PRINCE GEORGE'S COUNTY DEPARTMENT OF PARKS AND RECREATION

Drainage Solutions

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Introduction

The purpose of this document is to provide a drainage plan for the Prince George's County Department of Parks & Recreation that establishes the purpose and reasoning behind the implementation of newer drainage technologies that uses the most cost-effective treatment options available.

This report is based around, but not limited to, the tests performed at two golf courses in the county that were the subject of the drainage analyses. The two courses included in this report are Paint Branch Golf Course, a nine hole "Par 3" course and practice facility; and Enterprise Golf Course, which was a traditional 18-hole facility.

In this report and proposal, the following are included:

1. A site analysis of each golf course
2. Initial findings in our visits
3. The results/analysis of two separate soil tests that were performed.
4. A list of the most effective and available options
5. The recommended option that we believe will be the most cost effective

Background and Objectives

By working with PALS and PG County Parks, this project was designed to assess the various drainage issues on the greens at Paint Branch Golf Complex and Enterprise Golf Course. These recommendations are intended to yield improved infiltration rates, benefit root growth to improve playability, and be relatively budget-conscious.

The 9-hole Paint Branch course at the Paint Branch Golf Complex facility in College Park, Maryland features 2,035 yards of golf from the longest tees for a Par of 31. The course rating is 60.4 and it has a slope rating of 94. It was designed by Edmund B. Ault, ASGCA, and was opened in 1964.

Enterprise Golf Course was built in 1976 by architects Robert Elder and Bill Love. It is located in Mitchellville, Maryland, on the grounds of the historic Newton White Mansion. Enterprise is an 18-hole course with a Par of 72, which features 6750 yards of rolling fairways, laid out softly upon the land. The course has a slope of 120 and a rating of 71.5.

Many golf courses experience issues with drainage throughout their lifetime. In many instances the native soils in Maryland can be particularly heavy in their clay content which impedes the infiltration rate of water. Thus, it is not uncommon for "push-up" greens constructed decades ago to suffer from some form of drainage issue. The Paint Branch Golf Complex is also located on a flood plain, which lends to its propensity to have episodes of water damage.

The major objective of this project was to provide an understanding of the drainage problems associated with specific greens on the golf courses, and then to apply that information gained to arrive at a solution specific to the required needs of Paint Branch Golf Complex and Enterprise GC. In order to meet objectives, site visits were made to Paint Branch and Enterprise to conduct a variety of tests. These tests included bulk density measurements, soil infiltrometer readings. and traditional soil nutrient tests.

To gain better insight into the golf course we had the opportunity to meet and discuss the various drainage related issues with Paint Branch Golf Course Superintendent Ben Ellis. As Superintendent, one of Ben's goals is to keep the water in the soil profile where he needs it, and at the same time allow it to drain in a timely fashion where he doesn't need it. It's a tough task to achieve considering the location of Paint Branch on a flood plain. Ben was instrumental in showing us photographs of various green sites and fairway locations where water would site; he also came out on the course with our group to scout various green site locations which were most problematic.

Paint Branch Site Analysis

Paint Branch Golf Complex is located in College Park, Maryland. The neighboring properties to the golf complex are wooded areas and the University of Maryland Paint Branch Turfgrass Research facility. These surrounding areas give PBGC a secluded feel.

According to the National Cooperative Soil Survey[1], the land that the Paint Branch Golf Complex sits on is classified as a CF soil. The description of this soil identifies the key problem that we identified in the visits to the complex, which is that the area is poorly drained. As a superintendent, one's goal in water management is to keep the water where you need it then drain and run it away from where you don't need it. This makes it difficult when the soil complex lies upon is a poorly drained soil that receives 44" of precipitation annually, and has a very compacted soil profile beneath the root zone. The goal of the drainage implementation would be to keep adequate water in the rootzone to maintain healthy stands of turf, while actively moving unnecessary amounts of water away from the playing areas.

The goal during the first visit to the complex was to get the lay of the land and get eyes on problems that were conveyed by management. The signs of poor drainage in certain areas, annual bluegrass weevil damage, heavy compaction issue deep within soil profile, no organic matter layer on greens, and varieties of maintenance practices that all amounted to less than ideal green conditions. Discussing the multiple issues we observed with the golf course superintendent, Ben Ellis, indicated that not all damage is drainage related, but the majority is. Another point to consider is the issue of severe drought that was experienced by the area in the latter half of the summer, and the fact that the PBGC pump system is basically not existent. The parts of the irrigation system that do work are inadequate for the irrigation of a golf course.

One factor that our team noted was the amount of sand build up that is present in the rootzone from past aerifications. The top 2 1/2 - 3" were primarily coarse sand, almost to the point that they appear to be sand-capped. Aeration is a cultural practice that we would recommend for short term solutions for wet conditions with possibly a light fine topdressing. The sand found in the profile of these greens appears that of a granular size was too large for a topdressing.

We have concluded that the water movement problems at PBGC are a result of the combination of coarse sand atop a compacted clay which forms a perched water table in the soil profile. Water will be drained through the top layer of sand rather quickly, but once through the sand, it settles on the almost impermeable, compacted clay layer about an inch below the root zone. This water pools on the clay, creating the perched water table underneath the putting green. This is usually problematic and can contribute to Pythium root rot and wet wilt because of poor subsurface drainage. However, since the late part of the summer of 2019 had drought-like conditions, this perched water table helped the PBGC greens by providing a water source from below to the roots by adhesion of water and sand. This can be a benefit in very dry situations, but when normal conditions of rainfall and adequate irrigation are present, this poor subsurface drainage will encourage puddling on the surface thus contributing increased disease pressure.

Currently, the PBGC has little to no drainage on their putting greens. The course is dependent on the slope of the greens and the make-up of the soil profile to carry the water away from high traffic areas. This is in hopes that the soil dries out before play damages the grass more. These are two very important factors in drainage, but by adding another element like drain lines to low areas this would greatly improve the greens. The addition of these drain lines would allow PBGC to accommodate more rounds per year, alleviate some of the stress on the greens, and provide better playability for golfers.

Enterprise Golf Course Site Analysis

Enterprise Golf Course is located in Mitchellville, MD, opened in 1976 and is built on a historic property that was formerly the Old Newton White Dairy Farm. The drive into the property gives an aura of the historic significance of the land, and as you approach the clubhouse you are greeted with terrific views of the short game practice area and the rolling terrain of the golf course. The tree-lined property brings attention away from surrounding roads and local traffic and back to the golf course.

Similar to the soil classification of Paint Branch Golf Course, Enterprise rests upon a predominantly clay-based soil profile. This clay-based soil can pose many challenging obstacles for a golf course. For instance, a soil with a heavy clay content is poised to hold much more water in films around the clay particles than a sandier soil, and this usually leads to a much more saturated profile. Another issue clay soils pose is the risk of heavy compaction over time. The combination of mechanical traffic, as well as foot traffic, can compress these small clay particles and alter the soil structure. This compaction can be truly detrimental to growing and playing conditions due to the soil losing pore space for oxygen.

Through conversations with Matt Burroughs, the Golf Corse Superintendent at Enterprise, it was decided to do evaluations on greens 2, 5, and 12 since these greens often had the most problems with drainage. The bulk density test is used to determine the dry weight of the soil, in order to determine the amount of pore space, which relates to the ability of the soil to drain. The double ring infiltrometer measurement is a method by which we can determine the rate and which water infiltrates through a given area, which gives data on the time required for water to pass through the soil profile.

From the data, it can be concluded that the relative infiltration rates of the sampled greens are rather poor. From the site survey it was determined that there is a layer of coarse sand that has built up about 5” deep in the soil profile of the greens tested. There is also a substantial amount of thatch buildup underneath the canopy of the greens. It can be determined that most of the drainage issues on these greens could be connected to the incompatibility between texture and shape of sand used in older topdressing/aerification practices.

This could also be the case on green #12, where the slowest infiltrometer reading was taken. It was apparent that there was some sodding done to the back of the green. Sodding had been done after damage occurred due to heavily saturated soil, which encouraged wet wilt to occur. As the soil becomes saturated due to ineffective drainage, the roots of the turfgrass starve for oxygen. These anaerobic soil conditions, in combination with high temperatures and high light conditions, can decimate a stand of turfgrass.

Materials and Methods

A series of tests were conducted in an attempt to better characterize the infiltration characteristics of the greens. The first test conducted was the bulk density test, the purpose of which is to measure the volumetric weight of soil samples that were taken using a steel cylinder that will pull a specific size plug out of the testing area. After allowing adequate time for the samples to dry, scales were used to record the weight of the dry soil. The idea of measuring the weight is to determine how compact the soil is; a higher weight to a soil sample means more soil particles per unit area, which is not a good thing in a drainage situation where pore space is critical to get water infiltration. Using test cylinders which had a cubic volume of 86.7 g/cm3, two samples were taken from each green, and three greens from Paint Branch and three greens from Enterprise. Table 1 (below) details the findings of the bulk density test.

Table 1.

Bulk Density				
Paint Branch				
Green	Location	Dry Weight (Grams)	Bulk Density (g/cm3)	Average Bulk Density (g/cm3)
Hole Six	Back	127.29	1.47	1.42
	Front	118.18	1.36	
Hole Three	Back Center	119.42	1.38	1.37
	Back Left	118.18	1.36	
Hole Eight	Back	125.14	1.44	1.47
	Front	129.43	1.49	
Enterprise				
Hole Two	Back	106.62	1.23	1.22
	Front	104.73	1.21	
Hole Five	Back	121.34	1.40	1.33
	Front	109.09	1.26	
Hole Twelve	Back	118.96	1.37	1.29
	Front	103.87	1.20	
Comments				
Bulk density (g/cm3) = Dry soil weight (g) / Soil volume (cm3)				
Cumbic Volume of Soil Samples:				86.7
Number of Plugs:				12
Comments: Plugs air dried; mechanical drying process showed little difference in readings on the scale				

The second test performed was the water infiltration test. The methodology involved using a device known as a double ring infiltrometer. The soil's drainage capabilities can be measured by timing the water's infiltration into the soil as it happens in real time. Using ten minute intervals per test, the inner ring was filled, then the outer ring, respectively, with water and measure how deep the water was able to infiltrate, which can be used to calculate the infiltration per hour.

Infiltration Rate				
Paint Branch				
Green	Infiltration (Inches)	Iniltration/Hour	Mean Infiltration	Comments
Hole 3	2.357	14.14	13.71	Infiltration measured in increments of ten minutes per green using double ring infiltrometer.
Hole 6	1.25	7.50		
Hole 8	3.25	19.50		
Enterprise				
Hole 2	0.5	3.00	1.25	Infiltration on #12 did not move appriciateively. Significant drainage issues.
Hole 5	0.125	0.75		
Hole 12	0.00	0.00		

Discussion of Solution Approaches

Three options for installation to improve drainage on a putting green include Existing Greens Drainage (XGD), Sand Channel Drainage, and Passive Capillary Drainage (PC).

XGD is a drainage system that involves the installation of piping (typically two inch) in an existing green at a set spacing. The full process involves removing sod from the green, digging the trenches at a given spacing (typically three feet on center), backfilling the trench, and then replacing the previous sod. When backfilling, the typical mix added is a putting greens mix of 6-1-2 (six parts sand, one part peat, two parts soil). The water on greens is drained through the sand to the pipes and then out to a main drainage pipe. This method of drainage is known to be arguably the most effective way of improving drainage on an existing green without a full renovation. This process, when done professionally, can be completed in a matter of days with the course open for play almost immediately after completion. While this is the most effective, it is also the most expensive way to improve drainage. Mixing in soil and peat to the sand helps to resist the possibility that the mix will drain “too well” and be too droughty, posing management problems during the summer.

Sand channel drainage involves cutting slits out of greens and backfilling with 6:1:2 drainage sand. These slits are typically 9” deep at the maximum so they should interfere with properly installed drainage lines. The sand slits allow water to drain easier through the soil and then eventually reach the existing drain lines. The typical spacing of these lines are ten inches apart. The point of the entire process is to reduce surface water between existing drainage. This form is typically done by the grounds crew themselves as a drainage solution during the offseason but it can also be done professionally by a company. Doing it with a company is going to be much more expensive but ensures that it is done correctly in a timely manner.

Passive capillary action is a relatively unknown method of drainage since it has not gained popularity yet. Rope is installed into the greens in sand trenches to give water a path to flow. The process uses capillary action which states that water will flow through medium (such as this rope) against the flow of gravity by using intermolecular forces. Most people have seen this process in chemistry class by placing two beakers next to each other connected with a paper towel. One beaker is full and over time, the water travels through the paper towel, against gravity, to the other beaker. The same concept is applied to this drainage system. The water comes through the sand, to the rope, and then flows to a catch basin where it meets the main drainage lines. This is done on a tight three foot spacing.

Based on the limited budget and practicality, we believe that sand channel drainage would be the best option for Paint Branch to install on their problematic greens. This installation would provide the necessary drainage to the greens but also not be too expensive or tedious to the small crew. Paint Branch would also be able to do this as needed on their greens, meaning that it wouldn’t have to be installed on all of the greens and can be done year to year if more problems arise. Based on the three greens that we focused on, there are major drainage issues and this is a viable solution for the issue.

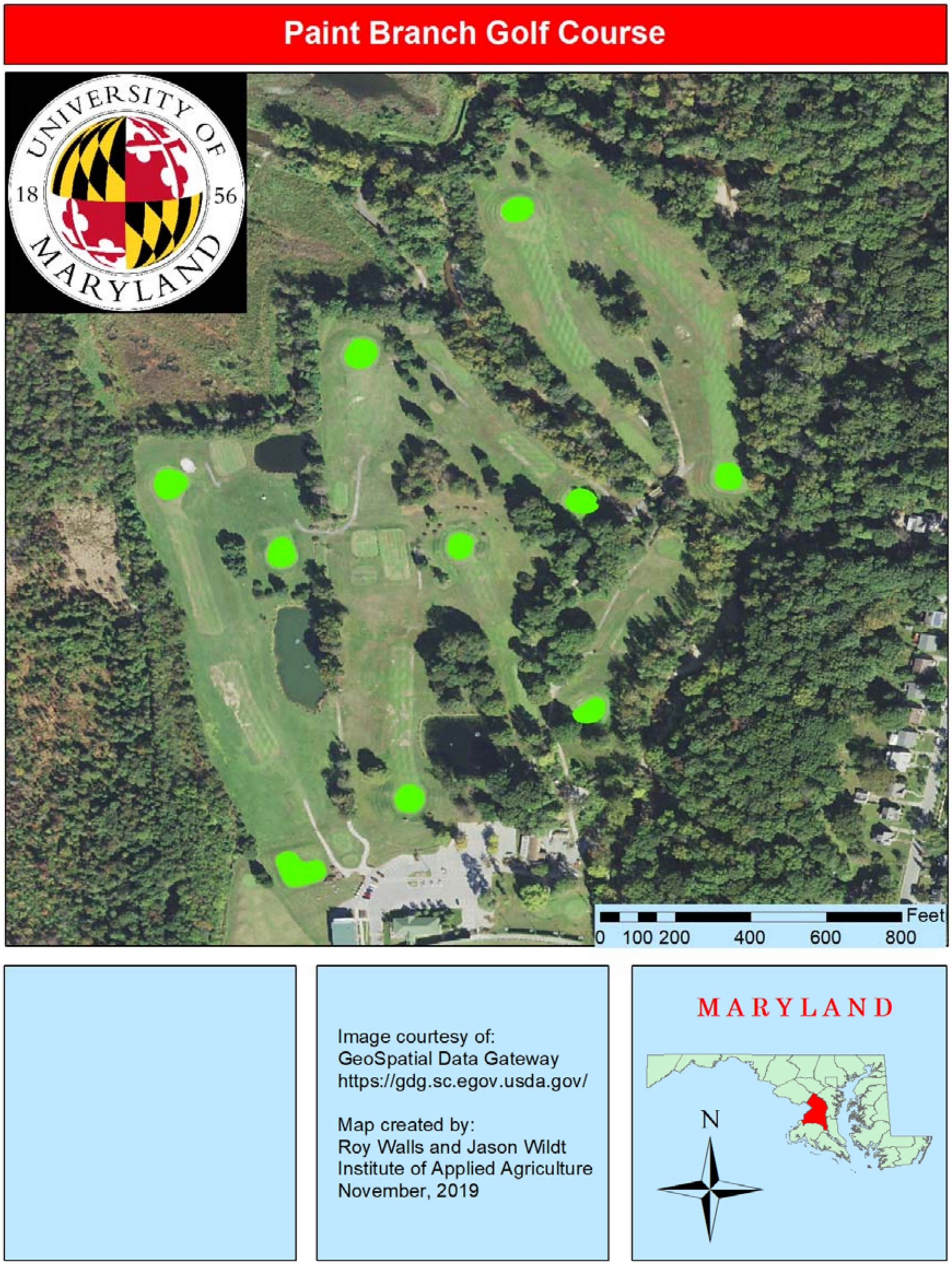
Conclusion

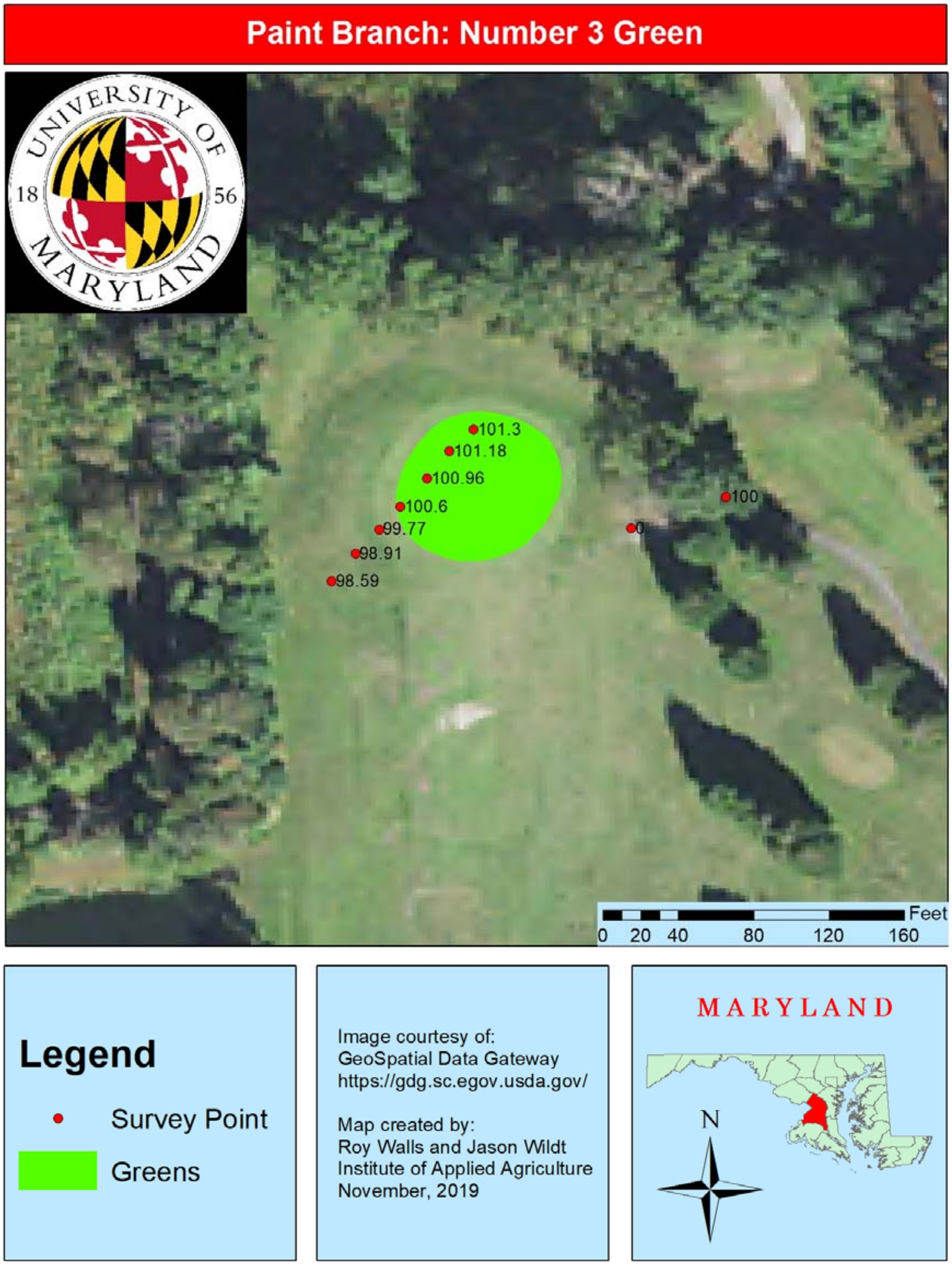
Though XGD drainage would be the ideal option, the more economical option would be the sand slit drainage. It's the most cost efficient option information that will provide the necessary results to reduce the negative effects of poor drainage such as scalding and promote better greens. It's never a great time to do a project like this during the growing season, but as a long term investment, it's the best available option. Nevertheless, this study's goal was to provide a plan to provide the *best* options available, which is why the others options were listed for consideration.

Improper or ineffective drainage is going to lead to significant loss in turfgrass over the growing or wet season. The negative effects can be reduced and ultimately negated with these drainage solutions, which is why it's recommended that the sand slit drainage be implemented to ultimately be stability to every green's soil hydrology and meet the expectations of the summer time.

Appendix

Paint Branch Greens Area	
Green	Area (sqft)
Hole 1	4448.72
Hole 2	3792.07
Hole 3	4214.58
Hole 4	3799.12
Hole 5	3586.88
Hole 6	3246.99
Hole 7	3315.18
Hole 8	2996.70
Hole 9	3690.02
Putting Green	6787.98
Total in sqft	39878.24
Total in Acres	0.92


Paint Branch Golf Course
UNIVERSITY OF MARYLAND
1856
Feet
0 100 200 400 600 800
Image courtesy of:
GeoSpatial Data Gateway
https://gdg.sc.egov.usda.gov/
Map created by:
Roy Walls and Jason Wildt
Institute of Applied Agriculture
November, 2019
MARYLAND
N


Paint Branch: Number 3 Green
101.3
101.18
100.96
100.6
99.77
98.91
98.59
100
0
Feet
0 20 40 80 120 160
Legend
Survey Point
Greens
Image courtesy of:
GeoSpatial Data Gateway
https://gdg.sc.egov.usda.gov/
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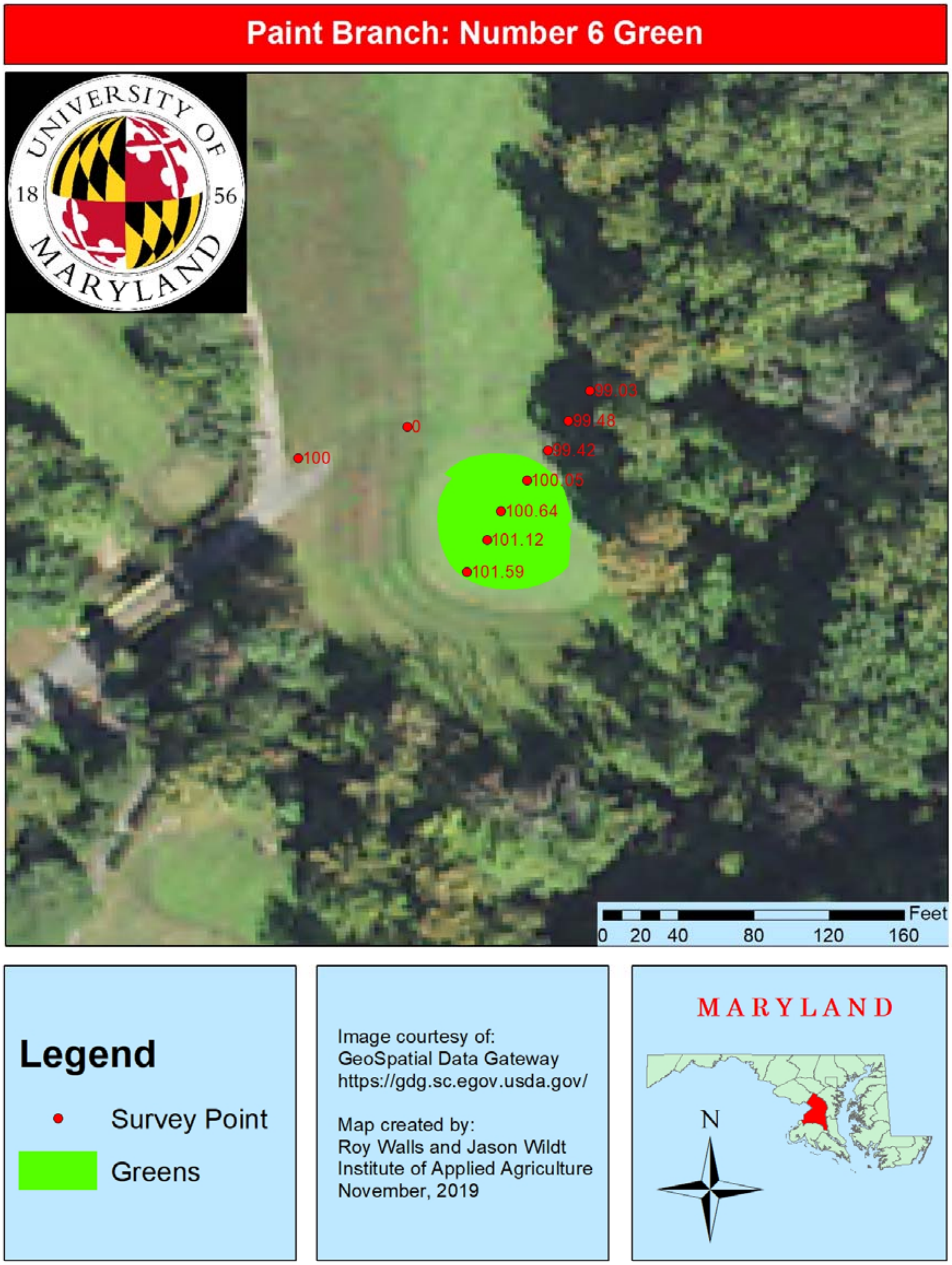
Paint Branch Hole 3 Elevation and Slope				
1	2	3	4	5
				Elev
STA	BS	HI	FS	Profile
BM	3.28			100.00
		103.28		
0+00			1.98	101.30
0+18			2.10	101.18
0+36			2.32	100.96
0+54			2.68	100.60
0+72			3.51	99.77
0+90			4.37	98.91
1+08			4.69	98.59
BM			3.28	
Existing Slope		0.0251	3%	


Paint Branch: Number 6 Green
UNIVERSITY OF MARYLAND
18 56
99.03
99.48
0
99.42
100
100.05
100.64
101.12
101.59
Feet
0 20 40 80 120 160
Legend
Survey Point
Greens
Image courtesy of:
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https://gdg.sc.egov.usda.gov/
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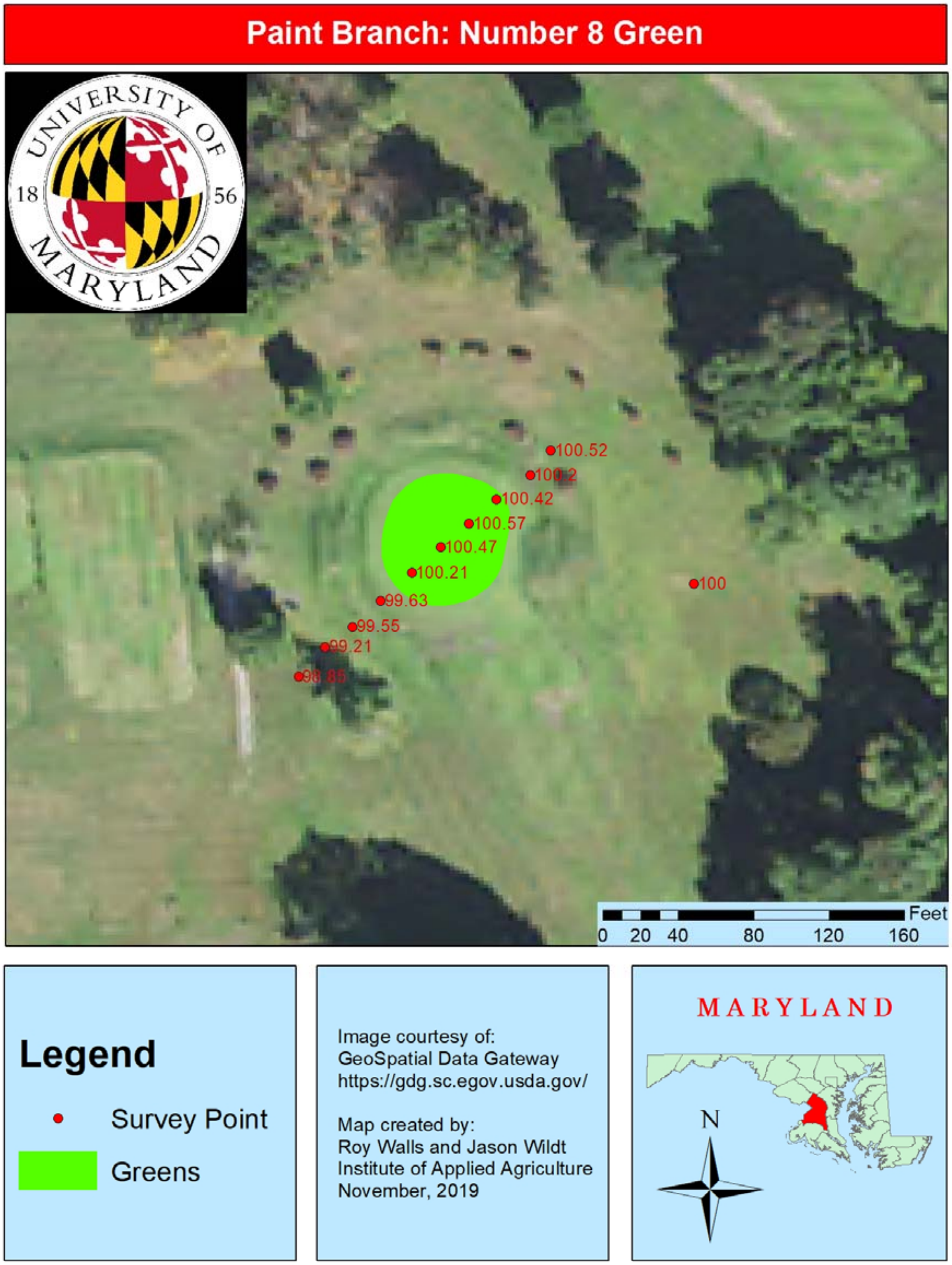
Paint Branch Hole 6 Elevation and Slope				
1	2	3	4	5
				Elev
STA	BS	HI	FS	Profile
BM	4.43			100.00
		104.43		
0+00			2.84	101.59
0+18			3.31	101.12
0+36			3.79	100.64
0+54			4.38	100.05
0+72			5.01	99.42
0+90			4.95	99.48
1+08			5.40	99.03
BM			4.43	
Existing Slope		0.023704	2%	



Paint Branch: Number 8 Green
UNIVERSITY OF MARYLAND
18 56
100.52
100.2
100.42
100.57
100.47
100.21
100
99.63
99.55
99.21
98.85
0 20 40 80 120 160
Feet
Legend
Survey Point
Greens
Image courtesy of:
GeoSpatial Data Gateway
https://gdg.sc.egov.usda.gov/
Map created by:
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Paint Branch Hole 8 Elevation and Slope				
1	2	3	4	5
				Elev
STA	BS	HI	FS	Profile
BM	4.32			100.00
		104.32		
0+00			3.80	100.52
0+18			4.12	100.20
0+36			3.90	100.42
0+54			3.75	100.57
0+72			3.85	100.47
0+90			4.11	100.21
1+08			4.69	99.63
1+26			4.77	99.55
1+44			5.11	99.21
1+62			5.47	98.85
BM			4.32	
Existing Slope		0.01031	1%	

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Grower: Geoffrey Rinehart

SOIL ANALYSIS REPORT

Analytical Method(s): SMP Buffer pH Mehlich 3 Loss On Ignition Water pH

Date Received: 11/20/2019 **Date Of Analysis:** 11/21/2019 **Date Of Report:** 11/21/2019

Sample ID Field ID	Lab Number	OM % Rate	W/V Soil Class	ENR lbs/A	Phosphorus M3 ppm Rate	Phosphorus ppm Rate	Phosphorus ppm Rate	Potassium K ppm Rate	Magnesium Mg ppm Rate	Calcium Ca ppm Rate	Sodium Na ppm Rate	pH Soil pH	pH Buffer Index	Acidity H meq/100g	C.E.C meq/100g
ENGrn2	14518	3.2 M		107	130 VH MD = 144			107 H MD = 68	74 M MD = 59	561 M MD = 44		5.8	6.84	0.9	4.6
ENGrn5	14519	3.0 M		100	120 VH MD = 133			88 L MD = 55	118 M MD = 92	1018 H MD = 102		6.6		0.4	6.7
ENGrn12	14521	2.4 L		91	136 VH MD = 150			146 H MD = 93	77 M MD = 61	536 M MD = 41		5.4	6.78	1.5	5.2
PBGrn3	14522	1.8 L		78	39 M MD = 45			102 M MD = 64	105 H MD = 83	758 H MD = 69		6.4		0.5	5.4
PBGrn8	14523	1.8 L		79	32 M MD = 37			96 M MD = 60	104 H MD = 82	773 H MD = 71		6.7		0.2	5.2

Sample ID Field ID	Percent Base Saturation K %	Mg %	Ca %	Na %	H %	Nitrate NO_3 N ppm Rate	Sulfur S ppm Rate	Zinc Zn ppm Rate	Manganese Mn ppm Rate	Iron Fe ppm Rate	Copper Cu ppm Rate	Boron B ppm Rate	Soluble Salts SS ms/cm Rate		
ENGrn2	6.0	13.4	61.0		19.6										
ENGrn5	3.4	14.7	76.0		6.0										
ENGrn12	7.2	12.3	51.5		28.8										
PBGrn3	4.8	16.2	70.2		9.3										
PBGrn8	4.7	16.7	74.3		3.8										

Values on this report represent the plant available nutrients in the soil. Rating after each value: VL (Very Low), L (Low), M (Medium), H (High), VH (Very High). ENR - Estimated Nitrogen Release. C.E.C. - Cation Exchange Capacity.

Explanation of symbols: % (percent), ppm (parts per million), lbs/A (pounds per acre), ms/cm (milli-mhos per centimeter), meq/100g (milli-equivalent per 100 grams). Conversions: ppm x 2 = lbs/A, Soluble Salts ms/cm x 640 = ppm.

This report applies to sample(s) tested. Samples are retained a maximum of thirty days after testing.

Analysis prepared by: Waypoint Analytical Virginia, Inc.

by: Pauric McGroary

Pauric McGroary

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PBGrn6	14524	2.0 L		83	30 L MD = 35			108 H MD = 68	110 H MD = 86	709 H MD = 63		6.9		0.1	4.8

Sample ID Field ID	Percent Base Saturation K %	Mg %	Ca %	Na %	H %	Nitrate NO_3 N ppm Rate	Sulfur S ppm Rate	Zinc Zn ppm Rate	Manganese Mn ppm Rate	Iron Fe ppm Rate	Copper Cu ppm Rate	Boron B ppm Rate	Soluble Salts SS ms/cm Rate		
PBGrn6	5.8	19.1	73.9		2.1										

Values on this report represent the plant available nutrients in the soil. Rating after each value: VL (Very Low), L (Low), M (Medium), H (High), VH (Very High). ENR - Estimated Nitrogen Release. C.E.C. - Cation Exchange Capacity.

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Analysis prepared by: Waypoint Analytical Virginia, Inc.

by: Pauric McGroary

Pauric McGroary

Date Received: 11/20/2019
Date Of Report: 11/21/2019

SOIL FERTILITY RECOMMENDATIONS

Sample ID Field ID	Intended Crop	Yield Goal	Lime Tons/A	Nitrogen N lb/A	Phosphate P_2O_5 lb/A	Potash K_2O lb/A	Magnesium Mg lb/A	Sulfur S lb/A	Zinc Zn lb/A	Manganese Mn lb/A	Iron Fe lb/A	Copper Cu lb/A	Boron B lb/A
PBGrn6	Putting Green	0	0.0	12.0	1.0	4.0	0						

Comments:
"The recommendations are based on research data and experience, but NO GUARANTEE or WARRANTY expressed or implied, concerning crop performance is made."

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ENGrn2	Putting Green	0	0.0	12.0	0	4.0	0						
ENGrn5	Putting Green	0	0.0	12.0	0	5.0	0						
ENGrn12	Putting Green	0	0.0	12.0	0	3.0	0						
PBGrn3	Putting Green	0	0.0	12.0	0.5	4.0	0						
PBGrn8	Putting Green	0	0.0	12.0	0.5	5.0	0						

Comments:
"The recommendations are based on research data and experience, but NO GUARANTEE or WARRANTY expressed or implied, concerning crop performance is made."

Pauric McGroary