ITEM 10
MANAGER'S REPORT NO. 11
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10\. Re: Swangard Stadium Turf
(Item 3, Report 92, December 10, 1973)
(Item 23, Report 83, November 5, 1973)
(Item 15, Report 75, October 9, 1973)

Council, at its meeting of October 9, 1973, received Item 15, Manager's Report No. 75, and, with other recommendations, adopted the following with respect to Swangard Stadium:

"THAT the Central Park Committee be asked by the Commission to consider the request made at the Committee's April 17, 1973 meeting that it bear one-half of the cost of the $10,000 extra expenditure for the correction of the drainage deficiency in the field."

Council, at its meeting of October 22, 1973, requested staff to provide a report explaining the reason for recent drainage problems at the Swangard Stadium playing field.

A letter dated October 26, 1973 from the B.C. Juvenile Soccer Association asking Council to correct drainage problems at Swangard Stadium was received by Council at its meeting of November 5, 1973. Item 23, Manager's Report No. 83, was also received by Council on November 5, 1973 and Council approved the Manager's recommendation that the letter from the B.C. Juvenile Soccer Association be referred to the Parks and Recreation Commission for study and comment.

The Parks and Recreation Commission, at its meeting of November 7, 1973, received a report from the Parks and Recreation Administrator (Item 11, Parks and Recreation Administrator's Report No. 18), along with a report dated November 3, 1973 from Dr. L. Goss, Consulting Agronomist. The Commission referred the two reports to the Central Park Committee with the advice that the Municipality of Burnaby would pay the cost of an independent consultant to examine and advise on this Stadium problem.

The Parks and Recreation Commission, at its meeting of December 5, 1973, approved of the terms of reference for a study to be undertaken by Ripley, Klohn & Leonoff International Ltd., Soil Engineers, and Mr. T. M. Lord, Consulting Agronomist.

Attached are xerox copies of reports dated December 31, 1973 from Ripley, Klohn & Leonoff International Ltd. and from Messrs. T.M. Lord and A.J. Green, Professional Agrologists. Also attached is a copy of a record memo, dated January 31, 1974, from the Parks and Recreation Administrator adding additional information to that contained on page 7 of the Ripley, Klohn & Leonoff Report.

The reports confirm that the drainage problem is caused by the soil above the drainage system lacking the porosity to permit movement of water to the drain tiles. Mr. Morrison, of Ripley, Klohn & Leonoff, points out on page 7 of his report that:

"We are of the opinion that the permeability of the natural soils was marginal prior to removal of the crown. We do not believe that the removal of the crown, the rototilling of the sand-sawdust mix, and the installation of turf at the field in the spring of 1973 significantly altered the drainage characteristics of the subsoils beneath the central and eastern portions of the field. ... There is apparently no problem with field drainage at the reconstructed western 1/3 of the field."

Council will recall that it was the western 1/3 of the field that was totally reconstructed during the progress of the work as an extra to the contract and that the design of this work was provided by Mr. Davies of Ron Davies and Associates Ltd.

The Consultants recommend that:

"... the central and eastern portions of the field be reconstructed with a drainage system that will absorb all normally expected rainfalls. We have not made a detailed check on rainfall, but we believe that the field should be capable of continuously absorbing water at a rate of about 0.75 inches per day, without significant surface ponding. This is necessary if the field is to remain essentially flat. Design for an average daily rainfall of 0.75 inches per day may allow some surface ponding during periods of intense rainfall, however, at most times the field should be free of surface water and any water that does pond during periods of intense rainfall should drain away rapidly when the intensity of rainfall decreases."

Continued ...

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The reports submitted recommend the use of a sand/soil mix, but the Parks and Recreation Administrator advises that the Consultants confirm that sand/peat or sand/sawdust, as preferred by the Burnaby staff, is equally acceptable as a mix. The Consultants estimate the cost of a complete reconstruction of the central and eastern portions of the field to be in the order of $25,000 to $35,000, but the Parks and Recreation Administrator feels that the cost of this work could exceed $50,000.

In a report noted as Item 12, Parks and Recreation Administrator's Report No. 2, submitted to the Parks and Recreation Commission on January 23, 1974, the Parks and Recreation Administrator notes that:

"There is little doubt that the scheme proposed by the Consultants would produce an efficient, well-drained field, capable of maintaining playability during all but the most severe winter conditions. Whether this high quality justifies the very significant expenditure, is a question which must be resolved by the Burnaby Parks and Recreation Commission and the Central Park Committee. Certainly the standard of drainage proposed is well above that which prevailed before the 1973 renovation."

In the same report, the Administrator notes that the proposal by the Consultants does not make provision for irrigation of the playing field. He points out that this is essential for the proper maintenance of high quality sports turf which is expected to withstand heavy use. The present irrigation system involving the use of portable equipment, is not only costly but also inefficient to operate. He has recommended that serious consideration be given to the installation of a fully automatic system which is estimated to cost $8,400.

The Parks and Recreation Commission, at its meeting of January 23, 1974, accepted the findings in the reports and after some considerable discussion on the matter, the Commission passed the following resolution:

"WHEREAS the Parks and Recreation Commission is satisfied that the field was playable prior to the renovations;

AND WHEREAS the removal of the crown of the field was a direct result of an endorsement of the Municipality for the purpose of the Canada Summer Games;

AND WHEREAS the Parks and Recreation Commission feels that the present problems are the responsibility of the Municipality;

THE PARKS AND RECREATION COMMISSION RESOLVE that the Municipality find the necessary monies to bring the field to a satisfactory playing condition, and recommends that complete reconstruction of the field and drainage system be undertaken, as recommended by Ripley, Klohn and Leonoff, and by T.M. Lord and A.J. Green."

At the same meeting, the Commission resolved to recommend to the Central Park Committee that the Committee undertake to install an automatic irrigation system at the same time that the corrective work is being undertaken at the field.

The Central Park Committee, at its meeting of February 5, 1974, considered this subject and concurred in the recommendation made by the Burnaby Parks and Recreation Commission in connection with the reconstruction of the field. At the same time, the Central Park Committee authorized an expenditure of $10,000 out of its 1974 Capital Budget to install the necessary underground, automatic irrigation system.

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As for the schedule of the work involved, the Parks and Recreation Administrator advised that if the work is approved by Council, he would hope to call tenders for it by the end of February, with the tenders to be returned by mid-March and the landscaping work to be completed by mid-May. On this basis, the field should be playable for the beginning of the fall season in August. We are highly dependent upon weather and contractors, so there is no way we can guarantee this schedule. The Parks and Recreation Administrator advises that he proposes to use sod wherever possible during the reconstruction rather than seeding.

From mid-March to July inclusive in 1972 there were 12 days that the field was used for 27 events. In the same period in 1971 there were 27 days that the field was used for 49 events. The closure of the field will, therefore, probably be for approximately 4½ months and we will have to make arrangements to accommodate the normal users during this period. It should be noted that we now have 3 additional fields in the Burnaby Lake Sports Complex that we did not have at the time when the Stadium was being renovated in 1973.

At the meeting of February 5, 1973, the Central Park Committee also agreed to contribute the $5,000 requested on April 17, 1973, to the extra costs for the 1973 field renovation contract which resulted from the need to completely reconstruct the westerly third of the field during the progress of the initial work.

At the Parks and Recreation Commission meeting, held on February 6, 1974, the Commission was advised that its recommendation would now be placed before the Municipal Council for its consideration.

In summary, the following conclusions can be reached:

1. The removal of the crown and the work undertaken by the Canada Summer Games Society did not significantly alter the drainage characteristics of the subsoils beneath the field.

2. The permeability of the natural soils was marginal prior to the removal of the crown.

3. The present condition is just not acceptable for the use to which the field should be put.

4. The "extra" work in the western 1/3 of the field that was recommended by Mr. Ron Davies was not only required but appears to be quite adequate.

5. Mr. Ron Davies' original recommendation to completely reconstruct the field was a sound one and the endeavours of the staff to find an alternative to complete reconstruction, with the concurrence by Mr. Davies and the Vancouver and Burnaby Parks staff, were not entirely successful. If the subsoil had been able to accept the surface water as anticipated it would by both Vancouver and Burnaby staffs, the savings would have been significant.

6. The improvements recommended by the Consultants will provide a facility which should be superior to that which existed prior to the modifications made by the Canada Summer Games Society.

7. If the crown had not been removed from the field, it is not possible to determine how long we could have gone on with the use of the field before additional improvements in drainage and soil condition were required, especially when one considers that lights have now been installed which would allow the field to be used more intensively than in the past. There is little doubt that the removal of the crown brought the whole drainage condition sharply into focus.

8. There may, indeed, be justification in asking the Central Park Committee to finance a portion of the expenditure to improve the field, but when it comes right down to it, notwithstanding the fact that the Central Park Committee approved of the work prior to it being done, we must act immediately if the field is to be improved and ready for play in the fall of 1974. Also, the Committee's budget is half financed by Burnaby in any event, so this reduces the significance of this argument. Further, the improvements that will be made to the field will be in Burnaby and there is little doubt that in the not too distant future serious consideration will have to be given to the operation of the Park reverting to Burnaby, rather than under a joint Committee.

Continued ...

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9. The Central Park Committee did contribute $5,000 towards the cost of the complete reconstruction of the westerly 1/3 of the field which was completed in 1973.

10. Ron Davies & Associates Ltd. guaranteed that:

> "... the drainage of the field and the field surface conditions will not be any worse after the rework than they are at present and there is every possibility that they will be better providing, of course, that a regular and routine field maintenance program is carried out as is the case at the present time. We cannot unconditionally guarantee that field conditions will be better after the rework because we were not involved in, nor did we have responsibility for, the original field design or installation."

There is no conclusive way to prove that the field is any worse now than it was prior to the Games for we have no specific documentation for comparison. As a matter of fact, for example, the April 3, 1972 issue of the Vancouver Sun notes that the Vancouver and District Juvenile Soccer Association had to switch its annual playoffs from Swangard Stadium to Hillcrest Park because of heavy rains. Further, a representative of the Burnaby District Soccer Commission on November 22, 1972 when making arrangements for alternative playing fields, pointed out that the drainage in the northwest quadrant of the soccer pitch at Swangard Stadium was not as good as he would like to see and he hoped that the renovation work that we would be doing would improve the situation.

11. Certainly now is not the time to delay the necessary work by arguing about sharing the responsibility for the position in which we find ourselves in such a "cloudy" issue where several parties are involved. Under the circumstances it is believed that the best that could be accomplished would be the sharing of the costs involved and by the time that this would be finalized, we would have delayed the work to the point where it would not be completed in time to have the field ready for the 1974 fall season. The Summer Games have come and gone and they were New Westminster and Burnaby.

12. The Canada Summer Games Society has not made a decision as to the disposition of any surplus funds that it might have which are being held by the Friends of the Games Society. It is expected that some of these surplus funds will be returned to Burnaby and New Westminster.

RECOMMENDATIONS:

THAT the complete reconstruction of the central and eastern portion of the field, including the drainage system, be undertaken as recommended by Ripley, Klohn and Leonoff International Ltd. and by Messrs. T.M. Lord and A.J. Green; and

THAT the estimated costs of $50,000 be financed by any surplus funds received from the Canada Summer Games Society and, if sufficient funds are not received from the Society, that provision be made in the Budget of the Parks and Recreation Department for any shortfall; and

THAT an underground, automatic irrigation system be installed at the same time that the corrective work is being undertaken at an estimated cost of $10,000 and at the expense of the Central Park Committee; and

THAT copies of this report item be forwarded for information purposes to the Canada Summer Games Society, Central Park Committee, City of New Westminster, Burnaby Parks and Recreation Commission and the B.C. Juvenile Soccer Association, in response to its letter of October 26, 1973.

Earle J. Klohn
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Our File VA 1855 December 31, 1973

Project: Swangard Stadium
Subsurface Drainage Study

Location: Central Park, Burnaby, B. C.

Client: Corporation of District of
Parks and Recreation Department

I. INTRODUCTION

This report presents the results of our recent investigations of the subsurface drainage problem at the playing field located at Swangard Stadium. This report is concerned with the engineering aspects of the subsurface drainage problem at the stadium. Mr. T.M. Lord and Mr. A.J. Green, P.Ag. are preparing a complimentary report that will be primarily concerned with related agronomic aspects.

Purpose of the investigations and studies was:

a. to define the nature and cause or causes of the drainage problem
b. to make recommendations as to the procedures to correct the drainage problem
c. to provide an estimate of cost of the complete corrective works

Prior to a start on the study, T.M. Lord, A.J. Green and K.I. Morrison met with members of both the Vancouver and Burnaby Parks Departments. Existing data on the stadium was made available to us at that time.

The work was authorized by Mr. P. Stockstad of the Burnaby Parks and Recreation Department. An outline of the work was presented in a letter from K.F. Williams, dated November 30, 1973.

II SYNOPSIS

The basic drainage problem at the central and eastern portions of the Swangard Stadium playing field is the shallow depth to the impervious, dense glacial till, and the low permeability of the soil that lies above the glacial till and between the perforated underdrain pipes. The field is essentially flat and must absorb virtually all the water that falls on it. If the soil is not saturated, as may be the case during the summer months, a vertical soil permeability as low as 1x10-4 cm/sec is great enough to allow penetration of water and complete absorbtion of a limited quantity of water at a rate in excess of 3" per day. However, in periods of extended rainfall that can occur during the spring, fall, and winter, the thin layer of soil above the glacial till becomes saturated and the rate of absorbtion of water is governed by the rate at which the water can flow laterally to the perforated drain pipes, which are at 15 foot spacing. Once the soils are saturated the maximum rate at which low permeability soils (1x10-4 cm/sec) can conduct water laterally to the drain pipes, and prevent ponding on the surface of the field at the mid points between the drain pipes is less than 0.15" per day. The rate of absorbtion directly over the drain pipes is higher than at the mid point between pipes, and the average rate of conduction to the underdrain laterals is about 0.3" per day. These rates are less than average rainfalls of up to 0.75" per day recorded in October 1973, and ponding of free water on the surface of the field would be expected. Because the field is uneven the surplus water that cannot be absorbed during periods of intense rainfall collects in low areas. The length of time required for disappearance of surface water in the lower areas is increased.

For the most stable surface conditions during the wet spring and fall seasons the water level in the soils at the field should be several inches below the surface of the field, and there should be no free water on the field surface at the time of play. In order to reliably obtain this situation a horizontal drainage layer of clean, highly porous sand should underlie the field. The horizontal drainage layer should provide for rapid lateral movement of water to the drains and thereby eliminate a ponded surface water condition under all but the most adverse situations. Some ponding of water might occur during periods of very intense rainfall, and ponding could be a problem if the depth of uneven depressions was allowed to become excessive. However, if the depth of undrained depressions was controlled by routine field maintenance, a rapid lowering of the groundwater table should quickly eliminate any minor ponding that may occur during periods of intense rainfall. The recommended method of correction proposed in this report should increase the drainage capacity of the central and eastern portions of the field by a factor of at least 5, in comparison to the present drainage capacity. The western portion of the field which was previously rebuilt with a sand base appears satisfactory, and needs no improvement in drainage.

III HISTORY OF PLAYING FIELD

At the pre-study meeting with Parks Board representatives we were given a verbal review of the history of the field. We have also reviewed specifications, reports and other correspondence describing previous work at the field. In summary form, our understanding of the history of the playing field is presented below:

- a playing field was originally constructed with a drainage system as shown on Dwg B-1855-1 attached. At the time of the original construction we understand the field had a mid point crown of about 14"
- during the spring and summer of 1973 the crown was removed from the field in preparation for the Canada Summer Games. We understand that international standards for soccer apparently require a field gradient of less than 1 in 1000, which for all practical purposes is a flat field
- after the crown removal and levelling of the field, the westerly 1/3 of the field was reconstructed to improve the drainage conditions. We understand the reconstruction work on this portion of the field involved a cleaning and relaying of the existing perforated subdrain laterals, and the laying of a bed of clean sand. Test pits TP10 and TP11 are located in this area. See dwgs D-1885-2 and D-1855-3 for test pit locations and the approximate positions of the various field areas mentioned.
- after crown removal and levelling the central and eastern portion of the field were not reconstructed, but the surface was rebuilt by placing a 3" layer of pump sand and sawdust mix "on the levelled area. The sand-sawdust mix was then blended to a depth of about 8" using

rototiller equipment. Care was taken not to disturb the existing perforated subdrain laterals.

- turf was laid over the entire field in preparation for the Summer Games.
- we understand that during the fall of 1973 (October) the field remained very wet following periods of rainfall, and was generally unsuitable for play.
- levels taken on the surface of the field and observations during heavy rainfalls show that the surface of the field is uneven and many areas of the field pond water. See dwg D-1855-3.

IV CONCLUSIONS AND RECOMMENDATIONS

1. Observations of Field Drainage

Observations by the writer during December 1973 indicate that water ponds on the central and eastern portions of the field during periods of moderate to heavy rainfall. Levels taken by Burnaby (see dwg D-1855-3) also indicate the uneven low areas. No surface water was observed on the western 1/3 of the field during heavy rainfalls, and the reconstructed portion which is underlain by sand apparently absorbs and carries away the rainfall without surface ponding.

We are of the opinion that it is not feasible to rely on surface drainage on a playing field with a surface gradient as flat as 1 in 1000. As well as the impracticability of obtaining a precise 1 in 1000 gradient during initial construction, we are of the opinion that frost action and minor differences in settlement will always produce depressions that will effectively prevent surface runoff.

2. Field Drainage Requirements

We recommend the central and eastern portions of the field be reconstructed with a drainage system that will absorb all normally expected rainfalls. We have not made a detailed check on rainfall, but we believe that the field should be capable of continuously absorbing water at a rate of about 0.75" per day, without significant surface ponding. This is necessary

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if the field is to remain essentially flat. Design for an average daily rainfall of 0.75" per day may allow some surface ponding during periods of intense rainfall, however, at most times the field should be free of surface water and any water that does pond during periods of intense rainfall should drain away rapidly when the intensity of rainfall decreases.

See dwg D-1855-3 for approximate outline of eastern, central, and western portions of the field previously mentioned.

3. Existing Soils, Rainfall and Field Drainage

The existing subsoils between the subdrain laterals and above the dense glacial till at the eastern and central portions of the field have a permeability that is too low for effective drainage of rainfall during the wet spring, fall and winter months. The silty, very dense and hard glacial till may be considered impervious at this site. See test pit logs on dwg D-1855-2.

Administrators report No. 18, prepared for commission meeting November 7, 1973, indicates that games were played in October 1973 after two days of rainfall averaging 0.53" per day and after four days of rain averaging 0.73" per day. Our calculations indicate that absorbtion of this rainfall is not possible, and that ponding and slow drainage should occur with a subsoil permeability of 10-4 cm/sec if the depth of the drain tiles is 1½ ft and they are at 15 ft spacing. For the above depth and spacing of drainage laterals we calculate (1) that for the early spring, fall and winter conditions that prevail in the lower mainland area the maximum rate at which rainfall can be absorbed into the field without ponding is about 0.15" per day, only 1/3 to 1/5 the rate of rainfall noted in October 1973.

(1) Calculations based on analyses presented in paper titled "Subsurface Drainage of Highways and Airports"
Report of Committee on Subsurface Drainage
E.S. Barber - Chairman
Highway Research Board Bulletin No. 209

Figure 4 in the Appendix presents the results of permeability and can tests that we have carried out on samples of the existing subsoil at the field. Not counting the results from TP11, which is in the reconstructed western portion of the field, the can test times show that for 5 out of 7 samples taken from the upper portions of the test pits the can test times are generally as low as the can test times for samples taken from the lower portions of the pits. This suggests that the upper zone that was blended with sand and sawdust at the time of field flattening is not significantly more porous than the lower subsoils.

The soils at the site have an apparent permeability value of about 1 or 2x10-4 cm/sec although the range could be between 10x10-4 cm/sec and 0.1x10-4 cm/sec depending on local variations in both silt content and compaction. Permeability tests on recompacted samples from TP3 S1, TP9 S1 and TP3 S2 indicate a range of permeability between 2x10-4 cm/sec and 10x10-4 cm/sec. We understand that Mr. Lord and Mr. Green have performed in place hydraulic conductivity tests on insitu cores at a depth of 4" to 7", and have recorded permeabilities of 1x10-4 cm/sec and 2x10-4 cm/sec (0.14 and 0.3 in/hr).

4. Subdrain Pipes at Field

The existing pattern of subdrain pipes at the field is shown on dwg D-1855-1. At most of the test pits the lateral drains are located about 1½ ft depth, and rest on or close to the underlying very dense glacial till. The drain pipe laterals are covered by a variable quantity and quality of drain sand or gravel. In some instances the perforations at the base of the pipe are laid directly on the glacial till with little or no

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gravel or sand beneath the pipe. At one test pit the pipes were plugged by the fine silty till soils. The drain sand or gravel does not extend to near the field surface, but is generally enclosed and covered by the relatively impervious soils described under 3 above.

5. Effect of Crown Removal at Field

We are of the opinion that the permeability of the natural soils was marginal prior to removal of the crown. We do not believe the removal of the crown, the rototilling of the sand-sawdust mix, and the installation of turf at the field in the spring of 1973 significantly altered the drainage characteristics of the subsoils beneath the central and eastern portions of the field. However, we consider that under heavy rainfall conditions the central and eastern portions of the flattened field should be expected to produce wetter ground conditions during the spring, fall and winter for the following reasons:

- removal of the crown must reduce the percentage of surface runoff during periods of heavy rainfall, and thereby increase the quantity of water that must infiltrate into the ground
- removal of the crown from the central portion of the field would reduce the depth of cover on the underdrain pipes by about 40%, and this should theoretically (1) reduce the rate of infiltration by a factor of about 3.

There is apparently no problem with field drainage at the reconstructed western 1/3 of the field.

(1) Based on analyses presented in paper titled
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Ripley, Klohn & Leonoff International Ltd.

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6. Correction of Drainage Problem at Field

We recommend that the drainage problem at the central and eastern portions of the field be corrected by a reconstruction described below. The reconstructed field should absorb and carry away a design average rainfall of about 0.75" per hour, without surface ponding:

a. excavate the central and eastern portions of the field to a depth of 14" below the final field elevation and stockpile a portion for reuse as described under (d) below. Be careful not to damage the perforated undrain laterals during this operation
b. lift existing laterals subdrain pipes, clean and relay in a graded drain gravel as indicated on Figure 9 in the Appendix
c. lay a 10" thick drainage layer of clean sand over the field area. Carefully grade and heavily water the sand drainage layer before placing additional fill
d. lay a 3" thickness of soil previously excavated and stockpiled as described in (a) above. The soil should be thoroughly mixed prior to placement, as specified in the report by Mr. Lord and Mr. Green
e. after the uniform 3" thickness of soil is placed over the 10" thick sand drainage layer, the upper 7" should be thoroughly rotovated to mix the upper 3" of soil with the top 4" of the underlying clean sand, as specified in the report by Mr. Lord and Mr. Green. Fertilizer may be added during the rotovating process if specified by Lord and Green. THE DEPTH OF MIXING MUST BE CONTROLLED BY STOPS ON THE ROTOVATING EQUIPMENT SO AS TO ENSURE A 6" THICKNESS OF CLEAN UNCONTAMINATED SAND WILL REMAIN.

We calculate that a 6" thick drainage layer of clean sand having a permeability of 100x10-4 cm/sec will continuously absorb rainfall at an average rate of 0.75" per day, and will conduct the water to the drains without any surface ponding. The 7" thickness of mixed soil and sand above the clean sand drainage layer, specified in the report by Lord and Green, should have a permeability equal to or higher than 1x10-4 cm/sec (3.4" per day).

f. after rotovating to mix the 3" of upper soil with the top 4" of sand, the surface of the field should be levelled and compacted by rolling. Sand turf as specified in the report by Lord and Green can be laid over the prepared surface.

g. If the field area is to be seeded rather than turfed, the thickness of soil laid under (d) above is increased to 4", and 4" of soil is rotovated with 4" of underlying sand, still leaving 6" thickness of clean sand as a drainage layer.

7. **Cost of Complete Correction**

Based on an approximate projection of the cost for previous work at the stadium we consider that the cost of complete reconstruction of the eastern and central portions of the field could be of the order of $25,000 to $35,000. If the partial correction described under 8 below is carried out, the cost may be reduced to the range of $20,000 to $30,000.

However, the only accurate method of obtaining a realistic cost estimate is to obtain the quotations from contractors who are familiar with the type of work. We recommend you obtain quotations from contractors if you require an accurate estimate.

8. **Partial Correction of Drainage Problem**

If for cost reasons the cost of correcting the drainage problem at the field must be minimized, you may wish to consider the following partial correction.

a) reconstruct the central portion of the field as recommended under 6 above.

b) on the eastern portion of the field, where the field usage is less severe, you could consider:
- leaving the existing playing field intact
- installing additional subdrains midway between the existing drain laterals, while leaving the existing laterals untouched

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- placing a longitudinal (south to north) drain pipe connecting the new midway laterals and leading this new main drain northward to the manhole to the north end of the field. The new main drain could be laid along the north-south contact between the completely reconstructed centre portion of the field, and the eastern portion of the field which would only have supplemental lateral drains installed.

We restate that in our opinion a complete reconstruction of both centre and eastern portions of the field as recommended under 6 above is required to obtain optimum results. Reconstruction at the central portion, which receives the heaviest play is considered a must in order to obtain a field that will carry away normally anticipated rates of rainfall with little or no ponding. No free surface water should be evident on the field within a few hours after the cessation of extended periods of heavy rainfall. If for cost reasons you choose not to completely reconstruct the eastern portion of the field, this area may remain wetter, however, this may be acceptable to you as it is not an area of heavy play, as is the central portion of the field.

We calculate that if the central portion of the field was not reconstructed and supplemental drains were installed between the existing drain lines, the spacing of the supplemental drains would have to be about 2½ ft to be as effective as the clean underdrainage layer of sand, recommended under 6 above.

V SAMPLING, TESTING AND DATA PRESENTATION

A. Test Pits

A total of 11 test pits were examined at the field during December 1973. The locations and logs of the pits are presented on dwg D-1855-2 attached. The same sample designation used on the test pit logs is also used to identify the samples tested in the laboratory.

B. Laboratory Testing

Samples from the test pits were tested as indicated below. Results of the tests are presented in the Appendix.

Can Tests

Representative samples from most of the pits were subjected to a comparative "Can" test described on Figure 2 in the Appendix. The test consists of heavily compacting moist samples in a tin can with a perforated bottom. A small depression formed in the top of the specimen is filled with water and the time for the water to infiltrate and disappear is noted. The length of time for the water to disappear in the simple can test gives an indication of the relative permeability or conductivity of the various samples.

Samples of a typical clean Fraser River sand and a typical concrete sand obtained from other sources were also tested in the can test.

Results of 19 can tests are presented on Figure 4 in the Appendix.

Pail Tests

Sample of the sand from TP11, located on the reconstructed western portion of the field, and a sample of drain gravel taken from around the main drain pipe at the bottom of TP1 were tested by the pail test described on Figure 3 in the Appendix. Samples of a typical Fraser River sand and a typical concrete sand were also tested by the pail test method.

Results of 4 pail tests are presented on Figure 4 in the Appendix.

Permeability Tests

Recompacted portions of TP3 S1, TP3 S2 and TP9 S1 were tested in a constant head permeability test in a lucite cylinder. Hydraulic gradient of about 16 was used for the test.

Results of the 3 permeability tests are presented on Figure 4 in the Appendix.

Grain Size Curves

Gradation tests were performed on seven typical samples of the relatively impervious soils taken from the test pits at the field. These gradation curves are presented on Figures 5, 6 and 7 in the Appendix. The silt content of the fine grain soils from the field, as represented by the percentage passing the symbol for #200 sieve, varied between 6.5 and 16.2 percent.

Gradation curves for the clean sand from TP11, located in the well draining previously reconstructed western portion of the field, are presented on Figure 5 in the Appendix.

A gradation curve for a sample of the gravel taken from around the central drain pipe is presented on Figure 7 in the Appendix.

Gradation occurs for a typical clean Fraser River sand and a typical concrete sand, obtained from other sources, are presented on Figure 8 in the Appendix, for comparison purposes.

VI MATERIAL SPECIFICATIONS FOR RECONSTRUCTION

A. Clean Sand for the Underdrainage Layer

Clean sand for the underdrainage layer recommended under IV 6 of this report must have a permeability of 100x10-4 cm/sec or greater. A number of control tests for permeability should be carried out in lucite cylinders on samples taken from the proposed source of clean sand, prior to hauling the sand to the site. Small variations in silt content and gradation can adversely affect the permeability of the sand, and the permeability should be definitely established prior to bringing the material to the site.

If a suitable source of clean Fraser River sand can be found, this material should be priced lower than concrete sand.

B. Soil Above Sand Underdrainage Layer

The blended soil above the sand underdrainage layer has been specified in the report by T.M. Lord and A.J. Green. We recommend the permeability of the final mix be greater than 1x10-4 cm/sec.

C. Graded Drain Gravel Around Perforated Pipes

Subdrain laterals at the field should be relayed as recommended in Section V 6 of this report. A recommended section through the relaid pipe laterals is shown on Figure 9 in the Appendix. We recommend the graded drain gravel placed below, around, and above the perforated subdrain laterals meet both of the following specification requirements:

1. The materials should have a pail test time less than 15 seconds
2. The material should be clean and well graded, from fine gravel sizes to medium sand size with very little fine sand. The 15 percent size should be between 1 mm and 2 mm. The 85 percent size should be between 3/4 inches and 3/8 inches.

The above specifications will ensure that the gravel will be free-draining, yet will prevent movement of sand or fine soils into the subdrain pipes.

Yours very truly
RIPLEY, KLOHN & LEONOFF INTERNATIONAL LTD

K.F. MORRISON, P.Eng.
Executive Engineer

cc. 10 - P. Stockstad (Burnaby Parks)
1 - E.J. Klohn (RKL)

encls.

ITEM 10
MANAGER'S REPORT NO. 11
COUNCIL MEETING Feb. 11/74

REPORT AND RECOMMENDATIONS TO CORRECT DRAINAGE CONDITIONS ON THE SWANGARD STADIUM SPORTS FIELD

by T. M. Lord and A. J. Green P.Ag.

December 31, 1973.

The Swangard Field was examined and surveyed at intervals from November 17 to December 16. The visits covered a wide range of weather conditions, including sustained periods of heavy rain and clear intervals of several days.

Soil profiles were examined in test pits and by means of auger cores throughout the entire field area. Representative samples of soil horizons (layers) were obtained for analysis and a set of undisturbed in situ soil cores were taken. Percolation tests were carried out on undisturbed soil cores, on reconstituted soil cores, and on soil-sand mixes; and chemical analyses on selective samples were done. The results are given in Table 1 and Table 2, followed by a discussion of the test findings.

Recommendations

The present combination of the tile drainage system, surface configuration of the field and nature of the soil material above the drains, is inadequate to handle excessive amounts of surface water. This condition is especially apparent in the zone of heavy play use between the goal posts. This zone, comprising a strip 90 to 100 feet wide along the north-south centre line of the field, closely approximates the area of standing water remaining after a heavy downpour or a sustained period of rainfall.

We recommend the joint proposal contained in the report submitted by Ripley, Klohn and Leonoff International Ltd., consulting geotechnical engineers. Under this proposal, the soil material from a central portion of the field (see Drawing D-1855-3 in report by Ripley et al) will be removed to the appropriate depth and stockpiled. Existing drains will be checked and relaid as necessary and the base of the excavated area will be carefully graded. At this stage, the option of draining peripheral areas adjoining the eastern boundary of the reconstruction zone is given.

The following stages leading to a finished surface grade, ready for installation of turf, or seeding to grass, are illustrated in accompanying X-sections.

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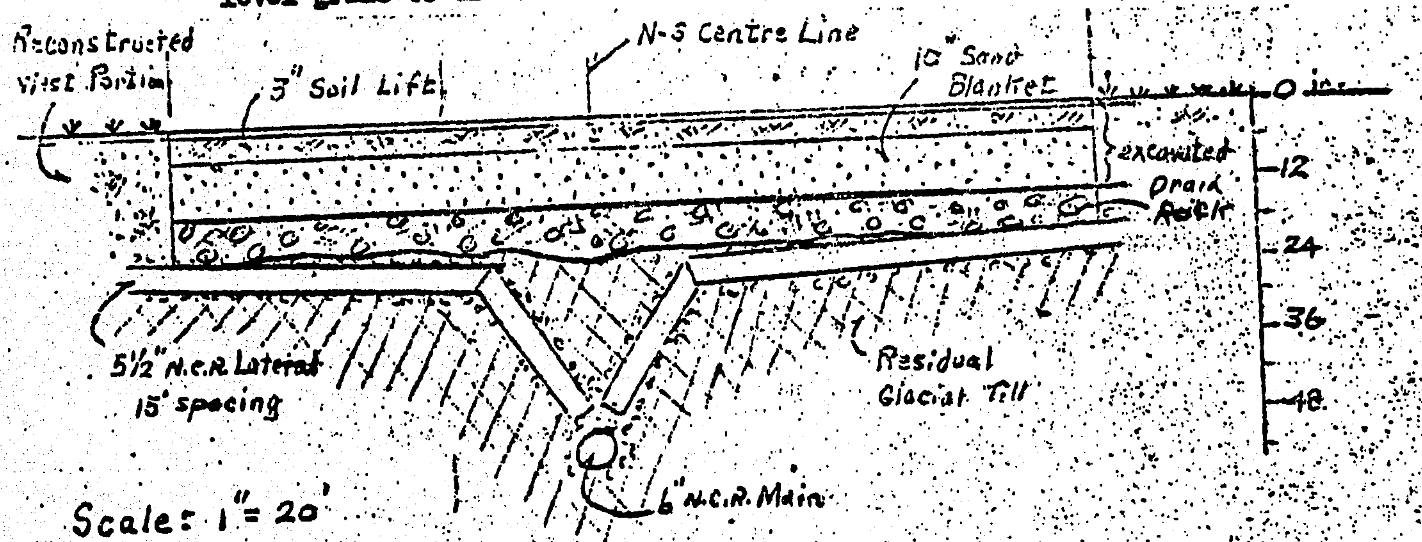
1.) Add 10 inches of coarse sand to the base grade of the excavated zone. This must be a free draining sand conforming to specifications laid down by Ripley et al, uniformly spread and compacted over the entire area.

2.) To the sand base add a 3 inch lift of the residual soil from the stockpile. This material should be well mixed together before it is spread over the sand. A 3 inch thickness is specified on the assumption that the reconstructed area will be finished with a one-inch thickness of sand-grown turf. If the area is to be seeded instead, or if the turf varies from the one-inch thickness, the thickness of the soil lift would be adjusted to give a finished level grade to the field.



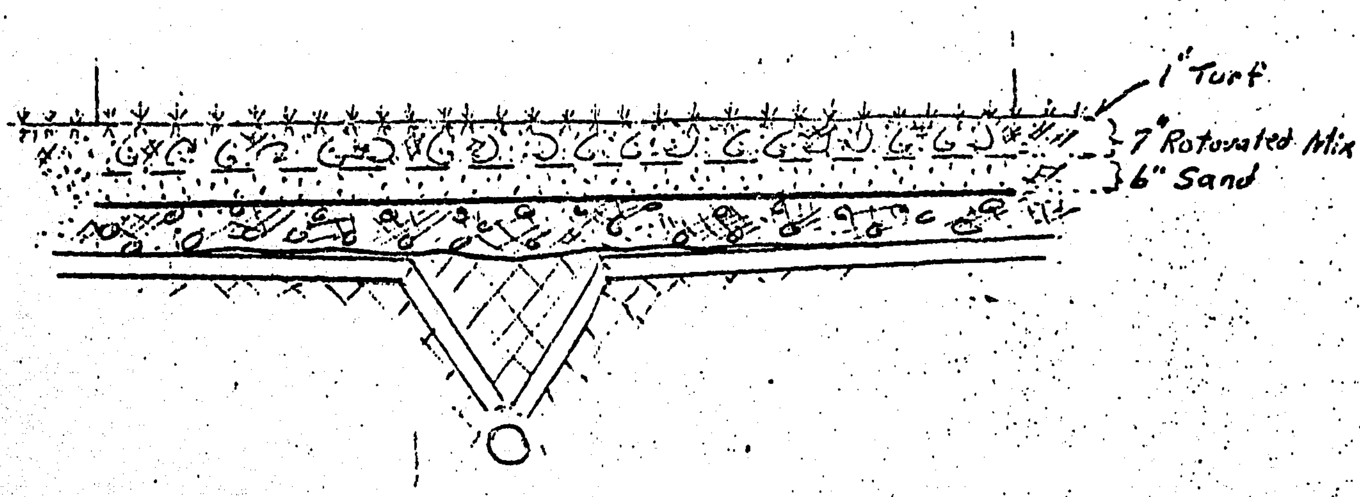
X-Section—Proposed Reconstruction Area

3.) At this stage it is advisable to add a complete fertilizer, based on the recommendations of Dr. Roy L. Goss in his report of November 3, 1973, and to incorporate it into the surface layer.

4.) Rotovate the 3 inch soil lift and fertilizer into the upper 4 inches of the sand blanket. It is essential that the resulting mix be at least 1:1 sand to soil and that the basal sand blanket remains undisturbed in the lower 6 inches. The rotovator should be equipped with a stop mechanism to limit penetration of the blade to a depth of 7 inches.

5.) Level and firm the surface to grade by "feathering" the new surface into the existing perimeter areas of good turf.

6.) Lay turf, or seed to grass.



X-Section following rotovation and laying new sod.

Soil Sampling and Testing

Soil profiles were examined by means of randomly spaced auger holes and at 14 test pit sites (see drawing) on the field. The reconstructed west portion of the field (ref. - Administrator's Report No. 18) was found to have a free-draining sandy profile that supported a vigorous turf. This area was not sampled and is excluded from the proposed reconstruction zone.

Although there was considerable variation in thickness of textural layers within the profiles examined on the other two thirds of the field area, a representative profile consists of the following:

0 - 2" coarse sand with inclusions of organic matter and fine sand
2 - 10" brown sandy loam containing pockets of coarse sand, and inclusions of loamy fine sand*clods that are compact and mottled.
10 - 22" (range in thickness from 6 to 16") brown compact loamy fine sand with inclusions of sandy loam.
22" + light gray, extremely compact, <u>in situ</u> basal till of loamy fine sand texture. This residual glacial till underlies the soil materials in the central part of the field at depths ranging from 19" to 30" from the surface.

* This texture class is described as "silt" (< 0.74 mm) by soil engineers.

During and following periods of heavy rainfall the upper 4 to 6" of the soil profile became saturated but the subsoil layers remained only moist, indicating very slow vertical movement of surface water.

Composite, bulk soil samples taken from the three main test pits (TP1, 2, 3) are described as follows:

Sample 1 - mixed sand and loamy sand from the surface layer, 10 to 12 inches thick

Sample 2 - brown compact loamy fine sand, often stained and mottled, from depths of 12 to 23 inches

Sample 3 - light gray extremely compact basal till sampled at depths ranging from 26 to 48 inches

During a 12 hour period of continuous rainfall on December 15, soil profiles and drainage conditions were checked. At the sites of TP4 (a pit directly over a lateral drain) and TP5 (a 20" deep trench between drain lines), the soil pit was draining freely while the trench was full to overflowing. Subsequent inspection showed the trench remained completely filled with water 12 hours after the rain had ceased, and 24 hours later the water level had dropped 8 inches in the trench. Samples taken at TP4 and at a site directly west near the centre line of the field were as follows:

Sample 4 - a composite bulk sample from the two sites at depths of 0 to 6 inches.

Duplicate, undisturbed soil cores were taken at 0 to 3 inch and 4 to 7 inch depths at each site. These in situ soil cores were obtained by forcing standard open-ended brass cylinders, 3" in diameter, vertically into the soil and then trimming the soil core to 3 inches. The samples are designated as follows:

Site A (0-3") - the surface layer at TP4
Site A (4-7) - the subsurface layer at TP4
Site B (0-3) - the surface layer near field centre line
Site B (4-7) - the subsurface layer near field centre line.

One additional, composite, bulk sample (Sample 5) was taken from the surface 10 to 12 inches of all profiles exposed in test pits within the failure zone.

Physical Tests

Percolation (hydraulic conductivity) tests were carried out on undisturbed (taken in situ) soil cores, on reconstituted cores of soil from the field, and on soil-sand mixes. Reconstituted soil cores were made up from composite bulk samples of soil that had been screened, air-dried and compacted in standard 3" x 3" brass cores. Soil-sand mixes at 1:1 ratios were made up as cores from composite soil samples and coarse sharp sand. Hydraulic conductivity was measured on saturated duplicate core samples under a 1 inch head of water over a period of 4 hours. Additional tests were run on soil cores and soil-sand cores to determine the "puddled" hydraulic conductivity. For this test, the surface inch of saturated soil in the core is stirred vigorously before testing, to simulate field conditions under heavy playing concentration.

The results of the tests are given in Table I

Sample	Hydraulic Conductivity in/hr.	Puddled Hydraulic Conductivity in./hr.
Undisturbed cores (taken in situ)		
Site A (0 to 3")	5.0	-
Site A (4 to 7")	0.14	-
Site B (0 to 3")	3.6	-
Site B (4 to 7")	0.3	-
Reconstituted cores		
No. 1 (0 to 12")	19.0	10.0
No. 2 (12 to 24")	16.0	3.2
No. 2 (repuddled and re-run)	-	0.7
No. 3 (basal till)	-	0.8
Composite of No. 1, 4, 5	-	3.7
Reconstituted cores plus sand @ 1:1 ratio		
Composite of No. 1, 4, 5	-	3.0
Composite of No. 1, 4, 5, 2	-	4.6

Table I. Averages of percolation rates

Chemical Tests

Four samples of soil from the field were analysed for available plant nutrients: nitrogen (N), phosphorous (P), potassium (K), and calcium (Ca) and soil reaction (pH). The results are given in Table 2.

Sample	pH	N	P	K	Ca
No. 1 (0-12")	4.6	VL*	L	L	L
No. 2 (12-24)	5.4	L	L	L	L
No. 3 (basal till)	5.2	L	L-M	L	L
Composite of No. 4, 5	5.2	VL	L	VL	L

*VL = very low L = low M = medium

Table 2. Chemical analyses of soil profile samples

Discussion of Results

Percolation Tests

Percolation rates through reconstituted soil cores (Samples 1,2) averaged 17.5 in./hr. and dropped to an average rate of 7.0 in./hr. on puddled cores. It is significant that the percolation rate dropped sharply to 0.7 in./hr. when Sample 2 was repuddled and then re-run.

When combinations of surface and subsurface soil samples were mixed together and combined with 50% sand, puddled percolation rates averaged about 3.5 in./hr. Puddled percolation rates through the basal till cores were 0.8 in./hr., similar to those on the re-run cores of Sample 2.

The undisturbed in situ cores taken from the field surface had percolation rates averaging 4.3 in./hr., but below the 4 inch depth percolation dropped drastically to an average rate of 0.22 in./hr.

Chemical Tests

Levels of available plant nutrients - nitrogen, phosphorous, potassium and calcium - in the samples are low to very low throughout the soil profile. Soil reaction (pH values) fall within the moderately to strongly acid range.

Summary

If the proposals outlined in this report and in the companion report submitted by Ripley, Klohn and Leonoff International Ltd. are adopted, we believe the present unsatisfactory drainage condition of the Swangard Field will be overcome.

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It is important that a free draining filter base of coarse sand be established over the present drain system. Of equal importance is the overlying surface layer of rotovated sand and soil. We have recommended that this layer consist of 3 inches of fertilized stockpile soil thoroughly mixed with 4 inches of the underlying sand blanket. This will ensure that the grass sod (or grass seedlings) may become rapidly established in a free draining rooting medium.

The future success of this athletic field will depend, as pointed out in reports by other consultants and parks board personnel, on a good maintenance program. Although the fine sand (silt) fraction of the residual soil on the field averages only 6 to 16 percent, and will be further diluted by the addition of sand, this particle size may yet cause surface compaction under excessive play concentration on a ponded surface.

We trust the foregoing is satisfactory.

Yours very truly,

T. M. Lord

A. J. Green P.Ag.

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RECORD MEMO: Date. January

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MUNICIPAL MANAGER'S OFFICE

Re: SWANGARD STADIUM - DRAINAGE
REPORTS OF RIPLEY, KLOHN AND LEONOFF INTERNATIONAL LTD
& T. M. LORD and A.J. GREEN.

Paragraph 5 on Page 7 of the report of Ripley, Klohn and Leonoff International Ltd. makes reference to the "crown effect". The Burnaby Parks and REcreation Department requested elaboration of this point by Mr. Ian Morrison, author of the Ripley, Klohn and Leonoff International Ltd., Report.

Mr. Morrison explained that adding a crown had an effect of increasing the depth of soil over the drain tile thereby increasing the "head" of water above the drain tile; and thus changing the hydrolic gradient. The steeper the angle between the surface and the drain the faster will be the drying effect on the soil. The less the cover of soil above the drain, the less effective will be the drainage system; because the angle between the surface and the drain is lessened. In other words, the water percolates much more rapidly through the soil in a vertical direction than it moves in a horizontal direction. Deep soil permits the water to flow to the drains with a direction of movement that is closer to the vertical than does a shallow soil.

Mr. Morrison was also questioned about the problem of settlement which we experienced; and offered the opinion that settlement probably will not occur again; and that if it does occur, it will be much less severe than it was last summer. He offered the explanation that a "pocket" of dry earth fill was sealed off when the original crown was installed on the field. When this crown was removed and rain occured, the dry fill became saturated and began to settle and compact, thus causing the depression which appeared on the flat surface. He recommends saturation of the field before seeding or sodding.

This additional information is supplied to aid the members of the Central Park Committee in understanding and interpreting the Consultants' Reports.

B. R. WILKINSON
ADMINISTRATOR,
BURNABY PARKS
AND RECREATION

CC: C. Man, Secretary, CPC
✓Municipal Manager
All Division Heads, P & R