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Physical Analysis of Turf Systems and Design Guidelines

Mr. Sawyer,

This study of the Brock material has been performed in order to determine the drainage capabilities of Brock in combination with synthetic turf. The extent of the research for Brock USA has ranged from theoretical calculations of typical turf cross-sections, to the physical modeling of Brock as part of a synthetic turf system. The combination of theoretical and physical modeling has aided in establishing performance characteristics for Brock, as well as developing design guidelines for a cost effective drainage system.

Research began by evaluating two design storms that provided representations of a short, intense storm vs. a long, steady and less intense storm. The two areas selected for the 10-year design storms were the Dallas, Texas and Portland, Oregon regions. For the Dallas storm we used a time of concentration of 10 minutes, resulting in a rainfall intensity of 8.0 in/hr for the 10 year storm. In Portland, a 30 minute time of concentration was used, which resulted in an intensity of 1.5 in/hr. The maximum discharge at the edge of the field on a per foot basis, using the rational method (Q=CIA), was calculated as 0.021 cfs (9.42 gpm) and 0.004 cfs (1.80 gpm) for the Dallas and Portland storms respectively. When the runoff values were compared to typical transmissivity values for a 6" stone base, the base appeared to be incapable of passing the design storm laterally. Therefore, it became apparent, theoretically, that the majority of the design runoff would occur as overland flow. In order to verify these results a physical model was constructed.

The model consisted of a mock up of the last 5-foot width of a synthetic turf field. This edge of field replication consisted of a 3-foot typical cross-section and a 2-foot trench drain section. The model was set up with a 6" stone base that met the specifications of a leading turf manufacturer. Upon testing the base, a maximum transmissivity rate of 0.000325 cfs per linear foot was calculated on a 0.5% slope. This flow rate accounts for roughly 8% of the runoff for the Portland design storm and only 1.5% of the runoff for the Dallas storm. The variance between actual runoff and transmissivity resulted in the large majority of runoff traveling as overland flow for both of the tested design storms. While testing the Dallas design storm, a constant ponding depth (head pressure) of over 2" occurred above the infill level at the edge of the field once a steady state condition had been reached.

A Brock and turf cross-section, placed over an impervious layer, was also tested in the model to determine how Brock would handle the overland flow that occurs during the design storm. The measured flow depths over the 3-foot section of Brock and turf cross-section closely resembled the calculated theoretical overland flow depths and therefore showed a strong correlation between the theoretical and physical modeling data. In this analysis, the Brock and turf cross-section was able to drain both storm events without ponding over the perimeter trench drain. All of the runoff in the Dallas design storm entered the drainage trench within a one foot section leaving no noticeable standing water. During the test, the system reached a steady state flow where the rate of water coming into the tank was equal to the rate of water exiting the tank. The steady state condition was held for a period of time before the flow was shut off to determine the time required for the field surface to drain to a point just below the infill surface. We found that the Brock and turf system drained to this level in an average time of 55 seconds for the Dallas design storm and less than 50 seconds for the Portland storm. Although this only represents the drainage time of the last 5 feet of the field, it is the area with the highest concentration of water during any storm event. The time to drain the entire field will vary depending on rainfall conditions and field dimensions.

The physical model demonstrated that the Brock material will effectively manage storm water as an overland flow condition when used with an adequately sized perimeter drainage system. When Brock and turf are placed directly above a perforated drainage pipe in a 2' wide pea gravel (1/4"- 3/8") envelope, along the perimeter of a field, the system will adequately drain synthetic turf fields throughout the United States for a 10-year storm event. Please refer to the attached Drainage Trench Detail for further information regarding this design.

To insure proper drainage, the perimeter drain pipe size and slope must be determined by a qualified drainage engineer in order to accommodate the expected flows for local storm events as well as City and County regulations. For the perimeter drain design the use of the Rational Method (Q=CIA) is recommended with a 10-30 minute time of concentration, depending on location, and a C value dependent on the location, rainfall type, soil type, impermeable layer, etc.) Historically, many of the stone based fields have incorporated an intermediate drainage system (ie: herring-bone drainage system, drainage mats, additional drainage trench, etc.) to provide additional drainage capacity. Given the ponding that occurred while testing the typical stone section, we would also recommend the use of additional drainage systems with a stone base in order to alleviate ponding at the edge of the field. Intermediate drainage systems may also be used in the Brock and turf cross-section to increase drainage capacity and decreased runoff depth, although not necessary.

Due to Brock's ability to efficiently drain overland flow from the turf surface, it appears that the perimeter drain could also be used to collect the runoff from the track surface that typically surrounds the field by increasing the drainage pipe size. The additional area of the track must be accounted for in the runoff calculations for correct pipe sizing.

In the design phase of the perimeter drainage system, it is imperative that the downstream Hydraulic Grade Line (HGL) is properly analyzed and determined to not affect the HGL of the perimeter drain system. Upon completion of construction, an as-built survey should be provided to the engineer in order to verify that the drainage system installation was completed per plan. Additionally, the Brock layer should be installed on a leveling base, specified by an engineer or architect, which is designed to provide a stable base and precision grading for the field surface.

In summary, the research suggests that the majority of the design storm runoff is occurring as overland flow and the most effective drainage system is one that best manages this type of flow. In addition, the investigation concludes that a turf and Brock cross-section will adequately handle typical design storm runoff as overland flow without excessive and prolonged ponding at the edge of the field, provided that the perimeter drainage system is properly designed and installed.

Respectfully Submitted,
MERRICK & COMPANY

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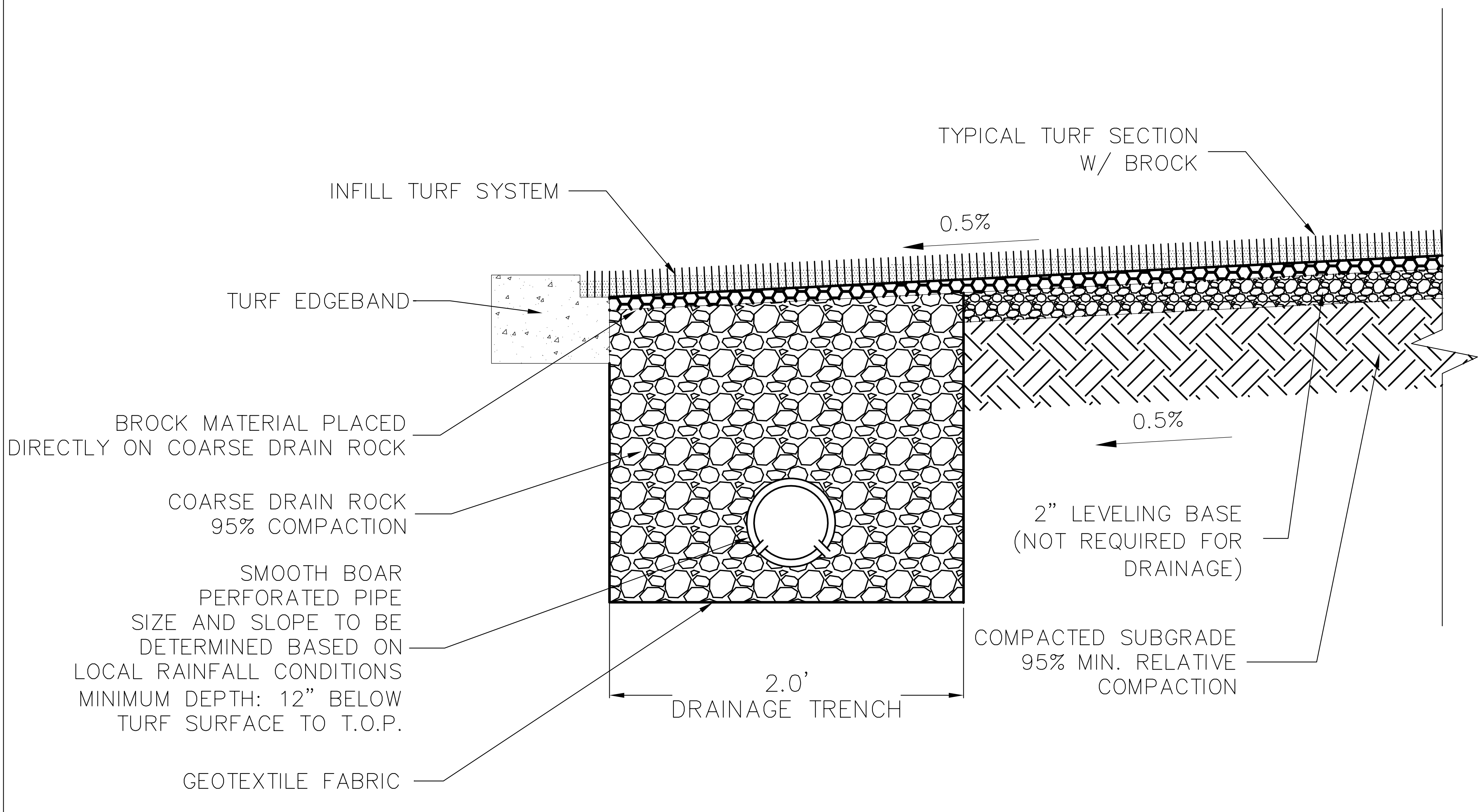

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DETAIL NAME

DRAINAGE TRENCH DETAIL

SCALE

N.T.S.