the amounts that turf typically needs. Warm season turf also requires much less water than cool season turf on a seasonal basis. Many climate-based smart controllers have settings for different plant types to accommodate their various water needs.

Rooting depth is another parameter typically required as an input. Effective turf rooting zones are usually considered to be around 6-8 inches deep although some can be deeper, such as Tall Fescue.

Microclimates are often numerous and varied in a residential landscape. Sunny areas will mean higher water demand by turf or plants, while shady areas have less water demand. Site exposure is also important. An east or north setting in a landscape will have less water demand than a west or south exposure.

Slopes result in changes in the irrigation schedule, also. All slopes should be run as cycle/soak, to minimize runoff down the slope.

**Soil Moisture-Based Controllers**

Soil moisture-based irrigation controllers use an on-site, buried soil moisture sensor to keep track of the available moisture status in the root zone. One sensor can be used to control irrigations for all zones, provided that each zone can be adjusted relative to the soil water content of the sensored zone.

**Installation**

The soil moisture sensor is installed in the driest zone, which is typically a full sun, south or west facing area. Choose an area where foot traffic is minimal to prevent soil compaction over the sensor. Staying at least 5 feet away from driveways, sidewalks, etc. is important. Keeping a minimum of 5 feet of distance from sprinkler heads is also important.

The soil the sensor is buried in should be as representative as possible of the soils found at the site. The sensor must be buried in the root zone of the turf or landscape plantings. Northern Water typically installs soil moisture sensors at about 5 inches. That allows for typical core aeration depths without damaging the sensor.

The soil moisture sensor must be in good contact with the soil at all times. Air gaps affect the accuracy of the sensor, so firming the sod back over the sensor is important, but over-compacting the soil over the sensor can cause poor soil water infiltration. It may take a few weeks for the plant roots to grow back around the sensor. Until that time, true plant ET is not being measured.

Once installed in the driest zone, other zones can be adjusted to water relative to the dry zone.

**Industry Standards & Testing**

Smart controllers are tested by the irrigation industry in accordance with protocols developed by the Irrigation Association. Protocols have been developed for climate-based controllers and are being developed for soil moisture-based controllers. Controllers that have been tested are listed at the above links.

Other smart controller resources:

**Weather and Soil Moisture Based Landscape Irrigation Schedule Devices**

This U.S. Bureau of Reclamation document provides an overview of smart irrigation technology.