DRAINAGE PROJECT

CLUB DE GOLF BEACONSFIELD INC.

GROUP PROJECT

presented to

Professor John Sheppard

by

Thomas Krause

I.D.# 8911182

and

Hugues Noël

I.D.# 8119193

Faculty of Agricultural and Environmental Sciences

Department of Agricultural Engineering

Macdonald Campus of McGill University

Ste-Anne de Bellevue, Quebec

December, 1992

ABSTRACT

Our project is a report on the drainage requirement: for the Beaconsfield Golf Club. In particular the area south of the 2-20 highway.

The type of drainage improvements recommended for Beaconsfield are a system of parallel slit trench drains and high capacity surface inlets installed in the wet areas of the golf course.

The lateral slit drains would be 38 mm diameter corrugated plastic tubing installed at depths ranging from 250 to 450 mm, backfilled to the surface with coarse sand.

Collectors ranging in size from 100 mm up to 300 mm in diameter will be installed according to design requirements.

High capacity surface inlets are proposed in low areas where surface drainage water characteristically ponds in the spring or after heavy rainfalls.

A pumping station is proposed to pump drainage water from the depressions across the plateau by holes 12 and 16 (tees) and lake 18G in front of hole 18 green. The drainage water would be pumped by a pump with an 17.9 l/sec (285 USGPM) capacity into lake 18T.

A water level control pipe would be installed on lake 18T to drain the lake and the pumped outflow from lake 18G by gravity across holes 12, 16 and 14 into a Pointe-Claire storm sewer system.

Ditch excavation work is recommended to provide proper drainage outlet for holes 11 and 13.

ACKNOWLEDGEMENTS

We would like to take the opportunity to express our thanks to the Superintendent of the golf course, Mr. Mark Dufresne. He loaned us topographic maps that the golf course had made for such a study, by Photosur. Without these maps, his full collaboration and help our project would have never matured.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

INTRODUCTION

The Beaconsfield Golf Club was incorporated in 1904. The original members were from the Westmount Golf Club, who could not accept the ban on Sunday Golfing (Swail, 1988). As a result they moved to Beaconsfield and began playing a six (6) hole lay-out on an old quarry site. This quarry, the Pointe-Claire quarry has supplied huge limestone blocks to build the piers of the Victoria Bridge. The stone cutting site itself was to be the great limestone plateau that forms the base of the first, tenth, twelfth and sixteenth tees.

The Beaconsfield Golf Club moved from being in a rural setting at the turn of the century to a semi-urban setting in the forties and to a complete urban-suburban environment in the sixties and seventies. Now this championship eighteen-hole golf course is part of the city of Pointe-Claire's limit. It is surrounded on its east and west side by residential housing, it is bounded to its north side by the Lakeshore General Hospital and to its south side by what is known as Pointe-Claire Village. It is also cut through its middle by the 2-20 highway that was built in 1940 (Swail, 1988).

This is the setting of our third year team project. And let us take this opportunity to state our objectives both for the project and the engineering work.

The project objectives are the following:

1) time management
2) team work and work distribution
3) project presentation (oral and written)

The engineering objectives are as follow:

1) identification of problems
2) solve the problems in a satisfactory manner for the golf industry in our urban setting.

Now let us go back to our problems. In this case it is the poor drainage of the course as a whole. This presents some particular problems to the golf industry. One of the first noticeable aspect of this problem is the damage that the fairway mowers cause by going through the puddles. They tear up the turf and create mud patches. This is not desirable for the golfers. Also, along the same line is the damage the golfers are doing by going through the same puddles and compounding the problems. Golf cart restrictions (Greenmaster staff, 1987) are a hard one to enforce at a private club. The mowers have to cut fairways everyday and skipping the cutting of a fairway for a day at our course would/will raise a lot of criticism from the membership.

The other condition that arises from the previous situation is not visible. It is the matter of soil compaction (Carrow, 1986), the pressing together of soil particles resulting in a more dense soil and less favourable growth medium.

Let us look in a more detailed fashion into this particular condition and its repercussions. In our case where the soil is clay (see Table 1 for more detail) a thick compacted zone of 2.5 to 7.6 centimetres occurs near the surface. This brings about (Brady, 1984) a decrease in the total pore space and fewer large pores (macropores) remain. Macropores are important for rapid drainage, gaseous movement into and out of the soil and root channels (Brady, 1984). More specifically, the following soil physical properties are altered:

1) Infiltration declines. With only a few larger pores at the surface, water does not enter the soil as rapidly. This makes good irrigation scheduling rather difficult, especially during hot, dry weather (Carrow, 1986). In periods of high precipitation, water collects in low spots or runs off the site.

2) Soil aeration decreases. Turfgrass roots cannot efficiently absorb water if soil O_2 is low (Turgeon, 1991). Since compaction reduces the volume of large pores, the O_2 level declines for long periods after saturation by rainfall or irrigation. The final result is poor root growth, root dieback, low root viability, and poor water uptake (Turgeon, 1991).

3) Soil strength increases. With fewer large pores, the roots must exert more energy to penetrate the small pore spaces. Also, a dense soil exhibits greater total adhesive and cohesive forces holding the soil particles together, especially as the soil dries (Brady, 1984). The lack of root channels and a hard soil slow the rate of root extension and cause a shallower root system to develop which limits water uptake (Carrow, 1986).

4) Moisture retention capabilities of the soil are altered. The greater number of small pores result in more total water retention but the water is often held too tightly by soil particles for plant use (Carrow, 1986). Thus, a compacted soil often has less available water for plants compared to the same soil that is not compacted, especially for loams and clay soils (Turgeon, 1981).

5) Soil temperatures can be altered. In the spring, compacted soils are usually colder due to their higher total water content (Brady, 1984). This delays root initiation and slows root growth (Carrow, 1986). During the summer, compacted soils are often warmer due to less turf cover (Turgeon, 1991). Drier, compacted soils transmit heat more rapidly than an uncompacted soil. Higher soil temperatures can result in root death, especially on cool-season grass species (Carrow, 1986).

This examination of soil compaction is to demonstrate to the reader(s) that draining this soil is of great importance for suitable turf viability and playability.

But this is not the only problem, as we first mentioned. The second problem that we will tackle is water accumulation at the foot of the plateau, in fairways 16, 12 and 18. This accumulation usually occurs in the spring time and is of about 1.2 m in depth. This is according to the golf staff. This water accumulation has to be pumped and usually delays the start of the golfing season. Also, this area will flood during heavy rain fall. This water has to be moved out and currently is removed by staff using gasoline powered pumps.

Those were the problems pointed out to us by the staff of the golf course. We then went on the course to visually see these areas and did some digging to determine the soil that we would have to deal with. At that point we decided to scale down our project and work on the south section only of the golf course.

At this point, we would like to inform the reader(s) that the focus of this project is to solve the aforementioned problems in a "real" world approach. Not as a theoretical problem to be solved through calculations solely. But as a situation that will use existing material and use some empirical solutions that were tried and found working.

2. MATERIALS

- Topographic map bases on an aerial photo taken in April 1990
- planimeter
- drawing equipment
- 35 mm camera

3. DRAINAGE DESIGN METHODS

3.1 Introduction: We met Golf Course Superintendent Mark Dufresne and Mr. Moch (irrigation specialist). Drainage improvements were discussed and problem areas were defined as well as locations of irrigation pipes, control wires and existing drainage.

3.2 Drainage Problems:

1) poor infiltration rate of compacted clay soil
2) localized depressions with poor surface drainage

The removal of excess water will be accomplished by the installation of slit drains and surface inlets.

3.3 Slit Drainage System

The slit trench drains consist of a 70-80 mm wide trench, 250 to 450 mm deep in which a geotextile covered drain pipe is installed and backfilled with coarse sand. No covering of sand with top soil or seeding is required and/or recommended. Adjacent turf can root in the sand without disturbing the high infiltration rate of the aggregate.

Excess surface water percolates through the sand and is taken away by the drain pipe. The principal of this system is the same as that of a french drain.

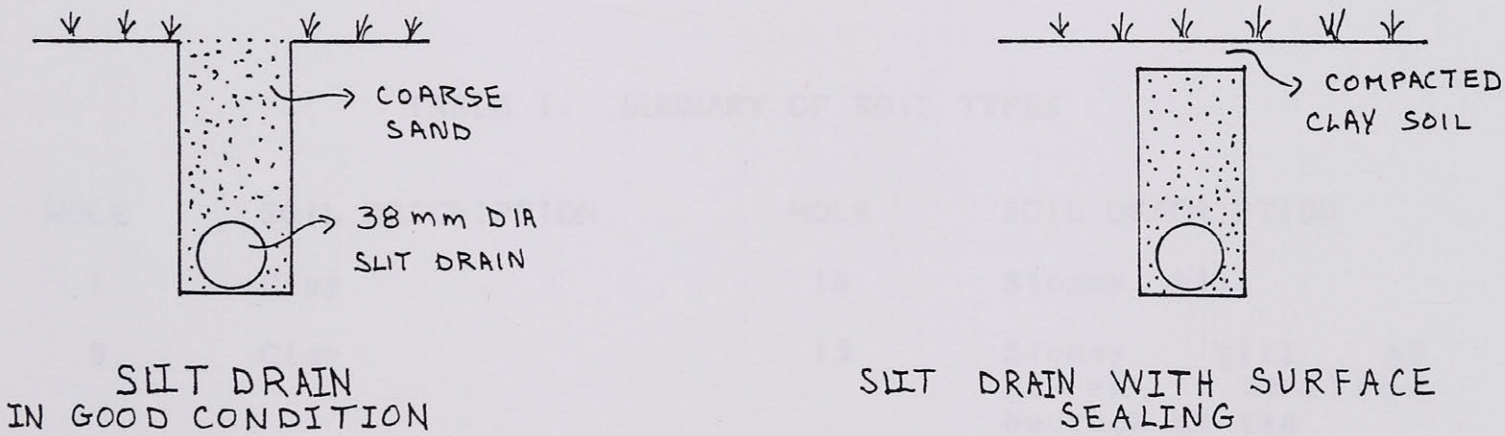

FIG 1. SLIT DRAIN

The design of a slit drainage system includes depth, soil type, spacing, and slope. The minimum depth for a 38 mm diameter drain pipe is 250 mm, to protect it from surface loads. The golf course soils are summarized in Table 1. Most of the areas to be drained have a clay soil. The clay is very compacted, with a very slow infiltration rate. Conventional subsurface drainage would, therefore, not be efficient in removing the excess water quickly.

After reviewing literature and speaking to local industry a spacing of 1.5 m has been chosen on level fairways. Wider spacings, (2-3 m) can be used on some steeper sections and in the rough because of the nature of the turf, and the smaller amount of traffic (Kelly, 1992).

The direction of the laterals is determined by the topography of each fairway. In order to properly drain surface runoff, water should flow across the drains, rather than between them. Therefore where ever possible, laterals will be parallel to contour lines. This will permit each lateral to intercept water as it flows down the slope.

TABLE 1. SUMMARY OF SOIL TYPES

HOLE	SOIL DESCRIPTION	HOLE	SOIL DESCRIPTION
1	Clay	14	Stoney till
9	Clay	15	Stoney till at green, shallow bedrock at tee
10	Clay	16	Very stoney till at tee, with a chance of bedrock. Clay at the green
11	Clay	17	Loam, stoney at a depth of 50 cm
12	Very stoney till at Tee, stoney till at green	18	Very stoney till at tee. Very stoney till, chance of bedrock at the green
13	Clay		

3.4 Collector Design

Based on weather data and financial considerations, a drainage rate of 25 mm/d has been chosen for the design of collectors. This rate has been successfully used for the Montreal region (Kelly, 1992).

The diameter of the collectors is determined by the discharge capacity required. The discharge capacity is determined by the area to be drained, drainage rate and internal roughness and the slope of the pipe.

Using Manning's velocity equation and equating the design flow to the hydraulic capacity of the pipe at full flow, the diameter is:

$$d = 51.7\ (D_c * A * n)^{0.375} * s^{-0.1875}$$ (Schwab et al., 1981)

Where
d = inside diameter in mm
D_c = drainage coefficient in mm/d
A = area of watershed in ha
n = roughness coefficient
s = slope of pipe in m/m

Using known pipe sizes, the slope can be calculated. The proper combination of diameter and slope were chosen by trial and error, to meet drainage requirements. 100 mm will be the minimum diameter used.

Surface inlets will require the collector to have a higher capacity than those with silt drains only. Sample calculations in appendices.

When collectors feed to open ditches there should be sufficient clearance between the outlet and the bottom of ditch, to prevent blockage. The minimum clearance chosen is 200 mm. This minimum clearance and limitation of collector depth must be taken into consideration. In some cases, either the ditch must be deepened or the collector rerouted to allow for the minimum clearance. All collector outlet pipes must have rodent traps to keep animals out. The number of crossings by collectors over underground utilities should be minimized.

Whenever possible, the design will use existing drainage pipes, surface drainage, lakes and storm sewers.

4. RESULTS

TABLE 2

Collector Name	No. of Coll. Outlets	No. of Surface Inlets	No. of Traps Drained	Length (m)	Diameter (mm)	Collectors in sand Traps (m)
1 a	1			34	100	
1 b	1			27	100	
1 c	1			12	100	
1 d	1			21	100	
1 e	1			30	100	
1 f	1			30	100	
1 g	1		1	50	100	21
Totals	7	0	1	204		21
9 a	1			25	38	
9 b	1			82	100	
9 c	1			49	100	
9 d	1			22	100	
9 e				5	38	
9 f				49	100	
Totals	4	0	0	232		0
10 a	1			28	100	
10 b-1	1			59	150	
10 b-2				89	100	
10 c	1			46	100	
10 d			1		100	26
Totals	3	0	1	222		26
11 a	1			81	100	
11 b				23	100	
11 c	1			20	100	
11 d	2			20	38	
11 e	1			101	100	
	1				250	
Totals	6	0	0	245		0
12T a				20	100	
12T b	1			20	100	
12G a-1				20	100	
12G a-2				75	101	
12G b			1		100	18
Totals	1	0	1	135		18

TABLE 2 (CONT'D)

Collector Name	No. of Coll. Outlets	No. of Surface Inlets	No. of Traps Drained	Length (m)	Diameter (mm)	Collectors in sand Traps (m)
13 a	1	1		40	100	
Totals	1	1	0	40		0
15 a	1			41	100	
15 b			1		100	34
Totals	1	0	1	41		34
16T a				91	100	
16T b				52	100	
16G a	1	2		237	300	
Totals	1	2	0	380		0
17 a			3	100	100	52
Totals	0	0	3	100		52
18G a	1	1		30	150	
18G b	1			15	38	
18G c	1			20	100	
18G d				28	100	
18G e				16	100	
18T a				85	200	
18T b-1				83	100	
18T b-2				119	101	
18T c				24	100	
18T d-1				60	100	
18T d-2	1			60	101	
18T e	1			70	38	
Totals	5	1	0	610		0
PR a	1			35	100	
PR b	1	1		40	100	
Totals	2	1	0	75		0

5. Discussion of Drainage Requirements

5.1 - Practice range and fairways 1, 9, 10 and 11.

An existing drainage pipe (250 mm diameter steel pipe) will be used to drain this area. There are 9 surface inlets along the collector. The surface area of the watershed is approximately 13.25 hectares. The diameter of the existing pipe has sufficient capacity to eliminate water from silt drainage systems and continue to drain water from existing manholes.

The outlet of the steel pipe is corroded and should be replaced. We propose to replace 3 m of pipe and install a rodent trap. Failure of the steel pipe can be expected eventually. The drainage system has been designed to avoid crossing the pipe to minimize replacement costs of the existing steel pipe.

Other drainage requirements include replacement and lowering of irrigation control wire on fairway 10 and deepening of ditch at collector outlet west of fairway 11 over a distance of 120 m.

5.2 - Fairway 12

The first sand trap to the west of the green and a small portion of the fairway in front of the green will be drained in the drainage flow to the apartment building south of 18 tee.

5.3 - Fairway 13

There are two major problems on fairway 13. The south side of the fairway along the woods is the lowest area on the golf course and floods every spring. The second problem is that there is insufficient soil cover along a 10 m strip in the rough next to the woods. This area is too low to allow proper clearance between outlet and open ditch. The ditch will enter the Lanthier Avenue catch basin via a 300 mm diameter pipe with a sloping inlet.

In order to solve the problem of the low area in the rough, it is proposed that this area be filled with approximately 100 m^3 of soil and either seed or sod the area depending on the preference of the golf course administration.

5.4 - Fairway 15

There are two problem areas. The first is in front of the green, the second is on the north side of maintenance access road in front of the tee.

At the green we find a stoney till. The soil is not deep but we believe the work can be done.

At the tee the soil is too shallow and bedrock can be seen. Drainage work in this area would not be feasible.

5.5 - Fairway 17

The problem areas are, a small area in front of the green and three bunkers on the west side of the green.

A 100 mm diameter collector is used to drain these areas and will join fairway 13 to drain excess water on that fairway as well. The section of the collector situated in the bunkers is a 100 mm perforated pipe.

5.6 - Fairway 18

Two small areas in front of 18 tee will be drained also in the drainage flow to the apartment building south of 18 tee.

5.6.1 - Pump drainage of depression along fairways 16, 12 (tee) and 18 (green).

The water shed of this drainage area is approximately 6.1 hectares with no surface drainage outlet for water to flow away by gravity. Lake 18G acts as a drainage reservoir for the depression. We propose the installation of a submersible 220 volt (3 phase) pump of a capacity of about 17.9 l/sec (285 USGPM) to pump the water into lake 18T via an existing 100 mm ABS smooth wall pipe. From lake 18T the water would flow by gravity in a plastic drainage pipe across fairways 12, 16 and 14 to a manhole an Cartier Avenue. A water level control device would be installed on the collector near lake 18T. That device would automatically open and start draining the lake when a preset water level will be attained. See appendix B for a description of this type of device.

5.6.2 - Drainage flow into Cartier Avenue storm sewer from fairways 18, 12 and 16.

A large area west of lake 18T on fairway 18 is drained into the collector that discharge into Cartier Avenue storm sewer.

The area right in front of fairway 12 green is also drained into that drainage flow. Note the position of the collector in the rough in order to minimize damage to the playing area.

The area west of fairway 16 green and in front of it will get a surface inlet and also be connected to that drainage flow. East of fairway 16 green in the rough a low area will get a surface inlet and linked with the collector that connects to Cartier Avenue.

5.6.3 - Expected drainage flow rate into Cartier Avenue storm sewer.

There are two (2) surface inlets to drain the depressions on the west and east side of fairway 16 at the green. The depression on the west side is 20 cm lower than the depression on the east side and is the limiting elevation for calculating flow rates to the storm sewer.

For calculating drainage flows we have assumed that drainage water ponds 600 mm deep in the west side depression and that the 300 mm sewer pipe on Cartier is flowing 2/3 full. The maximum flow through the 300 mm diameter proposed collector is approximately 48.7 l/sec. The average flow rate expected from the watershed snowmelt and subsequent runoff in the spring would be about 28.8 l/sec. This is based on approximately 36 cm of runoff in 14 days from the watershed.

CONCLUSIONS

Our solutions to the drainage problems facing the south section of the Beaconsfield golf club will provide a higher quality of turf in the play area, and minimize damage of turf area in the future from machinery and golf cart traffic.

Our drainage design integrates itself adequately within the urban environment surrounding the golf course, i.e. use of existing city storm sewer and ditches. We also were able to use existing drainage elements of the golf course in our design, there by minimizing costs.

All tasks required for proper completion of the project were respected and deadlines were met. Lastly we would like to offer two (2) recommendations:

1) A detailed cost estimate should be done prior to submitting the final report to the Board of Directors of the golf club. This cost estimate would also be necessary if the project is put to tender.

2) Arrangements with the city engineering department should be undertaken to get their approval of the use of their system. This should be done prior to putting the tenders out.

REFERENCES

Brady, N.C., 1984. The Nature and Properties of Soil. Ninth Edition. MacMillan Publishing Compagny. New York.

Carrow, Dr. R.N., 1986. Water Management on Compacted soils. Weeds Trees and Turf. Volume 25. Number 3. P. 34-40.

Conseil des productions végétales du Québec, 1976. Drainage souterrain. Cahier des normes. Agder 555. Ministère de l'Agriculture du Québec. Québec, Canada. 21 pp.

Conseil des productions végétales du Québec, 1978. Drainage souterrain. Cahier des normes. Agder 555. Ministère de l'Agriculture du Québec. Québec, Canada. 21 pp.

Council at Biology Editors, 1972. Council of Biology Editors Style Manual. American Institute of Biological Sciences Publishers. Washington, D.C., U.S.A. 297 pp.

Grenmaster'staff, 1987. Focus on Golf Carts. Greenmater. Volume 23, number 6, p. 8-10.

Irwin, R.W. and Clayton, R.E., 1981. Drainage guide for Ontario. Agdex 752. Ontario. Ministry of Agriculture and food. Toronto, Canada. 20 pp.

Kelly, John K., 1992. Personnel Communication. Kelly Ami Inc. Kirkland, Canada.

Research Branch Agriculture Canada, 1989. Handling Agricultural Materials. Liquid conveyors. Publication 1836/E. Minister of Supply and Services. Canada 1990. Ottawa, Canada. 50 pp.

Schwab, G.O., Frevert, R.K., Edminster, I.W. and Barnes K.K., 1981. Soil and Water Conservation Engineering. Third Edition. John Wiley and Sans. Inc. New York. 525 pp.

Swail, Brent., 1988. Beaconsfield ... built on tradition. Greenmaster. Volume 24, number 7, p. 18.

Turgeon, A.J., 1991. Turfgrass management. Third Edition. Prentice-Hall Inc. New Jersey, U.S.A. 418 pp.

A P P E N D I X   A

SAMPLE CALCULATIONS

SAMPLE CALCULATIONS

PIPE SIZE OF COLLECTOR 16_{GA}?

Watershed area is approximately 16.2 ha

$$d = 51.7\ (D_c * A * n)^{0.375} * s^{-0.1875}$$

Where: d = inside diameter of pipe in mm

D_c = 25 mm/d

A = 16.2 ha

n = 0.016 for corrugated plastic pipe

Assume slope of pipe s = 0.002 m/m

$$d = 51.7\ (25 * 16.2 * 0.016)^{0.375}\ (0.002)^{-0.1875}$$

$$d = 334 \text{ mm}$$

Too large

Assume slope of pipe s = 0.004 m/m

$$d = 51.7\ (25 * 16.2 * 0.016)^{0.375}\ (0.004)^{-0.1875}$$

$$d = 293.4 \text{ mm}$$

Therefore 300 mm diameter collector with a 0.004 m/m or 0.4% slope is required.

PUMP CAPACITY REQUIRED TO PUMP LAKE 18G TO LAKE 18T?

Watershed area is approximately 6.1 ha design flow:

$$q = A * i$$

Where q = design flow

A = watershed area

i = rainfall

$$q = 6.1 * 10^4 \, m^2 * 25 \, \frac{mm}{d} * \frac{10^{-3} \, m}{mm} * \frac{d}{24 \, h} * \frac{h}{3600 \, sec} * \frac{1000 \, l}{m^3} =$$

$$q = 17.65 \text{ l/sec}$$

Pump capacity of 285 USGPM (17.9 l/sec) was chosen.

APPENDIX B

WATER LEVEL CONTROL DEVICE

A P P E N D I X C

TOPOGRAPHIC MAP