Report of the Effects of the FRE-FLO™ Scale Prevention Equipment/Soil Amendment Tool In Turf Applications

BROOKSIDE GOLF COURSE STOCKTON, CALIFORNIA





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Executive Summary

On a course with clay soil, irrigated with water with high sodium, chloride and bicarbonate levels, a FRE-FLO[™] was installed. The results included:

- Large increase in soil moisture depth.
- Use of acidifying material was decreased by 90%, resulting in a significant cost savings.
- Water use reduced by 25% (4.1 acre feet per week) with no decrease in turf growth or quality.
- Levels of sodium and total dissolved solids in the irrigation water decreased by 15%.
- In one month, sodium in the leaching line increased by 164%, showing how rapidly the FRE-FLO™ treated water was flushing sodium out of the soil.
- More pleasing aesthetics as well as **improved playing surface area**.

Detailed Report

Brookside Golf Course was established in the fall of 1990. Its heavy clay topsoil has a cation exchange capacity of 33 - 40. The water source is from a channel of the San Joaquin River in the Delta just west of Stockton, California.

Course Superintendent Jim Ferrin was hired after the topsoil had been spread and grass establish-ment was started. To determine if there would be a problem with the available water, he had an analysis of the water source run in December of 1990. The water analysis indicated high sodium, chloride and bicarbonate levels, shown in Table 1. These high levels, combined with the clay soil, indicated real problems existed, because high bicarbonate levels in irrigation water cause calcium to be replaced by sodium on the soil exchange sites. The presence of sodium on the exchange sites causes the soil to deflocculate, which in turn causes surface sealing and loss of internal structure -meaning that water infiltration and percolation is difficult. Soil in this condition inhibits root growth because of both a lack of sufficient water and aeration.

There are three ways in which excess bicarbonate can be removed from water:

- By heating the water,
- By creating a pressure drop, or
- By acidifying the water.

Mr. Ferrin first choose to acidify the water during the establishment and early growth period of the cool season turf grasses (especially sensitive to salt, moisture and stress) on the golf course. However, the cost of the acidifying material was \$40,000 per year which prompted the search for a more economical solution.

Reduction of Sodium in Irrigation Water

A FRE-FLO[™] was installed on the course in July 1992 and **use of the acidifying material was decreased by 90%**, resulting in a significant cost savings. The acidifying is now used on a once or twice a month schedule to keep the pipes in the irrigation system free of organic slime and fresh water mussels. Table 1 contains results of water tests taken at intervals from the establishment of the course. The top rows in italics are the readings and the average **before** the installation of the FRE-FLO[™]. The lower four rows in bold are the readings and average **after** the installation of the FRE-FLO[™].

DATE	EC	SAR	RSC	рН	Boron mg/1	Sodium mg/1	Chloride Mg/1	Carb mg/1	Bicarb mg/1	Ca mg/1	Mg mg/1	TDS ppm
12/90	1.0	4.0	2.8-	7.85	.28	7.2	4.9	0	3.6	3.7	2.7	820
5/91	1.2	3.8	3.5-	7.9	.45	7.4	7.8	0	4.0	4.3	3.2	975
6/91	1.4	3.4	2.1-	7.3	.60	7.2	5.3	0	3.5	2.8	2.7	896
Avg.	1.2	3.7	2.8-	7.7	0.44	7.3	6.0	0	3.7	3.6	2.9	897
7/92	.97	5.8	1.97-	7.4	.36	5.3	5.1	0	3.3	3.0	2.3	726
8/92	1.1	4.8	†1.4	7.9	.52	8.2	5.5	0	6.0	1.9	2.8	943
9/92	1.1	3.8	†.55	7.9	.48	5.8	6.3	0	5.3	2.5	2.2	724
10/92	1.0	3.7	1.22-	7.6	.31	5.4	5.8	0	3.1	2.4	2.0	640
Avg.	1.0	4.5	1.3-	7.7	.42	6.1	5.7	0	4.4	2.5	2.3	758

<u>Table 1</u> Brookside Country Club Irrigation Water Tests *Before* & After FRE-FLO™

TDS - Total Dissolved Solids in the water

SAR - Sodium Hazard to the soil (6 is considered hazardous)

RSC - Sodium Concentration left in the soil after precipitation of calcium and magnesium from bicarbonate

Leaching Sodium Out of the Soil

Beginning in August of 1992, samples of the leach line water from one of the greens was sampled monthly to see if the sodium and chloride in the irrigation water were being leached out of the green, the leaching results were dramatic. The results are presented in Table 2.

Table 2

Brookside Country Club's Monthly Testing of Leach Line Drainage After FRE-FLO[™] was installed in August 1992

DATE	EC	SAR	RSC	рН	Boron meg/1	Sodium meg/1	Chloride meg/1	Carb meg/1	Bicarb meg/1	Ca meg/1	Mg meg/1	TDS ppm
8/92	3.3	2.0	2	7.3	0.87	† 5.9	†11.59	0	5.51	10.8	8.2	†1716
9/92	2.0	5.8		7.0	0.86	†15.6	†17.48	0	5.24	8.5	5.5	†1881
10/92	3.3	6.5	×	7.9	0.87	†17.4	†19.20	0	5.30	8.3	5.3	+2058

+ Note the high amount of leaching occurring in the ions that are most toxic to plants and most damaging to soil aggregation.

Because of evapotranspiration by the turf, the amounts of sodium and chloride in the leach line water should be higher than what is measured in the irrigation water if good leaching is taking place. This is shown above in the threefold increase in sodium in September's sample analysis compared to the August sample analysis. Another benefit of the FRE-FLO[™] is the generation of subcolloidal calcite (CaCO₃) particles which enhance the leaching of sodium out of the soil by the FRE-FLO[™] treated irrigation water. There is also an increase (although not as large as that for sodium) of chloride in the leach line water for the period. Biological activity in the soil of the green most likely accounts for the amount of bicarbonate in the leach line water.

Water Use Reduction

Since installing the FRE-FLO[™] the course superintendent at the Brookside Country Club golf course has reduced the amount of water used on the course by 25% (4.1 acre feet per week) with no decrease in turf growth or quality noted. The reduction represents a double savings. Even with special off peak electrical prices and reduced costs of reclaimed water, this is a tremendous savings in water and energy costs offering a excellent ROI.

Increase in Soil Moisture Depth

Sample results of the Dickey-John Soil Penetrometer readings are presented in Table 3. The Dickey-John was pressed into the soil until the dial read 300 lbs. PSI and the depth of water penetration was measured. **Generally the test area showed marked improvement in the depth of the penetration with time.**

Table 3

Brookside Country Club Soil Penetrometer Readings Before and After FRE-FLO™ Installation in August 1992

Location	6/29/92	7/29/92	8/31/92	9/28/92	10/22/92	
Fairway #1	XXX	.5"	1"	2"	8"	
Fairway #7	tip	tip	tip	18"	17"	
Fairway #11	3"	12"	9"	18"	32"	

Test Dates

General Comments on the Brookside Country Club Project

The following comments were provided by Dr. L.C. Saylor, University of North Carolina,

"It should be recognized that four months is a very short period of time to obtain meaningful results from water tests such as this. Considering the threefold increase in leaching of sodium out of the root zone (and the increased TDS in the leach vs. the TDS of the make-up water with reduced watering confirms this fact), the results obtained to date are quite impressive."

"Quantifiable data has been obtained that shows marked improvement in soil conditions in all test areas. These improvements provide more optimum conditions for root growth. They also allow better and deeper root penetration and water penetration into the soil, which in turn can dramatically reduce water requirements".

"THIS FEATURE OF WATER CONSERVATION IS ONE OF THE MOST IMPORTANT BENEFITS OF USING THE FRE-FLO™ FOR TURF AND AGRICULTURAL PURPOSES: A 25% REDUCTION IN WATER CONSUMPTION AND A 90% REDUCTION IN THE USE OF N-PHURIC ACID ARE EXTREMELY IMPORTANT RESULTS OF THIS STUDY. SUCH RESULTS CAN BE TRANSLATED INTO SOME VERY IMPORTANT MONETARY SAVINGS AS WELL AS PROVIDING IMPRESSIVE DATA TO THE ENVIRONMENTALISTS WITH REGARD TO REDUCED CHEMICAL APPLICATIONS AND REDUCED WATER WASTE."

"I would recommend continued observation of this test site, because there should be continued improvements, especially in the stress areas. I would also suggest that the Golf Course Superintendent watch carefully any dry spots on the greens to see if the grass improves with the use of treated water. These dry spots are a major problem in many areas."

CONCLUSION:

FRE-FLO[™] demonstrated its soil amendment capability even with a heavy clay topsoil. Using water high in sodium, chloride and bicarbonate FRE-FLO[™] showed its ability to improve infiltration, percolation and reduce compaction. FRE-FLO[™] clearly demonstrated leaching ability. These features produced optimum conditions for root growth, improved water penetration, pleasing aesthetics as well as improved playing surface area.

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Executive Summary of 25% Water Savings

Results of FRE-FLO[™] project at:

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On a course with clay soil, irrigated with water with high sodium, chloride and bicarbonate levels, a FRE-FLO[™] was installed. The results of the FRE-FLO[™] soil amendment/water conservation unit included:

- 1. Large beneficial increase in soil moisture depth.
- 2. Water use reduced by 25% (4.1 acre feet per week) with an increase in turf growth and quality observed.
- 3. The reduction in water use actually represents a double savings. Even with special off peak electrical prices and reduced costs of reclaimed water, this is a tremendous savings in both water and energy costs, offering an excellent ROI.

