YOUR
ISTRC SYSTEM™
REPORT

KINIPELA

Golf Club

January 18, 2008
Green #1 – 3 Tiers
Lab ID: 07120035

Presented To:

Mr. Rob Crompton,
Turf Consultant

11372 Strang Line Road
Lenexa, KS 66215

Phone: 800-362-8873
Phone: 913-829-8873
Fax: 913-829-4013
E-Mail: istrc@worldnet.att.net

January 18, 2008

Mr. Rob Crompton, Turf Consultant
KINIPELA GOLF CLUB
2500 Jeanine Drive
Victoria, BC V9B 4X9

re: Lab ID: 07120035; ISTRC SYSTEM™ BenchMarking of undisturbed core samples from Green #1 – 1st, 2nd, & 3rd tiers.

Dear Rob;

We have completed the ISTRC SYSTEM™ BenchMarking of the undisturbed core samples taken from Green #1 – 1st, 2nd, & 3rd tiers. The laboratory data is attached at the end of this report and pertinent time lapse photos are included with the text.

There are two sets of laboratory data attached to this report. The first set of data consists of the physical evaluation, the evaluation of the root systems, and the measurement of organic matter content by layer.

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

There is an Aerification Displacement Chart attached at the end of this report. The chart calculates the percentage of surface area affected/removed from a green with various size tines and spacings. It is an excellent reference tool and is helpful in evaluating the effectiveness of hollow core programs.

A copy of **ISTRC's Guidebook**, which discusses the basics of root zone management, is also included with this report. The **Guidebook** allows us to expand our discussion of important topics without encumbering the report. The section references in this report are to the **Guidebook**.

I. BACKGROUND

The green was built following USGA recommended specifications. It is approximately 650 sq. ft. in size and used as a laboratory for agronomy and botany purposes. The only traffic on the green is from normal maintenance. The turf is Perennial Poa grown from cores that were taken from 100 year old greens.

Table 1 evaluates the green's turf quality and micro-environment [growing conditions]. As a general rule, turf quality is a direct reflection of the interrelationship between the physical properties of the root zone and its micro-environment. It is possible to compensate for poor growing conditions by manipulating the physical properties of the root zone. Conversely, it is possible to compensate for poor physical properties with an excellent micro-environment. See, Section IV, D - *The Green's Micro-Environment* -at page 15.

Table 1. **Scale: 1 [bad] 3 [poor] 5 [moderate] 7 [good] 10 [excellent]**

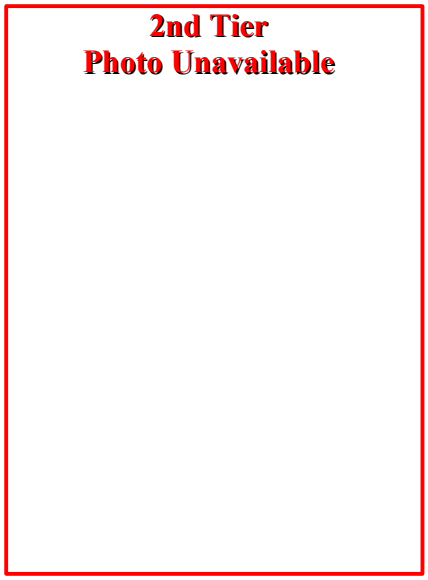
	Turf Quality	Air Movement	Direct Sunlight	Comments
Green #1	6 to 7	8	3	

There are large cedars that shade the green. The limbs, however, have been pruned up to allow the prevailing wind to reach the green. Nonetheless, a fan is used in the Summer to improve air flow. Pythium and root rot have been a problem.

The green is normally hollow cored in the Spring and Fall. This past year, the green was core aerified only once. A pitchfork is used for conventional aeration. The green is also regularly topdressed. A drop spreader is used to "dust" the surface. Grooming will be a regular part of the maintenance program this year.

Continued on the next page

II. DISCUSSION



The percolation rates for the 2nd & 3rd tiers are excellent. The green is able to drain efficiently through the lower tiers. The top tier [0 to 4 inches], however, has poor drainage. The 3.42 inches of water per hour infiltration rate is very low. This is a green that has poor evaporation as a result of its shade issues. The poor evaporation is compounded by a root zone that retains too much water even for an open location green – as measured by its water porosity & water holding properties. The source of the water retention is a combination of the particle size distribution of the sand in the top 2 inches and the high organic content in the 2 to 3 inch strata. This green is a classic example of the interrelationship between the sand's particle size distribution and the organic contents of a root zone.

Table 2. **ISTRC Target Ranges**

	Green #1			Well-Drained Greens
	1st Tier	2nd Tier	3rd Tier	
Infiltration Rate [In/hr]	3.42 [very low for the location – a problem with this green is that improving percolation & air porosity cannot compensate for inadequate sunlight]	27.69 [excellent]	24.23 [excellent]	**6 to 10**
Subsurface Air Capacity [Air Porosity]	17.47% [little low but a good foundation – regular aeration will keep the green open]	26.23% [excellent]	24.40% [excellent]	**~20%**
Water Porosity [Capillary]	32.13% [excessive for the location – this is a green that holds too much water]	12.31% [ok for a 2nd tier]	14.13% [ok for a 3rd tier]	**15% to 20%**
Bulk Density [g/cc]	1.31 [low but acceptable]	1.44 [ok]	1.47 [ok]	**1.35 to 1.45**
Water Holding	24.45% [excessive for the location]	8.56% [ok]	9.62 [ok]	**10% to 15%**
Organic Content ¼ to 1 in.	1.74% [ok except for the sand]	[4 to 5 in.] 0.57%	[8 to 9 in.] 0.61%	**1.5% to 2.5%**
Organic Content 1 to 2 in.	1.58% [ok except for the sand]	[5 to 6 in.] 0.52%	[9 to 10 in.] 0.44%	**1.0% to 2.0%**
Organic Content 2 to 3 in.	2.45% [very high]	[6 to 7 in.] 0.45%	[10 to 11 in.] 0.47%	**0.5% to 2.0%**
Organic Content 3 to 4 in.	1.47% [high]	[7 to 8 in.] 0.45%	[11 to 12 in.] 0.44%	**0.5% to 1.5%**
Root Mass	5/8 in.	N/A	N/A	**at least ½ in.**
Feeder Roots	Less than 3 in.	None	None	**at least 3.5 in. –med. Density**

Soil Structure

The red boxes highlight two areas where the distribution of the sand is not within USGA recommended particle size specifications. There is a clear shift in the top 2 inches to a finer graded sand. The fine/very fine sand, however, began the shift at the 5 to 6 inch depth [the 140 & 270 sieves].

The fine sand gradation increases the water retention that is inherent in the sand. The sand in the top 2 inches probably has enough moisture retention to support healthy turf in a straight sand root zone. Adding organic material increases the water retention to unacceptably high levels.

		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						
07120035-G01	.25 - 1.0 in.	96.94	0.02	3.04	0.00	1.98	15.80	49.00	16.58	5.48	5.55	2.55
Green #1	1.0 - 2.0 in.	98.42	0.01	1.57	0.00	1.83	18.73	50.75	16.38	4.78	4.20	1.75
1st Tier	2.0 - 3.0 in.	94.87	3.97	0.03	1.13	6.40	20.75	41.33	14.58	4.88	4.80	2.13
	3.0 - 4.0 in.	95.64	0.03	3.69	0.64	12.72	27.20	34.32	11.20	3.84	4.08	2.28
07120035-G01	4.0 - 5.0 in.	95.55	2.95	0.02	1.48	17.33	26.75	31.33	10.18	3.73	4.03	2.20
Green #1	5.0 - 6.0 in.	96.17	2.68	0.02	1.13	18.33	29.55	31.50	9.08	3.08	3.05	1.58
2nd Tier	6.0 - 7.0 in.	96.27	0.02	2.23	1.48	20.65	29.08	30.63	8.53	2.93	3.00	1.45
	7.0 - 8.0 in.	96.27	0.02	2.33	1.38	18.08	28.93	31.30	9.30	3.23	3.50	1.93
07120035-G01	8.0 - 9.0 in.	95.66	0.02	3.02	1.30	17.15	26.95	32.38	9.90	3.53	3.75	2.00
Green #1	9.0 - 10.0 in.	95.56	0.02	2.82	1.60	17.53	29.15	31.65	9.15	3.10	3.25	1.73
3rd Tier	10.0 - 11.0 in.	95.89	0.02	2.51	1.58	17.58	28.53	32.05	9.50	3.25	3.35	1.63
	11.0 - 12.0 in.	94.72	2.23	0.45	2.60	19.08	29.70	30.08	8.55	2.75	2.98	1.58
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.F.		10 Max.						10 Max. w/Silt & Clay	

The roots have clearly added organic matter to the top 4 inches. It is interesting that there is a spike to 2.45% in the 2 to 3 inch strata. Root density has been excellent at that depth. It is unfortunate that deep roots are not sustainable during the Summer.

Continued on the next page

III. SUMMARY

The particle size distribution of the sand in the top 3 to 4 inches needs to be changed to USGA recommended specifications. Our preference for a topdressing sand would be a material with at least 70% of the material retained on the 35 & 60 sieves with 80% the target. Silt, clay, and the fine sand particles retained on the 140 & 270 sieves should be less than 5%, total.

The organic contents in the top 2 inches are acceptable, but the hollow core program needs to be aggressive in order to change the particle size distribution of the sand. An aggressive program is also needed to reduce the amount of organic material in the 2 to 3 inch strata. 1/2" hollow quads on quad block spacing of 1.5" x 1.5" will displace 8.7% per pass. Tightening the spacing to 1.4" x 1.4" - which is possible with the Toro Pro Core 648 – increases the displacement to 10.2%. A minimum displacement target of 20% is recommended. A higher displacement percentage will merely accelerate the rebuilding process.

It is possible to use decomposition to reduce the organic material. Decomposition, however, requires soil oxygen. Soil oxygenation is poor in this green with its current 3.42 in./hr. infiltration rate. The infiltration rate is an indirect measurement of air permeability. Regular aeration – either with a pitchfork or a more conventional piece of equipment – is needed to maintain necessary soil oxygen levels.

A deep watering irrigation program can also be used to aerate the root zone. Deep watering, however, will require regular aeration to allow water to easily penetrate the top 3 to 4 inches. Deep watering requires irrigating a root zone until the weight of the water in the soil column breaks the tension of the perched water table. A vacuum is created that pulls excess water from the air pores and replaces the removed water with oxygen rich air from the atmosphere. The process not only replenishes soil moisture throughout the column, but it forces a gas exchange resulting the re-oxygenation of the soil. The root zone at the surface also holds less moisture with a deep watering program than a light and frequent program. [NOTE: Our research has found that inadequate soil oxygen is the primary cause of shallow root structures and poor decomposition rates.]

There are two ancillary benefits derived from deep watering: (a) the process firms the surface of the green, and (b) it cools the soil. Water is a more efficient heat sink than soil. As a consequence, a wet root zone will absorb and hold more heat than a dry root zone. But if the water can be removed from the soil, excess heat can be removed with it.

The deep watering program should be used whenever the green is irrigated. Syringing will be necessary to maintain hot spots between applications. Many of the PGA tour courses follow a deep watering program. It is possible to install shutoff valves on the trunk line(s). The valves are shut and the greens irrigated until water in the cup is about an inch from the surface. The valves are opened completing the process. [NOTE: If you allow the water to sit in the green for a few minutes before opening the valve, it will absorb more heat.] The value of the valve system is that you are ensured of an even distribution of water in the cavity and the efficient use of water.

A deep watering program that improves soil oxygen levels and cools the root zone should help sustain deep root structures later into the Summer. The oxygen is necessary for decomposition – as previously stated – and the maintenance of deep and dense root structures. It is a requirement for the maintenance of healthy turf that is better able to withstand heat stress.

It is possible to deep water with an infiltration rate of only 3.42 inches of water per hour, but the process will be more efficient with a higher rate of flow. Regular aeration is necessary to keep the green open and breathing while the hollow core program gradually changes the structure of the soil. Water injection, deep solid tines, deep slicing, bayonet tines, and star tines are the most common forms of non-disruptive aeration. We also include 1/4" hollow quads in our list. The green would benefit from a monthly 1/4" quad application. The tines are recommended to help control biomass production. The other forms should be used at least every 14 days. The actual frequency should be based on the length of time the cavities remain open.

Finally, we recommend monitoring your green with at least annual testing. The information derived from regular testing permits you to: (a) evaluate the maintenance program, (b) modify the program based on hard data, (c) make adjustments to the program to meet the individual needs of specific greens, and (d) detect problems before they affect the surface conditions of the greens.

We are always available to answer questions and discuss ideas with you. Our service is not confined to analyzing undisturbed cores. We do not charge for telephone calls and we encourage our client superintendents to use us as a resource.

Sincerely,

I.S.T.R.C.

by:
Robert S. Oppold

I.S.T.R.C.

"International Sports Turf Research Center, Inc."

11372 Strang Line Rd.
Lenexa, KS 66215

Phone: 913-829-8873
Phone: 800-362-8873
Fax: 913-829-4013

The I.S.T.R.C. System™

Company: KINIPELA GOLF CLUB
Name: Mr. Rob Crompton, Turf Consultant
Address: 2500 Jeanine Dr.
City, ST, Zip Victoria, B.C. V9B 4X9

Account No. 2509915
Date 11-Dec-07
Facility Kinipela G.C.
ISTRC Rep. N/A

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] %
07120035-G01	Green #1, 1st Tier	3.42	24.45	1.31	50.40	49.60	32.13	17.47
	Organic [ISTRC Walkley/Black] .25 to 1 in.	**1.74%**				**Root Mass: 5/8"**		
	Organic [ISTRC Walkley/Black] 1 to 2 in.	**1.58%**				**Feeders: less than 3"**		
	Organic [ISTRC Walkley/Black] 2 to 3 in.	**2.45%**						
	Organic [ISTRC Walkley/Black] 3 to 4 in.	**1.47%**						
07120035-G01	Green #1, 2nd Tier	27.69	8.56	1.44	61.46	38.54	12.31	26.23
	Organic [ISTRC Walkley/Black] 4 to 5 in.	**0.57%**				**Root Mass: N/A**		
	Organic [ISTRC Walkley/Black] 5 to 6 in.	**0.52%**				**Feeders: none**		
	Organic [ISTRC Walkley/Black] 6 to 7 in.	**0.45%**						
	Organic [ISTRC Walkley/Black] 7 to 8 in.	**0.45%**						
07120035-G01	Green #1, 3rd Tier	24.23	9.62	1.47	61.47	38.53	14.13	24.40
	Organic [ISTRC Walkley/Black] 8 to 9 in.	**0.61%**				**Root Mass: N/A**		
	Organic [ISTRC Walkley/Black] 9 to 10 in.	**0.44%**				**Feeders: none**		
	Organic [ISTRC Walkley/Black] 10 to 11 in.	**0.47%**						
	Organic [ISTRC Walkley/Black] 11 to 12 in.	**0.44%**						
	Organic [ISTRC Walkley/Black] .25 to 1 in.					**Root Mass:**		
	Organic [ISTRC Walkley/Black] 1 to 2 in.					**Feeders:**		
	Organic [ISTRC Walkley/Black] 2 to 3 in.							
	Organic [ISTRC Walkley/Black] 3 to 4 in.							
	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: _____

I.S.T.R.C.

International Sports Turf Research Center, Inc."

11372 Strang Line Rd.
Lenexa, KS 66215

Phone: 913-829-8873
Phone: 800-362-8873
Fax: 913-829-4013

Company: KINIPELA GOLF CLUB
Name: Mr. Rob Crompton, Turf Consultant
Address: 2500 Jeanine Dr.
City, ST, Zip Victoria, B.C. V9B 4X9

Account No. 2509915
Date 11-Dec-08
Facility Kinipela G.C.
ISTRC Rep. N/A

		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										
07120035-G01	.25 - 1.0 in.	96.94	0.02	3.04	0.00	1.98	15.80	49.00	16.58	5.48	5.55	2.55
Green #1	1.0 - 2.0 in.	98.42	0.01	1.57	0.00	1.83	18.73	50.75	16.38	4.78	4.20	1.75
1st Tier	2.0 - 3.0 in.	94.87	3.97	0.03	1.13	6.40	20.75	41.33	14.58	4.88	4.80	2.13
	3.0 - 4.0 in.	95.64	0.03	3.69	0.64	12.72	27.20	34.32	11.20	3.84	4.08	2.28
07120035-G01	4.0 - 5.0 in.	95.55	2.95	0.02	1.48	17.33	26.75	31.33	10.18	3.73	4.03	2.20
Green #1	5.0 - 6.0 in.	96.17	2.68	0.02	1.13	18.33	29.55	31.50	9.08	3.08	3.05	1.58
2nd Tier	6.0 - 7.0 in.	96.27	0.02	2.23	1.48	20.65	29.08	30.63	8.53	2.93	3.00	1.45
	7.0 - 8.0 in.	96.27	0.02	2.33	1.38	18.08	28.93	31.30	9.30	3.23	3.50	1.93
07120035-G01	8.0 - 9.0 in.	95.66	0.02	3.02	1.30	17.15	26.95	32.38	9.90	3.53	3.75	2.00
Green #1	9.0 - 10.0 in.	95.56	0.02	2.82	1.60	17.53	29.15	31.65	9.15	3.10	3.25	1.73
3rd Tier	10.0 - 11.0 in.	95.89	0.02	2.51	1.58	17.58	28.53	32.05	9.50	3.25	3.35	1.63
	11.0 - 12.0 in.	94.72	2.23	0.45	2.60	19.08	29.70	30.08	8.55	2.75	2.98	1.58
	.25 - 1.0 in.											
	1.0 - 2.0 in.											
	2.0 - 3.0 in.											
	3.0 - 4.0 in.											
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.F.		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**	**20 - #80**	**5 Max.**	
			10 Max. w/ Fine & V.F.		**10 Max.**		**65 to 85 Optimum**				**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.

For Additional Information Please Call:

800-362-8873
or
913-829-8873

Fax:
913-829-4013

Or Visit Our Website At:

www.istrc.com