pHAcid Case Study

Cane Garden Country Club, The Villages, Florida
April - June 2017

The Cane Garden Country Club in the Villages, Florida provide an excellent example of impact pHAcid can provide on turfgrass grown in alkaline conditions.

Water and soil samples were taken throughout the complex and high levels of bicarbonates and sodium were present. This was attributed to their use of effluent water sources. Water samples also revealed some elevated levels of calcium, magnesium, iron and phosphate. Soil samples from a basin reservoir also showed similar metal content.

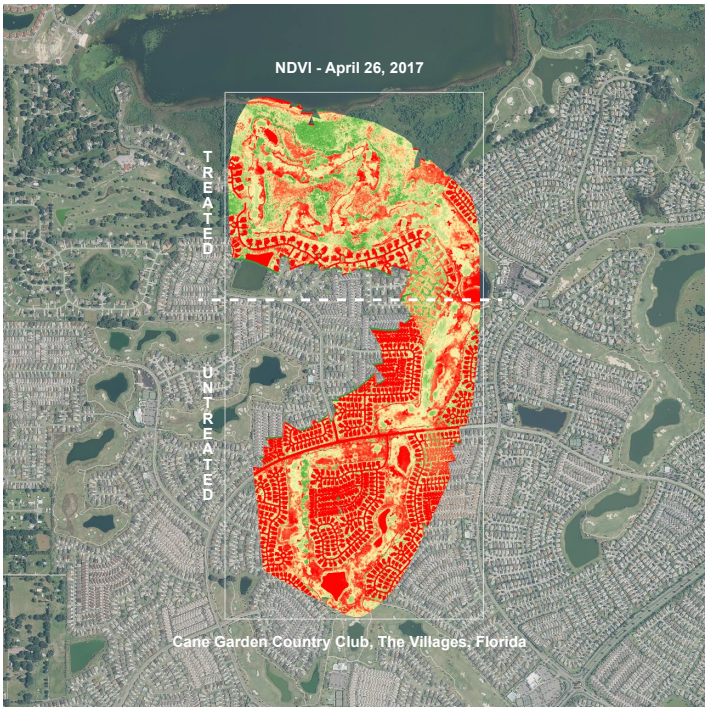
Superintendents complained that carbonate-related "debris" in irrigation heads was so high in some areas of the course that the pop-up irrigation heads would not function. Areas of reduced turf establishment were confirmed in a number of locations throughout the 27-hole course.

In addition to visual observations and water / soil analysis, aerial multi-spectral radiance data captured via drone was utilized to evaluate course pre- and post-treatment course/turfgrass conditions.

Pre-treatment drone spectral imagery was taken on April 26, 2017 and post-treatment spectral footage was taken on June 13, 2017. 2 rainfall events were recorded in June.

Pre-treatment Course Condition:

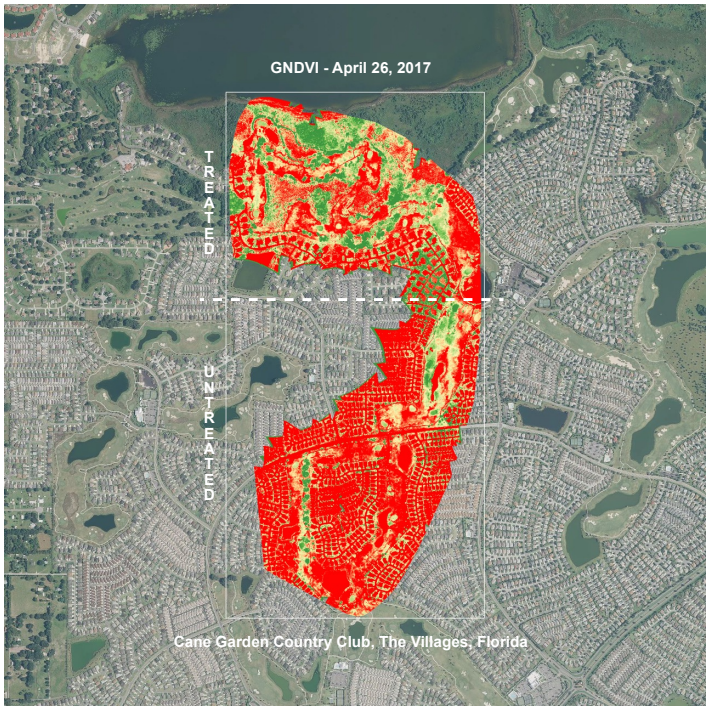
NDVI: April 26, 2017



The vast amount of yellow, orange and light green in the pre-treatment NDVI-rendered imagery shows a high degree of variability within in the turfgrass canopy. A Healthy and vigorous vegetation canopy (thickness of turfgrass) would render a more uniform "green" color.

Pre-treatment Course Condition:

GNDVI: April 26, 2017



The GNDVI-rendered imagery, which measures the photosynthetic activity, water and nitrogen uptake and general indication of stress also shows a high degree of variability. Note that radiance colors are much deeper indicating that even though the vegetative canopy shown in the NVDI shows some weakness, the more pronounced reds and oranges in the GNDVI suggest the distinct possibility of increased stress due to water deficit stress and/or poor nutrient availability. These results may also be indications of stress associated with bicarbonate toxicity. The dominance of dark red areas on the turf areas are indicative of sub-optimal plant health caused by poor root systems -- again, an indicator of bicarbonate induced damage to fine roots of turfgrass.

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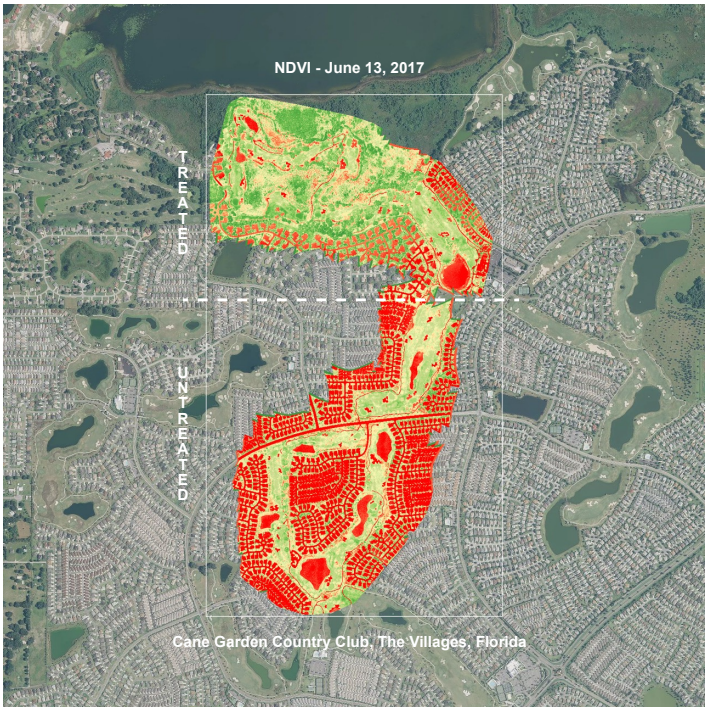
Post-Treatment Course Condition

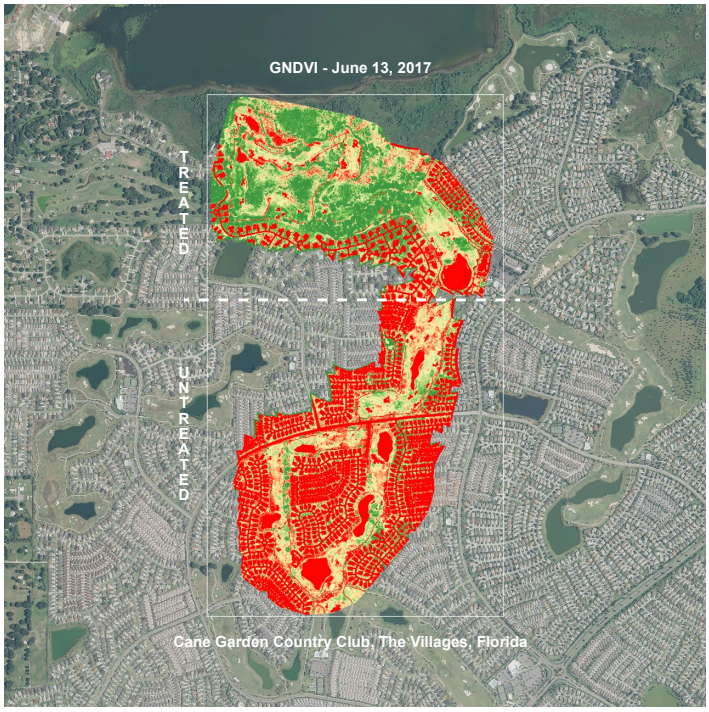
NDVI - June 13, 2017



The June 13, 2017 NDVI-rendered imagery indicates far less variability in the turfgrass canopy. Thickness of the canopy also shows improvement. The untreated 9 holes shows some improvement but one would expect this considering the two rainfall events. Darker green areas which indicate a thicker canopy remain absent in the untreated area.

Post-Treatment Course Condition

GNDVI - June 13, 2017



The GNDVI data depicted on the June 13, 2017 imagery is a picture of recovering turfgrass expressing much higher photosynthetic activity. The general health of turf on the 18 holes that were treated appear to be much healthier. This would suggest in addition to improved irrigation efficiency from the reduction of calcium and sodium carbonates, we also have indications of improved water and nutrient absorption by turfgrass roots -- and more importantly, data suggests treated turfgrass exhibited increased photosynthesis. The overall stress pattern previously noted in the April analysis is greatly improved.

GNDVI radiance imagery of the 9 untreated holes clearly show that poor turf establishment and general canopy health remains unchanged -- despite two rainfall events.

DISCUSSION

Additional information would be required to make definitive conclusions regarding the treatment of Cane Garden Country Club with pHAcid Injectable. The use of radiance imagery however, represents strong evidence of improved irrigation efficiency, general turfgrass condition and physiological function (improved photosynthesis) from the use of pHAcid under heavy bicarbonate pressure.

The unique blend of acidifiers and a high molecular weight surfactant found in pHAcid elicited a strong corrective response in the treated areas.

Today, many soil scientists recognize that management of alkaline and sodic conditions in coarse textured soils found in greens, tees and surrounds centers on tactics that 1) reduce the pH of the soil, 2) remove calcareous build-up that inhibits effective leaching strategies to be initiated 3) solubilize Ca and Mg carbonate and 4) **address bicarbonate toxicity**.

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USE DIRECTIONS

We strongly recommend that water and soil samples be taken and analyzed on a routine basis in order to develop and maintain a comprehensive management plan to correct bicarbonate-affected soils.

Any soil receiving irrigation water with high sodium (Na) and bicarbonate levels should be amended with a soluble source of calcium in addition to the pHAcid spray program.

pHAcid Injectable irrigation water program:

1. Apply pHAcid INJECTABLE at the rate of 1 to 2 gallons per 20,000 to 30,000 gallons of irrigation water every month if the bicarbonate levels are less than 150 PPM.
2. Inject pHAcid INJECTABLE at the rate of 1 to 2 gallons per 20,000 to 30,000 gallons of irrigation water every two weeks if the bicarbonate levels are greater than 150 PPM.

pHAcid Sprayable application program: 32 to 64 ounces per acre in a 1 to 2 gallon spray solution per 1000 ft^2 (24 ml per 100 sq. meters). Apply sufficient water to move product into the soil profile.

A good seasonal and annual monitoring program is recommended.

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