YOUR
ISTRC SYSTEM™
REPORT

# CITY
# OF
# FREDERICKSBURG

January 13, 2017
Park Area
Topdressing Sand
Lab ID: 16120031

Presented To:

**Mr. Bill Hanna**

11372 Strang Line Road
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January 13, 2017

Mr. Bill Hanna
CITY OF FREDERICKSBURG
126 W. Main St.
Fredericksburg, TX 78624

re: Lab ID: 16120031; ISTRC SYSTEM™ BenchMarking of undisturbed core samples from the Park Area: Southwest, Northwest and Southeast; Topdressing Sand Sample. **ISTRC Rep:** Mr. Curt Franklin.

Dear Bill;

We have completed the ISTRC SYSTEM™ BenchMarking of the undisturbed core samples taken from the Park Area's Southwest, Northwest, and Southeast locations. The test results are attached and time lapse photos are included. The section references in this report are to our **ISTRC's Guidebook**.

## I. DISCUSSION OF LAB RESULTS

The current plans are to amend the soil and install new grass. The current tests benchmark the condition of the Park's soil and the consistency that may exist between the different areas. A prospective topdressing sand sample was submitted with the undisturbed cores for a suitability analysis.

The testing found that the soil structure is essentially the same between the three test locations. The soils are classified as "sand" using the Department of Agriculture's Textural Triangle. The particle size distribution of the sand is fairly flat.

The soils cannot accept water and are very tight. Roots are confined to the surface due to the density of the soil. Silt and clay is not the cause of poor physical properties; rather, it is the fine gradation of the sand and the organic matter.

The fine/very fine sands retained on the 140 & 270 sieves [0.05 mm to 0.15 mm sizes], have a range of 21% to 39.44%. To place the percentages into context, the USGA recommends a maximum of 5%. The USGA's specifications for golf green construction do not apply to parks but they are helpful in analyzing soil deficiencies. The fine graded sand could work if there was very little silt, clay, and organic matter.

The testing found that the combined silt/clay percentages were fairly low. The problem is the amount of organic matter. Organic matter is taking the place of clay in these soils. Organic matter expands and contracts with hydration, it increases soil compaction/density, it holds water, slows water movement, and converts air pores to water pores. Expansive clays have the same physical properties.

The laboratory data can be found in its entirety at the end of this report. There are two sets of data. The first set of data consists of the physical evaluation, the evaluation of the root systems, and the measurement of the organic matter by layer.

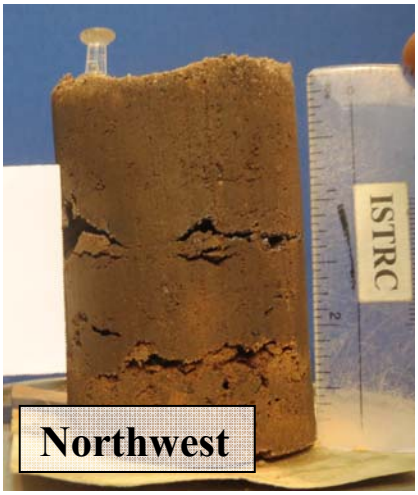
The second set of data contains the textural & particle size analysis. The textural analysis measures the percentage of gravel, sand, silt and clay comprising the soil. The particle size distribution analyzes the size distribution of the sand.

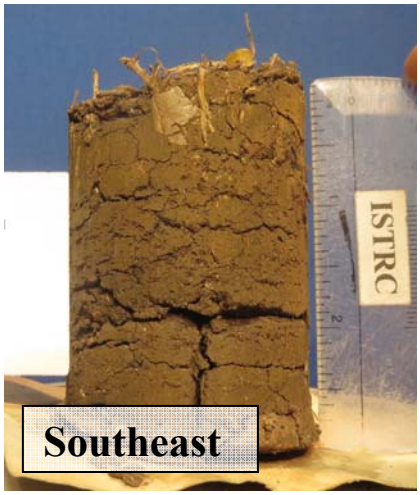
An aerification displacement chart is attached at the end of the report. The displacement chart was designed to calculate the percentage of surface area that is removed from a root zone with various size tines and spacings. The chart is an excellent reference to evaluate the effectiveness of your program.

On the following pages we will discuss the test results. Included with the discussion are selected time lapse photos of the undisturbed core samples. Table 1 compares the current test results to our recommended target ranges for well-drained, sand-based systems.

**Continued on the next page**

## Park Area




There is an obvious difference in the organic contents between the three locations. As a general proposition, healthy turf produces more organic matter than weak turf. In park settings, weak turf is common in high traffic areas and healthy turf is common in low traffic areas. If those historical observations hold true for the tested park, the Southeast location appears to receive the most traffic and the Southwest receives the least. Irrespective of the total amounts of organic matter in the tested areas, water cannot penetrate or percolate through the soils. These are anaerobic soils. The turf is confined to the surface for two reasons: (1) the soil is too tight for deep and dense root systems, and (2) the soil below the surface area is toxic to the roots.

**Table 1.** **ISTRC Target Ranges**

| Park Area | Southwest | Northwest | Southeast | Well-Drained Turf (1st Tier Sample) |
|---|---|---|---|---|
| **Infiltration Rate [In/hr]** | 0.00 [all three locations are sealed off – extended rain events will eventually hydrate the soil] | 0.00 [Once hydrated, these are soils that will be slow to dry out.] | 0.00 [Soil aeration/ oxygenation is non-existent. The soil is not permeable and does not have space for O2. | At least 6 |
| **Air Porosity [Non-Capillary]** | 6.70% [inadequate space in each location] | 6.53% [Air pores provide space for water movement, root growth, and soil O2.] | 8.09% [These are soils that are anaerobic. Microbial activity produces methane, CO2, and other toxic gases.] | ~20% |
| **Water Porosity [Capillary]** | 38.61% [very high] | 42.98% [excessive] | 19.54% [percentage is ok but the totality of the properties is not] | 15% to 25% |
| **Bulk Density [g/cc]** | 1.39 [compacted] | 1.46 [compacted] | 1.62 [severe compaction] | 1.35 to 1.45 |
| **Water Holding** | 27.73% [very high] | 29.43% [very high] | 12.09% [tight soil] | 10% to 20% |
| **Organic Content: 0-1"** | 6.63% [excessive] | 4.84% [excessive] | 1.53% [too high for the sand distribution] | 1.5% to 2.5% |
| **Organic Content: 1-2"** | 4.46% [excessive] | 3.67% [very high] | 1.40% [high] | 1.0% to 2.0% |
| **Organic Content: 2-3"** | 3.57% [very high] | 2.65% [very high] | 1.24% [high] | 0.5% to 2.0% |
| **Organic Content: 3-4"** | 1.45% [high] | 1.62% [high] | 0.83% [ok] | 0.5% to 1.5% |
| **Root Mass** | 3/8 in. | 3/8 in. | 3/8 in. | at least ½ in. |
| **Feeder Roots** | 3 ½ in. Sparse | 3 in. Sparse | Less than 3 in. | at least 3.5 in. –med. density |

# Particle Distribution

| | Textural Analysis | | | | Sand Particle Size Distribution | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sand | Silt | Clay | Gravel | Very Coarse | Coarse | Medium | Medium | Med/Fine | Fine | Very Fine |
| **USDA (mm)** | **.05 to 2.00** | **.002 to .05** | **<.002** | **2.00** | **1.00** | **0.50** | **0.25** | **0.18** | **0.15** | **0.10** | **0.05** |
| **U.S. Sieve (mesh)** | **270 to 18** | **(Pan)** | **(Pan)** | **10** | **18** | **35** | **60** | **80** | **100** | **140** | **270** |
| **SAMPLE NAME** | | | | | **% Retained on Sieve** | | | | | | |
| Southwest's 1st tier | .25 - 1.0 in. | 90.52 | 4.11 | 3.05 | 2.32 | 6.96 | 12.28 | 24.28 | 13.56 | 12.18 | 8.73 | 12.53 |
| | 1.0 - 2.0 in. | 97.20 | 0.88 | 0.87 | 1.05 | 4.55 | 11.60 | 21.90 | 11.90 | 9.45 | 15.60 | 22.20 |
| | 2.0 - 3.0 in. | 94.50 | 2.18 | 2.88 | 0.44 | 3.68 | 12.04 | 24.33 | 12.84 | 8.04 | 13.33 | 20.24 |
| | 3.0 - 4.0 in. | 94.29 | 1.50 | 2.37 | 1.84 | 3.04 | 10.60 | 24.84 | 13.04 | 8.36 | 13.73 | 20.68 |
| Northwest's 1st tier | .25 - 1.0 in. | 97.16 | 1.13 | 0.63 | 1.08 | 12.48 | 17.84 | 26.68 | 11.64 | 6.68 | 9.16 | 12.68 |
| | 1.0 - 2.0 in. | 97.57 | 0.78 | 0.65 | 1.00 | 9.64 | 18.76 | 27.40 | 12.28 | 6.56 | 9.40 | 13.53 |
| | 2.0 - 3.0 in. | 93.40 | 2.04 | 1.72 | 2.84 | 5.64 | 13.24 | 24.44 | 12.36 | 7.44 | 11.84 | 18.44 |
| | 3.0 - 4.0 in. | 92.42 | 1.77 | 2.05 | 3.76 | 1.24 | 12.28 | 25.13 | 12.93 | 8.88 | 12.60 | 19.36 |
| Southeast's 1st tier | .25 - 1.0 in. | 96.68 | 1.29 | 1.07 | 0.96 | 2.64 | 9.78 | 24.73 | 15.40 | 10.44 | 15.53 | 18.16 |
| | 1.0 - 2.0 in. | 96.81 | 1.29 | 1.06 | 0.84 | 2.76 | 8.12 | 22.24 | 16.68 | 11.53 | 17.24 | 18.24 |
| | 2.0 - 3.0 in. | 97.74 | 1.24 | 1.02 | 0.00 | 1.64 | 6.04 | 20.36 | 17.80 | 12.46 | 19.40 | 20.04 |
| | 3.0 - 4.0 in. | 96.25 | 1.38 | 1.64 | 0.73 | 3.00 | 7.93 | 20.88 | 16.88 | 11.96 | 17.56 | 18.04 |
| Topdressing Sand | Sample Run #1 | 74.83 | 0.06 | 4.54 | 20.57 | 24.35 | 18.57 | 16.15 | 6.17 | 3.33 | 3.39 | 2.87 |
| | Sample Run #2 | 73.90 | 1.01 | 2.89 | 22.20 | 28.37 | 16.93 | 14.07 | 5.30 | 2.90 | 3.60 | 2.73 |
| | **Average** | 74.37 | 0.54 | 3.72 | 21.39 | 26.36 | 17.75 | 15.11 | 5.74 | 3.12 | 3.50 | 2.80 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 89 to 100 | 5 Max. | 3 Max. | 3 Max. | 10 Max. | At least 60 | | 20 Max. | | 5 Max. |
| | | 10 Max. w/ Fine & V.F. | | 10 Max. | | | | | | 10 Max. w/Silt & Clay |
| | **89 to 100** | **5 Max.** | **3 Max.** | **3 Max.** | **10 Max.** | **15 to 25** | **40+** | **10 to 15** | **20 - #80** | **5 Max.** |
| | | **10 Max. w/ Fine & V.F.** | | **10 Max.** | | **65 to 85 Optimum** | | | | **10 Max. w/Silt & Clay** |

Above is the inch-by-inch analysis of the Textural & Sand Particle Size Distribution for the **Park Area** Southwest's, Northwest's and Southeast's 1st tier's and the Topdressing Sand Sample. The test results are also included in a data reporting sheet that is attached toward the end of the report. The lower box contains the USGA specifications & ISTRC Guidelines - the upper set is the USGA specifications and the lower set highlighted in gray contains our expanded guidelines.

The specifications and guidelines apply to sand based greens that have USGA drainage. The materials retained on the 35 & 60 sieves [0.25 mm to 1.0 mm sizes] are the most important. They produce stable air pores. The air pores produced by the material retained on the 10 & 18 sieves [1.0 mm, plus] are large enough to be contaminated with silt, clay, very fine sand, and organic matter moving with the flow of water. Very coarse sands, like the submitted topdressing sand, are poor choices. The contamination ultimately produces soils with low total porosity, low air porosity, and poor infiltration/air permeability.

The red box highlights the fine/very fine sand components discussed in the first two pages. The blue box highlights the gravel/very coarse sand components of the submitted topdressing sand. The sand is not suitable for the Park project.

## II. SUMMARY

A general discussion on Maintenance Practices is contained in Section V of **The ISTRC Guidebook**. We encourage you to reference the Guidebook for a wide range of topics relating to the root zone, environmental factors, and maintenance.

The Particle Size Distribution of the sand is the same between the three locations. The testing found substantial differences in the organic contents. These differences pose a problem. They are not conducive to producing a consistent root zone unless you strip off the top 3 inches. The soil distributions and organic contents are reasonably close in the 3 to 4 inch strata.

Three inches of waste may not be a tenable option. You could strip the turf, till in a USGA-compliant sand producing a 50/50 blend – we would rehab the top 4 inches, and re-grass. It would be possible to maintain the Park with regular aerification. Ideally, regular aerification would be a combination of hollow and solid tines on reasonably tight spacing. We would also topdress the Park with a light dusting every 2 to 3 weeks.

High traffic areas should be solid tined every 7 to 14 days. The aeration breaks up the surface, allows water and O2 to penetrate the soil, and provides room for new root growth.

You may need to purchase equipment. Our preference is the Toro tractor mounted 864 with a core harvester. The unit can be used on the Park and municipal athletic fields. You also need a high quality topdressing machine. We can help you devise an appropriate cultural program. If water quality is an issue, the contaminants will adversely affect the physical properties and their treatment will be part of the cultural program.

The current testing has established the Park's benchmark. You should test the Park after the renovation to establish the maintenance baseline.

If you have any questions or need any additional information we encourage you to give us a call. We are always available to answer questions and discuss ideas with you. Our service is not confined to analyzing undisturbed cores. Our sister company, ISTRC New Mix Lab, LLC, is certified to evaluate materials and mixes for the reconstruction project.

Sincerely,

**I.S.T.R.C.**

by:
Robert S. Oppold, V. P. – R&D

**encl.: ISTRC's Guidebook**

I.S.T.R.C. Form: Physical Evaluation
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Company: CITY OF FREDERICKSBURG
Name: Mr. Bill Hanna
Address: 126 W. Main St.
City, ST, Zip Fredericksburg, TX 78624

**Account No.** 8307521
**Date** 19-Dec-16
**Facility** City of Fredericksburg
**ISTRC Rep.** Curt Franklin

## Physical Evaluation

**ISTRC SYSTEM™ Core Analysis**

| LAB ID NO. | SAMPLE NAME | Infiltration Rate in/hr | 40 cm Water Holding % | Bulk Density g/cc | Solids % | Porosity: Total Porosity % | Porosity: Capillary [Water Pores] % | Porosity: Non-Capillary [Air Pores] % |
|---|---|---|---|---|---|---|---|---|
| 16120031-F01 | Sample #1, Southwest | 0.00 | 27.73 | 1.39 | 54.68 | 45.32 | 38.61 | 6.70 |
| | **Organic [ISTRC Walkley/Black] .25 to 1 in.** | **6.63%** | | | | **Root Mass: 3/8 in.** | | |
| | **Organic [ISTRC Walkley/Black] 1 to 2 in.** | **4.46%** | | | | **Feeders: 3 1/2 in. Medium** | | |
| | **Organic [ISTRC Walkley/Black] 2 to 3 in.** | **3.57%** | | | | | | |
| | **Organic [ISTRC Walkley/Black] 3 to 4 in.** | **1.45%** | | | | | | |
| 16120031-F01 | Sample #2, Northwest | 0.00 | 29.43 | 1.46 | 50.49 | 49.51 | 42.98 | 6.53 |
| | **Organic [ISTRC Walkley/Black] .25 to 1 in.** | **4.84%** | | | | **Root Mass: 3/8 in.** | | |
| | **Organic [ISTRC Walkley/Black] 1 to 2 in.** | **3.67%** | | | | **Feeders: 3 in. Sparse** | | |
| | **Organic [ISTRC Walkley/Black] 2 to 3 in.** | **2.65%** | | | | | | |
| | **Organic [ISTRC Walkley/Black] 3 to 4 in.** | **1.62%** | | | | | | |
| 16120031-F01 | Sample #3, Southeast | 0.00 | 12.09 | 1.62 | 72.37 | 27.63 | 19.54 | 8.09 |
| | **Organic [ISTRC Walkley/Black] .25 to 1 in.** | **1.53%** | | | | **Root Mass: 3/8 in.** | | |
| | **Organic [ISTRC Walkley/Black] 1 to 2 in.** | **1.40%** | | | | **Feeders: Less than 3 in.** | | |
| | **Organic [ISTRC Walkley/Black] 2 to 3 in.** | **1.24%** | | | | | | |
| | **Organic [ISTRC Walkley/Black] 3 to 4 in.** | **0.83%** | | | | | | |
| | USGA Sample Range [Root Zone Mix] | at least 6 | 10 to 20 | 1.4 to 1.7 | 45 to 65 | 35 to 55 | 15 to 25 | 15 to 30 |

Reviewed by: _____

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**Account No.** 8307521
**Date** 19-Dec-16
**Facility** City of Fredericksburg
**ISTRC Rep.** Curt Franklin

| | | Textural Analysis | | | | Sand Particle Size Distribution | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sand** | **Silt** | **Clay** | **Gravel** | **Very Coarse** | **Coarse** | **Medium** | **Medium** | **Med/Fine** | **Fine** | **Very Fine** |
| | **USDA (mm)** | **.05 to 2.00** | **.002 to .05** | **<.002** | **2.00** | **1.00** | **0.50** | **0.25** | **0.18** | **0.15** | **0.10** | **0.05** |
| | **U.S. Sieve (mesh)** | **270 to 18** | **(Pan)** | **(Pan)** | **10** | **18** | **35** | **60** | **80** | **100** | **140** | **270** |
| **LAB ID NO.** | **SAMPLE NAME** | | | | | **% Retained on Sieve** | | | | | | |
| 16120031-F01 | .25 - 1.0 in. | 90.52 | 4.11 | 3.05 | 2.32 | 6.96 | 12.28 | 24.28 | 13.56 | 12.18 | 8.73 | 12.53 |
| **Sample #1** | 1.0 - 2.0 in. | 97.20 | 0.88 | 0.87 | 1.05 | 4.55 | 11.60 | 21.90 | 11.90 | 9.45 | 15.60 | 22.20 |
| **1st Tier** | 2.0 - 3.0 in. | 94.50 | 2.18 | 2.88 | 0.44 | 3.68 | 12.04 | 24.33 | 12.84 | 8.04 | 13.33 | 20.24 |
| **Southwest** | 3.0 - 4.0 in. | 94.29 | 1.50 | 2.37 | 1.84 | 3.04 | 10.60 | 24.84 | 13.04 | 8.36 | 13.73 | 20.68 |
| | | | | | | | | | | | | |
| 16120031-F01 | .25 - 1.0 in. | 97.16 | 1.13 | 0.63 | 1.08 | 12.48 | 17.84 | 26.68 | 11.64 | 6.68 | 9.16 | 12.68 |
| **Sample #2** | 1.0 - 2.0 in. | 97.57 | 0.78 | 0.65 | 1.00 | 9.64 | 18.76 | 27.40 | 12.28 | 6.56 | 9.40 | 13.53 |
| **1st Tier** | 2.0 - 3.0 in. | 93.40 | 2.04 | 1.72 | 2.84 | 5.64 | 13.24 | 24.44 | 12.36 | 7.44 | 11.84 | 18.44 |
| **Northwest** | 3.0 - 4.0 in. | 92.42 | 1.77 | 2.05 | 3.76 | 1.24 | 12.28 | 25.13 | 12.93 | 8.88 | 12.60 | 19.36 |
| | | | | | | | | | | | | |
| 16120031-F01 | .25 - 1.0 in. | 96.68 | 1.29 | 1.07 | 0.96 | 2.64 | 9.78 | 24.73 | 15.40 | 10.44 | 15.53 | 18.16 |
| **Sample #3** | 1.0 - 2.0 in. | 96.81 | 1.29 | 1.06 | 0.84 | 2.76 | 8.12 | 22.24 | 16.68 | 11.53 | 17.24 | 18.24 |
| **1st Tier** | 2.0 - 3.0 in. | 97.74 | 1.24 | 1.02 | 0.00 | 1.64 | 6.04 | 20.36 | 17.80 | 12.46 | 19.40 | 20.04 |
| **Southeast** | 3.0 - 4.0 in. | 96.25 | 1.38 | 1.64 | 0.73 | 3.00 | 7.93 | 20.88 | 16.88 | 11.96 | 17.56 | 18.04 |
| | | | | | | | | | | | | |
| 16120031-SS01 | Sample Run #1 | 74.83 | 0.06 | 4.54 | 20.57 | 24.35 | 18.57 | 16.15 | 6.17 | 3.33 | 3.39 | 2.87 |
| **TD Sand Sample** | Sample Run #2 | 73.90 | 1.01 | 2.89 | 22.20 | 28.37 | 16.93 | 14.07 | 5.30 | 2.90 | 3.60 | 2.73 |
| **Caliche** | **Average** | 74.37 | 0.54 | 3.72 | 21.39 | 26.36 | 17.75 | 15.11 | 5.74 | 3.12 | 3.50 | 2.80 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **USGA** | | 89 to 100 | 5 Max. | 3 Max. | 3 Max. | 10 Max. | At least 60 | | 20 Max. | | 5 Max. | |
| Recommended Specifications | | | 10 Max. w/ Fine & V. Fine | | 10 Max | | | | | | 10 Max. w/ Silt & Clay | |
| **ISTRC Guidelines** | | **89 to 100** | **5 Max.** | **3 Max.** | **3 Max.** | **10 Max.** | **15 to 25** | **40+** | **10 to 15** | **5 to 10** | **5 Max.** | |
| | | | **10 Max. w/ Fine & V. Fine** | | **10 Max.** | | **65 - 75 Optimum** | | **Cummulative < 20%** | | **10 Max. w/ Silt & Clay** | |

Reviewed by: _____

# ISTRC

## International Sports Turf Research Center

## Aerification Displacement Chart

| Tine Size | 1.25” x 1.25” Centers | 1.5” x 1.5” Centers | 2.0” x 2.0” Centers | 2.5” x 2.5” Centers | 5” x 5” Centers |
|---|---|---|---|---|---|
| ¼” Hollow Tines | 3.14% | 2.18% | 1.23% | 0.79% | |
| 3/8” Hollow Tines | 7.07% | 4.91% | 2.76% | 1.77% | |
| ½” Hollow Tines | 12.57% | 8.73% | 4.91% | 3.14% | |
| 5/8” Hollow Tines | | 13.64% | 7.67% | 4.91% | |
| 5/8” Hollow Vertidrain | | | | | 1.23% |
| ¾” Hollow Tines | | | | 7.07% | 1.77% |
| ¾” Hollow Vertidrain | | | | | 1.77% |
| 1” Hollow Tines | | | | | 3.14% |
| 1” Hollow Vertidrain | | | | | 3.14% |
| 7/8” Drill & Fill (7” Ctrs) | | | | | 1.23% |
| Graden Verticutter (15 Blades @ 1” Spacings) | 1mm Blade 3.93% | 2mm Blade 7.87% | 3mm Blade 11.81% | | |

Note: 1/4" Quadtines remove as much material as Regular 1/2" Hollow Tines
3/8” minimum for ease of topdressing fill if replacement of material is required
For double aerification make two passes at approx. 37° (slightly less than 45°) to minimize overlap

# International Sports Turf Research Center, Inc.

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