Evaluation of the Geonics EM38 for soil moisture assessment

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Summary: The success of a turfgrass track lies in the balance between soil conditions that are ideal for horse racing balanced against the needs of the turfgrass plant. One of the most critical components of this complex soil-turf-horse system is soil moisture. Frequently, the high soil moisture conditions that favor ideal turfgrass growth results in conditions that are too wet and slow for ideal racing and horse safety. Conversely, dry conditions that favor racing may be too dry for uniform turfgrass growth and development. Under optimum conditions, the root zone would maintain constant soil strength regardless of soil moisture conditions. However, until that perfect root zone is identified, soil moisture will be a critical component of turfgrass track maintenance, safety and success.

The results provided here suggest that soil moisture measurement using a Geonics EM38 might provide assistance in delivering more uniform soil moisture conditions at the Del Mar Thoroughbred Club (DMTC). Further research is need to confirm that the EM38 readings predict the track performance as evaluated by horse traffic or using mechanical hoof developed by Dr. Michael Peterson. The EM38, however, is not a substitute for an improved irrigation system.

The Geonics EM38 is a precision sensor that measures the electrical conductivity of the soil passively. No soil samples are needed and no probes are used. The EM38 can be mounted on a sled and dragged behind a piece of maintenance equipment as illustrated in Figure 1. The soil electrical conductivity (EC) data provided by the EM 38 is influenced by soil type, soil moisture content, and soil salinity. For this study, changes in EM38 readings were observed at the end of the racing season, again following irrigation using 2 inches of water and an third time following aeration of the track and additional irrigation. These results indicate that it may be possible to survey the track and apply water in areas that are too dry for turf survival and withhold water in areas that are too wet for optimum horse racing and to help compensate for the poor irrigation design at DMTC (Figures 2,3,4). The ideal result would be more effective management of soil moisture conditions, more consistent track performance and ultimately, more safe races and larger fields of horses.

One of the key features of a well designed irrigation system is uniform application of water. With irrigation heads that apply water in a circular pattern, this generally means head-to-head coverage. Figure 5 and 6 illustrate the poor irrigation design that results in areas where head-to-head coverage

is adequate and areas where there is no head-to-head coverage. The result is more consistent soil moisture conditions in the areas with good coverage and variable soil moisture in areas where coverage is inadequate.

Even under optimum conditions, application of water in circular pattern will only deliver water with a distribution uniformity of about 80% - this measurement indicates that under optimum performance, some areas will be over-irrigated and others under-irrigated. There is no escaping this physical problem with circular pattern irrigation systems. The best alternative to circular irrigation systems for turfgrass tracks is a boom-mounted irrigation system such as the StrathAyr TrakSpan (Figure 7).

Based upon this initial observations, a systematic research project should be initiated to clearly outline the steps necessary to produce optimum track conditions at DMTC. This research should include evaluation of root zone composition, turfgrass selection, irrigation management, nutrient and cultural management.

Recommendations

- Adjust irrigation head placement to provide uniform distances between heads. Ignore the variable width of the track – focus on lateral head placement so that all heads are equally spaced.
- Evaluate the use of the EM38 to describe soil moisture conditions in conjunction with the Peterson robotic hoof to determine whether the EM38 provides a measurement that is meaningful in a horse racing situation. This study would be conducted on the track during the season.
- Evaluate the use of the EM38 for irrigation management in small plot conditions in conjunction with the Peterson robotic hoof to determine optimum EM38 reading for racing and turfgrass health.
- Evaluate the StraythAyr TrakSpan irrigator or a similar overhead boom irrigation system for uniform delivery of irrigation water in small plots or using a portion of the “shoot” for this evaluation without disruption of normal track operation.
- Establish on-site research plots that allow new turfgrass track concepts and ideas to be safely tested and understood before implementation.

- Focus research on identification of the root zone material that provides the most uniform and desirable soil strength for horse racing independent of soil moisture conditions (good performance whether wet or dry). Determine if and how to grow grass on this ideal rootzone. Rootzone candidates include the Polytrack and StraythAyr's system.

Figure 1. EM38 soil EC meter and NTech Greenseeker setup for use at DMTC.
Photo of the Geonics EM38 in tow behind a maintenance cart. The global positioning system (GPS) antenna provides location for each data point recorded. The NTech Industries Greenseeker is a normalized difference vegetative index (NDVI) meter that provides turfgrass quality measurements. The Greenseeker data will not be discussed in this report.

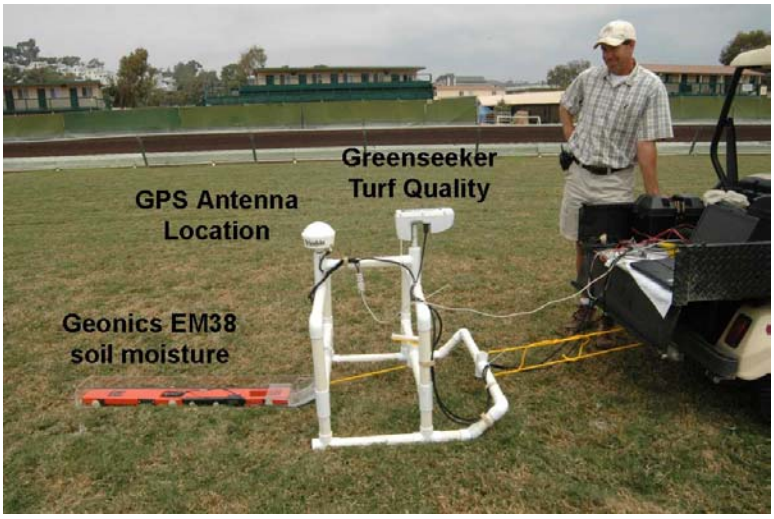

Figure 2. EM38 soil EC readings on 9/9/2005. Colored areas correspond to soil EC readings in the legend at the right side of the graph. Values represent deciSiemens per meter (dS/m). Higher EC values indicate higher soil moisture content. The ideal soil EC (a measure of soil moisture content when using the EM38) for turf performance and optimum racing conditions have not been identified. However, uniform soil moisture conditions should provide more uniform racing conditions. Note the red areas and compare this chart with EC readings taken on 9/19/2005 (Fig. 3) and EC readings taken on 10/5/2005 (Fig. 4). Also compare this illustration to Figure 5 that indicates irrigation head location and projected irrigation distribution.

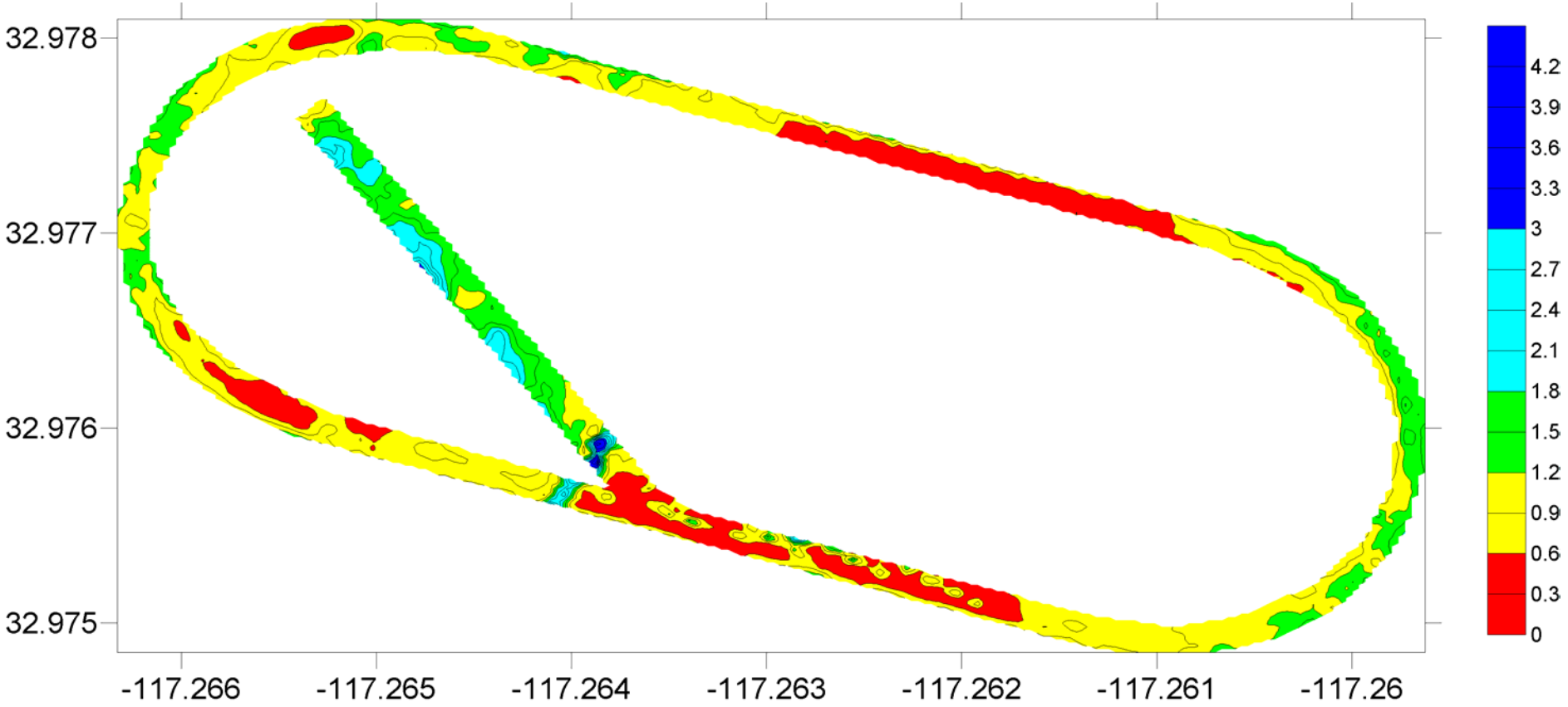

Figure 3. EM38 soil EC readings on 9/19/2005 following application of two inches of irrigation water. Colored areas correspond to soil EC readings in the legend at the right side of the graph. Values represent deciSiemens per meter (dS/m). Higher EC values indicate higher soil moisture content. The ideal soil EC (a measure of soil moisture content when using the EM38) for turf performance and optimum racing conditions have not been identified. However, uniform soil moisture conditions should provide more uniform racing conditions. Note the red areas and compare this chart with EC readings taken on 9/09/2005 (Fig. 2) and EC readings taken on 10/5/2005 (Fig. 4).

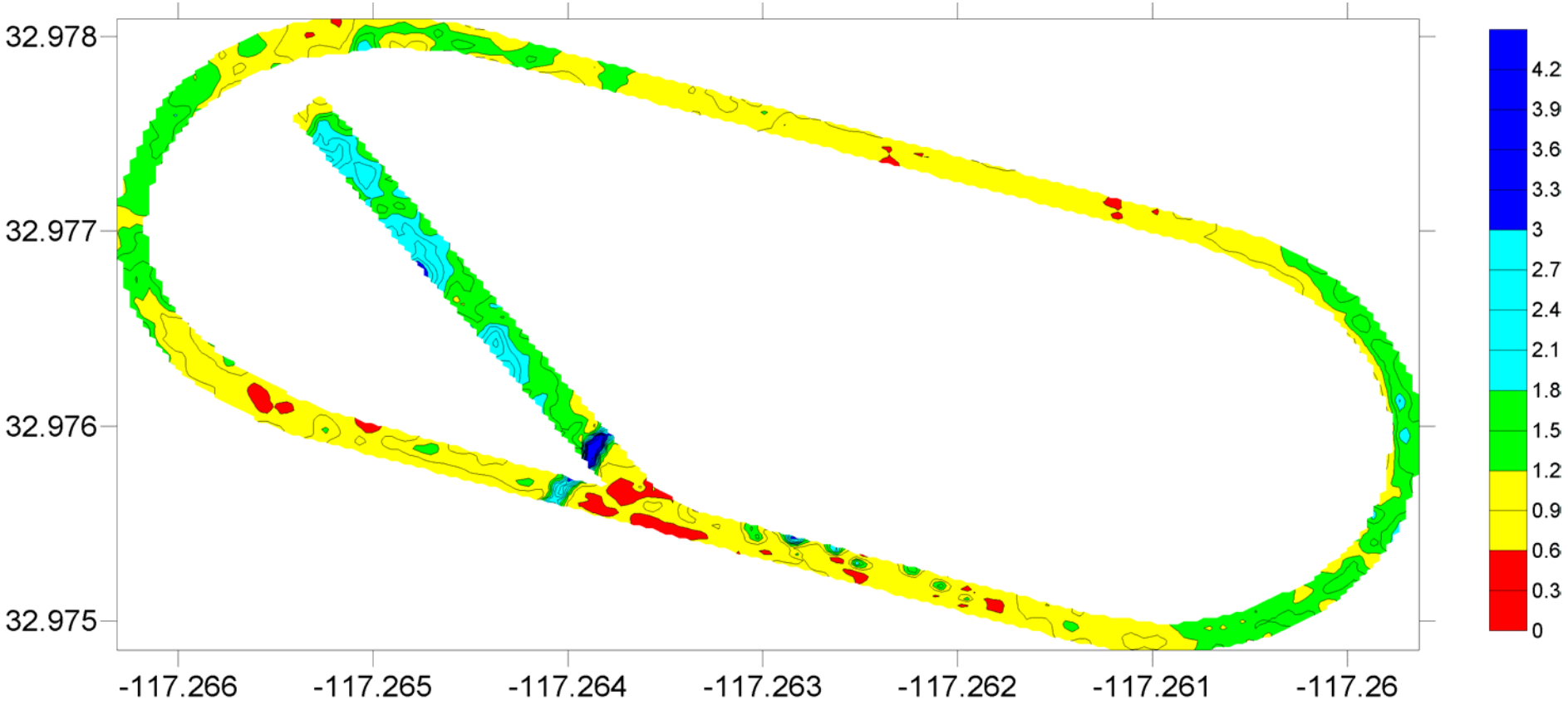

Figure 4. EM38 soil EC readings on 10/05/2005 following aeration and additional irrigation. Colored areas correspond to soil EC readings in the legend at the right side of the graph. Values represent deciSiemens per meter (dS/m). Higher EC values indicate higher soil moisture content. The ideal soil EC (a measure of soil moisture content when using the EM38) for turf performance and optimum racing conditions have not been identified. However, uniform soil moisture conditions should provide more uniform racing conditions. Note the red areas and compare this chart with EC readings taken on 9/09/2005 (Fig. 2) and EC readings taken on 9/19/2005 (Fig. 3).

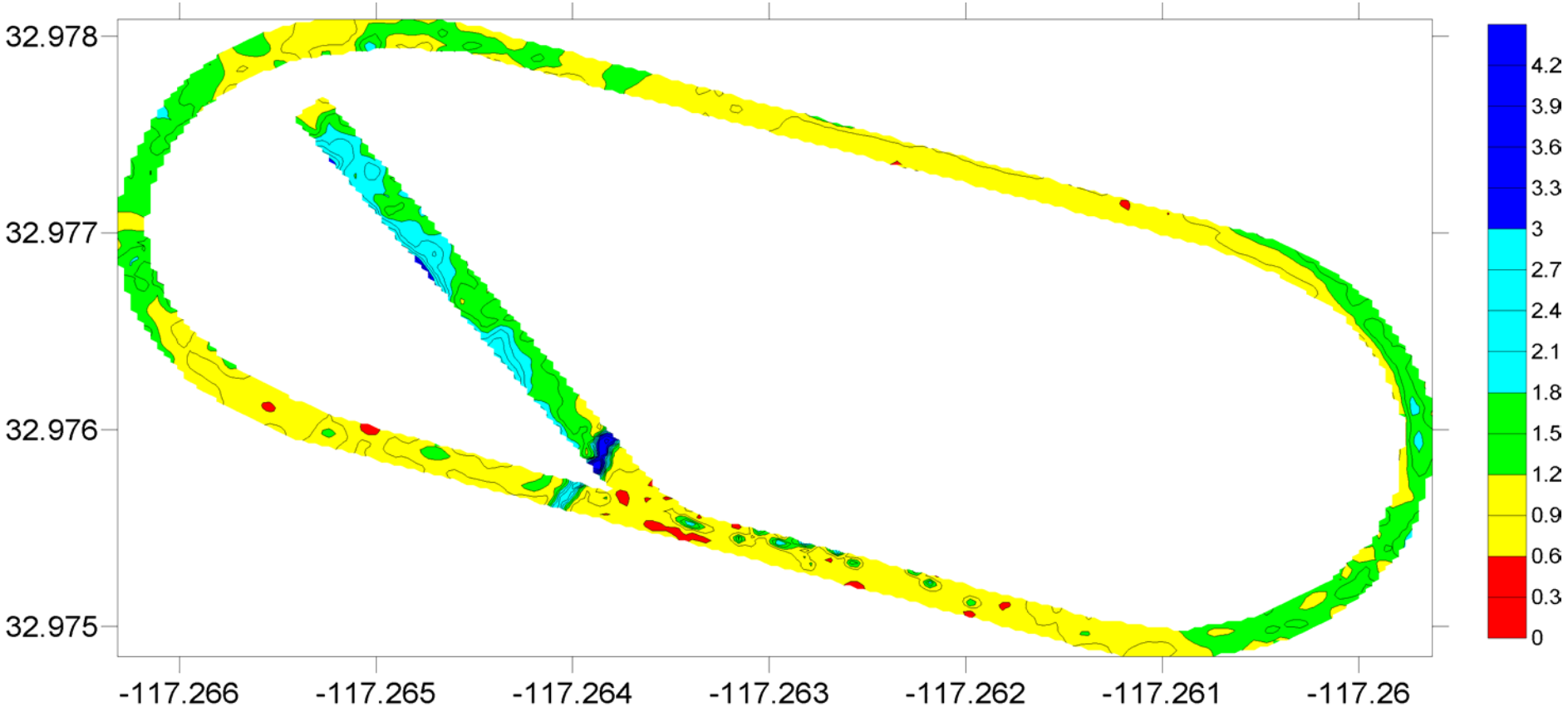

Figure 5. Poor irrigation coverage. The head spacing and resulting irrigation coverage is illustrated below. The areas of inconsistent EM38 readings (see Figure 2) are the areas where head spacing does not deliver head-to-head irrigation coverage. The back stretch with low EM38 readings is consistently low but the distribution of the water is uniform. The home stretch and corners where spacing is less than head-to-head results in inconsistent EM38 readings that suggest soil moisture is not uniform. The track will not perform consistently unless the irrigation system is improved.

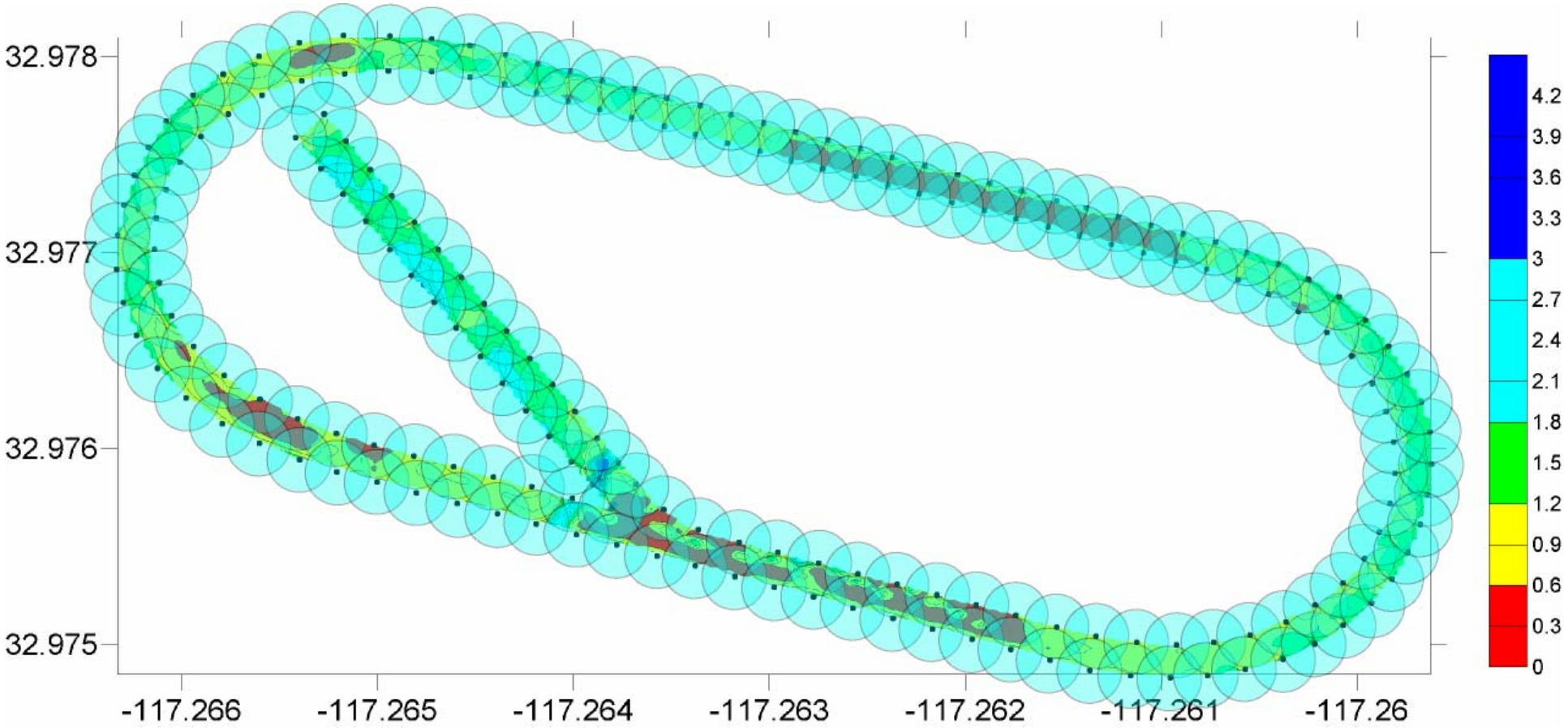

Figure 6. Location of irrigation heads and blocking. The irrigation heads at Del Mar are not uniformly spaced. Even when optimally spaced with head-to-head coverage, the uniformity of water application is inadequate to produce consistent soil moisture throughout the track. Complicating the problem is the fact that heads are valved in a blocked fashion requiring two to four heads to be turned on at the same time. Uniform soil moisture can only be attained through over-irrigation to deliver sufficient water to dry areas. The current root zone material is sensitive to excessive moisture and loss of soil strength when wet eliminating this option. The current irrigation system and root zone composition combined result in an extremely difficult management system.

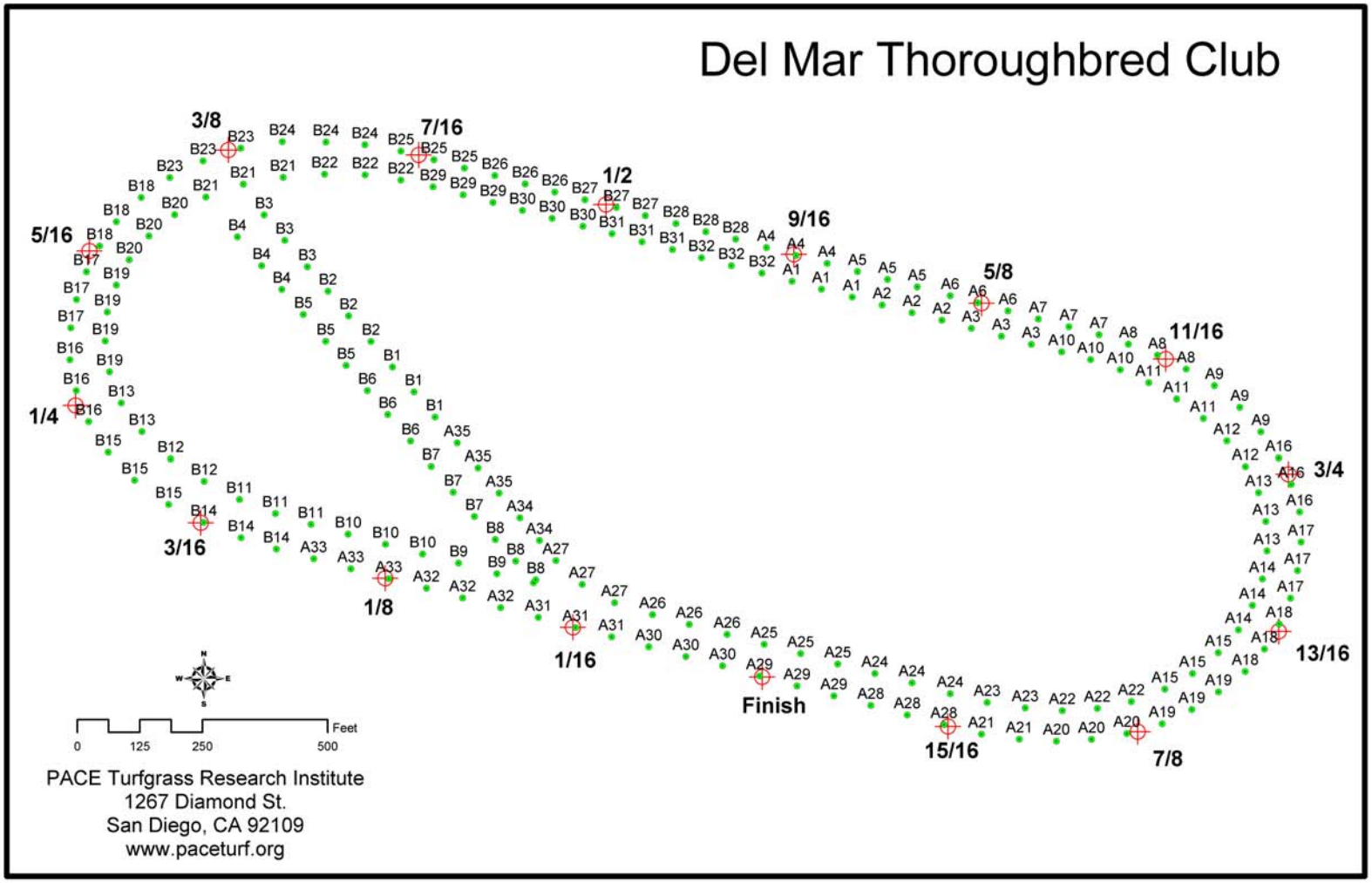

Figure 7. StrathAyr TrakSpan Irrigator that will apply water uniformly.